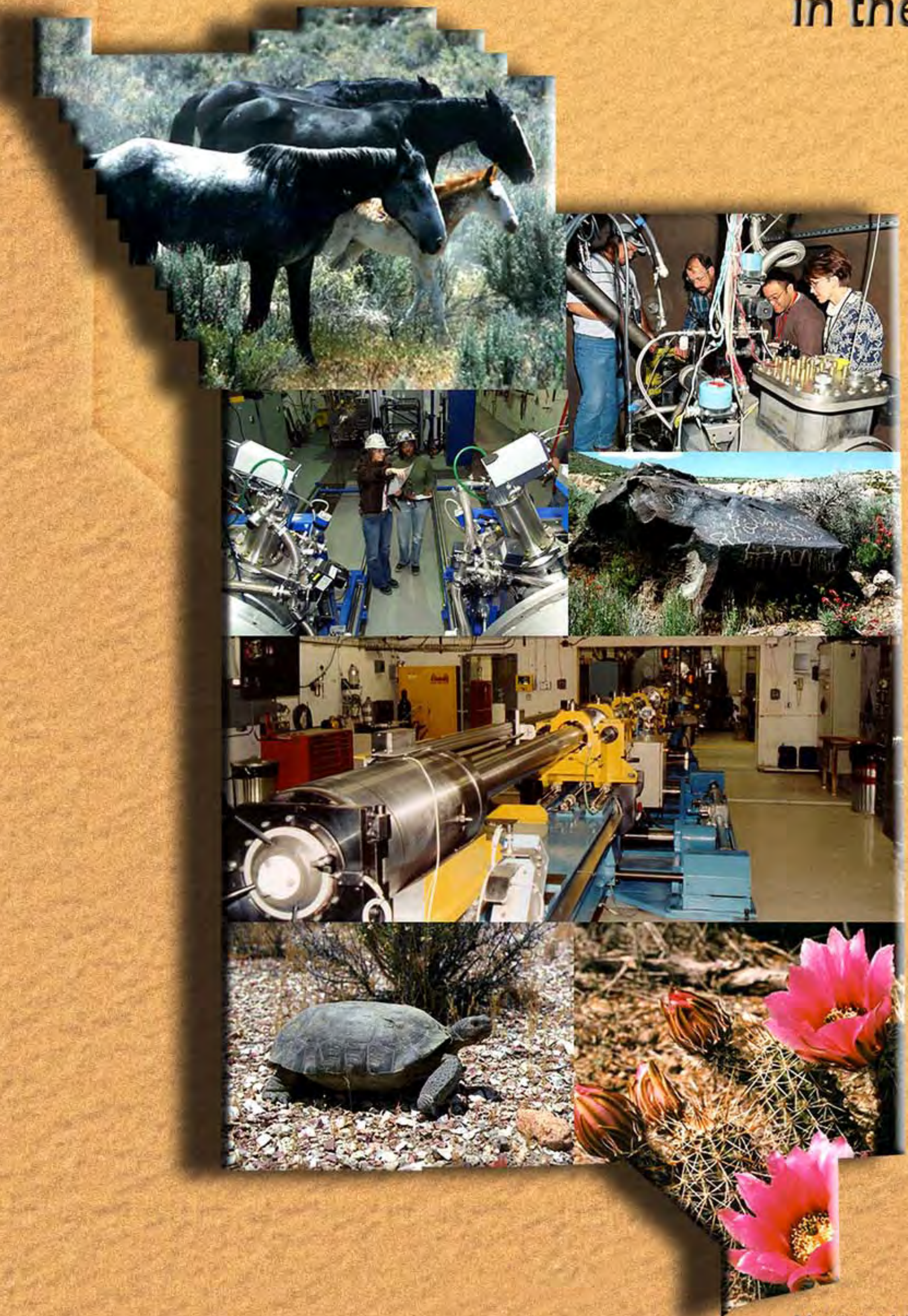
DOE/EIS-0426D

Draft Site-Wide Environmental Impact Statement for the Continued Operation of the Department of Energy/National Nuclear Security Administration Nevada National Security Site and Off-Site Locations in the State of Nevada

Volume 2

(Appendices A through I)



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

Availability of the Draft Site-Wide Environmental Impact Statement for the Continued Operation of the Department of Energy/ National Nuclear Security Administration Nevada National Security Site and Off-Site Locations in the State of Nevada (NNSS SWEIS)

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Location: Nye and Clark Counties, Nevada

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Abstract: This *Site-Wide Environmental Impact Statement for the Continued Operation of the Department of Energy/National Nuclear Security Administration Nevada National Security Site and Off-Site Locations in the State of Nevada (NNSS SWEIS)* analyzes the potential environmental impacts of proposed alternatives for continued management and operation of the Nevada National Security Site (NNSS) (formerly known as the Nevada Test Site) and other U.S. Department of Energy/National Nuclear Security Administration (DOE/NNSA)-managed sites in Nevada, including the Remote Sensing Laboratory (RSL) on Nellis Air Force Base in North Las Vegas, the North Las Vegas Facility (NLVF), the Tonopah Test Range (TTR), and environmental restoration areas on the U.S. Air Force Nevada Test and Training Range. The purpose and need for agency action is to provide support for meeting NNSA's core missions established by Congress and the President, and to satisfy the requirements of Executive orders and comply with congressional mandates to promote, expedite, and advance the production of environmentally sound energy resources, including renewable energy resources such as solar and geothermal energy systems.

The NNSS has a long history of supporting national security objectives by conducting underground nuclear tests and other nuclear and nonnuclear activities. Since the October 1992 moratorium on nuclear testing, NNSA's primary mission at the NNSS has evolved from an active nuclear testing program to maintaining readiness and the capability to conduct underground nuclear weapons tests, if so directed by the President. Resources have been reallocated to introduce and expand other mission activities/programs at the NNSS, RSL, NLVF, and the TTR to support three DOE/NNSA core missions: National Security/Defense, Environmental Management, and Nondefense. The National Security/Defense Mission includes the Stockpile Stewardship and Management, Nuclear Emergency Response, Nonproliferation and Counterterrorism, and Work for Others

Programs. The Work for Others Program supports other DOE programs and Federal agencies such as the U.S. Department of Defense, U.S. Department of Justice, and U.S. Department of Homeland Security. The Environmental Management Mission includes the Waste Management and Environmental Restoration Programs. The Nondefense Mission includes the General Site Support and Infrastructure, Conservation and Renewable Energy, and Other Research and Development Programs.

The NNSS, RSL, NLVF, and the TTR support DOE/NNSA's core missions by providing the capabilities to process and dispose of a damaged nuclear weapon or improvised nuclear device and to conduct high-hazard experiments involving special nuclear material and high explosives, non-nuclear experiments, and hydrodynamic testing. Nuclear stockpile stewardship activities at the NNSS include dynamic plutonium experiments that provide technical information to maintain the safety and reliability of the U.S. nuclear weapons stockpile and research and training in areas such as nuclear safeguards, criticality safety, and emergency response. Special Nuclear Materials are also stored at the NNSS. In addition, in accordance with the amended Record of Decision (ROD) (DOE/EIS-0243) for the *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada (1996 NTS EIS*) , NNSA receives low-level and mixed low-level radioactive waste for disposal at the NNSS.

This *NNSS SWEIS* analyzes the environmental impacts of three reasonable alternatives for continued operations at the NNSS, RSL, NLVF, and the TTR during the 10-year period following the issuance of a ROD. These alternatives include a No Action Alternative and two action alternatives: Expanded Operations and Reduced Operations. The No Action Alternative, which is analyzed as a baseline for evaluating the two action alternatives, would continue implementation of the *1996 NTS EIS* ROD (DOE/EIS-0243) and subsequent amendments (61 FR 65551and 65 FR 10061), as well as other decisions supported by separate NEPA analyses completed since issuance of the final *1996 NTS EIS*. The No Action Alternative reflects activity levels consistent with those seen since 1996. The Expanded Operations Alternative would consider adding reasonably foreseeable new work at the NNSS in the areas of nonproliferation and counterterrorism, high-hazard and other experiments, research and development and testing. Such expanded operations could include developing test beds for concept testing of sensors, mitigation strategies, and weapons effectiveness. The Reduced Operations Alternative would reduce the overall level of operations and close specific buildings and structures. NNSA would also consider allowing the development of solar power generation facilities under each alternative.

Public Comments: DOE issued a Notice of Intent (NOI) in the *Federal Register* (74 FR 36691) on July 24, 2009, to solicit public input on the preparation of this Draft SWEIS. Comments received from the public during the scoping period (July 24, 2009 to October 16, 2009) have been considered in the preparation of this Draft SWEIS. Comments received after the close of the comment period also have been considered. Comments on this Draft SWEIS will be accepted following publication of the U.S. Environmental Protection Agency's Notice of Availability (NOA) in the *Federal Register* for a period of 90 days, and will be considered in the preparation of the Final SWEIS. Any comments received after the comment period will be considered to the extent practicable. Public meetings and locations will be identified at a later date.

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ACRONYMS, ABBREVIATIONS, AND CONVERSION CHARTS

ACRONYMS, ABBREVIATIONS, AND CONVERSION CHARTS

AEGL	Acute Exposure Guideline Level
ARF	airborne release fraction
BEEF	Big Explosives Experimental Facility
CAS	corrective action site
CAU	corrective action unit
CEMP	Community Environmental Monitoring Program
CFR	*Code of Federal Regulations*
CH	contact-handled
D&D	decontamination and decommissioning
DAF	Device Assembly Facility
DAQEM	Department of Air Quality and Environmental Management
DART	days away from work, restricted duty, or transferred
DHS	U.S. Department of Homeland Security
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOE/NNSA	U.S. Department of Energy and the National Nuclear Security Administration
DOT	U.S. Department of Transportation
DPFF	Dense Plasma Focus Facility
DR	damage ratio
EA	Environmental Assessment
EDE	effective dose equivalent
EDMS	Emissions and dispersion Modeling System
EIS	environmental impact statement
EMAD	Engine Maintenance Assembly and Disassembly Facility
EODU	Explosives Ordnance Disposal Unit
EPA	U.S. Environmental Protection Agency
ERPGs	Emergency Response Planning Guidelines
FFACO	Federal Facility Agreement and Consent Order
FR	*Federal Register*
FRMAC	Federal Radiological Monitoring and Assessment Center
FY	fiscal year
GIS	geographic information system
HAP	hazardous air pollutant
HEST	High Explosive Simulation Technique
ICRP	International Commission on radiological Protection
IDLH	Immediately Dangerous to Life or Health
ISCORS	Interagency Steering Committee on Radiation Standards
ISO	International Organization for Standardization
JASPER	Joint Actinide Shock Physics Experimental Research
LANL	Los Alamos National Laboratory
LLNL	Lawrence Livermore National Laboratory
LCF	latent cancer fatality

LLW	low-level radioactive waste
LPF	leak path factor
MAR	material at risk
MEI	maximally exposed individual
MLLW	mixed low-level radioactive waste
NAAQS	National Ambient Air Quality Standards
NAC	Nevada Administrative Code
NASA	U.S. National Aeronautics and Space Administration
NDEP	Nevada Division of Environmental Protection
NEPA	National Environmental Policy Act of 1969
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NLVF	North Las Vegas Facility
NNSA	National Nuclear Security Administration
NNSA/NSO	National Nuclear Security Administration Nevada Site Office
NNSS	Nevada National Security Site
NPTEC	Nonproliferation Test and Evaluation Complex
NRC	U.S. Nuclear Regulatory Commission
NRF	National Response Framework
NSO	Nevada Site Office
NTTR	Nevada Test and Training Range
NTS	Nevada Test Site
NNSS SWEIS	*Site-Wide Environmental Impact Statement for the Continued Operation of the Department of Energy/National Nuclear Security Administration Nevada Test Site and Off-Site Locations in the State of Nevada*
OBODM	Open Burn/Open Detonation Model
OSHA	Occupational Safety and Health Administration
PCB	polychlorinated biphenyl
PM	particulate matter
rad	radiation absorbed dose
RCRA	Resource Conservation and Recovery Act
rem	roentgen equivalent man
RF	respirable fraction
RH	remote-handled
RNCTEC	Radiological/Nuclear Countermeasures Test and Evaluation Complex
ROD	Record of Decision
RSL	Remote Sensing Laboratory
RTG	radioisotope thermoelectric generator
RWMC	Radioactive Waste Management Complex
RWMS	Radioactive Waste Management Site
SGTs	safeguards transporters
SNM	special nuclear materials
STEL	Short-Term Exposure Limit
SWEIS	Site-Wide Environmental Impact Statement
TEELs	Temporary Emergency Exposure Limits

TLV	Threshold Limit Value
TNT	2,4,6-trinitrotoluene
TRC	total recordable cases
TRU	transuranic waste
TRUPACT	transuranic waste package transporter
TTR	Tonopah Test Range
UCVS	ultrafast closure valve system
UGTA	Underground Test Area
USAF	U.S. Air Force
VMT	vehicle miles traveled
VOC	volatile organic compound
Y-12	Y-12 National Security Complex
ZPPR	zero power plutonium reactor
ºC	degrees Centigrade
ºF	degrees Fahrenheit

CONVERSIONS

METRIC TO ENGLISH			ENGLISH TO METRIC		
Multiply	**by**	**To get**	**Multiply**	**by**	**To get**
Area					
Square meters	10.764	Square feet	Square feet	0.092903	Square meters
Square kilometers	247.1	Acres	Acres	0.0040469	Square kilometers
Square kilometers	0.3861	Square miles	Square miles	2.59	Square kilometers
Hectares	2.471	Acres	Acres	0.40469	Hectares
Concentration					
Kilograms/square meter	0.16667	Tons/acre	Tons/acre	0.5999	Kilograms/square meter
Milligrams/liter	1 [a]	Parts/million	Parts/million	1 [a]	Milligrams/liter
Micrograms/liter	1 [a]	Parts/billion	Parts/billion	1 [a]	Micrograms/liter
Micrograms/cubic meter	1 [a]	Parts/trillion	Parts/trillion	1 [a]	Micrograms/cubic meter
Density					
Grams/cubic centimeter	62.428	Pounds/cubic feet	Pounds/cubic feet	0.016018	Grams/cubic centimeter
Grams/cubic meter	0.0000624	Pounds/cubic feet	Pounds/cubic feet	16,025.6	Grams/cubic meter
Length					
Centimeters	0.3937	Inches	Inches	2.54	Centimeters
Meters	3.2808	Feet	Feet	0.3048	Meters
Kilometers	0.62137	Miles	Miles	1.6093	Kilometers
Temperature					
Absolute					
Degrees C + 17.78	1.8	Degrees F	Degrees F - 32	0.55556	Degrees C
Relative					
Degrees C	1.8	Degrees F	Degrees F	0.55556	Degrees C
Velocity/Rate					
Cubic meters/second	2118.9	Cubic feet/minute	Cubic feet/minute	0.00047195	Cubic meters/second
Grams/second	7.9366	Pounds/hour	Pounds/hour	0.126	Grams/second
Meters/second	2.237	Miles/hour	Miles/hour	0.44704	Meters/second
Volume					
Liters	0.26418	Gallons	Gallons	3.78533	Liters
Liters	0.035316	Cubic feet	Cubic feet	28.316	Liters
Liters	0.001308	Cubic yards	Cubic yards	764.54	Liters
Cubic meters	264.17	Gallons	Gallons	0.0037854	Cubic meters
Cubic meters	35.315	Cubic feet	Cubic feet	0.028317	Cubic meters
Cubic meters	1.3079	Cubic yards	Cubic yards	0.76456	Cubic meters
Cubic meters	0.0008107	Acre-feet	Acre-feet	1233.49	Cubic meters
Weight/Mass					
Grams	0.035274	Ounces	Ounces	28.35	Grams
Kilograms	2.2046	Pounds	Pounds	0.45359	Kilograms
Kilograms	0.0011023	Tons (short)	Tons (short)	907.18	Kilograms
Metric tons	1.1023	Tons (short)	Tons (short)	0.90718	Metric tons
ENGLISH TO ENGLISH					
Acre-feet	325,850.7	Gallons	Gallons	0.000003046	Acre-feet
Acres	43,560	Square feet	Square feet	0.000022957	Acres
Square miles	640	Acres	Acres	0.0015625	Square miles

a. This conversion is only valid for concentrations of contaminants (or other materials) in water.

METRIC PREFIXES

Prefix	Symbol	Multiplication factor
exa-	E	1,000,000,000,000,000,000 = 10^{18}
peta-	P	1,000,000,000,000,000 = 10^{15}
tera-	T	1,000,000,000,000 = 10^{12}
giga-	G	1,000,000,000 = 10^{9}
mega-	M	1,000,000 = 10^{6}
kilo-	k	1,000 = 10^{3}
deca-	D	10 = 10^{1}
deci-	d	0.1 = 10^{-1}
centi-	c	0.01 = 10^{-2}
milli-	m	0.001 = 10^{-3}
micro-	μ	0.000 001 = 10^{-6}
nano-	n	0.000 000 001 = 10^{-9}
pico-	p	0.000 000 000 001 = 10^{-12}

APPENDIX A
DETAILED DESCRIPTION OF ALTERNATIVES

APPENDIX A
DETAILED DESCRIPTION OF ALTERNATIVES

This appendix contains detailed descriptions of the alternatives that are being evaluated by the U.S. Department of Energy National Nuclear Security Administration (DOE/NNSA) for continued operation of the Nevada National Security Site (NNSS) (formerly known as the Nevada Test Site), the Remote Sensing Laboratory (RSL) at Nellis Air Force Base, the North Las Vegas Facility (NLVF), and the Tonopah Test Range (TTR). Also addressed are environmental restoration sites located on the Nevada Test and Training Range (formerly the Nellis Air Force Range). Three alternatives are addressed in this *Site-Wide Environmental Impact Statement for the Continued Operation of the Department of Energy/National Nuclear Security Administration Nevada National Security Site and Off-Site Locations in the State of Nevada (NNSS SWEIS)*: (1) the No Action Alternative, which represents the continuation of the levels of operations at the NNSS and offsite NNSA locations in Nevada; (2) the Expanded Operations Alternative, which includes the capabilities and projects described under the No Action Alternative, plus additional newly proposed capabilities and projects; and (3) the Reduced Operations Alternative, which reflects a reduction in the levels of operations for some programs, ceasing some activities, and limiting activities in some operational areas of the NNSS. This appendix provides additional technical content and detail to supplement the alternatives descriptions in Chapter 3. Section A.1 describes the No Action Alternative; Section A.2 describes the Expanded Operations Alternative; and Section A.3 describes the Reduced Operations Alternative.

Descriptions of the alternatives are organized under three mission areas, each with two or more associated programs. These missions and their associated programs are (1) the National Security/Defense Mission, which includes the Stockpile Stewardship and Management, Nuclear Emergency Response, Nonproliferation, Counterterrorism, and Work for Others Programs; (2) the Environmental Management Mission, which includes the Waste Management and Environmental Restoration Programs; and (3) the

Terminology Used in this Site-Wide Environmental Impact Statement (SWEIS)

Missions. In this SWEIS, this term refers to the major responsibilities assigned to the U.S. Department of Energy (DOE) and the National Nuclear Security Administration (NNSA), which are described in this section. DOE and NNSA accomplish these missions by assigning groups or types of activities to DOE's system of national security laboratories, production facilities, and other sites.

Programs. DOE and NNSA are organized into Program Offices, each of which has primary responsibilities within the set of DOE and NNSA missions. Funding and direction for activities at DOE facilities are provided through these Program Offices, and similar coordinated sets of activities to meet Program Office responsibilities are often referred to as "programs," which are usually long-term efforts with broad goals or requirements.

Capabilities. This term refers to the combination of facilities, equipment, infrastructure, and expertise necessary to undertake types or groups of activities and implement mission assignments. Capabilities at NNSA facilities in Nevada have been established over time, principally through mission assignments and activities directed by Program Offices.

Projects. This term is used to describe activities with a clear beginning and end that are undertaken to meet a specific goal or need. Projects can vary in scale from very small (such as a project to undertake one experiment or a series of small experiments) to large (such as a project to construct and start up a new nuclear facility). Projects are usually relatively short-term efforts, and they can cross multiple programs and missions, although they are usually "sponsored" by a primary Program Office. In this SWEIS, the term is usually used more narrowly to describe construction activities, including facility modifications (such as a project to build a new office building or to establish and demonstrate a new capability). Construction projects considered reasonably foreseeable at NNSA facilities in Nevada over about a 10-year period are discussed and analyzed in this SWEIS.

Activities. In this SWEIS, this term is used to describe physical actions used to implement missions, programs, capabilities, or projects.

Nondefense Mission, which includes the General Site Support and Infrastructure, Conservation and Renewable Energy, and Other Research and Development Programs.

For each of the proposed alternatives, mission-related capabilities, projects, activities, and facilities are identified.

The alternatives evaluated in this *NNSS SWEIS* comprise missions, programs, capabilities, and projects for which activities are currently in progress and/or future activities are proposed. Current activities include those that are ongoing or for which the capability is being maintained by NNSA. In evaluating the impacts of the projects and activities that make up the alternatives, the most reliable data are derived from current activities. Proposed projects are those that NNSA expects would be implemented over the next 10 years.

The projects proposed under the three alternatives have generally undergone sufficient conceptual development to allow a reasonable assessment. Those that have not been sufficiently defined to allow a reasonable assessment are noted in the text and will require further National Environmental Policy Act (NEPA) analysis should NNSA decide to implement them.

A.1 No Action Alternative

As defined in this *NNSS SWEIS,* the No Action Alternative reflects the use of existing facilities and ongoing projects to maintain operations consistent with those experienced in recent years at the NNSS and offsite locations in Nevada. For each mission area and its supporting programs, levels of operations for associated capabilities and projects were determined by evaluating historic absolute values since 1996, such as the amount of low-level radioactive waste (LLW) disposed through mid-2010; reasonable expectations for implemented projects, such as the number of projected shots for the Large-Bore Powder Gun; or the nature and number of proposed activities, such as training undertaken for the Office of Secure Transportation. For example, in 2004 and 2006, NNSA conducted 8 experiments with plutonium at the Joint Actinide Shock Physics Experimental Research Facility (JASPER); under the No Action Alternative, NNSA is analyzing up to 12 such experiments at JASPER. The operational level for disposal operations of LLW under the No Action Alternative is based on the volume of LLW disposed at the NNSS during Fiscal Years (FY) 1997 through 2010. The No Action Alternative level of operations represents the baseline against which the other alternatives are compared. In the *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada* (*1996 NTS EIS*) (DOE 1996), NNSA identified land use zones in which certain categories of activities, such as nuclear, dynamic, and hydrodynamic experiments and other compatible defense and nondefense research and development and testing, would be conducted. **Figure A–1** depicts these land use zones and the major facilities at the NNSS that would continue under the No Action Alternative.

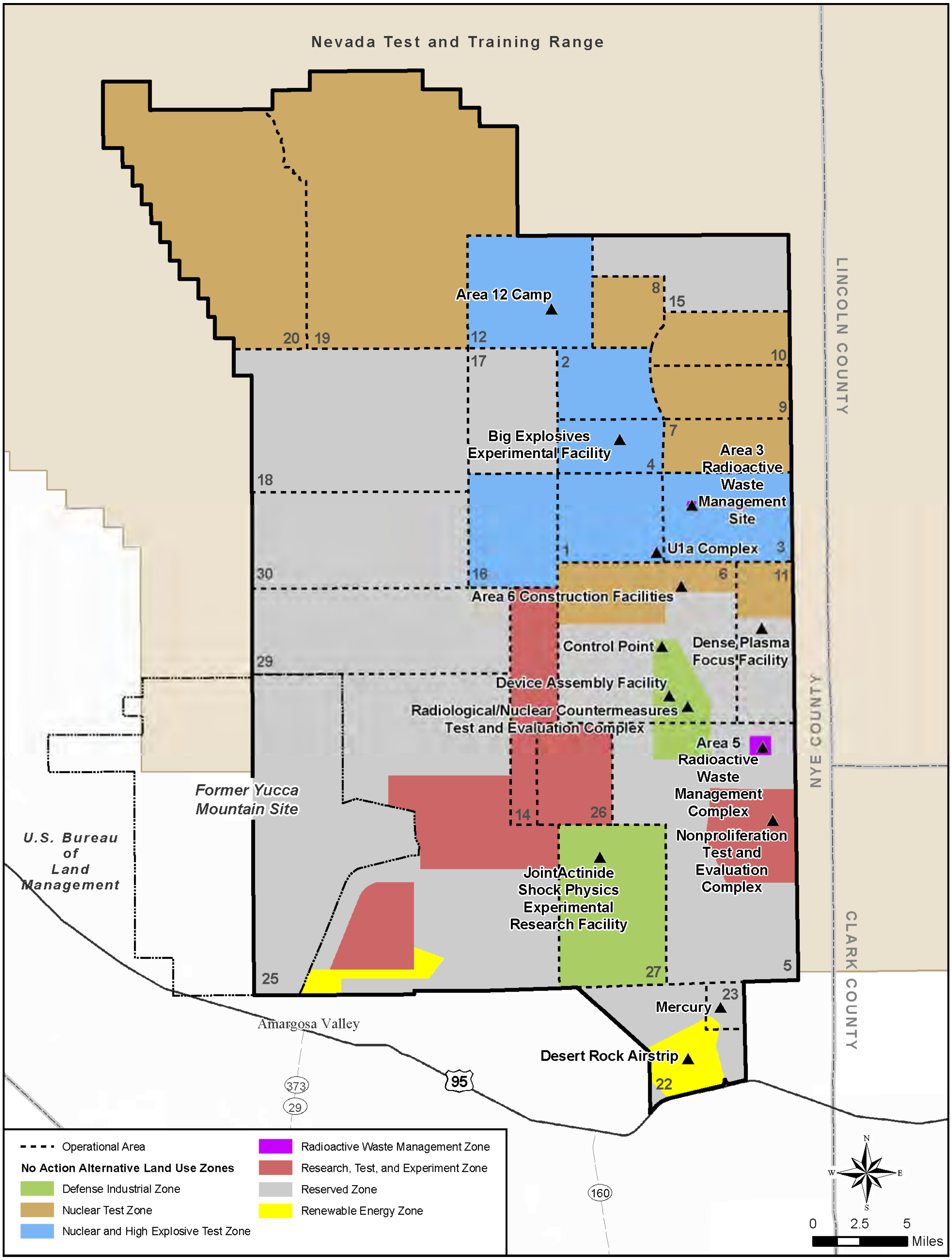

Figure A–1 Nevada National Security Site Land Use Zones and Major Facilities Under the No Action Alternative

A.1.1 National Security/Defense Mission

Under the No Action Alternative, NNSA would continue to pursue the Stockpile Stewardship and Management, Nuclear Emergency Response, Nonproliferation, Counterterrorism, and Work for Others Programs. Projects and activities managed under these programs are described in the following sections.

A.1.1.1 Stockpile Stewardship and Management Program

As part of its National Security/Defense Mission, NNSA is tasked with strengthening national security through the military application of nuclear energy and reducing the global threat from terrorism and weapons of mass destruction. The NNSA Stockpile Stewardship and Management Program supports national security by providing the following capabilities:

- Maintenance of a safe, secure, and reliable nuclear weapons stockpile to ensure the security of the United States and its allies, deter aggression, and support international stability
- Maintenance of a fully capable, agile, responsive nuclear weapons complex infrastructure to continue to support the nuclear weapons stockpile and to be prepared for an uncertain and evolving threat environment
- Research and development activities to ensure U.S. leadership in science and technology (DOE 2006)

> **Special Nuclear Material (SNM) and Security Categories**
>
> SNM is (1) plutonium, uranium-233, uranium enriched in isotopes of uranium-233 or -235, and any other materials that the U.S. Nuclear Regulatory Commission determines to be SNM, or (2) any material artificially enriched by any of these radioactive materials.
>
> The U.S. Department of Energy (DOE) uses a graded approach to provide SNM safeguards and security. Quantities of SNM stored at each DOE site are categorized into Security Categories I, II, III, and IV, with the greatest quantities included under Security Category I, and lesser quantities included in descending order under Security Categories II through IV.

The term "stockpile stewardship" refers to core competencies in activities associated with research, design, development, and testing of nuclear weapons components, as well as the assessment and certification of their safety and reliability. NNSA's science-based Stockpile Stewardship and Management Program maintains and enhances the safety, reliability, and performance of the U.S. nuclear weapons stockpile, including the ability to design, produce, and test weapons, to meet national security requirements. Stockpile stewardship and management activities at NNSA facilities in Nevada are conducted via a variety of methods, including experiments involving special nuclear material (SNM) and explosives, including high explosives (either in combination or separately), shock physics, nuclear criticality, pulsed power, and plasma physics and nuclear fusion. Under the No Action Alternative, diagnostics and other instrumentation would be developed and used in related tests and experiments. In addition, NNSA would conduct drillback operations; support Office of Secure Transportation training; and, as necessary, disposition damaged U.S. nuclear weapons. Major facilities at the NNSS where these activities are performed include the Device Assembly Facility (DAF), the U1a Complex, the Big Explosives Experimental Facility (BEEF), and JASPER. NNSA also conducts stockpile stewardship and management activities at the TTR.

Stockpile stewardship and management activities would continue at NNSA facilities in Nevada, particularly at the NNSS, under the conditions of the ongoing nuclear testing moratorium. These activities would emphasize science-based stockpile stewardship and management tests, experiments, and activities to maintain the safety and reliability of the nuclear weapons stockpile without underground nuclear testing. Historically, the primary mission of the NNSS was to conduct nuclear weapons tests. With the current moratorium on testing that began in October 1992, this mission changed to maintaining a readiness to conduct nuclear tests. For this reason, the No Action Alternative includes those activities necessary to maintain the capability to conduct nuclear tests if so directed by the President. Readiness-to-test activities include maintaining the necessary infrastructure and, more importantly, exercising the research and engineering disciplines of the Nation's nuclear weapons program through an active science-based Stockpile Stewardship and Management Program at the NNSS to ensure the continued competence of its technical staff. As part of its readiness-to-test activities, NNSA would conduct training and exercises using various kinds of nuclear weapon simulators.

In addition to maintaining the capability to conduct nuclear weapon tests and in support of stockpile stewardship and management, NNSA would perform a variety of activities under the No Action Alternative, as described below:

Dynamic experiments – Dynamic experiments include subcritical and hydrodynamic experiments. Subcritical experiments, a subset of dynamic plutonium experiments, use SNM coupled with explosives or explosive-driven flyer plates or impactors. These experiments would be conducted in alcoves at the U1a Complex, in unused nuclear test emplacement holes, or at other locations within the Nuclear Test and Nuclear and High Explosives Test Zones of the NNSS, which include all or parts of Areas 1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 16, 19, and 20.

Initially, subcritical experiments were conducted in alcoves in the U1a Complex that were designed and constructed to contain the detonation of explosives and contamination resulting from SNM used in the experiments. Following execution of these experiments, the alcoves were sealed and considered "expended." Since 1996, the operational concept for subcritical experiments has changed to include other methods. Lawrence Livermore National Laboratory (LLNL) introduced vessels to contain subcritical experiments that allowed multiple experiments to be conducted in a single alcove, and Los Alamos National Laboratory (LANL) introduced racklettes (small cylindrical racks), which are lowered into vertical emplacement holes within an alcove in the U1a Complex, and has also used vessels in a manner similar to LLNL. Subcritical experiments have been performed outside of the U1a Complex in vertical emplacement holes using racklettes similar to, but smaller than, the canisters used for underground nuclear testing. Experiments involving SNM are designed and conducted in a manner that contains the SNM and prevents release of contamination to an uncontrolled environment. This is accomplished by using a specially prepared alcove at the U1a Complex, stemming (engineered backfilling) emplacement holes, using a containment vessel, or a combination of these methods.

Hydrodynamic tests, which do not include SNM, may be conducted in the open air or underground, and may be contained or uncontained. Hydrodynamic tests and experiments would be conducted within some of the same areas as subcritical tests and other experiments (see the following discussion regarding conventional explosives tests and experiments).

Under the No Action Alternative in this site-wide environmental impact statement (SWEIS), 10 dynamic tests and experiments per year were evaluated over about a 10-year period. Over the next 10 years, a total of 5 dynamic experiments would be conducted in emplacement holes with each such experiment causing an estimated 20 acres of new land disturbance.

Conventional explosives experiments – Experiments using conventional explosives would continue to be conducted at BEEF and other locations in the Nuclear and High Explosives Test Zone (Areas 1, 2, 3, 4, 12, and 16). These experiments would use up to 70,000 pounds TNT [2,4,6-trinitrotoluene]-equivalent of explosive charges per experiment and may be conducted at or above the ground surface or underground. Experiments within the BEEF operational area would include potentially hazardous materials, such as beryllium, depleted uranium, deuterium, and tritium. Conventional explosives experiments would support activities for the Stockpile Stewardship and Management Program (other conventional explosives operations are described below for the Nuclear Emergency Response, Nonproliferation, Counterterrorism, and Work for Others Programs). Under the No Action Alternative, up to 20 conventional explosives experiments would be conducted each year at BEEF, and up to 10 per year would be conducted at other locations at the NNSS. The experiments would consist of both open-air and contained (no release to the atmosphere) research and diagnostic experiments using a variety of explosive compounds. All explosive operations would be conducted in compliance with DOE Manual 440.1-1A, *DOE Explosives Safety Manual*. These totals do not include the dynamic experiments discussed above.

Shock physics experiments – Shock physics experiments are a subset of dynamic experiments, but are not included in the dynamic experiments described above. There are two shock physics facilities at the NNSS: JASPER in Area 27, which uses a two-stage gas gun and is currently operational and the U1a Complex in Area 1, which uses a Large-Bore Powder Gun and is currently in development.

The basic concept of a gas gun is to use high-pressure gas to propel a projectile into a target at extremely high velocities. The JASPER gas gun is specifically designed to conduct research on plutonium and other actinides and surrogate materials as targets. The two-stage gas gun consists of a first-stage breech containing gunpowder and a chamber filled with helium, hydrogen, or argon (nitrogen is used as a purge gas), as well as a second-stage evacuated barrel for guiding the high-velocity projectile to the target. Hot gases from the burning propellant drive a heavy piston down the pump tube, compressing the gas. At sufficiently high pressures, the gas eventually breaks a rupture valve and enters the narrow barrel, propelling a projectile housed in the barrel toward the target, which is contained within a primary target chamber. The primary target chamber is designed to contain the experiment and prevent release of contaminants to the environment. For experiments using SNM, an ultrafast closure valve system traps debris, particles, and gases, including radioactive contaminants, within the primary target chamber after the projectile enters. When the projectile hits the target, it produces a high-pressure shock wave. In a fraction of a microsecond, the shock wave reverberates through the target. Triggered by the initial wave, diagnostic equipment measures the properties of the shocked material inside the target during this extremely brief period. The target is disintegrated by the impact of the projectile, but is contained within the primary target chamber. The primary target chamber is placed within a secondary confinement chamber prior to execution of the experiment. The secondary confinement chamber is designed and constructed to prevent release of SNM contamination to an uncontrolled environment. The data from these experiments are used by the national laboratories to refine the computer codes used to certify the U.S. nuclear stockpile. Up to 12 SNM shots per year using actinide targets would be conducted at JASPER under the No Action Alternative. Additional operations of the two-stage gas gun would be conducted without SNM for other experiments and to calibrate and evaluate the equipment.

There are two major project elements of the Large-Bore Powder Gun Project. The first is establishment of a development alcove in the U1a Complex and completion of engineering testing necessary to finalize designs. The second element is preparation of the actual test bed for the Large-Bore Powder Gun, which would be in an existing alcove in the U1a Complex and would be designed for conducting subcritical experiments using SNM. Once operational, the Large-Bore Powder Gun would use a powder charge to propel a projectile into a target within a confinement vessel. It operates at lower velocities than JASPER and uses a larger-diameter projectile and a larger target. The Large-Bore Powder Gun could also be used for experiments with materials other than SNM. These experiments would be designed to investigate the properties of SNM and enhance the understanding of the plutonium equation of state and constitutive models for plutonium alloys. Models would be used to perform higher-fidelity simulations of weapons performance. SNM experiments would be conducted using the Large-Bore Powder Gun firing into a single-use confinement vessel with a fast closure valve designed to confine SNM and avoid contamination of the alcove. The alcove would serve as a secondary confinement chamber for the Large-Bore Powder Gun. For experiments containing SNM, the confinement vessels would be entombed within the U1a Complex after the target is expended. The Large-Bore Powder Gun would be used to conduct a series of up to 10 subcritical experiments per year. Additional operations would be conducted without SNM for other experiments and to calibrate and evaluate the equipment.

Criticality experiments, training, and other activities – These activities were formerly performed at Technical Area 18 at LANL in New Mexico, but were moved to DAF after the December 5, 2002, Record of Decision (ROD) for the *Final Environmental Impact Statement for the Proposed Relocation of Technical Area 18 Capabilities and Materials at the Los Alamos National Laboratory* (67 *Federal Register* [FR] 79906). As part of the relocation of these activities, critical assemblies and associated Category I/II SNM were relocated from LANL to the NNSS. Criticality experiments provide information on nuclear criticality control and understanding of chain reacting systems needed to support nuclear safety and U.S. national security in the broadest sense. This encompasses both national defense and energy policy. To accomplish this objective, the following activities would be carried out:

- Experiments below critical levels (subcritical), in the delayed critical region, and super-prompt critical (pulsed-power) region
- Support for nuclear emergency and accident response programs, as well as programs established to respond to national and international terrorism
- Development of safeguards and arms control methods and technology to detect and control nuclear materials
- Training in support of all the above activities
- Activities to maintain the capability to respond to future criticality accidents or nuclear-materials-handling or -control situations that cannot be understood without special experiments

Critical Assembly

A critical assembly is a machine used to manipulate a mass of fissile material (uranium-233, uranium-235, plutonium-239, plutonium-241, or neptunium-237) with or without a moderator in a specific proportion and shape. The critical assembly can be gradually built up by adding additional fissile material and/or a moderator until this system achieves the dimensions necessary for a criticality condition.

The capability to conduct criticality experiments provides a means to measure and evaluate integral cross sections, perform accident simulation, and develop nuclear instruments, dosimetry, and protocols for the detection and characterization of nuclear material. Under the No Action Alternative, NNSA would conduct up to 500 criticality operations within DAF each year for experiments, training, and other purposes in support of the Stockpile Stewardship and Management and Work for Others Programs.

Criticality experiments would initially be conducted using the refurbished or replaced critical assemblies relocated from Technical Area 18 at LANL to DAF. Four Category I/II SNM critical assembly machines are required to support NNSA's criticality-related activities:

- A general-purpose, vertical-lift table machine is used for training and initial assembly of new experiments. Vertical-lift machines are ideal for this purpose because the stored energy for disassembly is provided by gravity. At the present time, the Planet machine provides this capability.

- A fast-neutron spectrum benchmarked assembly is used for validation of calculation methods, basic measurements of nuclear data of interest to defense and nuclear nonproliferation programs, and training. At the present time, the Flattop assembly serves this purpose.

- A pulse assembly is used to validate dynamic weapons models, verify the function of criticality alarm systems to a fast transient, calibrate detectors, and validate radiation dosimetry. The Godiva assembly provides this function at the present time

- A large-capacity, general-purpose, vertical table machine is used to accommodate benchmark experiments designed to explore unknowns. The Comet machine is used for this purpose.

In the future, NNSA may need to expand its criticality experiments capability to include other experimental machines capable of using security Category I SNM, such as a general-purpose, horizontal split table designed for large experiments that cannot be accommodated on a vertical-lift split table, as well as a low-temperature (cryogenic) critical assembly machine designed to evaluate potential space reactor applications. Potential acquisition of these or any other new critical assembly machines is not included under the proposed actions; thus, their operation is not analyzed in this *NNSS SWEIS*.

Pulsed-power experiments – The Atlas Facility's Pulsed-Power Machine was moved to Area 6 of the NNSS from LANL in 2004 following publication of the *Atlas Relocation and Operation at the Nevada Test Site Final Environmental Assessment* (DOE/EA-1381) (NNSA 2001) and issuance of a Finding of No Significant Impact on May 30, 2001. Experiments that provide the high-quality, high-energy density hydrodynamics data needed to validate new Accelerated Scientific Computing Initiative codes for the Stockpile Stewardship and Management Program would be conducted at the Atlas Facility. Computer models based on such codes would be used to certify the safety and reliability of the Nation's nuclear stockpile, as part of the NNSA Stockpile Stewardship and Management Program. Experiments in support of basic research in nondefense areas would also be conducted at the Atlas Facility.

The physical environments produced at the Atlas Facility enable a wide range of safe, highly precise, reproducible, and controllable experiments. The extreme conditions of high-energy density, strongly coupled plasmas, and high magnetic fields aid in the understanding of planetary physics, condensed-matter physics, fusion-energy research, and astrophysics.

The Atlas Facility is designed to perform pulsed-power experiments on macroscopic targets; that is, targets that are larger than those possible when using lasers and other currently available diagnostic equipment. Larger targets approximately a cubic centimeter in size make measurement easier and allow the investigation of physical phenomena that cannot be scaled down to smaller sizes without affecting parameters of importance. The Atlas Facility's Pulsed-Power Machine is designed to deliver a pulse of very high electrical current through a high-precision cylindrical metal liner that surrounds the sample of interest. The electrical current produces a brief but powerful magnetic force on the liner, which implodes upon the sample. For hydrodynamic experiments, the Pulsed-Power Machine would deliver 25 to 30 mega-amperes to an imploding liner, which would reach velocities of over 15 centimeters per microsecond with final kinetic energies of 2 to 5 megajoules. Pressures of up to 20 megabars could be achieved, depending on the design of the experiment. Under the No Action Alternative, the Atlas Facility would be maintained in a standby status with the capability to conduct up to 12 pulsed-power experiments per year.

Plasma physics and fusion experiments – Using the OneSys Dense Plasma Focus Machine, located in Area 11 of the NNSS, and the Gemini Dense Plasma Focus Machine, located at NLVF, NNSA would conduct plasma physics and fusion experiments under the No Action Alternative. These machines cause fusion (the process the Sun uses to create energy) by compressing and heating a gas. Both machines support Stockpile Stewardship and Management Program experiments and the Work for Others Program with the Defense Threat Reduction Agency and the U.S. Department of Homeland Security (DHS). These Dense Plasma Focus Machines are flexible and powerful scientific tools. They can be configured to investigate plasma physics and to cause nuclear fusion (i.e., joining light atomic nuclei to release energy, in contrast to nuclear fission, the splitting of heavy atomic nuclei to release energy). The most frequently used fusion processes involve combining (fusing) two atoms of hydrogen-2 (deuterium) to form helium-3 and an energetic neutron and fusing deuterium and hydrogen-3 (tritium) to form helium-4 and an energetic neutron. The neutron radiation is emitted in a short, intense pulse. The OneSys machine uses a deuterium-tritium source and the Gemini machine uses a deuterium-deuterium source. Both machines generate approximately 10^{12} neutrons per pulse. Because initiation of the fusion process requires a large electrical current, capacitor banks are used to store electrical energy (up to 1 million joules) at voltages up to 70,000 volts. Safety, radiation exposure protection, and emission control are ensured through administrative controls and redundant engineered systems, including use of coated lead. Up to 650 plasma physics and fusion experiments would be conducted yearly under the No Action Alternative: 50 in Area 11 of the NNSS and 600 at NLVF.

Drillback operations – Also known as "post-shot drilling," drillback operations were performed routinely when underground nuclear tests were conducted at the NNSS. Drillback operations provide essential data on the results and post-shot underground environment of the underground nuclear test. Post-shot drilling provided the means for obtaining samples from the explosion cavity region for radiochemical analysis and determining the size of the collapse chimney, the effects of the explosion on the surrounding medium, and the distribution of radioactivity in the cavity area. Drillback activities have been conducted since the end of underground nuclear testing as a means of exercising the capability to do such drilling (maintenance of capability) and to obtain data for groundwater studies. Drillback activities include standard directional or slant drilling using equipment and monitoring/warning devices and procedures to prevent a release of radioactivity to an uncontrolled environment from the drilling activity. NNSA estimates that up to five drillback operations would take place under the No Action Alternative over the next 10 years. Each drillback project would be conducted in the area of a former underground nuclear test location and would disturb approximately 5 acres of land.

Stockpile management activities – Stockpile management activities are the hands-on, day-to-day functions and activities involved in maintaining an enduring nuclear weapons stockpile, including assembly, disassembly, modification, and maintenance of nuclear weapons; quality assurance testing of weapons components; and interim storage of nuclear weapons and components.

NNSA would conduct some or all of the following stockpile management activities at the NNSS under the No Action Alternative:

Disposition of damaged U.S. nuclear weapons – A damaged U.S. nuclear weapon would be transported to the NNSS, where it would be evaluated for further action, which could involve repair or disposition. Activities associated with repair would include full or partial disassembly of the damaged weapon, repair or replacement of damaged parts, and reassembly of the weapon. If the weapon were damaged beyond repair, it would be disassembled and its component parts prepared for shipment. Following completion of this work, the weapon or its component parts would be transported to the Pantex Plant or another appropriate NNSA facility.

Nuclear Weapon Pit

The pit is the central core of a nuclear weapon containing plutonium-239 and/or highly enriched uranium that undergoes fission when compressed by high explosives. The pit and the high explosive are known as the "primary" of a nuclear weapon.

Storage and staging of nuclear devices – Nuclear devices would be staged (i.e., programmatic material, such as SNM or other materials, would be stored in a safe and secure manner until needed in a test, experiment, or other activity; staging does not include storage of material with no reasonable expectation of use in the foreseeable future) at DAF pending an underground nuclear test, if so directed by the President. Nuclear weapons training devices would be staged at DAF as part of readiness training and exercises.

Assembly and disassembly of nuclear devices – NNSA would conduct assembly/disassembly operations on nuclear devices associated with an underground nuclear test, if so directed by the President. Nuclear weapons training devices also would be assembled/disassembled as part of readiness exercises and training.

Staging of SNM, including nuclear weapon pits – SNM would be staged at the NNSS for operational purposes associated with dynamic experiments, pulsed-power experiments, criticality experiments, and other activities. All SNM would be staged and used in strict compliance with all applicable requirements.

Training for the Office of Secure Transportation – Through its Office of Secure Transportation, NNSA safely and securely transports nuclear weapons, weapons components, and SNM to meet projected NNSA, U.S. Department of Defense (DoD), and other customer requirements. These shipments are highly guarded to provide the utmost protection of the public and U.S. national security. Throughout their careers, the Federal agents who do this work are given in-service training to defend, recapture, and recover nuclear materials in case of an attack. This training also includes preparing the agents for disruptive demonstrations by activist or other kinds of groups or armed attacks. The Office of Secure Transportation would use existing infrastructure at the NNSS to conduct training and exercises to maintain and improve the skills of its agents to safely and securely transport nuclear weapons, weapons components, and SNM. Training would include convoy activities on existing NNSS roads and adjacent off-road areas using weapons simulators and live-fire exercises at various locations on the NNSS. These activities would occur up to six times each year.

TTR operations – The primary mission of NNSA at the TTR is to ensure that U.S. nuclear weapons systems meet the highest standards of safety and reliability. In addition, Work for Others Program activities are conducted at the TTR. NNSA activities at the TTR are conducted under the conditions set forth in a land use permit from the U.S. Air Force (USAF) and are the responsibility of the Sandia Site Office, located in Albuquerque, New Mexico. Certain TTR activities that were included in the *1996 NTS EIS* ROD (61 FR 65551) (seismic verifications, hazardous burn-test operations, chemical effects testing of stockpile weapons, and thermal testing) are no longer conducted. Under the No Action Alternative, NNSA would use the TTR for the following stockpile stewardship and management tasks:

- Tests and experiments, including flight test operations for gravity weapons (bombs), would be conducted to ensure the compatibility of the hardware necessary for the interface between weapons and delivery systems and to assess weapon system functions in realistic delivery conditions. NNSA does not expect to use Category I/II SNM in flight tests.
- Impact testing would be conducted to test various parameters of a weapon while in flight or when dropped, including penetration of the ground surface. Weapons tested would include joint test assemblies and conventional and inert projectiles. For joint test assemblies and nuclear projectiles, a portion of the nuclear package would be omitted, making them incapable of achieving criticality and producing a nuclear detonation. Impact tests would include the following:
  - Air drop operations – Delivery of any test asset (i.e., gravity bomb, air-dropped sensor package, parachute deployment system, etc.) from an airborne platform
  - Ground/air-launched rocket operations
  - Ground/air-launched missile operations
  - Compressed-air gun operations
  - Davis Gun operations
  - Fuel-air explosives operations

- Open-air and underground detonation of explosives
- Post-test procedures and recovery operations

- Passive tests using high-resonance energy, lasers, and ultrasound techniques would be conducted to check the systems in joint test assemblies and conventional weapons. Tests would also be conducted in support of nonproliferation research to develop equipment and techniques for determining whether other countries are using or developing nuclear capabilities. Passive tests would include the use of the following:
  - Telemetry, microwave, and photometric operations
  - Radar operations
  - Laser tracker operations
  - Radiographic operations
  - Electromagnetic radiation testing

Although not listed under the Work for Others description in Section A.1.1.3, all of these Stockpile Stewardship and Management Program activities are similar to activities that may be conducted under the Work for Others Program at the TTR.

A.1.1.2 Nuclear Emergency Response, Nonproliferation, and Counterterrorism Programs

Although no land area is specifically dedicated to Nuclear Emergency Response Program activities, NNSA facilities in Nevada provide a broad support base for those activities, including a variety of areas and facilities that may be used for training and exercise activities. Under the No Action Alternative, NNSA would provide support for the following Nuclear Emergency Response, Nonproliferation, and Counterterrorism Program activities:

- Personnel and logistical support for the Nuclear Emergency Support Team at RSL. The Nuclear Emergency Support Team provides specialized technical expertise in resolving nuclear or radiological terrorist incidents. NNSA assists the Federal Bureau of Investigation or U.S. Department of State in conducting, directing, and coordinating search and recovery operations for nuclear materials, weapons, or devices, and assists in identifying and deactivating an improvised nuclear device or a radiological dispersal device. Nuclear Emergency Support Team activities would also occur at the NNSS and other locations. This ongoing program provides search teams and equipment as required to respond to a nuclear/radioactive material dispersal event.

- Support would be provided for consequence management, including personnel with technical expertise from RSL. As part of this support, NNSA would continue to manage early-phase activities and provide personnel to staff the Federal Radiological Monitoring and Assessment Center (FRMAC). FRMAC coordinates the efforts of 17 agencies to integrate the Federal response to a radiological emergency within the United States. DOE's responsibility is to set up and initially manage FRMAC and NNSA provides the Consequence Management Response Team, which draws from NNSA Emergency Response Assets, including the Radiological Assistance Program and Aerial Measuring Systems. The Phase 1 Consequence Management Response Team is deployed from among NNSA Nevada Site Office (NNSA/NSO) assets. FRMAC is supported through activities at various locations in the United States, as required for training and/or response to a radiological emergency.

- Fixed-wing and rotary-wing aircraft would be provided for emergency response and aerial mapping activities as part of the Aerial Measuring System. The Aerial Measuring System provides rapid response to radiological emergencies with helicopters and fixed-wing aircraft equipped to detect and measure radioactive material. In addition, the Aerial Measuring System surveys DOE sites, participates in interagency exercises, and performs work for other Federal agencies. Aerial Measuring System can also provide detailed aerial photographs and multi-spectral imagery and analyses. The system is housed at and supported by RSL, and activities are conducted at various offsite locations.

- Personnel and logistical support would be provided to the Accident Response Group. The Accident Response Group develops and maintains readiness to efficiently manage the resolution of accidents or significant incidents involving nuclear weapons that are in DOE or DoD custody. The Accident Response Group's role in an emergency situation involving a nuclear weapon includes initial onsite assessment; evaluations to ensure the safety and health of emergency response personnel, the public, and the environment; weapon recovery; and support for onsite radiological monitoring, analysis, and assessment.

- Logistical support would be provided to the Radiological Assistance Program. The Radiological Assistance Program is a first-response resource that assesses a radiological emergency, conducts the initial radiological assessment of the area of the emergency, and provides assistance to minimize immediate radiation risks. The Radiological Assistance Program also provides emergency response training to first responders and is involved in the Weapons of Mass Destruction First Responder Training Program. The Radiological Assistance Program is implemented on a regional basis, with eight Regional Coordinating Offices in the United States. NNSA/NSO is part of Region 7, which is headquartered in Oakland, California.

- Weapons of mass destruction emergency responder training would be provided.

- Equipment and technical support would be provided to NNSA for the DOE-dedicated Emergency Communications Network.

- NNSA would disposition improvised nuclear devices on an as-needed basis at appropriate locations at the NNSS. This activity would include initial evaluation of an improvised nuclear device and, if considered safe to do so, disassembling the device. Throughout the disassembly process, the improvised nuclear device components would be turned over to the Disposition Forensics Program. The Disposition Forensics Program is an extension of the Disposition Program, and its function is to conduct forensics activities on an improvised nuclear device. Existing NNSS facilities would be used for staging, handling, and forensic analysis of improvised nuclear devices and their components. Training drills and exercises also would be conducted at the NNSS to maintain the readiness capability of the Disposition and Disposition Forensics Programs.

Nuclear Forensics

Nuclear forensics is the analysis of nuclear materials recovered from either the capture of unused materials or the radioactive debris following a nuclear explosion. Nuclear forensics can contribute significantly to the identification of the sources of the materials and the industrial processes used to obtain them. In the case of an explosion, nuclear forensics can also reconstruct key features of the nuclear device (AAAS 2008).

The Federal Bureau of Investigation has lead responsibility for nuclear forensics in response to a radiological event within the United States. However, for the most part, the scientific expertise and laboratory facilities for nuclear forensics and the assets for collection and storage of radiological samples reside in the DOE complex.

The NNSS has unique facilities and capabilities for staging, as well as experimentation with, nuclear materials and would provide a centralized location where currently dispersed nuclear forensics capabilities would be integrated. The Federal Bureau of Investigation Disposition Forensics Program would deploy a small number of personnel to the NNSS for training and exercises or for an actual incident, as needed. All activities would take place in existing facilities at the NNSS.

- Nonproliferation- and counterterrorism-related activities would continue in the areas of: (1) arms control (see below), (2) nonproliferation, (3) nuclear forensics (discussed above), and (4) counterterrorism. Nonproliferation- and counterterrorism-related activities would provide scientific research and development, technology realization, process and procedure development, equipment testing and certification, and training that support these areas. The kinds of activities that would be involved in supporting nonproliferation and counterterrorism include use of underground detonations of conventional explosives for seismic studies, releases of chemical and biological simulants, geological studies, and experiments to simulate radio frequencies resulting from various nuclear fuel cyle technologies. These activities are addressed in more detail in Section A.1.1.3. Activities supporting U.S. nonproliferation and counterterrorism efforts would occur at RSL and NLVF, but would primarily be conducted at the NNSS.

  The primary goal of the nonproliferation- and counterterrorism-related activities would be to integrate development, testing, and validation of technologies applied to control the spread of weapons of mass destruction, particularly those that are nuclear. This goal would be a platform for collaboration among a diverse group of Federal agencies and their partners, including allied and other foreign nations, international arms control organizations, and nongovernmental or industrial organizations, as appropriate. These activities would also support partnerships in counterterrorism and nuclear forensics. Nonproliferation- and counterterrorism-related activities would be designed for versatility to adapt to changing technology requirements and evolving global security conditions.

  Under the No Action Alternative, nonproliferation- and counterterrorism-related activities would integrate existing activities (i.e., research and development, training, nonproliferation tests and experiments, counterterrorism training, etc.) under an overall program. There would be no new facilities constructed, although existing buildings and other facilities would be used and modified as necessary to accommodate these activities.

Arms control – A key component of nonproliferation activities would be the use of existing facilities as part of an Arms Control Treaty Verification Test Bed dedicated to supporting U.S. arms control initiatives and commitments. Using existing capabilities (such as the Nonproliferation Test and Evaluation Complex [NPTEC], BEEF, various tunnels, laboratories, and training facilities), this component would support design and certification of treaty verification technology, training of inspectors, and development of arms control confidence-building measures. More specifically, in support of the work at the Arms Control Treaty Verification Test Bed, NNSA would conduct the following activities:

> **Test Bed**
> A test bed is an area that includes physical structures or designated terrain where tests and experiments are conducted. Test beds may be permanent facilities or temporary sites.

- Developing, testing, and certifying sensors for deployment with onsite arms control inspection teams

- Developing and testing technologies for seismic and electromagnetic pulse discrimination between nuclear and conventional explosions
- Developing and testing samples and measurements from aerial, surface, and subsurface environments for Comprehensive Test Ban Treaty verification purposes
- Developing and testing technologies and methods for nonintrusive observation of tunnel complexes and other underground facilities for potential nuclear weapons-related activities
- Providing training areas where inspectors can learn methods of conducting searches of large areas for radioactive debris or other evidence of nuclear activity
- Providing training in nuclear forensics of radiation-contaminated materials
- Training international inspectors for Strategic Arms Reduction Treaty follow-on and Comprehensive Test Ban Treaty inspections

Under the No Action Alternative, an existing facility in Mercury would be modified to provide important arms control functions such as data fusion, analysis, and visualization. This facility would integrate multiple disciplines and would use both state-of-the-art and experimental data analysis techniques and experimental methods to increase understanding of the means of detecting weapons materials, weapons of mass destruction, clandestine explosions, and hidden laboratories. These data would be combined with other data streams to facilitate turning raw data into actionable knowledge. In addition to treaty verification and weapons of mass destruction detection, this capability would be used for climate change studies, timely warning of natural disasters, environmental remediation, and advancement of earth sciences.

Nonproliferation – The NNSS would serve as a base of operations for the collaborative technical work that underlies nonproliferation programs. Facilities would be provided for Federal agencies to validate sensor performance. This capability would include a security-controlled environment for multinational collaboration in technology development and for technical training and information sharing. These multinational collaborations would be particularly aimed at U.S. allies that do not have ready access to areas where nuclear weapons have been tested in the past and would allow them to gain experience at former testing facilities and sites to aid in their nonproliferation programs. NNSA would use existing facilities in Nevada to support the following areas:

- Safeguarding fissile materials in nations with nuclear weapons or nuclear industries
- Tightening export controls on technology with potential application to weapons of mass destruction
- Improving border protection by installing detectors for radioactive materials
- Inspecting commercial shipments for smuggled nuclear materials
- Collaborating with law enforcement in these areas

For some specific tasks in support of nonproliferation and counterproliferation objectives, NNSA would use existing unique NNSS capabilities, such as NPTEC, areas contaminated by previous nuclear testing, and various tunnel complexes to conduct research, development, and training in the following areas:

- High-hazard experiments and evaluations of equipment and methods for detection of radioactive, chemical, or biological agents using simulants
- Hands-on training and exercises to “render safe” a contraband nuclear device

- Nuclear forensics field exercises involving collection of radioactive material dispersed by an explosion

- Airborne, electromagnetic, and seismic assessment of deep underground facilities

Counterterrorism – A counterterrorism training program would provide an advanced, immersive training environment that would include international participation. The ability to execute complex scenarios in field conditions, with various U.S. agencies and possibly international participants, would lead to refinement of tactics and a direct encounter with unanticipated problems. These training exercises would use the isolated, rugged terrain of the NNSS to simulate many current military areas of operation. The special attributes of the NNSS, which allow use of explosives, chemical and radiological substances, electronic countermeasures, and live weapons fire, would provide realistic training for the military, Federal agents, police officers, and others who conduct counterterrorism operations.

NNSA would support research, development, and training associated with detecting and countering various types of improvised explosive devices, including those that are vehicle-borne. These activities would occur at BEEF, NPTEC, and other NNSS locations. All explosive operations would be conducted in compliance with DOE Manual 440.1-1A, *DOE Explosives Safety Manual*. In addition to BEEF and the Area 11 Explosives Ordnance Disposal Unit, NNSA is currently permitted under the NNSS Air Quality Operating Permit to conduct up to 10 explosive detonations per year, each using up to 2,000 pounds of explosives, at each of the following facilities: (1) the High Explosive Simulation Technique Facility in Area 14, (2) Test Cell C in Area 25, (3) Port Gaston in Area 26, and (4) NPTEC in Area 5.

A.1.1.3 Work for Others Program

The Work for Others Program, hosted by NNSA, facilitates the use by other agencies and organizations of NNSA facilities and capabilities, such as BEEF, NPTEC, the Radiological and Nuclear Countermeasures Test and Evaluation Complex (RNCTEC), and the T-1 Training Area, as well as resources at the NNSS, RSL, NLVF, and the TTR. Under the No Action Alternative, NNSA would continue to host the projects and activities of other Federal agencies such as DoD and DHS, as well as other Federal, state, and local government agencies and nongovernmental organizations, including the following:

Treaty verification – NNSA would host activities related to verification under a number of nuclear weapon-related treaties. The activities that would be conducted range from hosting inspections by other nations to conducting research and development in the area of detecting violations of treaties by others.

Nonproliferation projects and counterproliferation research and development – NNSA would provide the following support to other agencies:

- Conventional weapons effects testing, including live-drop and static high-explosives detonations using up to 30,000-pound-class weapon systems with up to 20,000 pounds TNT-equivalent explosives. These activities would be conducted primarily in the Nuclear and High Explosives Test Zone (Areas 1, 2, 3, 4, 12, and 16 of the NNSS) and would be in compliance with the *DOE Explosive Safety Manual* (DOE Manual 440.1-1A) and other applicable requirements.

- Development and demonstration of capabilities and technologies to effectively threaten and defeat military missions protected in tunnels and other deeply buried hardened facilities. These activities would use military munitions and other explosives and nonexplosive methods. Existing tunnels and bunkers on the NNSS would be used for these activities.

- Conduct experiments and other operations using conventional explosives. All explosive operations would be conducted in compliance with DOE Manual 440.1-1A, *DOE Explosives Safety Manual*. In addition to BEEF and the Area 11 Explosives Ordnance Disposal Unit, NNSA is currently permitted under the NNSS Air Quality Operating Permit to conduct up to 10 explosive detonations per year, each using up to 2,000 pounds of explosives, at each of the following facilities: (1) the High Explosive Simulation Technique Facility in Area 11, (2) Test Cell C in Area 25, (3) Port Gaston in Area 26, and (4) NPTEC in Area 5.

- Controlled experiments involving releases (including explosive releases) of chemical and biological simulants. These experiments would support development of detectors, sensors, and equipment and methods to control leaking containers (i.e., tanks, truck and railroad tankers, etc.), and provide data for training first responders and others to detect biological and/or chemical traces that may indicate the manufacture or presence of a chemical or biological weapon. They would also support detection, control, and remediation of leaks and spills. Up to 20 controlled chemical and biological simulant release tests and experiments would be conducted yearly.

Large releases of chemicals would be conducted at NPTEC and would comply with the parameters in *Hazardous Materials Testing at the Hazardous Materials Spill Center, Nevada Test Site* (DOE/EA-0864) (DOE 2002), including: (1) chemical concentrations must not exceed specific limits within three 3.1-mile-wide geographic impact zones established in the downwind direction from the NPTEC release point (see **Table A–1** for limitations for each zone); (2) restrictions on materials that have cumulative, long-term persistence in the environment; (3) restrictions on the duration of releases that are of sufficient quantity and/or concentration to have a potential for environmental impacts in downwind testing sectors; (4) restrictions on the frequency of releases that may approach the limits of the geographic impact zones; (5) windspeed must be calm to 33.5 miles per hour; and (6) specific wind direction requirements for each of the three geographic impact zones. Before NNSA/NSO accepts any particular chemical release test or experiment, the proponent of the test/experiment must provide specific documentation, including a proposal letter, a test plan, a safety assessment, and a test management summary. These documents provide information used by NNSA/NSO to evaluate the proposed releases to determine whether they would comply with all applicable requirements to protect human health and the environment.

Chemical Release Criteria

Immediately Dangerous to Life or Health (IDLH) – The National Institute of Occupational Safety and Health (NIOSH) defines IDLH as a situation that poses a threat of exposure to airborne contaminants when that exposure is likely to cause death or immediate or delayed permanent adverse health effects or prevent escape from such an environment.

Short-Term Exposure Limit (STEL) – An Occupational Safety and Health Administration (OSHA) or NIOSH 15-minute time-weighted average that cannot be exceeded at any time during the workday.

Permissible Exposure Limit – An OSHA time-weighted average concentration that must not be exceeded during any 8-hour work shift in a 40-hour workweek.

Recommended Exposure Limit – A NIOSH time-weighted average concentration for up to a 10-hour workday during a 40-hour workweek.

Threshold Limit Value (TLV) – 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:

- The TLV-TWA (TLV Time-Weighted Average) is averaged over the normal 8-hour day/40-hour workweek.
- A TLV-STEL is a 15-minute exposure that should not be exceeded for even an instant. It is not a standalone 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 TLV-TWA is not exceeded.
- The TLV-C (Ceiling limit) is the concentration that should not be exceeded during any part of the working exposure.

Table A–1 Nonproliferation Test and Evaluation Complex Geographic Impact Zones

Zone	*Description*	*Allowable Chemical Concentration*
I	A semicircular area with a radius of 3.1 miles centered on a bearing of 225 degrees from the release point	May contain lethal concentrations for exposures of less than 15 minutes to humans and wildlife
II	An area centered on a bearing of 225 degrees extending from 3.1 miles to 6.2 miles from the release point and bounded on either side by bearing lines 270 degrees on the south and 180 degrees on the north	May contain concentrations for which an exposure of less than 15 minutes would have a low probability of morality, but may cause respiratory damage to humans or animals
III	An area centered on a bearing of 225 degrees extending from 6.2 miles to 9.3 miles from the release point and bounded on either side by bearing lines 260 degrees on the south and 190 degrees on the north	May contain concentrations that cause mild and reversible respiratory tract irritation on wildlife and minor and reversible effects on vegetation

Low concentrations of chemicals may be released anywhere on the NNSS within the requirements presented in the *Final Environmental Assessment for Activities Using Biological Simulants and Releases of Chemicals at the Nevada Test Site* (*Chem/Bio EA*) (DOE/EA-1494) (DOE 2004a). Under those requirements, chemical concentrations would not exceed the "Immediately Dangerous to Life or Health Program" limit beyond a radius of 328 feet from the release point; would not exceed the "Short-Term Exposure Limit" beyond 1,000 feet from the release point; and would not exceed the more conservative of "Permissible Exposure Limits," "Recommended Exposure Limit," or "Threshold Limit Value" beyond 1,640 feet from the release point.

Releases of biological simulants at the NNSS are subject to specific parameters addressed in the *Chem/Bio EA*. In the *Chem/Bio EA*, based on scientific information regarding potential effects on human and ecological receptors, NNSA identified six microorganisms that may be used in experiments as simulants for biological agents: *Bacillus subtilis* var. *niger* (formerly *B. globigii*), *B. thuringiensis*, *Clostridium sporogenes*, *Erwinia herbicola* (also known as *Panoea aggloverans*), Bacteriophage MS2, and noninfectious (killed) influenza A virus. A biological agent is a pathogenic microorganism or any naturally occurring, genetically manipulated, or synthesized component of biological origin that is capable of causing death, disease, or other biological malfunction in humans, animals, or plants, or causing deterioration of food, water, equipment, or supplies. A biological simulant is a biologically derived substance or microorganism that shares at least one physical or biological characteristic of the biological agent it is simulating, has been shown to be nonpathogenic, and can replace the biological agent in testing. Biological simulants are intended to mimic the behavior of potentially more lethal or severely debilitating biological agents that may be used in warfare or by terrorist organizations.

Counterterrorism – NNSA would continue to support DoD and other Federal agencies in developing methods for engaging or neutralizing an adversary in a variety of topographical environments. These organizations would take advantage of the NNSS restricted access and remote high desert terrain to develop realistic scenarios that could be encountered in specific mission profiles. Activities would include the following:

- Training in direct-action live-fire take-down of high-fidelity target test beds
- Low-altitude fixed- and rotary-wing desert flight training and technique development
- Development of and training in remote area advanced personnel overland navigation techniques

- Development and field-testing of special-use military hardware, including new ordnance and vehicles
- Field-testing and training activities for unmanned aerial vehicles and/or unmanned aircraft systems
- Overland movement of military personnel and equipment through rugged terrain to assess fatigue and war-fighter capability

In addition to the ground-based military operations that occur at the NNSS, the USAF would conduct military operations in the restricted air space above the NNSS and the TTR.

DHS technology programs and DoD would continue to use NNSS facilities to assist in development of technology for homeland security applications. The NNSS would continue to provide land and infrastructure to support evaluation of radiological and nuclear detection devices for use in transportation-related applications. DHS would continue to use RNCTEC (a facility constructed at the NNSS on behalf of DHS), as well as other NNSS land and infrastructure for its activities. RNCTEC would continue to operate as a less-than-Category-3 nonreactor nuclear facility with a mock Primary Port of Entry, Active Interrogation Facility, storage and staging areas, and a Test Support Building. Radioactive and nuclear materials (including SNM) used in RNCTEC activities would not be released under normal operations. All radionuclides would be transported in strict compliance with applicable regulations of the U.S. Department of Transportation. A detailed description of RNCTEC facilities and activities is contained in the *Radiological/Nuclear Countermeasures Test and Evaluation Complex, Nevada Test Site, Final Environmental Assessment* (DOE/EA-1499) (DOE 2004b).

DOE Hazard Categories

In accordance with DOE Order 5480.23, *Nuclear Safety Analysis Report*, as part of establishing the safety basis of DOE nuclear facilities, contractors that design, construct, or operate such a facility are required to perform a hazard analysis of their nuclear activities and classify their processes, operations, or activities in accordance with the following requirements (cited from DOE Order 5480.23):

"The consequences of unmitigated releases of radioactive and/or hazardous material shall be evaluated and classified by the following hazard categories:

(a) Category 1 Hazard. The hazard analysis shows the potential for significant offsite consequences.

(b) Category 2 Hazard. The hazard analysis shows the potential for significant onsite consequences.

(c) Category 3 Hazard. The hazard analysis shows the potential for only significant localized consequences."

NNSA's Counterterrorism Operations Support Program would continue supporting the Federal Emergency Management Agency. This program involves development and implementation of a national program to enhance the capability of state and local agencies to respond to weapons of mass destruction incidents through coordinated training, equipment acquisition, technical assistance, and support for state and local exercise planning.

Military Training and Exercises – NNSA would continue to support DoD by providing land, airspace, and infrastructure for use by various branches of the military to conduct training and exercises. These activities range from small-scale, i.e., focused at a specific building or site, to large-scale exercises involving multiple air and/or ground assets with live-fire operations. These activities would include use of live fire of military munitions, including small arms, hand grenades, rocket-propelled grenades, etc. Military training and exercises may be conducted throughout the NNSS, but would be primarily conducted in the western portions, including Areas 18, 19, 20, 25 (northern portion), 29, and 30 to preclude interference with and from other NNSS activities. Military training and exercises are subject all applicable regulatory requirements and to NNSA/NSO work authorization processes (NSO O 412.X1E, *Real Estate/Operations Permit*, December 9, 2009), which are designed to minimize hazards to workers, the environment, and NNSS physical assets.

Support for the U.S. National Aeronautics and Space Administration (NASA) – NNSA would conduct criticality experiments at DAF in support of NASA's efforts to develop power sources for use in future missions to Mars and similar space exploration.

Miscellaneous Work for Others Program activities – Customers would continue to use aerial platforms for various purposes, including research and development, training and exercises, and deployment of sensors for detection of various items. These types of activities would use a variety of manned and unmanned aerial vehicles, including fixed-wing aircraft (airplanes) and helicopters. Existing aviation facilities at the NNSS, Nellis and Creech Air Force Bases, and other locations would be used as part of these activities.

Work for Others Program activities at the TTR – These activities would be similar to those addressed under the Stockpile Stewardship and Management Program (Section A.1.1.1), with the following additions:

- Robotics testing and development (handling, application, and recovery of hazardous [chemical] material)
- Smart transportation-related testing – preprogrammed/remote-controlled vehicles (air and ground)
- Smoke obscuration operations
- Infrared tests
- Rocket development, testing, and deployment

A.1.2 Environmental Management Mission

DOE/NNSA's Environmental Management Mission includes the Waste Management Program and Environmental Restoration Program. These programs are under the organizational control of DOE's Environmental Management Program. The Waste Management Program conducts waste management operations for all solid wastes, LLW, and mixed low-level radioactive waste (MLLW) generated by NNSA operations and environmental restoration operations. The Waste Management Program operates disposal facilities that receive various waste types, including the Area 5 Radioactive Waste Management Complex (RWMC) and Area 3 Radioactive Waste Management Site (RWMS), which dispose LLW and MLLW received from onsite- and offsite-approved waste generators. The Environmental Restoration Program conducts, as needed, characterization, monitoring, and remediation of facilities, sites, and groundwater contaminated by previous nuclear weapons-related and other activities at the NNSS, the TTR, and the Nevada Test and Training Range. The Environmental Restoration Program also implements the Borehole Management Program, which plugs unneeded boreholes for which NNSA is responsible.

A.1.2.1 Waste Management Program

Waste management operations support DOE and NNSA operations and environmental cleanup and restoration programs. The waste management objective is to conduct proper disposal and monitoring of wastes generated by NNSA and other approved generators. Waste types stored, treated, and/or disposed at the NNSS include LLW, MLLW, transuranic (TRU) waste, mixed TRU waste, hazardous waste, asbestos, polychlorinated biphenyl (PCB) wastes, hydrocarbon-contaminated soil and debris, and solid wastes such as construction or demolition debris or sanitary solid waste. Liquid nonhazardous wastes (such as sewage and other wastewater) are not included under the Waste Management Program, but are addressed in Section A.1.3.1, "General Site Support and Infrastructure." All NNSA waste management activities operate in compliance with applicable regulatory requirements. Waste management activities at the NNSS under the No Action Alternative would include the following:

LLW and MLLW management – LLW and MLLW from NNSS, DoD, and other approved generators that meet the NNSS waste acceptance criteria would continue to be accepted and disposed. The volume of LLW projected for disposal at the NNSS and analyzed under the No Action Alternative is based on the actual volume of LLW disposed at the NNSS from FY 1997 through FY 2010 and is estimated to total about 15,000,000 cubic feet. The volume of MLLW projected for disposal at the NNSS and analyzed under the No Action Alternative is estimated to total about 900,000 cubic feet. This estimated volume is based on the disposal capacity of the new Mixed Waste Disposal Unit, Cell 18; the actual permitted capacity of Cell 18 is 899,996 cubic feet. The volumes of LLW and MLLW include those from authorized out-of-state generators as well as those from operations and environmental restoration at the NNSS and other authorized in-state locations.

NNSA would continue to manage in-state-generated MLLW by a combination of several options: (1) repackage MLLW, as appropriate, at the TRU Pad in the Area 5 RWMC; (2) store in-state-generated MLLW at the TRU Pad or at a new MLLW storage facility, pending certification for disposal; or (3) ship in-state-generated MLLW to a permitted facility such

Waste Definitions and Information

Radioactive Waste – Solid, liquid, or gaseous material that contains radionuclides regulated under the Atomic Energy Act of 1954, as amended, and of negligible economic value considering costs of recovery.

Transuranic (TRU) Waste – Radioactive waste containing alpha particle-emitting radionuclides having an atomic number greater than 92 (the atomic number of uranium) and half-lives greater than 20 years, in concentrations greater than 100 nanocuries per gram.

Low-Level Radioactive Waste (LLW) – Radioactive waste not classified as high-level radioactive waste, TRU waste, spent nuclear fuel, or byproduct material as defined by Section 11e(2) of the Atomic Energy Act of 1954, as amended. Test specimens of fissionable material irradiated for research and development only, and not for the production of power or plutonium, may be classified as LLW, provided the concentration of TRU elements is less than 100 nanocuries per gram.

Hazardous Waste – A category of waste regulated under the Resource Conservation and Recovery Act (RCRA). To be considered hazardous, a waste must be a solid waste under RCRA and must exhibit at least one of four characteristics described in Title 40 of the *Code of Federal Regulations* (CFR) 261.20-24 (ignitability, corrosivity, reactivity, and toxicity), or be specifically listed by the U.S. Environmental Protection Agency in 40 CFR 261.31-33.

Mixed Waste – Waste containing both radioactive and hazardous components, as defined by the Atomic Energy Act and RCRA, respectively. Mixed waste intended for disposal must meet the Land Disposal Restrictions as listed in 40 CFR Part 268. Mixed waste is a generic term for specific types of mixed waste, such as mixed low-level radioactive waste (MLLW) and mixed TRU waste.

Waste Generator – An individual, facility, corporation, government agency, or other institution that produces waste material for certification, treatment, storage, or disposal.

Waste Acceptance Criteria – A document that establishes the National Nuclear Security Administration Nevada Site Office waste acceptance criteria. The document provides the requirements, terms, and conditions under which the Nevada National Security Site (NNSS) accepts LLW and MLLW for disposal. It includes requirements for the generator's waste certification program, characterization, traceability, waste form, packaging, and transfer. The criteria apply to radioactive waste received at the NNSS Area 3 Radioactive Waste Management Site and Area 5 Radioactive Waste Management Complex for storage or disposal.

as Energy Solutions in Clive, Utah, or Materials and Energy Corporation in Oak Ridge, Tennessee, for appropriate treatment. MLLW treated at an offsite facility would be returned to the NNSS for disposal or would be disposed at a permitted commercial facility.

The Area 5 RWMC would continue to operate within the approximately 740-acre area set aside for waste management purposes. LLW and MLLW disposal units would be developed, filled, and closed as needed, in compliance with applicable regulatory requirements. NNSS- and offsite-generated LLW and MLLW would be disposed within these units. Individual disposal units would be operationally closed as they are filled to capacity, pending final closure at a later date. Final closure of existing operationally closed units, including the greater confinement disposal boreholes, began in calendar year 2011. LLW and permitted MLLW disposal would continue elsewhere at the Area 5 RWMC.

On December 1, 2010, the Nevada Division of Environmental Protection (NDEP) issued a permit to NNSA/NSO for a new MLLW Disposal Unit at the Area 5 RWMC. The new MLLW Disposal Unit consists of a single lined cell (Cell 18) with a capacity of about 900,000 cubic feet (actual permitted disposal volume is 899,996 cubic feet). Temporary storage operations for onsite-generated LLW and MLLW would continue. Support activities within the Area 5 RWMC, such as the Real-time Radiography Facility, would continue.

The Area 3 RWMS would be maintained in a standby status under the No Action Alternative.

Small quantities of LLW (a few to a few hundred cubic feet over the next 10 years) may be generated at RSL and NLVF. Normal operations at the TTR are not expected to generate radioactive waste, but environmental restoration activities would generate LLW and possibly unknown quantities of TRU waste. These environmental restoration wastes would be disposed at appropriate disposal facilities, such as the Area 5 RWMC and/or the Waste Isolation Pilot Plant, as appropriate.

TRU waste management – With the exception of two experimental spheres, the remaining legacy TRU waste previously stored at the NNSS was sent to Idaho National Laboratory for processing and then shipped to DOE's Waste Isolation Pilot Plant for disposal in 2009. Environmental Restoration Program projects at the NNSS, the TTR, and the Nevada Test and Training Range may generate some TRU waste, and experiments at JASPER and other national security activities would also generate small annual quantities (approximately 500 cubic feet per year) of TRU waste that would be safely stored at the TRU Pad pending characterization. Overall, NNSA estimates that about 9,600 cubic feet of TRU waste would be generated by its operations and the Environmental Restoration Program over the next 10 years. These TRU wastes would be shipped either directly to the Waste Isolation Pilot Plant for disposal or to another facility, such as Idaho National Laboratory, for processing before being sent to the Waste Isolation Pilot Plant.

TRU wastes would not be generated during RSL, NLVF, or NNSA Sandia Site Office activities at the TTR.

Hazardous waste management – DOE/NNSA activities would generate about 170,000 cubic feet of hazardous waste at the NNSS over the next 10 years under the No Action Alternative. The Hazardous Waste Storage Unit in Area 5 of the NNSS would continue to operate under a RCRA Part B permit issued by NDEP. Onsite-generated hazardous waste would be stored for up to 1 year prior to shipment to offsite treatment and/or disposal facilities.

RSL is a small-quantity generator of hazardous waste. Hazardous waste would continue to be accumulated at RSL for no more than 90 days before being transferred off site to a permitted facility for treatment and/or disposal. Waste management field activities at RSL are provided by the USAF as landlord services under a Memorandum of Agreement. USAF personnel pick up and dispose miscellaneous laboratory and process equipment wastes under the terms of Nellis Air Force Base Plan 12 (Hazardous Waste Management Plan, October 2007).

NLVF is a conditionally exempt small-quantity generator of hazardous waste. Hazardous waste would continue to be accumulated at NLVF for no more than 90 days before being transferred off site to a commercially permitted facility for treatment and/or disposal.

The TTR is a small-quantity generator of hazardous waste. Hazardous wastes would continue to be accumulated at the TTR for no more than 180 days before being transferred off site to a permitted treatment, storage, and disposal facility.

Used oil from all NNSA/NSO facilities and the TTR would continue to be collected and sent for recycling.

Asbestos and PCB waste management – Friable, nonradioactive asbestos waste would continue to be disposed at the Area 23 Solid Waste Disposal Site and possibly at the U10c Solid Waste Disposal Site, pending permit modification and review. Radioactive asbestos waste would continue to be disposed at the Area 5 RWMC. Nonfriable asbestos waste would continue to be disposed at the U10c Solid Waste Disposal Site. Nonradioactive PCB wastes would be stored at the Hazardous Waste Storage Unit in Area 5, pending transfer to a permitted treatment and/or disposal facility. Radioactive PCB-contaminated waste meeting U.S. Environmental Protection Agency (EPA) requirements (40 *Code of Federal Regulations* [CFR] Part 761) would continue to be disposed in a RCRA-permitted MLLW Disposal Unit through November 30, 2010. After that time, this waste type would be disposed in the new RCRA-permitted MLLW Disposal Unit described above. NNSA would continue to dispose asbestos and PCB wastes generated at the TTR at a permitted treatment, storage, and disposal facility.

Explosives waste treatment – NNSA would continue to treat old and/or unusable explosives by open-air detonation at the Explosives Ordnance Disposal Unit in Area 11. This treatment operation would continue to be governed by a RCRA Part B permit and the NNSS Air Quality Operating Permit.

Hydrocarbon-contaminated soil and debris management – The Area 6 Hydrocarbon Solid Waste Disposal Site would continue to operate under a permit issued by NDEP and would accept onsite-generated soil and debris contaminated with hydrocarbons. The U10c Solid Waste Disposal Site would also continue to operate under a permit issued by NDEP and would accept limited amounts of onsite-generated soil and debris contaminated with hydrocarbons. Onsite-generated, hydrocarbon-contaminated LLW would continue to be disposed in the Area 5 RWMC. If hydrocarbon-contaminated waste were generated due to an accidental release at RSL or NLVF, it would be disposed at a facility permitted to receive such waste. The TTR would continue to dispose hydrocarbon-contaminated soil and debris at a permitted/approved landfill.

Solid waste management – DOE/NNSA activities would generate about 3,700,000 cubic feet of sanitary solid waste and construction and demolation waste at the NNSS. NNSA would continue to operate the Area 23 Solid Waste Disposal Site. This permitted facility accepts less than 20 tons of sanitary waste per day. Industrial solid waste and construction and demolition debris would continue to be disposed at the U10c Solid Waste Disposal Site. About 370,000 cubic feet of sanitary solid waste would be sent off site to permitted facilties to be recycled.

At RSL and NLVF, sanitary solid waste would continue to be disposed by a municipal waste service.

At the TTR, sanitary solid waste would continue to be disposed at the USAF TTR sanitary landfill. Industrial solid waste, such as construction or demolition debris, would be disposed at a USAF landfill or shipped off site for disposal at the NNSS or a permitted commercial landfill.

Excess materials that are suitable for recycling or reuse, such as scrap metal, would be shipped off site.

A.1.2.2 Environmental Restoration Program

NNSA's Environmental Restoration Program is generally a DOE-funded activity under the organizational direction of the DOE Environmental Management Program. Under the No Action Alternative, the NNSA Environmental Restoration Program would continue, in compliance with the Federal Facility Agreement and Consent Order (FFACO), to characterize, monitor, and remediate identified contaminated areas, facilities, and the environment. Environmental restoration is not considered a land use, but is a necessary activity before reuse or disposition of land, facilities, and environmental media. The Environmental Restoration Program is organized into three projects and also supports the Defense Threat Reduction Agency in addressing its environmental restoration sites at the NNSS. The three projects are the Underground Test Area (UGTA) Project, Soils Project (includes contaminated soil sites from the TTR and the Nevada Test and Training Range), and Industrial Sites Project (includes the Decontamination and Decommissioning Project and facilities to be remediated at the TTR and the NNSS under the *1996 NTS EIS*). The *1996 NTS EIS* also included the Project Shoal Site and the Central Nevada Test Area as projects under the Environmental Restoration Program. These two sites have since been transferred to DOE's Office of Legacy Management and are not addressed in this SWEIS. NNSA Borehole Management Program work is executed by the Environmental Restoration Program. The following NNSA environmental restoration projects and activities would continue at the NNSS under the No Action Alternative:

Underground Test Area Project – The UGTA Project would monitor groundwater from existing wells; continue drilling characterization wells; expand groundwater monitoring to include new wells; develop groundwater flow and transport models; and continue to evaluate closure strategies, including adaptive monitoring and management. UGTA activities would occur on the NNSS, the Nevada Test and Training Range, U.S. Bureau of Land Management land, and privately owned land, as necessary and as permission is obtained. This project includes five corrective action units (CAUs): Yucca Flat/Climax Mine (CAU 97), Frenchman Flat (CAU 98), Rainier Mesa/Shoshone Mountain (CAU 99), Central Pahute Mesa (CAU 101), and Western Pahute Mesa (CAU 102). The UGTA Project has planned for Phase I and Phase II corrective action investigations for each CAU; however, depending on the results at the end of Phase I, NDEP may approve a Corrective Action Decision Document/Corrective Action Plan. In 2009, CAUs 101 and 102 began the second phase of characterization; a Phase II investigation was completed for CAU 98; and a Phase II Transport Model was submitted to NDEP. Also during 2009, a Phase I Flow Model was under preparation for CAU 97, and a Phase I Source Term Model was under preparation for CAU 99. The closure strategy for all CAUs in the UGTA Project is closure in place and long-term monitoring with institutional controls. An estimated five wells would be drilled for the UGTA Project each year for approximately 10 years, each affecting 10 acres due to construction of drill pads and fluid pits. Hydraulic testing would occur at many of these new wells, and possibly at existing wells, requiring the use of portable power generators and resulting in withdrawal of groundwater and disposition in the fluid pits. Tracer tests could also be conducted, which would involve injecting nonhazardous chemical substances (for example, bromide) into a well and monitoring their concentrations in an adjacent pumped well. Other characterization activities would include seismic or other geophysical tests.

Soils Project – The Soils Project would continue to investigate soil sites using in situ monitoring (thermoluminescent detectors, onsite radiation surveys, and aerial radiological surveys), air monitoring, surface-water contaminant transport studies, and soil sampling, as well as perform corrective actions using clean closure, closure in place, or a combination to ensure that the public and workers are protected. The Soils Project would ensure that proper use restrictions are in place to implement site closure, in compliance with access and posting requirements of DOE's *Occupational Radiation Protection* rules (10 CFR Part 835) and Nevada Test and Training Range radiation protection policies, which may include fencing and posting. The current closure strategy for Soils Project sites at the NNSS is based on a future industrial land use scenario with a 25-millirem-per-year exposure action level. This action level is used for the analysis under the No Action Alternative in this SWEIS. Soils sites on the Nevada Test and Training Range, including the TTR, are expected to be remediated to an action level that is mutually agreed upon by DOE/NNSA, the USAF, and NDEP. Activities would continue to be conducted in compliance with the FFACO, although alternate uses may require stricter cleanup levels than currently anticipated. The impacts of potential stricter cleanup levels are addressed under the Expanded Operations Alternative. Sixteen of the current 107 sites being addressed by the Soils Project have been closed. Over about 10 years, as more contaminated soil sites are found, the Soils Project is expected to add up to 20 additional sites. As these sites close, some may require postclosure monitoring and land use controls. NNSA anticipates that all identified Soils Project sites will be closed under the FFACO by the end of 2022.

Industrial Sites Project – The Industrial Sites Project would continue its field program to identify, characterize, and remediate industrial sites under the FFACO and to decontaminate and decommission unneeded facilities. Under the No Action Alternative, some industrial sites may require clean closure rather than closure in place. The majority of the FFACO industrial sites have been closed. Remediation, decontamination, and decommissioning activities are projected to be complete by the end of 2012, with the exception of CAU 114 (EMAD [Engine Maintenance Assembly and Disassembly Facility]). The current number of CAUs is 265, with a total of 1,870 corrective action sites (CASs) (including 64 CASs at the TTR, all of which have been closed as of September 2010). Twelve CAUs and 102 CASs remain to be closed at the NNSS. As of 2009, 8 of 9 Part A sites identified in the *1996 NTS EIS* (DOE 1996) were closed under RCRA. The remaining Part A site is expected to be closed by 2012. Some closed industrial sites may require monitoring and land use controls. Industrial Sites Project activities would continue at present levels, although alternate uses of remediated facilities may require revised cleanup levels.

Defense Threat Reduction Agency sites – The Defense Threat Reduction Agency sites are identified as part of the NNSA Environmental Restoration Program because their site activities are considered environmental remediation on the NNSS. However, the Defense Threat Reduction Agency is responsible for implementing and funding these activities in compliance with applicable agreements with NDEP. In September 2005, with the concurrence of NDEP, the Defense Threat Reduction Agency adopted a risk-based closure strategy for closure of nine CAUs (NDEP 2005). This risk-based closure strategy uses final action levels based on risks to human health and the environment. The final action levels were used to determine the risk a particular site poses to human health and the environment so that available resources would be used in the most effective manner in closing each site. Surface-disturbing activities have been completed and environmental monitoring, such as water sampling, would continue. The Environmental Restoration Program accepted responsibility for the E-Tunnel effluent ponds and associated long-term postclosure monitoring from the Defense Threat Reduction Agency in 2008.

Borehole Management Program – More than 4,000 boreholes were drilled on and off the NNSS in support of nuclear testing (DOE/NV 2009). The boreholes were drilled for various purposes, including post-shot investigation, exploratory holes, instrument holes, potable water wells, construction water supply wells, monitoring wells, and other special purposes. Unneeded boreholes would be plugged to reduce the potential for boreholes to act as conduits for contaminant transport from the surface or from contaminated aquifers to uncontaminated aquifers. To date, the Borehole Management Program has identified 874 unneeded boreholes (Townsend 2009) on the NNSS; 151 of these are believed to penetrate groundwater and underground nuclear test cavities (DOE/NV 2009). The NNSA Borehole Management

Program plugs unneeded boreholes as a matter of comity in accordance with *Nevada Administrative Code* 534.420-534.427 requirements, to the extent possible.

Through 2009, a total of 691 unneeded boreholes were plugged by the Borehole Management Program (Townsend 2009). Under the No Action Alternative, NNSA would continue to plug the remaining unneeded boreholes on the NNSS. Based on the current schedule and known inventory of unneeded boreholes on the NNSS that need to be plugged, the Borehole Management Program would be complete by the end of 2013.

A.1.3 Nondefense Mission

The Nondefense Mission generally includes those activities that are necessary to support mission-related programs, such as constructing and maintaining facilities, providing supplies and services, warehousing, and similar activities. Activities related to supply and conservation of energy, including renewable energy and other research and development projects, are also considered under the Nondefense Mission.

A.1.3.1 General Site Support and Infrastructure Program

Like any large facility, the NNSS has substantial infrastructure that provides all site-support services. Under the No Action Alternative, infrastructure-associated activities would continue, including small projects such as repairs and replacements to maintain present capabilities of NNSA facilities. For instance, maintenance and repair projects include, among other things, repairing the Area 23 sewer main; remediating underground storage tanks; replacing five roll-up doors; renovating and reactivating several water tanks; replacing electric hot water heaters; installing water tank security ladders; and replacing the roofs on several buildings. Increasing the capacities and capabilities or extending the ranges of facilities and/or services is not proposed under the No Action Alternative.

NNSS infrastructure includes buildings that house various functions, such as administration; storage; security, fire protection, and health care services; research and development; and industrial processes (see **Table A–2**). Utilities at the NNSS, NLVF, RSL, and the TTR include potable and nonpotable water systems, wastewater systems, electrical transmission and distribution systems, and communications systems. Although they are part of NNSA's infrastructure, characterization and monitoring wells developed under the UGTA Project are addressed as part of the Environmental Management Program rather than the General Site Support and Infrastructure Program.

The TTR contains about 105 major buildings, providing 161,505 square feet of space. TTR infrastructure also includes about 90 smaller buildings, towers, and small sheds. Services available at the TTR include security, fire protection, and health care. Utilities at the TTR include water systems, wastewater systems, and electrical systems.

In addition to maintaining and repairing its infrastructure at the NNSS, RSL, NLVF, and the TTR, NNSA would maintain the existing infrastructure, provide site security, and manage all applicable existing permits and agreements for the former Yucca Mountain Repository. NNSA would perform these functions pending decisions on the disposition of the former Yucca Mountain Repository.

Table A–2 Building Floor Space and Functions for National Nuclear Security Administration Facilities in Nevada

Function	*Nevada National Security Site 484 Buildings (square feet)*	*Remote Sensing Laboratory 7 Buildings (square feet)*	*North Las Vegas Facility 30 Buildings (square feet)*	*Offsite Leased (square feet)*
Administration	383,336	0	444,090	117,263
Storage	332,877	16,454	22,179	1,104
Industrial/Production/Process	359,980	0	58,969	8,253
Research and Development	486,405	144,059	136,079	87,451
Services	413,948	0	4,023	0
Other	255,056	1,015	648	0
Total	2,231,602	161,528	665,988	214,071

Source: Mason 2009.

A.1.3.2 Conservation and Renewable Energy Program

Under the No Action Alternative, NNSA would continue to identify and implement energy conservation measures and renewable energy projects, in compliance with Executive Order 13423, *Strengthening Federal Environmental, Energy, and Transportation Management* (72 FR 3919); DOE Order 430.2B, *Department of Energy, Renewable Energy and Transportation Management Requirements*; and Transformational Energy Action Management objectives.

Executive Order 13514, *Federal Leadership in Environmental, Energy, and Economic Performance*, was signed by President Obama on October 5, 2009. Executive Order 13514 expands the requirements of Executive Order 13423 in the following areas:

- Measuring and reporting greenhouse gases
- Implementing strategies and policies to support low-carbon commuting and travel
- Identifying, promoting, and implementing water reuse strategies that reduce potable water consumption
- Increasing diversion of compostable and organic material from waste streams
- Ensuring that planning for new facilities/leases considers pedestrian-friendly sites near existing employment
- Managing existing building systems to reduce consumption of energy, water, and materials
- Identifying opportunities to consolidate and dispose existing assets to optimize real property portfolios

In accordance with DOE Order 430.2B, Executive Order 13423, and Executive Order 13514, NNSA would continue to identify and implement requirements in the following areas:

- Energy efficiency
- Renewable energy

Energy Efficiency and Intensity

Energy efficiency can be defined for a component or service as the amount of energy required in the production of that component or service; for example, the amount of steel that can be produced with 1 billion British thermal units of energy. Energy efficiency is improved when a given level of service is provided with reduced amounts of energy inputs, or services or products are increased for a given amount of energy input.

Energy intensity is the amount of energy used in producing a given level of output or activity. It is measured by the quantity of energy required to perform a particular activity (service), expressed as energy per unit of output or activity measure of service.

Source: http://www1.eere.energy.gov/ba/pba/intensityindicators/trend_definitions.html

- Water conservation
- Transportation/fleet management
- High-performance sustainable buildings

NNSA activities (as of December 2009) associated with selected requirements from DOE Order 430.2B, Executive Order 13423, and Executive Order 13514 are discussed below.

Energy efficiency– NNSA would improve energy efficiency and reduce greenhouse gas emissions at the NNSS by reducing energy intensity by 3 percent annually or a total of 30 percent through the end of FY 2015, relative to the baseline of energy use in FY 2003. Energy intensity measures energy consumption per gross square foot of building space, including industrial and laboratory facilities. Greenhouse gas emissions would be reduced by 28 percent by FY 2020.

Table A–3 presents energy intensity reduction goals from the FY 2003 baseline through FY 2015 based on the Energy Independence and Security Act of 2007, Section 431, "Energy Reduction Goals." Additional mission requirements may preclude accomplishing this goal at the NNSS.

Table A–3 National Nuclear Security Administration Energy Intensity Reduction Goals

Fiscal Year	*Annual British Thermal Units Per Square Foot*	*Cumulative Percent Reduction*
2003	115,729	Base Year
2006	113,414	2
2007	111,100	4
2008	105,313	9
2009	101,842	12
2010	98,370	15
2011	94,898	18
2012	91,426	21
2013	87,954	24
2014	84,482	27
2015	81,010	30

Source: NSTec 2008.

NNSA would install advanced electric metering systems to the maximum extent practicable at all NNSS buildings, in accordance with the DOE metering plan for site monitoring of electric energy, and implement a centralized data collection, reporting, and management system. Standard metering systems for steam, natural gas, and water would also be installed and centrally monitored. Advanced meters have the capability to measure and record interval data (at least hourly for electricity) and to communicate the data to a remote location in a format that can be easily integrated into an advanced metering system.

As of December 2008, there were 395 electrical meters installed in the 423 buildings identified for electrical meter installation at the NNSS, with a projected 28 facilities identified for future installations (NSTec 2008). NLVF consists of 30 buildings, 3 of which are metered. Electrical, gas, and water meters would be installed at buildings at NLVF to allow NNSA to better track its use of electricity, water, and gas, thus improving its ability to identify conservation opportunities.

NNSA would, to the extent practicable, use standardized operations and maintenance and measurement and verification protocols, coupled with real-time information collection and centralized reporting capabilities. NNSA also would expedite improvement in the quality, consistency, and centralization of data collected and reported through the use of commercially available software.

Renewable energy – NNSA would maximize installation of onsite renewable energy projects at the NNSS where technically and economically feasible. The initial goal would be to acquire at least 7.5 percent of the NNSS's annual electricity and thermal consumption from onsite renewable sources. NNSA installed solar-powered pathway lighting where such lighting is feasible at the NNSS. This is expected to result in an energy savings of 120 million British thermal units per year. To achieve the initial goal under the No Action Alternative, NNSA would consider various options, including the possibility of entering into an agreement with a commercial entity to construct a solar power generation project at the NNSS. A portion of the electricity generated by such a project would be used to meet NNSS electrical needs.

Commercial Solar Power Generation – The *1996 NTS EIS* analyzed the environmental impacts of constructing and operating a solar power generation facility at two potential Solar Enterprise Zone sites on the NNSS (Area 22 and Area 25) and three non-NNSS sites in southern Nevada. The locations of the Area 22 and Area 25 solar power generation facility sites are depicted in Figure A–1. (The Solar Enterprise Zone on the NNSS is now called the Renewable Energy Zone.) Although a solar power generation facility was not constructed at any of the sites evaluated in the *1996 NTS EIS*, as part of the No Action Alternative in this SWEIS, NNSA is evaluating a potential commercial solar power generation facility at the NNSS. NNSA has determined that the southwestern portion of Area 25 is the only reasonable location on the NNSS for a commercial solar power generation facility. Area 25 includes an extensive area of suitable terrain for solar power facilities, has existing vehicular access from Highway 95 (Lathrop Wells Road) and an existing 138-kilovolt transmission line, and would not interfere with national security-related activities on the NNSS that require limited access to uncleared individuals. Although it possesses many of the same attributes as Area 25, Area 22 is not being considered as a potential location for solar power development in this *NNSS SWEIS* because all current solar power technologies require substantial water for cooling and other purposes and there would be potential impacts on Devil's Hole (see Chapter 5, Section 5.1.6) resulting from construction of any facility that would withdraw groundwater from the Mercury Valley (Hydrographic Basin 225). Low-water-use renewable energy projects may be considered for Area 22 in the future.

The solar technologies that are most likely to be deployed at utility scale over the next 20 years are photovoltaic and concentrating solar power, such as the parabolic trough, power tower, and dish engine technologies (BLM/DOE 2010). It is unknown which technology would be used in a solar power generation facility at the NNSS, but the analysis in this *NNSS SWEIS* assumes a concentrating solar power parabolic trough facility, based on the prevalence of that technology in other operating, proposed, and potential solar energy projects in southern Nevada (see Table 6–2 in Chapter 6). It is estimated that a concentrating solar power generation facility using parabolic trough technology would require between 9 and 10 acres of land for each megawatt of generating capacity, based on the proposed Amargosa Farm Road Solar Energy Project (BLM 2010). This acre per megawatt of generating capacity is about double that used in the *Draft Programmatic Environmental Impact Statement for Solar Energy Development in Six Southwestern States* (BLM/DOE 2010) but is consistent with proposed parabolic trough solar power generation facilities currently being considered in southern Nevada. The assumptions used in the *Draft Programmatic Environmental Impact Statement for Solar Energy Development in Six Southwestern States* are shown in **Table A–4**. Using the ratio scaled from the Amargosa Farm Road Solar Energy Project, the area of land required for a 240-megawatt parabolic trough solar power generation facility would be about 2,400 acres. For this SWEIS, NNSA assumed that the 240-megawatt capacity would employ a dry-cooled concentrating solar power technology using parabolic troughs, similar to the Amargosa Farm Road Solar Energy Project (BLM 2010). Potential impacts of commercial solar power generation at the NNSS are scaled from the Amargosa Farm Road Solar Energy Project (West 2010). In addition, additional electrical transmission capacity would be required to integrate the electricity generated by a 240-megawatt facility into the regional system. Approximately 10 miles of new 230-kilovolt transmission line (all off of the NNSS) was assumed for purposes of this analysis. As noted in Chapter 6, Section 6.2.4.4, Valley Electric Association intends to upgrade its electrical transmission system in its service territory, which would likely provide a suitable interconnection for the electrical generation from a commercial solar power generation facility on the NNSS. In addition, independent of, and unrelated to, the commercial solar power generation facilities considered in this *NNSS SWEIS*, NV Energy, a commercial electrical energy company, and Renewable Energy Transmission Company are planning separate new large capacity transmission line projects that would accommodate the additional electrical generation (see Chapter 6, Section 6.2.4.4, for additional information). Currently, no commercial solar power generation projects are proposed at the NNSS. Therefore, additional NEPA analysis would be required before any such project could be implemented.

Table A–4 Technology-Specific Assumptions for Environmental Impact Analyses from the Draft Programmatic Environmental Impact Statement for Solar Energy Development in Six Southwestern States

Parameter	*Parabolic Trough*	*Power Tower*	*Dish Engine*	*Photovoltaic*
Facility power capacities (megawatts)	100 – 400	100 – 400	10 – 750	10 – 750
Land area requirements (acres per megawatt) [a]	5	9	9	9
Operational water use (acre-feet per year per megawatt)				
Wet (recirculating) cooling [b]	4.5 – 14.5	4.5 – 14.5	N/A	N/A
Dry cooling [b]	0.2 – 1.0	0.2 – 1.0	N/A	N/A
Hybrid system [c]	0.9 – 2.9	0.9 – 2.9	N/A	N/A
Mirror/panel washing/other [d]	0.5	0.5	0.5	0.05
Chemicals/hazardous materials present on site	Heat transfer fluid, water treatment chemicals and herbicides	Heat transfer fluid, water treatment chemicals, and herbicides	Hydrogen tanks and herbicides	Encased semiconductor materials and herbicides

N/A = not applicable.

[a] Land area estimates were based on areas required for existing facilities and estimated areas for proposed facilities. In some cases disturbed area estimates were not available, so values were based on total plant area (which should approximate disturbed area). The estimated land use values for parabolic trough and tower facilities are minimums; the land area requirement could be higher if thermal energy storage is incorporated into facilities.

[b] Wet-cooling and dry-cooling requirements are based on estimates given as gallons per hour per megawatt in the *Nevada Test Site Environmental Report 2008* (DOE/NV 2009). An assumed range of operational hours of 30 to 60 percent of annual hours (1 gallon = ~3.1×10^{-6} acre-feet) was used to generate acre-feet per year per megawatt values.

[c] Hybrid systems were assumed to use 20 percent of the water requirements of wet-cooling systems.

[d] The mirror washing estimates originate from the assumed 2 percent of total water needs of wet-cooled parabolic trough facilities from DOE/NV (2009). This estimate equals 20 gallons per hour per megawatt, which corresponds to 0.5 acre-feet per year per megawatt, with no assumption on operational time (conservative estimate). The panel-washing estimate for photovoltaic facilities was assumed to be a factor of 10 less than that for concentrating solar power technologies (Appendix M).

Source: BLM/DOE 2010.

Water conservation – In FY 2007, NNSA established a water production baseline, 210.6 million gallons, in accordance with Executive Order 13423. Actual water consumption figures are not available because NNSS facilities do not have water meters attached to the buildings. Instead, water production data were used to provide metrics in this area. The FY 2007 production baseline was used during FY 2008 to identify trends, and make recommendations for the implementation of site-wide water conservation measures. NNSA sites began saving water through several conservation measures. Examples include the installation of WaterSense™ products, xeric landscaping, using nonpotable water for dust suppression, and the institution of 4-day workweeks.

Table A–5 presents potable water production goals from the FY 2007 baseline through FY 2015. Water production was reduced by 18 percent in FY 2008 compared with the FY 2007 baseline, thereby exceeding the FY 2015 goal of 16 percent water reduction. Water production was reduced by an additional 8 percent in FY 2009.

Table A–5 Potable Water Production Goals for the Nevada National Security Site

Fiscal Year	*Potable Water Production (millions of gallons)*	*Cumulative Percent Reduction*
2007	210.6	Base Year
2008	206	2
2009	202	4
2010	198	6
2011	194	8
2012	190	10
2013	185	12
2014	181	14
2015	177	16

Source: NSTec 2008.

Efforts to identify water-saving projects and obtain funding to complete them are ongoing to ensure that the water production reductions that have been achieved are maintained. NNSA would continue to use best management practices for water efficiency in the following areas: water management planning; system audits, leaks, and repairs; landscaping; irrigation; toilets and urinals; faucets and showerheads; boiler systems; and other water uses.

The NNSS does not have a water-recycling program. Water and sewage are discharged into either sewage lagoons or septic systems. NNSA evaluated recycling gray water at the NNSS and determined that the cost would be prohibitive given the quantity of flow and lack of means to redistribute the recycled water. The water could be used for dust control in some cases, but, depending on the extent of treatment, there are restrictions on how the water may be used. Water recycling is not being considered under the No Action Alternative.

Transportation/fleet management – The current NNSA fleet has 540 alternative-fuel vehicles, equal to 96 percent of the covered fleet. NNSA requires that its fleet operate any alternative-fuel vehicles exclusively on alternative fuels to the maximum extent practicable. In FY 2007, NNSA constructed an E85 fuel station in Mercury (E85 is an alcohol–fuel mixture that typically contains a mixture of up to 85 percent denatured fuel ethanol and gasoline or other hydrocarbon by volume) and implemented a successful plan to promote the use of the alternative fuel. In FY 2007, the total actual usage of E85 fuel was 135,141 gallons; the consumption in FY 2008 was 182,997 gallons, a 35 percent increase in usage. For every gallon of E85 fuel used, 85 percent of the petroleum base fuel is reduced; for every gallon of B-20 biodiesel fuel used, 20 percent of the petroleum base fuel is reduced; and for every gallon of unleaded gasoline used, 10 percent is reduced. Biodiesel fuel is used in all equipment, with the exception of emergency generators and boilers, and is currently at the maximum possible usage level.

High-performance sustainable buildings – NNSA would ensure that: (1) all new construction and renovation projects implement design, construction, maintenance, and operations practices in support of the high-performance building goals of Executive Order 13423 and statutory requirements; and (2) existing facilities' maintenance and operations practices meet the goals of Executive Order 13423. The High-Performance Building Plan would also align with Executive Order 13327 and DOE's Real Property Asset Management Plan. At a minimum, the High-Performance Building Plan would include employment of integrated design principles, optimization of energy efficiency, use of renewable energy, protection and conservation of water, enhancement of indoor environmental quality, and reduction of environmental impacts of materials in accordance with the guiding principles of DOE Order 430.2B, Attachment 1, and construction related to Executive Order 13423.

A.1.3.3 Other Research and Development Programs

In 1992, the NNSS became the seventh unit of the DOE National Environmental Research Park Program. The NNSS program initially operated under a cooperative agreement between the DOE Nevada Operations Office (now NNSA/NSO); the University of Nevada, Reno; and the University of Nevada, Las Vegas, whereby the DOE Nevada Operations Office's Environmental Management Office provided financial assistance to the two universities to conduct scientific research projects unique to the Nevada National Environmental Research Park. Areas of research would include, but would not be limited to, habitat reclamation, hydrogeologic systems, radionuclide transport, ecological change, waste management, monitoring processes, remediation, and characterization. In addition, scientific research projects conducted by parties other than those in the above-mentioned agreement could be conducted, but would be funded from sources other than DOE/NNSA.

The Nevada Desert Free-Air Carbon Dioxide Enrichment Facility and Mojave Global Change Facility are two environmental research facilities located in Area 5 of the NNSS that are conducting long-term environmental research.

The Nevada Desert Free-Air Carbon Dioxide Enrichment Facility is a state-of-the-art facility designed to study responses of an undisturbed desert ecosystem to increasing levels of atmospheric carbon dioxide. The experimental plots are designed to permit a controlled release of elevated carbon dioxide in the air around vegetation without disturbing other environmental and ecosystem conditions. There are nine experimental plots: three with elevated levels of atmospheric carbon dioxide and six without elevated carbon dioxide levels. Collaborators at the Nevada Desert Free-Air Carbon Dioxide Enrichment Facility include the Desert Research Institute; University of Nevada, Las Vegas; University of Nevada, Reno; and Brookhaven National Laboratory. The facility is supported by DOE and NNSA. This facility has been placed in a standby condition due to lack of funding.

The Mojave Global Change Facility was established in Area 5 of the NNSS and would continue to examine the impact of global climate change factors other than increased carbon dioxide (i.e., increasing summer monsoon rains, increased nitrogen deposition, and disturbance or destruction of the desert soil crust) on the Mojave Desert ecosystem. Three treatments at various levels are applied to the 96 196-square-meter plots. These treatments include three summer irrigation treatments, two levels of nitrogen fertilization, and soil crust disturbance.

An anticipated focus of research at these two facilities may be determining mechanisms by which carbon is sequestered in deserts. Results of research at the Mojave Global Change Facility and other arid region research sites suggest that arid regions sequester significantly more carbon than originally believed. Determining how this occurs would be a research priority.

A.2 Expanded Operations Alternative

The scope of the Expanded Operations Alternative in this SWEIS is defined to include all the capabilities and projects described under the No Action Alternative, plus additional newly proposed capabilities and projects. These additional activities would include modification or expansion of existing facilities and construction of new facilities. In addition, some ongoing activities would be conducted more frequently than under the No Action Alternative. For each activity addressed in this section, the differences from the No Action Alternative are noted. In addition to changes in activities, under the Expanded Operations Alternative, there would be two changes in NNSS land use zones: (1) the designated use for Area 15 would be changed from "Reserved" to "Research, Test, and Experiment"; and (2) approximately 39,600 acres within Area 25 would be designated as a Renewable Energy Zone. **Figure A–2** depicts the land use zones and major facilities at the NNSS under the Expanded Operations Alternative.

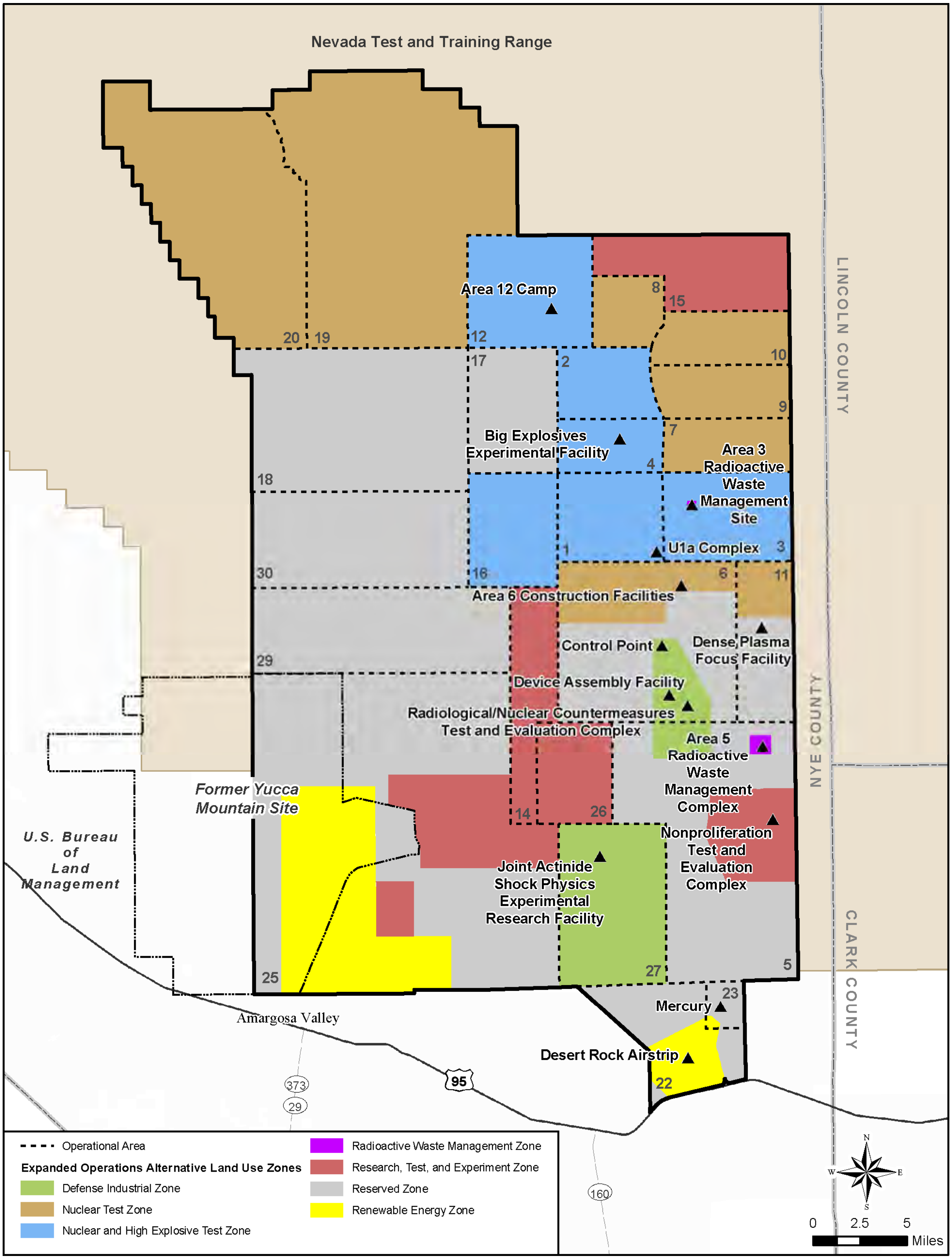

Figure A–2 Nevada National Security Site Land Use Zones and Major Facilities Under the Expanded Operations Alternative

A.2.1 National Security/Defense Mission

Under the Expanded Operations Alternative, NNSA would pursue additional activities associated with the Stockpile Stewardship and Management, Nuclear Emergency Response, Nonproliferation, Counterterrorism, and Work for Others Programs.

A.2.1.1 Stockpile Stewardship and Management Program

Under the Expanded Operations Alternative, Stockpile Stewardship and Management Program operations would continue at NNSA facilities in Nevada, particularly at the NNSS, under the conditions of the ongoing nuclear testing moratorium. This alternative would include those activities necessary to maintain the capability to conduct nuclear tests if so directed by the President. Readiness-to-test activities include maintaining the necessary infrastructure and, more importantly, exercising the research and engineering disciplines of the Nation's nuclear weapons programs through an active science-based Stockpile Stewardship and Management Program at the NNSS to ensure the continued competence of its technical staff.

Under the Expanded Operations Alternative, there would be no changes from the No Action Alternative (see Section A.1.1.1) for the following Stockpile Stewardship and Management Program projects and activities:

- Criticality experiments in DAF
- Drillback operations
- Disposition of damaged U.S. nuclear weapons
- Stockpile stewardship and management activities at the TTR

Stockpile stewardship and management activities that would change relative to the No Action Alternative under the Expanded Operations Alternative include the following:

Dynamic experiments, dynamic plutonium experiments (a type of subcritical experiment), and hydrodynamic tests – NNSA would conduct up to 20 dynamic experiments per year. Over the next 10 years, a total of 5 dynamic experiments would be conducted in emplacement holes, with each such experiment causing an estimated 20 acres of new land disturbance.

Conventional explosives experiments at BEEF and other locations in the Nuclear and High Explosives Test Zone – NNSA would conduct up to 100 explosives tests and experiments per year. NNSA would also add a firing table and ancillary features within the already developed area at BEEF. NNSA would also develop and test for proof of concept a high-energy x-ray capability at BEEF. Following successful testing, the new x-ray system would be moved to the U1a Complex for operational use.

In addition to activities at BEEF (limited to 70,000 pounds TNT-equivalent), NNSA would conduct tests and experiments using up to 120,000 pounds TNT-equivalent of explosives at various locations within the Nuclear and High Explosives Test Zone. These detonations would be conducted both underground and in the open air. Conventional explosives operations supporting other programs at the NNSS are described under those programs. All explosive operations would be conducted in compliance with DOE Manual 440.1-1A, *DOE Explosives Safety Manual*.

NNSA would establish up to three areas dedicated to conducting explosives tests and experiments using depleted uranium. Depleted uranium test and experiment areas may be established within Areas 2, 4, 12, or 16. Each of these depleted uranium test and experiment areas would be about 40 acres in size and dedicated to tests and experiments with depleted uranium and explosives. An annual maximum of 4,000 pounds of depleted uranium and 12,000 pounds TNT-equivalent of explosives would be used to conduct up to 20 of these types of tests and experiments per year. Individual experiments would use up to 200 pounds of depleted uranium and 600 pounds TNT-equivalent of explosives.

Shock physics experiments at JASPER, located in Area 27, and the Large-Bore Powder Gun, located in Area 1 in the U1a Complex – NNSA would make the shock physics experimental facilities available for academic and other research on a nonconflicting basis and would increase the number of experiments with actinide materials up to 36 per year at JASPER and 24 at the Large-Bore Powder Gun in the U1a Complex.

Pulsed-power experiments – Under the Expanded Operations Alternative, the Atlas Facility would be activated, and up to 24 pulsed-power experiments per year would be conducted.

Fusion experiments at the NNSS and NLVF – New experimental uses would be pursued for the Dense Plasma Focus Machines, requiring deuterium-deuterium, deuterium-tritium, and tritium-tritium fusion and pulsed x-ray production. These experiments also would require a much larger-capacity energy storage bank than the one currently in use at the Area 11 facility. These new experimental uses would include ensuring an enduring experimental capability to support nuclear resonance spectroscopy, neutron materials investigations, and other stockpile stewardship activities. To facilitate the new uses for the Dense Plasma Focus Machine currently located in Area 11 of the NNSS, it would be relocated to an existing building in Area 6 of the NNSS. Following the relocation, the Area 11 facility would be placed on standby. NNSA would conduct up to 1,650 plasma physics and fusion experiments per year: 1,000 in the Dense Plasma Focus Machine at NLVF, and 650 in the machine in Area 11 (or Area 6 if it is moved).

Stockpile management activities – NNSA would conduct nuclear explosives operations at the NNSS in association with conducting an underground nuclear test, if so directed by the President. In addition, under the Expanded Operations Alternative, NNSA would conduct the following activities:

- Staging of nuclear devices pending disassembly, modification/maintenance, and/or transportation to another location
- Dismantlement of select weapons or weapon systems to aid the United States in meeting its commitment to reduce its nuclear weapons stockpile (weapons shipments to the NNSS under this activity would not exceed 100 per year)
- Modification and maintenance of nuclear devices at DAF, including replacing limited-life components in selected nuclear weapons systems
- Weapons components testing for quality assurance purposes at DAF

Staging of SNM, including pits – NNSA would continue to stage SNM at appropriate facilities on the NNSS. SNM would be relocated from other DOE/NNSA sites. For example, the following materials would be moved to the NNSS: up to 4 metric tons of SNM currently part of the Zero Power Physics Reactor Program at Idaho National Laboratory (for use in criticality experiments); about 200 kilograms of global security SNM currently stored at Lawrence Livermore National Laboratory (for use in detector development and as radiation test objects); 2 kilograms of uranium-233 currently stored at Los Alamos National Laboratory (associated with test readiness); and 500 kilograms of highly enriched uranium, depleted uranium, and uranium stored at Lawrence Livermore National Laboratory (associated with criticality safety). In addition, NNSA would stage weapon pits at DAF, pending their transport to the Pantex Plant in Texas or another appropriate location.

Training for the Office of Secure Transportation – In addition to hosting training and exercises on NNSS roadways, NNSA would construct new support facilities in Area 17 to support Office of Secure Transportation training programs. The new facilities would include administrative offices (5,000 square feet), a mock town (20 acres), a 8,000- to 10,000-square-foot shooting house (a building that can simulate various kinds of structures for conducting scenario-driven tactics development and training), and target props. Support facilities would also include two modular training facilities with restrooms (2,000 square feet each), two Butler buildings (5,000 square feet each), an electrical substation (100 square feet), a communications trailer (300 square feet), a 10,000- to 20,000-gallon potable drinking water tank, and a septic system with a leach field. The entire training area, including buffer areas, would occupy approximately 10,000 acres (including a live-fire training area for the Office of Secure Transportation). A total of about 3,500 acres would be disturbed to provide individual training venues, and 25 miles of roads and firebreaks would be developed surrounding the whole active training area and between individual training venues. Most of these roads and firebreaks would be graded, single-lane dirt roads with shoulders; up to 4 miles would be paved asphalt, double-lane roads with shoulders. Potable water would be obtained from an existing well approximately 4.5 miles away, requiring construction of a water pipeline. An electrical distribution line would also be constructed to extend electrical service from the vicinity of the well to the new facilities. Main access to the complex would be from the Tippipah Highway.

The Office of Secure Transportation would expand its facilities in 12 Camp (Area 12), the Area 6 Control Point, or Mercury (Area 23), and maintenance buildings (20,000 square feet), administrative buildings (10,000 square feet), and a dormitory (20,000 square feet) would be constructed to support training operations.

These facilities would also be available to other NNSS customers (e.g., DoD and other Government agencies) when not in use by the Office of Secure Transportation.

A.2.1.2 Nuclear Emergency Response, Nonproliferation, and Counterterrorism Programs

Under the Expanded Operations Alternative, there would be no changes from the No Action Alternative for the following Nuclear Emergency Response Program, Nonproliferation, and Counterterrorism Program projects and activities:

- Nuclear Emergency Support Team support
- Consequence management support for FRMAC, the Aerial Measuring System, the Accident Response Group, and the Radiological Assistance Program
- Disposition of improvised nuclear devices on an as-needed basis
- Weapons of mass destruction emergency responder training
- Provision of equipment and technical support for the DOE-dedicated Emergency Communications Network
- Nuclear forensics

Activities associated with the Nuclear Emergency Response, Nonproliferation, and Counterterrorism Programs that would change relative to the No Action Alternative under the Expanded Operations Alternative include the following:

Nonproliferation and counterterrorism-related activities – NNSA nonproliferation- and counterterrorism-related activities would include four related areas: arms control, nonproliferation, nuclear forensics, and counterterrorism. Although the purpose of nonproliferation- and counterterrorism-related activities would be the same as that under the No Action Alternative, new nonproliferation and counterterrorism facilities, described below, would be constructed at various locations on the NNSS to undertake enhanced activities. Because the new nonproliferation and counterterrorism facilities (Arms Control Treaty Verification Test Bed, Nonproliferation Test Bed, and Urban Warfare Complex) are still conceptual in nature and their locations are unknown, they are not fully analyzed in this SWEIS, and an appropriate level of NEPA analysis would be required before they could be implemented.

Arms control – The Arms Control Treaty Verification Test Bed would require construction of both indoor and outdoor laboratory space and test areas for design and certification of treaty verification technology, training of inspectors, and development of arms-control-related confidence-building measures. These facilities would be sited at various locations at the NNSS; construction of new facilities would require a total of about 100 acres of land.

A new facility for data fusion, analysis, and visualization would also be constructed. The new building would have approximately 10,000 square feet of floor space and would be integrated with a building constructed to house other Arms Control Treaty Verification functions.

Nonproliferation – A Nonproliferation Test Bed would require construction of a new facility where users would simulate chemical and radiological processes that could be conducted clandestinely by an adversary.

Counterterrorism – In addition to counterterrorism training being conducted at existing facilities, an Urban Warfare Complex would be constructed at the NNSS. This would include full-scale, modular replicas of urban areas where terrorists and insurgents typically seek refuge. This urban warfare training ground would be wired and instrumented for continuous recording of exercises for post-event evaluations and classroom training. NNSA expects that the Urban Warfare Complex would cover about 100 acres in a remote location on the NNSS.

A.2.1.3 Work for Others Program

Under the Expanded Operations Alternative, there would be no changes from the No Action Alternative for the following Work for Others Program activities:

- Treaty verification activities
- Military training and exercises
- Work for Others Program activities at the TTR

Work for Others Program activities that would change relative to the No Action Alternative under the Expanded Operations Alternative include the following:

Nonproliferation projects and counterproliferation research and development – Support would be provided for development of radiation detection capabilities, additional sensor development, and active interrogation programs to detect nuclear material.

Counterterrorism – Under the Expanded Operations Alternative, NNSA's Work for Others Program would support the counterterrorism activities of other Federal agencies. Future USAF activities would include research, development, testing, and evaluation of unmanned aerial vehicles and/or unmanned aircraft systems, as well as integration of training and exercises. Other activities would include development and testing of sensors for detection and defeat of improvised explosive devices, which would require construction of test beds (roads, intersections, small towns, etc.) and support facilities. Construction of these facilities would require new buildings with about 10,000 square feet of new floor space and would disturb about 75 acres of land.

DHS counterterrorism operations support would include construction of new training facilities (about 10,000 square feet of floor space). In addition, RNCTEC would be operated up to the level of a Hazard Category 2 nonreactor nuclear facility, which would allow larger amounts of radioactive material in alternative configurations to be used in tests and experiments. A high-speed road, a short section of full-scale railroad line, a simulated seaport facility, and a mock urban area would also be added to RNCTEC (NNSA 2004), requiring about 125 acres of additional land in Area 6. Because these new facilities are still conceptual in nature and their locations are unknown, an appropriate level of NEPA analysis and documentation would be required before they could be implemented.

Support for NASA – NNSA would support NASA nuclear rocket motor development, including using existing boreholes to examine the use of deep alluvial basins for sequestering radionuclides released as part of emissions from tests of a yet-to-be-developed prototype nuclear rocket motor. Over about a 10-year period, NASA would not likely test a nuclear rocket motor, but may conduct proof-of-concept tests using a surrogate, such as spiked xenon, in a borehole to evaluate the effectiveness of the alluvium for this purpose. Research that could be performed in conjunction with this would use the results to determine field-scale properties of alluvial materials for improved modeling of transport of fluid and gases in unsaturated and saturated environments. If it becomes necessary to test an actual nuclear rocket motor, additional NEPA analysis would be conducted.

Aviation Work for Others – Activities would include increased research, development, and use of aerial platforms at the NNSS. To support these activities, additional facilities would be required at Desert Rock Airport (hangars, shops, and other buildings occupying approximately 200,000 square feet) and the Area 6 Aerial Operations Facility (a hangar occupying approximately 20,000 square feet). Additional facilities occupying approximately 5,000 square feet may be required at other locations to support air operations, including testing of various types of manned and unmanned aerial vehicles such as small, remote-controlled, fixed-wing airplanes and helicopters. Unmanned aerial vehicles would be tested for potential use carrying sensors for collecting environmental data (e.g., multi- and hyperspectral imagery) to be used in digital environmental model development and for terrain analysis in arid and semiarid regions.

Active Interrogation – Active interrogation uses penetrating nuclear radiation, such as neutrons or photons, as a probe to stimulate a unique radiation signature from fissionable material. It has been demonstrated as an effective way to sense the presence of SNM, even when it is shielded. Many active interrogation methods are based on the detection of neutrons from fission induced by fast neutrons or high-energy gamma rays (Pozzi n.d.). The energy spectrum of the fission neutrons provides data to identify the fissionable isotopes and materials such as shielding between the fissionable material and the detector. Active interrogation works by using an accelerator or other radiation-generating device to produce a pulsed radiation beam that is directed at a target, then the radiation that propagates from the target is measured, usually between the pulses.

Work for Others Program activities would include support for development of active interrogation systems to detect nuclear material and other materials of interest. NNSA would expand its support for research and development of active interrogation equipment, such as accelerators and other radiation-generating devices, as well as associated radiation detection systems, operations, methods, and training. DHS would use a facility at RNCTEC to conduct this activity, but other Federal agencies may require an additional facility, most likely located in Area 12 or 16. In addition to fixed facilities, temporary test beds would be used for testing accelerators and other radiation-generating devices and detectors. In general, temporary active interrogation test beds would use existing NNSS roads, but could also include some off-road areas. Operations at temporary test beds would most often involve the use of mobile accelerators/radiation-generating devices. Construction of additional support facilities and temporary test beds would disturb about 100 acres of previously undisturbed land over the next 10 years.

The accelerators/radiation-generating devices would be used to generate beams of electrons, x-rays, neutrons, gamma radiation, and other types of radiation, as appropriate, to interrogate target material. Test targets to be interrogated would include radioactive material, SNM, and various other materials utilized as shielding. The quantity of SNM that would be used as a target would be within subcritical limits, i.e., quantities that can be demonstrated to be subcritical under all normal, abnormal, and accident conditions (quantity and nature of process activities must preclude the potential for a nuclear criticality). Test targets would also incorporate various materials to better understand the physical properties associated with the exposure of materials to various forms of energy from the accelerators/radiation-generating devices.

The radiation from these machines would be penetrating, and significant transmission intensities could occur through shields of substantial thickness. Unshielded radiation from these devices would be primarily forward-directed and could travel over long distances (a few miles). This effect is beneficial for measurement situations focused on interrogating objects long distances away from the accelerator/radiation-generating device (often called standoff interrogation). Unshielded radiation fields in the vicinity of these devices are high, and occupational radiation exposure limits for personnel in the immediate vicinity of the device and for several hundred meters downrange could be exceeded without mitigating controls. However, with proper engineered and administrative controls, they can be readily used in a safe manner.

When energetic x-rays interact with materials, they have the potential to cause the ejection of neutrons (as well as protons and other charged particles) from atomic nuclei via photonuclear reactions including (γ,n), (γ,2n), and (γ,p). In fissionable materials, including uranium and plutonium, energetic x-rays can also induce fission to take place via the photofission (γ,fission) reaction. The x-ray energy thresholds and reaction probabilities for these reactions vary from isotope to isotope. Radiation, such as gamma rays, x-rays, or neutrons, produced during the interrogation pulse are called prompt radiation. Fission products also produce delayed radiation over a time period of several hundred seconds after the beam pulse. Radiation exposure from these interactions is expected to be relatively small when compared to the direct radiation from the beam itself at energies below 60 million electron-volts.

Unique differences exist in the energy, emission rates, and emission properties between these prompt and delayed radiations. Photonuclear active interrogation exploits these unique signatures to be able to detect, identify, and characterize different fissionable materials. Neutrons produced in the test object thermalize and are captured or produce fission in short time periods after each radiation pulse. Prompt and delayed photo-fission neutrons can remain in a test object for short periods of time (milliseconds) after each radiation beam pulse. In these short time periods, these residual neutrons can lead to additional neutron-induced fission events.

To measure these signatures, special detector systems must be employed that are simultaneously capable of withstanding the radiation fields generated when the device pulses and achieving very sensitive detection efficiencies for the delayed radiation products.

Initially, energy levels used in active interrogation research and development at the NNSS are not expected to exceed about 60 million electron-volts. Future activities may include machines that operate at energy levels in the range of 100 million electron-volts.

Radioactive tracer experiments – Radioactive tracer experiments would be conducted to validate sensor technology. These experiments would include both underground releases and open-air releases of radioactive noble gases and nonradioactive gases (helium and sulfur hexafluoride). The underground experiments would release up to 27 curies of radioactive noble gases with short half-lives (5 to 36 days); nonradioactive releases would include from about 300 gallons of helium to about 2,000 gallons of sulfur hexafluoride. The underground experiments would include explosive gas releases, pressurized releases, explosive radioactive particulate releases, and a baseline survey of legacy contamination. The open-air experiments would release small quantities of radionuclides with short half-lives. Up to 12 experiments involving open-air releases would be conducted each year. NNSA would comply with applicable requirements of 10 CFR Part 61, Subpart H, for all experiments that could result in a release of radioactive material to the air. Prior to conducting any experiment that would result in a release of radioactive materials to the air, NNSA would conduct an evaluation using EPA-approved methods to estimate the potential radiological dose to the maximally exposed individual at the boundary of the NNSS. For any release that may result in a dose of 0.1 millirem or more, NNSA would submit an application to the Nevada Bureau of Air Pollution Control and EPA for approval to conduct the experiment, in compliance with 40 CFR 61.96. NNSA would ensure that the cumulative annual radiological dose at the boundary of the NNSS resulting from all activities involving radioactive materials would comply with EPA's annual emission standard of 10 millirem (40 CFR 61.92).

New test beds – Additional test beds would be developed to support research and development for sensors, high-power microwaves, and high-power lasers, as required. These new test beds (including new buildings totaling approximately 50,000 square feet of floor space) would be constructed at various locations on the NNSS and would disturb approximately 200 acres of previously undisturbed land. Because there are no specific plans for construction of these new test beds at this time, additional NEPA analysis would be necessary before they could be implemented.

The following new test beds would be developed at the NNSS under the Expanded Operations Alternative:

Nuclear-Fuel-Cycle-Related Radionuclide Release, Diagnostics and Solids Detection, and Characterization Test Bed – In support of the various nuclear nonproliferation treaties in which the United States participates or anticipates participation, NNSA would establish test beds at the NNSS for use in developing sensors to support treaty verification and nonproliferation validation. Facilities to support deployment of fixed uranium oxides and controlled amounts of depleted uranium would include static concrete display pads, static target display pans, thermal targets, and ponds and pools of water.

Specialized Explosive Testing and Manufacture Test Bed – Support for DoD and the U.S. intelligence community would expand to include development of sensors and techniques for detection and defeat of improvised explosive devices, homemade explosives, conventional military ordnance, and chemical explosives, as well as explosives-driven, shaped-charge development and evaluation.

Radio Frequency Generation Test Bed – Technologies would be developed to detect, sample, characterize, and identify radio frequency signatures and observables. The test bed would be used to develop the ability to generate specific signals, to characterize the radio frequency environment, and to monitor tests.

Infrasonic Observations Test Bed – Technologies would be developed to monitor earthquakes and underground disturbances. The test bed would be used to develop the ability to detect specific signals, characterize the seismic environment, and monitor tests.

Chemical Test Bed – Activities at this test bed would include simulated manufacture and releases of illegal drugs by authorized Federal organizations to develop detection and prevention technologies. An existing facility would be used to train personnel and test sensors and procedures for detection of toxic industrial chemicals.

Biological Simulants Test Bed – Activities at this test bed would include manufacture of biological simulants by authorized Federal organizations for use in detection technology development. Biological simulant releases to the soil, the air, or an NNSS sewer/septic system, would emulate anticipated real-world scenarios. Construction to support these functions would disturb up to 50 acres of land.

A.2.2 Environmental Management Mission

The NNSA Environmental Management Mission includes the Waste Management and Environmental Restoration Programs. Under the Expanded Operations Alternative, the Waste Management Program would accept greater volumes of LLW and MLLW from both offsite and onsite sources. As under the No Action Alternative, the Environmental Restoration Program would continue to meet the requirements of the most recent FFACO.

A.2.2.1 Waste Management Program

Waste management operations would support DOE and NNSA research and environmental restoration programs. Under the Expanded Operations Alternative, the waste management objective for the NNSS would continue to be to properly dispose and monitor wastes generated from the NNSS, DoD, and other approved waste generator sites. Approval to ship waste to the NNSS for disposal may be granted only after a waste generator demonstrates that it has a waste characterization and certification program that meets the requirements stated in the NNSS waste acceptance criteria. The process by which NNSA certifies a waste generator, as well as the waste acceptance criteria, is described in greater detail in Chapter 4, Section 4.1.11.1.1.3.

In response to increased levels of operations at NNSA facilities in Nevada under the Expanded Operations Alternative, waste management activities associated with some waste types would increase. In particular, up to approximately 48,000,000 cubic feet of LLW and 4,000,000 cubic feet of MLLW would be disposed at the NNSS. These waste volumes are based on: (1) projections of the respective waste types that are designated for disposal at the NNSS, as well as those without a designated disposal location, as projected in DOE's Waste Information Management System Database as of April 2010, and (2) input from prospective waste generators regarding potential waste streams and/or volumes that are not currently included in the database. Waste estimates include those from West Valley Demonstration Project decontamination and decommissioning, commercial enrichment facilities, Oak Ridge National Laboratory Building 3019 U-233 downblending or direct disposal, disposal of DoD radioisotope thermoelectric generators, and the Global Threat Reduction Initiative.

Table A–6 contains a list of generators of LLW and MLLW under the Expanded Operations Alternative. The quantities shown comprise the inventories currently projected and are used for purposes of analysis. The table is not intended to provide a comprehensive listing of generators that could ship LLW and/or MLLW to the NNSS for disposal or of generator-specific waste volumes that could be disposed in the future. Some of the listed generators may ship larger or smaller quantities than shown based on site-specific determinations. Additionally, some yet-to-be-identified generators may ship LLW and/or

MLLW to the NNSS for disposal. While the quantities from individual generators may vary from those shown in the table, the total volumes would not exceed 48,000,000 cubic feet of LLW or 4,000,000 cubic feet for MLLW. The estimates of LLW and MLLW volumes to be disposed at the NNSS under the Expanded Operations Alternative are based upon conservative estimates from waste-generating facilities, and the aggregated totals reflect this conservatism (i.e., likely overestimate quantities). Additional NEPA review would be conducted if new generators or waste streams were identified.

Table A–6 Waste Generators and Volumes Under the Expanded Operations Alternative [a]

Waste Generators	*Region [b]*	*LLW (cubic feet)*	*MLLW (cubic feet)*
	Out-of-State Generators		
Argonne National Laboratory	Upper Midwest	1,300,000	1,200
Brookhaven National Laboratory	Northeast	120,000	NP
Energy Technology Engineering Center	West	110,000	NP
General Atomics	West	8,400	NP
Idaho National Laboratory	Mountain West	1,000,000	46,000
Lawrence Berkeley Laboratory	West	170,000	96
Lawrence Livermore National Laboratory	West	300,000	580
Los Alamos National Laboratory	Southwest	3,200,000	920,000
Naval Reactor Facility	Mountain West	530	NP
Nuclear Fuel Services	South	430,000	NP
Oak Ridge Reservation	South	2,500,000	370,000
Paducah Gaseous Diffusion Plant	South	5,100,000	1,500,000
Pantex Plant	Southwest	20,000	NP
Portsmouth Gaseous Diffusion Plant	Upper Midwest	14,000,000	58,000
Princeton Plasma Physics Laboratory	Northeast	9,900	NP
Puget Sound Naval Shipyard	Northwest	1,100	NP
Sandia National Laboratories	Southwest	7,800	2,900
Savannah River Site	Southeast	160,000	52,000
SLAC National Accelerator Laboratory	West	570,000	570,000
Separations Project Research Unit	Northeast	NP	2,500
West Valley Demonstration Project	Northeast	6,200,000	750
Waste treatment facilities [c]	Multiple regions	88,000	30,000
Commercial enrichment facilities	Upper Midwest	57,000	NP
U.S. Department of Defense (RTGs)	South (Norfolk, VA)	1,400	NP
Offsite Source Recovery Project	Southwest (San Antonio, TX)	8,500	NP
Total Out-of-State Generators		**36,000,000**	**3,500,000**
	In-State Generators		
Nevada Nuclear Security Site	Not applicable	1,300,000	520,000
North Las Vegas Facility	Not applicable	150	NP
Tonopah Test Range & Nevada Test and Training Range	Not applicable	11,000,000	NP
Total In-State Generators		**12,000,000**	**520,000**
All Generators		***48,000,000***	***4,000,000***

LLW = low-level radioactive waste; MLLW = mixed low-level radioactive waste; NP = none projected; RTG = radioisotope thermoelectric generator; SLAC = Stanford Linear Accelerator Center.

[a] Actual individual waste volumes by generator may be more or less than presented in the table, and other yet-to-be-identified generators may ship LLW and/or MLLW to the NNSS for disposal. The quantities shown constitute the inventories currently projected and are used for purposes of analysis only.

[b] Regional location of radioactive waste generators used in the transportation analysis.

[c] Refers to wastes from DOE generators that are sent to the NNSS for disposal after processing at a variety of treatment facilities.

Note: Totals may not equal the sum of individual values because of rounding.

Use of rail-to-truck transloading (i.e., intermodal transportation) would increase, including the use of transloading facilities within Nevada, should commercial vendors establish such a facility. As addressed for the No Action and Reduced Operations Alternatives, final closure of existing operationally closed disposal units would begin in calendar year 2011, and LLW and permitted MLLW disposal would continue elsewhere at the Area 5 RWMC. The Area 3 RWMS may be returned to operation to address, together with the Area 5 RWMC, the volumes of LLW projected for receipt under this alternative. Within the existing Area 5 RWMC and the Area 3 RWMS, new disposal units would be constructed, filled, and closed, as needed, to accommodate the additional waste volumes.

Under the Expanded Operations Alternative, NNSA would treat and store various types of MLLW received from authorized in-state and out-of-state generators. This would require development of one or more MLLW storage facilities similar to the Hazardous Waste Storage Unit. NNSA may modify existing facilities within the Area 5 RWMC or may construct a new facility for MLLW storage. Treatment capacity for both onsite- and offsite-generated MLLW would be developed. Existing facilities would be used to develop treatment facilities for both in-state- and out-of-state-generated MLLW. The treatment technologies that would be developed include macroencapsulation, stabilization/microencapsulation, sorting/segregating, and bench-scale mercury amalgamation. Appropriate permits would be obtained before expanding MLLW storage capacity or implementing any of these treatment technologies. Initially, additional MLLW storage capacity would be developed on the TRU Pad to accommodate MLLW treatment (for either in-state- or out-of-state-generated wastes), pending development of MLLW storage capacity in existing or new facilities at the Area 5 RWMC. To handle the increased volumes and more-frequent shipment receipt rates of LLW and/or MLLW, an additional waste offloading and staging area would be established within the Area 5 RWMC to maintain optimal disposal operations efficiency.

Waste management activities at the NNSS under the Expanded Operations Alternative would additionally include the following:

- Because of the projected increased annual number of experiments at JASPER and other national security activities, somewhat larger quantities of TRU waste would be annually generated (about 1,500 cubic feet per year). As with the No Action Alternative, TRU waste generated by DOE/NNSA activities in Nevada would be safely stored at the TRU Pad pending shipment off site for disposition along with other legacy or newly generated environmental restoration waste.

- Continued treatment by evaporation of liquids containing small concentrations of tritium. Continued management of hazardous waste (about 170,000 cubic feet would be generated by DOE/NNSA activities) in compliance with applicable regulations and permits.

- Continued management of asbestos and PCB wastes, and hydrocarbon-contaminated soil and debris, in compliance with applicable regulations and permits.

- Continued treatment of explosives at the Explosives Ordnance Disposal Unit in Area 11.

- Continued operation of the Area 23 Class II Solid Waste Disposal Site, the Area 6 Class III Solid Waste Disposal Site (Hydrocarbon Landfill), and the U10c Class III Solid Waste Disposal Site. Approximately 9,400,000 cubic feet of sanitary solid waste and construction and demolition debris would be generated by DOE/NNSA activities at the NNSS and disposed in these landfills over the next 10 years. To accommodate the potential increases in solid wastes that may be generated by various operations at the NNSS under the Expanded Operations Alternative, NNSA would seek permits to construct and operate new solid waste disposal facilities as needed. A new sanitary waste landfill would require approximately 15 acres of land. To support environmental restoration work in Area 25, NNSA would obtain appropriate permits to construct and operate a construction/demolition debris landfill that would disturb up to 20 acres in Area 25 of the NNSS. An estimated 9,700,000 cubic feet of sanitary solid waste generated by DOE/NNSA activities would be sent off site to permitted facilities to be recycled.

A.2.2.2 Environmental Restoration Program

Under the Expanded Operations Alternative, the NNSA Environmental Restoration Program would continue in compliance with the FFACO in the form of characterization, monitoring, and, if necessary, remediation of identified contaminated areas, facilities, or environmental media. The NNSA environmental restoration projects that would continue under the Expanded Operations Alternative include the following:

Underground Test Area Project – Activities would continue as identified under the No Action Alternative, but at a potentially accelerated rate.

Soils Project – Activities would continue as identified under the No Action Alternative for the UGTA and Industrial Sites Projects, remediation of Defense Threat Reduction Agency Sites, and Borehole Management Program, but most activities would accelerate. Cleanup standards for Soils Project sites on lands under the jurisdiction of the USAF are subject to agreement among the USAF, NDEP, and DOE. The No Action Alternative addressed cleanup levels consistent with current land uses. However, if more-stringent cleanup standards are adopted than currently planned or additional sites are included under the FFACO, the volumes of waste requiring transport and disposal would increase. For purposes of analysis under the Expanded Operations Alternative, this SWEIS assumes that, at a number of contaminated soil sites on the Nevada Test and Training Range and the TTR (i.e., Clean Slate 2, and 3, Project 57, and Small Boy), a total of about 504 acres would be excavated to a depth of 0.5 feet and the removed soil would be disposed as LLW at either the Area 5 RWMC or the Area 3 RWMS.

Industrial Sites Project – Activities would continue as identified under the No Action Alternative, but some activities would accelerate. The amount of waste that would require transport and disposal may increase if more sites are required to be remediated than currently planned.

Defense Threat Reduction Agency Sites – Activities would remain the same as those under the No Action Alternative for Defense Threat Reduction Agency environmental restoration activities.

Borehole Management Program – Activities would remain the same as those under the No Action Alternative. NNSA would continue to plug unneeded boreholes on the NNSS. Based on the current schedule and known inventory of unneeded boreholes on the NNSS that need to be plugged, the Borehole Management Program should be complete by the end of 2013.

A.2.3 Nondefense Mission

The Nondefense Mission generally includes those activities that are necessary to support mission-related programs, such as construction and maintenance of facilities, provision of supplies and services, warehousing, and similar activities. Activities related to energy supply and conservation, including renewable energy, are considered part of the Nondefense Mission, as are other research and development activities that may occur at NNSA facilities in Nevada, including activities at the Nevada National Environmental Research Park. As described in the following paragraphs, all Nondefense Mission programs would be modified to some extent under the Expanded Operations Alternative.

A.2.3.1 General Site Support and Infrastructure Program

Under the Expanded Operations Alternative, in addition to small projects to maintain the present capabilities of the NNSS, RSL, NLVF, and the TTR, infrastructure-associated activities would include increasing the capacities and capabilities or extending the ranges of facilities and/or services to accommodate new operational programs, projects, and activities.

In addition to accommodating operational requirements and constructing the new facilities described in Sections A.2.1 and A.2.2, the following infrastructure enhancements would be implemented:

- A new security building in Area 23 of the NNSS would be constructed adjacent to existing security facilities. This project would replace outdated facilities (most built in the 1950s and 1960s) and consolidate security facilities (Buildings 1000, 1001, 1002, 114, 701, 1103, 1106, 1107, 1108 and portions of Control Point-41, -111, and -525) and functions into a new, approximately 85,000-square-foot, two-story facility. The facility would include space for administrative offices, computer servers for systems supporting NNSS operations, training, emergency response, locker rooms, restrooms, storage space, armory, technology development, electronic security system engineering and maintenance, and classified work areas. The new building would decrease external exposure to critical security facilities located outside the secure boundaries of the NNSS. The buildings replaced would be evaluated and demolished or used for another purpose. This project is needed in order to provide a safe and secure NNSS to accommodate mandatory training; house new weapons and technology; consolidate protective force operations; provide electronic security system maintenance and testing; provide continuity of operations; and increase exercises per Site Safeguards and Security Plans, Vulnerability Assessments, and protection strategies designed to ensure adequate protective force staffing levels, equipment, facilities, training, management, and administrative support. The proposed project responds to DOE Orders and Federal Codes and Standards, including DOE Order 470.4a, *Safeguards and Security Program*; DOE Order 226.1a, *Implementation of Department of Energy Oversight Policy*; and 10 CFR Part 851, “Worker Safety and Health; Defense Nuclear Security Program; Master Security Plan; DOE Security Strategic Plan; NNSA Defense Nuclear Security Strategic Framework; and Graded Security Protection Policy.”

- About 38.5 miles of the existing NNSS 138-kilovolt electrical transmission system would be replaced between Mercury Switching Center in Area 23 and Valley Substation in Area 2. The replacement transmission line would be constructed using steel towers on a right-of-way generally paralleling the existing system. Sufficient separation would be imposed between the existing transmission and new line to ensure electrical safety during construction of the new line and demolition of the old line. Where terrain or other factors dictate, sections of the new line may require a new alignment. The new transmission line would include under-built fiber optic cable and all necessary hardware, including conductors and insulators, to complete a fully operational system. This project would require some new access road construction. The transmission line replacement project would occur in three distinct and separately operable stages: (1) Mercury Switching Center to Frenchman Flat Substation in Area 5, with a loop tap at Mercury Distribution Substation (approximately 15 miles); (2) Frenchman Flat Substation to Tweezer Substation in Area 6 (approximately 9.5 miles); and (3) Tweezer Substation to Valley Substation (approximately 14 miles). The replacement transmission line would increase the capacity of the system from the current level of about 40 megawatts to 100 megawatts and improve the efficiency of the system, but would not increase the system operating voltage. Due to the isolation, unreliability, and failure rate of the existing transmission line, replacement is a high priority. The existing line is part of a multi-utility corridor that contains power, communication fiber optics, supervisory control and data acquisitions, and relay protection. Failure of the power line would cause interruption of communication, supervisory control and data acquisitions, and relay protection.

- The telecommunication system on the NNSS would be upgraded. This project would replace the existing wired telephone switch with a new one that would seamlessly transition between the older and newer technologies. The wireless elements of the trunked radio infrastructure would be upgraded to interface with the packet switched technology. This project would transition the subscriber units (telephones, radios, Blackberry devices, and cellular phones) in a time-phased, replacement program to blend all elements of the wired and wireless systems into an integrated telecommunications hierarchy. Elements of the NNSA/NSO telecommunication/information backbone infrastructure are suffering from technological obsolescence, limited capacity, and inability to provide overall enterprise architecture for current and emerging NNSA/NSO mission imperatives. The existing telecommunications system technology for the present generation of telephone plant is approaching 40 years since its first design release and the wireless elements have also reached the end of their service life. The replacement parts for hardware, software, and spare parts are becoming scarce and exceedingly expensive to acquire as time passes. Replacement of the wired telephone switch with one that can seamlessly transition between the older and new technologies is necessary to allow for interaction with computerized features, video sessions, wireless mobile phone applications, and continued safety of full site coverage.

- Buildings in Mercury are typically 30 to 50 years old. To maintain an efficient and effective operation in support of national security activities, it is necessary to replace most of these facilities and supporting infrastructure due to their lack of energy efficiencies and deteriorating condition. The redevelopment would provide an optimization of square footage by reducing operational costs and consolidating operations. The NNSS, as part of the nuclear weapons complex, is a national asset that supports experimentation, testing, training, and demonstration for defense systems and advances in high hazard operations. If no action is taken, the requirements to provide a more energy-efficient, modern infrastructure and more-efficient operational site will affect programmatic requirements as operational costs increase. Mercury would be reconfigured to provide the modern facilities and infrastructure needed to support advanced experimentation and production at the NNSS. This proposed project would: (1) demolish facilities that are no longer needed or are not economically salvageable; (2) identify functional zones to facilitate groupings of similar activities; (3) replace obsolete buildings that are needed to support NNSS activities; and (4) rebuild/remodel selected facilities and infrastructure to extend their useful lives to accommodate existing and future support requirements. Because the reconfiguration of Mercury is conceptual in nature, an appropriate level of NEPA analysis and documentation would be required before it could be implemented.

These projects would contribute to meeting NNSA Strategic Goal 2.1: Transform the Nation's nuclear weapons stockpile and supporting infrastructure to be more responsive to the threats of the twenty-first century.

In addition to maintaining and repairing its infrastructure at the NNSS, RSL, NLVF, and the TTR, NNSA would maintain the existing infrastructure, provide site security, and manage all applicable existing permits and agreements for the former Yucca Mountain Repository. NNSA would perform these functions pending decisions on the disposition of the former Yucca Mountain Repository.

As noted under the No Action Alternative, although considered infrastructure, characterization and monitoring wells developed under the UGTA Project are addressed as part of the Environmental Management Program rather than the General Site Support and Infrastructure Program.

A.2.3.2 Conservation and Renewable Energy Program

Under the Expanded Operations Alternative, NNSA would continue to identify and implement energy conservation measures and renewable energy projects, in compliance with DOE Order 430.2B, *Department of Energy, Renewable Energy and Transportation Management Requirements*; Executive Order 13423, *Strengthening Federal Environmental, Energy, and Transportation Management*; and Transformational Energy Action Management objectives, as described under the No Action Alternative. In addition, NNSA would pursue renewable energy projects, including geothermal and solar projects.

NNSS Photovoltaic Power Project – Under the Expanded Operations Alternative, NNSA proposes to build a 5-megawatt photovoltaic solar power system near the Area 6 Construction Facilities. The 5-megawatt photovoltaic system would require about 50 acres of land, based on a similar project at Nellis Air Force Base (USAF 2006). Construction of this photovoltaic power project would require grading of the entire 50-acre site and erection of either fixed or tracking (one- or two-axis) photovoltaic arrays on most of the graded area. The photovoltaic arrays would be mounted on concrete foundations embedded in the ground. The balance of the graded area would be covered by electrical switchgear, such as inverters to convert the direct current electricity generated by the photovoltaic arrays into alternating current and transformers to raise the voltage of the photovoltaic-generated power to 34.5 kilovolts. A control building would also be erected on the site, along with a small parking area for workers. The facility would be constructed near to and interconnected with the NNSS 34.5-kilovolt electrical distribution system.

Commercial Solar Power Generation – Under the Expanded Operations Alternative, NNSA would allow development of one or more full-scale commercial solar power generation plants in Area 25 of the NNSS. As shown in Figure 3–2, the solar power generation plants would be located within an area of about 39,600 acres in the southwestern part of the NNSS. The reasons for NNSA's consideration of commercial solar power development only in Area 25 and decision to assess the concentrating solar power parabolic trough technology in this *NNSS SWEIS* are addressed under the No Action Alternative in Section A.1.3.2. The facility(ies) could use a variety of solar power-generating technologies (i.e., parabolic trough, power tower, dish engine, photovoltaic) with a combined generating capability of up to 1,000 megawatts. Approximately 10 miles of new 500-kilovolt electrical transmission line (outside of the NNSS) would be required to integrate the electricity generated into the regional system. The existing regional electrical transmission system does not have sufficient capacity to accommodate an additional 1,000 megawatts of power. Development of the solar power generation plants in Area 25 would require construction of additional transmission infrastructure in the region. Independent of, and unrelated to, the commercial solar power generation facilities considered in this *NNSS SWEIS*, NV Energy, a commercial electrical energy company, and Renewable Energy Transmission Company are planning new large capacity transmission line projects that would accommodate the additional electrical generation (see Chapter 6, Section 6.2.4.4, for additional information). The analysis in this SWEIS is based on assumptions for a representative commercial solar project (West 2010). Because there is no specific proposal for a commercial solar power generation project, additional NEPA analysis would be required to evaluate any such proposals in the future.

Geothermal electrical generation – The NNSS would be evaluated to determine the feasibility of demonstrating an enhanced geothermal system for generating electricity that is applicable to a much broader global geographic area than current 'hot spot' geothermal systems. The primary objective would be to demonstrate the viable recovery of practical operating level energy (5 to 50 megawatts) from rock that is hot (greater than 356 degrees Fahrenheit) but does not contain mobile water. The size of an electrical power plant would be unique to each site's geothermal characteristics and would be based on the optimal balance of temperature, rock reservoir size, heat exchange rate, water pressure, flow rate, etc. If feasible, this system would be developed as a laboratory for use both to improve similar systems and to supply power to the NNSS.

Modular geothermal power plants have a relatively small surface footprint. However, initial project support activities are estimated to require about 30 to 50 acres, including space for an excavated, lined sump to store water during drilling and reservoir development. To achieve the desired temperature (greater than 356 degrees Fahrenheit), several boreholes may be drilled up to 20,000 feet deep. Up to 20 acre-feet of water would be required for initial priming of the system (including the boreholes and underground rock reservoir). Based on the experience of LANL at Fenton Hill, New Mexico, water loss from an enhanced geothermal system was found to be relatively low (Brown 2009) and dependent on flow volume and pressure, which are directly related to electrical output of the power plant. A continuously operating 50-megawatt power plant would require an estimated 50 acre-feet of water per year.

There are a number of locations on the NNSS that have enhanced geothermal system potential, as shown by the red and blue circles depicted in **Figure A–3**. Although Figure A–3 includes areas of geothermal energy potential in areas outside of the NNSS, NNSA is not considering any activities associated with the offsite areas. A decision regarding the best location for a geothermal electrical generation facility would depend on a combination of the enhanced geothermal system's potential, use restrictions, environmental and economic considerations, and other factors. Because there are no specific proposals for geothermal exploration or development on the NNSS at this time, additional NEPA analysis would be required before such work could be conducted.

As a separate but related project, a geothermal research center may be established in Mercury. New construction is not expected to be required for a geothermal research center because existing unused or underused facilities would be employed for this purpose.

A.2.3.3 Other Research and Development Programs

Under the Expanded Operations Alternative, NNSA would continue to host existing environmental research projects at the NNSS and would actively promote and expand the National Environmental Research Park Program. NNSA would consider new environmental or other proposed research and/or development projects not related to the DOE or NNSA National Security/Defense or Environmental Management Missions on a case-by-case basis; however, no research and development projects are proposed at this time that would fall within this category.

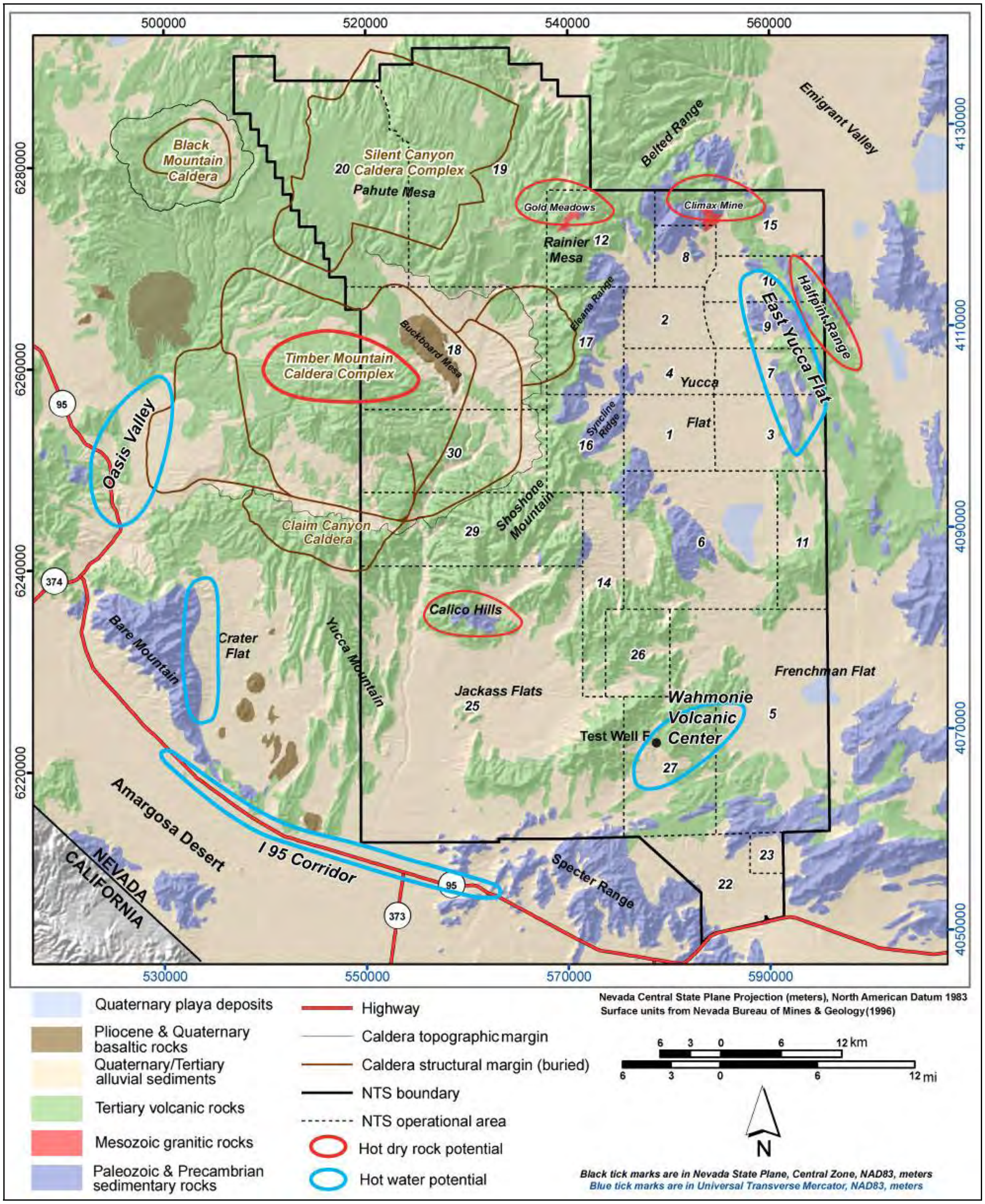

Figure A–3 Potential Locations on the Nevada National Security Site and Surrounding Area for Geothermal Energy Development

A.3 Reduced Operations Alternative

The Reduced Operations Alternative addressed in this SWEIS includes all of the types of activities considered under the No Action Alternative; however, for many programs, the levels of operations would be reduced. The Reduced Operations Alternative, compared to the No Action Alternative, includes diminished activity levels, additional decommissioned facilities, and limited activities in various areas at the NNSS and other NNSA-managed sites in Nevada. Perhaps the most significant changes from the No Action Alternative would be cessation of all activities other than environmental restoration, environmental monitoring, site security operations, and military training and exercises, and changing the land use zone designation to Limited Operations Zone in the northwestern portion of the NNSS (Areas 18, 19, 20, 29, and 30). Under this land use zone change, maintenance of Pahute Mesa, Stockade Wash, and Buckboard Mesa Roads would be terminated and operation of Pahute Mesa Airstrip would be limited to those activities necessary to provide access for the noted activities in these areas. The electrical transmission/distribution system beyond the Echo Peak Substation in Areas 19 and 20 would be de-energized. Ceasing all activities other than those mentioned in Areas 18, 19, 20, 29, and 30 would reduce NNSA's maintenance requirements at the NNSS and allow scarce resources to be focused on the more used areas of the NNSS. It may also reduce impacts on some resources, relative to the No Action and Expanded Operations Alternatives. **Figure A–4** illustrates the configuration of the NNSS under the Reduced Operations Alternative.

The following descriptions of missions, programs, projects, and activities that would be conducted under the Reduced Operations Alternative primarily address only this alternative's differences from the No Action Alternative; that is, those projects and activities that would be conducted at a lower level of intensity or not at all. Because activities under the Reduced Operations Alternative are similar to those under the No Action Alternative, detailed descriptions of the kinds of activities addressed below may be found in Section A.1 of this appendix.

A.3.1 National Security/Defense Mission

Under the Reduced Operations Alternative, NNSA would continue to pursue activities associated with the Stockpile Stewardship and Management, Nuclear Emergency Response, Nonproliferation, Counterterrorism, and Work for Others Programs.

A.3.1.1 Stockpile Stewardship and Management Program

Under the Reduced Operations Alternative, stockpile stewardship and management operations would continue at NNSA facilities in Nevada, particularly at the NNSS, under the conditions of the ongoing nuclear testing moratorium. As under the No Action Alternative, NNSA would continue to maintain its readiness to conduct an underground nuclear weapon test, if so directed by the President.

Under the Reduced Operations Alternative, there would be no change from the No Action Alternative for the following projects and activities associated with the Stockpile Stewardship and Management Program:

- Shock physics experiments at the Large-Bore Powder Gun
- Criticality experiments at DAF
- Disposition of damaged nuclear weapons
- Storage and staging of nuclear devices
- Staging of SNM, including pits
- Readiness-related training and exercises using various kinds of nuclear weapon simulators

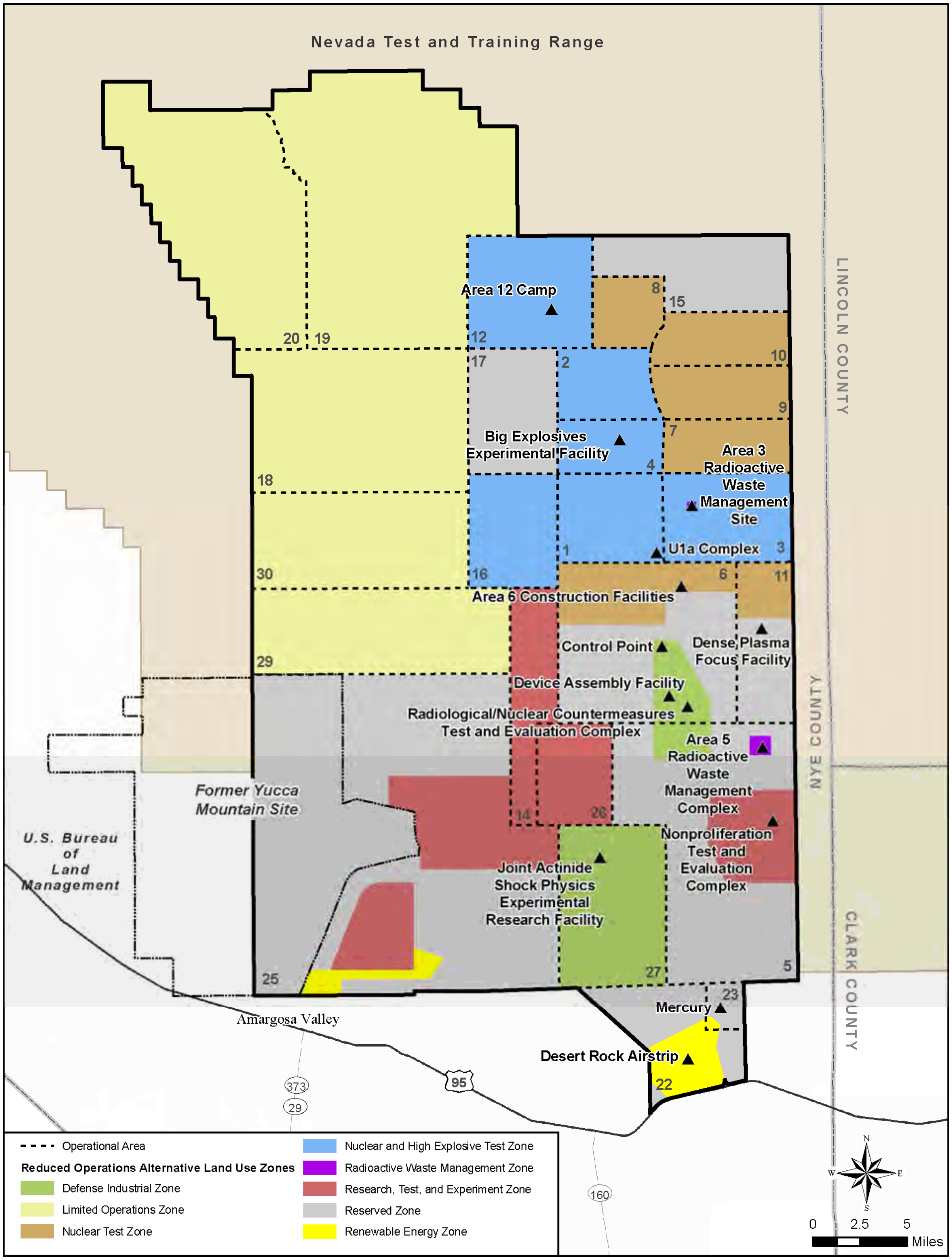

Figure A–4 Nevada National Security Site Land Use Zones and Major Facilities Under the Reduced Operations Alternative

In addition to maintaining these activities, under the Reduced Operations Alternative, the following changes in stockpile stewardship and management activities at NNSA facilities in Nevada would occur:

Dynamic experiments, dynamic plutonium experiments (including subcritical experiments), and hydrodynamic tests – NNSA would annually conduct no more than six of these tests over about a 10-year period. No dynamic or dynamic plutonium experiments or hydrodynamic tests would be conducted in Areas 19 or 20 of the NNSS. Over the next 10 years, a total of five dynamic experiments would be conducted in emplacement holes with each such experiment causing an estimated 20 acres of new land disturbance.

Conventional explosives tests – NNSA would annually conduct up to 10 conventional explosives experiments in the Nuclear and High Explosives Test Zone to directly support the Stockpile Stewardship and Management Program. No other explosives experiments would be conducted.

Shock physics experiments – No more than six shock physics experiments with SNM would be annually conducted at JASPER.

Pulsed-power experiments at the Atlas Facility – The Atlas Facility would be decommissioned and dispositioned.

Fusion experiments at the NNSS and NLVF – NNSA would conduct up to 375 plasma physics and fusion experiments per year: 350 at the Dense Plasma Focus Machine at NLVF, and 25 at the Dense Plasma Focus Machine in Area 11.

Support for Office of Secure Transportation Training – The number of times per year that Office of Secure Transportation training and exercises would be supported would be reduced to four.

Stockpile stewardship and management activities at the TTR – NNSA would not conduct ground- or air-launched rocket or missile operations or fuel-air explosives operations at the TTR.

A.3.1.2 Nuclear Emergency Response, Nonproliferation, and Counterterrorism Programs

There would be no change from the No Action Alternative for activities associated with the Nuclear Emergency Response, Nonproliferation, or Counterterrorism Programs. See Section A.1.1.2 for a detailed description of these activities.

A.3.1.3 Work for Others Program

The Work for Others Program is hosted by NNSA and includes the shared use of certain facilities and resources at the NNSS, RSL, NLVF, and the TTR. Under the Reduced Operations Alternative, NNSA would continue to host the projects and activities of other Federal agencies, such as DoD and DHS, as well as state and local governments and nongovernmental organizations; however, certain activities, such as large-scale explosives tests and experiments, would not be conducted. NNSA also would no longer support the following Work for Others Program activities, which are associated with nonproliferation projects and counterproliferation research and development:

- Conventional weapons effects tests, including live-drop and static explosives detonations using up to 30,000-pound-class bombs
- Development and demonstration of capabilities and technologies to attack and defeat military targets protected in tunnels and other deeply buried hardened facilities

- Conduct experiments using explosives and other explosives operations
- Tests and experiments requiring explosive releases of chemical and biological simulants

No Work for Others Program activities, except military training and exercises, would be conducted in Areas 18, 19, 20, 29, or 30 of the NNSS under the Reduced Operations Alternative. The reason for this exception is that military training and exercises are currently conducted primarily in the western half of the NNSS to ensure adequate separation and to avoid interference with other DOE/NNSA activities. This separation would need to be continued for safety and security considerations.

A.3.2 Environmental Management Mission

The NNSA Environmental Management Mission includes the Waste Management and Environmental Restoration Programs. Under the Reduced Operations Alternative, activities for both of these programs would be the same as under the No Action Alternative, except that less TRU waste would be annually generated (about 250 cubic feet per year) because of the projected reduced annual number of experiments at JASPER and other national security activities. As with the No Action Alternative, waste would be safely stored at the TRU Pad pending shipment off site for disposition along with other legacy or newly generated environmental restoration waste. DOE/NNSA activities would generate an estimated 170,000 cubic feet of hazardous waste, which would be sent off site to permitted treatment, storage, and disposal facilities. Smaller annual quantities of solid wastes (about 3,600,000 cubic feet) are also projected compared to the No Action Alternative because of reduced employment and construction activities.

A.3.3 Nondefense Mission

The Nondefense Mission generally includes those activities necessary to support NNSA-related programs, such as construction and maintenance of facilities, provision of supplies and services, warehousing, and similar activities. Activities related to supply and conservation of energy, including renewable energy and other research and development, are also considered under the Nondefense Mission. Activities under the Reduced Operations Alternative would be the same as those under the No Action Alternative, but at a lower level of effort, reflective of operational levels and establishment of the "Limited Operations Zone."

In addition to maintaining and repairing its infrastructure at the NNSS, RSL, NLVF, and the TTR, NNSA would maintain the existing infrastructure, provide site security, and manage all applicable existing permits and agreements for the former Yucca Mountain Repository. NNSA would perform these functions pending decisions on the disposition of the former Yucca Mountain Repository.

A.3.3.1 General Site Support and Infrastructure Program

Under the Reduced Operations Alternative, infrastructure-associated activities would include repairs, replacements, and projects to maintain the reduced capabilities of the NNSS. Increasing the capacities and capabilities or extending the ranges of facilities and/or services is not proposed under the Reduced Operations Alternative. NNSA would maintain only critical infrastructure within Areas 18, 19, 20, 29, and 30, including the Echo Peak, Motorola, and Shoshone communications facilities; the Echo Peak, Castle Rock, and Stockade Wash Substations; electrical transmission lines interconnecting these substations; and Well 8. Roads within Areas 18, 19, 20, 29, and 30 would only be minimally maintained to provide the basic access necessary to maintain the noted infrastructure.

A.3.3.2 Conservation and Renewable Energy Program

Under the Reduced Operations Alternative, NNSA would allow development of a 100-megawatt commercial solar power generation plant within the Area 25 Renewable Energy Zone, as proposed in the *1996 NTS EIS*, in which it was called the Solar Enterprise Zone. For purposes of the analysis in this SWEIS, NNSA assumed that the commercial solar power generation project would use a dry-cooled concentrating solar power technology, including parabolic troughs similar to the Amargosa Farm Road Solar Energy Project (BLM 2010). Potential impacts of commercial solar power generation at the NNSS would be scaled from the Amargosa Farm Road Solar Energy Project. In addition to a solar power generation plant, additional electrical transmission capacity would be required to integrate the electricity generated onto the regional system. Because no commercial solar power generation project is proposed at the NNSS at this time, additional NEPA analysis would be required before any such project could be implemented.

A.3.3.3 Other Research and Development Programs

Under the Reduced Operations Alternative, NNSA would continue to host existing environmental research projects at the NNSS. NNSA would consider any new environmental or other proposed research and/or development projects not related to the DOE or NNSA National Security/Defense or Environmental Management Missions on a case-by-case basis; however, no research and development projects that would fall within this category are proposed at this time.

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40 CFR Part 761, U.S. Environmental Protection Agency, "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions."

Executive Orders

Executive Order 13327, " Federal Real Property Asset Management."

Executive Order 13423, "Strengthening Federal Environmental, Energy, and Transportation Management."

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Federal Register Notices

61 FR 65551, U.S. Department of Energy, 1996, "Record of Decision: Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada," December 13.

67 FR 79906, U.S. Department of Energy, National Nuclear Security Administration, 2002, "Record of Decision for the Final Environmental Impact Statement for the Relocation of Technical Area 18 Capabilities and Materials at the Los Alamos National Laboratory," December 31.

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DOE Order 226.1a, *Implementation of Department of Energy Oversight Policy*.

DOE Order 430.2B, *Renewable Energy and Transportation Management Requirements*.

DOE Manual 440.1-1A, *DOE Explosives Safety Manual*.

DOE Order 470.4A, *Safeguards and Security Program*.

APPENDIX B
FEDERAL REGISTER NOTICES

DEPARTMENT OF ENERGY

National Nuclear Security Administration

Notice of Intent To Prepare an Environmental Impact Statement for the Continued Operation of the Department of Energy/National Nuclear Security Administration Nevada Test Site and Off-Site Locations in the State of Nevada

AGENCY: U.S. Department of Energy's National Nuclear Security Administration.

ACTION: Notice of intent to prepare an environmental impact statement and conduct public scoping meetings.

SUMMARY: Pursuant to the National Environmental Policy Act (NEPA) of 1969, as amended (42 U.S.C. 4321 *et seq.*), the Council on Environmental Quality (CEQ) and the U.S. Department of Energy (DOE) regulations implementing NEPA (40 CFR Parts 1500–1508 and 10 CFR Part 1021, respectively), the National Nuclear Security Administration (NNSA), a semi-autonomous agency within DOE, announces its intention to prepare a site-wide environmental impact statement (SWEIS) (DOE/EIS–0426) for the continued operation of DOE/NNSA activities at the Nevada Test Site (NTS) and certain off-site locations (the Remote Sensing Laboratory at Nellis Air Force Base, Las Vegas, Nevada, the DOE/NNSA campus in North Las Vegas, and the Nevada Test and Training Range (NTTR) including activities at the Tonopah Test Range (TTR)) in the State of Nevada. The purpose of this notice is to invite individuals, organizations, and government agencies and entities to participate in developing the scope of the SWEIS.

The new SWEIS will consider a No Action Alternative, which is to continue current operations through implementation of the 1996 Record of Decision (ROD) (61 FR 65551; 12/13/96), and subsequent decisions. Three action alternatives proposed for consideration in the SWEIS would be compared to the No Action Alternative. The three action alternatives would differ by either their type or level of on-going operations and may include proposals for new operations or the reduction or elimination of certain operations.

DATES: NNSA invites comments on the scope of this SWEIS. The public scoping period starts with the publication of this notice in the **Federal Register** and will continue through October 16, 2009. NNSA will consider all comments defining the scope of the SWEIS received or postmarked by this date. Comments received or postmarked after this date will be considered to the extent practicable. NNSA will conduct public scoping meetings in Las Vegas, Tonopah and Pahrump, Nevada and St. George, Utah scheduled as follows:

- Thursday, September 10, 2009—2–4 p.m. and 6–8 p.m.
  Frank H. Rogers Science & Technology Building, Desert Research Institute, 755 East Flamingo Road, Las Vegas, NV.
- Monday, September 14, 2009—5:30–7:30 p.m.
  Bob Ruud Community Center, 150 North Highway 160, Pahrump, NV.
- Wednesday, September 16, 2009—5:30–7:30 p.m.
  Tonopah Convention Center, 301 Brougher Ave., Tonopah, NV.
- Friday, September 18, 2009—5:30–7:30 p.m.
  Holiday Inn Conference Center, 850 South Bluff Street, St. George, Utah.

These scoping meetings will provide the public with an opportunity to present comments, ask questions, and discuss issues with NNSA officials regarding the SWEIS. Preparation of the SWEIS will require participation of other Federal agencies. As bordering land managers, the USAF and BLM have an inherent interest in activities at the Nevada Test Site (NTS). The DHS and DTRA are tenant organizations with ongoing and future operations at the NTS: Therefore requests for cooperating agency participation will be extended to the DOE, Department of Defense, U.S. Air Force (USAF) and the Defense Threat Reduction Agency (DTRA), the Department of Homeland Security (DHS), and the Department of the Interior, Bureau of Land Management (BLM.)

ADDRESSES: To submit comments on the scope of the SWEIS, questions about the document or scoping meetings, or to be included on the document distribution list, please contact: Linda M. Cohn, NNSA Nevada Site Office, SWEIS Document Manager, P.O. Box 98518, Las Vegas, Nevada 89193–8518; telephone (702) 295–0077; fax (702) 295–5300; or e-mail address: *nepa@nv.doe.gov.*

FOR FURTHER INFORMATION CONTACT: For general information about the DOE NEPA process, please contact: Carol M. Borgstrom, Director, Office of NEPA Policy and Compliance (GC–20), U.S. Department of Energy, 1000 Independence Avenue, SW., Washington, DC 20585; e-mail: *askNEPA@hq.doe.gov*; telephone: 202–586–4600, or leave a message at 1–800–472–2756; or fax: 202–586–7031. Please note that U.S. Postal Service deliveries to the Washington, DC office may be delayed by security screening. Additional information regarding DOE NEPA activities is available on the Internet through the NEPA Web site at *http://www.gc.energy.gov/nepa.*

SUPPLEMENTARY INFORMATION:

Background

The NTS occupies about 1,375 square miles (3,561 square kilometers) in southern Nevada, and is surrounded on three sides by the U.S. Air Force Nevada Test and Training Range (NTTR) (formerly the Nellis Air Force Range) and the Desert National Wildlife Refuge. The fourth boundary is shared with the Bureau of Land Management. The Nevada Site Office (NSO) operations are managed and performed for DOE/NNSA under contract by a management and operating contractor (currently National Security Technologies, LLC) which teams with personnel from Lawrence Livermore National Laboratory, Los Alamos National Laboratory, and Sandia National Laboratories as well as other governmental entities to perform NTS mission-related activities. NTS is a multi-disciplinary, multi-purpose facility primarily engaged in work that supports national security, homeland security initiatives, waste management, environmental restoration, and defense and non-defense research and development programs (R&D) for DOE/NNSA and other government entities. Historically, the primary DOE/NNSA mission work conducted at NTS was nuclear weapons testing. Since the moratorium on nuclear testing began in October 1992, NTS has been maintained in a state of readiness to conduct underground nuclear tests, if so directed by the President. It also conducts high-hazard experiments involving nuclear material and high explosives (HE); provides the capability to process and dispose of a damaged nuclear weapon or improvised nuclear device; and conducts non-nuclear experiments, hydrodynamic testing, and HE testing. Nuclear stockpile stewardship activities at the NTS include conducting dynamic plutonium experiments that provide technical information to maintain the safety and reliability of the U.S. nuclear weapons stockpile, and conducting research and training on nuclear safeguards, criticality safety, and emergency response. Special Nuclear Materials are also stored at the NTS. Also, in accordance with the amended 1996 *NTS EIS (DOE/EIS–0243)* ROD, NNSA continues to receive low-level and mixed low-level radioactive waste for disposal at NTS. Sandia National Laboratories, a DOE/NNSA contractor, operates the Tonopah Test Range (TTR) near Tonopah, Nevada for flight testing of gravity weapons (including R&D and testing of nuclear weapons components and delivery systems) in support of DOE/NNSA mission requirements.

The 1996 NTS EIS examined existing and potential impacts to the environment from ongoing and anticipated future DOE/NNSA operations conducted over approximately a 10-year period of time at NTS and at off-site locations in the State of Nevada, such as portions of the NTTR including the TTR. NSO's remediation efforts have been completed at Project Shoal and the Central Nevada Test Area.

The four alternatives analyzed in the 1996 NTS EIS were: (1) The No Action Alternative, to continue to operate at the level maintained in the previous 5 years; (2) Discontinue Operations; (3) Expanded Use, and (4) Alternative Use of Withdrawn Lands. DOE's ROD implemented Alternative 3, Expanded Use, plus the public educational activities of Alternative 4, Alternative Use of Withdrawn Lands. This ROD also selected the continuation of low-level and mixed low-level waste management activities as described in the No Action Alternative until decisions on the *Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste* (Waste Management PEIS) (DOE/EIS–0200) could be made. DOE issued its decisions on the Waste Management PEIS in a February 2000 ROD that included an amendment to the 1996 NTS EIS ROD. That February 2000 ROD announced DOE's decision to implement low-level and mixed low-level waste management activities in accordance with the Expanded Use Alternative of the 1996 NTS EIS.

In July 2002, DOE/NNSA completed a 5-year review of the 1996 NTS EIS with the preparation of a Supplement Analysis (SA) (DOE/EIS–0243–SA–01), pursuant to DOE's regulatory requirement to evaluate site-wide NEPA documents at least every 5 years (10 CFR 1021.330) to determine the adequacy of an existing EIS. Based on the 2002 *Supplement Analysis for the Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada* (DOE/EIS–0243–SA–01), DOE/NNSA determined that there were no substantial changes to the actions or impacts evaluated in the NTS EIS, and there were no significant new circumstances or information relevant to environmental concerns. Thus, the existing NTS EIS was adequate and neither a supplemental EIS or a new EIS was required.

In 2003, NNSA prepared a Supplement Analysis entitled *Supplement Analysis for the Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada to Address the Increase in Activities Associated with the National Center for Combating Terrorism & Counterterrorism Training & Related Activities* (DOE–EIS–0243–SA–02) to determine whether an anticipated increase in national security projects after the terrorist attacks of September 11, 2001, required further NEPA analysis. This analysis covered military training/exercises, and testing, evaluation, and development of technology for multiple Federal government agencies. Based upon this review, DOE/NNSA determined that the proposed increase in activities would not result in substantial changes to the NTS EIS or the ROD, and there were no significant new circumstances or information relevant to environmental concerns. Thus, neither a supplemental EIS nor a new EIS was required.

More recently, in 2007, DOE/NNSA initiated its second comprehensive 5-year review of the 1996 NTS EIS and prepared a SA entitled *Draft Supplement Analysis for the Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada* (DOE–EIS–0243–SA–03) which evaluated whether the 1996 NTS EIS continued to remain adequate for ongoing and reasonably foreseeable activities. This document was issued for public review and comment in April 2008. Based upon consideration of comments received on this draft SA regarding potential changes to the NTS program work scope, the DOE/NNSA decided to prepare a new SWEIS for the Continued Operation of the NTS and Off-Site Locations in the State of Nevada for the 10-year period commencing 2010.

Purpose and Need

The purpose and need for agency action is to continue the operation of NTS to provide support for DOE's core missions as directed by the Congress and the President. NTS has a long history of supporting national security objectives through the conduct of underground nuclear tests and other nuclear and non-nuclear activities. Since October 1992, there has been a moratorium on underground nuclear testing. Thus, the present mission of the DOE at NTS is to maintain a readiness to conduct tests. In addition, NTS supports DOE national security related research, development, and testing programs, and DOE's waste management/disposal activities. NTS also provides opportunities for various environmental research projects.

Alternatives for the SWEIS

In accordance with applicable DOE and CEQ NEPA regulations, the No Action Alternative will be analyzed in the SWEIS and will form the baseline for the action alternatives analyzed in the document. In this case, the No Action Alternative will be the continued implementation of the 1996 NTS EIS ROD, and the amendment to the ROD for the NTS (65 FR 10061 at 10065) at DOE/NNSA sites in Nevada over the next 10 years. Additionally, the No Action Alternative will also include the implementation of other decisions supported by separate NEPA analyses completed since the issuance of the final 1996 NTS EIS, including: the *Final Environmental Impact Statement for the Proposed Relocation of Technical Area 18 Capabilities and Materials at Los Alamos National Laboratory* (DOE/EIS–319) and ROD (67 FR 79906); and the *Final Complex Transformation Supplemental Programmatic Environmental Impact Statement* (DOE/EIS–0235–S4) and its RODs (73 FR 77644 and 73 FR 77656) and the *Waste Management PEIS* and ROD (65 FR 10061). The No Action Alternative will also include actions analyzed in eight environmental assessments and their associated Findings of No Significant Impacts, as well as actions categorically excluded from the need for preparation of either an EA or an EIS. These various documents are identified in the 2008 draft SA. Copies of these documents can be reviewed at the DOE/NNSA Public Reading Rooms at 755 E. Flamingo, Las Vegas, Nevada, and 100 North Stewart Street, Carson City, Nevada, and public libraries in St. George, Utah; and Tonopah and Pahrump, Nevada; and on the internet at: *http://www.gc.energy.gov/nepa.*

Three action alternatives will be considered in the SWEIS: Expanded Operations, Reduced Operations, and Renewable Energy Operations. All three of these alternatives will be compared to the No Action Alternative level of operations. The Expanded Operations Alternative will consider a greater proportion of reasonably foreseeable new work from other Federal organizations as identified by cooperating agencies. This work will relate to nonproliferation and counterterrorism, experiments, research, development and testing. Such expansion could include developing test beds for concept testing of sensors, mitigation strategies and weapons effectiveness. The Reduced Operations alternative will consider an overall reduction in the level of operations and closure of specific buildings and structures. The Renewable Energy Operations Alternative will consider renewable energy R&D and the potential deployment of those technologies on the NTS. Any new facilities/activities, regardless of which alternative they are associated with, will be included in the analysis if they are reasonably foreseeable (*i.e.,* proposed within the next 10 years).

This SWEIS will analyze potential impacts resulting from reasonably foreseeable operations and compare these impacts to those projected in the No-Action Alternative. The SWEIS will analyze projected impacts anticipated from operating the NTS and certain off-site locations in the State of Nevada at the current level with some modified work now being proposed at certain facilities, such as the Radiological and Nuclear Test Evaluation Center and the Non-Proliferation Test and Evaluation Center. Examples of newly proposed actions at NTS include development of enhanced national security programs to include increased homeland security activities in sensor development and testing, and chemical and biological simulant releases, as well as stockpile stewardship activities.

Direct and indirect, as well as unavoidable and irreversible and irretrievable impacts to the environment of the NTS and off-site locations in the State of Nevada will be identified and analyzed in the SWEIS. In addition, updated modeling and analysis will be conducted of potential migration of contaminants in the groundwater from historic nuclear testing on the NTS. Where appropriate, mitigation strategies will also be analyzed in the SWEIS. Further, an updated evaluation of NTS operational and transportation accident analyses, and a new assessment of cumulative impacts of DOE/NNSA operations in Nevada will also be included. DOE/NNSA plans to prepare the SWEIS as an unclassified document with a classified appendix. The classified information will not be available for public review; however, it will be considered in the decision-making process of the SWEIS. DOE/NNSA intends to re-evaluate the range of reasonable alternatives following public scoping.

Preliminary Identification of Environmental Issues

DOE/NNSA proposes to address the issues listed below when considering the potential impacts of each alternative. This list is presented to facilitate public comment during the scoping period and will be revisited as DOE/NNSA considers all scoping comments. It is not intended to be comprehensive, nor to imply any predetermination of impacts.

- Potential effects on the public health from exposure to hazardous materials under routine and credible accident scenarios;
- Impacts on surface and groundwater, and on water use and quality;
- Impacts on air quality and noise;
- Impacts on plants and animals, and their habitats, including species that are Federal- or state-listed as threatened or endangered, or of special concern;
- Impacts on geology and soil;
- Impacts on cultural resources such as Native American sites, historic mining and ranching, and Cold War structures;
- Socioeconomic impacts on potentially affected communities and disproportionately high and adverse impacts to minority and low-income populations;
- Potential impacts on land use.
- Pollution prevention and waste management practices and activities;
- Unavoidable adverse impacts and irreversible and irretrievable commitments of resources;
- Potential cumulative environmental effects of past, present, and reasonably foreseeable future actions;
- Potential impacts of intentional destructive acts, including sabotage and terrorism.

SWEIS Process and Invitation To Comment

The SWEIS scoping process provides an opportunity for the public to assist the DOE/NNSA in determining issues. Four public scoping meetings will be held as noted under DATES in this Notice. The purpose of scoping meetings is to provide attendees an opportunity to present comments, ask questions, and discuss concerns regarding the SWEIS with DOE/NNSA officials. Comments and recommendations can also be mailed to Linda M. Cohn as noted in this Notice under ADDRESSES. The SWEIS scoping meetings will use a format to facilitate dialogue between DOE/NNSA and the public and will provide individuals the opportunity to give written or oral statements. DOE/NNSA welcomes specific comments or suggestions on the SWEIS process. The SWEIS will describe the potential environmental impacts of each alternative by using available data where possible and obtaining additional data where necessary. Copies of written comments and transcripts of oral comments provided to DOE/NNSA during the scoping period will be available at the DOE Public Reading Room at 755 E. Flamingo, Las Vegas, Nevada, and public libraries in St. George, Utah; Tonopah and Pahrump, Nevada; and on the Internet at *http://www.nv.doe.gov/library/publications/environmental.*

After the close of the public scoping period, DOE/NNSA will begin developing the draft SWEIS. DOE/NNSA expects to issue the draft SWEIS for public review in mid-2010. Public comments on the draft SWEIS will be received for at least 60 days following publication of the Environmental Protection Agency's Notice of Availability in the **Federal Register**. The Notice of Availability, along with notices placed in local newspapers, will provide dates and locations for public hearings on the draft SWEIS and the deadline for comments on the draft document. Persons who submit comments with a mailing address during the scoping process will receive a copy of the draft SWEIS. Other persons who would like to receive a copy of the document for review when it is issued should notify Linda M. Cohn at one of the addresses provided previously. DOE/NNSA will include all comments received on the draft SWEIS, and responses to those comments in the final SWEIS. Issuance of the final SWEIS is currently scheduled for mid-2011.

Issued in Washington, DC, this 21st day of July 2009.

Thomas P. D'Agostino,

Administrator, National Nuclear Security Administration.

[FR Doc. E9–17751 Filed 7–23–09; 8:45 am]

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APPENDIX C
AMERICAN INDIAN ASSESSMENT OF RESOURCES AND ALTERNATIVES PRESENTED IN THE SWEIS

APPENDIX C
AMERICAN INDIAN ASSESSMENT OF RESOURCES AND ALTERNATIVES PRESENTED IN THE SWEIS

Prepared by the American Indian Writers Subgroup
of the Consolidated Group of Tribes and Organizations

"The land, air, and water are living entities. This is what all indigenous people know, understand, and acknowledge as the foundation and center of our existence. We believe we have been created in these lands. Because of this birth-right and tie to our ancestral land, the CGTO believes we have undeniable rights to interact with its precious resources, and a continuous obligation to protect it. The balance given at Creation involves Indian people, who are charged with interacting in culturally-appropriate ways with the animals, plants, minerals, air, and water. Without Indian people to care for these resources, there can be no balance. These resources cannot achieve the purposes given to them by the Creator.

The opportunity given to the CGTO to contribute our assessment and recommendations to this SWEIS is a highly positive step the DOE has taken toward voicing Indian concerns. As you read our input, you will discover these lands are part of the traditional Holy Lands of the Southern Paiute, Western Shoshone, and Owens Valley Paiute and Shoshone people (Stoffle et al. 1990). As Indian people, we are obligated to manage the land and its resources for seven generations. This means we evaluate and guide our actions in terms of what they could do for or to the next seven generations. The CGTO takes this obligation very seriously and has provided information in Appendix C so we can continue to fulfill our responsibility to care for these lands.

American Indian Writers Subgroup

Summary

Appendix C contains the American Indian assessment of resources and alternatives presented in the *Draft Site-Wide Environmental Impact Statement for the Continued Operation of the Department of Energy/National Nuclear Security Administration Nevada National Security Site and Off-Site Locations in the State of Nevada* (SWEIS). Appendix C has been prepared by the American Indian Writers Subgroup (AIWS) for the Consolidated Group of Tribes and Organizations (CGTO).

Since the beginning of time, the area encompassing the Nevada National Security Site (NNSS) (formerly the Nevada Test Site [NTS]) and the TTR has been a central place in the lives of American Indian tribes. Our land contains resources that are crucial for the continuity of American Indian culture, religion, and society.

In consideration of our strong ties and deep understanding of these lands and their resources, DOE invited the CGTO to participate in the development of the *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada* (1996 NTS FEIS). The CGTO has had a long-standing relationship with DOE, and is comprised of 17 tribes and organizations representing the Southern Paiute, Western Shoshone, and Owens Valley Paiute and Shoshone people. Each of these groups has substantiated cultural and historic ties to the NNSS and the surrounding areas (Steward 1938; Stoffle and Evans 1988).

Our participation in the 1996 NTS FEIS was based on the American Indian Consultation Model[1] for government-to-government interactions among DOE and culturally affiliated American Indian Tribes, which was considered an innovative approach by Federal agencies at that time. Concurrently, the CGTO created Appendix G for the 1996 NTS FEIS and provided italicized text for selected FEIS sections. Building on the success of the CGTO's involvement with the 1996 NTS FEIS, DOE invited the CGTO to assess the alternatives analyzed in the SWEIS and the resources potentially affected.

The CGTO knows American Indian people are charged by the Creator to care for and interact with the environment and its resources in culturally-appropriate ways to maintain balance. American Indian's further believe these lands and their resources contain life-sustaining characteristics that must be properly respected and cared for to ensure harmony. Appendix C contains our assessment and recommendations in an effort to regain balance in the NNSS and TTR area.

C.1 Introduction

Historically, DOE has considered the NNSS to be a safe and isolated place to conduct atomic testing and to dispose of radioactive waste produced at twenty-two other Federal facilities because it is essentially thought to be an empty and ugly wasteland. Conversely, the American Indian people have always believed the NNSS region to be a beautiful holy land filled with special places of power and life-sustaining natural resources.

In response, DOE began long-term research in 1985 concerning the inventory and evaluation of American Indian cultural resources within the NNSS region. This research was designed to comply with the American Indian Religious Freedom Act (AIRFA), which specifically reaffirms the rights of the American Indian people under the First Amendment of the United States Constitution, and to have access to lands

[1] The American Indian Consultation Model was based on the Consultation Model produced for the DoD Legacy Project (Deloria and Stoffle 1994), which was modified and implemented during the development of the 1996 NTS FEIS. This model was again revisited and implemented by the CGTO in the development of the SWEIS, and is presented in Section 10.2.1.

and resources essential in the conduct of our traditional religion. These rights are exercised not only in tribal lands but beyond the boundaries of a reservation (Stoffle et al. 1994b).

These ethnographic studies resulted in several reports that record the regional history of American Indian people and contribute to the understanding of the presence of Indian people in the NNSS area (Stoffle et al. 1990c). They identify properties of cultural and religious significance (Stoffle et al. 1989b, 1990b), provide recommendations for reducing potential adverse effects to cultural resources (Stoffle et al. 1988a), and discuss the consultation process (Stoffle and Evans 1988, 1990; Stoffle et al. 1990b, 1991).

These investigations concluded that the NNSS area is part of the traditional Holy Lands of the Western Shoshone, Southern Paiute, and Owens Valley Paiute and Shoshone peoples, who shared them for medicinal purposes, religious ceremonies, food, and places necessary to traditional narratives and religious beliefs.

It also became clear that these lands contain not only archaeological remains left by our ancestors but also natural resources and geologic formations in the region, such as plants, animals, water sources and minerals; natural landforms that mark important locations for keeping our history alive and for teaching our children about our culture. American Indians used traditional sites in the NNSS region to make tools, stone artifacts, and ceremonial objects; many sites are also associated with traditional healing ceremonies and power places.

Several areas in the NNSS region are recognized as traditionally or spiritually important. For example, Fortymile Canyon is an important crossroad where trails from such distant places as Owens Valley, Death Valley, and the Avawatz Mountain come together. Black Cone, in Crater Flats is an important religious site that is considered to be an entry to the underworld (AIWS 2005). Prow Pass continues to be an important ceremonial site and, because of this religious significance, tribal representatives recommend that DOE avoid affecting this area (Stoffle et al. 1988). Oasis Valley was historically an important area for trade, and continues to be a place recognized for ceremonial use. Other areas are considered important based on the abundance of artifacts, traditional-use plants and animals, rock art, and possible burial sites. Despite the current physical separation of tribes from the NNSS and neighboring lands, American Indians continue to value and recognize the meaningful role of these lands in their culture and continued survival.

The CGTO has consistently expressed its concern about environmental impacts resulting from DOE activities at the NNSS. In response, DOE has routinely used conventional methods in an effort to address these impacts. Although the CGTO has been and continues to be concerned about physical impacts, our deep concerns have also been based in terms of those rooted in spiritual and cultural impacts. One of our key struggles is that DOE and Indian people have largely talked past each other because each uses different cultural definitions of radioactivity and all it has and continues to impact.

The Stoffle and Arnold (2003) study that followed reaffirmed the disconnect among DOE and the tribes and concluded that Indian people expressed three basic ideas – we have been in these lands since Creation, non-Indians have failed to appreciate the importance of these lands, and radioactivity is viewed differently in Indian culture. To scientists, radioactive minerals are well understood with specific measurable physical properties, which if one prepares properly for them, are largely safe for use and disposal in a wasteland like the NNSS. Contrary to this belief, American Indian people explain radioactivity as an angry rock—a spiritual being that has been taken from its home without its permission, used in ways it does not agree with, and is being returned to the land without reducing its anger. The angry rock is alive and as sentient as humans are, because it is both powerful and spiritual. As a powerful spiritual being, the angry rock constitutes a threat that can neither be contained nor controlled by conventional means. It has the power to pollute food, medicine, and places, none of which can be used afterward by Indian people. Spiritual impacts are even more threatening, considering the angry rock would be transported along highways before ultimately being disposed of at the NNSS, thereby affecting animal creation places, access to spiritual beings, and unsung human souls. One of the most troubling conclusions reached by the study is that Indian people believe radioactivity has the potential to be transported along the path to the afterlife (Stoffle and Arnold 2003).

Indian knowledge and use of radioactive minerals in western United States goes back for thousands of years. Areas with high concentrations were called dead zones and placed off limits to average Indian people. Such areas were places of power or energy and could only be visited or the minerals used under the supervision of specially-trained Indian people that are sometimes referred to in the English language as shaman or medicine men. The DOE would benefit from this knowledge.

The CGTO knows that we, as Numic people, are traditional people. Traditional people are those who live a long time in one location and do not destroy the natural environment, themselves, or their way of life. Humans become traditional through a time-intensive process of co-adaptation in which both the people and their environment co-evolve to produce a sustainable way of life. At some level the people and the environment reach unification. As Numic people, we are co-adapted with our traditional lands and these lands are spiritually and physically co-adapted with us. This relationship has been documented through the various studies funded by the DOE. Traditional people are often uniquely threatened by pollution that has the potential of eliminating either our residency in or use of our homeland; thus, we are a special type of people at risk (Stoffle and Arnold, 2003).

Consolidated Group of Tribes and Organizations (CGTO)

In 1994, sixteen tribes and tribal organizations culturally affiliated[2] with the NNSS region formally aligned themselves as the CGTO to reinforce our cultural affiliation rights and to prevent the loss of ancestral ties to the area. The CGTO consists of officially-appointed tribal representatives who are responsible for presenting our respective tribal concerns and perspectives to DOE. Subsequent consultation efforts were expanded to 17 tribal groups and organizations in late 1994 to include the Ely Shoshone Tribe.

Presently, the CGTO consists of the following tribes and official Indian organizations:

- Southern Paiute

  Kaibab Paiute Tribe, Arizona
  Paiute Indian Tribe of Utah
  Moapa Band of Paiutes, Nevada
  Las Vegas Paiute Tribe, Nevada
  Pahrump Paiute Tribe, Nevada
  Chemehuevi Indian Tribe, California
  Colorado River Indian Tribes, Arizona

- Western Shoshone

  Duckwater Shoshone Tribe, Nevada
  Ely Shoshone Tribe, Nevada
  Yomba Shoshone Tribe, Nevada
  Timbisha Shoshone Tribe, California/Nevada

[2] *In anthropological terms, the concept of cultural affiliation means that an ethnic group (or groups) has an established history of prior occupancy and use of a region's lands and resources (Stoffle and Arnold, 2003).*

- Owens Valley Paiute and Shoshone

  Benton Paiute Tribe, California
  Bishop Paiute Tribe, California
  Big Pine Paiute Tribe of the Owens Valley, California
  Lone Pine Paiute-Shoshone Tribe, California
  Fort Independence Paiute Tribe, California

- Other

  Las Vegas Indian Center, Inc., Nevada

Of these groups, 15 are Federally recognized tribes[3]. The Pahrump Paiute Indian Tribe, which consists of a group of Southern Paiutes living in Pahrump, Nevada, has applied for Federal tribal recognition but to date has not received it. In addition, the Las Vegas Indian Center is not a Federally recognized tribe. It is an organization that represents urban Native Americans residing in Las Vegas and Clark County, Nevada.

One of the most enduring achievements of the CGTO has been the development of a model for tribal consultation in southern Nevada, and the formation and evolution of the CGTO as a consulting body working on behalf of its tribal members (Stoffle et al. 2001). This model has and continues to serve as the basis for American Indian consultations throughout federal agencies, including but not limited to DOE, the U.S. Fish and Wildlife Service, the National Park Service, and the U.S. Department of Defense.

Another achievement of the CGTO lies in its recommendation for “preservation-in-place.” This CGTO recommendation prompted the DOE to adopt a “preservation-in-place” policy whereby artifacts are avoided and left undisturbed without collection, wherever feasible. In another case, DOE initiated a program based on CGTO’s recommendation whereby American Indian monitors would be employed on archaeological projects to ensure that American Indian sensitivities are considered, especially during artifact collection.

The CGTO convened a subcommittee, called the American Indian Writers Subgroup, whose recognized role and responsibility is to closely follow specific issues and to report back to the CGTO. The CGTO members then report back to their respective tribal governments or Indian organization governing bodies. Official responses from tribal governments and governing boards are then submitted to DOE or additional guidance is provided back to CGTO representatives.

American Indian Writers Subgroup (AIWS)

In 1995, the CGTO convened the AIWS and designated individuals to represent the three main tribal groups to document our viewpoints on the NNSS area. Specifically, the CGTO-sanctioned role and responsibility of the AIWS was to represent the seventeen tribes and Indian organizations in the development of the 1996 FEIS, and to write Appendix G to that document. The purpose and scope of Appendix G was to represent the American Indian perspective of the actions proposed and analyzed by DOE for the NNSS, and to consider and address the resources potentially impacted.

In October 2009, DOE responded to the CGTO recommendation to replicate tribal involvement in the 1996 NTS FEIS and participate in the development of the SWEIS. The AIWS reaffirms the general

[3] Defined by the U.S. Department of Interior as, “Any tribe, band, nation, or other organized group or community of Indians, including any Alaska Native village…which is recognized as eligible for the special programs and services provided by the United States to Indians because of their status as Indians.” (25 U.S.C. 3001[7]) A list of Federally recognized tribes is maintained by the Bureau of Indian Affairs for the U.S. Department of Interior.

concepts presented in Appendix G and the American Indian perspective presented in italics within discrete sections of the 1996 NTS FEIS. In its development of Appendix C to the SWEIS, the AIWS has focused its attention on the alternatives and activities introduced in DOE's Notice of Intent to develop an environmental impact statement, and the information provided in the SWEIS for the proposed activities, alternative actions, and resources impacted.

C.1.1 Purpose, Scope, and Obligation

Appendix C contains the American Indian assessment of resources and alternatives presented in the *Draft Site-Wide Environmental Impact Statement for the Continued Operation of the Department of Energy/National Nuclear Security Administration Nevada National Security Site and Off-Site Locations in the State of Nevada* (SWEIS). Appendix C has been prepared by the AIWS at the direction of the CGTO.

In consideration of our ties to these lands and their resources, DOE asked the CGTO to review the SWEIS, and develop text for Appendix C and throughout the SWEIS to enable DOE to comply with the intent of Executive Order 13127, "*Consultation and Coordination with Indian Tribal Governments*," and DOE Order 144.1, "*Department of Energy American Indian Tribal Government Interactions and Policy*." DOE Order 144.1 outlines seven principles regarding decision making and interaction with Federally recognized tribal governments. It requests that all Departmental elements ensure tribal participation and interaction regarding pertinent decisions that may affect the environmental and cultural resources of tribes.

Consultation between the CGTO and DOE (representing the United States government) was conducted during DOE's development of the 1996 FEIS, and documented in Appendix G and throughout pertinent resource sections within the FEIS. Similar to Appendix G of the 1996 FEIS, the CGTO's participation during current consultation efforts is not limited to the alternatives presented in the SWEIS, but also integrates relevant recommendations made by Indian people for the survival and sustainability of important American Indian resources such as land, water, air, plants and animals.

American Indian people believe these resources contain life-sustaining characteristics that must be respected and cared for to ensure harmony. The CGTO knows that American Indian people have been charged by the Creator to interact with these resources in culturally-appropriate ways to maintain balance. The CGTO takes this responsibility very seriously and has developed Appendix C in an effort to once again achieve this obligation for the NNSS area. Appendix C represents the official views of the tribal governments and governing boards represented by the CGTO.

C.1.2 American Indian Participation in the SWEIS

The American Indian Writers Subgroup was comprised of the following representatives from the CGTO, with assistance from the Desert Research Institute:

Gerald Kane	Bishop Paiute Tribe	Owens Valley Paiute
Richard Wilder	Fort Independence Indian Reservation	Owens Valley Paiute
Betty Cornelius	Colorado River Indian Tribes	Chemehuevi
Lalovi Miller	Moapa Paiute Tribe	Southern Paiute
Maurice Frank-Churchill	Duckwater Shoshone Tribe	Western Shoshone
Jerry Charles	Ely Shoshone Tribe	Western Shoshone
Richard Arnold	Desert Research Institute	Southern Paiute
Brenda Bowlby	Desert Research Institute	

C.1.3 Acknowledgement

Since the early 1980's, DOE has supported systematic American Indian studies representing tribal elders' perspectives about the cultural significance of the lands and the resources of the NNSS. The CGTO and DOE continue to receive praise for their efforts to preserve American Indian culture and protect resources through the NEPA process. American Indian consultation procedures, described further in Section 10.2.1 of this SWEIS, have and continue to serve as a model for involving American Indians in both current and future NEPA efforts. The CGTO believes these efforts, combined with DOE's commitment to include the tribes in the SWEIS, will facilitate other Federal agencies to include Indian tribes and organizations into their NEPA processes, comply with DOE Order 144.1 and EO 13175, and to enable American Indian tribes and organizations to better protect their holy lands, cultural resources, and sustainably-manage American Indian resources.

C.2 American Indian Assessment of Potentially Affected Resources

The following text closely follows the outline of issues and resources as they arise in the body of the SWEIS. However, Indian people think in terms that involve Indian use of resources in the ways that nature intended. Indian use of resources requires balance-keeping strategies whereby both people and nature are sustained by each other. This means that resources must co-exist, and Indian use of these resources are often intertwined. For example, impacts to water resources also impact biological resources, which may in turn, impact geology and soils, and so forth. Because of this holistic view, discussions of these resources often overlap each other and may be repeated in other sections within Appendix C.

C.2.1 Land Use

As discussed in Section C.1, Introduction, the NNSS area is part of the traditional Holy Lands of the Western Shoshone, Southern Paiute, and Owens Valley Paiute and Shoshone peoples. The lands were central in the lives of these people and were mutually shared for religious ceremony, resource-use, and social events (Stoffle et al. 1990a and b).

American Indians consider the NNSS lands and the surrounding area to contain not only archaeological remains left by their ancestors but also countless natural resources and geologic formations, such as plants, animals, water sources and minerals; natural landforms that mark important locations for keeping our history alive and for teaching our children about our culture. American Indians rely on these lands for medicinal purposes, religious activities and ceremonies, food, recreational use, and integral places described in traditional narratives and religious ceremonies.

The NNSS area and nearby lands were significant to the Western Shoshone, Southern Paiute, and Owens Valley Paiute and Shoshone people. For many centuries, the NNSS area has been a central place in the lives of American Indian tribes, continuously used by these tribes from antiquity to contemporary times. Until the mid-1900s, traditional festivals involving religious and secular activities attracted American Indian people to the area from as far as San Bernardino, California. Similarly, groups came to the area from a broad region during the hunting season and used animal and plant resources that were crucial for their survival and cultural practices. As one elder noted, "*Land is to be respected. It sustains us economically, spiritually, and socially.*"

The CGTO maintains we have Creation-based rights to protect, use, and have access to lands of the NNSS and the immediate area. These rights were established at Creation and persist forever. Despite the loss of many traditional lands on the NNSS to pollution and reduced access, Indian people have neither lost our ancestral ties nor have we forgotten our responsibilities in caring for it.

One elder from the Moapa Paiute Tribe in Nevada responded to the potential impacts of radioactive contamination of his traditional land as follows: *"You non-Indians can move if you pollute the land on which you live, but we were created for this place, so we must face whatever happens here. We cannot move and continue to be Paiute people – this is our land – we are this land."* (Stoffle and Arnold 2003) This view is shared by other culturally-affiliated tribes within the CGTO.

During the past decade, representatives of the CGTO have visited portions of the NNSS and have identified places, spiritual trails, and cultural landscapes of traditional and contemporary cultural significance. Because this is a public document, the exact locations of these areas will not be revealed; however, they do include a burial cave, a Native American Graves Protection and Repatriation Act (NAGPRA) reburial area, and a local trail and ceremonial landscape near a large water tank. These actions by DOE are considered positive steps towards facilitating co-stewardship arrangements between DOE and the CGTO to help co-manage important Indian resources of the NNSS and to regain balance.

In order to fulfill the Holy Land use expectations, the CGTO recommends continuing to identify special places, spiritual trails, and landscapes and setting aside these places for unique co-stewardship and ceremonial access. For example, studies have begun regarding the identification of places, spiritual trails and cultural landscapes in the Timber Mountain Caldera. We strongly encourage DOE to pursue these studies. When completed, these will add an American Indian cultural component that will contribute to the currently recognized importance of this National Natural Landmark.

According to tribal elders, *"The CGTO knows that ethnographic studies conducted at the NNSS have assisted DOE in incorporating a cultural component to understand that natural phenomena are dynamic, interacting processes and offer opportunities and limitations to human use. It helps federal land managers understand the cultural component of the land--such as song scapes, story scapes, spiritual trails--and its complexity. Until these ethnographic studies are completed, there will continue to be uncertainty regarding the full extent of this cultural component and the true impacts to the land from DOE's activities at the NNSS."*

C.2.2 Infrastructure and Energy

Although infrastructure and energy are analyzed in the SWEIS, the CGTO does not believe it is necessary to provide our assessment of these resources at this time.

C.2.3 Transportation

Indian reservations within the region of influence are located in remote areas with limited access by standard and substandard roads. Should an emergency situation arise resulting from NNSS-related activities, including the transportation of hazardous and radioactive waste, it could result in the closure of the main transportation artery to that land. If a major (only) road into a reservation closes, numerous adverse social and economic impacts could occur. For example, Indian students who have to travel an unusually high number of miles to or from school could realize delays or separation from their families or support systems. Delays could also occur for regular deliveries of necessary supplies for inventories needed by tribal enterprises and personal use or medical supplies. Emergency medical services en route to or from the reservation, and purchases by patrons of tribal enterprises could be dramatically impeded. Potential investors interested in expanding tribal enterprises, as well as on-going considerations by tribal governments for future or current tribal enterprises, may significantly diminish because of the real and perceived risks from the transportation of hazardous and radioactive waste associated with NNSS-related activities.

Because of these potential transportation impacts relating directly to NNSS activities, the CGTO recommends DOE collaborate with potentially affected tribes to develop emergency response measures regarding transportation.

C.2.4 Socioeconomics

Indian people prefer to live in our traditional homelands. One primary reason for this is because Indian people have special ties to our traditional lands and a unique relationship with each other. When Indian people receive employment near our reservations, we can remain on the reservations while commuting to work. This pattern of employment tends to have positive benefits for both the Indian community and tribal enterprises like housing. The reservation Indian community has the participation of the individual and his (her) financial contribution. The individual payment for housing is tied to income level, so the more a person earns with the job, the more they pay to the tribal housing office, and thus making tribally sponsored housing more economically sustainable and attractive for tribal governments.

When employment opportunities decline on reservations, however, Indian families must often move away from our reservations to seek employment elsewhere. As Indian people move away, Indian culture is threatened because the number of families living on reservations declines. Tribal members who choose to relocate from their reservations impact reservation economies, school, housing, and emergency services. Both schools and economies are impacted because federal funding available to tribes is based on population statistics.

With local employment opportunities such as those offered by the NNSS for eligible tribal representatives, prices of tribal housing rise because they are based on income. If a positive balance between increased income and increased cost of living in tribal reservations is achieved, then both individual members and the tribe benefit from employment opportunities.

Tribal housing programs become jeopardized if vacancies occur in rental properties and dwellings remain unoccupied. If vacancies occur, tribal revenues and federal funding are adversely impacted and making it more difficult to expand housing programs in future years.

Additionally, vacant units require more maintenance. If tribal members are unavailable to occupy a tribal housing unit, then tribes make units available to non-Indians, and this, too, potentially impacts Indian culture. The increased presence of non-Indians on a reservation or in an Indian community reduces the privacy needed for the conduct of certain ceremonies and traditional practices. When non-Indian children are in constant interaction with Indian children, it creates a situation that potentially disrupts the perpetuation of cultural learning opportunities that occur in everyday life.

When Indian people move away from our reservations several dilemmas occur. Typically, Indian people experience a feeling of isolation from their tribe, culture, and family. When an Indian person relocates to an off-reservation area, the individual finds that there are fewer people of their tribe and culture around them. As a result, Indian people must decide on the appropriateness of practicing traditional ceremonies in the presence of non-Indian people. Indian people are continually torn between the decision to stay in the city or return to the reservation to participate in traditional ceremonies and interact with other tribal members. This dilemma occurs on a regular basis and potentially impacts the livelihood and cultural well-being of off-reservation employees and their families. When off-reservation individuals choose to return to our homelands to participate in traditional ceremonies or renew familial ties, they risk losing their jobs or being subjected to disciplinary actions against their children who attend public schools due to excessive absenteeism.

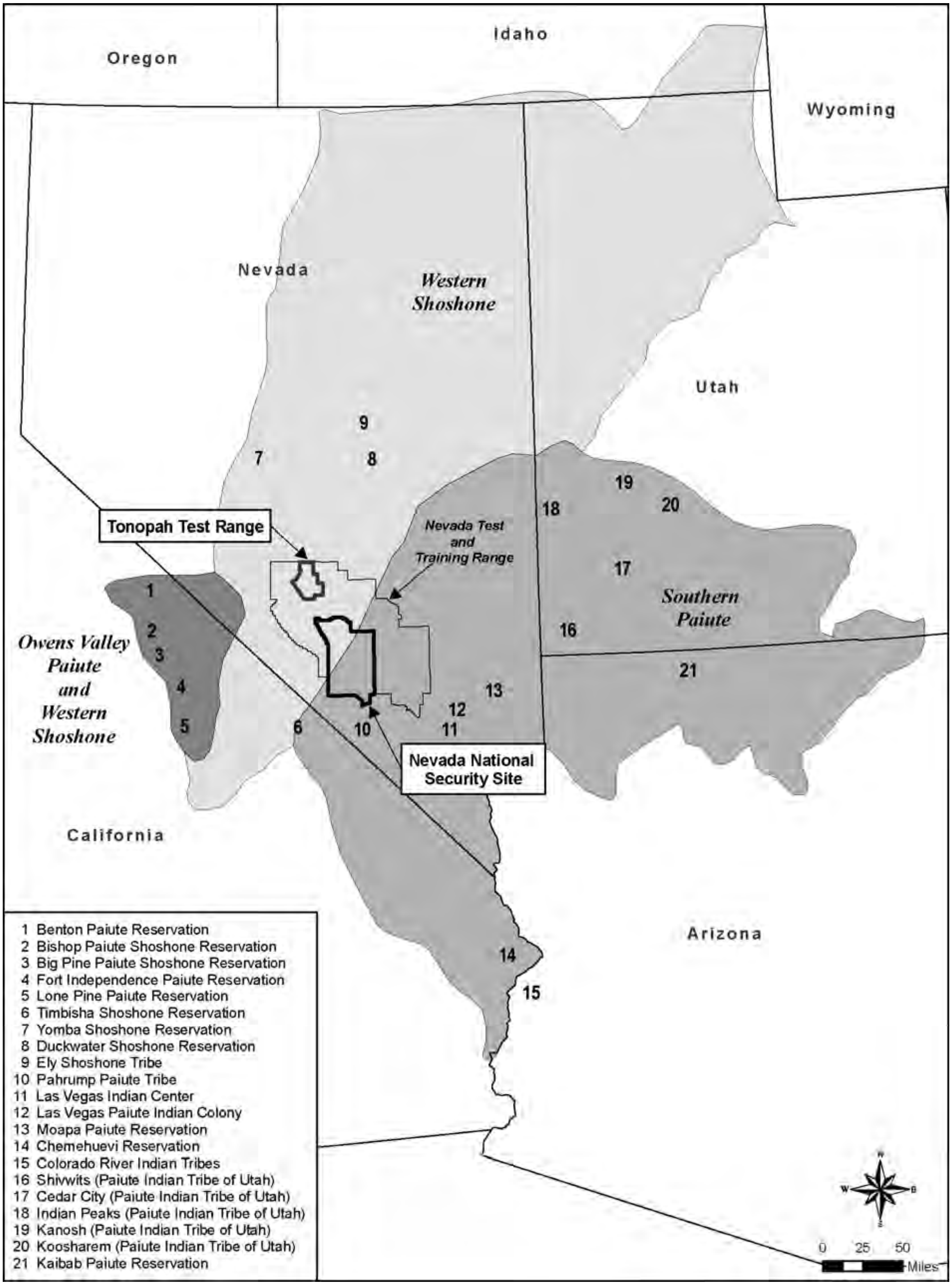

Figure C–1 American Indian Region of Influence for the Nevada National Security Site-Wide Environmental Impact Statement

Under federal and tribal law, American Indian children can be educated in tribally-controlled and federally-certified schools located on Indian reservations (also known as Indian Trust Land). Federal funds are available through the Indian Education Act for the education of Indian children. Compensation from the federal government is provided to any school district that has entered into a cooperative agreement with federally-recognized tribes, whether it be public, private, or an Indian-controlled school.

Small rural Indian reservations must have a sufficient number of people to generate an emergency response capability. The need for emergency services will decline as people move away from the reservation. Tribal members employed in these emergency service occupations may move away because of their marketable skills. Tribal revenues for administration, school, housing, and emergency services will be reduced accordingly, due to a decline in population size.

Many Indian reservations within the region of influence are located in remote areas with limited access by standard and substandard roads. Should an emergency situation occur resulting from NNSS-related activities, including the transportation of hazardous and radioactive waste, it could result in the closure of the main or only transportation artery to our land. If a major (only) road into a reservation closes, numerous adverse social and economic impacts could occur. For example, Indian students who have to travel an unusually high number of miles to or from school could realize delays. Delays also could occur for regular deliveries of necessary supplies for inventories needed by tribal enterprises and personal use. Emergency medical services en route to or from the reservation, and purchases by patrons of tribal enterprises could be dramatically impeded. Potential investors interested in expanding tribal enterprises, as well as on-going considerations by tribal governments for future tribal enterprises, may significantly diminish because of the real and perceived risks from the transportation of hazardous and radioactive waste associated with NNSS-related activities.

Although DOE continues to make strides to diversify their workforce, the CGTO strongly encourages DOE to enhance efforts to hire more Indian people and promote the hiring of Indian-owned businesses to mitigate socioeconomic impacts. We recommend the CGTO serve as a conduit to assist DOE and its contractors in identifying and facilitating employment opportunities for American Indians at the NNSS.

C.2.5 Geology and Soil

When visiting Area 5 of the NNSS in 2009, Indian people observed several traditional use minerals. In particular, Indian people have observed the presence of: (1) Chalcedony, (2) Obsidian, (3) Yellow Chert (otherwise known as Jasper), (4) Black Chert, (5) Pumice, (6) Quartz Crystal, and (7) Rhyolite Tuff. Other traditional use minerals are known to exist in other areas throughout the NNSS.

Minerals are culturally important and have significant roles in many aspects of Indian life. For example, the Chalcedony would have made an attractive offering, which could be acquired here and then left at the vision quest or medicine site located to the north on top of a volcano like Scrugham Peak. Upon return, traditional Indian people would bring offerings back to where we acquired offerings.

Obsidian is a glass-like stone produced by volcanoes. Indian people used a green volcanic glass during curing ceremonies that involved bleeding the patient. Volcanic glass found below Scrugham Peak was used in the first arrow making lessons for young men. Such lessons were held in small rock shelters found along the base of the basalt flow that constitutes Buckboard Mesa. Obsidian flakes were placed before important rock art panels as offering to the spirits that lived on the other side of the passageway provided by the panel. Small obsidian stones, commonly called Apache Tears, have been found on the face of Shoshone Mountain in southern Nevada. This massive deposit of obsidian stones is interpreted by Indian people as being provided by the mountain as both a spiritual backdrop and a location rationale for vision quests (Stoffle et al. 2001).

Volcanic rocks are used in a wide range of ceremonial activities. Indian women enhance the quality of breast milk by squirting it on heated rocks (Stewart 1940; Miller 2004). They are used for medicine society sweat lodge meetings (Zedeno et al. 2001: 146). Indian people call some volcanic rocks "grandfather stones," a designation that reflects reverence as well as wisdom. Such rocks are sought in special places of power and carried over long distances to serve as the heated stones in sweat lodges.

During the evaluation of the 1996 FEIS, the CGTO noted repeated nuclear testing activities had resulted in severe disturbances to the geology and soils, or minerals, in large portions of the NNSS. This seemingly irreparable damage has made certain areas unfit for human use and inaccessible to American Indians who have relied on the earth and rocks for medicine and religious purposes. Sedan Crater, for example, continues to be a dead site; the spirits of the site and resources on it were destroyed in 1962 and the loss can still be felt by members of the CGTO.

The CGTO visited the NNSS in February 2010 and believes the geology and soils are in even poorer condition than they were during the 1996 FEIS due to the continued drought. Drought conditions, ground disturbing site activities, and damage to the soil from previous underground nuclear testing are significantly enhancing erosion. Negative impacts to these resources are long-lasting.

Activities that alter geologic structure also alter hydrologic systems. Such actions result in changes to important geologic and soil features that directly connect the tribes to their homelands in specific, spiritual ways. These changes require spiritual and cultural intervention necessary for restoring balance.

According to tribal elders, *"Bombs have melted the soil. It turned to glass. . . Severe disturbances are still out there. Everything is still suffering from it. . . . All Tribes are in agreement that they want to be here to do what they can to help stop this terrible pressure put on the earth and to sing the songs to help the site and to say prayers. The land has its own songs and when you sing the songs to the land, it'll sing back to you. These songs must be sung to help heal the earth and to restore harmony and balance."*

In the 1996 NTS FEIS and in the 2002 NTS EIS Supplemental Analysis, the CGTO continued to express concerns about the removal of contaminated soils, and reasserted the need for religious leaders to conduct balancing ceremonies and healing prayers at these disturbed locations. The CGTO recommended that tribal representatives provide information about the re-vegetation of a portion of the Double Tracks Site located on the TTR. The CGTO maintains our involvement is still necessary for the Double Tracks site as well as for the Clean Slates site located at TTR; however, we are awaiting DOE's approval to proceed. Because of the long lapse of time since the last visits, the CGTO believes it is necessary to revisit and re-evaluate site conditions.

In general, the mitigation measures proposed by DOE for geology and soils include erosion control through stabilization and re-vegetation. The CGTO is concerned about the unnatural erosion control methods proposed by DOE. In particular, the CGTO struggles with activities that require relocating rocks and soil from where originally placed by the Creator and are being used contrary to the Creator's intention. Indian people know that relocating the soil in a culturally-unacceptable manner can cause adverse impacts to the environment such as the increased potential for noxious weed growth. This could potentially threaten nearby native vegetation and harm Indian people and wildlife that rely on this vegetation for survival.

Therefore, the CGTO recommends DOE implement culturally-appropriate stabilization efforts, and re-vegetation techniques using traditional ecological knowledge. Indian people stabilize our land by offering prayers to explain to the soil why we are removing it, and to thank it for its use. We then remove and protect the topsoil for future use. We replace the soil with dirt and gravel from nearby land only after offering prayers, and re-contour the land out of respect to the visual landscape. Indian people continually re-vegetate our land by offering prayers to bless the seeds and the plants so they will grow strong. We place the seedlings in the direction of the morning sun, and then give thanks for the opportunity to plant them. Our key objective is to protect and restore our ancestral land. We encourage DOE to make provisions for Indian people to participate in its stabilization and re-vegetation to mitigate adverse impacts to geology and soils.

C.2.6 Hydrology

Indian people believe water is a living organism that is fully sentient and willful. The forces of power in the world move along channels and combine into specific nodes or places of power. A common set of these channels follows the path of water. These paths begin at the tops of mountains, especially the highest peaks. Snow and rain falls on these highlands and peaks after being called down by the mountain itself. From this beginning, the water moves downhill in rivulets, washes, and streams. The water often goes underground where it forms similar networks of channels moving in various directions, only somewhat corresponding to what non-native people call hydrologic basins. Water is often attracted to volcanic activity, thus producing significant power places like hot mineral springs.

According to tribal elders, *"Water is life. Water is needed by the plants and animals. Indian people bless themselves with it. It purifies the body. Water is medicine and must be respected. American Indians need it to conduct religious ceremonies. It cleans the earth. It has a vast connection to the underground. Water shouldn't be contaminated or it will die and lose its spirit."*

The CGTO knows we are in a drought because humans have disrespected the earth. It is affecting the balance of our earth's climate. One inevitable implication of the current 100-year drought is that the surface water[4] on the NNSS and immediate areas have diminished and become more sporadic. The modification and availability of surface water has the ability to affect all trophic levels on the NNSS.

Each of the discreet underground water basins, or hydrological basins, has its own origin story. One tribal story tells of a discreet underground water network created by Ocean Woman and where she placed her feet. According to this traditional story, there are points where the water emerges at the surface in springs and seeps. It was here that Ocean Woman placed her medicine staff into the ground and water emerged.

At other points, the surface water in low playa lakes meets the underground water channels. These points are like doorways between the surface world and the underworld.

Rain calling is a basic aspect of American Indian life and culture. Rain ceremonies from the spiritual world help facilitate rain production, and were led by rain callers, often called rain shamans or rain doctors in the English language. The rain caller calls upon the rain by singing songs, and is aided by his spirit helper, which is usually in the form of a mountain sheep. The mountains also had important roles in this activity, and were called up to interact with the clouds and the sky to call down the rain.

Even today, individual traditional Indian people can bring rain. One way this is done is by turning a stinkbug on his back. The rain will come, provided the stinkbug allows a person to tickle his belly with a small stick. As this person prays for rain, he tells the stinkbug why he is asking for rain.

If too much rain fell, certain precautions are taken. For example, the children are not allowed to shake willows that will be used for weaving or to kill frogs as this brings more rain. Hummingbirds were not killed for many reasons, but if they are killed, there will be flooding and lightning storms, with lightning killing the person who killed the hummingbird.

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[4] *Surface water is defined here as water available for shallow rooted plants during rainfall, water available during post-rain ponding, runoff, and absorption, and water recharged into near-surface aquifers.*

The Snow Ceremony was performed to ensure a good winter with heavy snow fall. The spiritual leader, often called a weather doctor in the English language, would call the people together and meet at a special place in the mountains, sometimes near a pine nut gathering area. The spiritual leader would sing songs and offer prayers.

According to Indian tradition, the Snow Ceremony is performed during the late fall when the weather becomes cold. A part of this ceremony involves calling on the Snow Fleas. They represent a special category of American Indian environmental knowledge because they are almost invisible and live at the highest elevations on the mountains. The Snow Fleas are the ones that make the snow wet and absorb into the mountain. Without them, the snow is dry and evaporates quickly, and there is less water for the mountains and the valleys below. The Snow Ceremony is conducted in relationship with ceremony of the seeds where young girls dance with seeds in winnowing trays and a spiritual person sings songs to bring whirlwinds, which surround the dancers and scatter the seeds as a gesture of fertilizing the earth. Water is called upon to nourish the soil and the seeds to make them fertile.

Because water is a powerful being it is associated with other powerful beings, such as water babies. Water babies are like the people of the water. They are highly respected by American Indian culture. If water is contaminated, the water babies will move to other areas that are not contaminated. Proof of their existence has been depicted in historic rock drawings throughout Nevada, including one pecked at the volcanic butte at Black Canyon, Pahranagat Valley.

According to a tribal elder, *"Water babies are important to our culture. They are supernatural. They connect everything and you don't want to disrespect them. The springs are all connected and they follow the water flow. Water babies are supernatural beings and are the guardians of the water. They can make sounds like a baby, and you don't want to startle them because they can disturb life. We are taking their native environment away when we drill and contaminate the water. It angers them. When they get mad, there are adverse impacts to wildlife as they can drain you spiritually and physically."*

Other tribal elders noted, *"Water has been disrespected and therefore it is disappearing. It is a medicine—used to heal and used for healing. It is used for ceremonial purposes in prayer. It is alive and must be awakened. It is spiritual--an essential component to begin religious ceremonies, and part of sweat ceremonies. Historically, water was pure and available to those who respected it. Bathing was a ritual. Now we do not trust the purity of the water because it has been disrespected. Hot springs have been affected and are no longer at the temperatures they used to be."*

Playas

The CGTO knows that playas occupy a special place in American Indian culture. Playas are often viewed as empty and meaningless places by western scientists, but to Indian people, playas have a role and often contain special resources that do not occur anywhere else.

The CGTO knows that playas were used in traveling or moving to places where work, hunting, pine cutting, or gathering of other important foods and medicine could be done. One elder remembers crossing over dry lake beds and traveling around but near the edges, and how provisions were left there and at nearby springs by previous travelers at camping spots.

According to tribal elders, who were interviewed during previous NNSS evaluations, *"Indian people left caches in playa areas for people who crossed valleys when water and food was scarce. Frenchman playa is such a place. Indian people took advantage of traveling through this playa as mountains completely surround this area. The CGTO knows that most dry lakes are not known to be completely dry. An example is Soda Lake near Barstow, California. The Mohave River flows into this dry lake and most of* *the year it looks dry but it actually flows underground. . . . Although some people continue to view Frenchman playa [and other playas] as a wasteland, the CGTO knows it is not."*

When humans respect water, it sustains them and life-forms on the surface, but when water is not treated well, it withdraws its life-giving support and returns to the underworld. The CGTO knows that the springs on Pahute and Rainier mesas and near Buckboard Mesa have dried up. Water has returned to the underworld because it has not been treated correctly by the DOE activities. There are places on the NNSS where the rain falls but does not nurture the plants and animals. The CGTO wants to be involved in DOE hydrology studies because if the water continues to be treated in inappropriate ways, it will totally remove itself from the NNSS.

To minimize some adverse impacts to hydrological resources, the CGTO recommends the DOE allow Indian people access to clean the *pohs* and tanks found throughout the NNSS. *Pohs* and tanks are naturally formed geologic features or basins used to bring and gather water from the rain and to nourish the plants and animals. The water within these *pohs* and tanks are central to our ceremonies to restore balance. By supporting the CGTO proposed project to clean the *pohs* and tanks, DOE will help reduce drought conditions. In turn, this project will provide spiritual, cultural, and ecological benefits to the land and the environment, thereby facilitating our obligation of spiritual and ecological rebalancing. Implementation of this process will require Indian people to identify project sites, to inventory and evaluate the conditions, resources, and features of the site, and to design and implement these mitigation measures.

The CGTO also recommends DOE implement mitigation measures for erosion and sediment control through culturally-appropriate stabilization efforts, and re-vegetation techniques using traditional ecological knowledge. Indian people stabilize our land by offering prayers to explain to the soil why we are removing it, and to thank it for its use. We then remove and protect the topsoil for future use. We replace the soil with dirt and gravel from nearby land only after offering prayers, and re-contour the land out of respect to the visual landscape. Indian people revegetate our land by offering prayers to bless the seeds and the plants so they will grow strong. We place the seedlings in the direction of the morning sun, and then give thanks for the opportunity to plant them. Our key objective is to protect and restore our ancestral land. The CGTO encourages DOE to make provisions for Indian people to participate in the stabilization and re-vegetation necessary to mitigate adverse impacts to hydrological resources.

C.2.7 Biological Resources

The CGTO knows the NNSS contains an ancient playa, surrounded by mountain ranges. The runoff from these ranges serves to maintain a healthy desert floor and environment. Animals frequent the area, and there are numerous animal trails. Animals and the places where they live play a significant part in Indian history and lifestyle. The CGTO knows Indian people have lived on these lands since Creation value all plants and animals, yet some of these occupy more cultural significance in our lives. It is widely known that many Indian people still collect and use plants and animals that are found within the NNSS region. We describe these plants, animals, and insects in this section in an effort to demonstrate their importance to our well-being and survival, and their role in maintaining ecological balance to our Holy Land.

The CGTO knows, based on previous DOE-sponsored ethnobotany studies, that there are at least 364 American Indian traditional use plants on the NNSS (see Table C–1). Plants are still used for medicine, food, basketry, tools, homes, clothing, fire, and ceremony – both social and healing. Sage is used for spiritual ceremonies, smudging[5] and medicine. Indian rice grass and wheat grass are used for breads and puddings. Joshua tree is important for hair dye, basketry, foot ware, and rope. Globe mallow had traditional medicine uses, but in recent times is also used for curing European contagious diseases.

[5] *Smudging is a spiritual cleansing involving the use of smoke from certain plants during prayers and ceremonies.*

In order to convey the American Indian meaning of these plants, a series of ethnobotany studies were conducted and the findings used to establish a set of criteria for assessing the cultural importance of each plant and of places where plant communities exist. The CGTO provided these cultural guidelines so that NEPA analyses and other agency decisions could be assessed from an American Indian perspective.

The CGTO knows, based on previous DOE-sponsored ethnofauna studies, there are at least 170 Indian use animals on the NNSS (see Table C–2). All are culturally important to Indian people.

The CGTO knows if they care for the earth and its resources, the Creator will always provide for them. The NNSS area was among the tribes' places to hunt and trap a variety of animals. It is known that special leaders within each tribe would organize large hunts where many Indian people participated. The Indian people would use these animals for many purposes, including food, bones for tool making, fur for warm blankets, ceremonial purposes, and described in traditional winter stories.

Indian people refrain from eating coyote, wolves, and some birds because these animals are fundamental to stories and songs that teach us life lessons to heal, to build character, and to become better people.

The relationships between the animals, the Earth, and Indian people are represented by the respectful roles they play in the stories of our lives then and now. For example, the NNSS contains a valley where an important spiritual journey occurred. It involved Wolf (*Tavats* in Southern Paiute, *Bia esha* in Western Shoshone, *Wi gi no ki* in Owens Valley Paiute) and is considered a Creation story. Out of respect to our traditional teachings, only parts of this story are presented here. When Wolf and Coyote had a battle over who was more powerful, Coyote killed Wolf and felt glorious. Everyone asked Coyote what happened to his brother Wolf. Coyote felt extremely guilty and tried to run and hide but to no avail. Meanwhile, the Creator took Wolf and made him into a beautiful Rainbow (*Paro wa tsu wu nutuvi* in Southern Paiute, *Oh ah podo* in Western Shoshone, *Paduguna* in Owens Valley Paiute). When Coyote saw this special privilege he cried to the Creator in remorse and he too wanted to be a Rainbow. Because Coyote was bad, the Creator put Coyote as a fine, white mist at the bottom of the Rainbow's arch. This story and the spiritual trails discussed in the full version are connected to the Spring Mountains and the large sacred cave in the Pintwater Range as well as to lands now called the NNSS. These areas comprise the home of Wolf, whose spirit is still present and watches over Indian people and our Holy Land.

Both the mountain sheep and the stink bug are traditionally used to call the rain. Rain calling is a basic aspect of American Indian life and culture. Rain ceremonies from the spiritual world help facilitate rain production, and were led by rain callers, often called rain shamans or rain doctors in the English language. The rain caller calls upon the rain by singing songs, and is aided by his spirit helper, which is usually in the form of a mountain sheep. Rain could also be called by turning a stinkbug[6] on his back. The rain will come if the stinkbug allows a person to tickle his belly with a small stick. As this person prays, he tells the stinkbug why he is asking for rain.

Willows, frogs and hummingbirds are also important to Indian people and our respect for the rain. If too much rain fell, certain precautions are taken. For example, the children are not allowed to shake willows that would be used for weaving or to kill frogs as this brings more rain. Hummingbirds are not killed for many reasons, but if they are killed, there will be flooding and lightning storms, with lightning killing the person who killed the hummingbird.

The Snow Fleas are important to Indian people and our Snow Ceremony. The Snow Ceremony is performed in the fall to ensure a good winter with heavy snow fall. The spiritual leader, often called a weather doctor in the English language, calls the Indian people together and meets at a special place in the

[6] *Called "Bee-voos" in Western Shoshone and Wu-who-koo-wechuts in Southern Paiute.*

mountains, sometimes near a pine nut gathering area. The spiritual leader sings songs and offers prayers. A part of this ceremony involves calling on the Snow Fleas. They represent a special category of American Indian environmental knowledge because they are almost invisible and live at the highest elevations on the mountains. The Snow Fleas are the ones that make the snow wet and absorb into the mountain. Without them, the snow is dry and evaporates quickly, and there is less water for the mountains and the valleys below. The Snow Ceremony is conducted in relationship with ceremony of the seeds where young girls dance with seeds in winnowing trays. A spiritual person sings songs to bring whirlwinds, which surround the dancers and scatter the seeds as a gesture of fertilizing the earth. Water is then called upon to nourish the soil and the seeds to make them fertile.

If any of these plants, animals, and insects, continue to be disrespected, then the hydrological systems and weather patterns will remain unbalanced. The CGTO knows this unbalance has resulted in the drought our land and its resources continue to suffer.

The current 100-year drought has increasingly stressed the physical and spiritual nature of the plants and animals on the NNSS. Its environmental impacts are unprecedented in the history of the operation and management of these lands. The CGTO knows the 100-year drought has modified the abundance and distribution of all animals and plants. The quality, quantity, and distribution of indigenous plants, animals, and insects necessary to sustain a healthy environment and to maintain a productive animal habitat are clearly affected.

Water -- both as free flowing springs and absorbed by plants and distributed to animals -- has diminished. Certain springs have dried up making animals travel into other unfamiliar lands. Food foraging becomes difficult and land dries up. Wildlife has less body fat, which results in shorter hibernation cycles. Indian people have observed that ground squirrels are becoming cannibalistic to survive. Other animals are changing their habits as the environment continues to be impacted by this drought. For example, rabbits are now forced to eat unusual foods like Yucca. According to one tribal elder, *"The cries of some birds have changed since the drought began."*

Two discrete efforts in which the CGTO and DOE can work collaboratively to manage biological resources include pine nut harvesting, and the relocation and reintroduction of the big horn sheep and desert tortoise.

Pine Nut Harvesting

Pine nut harvesting areas present a unique opportunity to address significant cultural and ecological problems. In times past, the pine nut trees were cared for by pruning and whipping to encourage production and reduce dead wood. The areas under and around the trees were kept clean by using these materials during routine visits, and other traditional use plants in the area were cared for as well. Ceremonies and cleaning activities occurred in the spring and fall each year. The removal of Indian people from accessing these areas has resulted in limitations to passing on traditional cultural and ecological knowledge, and in unhealthy ecosystems. The contemporary concerns with wildfires and invasive species such as cheat grass in the Great Basin are issues that can be addressed proactively through the reintroduction of traditional pine nut harvesting practices. This project can provide spiritual, cultural, and ecological benefits to the CGTO, DOE, and the environment, consequently fulfilling the primary goal of rebalancing. Implementation of this project will require Indian people to identify project sites, to inventory and evaluate the conditions, resources, and features of the sites, and to design the restoration plan. This project would involve annual activities and monitoring of site conditions so that potential benefits can be measured.

Part of the mitigation measures presented by DOE in Section 7 of the SWEIS includes notifying the U.S. Fish and Wildlife Service (FWS) of incidental taking of desert tortoises. The desert tortoise is culturally-significant to Indian people because of its healing powers, longevity, and wisdom. It is integral to our traditional stories, well-being and perpetuation of our native culture. Incidental taking of this traditionally-important animal is particularly disturbing to native people. Accordingly, the CGTO must be notified concurrently with the FWS so that we may conduct the necessary balancing ceremonies.

According to information presented in the SWEIS, DOE will conduct preactivity surveys for cultural and biological resources prior to project initiation. If biological resources such as the desert tortoise or its habitat are determined to be present at the proposed project site, and avoidance of these is determined by DOE to be impossible, it is the CGTO's understanding from the information presented in the SWEIS that project biologists will relocate and reintroduce these impacted biological resources elsewhere. Over the past 14 years, various initiatives have been undertaken to relocate and reintroduce certain animals without participation from the CGTO. In particular, this has occurred with the desert big horn sheep and the desert tortoise near the southern portion of the NNSS.

Relocation and reintroduction of animals that require their adaptation to unfamiliar habitats are considered highly sensitive religious acts and require oversight by Indian people. Relocating animals from where originally placed by the Creator causes tremendous stress to the animals. They are in a new environment, where food and water sources are unknown. These animals have been improperly removed with disregard for their families and all they know. They must now seek the songs, prayers and voices of the Indian people, as they are no longer in their homeland. They are isolated. This depletes their spirit. Without cultural intervention, relocated animals are unable to reproduce, and often die of premature deaths due to loneliness, thirst and hunger. Therefore, animals should not be relocated unless absolutely necessary.

The desert bighorn sheep and the desert tortoise are both culturally sensitive animals to Indian people. Among their many special qualities, when used ceremonially, they have the ability to bring rain and reduce drought impacts. The reintroduction of desert bighorn sheep is a critical issue for us. For relocation and reintroduction of animals to be successful, it is essential to have tribal representatives involved throughout this process.

In the 2008 Draft NTS EIS Supplemental Analysis, the AIWS presented information regarding the successful reintroduction of a gray wolf in Idaho during the late 1970's, which was a collaborative effort between American Indians and a Federal agency. On the day of release, a Federal liaison unlatched the door of the cage and the animal scrambled out. Waiting for the wolf was an American Indian holy man in traditional regalia, sitting on a horse and watching. The wolf and man gazed at each other and the man spoke words welcoming the wolf back to its new home. The wolf stood for a few more seconds and accepted the holy man's encouragement and blessing. Then the wolf turned and ran into the forest. Everyone present was very moved by the welcoming back ceremony. They knew that was the right thing to do. The CGTO believes collaborative projects such as this underscores the need for American Indian involvement whenever plant or animal species transplanted from other locations are reintroduced to the NNSS area.

Once reintroduced, the desert bighorn sheep and the desert tortoise must be provided all of the resources and considerations necessary to encourage them to remain in their new location. Resources include spiritual and cultural aspects that must be addressed by tribal specialists and cultural experts, and consideration of other species in the area that may be affected negatively by these relocated animals, or may compete with and impede successful rebalancing. This project can provide spiritual, cultural, and ecological benefits to the CGTO, DOE, and the environment, consequently fulfilling the primary goal of rebalancing. Implementation of this project will require the appropriate cultural experts to identify projects sites, to inventory and evaluate the conditions, resources, and features of the sites, and to design the restoration plan including off-site resources necessary to support project sites such as landings or birthing places. This project would involve annual activities and monitoring site conditions.

The CGTO recommends DOE mitigate adverse impacts to biological resources through avoidance, culturally-appropriate re-vegetation efforts, reintroduction of native animals, and traditional plant and animal management methods. Indian people have extensive, traditional ecological knowledge and deep concern for the biological resources of the area and should participate directly with DOE to mitigate adverse impacts and protect these resources.

According to tribal elders, *"Prior to re-vegetation efforts, we talk to the land to let it know what we plan to do and ask the Creator for its help. We choose our seeds from the sweetest and the best plants, and store them for the winter to dry. When the winter is over, we place the seeds in a moist towel or sock and allow the new plant to sprout. We then plant the sprouts into small containers with soil until they are ready to transplant into the ground. This is a long and delicate process, requiring patience and knowledge passed down from our ancestors. If the plants are struggling to grow, we tag them and move them to face the same direction as the sun."*

The DOE would benefit from this knowledge to enhance their re-vegetation efforts. The CGTO knows DOE struggles with the success rates regarding the density and diversity of native plants during their re-vegetation efforts. A co-stewardship approach to this land with the tribes would enable DOE to enhance their re-vegetation efforts, saving time, money, and resources.

C.2.8 Air Quality and Climate

The CGTO knows that the air is alive. The Creator puts life into the air, which is shared by all living things. When a child is born, he pulls in the air to begin its life. The mother watches carefully to make sure that the first breath is natural and that there is no obstruction in the throat. It is believed if the day of birth is a windy day, it is a good day and the child will have a good life.

According to tribal elders' perspectives from Area 5 NNSS activities, *" . . . You can listen to the wind. The wind talks to you. Things happen in nature. Our people had weather watchers, who are kinds of people who will know when crops and things should be done. They watch the different elements in nature and pray to ask the winds to come and talk about these things. Sometimes you ask the north wind to come down and cool the weather. The north wind is asked to blow away the footsteps of the people who have passed on to the afterlife. That kind of wind helps people, it is positive. The wind also brings you songs and messages. Sometimes the messages are about healing people, a sign that the sickness is gone now from the person, or that it is coming to get that sickness to take it away, or it is coming to bring you the strength that you will need to deal with the illness."*

Air can be destroyed, causing pockets of dead air. There is only so much alive air that surrounds the world. If you kill the living air, it is gone forever and cannot be restored.

Dead air lacks the spirituality and life necessary to support other life forms. Airplanes crash when they hit dead air. During a previous CGTO evaluation of the area, one member of the CGTO compared this Indian view of killing air with what happens when a jet flies through the air and consumes all of the oxygen, producing a condition where another jet cannot fly through it.

As one tribal elder noted, *"The spiritual journey of the Southern Paiute Salt Songs are affected as the air quality is not the same as in the days of old. This Salt Singer wonders what is going to happen if the situation isn't corrected. Southern Paiutes need this spiritual journey to ascend their deceased to the next life."*

As people are emitting things into the air that are unnatural, such as radiation from atomic blasts or dust and debris from decontaminating and decommissioning old NNSS buildings, climatic changes such as droughts are occurring because the air is being disrespected. As the air continues to be disrespected, it perpetuates and intensifies imbalance throughout the environment. This impacts many resources, including the land, soil, water, plants, and animals.

Dust devils in various forms and sizes are culturally significant to Indian people and known to bring harm. The CGTO knows the frequency and intensity of dust devils have increased within the NNSS and the surrounding area. Dust devils contain negative energy, and can disperse hazardous and radioactive contaminants from the soil at the NNSS. Their spirits can bring harm if the air is disrespected and if you watch it or allow them to come near or pass through you. If this occurs, a person will become ill and must seek cultural intervention to heal.

Some Indian people who were present during aboveground nuclear tests at the NNSS believe that the sickness they have came from the radiation. To some of these people, the effects of the radiation were in addition to what happened when the air itself was killed. Some tribal elders believe that even when the plants survived the effects of radiation, the dead air killed many of them or made some lose their spiritual power to heal things.

As noted by tribal elders, *"Sheep and other animals are being born out of season, which places them at greater risk from predators and from living full lives. Consequently, their loss adversely impacts our cultural survival, as many of our stories and traditions surround these animals. Weather is out of balance. For example, when it snows, one can also hear thunder. Native people observe the changed nature of the vegetation and blame the atmospheric change on the air quality from the bomb testing on the NNSS."*

The CGTO recognizes that climatic change is occurring and will continue to impact the natural resources of the NNSS and the surrounding region. When rain gauge data are averaged over a decade they can mask the reality that plants and animals are adjusted to regular cycles of rain and snow. Isolated heavy rain events can increase the annual rainfall amounts, but are largely not useful for sustaining life. Plants and animals need the climate to return to its historic, normal annual rainfall that is more evenly dispersed by season.

The CGTO knows that ceremonies have historically helped manage the climate in the NNSS region. Unfortunately, we have not been able to perform these ceremonies since the NNSS area was used for nuclear testing and our Holy Land continues to suffer. To facilitate the healing of this area, DOE must make provisions for the CGTO to access the land and perform these rituals, which are further described below.

Calling the Rain

Rain calling is an important aspect of American Indian life and culture. Rain ceremonies associated with the spiritual world help facilitate rain production, and are led by rain callers, often called rain shamans or rain doctors in the English language. The rain caller calls upon the rain by singing songs, and is aided by his spirit helper, which is usually in the form of a mountain sheep. The mountains also had important roles in this activity, and are called up to interact with the clouds and the sky to call down the rain.

Individual traditional Indian people can also bring rain. This is done by turning a stinkbug[7] on his back. The rain will come, provided the stinkbug allows a person to tickle his belly with a small stick. As this person prays, he tells the stinkbug why he is asking for rain.

If too much rain falls, certain precautions are taken. For example, the children are not allowed to shake willows that would be used for weaving or to kill frogs as this brings more rain. Hummingbirds are not killed for many reasons, but if they are killed, this brings on flooding and lightning storms, with lightning killing the person who killed the hummingbird.

Snow Making Ceremonies

The Snow Ceremony was performed in the fall to ensure a good winter with heavy snow fall. The spiritual leader, often called a weather doctor in the English language, would call the people together and meet at a special place in the mountains, sometimes near a pine nut gathering area. The spiritual leader would sing songs and offer prayers.

According to Indian tradition, the Snow Ceremony is performed during the late fall when the weather becomes cold. A part of this ceremony involves calling on the Snow Fleas. They represent a special category of American Indian environmental knowledge because they are almost invisible and live at the highest elevations on the mountains. The Snow Fleas are the ones that make the snow wet and absorb into the mountain. Without them, the snow is dry and evaporates quickly, and there is less water for the mountains and the valleys below. The Snow Ceremony is conducted in relationship with ceremony of the seeds where young girls dance with seeds in winnowing trays and a spiritual person sings songs to bring whirlwinds, which surround the dancers and scatter the seeds as a gesture of fertilizing the earth. Water is called upon to nourish the soil and the seeds to make them fertile.

Balancing Ceremonies

The earth needs to be rebalanced. The CGTO knows that the air, the climate and all of the Earth's living resources are struggling to adapt and recover from the current drought. As Indian people, we have a responsibility to help them recover and regain balance. According to tribal elders, "*We need to access strategic locations to restore the climate. We need access to conduct balancing ceremonies for the well-being of the people and the well-being of the future—access to the past, the present, and the future. The prayers are far-reaching, and include the environment, people, and everything. The ceremonies and prayers are needed to renew the earth and should be conducted semi-annually by Indian people.*"

We recommend that Indian people perform balancing ceremonies to try to restore the balance to the air, the climate, and the Earth's living resources. Ideally, balancing ceremonies are done in the spring and fall, to pray for good crops and to pray for plentiful harvest, respectively. At a minimum, DOE should make arrangements for Indian people to access the NNSS annually to perform these ceremonies. Renewal ceremonies, or balancing ceremonies, such as these have successfully been conducted with other federal agencies for many years, and we strongly encourage DOE to do the same.

C.2.9 Visual Resources

All landforms within the NNSS have high sensitivity levels for American Indians. The ability to see the land without the distraction of buildings, towers, cables, roads, and other objects is essential for the spiritual interaction between Indian people and our traditional lands.

[7] Called "Bee-voos" in Western Shoshone and Wu-who-koo-wechuts in Southern Paiute.

Views from places are an important cultural resource that contributes to the location and performance of American Indian ceremonialism. Views combine with other cultural resources to produce special places where power is sought for medicine and other types of ceremony. Views can be of any landscape, but more central viewscapes are experienced from high places, which are often the tops of mountains and the edges of mesas. Indian viewscapes tend to be panoramic and are made special when they contain highly diverse topography. The viewscape panorama is further enhanced by the presence of volcanic cones and lava flows.

Viewscapes are tied with songscapes and storyscapes especially when the vantage point has a panorama composed of multiple locations described by traditional songs or stories. Our traditional songscapes and storyscapes can be compromised if projects like geothermal energy development are pursued. If geothermal resources are altered, our songs and stories will be impacted and will no longer accurately reflect key traditional aspects of the viewscape.

The CGTO recognizes the cultural significance of viewscapes and have identified a number of these on the NNSS. The Timber Mountain Caldera contains a number of significant vantage points with different panoramas including but not limited to Scrugham Peak, Shoshone Mountain, and Buckboard and Pahute Mesas. The CGTO feels revisiting sites within the viewscapes are essential to Indian people to interact with the land, communicate with the spirits who watch over the land, conduct religious ceremonies with prayers and songs, and monitor each site’s condition. Special considerations should be given to tribal elders and youth to provide an educational experience and reinforce positive connections with our culture.

Central to the Indian experience of viewscapes is isolation and serenity in an uncompromised landscape. If construction and operation of the proposed activities proceed in a culturally-inappropriate manner, then visual resources within the NNSS area will be adversely impacted, further perpetuating an unbalanced environment. To restore balance to the environment and it’s visual resources, the DOE must provide access for Indian people to conduct religious and cultural ceremonies to fulfill traditional obligations. In this manner, we can restore and preserve our spiritual harmony as a whole.

The CGTO knows many of the activities described under the proposed action and alternatives, such as those associated with facility construction and environmental restoration, will adversely impact visual resources. For Indian people, the adverse impact to visual resources will most certainly impact the spiritual harmony of the environment as a whole. Facility construction and operation will impede visual resources, and affect the solitude and cultural integrity of the land.

Visual resources may be negatively impacted if proposed solar enterprise zones and geothermal projects are pursued. The CGTO must be part of any additional, future discussions of these projects at a minimum as these may impact visual resources and may degrade traditional and cultural ceremonies.

According to the information presented by DOE in the SWEIS regarding the no action alternative, the CGTO knows the NNSS has been selected to pursue the development of the solar enterprise zone within Area 25. We also understand the project schedule presented in the Memorandum of Understanding between DOE and DOI initiates environmental evaluations in July 2010. The CGTO must be part of any additional, future environmental assessments as this proposed activity will adversely impact visual resources and degrade traditional and religious ceremonies. The visual quality of the landscape will lose its integrity and the viewscape will be marred from the introduction of considerable infrastructure directly visible from U.S. 95. For Indian people, an adversely impacted resource will most certainly impact the spiritual harmony as a whole. Therefore, Indian people will need to perform ceremonies, offer prayers, and sing songs in an effort to mitigate these impacts. If construction proceeds, DOE will need to make provisions for Indian monitors to assess the construction footprint and implement traditional techniques that require minimum ground-disturbing actions.

Fundamentally, the CGTO struggles with the idea of pursuing solar energy as a "cleaner" form of energy and the potential impacts to the Sun. According to some tribal elders, *"The Sun is like a big battery. Once you drain its power, will it die? For those spiritually connected to the Sun, we are concerned about unnaturally harnessing it's power. We know the Sun was given only so much energy. If the Sun is drained, how will it be replenished? If the Sun goes away, everything will die. The stories and activities of our ancestors are tied greatly to the Sun. Today, our prayers and ceremonies still travel or rely on its strength."* Because of the complexity and potential implications to the environment, to the cultural and visual landscape, and for our own survival, it is imperative that DOE support an ethnographic study to evaluate the cultural implications of pursuing solar energy on the NNSS. The CGTO also recommends Indian people provide their expertise in the development of the Solar Enterprise Environmental Assessment.

Although DOE proposes to mitigate visual resource impacts by painting structures to reduce visibility, the CGTO knows additional mitigation measures are necessary. The CGTO recommends that landscape modifications, including those associated with environmental restoration activities, be done in consultation with American Indians. Specifically, we recommend DOE make provisions for Indian people to access the land and culturally assess its visual resources. DOE should employ Indian people to participate in annual monitoring of land disturbing activities throughout the duration of the project. The CGTO should also participate in restoring the land, and concealing infrastructure using traditional Indian re-vegetation methods, as we have described in Section C.2.7. Finally, we strongly encourage DOE to make provisions for Indian people to conduct ceremonies, and offer prayers and songs in an effort to re-balance this adversely impacted resource.

C.2.10 Cultural Resources

American Indians consider cultural resources to include not only archaeological remains left by their ancestors but also natural resources and geologic formations in the region, such as plants, animals, water sources, minerals, and natural landforms that mark important locations for keeping their history alive and for teaching their children about their culture.

The NNSS area and nearby lands were significant to the Western Shoshone, Southern Paiute, and Owens Valley Paiute and Shoshone people. The lands were central in the lives of these people and were mutually shared for religious ceremony, resource use, and social events (Stoffle et al. 1990a and b). When Europeans encroached on these lands, the numbers of Indian people, their relations with one another, and the condition of their traditional lands began to change. European diseases killed many Indian people; European animals replaced Indian animals and disrupted fields of natural plants; Europeans were guided to and then assumed control over Indian minerals; and Europeans took Indian agricultural areas. Indian people believe that the natural state of their traditional lands was what existed before European contact, when Indian people were fully responsible for the continued use and management of these lands.

The withdrawal of Nevada's lands for military purposes in the 1940's, followed by use of the land by the DOE continued the process of Euroamerican encroachment on Indian lands. Land-disturbing activities followed, thus causing some places to become unusable again for Indian people. On the other hand, many places were protected by this land withdrawal because "pothunters" were kept from stealing artifacts from rock shelters and European animals were kept from grazing on Indian plants. The forced removal of Indian people from the land was combined with their involuntary registration and removal to distant reservations in the early 1940s. Indian people were thus removed from lands that had been central to their lives for thousands of years.

The CGTO knows, based upon its collective knowledge of Indian culture and past American Indian studies, that American Indian people view cultural resources as being interconnected. Thus, certain systematic studies of a variety of American Indian cultural resources must be conducted before the cultural significance of a place, area, or region can be fully assessed. The following is a list of studies that are required for a complete American Indian assessment:

1. Ethnoarchaeology – the interpretation of the physical artifacts produced by our Indian ancestors
2. Ethnobotany[8] – the identification and interpretation for the plants used by Indian people
3. Ethnozoology[9] –the identification and interpretation of the animals used by Indian people
4. Rock art – the identification and interpretation of traditional Indian paintings and rock peckings
5. Traditional Cultural Properties – the identification and interpretation of places of central cultural importance to a people, often referred to as "power places" by Indian people
6. Ethnogeography – the identification and interpretation of soil, rocks, water, and air
7. Cultural landscapes – the identification and interpretation of spatial units that are culturally and geographically unique area for American Indian people. Examples of these include songscapes, storyscapes, and spiritual trails.
8. Ethnoastronomy – includes the identification and interpretation of the universe within and beyond the earth's atmosphere, and its influence on American Indians and their environment.

When all of these subjects have been studied, American Indian people assess the information and answer three critical questions: (1) What is the natural condition of this portion of our traditional lands? (2) What has changed due to NNSS activities? And, (3) What impacts will proposed activities have on either furthering existing changes in the natural environment or restoring our traditional lands to their natural condition? Tribal governments and organizations must then have the opportunity to review the recorded thoughts of its elders to determine their support of the conclusions.

DOE has supported several cultural resource studies at the NNSS, most occurring as a result of recommendations made by the CGTO in the 1996 NTS FEIS and commitments made by DOE in the subsequent Record of Decision. Many of these studies are cited throughout Appendix C of the SWEIS. These studies were also designed to comply with various federal laws and executive orders, including AIRFA, Native American Grave Protection and Repatriation Act, and Executive Order 13007, *Indian Sacred Sites*.

Through these studies, the CGTO confirmed that American Indians used traditional sites in the NNSS area to make tools, stone artifacts, and ceremonial objects; many sites are also associated with traditional healing ceremonies and power places. Several areas in the NNSS region are recognized as traditionally or spiritually important. For example, Fortymile Canyon was an important crossroad where trails from such distant places as Owens Valley, Death Valley, and the Avawatz Mountain came together. Black Cone, in Crater Flat, is an important religious site that is considered to be an entry to the underworld. Alice Hill, (refine location with acceptable language) is also regarded as a culturally important place (AIWS 2005). Prow Pass was an important ceremonial site and, because of this religious significance, tribal representatives have recommended that DOE avoid affecting this area (Stoffle et al. 1988). Oasis Valley was another important area for trade and ceremonies. In 1993, tribal members visited a rockshelter site containing perishable basketry and crookneck staff on the NNSS, and recommended that the items be left in place, with annual monitoring to assess their condition. Other areas are considered important based on the abundance of artifacts, traditional-use plants and animals, rock art, and possible burial sites.

[8] *Ethnobotany is sometimes also referred to as ethnoflora.*
[9] *Ethnozoology is sometimes also referred to as enthofauna.*

The CGTO knows the distribution and density of sites has not changed since the 1996 NTS EIS. We know the largest number of recorded cultural resources is in the northwest part of the NNSS, on and around Jackass Flats, Yucca Mountain and Shoshone Mountain. This is because numerous activities were conducted on those portions of the NNSS within the last 14 years, less attention has been directed to these regions, and adverse impacts to these areas have been minimized.

The CGTO recommends tribal visits to monitor the state of cultural sites located within the NNSS and to offer blessings. The CGTO also recommends tribal visits to areas that have been designated for repatriation, such as the Timber Mountain area, and periodic assessments conducted to comply with NAGPRA. According to a tribal elder, *"When Indian people are buried, they are never meant to be disturbed. Laws, such as NAGPRA, are difficult for Indian people to implement because they force us to come up with blessings and methods to address something abnormal and contrary to ceremonial intent."*

C.2.11 Waste Management

We continue to strongly oppose the transportation, storage and disposal of radioactive waste at the NNSS; however, Indian people must continue to fulfill our birth-rite obligation to care for our Holy Land and do what we can to try to restore balance to Area 5 and other contaminated locations.

The CGTO knows the NNSS is used to dispose of low-level radioactive waste and low-level mixed radioactive waste (i.e., containing certain hazardous wastes) in Area 5, and non-hazardous waste and debris. Indian people hold traditional and scientific views of radioactive materials and waste. As an example, the former builds on the view that all resources--including the rocks--are alive. Radioactive rocks are powerful, but they can become "angry rocks" if they are removed without proper ceremony, used in a culturally inappropriate way, disposed of without ceremony, or placed where they do not want to be (Stoffle et al. 1989a and 1990c). The practice of dealing with "bad medicine" or neutralizing negative forces is a part of our traditional culture. Indian knowledge and use of radioactive rocks, or minerals, in the western United States goes back for thousands of years. Areas with high concentrations of these minerals are called dead zones. Such areas contain places of power or energy and can only be visited or certain minerals used under the supervision of specially-trained Indian people, who are sometimes referred to in the English language as a shaman or medicine man (Stoffle and Arnold 2003). Therefore, the DOE would benefit from this knowledge if applied correctly.

A head Salt Song singer and religious leader for the Chemehuevi Paiutes once explained the impacts of radiation as follows:

"Our spirits will paint their faces and become angry because they are disturbed by the presence of angry rocks. When we are out there now, it is still and peaceful; it is like being in a church chamber. Radiation will disturb the harmony . . . It will no longer be the same. It will be violated. All the previous songs stories that have been shared in the area will be disturbed. Once a song is sung it continues to be there. When you sing a song you are on the trail – your spirit is making that trip. You are describing where you are at and what is happening. You tell in the song where you are and what you are doing. When people go to these areas today a person can get a song. Previous songs live in the mountains in the canyons. If you were a gifted person that was meant to be an owner of the song you can actually hear it. . . . There are still areas today where you can go and hear the song. Some people hear the songs and it scares them because they do not know what it is. Young people need to be told what it is they are hearing. The places need to be protected from damage so the songs continue to be there for future generations. It is like a delayed echo that never goes away and can come again and again to new people."

We are very concerned about the tritiated liquids disposed at the NNSS and treated by evaporation into the air from ponds, open tanks, and sewage lagoons. The CGTO is concerned about the ponds drying up and the airborne residue adversely impacting the environment.

According to tribal elders,

"Evaporating tritium like this is not a natural process. The natural environment is altered. The wildlife could drink this contaminated water, birds could land on the ponds, insects and vegetation can become contaminated. This contamination would then adversely impact the food chain. We are concerned the animals will become contaminated or sick if they ingest other contaminated species in the food chain. How can they clean themselves to survive? How can DOE contain this contamination? "

We are also concerned about adverse impacts to the land, animals, plants, water, air, and insects from the waste and noise generated during explosive waste detonation at the Area 11 Explosives Ordnance Disposal Unit. Indian people have witnessed the destructive force of explosive detonations and the resulting destruction to the environment. For example, animals relocate to unfamiliar habitats, which adversely impact their survival rate. Air is adversely impacted, increasing the occurrence of dead air[10]. Noise and vibration from the detonations impact the insects, and disrupt vegetation growth.

Indian people know if the earth and environment are being disrespected, such as in Areas 5 and 11, the spirits that protect and watch over these can become upset and respond negatively. This can result in the characteristics of the environment changing, causing animals to leave their natural habitats, reducing the native vegetation[11], further reducing water resources, and increasing occurrences of perceived mishaps.

The CGTO is also concerned about transporting hazardous and radioactive waste through American Indian homelands and adversely impacting their health and environment. Many of the Indian land within the region of influence are located in remote areas with limited access by standard and substandard roads. Should an emergency situation resulting from NNSS related activities including the transportation of hazardous and radioactive waste occur, it could result in the closure of a major reservation road. If a major (only) road into a reservation is closed, numerous adverse social and economic impacts could occur. For example, Indian students who have to travel an unusually high number of miles to or from school could realize delays. Delays also could occur for regular deliveries of necessary supplies for inventories needed by tribal enterprises and personal use. Purchases by patrons of tribal enterprises and emergency medical services in route to or from the reservation could be dramatically impeded. Potential investors interested in expanding tribal enterprises and on-going considerations by tribal governments for future tribal developments may significantly diminish because of the perceived risks associated with NNSS related activities including the transportation of radioactive waste.

Finally, the CGTO struggles with the ethics of relocating radioactive waste from other American Indian lands so those people can live without fear of radioactivity. We are greatly concerned about the adverse spiritual, environmental, and health impacts associated with relocating these angry rocks from their current locations to our Holy Land. We believe transporting these to our land perpetuates animosity and discord among tribal governments. We strongly encourage DOE to host a break out session among the culturally affiliated tribes associated with the NNSS and the multi-state waste generator facilities during the 2011 NNSS Generator Workshops to facilitate further discussion and understanding, and each, annual generator workshop thereafter.

[10] *For additional information on dead air, see Appendix C.2.8.*
[11] *Reducing the natural vegetation may result in the introduction of noxious weeds.*

The CGTO recommends DOE allocate funds and resources for Indian people to conduct systematic ethnographic studies of these waste management programs. If DOE selects the expanded use alternative, the CGTO must conduct a cultural assessment of the Area 3 RWMS prior to new use to mitigate potential impacts.

The CGTO supports DOE's intention to minimize waste within the NNSS area. We encourage the DOE to partner with us to develop and participate in DOE's waste minimization and pollution prevention programs. In particular, the waste minimization efforts described in the SWEIS regarding land commitments must include members of the CGTO to ensure the cultural implications of these decisions are considered prior to implementation.

C.2.12 Human Health

As discussed previously in Section C.2.7, Biological Resources, it is widely known that many tribal representatives still collect and use plants and animals found within the NNSS region. Many of the plants and animals cannot be gathered or found in other places. Consumption patterns of Indian people who still use plants and animals for food, medicine, and other cultural or ceremonial purposes force the CGTO to question if its member tribes are still being exposed to radiation, and possibly hazardous waste located at the NNSS.

The CGTO is aware that, typically, risk assessment models have been used and accepted as a means of mathematically calculating potential risks and assessments to human health and safety. While these models project the potential impacts based on a worst-case scenario, they do not consider the perceived risks which are considered meaningful to Indian people. The lack of knowledge of an unfamiliar concept can lead to a feeling of perceived danger. A perceived danger or hazard associated with something can be very real to Indian people. Indian people view things holistically and believe that everything is interrelated resulting in a cause-and-effect model. This is contrary to scientific models that tend to compartmentalize things from a mathematical point of view, calculating potential risks to health and safety. This viewpoint often does not consider perceived risks, which play an integral role to American Indian cultural beliefs. To address this important issue, DOE listened to the recommendations from our people and commissioned a study in 1998 to evaluate perceived risks of radiation to Indian people. (See C.2.5 for additional information regarding this study.)

Emergency Preparedness

The CGTO knows that some of our member tribes are within close proximity to the NNSS and TTR. These Indian people will be directly, adversely, and potentially irrevocably impacted if an emergency occurs from DOE activities.

Indian reservations within the region of influence are located in remote areas with limited access by standard and substandard roads. Should an emergency situation resulting from NNSS-related activities, including the transportation of hazardous and radioactive waste occur, it could result in the closure of the main transportation artery to that land. If a major (only) road into a reservation closes, access to hospitals and medical facilities could be impeded or cut off entirely. Delays could occur for regular deliveries of necessary supplies, such as food and medicine. Emergency medical services en route to or from the reservation could result in death.

Accordingly, the CGTO recommends DOE collaborate with potentially affected tribes to develop emergency response measures. In particular, we understand DOE has developed the NNSS Emergency Preparedness Plan and an emergency management program. Each tribal government must have a copy of this plan, and participate in the training and implementation of the emergency management program set forth by DOE and its contractors.

Noise and Vibration

Numic people sing the souls of deceased tribal members to the afterlife in a multiple day ceremony called the Cry. The songs sung are called Salt Songs, a name derived from a spiritual journey taken by two sisters. The path of the journey is punctuated by topographically special places, which are reached at the end of various songs or sets of songs. The interactions between songs and places create a songscape (Stoffle, Halmo, and Austin 1997). The CGTO knows Salt Songs follow a spiritual trail. Salt Songs are still sung by Indian people today.

Noise can be a deterrent and a distraction. Noise upsets the spirituality of the area, negatively impacting the ability of salt songs to be heard. Because the thoughts and focus are interrupted, the balance, harmony, and well-being of the community as a whole become affected.

Increased aircraft activities proposed in the SWEIS will increase the noise and vibration throughout the area. According to one tribal elder, "*Noise and vibrations [from the proposed increased air traffic] will cause the animals to migrate from the area. The animals are placed where they are by the Creator. Forcing them to move results in their loss of power, their life span is shortened, and their very existence is endangered. This could disrupt the entire food chain. If these are used culturally and traditionally for medicines, stories, and songs, then harmony is broken. The Creator put them in their area. If you move them outside of their home, then their spirit dies and will cause undo and irreparable stress. They are grounded in the area. If habitats and animals are disturbed, then the benefit of salt songs and stories are diminished and will harm the culture of our people. The mountain needs to hear our songs, to hear our voices, and to still know that we are here. If we are not out there performing these, then the mountain, the wind, the water, and all of the others will continue to be unbalanced. This needs to be part of the Environmental Restoration process. People don't understand harmony. This is our destiny and our responsibility. We are all woven together. The spirits are waiting for the Indian people to come back and to talk to them so that they can heal. We believe it is now time to allow the Indian people to begin the healing process. To do this, we propose balancing ceremonies.*"

The CGTO recommends that DOE work with us to develop a schedule to allow Indian people access to specific areas and perform traditional ceremonies. The CGTO also recommends the DOE establish quiet zones near or on the NNSS where and when Indian people are conducting these ceremonies.

Gold Meadows is extremely important to the Indian people. There are known culturally-sensitive resources in the area that must be protected and undisturbed from noise and human intrusion. Noise pollution becomes a disturbance and a hindrance to the singing of Salt Songs. Therefore, the CGTO recommends this area in particular become a no fly zone.

C.2.13 Environmental Justice

Federal agencies are directed by EO 12898, Environmental Justice, to detect and mitigate potentially disproportionately high and adverse human health or environmental effects of its planned programs, policies, and activities to promote nondiscrimination among various populations in the United States. In the Record of Decision for the 1996 NTS EIS, DOE recognized the need to address environmental justice concerns of the CGTO based on disproportionately high and adverse impacts to their member tribes from DOE NNSS activities. In the 2002 NTS Supplemental Analysis, DOE concluded that the selection and implementation of the Preferred Alternative would impact its member tribes at a disproportionately high and adverse level, perpetuating environmental justice concerns. The CGTO maintains that environmental justice concerns continue to exist.

Of special concern to the CGTO is the potential for holy land violations, cultural survival-access violations, and disproportionately high and adverse human health and environmental impacts to the Indian population. These environmental justice issues need to be addressed in the NNSS SWEIS.

There is no question that the holy lands of Indian people have been, continue to be, and will be impacted by activities at the NNSS. It is also well known that only Indian people have lost cultural traditions because they have been denied free access to many places on the NNSS where ceremonies need to occur, where plants need to be gathered, and where animals need to be hunted in a traditional way. Prior to undertaking or approving activities at the NNSS, the CGTO recommends that DOE comply with EO 12898 and EO 13127 by facilitating tribal access to the NNSS, sponsoring an Indian subsistence consumption study, and sponsoring a study to determine perceived health risks and environmental impacts resulting from NNSS activities to CGTO member tribes.

On February 11, 1994, President Clinton signed EO 12898 which mandated each federal agency to review and achieve environmental justice as part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low-income populations in the United States. Specifically, each federal agency is to (1) promote enforcement of all health and environmental statutes in area with minority and low-income populations, (2) ensure greater public participation, (3) improve research and data collection relating to the health and environment of minority and low-income populations, and (4) identify differential patterns of consumption of natural resources among minority and low-income populations. In addition, the environmental justice strategy shall include, where appropriate, a timetable for undertaking identified revisions and consideration of economic and social implications of the revisions.

The EO requires federal agencies such as the DOE to (1) identify an internal administrative process for developing its environmental justice strategy, and inform the Interagency Work Group on Environmental Justice (IWGEJ) within 4 months from the date of the order; (2) provide the IWGEJ with an outline of its proposed environmental justice strategy within 6 months; (3) provide the IWGEJ with the actual environmental justice strategy within 10 months; (4) finalize the strategy and provide a copy and written description of its strategy within 12 months to the IWGEJ including the identity of several specific projects that can be promptly undertaken to address particular concerns; and lastly, (5) report its progress in implementing its agency-wide environmental justice strategy within 24 months to the IWGEJ.

The CGTO has other concerns that fall within the context of EO 12898, such as subsistence consumption. Subsistence consumption requires the DOE to collect, maintain, and analyze information on consumption patterns such as those of Indian populations who rely principally on fish and/or wildlife for existence. Most importantly, the EO mandates each federal agency to apply equally their environmental justice strategy to Native American programs and assume the financial costs necessary for compliance.

To date, DOE has not shared its design and implementation strategy for Environmental Justice with the CGTO, nor has it identified and analyzed subsistence consumption patterns of natural resources by Indian people within the region of influence. Since the EO specifically addresses equity to Indian people and low-income populations, it is critical that the DOE immediately address the concerns of Indian tribes and communities by conducting systematic ethnographic studies and eliciting input necessary for administrative compliance and in the spirit of the DOE American Indian Policy. This policy outlines seven principles in its decision making and interaction with Federally-recognized Tribal governments. It requests that all Departmental elements ensure Tribal participation and interaction regarding pertinent decisions that may affect the environmental and cultural resources of Tribes. Of particular interest within these seven guiding principles is (1) Recognize the Department's trust responsibility. (2) Commit to a government-to-government relationship. (3) Consult with Tribes to assure rights and concerns are considered prior to taking actions, making decisions, or implementing programs. (4) Consult with Tribes about potential impacts of proposed DOE actions on cultural resources or religious concerns that will avoid unnecessary interference with traditional religious practices. (5) The Department will initiate a coordinated effort for technical assistance, economic self determination opportunities and training.

In the Record of Decision for the 1996 NTS EIS, DOE recognized the need to address environmental justice concerns of the CGTO based on disproportionately high and adverse impacts to their member tribes from DOE NNSS activities. In the 2002 NTS Supplemental Analysis, DOE concluded that the selection and implementation of the Preferred Alternative would impact its member tribes at a disproportionately high and adverse level, perpetuating environmental justice concerns. The CGTO maintains that environmental justice concerns continue to exist and include (1) holy land violations, (2) cultural survival-access violations, and (3) disproportionately high and adverse human health and environmental impacts to the Indian population.

C.2.13.1 Holy Land Violations

American Indian people who belong to the CGTO consider the NNSS lands to be as central to their lives today as they have been since the creation of their people. The NNSS lands are part of the holy lands of Western Shoshone, Southern Piute, and Owens Valley Piute, and Shoshone people. The CGTO perceives that the past, present, and future pollution of these holy lands constitutes both Environmental Justice and equity violations. No other people have had their holy lands impacted by NNSS-related activities. Prior to undertaking or approving new activities, the CGTO should be funded to design, conduct, and produce a systematic American Indian Environmental Justice study.

C.2.13.2 Cultural Survival-Access Violations

One of the most detrimental consequences to the survival of American Indian culture, religion, and society has been the denial of free access to their traditional lands and resources. Loss to access to traditional food sources and medicine has greatly contributed to undermining the cultural well-being of Indian people. These Indian people have experienced, and will continue to experience, breakdowns in the process of cultural transmission due to lack of free access to government-controlled lands and resources such as those in the NNSS area. No other people have experienced similar cultural survival impacts due to lack of free access to the NNSS area.

In 1996, President Clinton signed EO 13007, *Indian Sacred Sites*. The EO promotes accommodation of access to American Indian sacred sites by Indian religious practitioners and provides for the protection of the physical integrity of such sites located on federal lands. The CGTO recommends that open access be allowed for American Indians who must conduct their traditional ceremonies and obtain resources within the NNSS study area. Unfortunately, however, land disturbance and irreparable damage of cultural landscapes, potential TCPs, and cultural resources may render certain locations unusable.

C.2.13.3 Disproportionately High and Adverse Human Health and Environmental Impacts to the Indian Population

It is widely known that many tribal representatives still collect and use plants and animals that are found within the NNSS region. Many of the plants and animals cannot be gathered or found in other places. Consumption patterns of Indian people who still use plants and animals for food, medicine, and other cultural or ceremonial purposes and the issues raised in this study force the CGTO to question if its member tribes are still being exposed to radiation, and possibly hazardous waste located at the NNSS.

C.3 American Indian Assessment of Alternatives

Since the early 1990's, DOE provided opportunities for representatives of the CGTO to visit portions of the NNSS and identify important places, spiritual trails, and landscapes of traditional and contemporary cultural significance.[12] These actions by DOE are considered positive steps towards fulfilling its trust responsibility through facilitating co-stewardship and land management strategies between DOE and the CGTO; however, this is an ongoing process.

The CGTO is concerned about culturally-perceived harmful land disturbing DOE actions described in Chapter 3 and Appendix A of this SWEIS. We are concerned because these actions adversely impact the NNSS land and offsite locations, which in turn affect the American Indian cultural landscape. To avert or minimize these impacts, the CGTO recommends DOE and the CGTO develop co-management strategies to help protect the land by implementing the following actions before continuing with these current or proposed activities:

- Identify those areas that have been disrespected and culturally damaged, so that balance can once again be restored
- Avoid further harmful ground-disturbing activities
- Make mitigation or restorable areas a top priority
- Avert or minimize damage to geological formations important to the cultural and ecological landscape
- Implement collaborative environmental restoration techniques that require minimum ground disturbing activities
- Continue to pursue systematic consultations with American Indians so that potentially impacted resources can be readily identified, alternative solutions discussed, and adverse impacts averted
- Provide American Indian people increased access to culturally significant areas so that we can use our knowledge, prayers, and traditions to effectively restore balance to the natural and spiritual harmony of the NNSS area and offsite locations.

In addition, the CGTO recommends DOE and the CGTO continue to hold annual meetings to discuss current and proposed actions in greater depth, to deliberate potential impacts, and to consider and develop mutually acceptable mitigation measures. This is particularly necessary for those actions requiring additional NEPA analysis, including but not limited to solar and geothermal energy development.

We believe we have been created in these lands. Because of this birth-right and tie to our ancestral land, the CGTO believes we have undeniable rights to interact with its precious resources, and a continuous obligation to protect it. The CGTO takes this responsibility very seriously and has developed our input for the alternatives presented throughout Section C.3 so we may fulfill this obligation.

[12] *Because this is a public document, the exact locations of these areas will not be revealed unless determined necessary during government-to-government consultation.*

C.3.1 No Action Alternative

C.3.1.1 National Security/Defense Mission

The CGTO's concerns and perspective regarding the National Security/Defense Mission is presented here, which summarizes our views and applies to all aspects of this mission, including those pertaining to the Stockpile Stewardship and Management Program; the Nuclear Emergency Response, Nonproliferation, and Counterterrorism Program; and the Work for Others Program. According to tribal elders, *"There is always going to be testing. Areas such as U1a support underground testing is where the affects are evaluated. There are programs and facilities where stockpile stewardship and management activities are currently performed. The CGTO knows that DOE maintains and conducts experiments and testing at various locations throughout the NNSS. We continue to be concerned about these activities and their impacts to the cultural landscape. Our involvement is essential to restoring and maintaining the balance to the land and its resources."*

The CGTO understands the National Security Defense Mission includes complying with the nuclear weapons test moratorium of 1992, which precludes new underground nuclear testing. We also understand DOE is required to maintain a state of readiness to resume nuclear tests if so directed by the President. The CGTO continues to be intensely opposed to underground nuclear testing. In consideration of our ancestral ties and proximity to the land, the CGTO must be informed prior to any preparations for testing so we can protect the spiritual and physical health of our people.

The CGTO understands the fundamental intent of the Nonproliferation and Counterterrorism projects is to promote world peace and reduce the need to use the NNSS and its offsite locations for nuclear weapons production, storage, assembly, and testing. However, the CGTO believes these activities may increase the number of weapons stored, disassembled, and disposed. These dangerous conditions may result in the land becoming angry and further contaminated, thereby impeding our ability to access important resources on our ancestral land.

The CGTO knows from past experience, but not formal study, that military training exercises and weaponry tests can adversely impact cultural resources. Military people move across the land on foot and in vehicles without either the time or the purpose to pay attention to the plants that are being disturbed, the animals that are being dislocated, or the archaeological material and other important resources underfoot.

Often geographically distinctive power places or culturally-sensitive areas are targeted without regard or knowledge of the significance to Indian people. Military exercises involving aircraft disrupt the harmony within the cultural landscape. Cultural resources may be damaged when conventional weapons are fired nearby. The environmental setting is disrupted from the noise and vibrations associated with these military operations and overflights. Noise and vibrations upset the spirituality and solitude of the area, negatively impacting songscapes and storyscapes. When the thoughts and focus are interrupted, the balance and well-being of the community as a whole become affected.

C.3.1.2 Environmental Management Mission

The CGTO's concerns and perspective regarding the Environmental Management Mission are presented under the Waste Management Program (Section C.3.1.2.1) and the Environmental Restoration Program (Section C.3.1.2.2), as appropriate.

C.3.1.2.1 Waste Management Program

The CGTO understands that current and proposed waste management activities identified under the Environmental Management Mission include high-hazard experiments involving nuclear material and high explosives, and storing special nuclear materials. The CGTO is aware the NNSS is used to store hazardous waste, and to store and dispose of low-level radioactive waste, low-level mixed radioactive waste (i.e., containing certain hazardous wastes), and non-hazardous waste and debris. After many years, the CGTO continues to be greatly concerned with the ongoing storage and disposal of these wastes at the NNSS, and the transportation of radioactive waste from off-site generators to the NNSS for storage and disposal.

We understand the radioactive and hazardous waste described in this SWEIS are defined in scientific terms and governed by state and federal regulations. Indian people hold both complex traditional and scientific views of these materials and waste. As an example, the former builds on the view that all resources--including the rocks--are alive.

To scientists, radioactive rocks are well understood with specific quantifiable physical properties. Scientists believe if they manage radioactivity in a purely scientifically appropriate manner, they are largely safe for use and disposal at the NNSS, an area often perceived by non-Indian people as a barren wasteland.

American Indian people believe radioactive rocks are powerful. However, contrary to scientific belief, we know that radioactive rocks can become "angry rocks" if they are removed without proper ceremony, used in a culturally inappropriate way, disposed of without ceremony, or placed where they do not want to be (Stoffle et al. 1989; Stoffle et al. 1990). The angry rock constitutes a threat that can neither be contained nor controlled by conventional means. It has the power to pollute food, medicine, and places, none of which can be used afterward by Indian people. Spiritual impacts are even more threatening, considering the angry rock would be transported along highways before ultimately being disposed of at the NNSS, affecting animal creation places, access to spiritual beings, and unsung human souls (Stoffle and Arnold 2003).

Indian knowledge and use of radioactive rocks, or minerals, in the western United States goes back for thousands of years. The DOE would benefit from this knowledge. Areas with high concentrations of these minerals were called dead zones and placed off limits to average Indian people. Such areas were places of power or energy and could only be visited or the minerals used under the supervision of specially-trained Indian people that are sometimes referred to in the English language as shaman or medicine men.

According to tribal elders, *"We are not sure how long Nellis and the NNSS have been facilities, and how much waste has been created, stored, and transported. This information is necessary for the CGTO to fully understand how significant the people and our resources may have been affected, and to prepare ceremonies, prayers, and culturally appropriate mitigation measures to attempt to restore balance. For example, Sunrise Mountain is a very significant mountain. Behind this mountain is a significant cave, Gypsum Cave, which some Indian people fear. There are traditional stories surrounding this area. The mountain and the cave are both culturally significant. Caves are supposed to hold much power. They are supposed to react with your mind. When you leave a cave, you are much more powerful."* Gypsum Cave, which is protected and monitored by culturally affiliated tribes and the BLM, is a potential Traditional Cultural Property that may be impacted by the transportation of the waste.

C.3.1.2.2 Environmental Restoration Program

According to tribal elders, *"The Creator placed everything—the land, the rocks, the plants and animals-where they are for a purpose. However, now that the NNSS land is disturbed, we must come up with the appropriate prayers and ceremonies to rebalance the land and its resources."*

The CGTO views environmental restoration activities attributed to the Environmental Management Mission as a positive effort to rebalance the world. Everything is connected. Individual restoration projects are insufficient alone but are starting points and should be considered as stages or steps in a comprehensive spiritual and ecological restoration program. The CGTO's view is ideally suited to the spirit of holistic ecosystem management subscribed by the public and many Federal agencies.

Although the CGTO is supportive of restoring the environment, we are concerned about the future plans to decontaminate and decommission (D&D) some buildings that may have asbestos and other contamination, which will be released during the process. Specifically, the CGTO is concerned about potential impacts to the air, water, plants and animals. In addition, nearby tribes may be performing ceremonies and prayers and need to be notified so the D&D process does not negatively impact these important religious and traditional events through elevated noise and vibration levels.

We recommend conducting ethnographic studies involving the CGTO to better understand sites such as, but not limited to, Water Bottle Canyon, Timber Mountain, Shoshone Mountain, and other sites identified by the CGTO. Spiritual and ecological restoration assessments and projects require traditional management practices, and the involvement of tribal cultural experts to be successful. These specialists are needed to conduct initial assessments and site inventories, and to make recommendations for the next steps of the restoration effort. This strategy will result in the identification of resources, features, and other site aspects both tangible and intangible, that are in need of healing and restoration using culturally appropriate steps necessary to achieve restoration and balance.

Members of the CGTO have unique and extensive experience in collaborative spiritual and ecological restoration. We have many examples of successful collaboration among our tribal members and federal agencies. For example, the Big Warm Spring near the Duckwater Shoshone Tribe has been used throughout history for spiritual cleansing and healing. Young men are taken there during the "coming of age" to wash and cleanse themselves. In 2005, in collaboration with the U.S. Fish and Wildlife Service, the Duckwater Shoshone Tribe restored the Big Warm Spring to its original size and removed the non-native fish species. In 2007, during the final phase of the project, tribal members reintroduced the Railroad Valley Spring Fish to the Big Warm Spring in a culturally appropriate manner, successfully completing the spiritual and ecological restoration for this collaborative effort.

There are many potential spiritual and ecological restoration projects on the NNSS in need of attention, all with the goal of balancing the spiritual, cultural and ecological inner-workings of the project places. Based on CGTO experience with environmental restoration projects, we suggest a more aggressive collaborative environmental restoration program. Potential projects for which proposals have been or are being developed for the protection of wildlife, plant resources, and geological features, including the following:

Restoration of Water Bottle Canyon

Water Bottle Canyon is a natural water tank area and an exceptional cultural site. Cultural resources include *pohs*, tanks, rock rings, tonal rocks, and traditional use plants (Stoffle et al. 2006). Any activities in or impacts to a side canyon or to Water Bottle Canyon affect the rest of the canyon system, which is connected through physical and spiritual flows. Presently, the spiritual aspects of Water Bottle Canyon are out of balance and require cultural interactions to bring the canyon back into balance. The cleaning of the *pohs* and tanks in this canyon system is one of several cultural practices needed to begin spiritual and ecological restoration. This project can reduce drought conditions, and provide spiritual, cultural, and ecological benefits to the CGTO, DOE, and the environment, consequently fulfilling the primary goal of spiritual and ecological rebalancing. Implementation of this project will require the appropriate cultural experts to identify project sites, to inventory and evaluate the conditions, resources, and features of the sites, and to design the restoration plan. The Project would involve overnight camping, annual activities, and monitoring of site conditions.

Evaluation of Traditional Cultural Property

During the DOE Annual Tribal Meeting with the CGTO, held September 1-2, 2009, the CGTO recommended the DOE support the nomination of a Traditional Cultural Property, previously identified as *Wunjikuda*. The CGTO recommended expanding the studies to enhance previously collected ethnographic information, and determining an appropriate title using knowledgeable tribal elders identified by the CGTO. The CGTO also recommended the DOE sponsor overnight camping activities at this site to elicit additional information from knowledgeable tribal representatives for the submittal of the nomination.

Cleaning Pohs and Tanks

The *pohs* and tanks found throughout the NNSS require cultural practices to function effectively. The *pohs* and tanks at Water Bottle Canyon and Ammonia Tanks, for example, are interrelated and tie each location to each other. Both sites are used to bring water from the rain that is needed and used for ceremonial use to restore balance. American Indian people have Rain Shaman who have the ability to talk to all of the elements responsible for bringing water or rain to the land, people and animals. According to tribal elders, *"When the water arrives, it is approached with great respect and awakened very carefully when prayed upon. In appreciation and in honor of the water's return, the animals come back, the plants will grow and people will continue to pray--all ultimately leading to balance and restoration of the area."* Customarily, Indian people cleaned the *pohs* and tanks through the use of songs, stories and prayers. The women cleaned the *pohs* and tanks and were followed by the Rain Shaman who called the rains.

By supporting the CGTO proposed project to clean the *pohs* and tanks, DOE will reduce drought conditions and restore balance to the area. It will provide spiritual, cultural, and ecological benefits to the CGTO, DOE, and the environment, thereby facilitating our obligation of spiritual and ecological rebalancing. Implementation of this project will require the appropriate cultural experts to identify project sites, to inventory and evaluate the conditions, resources, and features of the site, and to design a culturally appropriate restoration plan.

C.3.1.3 Nondefense Mission

There are a variety of current and proposed actions considered under the Nondefense Mission. Many of these are related to the NNSS Environmental Research Park, which allows universities and other federal agencies to conduct research. Other projects involve solar and geothermal energy development, and constructing the Nevada Desert Free-Air Carbon Dioxide Enrichment and the Mojave Global Change facilities proposed in Area 5. The CGTO's concerns and perspective regarding the Nondefense Mission, including activities associated with the Infrastructure, Conservation and Renewable Energy, and Other Research and Development Programs, are summarized here.

Indian people view each proposed project under the Nondefense Mission as potentially impacting cultural resources. Non-Indian people unfamiliar with the importance of leaving cultural resources untouched may find and collect artifacts or remove plants that are significant to American Indian people. Construction of the proposed solar generating facility in Area 25 involves draining the Sun of its power unnaturally and making it week. Construction also involves scraping the land, generating dust emissions, facilitating erosion, and impeding visual resources.

All landforms within the NNSS have high sensitivity levels for American Indians. The ability to see the land without the distraction of buildings, towers, cables, roads, and other objects is central to the spiritual interaction between Indian people and their traditional lands. Visual resources may be negatively impacted if proposed solar and geothermal projects are pursued. The CGTO must be part of any future discussions of these projects due to potential impacts to visual resources that may impede traditional and cultural ceremonies.

Only Indian people know which places are appropriate for visits by non-Indian people and how to collect plants, animals, and soil samples so that these activities do not disrupt the land and its associated spirituality. Because of the potential affects to the environment and its resources from Nondefense Mission projects, the CGTO must become an integral part of site-specific studies and develop culturally-appropriate text for future NEPA analyses, including environmental assessments and mitigation plans.

C.3.2 Expanded Use Alternative

The CGTO's concerns and perspective regarding the Expanded Use Alternative include those discussed previously. Under the Expanded Use Alternative, DOE would pursue geothermal electrical generation in a variety of locations depicted in SWEIS Figure A.2.3-1, and solar energy systems and facilities in Areas 6 and 25, respectively.

According to the information presented by DOE in the SWEIS, the CGTO knows the NNSS has been selected to pursue the development of the solar enterprise zone within Area 25. We also understand the project schedule presented in the Memorandum of Understanding between DOE and DOI initiates environmental evaluations in July 2010. The CGTO must be part of any additional, future environmental assessments as this proposed activity will adversely impact visual resources and degrade traditional and religious ceremonies. The visual quality of the landscape will lose its integrity and the viewscape will be marred from the introduction of considerable infrastructure directly visible from U.S. 95. For Indian people, an adversely impacted resource will most certainly impact the spiritual harmony as a whole. Therefore, Indian people will need to perform ceremonies, offer prayers, and sing songs in an effort to mitigate these impacts. If construction proceeds, DOE will need to make provisions for Indian monitors to assess the construction footprint and implement traditional techniques that require minimum ground-disturbing actions.

The CGTO understands DOE is proposing to construct modular geothermal power plants that have a relatively small surface footprint. However, the initial project support activities will reportedly impact 30 to 50 acres. The CGTO also understands that DOE may pursue solar power by constructing a 5-megawatt photovoltaic system, and commercial solar power generating facilities. These proposed solar power electrical generation projects would impact approximately 50 acres and 39,600 acres of land, respectively. The CGTO is particularly concerned with the land and resources potentially impacted by these projects.

Fundamentally, the CGTO struggles with the idea of pursuing solar energy as a "cleaner" form of energy and the potential impacts to the Sun. According to some tribal elders, *"The Sun is like a big battery. Once you drain its power, will it die? For those spiritually connected to the Sun, we are concerned about unnaturally harnessing it's power. We know the Sun was given only so much energy. If the Sun is drained, how will it be replenished? If the Sun goes away, everything will die. The stories and activities of our ancestors are tied greatly to the Sun. Today, our prayers and ceremonies still travel or rely on its strength."* Because of the complexity and potential implications to the environment, to the cultural and visual landscape, and for our own survival, it is imperative that DOE support an ethnographic study to evaluate the cultural implications of pursuing solar energy on the NNSS. The CGTO also recommends Indian people provide their expertise in the development of the Solar Enterprise Environmental Assessment.

Construction of the solar power electrical generation system and facilities, and the geothermal electrical generation facility will involve scraping the land, irreparably destroying the land and vegetation. Facility construction will facilitate erosion, impede visual resources, and will emit dust and other potentially hazardous pollutants into the air. This will, in turn, impact the land, water, air, plants, animals, and cultural resources, and will affect the solitude of the land.

The CGTO is concerned that DOE's proposed activities unnaturally harnesses the earth's power without understanding the implications of these actions or all that is necessary to begin to prepare the earth and its resources. Numic people have a complex understanding of *power* and believe it is special force that was placed in all things at the time the world was created. It is that spark which keeps the world going and all of its elements thinking, talking, moving, and interacting. This special *power* moves and has the ability to move down hill, often concentrating or pooling in certain places like mineral outcrops, cliffs, and caves. It has characteristics similar to water, and can be understood as having the ability to return to the sky to become like rain and snow, which are called down from the sky by the highest mountains. This special *power* has a rotation of movement similar to the hydrological cycle and has the ability to impact all things (Carroll et al. 2006).

According to information presented throughout the SWEIS, the proposed geothermal electrical generation facilities would use the power of rocks that are hot. Rocks, or minerals, are culturally important and have significant roles in many aspects of Indian life. For example, the Chalcedony would have made an attractive offering acquired and then left at the vision quest or medicine site located to the north on top of a volcano like Scrugham Peak. In particular, Indian people have observed the presence of the following minerals at the NNSS: (1) Obsidian, (2) Chalcedony, (3) Yellow Chert (otherwise known as Jasper), (4) Black Chert, (5) Pumice, (6) Quartz Crystal, and (7) Rhyolite Tuff.

Other traditional use minerals are known to exist throughout the NNSS and offsite locations (see C.2.5). In order to document the cultural significance of these areas, additional ethnographic mineral studies are needed to fully understand the location and importance of these minerals at the proposed project site locations prior to any surface disturbing activities. The CGTO is particularly concerned about the potential impacts or use of these minerals relating to proposed geothermal activities.

Some of the locations proposed for geothermal electrical power plants are recognized as traditionally or spiritually important. In particular, the CGTO is concerned about activities that have the potential to impact Oasis Valley, Amargosa River, Timber Mountain Caldera Complex, Black Mountain, Gold Meadows, Cane Springs, Calico Hills area, Crater Flats, Scrugham Peak, Shoshone Mountain, Devil's Hole, Ash Meadows, and Death Valley. The CGTO is concerned about locating the proposed geothermal project along hydrological basins, whose power is derived from volcanic activity.

We know the forces of power in the world move along channels and combine into specific nodes or places of power. A common set of these channels follows the path of water. From this beginning, the water moves downhill in rivulets, washes, and streams. The water often goes underground where it forms similar networks of channels moving in various directions, corresponding to hydrological basins. Water is often attracted to volcanic activity, thus producing power places like hot mineral springs.

The CGTO is concerned that DOE may impact hot springs in their pursuit of geothermal power. According to information obtained by Dr. Richard Stoffle with the University of Arizona and presented in the report *Black Mountain: Traditional Uses of Volcanic Landscapes* (Carroll et al. 2006), hot springs come from the earth where volcanic activity still occurs even if the magma cannot be seen on the surface. Such springs are a combination of water and volcanoes producing a special place where both ceremonial and medicine occur. Indian people from Owens Valley have a single origin story for all of the hot springs in the southern Great Basin and northern Mohave Desert. According to traditional stories, a great ball of fire came from the sky and landed at Coso Hot Springs and then splashed to form at once all of the other hot springs.

Hydrological Impacts

According to information presented in the SWEIS, the proposed solar and geothermal projects will require a tremendous amount of water. A modular geothermal power plant alone will require up to 20-acre-feet to initially prime the system.

Indian people believe water is a living being that is fully sentient and willful. Water is already stressed throughout the region. The CGTO is concerned about the use of this very limited and important resource.

Because water is a powerful being it is associated with other powerful beings, such as water babies, a supernatural being that lives in and protects the water. These beings are like the people of the water. They are highly respected by American Indian culture. If water is contaminated and misused, the water babies may cause harm and move to other areas that are not contaminated.

Air Quality and Climate Impacts

Construction of these proposed facilities will impact large areas of land, potentially emitting dust and contaminants. The CGTO knows the air is alive. The Creator puts life into the air, which is shared by all living things. Air can be destroyed, causing pockets of dead air. There is only so much alive air that surrounds the world. If you kill the living air, it is gone forever and cannot be restored. Dead air lacks the spirituality and life necessary to support other life forms. The CGTO is concerned about emitting things into the air that are unnatural, and the potential health and environmental issues associated with these emissions.

Visual Resource Impacts

All landforms within the NNSS have high sensitivity levels for American Indians. The ability to see the land without obstructions like buildings, towers, cables, roads, and other objects is essential for the spiritual interaction between Indian people and their traditional homelands. Visual resources may be negatively impacted if proposed solar and geothermal projects are pursued. The CGTO must be part of any future discussions as these may impact visual resources and may impede traditional and cultural ceremonies.

C.3.3 Reduced Operations Alternative

The CGTO's concerns and perspective regarding the Reduced Operations Alternative include those discussed previously. The CGTO is supportive of a decrease to culturally-perceived harmful land disturbing activities within the NNSS and TTR areas. To successfully reduce operations and restore environmental balance, it is essential to have tribal representatives involved throughout the process to help guide DOE in conducting culturally appropriate activities.

C.4 Mitigation Measures

Only Indian people have traditional ecological knowledge that tells us how and where to interact with the earth and all of its resources to minimize or avoid impacts to the land while maintaining its spiritual integrity. According to tribal elders, "*Indian people have the conviction that the ecology of the natural environment is all integrated. We have been blessed from the beginning of creation as having a unique understanding of being a good steward, and a clear path to care for the land and its resources. The songs, stories, tradition and customs play a profound development of this conviction. It is like the world is a huge stage and there are many cast members all manipulating their intrinsic ties, using their roles to make possible for a successful event.*"

With this in mind, the CGTO is providing DOE recommendations in Section C.4 in an effort to avert or minimize impacts. We must emphasize that recommendations made by the CGTO do not imply we support the proposed actions and alternatives. These are merely our attempt to restore the harmony and balance to the resources impacted or potentially impacted by DOE activities using the NEPA process.

In 1996 and 2000, the DOE invited the CGTO to participate in the development of the NTS/DOE Resource Management Plan (RMP) in an effort to mitigate impacts to resources. The CGTO provided culturally-appropriate resource management strategies for integration on the NNSS based on traditional Indian perspectives. The CGTO long-term objective is to see our existing government-to-government relationship evolve into co-management of the NNSS land and its resources. The key concept driving the RMP is ecosystem management officially recognized in federal guidelines for land management agencies. This fits well with the traditional Indian views regarding maintaining balance and harmony among the land and its resources. Therefore, the CGTO believes the continued development of a RMP is essential to blending elements of the two worldviews. This promotes implementation of culturally-sensitive strategies for land and resource management, which is mutually beneficial to the DOE and the tribes. The CGTO understands the RMP is a dynamic, living document that requires periodic evaluation and updates, as appropriate. Accordingly, the CGTO recommends DOE hold annual update meetings, which would include current and proposed activities at the NNSS, and discussions regarding the RMP, mitigation measures, and their implementation.

C.4.1 Land Use

The CGTO is concerned with DOE's plans to continue to restrict access and potentially close areas within the NNSS. The NNSS area is part of the traditional Holy Lands of the Western Shoshone, Southern Paiute, and Owens Valley Paiute and Shoshone peoples. The lands are central in the lives of our people and mutually shared for religious ceremony, resource use, and social events (Stoffle et al. 1990a and b).

Since the early 1990's, DOE has funded representatives of the CGTO to visit portions of the NNSS. Because of this involvement, we have identified places, spiritual trails, and cultural landscapes of traditional and contemporary cultural significance. CGTO remains committed in our assertion that portions of the NNSS must be set aside for traditional and contemporary ceremonial use.

In order to fulfill the Holy Land use expectations, the CGTO also recommends continuing to identify special places, spiritual trails, and landscapes and setting aside these places for unique co-stewardship and ceremonial access. For example, studies have begun regarding the identification of places, spiritual trails and cultural landscapes in the Timber Mountain Caldera. We strongly encourage DOE to pursue these studies, which, when completed, will add an American Indian cultural component that will contribute to the importance of this National Natural Landmark. The CGTO believes these actions by DOE are considered positive steps for facilitating co-stewardship arrangements between our governments to help co-manage important Indian resources of the NNSS and to regain balance.

The CGTO recommends Gold Meadows continue to be set aside for exclusive Indian use because it contains a concentration of significant cultural resources. Similarly, the CGTO recommends DOE set aside Water Bottle Canyon, Scrugham Peak, Prow Pass, Timber Mountain and select areas within Calico Hills and Shoshone Mountain for exclusive Indian use. Efforts should be made to forego any additional land disturbances within these areas and provide access to Indian people. The CGTO also recommends tribal visits to areas designated for repatriation, such as the Pahute Mesa, and periodic assessments conducted to comply with NAGPRA.

C.4.2 Socioeconomics

Although DOE continues to make strides to diversify their workforce, the CGTO strongly encourages DOE to enhance efforts to hire more Indian people and promote the hiring of Indian-owned businesses to mitigate socioeconomic impacts to our people. To facilitate this effort, the CGTO could serve as a conduit to assist DOE and its contractors in identifying and promoting employment opportunities for American Indians at the NNSS.

C.4.3 Geology and Soils

During the evaluation of the 1996 FEIS, the CGTO noted that repeated nuclear testing had resulted in severe disturbances to the geology and soils, or minerals, in large portions of the NNSS. This seemingly irreparable damage has made certain areas unfit for human use and inaccessible to American Indians who have relied on the earth and rocks for medicine and religious purposes.

In general, the mitigation measures proposed by DOE for geology and soils include erosion control through stabilization and re-vegetation. The CGTO is concerned about the unnatural erosion control methods proposed by DOE. In particular, the CGTO struggles with activities that require relocating rocks and soil from where originally placed by the Creator and are being used contrary to the Creator's intention. Indian people know that relocating the soil in a culturally-unacceptable manner can cause adverse impacts to the environment such as the increased potential for noxious weed growth. This could potentially threaten nearby native vegetation and harm Indian people and wildlife that rely on it for survival.

Therefore, the CGTO recommends DOE implement culturally-appropriate stabilization efforts, and re-vegetation techniques using traditional ecological knowledge. Indian people stabilize our land by offering prayers to explain to the soil why we are removing it, and to thank it for its use. We then remove and protect the topsoil for future use. We replace the soil with dirt and gravel from nearby land only after offering prayers, and re-contour the land out of respect to the visual landscape. Indian people re-vegetate our land by offering prayers to bless the seeds and the plants so they will grow strong. We place the seedlings in the direction of the morning sun, and then give thanks for the opportunity to plant them. Our key objective is to protect and restore our ancestral land. This is our ancestral land and we encourage DOE to make provisions for Indian people to participate in its stabilization and re-vegetation to mitigate adverse impacts to geology and soils.

In the 1996 NTS FEIS and in the 2002 NTS EIS Supplemental Analysis, the CGTO continued to express concerns about the removal of contaminated soils and the need for religious leaders to conduct balancing ceremonies and healing prayers at these disturbed locations. In particular, the CGTO recommended tribal representatives provide information about the re-vegetation of a portion of the Double Tracks Site located on the TTR. The CGTO maintains our involvement is still necessary for the Double Tracks site as well as for the Clean Slates site located at TTR; however, we are awaiting DOE's approval to proceed so we may begin to heal these lands.

C.4.4 Hydrology

When water is respected, it sustains all life forms. When water is mistreated, it withdraws life-giving support and returns to the underworld. The CGTO knows the hydrological systems throughout the NNSS have been impacted from the drought. Drainage patterns have been altered from DOE activities and will continue to be impacted if these proceed. There are places on the NNSS where the rain falls but does not nurture the plants and animals. Therefore, the CGTO must be involved with DOE in mitigating impacts to hydrological resources because if the water is treated inappropriately, it will remove itself from the NNSS.

To minimize some adverse impacts to hydrological resources, the CGTO recommends the DOE allow Indian people access to clean the *pohs* and tanks found throughout the NNSS. *Pohs* and tanks are naturally formed geologic features or basins used to bring and gather water from the rain and to nourish the plants and animals. The water within these *pohs* and tanks are central to our ceremonies to restore balance. By supporting the CGTO proposed project to clean the *pohs* and tanks, DOE will help reduce drought conditions. In turn, this project will provide spiritual, cultural, and ecological benefits to the land and the environment, thereby facilitating our obligation of spiritual and ecological rebalancing. Implementation will require cultural experts to identify sites, to inventory and evaluate the conditions, resources, and features of the site, and to implement culturally-appropriate mitigation measures.

C.4.5 Biological Resources

The mitigation measures presented by DOE in SWEIS Section 7.7 focus on avoidance of biological resources, relocation of animal species, and monitoring plants, animals, and their habitats. The CGTO recommends DOE mitigate adverse impacts to biological resources through avoidance, culturally-appropriate revegetation efforts, reintroduction of native animals, and traditional plant and animal management methods. Indian people have extensive, traditional ecological knowledge and deep concern for the biological resources of the area and should participate directly with DOE to mitigate adverse impacts and protect these resources.

According to tribal elders, *"Prior to re-vegetation efforts, we talk to the land to let it know what we plan to do and ask the Creator for its help. We choose our seeds from the sweetest and the best plants, and store them for the winter to dry. When the winter is over, we place the seeds in a moist towel or sock and allow the new plant to sprout. We then plant the sprouts into small containers with soil until they are ready to transplant into the ground. This is a long and delicate process, requiring patience and knowledge passed down from our ancestors. If the plants are struggling to grow, we tag them and move them to face the same direction as the sun."*

The DOE would benefit from this knowledge to enhance their re-vegetation efforts. The CGTO knows DOE struggles with the success rates regarding the density and diversity of native plants during re-vegetation efforts. A co-stewardship approach with the tribes would enable DOE to enhance their re-vegetation efforts, saving time, money, and resources.

Part of the mitigation measures presented by DOE in this section includes notifying the U.S. Fish and Wildlife Service (FWS) of incidental taking of desert tortoises. The desert tortoise is culturally-significant to Indian people because of its healing powers, longevity, and wisdom. It is integral to our traditional stories, well-being and perpetuation of our native culture. Incidental taking of this traditionally-important animal is particularly disturbing to native people. Accordingly, the CGTO must be notified concurrently with the FWS so prepare our people and the environment for this loss.

Over the past 14 years, various initiatives have been undertaken to restore animal habitats and reintroduce certain animals, such as the desert big horn sheep near the southern portion of the NNSS, without participation from the CGTO. Modification of habitat or the restocking of animals is considered a highly sensitive religious act and requires participation from Indian people. For these activities to be successful and to restore balance, it is essential to have tribal representatives involved throughout this process.

C.4.6 Visual Resources

All landforms within the NNSS have high sensitivity levels for American Indians. The ability to see the land without the distraction of buildings, towers, cables, roads, and other objects is essential for the spiritual connection between Indian people and their traditional lands. Views from places are an important cultural resource that contributes to the location and performance of American Indian ceremonialism. Viewscapes are tied with songscapes and storyscapes especially when the vantage point has a panorama composed of multiple locations from either song or story.

The CGTO knows that many of the activities described under the proposed action and alternatives, such as those associated with facility construction and environmental restoration, will adversely impact visual resources. For Indian people, the adverse impact to visual resources will most certainly impact the spiritual harmony of the environment as a whole. Facility construction and operation will impede visual resources, and affect the solitude and cultural integrity of the land.

Although DOE proposes to mitigate visual resource impacts by painting structures to reduce visibility, the CGTO knows additional mitigation measures are necessary. The CGTO recommends that landscape modifications, including those associated with environmental restoration activities, be done in consultation with American Indians. Specifically, DOE should make provisions for Indian people to access the land and culturally assess its visual resources. DOE should make provisions for Indian people to participate in annual monitoring of land disturbing activities through the duration of the project. The CGTO should also participate in restoring the land, and concealing infrastructure using traditional Indian re-vegetation methods (See Section C.4.5, Biological Resources.) Finally, the CGTO recommends that DOE make provisions for Indian people to conduct ceremonies, and offer prayers and songs in an effort to re-balance this adversely impacted resource.

C.4.7 Cultural Resources

We are concerned about impacts to cultural resources from activities including but not limited to scraping the land; underground testing; drilling; grading; excavation; fencing; subsidence crater development resulting from explosives; live fire; cleanup activities; construction of buildings, roads, firebreaks, and utilities; and building modification, decontamination, or demolition. We are also concerned about proposed improvements to existing roads and facilities associated with new construction activities, and the potential impacts to cultural resources on previously disturbed and undisturbed locations. Finally, we are concerned about vehicular and pedestrian access in areas containing cultural resources and the increased potential for vandalism or unauthorized artifact collection.

The CGTO understands the mitigation measures proposed by DOE to protect cultural resources include avoidance, evaluation and data recovery, and monitoring, as described further under Mitigation Measures 1 through 6 of the NTS Cultural Resource Management Plan (Drollinger and Beck 2010). Accordingly, the CGTO must be an integral part of these mitigation measures so that impacts on American Indian cultural resources can be efficiently minimized or averted. American Indian people know the NNSS landscape in great depth and can help DOE identify and protect plants, animals, geography, archaeological sites, and traditional cultural properties that have been or will be adversely impacted by NNSS programs and activities.

The CGTO recommends that DOE make provisions for Indian people to continue to identify culturally-significant locations so potentially impacted resources can be identified, alternative solutions discussed, and adverse impacts averted. These studies will address and guide DOE in developing culturally-appropriate Best Management Practices to protect cultural resources and more effectively implement Mitigation Measures 1 through 6. To accomplish this, Indian people must be involved with the following actions:

- Assess and determine culturally-appropriate measures to protect geological formations important to the spiritual landscape
- Implement culturally-appropriate environmental restoration techniques that require minimal ground disturbance
- Restore impacted plant and animal species essential to the spiritual and cultural landscape
- Provide American Indian people access to CGTO designated areas so they can contribute their knowledge, conduct purification ceremonies with prayers and offerings to restore the natural and spiritual harmony of the NNSS landscape.
- Complete the TCP nomination process previously recommended by the CGTO in 2009 for Shoshone Mountain and initiated for Water Bottle Canyon.
- Complete the Indian History Project report prepared by the DOE, DOD, and CGTO, which originally began in 2001. Specifically, complete editorial changes to the report (as necessary), publish, and distribute.
- Develop and implement systematic American Indian ethnographic studies to better understand the interconnectedness of the cultural landscape and culturally-appropriate methods to protect the landscape and maintain balance.
- Complete the revegetation effort for the restoration of Clean Slates, which began in 1996.

In addition, the CGTO recommends Gold Meadows continue to be set aside for exclusive Indian use because the area contains a concentration of significant cultural resources. Similarly, the CGTO recommends DOE set aside Water Bottle Canyon, Scrugham Peak, Prow Pass, Timber Mountain and select areas within Calico Hills and Shoshone Mountain for exclusive Indian use. Efforts should be made to forego any additional land disturbances within these areas and provide access to Indian people.

The CGTO agrees with DOE's mitigation measure regarding site monitoring, and recommends Indian people serve as site monitors. At a minimum, the CGTO recommends annual tribal visits to monitor the state of cultural sites located within the NNSS and to offer blessings. The CGTO also recommends tribal visits to areas designated for repatriation, such as the Pahute Mesa, and periodic assessments conducted to comply with NAGPRA.

C.4.8 Waste Management

We continue to strongly oppose the transportation, storage and disposal of radioactive waste at the NNSS; however, Indian people must continue to fulfill our birth-rite obligation to care for our Holy Land and do what we can to try to restore balance to Area 5 and other contaminated locations. The CGTO recommends DOE allocate funds and resources for Indian people to conduct systematic ethnographic studies of these waste management programs. If DOE selects the expanded use alternative, the CGTO must conduct a cultural assessment of the Area 3 RWMS prior to new use to mitigate potential impacts.

The CGTO supports DOE's intention to minimize waste within the NNSS area. We encourage the DOE to partner with us to develop and participate in DOE's waste minimization and pollution prevention programs. In particular, the waste minimization efforts described in the SWEIS regarding land commitments must include members of the CGTO to ensure the cultural implications of these decisions are considered prior to implementation.

Finally, the CGTO struggles with the ethics of transporting and relocating radioactive waste from other American Indian lands so those people can live without fear of radioactivity. We are greatly concerned about the adverse spiritual, environmental, and health impacts associated with relocating these angry rocks from their current locations to our Holy Land. We believe transporting these to our land perpetuates animosity and discord among tribal governments. Because these decisions adversely impact our land and our relationships with other tribal governments, the CGTO recommends DOE host a break out session for culturally-affiliated tribes associated with the NNSS and the multi-state waste generator facilities during DOE's Annual Waste Generator Conference. These efforts will facilitate further discussion, understanding, and to develop culturally-appropriate mitigation measures.

C.5 Conclusions and Recommendations

Ultimately, the CGTO is concerned about impacts to (1) tribal members and the people they represent; (2) tribal economies and enterprises; (3) flora and fauna which are considered vital to cultural survival; (4) important resources which may be damaged from ground-disturbing activities; and (5) shipments and storage of waste through the traditional Holy Lands of the Western Shoshone, Southern Paiute, and Owens Valley Paiute and Shoshone people.

Indian people have a unique understanding based on traditional ecological knowledge which tells us how and where to interact with plants and animals, water sources, and collect soil samples to minimize impacts to the land while maintaining its spiritual integrity. Because of the potential affects to our ancestral land and its delicate resources, the CGTO must be an integral part of NNSS and TTR activities.

The CGTO has provided recommendations to DOE throughout Appendix C and within our text boxes throughout the SWEIS. In addition to these, the CGTO recommends DOE and the CGTO continue to hold annual meetings to discuss current and proposed actions in greater depth, to deliberate potential impacts, and to consider and develop mutually acceptable mitigation measures. This is particularly necessary for those actions requiring additional NEPA analysis, including but not limited to solar and geothermal energy development.

The CGTO strongly encourages DOE to evaluate the cultural impacts of pursuing solar and geothermal energy because of the complexity and the potential implications to the environment, cultural landscape, and our survival. The CGTO recommends developing culturally-appropriate text for future NEPA analyses, including the environmental assessments and mitigation plans required for these proposed undertakings.

In conclusion, the CGTO must continue to fulfill our obligation to care for our Holy Land. We must gain access and opportunity to conduct ceremonies, and to care for the NNSS and TTR land as the Creator intended and in ways only known by Indian people.

Table C–1 American Indian Traditional-Use Plants Present at the Nevada National Security Site

Scientific Name	Common Name	GC/UTTR	YM	PM/RM
1. *Ambrosia dumosa*	White bursage	X		
2. *Amelanchier utahensis*	serviceberry		X	
3. *Amsinckia tesselata*	fiddleneck		X	
4. *Anemopsis californica*	yerba mansa		X	
5. *Arabis pulchra*	wild mustard		X	
6. *Artemisia ludoviciana*	sagebrush, wormwood	X	X	
7. *Artemisia nova*	black sagebrush	X		X
8. *Artemisia tridentata*	big sagebrush		X	X
9. *Atriplex canescens*	four-winged saltbush	X		
10. *Atriplex confertifolia*	Shadscale		X	
11. *Brodiaea pulchella*	desert hyacinth		X	
12. *Calochortus bruneaunis*	sego lily			X
13. *Calochortus flexuosus*	mariposa lily		X	
14. *Carex spp.*	sedge	X		
15. *Castilleja chromosa*	Indian paintbrush		X	
16. *Castilleja martinii*	narrowleaf paintbrush			X
17. *Ceratoides lanata*	winterfat			X
18. *Chenopodium fremontii*	Fremont goosefoot			X
19. *Chrysothamnus nauseosus*	rabbitbrush	X	X	X
20. *Cirsium mohavense*	desert thistle		X	
21. *Coleogyne ramosissima*	black brush		X	
22. *Coryphantha vivipara var.*	fishhook cactus	X	X	
23. *Coryphantha vivipara var.*	foxtail cactus			X
24. *Datura meteloides*	jimsonweed	X	X	
25. *Descurainia pinnata*	tansy mustard		X	
26. *Distichlis spicata*	salt grass		X	
27. *Echinocactus polycephalus*	cotton-top cactus		X	
28. *Echinocereus englemannii*	hedge hog cactus	X	X	
29. *Eleocharis palustris*	Spikerush			X
30. *Elymus elymoides*	squirrel tail			X
31. *Encelia virginensis var.*	brittlebush		X	
32. *Ephedra nevadensis*	Indian tea	X	X	X
33. *Ephedra viridis*	Indian tea		X	X
34. *Eriastrum eremicum*	desert eriastrum			X
35. *Eriogonum inflatum*	desert trumpet		X	
36. *Erodium cicutarium*	herringbill			X
37. *Euphorbia albomarginata*	rattlesnake weed		X	X
38. *Geastrum spp.*	earthstar		X	
39. *Gilia inconspicua*	gilia			X
40. *Grayia spinosa*	spiny hop sage			X
41. *Gutierrezia microcephala*	matchweed	X	X	
42. *Juncus mexicanus*	wire grass		X	
43. *Juniperus osteosperma*	juniper, cedar	X	X	X
44. *Krameria parvifolia*	range ratany		X	
45. *Larrea tridentata*	creosote bush	X	X	
46. *Lewisia rediviva*	bitter root			X
47. *Lycium andersonii*	wolfberry	X	X	
48. *Lichen*	lichen		X	X

Scientific Name	***Common Name***	***GC/UTTR***	***YM***	***PM/RM***
49. *Lycium pallidum*	wolfberry		X	
50. *Menodora spinescens*	spiny menodora		X	
51. *Mentzelia albicaulis*	desert corsage		X	X
52. *Mirabilis multiflora*	four o'clock	X		X
53. *Nicotiana attenuata*	coyote tobacco			X
54. *Nicotiana trigonophylla*	Indian tobacco	X	X	
55. *Opuntia basilaris*	beavertail cactus	X	X	
56. *Opuntia echinocarpa*	golden cholla cactus		X	
57. *Opuntia erinacea*	Mojave prickly pear	X	X	
58. *Opuntia polycantha*	grizzly bear cactus			X
59. *Orobanche corymbosa*	broomrape, wild			X
60. *Oryzopsis (Stipa) hymenoides*	Indian ricegrass	X	X	X
61. *Penstemon floridus*	Panamint beard tongue			X
62. *Penstemon pahutensis*	Pahute beard tongue			X
63. *Peraphyllum ramosissimum*	squawapple		X	
64. *Phragmites australis*	cane, reed	X	X	
65. *Pinus monophylla*	pinyon pine		X	X
66. *Prosopis glandulosa*	mesquite	X	X	
67. *Prosopis pubescens*	screwbean		X	
68. *Psorothamnus polydenius*	dotted dalea		X	
69. *Purshia glandulosa*	buckbrush		X	
70. *Purshia mexicana*	cliffrose			X
71. *Purshia tridentata*	buckbrush			X
72. *Quercus gambelii*	scrub oak		X	X
73. *Rhus aromatica*	skunkbush, sumac			X
74. *Rhus trilobata var. anisophylla*	squawbush		X	
75. *Rhus trilobata var. simplicifolia*	squawbush	X	X	
76. *Ribes cereum*	white squaw currant			X
77. *Ribes velutinum*	desert gooseberry			X
78. *Rosa woodsii*	woods rose			X
79. *Rumex crispus*	curly dock, wild rhubarb		X	
80. *Salix exigua*	willow	X	X	
81. *Salix gooddingii*	black willow	X	X	
82. *Salsola iberica*	Russian thistle	X		X
83. *Salvia columbariae*	chia sage		X	
84. *Salvia dorrii*	purple sage, Indian	X		
85. *Sarcobatus vermiculatus*	greasewood	X		
86. *Sisymbrium altissimum*	tumbling mustard			X
87. *Sphaeralcea ambigua*	globe mallow	X	X	X
88. *Stanleya pinnata*	Indian spinach	X	X	X
89. *Stephanomeria sp. spinosa*	spiny wire lettuce, gum	X	X	
90. *Stipa speciosa*	bunchgrass			
91. *Streptanthella longirostris*	wild mustard		X	
92. *Streptanthus cordatus*	wild mustard		X	
93. *Suaeda torreyana*	seepweed		X	
94. *Symphoricarpos longiflorus*	snowberry		X	
95. *Symphoricarpos spp.*	snowberry			
96. *Tessaria sericeae*	arrowweed	X	X	
97. *Thamnosma montana*	turpentine bush	X	X	
98. *Thelypodium integrifolium*	wild cabbage		X	

Scientific Name	***Common Name***	***GC/UTTR***	***YM***	***PM/RM***
99. *Typha domingensis*	cattail		X	
100. *Typha latifolia*	cattail	X	X	
101. *Veronica anagallis-aquatica*	speedwell		X	
102. *Vitis arizonica*	wild grape	X	X	
103. *Xylorhiza tortifolia*	desert aster		X	
104. *Yucca baccata*	banana yucca	X	X	X
105. *Yucca brevifolia*	Joshua tree		X	
106. *Yucca spp.*	yucca		X	
107. *Yucca schidigera*	Mojave yucca, Spanish		X	

NOTE: American Indian traditional-use plants present in the NNSS area are identified in the project reports entitled *Native American Plant Resources in the Yucca Mountain Area, Nevada* (YM) (Stoffle et al. 1989b) *and Native American Cultural Resources on Pahute and Rainier Mesas, Nevada Test Site* (PM/RM) (Stoffle et al. 1994b). This table includes traditional-use plants identified in the Colorado River Corridor Study (GC) and in the Utah Test and Training Range Study (UTTR) that are also present at the NNSS (see 1996 NTS EIS, Table 4-38).

Table C–2 American Indian Traditional-Use Animals Present at the Nevada National Security Site

Scientific Name	***Common Name***
Alectoris chukar	chukar
Ammospermophilus leucurus	white-tailed antelope squirrel
Amphispiza bilienata	black-throated sparrow
Aquila chrysaetos	golden eagle
Buteo jamaicensis	red-tailed hawk
Callipepla gambelii	Gambel's quail
Canis latrans	coyote
Cicadidae spp.	cicada
Cnemidophorus tigris	western whiptail lizard
Canis latrans	coyote
Colaptes auratus	northern flicker
Crotalus spp.	rattlesnake
Eutamias dorsalis	cliff chipmunk
Felis concolor	mountain lion
Felis rufus	bobcat
Formicidae formicinae	mound-building ant (red and black ant)
Gopherus agassizii	desert tortoise
Haliaeetus leucocephalus	bald eagle
Odocoileus hemionus	mule deer
Ovis canadensis	bighorn sheep
Sauromalus obesus	chuckwalla
Spizella breweri	Brewer's sparrow
Stagmomantis spp.	praying mantis
Sylvilagus spp.	cottontail
Vulpes velox	kit fox
Zanaida macroura	mourning dove

NOTE: American Indian traditional-use animals are identified in the project report entitled *Native American Cultural Resources on Pahute and Rainier Mesas, Nevada Test Site* (Stoffle et al. 1994b). This table presents only a partial list of traditional-use animals present at the NNSS (see NTS EIS, Table 4-39). To date, no systematic or extensive animal studies have been conducted at the NNSS.

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APPENDIX D
AIR QUALITY AND CLIMATE

APPENDIX D
AIR QUALITY AND CLIMATE

D.1 Affected Environment

D.1.1 Nevada National Security Site

D.1.1.1 Meteorology

This section provides further details on the meteorology discussion presented in Chapter 4, Section 4.1.8.1, of this *Site-Wide Environmental Impact Statement for the Continued Operation of the Department of Energy/National Nuclear Security Administration Nevada National Security Site and Off-Site Locations in the State of Nevada (NNSS SWEIS)*. **Table D–1** shows the meteorological data used in the climate and air quality analysis. The use of different data in the various analyses reflects the availability of historical data collection efforts and consistency in the methodology used in the data collection.

Table D–1 Summary of Meteorological Data Used in the Nevada National Security Site Air Quality Analysis

Years	*Meteorological Parameter*	*Reference*
Climatological Data		
1983-2002	Temperature	NOAA (2006)
1983-2002	Snowfall	NOAA (2006)
1983-2002	Thunderstorms	NOAA (2006)
1966-2005	Precipitation	DOE (2008f), NOAA (2006)
1954-1983	Tornado Frequency	NRC (1986)
1973-1977	Mixing Heights – Yucca Flat	NOAA (2006)
2004-2008	Wind Roses MEDA Stations	NOAA (2010)
Dispersion Modeling		
2003-2007	Desert Rock Upper-Air – wind and temperature	DOE (2009b)
2003-2007	Desert Rock Surface – wind, temperature, cloud cover	DOE (2009b)

Temperature. Temperatures, especially daily maximum temperatures, have been trending upward over at least the last 25 years. The average annual maximum temperature at most Nevada National Security Site (NNSS) locations have increased about 4 degrees Fahrenheit (°F) from 1983 through 2002, while average annual minimum temperature trends ranged from about -2 °F to +3.3 °F between NNSS locations, with an average increase of about +1 °F (NOAA 2006).

Precipitation. Much of the 1980s and 1990s were wetter than normal. The rain gauge network within the NNSS, however, reflects local variations and tends to show precipitation amounts over the last 10 years being nearly equal or slightly greater than in the last 40 years (DOE 2008f).

Snowfall varies widely within the NNSS, but is generally confined to elevations above about 6,000 feet and is infrequent below about 4,000 feet. An estimated annual average of about 60 inches of snow might fall on the highest point in the NNSS (Rainier Mesa at 7,490 feet). At Desert Rock (southeastern NNSS, 3,251 feet), the average annual measured snowfall is about 3 inches (NOAA 2006).

Thunderstorms occur primarily during two time periods – in spring due to cold front passages and in middle to late summer due to convection from daytime heating. The two thunderstorm recording stations (Yucca Flat in east–central NNSS and Desert Rock in extreme southeastern NNSS) both report about 15 thunderstorm days per year, with multiple peaks in activity between early July and early September. Thunderstorms are more frequent and begin earlier in the afternoon on the mesas compared with lower elevations. Thunderstorm activity tends to reach a maximum in the early afternoon in the northern NNSS and in the later afternoon in the southern NNSS. Some thunderstorms move into the southern NNSS after midnight after forming earlier in the day over the Spring Mountain Range located to the south of the NNSS (NOAA 2006).

It is rare for a thunderstorm to produce more than about 0.5 inches of rain at a given location, so flooding is rarely a problem on the NNSS. Thunderstorms in the NNSS can be severe at times, with strong surface wind gusts and intense cloud-to-ground lightning, but hail is infrequent and hail size is small (less than about 0.5 inches in diameter). Cloud-to-ground lightning activity tends to maximize over higher elevations particularly during July through September (NOAA 2006). Tornadoes are very rare in Nevada as a whole, with a 1954 to 1983 tornado climatology indicating a statewide tornado strike probability of three per year (NRC 1986).

Wind Flow Patterns. Since nighttime low clouds are infrequent and nighttime mixing heights tend to be less than 700 feet (according to measurements taken at the Yucca Flat station during the period of record from 1973–1977), localized terrain gradients are the dominant nighttime wind flow modifier. In summer months, daytime heating is sufficient to generate uneven heating over the varying terrain, which creates up-slope (southerly) winds during the day. In the winter, daytime winds tend to be down-slope (northerly) (NOAA 2006).

Near the Big Explosives Experimental Facility (BEEF) (see **Figure D–1**), the dominant flow is northwesterly, with a secondary peak from the south. The most significant nearby elevated terrain runs north–south about 6 miles west of BEEF and curves towards the east about 9 miles north of BEEF, which may explain the down-slope preference from the northeast and the up-slope preference towards the north. The maximum observed peak wind speed during the period from 2004–2008 was 100 miles per hour, but the more typical annual maximum wind speed was around 70 miles per hour (not shown).

Near the Nonproliferation Test and Evaluation Complex (NPTEC) (**Figure D–2**), the dominant flow is south-southwesterly, with a minor peak from the north. The nearby terrain is fairly uniform in most directions, though the elevation steadily increases for about 4 miles northward and decreases for about 3 miles southward, which may explain the southerly and northerly up-slope and down-slope directions, respectively. The maximum observed wind speed during the period from 2004–2008 was about 90 miles per hour, but the more typical annual maximum wind speed was around 55 miles per hour.

Near Test Cell C (see **Figure D–3**), the dominant flow is northeasterly, with a secondary peak from the southwest. The most significant nearby elevated terrain is about 4 miles southeast and about 4 miles northeast of the station. Since the elevated terrain to the southeast faces west, away from the rising sun, it may not provide the uneven heating necessary to create slope flows. Instead, the terrain to the northeast may dominate up-slope and down-slope effects, perhaps leading to the northeasterly and southwesterly flow preferences. The maximum observed wind speed during the period from 2004–2008 was about 78 miles per hour, but the more typical annual maximum wind speed was around 56 miles per hour (not shown).

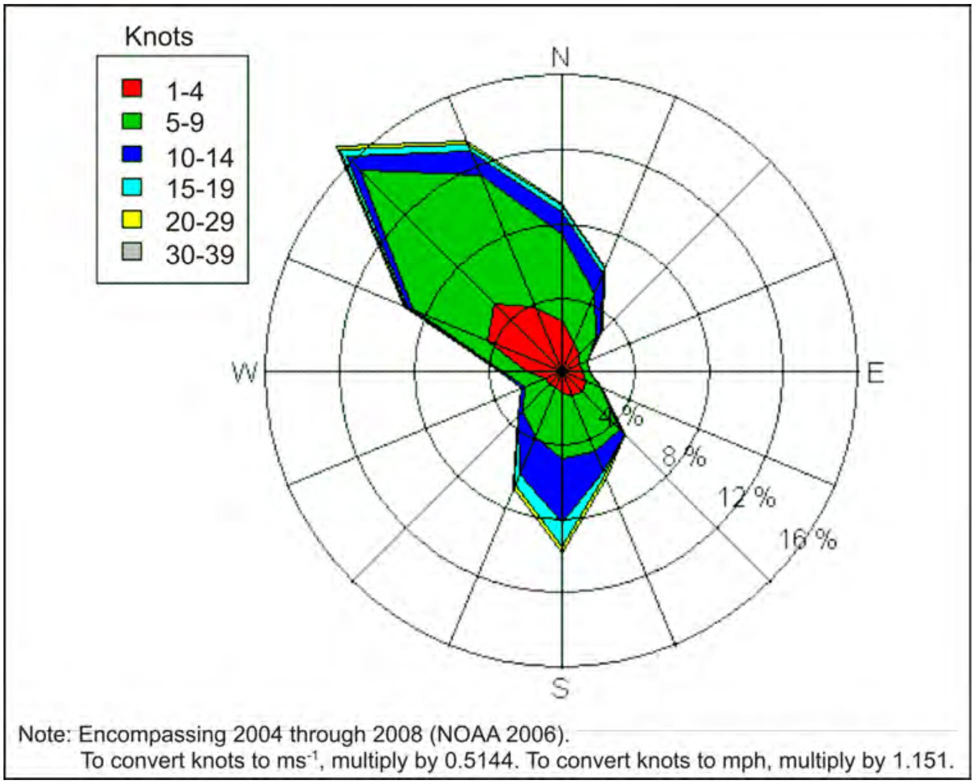


Figure D–1 Annual Average Wind Rose for Meteorological Data Acquisition Station 49 near the Big Explosives Experimental Facility

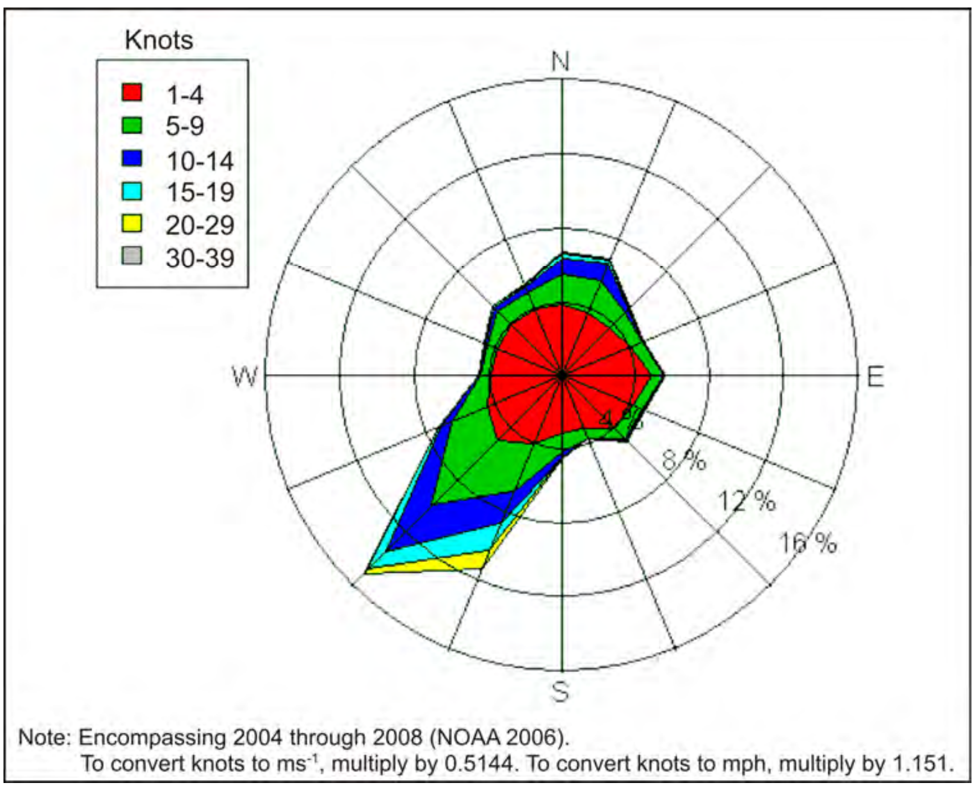
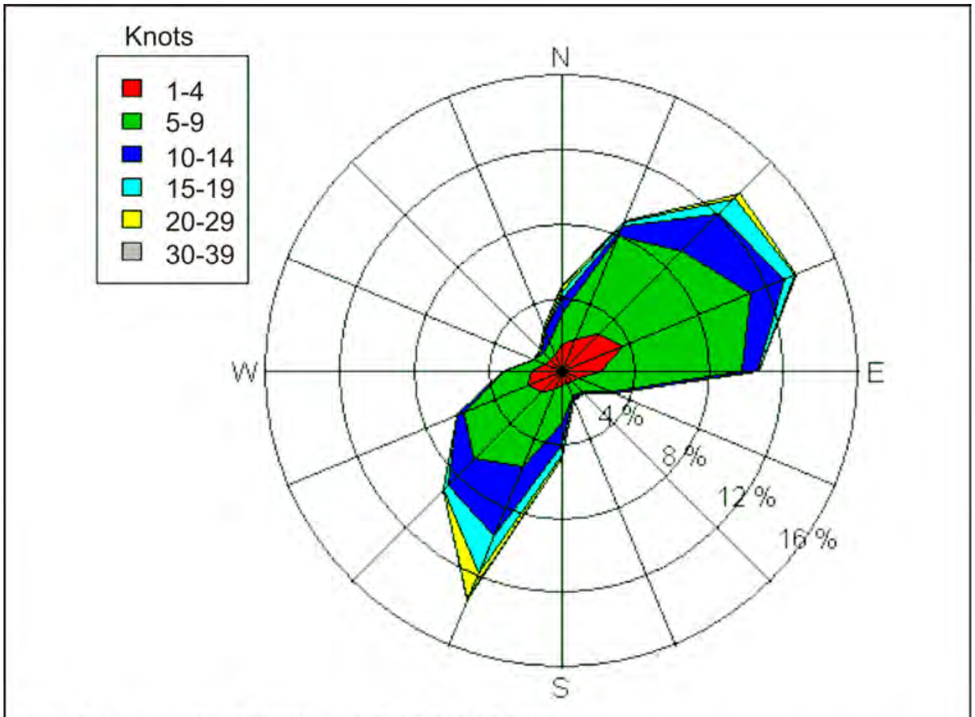


Figure D–2 Annual Average Wind Rose for Meteorological Data Acquisition Station 13 near the Nonproliferation Test and Evaluation Complex



Note: Encompassing 2004 through 2008 (NOAA 2006).
To convert knots to ms^{-1}, multiply by 0.5144. To convert knots to mph, multiply by 1.151.

Figure D–3 Annual Average Wind Rose for Meteorological Data Acquisition Station 26 near Test Cell C

Calm winds are infrequent at the NNSS. For example, at the stations near BEEF (see Figure D–1), NPTEC (see Figure D–2), and Test Cell C (see Figure D–3), the percentage of observations that showed wind speeds of less than 1 knot were between 1 and 2 percent. Locations in basins such as the dry lake beds in the Yucca and Frenchman Flats tend to have the lightest winds (i.e., average annual wind speeds of about 5 to 10 miles per hour). Mesa locations tend to have slightly stronger winds (i.e., average annual wind speeds of about 11 miles per hour) because they tend to reflect the larger-scale wind flow and have less surface roughness. Mountaintop locations tend to have the fastest winds (i.e., average annual wind speeds of about 13 to 20 miles per hour) because they are strongly influenced by upper-level winds. Locations with steep elevation gradients also tend to have higher wind speeds due to stronger up-slope and down-slope wind flows. Seasonally, winds tend to be strongest at all locations on the NNSS during the spring due to more-frequent frontal passages and weakest in the fall. Wind gusts in excess of 55 miles per hour can be observed during springtime frontal passages and during summertime convective thunderstorms (NOAA 2006). When unaccompanied by rainfall, stronger springtime wind speeds can commonly lead to dust storms.

D.1.1.2 Ambient Air Quality on and near the Nevada National Security Site

This section expands the ambient air quality discussion presented in Chapter 4, Section 4.1.8.2, of this *NNSS SWEIS*.

D.1.1.2.1 Existing Air Quality

Emissions from Stationary Sources. Title V of the Clean Air Act gives states the authority to use air quality permits to regulate stationary source emissions of criteria pollutants. At the NNSS, there is one Class II Air Quality Permit. Class II permits are issued for "minor" sources where the following emissions limits are in effect: (1) annual emissions of any one criteria pollutant must not exceed 100 tons; (2) annual emissions of any one hazardous air pollutant (HAP) must not exceed 10 tons (including lead); or (3) annual emissions of any combination of HAPs must not exceed 25 tons (including lead). The emissions limits with associated with the NNSS permit are occasionally re-evaluated and reissued—most recently in 2009. The NNSS facilities regulated by this permit include the following (DOE 2009d, 2009e):

- Over 15 facilities and 185 pieces of equipment in Areas 1, 3, 5, 6, 12, 23, and 27
- NPTEC (in Area 5)
- Sitewide chemical release areas
- BEEF in Area 4
- Explosives Ordnance Disposal Unit in Area 11
- Explosive pads at the HEST [High Explosive Simulation Technique] test range in Area 14,
- Test Cell C in Area 25, and Port Gaston in Area 26

A summary of the historical stationary source emissions and the maximum permitted emission rates are shown in **Table D–2** based on reports submitted to the Nevada Division of Environmental Protection. The actual annual emissions of individual criteria pollutants have been well below the permitted levels over the past 11 years. Most of these emissions are associated with emissions from diesel generators (DOE 2009d). The Class II permit also requires that the best practical method be used to limit the resuspension of soil dust into the air during various site activities. At the NNSS, the main method of dust control is the use of water sprays. Observations of fugitive dust tests conducted during 2008 showed no excessive fugitive dust events on the NNSS (DOE 2009d).

Table D–3 shows the 2008 onsite emissions of criteria pollutants and HAPs associated with permitted onsite stationary sources. Emissions from the current construction and associated surface disturbance activities were much smaller relative to the stationary sources and the other mobile sources and were not explicitly calculated. Levels of particulate matter with an aerodynamic diameter less than or equal to 2.5 micrometers ($PM_{2.5}$) for stationary sources have not been explicitly reported by the NNSS, so the $PM_{2.5}$ levels were conservatively assumed to be equal to emission rates of particulate matter with an aerodynamic diameter less than or equal to 10 micrometers (PM_{10}).

Onsite stationary sources emitted approximately 5.18 tons of criteria pollutants in 2008, the bulk of which was attributable to diesel generators. The stationary sources emitted 0.09 tons of HAPs in 2008, most of which was attributable to chemical spill tests at NPTEC.

Table D–2 Calculated Emissions and Annual Permitted Amounts of Criteria Pollutants and Hazardous Air Pollutants from Nevada National Security Site Stationary Sources, 1998–2008 (tons per year)

Pollutant	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*Annual Permitted Amount*
PM_{10}	1.11	1.7	1.46	2.05	3.61	2.39	0.94	0.84	0.69	0.54	0.22	*25.59*
CO	1.85	1.87	2.76	4.84	4.6	1.79	0.24	0.15	0.43	0.51	0.94	*9.57*
NO_x	7.57	8.07	12.75	22.23	21.09	8.11	1.01	0.69	2.02	1.21	3.36	*28.53*
SO_2	0.37	0.42	0.98	1.68	1.62	0.76	0.12	0.04	0.03	0.01	0.06	*3.49*
VOCs	11.76	1.99	1.89	2.01	2.1	1.21	4.6	1.94	1.4	1.14	0.6	*14.91*
HAPs	NR [a]	NR [a]	0.01	0.03	0.01	0	0.41	0.05	1.87	0.02	0.09 [b]	*N/A*
Criteria pollutant total [c]	22.66	14.05	19.85	32.84	33.03	14.26	7.32	3.71	6.44	3.43	5.18	*N/A*

CO = carbon monoxide; HAP = hazardous air pollutant; N/A = not applicable; NO_x = nitrogen oxides; NR = not reported; NNSS = Nevada National Security Site; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; VOC = volatile organic compound.
[a] HAPs may have been released in 1998 and 1999 but were not reported.
[b] In 2008, 95 percent of HAPs were emitted during chemical spill tests at the Nonproliferation Test and Evaluation Complex.
[c] This total includes all displayed pollutants except HAPs.
Source: DOE 2009d.

Table D–3 Calculated Emissions of Criteria Pollutants and Hazardous Air Pollutants from Onsite Nevada National Security Site Stationary Sources, 2008 (tons per year)

Pollutant	*BEEF*	*NPTEC*	*Storage Tanks*	*Other Sources* [a]	*TOTAL (all programs)*	*Reference*
PM_{10}	0.01	0	0	0.212	*0.22*	DOE 2009d, pages 3-22 and 3-23
$PM_{2.5}$	0.01	0	0	0.212	*0.22*	
CO	0.17	0.01	0	0.76	*0.94*	
NO_x	0	0.001	0	3.36	*3.36*	
SO_2	0	0	0	0.06	*0.06*	
VOCs	0.001	0.12	0.35	0.13	*0.60*	
Lead	N/A	N/A	N/A	N/A	*0.0023*	DOE 2009d, Table 10.2, page 10-3
HAPs	N/A	N/A	<0.09	N/A	*0.09*	DOE 2009d, pages 3-22 and 3-23

< = less than; BEEF = Big Explosives Experimental Facility; CO = carbon monoxide; HAP = hazardous air pollutant; N/A = not applicable; NO_x = nitrogen oxides; NPTEC = Nonproliferation Test and Evaluation Complex; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; VOC = volatile organic compound.
Note: Activities are partitioned by source type.
[a] Other sources include diesel-fired generators, aggregate and concrete handling, cement services equipment, and portable bins.

Emissions from Onsite Government-Owned Vehicles. The MOVES2010 [Motor Vehicle Emission Simulator 2010] (Version 20091221; EPA 2009) mobile source emissions model was used to estimate annual emission rates due to government vehicle traffic on the NNSS. Onsite government-owned mobile source activity data were derived from the onsite vehicle counts in the *Traffic Study and Cost Benefit Analysis to Renovate Existing Roadways, Nevada Test Site* (referred to hereafter as the "1999 NTS road renovation study") (BN 1999). **Table D–4** and the discussion that follows contain further details on the activity and vehicle data used. See Chapter 4, Section 4.1.3, for more details.

Table D–4 Vehicle Activity Data Used to Model Emissions from Onsite Government Vehicles at the Nevada National Security Site

Vehicle Type Observed [a]	***MOVES2010 Vehicle Type***	***MOBILE6 Vehicle Type***	***Count***	***Annual VMT***	***Percentage Annual VMT Occurring on Weekdays***	***Fuel Types Used***	***Average Vehicle Age (model year)***	***Vehicle Fuel Economy (miles per gallon)***	***VMT per Applicable Fuel Type***	***Annual Lead Emissions (pounds)***
Single-unit trucks (2 to 3 axles)	Single-unit, short-haul trucks	Light-duty trucks, 6,001–8,500	141	715,842	98	Biodiesel (B-20) and No. 2 diesel	11 years (1997)	11.2	61,247 No. 2 diesel 324,195 B-20	0.007
Cars/light trucks	Light-duty passenger vehicles	Light-duty passenger vehicles, all	1,007	4,191,978	95	E85 (assumed to be E10 for MOVES modeling) and unleaded gasoline	9 years (1999)	24.1	2,974,970 Unleaded gasoline 1,258,657 E10	0.021
Cars/light trucks	Light-duty trucks	Light-duty trucks, 0–6,000	1,007	5,556,808	95	E85 (assumed to be E10 for MOVES modeling) and unleaded gasoline	9 years (1999)	18.5	3,875,501 Unleaded gasoline 1,639,656 E10	0.02
Buses	Transit buses	Heavy-duty transit buses, all	70	90,228	95	Biodiesel (B-20) and No. 2 diesel	9 years (1999)	4.4	77,933 No. 2 diesel 412,522 B-20	0.0087

MOBILE6 = Mobile Source Emission Factor Model; MOVES2010 = Motor Vehicle Emission Simulator 2010; VMT = vehicle miles traveled.

[a] Vehicle types observed in Traffic Study and Cost Benefit Analysis to Renovate Existing Roadways, Nevada National Security Site (BN 1999).

Note: Modeling performed using MOVES2010.

Onsite government vehicle data used for emissions modeling are discussed below (see Chapter 4, Section 4.1.3, for more details):

- **Onsite government vehicle types.** The vehicle types observed in the 1999 NTS road renovation study (BN 1999) were linked to MOVES vehicle types, as shown in Table D–3. Note that the light-duty vehicles and light-duty passenger trucks were not separated in the road renovation study, so vehicle data derived from that study were split equally among light-duty vehicles and light-duty passenger trucks for the purposes of MOVES modeling.
- **Vehicle counts.** The vehicle counts in Table D–4 were derived from those observed in the 1999 NTS road renovation study (BN 1999), which were scaled to reflect the change in NNSS employment since that study.
- **Vehicle miles traveled (VMTs).** The VMTs in Table D–4 were derived from the vehicle counts observed in the 1999 NTS road renovation study (BN 1999) and from assumed vehicle destinations.
- **Vehicle age.** The average national default age was used Table D–4 for each vehicle type since this information was not provided in the the 1999 study.
- **Fuel types.** The National Nuclear Security Administration (NNSA) provided fuel usage amounts of unleaded gasoline (435,000 gallons), E85 (184,000 gallons), biodiesel (343,191 gallons), and No. 2 diesel (644,844 gallons) by onsite government vehicles for fiscal year 2009. These fuel usage amounts were assumed to be similar to usage in calendar year 2008. Fuel amounts are not directly used in MOVES; rather, fuel fraction and fuel supply market share were incorporated into the model in the following way:
    - **Fuel types to vehicles.** Unleaded gasoline and E85 was allocated only to light-duty passenger trucks and light-duty vehicles. Buses and single-unit, short-haul heavy-duty trucks were assigned No. 2 diesel and biodiesel. E85 ethanol or B-100 biodiesel are not included in MOVES. As a conservative assumption, the fuel properties for E10 were used in place of E85 and B-20 in place of B-100.
    - **Market shares of each fuel.** The MOVES default fuel supply market share for Nye County includes only one formulation of diesel and two formulations of gasoline (due mostly to changes in Reid vapor pressure) with a seasonal split of 0.286 and 0.714. However, these default formulations do not include ethanol or biodiesel, which are used at the NNSS. The NNSS fuel usage numbers have an ethanol-to-(gasoline+ethanol) fuel usage ratio of 0.297. The corresponding gasoline market share was then adjusted as follows: (1 - 0.297) = 0.703. Multiplying this gasoline market share by the MOVES default market shares of gasoline formulations results in a 0.201 and 0.502 split between the two types of unleaded gasoline. For biodiesel and No.2 diesel, the NNSS fuel usage is 0.159, so the No. 2 diesel market share was set to 0.841.
- **Lead emissions per vehicle and fuel types.** The U.S. Environmental Protection Agency's (EPA) *Air Quality Criteria for Lead* (EPA 2006) was used to estimate the lead emissions factors for mobile sources. The reference has lead-mass-per-mile factors for gasoline, for No. 2 diesel consumed by trucks, and for No. 2 diesel consumed by buses. The reference contains no lead emission factors for ethanol or biodiesel, so it was conservatively assumed that the same factors apply for unleaded gasoline and No. 2 diesel, respectively. The results are shown in Table D–4.
- **Monthly and hourly distributions of VMT.** MOVES default data were used.
- **Road types.** All Nye County roads are assumed to be rural roads with unrestricted access.

- **Meteorology and road speed distributions.** MOVES default data for Nye County were used.
- **Emissions Types.** Only emissions from running exhaust, evbrake wear, and tire wear were modeled.

Table D–5 shows the modeled current (approximately 2008) onsite mobile emissions of criteria pollutants and HAPs associated with NNSS government-owned vehicles. Total onsite emissions from stationary sources (shown in more detail in Table D–2) are also provided in Table D–4 to show the total onsite emissions from both stationary sources and government-owned vehicle mobile sources.

The mobile source criteria pollutant emissions were dominated by carbon monoxide (39.6 tons) and, to a lesser extent, nitrogen oxides (13.9 tons). Light-duty passenger trucks were the largest onsite mobile source emitters (65 percent of onsite government-owned vehicle emissions), followed by light-duty vehicles (21 percent).

Table D–5 Estimated Emissions of Criteria Pollutants and Hazardous Air Pollutants from Onsite Nevada National Security Site Stationary Sources and Government-Owned Mobile Sources, 2008 (tons per year)

	Nye County						
	On NNSS						
	Government-Owned Mobile Source Type (Modeled)						
Pollutant	*Light-Duty Vehicles*	*Light-Duty Passenger Trucks*	*Buses*	*Single-Unit, Short-Haul Trucks*	*Total*	*Stationary Source Type (calculated)*	*Total*
PM_{10}	0.11	0.20	0.11	0.40	0.82	*0.22*	*1.0*
$PM_{2.5}$	0.066	0.12	0.10	0.37	0.66	*0.22*	*0.88*
CO	9.3	28.1	0.55	1.6	39.6	*0.94*	*40.5*
NO_x	2.1	6.9	1.3	3.6	13.9	*3.36*	*17.3*
SO_2	0.026	0.048	0.00035	0.0014	0.076	*0.06*	*0.14*
VOCs	0.10	0.60	0.013	0.084	0.80	*0.6*	*1.4*
Lead	0.0000050	0.000010	0.0000035	0.0000035	0.000022	*0.0023*	*0.0023*
HAPs	0.0098	0.046	0.00029	0.0018	0.058	*0.09*	*0.15*

CO = carbon monoxide; HAP = hazardous air pollutant; NO_x = nitrogen oxides; NNSS = Nevada National Security Site; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; VOC = volatile organic compound.
Note: Government-owned mobile source activities are partitioned by source type. The source type partitioning of stationary source activities is shown in Table D–3.

Emissions from Commuter Vehicles. The MOVES2010 (Version 20091221; EPA 2009) mobile source model was used to estimate emissions due to vehicle traffic from employees commuting to the NNSS using personal vehicles. **Table D–6** and the following discussion contain further details on the activity and vehicle data that were used. Chapter 4, Section 4.1.3, of this *NNSS SWEIS* contains information regarding the origin of these activity numbers.

Private-vehicle commuter activity data were based on employment numbers and residence information. Half of the commuter vehicles were assumed to be light-duty vehicles and the other half, light-duty passenger trucks. To estimate the personal-vehicle emissions in various locations, it was assumed that all personal-vehicle commuters enter the NNSS via Mercury Highway and park at Entry Gate 100. This commuting pattern results in about 4 miles round trip on site per commuter traveling by personal vehicle at the NNSS. It was also assumed that all personal-vehicle commuters coming from Clark County use

U.S. Route 95, which results in about 12 miles round trip per commuter traveling by personal vehicle within Nye County and outside of the NNSS. For Clark County roads, GIS [geographic information system] was used to estimate the total length of various road types; roads outside and inside of the Las Vegas spaghetti bowl correspond to rural and urban roads, respectively. For the Clark County portion of travel, the following fractions were used: 0.176 rural restricted, 0.595 rural unrestricted, 0.058 urban restricted, and 0.171 urban unrestricted.

Table D–6 Vehicle Activity Data Used to Model Emissions from Commuting to and from the Nevada National Security Site

MOVES2010 Vehicle Type	*Count Originating in Clark County*	*Count Originating in Nye County*	*Annual VMT Within Clark County*	*Annual VMT Within Nye County but Outside the NNSS*	*Annual VMT Within Nye County and Inside the NNSS*	*Percentage Annual Clark County VMT Occurring on Weekdays*	*Percentage Annual Nye County VMT Outside the NNSS Occurring on Weekdays*	*Percentage Annual Nye County VMT Inside the NNSS Occurring on Weekdays*	*Fuel Type Used*
Light-duty vehicles	328	97	9,868,361	2,808,808	430,088	85	90	87	Unleaded gasoline
Light-duty passenger trucks	327	98	9,868,361	2,808,808	430,088				
Transit buses	11	0	420,347	19,667	147,576	89	89	89	No. 2 diesel

MOVES2010 = Motor Vehicle Emission Simulator 2010; NNSS = Nevada National Security Site; VMT = vehicle miles traveled.
Note: Modeling performed using MOVES2010.

The default MOVES fuel market shares, meteorology, vehicle speed distributions, and monthly and hourly VMT distributions were used in the analysis. Only emissions associated with vehicle exhaust, brake wear, and tire wear were modeled. As was done for onsite government vehicles, light-duty vehicles and light-duty passenger trucks were conservatively assumed to have an average age of 9 years.

Emissions from transit buses were not modeled using MOVES2010. Instead, emissions from the NNSS bus fleet were modeled using the age of the current bus fleet (all 2003 model year buses) all meeting the 1998 EPA heavy-duty emissions standards. These emissions standards include the following: 72.5 grams per mile of carbon monoxide; 18.7 grams per mile of nitrogen oxides; and 0.468 grams per mile for particulate matter, conservatively assumed to be entirely $PM_{2.5}$. Sulfur dioxide emissions were calculated using Equation 39 from the PART5 Model, Appendix A (EPA 1995b), and using the standard fuel economy of transit buses from MOBILE6 [Mobile Source Emission Factor Model] (EPA 2003). These emissions standards were combined with the bus fleet annual VMT to arrive at annual emissions. The onsite government bus counts derived from the 1999 NTS *Traffic Study and Cost Benefit Analysis to Renovate Existing Roadways* (BN 1999) were used for the spatial allocation. All buses were assumed to make round trips between Clark County and the NNSS, spending 8 round-trip miles inside Nye County.

Table D–7 shows the modeled current (approximately 2008) mobile emissions of criteria pollutants and HAPs associated with onsite employees commuting to the NNSS. Light-duty passenger vehicles contributed about 21 percent of the criteria pollutant total, while light-duty passenger trucks contributed 46 percent and commuter buses, 33 percent. Carbon monoxide was emitted in the largest amounts (136.5 tons) among the criteria pollutants. Commuting activities related to the NNSS emitted approximately 0.14 tons of HAPs in 2008. The majority (71 percent) of emissions related to commuting to the NNSS took place in Clark County, while about 16 percent took place in the portion of Nye County that is outside of the NNSS, and the remaining 13 percent took place on the NNSS.

Table D–7 Estimated Emissions of Criteria Pollutants and Hazardous Air Pollutants from Commuting to and from the Nevada National Security Site, 2008 (tons per year)

	Light-Duty Vehicles (Modeled)			*Light-Duty Passenger Tucks (Modeled)*			*Transit Buses (calculated)*			*Total*			
		Nye County			*Nye County*			*Nye County*			*Nye County*		
Pollutant	*Clark County*	*Off NNSS*	*On NNSS*	*Clark County*	*Off NNSS*	*On NNSS*	*Clark County*	*Off NNSS*	*On NNSS*	*Clark County*	*Off NNSS*	*On NNSS*	*Total*
PM_{10}	0.25	0.076	0.025	0.37	0.11	0.036	0.22	0.010	0.076	*0.83*	*0.19*	*0.14*	*1.2*
$PM_{2.5}$	0.14	0.044	0.015	0.2	0.058	0.02	0.22	0.010	0.076	*0.56*	*0.11*	*0.11*	*0.78*
CO	20.9	6.1	2.1	44.5	14	4.9	33.6	1.6	11.8	*97*	*21*	*18.5*	*136.5*
NO_x	4.5	1.5	0.48	11.5	3.6	1.2	8.7	0.41	3.0	*24*	*5.3*	*4.6*	*34*
SO_2	0.073	0.02	0.0064	0.11	0.027	0.0097	0.010	0.00047	0.0035	*0.19*	*0.047*	*0.019*	*0.26*
VOCs	0.24	0.071	0.024	1.1	0.3	0.11	N/A	N/A	N/A	*1.2*	*0.35*	*0.12*	*1.7*
Lead	0.000022	6.2×10^{-6}	9.4×10^{-7}	0.000022	6.2×10^{-6}	9.7×10^{-7}	3.4×10^{-6}	1.6×10^{-7}	1.2×10^{-6}	*0.000048*	*0.000013*	3.1×10^{-6}	*0.000064*
HAPs	0.021	0.0069	0.0023	0.08	0.025	0.0087	N/A	N/A	N/A	*0.095*	*0.03*	*0.01*	*0.14*

CO = carbon monoxide; HAP = hazardous air pollutant; N/A = not applicable; NO_x = nitrogen oxides; NNSS = Nevada National Security Site; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; VOC = volatile organic compound.

Emissions from Commercial Vendor Mobile Sources. The MOVES2010 model was used to estimate emissions due to vehicle traffic from nonradioactive waste transport (commercial vendors). **Table D–8** and the following discussion provide further details on the activity and vehicle data used. See Chapter 4, Section 4.1.3, for more details on the development of these numbers.

Table D–8 Vehicle Activity Data Used to Model Emissions from Commercial Vendors Traveling to and from the Nevada National Security Site

MOVES2010 Vehicle Type	*Count*	*Annual VMT Within Clark County*	*Annual VMT Within Nye County but Outside the NNSS*	*Annual VMT Within Nye County and Inside the NNSS*	*Percentage Annual VMT Occurring on Weekdays*	*Fuel Type Used*
Single-unit, short-haul trucks	17	399,126	55,692	194,922	95	No. 2 diesel

MOVES2010 = Motor Vehicle Emission Simulator 2010; NNSS = Nevada National Security Site; VMT = vehicle miles traveled.
Note: Modeling performed using MOVES2010.

Commercial vendor activity was derived from employee count data and from the 1999 NTS road renovation study (BN 1999). Commercial vendors were assumed to use single-unit trucks fueled by No. 2 diesel. The lead emissions factors for mobile sources in EPA's *Air Quality Criteria for Lead* (EPA 2006) were used to estimate lead emissions for NNSS commercial vendor vehicles.

Commercial vendors were assumed to enter the NNSS via Mercury Highway and go to the Area 5 Radioactive Waste Management Site (RWMS). The RWMS was chosen because nearly all hazardous waste is currently (in 2008) stored at the Pit 3 Mixed Waste Disposal Unit, which is near RWMS (DOE 2009c). Hazardous waste was estimated to travel 84 miles per vehicle trip in Clark County, 12 miles per vehicle trip in Nye County but outside the NNSS, and 40 miles per vehicle trip inside the NNSS. MOVES default fuel supply market shares, meteorology, vehicle speed distribution, and monthly and hourly VMT distributions were used in the analysis. Only running exhaust, brake wear, and tire wear were modeled. As was done for onsite government vehicles, single-unit, short-haul trucks were assumed to have an average age of 11 years old. All Nye County roads were assumed to be rural roads with unrestricted access, and the same Clark County road distribution as used for commuter traffic was used for commercial vendors.

Table D–9 shows the 2008 mobile emissions of criteria pollutants and HAPs associated with commercial vendors traveling to and from the NNSS. Approximately 5.9 tons of criteria pollutants were emitted due to commercial vendor activities related to the NNSS in 2008. Nitrogen oxide emissions comprised the single largest amount (3.4 tons) among the criteria pollutants. About 0.068 tons of HAPs were emitted as a result of commercial vendor activities in 2008. The majority (63 percent) of emissions related to NNSS commercial vendors took place in Clark County, while about 29 percent took place in the portion of Nye County that is outside of the NNSS, and the remaining 8 percent took place on the NNSS.

Emissions from Radioactive Waste Truck Mobile Sources. The MOVES2010 (Version 20091221 for Nye County; Version 20100515 for Clark County; EPA 2009) mobile source model was used to estimate emissions due to vehicle traffic from radioactive waste transport. **Table D–10** and the following discussion contain details on the activity and vehicle data that were used in modeling the emissions. See Chapter 4, Section 4.1.3, for more details on the development of the transportation activity levels.

Table D–9 Estimated Emissions of Criteria Pollutants and Hazardous Air Pollutant from Commercial Vendors Traveling to and from the Nevada National Security Site, 2008 (tons per year)

	Single-Unit, Short-Haul Trucks			
		Nye County		
Pollutant	***Clark County***	***Off NNSS***	***On NNSS***	***Total***
PM_{10}	0.24	0.032	0.11	0.38
$PM_{2.5}$	0.22	0.029	0.10	0.35
CO	0.98	0.13	0.46	1.6
NO_x	2.2	0.277494	0.97	3.4
SO_2	0.0041	0.00051	0.0018	0.0064
VOCs	0.32	0.042	0.15	0.51
Lead	3.8×10^{-6}	5.2×10^{-7}	1.8×10^{-6}	6.1×10^{-6}
HAPs	0.042	0.0056	0.020	0.068

CO = carbon monoxide; HAP = hazardous air pollutant; NO_x = nitrogen oxides; NNSS = Nevada National Security Site; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; VOC = volatile organic compound.

Table D–10 Vehicle Activity Data Used to Model Emissions from Radioactive Waste Trucks Traveling to and from the Nevada National Security Site

MOVES2010 Vehicle Type	***Count***	***Annual VMT Within Clark County***	***Annual VMT Within Nye County but Outside the NNSS***	***Annual VMT Within Nye County and Inside the NNSS***	***Percentage Annual VMT Occurring on Weekdays***	***Fuel Type Used***
Combination-unit, short-haul trucks	9 [a]	106,799	328,765	2,915	95	No. 2 diesel

MOVES2010 = Motor Vehicle Emission Simulator 2010; NNSS = Nevada National Security Site; VMT = vehicle miles traveled.

[a] The number of radioactive waste trucks was unknown. The number of multiple-axle trucks used by commercial vendors was used as a surrogate.

Note: Modeling performed using MOVES2010.

Radioactive waste transport activity was derived from the average number of transports in 2007 and 2008 and assumed origin-to-NNSS distances. After rounding to the nearest 100,000 miles to account for other special shipments that may not have been accounted for, this activity calculation resulted in an estimated 5.3 million miles driven annually within Nevada due to these transports. An estimated 0.55 percent of this mileage took place on the NNSS. A map of the seasonal routes taken by these transports was used to estimate the mileage percentages within Nye County (62 percent) and Clark County (20 percent). Radioactive waste was transported only by combination-unit trucks, and all of these trucks were assumed to use only No. 2 diesel. The lead emissions factors for mobile sources in EPA's *Air Quality Criteria for Lead* (EPA 2006) were used for estimating lead emissions for NNSS radioactive waste transport vehicles.

Radiological trucks were assumed to travel the preferred transportation routes through Nevada when transporting radioactive waste. MOVES default fuel supply market shares, meteorology, vehicle speed distribution, and monthly and hourly VMT distributions were used in estimating emissions. Only running exhaust, brake wear, and tire wear were modeled. As was done for onsite government vehicles and commercial vendors, combination-unit, short-haul trucks were assumed to have an average age of 11 years. All Clark County and Nye County roads on the seasonal routes taken by these transports were assumed to be rural roads with unrestricted access.

Table D–11 shows the modeled current (approximately 2008) mobile emissions of criteria pollutants and HAPs associated with radioactive waste transport to and from the NNSS. Approximately 13.4 tons of criteria pollutants were emitted due to radioactive waste truck activities related to the NNSS in 2008. Nitrogen oxides were the largest single pollutant at (9.6 tons). Approximately 0.058 tons of HAPs were emitted as a result of radioactive waste truck activities related to the NNSS in 2008. The majority (75 percent) of emissions related to NNSS radioactive waste trucks took place in the portion of Nye County that is outside of the NNSS, while about 25 percent took place in Clark County, and the remaining percentage (less than 1 percent) took place on the NNSS.

Table D–11 Estimated Emissions of Criteria Pollutants and Hazardous Air Pollutants from Radioactive Waste Trucks Traveling to and from the Nevada National Security Site, 2008 (tons per year)

	Combination-Unit, Short-Haul Trucks			
		Nye County		
Pollutant	***Clark County***	***Off NNSS***	***On NNSS***	***Total***
PM_{10}	0.17	0.51	0.0046	*0.68*
$PM_{2.5}$	0.16	0.48	0.0042	*0.64*
CO	0.67	2	0.018	*2.7*
NO_x	2.3	7.2	0.064	*9.6*
SO_2	0.0033	0.01	0.000088	*0.013*
VOCs	0.11	0.33	0.0029	*0.44*
Lead	2.2×10^{-6}	1.9×10^{-6}	1.7×10^{-9}	4.1×10^{-6}
HAPs	0.014	0.044	0.00038	*0.058*

CO = carbon monoxide; HAP = hazardous air pollutant; NO_x = nitrogen oxides; NNSS = Nevada National Security Site; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; VOC = volatile organic compound.

Measurements of Ambient Air Concentrations on the NNSS. The monitored concentrations cannot be directly compared with the standards because the standards use calendar years and some of the standards use other statistics and time periods as part of their calculation. However, given that the monitored concentrations presented in Chapter 4, Table 4–38, are maximum observed concentrations for their respective time periods, and given that none of them exceeded the ambient air quality standards, these monitored concentrations demonstrate that the area is attaining the air quality standards. Listed below are summary concentration statistics from the YMP1 station for the period from October 1991 through September 1995, compared directly with the standard concentration values (ignoring the above comparison issues):

- The maximum 1-hour carbon monoxide concentration was 0.2 parts per million, which is less than 1 percent of the National Ambient Air Quality Standards (NAAQS) value (35 parts per million).

- The maximum 8-hour carbon monoxide concentration was 0.2 parts per million, which is 2 percent of the Nevada standard value for elevations below 5,000 feet (9 parts per million; the YMP1 monitoring station is about 4,000 feet above mean sea level).

- The maximum October-to-September annual nitrogen dioxide concentration was 0.00214 parts per million, which is 4 percent of the NAAQS value (0.053 parts per million).

- The maximum 1-hour ozone concentration was 0.096 parts per million, which is 80 percent of the NAAQS value (0.120 parts per million; this NAAQS is no longer in effect).

- The maximum 3-hour, 24-hour, and September-to-October annual concentrations of sulfur dioxide were all 0.002 parts per million, which are less than 1 percent, 1 percent, and 7 percent of the 3-hour, 24-hour, and annual NAAQS values (0.5, 0.14, and 0.03 parts per million), respectively.

Ozone was the only gaseous criteria pollutant to routinely register ambient levels above the instrument threshold. Ozone levels never exceeded the regulatory limit for the 1-hour average standard (0.12 parts per million by volume). The 1-hour average standard was withdrawn in 2005, and has now been replaced with an 8-hour average standard (0.075 parts per million). Ozone is formed in the atmosphere under the presence of sunlight, nitrogen oxides, and volatile organic compounds. Ozone typically has the highest concentrations during warm weather because strong sunlight and high temperatures are more conducive to higher ambient concentrations. Approximately 90 percent of the warm-season hours had concentrations between 0.020 and 0.060 parts per million; only 44 hours had concentrations in excess of 0.080 parts per million.

No ambient monitoring data were available for lead. However, the U.S. Department of Energy (DOE) expects concentrations of lead to be far below the regulatory standard because there are no industrial sources in the region of influence (or near enough to transport this contaminant into the region of influence), and lead-based gasoline, previously the principal source of lead in the air, has been phased out.

Some annual statistics on observed ambient PM_{10} concentrations at the YMP1, YMP5, YMP6, and YMP9 monitoring stations from 1989 through 2005 are shown in Chapter 4, Table 4–39. This table also shows the NAAQS or Nevada Ambient Air Quality Standards (whichever one is lower) that were in place at the time of monitoring. Note, however, that the air quality standards are not as restrictive as just the highest concentration. For example, the 24-hour PM_{10} standard is not to be exceeded more than once on average over 3 years and the annual PM_{10} standard is the 3-year weighted average PM_{10} concentration. However, these observed concentrations in Table 4–39 do demonstrate compliance with the current 24-hour PM_{10} standard as none of these concentrations exceed the ambient air quality standards. Listed below are some summary concentration statistics from these monitoring stations for the period from 1989 through 2005, compared directly with the air quality standard concentration values (ignoring the above comparison issues):

- The largest 24-hour averaged value observed across these 17 years and 4 monitoring stations was 67 micrograms per cubic meter (at the YMP5 station in 1995), or 45 percent of the NAAQS value (150 micrograms per cubic meter).
- Across the observations for these 17 years and 4 monitoring stations, 41 percent of the annual largest 24-hour averaged values were less than 20 percent of the NAAQS value (150 micrograms per cubic meter).
- The largest annual averaged value observed was 13 micrograms per cubic meter (at the YMP5 station in 1989), or 26 percent of the Nevada Ambient Air Quality Standard value.
- Across the observations for these 17 years and 4 monitoring stations, 54 percent of the annual averaged values were less than 20 percent of the Nevada Ambient Air Quality Standard value for PM_{10}.

No ambient monitoring data were available for $PM_{2.5}$; however, because $PM_{2.5}$ is a subset of PM_{10}, $PM_{2.5}$ can be estimated from measurements of ambient PM_{10}. In the region of influence, most of the PM_{10}

would be generated from the resuspension of surface-level soil and mineral materials with some additional PM_{10} from fuel combustion. A U.S. Department of Agriculture study on wind erosion in the western United States found that over all soils, the fraction of PM_{10} as $PM_{2.5}$ was about 15 percent, ranging from 10 to 30 percent (Hagen 2001). To be conservative, DOE applied the upper end of this range (30 percent) to the ambient PM_{10} data collected in Area 25 (the YMP1, YMP5, and YMP9 stations) over the past 8 years (1998 through 2005), and the resulting data indicated the highest expected 24-hour concentration of $PM_{2.5}$ would be 16 micrograms per cubic meter, and the highest expected annual average concentration would be 4 micrograms per cubic meter. These numbers are 46 and 26 percent of the ambient air quality standards for $PM_{2.5}$.

Modeling of Ambient Air Concentrations on and near the NNSS. Because the NNSS covers some 1,360 square miles, ambient air quality monitoring on the prevailing upwind side of the NNSS (Area 25) may not capture emission impacts from onsite sources. The majority of routine emission sources is concentrated in Areas 6 and 23 and is associated with sand and aggregate processing and fuel-burning, as shown in Table D–3. Impacts from those emissions are small and will likely have little effect on the ambient air quality. However, emissions from other sources (e.g., explosives testing) occur infrequently, but produce high concentrations for short periods. **Figure D–4** shows the locations of the emissions associated with these open detonations: Areas 4 (BEEF), 5 (NPTEC), 11 (EODU [Explosives Ordnance Disposal Unit]), 14 (HEST [High Explosive Simulation Technique] test range), 25 (Test Cell C), and 26 (Port Gaston).

Modeling Methodology. As part of an environmental evaluation for the NNSS Class II Air Quality Operating Permit AP9711-0549.01 (DOE 2009b), dispersion modeling was conducted in 2009 to estimate the air quality impacts from non-explosive emission sources and from explosives testing at the NNSS. Two EPA-approved models – AERMOD and OBODM [Open Burn/Open Detonation Model] – were used to model the non-explosive sources and the detonation activities, respectively.

For the NNSS Class II Air Quality Operating Permit modeling support study, AERMOD was run with many non-explosive stationary sources throughout the NNSS, including industrial sources and storage tanks. AERMOD was run without deposition to conservatively model the air concentration. The AERMOD modeling used 3,785 receptors surrounding the NNSS boundary, forming a 1.5-mile buffer around the NNSS boundary at a spacing of about 0.31 miles (500 meters). The receptors are shown in Figure D–4, but the non-explosive stationary sources are not shown.

OBODM was run for six explosive test sites in the NNSS. The OBODM modeling for the Permit used 1,203 receptors – some were placed at discrete locations along the NNSS boundary, and some were placed east of the NNSS boundary out to a distance of about 3.7 miles at a spacing of about 0.31 miles (500 meters). These eastern receptors were chosen because they are predominantly downwind from the detonation operations.

For this site-wide environmental impact statement (SWEIS), several supplementary OBODM model runs were performed to estimate particulate matter concentrations (not done in the permit support study) at locations accessible to the public (i.e., the Nevada Test and Training Range boundary downwind from the detonation operations) for the baseline affected environment conditions and for the future environmental consequences conditions. The public has access to areas along the southern border of the NNSS. Otherwise, the public's closest approach is along the border of the Nevada Test and Training Range. The Nevada Test and Training Range effectively creates a public access buffer zone of up to 30 miles beyond the northern, western, and eastern NNSS boundaries. The receptors used in the OBODM runs are shown in Figure D–4.

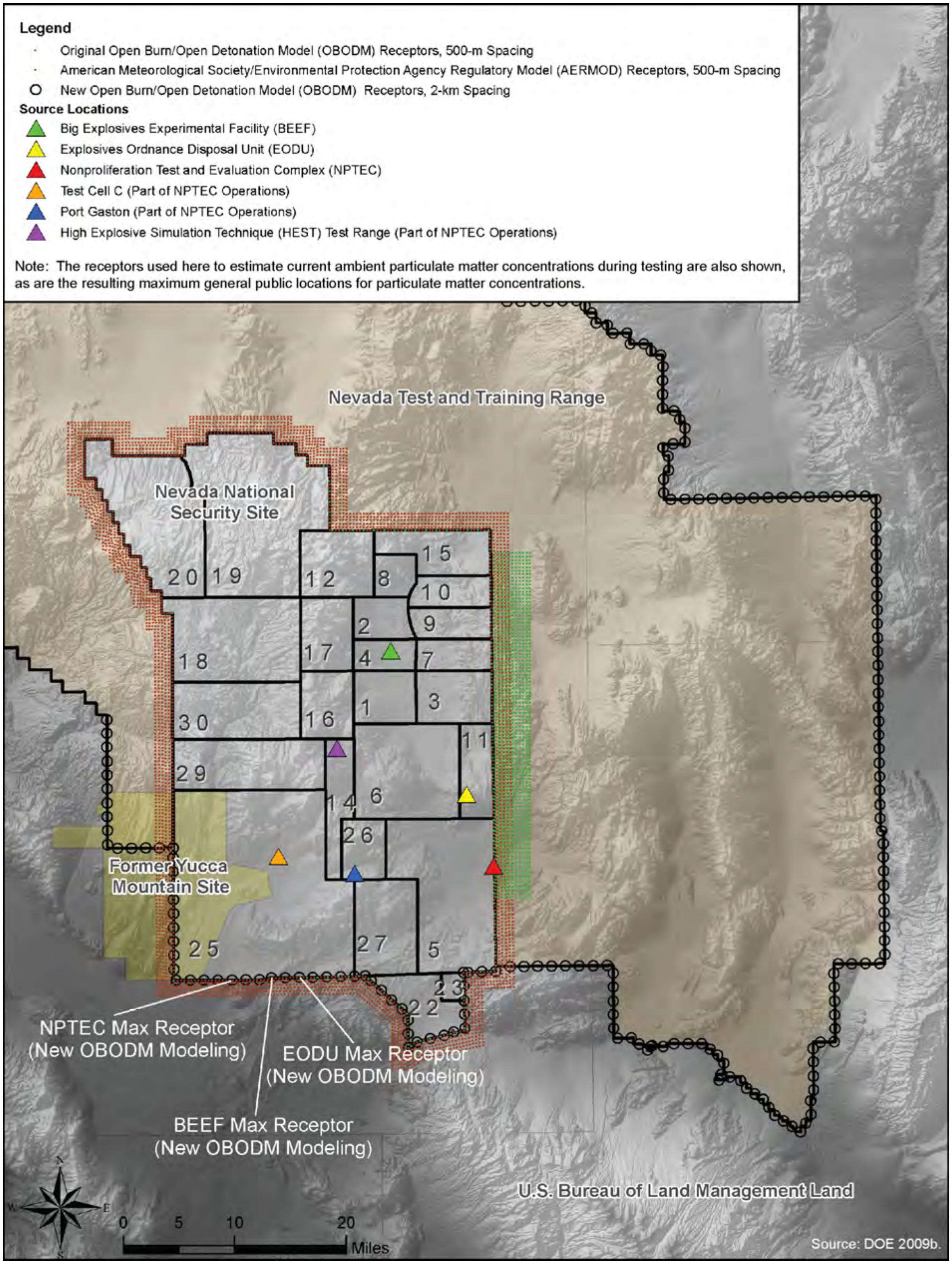


Figure D–4 Locations of the Open-Air Detonation Locations Modeled for the Nevada National Security Site Class II Air Quality Operating Permit (AP9711-0549.01)

AERMOD and OBODM use a suite of hourly meteorological data for years 2003-2007 to simulate dispersion of emissions in the atmosphere. The most complete set of hourly meteorological data is collected at the first order weather station at Desert Rock located on the southern side of the NNSS at 36.6241 degrees north, 116.0192, degrees west, and 3,300 feet (1,000 m) elevation above mean sea level. Both surface and upper air meteorological data are collected at the site and are consistent with the requirements for both models. The surface meteorological dataset contains wind direction and wind speed, temperature and sky cover. Surface temperature data are collected at 6.6 feet (2 meters) above ground level, and surface wind data are collected at 32.8 feet (10 meters). Very little surface data were missing or invalid. For OBODM modeling, wind speeds exceeding 34.4 feet per second (10.5 meters per second) were set to 0 feet per second because detonations would not take place during such high wind speeds and OBODM does not calculate concentrations during calm hours (i.e., when wind speeds are 0). For upper-air data, beginning in early 2005, upper-air data was not collected on weekends and holidays due to budget constraints, and no data substitutions were made because the next closest upper-air station was too far away. In regards to the surface data some differences are found in surface wind patterns within the NNSS (Figure 4-18, Soule, 2006) however, the nature of these elevated releases tend to minimize the differences particularly for the relatively long transport distances to the nearest off-site receptors.

The modeling analysis for the BEEF assumed a maximum emission rate that occurred once daily, that is, one detonation of 21.5 tons of explosives at 9 a.m. daily and then repeated each day. This same approach was used in the Nevada National Security Site Class II Air Quality Operating Permit AP9711-0549.01. This modeling was performed daily over the five year of meteorological data (2003-2007) to determine the maximum downwind concentration. These maximum concentrations are the explosive source result reported in **Table D–12**. For detonations at EODU, hourly detonations of 100 pounds of explosives were modeled to occur from 0800 LT through 1500 LT as long as the wind speed remained below 23.5 miles per hour. For the NPTEC the modeling analysis assumed a worst-case scenario that is a single detonation of 1 ton of explosives per day at 9 a.m.

Table D–12 Particle Mass Distribution per Particle Size Used in Open Burn/Open Detonation Modeling

Permit Modeling		*New Modeling for This SWEIS*	
Particle Diameter Interval (micrometers)	*Mass Fraction of Total PM_{10} Mass*	*Particle Diameter Interval (micrometers)*	*Mass Fraction of Total PM_{10} Mass (Mass Fraction of Total $PM_{2.5}$ Mass)*
4 to 5	0.033	0.21 to 0.24	0.00001 (0.00011)
5 to 6	0.126	0.24 to 0.33	0.00007 (0.00075)
6 to 7	0.341	0.33 to 0.46	0.00026 (0.00298)
7 to 8	0.341	0.46 to 0.64	0.00098 (0.01111)
8 to 9	0.126	0.64 to 0.89	0.00309 (0.03507)
9 to 10	0.033	0.89 to 1.23	0.00846 (0.09596)
		1.23 to 1.72	0.02066 (0.23442)
		1.72 to 2.28	0.03582 (0.40643)
		2.28 to 2.50	0.01879 (0.21317)
		2.50 to 2.65	0.01091 (N/A)
		2.65 to 3.34	0.10200 (N/A)
		3.34 to 4.66	0.14923 (N/A)
		4.66 to 6.49	0.22742 (N/A)
		6.49 to 8.76	0.27830 (N/A)
		8.76 to 10	0.14400 (N/A)

N/A = not applicable; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers.
Source: DoD 2004; Pinnick et al. 1983.

Listed below are other important parameter settings used in the OBODM modeling. Some details about the environmental consequences scenarios are also shown. Note that the OBODM modeling for the Air Quality Permit study only modeled PM_{10}. For the supplementary OBODM modeling performed for this SWEIS, $PM_{2.5}$ was also modeled. Some details about the $PM_{2.5}$ modeling are shown in the list below, and $PM_{2.5}$ is discussed further in the text following the list.

- No depletion from gravitational deposition
- Final cloud-rise height used for all calculations
- Flat terrain, where receptor heights greater than zero are treated as flag poles
- Use both stable and adiabatic plume rise
- Let OBODM calculate: particulate matter settling velocity, reflection coefficient, source effective release height above ground, diameter of initial source material immediately after detonation, wind speed power law, lateral turbulence intensity, vertical turbulence intensity, alongwind turbulence intensity, vertical potential temperature gradients, wind speed shear, and pasquill stability category calculated by OBODM
- Standard deviations of wind direction angle and wind elevation angle calculated by OBODM using internal lookups and defaults at 600-s measuring time
- Calm wind or missing hours have no dispersion or deposition
- If short term wind averages have less than 75 percent valid (non-calm non-missing) hours, use EPA guideline of 75 percent of the possible hours rounded up to the nearest integer
- 24-hour concentration averaging time
- Fuel Heat Content 1000 cal/g
- Fuel Burn Time 2.5s
- Particulate Matter Molecular Weight 90.68 g/g-mol
- Particulate Matter Density of Species 2.05 g/cm^3
- BEEF:
  - 1 instantaneous volume source
  - PBXN-110 Propellant
  - X Coordinate (UTM 11N): 580601 meters, Y Coordinate (UTM 11N): 4105930 meters, Flagpole: 106.6 feet (35.2 meters)
  - Fraction of exhaust cloud constituting pollutant/species: PM_{10} = 0.49, $PM_{2.5}$ = 0.043169
- EODU:
  - 1 instantaneous volume source
  - 0.38 Special Cartridges
  - X Coordinate (UTM 11N): 591532 meters, Y Coordinate (UTM 11N): 4085260 meters, Flagpole 15.4 feet (4.7 meters)
  - Fraction of exhaust cloud constituting pollutant/species: PM_{10} = 0.057, $PM_{2.5}$ = 0.005016

- NPTEC:
  - 4 instantaneous volume sources
  - C-4 Demo Charges
  - 1. NPTEC: X Coordinate (UTM 11N): 595470 meters, Y Coordinate (UTM 11N): 4074879 meters, Flagpole 41.7 feet (12.7 meters)
  - 2. Test Cell C: X Coordinate (UTM 11N): 564419 meters, Y Coordinate (UTM 11N): 4076329 meters, Flagpole 41.7 feet (12.7 meters)
  - 3. Port Gaston: X Coordinate (UTM 11N): 575407 meters, Y Coordinate (UTM 11N): 4073895 meters, Flagpole 41.7 feet (12.7 meters)
  - 4. HEST: X Coordinate (UTM 11N): 572869 meters, Y Coordinate (UTM 11N): 4091869 meters, Flagpole 41.7 feet (12.7 meters)
  - Fraction of exhaust cloud constituting pollutant/species: $PM_{10} = 0.021$, $PM_{2.5} = 0.001848$

The particle mass size distribution used in the Permit modeling (shown in Table D–12) was not used in this analysis because the earlier modeling had assumed none of the particles had a mean aerodynamic diameter smaller than 4 micrometers since the permitting was focused only on PM_{10}. A study by Pinnick et al. (1983) examined several different types of high explosives detonated in a variety of soil types, including sand to silty sand soil as found at the NNSS. The study found that the post explosion particles ranged in mean particle diameter from 0.2 micrometers to larger than 200 micrometers. The study found that the particulate size mass distributions were similar across explosive material and soil types, and that the distributions were both bimodal and lognormal. Based on this information (Pinnick et al. 1983), an equation of two lognormal probability density functions was developed to describe the mass fraction as a function of mean particle diameter (DoD 2004) with the characteristic bimodal distribution. Integrating this equation across the particulate diameters yields the particulate mass fractions as shown in Table D–12 for PM_{10} and $PM_{2.5}$. Note that $PM_{2.5}$ makes up only 8.8 percent of PM_{10} by mass.

Other conservative modeling assumptions include the following: (1) 100 percent of nitric oxide was assumed to be converted into nitrogen dioxide in AERMOD modeling and (2) total pollutant concentrations attributable to NNSS sources were evaluated by adding together the highest calculated concentrations from AERMOD and OBODM, without coupling the concentrations in either time or space.

For this SWEIS, the background concentrations used in the Permit were updated to be based on the Area 25 monitoring data. Measurements taken at the YMP9 and YMP1 stations from 1998 through 2005 (DOE 2008d) show that the PM_{10} 24-hour average background concentration is 39 micrograms per cubic meter using the second highest high PM_{10} concentration, which approximates the PM_{10} exceedance-based standard, which allows no more than one exceedance per year on average across 3 years. The carbon monoxide, sulfur dioxide, and nitrogen dioxide background concentrations were the largest monitored concentrations shown in Chapter 4, Table 4–38.

Results of Permit Modeling. Table D–11 presents these maximum modeled concentrations of carbon monoxide, nitrogen dioxide, sulfur dioxide, and PM_{10}. These concentrations are only from the Permit modeling (does not include the supplementary OBODM runs made for this SWEIS), and they include the above update to background concentrations. **Table D–13** also shows the current (2009) NAAQS and Nevada Ambient Air Quality Standards. As shown in Table D–13, all of the maximum modeled concentrations of carbon monoxide, nitrogen dioxide, and sulfur dioxide were significantly smaller than the ambient air quality standards. Due to the explosives detonations, the maximum modeled PM_{10} concentration exceeded the ambient air quality PM_{10} standard by a large margin in areas beyond the eastern border of the NNSS. The maximum distance beyond the eastern border of the NNSS at which the PM_{10} standard was exceeded was 4.3 miles. However, this location is entirely within the non-public access area (Nevada Test and Training Range) of the Desert National Wildlife Refuge.

Table D–13 Dispersion Modeling Results from all Nevada National Security Site Stationary, Fugitive, and Detonation Sources (micrograms per cubic meter)

Pollutant	Averaging Period	NAAQS [a]	Nevada AAQS [a]	Background Concentration [a]	Nonexplosive Sources	Explosive Sources	Total Maximum Concentration [a] (percentage of NAAQS, percentage of Nevada AAQS)
					Maximum Concentration [a]	Maximum Concentration [a]	
CO	1-hour	40,000 [b]	40,500 [b]	229	41	< 1,007	< 1,277 (<3.2%, <3.2%)
	8-hour	10,000 [b]	10,500 [b,c]	229	10	< 137	< 376 (<3.8%, <3.6%)
NO_2	Annual	100 [d]	100 [d]	4.0	16 [e]	< 3.0 [e]	< 23 [e] (<23%, <23%)
PM_{10}	24-hour	150 [f]	150 [f]	39	5	< 4,013	< 4,057 (<2,163%, <2,163%)
SO_2 [g]	3-hour	1,300 [b]	N/A	5.2	6.3	< 6.4	< 17.9 (<1.4%, N/A)
	24-hour	365 [b]	365 [b]	5.2	1.1	< 0.66	< 7.0 (<1.9%, <1.9%)
	Annual	80 [d]	80 [d]	5.2	1.1 [e]	< 0.66 [e]	< 7.0 [e] (<8.8%, <8.8%)

< = less than; AAQS = Ambient Air Quality Standards; CO = carbon monoxide; NAAQS = National Ambient Air Quality Standards; NO_2 = nitrogen dioxide; PM_{10} = particulate matter with an aerodynamic diameter less than or equal to 10 micrometers; SO_2 = sulfur dioxide.

[a] Concentration units are micrograms per cubic meter. To convert micrograms per cubic meter to parts per million, multiply micrograms per cubic meter by 0.024465 and divide by the molecular weight at 760 millimeters mercury and 25 degrees Centigrade).

[b] Not to be exceeded more than once per year.

[c] For locations below 5,000 feet above mean sea level.

[d] Not to be exceeded.

[e] Maximum 24-hour average.

[f] Not to be exceeded more than once per year on average over 3 years.

[g] There is no 3-hour SO_2 Nevada Ambient Air Quality Standard.

Source: Based on data from DOE 2009b: App. 7, Table 7-1.

Results of Supplementary OBODOM Modeling Performed for This SWEIS: For areas where the public has access, worst-case activities at BEEF activities produced the highest modeled PM_{10} concentrations, but these concentrations were below the PM_{10} NAAQS value. The maximum modeled 24-hour average PM_{10} concentration was 62 micrograms per cubic meter (April 12, 2007; along southern border of Area 25 – see Figure D–4; X Coordinate (UTM 11N): 563420 meters, Y Coordinate (UTM 11N): 4058840 meters), which, even when combined with the maximum background concentration of 39 micrograms per cubic meter, is well below the Nevada Ambient Air Quality Standards value of 150 micrograms per cubic meter. The maximum modeled 24-hour average PM_{10} concentration associated with activities at NPTEC was about 8 micrograms per cubic meter (April 12, 2007; along southern border of Area 25 – see Figure D–4; X Coordinate (UTN 11N): 557729 meters, Y Coordinate (UTM 11N): 4058503 meters); for the Explosives Ordnance Disposal Unit, the corresponding concentration was less than 1 microgram per cubic meter(February 11, 2005; along southern border of Area 25 – See Figure D–4; X Coordinate (UTM 11N): 567419 meters, Y Coordinate (UTM 11N): 4058854 meters).

For areas where the public has access, worst-case BEEF activities produced the highest modeled $PM_{2.5}$ concentrations, but these concentrations were also below the NAAQS values. The maximum modeled

24-hour average $PM_{2.5}$ concentration was 11 micrograms per cubic meter (same date and location as with PM_{10} above), which, when combined with a maximum background concentration of 12 micrograms per cubic meter, is below the NAAQS value of 35 micrograms per cubic meter. The maximum modeled 24-hour average $PM_{2.5}$ concentrations due to worst case NPTEC and Explosives Ordnance Disposal Unit activities were each less than 1 microgram per cubic meter (same dates and locations as with PM_{10} above). Even if all three activities took place at the same time, their combined concentration would be less than the $PM_{2.5}$ NAAQS value of 35 micrograms per cubic meter. The maximum modeled annual average $PM_{2.5}$ concentration was less than 1 microgram per cubic meter, which adds little to the $PM_{2.5}$ annual background concentration of 3.6 micrograms per cubic meter. The $PM_{2.5}$ annual average NAAQS value is 15 micrograms per cubic meter.

Ozone was not modeled as part of the air permit evaluation for this *NNSS SWEIS*, but it is generally recognized as a regional-scale air quality problem. Ozone is formed in the atmosphere under the presence of sunlight, nitrogen oxides, and volatile organic compounds. The emissions of nitrogen oxides (a precursor to ozone formation) and volatile organic compounds at the NNSS are less than 50 tons per year (see Table D–3) and are small relative to the existing regional emissions of nitrogen oxides and volatile organic compounds. Further, these emissions are considerably less than the conformity emission threshold levels of 100 tons per year for nitrogen oxides and volatile organic compounds. These threshold emission levels were set small enough as to not create a measurable impact on ozone levels. Thus, current emissions at the NNSS are not anticipated to increase downwind ozone concentrations beyond the measured ozone concentrations, which are well below the ozone air quality standard.

D.1.1.2.2 Radiological Air Quality

This section expands the radiological air quality discussion presented in Chapter 4, Section 4.1.8.3, of this SWEIS.

The locations of the ambient radiological monitoring stations on and surrounding the NNSS are discussed in Section D.1.1.3.1. The locations of potential radiation emissions on the NNSS and the types of activities that might produce them are discussed in Section D.1.1.3.2. The recent radiation concentrations and exposure levels are discussed in Section D.1.1.3.3.

D.1.1.2.2.1 Ambient Radiological Monitoring on and near the Nevada National Security Site

On the NNSS, six of the 16 monitoring stations established by DOE that monitor ambient tritium (hydrogen-3) levels are considered "critical receptors." These "critical receptors" are approved to monitor levels of various radionuclides for National Emission Standards for Hazardous Air Pollutants (NESHAPs) compliance. The radiological monitoring network overall indicates that levels of americium-241; plutonium-238, -239, and -240; cesium-137; strontium-90; and tritium on the NNSS have been well below the NESHAPs concentration levels since the *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada (1996 NTS EIS)*. More details about radiation detected at NNSS locations are provided in Section D.1.1.3.3.

The Desert Research Institute of the Nevada System of Higher Education runs the Community Environmental Monitoring Program (CEMP), which constitutes an offsite nonregulatory network of environmental air and radiation monitoring stations across southern Nevada, southeastern California, and southwestern Utah. These monitoring stations measure penetrating gamma radiation using thermoluminescent dosimeters, gamma radiation exposure rates using pressurized ion chamber detectors, gross alpha and beta radioactivity in airborne particulates using low-volume particulate air samplers, and meteorological data (DOE 2009b). Alpha and beta particles and gamma rays all occur naturally, but they can be proxies for manmade nuclear activity when detected above certain levels. Alpha particles are usually emitted by decaying uranium isotopes, beta particles are usually emitted as atomic decay products of nuclear fission, and gamma rays occur with alpha and beta particle emissions when certain radionuclides transition to a lower energy state (DOE 2009b, 2009d). More details about the radiation detected at CEMP locations are provided in Section D.1.1.3.3.

D.1.1.2.2.2 Sources of Radiation on the Nevada National Security Site

Between 1951 and 1992, 100 atmospheric and 828 underground nuclear tests were conducted on the NNSS (DOE 2009d). Nuclear testing ended in 1992; since then, the NNSS radiation monitoring has focused on detecting airborne radionuclides from historically contaminated soils. Other than soil resuspension and evapotranspiration of historical radionuclides, as discussed in the main body of the SWEIS, some activities on and near the NNSS still involve radioactive materials. Some special research projects, analytical laboratory operations, Environmental Restoration Program projects, and Borehole Management projects may involve radioactive materials and may result in measurable air emissions of radionuclides. More-specific activities on the NNSS that involve radioactive materials and possible air releases of radionuclides in recent years include the following (DOE 2009d):

- Disposal of tritium-contaminated water removed from the sump well below Building A-1 of the offsite North Las Vegas Facility (NLVF) on the NNSS
- Underground Testing Area Project pumping of tritium-contaminated water to the surface from wells used to characterize the aquifers at the sites of past underground nuclear tests
- Pulsed neutron generator activities that can release tritium at the Dense Plasma Focus Facility (in Area 11)
- Dynamic experiments and hydrodynamic tests that may release tritium and depleted uranium at BEEF (in Area 4)
- Radioactive waste management, including the Area 3 RWMS and Area 5 Radioactive Waste Management Complex, from which measurable tritium releases have been detected
- Operations at the Radiological/Nuclear Countermeasures Test and Evaluation Complex (in Area 6)
- Subcritical experiments at the U1a Complex (in Area 1)
- Handling, transport, storage, and assembly of radioactive targets for the Joint Actinide Shock Physics Experiment Research gas gun (in Area 27)

Accidental or unplanned air releases of radiation are infrequent on the NNSS. Since 1997, such releases have only occurred on the NNSS in 2008, when contaminated debris was carried beyond two control boundaries. In one case, the contaminated area was blocked off, contaminated debris was recovered, and a corrective policy was implemented to ensure that highly contaminated waste is only generated when it can be immediately disposed of. In the other case, the debris was marked and the original contamination area was extended to include the debris (DOE 2009d).

D.1.1.2.2.3 Radiation Levels on and near the Nevada National Security Site

Table D–14 presents the estimated air emissions of radionuclides on the NNSS for the period from 1997 through 2008. The 1993 estimates that were cited in the *1996 NTS EIS* are also shown. These estimates are presented in each year's NNSS environmental report and are used in estimations of equivalent exposure. The methods used to estimate these air emissions included the use of annual field and water monitoring data, historical soil inventory data, and accepted soil resuspension and air transport models (DOE 2009d).

Table D–14 Annual Estimated Air Releases of Radionuclides on the Nevada Nuclear Security Site, 1997–2008 (curies) [a,b]

	1993 (presented in the 1996 NTS EIS)	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*
Tritium	708	160	297	362.7	431	564	290	314	560	170	245	550	440
Krypton-85 [c]	160	--	--	--	--	--	--	--	0	0	0	0	0
Plutonium (unspecified isotopes)	0.0018	--	--	--	--	--	--	--	--	--	--	--	--
Plutonium-238	--	0.0000015	0.0000043	0.0000055	~0	~0	~0	~0	~0	~0	~0	0.054	0.05
Plutonium-239 and -240	--	0.280034	0.240038	0.240048	0.32	0.32	0.29	0.29	0.29	0.29	0.29	0.32	0.29
Strontium-90	--	0.000015	0.000024	0.000032	--	--	~0	~0	0	~0	~0	~0	~0
Cesium-137	--	0.0017	0.0015	0.0041	~0	~0	~0	~0	~0	~0	~0	~0	~0
Americium-241	--	--	--	--	0.049	0.049	0.047	0.047	0.047	0.047	0.047	0.047	0.047
Reference	DOE 1996, page 4-150 (from DOE 1994)	DOE 1998, page 1-11	DOE 1999, page 1-12	DOE 2000, page 1-13	DOE 2001, page 1-11	DOE 2002, page 1-11	DOE 2003, page 1-10	DOE 2004, page ES-14	DOE 2005, page 3-21	DOE 2006, page iii	DOE 2007, page v	DOE 2008c, page v	DOE 2009d, page v

[a] Assumes worst-case point and diffuse source releases, including evaporation from containment ponds. Includes calculated data from air sampling results, postulated loss of laboratory standards, and calculated resuspension of surface deposits.

[b] "~0" indicates that observed concentrations were greater than the minimum detectable concentration only a small number of times or not at all, and/or the concentrations contributed less than 10 percent towards the dose estimated to be received by the maximally exposed public individual. "--" indicates that the air emissions of the radionuclide were not mentioned in the reference as contributing towards the official radionuclide air emissions estimation.

[c] Krypton was no longer monitored on site beginning in 1998 since there are no detectable emissions.

Table D–15 shows maximum observed and maximum annual averaged radionuclide concentrations at the six critical receptors for reporting years 2002 through 2008. Years prior to 2002 are not shown because the six critical receptors were chosen in the middle of 2001. The averaging periods for each radionuclide are also shown; tritium is sampled for 26 2-week periods per year, while the other radionuclides are sampled for 1 1-week period per month. So, for example, the maximum observed concentration of plutonium-238 presented in Table D–15 was one of the 12 1-week average values observed in 2006 at the 3545 Substation, and the maximum annual averaged observed concentration of plutonium-238 was the average of the 12 1-week average values observed in 2008 at the Schooner monitoring station.

Table D–15 Comparison of Observed Concentrations of Radionuclides on the Nevada National Security Site at the Six Critical Receptors Used for NESHAPs Compliance with NESHAPs Concentration Levels, 2002-2008

Radionuclide (averaging period; maximum number of annual samples)	*Maximum Observed Concentration*	*Year and Location of Observation*	*Maximum Annual Average Observed Concentration*	*Percentage of NESHAPs CL*	*Year and Location of Maximum*	*Reference*
Tritium (2 weeks; 26 annual samples)	$1,228 \times 10^{-6}$ pCi/mL	2006, Schooner (in Area 20)	434×10^{-6} pCi/mL	29	2002, Schooner (in Area 20)	DOE 2007, page 3-13; DOE 2003, page 2-14
Plutonium-238 (1 week; 12 annual samples)	32×10^{-18} µCi/mL	2006, 3545 Substation (in Area 16)	5×10^{-18} µCi/mL	<1	2008, Schooner (in Area 20)	DOE 2007, page 3-8; DOE 2009d, page 3-8
Plutonium-239 and -240 (1 week; 12 annual samples)	640×10^{-18} µCi/mL	2007, Gate 700 S (in Area 10)	59×10^{-18} µCi/mL	3 [a]	2007, Gate 700 S (in Area 10)	DOE 2008b, page 3-9
Cesium-137 (1 week; 12 annual samples)	48×10^{-16} µCi/mL	2004, Mercury Track (in Area 23)	9×10^{-16} µCi/mL	5	2004, Mercury Track (in Area 23)	DOE 2005, page 3-8
Americium-241 (1 week; 12 annual samples)	106×10^{-18} µCi/mL	2007, Gate 700 S (in Area 10)	12×10^{-18} µCi/mL	<1	2007, Gate 700 S (in Area 10)	DOE 2008b, page 3-6

< = less than; µCi/mL = microcuries per milliliter; CL = concentration level; NESHAPs = National Emission Standards for Hazardous Air Pollutants; pCi/mL = picocuries per milliliter.

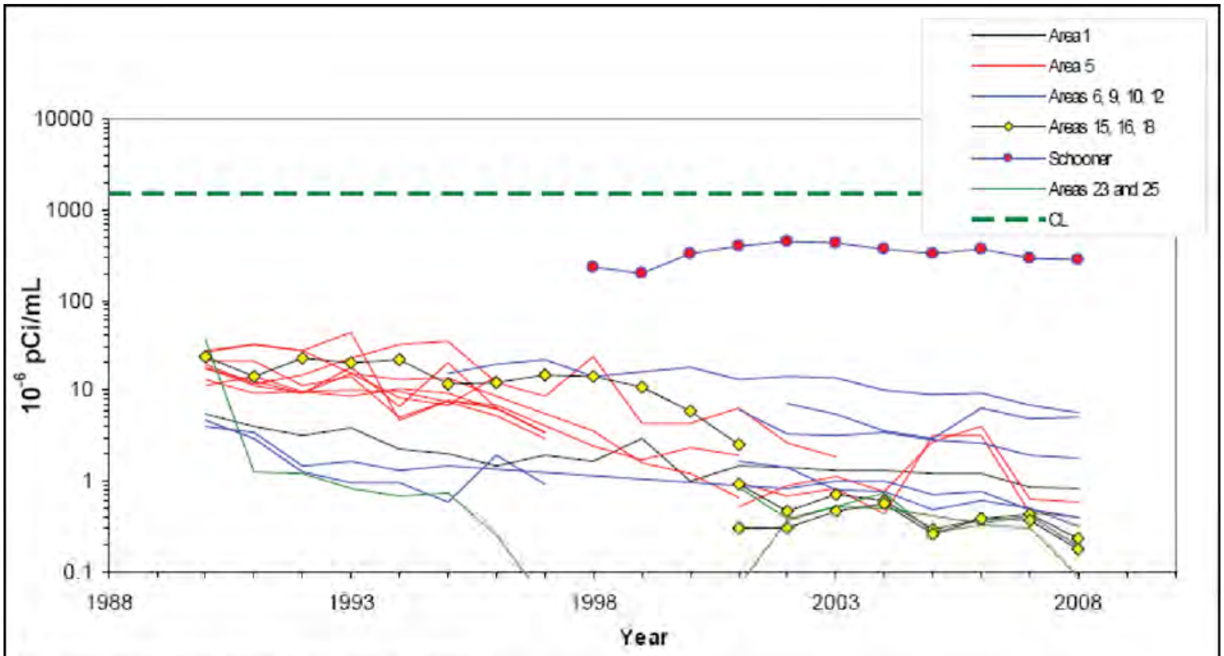
[a] For plutonium-239 and -240, the NESHAPs CL is for plutonium-239 only. Analytical methods cannot distinguish between plutonium-239 and plutonium-240.

Note: The averaging period for each concentration observation is shown in the first column.

As shown in Table D–15, the maximum annual averaged tritium concentration among the six critical receptors from 2002 through 2008 was about 434×10^{-6} picocuries per milliliter, which was 29 percent of the NESHAPs concentration level. Although the maximum observed 2-week averaged concentration cannot be compared to the NESHAPs concentration level for regulatory purposes, it is noteworthy that even the maximum concentration ($1,228 \times 10^{-6}$ picocuries per milliliter) was still only 82 percent of the NESHAPs CL. The maximum sampled tritium concentration always occurred at the Schooner monitoring station (in Area 20).

Figure D–5 shows the annual mean concentrations of tritium from 1990 through 2008 measured in many of the NNSS areas with long-term measurement histories. At most locations, tritium levels have been decreasing steadily, with an average rate of decline of 14 percent among all stations except Schooner. At Schooner (in Area 20), the tritium levels seem directly related to temperature and precipitation trends.

The increased tritium levels at Schooner is a result of much higher readings during the dry hot summer months when the movement of relatively deep soil moisture containing high concentrations of tritium migrates to the surface. The data also suggests that seasonal precipitation and recharge from below plays a role in maintaining the higher levels over time. All of these mean tritium concentrations are below the tritium NESHAPs concentration level, which is also shown in the figure.



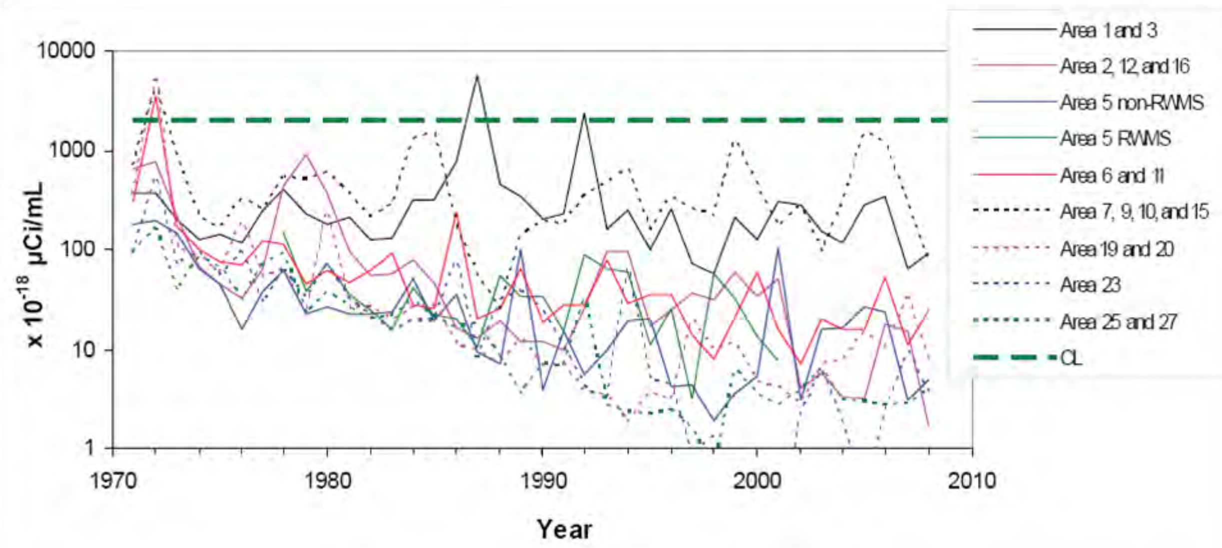
CL = concentration level; pCi/mL = picocuries per milliliter.
Note: Data are presented on a logarithmic scale. Data before 1999 have been adjusted to compensate for sampling method changes. The tritium National Emission Standards for Hazardous Air Pollutants concentration level is also shown (green, dotted line).
Source: DOE 2009d

Figure D–5 Annual Mean Tritium Concentrations in Nevada National Security Site Areas with Long-Term Measurement Histories

As shown in Table D–15, the maximum annual averaged plutonium-238 concentration among the six critical receptors from 2002 through 2008 was about 5×10^{-18} microcuries per milliliter, which is less than 1 percent of the NESHAPs concentration level. Although the maximum observed 1-week averaged concentration cannot be compared to the NESHAPs concentration level for regulatory purposes, it is noteworthy that even the maximum concentration (32×10^{-18} microcuries per milliliter) was still only 2 percent of the NESHAPs concentration level. The maximum annual averaged plutonium-238 concentration usually occurred either at the Yucca station (in Area 6) or the 3545 Substation (in Area 16).

As shown in Table D–15, the maximum annual averaged plutonium-239 and -240 concentration among the six critical receptors measured from 2002 through 2008 was about 59×10^{-18} microcuries per milliliter, which was 3 percent of the NESHAPs CL. Although the maximum observed 1-week averaged concentration cannot be compared to the NESHAPs concentration level for regulatory purposes, it is noteworthy that even the maximum concentration (640×10^{-18} microcuries per milliliter) was still only 32 percent of the NESHAPs concentration level. The maximum annual averaged plutonium-239 and -240 concentration usually occurred either at the Yucca monitor (Area 6) or the Gate 700 S monitor (in Area 10).

Figure D–6 shows the highest annual mean plutonium-239 and -240 concentrations from 1971 through 2008 as observed by stations in NNSS areas. Only stations with at least 15 years of measurement history are included. The average rate of concentration decline ranges from 2.9 percent (in Areas 1 and 3) to 17.7 percent (in Areas 19 and 20). These decline rates are faster than would be expected given the very long half-lives of plutonium-239 and -240, and are attributed to plutonium immobilization in the soil and/or decreases in NNSS activities that would resuspend the plutonium from the soil into the air. All of these maximum mean plutonium-239 and -240 concentrations have been below the plutonium-239 NESHAPs concentration level since 1993. In the period from 1971 through 1992, these maximum mean concentrations exceeded the NESHAPs concentration level three times (in 1972, 1987, and 1992).



µCi/mL = microcuries per milliliter; CL = concentration level; RWMS = Radioactive Waste Management Site.
Note: Data are presented on a logarithmic scale. The plutonium-239 National Emission Standards for Hazardous Air Pollutants concentration level is also shown (green, dotted line).
Source: DOE 2009d

Figure D–6 Highest Annual Mean Plutonium-239 and -240 Concentrations Observed Within Nevada National Security Site Areas with Long-Term Measurement Histories

As shown in Table D–15, the maximum annual averaged cesium-137 concentration among the six critical receptors from 2002 through 2008 was about 9×10^{-16} microcuries per milliliter, which was 5 percent of the NESHAPs concentration level. Although the maximum observed 1-week averaged concentration cannot be compared to the NESHAPs concentration level for regulatory purposes, it is noteworthy that even the maximum concentration (48×10^{-16} microcuries per milliliter) was still only 25 percent of the NESHAPs concentration level. The maximum annual averaged cesium-137 concentration usually occurred either at the Yucca station (in Area 6), the 3545 Substation (in Area 16), or the Mercury Track station (in Area 23).

As shown in Table D–15, the maximum annual averaged americium-241 concentration among the six critical receptors from 2002 through 2008 was about 12×10^{-18} microcuries per milliliter, which was less than 1 percent of the NESHAPs concentration level. Although the maximum observed 1-week averaged concentration cannot be compared to the NESHAPs concentration level for regulatory purposes, it is noteworthy that even the maximum concentration (106×10^{-18} microcuries per milliliter) was still only 6 percent of the NESHAPs concentration level. The maximum annual averaged americium-241 concentration usually occurred either at the Yucca monitoring station (in Area 6), the Gate 700 S station (in Area 10), or the Schooner station (in Area 20).

Since the offsite CEMP stations surrounding the NNSS were upgraded in 1999 (DOE 2009a), the CEMP monitors have not detected radiation that can be attributed to NNSS activities, and the observed radiation levels are well within the background levels typically observed in other parts of the country (DOE 2009d). **Table D–16** presents the maximum monthly average observed gamma radiation readings at some selected stations surrounding the NNSS from late 1999 through 2008 (see Figure D–4 for a map of all CEMP locations). Although these are maximum monthly average values, they are still well within the range of natural background exposures estimated for cities in the United States (see Table D–16).

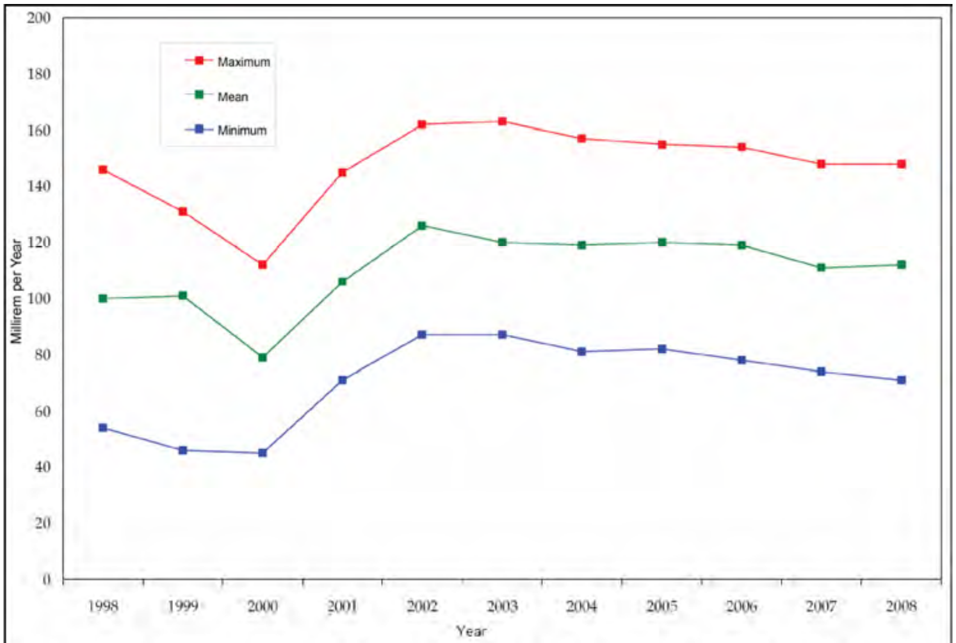
Table D–16 Average Monthly Maximum Gamma Radiation Observations from Select Community Environmental Monitoring Program Stations Surrounding the Nevada National Security Site (millirem per year [a])

	Tonopah	***Goldfield***	***Indian Springs***	***Las Vegas***	***Medlin's Ranch***	***Amargosa Valley***	***Average***
Jan	147	138	104	94	147	110	123
Feb	148	138	102	94	147	110	123
Mar	146	137	101	92	145	110	122
Apr	148	137	101	91	145	112	122
May	146	135	100	91	145	112	121
Jun	146	134	99	90	145	112	121
Jul	145	134	98	91	145	111	121
Aug	145	133	99	91	143	111	120
Sep	148	135	102	91	142	112	122
Oct	149	138	102	92	148	111	123
Nov	149	138	103	94	147	110	124
Dec	150	140	105	95	149	111	125
Period	Oct 1999 – Dec 2008	Oct 1999 – Dec 2008	Sep 1999 – Dec 2008	Jan 2000 – Dec 2008	Nov 1999 – Dec 2008	Oct 1999 – Dec 2008	

[a] Data in the reference source were presented in units of microroentgen per hour; this table presents the data in millirem per year for ease in comparing with the reference level of the National Emission Standards for Hazardous Air Pollutants. The conversion assumed that 1 roentgen gamma exposure from the most common external radionuclides generally produces a dose of 1 rem (DOE 2009d, page 14).

Source: DOE 2009e.

Figure D–7 shows the annual average radiation levels among all CEMP stations from 1998 through 2008, along with annual maximum and minimum values from among the individual stations. These levels were measured by thermoluminescent dosimeters, which measure ionizing radiation from all natural and manmade sources (DOE 2009d).



Note: Radiation levels measured by thermoluminescent dosimeters. The displayed radiation rate unit is milliroentgen per year, which is equivalent to a dose of 0.933 millirem per year, assuming 1 roentgen gamma exposure from the most common external radionuclides generally produces a 1 rem dose.
Source: DOE 2009d

Figure D–7 Annual Average Radiation Levels and Maximum and Minimum Values Among all Community Environmental Monitoring Program Stations, 1999–2008

Table D–17 presents a number of dose estimates resulting from the inhalation of radionuclides on or near the NNSS. From 2003 through 2008, the NNSS environmental reports presented the effective dose equivalent (EDE) (in millirem per year) received by a person residing at the critical receptor that had the largest sum of NESHAPs concentration level fractions (which in all cases was the Schooner receptor in Area 20). For example, in 2008, the Schooner critical receptor had a sum of NESHAPs concentration level fractions of 0.193. This sum of 0.193 indicates that the theoretical person at the receptor experienced an EDE that is 19.3 percent of the NESHAPs level. Since the NESHAPs level is 10 millirem per year, the EDE at the Schooner receptor was 1.93 millirem per year. Although no member of the public has access to areas near these critical receptors, these EDEs can be considered conservative; the EDE experienced by a member of the public off site would be considerably lower. Note that even these EDEs are well below the 10 millirem per year NESHAPs limit for inhalation.

Table D–17 also shows what each year's NNSS environmental report presents as the EDE experienced by the maximally exposed individual (MEI). However, the definition of the MEI changed in 2005, and the method of calculating the EDE changed in 2005 and in 2007. Prior to 2005, the CAP88-PC model (a computer model for estimating dose and risk from radionuclide air emissions) was used with onsite emissions estimates to calculate the EDE experienced by the offsite MEI. Beginning in 2005, CAP88-PC was no longer used for this purpose. In 2005 and 2006, the MEI was still assumed to be off site, but the EDE for the offsite MEI was not directly calculated. Instead, it was assumed to be no greater than 0.2 millirem per year, which was based on the CAP88-PC results from 1992 through 2004. In 2007 and 2008, the MEI was assumed to be located at the critical receptor that had the largest sum of NESHAPs concentration level fractions, and the EDE was estimated directly based on this sum (the sum was multiplied by the NESHAPs level of 10 millirem per year to arrive at the EDE). Compared with using CAP88-PC for an offsite MEI, using direct monitoring results for a critical receptor MEI is very conservative because critical receptors are generally the locations of maximum diffuse radioactive emissions on the NNSS so they likely overstate the radiation dose to the offsite MEI.

Table D–17 Effective Dose Equivalents for Maximally Exposed Individuals by Various Estimation Methods, 1997–2008 (millirem per year)

	1997	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*
EDE received by an MEI at the critical receptor with the largest sum of NESHAPs CL fractions [a]	--	--	--	--	--	--	2.86	2.45	2.3	2.49	1.9	1.93
EDE to the MEI, as presented in the NNSS environmental reports	0.089 [b]	0.092 [b]	0.12 [b]	0.17 [b]	0.17 [b]	0.11 [b]	0.1 [b]	0.12 [b]	[c]	[c]	[d]	[d]
Reference	DOE 1998, page 7-2	DOE 1999, page 7-2	DOE 2000, page 1-4	DOE 2001, page 1-5	DOE 2002, page 1-5	DOE 2003, page 1-4	DOE 2004, pages 2-19 and 7-3	DOE 2005, pages 3-20 and 8-9	DOE 2006, pages 3-18 and 8-7	DOE 2007, pages 3-18 and 8-5	DOE 2008c, pages 3-18 and 8-5	DOE/NV 2009, pages 3-18 and 8-6

CL = concentration level; EDE = effective dose equivalent; MEI = maximally exposed individual; NESHAPs = National Emission Standards for Hazardous Air Pollutants; NNSS = Nevada National Security Site.

[a] The sum of NESHAP CL fractions was not presented in the NNSS environmental reports from 1997 through 2002. From 2003 through 2008, the critical receptor with the largest sum of NESHAPs CL fractions was the Schooner site in Area 20.

[b] Through 2004, the CAP88-PC model was used with onsite emissions estimates to calculate the EDE to the offsite MEI.

[c] Beginning in 2005, the CAP88-PC model was no longer used to estimate offsite exposure to onsite radioactive emissions. In 2005 and 2006, the EDE to the offsite MEI was estimated to be no more than 0.2 millirem per year based on the CAP88-PC results from 1992 through 2004.

[d] Beginning in 2005, the CAP88-PC model was no longer used to estimate offsite exposure to onsite radioactive emissions. In 2007 and 2008, the MEI was considered to be a person residing at the critical receptor with the largest sum of NESHAPs CL fractions, though the public has had never access to that location.

To put the inhalation radiation dose numbers in Table D–17 into perspective, **Figure D–8** shows a comparison of radiation dose sources received by an offsite MEI. Exposure to radon represents about 59 percent of total radiation exposure to the MEI, while the dose received from NNSS emissions (assumed to be 0.2 millirem per year, based on data in Table D–17) represents less than 1 percent of total radiation exposure to the MEI.

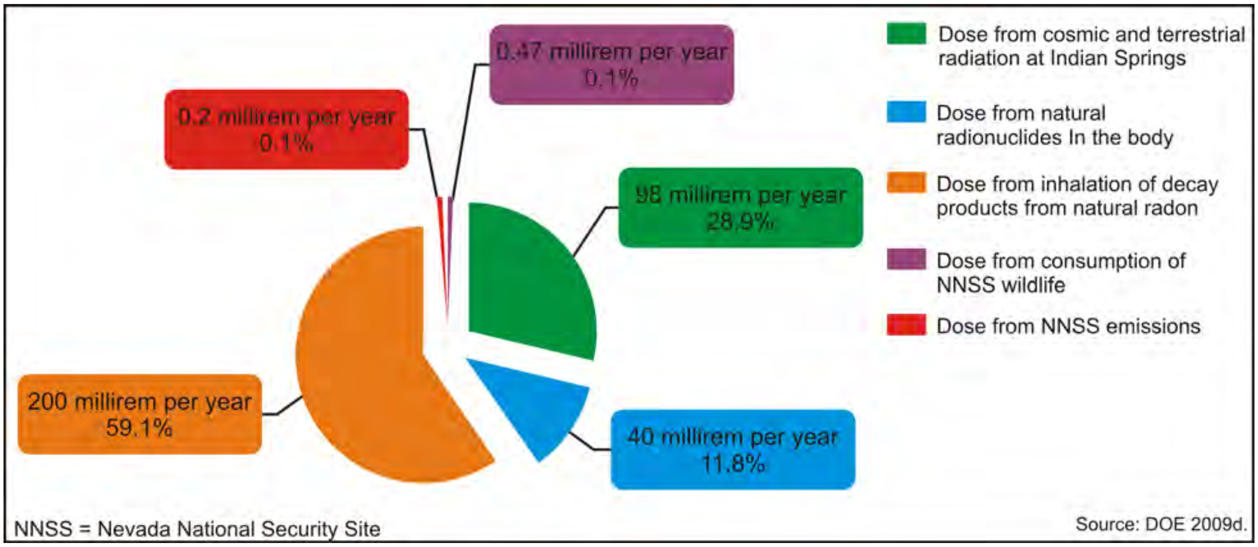


Figure D–8 Comparison of Radiation Doses to the Offsite Maximally Exposed Individual from Natural Background Sources and the Nevada National Security Site

D.1.1.3 Climate Change

Greenhouse gas emissions due to NNSS activities were calculated using the EPA Climate Leaders Simplified Greenhouse Gas Emissions Calculator (EPA 2010). The electricity consumption by NNSS activities for fiscal year 2009 (45,300,740 kilowatt-hours) was provided by NNSA. This electricity consumption was assumed to be representative of calendar year 2008. The NNSS purchased electricity off of the Arizona-New Mexico (WECC Southwest) eGRID subregion. Greenhouse gas emissions from onsite permitted stationary sources were derived from the amount of red dye diesel used on site (66,433 gallons), as reported by NNSA for fiscal year 2009 and assumed to be representative of calendar year 2008. Emissions from refrigeration and air conditioning (22 pounds HFC-32 [diflouoromethane], 22 pounds HFC-125 [pentafluoroethane], 443 pounds HFC-134a [1,1,1,2-tetrafluoroethane], and 57.7 pounds of SF_6 [sulfur hexafluoride]) were provided by NNSA for fiscal year 2008 and are assumed to be representative of calendar year 2008.

For carbon dioxide emissions by onsite government vehicles, greenhouse gas emissions were estimated using vehicle fuel consumption. Fuel consumption amounts for each vehicle type and fuel type were derived in the same way as VMT amounts for each vehicle type and fuel type were derived (see the discussion in Section D.1.1.2). In short, the estimated fraction of each fuel group (gasoline+ethanol and No. 2 diesel+biodiesel) used by each vehicle type (see Table D–4) was multiplied by the total amount of each fuel type consumed on site (see Section D.1.1.2.1) to arrive at the amount of fuel consumed by each vehicle type and fuel type. For nitrous oxide and methane emissions by onsite government vehicles, and for the greenhouse gas emissions by all other NNSS-related vehicles, the VMT by each vehicle type and each fuel type (see Table D–4) were used. For the purposes of greenhouse gas emissions calculations, ethanol-consuming passenger cars and trucks were considered light-duty vehicles, gasoline-consuming passenger trucks were considered light-duty trucks, and all No. 2 diesel-consuming vehicles were considered heavy-duty vehicles. All other vehicle type and fuel type combinations had obvious matches in the Greenhouse Gas Emissions Calculator.

D.1.2 Remote Sensing Laboratory

D.1.2.1 Meteorology

This section expands on the meteorological characteristics of the Remote Sensing Laboratory (RSL) site presented in Chapter 4, Section 4.2.8.1, of this *NNSS SWEIS*.

The average annual rainfall in the Las Vegas Valley is about 4.5 inches. Rainfall is most common in the late winter and early spring (during Pacific storm passage) and in the late summer (with convective thunderstorms, monsoons, and the occasional tropical storm) (based on climate averages measured at the Las Vegas Weather Service Office Airport from 1971–2000; NCDC 2009). Nevada on the whole has been in a drought most of the last decade, with precipitation amounts far below normal (DOE 2008f), though some recent years (notably 2003 through 2005) were wetter than normal (NWS VEF 2009). Snowfall in the Las Vegas area is rare, with an annual average snowfall total of about 1 inch (based on the measurements taken from 1937–2009 at the Las Vegas Weather Service Office Airport; NCDC 2009). The average annual number of thunderstorm days is about 13, with thunderstorms most frequently occurring in July and August (NWS VEF 2009). Tornadoes in Nevada are exceedingly rare (NRC 1986).

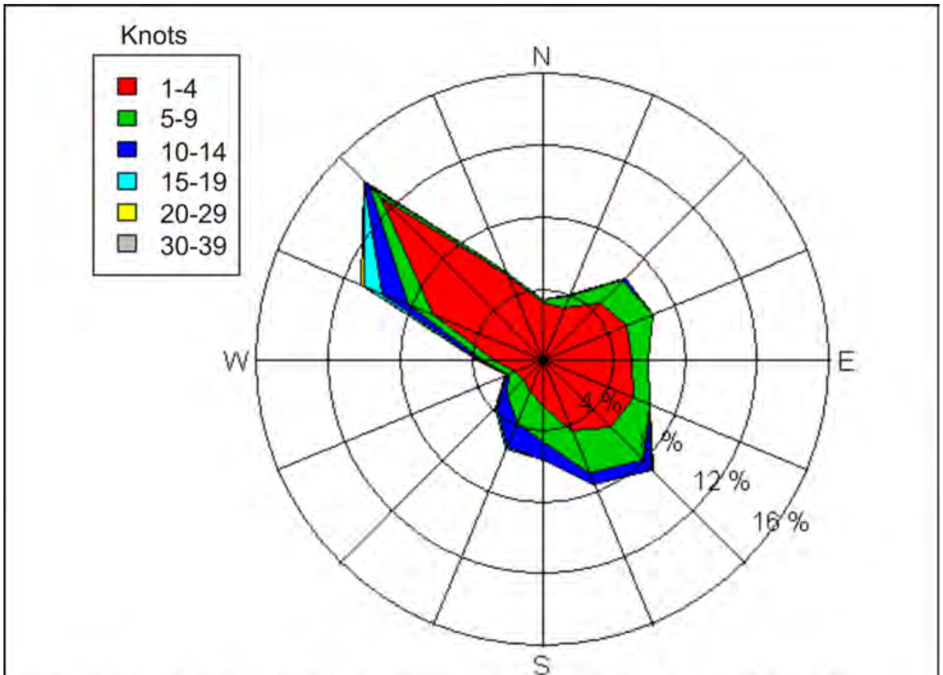
The Clark County Department of Air Quality and Environmental Management (DAQEM) maintains two ambient monitoring sites (the J.D. Smith and E. Craig Road sites) near RSL and NLVF. The annual average (2004–2008) wind roses are shown in **Figures D–9** and **D–10** for these two locations. A review of the timing in these figures shows that during the night, down-slope (northwesterly) drainage winds dominate. During the day, up-slope (southeasterly) winds dominate (Lehrman et al. 2006).

D.1.2.2 Ambient Air Quality on and near the Remote Sensing Laboratory

This section expands the ambient air quality discussion presented in Chapter 4, Section 4.2.8.2, of this SWEIS.

D.1.2.2.1 Existing Air Quality

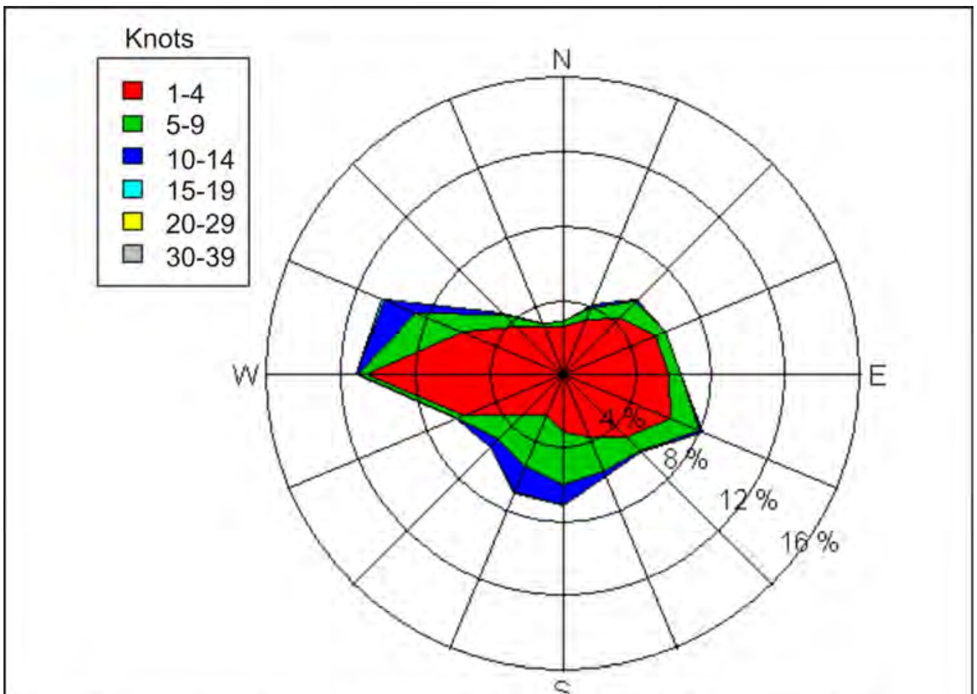
RSL is located about 60 miles southeast of the southern border of the NNSS. The region of influence for air quality and climate for RSL operations is northern Clark County. Historic data on pollutant emissions inventories and compliance status for the State of Nevada are calculated at the resolution of county or hydrographic areas and provide a basis for determining existing air quality in the region of influence and a metric for emissions comparison assessments. See Chapter 4, Section 4.1.8.2.2, for a discussion on the current NAAQS and Nevada Ambient Air Quality Standards.



Note: To convert knots to meters per second, multiply by 0.5144. To convert knots to miles per hour, multiply by 1.121.

Source: Clark County 2010.

Figure D–9 Annual Average Wind Rose for the E. Craig Road DAQEM Site at 4701 Mitchell Street, 2004–2008



Note: To convert knots to meters per second, multiply by 0.5144. To convert knots to miles per hour, multiply by 1.121.

Source: Clark County 2010.

Figure D–10 Annual Average Wind Rose for the J.D. Smith DAQEM Site at 1301 East Tonopah Road, 2004–2008

Emissions from Onsite Stationary and Mobile Sources. The 2008 emissions of onsite permitted stationary sources were from the 2008 NNSS environmental report (DOE 2009d). The amount of natural gas combusted for heating (33,673 therms, or 3,367,300 cubic feet) for fiscal year 2009 was provided by the DOE/NNSA Nevada Site Office (NSO), and the resulting emissions were derived from the EPA AP-42 emissions factors database (EPA 1995a). This natural gas combustion was assumed to be representative of calendar year 2008.

Table D–18 shows the emissions rates and activity times used to estimate emissions from activity related to RSL aircraft. The amount of jet fuel combusted by RSL aircraft (111,030 gallons) for fiscal year 2009 was provided by the DOE NNSA/NSO, and this aircraft fuel combustion was assumed to be representative of calendar year 2008. The number of landings and takeoffs for airplanes (Raytheon Beechcraft Super King Air 200) and helicopters (Bell model) for fiscal years 2005 through 2009 were also provided by DOE NNSA/NSO. Landing and takeoff counts for fiscal year 2006 (260 landings and takeoffs for airplanes, 180 landings and takeoffs for helicopters) were used here because they were the largest of the five years, which creates a more health-conservative calculation of aircraft-related emissions.

Emissions of carbon monoxide, volatile organic compounds, nitrogen oxides, sulfur oxides, PM_{10}, and $PM_{2.5}$ from the airplane activity were derived from EDMS [Emissions and Dispersion Modeling System], v5.1.1 (FAA 2009), where the engine type was PT6A-42, the average mixing depth was 3,000 feet, and the taxi-in and -out times were 4.58 minutes and 30.74 minutes, respectively, across 493.5 total landings and takeoffs. Jet fuel contains no lead.

Appropriate emissions factors for helicopters were not readily available, so the same emission rates used for airplanes (from EDMS, v5.1.1; FAA 2009) were used after scaling them by the generic estimated helicopter activity times compared to the generic estimated turboprop airplane activity times (from EPA 1992). Jet fuel contains no lead.

Emissions of carbon monoxide, volatile organic compounds, nitrogen oxides, sulfur oxides, PM_{10}, and $PM_{2.5}$ from airplane ground support equipment for Raytheon Beechcraft Super King Air 200 airplanes were estimated from the emissions factors in EDMS, v5.1.1 (FAA 2009). The emission rate of lead from ground support equipment was derived from the Health Effects Institute study of mobile source metal emissions (HEI 2006, pages 36 through 48).

Emissions from current construction and surface disturbance activities were much smaller relative to these stationary and other mobile sources and were not explicitly calculated. $PM_{2.5}$ levels were not reported, so the $PM_{2.5}$ levels were conservatively assumed to be equal to the PM_{10} emission rates.

Table D–19 shows the current (approximately 2008) onsite emissions of criteria pollutants and HAPs associated with RSL permitted stationary sources, with heating using natural gas, and with aircraft and aircraft-related operations associated with RSL operations.

Table D–18 Aircraft-Related Emission Rates Used to Calculate Emissions from Aircraft-Related Activities at the Remote Sensing Laboratory

Aircraft	*Engine*	*Mode*	*Time in Mode (minutes)*	*Emissions per Mode per Landing or Takeoff (kilograms)*						
				CO	*VOCs*	*NO_x*	*SO_x*	*PM_{10}*	*$PM_{2.5}$*	*Lead*
Raytheon Beechcraft Super King Air 200	PT6A-42	Taxi out	19	1.83471084	0.47912844	0.05182179	0.03140373	0	0	0
		Takeoff	0.5	0.0310217	0.00217574	0.00239067	0.00109993	0	0	0
		Climbout	2.5	0.02877526	0.00024815	0.00251907	0.00113136	0	0	0
		Approach	4.5	0.1401291	0.03659423	0.00392481	0.00236548	0	0	0
		Taxi in	7	0.2745547	0.07169902	0.00775485	0.0046994	0	0	0
		Ground support	--	0.2410693	0.00908567	0.02079159	0.00252632	0.00140188	0.00130097	0.00016
Helicopters (Raytheon Beechcraft Super King Air 200 as surrogate)	(PT6A-42 as surrogate)	Taxi out	3.5	0.33797305	0.0882605	0.00954612	0.0057849	0	0	0
		Takeoff	0	0	0	0	0	0	0	0
		Climbout	6.5	0.07481569	0.00064518	0.00654957	0.00294154	0	0	0
		Approach	6.5	0.2024087	0.05285834	0.00566917	0.00341681	0	0	0
		Taxi in	3.5	0.13727735	0.03584951	0.00387743	0.0023497	0	0	0

CO = carbon monoxide; NO_x = nitrogen oxides; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_x = sulfur oxides; VOC = volatile organic compound.

Table D–19 Calculated Air Emissions of Criteria Pollutants and Hazardous Air Pollutants from Onsite Remote Sensing Laboratory Activities (tons per year)

	Clark County								
	On the Remote Sensing Laboratory								
	Stationary Sources			*Aircraft-Related Sources*					
Pollutant	***Spray Paint Booths, Emergency Generators, Boilers, Cooling Towers, Vapor Degreasers, Water Heaters***	***Natural Gas for Heating***	***Total***	***Airplane LTOs***	***Helicopter LTOs***	***Aircraft Ground Support Equipment***	***Total***	***Total***	***Reference***
PM_{10}	0.025	0.013	*0.038*	0	0	0.00040	*0.00040*	*0.038*	DOE 2009c, page A-10; EPA 1992, page 176; EPA 1995a, pages 1.4-5 to 1.4-6; FAA 2009
$PM_{2.5}$	0.025 [a]	0.013 [a]	*0.038* [a]	0	0	0.00037	*0.00037*	*0.038*	
CO	0.217	0.14	*0.36*	0.66	0.15	0.069	*0.88*	*1.2*	
NO_x	0.426	0.47	*0.90*	0.020	0.0051	0.020	*0.045*	*0.94*	
SO_2	0.009	0.0010	*0.010*	0.012	0.0029	0.00072	*0.016*	*0.026*	
VOCs	0.023	0.0093	*0.032*	0.17	N/A	0.0026	*>0.17*	*>0.20*	
Lead	<0.01 [b]	8.4×10^{-7}	*0.010*	0	0	6.4×10^{-8}	*~0.00040*	*~0.038*	EPA 1995a, pages 1.4-5 to 1.4-6; HEI 2006, pages 36-48
HAPs	0.004	0.0031	*0.0071*	<0.17 [c]	N/A [c]	<0.0026 [c]	*~0.17* [c]	*~0.18*	DOE 2009c, page A-10

~ = approximately; < = less than; CO = carbon monoxide; HAP = hazardous air pollutant; LTOs = landings and takeoffs; N/A = not applicable; NO_x = nitrogen oxides; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; VOC = volatile organic compound.

[a] PM_{10}, as reported in the reference, is conservatively assumed to correspond to $PM_{2.5}$.

[b] Lead emissions are not explicitly reported on site, but they are assumed to be very small.

[c] HAP calculation was unavailable, but HAP emissions should be a factor of VOC emissions, and should be comparatively small.

Note: Activities are partitioned by source type. Stationary permitted source emissions are representative of 2008, while natural gas and aircraft-related sources are representative of fiscal year 2006, which is assumed to be representative of calendar year 2008.

Onsite permitted stationary sources emitted approximately 0.7 tons of criteria pollutants in 2008, the bulk of which (0.426 tons) was nitrogen oxides. Emissions from spray booths and vapor degreasers were nearly 0 (less than 0.001 tons of HAPs from spray booths and less than 0.01 tons of volatile organic compounds from vapor degreasers) (DOE 2008b). So, among the onsite permitted stationary sources, about 54 percent of emissions (about 0.38 tons criteria pollutants, 0 tons HAPs) were from boilers and water heaters and about 46 percent (about 0.32 tons criteria pollutants, 0 tons HAPs) were from diesel generators.

Natural gas used for heating on RSL resulted in about 0.63 tons of criteria pollutant emissions in fiscal year 2009, which is assumed to be representative of calendar year 2008. Most of the criteria pollutant emissions (0.47 tons) were nitrogen oxides. A very small amount (0.0031 tons) of HAPs was emitted.

Airplane landing and takeoff activities at RSL resulted in about 0.86 tons of criteria pollutant emissions in fiscal year 2006, which is assumed to be representative of calendar year 2008. Most of those criteria pollutant emissions (0.66 tons) were carbon monoxide. A very small amount (less than 0.17 tons) of HAPs were emitted. Ground support equipment related to these airplane landings and takeoffs emitted about 0.09 tons of criteria pollutants and less than 0.0026 tons of HAPs. Helicopters emitted about 0.16 tons of criteria pollutants, most of which (0.15 tons) was carbon monoxide. Altogether, aircraft-related activities emitted about 1.1 tons of criteria pollutants (0.88 tons of which was carbon monoxide) and less than 0.2 tons of HAPs.

Overall, onsite stationary source, heating, and aircraft-related sources emitted about 2.4 annual tons of criteria pollutants in 2008, most of which (about 1.2 tons) was carbon monoxide. Most (55 percent) of these onsite criteria pollutant emissions were from stationary sources, while 42 percent were from aircraft and 4 percent were from aircraft-related ground support equipment. A small amount of HAPs (less than 0.2 tons) was emitted on site.

Emissions from Commuter and Commercial Vendor Mobile Sources. The MOVES2010 (Version 20091221; EPA 2009) mobile source model was used to estimate emissions due to vehicle traffic from employees commuting to the RSL using personal vehicles and from nonradioactive waste trucks (commercial vendors) servicing RSL. **Table D–20** and the following discussion contain further details on the activity and vehicle data that were used. See Chapter 4, Section 4.1.3, for further details on the traffic activity levels. Mobile emissions from onsite activities at RSL are believed to be very small compared to commuter emissions and are not shown.

Table D–20 Vehicle Activity Data Used to Model Emissions from Commuters and Commercial Vendors Traveling to and from the Remote Sensing Laboratory

Activity Type	*MOVES2010 Vehicle Type*	*Count*	*Annual VMT*	*Percentage Annual VMT Occurring on Weekdays*	*Fuel Type Used*
Commuting	Light-duty vehicles	53	471,731	95	Unleaded gasoline
	Light-duty passenger trucks	53	471,731		
Commercial vendors	Single-unit, short-haul trucks	5	72,072	95	No. 2 diesel

MOVES2010 = Motor Vehicle Emission Simulator 2010; VMT = vehicle miles traveled.
Note: Modeling performed using MOVES2010.

Private-vehicle commuter activity data were derived from employee count and residence information. Commercial vendor activity was derived from employee count data and from the 1999 NTS road renovation study (BN 1999). Radioactive waste transport does not usually occur at RSL, and it did not occur in 2008. For personal-vehicle commuters, half were assumed to use light-duty vehicles and the other half were assumed to use light-duty passenger trucks. All personal-vehicle commuters were assumed to use only unleaded gasoline, and all commercial vendors were assumed to use only No. 2 diesel. The lead emissions factors for mobile sources in EPA's *Air Quality Criteria for Lead* (EPA 2006) were used to estimate lead emissions for RSL personal-vehicle commuter vehicles and RSL commercial vendor vehicles.

MOVES default fuel market shares, meteorology, vehicle speed distributions, and monthly and hourly VMT distributions were used. Only running exhaust, brake wear, and tire wear were modeled. As was done for NNSS onsite government vehicles, light-duty vehicles and light-duty passenger trucks were assumed to have an average age of 9 years and single-unit, short-haul trucks were assumed to have an average age of 11 years old. The same Clark County road distribution used for NNSS commuter traffic was used for RSL commuters and commercial vendors (see Section D.1.1.2.1).

Table D–21 shows the modeled current (approximately 2008) ground vehicle emissions of criteria pollutants and HAPs associated with onsite employees commuting to the RSL and with commercial vendors traveling to and from RSL. Mobile source emissions related to RSL commuters and commercial vendors were much larger than stationary source emissions on RSL and were smaller than aircraft landing and takeoff emissions. Mobile source commuter activities emitted about 4 tons of criteria pollutants (3.1 tons of carbon monoxide alone) and about 0.0048 tons of HAPs. Light-duty vehicles contributed about 31 percent towards this criteria pollutant commuter total and about 21 percent towards this HAP commuter total, while light-duty passenger trucks contributed the remainders. Commercial vendors emitted about 0.68 tons of criteria pollutants (0.40 tons of nitrogen oxides alone) and about 0.048 tons of HAPs.

Table D–21 Estimated 2008 Air Emissions of Criteria Pollutants and HAPs from Commuters and Commercial Vendors Traveling to and from the Remote Sensing Laboratory (tons per year)

	Clark County				
	Off the Remote Sensing Laboratory				
	Commuting			*Commercial Vendors*	
Pollutants	***Light-Duty Vehicles***	***Light-Duty Passenger Trucks***	***Total***	***Single-Unit, Short-Haul Trucks***	***Total***
PM_{10}	0.012	0.018	*0.030*	0.043	*0.073*
$PM_{2.5}$	0.0065	0.0097	*0.016*	0.040	*0.056*
CO	0.98	2.1	*3.1*	0.18	*3.3*
NO_x	0.21	0.55	*0.76*	0.40	*1.2*
SO_2	0.0035	0.0049	*0.0084*	0.00074	*0.0091*
VOCs	0.011	0.051	*0.062*	0.058	*0.12*
Lead	1.0×10^{-6}	1.0×10^{-6}	*2.0×10^{-6}*	6.8×10^{-7}	*2.7×10^{-6}*
HAPs	0.001	0.0038	*0.0048*	0.0076	*0.012*

CO = carbon monoxide; HAP = hazardous air pollutant; NO_x = nitrogen oxides; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; VOC = volatile organic compound.

D.1.2.3 Climate Change

This section expands the climate change discussion presented in Chapter 4, Section 4.2.8.4, of this *NNSS SWEIS*.

Greenhouse gas emissions due to RSL activities were calculated using the EPA Climate Leaders Simplified Greenhouse Gas Emissions Calculator (EPA 2010). About 33 percent of the electricity consumed by RSL was supplied by renewable sources for fiscal year 2009, which is assumed to be representative of calendar year 2008. The resulting nonrenewable electricity consumption by RSL activities (3,250,630 kilowatt-hours) was provided by NNSA. RSL purchased electricity off of the Arizona-New Mexico (WECC Southwest) eGRID subregion. The amount of natural gas consumed by RSL activities (33,673 therms, or 3,367,300 cubic feet) was supplied by NNSA for fiscal year 2009, which is assumed to be representative of calendar year 2008. Greenhouse gas emissions from onsite permitted diesel generators were derived from the amount of amount of red dye diesel used by the generators in 2008 (960 gallons), as reported by DOE (2008b).

The amount of jet fuel used by RSL-related aircraft activities (111,030 gallons) for fiscal year 2009 was provided by NNSA and is assumed to be representative of calendar year 2008. The amount of fuel used by aircraft-related ground support equipment, which are set as heavy-duty vehicles in the Greenhouse Gas Emissions Calculator, was unknown but should be fairly small given the relatively few airplane operations there (an average of 232 annually from fiscal years 2005 through 2009). Ground support equipment was assumed to use 60 gallons of diesel, which was back-calculated from the relationship between the known VMTs by RSL commercial vendors and the ratio of modeled PM_{10} emission rates to estimated fuel consumption based on assumed fuel economy.

VMTs by each vehicle type and each fuel type were used in developing the greenhouse gas emissions attributed to RSL commuter and commercial vendor vehicles. For the purposes of greenhouse gas emissions calculations, gasoline-consuming light-duty passenger trucks were considered light-duty trucks, and all No. 2 diesel-consuming vehicles were considered heavy-duty vehicles. All other vehicle type and fuel type combinations had obvious matches in the Greenhouse Gas Emissions Calculator.

D.1.3 North Las Vegas Facility

D.1.3.1 Meteorology

The meteorological characteristics of the NLVF and RSL sites are based on the same observations due to the close proximity of the locations. Please see Section D.6 for a complete analysis of the meteorological characteristics of the NLVF site.

D.1.3.2 Ambient Air Quality on or near the North Las Vegas Facility

This section expands the meteorology discussion presented in Chapter 4, Section 4.3.8.2, of this *NNSS SWEIS*.

D.1.3.2.1 Existing Air Quality

This section expands the discussion on the methodology used in determining the air emissions for the NLVF.

Emissions from Onsite Stationary Sources. The 2008 emissions of onsite permitted stationary sources were from the 2008 NNSS environmental report (DOE 2009d). The amount of natural gas combusted for heating (25,947 therms, or 2,594,700 cubic feet) for fiscal year 2009 was provided by the DOE NNSA/NSO, and the resulting emissions were derived from the EPA AP-42 emissions factors database (EPA 1995a). This natural gas combustion was assumed to be representative of calendar year 2008. Emissions from current construction and surface disturbance activities were much smaller relative to these stationary and other mobile sources and were not explicitly calculated. $PM_{2.5}$ levels were not reported, so the $PM_{2.5}$ levels were conservatively assumed to be equal to the PM_{10} emission rates.

Onsite permitted stationary sources emitted approximately 0.5 tons of criteria pollutants in 2008, the bulk of which (0.365 tons) was nitrogen oxides. Emissions from sanders, blasters, and paint booths was nearly 0 (about 0.01 tons of PM_{10} from aluminum sanders; DOE 2008e), so among the onsite stationary sources, 98 percent of emissions were from diesel generators.

Natural gas used for heating on NLVF resulted in about 0.49 tons of criteria pollutants in fiscal year 2009, which is assumed to be representative of calendar year 2008. Most of the criteria pollutant emissions (0.36 tons) were nitrogen oxides. A very small amount (0.0024 tons) of HAPs were emitted.

Criteria pollutant and HAP emissions from activities at NLVF are shown in **Table D–22**. Activities are partitioned by source type. Stationary permitted source emissions are representative of 2008; natural gas combustion emissions are representative of fiscal year 2009 (assumed to be representative of calendar year 2008).

Table D–22 Calculated Emissions of Criteria Pollutants and Hazardous Air Pollutants from Onsite North Las Vegas Facility Activities (tons per year)

	Clark County			
	On the North Las Vegas Facility			
Pollutant	*Sanders, Blasters, Spray Paint Booths, Emergency Generators, Boilers, Cooling Towers*	*Natural Gas Consumption*	*TOTAL*	*Reference*
PM_{10}	0.027	0.0099	*0.037*	DOE 2009d, page A-7 and EPA 1995a, pages 1.4-5 to 1.4-6
$PM_{2.5}$	0.027 [a]	0.0099	*0.037*	
CO	0.082	0.11	*0.19*	
NO_x	0.365	0.36	*0.73*	
SO_2	0.016	0.00078	*0.017*	
VOCs	0.021	0.0071	*0.028*	
Lead	<0.01 [b]	6.5×10^{-7}	*<0.01*	EPA 1995a, pages 1.4-5 to 1.4-6
HAPs	0.0002	0.0024	*0.0026*	DOE 2009d, page A-7 and EPA 1995a, pages 1.4-7 to 1.4-8

< = less than; CO = carbon monoxide; HAP = hazardous air pollutant; NO_x = nitrogen oxides; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; VOC = volatile organic compound.

[a] PM_{10}, as reported in the reference, is conservatively assumed to correspond to $PM_{2.5}$.

[b] Lead emissions are not explicitly reported on site, but they are assumed to be very small.

Emissions from Commuter, Commercial Vendor, and Radioactive Waste Transport Mobile Sources. The MOVES2010 (Version 20091221; EPA 2009) mobile source model was used to estimate emissions due to vehicle traffic to and from the NNSS. **Table D–23** and the following discussion contain further details on the activity and vehicle data that were used. See Chapter 4, Section 4.1.3, for more details.

Table D–23 Vehicle Activity Data Used to Model Emissions from Commuters, Commercial Vendors, and Radioactive Waste Trucks Traveling to and from the North Las Vegas Facility

Activity Type	*MOVES2010 Vehicle Type*	*Count Originating in Clark County*	*Count Originating in Nye County*	*Annual VMT Within Clark County*	*Annual VMT Within Nye County but Outside the NNSS*	*Annual VMT Within Nye County and Inside the NNSS*	*Percentage Annual Clark County VMT Occurring on Weekdays*	*Percentage Annual Nye County VMT Outside the NNSS Occurring on Weekdays*	*Percentage Annual Nye County VMT Inside the NNSS Occurring on Weekdays*	*Fuel Type Used*
Commuting	Light-duty vehicles	567	5	3,864,738	23,435	0	95	95	0	Unleaded gasoline
	Light-duty passenger trucks	566	4	3,864,738	23,435	0	95	95	0	
Commercial vendors	Single-unit, short-haul trucks	23	0	310,565	0	0	95	0	0	No. 2 diesel
Radioactive waste trucks	Combination-unit, short-haul trucks	1	0	3,068	312	208	100	100	100	No. 2 diesel

MOVES2010 = Motor Vehicle Emission Simulator 2010; NNSS = Nevada National Security Site; VMT = vehicle miles traveled.
Note: Modeling performed using MOVES2010.

Private-vehicle commuter activity data were derived from employee count and residence information. Commercial vendor activity was derived from employee count data and from the 1999 NTS road renovation study (BN 1999). Radioactive waste transport activity was derived from the number of transports and the NNSS destination reported as part of the 2009 NESHAPs submission (NSTec 2010), and these 2009 data are assumed to be representative of 2008. Note that these radioactive waste transports are occurring only because of a 1995 tritium contamination in the Building A-1 basement, not due to any other regular activities at NLVF. Mobile emissions from onsite activities at NLVF are believed to be very small compared with commuter emissions and are not shown.

For personal-vehicle commuters, half were assumed to use light-duty vehicles and the other half were assumed to use light-duty passenger trucks. Commercial vendors and radioactive waste transports used combination-unit trucks. All personal-vehicle commuters were assumed to only use unleaded gasoline, and all waste trucks were assumed to only use No. 2 diesel. The lead emissions factors for mobile sources in EPA's *Air Quality Criteria for Lead* (EPA 2006) were used for estimating lead emissions for NLVF personal-vehicle commuter vehicles, NLVF commercial vendor vehicles, and NLVF radioactive waste transport vehicles.

MOVES default fuel market shares, meteorology, vehicle speed distributions, and hourly VMT distributions were used. Only running exhaust, brake wear, and tire wear were modeled. For commuters and commercial vendors, MOVES-default monthly VMT distributions were used. For radioactive waste trucks, transport activity data were available by month, so the monthly VMT distribution was developed from the monthly data. As was done for the NNSS, onsite government vehicles, light-duty vehicles, and light-duty passenger trucks were assumed to be 9 years old, and single-unit, short-haul trucks were assumed to be 11 years old. The same Clark County road distribution used for NNSS commuter traffic was used for NLVF personal-vehicle commuter vehicles, NLVF commercial vendor vehicles, and NLVF radioactive waste transport vehicles (see Section D.1.1.2.1).

Table D–24 shows the modeled current (approximately 2008) ground vehicle emissions of criteria pollutants and HAPs associated with onsite employees commuting to NLVF and with waste transport (commercial vendors and radioactive waste trucks) to and from NLVF.

Mobile source emissions related to NLVF commuting and waste transport were much larger than stationary source emissions on NLVF. Mobile source commuter activities emitted about 31.7 tons of criteria pollutants (24.9 tons of carbon monoxide alone) and about 0.038 tons of HAPs. Light-duty vehicles contributed about 32 percent towards this criteria pollutant commuter total and about 22 percent towards this HAP commuter total, while light-duty passenger trucks contributed the remainders. Over 99 percent of these commuter emissions took place in Clark County, and the remainder took place in Nye County. Commercial vendors emitted about 7.9 tons of criteria pollutants (5.2 tons of nitrogen oxides alone) and about 0.055 tons of HAPs. Single-unit trucks contributed about 37 percent towards this commercial vendor criteria pollutant total and about 60 percent of this commercial vendor HAP total, while combination-unit trucks contributed the remainders. Radioactive waste truck activities related to NLVF emitted approximately 0.11 tons of criteria pollutants and 0.00050 tons of HAPs in 2008. Nitrogen oxides were emitted in by far the largest amounts (0.080 tons) among the criteria pollutants.

Table D–24 Estimated Emissions of Criteria Pollutants and Hazardous Air Pollutants from Ground Vehicle Activity Related to the North Las Vegas Facility, 2008 (tons per year)

	Commuting				*Commercial Vendors*	*Radioactive Waste Transport*						
	Light-Duty Vehicles		*Light-Duty Passenger Trucks*		*Single-Unit, Short-Haul Trucks*	*Combination-Unit, Short-Haul Trucks*			*Total*			
	Clark County	*Nye County*	*Clark County*	*Nye County*	*Clark County*	*Clark County*	*Nye County*		*Clark County*	*Nye County*		
Pollutant	*Off NLVF*	*Off NNSS*	*Off NLVF*	*Off NNSS*	*Off NLVF*	*Off NLVF*	*On NNSS*	*Off NNSS*	*Off NLVF*	*On NNSS*	*Off NNSS*	*Total*
PM_{10}	0.10	0.00063	0.15	0.00086	0.19	0.0051	0.00032	0.00048	*0.45*	*0.00032*	*0.002*	*0.45*
$PM_{2.5}$	0.053	0.00037	0.08	0.00049	0.17	0.0048	0.0003	0.00045	*0.31*	*0.00030*	*0.0013*	*0.31*
CO	8.1	0.051	17.4	0.11	0.76	0.020	0.0013	0.0019	*26.3*	*0.0013*	*0.16*	*26.4*
NO_x	1.7	0.012	4.5	0.030	1.7	0.069	0.0045	0.0068	*8.0*	*0.0045*	*0.049*	*8.0*
SO_2	0.029	0.00016	0.040	0.00023	0.0032	0.000098	6.2×10^{-6}	9.4×10^{-6}	*0.072*	6.2×10^{-6}	*0.00040*	*0.073*
VOCs	0.093	0.00060	0.42	0.0026	0.25	0.0033	0.00021	0.00032	*0.77*	*0.00021*	*0.0035*	*0.77*
Lead	8.5×10^{-6}	5.2×10^{-7}	8.5×10^{-6}	5.1×10^{-8}	2.9×10^{-6}	2.9×10^{-8}	2.9×10^{-9}	2.9×10^{-9}	*0.000020*	2.9×10^{-9}	5.7×10^{-7}	*0.000021*
HAPs	0.0082	0.000058	0.032	0.00020	0.033	0.00043	0.000028	0.000042	*0.074*	*0.000028*	*0.00030*	*0.074*

CO = carbon monoxide; HAP = hazardous air pollutant; NLVF = North Las Vegas Facility; NO_x= nitrogen oxides; NNSS = Nevada National Security Site; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; VOC = volatile organic compound.

D.1.3.3 Climate Change

This section discusses the basis for estimating the greenhouse gas emissions as presented in Chapter 4, Section 4.3.8.4, of this *NNSS SWEIS*.

The greenhouse gas emissions due to NLVF activities were calculated within the EPA Climate Leaders Simplified Greenhouse Gas Emissions Calculator (EPA 2010). The electricity consumption by NLVF activities for fiscal year 2009 (13,331,050 kilowatt-hours) was provided by NNSA. This electricity consumption was assumed to be representative of calendar year 2008. NLVF purchased electricity off of the Arizona-New Mexico (WECC Southwest) eGRID subregion. The amount of natural gas consumed by NLVF activities (25,947 therms, or 2,594,700 cubic feet) was supplied by NNSA for fiscal year 2009, which is assumed to be representative of calendar year 2008. Greenhouse gas emissions from onsite permitted diesel generators were derived from the amount of amount of red dye diesel used by the generators in 2008 (1,298 gallons), as reported by DOE (2008e). For greenhouse gas emissions by NLVF commuter, commercial vendor, and radioactive waste transport vehicles, the VMT by each vehicle type and each fuel type (see Table D–23) were used. For the purposes of greenhouse gas emissions calculations, gasoline-consuming light-duty passenger trucks were considered light-duty trucks, and all No. 2 diesel-consuming vehicles were considered heavy-duty vehicles. All other vehicle type and fuel type combinations had obvious matches in the Greenhouse Gas Emissions Calculator.

D.1.4 Tonopah Test Range

D.1.4.1 Meteorology

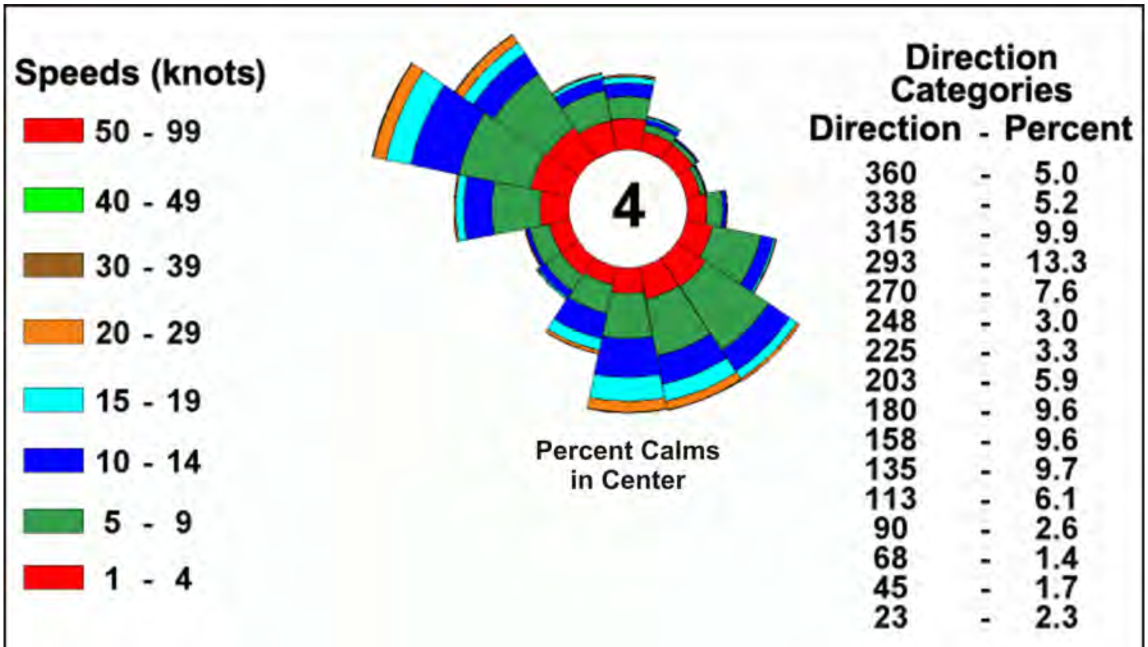
This section expands the meteorology discussion presented in Chapter 4, Section 4.4.8.2, of this *NNSS SWEIS*.

Precipitation. From about 1983 to 1990, the average annual snowfall total at the Tonopah Test Range Airport was about 15 inches (SORD 2002). A 7-year record (1961–1967) at a weather station that existed about 2 miles northeast of the current Tonopah Test Range Airport station recorded an average annual snowfall of about 19 inches (Schaeffer 1968). At the Tonopah Airport (about 25 miles northeast of KTNX at an elevation of about 5,394 feet above mean sea level), the average annual snowfall is about 13 inches (averaged over the period from 1954–2009 Average; NCDC 2009). At the highest elevations, annual snowfall amounts between about 40 and 60 inches are anticipated based on estimates made for Rainier Mesa (about 50 miles southeast of the Tonopah Test Range Airport at an elevation of 7,490 feet above mean sea level; Soulé 2006) and measurements (averaged over the period from 1966–2002) made at Snowball Ranch (90 miles northeast of the Tonopah Test Range Airport; at an elevation of about 7,159 feet above mean sea level; NCDC 2009).

Thunderstorms at the Tonopah Test Range occur primarily in springtime due to frontal passages and in the middle to late summer due to convection from daytime heating (Soulé 2006), and the same is likely true for the Tonopah Test Range (TTR). In a 29-month period (March 1990 through August 1992) at the Tonopah Test Range Airport, the average annual number of days with thunderstorms was 28 (USAF 2003), which is about 13 more than are typically recorded on the NNSS at Yucca Flat (about 68 miles southeast of the Tonopah Test Range Airport at an elevation of 3,921 feet above mean sea level) and at Desert Rock (90 miles southeast of the Tonopah Test Range Airport at an elevation of 3,304 feet above mean sea level). Observations on the NNSS suggest that thunderstorms are more frequent and begin earlier in the afternoon on the mesas compared to lower elevations (Soulé 2006). At the Tonopah Test Range Airport, thunderstorm activity tends to reach a maximum in the middle afternoon, with some summertime thunderstorms existing near and sometimes after midnight (USAF 2003).

On the NNSS, and likely on the TTR as well, it is rare for a thunderstorm to produce more than about 0.5 inches of rain at a given location, so flooding is rarely a problem. Thunderstorms on the NNSS can be severe at times, with strong surface wind gusts and intense cloud-to-ground lightning, but hail is infrequent and hail size is small (less than about 0.5 inches in diameter). Cloud-to-ground lightning activity tends to maximize over higher elevations particularly during the period from July through September (Soulé 2006). Tornadoes are very rare in Nevada as a whole, with a 1954–1983 tornado climatology indicating a tornado strike probability of 3 per year statewide (NRC 1986).

Wind Flow Overview. On the whole, the preferences towards down-slope winds (which tend to be northwesterly) and up-slope winds (which tend to be southerly or southeasterly) are apparent in the Tonopah Test Range Airport annual average wind rose (see **Figure D–11**). Similar wind flows are seen near the town of Tonopah at its CEMP station (see **Figure D–12**), about 31 miles northeast of the Tonopah Test Range Airport at an elevation of about 6,181 feet above mean sea level.



Note: To convert knots to meters per second, multiply by 0.5144. To convert knots to miles per hour, multiply by 1.121.

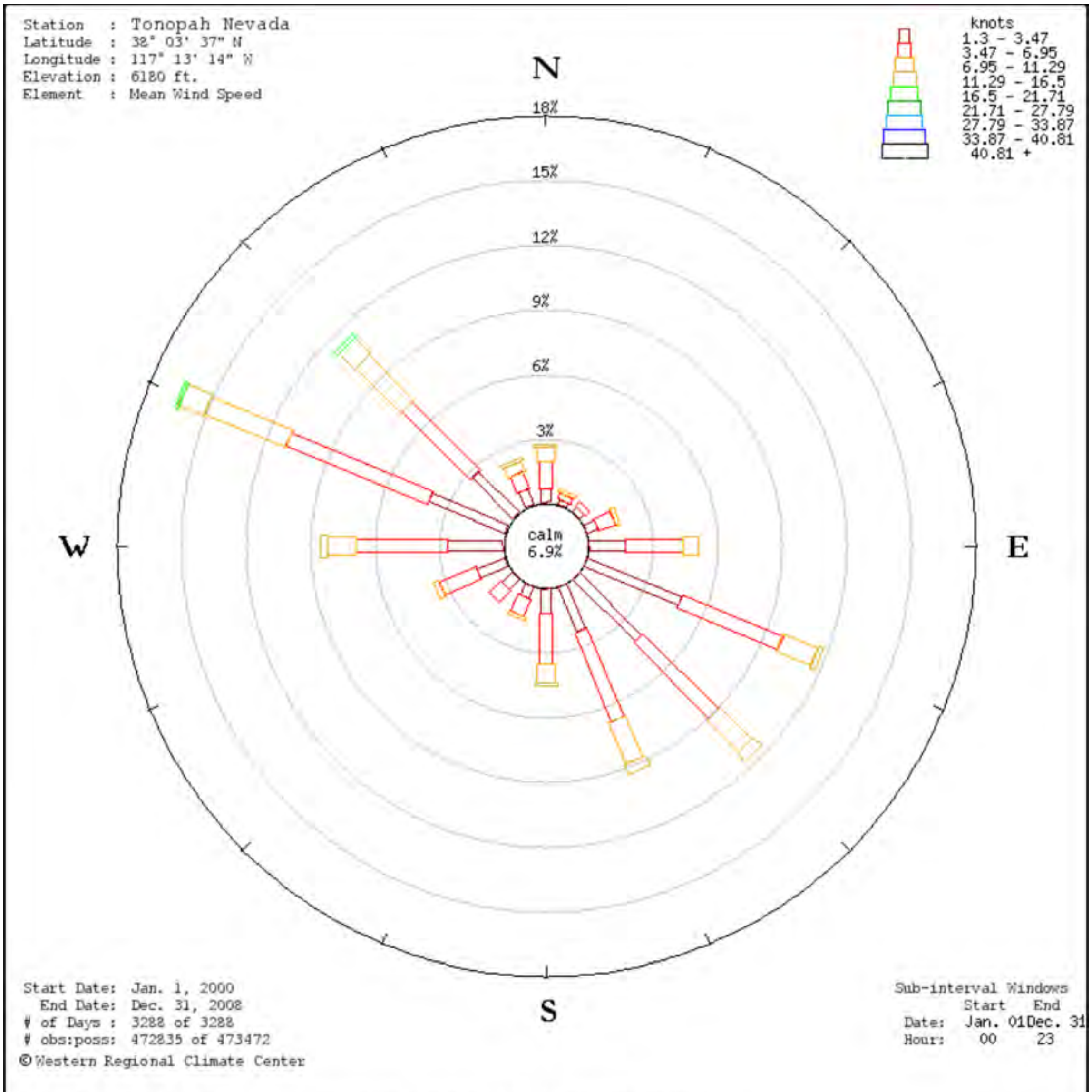
Source: SORD 2005.

Figure D–11 Annual Average Wind Rose for Tonopah Test Range Airport, 1981–2004

Calm winds occur about 4 percent of the hours at the Tonopah Test Range Airport (see Figure D–11) and about 7 percent of the hours at the Tonopah CEMP station (see Figure D–12), with calm conditions more frequent during the winter months and less frequent during the summer. The annual average wind speed at the Tonopah Test Range Airport is about 9 miles per hour (USAF 2003) and at the Tonopah CEMP, about 7 miles per hour (CEMP 2009). Wind speeds along the Cactus and Kawich Mountain Ranges tend to be stronger because they are more influenced by generally stronger upper-level winds. Seasonally, winds tend to be strongest in the spring due to frontal passages and weakest in the fall. Wind gusts in excess of about 55 miles per hour can be observed during springtime frontal passages and during summertime convective thunderstorms (Soulé 2006). Dust storms are common in the spring, when monthly average wind speeds reach about 16 miles per hour (DOE 2009e).

Cloud cover measurements used to estimate atmospheric stability are available from the Desert Rock site located in the southeastern corner of the NNSS, 90 miles southeast of the Tonopah Test Range Airport.

Based on data recorded from 1978 through 2004 at Desert Rock, stable conditions dominate at night, though stronger wind speeds will tend to mix the atmosphere, leading to neutral conditions. Nighttimes tend to be more stable during the summer and fall months because of lighter winds at night relative to the winter and spring periods. Since greater solar radiation leads to greater instability, unstable conditions dominate the daytime hours and the months with the greatest solar radiation (summer) (Soulé 2006). These stability patterns would be slightly modified within the TTR based primarily on wind speed differences and potentially on differences in local cloud cover relative to what occurs at Desert Rock.



Note: To convert knots to meters per second, multiply by 0.5144. To convert knots to miles per hour, multiply by 1.121.

Source: CEMP 2009.

Figure D–12 Annual Average Wind Rose for the Tonopah Test Range Community Environmental Monitoring Program Station, 2000–2008

D.1.4.2 Ambient Air Quality on or near the Tonopah Test Range

This section expands the ambient air quality discussion presented in Chapter 4, Section 4.4.8.2, of this *NNSS SWEIS*.

D.1.4.2.1 Existing Air Quality

Emissions from Onsite Stationary Sources. The emissions from the TTR generators and propane boilers were not explicitly available. However, the horsepower and activity data for the TTR air permit were available for each generator and boiler. This information, in conjunction with the EPA AP-42 emissions factors (EPA 1995a), was used to estimate maximum allowed emissions levels. The emissions from the TTR storage tanks were not explicitly available.

Table D–25 shows the estimated maximum allowed air emissions of criteria pollutants and HAPs from onsite stationary TTR activities. These estimates reflect both permitted facilities operating at maximum permitted capacity and non-permitted facilities operating at peak capacity. The data are approximately representative of 2007, but are assumed to be representative of 2008 as well.

Table D–25 Estimated Maximum Allowed Air Emissions of Criteria Pollutants and Hazardous Air Pollutants from Onsite Stationary Tonopah Test Range Activities (tons per year)

	Nye County						
	On Tonopah Test Range						
Pollutant	*Screening Plant*	*Diesel Generators*	*Gasoline Generators*	*Propane Boilers*	*Storage Tanks*	*TOTAL (all programs)*	*Reference*
PM_{10}	<2.7	<0.95	<0.00072	<0.000031	0	*<3.7*	NDEP 2007, page V-1–V-7 and Appendix; and EPA 1995a, pages 1.5-3 and 3.3-6
$PM_{2.5}$	<2.7	<0.95	<0.00072	<0.000031	0	*<3.7*	
CO	N/A	<2.9	<0.0070	<0.00032	0	*<2.9*	
NO_x	N/A	<13.3	<0.011	<0.00057	0	*<13.3*	
SO_2	N/A	<0.88	<0.00059	<0.033	0	*<0.91*	
VOCs	<0.35	<0.13	<0.13	N/A	<0.35	*<0.96*	
Lead	<0.01	<0.01	<0.01	<0.01	<0.01	*<0.01*	
HAPs	<0.83	<0.21	<0.00049	N/A	<0.09	*<1.1*	NDEP 2007, page V-1–V-7 and Appendix; and EPA 1995a, page 3.3-7

< = less than; CO = carbon monoxide; N/A = not applicable; NO_x = nitrogen oxides; PM_n = particulate matter with an aerodynamic diameter less than or equal to n micrometers; SO_2 = sulfur dioxide; VOC = volatile organic compound.

Emissions from Onsite Government-Owned Vehicle Mobile Sources. The MOVES2010 (Version 20091221; EPA 2009) mobile source model was used to estimate emissions due to government vehicle traffic on the TTR. Onsite mobile source activity data were derived from the onsite TTR fleet count from the *1996 NTS EIS* (DOE 1996), the NNSS onsite government-owned vehicle counts in the 1999 NTS road renovation study (BN 1999), the NNSS onsite government-owned fuel usage data (see Section D.1.1.2), the current estimated TTR VMTs (SNL 2010), and the weekday/weekend traffic ratios used for the TTR commuters (see commuter discussion below). The same methodology for estimating lead emissions that was used for onsite government vehicles (see Section D.1.1.2.1) was also used for personal-vehicle commuter vehicles. **Table D–26** contains further details on the activity and vehicle data that were used. See Chapter 4, Section 4.1.3, for more details.

Table D–26 Vehicle Activity Data Used to Model Emissions from Onsite Government Vehicles at the Tonopah Test Range

Vehicle Type Observed [a]	*MOVES2010 Vehicle Type*	*MOBILE6 Vehicle Type*	*Count*	*Annual VMT*	*Percentage Annual VMT Occurring on Weekdays*	*Fuel Types Used*	*Average Vehicle Age (model year)*	*Vehicle Fuel Economy (miles per gallon)*	*VMT per Applicable Fuel Type*	*Annual Lead Emissions (pounds)*
Single-unit trucks (2 to 3 axles)	Single-unit, short-haul trucks	Light-duty trucks 6,001–8,500	6	64,928	97	Biodiesel (assumed to be B-20 for MOVES modeling) and No. 2 diesel	11 years (1997)	11.2	10,317 No. 2 diesel 54,611 B-20	0.0012
Cars/light trucks	Light-duty vehicles	Light-duty trucks All	43	380,216		E85 (assumed to be E10 for MOVES modeling) and unleaded gasoline	9 years (1999)	24.1	267,178 Unleaded gasoline 113,038 E-10	0.0017
Cars/light trucks	Light-duty passenger trucks	Light-duty trucks 0–6,000	42	504,008		E85 (assumed to be E10 for MOVES modeling) and unleaded gasoline	9 years (1999)	18.5	354,166 Unleaded gasoline 149,842 E10	0.0022

MOBILE6 = Mobile Source Emission Factor Model; MOVES2010 = Motor Vehicle Emission Simulator 2010; VMT = vehicle miles traveled.
[a] Vehicle types observed in *Traffic Study and Cost Benefit Analysis to Renovate Existing Roadways, Nevada Test Site* (BN 1999).
Note: Modeling performed using MOVES2010.

Table D–27 shows the modeled current (approximately 2008) onsite mobile emissions of criteria pollutants and HAPs associated with TTR government vehicles. Total onsite emissions from stationary sources (shown in more detail in Table D–25) are also provided in Table D–27 to show the total onsite emissions from both stationary sources and government vehicle mobile sources.

The mobile source criteria pollutant emissions were dominated by carbon monoxide and nitrogen oxide emissions. Light-duty passenger trucks were the largest emitters (3.3 tons of criteria pollutants). Altogether, onsite TTR activities (mobile and stationary) emitted up to 26.5 tons of criteria pollutants and up to 1.1 tons of HAPs in 2008 if stationary sources were operating at maximum allowed levels.

Table D–27 Estimated Emissions of Criteria Pollutants and Hazardous Air Pollutants from Onsite Stationary Tonopah Test Range Sources and Mobile Sources, 2008 (tons per year)

	Nye County					
	On Tonopah Test Range					
	Government-Owned Mobile Source Type (Modeled)					
Pollutant	***Light-Duty Vehicles***	***Light-Duty Passenger Trucks***	***Single-Unit, Short-Haul Trucks***	***Total***	***Stationary Source Type (calculated)***	***Total***
PM_{10}	0.010	0.018	0.037	*0.065*	*<3.7*	<3.8
$PM_{2.5}$	0.0059	0.010	0.034	*0.050*	*<3.7*	<3.8
CO	0.84	2.6	0.15	*3.6*	*<2.9*	<4.5
NO_x	0.024	0.63	0.32	*0.97*	*<13.3*	<14.3
SO_2	0.0023	0.0043	0.00051	*0.0071*	*<0.91*	<0.92
VOCs	0.0095	0.054	0.041	*0.10*	*<0.96*	<1.1
Lead	0.0017	0.0022	0.00096	*0.0049*	*<0.01*	<0.015
HAPs	0.00089	0.0042	0.0046	*0.0097*	*<1.1*	<1.1

< = less than; CO = carbon monoxide; NO_x = nitrogen oxides; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; VOC = volatile organic compound.
Note: Mobile source activities are partitioned by source type. The source type partitioning of stationary source activities is shown in Table D–24.

Emissions from Commuter Mobile Sources. The MOVES2010 (Version 20091221; EPA 2009) mobile source model was used to estimate emissions due to vehicle traffic from employees commuting to the TTR using personal vehicles. **Table D–28** and the following discussion contain further details on the activity and vehicle data that were used. See Chapter 4, Section 4.1.3, for more details.

Table D–28 Vehicle Activity Data Used to Model Emissions from Commuting to and from the Tonopah Test Range

MOVES2010 Vehicle Type	***Annual VMT Within Clark County***	***Annual VMT Within Nye County but Outside the TTR***	***Annual VMT Within Nye County and Inside the TTR***	***Percentage Annual Clark County VMT Occurring on Weekdays***	***Percentage Annual Nye County VMT Outside of the TTR Occurring on Weekdays***	***Percentage Annual Nye County VMT Inside the TTR Occurring on Weekdays***	***Fuel Type Used***
Light-duty vehicles	138,902	574,804	16,978	100	97	92	Unleaded gasoline
Light-duty passenger trucks	138,902	574,804	16,978				

MOVES2010 = Motor Vehicle Emission Simulator 2010; TTR = Tonopah Test Range; VMT = vehicle miles traveled.
Note: Modeling performed using MOVES2010.

Private-vehicle commuter activity data were derived from employee count and residence information. For personal vehicle commuters, half were assumed to use light-duty vehicles and the other half were assumed to use light-duty passenger trucks. All personal-vehicle commuters were assumed to use only unleaded gasoline. The lead emissions factors for mobile sources in EPA's *Air Quality Criteria for Lead* (EPA 2006) were used for estimating lead emissions for TTR personal-vehicle commuter vehicles.

To estimate the personal-vehicle emissions taking place in various locations, it was assumed that all personal-vehicle commuters enter the TTR via Route 504 near the Tonopah Test Range Airport. All personal-vehicle commuters coming from Clark County were assumed to use U.S. Route 95, which means that about 75 percent of their commute (about 371 round-trip miles per vehicle) is within Nye County and outside of the TTR and about 24 percent of their commute (about 119 round-trip miles per vehicle) is within Clark County. Roads within Nye County were assumed to be rural roads with unrestricted access. For Clark County roads, the same Clark County road distribution used for NNSS commuter traffic was used for TTR commuters (see Section D.1.1.2.1).

MOVES default fuel market shares, meteorology, vehicle speed distributions, and monthly and hourly VMT distributions were used. Only running exhaust, brake wear, and tire wear were modeled. Average age for onsite government vehicles, light-duty vehicles, and light-duty passenger trucks was assumed to be 9 years old.

Table D–29 shows the modeled current (approximately 2008) mobile emissions of criteria pollutants and HAPs associated with onsite employees commuting to the TTR. Commuting activities included privately owned light-duty vehicles and light-duty passenger trucks. The MOVES2010 (Version 20091221; EPA 2009) mobile source model was used to estimate emissions due to vehicle traffic from employees commuting to the TTR. Private vehicle mobile source activity data were derived from employee count and residence information. See Chapter 4, Section 4.1.3, for more details on how commuter private vehicle activity data were determined.

Commuting activities related to the TTR emitted approximately 6.5 tons of criteria pollutants in 2008. Light-duty vehicles contributed about 31 percent towards this criteria pollutant total, while light-duty passenger trucks contributed the remainder. Carbon monoxide was emitted in the largest amounts at 5.1 tons. Commuting activities related to the TTR emitted approximately 0.0079 tons of HAPs in 2008. The majority (82 percent) of emissions related to commuting to the TTR took place in Nye County, most of which (98 percent) took place outside of the TTR. The remaining 18 percent of commuting emissions took place in Clark County.

Table D–29 Vehicle Activity Data Used to Model Emissions from Onsite Government Vehicles at the Tonopah Test Range (tons per year)

	Light-Duty Vehicles			*Light-Duty Passenger Trucks*			*Total*			
		Nye County			*Nye County*			*Nye County*		
Pollutant	***Clark County***	***Off TTR***	***On TTR***	***Clark County***	***Off TTR***	***On TTR***	***Clark County***	***Off TTR***	***On TTR***	***Total***
PM_{10}	0.0036	0.016	0.00046	0.0052	0.021	0.00062	*0.0087*	*0.037*	*0.0010*	*0.047*
$PM_{2.5}$	0.0019	0.0090	0.00026	0.0029	0.012	0.00035	*0.0048*	*0.021*	*0.00061*	*0.026*
CO	0.29	1.3	0.037	0.63	2.9	0.0085	*0.91*	*4.1*	*0.047*	*5.1*
NO_x	0.063	0.29	0.0087	0.16	0.73	0.022	*0.22*	*1.0*	*0.030*	*1.2*
SO_2	0.0010	0.0040	0.00012	0.0014	0.0056	0.00016	*0.0024*	*0.0095*	*0.00028*	*0.012*
VOCs	0.0034	0.015	0.00043	0.015	0.062	0.0018	*0.018*	*0.075*	*0.0022*	*0.095*
Lead	6.0×10^{-7}	1.3×10^{-6}	3.7×10^{-8}	6.1×10^{-7}	1.2×10^{-6}	3.7×10^{-8}	*1.2×10^{-6}*	*2.5×10^{-6}*	*7.4×10^{-8}*	*3.8×10^{-6}*
HAPs	0.00029	0.0014	0.000041	0.0011	0.0051	0.00015	*0.0014*	*0.0063*	*0.00019*	*0.0079*

CO = carbon monoxide; HAP = hazardous air pollutant; NO_x = nitrogen oxides; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; TTR = Tonopah Test Range; VOC = volatile organic compound.
Note: Modeling performed using MOVES2010.

Emissions from Commercial Vendor Mobile Sources. The MOVES2010 (Version 20091221; EPA 2009) mobile source model was used to estimate emissions due to vehicle traffic from nonradioactive waste transport (commercial vendors). **Table D–30** and the following discussion contain further details on the activity and vehicle data that were used. See Chapter 4, Section 4.1.3, for more details on the waste transport activity levels. Radioactive waste transport does not usually occur at the TTR, and it did not occur in 2008.

Table D–30 Vehicle Activity Data Used to Model Emissions from Commercial Vendors Traveling to and from the Tonopah Test Range

MOVES2010 Vehicle Type	***Daily Average Count***	***Annual VMT Within Clark County***	***Annual VMT Within Nye County but Outside the TTR***	***Annual VMT Within Nye County and Inside the TTR***	***Percentage Annual VMT Occurring on Weekdays***	***Fuel Type Used***
Single-unit, short-haul trucks	8	199,093	946,851	11,575	95	No. 2 diesel

MOVES2010 = Motor Vehicle Emission Simulator 2010; TTR = Tonopah Test Range; VMT = vehicle miles traveled.
Note: Modeling performed using MOVES2010.

Commercial vendor activity data were derived from employee count data. To estimate the commercial vendor emissions in various locations, all commercial vehicles (which are combination- and single-unit, short-haul trucks) were assumed to enter the TTR via Route 504.

MOVES default fuel supply market shares, meteorology, vehicle speed distribution, and monthly and hourly VMT distributions were used in the analysis. Only running exhaust, brake wear, and tire wear were modeled. As was done for NNSS onsite government vehicles, combination- and single-unit, short-haul trucks were assumed to have an average age of 11 years. All roads in Nye County were assumed to be rural roads with unrestricted access. For Clark County roads, the same Clark County road distribution used for NNSS commuter traffic was used for TTR commercial vendors (see Section D.1.1.2.1).

Table D–31 shows the modeled current (approximately 2008) mobile emissions of criteria pollutants and HAPs associated with commercial vendors traveling to and from the TTR. Commercial vendor activities related to the TTR emitted approximately 10.2 tons of criteria pollutants in 2008. Nitrogen oxides were emitted in by far the largest amounts (5.9 tons) among the criteria pollutants. Commercial vendor activities related to the TTR emitted approximately 0.12 tons of HAPs in 2008. The majority (82 percent) of emissions related to TTR commercial vendors took place in Nye County, with most of those emissions (99 percent) taking place outside of the TTR. About 18 percent of TTR-related commercial vendor emissions took place in Clark County.

Table D–31 Estimated Annual Emissions of Criteria Pollutants and HAPs from Commercial Vendors Traveling to and from the Tonopah Test Range, 2008 (tons per year)

Pollutant	Single-Unit, Short-Haul Trucks			
		Nye County		
	Clark County	Off TTR, Off NNSS	On TTR	Total
PM_{10}	0.12	0.54	0.0066	*0.67*
$PM_{2.5}$	0.11	0.5	0.0061	*0.62*
CO	0.49	2.2	0.027	*2.7*
NO_x	1.1	4.7	0.058	*5.9*
SO_2	0.002	0.0087	0.00011	*0.011*
VOCs	0.16	0.72	0.0088	*0.89*
Lead	1.9×10^{-6}	8.9×10^{-6}	1.1×10^{-7}	*0.000011*
HAPs	0.021	0.095	0.0012	*0.12*

CO = carbon monoxide; HAP = hazardous air pollutant; NO_x = nitrogen oxides; NNSS = Nevada National Security Site; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; TTR = Tonopah Test Range; VOC = volatile organic compound.

D.1.4.3 Climate Change

Greenhouse gas emissions due to TTR activities were calculated using the EPA Climate Leaders Simplified Greenhouse Gas Emissions Calculator (EPA 2010). The typical annual electricity consumption by TTR activities (595,000 kilowatt-hours) was provided by DOE (2008g). This electricity consumption was assumed to be representative of calendar year 2008. The TTR purchased electricity off of the Northwest Power Pool (Western Electric Coordinating Council Northwest) eGRID subregion. The permitted stationary sources at the TTR are not associated with combustion and should generate no greenhouse gases. The carbon dioxide emissions from onsite, nonpermitted diesel generators and propane boilers were not calculated using the Greenhouse Gas Emissions Calculator, but rather were calculated using maximum operating hours, maximum horsepower, maximum energy usage (NDEP 2007), and the EPA AP-42 emissions factors database (EPA 1995a).

For carbon dioxide emissions by onsite government vehicles, greenhouse gas emissions were estimated using vehicle fuel consumption. For each vehicle type, given how many VMTs were estimated for each applicable fuel type (see Table D–26), the amount of each fuel type consumed was estimated using those VMTs and the estimated vehicle fuel economies (see Table D–26). For nitrous oxide and methane emissions by onsite government vehicles, and for greenhouse gas emissions by all other NNSS-related vehicles, the VMT by each vehicle type and each fuel type (see Table D–26) were used. For the purposes of greenhouse gas emissions calculations, ethanol-consuming light-duty vehicles and light-duty passenger trucks were considered light-duty vehicles, gasoline-consuming light-duty passenger trucks were considered light-duty trucks, and all No. 2 diesel-consuming vehicles were considered heavy-duty vehicles. All other vehicle type and fuel type combinations had obvious matches in the Greenhouse Gas Emissions Calculator.

D.2 Environmental Consequences

D.2.1 Nevada National Security Site

D.2.1.1 No Action Alternative

D.2.2 Emissions on and near the Nevada National Security Site

Emissions from Construction Activities. Construction emissions for the proposed solar power generation facility were scaled based on the generating capacity of the Amargosa Farm Road Solar Energy Project Environmental Impact Statement (BLM 2010). Emissions for criteria pollutants under construction and operations were scaled based on total energy output of the solar power generation facility.

Emissions from Stationary Sources. No specific changes to the operation of established stationary sources on the NNSS are anticipated under the No Action Alternative. See Chapter 4, Section 4.1.8.2.2, of this document for the current (2008) air emissions from onsite stationary sources. Emissions from stationary sources required for the operation of the proposed solar power generation facility are included with the stationary source emissions in the No Action Alternative. Operation emissions for the solar power generation facility are based on the operation of the auxiliary boiler for startup, weekly diesel generator testing, cooling tower operations, HTF ullage system vent, and maintenance vehicles operated at the site.

Emissions from Onsite Government-Owned Vehicles. The MOVES2010 (Version 20100515; EPA 2009) mobile source emissions model was used to estimate annual emission rates due to government vehicle traffic on the NNSS. Section D.1.1.2.1 describes how onsite government-owned vehicle activity data representative of 2008 were derived. PM_{10} and $PM_{2.5}$ emissions from the diesel fueled vehicles are included in the total PM_{10} and $PM_{2.5}$ throughout the analysis. Actions on efforts to mitigate diesel emissions are discussion in Chapter 7, Section 7.9. For the No Action Alternative, these 2008 activity data (vehicle counts and VMTs) were scaled up 9 percent, corresponding to the increase in NNSS employees (including solar power generation facility contractors) for the No Action Alternative compared to the 2008 baseline. The modeling for the No Action Alternative used 2015 as the midpoint year (relative to 2008 baseline year) and the MOVES national default age distributions for each vehicle type to determine the total mobile source emissions. By 2015, all gasoline-type vehicles in this area of Nevada are assumed by MOVES to be run on ethanol blends, while diesel-type vehicles (buses and short-haul trucks) are operating on the same fraction of No. 2 diesel and biodiesel as in 2008.

Table D–32 shows the modeled 2015 annual onsite mobile emissions of criteria pollutants and HAPs associated with NNSS government-owned vehicles under the No Action Alternative. Total onsite emissions from stationary sources are also provided in Table D–32 to show the total onsite emissions from both stationary sources and government-owned vehicle mobile sources. Despite a 9 percent increase in VMTs, these modeled No Action Alternative emissions are about 30 percent lower overall than the 2008 baseline emissions, largely due to improvements in vehicle control technology due to vehicle fleet turnover.

Table D–32 Estimated Annual Emissions of Criteria Pollutants and Hazardous Air Pollutants from Onsite Nevada National Security Site Stationary Sources and Government-Owned Mobile Sources Under the No Action Alternative, 2015 (tons per year)

	Nye County						
	Government-Owned Mobile Source Type (Modeled)						
Pollutant	*Light-Duty Vehicles*	*Light-Duty Passenger Trucks*	*Buses*	*Single-Unit, Short-Haul Trucks*	*Total*	*Stationary Source Type (calculated)*	*Total*
PM_{10}	0.12	0.23	0.097	0.41	0.86	4.0	5.7
$PM_{2.5}$	0.067	0.14	0.092	0.38	0.68	1.4	2.8
CO	9.0	18.6	0.22	1.7	29.5	2.6	61.6
NO_x	0.84	2.5	0.74	3.4	7.5	4.0	19.0
SO_2	0.029	0.05	0.00021	0.0010	0.080	0.21	0.37
VOCs	0.12	0.31	0.0090	0.071	0.51	1.8	2.8
Lead	0.000010	0.000013	7.2×10^{-7}	7.3×10^{-6}	0.000031	<0.03	<0.030
HAPs	0.011	0.028	0.00020	0.0015	0.041	~0.1	~0.18

< = less than; CO = carbon monoxide; HAP = hazardous air pollutant; NO_x = nitrogen oxides; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; VOC = volatile organic compound.

Emissions from Personal Commuter Vehicles. The MOVES2010 (Version 20100515; EPA 2009) mobile source emissions model was used to estimate annual emission rates due to NNSS employees and solar power generation facility contract employees traveling to and from the NNSS in personal vehicles. However, the NNSS bus fleet was calculated separately because, by 2015, the fleet will be using buses that meet the 2010 EPA heavy-duty diesel emission standards.

Section D.1.1.2.1 describes how personal commuter vehicle activity data representative of 2008 were derived. For the No Action Alternative, the 2008 personal commuter vehicle activity data (vehicle counts and VMTs) were scaled up 9 percent, corresponding to the increase in NNSS employees (including solar power generation facility contractors) under the No Action Alternative compared to the 2008 baseline. The number of employee transit buses needed under the No Action Alternative was also scaled up 9 percent from the number needed for the 2008 baseline. The total transit bus VMTs under the No Action Alternative were derived based on the 2008 baseline VMT-per-bus ratio. The modeling for the No Action Alternative used 2015 as the modeling year (compared to the 2008 baseline) and the MOVES national default age distributions for each vehicle type (compared to single). By 2015, all gasoline-type vehicles in this area of Nevada are assumed to be run on ethanol blends

Table D–33 shows the modeled 2015 annual onsite mobile emissions of criteria pollutants and HAPs associated with NNSS employee commuters traveling to and from the NNSS under the No Action Alternative. Despite a 9 percent increase in VMTs, these modeled No Action Alternative emissions are about 37 percent lower overall than the modeled 2008 baseline emissions, largely due to improvements in vehicle control technology resulting from vehicle fleet turnover.

Table D–33 Estimated Annual Emissions of Criteria Pollutants and Hazardous Air Pollutants from Commuting to and from the Nevada National Security Site Under the No Action Alternative, 2015 (tons per year)

	Light-Duty Vehicles			*Light-Duty Passenger Trucks*			*Transit Buses*			*Total*			
		Nye County			*Nye County*			*Nye County*			*Nye County*		
Pollutant	*Clark County*	*Off NNSS*	*On NNSS*	*Clark County*	*Off NNS*	*On NNSS*	*Clark County*	*Off NNSS*	*On NNSS*	*Clark County*	*Off NNSS*	*On NNSS*	*Total*
PM_{10}	0.27	0.081	0.012	0.42	0.13	0.020	0.024	0.0011	0.0083	0.71	0.21	0.040	0.97
$PM_{2.5}$	0.14	0.046	0.007	0.23	0.076	0.012	0.024	0.0011	0.0083	0.39	0.12	0.027	0.54
CO	20.8	5.7	0.87	44.3	13.0	2.0	1.2	0.057	0.43	66.3	18.8	3.3	88.4
NO_x	2.9	0.85	0.13	9.0	2.6	0.39	0.47	0.022	0.17	12.4	3.5	0.69	16.5
SO_2	0.071	0.019	0.0029	0.93	0.025	0.0038	0.011	0.00051	0.0039	1.0	0.045	0.011	1.1
VOCs	0.39	0.12	0.019	1.4	0.40	0.62	N/A	N/A	N/A	1.8	0.52	0.64	2.9
Lead	0.000024	6.7×10^{-6}	1.0×10^{-6}	0.000024	6.7×10^{-6}	1.0×10^{-6}	3.7×10^{-6}	1.7×10^{-7}	1.3×10^{-6}	0.000052	0.000014	3.3×10^{-6}	0.000069
HAPs	0.031	0.011	0.0016	0.11	0.032	0.0049	N/A	N/A	N/A	0.14	0.043	0.0065	0.19

CO = carbon monoxide; HAP = hazardous air pollutant; N/A = not applicable; NNSS = Nevada National Security Site; NO_x = nitrogen oxides; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; VOC = volatile organic compound.

Emissions from Commuter Vehicles Used by Construction Employees. The MOVES2010 (Version 20100515; EPA 2009) mobile source emissions model was used to estimate annual emission rates due to construction employees commuting to and from the NNSS in personal vehicles. The 2010 EPA heavy-duty mobile emission standards were used to estimate nitrogen oxides and PM emissions due to commuters using transit buses. The 2010 standard does not specifically improve carbon monoxide emission standards, but the MOVES model suggests that, by 2015, emissions will improve to about 2.4 grams per mile.

These construction employees were assumed to reside in central-west Las Vegas and to commute an average distance of 66 miles each way to and from the NNSS during weekdays only. Similar to regular NNSS employees, half of the construction employees were assumed to commute via personal vehicles, while the remaining half was assumed to use transit buses. Because new construction is anticipated to take place over the next few years, the modeling for the No Action Alternative used 2011 as the modeling year and the MOVES national default age distributions for each vehicle type. The same passenger-to-bus and VMT-to-bus ratios used for the 2008 baseline were used for the No Action Alternative analysis.

Table D–34 shows the modeled 2011 annual onsite mobile emissions of criteria pollutants and HAPs associated with construction employee commuters traveling to and from the NNSS under the No Action Alternative.

Table D–34 Estimated Annual Emissions of Criteria Pollutants and Hazardous Air Pollutants from Construction Employees Commuting to and from the Nevada National Security Site Under the No Action Alternative, 2015 (tons per year)

	Light-Duty Vehicles			*Light-Duty Passenger Trucks*			*Transit Buses*			*Total*			
		Nye County			*Nye County*			*Nye County*			*Nye County*		
Pollutant	***Clark County***	***Off NNSS***	***On NNSS***	***Clark County***	***Off NNSS***	***On NNSS***	***Clark County***	***Off NNSS***	***On NNSS***	***Clark County***	***Off NNSS***	***On NNSS***	***Total***
PM_{10}	0.044	0.0093	0.0031	0.065	0.013	0.0045	0.0059	0.00028	0.0021	0.11	0.023	0.0097	0.15
$PM_{2.5}$	0.023	0.0056	0.0019	0.035	0.0085	0.0028	0.0059	0.00028	0.0021	0.064	0.014	0.0068	0.085
CO	3.7	0.84	0.28	7.2	1.7	0.57	0.30	0.014	0.11	11.2	2.6	0.96	14.7
NO_x	0.73	0.17	0.058	1.5	0.37	0.12	0.12	0.0055	0.042	2.4	0.55	0.22	3.1
SO_2	0.010	0.0022	0.00072	0.014	0.0029	0.00096	0.0027	0.00013	0.00096	0.027	0.0052	0.0026	0.035
VOCs	0.11	0.026	0.0086	0.29	0.061	0.020	N/A	N/A	N/A	0.40	0.087	0.029	0.52
Lead	2.9×10^{-6}	6.9×10^{-7}	2.3×10^{-7}	2.9×10^{-6}	6.9×10^{-7}	2.3×10^{-7}	9.2×10^{-7}	4.3×10^{-8}	3.2×10^{-7}	6.7×10^{-6}	1.4×10^{-6}	7.8×10^{-7}	8.9×10^{-6}
HAPs	0.0083	0.0021	0.00070	0.021	0.0048	0.0016	N/A	N/A	N/A	0.029	0.0069	0.0023	0.039

CO = carbon monoxide; HAP = hazardous air pollutant; N/A = not applicable; NNSS = Nevada National Security Site; NO_x = nitrogen oxides; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; VOC = volatile organic compound.

Emissions from Commercial Vendor Vehicles. The MOVES2010 (Version 20100515; EPA 2009) mobile source emissions model was used to estimate annual emission rates due to commercial vendors traveling to and from the NNSS. Section D.1.1.2.1 describes how commercial vendor vehicle activity data representative of 2008 were derived. For the No Action Alternative, these 2008 activity data (vehicle counts and VMTs) were scaled up 9 percent, corresponding to the increase in NNSS employees (including solar power generation facility contractors) under the No Action Alternative compared to the 2008 baseline. The modeling for the No Action Alternative used 2015 as the modeling year (compared to the 2008 baseline) and the MOVES national default age distributions for single-unit, short-haul trucks.

Table D–35 shows the modeled 2015 annual onsite mobile emissions of criteria pollutants and HAPs associated with commercial vendors traveling to and from the NNSS under the No Action Alternative. Despite a 9 percent increase in VMTs, these modeled No Action Alternative emissions are about 59 percent lower overall than the modeled 2008 baseline emissions, largely due to improvements in vehicle control technology resulting from vehicle fleet turnover.

Table D–35 Estimated Annual Emissions of Criteria Pollutants and Hazardous Air Pollutants from Commercial Vendors Traveling to and from the Nevada National Security Site Under the No Action Alternative, 2015 (tons per year)

	Single-Unit, Short-Haul Trucks			
		Nye County		
Pollutant	***Clark County***	***Off NNSS***	***On NNSS***	***Total***
PM_{10}	0.096	0.012	0.043	0.15
$PM_{2.5}$	0.078	0.010	0.036	0.12
CO	0.36	0.049	0.17	0.58
NO_x	0.96	0.12	0.43	1.5
SO_2	0.0022	0.00027	0.00095	0.0034
VOCs	0.10	0.014	0.049	0.16
Lead	4.1×10^{-6}	5.6×10^{-7}	2.0×10^{-6}	6.7×10^{-6}
HAPs	0.014	0.0018	0.0064	0.022

CO = carbon monoxide; HAP = hazardous air pollutant; NNSS = Nevada National Security Site; NO_x = nitrogen oxides; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; VOC = volatile organic compound.

Emissions from Radioactive Waste Trucks. The MOVES2010 (Version 20100515; EPA 2009) mobile source emissions model was used to estimate annual emission rates due to radioactive waste trucks traveling to and from the NNSS. Section D.1.1.2.1 describes how radioactive waste truck activity data representative of 2008 were derived. Based on the anticipated radioactive waste projections under the No Action Alternative, these 2008 VMT data were scaled up about 250 percent. The modeling for the No Action Alternative used 2015 as the modeling year (compared to the 2008 baseline) and the MOVES national default age distributions for combination-unit, short-haul trucks.

Table D–36 shows the modeled 2015 annual onsite mobile emissions of criteria pollutants and HAPs associated with commercial vendors traveling to and from the NNSS under the No Action Alternative. Despite about a 250 percent increase in VMTs, these modeled No Action Alternative emissions are about 1 percent lower overall than the modeled 2008 baseline emissions, largely due to improvements in vehicle control technology resulting from vehicle fleet turnover.

Table D–36 Estimated 2015 Annual Emissions of Criteria Pollutants and Hazardous Air Pollutants from Radioactive Waste Trucks Traveling to and from the Nevada National Security Site Under the No Action Alternative (tons per year)

	Combination-Unit, Short-Haul Trucks			
		Nye County		
Pollutant	***Clark County***	***Off NNSS***	***On NNSS***	***Total***
PM_{10}	0.20	0.55	0.031	0.78
$PM_{2.5}$	0.17	0.49	0.027	0.68
CO	0.56	1.6	0.088	2.2
NO_x	2.5	7.2	0.40	10.1
SO_2	0.0056	0.016	0.00088	0.022
VOCs	0.11	0.31	0.017	0.44
Lead	3.5×10^{-6}	0.000011	6.1×10^{-7}	0.000015
HAPs	0.014	0.041	0.0023	0.057

CO = carbon monoxide; HAP = hazardous air pollutant; NNSS = Nevada National Security Site; NO_x = nitrogen oxides; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; VOC = volatile organic compound.

Emissions from Explosive and Open Detonation Tests. Conventional high-explosives experiments are anticipated under the No Action Alternative. These experiments may be conducted underground or at or above the ground surface. The air emissions from these explosive experiments have been estimated based on actual experiments and their associated emissions conducted at BEEF in 2008 (see Table D–2 for the 2008 BEEF emissions).

Under the No Action Alternative, up to 20 conventional high-explosives experiments may be conducted at BEEF per year and up to 10 per year at other Nuclear and High Explosives Test Zone locations, using up to 70,000 TNT [2,4,6-trinitrotoluene]-equivalent pounds of explosives. **Table D–37** shows the estimated emissions from these explosive tests under the No Action Alternative. These emissions were estimated by scaling the 2008 BEEF emissions (when 2.55 tons of explosives were used) up to a maximum of 70,000 pounds of explosives per 12-month period. All modeled concentrations where the general public may have access were modeled to be below the ambient air quality standards.

Table D–37 Estimated Annual Emissions of Criteria Pollutants and Hazardous Air Pollutants from Conventional High-Explosives Experiments Under the No Action Alternative (tons per year) [a]

	Nye County
Pollutant	***On NNSS***
PM_{10}	0.14
$PM_{2.5}$	0.14
CO	2.3
NO_x	0
SO_2	0
VOCs	0.014
Lead	N/A
HAPs	N/A

CO = carbon monoxide; HAP = hazardous air pollutant; N/A = not applicable; NNSS = Nevada National Security Site; NO_x = nitrogen oxides; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; VOC = volatile organic compound.

[a] These emissions may be considered maximum, as they are scaled from the amount of TNT-equivalent explosives used at BEEF in 2008 (2.55 tons) up to 35 tons (70,000 pounds) of TNT-equivalent explosives per 12-month period.

D.2.2.1 Expanded Operations Alternative

D.2.2.1.1 Emissions on and near the Nevada National Security Site

Emissions from Construction Activities. New construction activities at the NNSS under the Expanded Operations Alternative are presented in **Table D–38**.

Table D–38 Summary of All New Buildings Under the Expanded Operations Alternative

Building Type	*Location*	*Approximate Size of Building(s) Floor Space (square feet)*	*Years of Construction*
Miscellaneous New Facilities [a]	Area 17	89,000	4
Arms Control Building	TBD	10,000	3
Counterterrorism Building	TBD	10,000	3
Work for Others Program	Counterterrorism	10,000	3
Work for Others Program	Future Counterterrorism	10,000	3
Work for Others Program Aerial Platforms	Desert Rock Airport	200,000	3
Work for Others Program Aerial Platforms	Area 6 Hangar	20,000	3
Work for Others Program Aerial Platforms	Unknown location	5,000	3
Work for Others Program Active Interrogation of Nuclear Materials	Area 12 or 16	10,000	2
Work for Others Program Test Bed Applications - New Facility	TBD	50,000	3
Waste Management Program New Facility	Area 23	5,000	1
Waste Management Program New Facility for Solar Support	Area 25	5,000	1
Total Size (square feet)		424,400	

TBD = to be determined.
[a] Represents the sum of all new facilities under "Conduct Training for Office of Secure Transportation."

Emissions of PM_{10} due to construction activities were calculated using the Western Regional Air Partnership's (*WRAP) Fugitive Dust Handbook* (WGA 2006). A general emission factor of 0.11 tons of PM_{10} per acre-month was used for all construction activities. Due to the scale of each project, it was estimated that only 10 percent of the total site would be disturbed in any 1-month period. Periodic watering of the disturbed areas would reduce the fugitive dust emissions by 74 percent per WRAP guidance. Equation D–1 was used to determine PM_{10} emissions from new construction activities.

Equation D–1. PM_{10} emissions from general construction activities per year.

PM_{10} EmissionsC = EFC x AcrePerMonth x Months x (1-ContEff) / TotalYears

Where:

PM_{10} EmissionsC = Total PM_{10} emissions per year due to new construction activities under the Expanded Operations Alternative

EFC = Emission factor for general construction activities (0.11 tons PM_{10} per acre-month)

AcrePerMonth = Total acres disturbed per month

Months = Total number of months to complete construction on entire sire (assumed to be 10)

ContEff = Control efficiency of daily water application to disturbed site (0.74)

TotalYears = Total length of construction period in years

Road construction was calculated with an average emission factor of 0.42 tons PM_{10} per acre-month following the WRAP handbook. The number of miles disturbed was calculated using local and minor roads ("Group 4") presented in the WRAP handbook. Equation D–2 is the final equation used to determine PM_{10} emissions from new road construction.

Equation D–2. PM_{10} emissions from road construction activities per year

PM_{10} EmissionsR = EFR x AcrePerMonth x Months x (1-ContEff) / TotalYears

Where:

PM_{10} EmissionsR = Total PM_{10} emissions per year due to new road construction activities under the Expanded Operations Alternative

EFR = Emission factor for road construction activities (0.42 tons PM_{10} per acre-month)

AcrePerMonth = Total acres disturbed per month (assumed to be 10 percent of total disturbed site). Total acres were calculated by multiplying total miles of new road (20 miles) by the miles-to-acres conversion factor (7.9 acres per mile) (WGA 2006).

Months = Total number of months to complete construction on entire sire (assumed to be 10)

ContEff = Control efficiency of daily water application to disturbed site (0.74)

TotalYears = Total length of construction period in years

Emissions from construction vehicles during new construction were scaled from the Caliente Rail Corridor Analysis Report (BSC 2007). Emissions for criteria pollutants were scaled based on the building footprint size (number of square feet).

Construction emissions for the proposed solar power generation facility were scaled based on generating capacity from the *Amargosa Farm Road Solar Energy Project Environmental Impact Statement* (BLM 2010). Emissions for criteria pollutants under construction and operations were also scaled based on generating capacity of the solar power generation facility.

Emissions from Stationary Sources. No specific changes to the operation of established stationary sources on the NNSS are anticipated under the Expanded Operations Alternative. See Chapter 4, Section 4.1.8.2.2, of this document for the current (2008) air emissions from onsite stationary sources. Emissions from stationary sources required for the operation of the proposed solar power generation facility are included with the stationary source emissions under the Expanded Operations Alternative. Operation emissions for the solar power generation facility are based on the operation of the auxiliary boiler for start-up, weekly testing of diesel generators, cooling tower operations, HTF ullage system vent, and maintenance vehicles that operate exclusively onsite at the solar power generation facility.

Emissions from Onsite Government-Owned Vehicles. The MOVES2010 (Version 20100515; EPA 2009) mobile source emissions model was used to estimate annual emission rates due to government vehicle traffic on the NNSS. Section D.1.1.2.1 describes how onsite government-owned vehicle activity data representative of 2008 were derived. For the Expanded Operations Alternative, these 2008 activity data (vehicle counts and VMTs) were scaled up 37 percent, corresponding to the increase in NNSS employees (including solar power generation facility contractors) under the Expanded Operations Alternative compared to the 2008 baseline. The modeling for the Expanded Operations Alternative used 2015 as the modeling year (compared to the 2008 baseline) and the MOVES national default age distributions for each vehicle type (compared to single, averaged age values for the baseline). By 2015, all gasoline-type vehicles in this area of Nevada are assumed to be run on ethanol blends, while diesel-type vehicles are assumed to still consume the same fractions of No. 2 diesel and biodiesel that were determined for the 2008 baseline.

Table D–39 shows the modeled 2015 annual onsite mobile emissions of criteria pollutants and HAPs associated with NNSS government-owned vehicles under the Expanded Operations Alternative. Total onsite emissions from stationary sources (shown in more detail in Table D–3) are also shown in Table D–39 to show the total onsite emissions from both stationary sources and government-owned vehicle mobile sources. Despite a 37 percent increase in VMTs, these modeled Expanded Operations Alternative emissions are about 12 percent lower than the 2008 baseline emissions, largely due to improvements in vehicle control technology due to vehicle fleet turnover.

Emissions from Personal Commuter Vehicles. The MOVES2010 (Version 20100515; EPA 2009) mobile source emissions model was used to estimate annual emission rates due to NNSS employees and solar power generation facility contract employees commuting to and from the NNSS in personal vehicles. The 2010 EPA heavy-duty mobile emission standards were used to estimate nitrogen oxides and PM emissions from NNSS transit buses. The current 15 parts per million standard for sulfur dioxide was assumed to still apply. Section D.1.1.2.1 describes how personal commuter vehicle activity data representative of 2008 were derived.

For the Expanded Operations Alternative, the 2008 personal commuter vehicle activity data (vehicle counts and VMTs) were scaled up 37 percent, corresponding to the increase in NNSS employees (including solar power generation facility contractors) under the Expanded Operations Alternative compared to the 2008 baseline. The number of employee transit buses needed under the Expanded Operations Alternative was also scaled up 37 percent from the number needed for the 2008 baseline. The total transit bus VMTs under the Expanded Operations Alternative were derived based on the 2008 baseline VMT-per-bus ratio. The modeling for the Expanded Operations Alternative used 2015 as the modeling year (compared to the 2008 baseline) and the MOVES national default age distributions for each vehicle type (compared to single, averaged age values for the baseline). By 2015, all gasoline-type vehicles in this area of Nevada are assumed to be run on ethanol blends.

Table D–39 Estimated Annual Emissions of Criteria Pollutants and Hazardous Air Pollutants from Onsite Nevada National Security Site Stationary Sources and Government-Owned Mobile Sources Under the Expanded Operations Alternative, 2015 (tons per year) [a]

	Clark County						
	On NNSS						
	Government-Owned Mobile Source Type (Modeled)					*Stationary Source Type (calculated)*	*Total*
Pollutant	*Light-Duty Vehicles*	*Light-Duty Passenger Trucks*	*Buses*	*Single-Unit, Short-Haul Trucks*	*Total*		
PM_{10}	0.15	0.29	0.12	0.51	1.1	16.2	18.4
$PM_{2.5}$	0.084	0.18	0.12	0.48	0.86	5.1	6.8
CO	11.3	23.4	0.28	2.1	37.1	7.9	82.1
NO_x	1.1	3.1	0.93	4.3	9.4	5.8	24.6
SO_2	0.036	0.063	0.00026	0.0013	0.10	0.68	0.88
VOCs	0.15	0.39	0.011	0.089	0.64	5.6	6.9
Lead	0.000013	0.000016	9.0×10^{-7}	9.2×10^{-6}	0.000039	<0.010	~0.010
HAPs	0.014	0.035	0.00025	0.0019	0.051	~0.1	~0.20

< = less than; ~ = approximately; CO = carbon monoxide; HAP = hazardous air pollutant; NNSS = Nevada National Security Site; NO_x = nitrogen oxides; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; VOC = volatile organic compound.
[a] Government-owned mobile source activities are partitioned by source type.

Table D–40 shows the modeled 2015 annual onsite mobile emissions of criteria pollutants and HAPs associated with NNSS employee commuters traveling to and from the NNSS under the Expanded Operations Alternative. Despite a 37 percent increase in VMTs, these modeled Expanded Operations Alternative emissions are about 21 percent lower overall than the modeled 2008 baseline emissions, largely due to improvements in vehicle control technology due to vehicle fleet turnover.

Emissions from Commuter Vehicles Used by Construction Employees. The MOVES2010 (Version 20100515; EPA 2009) mobile source emissions model was used to estimate annual emission rates due to construction employees commuting to and from the NNSS in personal vehicles. The 2010 EPA heavy-duty mobile emission standards were used to estimate nitrogen oxides and PM emissions due to commuters using transit buses. The current 15 parts per million standard for sulfur dioxide was assumed to still apply.

These construction employees were assumed to reside in central-west Las Vegas and to commute an average distance of 66 miles each way to and from the NNSS during weekdays only. Similar to regular NNSS employees, half of the construction employees were assumed to commute via personal vehicles, while the remaining half was assumed to use transit buses. Because new construction is anticipated to take place over the next few years, the modeling for the Expanded Operations Alternative used 2011 as the modeling year and the MOVES national default age distributions for each vehicle type. The same passenger-to-bus and VMT-to-bus ratios used for the 2008 baseline were used for the Expanded Operations Alternative analysis.

Table D–41 shows the modeled 2011 annual onsite mobile emissions of criteria pollutants and HAPs associated with construction employee commuters traveling to and from the NNSS under the Expanded Operations Alternative.

Table D–40 Estimated Annual Emissions of Criteria Pollutants and Hazardous Air Pollutants from Commuting to and from the Nevada National Security Site Under the Expanded Operations Alternative, 2015 (tons per year)

	Light-Duty Vehicles			*Light-Duty Passenger Trucks*			*Transit Buses*			*Total*			
		Nye County			*Nye County*			*Nye County*			*Nye County*		
Pollutant	*Clark County*	*Off NNSS*	*On NNSS*	*Clark County*	*Off NNSS*	*On NNSS*	*Clark County*	*Off NNSS*	*On NNSS*	*Clark County*	*Off NNSS*	*On NNSS*	*Total*
PM_{10}	0.34	0.10	0.015	0.53	0.16	0.025	0.030	0.0014	0.010	0.89	0.26	0.050	1.2
$PM_{2.5}$	0.18	0.058	0.0088	0.29	0.096	0.015	0.030	0.0014	0.010	0.49	0.15	0.034	0.68
CO	26.1	7.2	1.1	55.7	16.3	2.5	1.5	0.072	0.54	83.3	23.6	4.1	111.1
NO_x	3.6	1.1	0.16	11.3	3.3	0.49	0.59	0.028	0.21	15.6	4.4	0.87	20.7
SO_2	0.089	0.024	0.0036	1.2	0.031	0.0048	0.014	0.00064	0.0049	1.3	0.057	0.014	1.4
VOCs	0.49	0.15	0.024	1.8	0.50	0.78	N/A	N/A	N/A	2.3	0.65	0.80	3.6
Lead	0.000030	8.4×10^{-6}	1.3×10^{-6}	0.000030	8.4×10^{-6}	1.3×10^{-6}	4.7×10^{-6}	2.1×10^{-7}	1.6×10^{-6}	0.000065	0.000018	4.1×10^{-6}	0.000087
HAPs	0.039	0.014	0.0020	0.14	0.040	0.0062	N/A	N/A	N/A	0.18	0.054	0.0082	0.24

CO = carbon monoxide; HAP = hazardous air pollutant; N/A = not applicable; NNSS = Nevada National Security Site; NO_x = nitrogen oxides; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; VOC = volatile organic compound.

Table D–41 Estimated Annual Emissions of Criteria Pollutants and Hazardous Air Pollutants from Construction Employees Commuting to and from the Nevada National Security Site Under the Expanded Operations Alternative, 2011 (tons per year)

	Light-Duty Vehicles			*Light-Duty Passenger Trucks*			*Transit Buses*			*Total*			
		Nye County			*Nye County*			*Nye County*			*Nye County*		
Pollutant	*Clark County*	*Off NNSS*	*On NNSS*	*Clark County*	*Off NNSS*	*On NNSS*	*Clark County*	*Off NNSS*	*On NNSS*	*Clark County*	*Off NNSS*	*On NNSS*	*Total*
PM_{10}	0.066	0.014	0.0047	0.098	0.020	0.0068	0.0089	0.00042	0.0032	0.17	0.035	0.015	0.23
$PM_{2.5}$	0.035	0.0084	0.0029	0.053	0.013	0.0042	0.0089	0.00042	0.0032	0.096	0.021	0.010	0.13
CO	5.6	1.3	0.42	10.8	2.6	0.86	0.45	0.021	0.17	16.8	3.9	1.4	22.1
NO_x	1.1	0.26	0.087	2.3	0.56	0.18	0.18	0.0083	0.063	3.6	0.83	0.33	4.7
SO_2	0.015	0.0033	0.0011	0.021	0.0044	0.0014	0.0041	0.00020	0.0014	0.041	0.0078	0.0039	0.053
VOCs	0.17	0.039	0.013	0.44	0.092	0.030	N/A	N/A	N/A	0.60	0.13	0.044	0.78
Lead	4.4×10^{-6}	1.0×10^{-6}	3.5×10^{-7}	4.4×10^{-6}	1.0×10^{-6}	3.6×10^{-7}	1.4×10^{-6}	6.5×10^{-8}	4.8×10^{-7}	0.000010	2.1×10^{-6}	12×10^{-6}	0.000013
HAPs	0.012	0.0032	0.0011	0.032	0.0072	0.0024	N/A	N/A	N/A	0.044	0.010	0.0035	0.059

CO = carbon monoxide; HAP = hazardous air pollutant; N/A = not applicable; NNSS = Nevada National Security Site; NO_x = nitrogen oxides; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; VOC = volatile organic compound.

Emissions from Commercial Vendor Vehicles. The MOVES2010 (Version 20100515; EPA 2009) mobile source emissions model was used to estimate annual emission rates due to commercial vendors traveling to and from the NNSS. Section D.1.1.2.1 describes how commercial vendor vehicle activity data representative of 2008 were derived. For the Expanded Operations Alternative, these 2008 activity data (vehicle counts and VMTs) were scaled up 37 percent, corresponding to the increase in NNSS employees (including solar power generation facility contractors) for the Expanded Operations Alternative compared to the 2008 baseline. The modeling for the Expanded Operations Alternative used 2015 as the modeling year (compared to the 2008 baseline) and the MOVES national default age distributions for single-unit, short-haul trucks (compared to a single, averaged age value for the baseline).

Table D–42 shows the modeled 2015 annual onsite mobile emissions of criteria pollutants and HAPs associated with commercial vendors traveling to and from the NNSS under the Expanded Operations Alternative. Despite a 37 percent increase in VMTs, these modeled Expanded Operations Alternative emissions are about 49 percent lower overall than the modeled 2008 baseline emissions, largely due to improvements in vehicle control technology due to vehicle fleet turnover.

Table D–42 Estimated Annual Emissions of Criteria Pollutants and Hazardous Air Pollutants from Commercial Vendors Traveling to and from the Nevada National Security Site Under the Expanded Operations Alternative, 2015 (tons per year)

	Single-Unit, Short-Haul Trucks			
		Nye County		
Pollutant	***Clark County***	***Off NNSS***	***On NNSS***	***Total***
PM_{10}	0.12	0.015	0.054	0.19
$PM_{2.5}$	0.098	0.013	0.045	0.16
CO	0.45	0.062	0.21	0.72
NO_x	1.2	0.15	0.54	1.9
SO_2	0.0028	0.00034	0.0012	0.0043
VOCs	0.13	0.018	0.062	0.21
Lead	5.2×10^{-6}	7.0×10^{-7}	2.6×10^{-6}	8.4×10^{-6}
HAPs	0.018	0.0023	0.0080	0.028

CO = carbon monoxide; HAP = hazardous air pollutant; NNSS = Nevada National Security Site; NO_x = nitrogen oxides; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; VOC = volatile organic compound.

Emissions from Radioactive Waste Trucks. The MOVES2010 (Version 20100515; EPA 2009) mobile source emissions model was used to estimate annual emission rates due to radioactive waste trucks traveling to and from the NNSS. Section D.1.1.2.1 describes how radioactive waste truck activity data representative of 2008 were derived. The same number of trucks (12) was used for both the 2008 baseline and the Expanded Operations Alternative. Based on the anticipated radioactive waste needs under the Expanded Operations Alternative, these 2008 VMT data were scaled up about 550 percent. The modeling for the Expanded Operations Alternative used 2015 as the modeling year (compared to 2008 for the baseline) and the MOVES national default age distributions for combination-unit, short-haul trucks (compared to a single, averaged age value for the baseline).

Table D–43 shows the modeled 2015 annual onsite mobile emissions of criteria pollutants and HAPs associated with commercial vendors traveling to and from the NNSS under the Expanded Operations Alternative. Despite about a 550 percent increase in VMTs, these modeled Expanded Operations Alternative emissions increased by 88 percent overall compared to the modeled 2008 baseline emissions, largely due to improvements in vehicle control technology due to vehicle fleet turnover.

Table D–43 Estimated Annual Emissions of Criteria Pollutants and Hazardous Air Pollutants from Radioactive Waste Trucks Traveling to and from the Nevada National Security Site Under the Expanded Operations Alternative, 2015 (tons per year)

	Combination-Unit, Short-Haul Trucks			
		Nye County		
Pollutant	***Clark County***	***Off NNSS***	***On NNSS***	***Total***
PM_{10}	0.37	1.0	0.058	1.5
$PM_{2.5}$	0.32	0.91	0.05	1.3
CO	1.0	3.0	0.16	4.1
NO_x	4.6	13.3	0.74	18.8
SO_2	0.010	0.03	0.0016	0.041
VOCs	0.20	0.58	0.032	0.82
Lead	6.5×10^{-6}	0.000020	1.1×10^{-6}	0.000028
HAPs	0.026	0.076	0.0043	0.11

CO = carbon monoxide; HAP = hazardous air pollutant; NNSS = Nevada National Security Site; NO_x = nitrogen oxides; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; VOC = volatile organic compound.

Emissions from Explosive and Open Detonation Tests. The dynamic experiments anticipated under the Expanded Operations Alternative would use considerably less explosive material than was used at BEEF in 2008. These experiments also would be underground, with little to no air releases. Thus, air emissions from these dynamic experiments are anticipated to be much less than those from BEEF in 2008 (see Table D–3 for 2008 BEEF emissions).

Up to 100 annual conventional high-explosives tests and experiments may be conducted at Nuclear and High Explosives Test Zone locations, using up to 120,000 TNT-equivalent pounds of explosives (with no more than 70,000 TNT-equivalent pounds of explosives used at BEEF). **Table D–44** shows the estimated emissions from these explosive tests under the Expanded Operations Alternative. These emissions were estimated by scaling the 2008 BEEF emissions (when 2.55 tons of explosives were used) up to a maximum of 120,000 pounds of explosives per 12-month period. The modeled maximum offsite concentrations were: 24-hour average PM_{10} concentration (about 84 micrograms per cubic meter), 24-hour average $PM_{2.5}$ concentration (about 15 micrograms per cubic meter), and annual average $PM_{2.5}$ concentration (less than 1 microgram per cubic meter), all of which would likely occur a few miles east of the Amargosa Valley, but would be well below their respective NAAQS levels (150 micrograms per cubic meter, 35 micrograms per cubic meter, and 15 micrograms per cubic meter, respectively). Even when combined with background concentrations of 39 micrograms per cubic meter, 3.6 micrograms per cubic meter, and 2.0 micrograms per cubic meter, respectively, these offsite concentrations would still be well below NAAQS levels.

Table D–44 Estimated Annual Emissions of Criteria Pollutants and Hazardous Air Pollutants from Nevada National Security Site Conventional High-Explosives Tests Under the Expanded Operations Alternatives (tons per year) [a]

Pollutant	*Nye County*
	On NNSS
PM_{10}	0.24
$PM_{2.5}$	0.24
CO	4
NO_x	0
SO_2	0
VOCs	0.024
Lead	Not applicable
HAPs	Not applicable

CO = carbon monoxide; HAP = hazardous air pollutant; NNSS = Nevada National Security Site; NO_x = nitrogen oxides; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; VOC = volatile organic compound.

[a] These emissions may be considered “worst-case” because they are scaled from the amount of TNT-equivalent explosives used at BEEF in 2008 (2.55 tons) up to 60 tons (120,000 pounds) of TNT-equivalent explosives per 12-month period.

D.2.2.2 Reduced Operations Alternative

D.2.2.2.1 Emissions on and near the Nevada National Security Site

Emissions from Construction Activities. Construction emissions for the proposed solar power generation facility were scaled from the Amargosa Farm Road Solar Energy Project Environmental Impact Statement (BLM 2010). Emissions for criteria pollutants under construction and operations were scaled based on total energy output of the solar power generation facility.

Emissions from Stationary Sources. No specific changes to the operation of stationary sources on the NNSS are anticipated under the Reduced Operations Alternative. See Chapter 4, Section 4.1.8.2.2, of this document for the current (2008) air emissions from onsite stationary sources.

Emissions from Onsite Government-Owned Vehicles. The MOVES2010 (Version 20100515; EPA 2009) mobile source emissions model was used to estimate annual emission rates due to government vehicle traffic on the NNSS. For the Reduced Operations Alternative, these 2008 activity data (vehicle counts and VMTs) were scaled down by 3 percent, corresponding to the decrease in NNSS employees (including solar power generation facility contractors) for the Reduced Operations Alternative compared to the 2008 baseline. The modeling for the Reduced Operations Alternative used 2015 as the modeling year (compared to the 2008 baseline) and the MOVES national default age distributions for each vehicle type (compared to single, averaged age values for the baseline). By 2015, all gasoline-type vehicles in this area of Nevada are assumed to be run on ethanol blends, while diesel-type vehicles are assumed to still consume the same fractions of No. 2 diesel and biodiesel that were determined for the 2008 baseline.

Table D–45 shows the modeled 2015 annual onsite mobile emissions of criteria pollutants and HAPs associated with NNSS government-owned vehicles under the Reduced Operations Alternative. Total onsite emissions from stationary sources are provided in Table D–45 to show the total onsite emissions from both stationary sources and government-owned vehicle mobile sources. Despite only a 3 percent decrease in VMTs, these modeled Reduced Operations Alternative emissions are about 38 percent lower overall than the modeled 2008 baseline emissions, largely due to improvements in vehicle control technology due to vehicle fleet turnover.

Table D–45 Estimated Annual Emissions of Criteria Pollutants and Hazardous Air Pollutants from Onsite Nevada National Security Site Stationary Sources and Government-Owned Mobile Sources Under the Reduced Operations Alternative, 2015 (tons per year) [a]

Pollutant	*Clark County*						
	On NNSS						
	Government-Owned Mobile Source Type (Modeled)					*Stationary Source Type (calculated)*	*Total*
	Light-Duty Vehicles	*Light-Duty Passenger Trucks*	*Buses*	*Single-Unit, Short-Haul Trucks*	*Total*		
PM_{10}	0.11	0.20	0.086	0.36	0.77	0.22	0.98
$PM_{2.5}$	0.060	0.12	0.082	0.34	0.61	0.22	0.82
CO	8.0	16.6	0.20	1.5	26.3	0.94	27.2
NO_x	0.75	2.2	0.66	3.0	6.7	3.36	10.0
SO_2	0.026	0.044	0.00019	0.00089	0.071	0.06	0.13
VOCs	0.11	0.28	0.0080	0.063	0.45	0.60	1.1
Lead	8.9×10^{-6}	0.000012	6.4×10^{-7}	6.5×10^{-6}	0.000028	0.0023	0.0023
HAPs	0.0098	0.025	0.00018	0.0013	0.036	0.09	0.13

CO = carbon monoxide; HAP = hazardous air pollutant; NNSS = Nevada National Security Site; NO_x = nitrogen oxides; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; VOC = volatile organic compound.

[a] Government-owned mobile source activities are partitioned by source type. The source type partitioning of stationary source activities is shown in Table D–2.

Emissions from Personal Commuter Vehicles. The MOVES2010 (Version 20100515; EPA 2009) mobile source emissions model was used to estimate annual emission rates due to NNSS employees and solar power generation facility contract employees traveling to and from the NNSS in personal commuter vehicles. The 2010 EPA heavy-duty mobile emission standards were used to estimate emissions for commuters using transit buses.

Section D.1.1.2.1 describes how the personal commuter vehicle activity data representative of 2008 were derived. For the Reduced Operations Alternative, the 2008 personal commuter vehicle activity data (vehicle counts and VMTs) were scaled down by 3 percent, corresponding to the decrease in NNSS employees (including solar power generation facility contractors) under the Reduced Operations Alternative compared to the 2008 baseline. The number of employee transit buses needed under the Reduced Operations Alternative was also scaled down by 3 percent from the number needed for the 2008 baseline. The total transit bus VMTs under the Reduced Operations Alternative were derived based on the 2008 baseline VMT-per-bus ratio. The modeling for the Reduced Operations Alternative used 2015 as the modeling year (compared to the 2008 baseline) and the MOVES national default age distributions for each vehicle type. By 2015, all gasoline-type vehicles in this area of Nevada are assumed by MOVES to be run on ethanol blends.

Table D–46 shows the modeled 2015 annual onsite mobile emissions of criteria pollutants and HAPs associated with NNSS employee commuters traveling to and from the NNSS under the Reduced Operations Alternative. Despite only a 3 percent decrease in VMTs, these modeled Reduced Operations Alternative emissions are about 43 percent smaller overall than the modeled 2008 baseline emissions, largely due to improvements in vehicle control technology due to vehicle fleet turnover.

Table D–46 Estimated Annual Emissions of Criteria Pollutants and Hazardous Air Pollutants from Commuting to and from the Nevada National Security Site Under the Reduced Operations Alternative, 2015 (tons per year)

Pollutant	*Light-Duty Vehicles*			*Light-Duty Passenger Trucks*			*Transit Buses*			*Total*			
		Nye County			*Nye County*			*Nye County*			*Nye County*		
	Clark County	*Off NNSS*	*On NNSS*	*Clark County*	*Off NNSS*	*On NNSS*	*Clark County*	*Off NNSS*	*On NNSS*	*Clark County*	*Off NNSS*	*On NNSS*	*Total*
PM_{10}	0.24	0.072	0.011	0.38	0.12	0.018	0.021	0.00098	0.0074	0.64	0.19	0.036	0.87
$PM_{2.5}$	0.13	0.041	0.0063	0.21	0.068	0.011	0.021	0.00098	0.0074	0.35	0.11	0.024	0.48
CO	18.6	5.1	0.78	39.6	11.6	1.8	1.1	0.051	0.38	59.3	16.8	3.0	79.0
NO_x	2.6	0.76	0.12	8.1	2.3	0.35	0.42	0.020	0.15	11.1	3.1	0.62	14.8
SO_2	0.064	0.017	0.0026	0.083	0.022	0.0034	0.0098	0.00046	0.0035	0.16	0.040	0.0098	0.21
VOCs	0.35	0.11	0.017	1.3	0.36	0.55	N/A	N/A	N/A	1.6	0.47	0.57	2.6
Lead	0.000021	6.0×10^{-6}	8.9×10^{-7}	0.000021	6.0×10^{-6}	8.9×10^{-7}	3.3×10^{-6}	1.5×10^{-7}	1.2×10^{-6}	0.000047	0.000013	3.0×10^{-6}	0.000062
HAPs	0.028	0.0098	0.0014	0.098	0.029	0.0044	N/A	N/A	N/A	0.13	0.038	0.0058	0.17

CO = carbon monoxide; HAP = hazardous air pollutant; N/A = not applicable; NNSS = Nevada National Security Site; NO_x = nitrogen oxides; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; VOC = volatile organic compound.

Emissions from Commuter Vehicles Used by Construction Employees. The MOVES2010 (Version 20100515; EPA 2009) mobile source emissions model was used to estimate annual emission rates due to construction employees commuting to and from the NNSS in personal vehicles. It was assumed that the NNSS transit buses would comply with the 2010 EPA heavy-duty diesel mobile emission standards.

The construction employees were assumed to reside in central-west Las Vegas and to commute an average distance of 66 miles each way to and from the NNSS during weekdays only. Similar to regular NNSS employees, half of the construction employees were assumed to commute via personal vehicles, while the remaining half was assumed to use transit buses. Because new construction is anticipated to take place over the next few years, the modeling for the Reduced Operations Alternative used 2011 as the modeling year and the MOVES national default age distributions for each vehicle type. The same passenger-to-bus and VMT-to-bus ratios used for the 2008 baseline were used for the Reduced Operations Alternative analysis.

Table D–47 shows the modeled 2011 annual onsite mobile emissions of criteria pollutants and HAPs associated with construction employee commuters traveling to and from the NNSS under the Reduced Operations Alternative.

Emissions from Commercial Vendor Vehicles. The MOVES2010 (Version 20100515; EPA 2009) mobile source emissions model was used to estimate annual emission rates due to commercial vendors traveling to and from the NNSS. Section D.1.1.2.1 describes how commercial vendor vehicle activity data representative of 2008 were derived. For the Reduced Operations Alternative, these 2008 activity data (vehicle counts and VMTs) were scaled down by 3 percent, corresponding to the decrease in NNSS employees (including solar power generation facility contractors) under the Reduced Operations Alternative compared to the 2008 baseline. The modeling for the Reduced Operations Alternative used 2015 as the modeling year (compared to the 2008 baseline) and the MOVES national default age distributions for single-unit, short-haul trucks (compared to a single, averaged age value for the baseline).

Table D–48 shows the modeled 2015 annual onsite mobile emissions of criteria pollutants and HAPs associated with commercial vendors traveling to and from the NNSS under the Reduced Operations Alternative. Despite only a 3 percent decrease in VMTs, these modeled Reduced Operations Alternative emissions are about 63 percent lower overall than the modeled 2008 baseline emissions, largely due to improvements in vehicle control technology resulting from vehicle fleet turnover.

Table D–47 Estimated Annual Emissions of Criteria Pollutants and Hazardous Air Pollutants from Construction Employees Commuting to and from the Nevada National Security Site Under the Reduced Operations Alternative, 2011 (tons per year)

	Light-Duty Vehicles			***Light-Duty Passenger Trucks***			***Transit Buses***			***Total***			
		Nye County			***Nye County***			***Nye County***			***Nye County***		
Pollutant	***Clark County***	***Off NNSS***	***On NNSS***	***Clark County***	***Off NNSS***	***On NNSS***	***Clark County***	***Off NNSS***	***On NNSS***	***Clark County***	***Off NNSS***	***On NNSS***	***Total***
PM_{10}	0.035	0.0074	0.0025	0.052	0.010	0.0036	0.0047	0.00022	0.0017	0.088	0.018	0.0078	0.12
$PM_{2.5}$	0.018	0.0045	0.0015	0.028	0.0068	0.0022	0.0047	0.00022	0.0017	0.051	0.011	0.0054	0.068
CO	3.0	0.67	0.22	5.8	1.4	0.46	0.24	0.011	0.088	9.0	2.1	0.77	11.8
NO_x	0.58	0.14	0.046	1.2	0.30	0.096	0.096	0.0044	0.034	1.9	0.44	0.18	2.5
SO_2	0.0080	0.0018	0.00058	0.011	0.0023	0.00077	0.0022	0.00010	0.00077	0.022	0.0042	0.0021	0.028
VOCs	0.088	0.021	0.0069	0.23	0.049	0.016	N/A	N/A	N/A	0.32	0.070	0.023	0.42
Lead	2.3×10^{-6}	5.5×10^{-7}	1.8×10^{-7}	2.3×10^{-6}	5.5×10^{-7}	1.8×10^{-7}	7.4×10^{-7}	3.4×10^{-8}	2.6×10^{-7}	5.4×10^{-6}	1.1×10^{-6}	6.2×10^{-7}	7.1×10^{-6}
HAPs	0.0066	0.0017	0.0056	0.017	0.0038	0.0013	N/A	N/A	N/A	0.023	0.0055	0.0018	0.031

CO = carbon monoxide; HAP = hazardous air pollutant; N/A = not applicable; NNSS = Nevada National Security Site; NO_x = nitrogen oxides; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; VOC = volatile organic compound.

Table D–48 Estimated Annual Emissions of Criteria Pollutants and Hazardous Air Pollutants from Commercial Vendors Traveling to and from the Nevada National Security Site Under the Reduced Operations Alternative, 2015 (tons per year)

	Single-Unit, Short-Haul Trucks			
		Nye County		
Pollutant	***Clark County***	***Off NNSS***	***On NNSS***	***Total***
PM_{10}	0.086	0.011	0.038	0.14
$PM_{2.5}$	0.070	0.0089	0.032	0.11
CO	0.32	0.044	0.15	0.51
NO_x	0.86	0.11	0.38	1.4
SO_2	0.0020	0.00024	0.00085	0.0031
VOCs	0.089	0.013	0.044	0.15
Lead	3.7×10^{-6}	5.0×10^{-7}	1.8×10^{-6}	6.0×10^{-6}
HAPs	0.013	0.0016	0.0057	0.020

CO = carbon monoxide; HAP = hazardous air pollutant; NNSS = Nevada National Security Site; NO_x = nitrogen oxides; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; VOC = volatile organic compound.

Emissions from Radioactive Waste Trucks. The MOVES2010 (Version 20100515; EPA 2009) mobile source emissions model was used to estimate annual emission rates due to radioactive waste trucks traveling to and from the NNSS. See Section D.1.1.2.1 for more details on how the radioactive waste truck activity data representative of 2008 were derived. The same number of trucks (12) was used for both the 2008 baseline and the Reduced Operations Alternative. Based on the anticipated radioactive waste needs under the Reduced Operations Alternative, these 2008 VMT data were scaled up about 240 percent in Clark County and in the portion of Nye County outside of the NNSS. The modeling for the Reduced Operations Alternative used 2015 as the modeling year (compared to the 2008 baseline) and the MOVES national default age distributions for combination-unit, short-haul trucks (compared to a single, averaged age value for the baseline).

Table D–49 shows the modeled 2015 annual onsite mobile emissions of criteria pollutants and HAPs associated with commercial vendors traveling to and from the NNSS under the Reduced Operations Alternative. Despite the 240 percent increase in VMTs, these modeled Reduced Operations Alternative emissions decreased by 2 percent overall compared to the modeled 2008 baseline emissions, largely due to improvements in vehicle control technology resulting from vehicle fleet turnover.

Table D–49 Estimated Annual Emissions of Criteria Pollutants and Hazardous Air Pollutants from Radioactive Waste Trucks Traveling to and from the Nevada National Security Site Under the Reduced Operations Alternative, 2015 (tons per year)

	Combination-Unit, Short-Haul Trucks			
		Nye County		
Pollutant	***Clark County***	***Off NNSS***	***On NNSS***	***Total***
PM_{10}	0.19	0.54	0.03	0.76
$PM_{2.5}$	0.17	0.48	0.026	0.67
CO	0.54	1.6	0.088	2.2
NO_x	2.4	7.0	0.39	9.7
SO_2	0.0054	0.016	0.00088	0.022
VOCs	0.11	0.30	0.017	0.42
Lead	3.4×10^{-6}	0.000011	6.1×10^{-7}	0.000015
HAPs	0.014	0.040	0.0023	0.056

CO = carbon monoxide; HAP = hazardous air pollutant; NNSS = Nevada National Security Site; NO_x = nitrogen oxides; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; VOC = volatile organic compound.

Emissions from Explosive and Open Detonation Tests. The dynamic experiments anticipated under the Reduced Operations Alternative would use considerably less explosive material than was used at BEEF in 2008. These experiments also would be underground, with little to no air releases. Thus, air emissions from these dynamic experiments are anticipated to be much less than those from BEEF in 2008 (see Table D–3 for 2008 BEEF emissions).

Up to 10 annual conventional high-explosives tests and experiments may be conducted at Nuclear and High Explosives Test Zone locations, using up to 70,000 TNT-equivalent pounds of explosives. If the full 70,000 TNT-equivalent pounds of explosives were used at BEEF, the limit on total annual explosive tonnage at any one location (32 tons) would be in place. **Table D–50** shows the estimated emissions from these explosive tests under the Reduced Operations Alternative. These emissions were estimated by scaling the 2008 BEEF emissions (when 2.55 tons of explosives were used) up to a maximum of 70,000 pounds of explosives per 12-month period. The same maximum PM_{10} and $PM_{2.5}$ air concentrations modeled for BEEF in Section D.1.1.2 would apply for this Reduced Operations Alternative scenario. All modeled radiation exposures in locations accessible to the public would be well below NAAQS levels.

Table D–50 Estimated Annual Emissions of Criteria Pollutants and Hazardous Air Pollutants from the Nevada National Security Site Conventional High-Explosives Tests (tons per year) [a]

Pollutant	*Nye County*
	On NNSS
PM_{10}	0.14
$PM_{2.5}$	0.14
CO	2.3
NO_x	0
SO_2	0
VOCs	0.014
Lead	N/A
HAPs	N/A

CO = carbon monoxide; HAP = hazardous air pollutant; N/A = not applicable; NNSS = Nevada National Security Site; NO_x = nitrogen oxides; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; VOC = volatile organic compound.

[a] These emissions may be considered "worst-case," as they are scaled from the amount of TNT-equivalent explosives used at BEEF in 2008 (2.55 tons) up to 35 tons (70,000 pounds) of TNT-equivalent explosives per 12-month period.

D.2.3 Remote Sensing Laboratory

D.2.3.1 No Action Alternative

D.2.3.1.1 Emissions on and near the Remote Sensing Laboratory

Emissions from Stationary Sources. No specific changes to the operation of stationary sources on RSL are anticipated under the No Action Alternative. See Chapter 4, Section 4.2.8.2.2, of this document for the current (2008) air emissions from onsite stationary sources.

Emissions from Aircraft-Related Sources. No specific changes the operation of aircraft-related sources on RSL are anticipated under the No Action Alternative. See Chapter 4, Section 4.2.8.2.2, of this document for the current (2008) air emissions from aircraft-related sources.

Emissions from Commuter Vehicles. The MOVES2010 (Version 20100515; EPA 2009) mobile source emissions model was used to estimate annual emission rates due to RSL employees traveling to and from RSL in personal vehicles.

For the No Action Alternative, the 2008 personal vehicle activity data (vehicle counts and VMTs) were used because no change in the number of employees is anticipated under this alternative. The modeling for the No Action Alternative used 2015 as the midpoint modeling year (compared to the 2008 baseline) and the MOVES national default age distributions for each vehicle type. By 2015, all gasoline-type vehicles in this area of Nevada are assumed to be run on ethanol blends.

Table D–51 shows the modeled 2015 annual onsite mobile emissions of criteria pollutants and HAPs associated with RSL employee commuters traveling to and from RSL under the No Action Alternative. Even with the same VMT, mobile emissions decrease under the No Action Alternative by about 13 percent overall compared to the modeled 2008 baseline emissions, largely due to improvements in vehicle control technology resulting from vehicle fleet turnover.

Table D–51 Estimated Annual Emissions of Criteria Pollutants and Hazardous Air Pollutants from Commuting to and from the Remote Sensing Laboratory Under the No Action Alternative, 2015 (tons per year)

Pollutant	*Light-Duty Vehicles*	*Light-Duty Passenger Trucks*	*Total*
	Clark County		
	Off RSL		
PM_{10}	0.012	0.018	0.030
$PM_{2.5}$	0.0061	0.010	0.016
CO	0.91	1.9	2.8
NO_x	0.13	0.4	0.53
SO_2	0.0031	0.0041	0.0072
VOCs	0.017	0.062	0.079
Lead	1.0×10^{-6}	1.0×10^{-6}	2.0×10^{-6}
HAPs	0.0014	0.0046	0.0060

CO = carbon monoxide; HAP = hazardous air pollutant; NO_x = nitrogen oxides; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; RSL = Remote Sensing Laboratory; SO_2 = sulfur dioxide; VOC = volatile organic compound.

Emissions from Commercial Vendor Vehicles. The MOVES2010 (Version 20100515; EPA 2009) mobile source emissions model was used to estimate annual emission rates due to commercial vendors traveling to and from RSL.

For the No Action Alternative, these 2008 activity data (vehicle counts and VMTs) were used because no change in the number of employees is anticipated under this alternative. The modeling for the No Action Alternative used 2015 as the midpoint modeling year (compared to the 2008 baseline) and the MOVES national default age distributions for single-unit, short-haul trucks.

Table D–52 shows the modeled 2015 annual onsite mobile emissions of criteria pollutants and HAPs associated with commercial vendors traveling to and from RSL under the No Action Alternative. Despite the same VMT, these modeled No Action Alternative emissions are about 63 percent lower overall than the modeled 2008 baseline emissions, largely due to improvements in vehicle control technology due to vehicle fleet turnover.

Table D–52 Estimated Annual Emissions of Criteria Pollutants and Hazardous Air Pollutants from Commercial Vendors Traveling to and from Remote Sensing Laboratory Under the No Action Alternative, 2015 (tons per year)

Pollutant	*Single-Unit, Short-Haul Trucks* – *Clark County* – *Off RSL*
PM_{10}	0.016
$PM_{2.5}$	0.013
CO	0.060
NO_x	0.16
SO_2	0.00036
VOCs	0.017
Lead	6.8×10^{-7}
HAPs	0.0023

CO = carbon monoxide; HAP = hazardous air pollutant; NO_x = nitrogen oxides; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; RSL = Remote Sensing Laboratory; SO_2 = sulfur dioxide; VOC = volatile organic compound.

D.2.4 North Las Vegas Facility

D.2.4.1 No Action Alternative

D.2.4.1.1 Emissions on and near the North Las Vegas Facility

Emissions from Stationary Sources. No specific changes to the operation of stationary sources on NLVF are anticipated under the No Action Alternative. See Chapter 4, Section 4.3.8.2.2, of this document for the current (2008) air emissions from onsite stationary sources.

Emissions from Commuter Vehicles. The MOVES2010 (Version 20100515; EPA 2009) mobile source emissions model was used to estimate annual emission rates due to NLVF employees traveling to and from NLVF in personal vehicles.

For the No Action Alternative, the 2008 personal vehicle activity data (vehicle counts and VMTs) were scaled up 1 percent, corresponding to the increase in NLVF employees for the No Action Alternative compared to the 2008 baseline. The modeling for the No Action Alternative used 2015 as the modeling year (compared to the 2008 baseline) and used national default age distributions for each vehicle type. By 2015, all gasoline-type vehicles in this area of Nevada are assumed to be run on ethanol blends.

Table D–53 shows the modeled 2015 annual onsite mobile emissions of criteria pollutants and HAPs associated with NLVF employee commuters traveling to and from NLVF under the No Action Alternative. Despite a small increase in VMTs, these modeled No Action Alternative emissions are about 11 percent lower overall than the modeled 2008 baseline emissions, largely due to improvements in vehicle control technology resulting from vehicle fleet turnover.

Table D–53 Estimated Annual Emissions of Criteria Pollutants and Hazardous Air Pollutants from Commuting to and from the North Las Vegas Facility Under the No Action Alternative, 2015 (tons per year)

	Light-Duty Vehicles		*Light-Duty Passenger Trucks*		*Total*		
	Clark County	*Nye County*	*Clark County*	*Nye County*	*Clark County*	*Nye County*	
Pollutant	*Off NLVF*	*Off NNSS*	*Off NLVF*	*Off NNSS*	*Off NLVF*	*Off NNSS*	*Total*
PM_{10}	0.099	0.00063	0.15	0.00097	0.25	0.0016	0.25
$PM_{2.5}$	0.051	0.00036	0.085	0.00059	0.14	0.00095	0.14
CO	7.6	0.044	16.2	0.10	23.8	0.14	23.9
NO_x	1.1	0.0066	3.3	0.020	4.4	0.027	4.4
SO_2	0.026	0.00015	0.034	0.00019	0.060	0.00034	0.060
VOCs	0.14	0.00095	0.52	0.0031	0.66	0.0041	0.66
Lead	8.6×10^{-6}	5.2×10^{-8}	8.6×10^{-6}	5.2×10^{-8}	0.000017	1.0×10^{-7}	0.000017
HAPs	0.011	0.000082	0.038	0.00025	29.2	0.17	0.049

CO = carbon monoxide; HAP = hazardous air pollutant; NLVF = North Las Vegas Facility; NNSS = Nevada National Security Site; NO_x = nitrogen oxides; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; VOC = volatile organic compound.

Emissions from Commercial Vendor Vehicles. The MOVES2010 (Version 20100515; EPA 2009) mobile source emissions model was used to estimate annual emission rates due to commercial vendors traveling to and from NLVF.

See Section D.1.3.2.1 for more details on how the commercial vendor vehicle activity data representative of 2008 were derived. For the No Action Alternative, these 2008 activity data (vehicle counts and VMTs) were scaled up 1 percent, corresponding to the increase in NLVF employees for the No Action Alternative compared to the 2008 baseline. The modeling for the No Action Alternative used 2015 as the modeling year (compared to the 2008 baseline) using the MOVES model with the national default age distribution.

Table D–54 shows the modeled 2015 annual onsite mobile emissions of criteria pollutants and HAPs associated with commercial vendors traveling to and from NLVF under the No Action Alternative. Despite a small increase in VMTs, these modeled No Action Alternative emissions are about 62 percent lower overall than the modeled 2008 baseline emissions, largely due to improvements in vehicle control technology due to vehicle fleet turnover.

Table D–54 Estimated Annual Emissions of Criteria Pollutants and Hazardous Air Pollutants from Commercial Vendors Traveling to and from North Las Vegas Facility Under the No Action Alternative, 2015 (tons per year)

	Single-Unit, Short-Haul Trucks
	Clark County
Pollutant	*Off NLVF*
PM_{10}	0.069
$PM_{2.5}$	0.057
CO	0.26
NO_x	0.70
SO_2	0.0016
VOCs	0.076
Lead	3.0×10^{-6}
HAPs	0.01

CO = carbon monoxide; HAP = hazardous air pollutant; NLVF = North Las Vegas Facility; NO_x = nitrogen oxides; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; VOC = volatile organic compound.

Emissions from Radioactive Waste Vehicles. The MOVES2010 (Version 20100515; EPA 2009) mobile source emissions model was used to estimate annual emission rates due to radioactive waste trucks traveling to and from NLVF.

See Section D.1.3.2.1 for more details on how the radioactive waste truck activity data representative of 2008 were derived. The same number of trucks was used for the 2008 baseline and the No Action Alternative. For the No Action Alternative, the 2008 VMTs were scaled up 1 percent, corresponding to the increase in NLVF employees for the No Action Alternative compared to the 2008 baseline. The modeling for the No Action Alternative used 2015 as the modeling year (compared to the 2008 baseline) and the MOVES national default age distributions.

Table D–55 shows the modeled 2015 annual onsite mobile emissions of criteria pollutants and HAPs associated with radioactive waste trucks traveling to and from NLVF under the No Action Alternative. Despite a small increase in VMTs, these modeled No Action Alternative emissions are about 71 percent lower overall than the modeled 2008 baseline emissions, largely due to improvements in vehicle control technology resulting from vehicle fleet turnover.

Table D–55 Estimated Annual Emissions of Criteria Pollutants and Hazardous Air Pollutants from Radioactive Waste Trucks Traveling to and from the North Las Vegas Facility Under the No Action Alternative, 2015 (tons per year)

	Combination-Unit, Short-Haul Trucks			
	Clark County	*Nye County*		
Pollutant	***Off NLVF***	***Off NNSS***	***On NNSS***	***Total***
PM_{10}	0.0017	0.00015	0.00010	0.0020
$PM_{2.5}$	0.0014	0.00013	0.000090	0.0016
CO	0.0046	0.00045	0.00030	0.0054
NO_x	0.021	0.0020	0.0013	0.024
SO_2	0.000046	4.4×10^{-6}	2.0×10^{-6}	0.000053
VOCs	0.00091	0.000086	0.000057	0.0011
Lead	2.9×10^{-8}	3.0×10^{-9}	2.0×10^{-9}	3.4×10^{-8}
HAPs	0.00012	0.000011	0.0000076	0.00014

CO = carbon monoxide; HAP = hazardous air pollutant; NLVF = North Las Vegas Facility; NNSS = Nevada National Security Site; NO_x = nitrogen oxides; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; VOC = volatile organic compound.

D.2.4.2 Expanded Operations Alternative

D.2.4.2.1 Emissions on and near the North Las Vegas Facility

Emissions from Stationary Sources. No specific changes to the operation of stationary sources on NLVF are anticipated under the Expanded Operations Alternative. See Chapter 4, Section 4.3.8.2.2, of this document for the current (2008) air emissions from onsite stationary sources.

Emissions from Commuter Vehicles. The MOVES2010 (Version 20100515; EPA 2009) mobile source emissions model was used to estimate annual emission rates due to NLVF employees traveling to and from NLVF in personal vehicles.

For the Expanded Operations Alternative, the 2008 personal vehicle activity data (vehicle counts and VMTs) were scaled up 27 percent, corresponding to the increase in NLVF employees for the Expanded Operations Alternative compared to the 2008 baseline. The modeling for the Expanded Operations

Alternative used 2015 as the modeling year (compared to the 2008 baseline) and the MOVES national default age distributions. By 2015, all gasoline-type vehicles in this area of Nevada are assumed to be run on ethanol blends.

Table D–56 shows the modeled 2015 annual onsite mobile emissions of criteria pollutants and HAPs associated with NLVF employee commuters traveling to and from NLVF under the Expanded Operations Alternative. Despite a 27 percent increase in VMTs, these modeled Expanded Operations Alternative emissions are only 12 percent greater overall than the modeled 2008 baseline emissions, largely due to improvements in vehicle control technology due to vehicle fleet turnover.

Table D–56 Estimated Annual Emissions of Criteria Pollutants and Hazardous Air Pollutants from Commuting to and from North Las Vegas Facility Under the Expanded Operations Alternative, 2015 (tons per year)

	Light-Duty Vehicles		*Light-Duty Passenger Trucks*		*Total*		
	Clark County	*Nye County*	*Clark County*	*Nye County*	*Clark County*	*Nye County*	
Pollutant	*Off NLVF*	*Off NLVF*	*Off NLVF*	*Off NLVF*	*Off NLVF*	*Off NLVF*	*Total*
PM_{10}	0.12	0.00079	0.19	0.0012	0.31	0.0020	0.31
$PM_{2.5}$	0.064	0.00045	0.11	0.00074	0.17	0.0020	0.18
CO	9.5	0.055	20.3	0.13	29.8	0.19	29.9
NO_x	1.4	0.0083	4.1	0.025	5.5	0.033	5.5
SO_2	0.033	0.00019	0.043	0.00024	0.076	0.00043	0.075
VOCs	0.18	0.0012	0.65	0.0039	0.83	0.0051	0.83
Lead	0.000011	6.5×10^{-8}	0.000011	6.5×10^{-8}	0.000022	1.3×10^{-7}	0.000021
HAPs	0.014	0.00010	0.048	0.00031	0.062	0.00041	0.061

CO = carbon monoxide; HAP = hazardous air pollutant; NLVF = North Las Vegas Facility; NO_x = nitrogen oxides; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; VOC = volatile organic compound.

Emissions from Commercial Vendor Vehicles. The MOVES2010 (Version 20100515; EPA 2009) mobile source emissions model was used to estimate annual emission rates due to commercial vendors traveling to and from NLVF.

For the Expanded Operations Alternative, these 2008 activity data (vehicle counts and VMTs) were scaled up 27 percent, corresponding to the increase in NLVF employees for the Expanded Operations Alternative compared to the 2008 baseline. The modeling for the Expanded Operations Alternative used 2015 as the modeling year (compared to the 2008 baseline) and the MOVES national default age distributions for single-unit, short-haul trucks.

Table D–57 shows the modeled 2015 annual onsite mobile emissions of criteria pollutants and HAPs associated with commercial vendors traveling to and from NLVF under the Expanded Operations Alternative. Despite a 27 percent increase in VMTs, these modeled Expanded Operations Alternative emissions are about 52 percent lower overall than the modeled 2008 baseline emissions, largely due to improvements in vehicle control technology resulting from vehicle fleet turnover.

Table D–57 Estimated Annual Emissions of Criteria Pollutants and Hazardous Air Pollutants from Commercial Vendors Traveling to and from the North Las Vegas Facility Under the Expanded Operations, 2015 (tons per year)

	Single-Unit, Short-Haul Trucks
	Clark County
Pollutant	***Off NLVF***
PM_{10}	0.086
$PM_{2.5}$	0.071
CO	0.33
NO_x	0.88
SO_2	0.002
VOCs	0.095
Lead	3.8×10^{-6}
HAPs	0.013

CO = carbon monoxide; HAP = hazardous air pollutant; NLVF = North Las Vegas Facility; NO_x = nitrogen oxides; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; VOC = volatile organic compound.

Emissions from Radioactive Waste Vehicles. The MOVES2010 (Version 20100515; EPA 2009) mobile source emissions model was used to estimate annual emission rates due to radioactive waste trucks traveling to and from NLVF.

For the Expanded Operations Alternative, the 2008 VMTs were scaled up 27 percent, corresponding to the increase in NLVF employees for the Expanded Operations Alternative compared to the 2008 baseline. The modeling for the Expanded Operations Alternative used 2015 as the modeling year (compared to the 2008 baseline) and the MOVES national default age distributions for combination-unit, short-haul trucks.

Table D–58 shows the modeled 2015 annual onsite mobile emissions of criteria pollutants and HAPs associated with radioactive waste trucks traveling to and from NLVF under the Expanded Operations Alternative. Despite about a 27 percent increase in VMTs, these modeled Expanded Operations Alternative emissions are about 64 percent lower overall than the modeled 2008 baseline emissions, largely due to improvements in vehicle control technology due to vehicle fleet turnover.

Table D–58 Estimated Annual Emissions of Criteria Pollutants and Hazardous Air Pollutants from Radioactive Waste Trucks Traveling to and from the North Las Vegas Facility Under the Expanded Operations Alternative, 2015 (tons per year)

	Combination-Unit, Short-Haul Trucks			
	Clark County	***Nye County***		
Pollutant	***Off NLVF***	***Off NLVF***	***On NLVF***	***Total***
PM_{10}	0.0021	0.00019	0.00013	0.0025
$PM_{2.5}$	0.0018	0.00016	0.00011	0.0020
CO	0.0058	0.00056	0.00038	0.0068
NOx	0.026	0.0025	0.0016	0.030
SO2	0.000058	5.5×10^{-6}	3.6×10^{-6}	0.000066
VOCs	0.0011	0.00011	0.000071	0.0014
Lead	3.6×10^{-8}	3.8×10^{-9}	2.5×10^{-9}	4.3×10^{-8}
HAPs	0.00015	0.000014	9.5×10^{-6}	0.00018

CO = carbon monoxide; HAP = hazardous air pollutant; NLVF = North Las Vegas Facility; NO_x = nitrogen oxides; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; VOC = volatile organic compound.

D.2.4.3 Reduced Operations Alternative

D.2.4.3.1 Emissions on and near the North Las Vegas Facility

Emissions from Stationary Sources. No specific changes to the operation of established stationary sources on NLVF are anticipated under the Reduced Operations Alternative. See Chapter 4, Section 4.3.8.2.2, of this document for the current (2008) air emissions from onsite stationary sources.

Emissions from Commuter Vehicles. The MOVES2010 (Version 20100515; EPA 2009) mobile source emissions model was used to estimate annual emission rates due to NLVF employees traveling to and from NLVF in personal vehicles.

For the Reduced Operations Alternative, the 2008 personal vehicle activity data (vehicle counts and VMTs) were scaled down by 9 percent, corresponding to the decrease in NLVF employees for the Reduced Operations Alternative compared to the 2008 baseline. The modeling for the Reduced Operations Alternative used 2015 as the modeling year (compared to the 2008 baseline) and the MOVES national default age distributions for each vehicle type. By 2015, all gasoline-type vehicles in this area of Nevada are assumed to be run on ethanol blends

Table D–59 shows the modeled 2015 annual onsite mobile emissions of criteria pollutants and HAPs associated with NLVF employee commuters traveling to and from NLVF under the Reduced Operations Alternative. Despite only a 9 percent decrease in VMTs, these modeled Reduced Operations Alternative emissions are about 19 percent lower overall than the modeled 2008 baseline emissions, largely due to improvements in vehicle control technology due to vehicle fleet turnover.

Table D–59 Estimated Annual Emissions of Criteria Pollutants and Hazardous Air Pollutants from Commuting to and from the North Las Vegas Facility Under the Reduced Operations Alternative, 2015 (tons per year)

	Light-Duty Vehicles		*Light-Duty Passenger Trucks*		*Total*		
	Clark County	*Nye County*	*Clark County*	*Nye County*	*Clark County*	*Nye County*	
Pollutant	*Off NLVF*	*Off NLVF*	*Off NLVF*	*Off NLVF*	*Off NLVF*	*Off NLVF*	*Total*
PM_{10}	0.089	0.00057	0.14	0.00087	0.23	0.0014	0.23
$PM_{2.5}$	0.046	0.00032	0.077	0.00053	0.12	0.00085	0.13
CO	6.8	0.040	14.6	0.090	21.4	0.13	21.5
NO_x	0.99	0.0059	3.0	0.018	4.0	0.024	4.0
SO_2	0.023	0.00014	0.031	0.00017	0.054	0.00031	0.054
VOCs	0.13	0.00086	0.47	0.0028	0.60	0.0037	0.59
Lead	7.7×10^{-6}	4.7×10^{-8}	7.7×10^{-6}	4.7×10^{-8}	0.000015	9.4×10^{-8}	0.000015
HAPs	0.0099	0.000074	0.034	0.00022	0.044	0.00029	0.044

CO = carbon monoxide; HAP = hazardous air pollutant; NLVF = North Las Vegas Facility; NO_x = nitrogen oxides; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; VOC = volatile organic compound.

Emissions from Commercial Vendor Vehicles. The MOVES2010 (Version 20100515; EPA 2009) mobile source emissions model was used to estimate annual emission rates due to commercial vendors traveling to and from NLVF.

See Section D.1.3.2.1 for more details on how the commercial vendor vehicle activity data representative of 2008 were derived. For the Reduced Operations Alternative, the 2008 personal vehicle activity data (vehicle counts and VMTs) were scaled down by 9 percent, corresponding to the decrease in NLVF employees for the Reduced Operations Alternative compared to the 2008 baseline. The modeling for the Reduced Operations Alternative used 2015 as the modeling year (compared to the 2008 baseline) and the MOVES national default age distributions for single-unit, short-haul trucks.

Table D–60 shows the modeled 2015 annual onsite mobile emissions of criteria pollutants and HAPs associated with commercial vendors traveling to and from NLVF under the Reduced Operations Alternative. Despite only a 9 percent decrease in VMTs, these modeled Reduced Operations Alternative emissions show a 66 percent overall reduction from the modeled 2008 baseline emissions, largely due to improvements in vehicle control technology due to vehicle fleet turnover.

Table D–60 Estimated Annual Emissions of Criteria Pollutants and Hazardous Air Pollutants from Commercial Vendors Traveling to and from the North Las Vegas Facility Under the Reduced Operations Alternative, 2015 (tons per year)

	Single-Unit, Short-Haul Trucks
	Clark County
Pollutant	***Off NLVF***
PM_{10}	0.062
$PM_{2.5}$	0.051
CO	0.23
NO_x	0.63
SO_2	0.0014
VOCs	0.068
Lead	0.0000027
HAPs	0.0090

CO = carbon monoxide; HAP = hazardous air pollutant; NLVF = North Las Vegas Facility; NO_x = nitrogen oxides; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; VOC = volatile organic compound.

Emissions from Radioactive Waste Vehicles. The MOVES2010 (Version 20100515; EPA 2009) mobile source emissions model was used to estimate annual emission rates due to radioactive waste trucks traveling to and from NLVF.

The same number of trucks was used for the 2008 baseline and the Reduced Operations Alternative. For the Reduced Operations Alternative, the 2008 VMTs were scaled lower by 9 percent, corresponding to the decrease in NLVF employees for the Reduced Operations Alternative compared to the 2008 baseline. The modeling for the Reduced Operations Alternative used 2015 as the modeling year (compared to the 2008 baseline) and the MOVES national default age distributions for combination-unit, short-haul trucks.

Table D–61 shows the modeled 2015 annual onsite mobile emissions of criteria pollutants and HAPs associated with radioactive waste trucks traveling to and from NLVF under the Reduced Operations Alternative. Despite only a 9 percent decrease in VMTs, these modeled Reduced Operations Alternative emissions are projected to decrease 74 percent compared to the modeled 2008 baseline emissions, largely due to improvements in vehicle control technology due to vehicle fleet turnover.

Table D–61 Estimated Annual Emissions of Criteria Pollutants and Hazardous Air Pollutants from Radioactive Waste Trucks Traveling to and from the North Las Vegas Facility Under the Reduced Operations Alternative, 2015 (tons per year)

	Combination-Unit, Short-Haul Trucks			
	Clark County	***Nye County***		
Pollutant	***Off NLVF***	***Off NLVF***	***On NLVF***	***Total***
PM_{10}	0.0015	0.00013	0.00009	0.0018
$PM_{2.5}$	0.0013	0.00012	0.000081	0.0014
CO	0.0041	0.00041	0.00027	0.0049
NO_x	0.019	0.0018	0.0012	0.022
SO_2	0.000041	4.0×10^{-6}	2.6×10^{-6}	0.000048
VOCs	0.00082	0.000077	0.000051	0.00099
Lead	2.6×10^{-8}	2.7×10^{-9}	1.8×10^{-9}	3.1×10^{-8}
HAPs	0.00011	9.9×10^{-6}	6.8×10^{-6}	0.00013

CO = carbon monoxide; HAP = hazardous air pollutant; NLVF = North Las Vegas Facility; NO_x = nitrogen oxides; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; VOC = volatile organic compound.

D.2.5 Tonopah Test Range

D.2.5.1 No Action Alternative

D.2.5.1.1 Emissions on and near the Tonopah Test Range

Emissions from Stationary Sources. No specific changes to the operation of stationary sources on the TTR are anticipated under the No Action Alternative. See Chapter 4, Section 4.1.8.2.2, of this document for the current (2008) air emissions from onsite stationary sources.

Emissions from Onsite Government-Owned Vehicles. The MOVES2010 (Version 20100515; EPA 2009) mobile source emissions model was used to estimate annual emission rates due to government vehicle traffic on the TTR. See Section D.1.4.2 for more details on how the activity data representative of 2008 were derived. For the No Action Alternative, the 2008 onsite government-owned vehicle activity data (vehicle counts and VMTs) were used because no change in the number of employees is anticipated under this alternative. The modeling for the No Action Alternative used the midpoint year of 2015 as the modeling year (compared to the 2008 baseline) and the MOVES national default age distributions for each vehicle type. By 2015, all gasoline-type vehicles in this area of Nevada are assumed to be run on ethanol blends, while diesel-type vehicles are assumed to still consume the same fractions of No. 2 diesel and biodiesel as used in 2008.

Table D–62 shows the modeled 2015 annual onsite mobile and stationary source emissions of criteria pollutants and HAPs associated with TTR government-owned vehicles and equipment under the No Action Alternative. Despite no change in VMTs, these modeled No Action Alternative emissions are about 33 percent lower overall than the modeled 2008 baseline emissions, largely due to improvements in vehicle control technology due to vehicle fleet turnover.

Table D–62 Estimated Annual Emissions of Criteria Pollutants and Hazardous Air Pollutants from Onsite Tonopah Test Range Stationary Sources and Government-Owned Mobile Sources Under the No Action Alternative, 2015 (tons per year) [a]

	Government-Owned Mobile Source Type (modeled)				*Stationary Source Type (calculated)*	*Total*
	Light-Duty Vehicles	*Light-Duty Passenger Trucks*	*Single-Unit, Short-Haul Trucks*	*Total*		
	Nye County					
Pollutant	*On Tonopah Test Range*					
PM_{10}	0.011	0.02	0.036	0.067	<3.7	<3.8
$PM_{2.5}$	0.0059	0.012	0.033	0.051	<3.7	<3.8
CO	0.79	1.6	0.15	2.5	<2.9	<5.4
NO_x	0.073	0.22	0.29	0.58	<13.3	<13.9
SO_2	0.0025	0.0044	0.000087	0.007	<0.91	<0.92
VOCs	0.011	0.027	0.0062	0.044	<0.96	<1.0
Lead	8.9×10^{-7}	1.2×10^{-6}	6.4×10^{-7}	2.7×10^{-6}	<0.01	<0.01
HAPs	0.001	0.0025	0.00013	0.0036	<1.1	<1.1

< = less than; CO = carbon monoxide; HAP = hazardous air pollutant; NO_x = nitrogen oxides; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; VOC = volatile organic compound.

[a] Government-owned mobile source activities are partitioned by source type. The source type partitioning of stationary source activities is shown in Table D–24.

Emissions from Personal Commuter Vehicles. The MOVES2010 (Version 20100515; EPA 2009) mobile source emissions model was used to estimate annual emission rates due to TTR employees traveling to and from the TTR in personal commuter vehicles. Section D.1.1.2.1 describes how personal commuter vehicle activity data representative of 2008 were derived. For the No Action Alternative, the 2008 personal vehicle activity data (vehicle counts and VMTs) were used because no change in the number of employees is anticipated under this alternative. The modeling for the No Action Alternative used the midpoint year of 2015 as the modeling year and the MOVES national default age distributions for each vehicle type. By 2015, all gasoline-fueled vehicles in this area of Nevada are assumed to be run on ethanol blends.

Table D–63 shows the modeled 2015 annual mobile emissions of criteria pollutants and HAPs associated with TTR employee commuters traveling to and from the TTR under the No Action Alternative. Despite no change in VMTs, these modeled No Action Alternative emissions are about 15 percent lower overall than the 2008 baseline emissions, largely due to improvements in vehicle control technology due to vehicle fleet turnover.

Table D–63 Estimated Annual Emissions of Criteria Pollutants and Hazardous Air Pollutants from Commuting to and from the Tonopah Test Range Under the No Action Alternative, 2015 (tons per year)

	Light-Duty Vehicles			*Light-Duty Passenger Trucks*			*Total*			
		Nye County			*Nye County*			*Nye County*		
Pollutant	***Clark County***	***Off TTR***	***On TTR***	***Clark County***	***Off TTR***	***On TTR***	***Clark County***	***Off TTR***	***On TTR***	***Total***
PM_{10}	0.0035	0.014	0.0016	0.0064	0.022	0.0024	0.0099	0.036	0.0040	0.05
$PM_{2.5}$	0.0018	0.008	0.00088	0.0030	0.013	0.0015	0.0048	0.021	0.0024	0.028
CO	0.27	1.0	0.11	0.57	2.3	0.25	0.84	3.3	0.36	4.5
NO_x	0.038	0.15	0.016	0.12	0.45	0.049	0.16	0.60	0.065	0.82
SO_2	0.00092	0.0033	0.00036	0.0012	0.0043	0.00048	0.0021	0.0076	0.00084	0.011
VOCs	0.0050	0.021	0.0023	0.018	0.070	0.0077	0.023	0.091	0.010	0.12
Lead	3.1×10^{-7}	1.2×10^{-6}	1.3×10^{-7}	3.1×10^{-7}	1.2×10^{-6}	1.3×10^{-7}	6.2×10^{-7}	2.4×10^{-6}	2.6×10^{-7}	3.3×10^{-6}
HAPs	0.00041	0.0018	0.00020	0.0014	0.0056	0.00062	0.0018	0.0074	0.00082	0.01

CO = carbon monoxide; HAP = hazardous air pollutant; NO_x = nitrogen oxides; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; TTR = Tonopah Test Range; VOC = volatile organic compound.

Emissions from Commercial Vendor Vehicles. The MOVES2010 (Version 20100515; EPA 2009) mobile source emissions model was used to estimate annual emission rates due to commercial vendors traveling to and from the TTR. Section D.1.1.2.1 describes how commercial vendor vehicle activity data representative of 2008 were derived. For the No Action Alternative, these 2008 activity data (vehicle counts and VMTs) were used because no change in the number of employees is anticipated under this alternative. The modeling for the No Action Alternative used 2015 as the modeling year (compared to the 2008 baseline) and the MOVES national default age distributions for single-unit, short-haul trucks.

Table D–64 shows the modeled 2015 annual onsite mobile emissions of criteria pollutants and HAPs associated with commercial vendors traveling to and from the TTR under the No Action Alternative. Despite no change in VMTs, these modeled No Action Alternative emissions are about 62 percent lower overall than the modeled 2008 baseline emissions, largely due to improvements in vehicle control technology due to vehicle fleet turnover.

Table D–64 Estimated Annual Emissions of Criteria Pollutants and Hazardous Air Pollutants from Commercial Vendors Traveling to and from the Tonopah Test Range Under the No Action Alternative, 2015 (tons per year)

	Single-Unit, Short-Haul Trucks			
		Nye County		
Pollutant	***Clark County***	***Off TTR***	***On TTR***	***Total***
PM_{10}	0.044	0.19	0.0019	0.24
$PM_{2.5}$	0.036	0.16	0.0016	0.20
CO	0.17	0.77	0.0078	0.95
NO_x	0.44	1.9	0.020	2.4
SO_2	0.00099	0.0042	0.000043	0.0052
VOCs	0.048	0.22	0.0022	0.27
Lead	1.9×10^{-6}	8.9×10^{-6}	9.0×10^{-8}	0.000011
HAPs	0.0063	0.029	0.00029	0.036

CO = carbon monoxide; HAP = hazardous air pollutant; NO_x = nitrogen oxides; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; TTR = Tonopah Test Range; VOC = volatile organic compound.

D.2.5.2 Expanded Operations Alternative

D.2.5.2.1 Emissions on and near the Tonopah Test Range

Emissions from Stationary Sources. No specific changes to the operation of stationary sources on the TTR are anticipated under the Expanded Operations Alternative. See Chapter 4, Section 4.1.8.2.2, of this document for the current (2008) air emissions from onsite stationary sources.

Emissions from Onsite Government-Owned Vehicles. The MOVES2010 (Version 20100515; EPA 2009) mobile source emissions model was used to estimate annual emission rates due to government vehicle traffic on the TTR. For the Expanded Operations Alternative, the 2008 onsite government-owned vehicle activity data (vehicle counts and VMTs) were scaled down by 59 percent, corresponding to the decrease in TTR employees for the Expanded Operations Alternative. The modeling for the Expanded Operations Alternative used 2015 as the modeling year (compared to the 2008 baseline) and the MOVES national default age distributions for each vehicle type. By 2015, all gasoline-type vehicles in this area of Nevada are assumed to be using ethanol blends, while diesel-type vehicles use the same fractions of No. 2 diesel and biodiesel that used in the 2008 baseline.

Table D–65 shows the modeled 2015 annual onsite mobile emissions of criteria pollutants and HAPs associated with TTR government-owned vehicles under the Expanded Operations Alternative. Total onsite emissions from stationary sources (shown in more detail in Table D–25) are also provided in Table–65 to show the total onsite emissions from both stationary sources and government-owned vehicle mobile sources. Even with a 59 percent decrease in VMTs, these modeled Expanded Operations Alternative emissions are about 73 percent lower than the modeled 2008 baseline emissions, largely due to improvements in vehicle control technology due to vehicle fleet turnover.

Table D–65 Estimated Annual Emissions of Criteria Pollutants and Hazardous Air Pollutants from Onsite Tonopah Test Range Stationary Sources and Government-Owned Mobile Sources Under the Expanded Operations Alternative, 2015 (tons per year) [a]

Pollutant	*Government-Owned Mobile Source Type (Modeled)*				*Stationary Source Type (calculated)*	*Total*
	Light-Duty Vehicles	*Light-Duty Passenger Trucks*	*Single-Unit, Short-Haul Trucks*	*Total*		
	Nye County					
	On TTR					
PM_{10}	0.0045	0.0082	0.015	0.027	<3.7	<3.7
$PM_{2.5}$	0.0024	0.0049	0.014	0.021	<3.7	<3.7
CO	0.32	0.66	0.062	1.0	<2.9	<3.9
NO_x	0.030	0.090	0.012	0.24	<13.3	<13.4
SO_2	0.0010	0.0018	0.000036	0.0029	<0.91	<0.91
VOCs	0.0045	0.011	0.0025	0.018	<0.96	<0.98
Lead	3.6×10^{-7}	4.9×10^{-7}	2.6×10^{-7}	1.1×10^{-6}	<0.01	<0.01
HAPs	0.00041	0.0010	0.000053	0.0015	<1.1	<1.1

CO = carbon monoxide; HAP = hazardous air pollutant; NO_x = nitrogen oxides; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; TTR = Tonopah Test Range; VOC = volatile organic compound.

[a] Government-owned mobile source activities are partitioned by source type. The source type partitioning of stationary source activities is shown in Table D–24.

Emissions from Personal Commuter Vehicles. The MOVES2010 (Version 20100515; EPA 2009) mobile source emissions model was used to estimate annual emission rates due to TTR employees traveling to and from the TTR in personal commuter vehicles. Section D.1.1.2.1 describes how personal commuter vehicle activity data representative of 2008 were derived. For the Expanded Operations Alternative, the 2008 personal vehicle activity data (vehicle counts and VMTs) were scaled down by 59 percent, corresponding to the decrease in TTR employees for the Expanded Operations Alternative. The modeling for the Expanded Operations Alternative used 2015 as the modeling year (compared to the 2008 baseline) and the MOVES national default age distributions for each vehicle type. By 2015, all gasoline-type vehicles in this area of Nevada are assumed to be run on ethanol blended fuel.

Table D–66 shows the modeled 2015 annual mobile emissions of criteria pollutants and HAPs associated with TTR employee commuters traveling to and from the TTR under the Expanded Operations Alternative. Even with a 59 percent decrease in VMTs, these modeled Expanded Operations Alternative emissions are about 66 percent lower overall than the modeled 2008 baseline emissions, largely due to a combination of reduced vehicle activity and improvements in vehicle control technology due to vehicle fleet turnover.

Table D–66 Estimated Annual Emissions of Criteria Pollutants and Hazardous Air Pollutants from Commuting to and from the Tonopah Test Range Under the Expanded Operations Alternative, 2015 (tons per year)

	Light-Duty Vehicles			*Light-Duty Passenger Trucks*			*Total*			
		Nye County			*Nye County*			*Nye County*		
Pollutant	*Clark County*	*Off TTR*	*On TTR*	*Clark County*	*Off TTR*	*On TTR*	*Clark County*	*Off TTR*	*On TTR*	*Total*
PM_{10}	0.0014	0.0057	0.00065	0.0026	0.0089	0.00097	0.0040	0.015	0.0016	0.020
$PM_{2.5}$	0.00073	0.0032	0.00036	0.0012	0.0053	0.00061	0.0019	0.0085	0.00097	0.011
CO	0.11	0.41	0.044	0.23	0.93	0.10	0.34	1.3	0.15	1.8
NO_x	0.015	0.061	0.0065	0.049	0.18	0.020	0.065	0.24	0.026	0.33
SO_2	0.00037	0.0013	0.00015	0.00049	0.0017	0.00019	0.00085	0.0031	0.00034	0.0045
VOCs	0.0020	0.0085	0.00093	0.0073	0.028	0.0031	0.0093	0.037	0.0041	0.049
Lead	1.3×10^{-7}	4.9×10^{-7}	5.3×10^{-8}	1.3×10^{-7}	4.9×10^{-7}	5.3×10^{-8}	2.5×10^{-7}	9.7×10^{-7}	1.1×10^{-7}	1.3×10^{-6}
HAPs	0.00017	0.00073	0.000081	0.00057	0.0023	0.00025	0.00073	0.003	0.00033	0.0041

CO = carbon monoxide; HAP = hazardous air pollutant; NO_x = nitrogen oxides; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; TTR = Tonopah Test Range; VOC = volatile organic compound.

Emissions from Commercial Vendor Vehicles. The MOVES2010 (Version 20100515; EPA 2009) mobile source emissions model was used to estimate annual emission rates due to commercial vendors traveling to and from the TTR. Section D.1.1.2.1 describes how commercial vendor vehicle activity data representative of 2008 were derived. For the Expanded Operations Alternative, these 2008 activity data (vehicle counts and VMTs) were scaled down by 59 percent, corresponding to the decrease in TTR employees under the Expanded Operations Alternative. The modeling for the Expanded Operations Alternative used 2015 as the modeling year (compared to the 2008 baseline) and the national default age distributions for single-unit, short-haul trucks.

Table D–67 shows the modeled 2015 annual onsite mobile emissions of criteria pollutants and HAPs associated with commercial vendors traveling to and from the TTR under the Expanded Operations Alternative. Even with a 59 percent decrease in VMTs, these modeled Expanded Operations Alternative emissions are about 85 percent lower than the modeled 2008 baseline emissions, largely due to a combination of reduced vehicle activity and improvements in vehicle control technology due to vehicle fleet turnover.

Table D–67 Estimated Annual Emissions of Criteria Pollutants and Hazardous Air Pollutants from Commercial Vendors Traveling to and from the Tonopah Test Range Under the Expanded Operations Alternative, 2015 (tons per year)

	Single-Unit, Short-Haul Trucks			
		Nye County		
Pollutant	***Clark County***	***Off TTR***	***On TTR***	***Total***
PM_{10}	0.018	0.077	0.00077	0.097
$PM_{2.5}$	0.015	0.065	0.00065	0.081
CO	0.069	0.31	0.0032	0.39
NO_x	0.18	0.77	0.0081	0.97
SO_2	0.00040	0.0017	0.000017	0.0021
VOCs	0.019	0.089	0.00089	0.11
Lead	7.7×10^{-7}	3.6×10^{-6}	3.7×10^{-8}	4.5×10^{-6}
HAPs	0.0026	0.012	0.00012	0.015

CO = carbon monoxide; HAP = hazardous air pollutant; NO_x = nitrogen oxides; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; TTR = Tonopah Test Range; VOC = volatile organic compound.

D.2.5.3 Reduced Operations Alternative

D.2.5.3.1 Emissions on and near the Tonopah Test Range

Emissions from Stationary Sources. No specific changes to the operation of stationary sources on the TTR are anticipated under the Reduced Operations Alternative. See Chapter 4, Section 4.1.8.2.2, of this document for the current (2008) air emissions from onsite stationary sources.

Emissions from Onsite Government-Owned Vehicles. The MOVES2010 (Version 20100515; EPA 2009) mobile source emissions model was used to estimate annual emission rates due to government vehicle traffic on the TTR. See Section D.1.4.2 for more details on how the activity data representative of 2008 were derived. For the Reduced Operations Alternative, the 2008 onsite government-owned vehicle activity data (vehicle counts and VMTs) were scaled down by 63 percent, corresponding to the decrease in TTR employees for the Expanded Operations Alternative. The modeling for the Reduced Operations Alternative used 2015 as the modeling year (compared to the 2008 baseline) and the MOVES national default age distributions for each vehicle type. By 2015, all gasoline-type vehicles in this area of Nevada are assumed to be run on ethanol blends, while diesel-type vehicles are assumed to continue with same fractions of No. 2 diesel and biodiesel that were used in 2008.

Table D–68 shows the modeled 2015 annual onsite mobile emissions of criteria pollutants and HAPs associated with TTR government-owned vehicles under the Reduced Operations Alternative. Total onsite emissions from stationary sources (shown in more detail in Table D–24) are also provided in Table D–68 to show the total onsite emissions from both stationary sources and government-owned vehicle mobile sources. Even with a 63 percent decrease in VMTs, these modeled Reduced Operations Alternative emissions are about 75 percent lower overall than the modeled 2008 baseline emissions, largely due to a combination of reduced activity and improvements in vehicle emission control technology due to vehicle fleet turnover.

Table D–68 Estimated Annual Emissions of Criteria Pollutants and Hazardous Air Pollutants from Onsite Tonopah Test Range Stationary Sources and Government-Owned Mobile Sources Under the Reduced Operations Alternative, 2015 (tons per year) [a]

Pollutant	*Government-Owned Mobile Source Type (Modeled)*				*Stationary Source Type (calculated)*	*Total*
	Light-Duty Vehicles	*Light-Duty Passenger Trucks*	*Single-Unit, Short-Haul Trucks*	*Total*		
	Nye County					
	On TTR					
PM_{10}	0.0041	0.0074	0.013	0.025	<3.7	<3.7
$PM_{2.5}$	0.0022	0.0044	0.012	0.019	<3.7	<3.7
CO	0.29	0.59	0.056	0.93	<2.9	<3.8
NO_x	0.027	0.081	0.11	0.21	<13.3	<13.5
SO_2	0.00093	0.0016	0.000032	0.0026	<0.91	<0.91
VOCs	0.0041	0.010	0.0023	0.016	<0.96	<0.98
Lead	3.3×10^{-7}	4.4×10^{-7}	2.4×10^{-7}	1.0×10^{-6}	<0.01	<0.01
HAPs	0.00037	0.00093	0.000048	0.0013	<1.1	<1.1

CO = carbon monoxide; HAP = hazardous air pollutant; NO_x = nitrogen oxides; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; TTR = Tonopah Test Range; VOC = volatile organic compound.

[a] Government-owned mobile source activities are partitioned by source type. The source type partitioning of stationary source activities is shown in Table D–24.

Emissions from Personal Commuter Vehicles. The MOVES2010 (Version 20100515; EPA 2009) mobile source emissions model was used to estimate annual emission rates due to TTR employees traveling to and from the TTR in personal commuter vehicles. Section D.1.1.2.1 describes how commuting activity data representative of 2008 were derived. For the Reduced Operations Alternative, the 2008 personal vehicle activity data (vehicle counts and VMTs) were scaled down by 63 percent, corresponding to the decrease in TTR employees for the Expanded Operations Alternative. The modeling for the Reduced Operations Alternative used 2015 as the modeling year (compared to the 2008 baseline) and the MOVES national default age distributions for each vehicle type. By 2015, all gasoline-type vehicles in this area of Nevada are assumed to be run on ethanol blended gasoline

Table D–69 shows the modeled 2015 annual mobile emissions of criteria pollutants and HAPs associated with TTR employee commuters traveling to and from the TTR under the Reduced Operations Alternative. Even with a 63 percent decrease in VMTs, these modeled Reduced Operations Alternative emissions are about 68 percent lower overall than the modeled 2008 baseline emissions, largely due to a combination of reduced vehicle activity and improvements in vehicle emission control technology due to vehicle fleet turnover.

Table D–69 Estimated Annual Emissions of Criteria Pollutants and Hazardous Air Pollutants from Commuting to and from the Tonopah Test Range Under the Reduced Operations Alternative, 2015 (tons per year)

	Light-Duty Vehicles			*Light-Duty Passenger Trucks*			*Total*			
		Nye County			*Nye County*			*Nye County*		
Pollutant	*Clark County*	*Off TTR*	*On TTR*	*Clark County*	*Off TTR*	*On TTR*	*Clark County*	*Off TTR*	*On TTR*	*Total*
PM_{10}	0.0013	0.0052	0.00059	0.0024	0.0081	0.00088	0.0036	0.013	0.0015	0.018
$PM_{2.5}$	0.00066	0.0029	0.00032	0.0011	0.0048	0.00055	0.0018	0.0077	0.00088	0.010
CO	0.099	0.37	0.040	0.21	0.85	0.092	0.31	1.2	0.13	1.7
NO_x	0.014	0.055	0.0059	0.044	0.17	0.018	0.059	0.22	0.024	0.30
SO_2	0.00034	0.0012	0.00013	0.00044	0.0016	0.00018	0.00077	0.0028	0.00031	0.0040
VOCs	0.0018	0.0077	0.00085	0.0066	0.026	0.0028	0.0085	0.033	0.0037	0.044
Lead	1.1×10^{-7}	4.4×10^{-7}	4.8×10^{-8}	1.1×10^{-7}	4.4×10^{-7}	4.8×10^{-8}	2.3×10^{-7}	8.8×10^{-7}	9.6×10^{-8}	1.2×10^{-6}
HAPs	0.00015	0.00066	0.000074	0.00052	0.0021	0.00023	0.00066	0.0027	0.00030	0.0037

CO = carbon monoxide; HAP = hazardous air pollutant; NO_x = nitrogen oxides PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; TTR = Tonopah Test Range; VOC = volatile organic compound.

Emissions from Commercial Vendor Vehicles. The MOVES2010 (Version 20100515; EPA 2009) mobile source emissions model was used to estimate annual emission rates due to commercial vendors traveling to and from the TTR. Section D.1.1.2.1 describes how commercial vendor vehicle activity data representative of 2008 were derived. For the Reduced Operations Alternative, these 2008 activity data (vehicle counts and VMTs) were scaled down by 63 percent, corresponding to the decrease in TTR employees for the Expanded Operations Alternative. The modeling for the Reduced Operations Alternative used 2015 as the modeling year (compared to the 2008 baseline) and the MOVES national default age distributions for single-unit, short-haul trucks.

Table D–70 shows the modeled 2015 annual onsite mobile emissions of criteria pollutants and HAPs associated with commercial vendors traveling to and from the TTR under the Reduced Operations Alternative. Even with a 63 percent decrease in VMTs, these modeled Reduced Operations Alternative emissions are about 86 percent lower overall than the modeled 2008 baseline emissions, largely due to a combination of reduced vehicle activity and improvements in vehicle emission control technology due to vehicle fleet turnover.

Table D–70 Estimated Annual Emissions of Criteria Pollutants and Hazardous Air Pollutants from Commercial Vendors Traveling to and from the Tonopah Test Range Under the Reduced Operations Alternative, 2015 (tons per year)

	Single-Unit, Short-Haul Trucks			
		Nye County		
Pollutant	***Clark County***	***Off TTR***	***On TTR***	***Total***
PM_{10}	0.016	0.070	0.00070	0.088
$PM_{2.5}$	0.013	0.059	0.00059	0.073
CO	0.063	0.28	0.0029	0.35
NO_x	0.16	0.70	0.0074	0.88
SO_2	0.00036	0.0015	0.000016	0.0019
VOCs	0.018	0.081	0.00081	0.099
Lead	0.00000070	0.0000033	0.000000033	0.0000041
HAPs	0.0023	0.011	0.00011	0.013

CO = carbon monoxide; HAP = hazardous air pollutant; NO_x = nitrogen oxides; PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; SO_2 = sulfur dioxide; TTR = Tonopah Test Range; VOC = volatile organic compound.

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APPENDIX E
EVALUATION OF HUMAN HEALTH EFFECTS FROM TRANSPORTATION

APPENDIX E
EVALUATION OF HUMAN HEALTH EFFECTS FROM TRANSPORTATION

E.1 Introduction

Transportation of any commodity involves a risk to both transportation crewmembers and the public. This risk results directly from transportation-related accidents and indirectly from increased levels of pollution from vehicle emissions, regardless of the cargo. The transportation of certain materials, such as hazardous or radioactive waste, can pose an additional risk due to the unique nature of the material itself. To permit a complete appraisal of the environmental impacts of the proposed actions and alternatives, the human health risks associated with the transportation of waste (both radioactive and nonradioactive) and radioactive materials on public highways and railroads were assessed.

This appendix provides an overview of the approach used to assess the human health risks that could result from the transportation that would be needed to implement the alternatives considered in this site-wide environmental impact statement (SWEIS). The topics in this appendix include the scope of the assessment, packaging and determination of potential transportation routes, analytical methods used for the risk assessment (e.g., computer models), and important assessment assumptions. In addition, to aid in the understanding and interpretation of the results, specific areas of uncertainty are described with an emphasis on how the uncertainties may affect comparisons of the alternatives.

The risk assessment results are presented in this appendix in terms of "per-shipment" risk factors, as well as the total risk for a given alternative. Per-shipment risk factors provide an estimate of the risk from a single shipment. The total risk for a given alternative is estimated by multiplying the expected number of shipments by the appropriate per-shipment risk factors.

E.2 Scope of Assessment

The scope of the transportation human health risk assessment, including the alternatives, transportation activities, potential radiological and nonradiological impacts, and transportation modes, is described in this section. There are several shipping arrangements for various radioactive wastes that cover all alternatives evaluated in this SWEIS. This evaluation focuses on using public highways and rail systems. Additional details of the assessment are provided in the remaining sections of this appendix.

E.2.1 Transportation-Related Activities

The transportation risk assessment is limited to estimating the human health risks related to transportation under each alternative. The risks to workers or the public during loading, unloading, and handling prior to or after shipment are addressed in Chapter 5, Section 5.1.12, Human Health and Safety, of this SWEIS. The impacts of increased transportation levels on local traffic flow and infrastructure are addressed in Chapter 5, Section 5.2.3.2, Traffic.

E.2.2 Radiological Impacts

For each alternative, radiological risks (i.e., risks resulting from the radioactive nature of the materials) were assessed for both incident-free (i.e., normal) and accident transportation conditions. The radiological risk associated with incident-free transportation conditions would result from the potential exposure of people to external radiation in the vicinity of a shipment. The radiological risk from transportation accidents would result from the potential release and dispersal of radioactive material into the environment during an accident and the subsequent exposure of people to that material.

All radiological impacts are calculated in terms of committed dose and associated health effects in the exposed populations. The radiation dose calculated is the total effective dose equivalent (see Title 10 of the *Code of Federal Regulations* [CFR], Part 20), which is the sum of the effective dose equivalent from external radiation exposure and the 50-year committed effective dose equivalent from internal radiation exposure. Radiation doses are presented in units of roentgen equivalent man (rem) for individuals and person-rem for collective populations. The impacts are further expressed as health risks in terms of latent cancer fatalities (LCFs) in exposed populations using the dose-to-risk conversion factors recommended by the U.S. Department of Energy (DOE) Office of National Environmental Policy Act Policy and Compliance, based on guidance from the Interagency Steering Committee on Radiation Standards (DOE 2003).

E.2.3 Nonradiological Impacts

In addition to the radiological risks posed by transportation activities, vehicle-related risks were also assessed for nonradiological causes (i.e., risks related to the transport vehicles rather than the radioactive cargo) for the same transportation routes. The nonradiological transportation risks, which would be incurred by similar shipments of any commodity, were assessed for accident conditions. The nonradiological accident risks are associated with the potential occurrence of transportation accidents that result in fatalities unrelated to the radioactive nature of the cargo.

Nonradiological risks during incident-free transportation conditions could also be caused by potential exposure to increased vehicle exhaust emissions. As explained in Section E.5.2, these emission impacts were not considered.

E.2.4 Transportation Modes

All shipments were assumed to be transported by either dedicated truck or general freight rail. Rail shipments to the Nevada National Security Site (NNSS) would end at a transfer station, where the cargo would be transferred to trucks to complete the trip to the NNSS.

E.2.5 Receptors

Transportation-related risks are calculated and presented separately for workers and members of the general public. The workers considered are truck and rail crewmembers involved in transporting and inspecting the packages and rail-to-truck transfer station workers involved in transferring waste packages between railcars and trucks. The general public includes all persons who could be exposed to a shipment while it is moving or stopped during transit. Potential risks were estimated for the affected populations and for a hypothetical maximally exposed individual (MEI). When analyzing incident-free transportation conditions, the affected population comprises those individuals living within 0.5 miles of each side of the road or rail line, while the MEI would be a resident living near a highway or rail line that is exposed to all shipments transported on that road or rail line. During accident conditions, the affected population would comprise individuals residing within 50 miles of the accident, and the MEI would be an individual located 330 feet directly downwind from the accident. The risk to the affected population is a measure of the radiological risk posed to society as a whole by the alternative being considered. As such, the impact on the affected population is used as the primary means of comparing various alternatives.

E.3 Packaging and Transportation Regulations

This section provides a high-level summary of regulations for packaging and transporting radioactive materials issued by the U.S. Department of Transportation (DOT) and U.S. Nuclear Regulatory Commission (NRC). Specifics on details on these regulations can be found in 49 CFR Parts 106, 107, and 171–178 (DOT regulations); 10 CFR Parts 20, 61, and 71 (NRC regulations); and 39 CFR Part 121 (U.S. Postal Service regulations). See the cited sections of these regulations for more information, or review the 2008 regulations review document, *Radioactive Material Regulations Review* (RAMREG-12-2008) (DOT 2008), for a comprehensive discussion of radioactive material regulations.

E.3.1 Packaging Regulations

Packaging requirements are an important consideration for transportation risk assessment. The primary regulatory approach to promoting safety from radiological exposure is the specification of standards for the packaging of radioactive materials. Packaging represents the primary barrier between the radioactive material being transported and the public, workers, and the environment. Transportation packaging for radioactive materials must be designed, constructed, and maintained to contain and shield its contents during normal transportation conditions. For highly radioactive material, such as greater-than-Class C waste and certain special nuclear materials, packaging must contain and shield the contents in the event of severe accident conditions. The type of packaging to be used is determined by the total radioactive hazard presented by the material within the packaging. Four basic types of packaging are used: Excepted, Industrial, Type A, and Type B. Specific requirements for these packages are detailed in 49 CFR Part 173, Subpart I. All packages are designed to protect and retain their contents during incident-free transportation conditions.

Excepted packagings are limited to the transport of materials that have extremely low levels of radioactivity and very low external radiation. Industrial packagings are used to transport materials that present a limited hazard to the public and the environment because of their low concentration of radioactive materials. Type A packagings are designed to protect and retain their contents during incident-free transportation conditions and, because of the higher radioactivity of their contents, must maintain sufficient shielding to limit radiation exposure to handling personnel. Type A packagings, typically 55-gallon drums or standard waste boxes, are commonly used to transport radioactive materials with higher concentrations or amounts of radioactivity than Excepted or Industrial packages. Type B packagings are used to transport material with even higher radioactivity levels and are designed to protect and retain their contents during transportation accident conditions. They are described in more detail in the following sections.

Radioactive materials shipped in Type A packagings or containers, are subject to specific radioactivity limits identified as A1 and A2 values in 49 CFR 173.435, "Table of A1 and A2 Values for Radionuclides." In addition, external radiation limits, as prescribed in 49 CFR 173.441, "Radiation Level Limitations," must be met. If the A1 or A2 limits are exceeded, the material must be shipped in a Type B container unless it can be demonstrated that the material meets the definition of "low specific activity." If the material qualifies as low specific activity, as defined in 10 CFR Part 71 and 49 CFR Part 173, it may be shipped in a shipping container such as Industrial or Type A packaging (49 CFR 173.427); see also RAMREG-001-98, the 1998 *Radioactive Material Regulations Review* (DOT 1998). Type B containers or casks are subject to the radiation limits in 49 CFR 173.441, but no quantity limits are imposed except in the case of fissile materials and plutonium.

Type A packagings are designed to retain their radioactive contents in normal transport. Under normal conditions, a Type A package must withstand the following:

- Operating temperatures ranging from –40 degrees Fahrenheit (°F) to 158 °F
- External pressures ranging from 3.5 to 20 pounds per square inch
- Normal vibration experienced during transportation

- Simulated rainfall of 2 inches per hour for 1 hour
- Free fall from 1 to 4 feet, depending on the package weight
- Water immersion-compression tests
- Impact of a 13-pound steel cylinder with rounded ends dropped from 3.3 feet onto the most vulnerable surface

Type B packagings are designed to retain their radioactive contents during both incident-free and accident conditions. A Type B package must withstand the following during accident conditions in addition to the Type A packaging criteria listed above:

- Free drop from 30 feet onto an unyielding surface in a position most likely to cause damage
- Free drop from 3.3 feet onto the end of a 6-inch-diameter vertical steel bar
- Exposure to a temperature of 1,475 °F for at least 30 minutes
- For all packages, immersion in at least 50 feet of water
- For some packages, immersion in at least 3 feet of water in an orientation most likely to result in leakage
- For some packages, immersion in at least 660 feet of water for 1 hour

Compliance with these requirements is demonstrated by using a combination of simple calculation methods, computer modeling techniques, and scale-model or full-scale testing of transportation packages or casks.

E.3.2 Transportation Regulations

The regulatory standards for packaging and transporting radioactive materials are designed to achieve the following four primary objectives:

- Protect persons and property from radiation emitted from packages during transportation by imposing specific limitations on the allowable radiation levels.
- Contain radioactive material in the package (achieved by packaging design requirements based on performance-oriented packaging integrity tests and environmental criteria).
- Prevent nuclear criticality (an unplanned nuclear chain reaction that could occur as a result of concentrating too much fissile material in one place).
- Provide physical protection against theft and sabotage during transit.

DOT regulates the transportation of hazardous materials in interstate commerce by land, air, and water. DOT specifically regulates the carriers of radioactive materials and the conditions of transport, such as routing, handling and storage, and vehicle and driver requirements to reduce transportation impacts. Other DOT regulations specify the maximum dose rate from radioactive material shipments. DOT also regulates the labeling, classification, and marking of radioactive material packagings.

NRC regulates the packaging and transportation of radioactive material for its licensees, including commercial shippers of radioactive materials. In addition, under an agreement with DOT, NRC sets the standards for Type B packagings and packages containing fissile materials.

Through its management directives, orders, and contractual agreements, DOE ensures the protection of public health and safety by imposing transportation activities standards equivalent to those of DOT and NRC. According to 49 CFR 173.7(d), packagings made by or under the direction of DOE may be used for transporting radioactive (Class 7) materials when the packages are evaluated, approved, and certified by DOE against packaging standards equivalent to those specified in 10 CFR Part 71.

The U.S. Department of Homeland Security is responsible for establishing policies for and coordinating civil emergency management, planning, and interaction with Federal Executive agencies that have emergency response functions in the event of a transportation incident. Guidelines for response actions are outlined in the *National Response Framework (NRF)* (DHS 2008a) in the event of a transportation incident involving nuclear material.

The Department of Homeland Security would use the Federal Emergency Management Agency, an organization within the department, to coordinate Federal and state participation in developing emergency response plans and to be responsible for the development and maintenance of the *Nuclear/Radiological Incident Annex* to the *NRF* (DHS 2008b). The *Nuclear/Radiological Incident Annex* describes the policies, situations, concepts of operations, and responsibilities of the Federal departments and agencies governing the immediate response and short-term recovery activities for incidents involving release of radioactive materials to address the consequences of the event.

E.4 Transportation Analysis Impact Methodology

The transportation risk assessment is based on the alternatives described in Chapter 3 of this SWEIS. **Figure E–1** summarizes the transportation risk assessment methodology. After the SWEIS alternatives were identified and the requirements of the shipping campaign were understood, data were collected on material characteristics and accident parameters. The methodology used to conduct the analysis is based on DOE guidance contained in *A Resource Handbook on DOE Transportation Risk Assessment* (DOE 2002b).

Transportation impacts calculated in this SWEIS are presented in two parts: impacts of incident-free (i.e., normal) transportation and impacts of transportation accidents. Impacts of incident-free transportation and transportation accidents were further divided into nonradiological and radiological impacts. Nonradiological impacts could result from transportation accidents in terms of traffic fatalities. Radiological impacts of incident-free transportation include impacts on members of the public and crew from radiation emanating from materials in the shipment. Radiological impacts from accident conditions consider all foreseeable scenarios that could damage transportation packages, leading to releases of radioactive materials to the environment.

The impacts of transportation accidents are expressed in terms of probabilistic risk, which is the probability of an accident multiplied by the consequences of that accident and summed over all reasonably conceivable accident conditions. Hypothetical transportation accident conditions, ranging from low-speed “fender-bender” collisions to high-speed collisions with and without fires, were analyzed. The frequencies of accidents and consequences were evaluated using a method developed by NRC and previously published in NUREG-0170, *Final Environmental Impact Statement on the Transportation of Radioactive Materials by Air and Other Modes* (NRC 1977); NUREG/CR-4829, *Shipping Container Response to Severe Highway and Railway Accident Conditions* (NRC 1987); and NUREG/CR-6672, *Reexamination of Spent Fuel Shipping Risk Estimates* (NRC 2000). Hereafter, these reports are cited as the *Radioactive Material Transportation Study*; *Modal Study*; and *Reexamination Study*, respectively. Radiological accident risk is expressed in terms of additional LCFs, and nonradiological accident risk is expressed in terms of additional immediate (traffic) fatalities. Incident-free risk is also expressed in terms of additional LCFs.

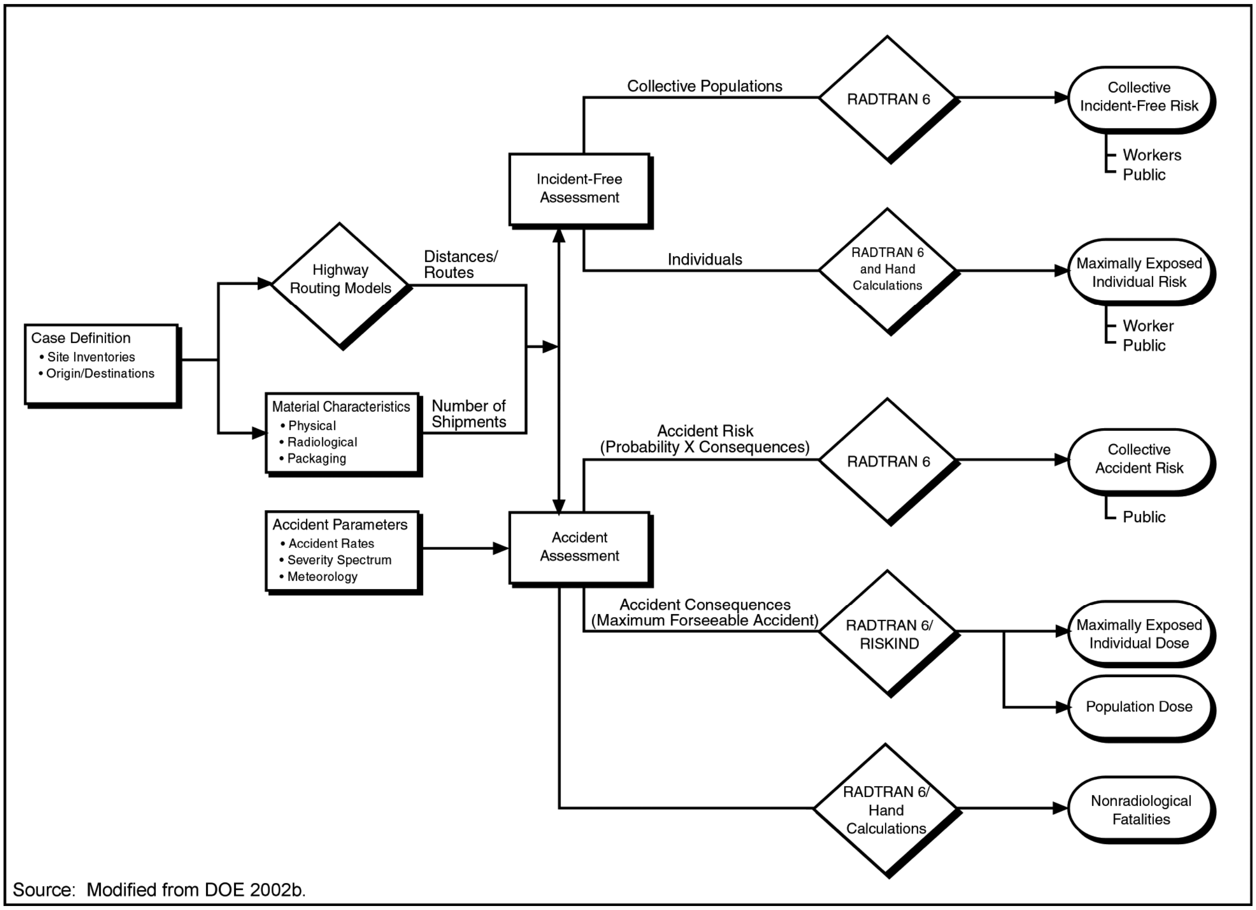

Figure E–1 Transportation Risk Assessment

Transportation-related risks were calculated and are presented separately for workers and members of the general public. The workers considered are truck/rail crewmembers involved in the actual transportation. The general public includes all persons who could be exposed to a shipment while it is moving or stopped during transit.

The first step in the ground transportation analysis was to determine the distances and populations along the routes. The TRAGIS [Transportation Routing Analysis Geographic Information System] computer program (Johnson and Michelhaugh 2003) was used to choose representative truck and rail routes and associated distances and populations. TRAGIS is a geographic information system-based transportation analysis computer program used to identify and select highway, rail, and waterway routes for transporting radioactive materials within the United States. The features in TRAGIS allow users to determine radioactive materials shipment routes that conform to DOT regulations specified in 49 CFR Part 397. Both the road and rail network are 1:100,000-scale databases that were developed from the U.S. Geological Survey digital line graphs and the U.S. Census Bureau Topological Integrated Geographic Encoding and Referencing System. The current version of TRAGIS uses population densities along each route derived from 2000 census data. State-level population data from the 2000 census (the basis for the TRAGIS population densities) and the 2010 census were used to escalate the route-specific population densities to 2016 (Census 2010).

This information, along with the properties of the material being shipped and route-specific accident frequencies, was entered into the RADTRAN 6 [Radioactive Material Transportation] computer code (SNL 2009), which was used to calculate incident-free and accident risks on a per-shipment basis. The risks under each alternative were determined by summing the products of per-shipment risks for each waste type by the number of shipments.

The RADTRAN 6 computer code was used to estimate the impacts of incident-free transportation and transportation accidents on populations and the impacts of incident-free transportation on MEIs. RADTRAN 6 was developed by Sandia National Laboratories to calculate population risks associated with the transportation of radioactive materials by a variety of modes, including truck, rail, air, ship, and barge.

The RADTRAN 6 population risk calculations include both the consequences and probabilities of potential exposure events. The RADTRAN 6 code consequence analyses include the following exposure pathways: cloud shine, ground shine, direct radiation (from loss of shielding) inhalation (from dispersed materials), and resuspension (inhalation dose from resuspended materials). The collective population risk is a measure of the total radiological risk posed to society as a whole by the alternative being considered. As such, the collective population risk is used as the primary means of comparing the various alternatives. The RISKIND [Risks and Consequences of Radiological Material Transport] computer code (Yuan et al. 1995) was used to estimate the doses to MEIs and populations for the maximum reasonably foreseeable transportation accident. The RISKIND computer code was developed for DOE's Office of Civilian Radioactive Waste Management to analyze the exposure of individuals during incident-free transportation and provide a detailed assessment of the consequences for individuals and population subgroups from severe transportation accidents under various environmental settings.

The RISKIND calculations were conducted to supplement the collective risk results calculated with RADTRAN. Whereas the collective risk results provide a measure of the overall risks of each alternative, the RISKIND calculations are meant to address areas of specific concern to individuals and population subgroups. Essentially, the RISKIND analyses are meant to address "What if" questions, such as "What if I live next to a site access road?" or "What if an accident happens near my town?"

E.4.1 Transportation Routes

To conduct the transportation analysis, an origination point and a destination were required for each truck and rail route. The NNSS may receive low-level radioactive waste (LLW) and mixed low-level radioactive waste (MLLW) from many waste generators throughout the United States. Many waste generators are known because of past waste receipts and solid waste forecasts; however, there is uncertainty as to the waste volumes to be received from waste generators, and it is possible that currently unidentified waste generators may transport radioactive waste to the NNSS for disposal. To take into account the uncertainty in waste volumes and possible waste generators, a representative origination point that would provide a conservative estimate of the impacts associated with transporting LLW and MLLW from a location within a region to the NNSS was assumed for eight regions of the United States. **Figure E–2** identifies the regions and representative origination point for each region.

Figure E–2 Regions of the United States Analyzed in this Site-Wide Environmental Impact Statement

Transportation impacts were assessed for two cases, as follows:

Constrained Case: This case constrains the transportation routes that can be used to those that do not travel through Las Vegas or over the bridge downstream of the Hoover Dam. As described in Chapter 4, Section 4.1.3.2.1, Regional Transportation, trucks transporting waste on Interstate 15 from the south avoid traveling through Las Vegas by taking Nevada State Route 160 to its intersection with U.S. Route 95. Radioactive waste being transported to the NNSS from points north of Las Vegas avoids Interstate 15 in Nevada by using Route 6 and then south on U.S. Route 95. In addition, rail transport was analyzed from each region, with shipments going to West Wendover, Nevada (using Tecoma, Nevada, as a proxy), or to Parker, Arizona (using Barstow, California, and Kingman, Arizona, as proxies). It was assumed that only shipments from Idaho National Laboratory would go to West Wendover, while all other shipments would go to Parker. Truck travel from the rail-to-truck transfer stations at these two locations would proceed to the NNSS along the constrained routes. **Figure E–3** shows the constrained truck routes that were analyzed and the rail routes to transfer stations in West Wendover, Nevada, and Parker, Arizona, from each region. **Figure E–4** shows the truck routes from the transfer stations to the NNSS. Note that while the routes shown are meant to represent current transportation activities, other routes can be taken depending on road and weather conditions, logistics, and judgment of the carrier or driver.

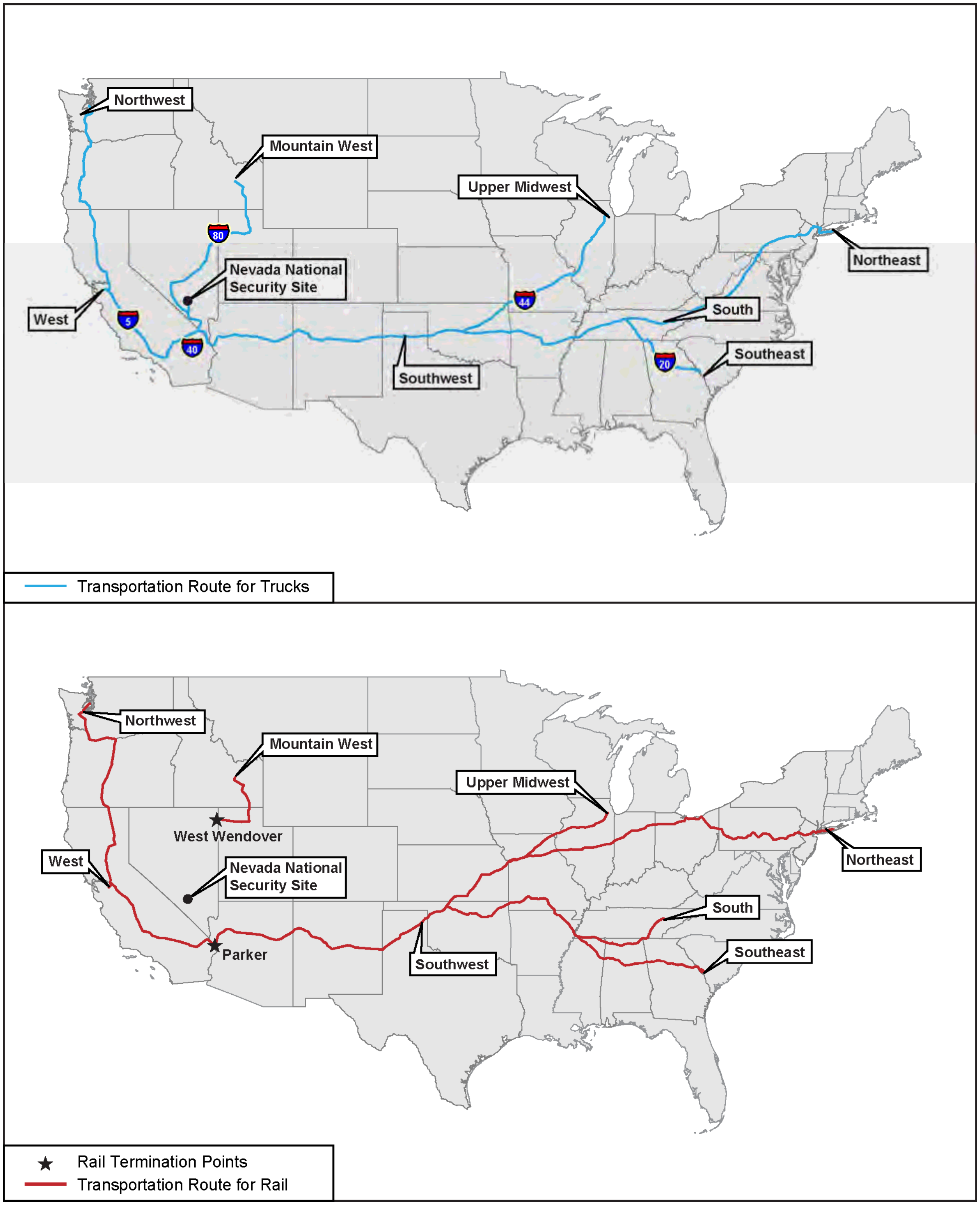

Figure E–3 Constrained Case – Truck Routes to the Nevada National Security Site and Rail Routes to Transfer Stations in West Wendover, Nevada, and Parker, Arizona

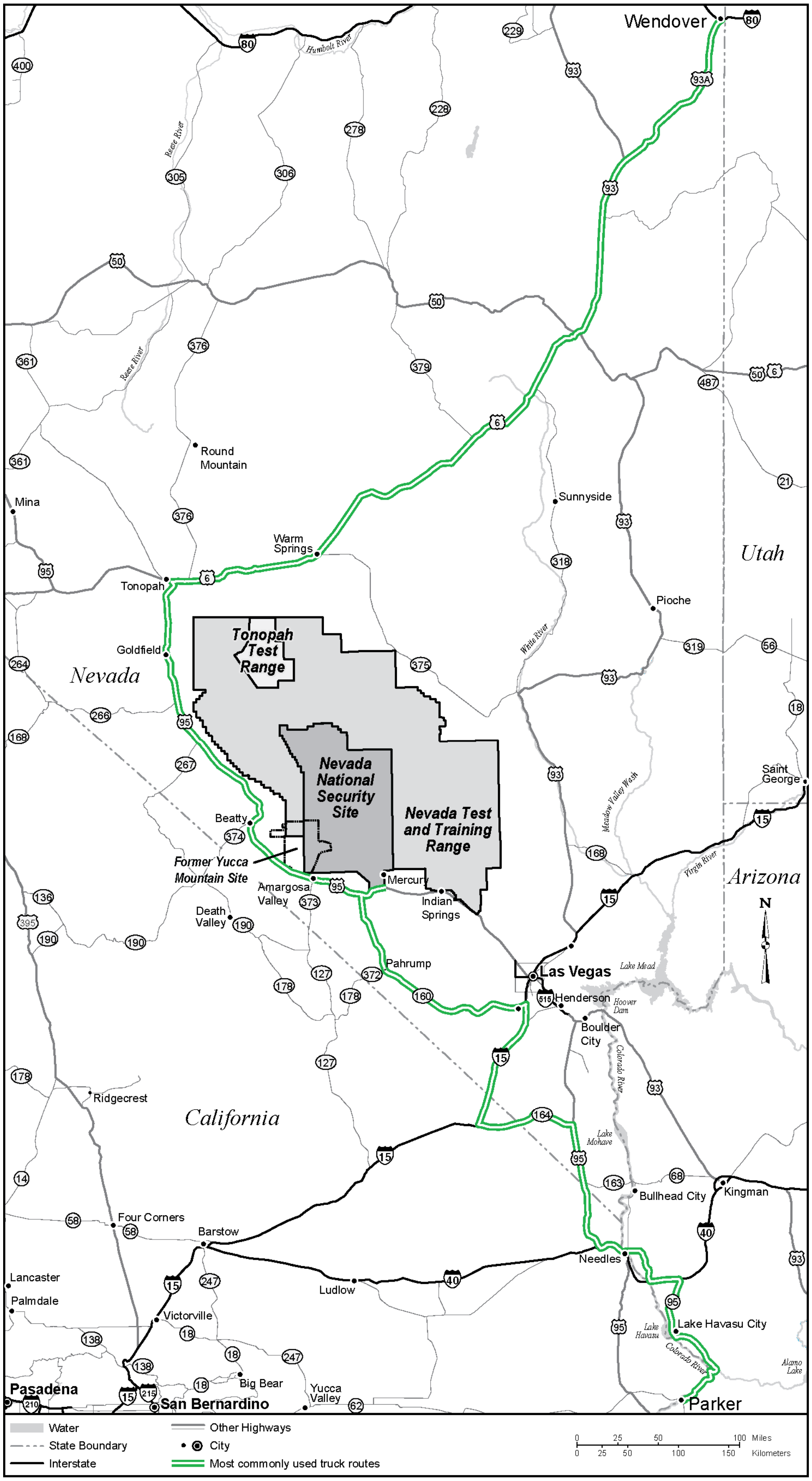

Figure E–4 Constrained Case – Truck Routes from the Transfer Stations to the Nevada National Security Site

Low-Level Radioactive Waste Transportation through the Las Vegas Valley

Historically, the U.S. Department of Energy (DOE) committed to the State of Nevada that it would avoid shipping low-level radioactive waste through the Interstate 15/U.S. 95 interchange in Las Vegas, Nevada. This commitment was made when major highways, such as Interstate 15 and U.S. Route 95, were unable to accommodate increased traffic volumes. The commitment as stated in the Waste Acceptance Criteria for the Nevada National Security Site (NNSS) avoided Hoover Dam and Las Vegas. In compliance with this requirement, commercial carriers of low-level radioactive waste used alternate shipping routes, such as Nevada State Route 160.

Now, the transportation infrastructure throughout metropolitan Las Vegas, such as Interstate 15 and U.S. Route 95, have been expanded and improved. In addition, the 215 Beltway was built to take traffic around the center of Las Vegas. Moreover, highways that continue to be used to transport waste, such as Nevada State Route 160, have experienced increased traffic as the population has grown in that area of the valley.

The National Nuclear Security Administration (NNSA) has analyzed two transportation cases: one that reflects the existing commitment (Constrained Case) and one that permits shipments through the greater metropolitan Las Vegas area (Unconstrained Case). This analysis was undertaken to develop a greater understanding of the potential environmental consequences of shipping such waste through and around metropolitan Las Vegas, and to provide information relevant to consideration of potential highway routing-related revisions to NNSS's waste acceptance criteria. Although an analysis of low-level/mixed low-level waste shipping routes is included in this site-wide environmental impact statement, individual decisions on routing will not be made as part of this National Environmental Policy Act process; such decisions are developed in accordance with NNSA's standard practices, which include consultation with the State of Nevada, and when finalized, become publicly available through publication on the NNSS website.

As part of the Constrained Case, materials and wastes other than LLW and MLLW would be transported to and from the NNSS. Transuranic (TRU) waste would be shipped from the NNSS to Idaho National Laboratory for treatment and certification. The TRU waste would then be shipped from the Idaho National Laboratory to the Waste Isolation Pilot Plant in New Mexico. Truck routes from specific origination and destination sites were analyzed for the transportation of radioisotope thermoelectric generators, special nuclear material, and sealed sources. For nuclear weapons transport, per-shipment risks were calculated for routes from different regions of the United States, and the route with the highest risk was assumed to be used for all transports. Rail transport was not analyzed for TRU waste, special nuclear material, or nuclear weapons.

Unconstrained Case: In the Unconstrained Case, transportation by (a) truck only and (b) a combination of rail and truck were analyzed.

(a) Truck Only: Impacts were analyzed for two route segments. The first segment is from the regional origination point to entry points to Las Vegas (see **Figure E–5**). These entry points are Henderson (at the intersection of Interstate 515 and U.S. Route 95), Apex (on Interstate 15 north of Las Vegas), and Arden (on Interstate 15 just south of the junction of Interstates 15 and 215). Only a portion of the offsite shipments to each entry point was analyzed; with the sum entering all three points being 100 percent of the shipments. This provides a more-realistic analysis, as truck shipments would only enter the Las Vegas area from a direction that makes the most sense (for example, shipments from the West region would not go to Henderson, but would instead enter the Las Vegas area at Arden). The second segment consists of different routes from these entry points to the NNSS. It was assumed that there would be no route limitations in the Las Vegas area; shipments could proceed through or around Las Vegas on several different possible routes, as depicted in **Figure E–6.** Truck routes were analyzed in segments to make it easier to analyze multiple routes (different segments can be added together).

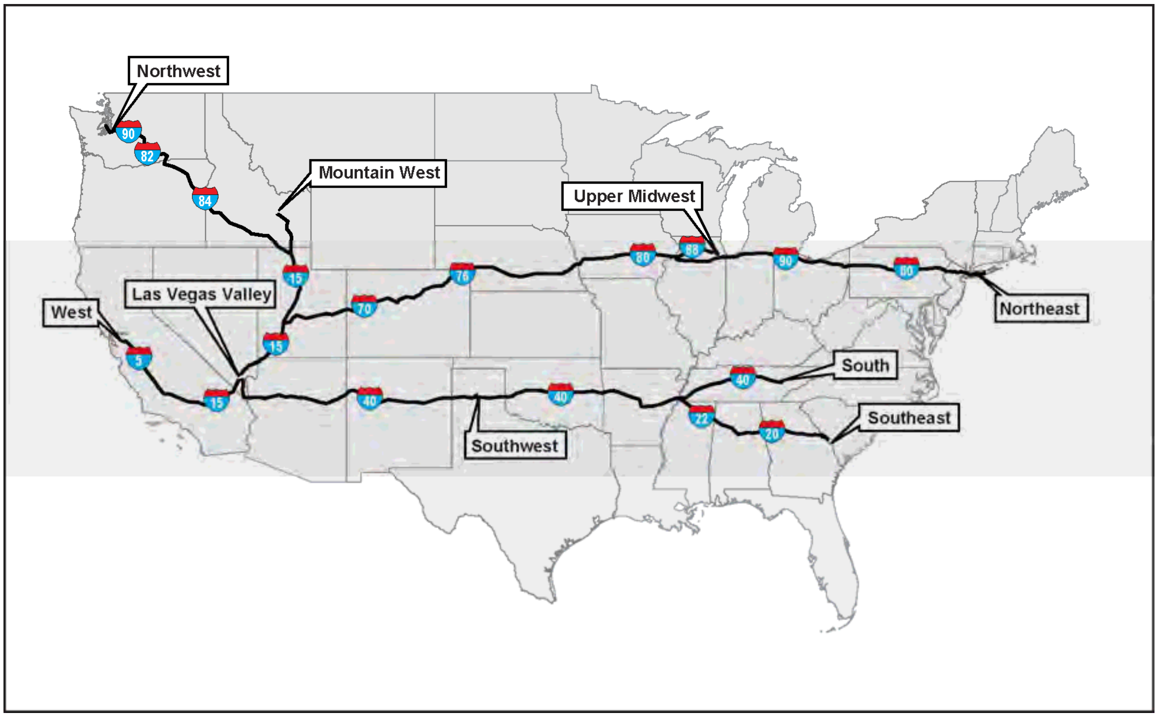

Figure E–5 Unconstrained Case – Truck Routes to Las Vegas Entry Points

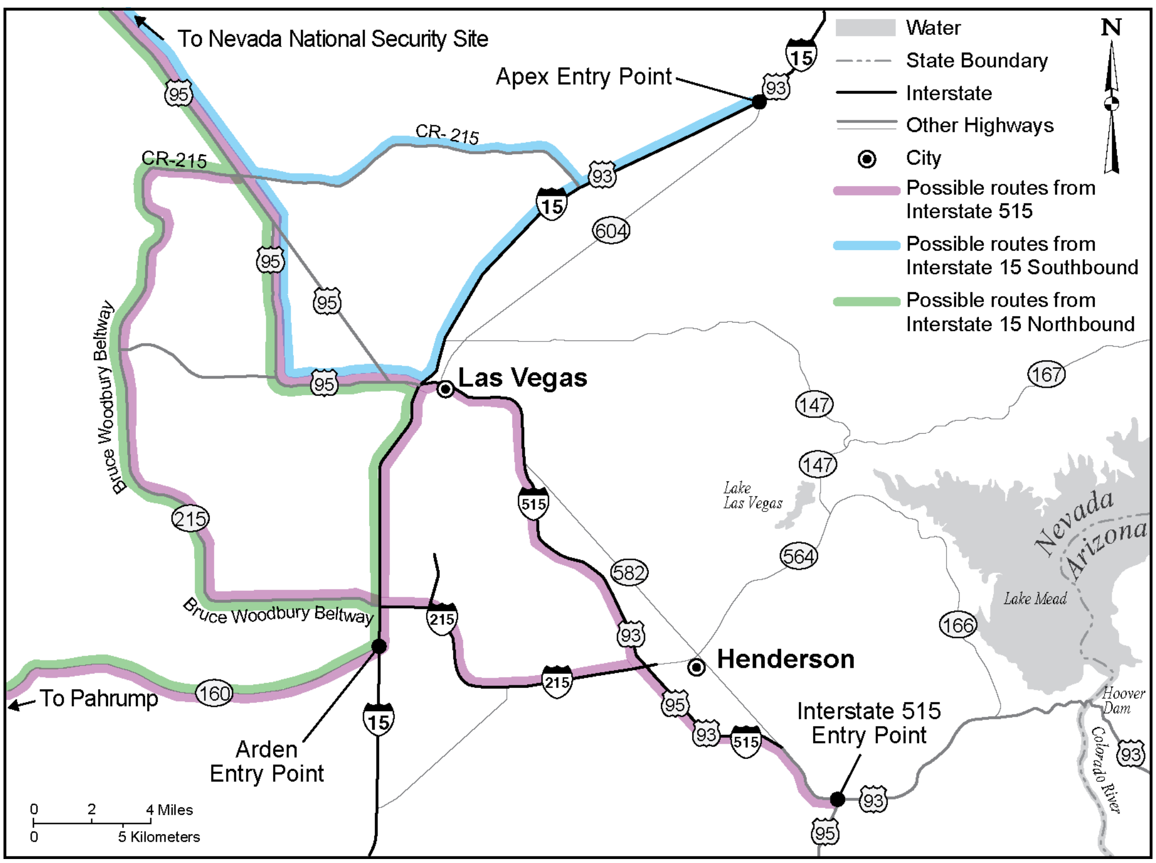

Figure E–6 Unconstrained Case – Truck Routes From Las Vegas Entry Points to the Nevada National Security Site

(b) Multiple routes could be taken from each entry point to the NNSS, as follows (and as shown in Figure E–6):

From Apex to the NNSS:	Interstate 15 to Clark County Route 215 to U.S. Route 95 Interstate 15 to U.S. Route 95
From Arden to the NNSS:	Interstate 15 to U.S. Route 95 Interstate 15 to Interstate 215 to Clark County Route 215 to U.S. Route 95 Interstate 15 to Nevada State Route 160 through Pahrump to U.S. Route 95
From Henderson to the NNSS:	Interstate 515 to U.S. Route 95 Interstate 515 to Interstate 215 to Interstate 15 to U.S. Route 95 Interstate 515 to Interstate 215 to Clark County Route 215 to U.S. Route 95 Interstate 515 to Interstate 215 to Interstate 15 to Nevada State Route 160 through Pahrump to U.S. Route 95

This appendix analyzes and compares all of these potential routes.

(c) Rail-to-Truck: Rail-to-truck transportation impacts were also analyzed by route segment. The first segment is rail transport from each region of the United States to a transfer station located in the Las Vegas region. All of the rail shipments were assumed to be transported to one of five different transfer stations, where they would be transferred to trucks. These five locations are West Wendover, Apex, and Arden, Nevada, and Parker and Kingman, Arizona. [Note: In practice, the location at which shipments would be received would be dependent on arrangements made by the shipper. The actual impacts would fall within the range of results determined in this analysis.] **Figures E–7** and **E–8** show the rail routes to each transfer station.

When analyzing rail-to-truck transportation, truck transport from an analyzed transfer station to a Las Vegas entry point (identified in (a) above) is evaluated as a segment, as shown in **Figure E–9**. Note that the truck segment from the transfer station to the entry point is only applicable to West Wendover, Parker, and Kingman because the transfer stations at Apex and Arden are already located at entry points to Las Vegas. Truck transport from West Wendover would proceed to the Apex entry point; truck transport from Parker would proceed to Henderson via U.S. Route 95; and truck transport from Kingman would proceed to Henderson via U.S. Route 93 over the bridge downstream of the Hoover Dam. The final segment is truck travel from a Las Vegas entry point to the NNSS, as described in (a) above and depicted in Figure E–6.

In addition to analyzing the use of transfer stations in the Las Vegas region, truck-to-rail transfer station locations were analyzed for three different regions of the United States: Southwest region, Northeast region, and West region. This analysis was performed to provide representative impacts associated with transporting LLW and MLLW from generating sites in these regions to a regional transfer station. These regions were selected because there are known LLW/MLLW generating sites in these regions that do not have direct access to rail.

Offsite Route Characteristics

Route characteristics that are important to the radiological risk assessment include the total shipment distance and population distribution along the route. The specific route selected determines both the total potentially exposed population and the expected frequency of transportation-related accidents. Rural, suburban, and urban areas, or zones, are characterized according to the following breakdown:

- Rural population densities range from 0 to 139 persons per square mile.
- Suburban population densities range from 140 to 3,326 persons per square mile.
- Urban population densities include all population densities greater than 3,326 persons per square mile.

The affected population for route characterization and incident-free dose calculation includes all persons living within 0.5 miles of each side of the transportation route.

Table E–1 presents the route characteristics for transporting materials and wastes to and from the NNSS under the Constrained Case. **Table E–2** presents the route characteristics for transporting LLW and MLLW under the Unconstrained Case. Note that the analysis was performed using kilometers, but is presented below in miles.

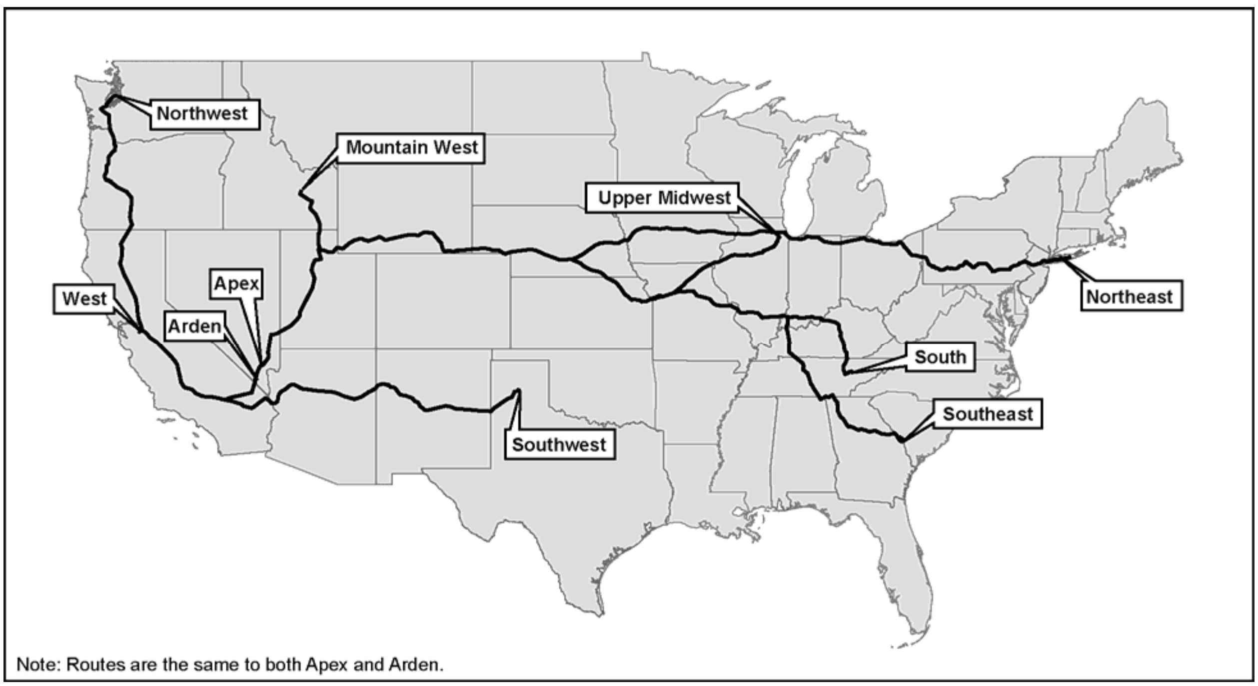

Figure E–7 Unconstrained Case – Rail Routes to Transfer Stations at Apex and Arden, Nevada

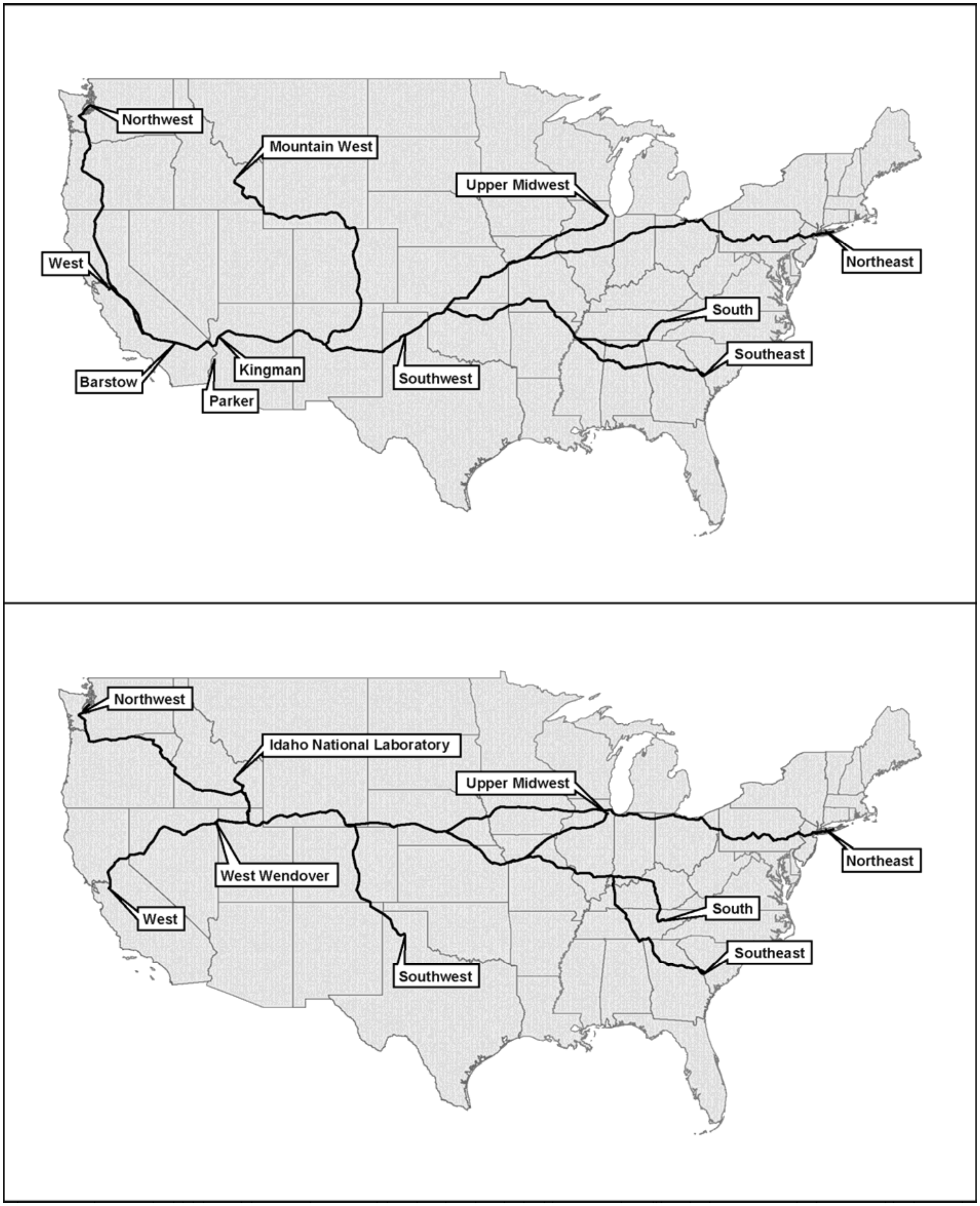

Figure E–8 Rail Routes to Transfer Stations at Parker and Kingman, Arizona, and West Wendover, Nevada

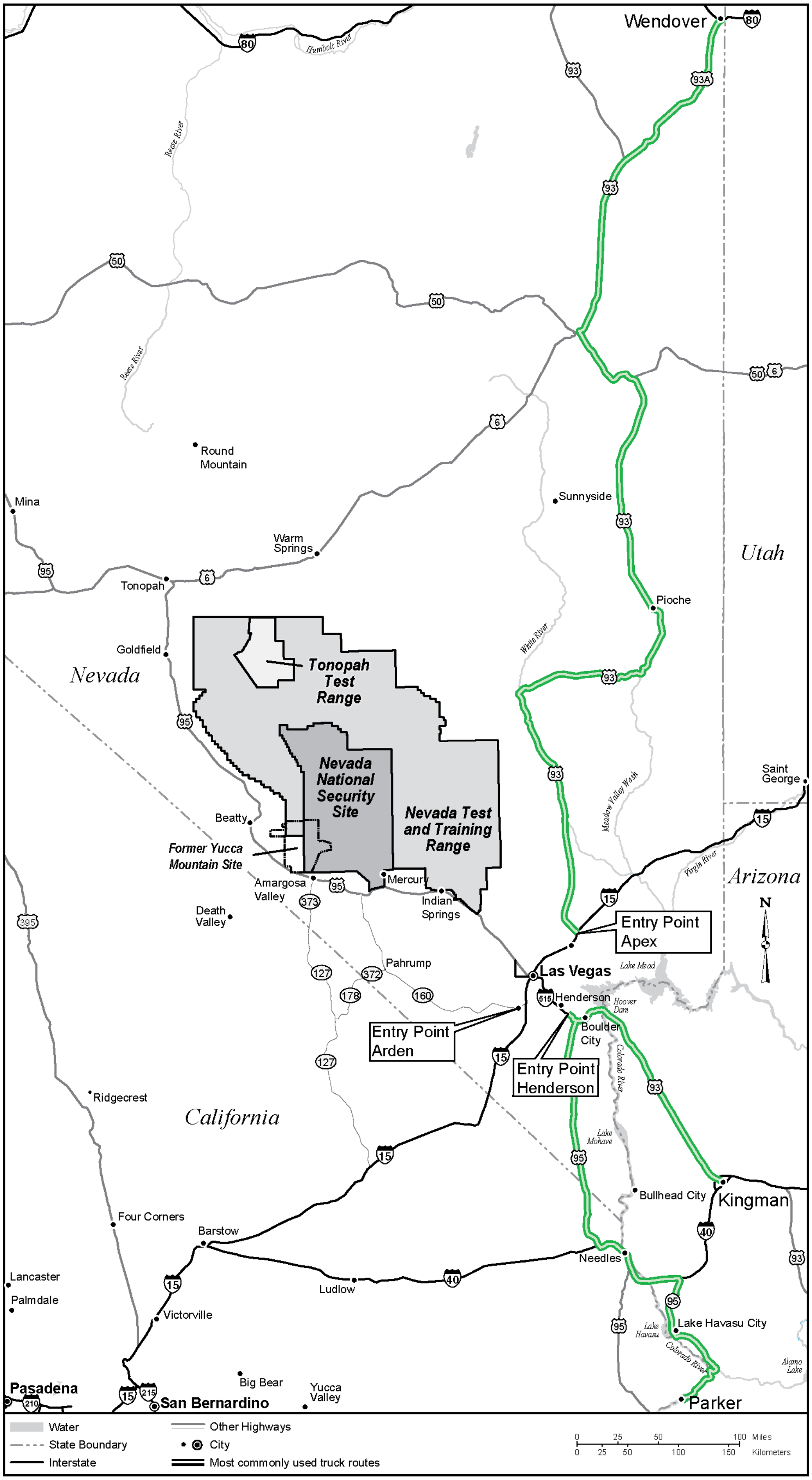

Figure E–9 Truck Routes from Transfer Stations to Las Vegas Entry Points

Table E–1 Constrained Case – Offsite Transport Truck and Rail Route Characteristics

Origin or Destination	Transport Mode	Nominal Distance (miles)	Distance Traveled in Zone (miles)			Population Density in Zone (persons per square mile)			Number of Affected Persons [a]
			Rural	Suburban	Urban	Rural	Suburban	Urban	
Radioactive Waste Shipments									
Northeast	Truck	2,990	2130.5	749.7	107.2	36.0	1,009.7	7,179.9	1,594,356
	Rail [b]	3,000	2,314.2	498.3	186.3	23.7	1,235.9	7,377.1	2,033,545
South	Truck	2,170	1,768.5	355.9	42.5	31.2	965.9	7,145.4	698,533
	Rail [b]	2,360	1,985.3	331.4	39.3	25.5	1,216.5	6,643.8	710,887
Southeast	Truck	2,410	1,866.0	477.6	66.2	32.5	1,069.2	7,363.8	1,052,981
	Rail [b]	2,580	2,115.8	406.3	56.4	26.8	1,267.6	7,018.4	962,105
Upper Midwest	Truck	2,090	1,689.6	361.8	37.0	31.7	976.2	6,969.3	660,552
	Rail [b]	2,030	1,827.3	175.5	29.6	17.0	1,221.3	6,897.1	446,896
Southwest	Truck	1,080	971.1	93.8	16.2	23.8	1,126.6	7,746.1	252,527
	Rail [b]	1,090	1,002.9	77.5	10.6	17.1	1,206.4	7,546.2	189,742
Mountain West [c]	Truck	805	725.9	66.1	12.6	15.9	1,294.8	8,635.1	204,866
	Rail [b]	322	285.4	32.2	4.4	25.5	1,123.9	7,976.3	78,183
West	Truck	713	580.7	92.4	40.1	25.8	1,146.6	8,893.4	474,579
	Rail [b]	687	526.4	109.9	50.3	26.3	1,116.9	7,746.5	341,946
Northwest	Truck	1,520	1,030.1	385.6	103.6	35.8	1,157.1	7,995.3	1,304,115
	Rail [b]	1,560	1,260.6	239.0	61.0	22.7	1,147.8	7,559.4	759,834
Parker, AZ	Truck [b]	337	301.8	34.2	1.3	22.5	1,187.3	8,194.9	57,725
West Wendover, NV	Truck [b]	464	457.1	6.6	0.6	7.2	1,570.7	8,660.5	18,457
Norfolk, VA [d]	Truck	2,690	2,040.9	592.7	60.4	35.3	958.3	7,172.6	1,067,067
Special Nuclear Material and Sealed Sources									
INL	Truck	805	725.9	66.1	12.6	15.9	1,294.8	8,635.1	204,866
LLNL	Truck	713	580.7	92.4	40.1	25.8	1,146.6	8,893.4	474,579
LANL	Truck	868	768.6	88.5	10.7	25.8	1,146.6	8,893.4	215,687
Oak Ridge Reservation	Truck	2,170	1,768.5	355.9	42.5	31.2	965.9	7,145.4	698,533
San Antonio, TX	Truck	1,410	1,204.3	157.8	45.9	24.2	1,265.6	9,921.5	688,197
Nuclear Weapons									
Norfolk, VA	Truck	2,690	2,040.9	592.7	60.4	35.3	958.3	7,172.6	1,067,067
Y-12	Truck	2,170	1,768.5	355.9	42.5	31.2	965.9	7,145.4	698,533
Pantex	Truck	1,080	971.1	93.9	16.2	23.8	1,126.6	7,746.1	252,527
LANL	Truck	868	768.6	88.5	10.7	25.8	1,146.6	8,893.4	215,687

INL = Idaho National Laboratory; LANL = Los Alamos National Laboratory; LLNL = Lawrence Livermore National Laboratory; Y-12 = Y-12 National Security Complex.

[a] The estimated number of persons residing within 0.5 miles of the transportation route.

[b] For all alternatives, Barstow, California (for westbound shipments), and Kingman, Arizona (for eastbound shipments), are used as proxy sites for Parker, Arizona, where radioactive materials being shipped by rail are transferred to trucks to complete the trip to the NNSS. Tecoma, Nevada, is used as a proxy site for West Wendover, Nevada. Proxy sites are used because route-specific distance and population data cannot be determined for Parker, Arizona, and West Wendover, Nevada, using TRAGIS.

[c] Transuranic waste originating at the NNSS would be sent to INL for certification.

[d] It was assumed that radioisotope thermoelectric generators unrelated to weapons to be disposed at the NNSS would originate in Norfolk Naval Shipyard, Virginia.

Table E–2 Unconstrained Case – Offsite Transport Truck and Rail Route Characteristics

Mode	To	From	Nominal Distance (miles)	Distance Traveled in Zone (miles)			Population Density in Zone (persons per square mile)			Population Affected [a]
				Rural	Suburban	Urban	Rural	Suburban	Urban	
Truck	Apex	Northeast	2,570	1,911.8	569.2	84.6	32.1	810.4	6,645.2	1,735,418
	Henderson	South	1,960	1,585.9	330.9	39.5	26.2	792.8	5,877.8	857,159
	Henderson	Southeast	2,150	1,676.6	425.6	50.1	28.0	822.3	5,802.1	1,099,911
	Apex	Upper Midwest	1,720	1,438.3	253.0	26.9	27.5	772.9	5,982.1	633,580
	Henderson	Southwest	883	786.7	79.2	16.8	18.9	886.0	6,068.4	299,008
	Apex	Mountain West	630	479.0	122.3	28.2	25.4	941.2	6,334.9	489,541
	Apex	Northwest	1,290	975.6	267.1	44.9	25.1	869.5	6,114.7	849,659
	Arden	West	513	461.9	44.2	6.7	22.0	755.8	6,238.8	136,756
Rail	West Wendover [b]	Northeast	2,530	1,763.0	544.9	219.5	26.7	1,049.0	7,096.6	3,481,698
		South	2,020	1,683.2	292.0	42.3	22.0	988.3	5,700.1	906,468
		Southeast	2,350	1,851.7	420.0	74.1	22.3	1,057.0	5,656.3	1,447,133
		Upper Midwest	1,640	1,489.6	133.0	19.2	14.8	950.5	5,573.7	408,645
		Southwest	1,180	1,023.7	128.1	24.0	11.1	1,021.2	5,900.3	454,613
		Mountain West	322	285.4	32.2	4.4	18.4	814.6	5,837.6	91,552
		Northwest	1,140	967.2	149.9	22.1	20.2	913.5	5,938.4	460,587
		West	637	522.5	81.0	33.7	14.5	1,000.0	6,720.8	504,588
	Arden	Northeast	2,910	2,099.9	575.3	234.2	23.8	1,061.6	7,062.2	3,703,593
		South	2,400	2,020.1	322.4	57.0	19.9	1,017.1	5,919.2	1,128,802
		Southeast	2,730	2,188.7	450.4	88.9	20.2	1,073.0	5,803.9	1,669,214
		Upper Midwest	2,020	1,826.5	163.4	33.9	13.7	1,014.2	5,996.6	630,727
		Southwest	1,240	1,159.5	74.9	10.3	12.2	917.4	5,729.6	226,566
		Mountain West	707	622.7	65.1	19.6	13.5	1,031.6	6,384.1	321,365
		Northwest	1,410	991.8	319.6	96.7	24.9	1,029.0	6,617.5	1,589,398
		West	543	385.8	117.1	39.9	22.8	1,017.1	6,972.0	649,683
	Apex	Northeast	2,880	2,080.2	568.9	230.5	23.8	1,061.9	7,049.0	3,645,804
		South	2,370	2,000.4	316.0	53.4	19.9	1,016.3	5,784.3	1,071,609
		Southeast	2,700	2,168.9	444.0	85.2	20.2	1,073.3	5,714.8	1,611,476
		Upper Midwest	1,990	1,806.8	156.9	30.3	13.5	1,012.7	5,768.5	572,445
		Southwest	1,270	1,179.2	81.4	13.9	12.4	928.3	6,297.1	283,960
		Mountain West	678	602.9	58.6	16.0	13.0	1,028.7	6,040.1	263,270
		Northwest	1,440	1,011.5	326.1	100.4	24.9	1,029.5	6,663.8	1,647,354
		West	573	405.5	123.6	43.5	22.8	1,019.2	7,049.2	706,901

Mode	To	From	Nominal Distance (miles)	Distance Traveled in Zone (miles)			Population Density in Zone (persons per square mile)			Population Affected [a]
				Rural	Suburban	Urban	Rural	Suburban	Urban	
Rail (cont'd)	Kingman	Northeast	2,770	2,095.4	487.4	185.4	22.3	1,128.7	6,927.5	3,009,370
		South	2,130	1,766.6	320.4	38.3	23.1	1,022.3	5,506.6	927,062
		Southeast	2,350	1,897.0	395.3	55.4	23.8	1,044.8	5,658.1	1,234,941
		Upper Midwest	1,800	1,608.5	164.6	28.5	15.0	1,029.3	5,880.6	578,083
		Southwest	860	784.2	66.6	9.6	15.0	917.6	5,779.8	205,714
		Mountain West	1,710	1,506.9	173.7	34.3	14.5	1,051.5	5,960.9	654,300
		Northwest	1,470	1,097.6	289.1	83.5	24.1	1,012.4	6,422.9	1,368,879
		West	598	435.4	122.3	40.5	20.7	1,017.6	6,940.9	663,560
	Parker [b]	Northeast	3,000	2,314.2	498.3	186.3	20.7	1,125.4	6,917.1	3,036,409
		South	2,360	1,985.3	331.4	39.3	21.2	1,020.7	5,493.9	954,395
		Southeast	2,580	2,115.8	406.3	56.4	22.3	1,043.0	5,646.5	1,263,073
		Upper Midwest	2,030	1,827.3	175.5	29.6	14.0	1,025.6	5,851.1	605,846
		Southwest	1,090	1,002.9	77.5	10.6	13.2	925.4	5,707.1	233,040
		Mountain West	1,950	1,725.7	184.6	35.3	13.5	1,047.1	5,933.7	681,560
		Northwest	1,470	1,097.6	289.1	83.5	24.1	1,012.4	6,422.9	1,368,879
		West	598	435.4	122.3	40.5	20.7	1,017.6	6,940.9	663,560
Truck from Rail stop to Las Vegas Valley	Junction I–15/C–215	West Wendover	358	352.9	4.7	0.3	5.7	975.4	4,570.6	12,860
	N/A	Arden	n/a	-	-	-	-	-	-	-
	N/A	Apex	n/a	-	-	-	-	-	-	-
	I–515 Henderson	Kingman	94.3	81.3	10.1	2.9	16.1	1,249.4	5,893.6	49,874
	Lake Havasu	Parker	51.2	41.0	9.8	0.4	18.6	1,101.0	4,570.6	21,590
	I–515 Henderson	Lake Havasu	139	124.5	12.6	1.8	15.3	864.0	6,608.9	39,535
Truck to Las Vegas	NNSS from Henderson	via I–515 to US 95	103	73.9	12.9	16.0	8.5	1,165.5	7,628.3	219,906
		via I–215 to I–15 to US 95	108	76.4	19.0	12.3	9.6	1,138.6	7,448.6	182,322
		via I–215 to C–215 to US 95	111	86.7	19.3	4.4	12.4	784.3	7,029.5	75,594
		through Pahrump	129	108.4	16.2	4.3	11.9	893.3	7,072.8	73,764
	NNSS from Arden	via I–15 to US 95	97.6	75.2	13.9	8.4	8.5	1,054.6	7,529.7	125,576
		via I–215 to C–215 to US 95	100	85.6	14.2	0.6	11.7	576.0	5,344.7	19,492
		through Pahrump	117	106.6	9.9	0.1	10.9	645.7	6,109.8	13,341
	NNSS from Apex	via C–215 to US 95	96.1	91.3	4.6	0.2	9.6	579.4	6,852.4	7,706
		via I–15 to US 95	103	81.4	12.2	9.8	9.3	1,031.9	7,841.2	143,816

Mode	***To***	***From***	***Nominal Distance (miles)***	***Distance Traveled in Zone (miles)***			***Population Density in Zone (persons per square mile)***			***Population Affected [a]***
				Rural	***Suburban***	***Urban***	***Rural***	***Suburban***	***Urban***	
Truck to Regional Rail stop	Princeton to Philadelphia	Northeast	33.0	4.7	17.8	10.5	37.3	1,474.0	7,126.4	161,929
	N/A	South	All known waste generators have access to rail at their site.							
	N/A	Southeast	All known waste generators have access to rail at their site.							
	N/A	Upper Midwest	All known waste generators have access to rail at their site.							
	LANL to Albuquerque, NM	Southwest	96.3	71.7	20.3	4.3	20.5		779.8	6,056.5 69,772
	N/A	Mountain West	All known waste generators have access to rail at their site.							
	N/A	Northwest	All known waste generators have access to rail at their site.							
	LBNL to Tracy, CA	West	64.6	27.3	18.3	19.0	34.4		1,264.7	8,009.3 282,257

C = Clark County Route; I = Interstate; LANL = Los Alamos National Laboratory; LBNL = Lawrence Berkeley National Laboratory; N/A = not applicable; US = U.S. Route.

[a] The estimated number of persons residing within 0.5 miles of the transportation route.

[b] For all alternatives, Barstow, California (for westbound shipments), and Kingman, Arizona (for eastbound shipments), are used as proxy sites for Parker, Arizona, where radioactive materials being shipped by rail are transferred to trucks to complete the trip to the Nevada National Security Site. Tecoma, Nevada, is used as a proxy site for West Wendover, Nevada. Proxy sites are used because route-specific distance and population data cannot be determined for Parker, Arizona, and West Wendover, Nevada, using TRAGIS.

E.4.2 Radioactive Material Shipments

All waste types were assumed to be shipped in certified or certified-equivalent packaging on exclusive-use vehicles. Legal-weight, heavy-haul combination trucks are used for highway transportation. Type A packages are transported on common flatbed or covered trailers; Type B packages are generally shipped on trailers designed specifically for the packaging being used. For transportation by truck, the maximum payload weight is considered to be about 48,000 pounds, based on the Federal gross vehicle weight limit of 80,000 pounds. While there are large numbers of multi-trailer combinations (known as longer combination vehicles) with gross weights in excess of the Federal limit in operation on rural roads and turnpikes in some states (FHWA 2003), for evaluation purposes, the load limit for the legal truck is based on the Federal gross vehicle weight. However, the maximum load is often limited by the design load capacity of the cargo container(s), and not the limits on the gross truck weight.

An example of a Type B package is the transuranic waste package transporter II (TRUPACT-II), which is used to transport contact-handled TRU waste (NRC 2009). A new design, the transuranic waste package transporter III (TRUPACT-III), is under licensing review. The TRUPACT-III is a rectangular package that would accommodate waste boxes that are too large for the TRUPACT-II (NEI 2010). Type B packages used to transport special nuclear materials are shipped in specially designed safeguards transporters (SGTs) that contain enhanced structural and security features that are classified. These packages are shipped under operational security procedures and emergency plans that include armed escort, satellite tracking, and advanced communications.

Rail transport can be performed using dedicated and/or general freight trains. For analysis purposes, use of a general freight (manifest) train was assumed. Payload weights for railcars range from 100,000 to 150,000 pounds. A median payload weight of 120,000 pounds was used in this analysis.

The following types of radioactive and nonradioactive wastes and disposal destinations were evaluated for this SWEIS:

- LLW and MLLW, including both contact-handled and remote-handled wastes, would be received for disposal at the NNSS from both onsite and offsite sources. In addition to LLW and MLLW received from DOE facilities, radioisotope thermoelectric generators and sealed sources would also be disposed as LLW.
- TRU waste generated at the NNSS would be transported to Idaho National Laboratory for treatment and certification based on an amended Record of Decision published on March 7, 2008 (73 *Federal Register* [FR] 12401). TRU waste at the NNSS would consist of TRU waste generated by Joint Actinide Shock Physics Experimental Research Facility (JASPER) operations, two 3-foot-diameter steel spheres containing plutonium that were used in subcritical experiments and are now stored at the NNSS, and waste from environmental restoration activities at the Tonopah Test Range (TTR) and the Nevada Test and Training Range. The TRU waste would then be shipped from Idaho National Laboratory to the Waste Isolation Pilot Plant in New Mexico.
- For analytical purposes, hazardous waste generated at the NNSS, TTR, North Las Vegas Facility, and Remote Sensing Laboratory was assumed to be shipped to a treatment, storage, and disposal facility located in Albuquerque, New Mexico, because this location is farther away than the other commonly used facility located in Beatty, Nevada, thereby maximizing the estimated impacts.
- Hazardous and nonhazardous recyclables were assumed to be transported an average of 100 miles one way for disposition.
- Nonradioactive waste, including sanitary solid waste and construction and demolition debris, was assumed to be transported an average of 50 miles one way for disposition.

Special nuclear materials would be received from offsite sources for possible repackaging and temporary storage. Special nuclear material shipments analyzed in this SWEIS include the following:

- 4.4 tons of special nuclear material shipped from Idaho National Laboratory (under the Expanded Operations Alternative only)
- 440 pounds of special nuclear material shipped from Lawrence Livermore National Laboratory (under all alternatives)
- 4.9 pounds of uranium-233 shipped from Los Alamos National Laboratory (under the Expanded Operations Alternative only)
- 1,100 pounds of highly enriched uranium, depleted uranium, and uranium associated with criticality safety experiments shipped from Lawrence Livermore National Laboratory (under all alternatives)
- 880 pounds of plutonium material from Idaho National Laboratory related to Zero Power Plutonium Reactor operations (under the Expanded Operations Alternative only)
- 110 pounds of uranium-233 targets shipped from Oak Ridge National Laboratory (under the Expanded Operations Alternative only)
- Up to 26 pounds of target material, depending on the alternative, shipped from Lawrence Livermore National Laboratory

Sealed sources from the Offsite Source Recovery Program and Global Threat Reduction Initiative would be transported to the NNSS for disposal. For analytical purposes, it was assumed that the sealed sources would originate from the Southwest Research Institute in San Antonio, Texas, as most sealed sources sent to the NNSS would originate from this location.

As part of the Expanded Operations Alternative, nuclear weapons would be transported to the NNSS for component replacement and returned to the U.S. Department of Defense site. Nuclear weapons would be disassembled and the plutonium transported to the Pantex Plant; the canned subassemblies containing enriched uranium would be transported to the Y–12 National Security Complex; milliwatt generators would be transported to Los Alamos National Laboratory; and tritium canisters would be transported to the Savannah River Site (note that this analysis does not evaluate the transportation of tritium because tritium is a beta-emitter and, therefore, would not be a significant source of an external radiation dose).

For the Expanded Operations Alternative, LLW and MLLW volumes from waste generators were determined using data from the Waste Management Information System. These waste volumes were apportioned to containers and numbers of shipments using historical data regarding the types of containers typically received. These waste volumes are shown in **Table E–3** by waste generator. Approval to ship waste to the NNSS for disposal may be granted only after a waste generator demonstrates that it has a waste characterization and certification program that meets the requirements stated in the NNSS waste acceptance criteria. The process by which NNSA certifies a waste generator, as well as the waste acceptance criteria, is described in greater detail in Chapter 4, Section 4.1.11.1.1.3.

The quantities shown in Table E–3 comprise the inventories currently projected and are used for purposes of analysis. The table is not intended to provide a comprehensive listing either of generators that could ship LLW and/or MLLW to the NNSS for disposal or of generator-specific waste volumes that could be disposed in the future. Some of the listed generators may ship larger or smaller quantities than shown based on site-specific determinations. Additionally, some yet-to-be-identified generators may ship LLW and/or MLLW to the NNSS for disposal. While the quantities from individual generators may vary from those shown in the table, the total volume would not exceed 52,000,000 cubic feet of LLW/MLLW. The estimates of LLW and MLLW volumes to be disposed at the NNSS under the Expanded Operations

Alternative are based upon conservative estimates from waste-generating facilities, and the aggregated totals reflect this conservatism (i.e., likely overestimates quantities). Additional National Environmental Policy Act (NEPA) review would be conducted if new generators or waste streams were identified.

Table E–3 Radioactive Waste Generators and Volumes under the Expanded Operations Alternative [a]

Waste Generators	*Region [b]*	*LLW (cubic feet)*	*MLLW (cubic feet)*
	Out-of-State Generators		
Argonne National Laboratory	Upper Midwest	1,300,000	1,200
Brookhaven National Laboratory	Northeast	120,000	NP
Energy Technology Engineering Center	West	110,000	NP
General Atomics	West	8,400	NP
Idaho National Laboratory	Mountain West	1,000,000	46,000
Lawrence Berkeley Laboratory	West	170,000	96
Lawrence Livermore National Laboratory	West	300,000	580
Los Alamos National Laboratory	Southwest	3,200,000	920,000
Naval Reactor Facility	Mountain West	530	NP
Nuclear Fuel Services	South	430,000	NP
Oak Ridge Reservation	South	2,500,000	370,000
Paducah Gaseous Diffusion Plant	South	5,100,000	1,500,000
Pantex Plant	Southwest	20,000	NP
Portsmouth Gaseous Diffusion Plant	Upper Midwest	14,000,000	58,000
Princeton Plasma Physics Laboratory	Northeast	9,900	NP
Puget Sound Naval Shipyard	Northwest	1,100	NP
Sandia National Laboratories	Southwest	7,800	2,900
Savannah River Site	Southeast	160,000	52,000
SLAC National Accelerator Laboratory	West	570,000	570,000
Separations Project Research Unit	Northeast	NP	2,500
West Valley Demonstration Project	Northeast	6,200,000	750
Waste treatment facilities [c]	Multiple regions	88,000	30,000
Commercial enrichment facilities	Upper Midwest	57,000	NP
U.S. Department of Defense (RTGs)	South (Norfolk, VA)	1,400	NP
Offsite Source Recovery Project	Southwest (San Antonio, TX)	8,500	NP
Total Out-of-State Generators		**36,000,000**	**3,500,000**
	In-State Generators		
Nevada Nuclear Security Site	Not applicable	1,300,000	520,000
North Las Vegas Facility	Not applicable	150	NP
Tonopah Test Range & Nevada Test and Training Range	Not applicable	11,000,000	NP
Total In-State Generators		**12,000,000**	**520,000**
All Generators		***48,000,000***	***4,000,000***

LLW = low-level radioactive waste; MLLW = mixed low-level radioactive waste; NP = none projected; RTG = radioisotope thermoelectric generator; SLAC = Stanford Linear Accelerator Center.

[a] Actual individual waste volumes by generator may be more or less than presented in the table, and other yet-to-be-identified generators may ship LLW and/or MLLW to the NNSS for disposal. The quantities shown constitute the inventories currently projected and are used for purposes of analysis only.

[b] Regional location of radioactive waste generators used in the transportation analysis.

[c] Refers to wastes from DOE generators that are sent to the NNSS for disposal after processing at a variety of treatment facilities.

Note: Totals may not equal the sum of individual values because of rounding.

Waste volumes in the table are apportioned to regions of the United States (see Figure E–2) based on the locations of the waste generators. The transportation analysis is based on the regional waste volume totals so that waste generators would not be limited to those obtained from the Waste Management Information System. The total waste volumes by region are assumed to provide conservative estimates of the waste volume to be received from each region of the country.

For the No Action Alternative and Reduced Operations Alternative, it was assumed that the total amount of LLW to be received over a 10-year period, 15,000,000 cubic feet, would be based on the average annual volumes received between FY 1997 and the end of FY 2010. The volume of MLLW analyzed under the No Action and Reduced Operations Alternatives is 900,000 cubic feet, which is based on the permitted volume of Cell 18 at the Area 5 RWMC (the actual permitted volume is 899,996 cubic feet). This volume was apportioned to the waste generators shown in Table E–3 using the percentage of the total volume each waste generator contributed under the Expanded Operations Alternative.

Table E–4 shows the containers assumed to be used for transporting materials and wastes and their physical characteristics. Other containers may be used in addition to, or in lieu of, these containers.

Table E–4 Material or Waste Type and Container Characteristics [a]

Material or Waste Type	*Container*	*Container Volume (cubic feet)* [b]	*Container Mass (pounds)* [c]	*Number of Containers per Shipment*
LLW and MLLW	55-gallon drum	7.35	600	80 per truck 160 per rail
LLW and MLLW	B-12 box	45	10,000	5 per truck 10 per rail
LLW and MLLW	B-25 box	90	10,000	5 per truck 10 per rail
LLW and MLLW	20-foot ISO container	1,360	67,200	1 per truck 2 per rail
Special nuclear material	9975, 9977, B&W 5X22	7.35	300-404	Up to 25 per truck
High-activity LLW and MLLW	High-integrity container	180	20,000	1 per truck 2 per rail
Transuranic waste (JASPER)	Standard waste box	(4) 55-gallon drums	3,633	2 per TRUPACT-II
Transuranic waste	TRUPACT-II	14 drums or 2 standard waste boxes	19,250	3 TRUPACT-IIs per truck 6 TRUPACT-IIs per rail
Special waste [d]	Large box	184	9,500	1 per TRUPACT-III; 3 TRUPACT-IIIs per truck 6 TRUPACT-IIIs per rail
Construction/demolition debris	Roll-on/Roll-off	540	Not applicable	1 per truck
Hazardous	55-gallon drum	7.35	880	60 per truck

ISO = International Organization for Standardization; JASPER = Joint Actinide Shock Physics Experimental Research Facility; LLW = low-level radioactive waste; MLLW = mixed low-level radioactive waste; TRUPACT = transuranic waste package transporter.

[a] Other containers may be used that are not listed in this table.

[b] Container exterior volume. To convert cubic feet to cubic meters, multiply by 0.028317; gallons to liters, by 3.785.

[c] Filled container maximum mass. Container mass includes the mass of the container shell, its internal packaging, and the materials within.

[d] The two 3-foot-diameter steel spheres containing plutonium that were used in subcritical experiments and are now stored at the Nevada National Security Site were assumed to be transported in a TRUPACT-III package.

Note: Hazardous waste would be shipped to an offsite treatment, storage, and disposal facility by truck. Construction debris would be shipped to either an onsite disposal facility or a local offsite location by truck.

Source: CPC 2006; CVSA 2004; Maersk 2010; Certificates of Compliance numbers 9218, 9279, 9250, 9975, 9977.

A shipment is defined as the amount of waste transported on a single truck or a single railcar. In the case of rail transportation, multiple railcars (two or more railcars carrying waste) per train could be used to reduce the number of rail transport shipments. Because the rail accident and fatalities data are per railcar-mile (see Section E.6.2), the transportation analysis presented here is based on one railcar (carrying waste) per transport.

The number of shipping containers per shipment was estimated on the basis of dimensions and weight of the shipping containers, the Transport Index,[1] and the transport vehicle dimensions and weight limits. In general, the various materials and wastes were assumed to be transported on standard truck semi-trailers and railcars in a single stack.

Radioactive waste shipments were assumed to meet the NNSS waste acceptance criteria. This analysis does not specifically account for waste shipments that would be received at the NNSS but returned to the generator because the shipment did not meet the waste acceptance criteria. It is expected that the number of such shipments would be very small compared to the number of shipments received at the NNSS and would not impact the risk results.

This analysis considers transportation of depleted uranium conversion products from the Portsmouth Gaseous Diffusion Plant in Ohio and from the Paducah Gaseous Diffusion Plant in Kentucky to the NNSS under the No Action, Reduced Operations, and Expanded Operations Alternatives. Transportation of these two waste streams to the NNSS for disposal was originally analyzed in the plants' respective environmental impact statements (DOE 2004a, 2004b); however, the analyses for the No Action and Reduced Operations Alternatives use waste volumes and number of shipments analyzed 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 2002c), while the analysis for the Expanded Operations Alternative accounts for the estimated number of truck and rail shipments in the plants' environmental impact statements.

The analysis for the Expanded Operations Alternative also considers transportation of radioactive waste from the West Valley Nuclear Service Center in New York as specified in the *Final Environmental Impact Statement for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center* (DOE 2010b) and the associated Record of Decision published on April 21, 2010 (75 FR 20582). The analysis also considers operational and decommissioning activities associated with United States Enrichment Corporation fuel enrichment activities; uranium-233 downblending activities at Oak Ridge National Laboratory; and sealed sources from the Offsite Source Recovery Program and Global Threat Reduction Initiative. This analysis incorporates the results from these documents. A smaller number of shipments of sealed sources was analyzed under the No Action and Reduced Operations Alternatives.

Radionuclide Inventories

Radionuclide concentrations for the contact-handled and remote-handled LLW and MLLW were determined using NNSS receipt data from fiscal year 2009 and earlier, as applicable. Many different radioactive waste streams, each with a unique radionuclide inventory, would be transported to the NNSS for disposal. To simplify the analysis and provide conservatism, the largest concentration of each radionuclide across all waste streams was assumed for a shipment. The radionuclide concentration for each radioisotope was proportionally adjusted for each type of container based on container volume. **Table E–5** shows the radionuclide concentrations that were used in the analysis for LLW and MLLW. **Table E–6** shows the radionuclide concentration inventory assumed for TRU waste shipments.

[1] *Transport Index is a dimensionless number (rounded up to the next tenth) placed on a package's label to designate the degree of control to be exercised by the carrier. Its value is equivalent to the maximum radiation level in millirem per hour at 1 meter (3.3 feet) from the package (10 CFR 71.4; 49 CFR 173.403).*

Table E–5 Low-Level and Mixed Low-Level Radioactive Waste Radionuclide Concentrations

Radionuclide	*Curies per Cubic Foot*	*Radioisotope*	*Curies per Cubic Foot*	*Radioisotope*	*Curies per Cubic Foot*
Actinium-227	0.000388	Gadolinium-153	4.81×10^{-15}	Radium-226	0.000175
Antimony-124	9.90×10^{-10}	Hydrogen-3	0.661	Radium-228	3.37×10^{-11}
Antimony-125	1.85×10^{-6}	Iodine-125	2.59×10^{-10}	Ruthenium-106	0.0000314
Americium-241	0.0000657	Iodine-129	2.61×10^{-7}	Samarium-151	1.88×10^{-8}
Americium-242M	9.34×10^{-9}	Iron-55	0.212	Scandium-46	6.14×10^{-13}
Americium-243	7.18×10^{-7}	Iron-59	1.58×10^{-9}	Sodium-22	4.49×10^{-8}
Cadmium-109	7.52×10^{-10}	Krypton-85	2.09×10^{-9}	Strontium-89	1.22×10^{-6}
Cadmium-113M	0.0000145	Lead-210	0.0000658	Strontium-90	1.80
Calcium-45	5.06×10^{-10}	Manganese-54	0.0000333	Tantalum-182	0.000364
Californium-252	4.61×10^{-9}	Neptunium-237	5.09×10^{-7}	Technetium-99	0.00129
Carbon-14	0.000402	Neptunium-239	0.0000141	Thallium-204	6.67×10^{-9}
Cesium-134	3.57×10^{-6}	Nickel-59	0.000972	Thorium-228	0.000388
Cesium-137	0.00359	Nickel-63	0.216	Thorium-229	2.82×10^{-8}
Cesium-144	0.0000462	Niobium-94	3.50×10^{-7}	Thorium-230	1.08×10^{-7}
Cobalt-57	6.93×10^{-9}	Palladium-107	3.13×10^{-11}	Thorium-232	1.49×10^{-6}
Cobalt-58	4.71×10^{-6}	Phosphorus -32	2.58×10^{-7}	Thorium-234	0.00114
Cobalt-60	0.315	Plutonium-236	6.17×10^{-12}	Tin-113	2.59×10^{-11}
Curium-242	1.80×10^{-8}	Plutonium-238	0.0000174	Tin-126	4.11×10^{-8}
Curium -243	2.27×10^{-6}	Plutonium-239	0.0000831	Uranium-232	1.97×10^{-6}
Curium -244	0.00116	Plutonium-240	0.0000264	Uranium-233	1.50×10^{-6}
Curium -245	8.98×10^{-7}	Plutonium-241	0.000591	Uranium-234	0.000563
Curium -246	1.40×10^{-7}	Plutonium-242	5.42×10^{-8}	Uranium-235	0.0000398
Curium -247	9.03×10^{-10}	Plutonium-244	1.78×10^{-12}	Uranium-236	0.0000615
Curium -248	2.74×10^{-9}	Polonium-210	6.26×10^{-9}	Uranium-238	0.00476
Europium-152	1.74×10^{-6}	Promethium-147	0.0000313	Yttrium-90	2.58×10^{-10}
Europium-154	0.174	Protactinium-231	4.85×10^{-7}	Zinc-65	9.97×10^{-6}
Europium-155	0.0561	Radium-224	2.33×10^{-10}	Zirconium-93	5.60×10^{-10}

Table E–6 Transuranic Waste Radionuclide Concentrations

Radionuclide	*Curies per Cubic Foot*	*Radionuclide*	*Curies per Cubic Foot*
Americium-241	0.00382	Plutonium-240	0.00227
Plutonium-238	0.00199	Plutonium-241	0.0694
Plutonium-239	0.00281	–	–

Source: Gordon 2010.

Remote-handled LLW and MLLW would be transported to the NNSS for disposal. **Table E–7** summarizes the inventory assumed for this waste stream.

Table E–7 Remote-Handled Low-Level and Mixed Low-Level Radioactive Waste Radionuclide Concentrations

Radionuclide	*Curies per Cubic Foot*	*Radionuclide*	*Curies per Cubic Foot*	*Radionuclide*	*Curies per Cubic Foot*
Carbon-14	0.0000168	Iron-55	0.459	Nickel-63	0.0184
Cobalt-58	0.689	Manganese-54	0.055	Niobium-94	0.0000138
Cobalt-60	0.497	Nickel-59	0.000122	Tantalum-182	0.176

Source: Gordon 2010.

A shipment of special nuclear material containing uranium-233 would be received at the NNSS from Los Alamos National Laboratory under the Expanded Operations Alternative. **Table E–8** shows the radionuclide inventory for a uranium-233 shipment with a low uranium-232 contamination with progenies decayed over 20 years that is used for the analysis in this SWEIS.

Table E–8 Uranium-233 Shipment Radionuclide Inventory

Radionuclide	*Curies*	*Radionuclide*	*Curies*	*Radionuclide*	*Curies*	*Radionuclide*	*Curies*
Actinium-225	0.0705	Radium-224	0.273	Thorium-228	0.273	Uranium-233	24.99
Lead-212	0.0273	Radium-225	0.0706	Thorium-229	0.0707	Uranium-232	0.266

Source: DOE 2008a.

For sealed sources, it was assumed for analytical purposes that each package would have the same characteristics (i.e., dimensions and dose rate). The maximum inventories per package for cobalt-60 and cesium-137 radioisotopes are 6,000 and 10,000 curies, respectively.

Special nuclear material containing plutonium would be transported to the NNSS from Idaho National Laboratory and Lawrence Livermore National Laboratory. For purposes of analysis, it was assumed that the plutonium would be weapons-grade. **Table E–9** shows the radionuclide inventory assumed for a shipment transported from Oak Ridge Reservation containing uranium-233 plates.

Table E–9 Uranium-233 Plates Radionuclide Inventory for a Shipment

Radionuclide	*Curies*	*Radionuclide*	*Curies*	*Radionuclide*	*Curies*	*Radionuclide*	*Curies*
Uranium-232	0.066	Uranium-234	0.033	Uranium-236	< 0.0001	Plutonium-239	0.0003
Uranium-233	4.38	Uranium-235	< 0.001	Uranium-238	< 0.0001		

< = less than.

E.5 Incident-Free Transportation Risks

E.5.1 Radiological Risk

During incident-free transportation of radioactive materials, a radiation dose results from exposure to the external radiation field that surrounds the shipping containers. The population dose is a function of the number of people exposed, their proximity to the containers, the length of exposure time, and the intensity of the radiation field surrounding the containers.

Radiological impacts were determined for crewmembers and the general population during incident-free transportation. For truck shipments, the crewmembers are the drivers of the shipment vehicle. For rail shipments, the crew consists of workers in close proximity to the shipping containers during inspection or classification of railcars. The general population is composed of persons residing within 0.50 miles of the truck or rail routes (off-link), persons sharing the road or railway (on-link), and persons at stops. Exposures to workers who would load and unload the shipments at generator and disposal sites are not included in this analysis, but are included in the occupational estimates for site workers. Exposures to the inspectors, transfer station workers, and escorts are evaluated and presented separately.

Offsite transportation of the radioactive material has a defined regulatory limit of 10 millirem per hour at 6.6 feet from the conveyance (10 CFR 71.47; 49 CFR 173.441). If a waste container shows an external dose rate that could exceed the DOT limit of 10 millirem per hour at 6.6 feet from the outer, or lateral, edge of the vehicle, it would be transported in a Type A or Type B shielded shipping container. The shielding would reduce the external dose rate to levels within the DOT limits.

Collective doses to the crew and general population were calculated using the RADTRAN 6 computer code (SNL 2009). RADTRAN dose calculations are based on an external dose rate at 3.3 feet from the surface of the waste container. A waste container's dose rate, or its Transport Index, depends on the distribution and quantities of radionuclides, waste density, shielding provided by the packaging, and self-shielding provided by the waste mixture. Wastes were assumed to be in appropriate Type A or Type B shipping packages. For example, contact-handled LLW was assumed to be shipped in containers such as B-25 boxes or 55-gallon drums (Type A containers), and remote-handled LLW in a CNS 10-160B (Type B) cask.

Dose rates of 1 millirem per hour at 3.3 feet and 10 millirem per hour at 3.3 feet were assigned for contact-handled LLW and MLLW and remote-handled LLW and MLLW, respectively. A dose rate of 0.01 millirem per hour at 3.3 feet was assigned for LLW and MLLW from the TTR and the Nevada Test and Training Range. The contact-handled TRU waste package was assigned a dose rate of 4 millirem per hour at 3.3 feet (DOE 1997). A dose rate of 1 millirem per hour at 3.3 feet was assigned to plutonium pits, highly enriched uranium, and uranium-233. A dose rate of 5 millirem per hour at 3.3 feet was assigned to plutonium transported under the Global Threat Reduction Initiative.

For sealed sources, the external dose rate at 3.3 feet from the trailer was assumed to be 10 millirem per hour. The external dose rate for nuclear weapons transport was assumed to be 3 millirem per hour at 3.3 feet. The dose rate for shipments of the milliwatt generators was assumed to be at the regulatory limit of 10 millirem per hour at 6.6 feet from the cask or the outer surface of the vehicle (10 CFR 71.47). The dose rates for plutonium and enriched uranium were assumed to be 1 millirem per hour at 3.3 feet from the outer surface of the vehicle. The tritium gas, which undergoes beta decay and is contained within the canister shielding, does not exhibit any measurable external dose rate and was not analyzed. The dose rates for other special nuclear materials not specified here were assumed to be 1 millirem per hour at 3.3 feet.

To calculate the collective dose, a unit risk factor was developed to estimate the impact of transporting one shipment of radioactive material over a unit distance of travel in a given population density zone. The unit risk factors were combined with routing information, such as the shipment distances in various population density zones, to determine the risk for a single shipment (a shipment risk factor) between a given origin and destination. Unit risk factors were developed on the basis of travel on interstate highways and freeways, as required by 49 CFR Parts 171 through 177 for highway-route-controlled quantities of radioactive material within rural, suburban, and urban population zones by using RADTRAN and its default data. In addition, the analysis assumed that, 10 percent of the time, travel through suburban and urban zones would encounter rush-hour conditions, leading to lower average speed and higher traffic density. The radiological risks from transporting the waste are estimated in terms of the number of LCFs among the crew and the exposed population. A health risk conversion factor of 0.0006 LCFs per person-rem of exposure was used for both the public and workers (DOE 2003).

E.5.2 Nonradiological Risk

The nonradiological (vehicle-related) health risks resulting from incident-free transport may be associated with the generation of air pollutants by transport vehicles during shipment and are independent of the radioactive nature of the shipment. The health endpoint assessed under incident-free transport conditions is the excess latent mortality due to inhalation of vehicle emissions. Unit risk factors for pollutant inhalation in terms of mortality have been generated (Rao et al. 1982); however, the emergence of considerable data regarding threshold values for various chemical constituents of vehicle exhaust has made linear extrapolation to estimate the risks from vehicle/rail emissions untenable (Neuhauser et al. 2000). This calculation has been dropped from RADTRAN in its recent revision (SNL 2009); therefore, no risk factors have been assigned to the vehicle emissions in this SWEIS.

E.5.3 Maximally Exposed Individual Exposure Scenarios

The maximum individual doses for routine offsite transportation were estimated for transportation workers, as well as for members of the general population. For truck shipments, three hypothetical scenarios were evaluated to determine the MEI in the general population. These scenarios are as follows (DOE 2002a):

- A person caught in traffic and located 3.3 feet from the surface of the shipping container for 30 minutes
- A resident living 98 feet from the highway used to transport the shipping container
- A service station worker at a distance of 52 feet from the shipping container for 50 minutes

The hypothetical MEI doses were accumulated over a single year for all transportation shipments. However, for the scenario involving an individual caught in traffic next to a shipping container, the radiological exposures were calculated for only one event because it was considered unlikely that the same individual would be caught in traffic next to all containers for all shipments. For truck shipments, the maximally exposed transportation worker is the driver, who was assumed to have been trained as a radiation worker and to drive shipments for up to 2,000 hours per year, accumulating an exposure of 2 rem per year. For a member of the truck crew who is not trained as a radiation worker, the maximum annual dose rate would be 100 millirem (10 CFR 20.1301).

The following three hypothetical scenarios were also evaluated for railcar shipments:

- A rail yard worker working at a distance of 33 feet from the shipping container for 2 hours
- A resident living 98 feet from the rail line where the shipping container is being transported
- A resident living 656 feet from a rail stop during classification and inspection for 20 hours

The maximally exposed transportation worker (excluding drivers) for both truck and rail shipments is an individual inspecting the cargo at a distance of 3.3 feet from the shipping container for 1 hour.

E.6 Transportation Accident Risks

E.6.1 Methodology

The offsite transportation accident analysis considers the impact of accidents during the transportation of waste by truck or rail. Under accident conditions, human health and environmental impacts could result from the release and dispersal of radioactive material. Transportation accident impacts were assessed using an accident analysis methodology developed by NRC. This section provides an overview of the methodologies; detailed descriptions of various methodologies are found in NUREG-0170, *Radioactive Material Transportation Study*; NUREG/CR-4829, *Modal Study*; and NUREG/CR-6672, *Reexamination Study* (NRC 1977, 1987, 2000). Accidents that could potentially breach the shipping container are represented by a spectrum of accident severities and radioactive release conditions. Historically, most transportation accidents involving radioactive materials have resulted in little or no release of radioactive material from the shipping container. Consequently, the analysis of accident risks takes into account a spectrum of accidents ranging from high-probability accidents of low severity to hypothetical high-severity accidents that have a correspondingly low probability of occurrence. The accident analysis calculates the probabilities and consequences from this spectrum of accidents.

To provide DOE and the public with a reasonable assessment of radioactive waste transportation accident impacts, two types of analysis were performed. First, an accident risk assessment was performed that takes into account the probabilities and consequences of a spectrum of potential accident severities using a methodology developed by NRC (NRC 1977, 1987, 2000). For the spectrum of accidents considered in the analysis, accident consequences in terms of collective "dose risk" to the population within 50 miles were determined using the RADTRAN 6 computer program (SNL 2009). The RADTRAN code sums the product of consequences and probability over all accident severity categories to obtain a probability-weighted risk value referred to in this appendix as "dose risk," which is expressed in units of person-rem. Second, to represent the maximum reasonably foreseeable impacts on individuals and populations should an accident occur, maximum radiological consequences were calculated in an urban or suburban population zone for an accidental release with a likelihood of occurrence greater than 1 in 10 million per year using the RISKIND computer program (Yuan et al. 1995).

For accidents in which a waste container or the cask shielding is not damaged, population and individual radiation exposures from the waste package were evaluated for the duration of time needed to recover and resume shipment. The collective dose over all segments of transportation routes was evaluated for an affected population up to a distance of 0.5 miles from the accident location. This dose would be an external dose and would be approximately inversely proportional to the square of the distance of the affected population from the accident. Any additional dose to those residing beyond 0.5 miles from the accident would be negligible. The dose to an individual (first responder) was calculated assuming that the individual would be located at 6.6 to 33 feet from the package. For the accidents leading to loss of cask shielding, a method similar to that provided in NUREG/CR-6672, *Reexamination Study* (NRC 2000) and adapted in the *Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada (Yucca Mountain EIS)* was used (DOE 2002a).

E.6.2 Accident Rates

Whenever material is shipped, the possibility exists that a traffic accident could result in vehicular damage, injury, or death. Even when drivers are trained in defensive driving and taking great care, there is a risk of a traffic accident. To date, DOE and its predecessor agencies have a successful 50-year history in transporting radioactive materials. In the years 2004 to 2008, no fatalities related to DOE's transportation of hazardous or radioactive material cargo for the Office of Environmental Management occurred (DOE 2009). DOE Manual 460.2-1A, *Radioactive Material Transportation Practices Manual for Use with DOE Order 460.2A*, contains stipulations that DOE and its shipping contractors follow regarding conditions under which shipments should be made (DOE 2008b).

To calculate the accident risks, vehicle accident and fatality rates were taken from data provided in *State-Level Accident Rates for Surface Freight Transportation: A Reexamination* (Saricks and Tompkins 1999). Accident rates are generically defined as the number of accident involvements (or fatalities) in a given year per unit of travel in that same year. Therefore, the rate is a fractional value, with accident involvement count as the numerator of the fraction and vehicular activity (total travel distance in truck miles) as its denominator. Accident rates were generally determined for a multi-year period. For assessment purposes, the total number of expected accidents or fatalities was calculated by multiplying the total shipment distance for a specific case by the appropriate accident or fatality rate. No reduction in accident or fatality rates was assumed even though radioactive material carrier drivers are better trained and have better-maintained equipment.

For truck transportation, the rates presented are specifically for heavy-haul combination trucks involved in interstate commerce (Saricks and Tompkins 1999). Heavy-haul combination trucks are rigs composed of a separable tractor unit containing the engine and one to three freight trailers connected to each other. Heavy-haul combination trucks are typically used for radioactive material shipments. Truck accident rates were computed for each state based on statistics compiled by the Federal Highway Administration, Office of Motor Carriers, from 1994 to 1996. A fatality caused by an accident is the death of a member of the public who is killed instantly or dies within 30 days due to injuries sustained in the accident. The accident and fatality rates are per truck-mile or railcar-mile.

For offsite transportation, the accident and fatality rates for this SWEIS were based on state-level data provided in the Saricks and Tompkins report (Saricks and Tompkins 1999). The rates in the Saricks and Tompkins report are given in terms of accident and fatality per car-kilometer and railcar-kilometer traveled. Accident and fatality rates for trucks are provided by population zone. This information is used to determine the accident and fatality rate specific to each truck and rail route. For in-state truck transport, Nevada accident and fatality rates were used (Saricks and Tompkins 1999).

A recent review of the truck accidents and fatalities reports by the Federal Carrier Safety Administration indicated that state-level accidents and fatalities were underreported. For the years 1994 through 1996, which were the basis for the analysis in the Saricks and Tompkins report, the review found that accidents were underreported by about 39 percent and fatalities were underreported by about 36 percent (UMTRI 2003). Therefore, truck accident and fatality rates were increased by factors of 1.64 and 1.57, respectively, in this SWEIS to account for the underreporting. Rail accident and fatality rates were increased by a factor of 3.

For each rail shipment, it was assumed that each train would consist of at least three cars: a locomotive, a crew car, and a railcar carrying waste.

For DOE SGTs, the DOE operational experience between 1984 and 1999 was used. The mean probability of an accident requiring towing of a disabled SGT was about 6 per 100 million kilometers (DOE 2000). The number of SGT trailer accidents is too small to support allocating this overall rate among the various types of routes (interstate, primary, others) used in the accident analysis. Therefore, data for the relative rate of accidents on these route types, or influence factor, provided in *Determination of Influence Factor and Accident Rates for Armored Tractor/Safe Secure Trailer* (Phillips, Clauss, and Blower 1994), were used to estimate accident frequencies for rural, urban, and suburban transports. Accident fatalities for SGTs were estimated using the commercial truck transport fatality per accident ratios within each zone.

E.6.3 Accident Severity Categories and Conditional Probabilities

Accident severity categories for potential radioactive waste transportation accidents are described in NUREG-0170, *Radioactive Material Transportation Study* (NRC 1977) (for radioactive waste in general); in NUREG/CR-4829, *Modal Study* (NRC 1987); and in NUREG/CR-6672, *Reexamination Study* (NRC 2000) (for spent nuclear fuel). The methods described in the *Modal Study* and the *Reexamination Study* are applicable to transportation of radioactive materials in a Type B spent fuel cask.

The accident severity categories presented in the *Radioactive Material Transportation Study* would be applicable to all other waste transported off site.

The *Radioactive Material Transportation Study* (NRC 1977) originally was used to estimate conditional probabilities associated with accidents involving transportation of radioactive materials. The *Modal Study* and the *Reexamination Study* (NRC 1987, 2000) are initiatives taken by NRC to refine more precisely the analysis presented in the *Radioactive Material Transportation Study* for spent nuclear fuel shipping casks.

Whereas the *Radioactive Material Transportation Study* (NRC 1977) analysis was primarily performed using best engineering judgments and presumptions concerning cask response, the later studies relied on sophisticated structural and thermal engineering analysis and a probabilistic assessment of the conditions that could be experienced in severe transportation accidents. The latter results are based on representative spent nuclear fuel casks assumed to have been designed, manufactured, operated, and maintained according to national codes and standards. Design parameters of the representative casks were chosen to meet the minimum test criteria specified in 10 CFR Part 71. The study is believed to provide realistic, yet conservative, results for radiological releases during transport accident conditions.

In both the *Modal Study* and the *Reexamination Study*, potential accident damage to a cask is categorized according to the magnitude of the mechanical forces (impact) and thermal forces (fire) to which a cask may be subjected during an accident. Because all accidents can be described in these terms, severity is independent of the specific accident sequence. In other words, any sequence of events that results in an accident in which a cask is subjected to forces within a certain range of values is assigned to the accident severity region associated with that range. The accident severity scheme is designed to take into account all potential foreseeable transportation accidents, including accidents with low probability but high consequences and those with high probability but low consequences.

As discussed earlier, the accident consequence assessment considers the potential impacts of severe transportation accidents. In terms of risk, the severity of an accident must be viewed in terms of potential radiological consequences, which are directly proportional to the fraction of the radioactive material within a cask that is released to the environment during the accident. Although accident severity regions span the entire range of mechanical and thermal accident loads, they are grouped into accident categories that can be characterized by a single set of release fractions and are, therefore, considered together in the accident consequence assessment. The accident category severity fraction is the sum of all conditional probabilities in that accident category.

For the accident risk assessment, accident "dose risk" was generically defined as the product of the consequences of an accident and the probability of occurrence of that accident, an approach consistent with the methodology used by the RADTRAN computer code. The RADTRAN code sums the product of consequences and probability over all accident categories to obtain a probability-weighted risk value referred to in this appendix as "dose risk," which is expressed in units of person-rem.

E.6.4 Atmospheric Conditions

Because it is impossible to predict the specific location of an offsite transportation accident, generic atmospheric conditions were selected for the risk and consequence assessments. On the basis of observations from National Weather Service surface meteorological stations at more than 177 locations in the United States, on an annual average, neutral conditions (Pasquill Stability Classes C and D) occur 58.5 percent of the time, and stable (Pasquill Stability Classes E, F, and G) and unstable (Pasquill Stability Classes A and B) conditions occur 33.5 percent and 8 percent of the time, respectively (DOE 2002a). The neutral weather conditions dominate in each season, but most frequently in the winter (nearly 60 percent of the observations).

Neutral weather conditions (Pasquill Stability Class D) are the most frequently occurring atmospheric stability condition in the United States and are thus most likely to be present in the event of an accident involving a radioactive waste shipment. Neutral weather conditions are typified by moderate windspeeds, vertical mixing within the atmosphere, and good dispersion of atmospheric contaminants. Stable weather conditions are typified by low windspeeds, very little vertical mixing within the atmosphere, and poor dispersion of atmospheric contaminants. The atmospheric condition used in RADTRAN is an average weather condition that corresponds to a stability class spread between Class D (for near distance) and Class E (for farther distance).

The accident consequences for the maximum reasonably foreseeable accident (an accident with a likelihood of occurrence greater than 1 in 10 million per year) were assessed under both stable (Class F with a windspeed of 3.3 feet per second) and neutral (Class D with a windspeed of 13 feet per second) atmospheric conditions. The population dose was evaluated under neutral atmospheric conditions and the MEI dose, under stable atmospheric conditions. The population dose would represent an accident during average weather conditions, while the MEI dose would represent an accident during weather conditions that would yield the greatest impacts (stable conditions, with minimum diffusion and dilution).

E.6.5 Radioactive Release Characteristics

Radiological consequences were calculated by assigning radionuclide release fractions on the basis of the type of waste, the type of shipping container, and the accident severity category. The release fraction is defined as the fraction of the radioactivity in the container that could be released to the atmosphere in a given severity of accident. Release fractions vary according to waste type and the physical or chemical properties of the radioisotopes. Most solid radionuclides are nonvolatile and are, therefore, relatively nondispersible.

Representative release fractions were developed for each waste and container type on the basis of DOE and NRC reports (DOE 1994, 2002b, 2003; NRC 1977, 2000). The severity categories and corresponding release fractions provided in these documents cover a range of accidents from no impact (zero speed) to impacts with speeds in excess of 120 miles per hour onto an unyielding surface. Traffic accidents that could occur at the site would result in minor impacts due to lower local speed, with no release potential.

For radioactive wastes transported in a Type B cask, the particulate release fractions were developed consistent with the models in NUREG/CR-6672, *Reexamination Study* (NRC 2000). For wastes transported in Type A containers (e.g., 55-gallon drums and boxes), the fractions of radioactive material released from the shipping container were based on recommended values from the *Radioactive Material Transportation Study* (NRC 1977) and the *DOE Handbook on Airborne Release and Respirable Fractions* (DOE 1994). For contact-handled and remote-handled TRU waste, the release fractions corresponding to the *Radioactive Material Transportation Study* severity categories, as adapted in the *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement (WIPP SEIS-II)*, were used (DOE 1997). For wastes transported in high-integrity containers and lift liners in 20-foot International Organization for Standardization (ISO) containers, release fractions were calculated using a method similar to that used in the *WIPP SEIS-II*.

For accidents in which the waste container or cask shielding is not damaged and no radioactive material is released, it was assumed that it would take 12 hours to recover from the accident and resume shipment. During this period, no individual would remain close to the cask. A first responder could stay at a location 6.6 to 33 feet from the package, at a position where the dose rate would be the highest, for 30 minutes in a loss-of-shielding accident and 1 hour for other accidents with no release (DOE 2002b).

E.6.6 Acts of Sabotage or Terrorism

In the aftermath of the tragic events of September 11, 2001, DOE is continuing to assess measures to minimize the risk or potential consequences of radiological sabotage. While it is not possible to determine terrorists' motives and targets with certainty, DOE considers the threat of terrorist attacks to be real and makes all efforts to reduce any vulnerability to this threat. DOE considers, evaluates, and plans for potential terrorist attacks during transportation and storage of special nuclear materials such as plutonium and enriched uranium. These materials would be transported using DOE's safe and secure transport equipment and would be escorted by protective force personnel. DOE has a proven record of protecting these assets; no diversion of any DOE nuclear material has occurred. The details of any postulated terrorist attack, as well as DOE's plans for the security of its facilities and terrorist countermeasures, are classified. A classified appendix has been prepared for this SWEIS that includes impact analyses for intentional acts of destruction related to transportation.

Additionally, DOE has evaluated the impacts of acts of sabotage and terrorism on transportation of spent nuclear fuel and high-level radioactive waste shipments (DOE 1996, 2002a). The spectrum of accidents considered ranges from a direct attack on a cask from afar to hijacking and exploding a shipping cask in an urban area. Both of these actions would result in damaging the cask and its contents and releasing radioactive materials. The fraction of the materials released is dependent on the nature of the attack (type of explosive or weapon used). The sabotage event evaluated in the *Yucca Mountain EIS* (DOE 2002a) was considered as the enveloping analysis for this SWEIS. The event was assumed to involve either a truck-sized or a rail-sized cask containing light-water reactor spent nuclear fuel. The consequences of such an act were calculated to result in an MEI dose (at 460 feet) of 40 to 110 rem for events involving a rail-sized or truck-sized cask, respectively. These events would lead to an increase in the risk of fatal cancer to the MEI by 2 to 7 percent, or 2 chances in 100 to 7 chances in 100 (DOE 2002a). The quantity of radioactive materials transported under all alternatives considered here would be less than that considered in the analysis in the *Yucca Mountain EIS*. Therefore, estimates of risk in the *Yucca Mountain EIS* envelop the risks from an act of sabotage or terrorism involving the radioactive material transported under all alternatives considered in this SWEIS.

E.7 Risk Analysis Results

Per-shipment risk factors have been calculated for the collective populations of exposed persons and for the crew for all anticipated routes and shipment configurations. Radiological risks are presented in doses per shipment for each unique route, material, and container combination. Radiological risk factors per shipment for incident-free transportation and accident conditions for the Constrained Case are presented in **Table E–10**. For incident-free transportation, both dose and LCF risk factors are provided for the crew and the exposed general population. The radiological risks would result from potential exposure of people to external radiation emanating from the packaged waste. The exposed population includes the off-link public (i.e., people living along the route), the on-link public (i.e., pedestrian and car occupants along the route), and the public at rest and fuel stops.

Table E–10 Risk Factors per Shipment of Radioactive Waste and Materials

Region/ Destination/ Origin	*Waste or Materials*	*Container*	*Incident-Free Conditions*				*Accident Conditions*	
			Crew Dose (person-rem)	*Crew Risk (LCF)*	*Population Dose (person-rem)*	*Population Risk (LCF)*	*Radiological Risk (LCF)*	*Roundtrip Nonradiological Risk (traffic fatalities)*
Truck Shipments								
Northeast	CH-LLW/MLLW [a]	55-gallon drum (CH)	0.058	0.000035	0.027	0.000016	1.7×10^{-8}	0.00016
		B-25 box	0.048	0.000029	0.016	9.4×10^{-6}	1.5×10^{-8}	0.00016
		B-12 box	0.042	0.000025	0.016	9.4×10^{-6}	7.6×10^{-9}	0.00016
		20-foot ISO	0.083	0.00005	0.021	0.000013	2.8×10^{-8}	0.00016
	RH-LLW/MLLW [b]	55-gallon drum (RH)	0.42	0.00025	0.055	0.000033	3.9×10^{-12}	0.00016
Southeast	CH-LLW/MLLW [a]	55-gallon drum (CH)	0.047	0.000028	0.021	0.000013	1.2×10^{-8}	0.00013
		B-25 box	0.039	0.000023	0.012	7.4×10^{-6}	1.0×10^{-8}	0.00013
		B-12 box	0.034	0.00002	0.012	7.4×10^{-6}	5.1×10^{-9}	0.00013
		20-foot ISO	0.067	0.00004	0.015	9.3×10^{-6}	1.9×10^{-8}	0.00013
	RH-LLW/MLLW [b]	55-gallon drum (RH)	0.34	0.0002	0.043	0.000026	2.5×10^{-12}	0.00013
South	CH-LLW/MLLW [a]	55-gallon drum (CH)	0.042	0.000025	0.019	0.000011	8.0×10^{-9}	0.00011
		B-25 box	0.035	0.000021	0.011	6.6×10^{-6}	7.0×10^{-9}	0.00011
		B-12 box	0.03	0.000018	0.011	6.6×10^{-6}	3.5×10^{-9}	0.00011
		20-foot ISO	0.060	0.000036	0.014	8.2×10^{-6}	1.3×10^{-8}	0.00011
	RH-LLW/MLLW [b]	55-gallon drum (RH)	0.03	0.00018	0.038	0.000023	1.6×10^{-12}	0.00011
Southwest	CH-LLW/MLLW [a]	55-gallon drum (CH)	0.021	0.000012	0.0090	5.4×10^{-6}	2.8×10^{-9}	0.000052
		B-25 box	0.017	0.00001	0.0053	3.2×10^{-6}	2.4×10^{-9}	0.000052
		B-12 box	0.015	8.9×10^{-6}	0.0053	3.2×10^{-6}	1.2×10^{-9}	0.000052
		20-foot ISO	0.03	0.000018	0.0059	3.5×10^{-6}	4.6×10^{-9}	0.000052
	RH-LLW/MLLW [b]	55-gallon drum (RH)	0.15	0.00009	0.019	0.000011	6.2×10^{-13}	0.000052
West	CH-LLW/MLLW [a]	55-gallon drum (CH)	0.014	8.3×10^{-6}	0.0065	3.9×10^{-6}	4.1×10^{-9}	0.000037
		B-25 box	0.011	6.9×10^{-6}	0.0038	2.3×10^{-6}	3.6×10^{-9}	0.000037
		B-12 box	0.0099	5.9×10^{-6}	0.0038	2.3×10^{-6}	1.8×10^{-9}	0.000037
		20-foot ISO	0.02	0.000012	0.0046	2.8×10^{-6}	6.7×10^{-9}	0.000037
	RH-LLW/MLLW [b]	55-gallon drum (RH)	0.1	0.00006	0.013	8.0×10^{-6}	1.5×10^{-12}	0.000037

Region/ Destination/ Origin	Waste or Materials	Container	*Incident-Free Conditions* Crew Dose (person-rem)	Crew Risk (LCF)	Population Dose (person-rem)	Population Risk (LCF)	*Accident Conditions* Radiological Risk (LCF)	Roundtrip Nonradiological Risk (traffic fatalities)
Northwest	CH-LLW/MLLW [a]	55-gallon drum (CH)	0.03	0.000018	0.015	8.8×10^{-6}	1.2×10^{-8}	0.000087
		B-25 box	0.025	0.000015	0.0086	5.2×10^{-6}	1.1×10^{-8}	0.000087
		B-12 box	0.021	0.000013	0.0086	5.2×10^{-6}	5.4×10^{-9}	0.000087
		20-foot ISO	0.042	0.000025	0.013	7.9×10^{-6}	2.0×10^{-8}	0.000087
	RH-LLW/MLLW [b]	55-gallon drum (RH)	0.22	0.00013	0.030	0.000018	3.6×10^{-12}	0.000087
Mountain West	CH-LLW/MLLW [a]	55-gallon drum (CH)	0.015	9.3×10^{-6}	0.0067	4.0×10^{-6}	2.2×10^{-9}	0.000039
		B-25 box	0.013	7.7×10^{-6}	0.0040	2.4×10^{-6}	1.9×10^{-9}	0.000039
		B-12 box	0.011	6.6×10^{-6}	0.0040	2.4×10^{-6}	9.4×10^{-10}	0.000039
		20-foot ISO	0.022	0.000013	0.0045	2.7×10^{-6}	3.5×10^{-9}	0.000039
	RH-LLW/MLLW [b]	55-gallon drum (RH)	0.11	0.000067	0.014	8.3×10^{-6}	5.2×10^{-13}	0.000039
Upper Midwest	CH-LLW/MLLW [a]	55-gallon drum (CH)	0.040	0.000024	0.018	0.000011	7.8×10^{-9}	0.00011
		B-25 box	0.034	0.00002	0.011	6.3×10^{-6}	6.8×10^{-9}	0.00011
		B-12 box	0.029	0.000017	0.011	6.3×10^{-6}	3.4×10^{-9}	0.00011
		20-foot ISO	0.058	0.000035	0.013	8.1×10^{-6}	1.3×10^{-8}	0.00011
	RH-LLW/MLLW [b]	55-gallon drum (RH)	0.29	0.00018	0.037	0.000022	1.4×10^{-12}	0.00011
INL	TRU waste [c, g]	55-gallon drum	0.049	0.000029	0.016	9.8×10^{-6}	7.0×10^{-10}	0.000039
Parker	CH-LLW/MLLW [a]	55-gallon drum (CH)	0.0065	3.9×10^{-6}	0.0028	1.7×10^{-6}	7.9×10^{-10}	0.000016
		B-25 box	0.0054	3.2×10^{-6}	0.0016	9.9×10^{-7}	6.9×10^{-10}	0.000016
		B-12 box	0.0046	2.8×10^{-6}	0.0016	9.9×10^{-7}	3.5×10^{-10}	0.000016
		20-foot ISO	0.0092	5.5×10^{-6}	0.0019	1.2×10^{-6}	1.3×10^{-9}	0.000016
	RH-LLW/MLLW [b]	55-gallon drum (RH)	0.047	0.000028	0.0057	3.4×10^{-6}	9.7×10^{-14}	0.000016
West Wendover	CH-LLW/MLLW [a]	55-gallon drum (CH)	0.0088	5.3×10^{-6}	0.0037	2.2×10^{-6}	2.5×10^{-10}	0.000021
		B-25 box	0.0073	4.4×10^{-6}	0.0022	1.3×10^{-6}	2.2×10^{-10}	0.000021
		B-12 box	0.0063	3.8×10^{-6}	0.0022	1.3×10^{-6}	1.1×10^{-10}	0.000021
		20-foot ISO	0.013	7.5×10^{-6}	0.0020	1.2×10^{-6}	4.1×10^{-10}	0.000021
	RH-LLW/MLLW [b]	55-gallon drum (RH)	0.064	0.000038	0.0076	4.6×10^{-6}	3.4×10^{-14}	0.000021
Transport in Nevada – via southern route (Routes 95 - 160)	CH-LLW/MLLW [a, h]	55-gallon drum (CH)	0.0036	2.2×10^{-6}	0.0016	9.3×10^{-7}	3.8×10^{-10}	0.000021
		B-25 box	0.0030	1.8×10^{-6}	0.00092	5.5×10^{-7}	3.3×10^{-10}	0.000021
		B-12 box	0.0026	1.6×10^{-6}	0.00092	5.5×10^{-7}	1.7×10^{-10}	0.000021
		20-foot ISO	0.0052	3.1×10^{-6}	0.0010	6.0×10^{-7}	6.2×10^{-10}	0.000021
	RH-LLW/MLLW [b]	55-gallon drum (RH)	0.026	0.000016	0.0032	1.9×10^{-6}	5.1×10^{-14}	0.000021

Region/ Destination/ Origin	***Waste or Materials***	***Container***	***Incident-Free Conditions***				***Accident Conditions***	
			Crew Dose (person-rem)	***Crew Risk (LCF)***	***Population Dose (person-rem)***	***Population Risk (LCF)***	***Radiological Risk (LCF)***	***Roundtrip Nonradiological Risk (traffic fatalities)***
Transport in Nevada – via northern route (Routes 6 - 95)	CH-LLW/MLLW [a, h]	55-gallon drum (CH)	0.0088	5.3×10^{-6}	0.0037	2.2×10^{-6}	1.4×10^{-10}	0.000021
		B-25 box	0.0073	4.4×10^{-6}	0.0022	1.3×10^{-6}	1.3×10^{-10}	0.000021
		B-12 box	0.0063	3.8×10^{-6}	0.0022	1.3×10^{-6}	6.3×10^{-11}	0.000021
		20-foot ISO	0.013	7.5×10^{-6}	0.0020	1.2×10^{-6}	2.3×10^{-10}	0.000021
	RH-LLW/MLLW [b]	55-gallon drum (RH)	0.064	0.000038	0.0076	4.5×10^{-6}	1.8×10^{-14}	0.000021
Truck Shipments for Sealed Sources								
Southwest Research Institute	Cobalt-60	CNS 10-160B	0.14	0.000083	0.036	0.000021	1.8×10^{-15}	0.000036
	Cesium-137	CNS 10-160B	0.14	0.000083	0.036	0.000021	4.0×10^{-13}	0.000036
In Nevada [h]	Cobalt-60	CNS 10-160B	0.018	0.000011	0.0046	2.7×10^{-6}	9.5×10^{-17}	4.3×10^{-6}
	Cesium-137	CNS 10-160B	0.018	0.000011	0.0046	2.7×10^{-6}	6.1×10^{-15}	4.3×10^{-6}
Special Nuclear Material Shipments								
LLNL [d]	SNM/HEU	Drum [e]	0.0022	1.3×10^{-6}	0.0027	1.6×10^{-6}	1.6×10^{-15}	3.3×10^{-6}
LLNL [d]	Plutonium/fuel grade	Drum [e]	0.011	6.6×10^{-6}	0.014	8.1×10^{-6}	2.0×10^{-11}	3.3×10^{-6}
LLNL	Plutonium/target material	Drum	0.00079	4.7×10^{-7}	0.00062	3.7×10^{-7}	4.0×10^{-10}	0.000038
INL [d]	SNM/HEU	Drum [e]	0.0025	1.5×10^{-6}	0.0029	1.7×10^{-6}	1.1×10^{-15}	3.3×10^{-6}
INL	SNM/plutonium plates	Drum [e]	0.0032	1.9×10^{-6}	0.0073	4.4×10^{-6}	1.5×10^{-10}	3.3×10^{-6}
LANL [d]	Uranium-233	Drum [e]	0.020	0.000012	0.030	0.000018	3.2×10^{-12}	3.6×10^{-6}
Oak Ridge Reservation	Uranium-233 plates	Drum	0.0033	2.0×10^{-6}	0.0027	1.6×10^{-6}	5.6×10^{-11}	0.00011
Pantex [d]	SNM/plutonium	Drum [e]	0.0033	2.0×10^{-6}	0.0038	2.3×10^{-6}	3.4×10^{-11}	4.4×10^{-6}
Norfolk, VA	Nuclear Weapon	SGT	0.025	0.000015	0.029	0.000018	5.5×10^{-10}	0.000013
Y-12	Enriched Uranium	ES3100	0.0067	4.0×10^{-6}	0.0078	4.7×10^{-6}	5.7×10^{-15}	9.5×10^{-6}
LANL	Milliwatt Generator	Mound-1KW	0.021	0.000012	0.018	0.000011	4.0×10^{-10}	3.6×10^{-6}
Rail Shipments [f]								
Northeast	CH-LLW/MLLW [a]	55-gallon drum (CH)	0.033	0.000020	0.013	8.0×10^{-6}	6.9×10^{-9}	0.00075
		B-25 box	0.037	0.000022	0.016	9.8×10^{-6}	6.0×10^{-9}	0.00075
		B-12 box	0.037	0.000022	0.016	9.8×10^{-6}	3.0×10^{-9}	0.00075
		20-foot ISO	0.033	0.000020	0.013	8.0×10^{-6}	1.1×10^{-8}	0.00075
	RH-LLW/MLLW [b]	55-gallon drum (RH)	0.17	0.00010	0.067	0.000040	8.5×10^{-12}	0.00075

			Incident-Free Conditions				***Accident Conditions***	
Region/ Destination/ Origin	***Waste or Materials***	***Container***	***Crew Dose (person-rem)***	***Crew Risk (LCF)***	***Population Dose (person-rem)***	***Population Risk (LCF)***	***Radiological Risk (LCF)***	***Roundtrip Nonradiological Risk (traffic fatalities)***
Southeast	CH-LLW/MLLW [a]	55-gallon drum (CH)	0.029	0.000018	0.011	6.7×10^{-6}	5.9×10^{-9}	0.00065
		B-25 box	0.032	0.000019	0.014	8.2×10^{-6}	5.2×10^{-9}	0.00065
		B-12 box	0.032	0.000019	0.014	8.2×10^{-6}	2.6×10^{-9}	0.00065
		20-foot ISO	0.029	0.000018	0.011	6.7×10^{-6}	9.6×10^{-9}	0.00065
	RH-LLW/MLLW [b]	55-gallon drum (RH)	0.15	0.000088	0.056	0.000033	3.1×10^{-12}	0.00065
South	CH-LLW/MLLW [a]	55-gallon drum (CH)	0.027	0.000016	0.0092	5.5×10^{-6}	4.7×10^{-9}	0.00059
		B-25 box	0.030	0.000018	0.011	6.7×10^{-6}	4.1×10^{-9}	0.00059
		B-12 box	0.030	0.000018	0.0011	6.7×10^{-6}	2.1×10^{-9}	0.00059
		20-foot ISO	0.027	0.000016	0.0092	5.5×10^{-6}	7.7×10^{-9}	0.00059
	RH-LLW/MLLW [b]	55-gallon drum (RH)	0.13	0.000081	0.046	0.000028	2.2×10^{-12}	0.00059
Southwest	CH-LLW/MLLW [a]	55-gallon drum (CH)	0.014	8.6×10^{-6}	0.0038	2.3×10^{-6}	1.2×10^{-9}	0.00027
		B-25 box	0.016	9.5×10^{-6}	0.0047	2.8×10^{-6}	1.0×10^{-9}	0.00027
		B-12 box	0.016	9.5×10^{-6}	0.0047	2.8×10^{-6}	5.1×10^{-10}	0.00027
		20-foot ISO	0.014	8.6×10^{-6}	0.0038	2.3×10^{-6}	1.9×10^{-9}	0.00027
	RH-LLW/MLLW [b]	55-gallon drum (RH)	0.072	0.000043	0.019	0.000012	6.3×10^{-13}	0.00027
West	CH-LLW/MLLW [a]	55-gallon drum (CH)	0.0097	5.8×10^{-6}	0.0039	2.3×10^{-6}	1.2×10^{-9}	0.00016
		B-25 box	0.011	6.4×10^{-6}	0.0048	2.9×10^{-6}	1.1×10^{-9}	0.00016
		B-12 box	0.011	6.4×10^{-6}	0.0048	2.9×10^{-6}	5.3×10^{-10}	0.00016
		20-foot ISO	0.0097	5.8×10^{-6}	0.0039	2.3×10^{-6}	2.0×10^{-9}	0.00016
	RH-LLW/MLLW [b]	55-gallon drum (RH)	0.048	0.000029	0.019	0.000012	1.4×10^{-12}	0.00016
Northwest	CH-LLW/MLLW [a]	55-gallon drum (CH)	0.019	0.000011	0.0069	4.2×10^{-6}	3.1×10^{-9}	0.00039
		B-25 box	0.021	0.000013	0.0085	5.1×10^{-6}	2.7×10^{-9}	0.00039
		B-12 box	0.021	0.000013	0.0085	5.1×10^{-6}	1.4×10^{-9}	0.00039
		20-foot ISO	0.019	0.000011	0.0069	4.2×10^{-6}	5.1×10^{-9}	0.00039
	RH-LLW/MLLW [b]	55-gallon drum (RH)	0.095	0.000057	0.035	0.000021	3.0×10^{-12}	0.00039
Mountain West	CH-LLW/MLLW [a]	55-gallon drum (CH)	0.0067	4.0×10^{-6}	0.0026	1.6×10^{-6}	4.6×10^{-10}	0.000081
		B-25 box	0.0074	4.4×10^{-6}	0.0032	1.9×10^{-6}	4.0×10^{-10}	0.000081
		B-12 box	0.0074	4.4×10^{-6}	0.0032	1.9×10^{-6}	2.0×10^{-10}	0.000081
		20-foot ISO	0.0067	4.0×10^{-6}	0.0026	1.6×10^{-6}	7.5×10^{-10}	0.000081
	RH-LLW/MLLW [b]	55-gallon drum (RH)	0.033	0.000020	0.013	7.9×10^{-6}	2.7×10^{-13}	0.000081

			Incident-Free Conditions				***Accident Conditions***	
Region/ Destination/ Origin	***Waste or Materials***	***Container***	***Crew Dose (person-rem)***	***Crew Risk (LCF)***	***Population Dose (person-rem)***	***Population Risk (LCF)***	***Radiological Risk (LCF)***	***Roundtrip Nonradiological Risk (traffic fatalities)***
Upper Midwest	CH-LLW/MLLW [a]	55-gallon drum (CH)	0.024	0.000014	0.0060	3.6×10^{-6}	2.6×10^{-9}	0.00051
		B-25 box	0.026	0.000016	0.0074	4.4×10^{-6}	2.2×10^{-9}	0.00051
		B-12 box	0.026	0.000016	0.0074	4.4×10^{-6}	1.1×10^{-9}	0.00051
		20-foot ISO	0.024	0.000014	0.0060	3.6×10^{-6}	4.2×10^{-9}	0.00051
	RH-LLW/MLLW [b]	55-gallon drum (RH)	0.12	0.000071	0.030	0.000018	1.5×10^{-12}	0.00051

CH = contact-handled; HEU = highly enriched uranium; INL = Idaho National Laboratory; ISO = International Organization for Standardization; LANL = Los Alamos National Laboratory; LCF = latent cancer fatality; LLNL = Lawrence Livermore National Laboratory; LLW = low-level radioactive waste; MLLW = mixed low-level radioactive waste; rem = roentgen equivalent man; RH = remote-handled; SGT = safeguards transporter; SNM = special nuclear material; TRU = transuranic; Y-12 = Y-12 National Security Complex.

[a] LLW and MLLW were assumed to be transported in 55-gallon drums, B-25 boxes, B-12 boxes, and 20-foot ISO (Sealand) containers based on historical information regarding prevalence of use.

[b] RH-LLW and RH-MLLW were assumed to be transported in 55-gallon drums in Type B packages.

[c] TRU waste generated from operation of the Joint Actinide Shock Physics Experimental Research Facility and environmental restoration was assumed to be in standard waste boxes and transported in TRUPACT-II packages. The two 3-foot-diameter steel spheres containing plutonium that were used in subcritical experiments and are now stored at the Nevada National Security Site would be transported in TRUPACT-III packages that have yet to be certified by NRC.

[d] These transports are performed using secured trailers. These transport trailers have different accident and fatality rates from those used for transporting LLW/MLLW.

[e] The special nuclear materials and pits are transported in special Type B packaging that are drum-like containers.

[f] Rail shipments would end in a rail-to-truck transfer station location. These locations would be either Tecoma, Nevada (for West Wendover, Nevada), or Barstow, California, and Kingman, Arizona (for Parker, Arizona). After a rail shipment ends at a transfer station location, the waste would be transported by truck to the Nevada National Security Site. The risk factors for rail transports are based on the assumption of Barstow, California, Kingman, Arizona, and Tecoma, Nevada, as transfer station sites.

[g] No RH-TRU was identified.

[h] The risk factors are the maximum values for transport within Nevada.

During accident conditions, the population would be exposed to radiation from released radioactivity if the package is breached. If the package remains unbreached, the population exposure would be limited to direct radiation emanating from the package. For the accidents with no release, the analysis conservatively assumed that it would take about 12 hours to remove the package and/or vehicle from the accident area (DOE 2002a). Accidents leading to a loss of cask shielding would only be applicable to those shipments that use shielded casks, such as transport of remote-handled Class C and TRU wastes.

LCFs represent the number of additional latent fatal cancers among the exposed population. To calculate the number of LCFs, the incident-free population dose and accident population dose were multiplied by the health risk factor of 0.0006 cancer fatalities per person-rem of exposure. The nonradiological risk factors are nonoccupational traffic fatalities resulting from transportation accidents and are representative of the national mean rates.

Transportation risks were calculated assuming that wastes would be transported using either truck only or a combination of rail and truck. In this latter case, shipments involving both modes of transport would involve workers who would transfer waste containers from railcars to trucks (or vice versa) at a transfer station.

As indicated in Table E–10, all risk factors are less than 1. This means that no LCFs or traffic fatalities are expected to occur during each transport. For example, the risk factors for truck crewmembers and the general population for transporting one shipment of LLW or MLLW in 55-gallon drums from the Northeast region to the NNSS are given as 0.000035 and 0.000016 LCFs, respectively. This risk can also be interpreted as meaning that there is a chance of 1 in 29,000 shipments that an additional LCF could be experienced among the exposed workers from exposure to radiation during one shipment of LLW or MLLW from the Northeast region to the NNSS. Similarly, there is a chance of 1 in 63,000 shipments that an additional LCF could be experienced among the exposed general population residing along the transport route. These are essentially equivalent to zero risk. Note that the maximum allowable dose rate in the truck cabin is less than or equal to 2 millirem per hour, and the maximum annual dose to a commercial truck driver is 100 millirem per year, unless the individual is a trained radiation worker, in which case the administrative annual dose limit would be 2 rem (DOE 1999a). The values could be higher if drivers are radiation workers operating under a federally or state-licensed program (49 CFR 173.441). An individual receiving a dose of 100 millirem would have an expected risk of developing a latent fatal cancer of 0.00006. The same individual is expected to receive a dose of about 620 millirem per year on average from background and other sources of radiation (NCRP 2009).

As discussed in Section E.6.3, the accident dose is called the "dose risk" because the values incorporate the spectrum of accident severity probabilities and associated consequences (e.g., dose). The accident dose risks are very low because accident severity probabilities (i.e., the likelihood of accidents leading to confinement breach of a package or shipping cask and release of its contents) are small, and the content and form of the wastes (such as solid dirt-like contamination) are such that they would lead to nondispersible and mostly noncombustible release. Although persons reside within a 50-mile radius of the transportation route, they are generally quite far from the route. Because RADTRAN uses an assumption of homogeneous population, it would greatly overestimate the actual doses.

Table E–11 provides the estimated numbers of combined LLW and MLLW shipments from each region of the United States and from onsite sources for each alternative for truck transport, by container type (as described in Section E.4.2).

Table E–11 Estimated Number of Truck Shipments of Low-Level Radioactive/Mixed Low-Level Radioactive Waste Under Each Alternative [a]

In-State/Out-of-State Source	*Total Number of Shipments*	*Container Type*				
		Drums	*B-25 Box*	*Sealand [b]*	*B-12 Box*	*Type B Container [c]*
No Action and Reduced Operations Alternatives						
Northeast	140	13	88	39	0	0
South	9,100	520	1,500	3,200	0	3,900
Southeast	120	15	26	75	0	0
Upper Midwest	10,000	480	2,400	7,100	0	7
Southwest	3,100	3,000	9	10	0	0
Mountain West	1,200	1	310	340	470	94
West	1,000	660	120	270	0	0
Northwest	7	1	2	4	0	0
Other Out-of-State Shipments [e]	1,600	N/A	N/A	1,600	N/A	N/A
In-State [g]	2,300	790	0	1,500	0	0
Total – Out-of-State Waste	**26,000**	**4,700**	**4,500**	**13,000**	**470**	**4,000**
Total – All	**29,000**	**5,500**	**4,500**	**14,000**	**470**	**4,000**
Expanded Operations Alternative [d]						
Northeast	290	24	190	80	0	0
South	19,000	50	3,100	7,800	0	8,200
Southeast	310	30	100	180	0	0
Upper Midwest	20,000	1,000	5,100	14,000	0	14
Southwest	7,800	7,800	20	19	0	0
Mountain West	3,100	1	1,200	740	990	190
West	3,000	2,200	250	560	0	0
Northwest	24	4	16	4	0	0
Other Out-of-State Shipments [f]	26,000	N/A	N/A	N/A	N/A	N/A
In-State [g, h]	15,000	100	0	15,000	0	0
Total – Out-of-State Waste	**80,000**	**11,000**	**10,000**	**23,000**	**990**	**8,400**
Total – All	**94,000**	**11,000**	**10,000**	**38,000**	**990**	**8,400**

N/A = not applicable.

Note: Total may not equal the sum of the contributions due to rounding.

[a] Number of rail shipments was assumed to be one-half of the number of truck shipments, except for the number of rail shipments for transporting depleted uranium conversion products (see footnote f).

[b] For purposes of analysis, it was assumed that supersacks would be transported in Sealand containers.

[c] A Type B container is used to transport remote-handled low-level or mixed low-level radioactive waste.

[d] In addition to shipments estimated from the U.S. Department of Energy Waste Management Information System, these numbers include estimated shipments of waste from operation and decontamination and decommissioning of the U.S. Enrichment Corporation lead cascade fuel enrichment facility and operation of the U.S. Enrichment Corporation fuel enrichment full-scale facility.

[e] Includes shipments analyzed in other NEPA documents as follows: 1,026 truck shipments from Paducah in the South region (DOE 2004b) and 553 truck shipments from Portsmouth in the Upper Midwest region (DOE 2004a). These shipments were assumed to consist of Sealand containers transporting depleted uranium conversion products.

[f] Includes shipments analyzed in other NEPA documents as follows: 12,243 truck shipments from the West Valley Demonstration Project in the Northeast region (DOE 2010b); 367 shipments of uranium-233 downblending waste from Oak Ridge National Laboratory in the South region; uranium oxide conversion product consisting of 7,240 truck shipments from Paducah, Kentucky, in the South region (DOE 2004b); and 5,834 truck shipments from Portsmouth, Ohio, in the Upper Midwest region (DOE 2004a). For the uranium oxide conversion products, the number of truck shipments is based on depleted uranium hexafluoride cylinders being filled with uranium oxide conversion product, two cylinders per truck. The numbers of rail shipments required for shipment of uranium oxide conversion products are 5,963 from Paducah (DOE 2004b) and 3,216 from Portsmouth (DOE 2004a). This does not include shipments that would occur after 2020.

[g] Includes radioactive waste generated by environmental restoration activities at the Nevada Test and Training Range and Tonopah Test Range (230 shipments of Sealand containers under the No Action and Reduced Operations Alternatives and 13,000 shipments of Sealand containers under the Expanded Operations Alternative).

[h] Includes shipment of MLLW from the NNSS to the Oak Ridge area for treatment and return to the NNSS.

TRU waste would be generated at the NNSS under all alternatives. The TRU waste projected to be shipped would include waste in storage and TRU waste generated by JASPER operations from 2011 to 2020, the two 3-foot-diameter steel spheres containing plutonium that were used in subcritical experiments and are now stored at the NNSS, and TRU waste from environmental restoration activities at the TTR and Nevada Test and Training Range. **Table E–12** shows the number of shipments of TRU waste, special nuclear material, radioisotope thermoelectric generators, and nuclear weapons under each alternative.

Table E–12 Estimated Number of Shipments of Transuranic Waste, Radioisotope Thermoelectric Generators, Special Nuclear Material, and Nuclear Weapons [a]

Origin or Activity	*Number of Shipments*		
	No Action Alternative	*Expanded Operations Alternative*	*Reduced Operations Alternative*
Transuranic Waste			
JASPER [b]	16	36	11
Environmental Restoration	6	6	6
Radioisotope Thermoelectric Generators			
Norfolk, Virginia	3	10	3
Sealed Sources			
San Antonio, Texas	120	240	120
Special Nuclear Material			
Lawrence Livermore National Laboratory (Global Security SNM)	3	3	3
Lawrence Livermore National Laboratory (highly enriched uranium)	1	1	1
Los Alamos National Laboratory (uranium-233)	0	1	0
Idaho National Laboratory (ZPPR)	0	7	0
Idaho National Laboratory (ZPPR) – plutonium material	0	8	0
Oak Ridge National Laboratory (uranium-233)	0	32	0
Lawrence Livermore National Laboratory (target material for JASPER)	120	240	60
Nuclear Weapons			
Transport to/from the NNSS	0	8,200 [c]	0
Weapon Component Disposition [d]	0	2,010	0

JASPER = Joint Actinide Shock Physics Experimental Research Facility; NNSS = Nevada National Security Site; SNM = special nuclear material; ZPPR = Zero Power Plutonium Reactor.

[a] Number of shipments are for one-way, except for two-way transport of nuclear weapons that would undergo refurbishment at the NNSS.

[b] Includes number of shipments related to transuranic waste in storage.

[c] Includes 100 shipments per year of nuclear weapons to the NNSS for disassembly and 360 shipments per year of nuclear weapons to the NNSS to support component exchange. Includes return shipments of refurbished weapons.

[d] Includes 100 shipments per year of canned subassemblies to the Y-12 National Security Complex and plutonium to the Pantex Plant and 1 shipment per year of milliwatt generators to Los Alamos National Laboratory.

Under the Expanded Operations Alternative, it was assumed there would be 360 shipments of nuclear weapons per year to and from the NNSS for component replacement and 100 shipments per year of nuclear weapons to the NNSS for disassembly. For analytical purposes, it was assumed that each weapon disassembly would result in 1 shipment of plutonium to the Pantex Plant and 1 shipment of enriched uranium to the Y–12 National Security Complex. Disassembly of 100 nuclear weapons would also result in 10 shipments of milliwatt generators to Los Alamos National Laboratory. NNSA would use certified Type B packages and transport these packages using DOE's SGTs.

There would be 124 shipments of special nuclear material under the No Action Alternative, 64 shipments under the Reduced Operations Alternatives, and 292 shipments under the Expanded Operations Alternative. The transport of sealed sources would occur under all alternatives, with twice the number occurring under the Expanded Operations Alternative compared to the other alternatives.

E.7.1 Constrained Case

Tables E–13 and **E–14** show the risks of transporting radioactive waste and radioactive materials, respectively, under each alternative for the Constrained Case. The risks are calculated by multiplying the previously given per-shipment factors by the number of shipments over the duration of the program and, for radiological doses, by the health risk conversion factors. The risks are for the transport of the radioactive wastes over a 10-year period under each alternative.

The values presented in Tables E–13 and E–14 show that the total radiological risks (the product of consequence and frequency) are small under all three alternatives. For truck drivers, about 1 (1.3) LCF could occur under the No Action and Reduced Operations Alternatives, and 3 (3.3) LCFs could occur under the Expanded Operations Alternative, assuming no administrative controls are applied. These results reflect the sum of the risks associated with transport of LLW, MLLW, and other radioactive wastes and materials. For rail workers, less than 1 (0.3) LCF could occur under the No Action and Reduced Operations Alternatives, and 1 (0.6) LCF could occur under the Expanded Operations Alternative, assuming no administrative controls are applied. Note that the maximum annual dose to a transportation worker would be limited to 100 millirem per year, unless the individual is a trained radiation worker, in which case the administrative annual dose limit would be 2 rem (DOE 1999a).[2] The potential for a trained radiation worker to develop a latent fatal cancer from the maximum annual exposure is 0.001; therefore, no individual transportation worker is expected to develop a latent fatal cancer from exposures during activities under all three alternatives.

The risk to the public from incident-free truck transport of all radioactive materials and wastes would be less than 1 (0.2) LCF under the No Action and Expanded Operations Alternatives and about 1 (0.8) LCF under the Expanded Operations Alternative. If rail transport were used to transport LLW and MLLW to the NNSS, then the radiological risk from all rail-to-truck transports would be less than 1 (0.1) LCF under the No Action and Expanded Operations Alternatives, but about 1 (0.5) LCF under the Expanded Operations Alternative.

Nonradiological accident risks (the potential for fatalities as a direct result of traffic accidents) present the greatest risks. The impacts of using only trucks for transporting radioactive materials would range from 2 to 7 traffic fatalities among the alternatives, while using rail-to-truck transport would cause impacts ranging from 6 to 16 traffic fatalities. Considering that the transportation activities analyzed in this SWEIS would occur over a period of 10 years and that the average number of traffic fatalities in the United States is about 40,000 per year (NHTSA 2006), the traffic fatality risk under all alternatives would be small.

[2] *A DOE transportation contractor may choose another dose limit for workers, but this dose is limited to 5 rem per year as set forth in 10 CFR 20.1201.*

Table E–13 Risks of Transporting Radioactive Waste Under Each Alternative – Constrained Case [a]

					Incident-Free Conditions				*Accident Conditions*	
					Crew		*Population*			
Region	***Transport Mode***	***Number of Shipments***	***One-Way Kilometers Traveled (million)***	***One-Way Miles Traveled (million)***	***Dose (person-rem)***	***Risk [b]***	***Dose (person-rem)***	***Risk [b]***	***Radiological Risk [b]***	***Roundtrip Nonradiological Risk [b]***
No Action Alternative										
Northeast	Truck	140	0.67	0.42	8.2	5×10^{-3}	2.6	2×10^{-3}	3×10^{-6}	2×10^{-2}
	Rail only [c]	70	0.34	0.21	2.5	1×10^{-3}	1.1	6×10^{-4}	5×10^{-7}	5×10^{-2}
	Rail/Truck [d]	210	0.41	0.26	3.4	2×10^{-3}	1.6	1×10^{-3}	8×10^{-7}	6×10^{-2}
South	Truck	9,100	31.73	19.72	1400	9×10^{-1}	220	1×10^{-1}	6×10^{-5}	1
	Rail only [c]	4,500	16.84	10.46	330	2×10^{-1}	110	7×10^{-2}	2×10^{-5}	3
	Rail/Truck [d]	13,600	21.78	13.53	550	3×10^{-1}	150	9×10^{-2}	2×10^{-5}	3
Southeast	Truck	120	0.45	0.28	6.7	4×10^{-3}	1.9	1×10^{-3}	2×10^{-6}	1×10^{-2}
	Rail only [c]	60	0.24	0.15	1.8	1×10^{-3}	0.69	4×10^{-4}	5×10^{-7}	4×10^{-2}
	Rail/Truck [d]	180	0.31	0.19	2.7	2×10^{-3}	0.92	6×10^{-4}	6×10^{-7}	2×10^{-3}
Upper Midwest	Truck	10,000	33.77	20.99	510	3×10^{-1}	130	8×10^{-2}	1×10^{-4}	1
	Rail only [c]	5,000	16.44	10.22	120	7×10^{-2}	32	2×10^{-2}	2×10^{-5}	3
	Rail/Truck [d]	15,100	21.90	13.61	200	1×10^{-1}	51	3×10^{-2}	3×10^{-5}	3
Southwest	Truck	3,100	4.28	2.66	64	4×10^{-2}	28	2×10^{-2}	9×10^{-6}	1×10^{-1}
	Rail only [c]	1,500	2.69	1.67	22	1×10^{-2}	5.9	4×10^{-3}	2×10^{-6}	4×10^{-1}
	Rail/Truck [d]	4,600	4.36	2.71	42	3×10^{-2}	14	9×10^{-3}	4×10^{-6}	5×10^{-1}
Mountain West	Truck	1,200	1.58	0.98	27	2×10^{-2}	6.0	4×10^{-3}	2×10^{-6}	5×10^{-2}
	Rail only [c]	610	0.32	0.20	5.6	3×10^{-3}	2.3	1×10^{-3}	2×10^{-7}	5×10^{-2}
	Rail/Truck [d]	1,800	1.23	0.76	21	1×10^{-2}	5.4	3×10^{-3}	5×10^{-7}	7×10^{-2}
West	Truck	1,000	1.20	0.75	16	9×10^{-3}	6.0	4×10^{-3}	5×10^{-6}	4×10^{-2}
	Rail only [c]	530	0.53	0.33	5.1	3×10^{-3}	2.1	1×10^{-3}	7×10^{-7}	8×10^{-2}
	Rail/Truck [d]	1,600	1.10	0.68	13	8×10^{-3}	4.7	3×10^{-3}	2×10^{-6}	1×10^{-1}
Northwest	Truck	7	0.02	0.01	0.25	1×10^{-4}	0.085	5×10^{-5}	1×10^{-7}	6×10^{-4}
	Rail only [c]	4	0.01	0.01	0.08	5×10^{-5}	0.029	2×10^{-5}	2×10^{-8}	2×10^{-3}
	Rail/Truck [d]	10	0.01	0.01	0.13	8×10^{-5}	0.04	3×10^{-5}	2×10^{-8}	2×10^{-3}
Total – Offsite LLW/MLLW from all regions	Truck	24,700	73.7	45.8	2,100	1.2	390	2×10^{-1}	2×10^{-4}	2
	Rail only [c]	12,300	37.4	23.2	490	3×10^{-1}	160	9×10^{-2}	4×10^{-5}	6
	Rail/Truck [d]	37,000	51.1	31.8	840	5×10^{-1}	220	1×10^{-1}	6×10^{-5}	6
Onsite	Truck	2,000	0.05	0.03	4.0	2×10^{-3}	1.5	9×10^{-4}	2×10^{-8}	1×10^{-3}
ER Waste (TTR/Nevada Test and Training Range)	Truck	230	0.09	0.06	0.015	9×10^{-6}	0.0022	1×10^{-6}	4×10^{-13}	2×10^{-3}
TRU waste [e]	Truck	20	0.03	0.02	1.08	6×10^{-4}	0.36	2×10^{-4}	2×10^{-8}	9×10^{-4}
RTGs	Truck	3	0.01	0.01	0.37	2×10^{-4}	0.49	3×10^{-3}	3×10^{-10}	2×10^{-3}
Total – radioactive waste transport	Truck	27,000	73.9	45.9	2,100	1.2	390	2×10^{-1}	2×10^{-4}	2
	Rail/Truck [d]	39,300	51.3	31.9	850	5×10^{-1}	230	1×10^{-1}	6×10^{-5}	6
Transport through Nevada [f]	Truck	24,800	8.12	5.01	200	1×10^{-1}	38	2×10^{-2}	3×10^{-6}	2×10^{-1}

Region	Transport Mode	Number of Shipments	One-Way Kilometers Traveled (million)	One-Way Miles Traveled (million)	Incident-Free Conditions				Accident Conditions	
					Crew		Population			
					Dose (person-rem)	Risk [b]	Dose (person-rem)	Risk [b]	Radiological Risk [b]	Roundtrip Nonradiological Risk [b]
Expanded Operations Alternative										
Northeast	Truck	290	1.40	0.87	17	1×10^{-2}	5.5	3×10^{-3}	6×10^{-6}	5×10^{-2}
	Rail only [c]	150	0.70	0.44	5.2	3×10^{-3}	2.2	1×10^{-3}	1×10^{-6}	1×10^{-1}
	Rail/Truck [d]	440	0.86	0.54	7.1	4×10^{-3}	2.8	2×10^{-3}	1×10^{-6}	1×10^{-1}
South	Truck	19,300	67.32	41.83	3,500	2	460	3×10^{-1}	4×10^{-5}	2
	Rail only [c]	9,600	36.16	22.47	700	4×10^{-1}	240	1×10^{-1}	4×10^{-5}	6
	Rail/Truck [d]	28,900	46.65	28.99	1,200	7×10^{-1}	310	2×10^{-1}	5×10^{-5}	6
Southeast	Truck	310	1.22	0.76	17	1×10^{-2}	5.1	3×10^{-3}	5×10^{-6}	4×10^{-2}
	Rail only [c]	160	0.66	0.41	4.8	3×10^{-3}	1.9	1×10^{-3}	1×10^{-6}	1×10^{-1}
	Rail/Truck [d]	470	0.83	0.51	7.2	4×10^{-3}	2.5	1×10^{-3}	2×10^{-6}	5×10^{-3}
Upper Midwest	Truck	20,100	67.60	42.01	,1000	6×10^{-1}	260	2×10^{-1}	2×10^{-4}	2
	Rail only [c]	10,100	32.90	20.44	250	1×10^{-1}	64	4×10^{-2}	4×10^{-5}	5
	Rail/Truck [d]	30,200	43.82	27.23	410	2×10^{-1}	100	6×10^{-2}	6×10^{-5}	5
Southwest	Truck	7,800	10.91	6.78	160	1×10^{-1}	70	4×10^{-2}	2×10^{-5}	3×10^{-1}
	Rail only [c]	3,900	6.86	4.26	56	3×10^{-2}	15	9×10^{-3}	5×10^{-6}	1
	Rail/Truck [d]	11,700	11.09	6.89	110	6×10^{-2}	37	2×10^{-2}	1×10^{-5}	1
Mountain West	Truck	3,100	4.03	2.50	64	4×10^{-2}	15	9×10^{-3}	6×10^{-6}	1×10^{-1}
	Rail only [c]	1,600	0.81	0.50	14	8×10^{-3}	5.8	3×10^{-3}	6×10^{-7}	1×10^{-1}
	Rail/Truck [d]	4,700	3.14	1.95	50	3×10^{-2}	13	8×10^{-3}	1×10^{-6}	2×10^{-1}
West	Truck	3,000	3.48	2.16	45	3×10^{-2}	18	1×10^{-2}	1×10^{-5}	1×10^{-1}
	Rail only [c]	1,500	1.52	0.95	15	9×10^{-3}	6.0	4×10^{-3}	2×10^{-6}	2×10^{-1}
	Rail/Truck [d]	4,600	3.17	1.97	36	2×10^{-2}	14	8×10^{-3}	5×10^{-6}	3×10^{-1}
Northwest	Truck	24	0.06	0.04	0.68	4×10^{-4}	0.25	1×10^{-4}	3×10^{-7}	2×10^{-3}
	Rail only [c]	12	0.04	0.02	0.24	1×10^{-4}	0.096	6×10^{-5}	4×10^{-8}	5×10^{-3}
	Rail/Truck [d]	36	0.05	0.03	0.39	2×10^{-4}	0.14	8×10^{-5}	6×10^{-8}	5×10^{-3}
Total – Offsite LLW/MLLW from all regions	Truck	5	156	96.9	4,900	2.9	830	5×10^{-1}	3×10^{-4}	5
	Rail only [c]	26,900	79.6	49.5	1,000	6×10^{-1}	340	2×10^{-1}	8×10^{-5}	12
	Rail/Truck [d]	80,900	110	68.4	1,800	1.1	480	3×10^{-1}	1×10^{-4}	13
Onsite	Truck	2,300	0.06	0.04	4.15	2×10^{-3}	1.5	9×10^{-4}	2×10^{-8}	2×10^{-3}
ER Waste (TTR/Nevada Test and Training Range)	Truck	13,100	4.91	3.05	0.82	5×10^{-4}	0.28	2×10^{-4}	2×10^{-11}	1×10^{-1}
TRU waste [e]	Truck	32	0.04	0.03	1.6	9×10^{-4}	0.52	3×10^{-4}	2×10^{-8}	1×10^{-3}
RTGs	Truck	10	0.05	0.03	1.2	7×10^{-4}	1.6	1×10^{-3}	9×10^{-10}	7×10^{-3}
Paducah DUF_6 DOE/EIS-359 [g]	Truck	7,200	20.4	12.7	120	7×10^{-2}	80	5×10^{-2}	3×10^{-3}	5×10^{-1}
	Rail	2,900	9.93	6.19	370	2×10^{-1}	14	8×10^{-3}	2×10^{-3}	2×10^{-1}
Portsmouth DUF_6 DOE/EIS-360 [g]	Truck	5,800	19.6	12.2	11	7×10^{-3}	78	5×10^{-2}	7×10^{-3}	4×10^{-1}
	Rail	2,300	9.37	5.84	330	2×10^{-1}	14	9×10^{-3}	3×10^{-3}	3×10^{-1}

					Incident-Free Conditions				***Accident Conditions***	
					Crew		***Population***			
Region	***Transport Mode***	***Number of Shipments***	***One-Way Kilometers Traveled (million)***	***One-Way Miles Traveled (million)***	***Dose (person-rem)***	***Risk*** [b]	***Dose (person-rem)***	***Risk*** [b]	***Radiological Risk*** [b]	***Roundtrip Nonradiological Risk*** [b]
West Valley DOE/EIS-0226 [g]	Truck	12,000	48.0	29.9	230	1×10^{-1}	64	4×10^{-2}	9×10^{-6}	9×10^{-1}
	Rail	6,100	26.5	16.5	9.3	6×10^{-3}	14	8×10^{-3}	3×10^{-6}	2
ORNL (uranium-233) DOE/EA-1651 [h]	Truck	367	No data	No data	No data	No data	9.5	6×10^{-3}	7×10^{-12}	<1
Total – radioactive waste transport	Truck	94,800	249	155	5,300	3.1	1,100	6×10^{-1}	1×10^{-2}	7
	Rail/Truck [d]	108,000	161	100	2,500	1.5	540	3×10^{-1}	5×10^{-3}	16
Transport through Nevada [f]	Truck	54,100	17.92	11.14	440	3×10^{-1}	82	5×10^{-2}	8×10^{-6}	5×10^{-1}
Reduced Operations Alternative										
All Regions	Truck	See No Action Alternative								
	Rail	See No Action Alternative								
Onsite	Truck	See No Action Alternative								
TRU waste [e]	Truck	17	0.02	0.01	0.83	5×10^{-4}	0.28	2×10^{-4}	1×10^{-8}	7×10^{-4}
Transport through Nevada [f]	Truck	See No Action Alternative								

< = less than; DUF_6 = depleted uranium hexafluoride; ER = Environmental Restoration; ORNL = Oak Ridge National Laboratory; rem = roentgen equivalent man; RTG = radioisotope thermoelectric generator; SGT = safeguards transporter; SNM = special nuclear material; TRU = transuranic; TTR = Tonopah Test Range.

[a] LLW and MLLW were assumed to be transported in 55-gallon drums, B-25 boxes, B-12 boxes, and 20-foot ISO (Sealand) containers based on historical information regarding prevalence of use.

[b] Risk is expressed in terms of LCFs, except for nonradiological risk, where it refers to the number of traffic accident fatalities. Accident dose risk can be calculated by dividing the risk values by 0.0006 (DOE 2003).

[c] These values reflect only the portion of the routes traveled by railcar.

[d] These values reflect the combined use of railcar and truck shipments to transport waste to the NNSS.

[e] Transuranic waste is first transported to Idaho National Laboratory for characterization and then transported back to the NNSS with final disposal at the Waste Isolation Pilot Plant.

[f] The cited risk values are representative of the portion of the routes for transporting LLW and MLLW within Nevada to the NNSS, excluding shipments identified in other NEPA documentation. The stated risks for travel within Nevada are included in the risks for the regional routes shown in the table. The values for the Reduced Operations Alternative are similar to those for the No Action Alternative.

[g] The risks from transporting Paducah and Portsmouth DUF_6 conversion wastes and the West Valley wastes to the NNSS are directly from their respective site EISs (DOE 2004a, 2004b, 2010b), proportionally adjusted for a 10-year period. The rail transport risk values for these analyses consider direct transport to the NNSS; therefore, the risks do not include truck transport from a transfer station. If rail-to-truck transport was used for these shipments, the incident-free risk would be lower, while the accident risk would be slightly higher, given the results of transporting LLW and MLLW. Transportation risks from transporting wastes associated with these waste streams generated beyond this 10-year period are included in the cumulative impacts (Chapter 6).

[h] DOE 2010a.

Note: To convert kilometers to miles, multiply by 0.62137. Total may not equal the sum of the contributions due to rounding. Also due to rounding, the cited risk values are different from multiplication of dose by the dose risk factor of 0.0006 LCFs per person-rem.

Table E–14 Risks of Transporting Radioactive Materials Under Each Alternative – Constrained Case

Material	*Number of Shipments*	*One-Way Kilometers Traveled (million)*	*One-Way Miles Traveled (million)*	*Incident-Free Conditions*				*Accident Conditions*	
				Crew		*Population*			
				Dose (person-rem)	*Risk* [b]	*Dose (person-rem)*	*Risk* [a]	*Radiological Risk* [b]	*Roundtrip Nonradiological Risk* [a]
No Action Alternative									
Special Nuclear Material	120	0.14	0.088	0.13	8×10^{-5}	0.12	7×10^{-5}	5×10^{-8}	5×10^{-3}
Special Nuclear Material – in Nevada	120	0.04	0.02	0.028	2×10^{-5}	0.023	1×10^{-5}	7×10^{-9}	9×10^{-5}
Sealed Sources	120	0.27	0.17	17	1×10^{-2}	4.3	3×10^{-3}	2×10^{-11}	9×10^{-3}
Sealed Sources – in Nevada	120	0.04	0.02	2.2	1×10^{-3}	0.55	3×10^{-4}	4×10^{-13}	1×10^{-3}
Expanded Operations Alternative									
Special Nuclear Material	290	0.41	0.25	0.39	2×10^{-4}	0.39	2×10^{-4}	1×10^{-7}	1×10^{-2}
Special Nuclear Material – in Nevada	290	0.09	0.06	0.097	6×10^{-5}	0.11	7×10^{-5}	1×10^{-8}	2×10^{-4}
Weapon Component Disposition	2,000	3.49	2.17	10	6×10^{-3}	12	7×10^{-3}	4×10^{-8}	1×10^{-2}
Weapon Component Disposition – in Nevada	2,000	0.71	44.1	1.3	8×10^{-4}	1.5	9×10^{-4}	3×10^{-8}	2×10^{-3}
Weapon Transport	8,200	38.15	23.71	210	1×10^{-1}	240	1×10^{-1}	6×10^{-6}	1×10^{-1}
Weapon Transport – in Nevada	8,200	2.50	1.55	14	9×10^{-3}	16	1×10^{-2}	2×10^{-7}	6×10^{-3}
Sealed Sources	240	0.55	0.34	33	2×10^{-2}	8.5	5×10^{-3}	5.E-11	2×10^{-2}
Sealed Sources – in Nevada	240	0.07	0.05	4.4	3×10^{-3}	1.1	7×10^{-4}	7.E-13	2×10^{-3}
Reduced Operations Alternative									
Special Nuclear Material	60	0.07	0.04	0.083	5×10^{-5}	0.081	5×10^{-5}	2×10^{-8}	5×10^{-3}
Special Nuclear Material – in Nevada	60	0.02	0.01	0.015	9×10^{-6}	0.013	8×10^{-6}	3×10^{-9}	5×10^{-5}
Sealed Sources	See No Action Alternative								
Sealed Sources – in Nevada	See No Action Alternative								

rem = roentgen equivalent man.

[a] Risk is expressed in terms of latent cancer fatalities, except for the nonradiological risk, where it refers to the number of traffic accident fatalities. Accident dose risk can be calculated by dividing the risk values by 0.0006 (DOE 2003).

The risks to various exposed individuals during incident-free transportation conditions have been estimated for hypothetical exposure scenarios identified in Section E.5.3. The estimated doses to workers and the public are presented in **Table E–15**. Doses are presented on a per-event basis (person-rem per event, per exposure, or per shipment), as it is generally unlikely that the same person would be exposed to multiple events. For those individuals that could have multiple exposures, the cumulative dose could be calculated. The maximum dose to a crewmember is based on the same individual being responsible for driving every shipment for the duration of the campaign. Note that the potential exists for larger individual exposures under onetime events of a longer duration. For example, the dose to a person stuck in traffic next to a shipment of Class B or Class C wastes for 30 minutes is calculated to be 0.0097 rem (9.7 millirem). This is generally considered a onetime event for that individual, although this individual may encounter another exposure of a similar or longer duration in his or her lifetime.

A member of the public residing along the route would likely receive multiple exposures from passing shipments. The cumulative dose to this resident can be calculated assuming all shipments pass his or her home. The cumulative dose is calculated assuming that the resident is present for every shipment and is unshielded at a distance of about 98 feet from the route. Therefore, the cumulative dose depends on the number of shipments passing a particular point and is independent of the actual route being considered. If the maximum resident dose provided in Table E–15 is assumed for all waste transport types, then the maximum dose to this resident on a truck route, if all the materials were to be shipped via this route, would be about 10 millirem for the No Action and Reduced Operations Alternatives, and about 20 millirem for the Expanded Operations Alternative (rounded to the nearest 10 millirem). A resident living along a rail route, if exposed to all rail shipments, would receive a dose of about 10 millirem for the No Action and Reduced Operations Alternative, and about 30 millirem for the Expanded Operations Alternative.

Table E–15 Estimated Dose to Maximally Exposed Individuals During Incident Free Transportation Conditions

Receptor	*Dose to Maximally Exposed Individual*
Workers	
Crewmember (truck/rail driver)	2 rem per year [a]
Inspector	0.023 rem per event per hour of inspection
Rail yard worker	0.0011 rem per event
Transfer station worker [b]	0.00034 person-rem per container transfer between rail and truck
Public	
Resident (along the rail route)	6.3×10^{-7} rem per event
Resident (along the truck route)	2.4×10^{-7} rem per event
Person in traffic congestion	0.0097 rem per event per half hour of stop
Resident near the rail yard during classification	0.000065 rem per event
Person at a rest stop/gas station	0.000062 rem per event per hour of stop
Gas station attendant	0.0002 rem per event

rem = roentgen equivalent man.

[a] Maximum administrative dose limit per year for a trained radiation worker (truck/rail crewmember). The value could be higher if drivers are radiation workers operating under a federally or state-licensed program (49 CFR 173.441).

[b] Transfer station worker dose is based on the *NTS Intermodal Study* (DOE 1999b), with a Transport Index of 1.

The accident risk assessment and the impacts shown in Tables E–13 and E–14 consider the entire spectrum of potential accidents, from a fender bender to an extremely severe accident. To provide additional insight into the severity of accidents in terms of the potential dose to an MEI and the public, an accident consequence assessment has been performed for a maximum reasonably foreseeable hypothetical transportation accident with a likelihood of occurrence greater than 1 in 10 million per year. The results, presented in **Table E–16**, include all conceivable accidents, irrespective of their likelihood.

Table E–16 Estimated Dose to the Population and to Maximally Exposed Individuals During Most-Severe Accident Conditions [a]

Alternative/ Transport Mode [b]		*Waste Material in the Accident With the Highest Consequences*	*Likelihood of the Accident (per year)*	*Population* [c]		*Maximally Exposed Individual* [d]	
				Dose (person-rem)	*Risk (LCF)*	*Dose (rem)*	*Risk (LCF)*
No Action and Reduced Operations	Truck	LLW/MLLW in 20-foot ISO container	3.1×10^{-7}	180	0.1	0.034	2×10^{-5}
Expanded Operations	Truck	LLW/MLLW in 20-foot ISO container	6.1×10^{-7}	180	0.1	0.034	2×10^{-5}
Transport within Nevada [e]		LLW/MLLW in 20-foot ISO container	2.4×10^{-6}	27	0.02	0.034	2×10^{-5}

ISO = International Organization for Standardization; LCF = latent cancer fatality; LLW = low-level radioactive waste; MLLW = mixed low-level radioactive waste; rem = roentgen equivalent man.

[a] The likelihood of accidents is based on the annual estimated number of transports from each region to the Nevada National Security Site. The cited likelihood of accidents is the highest calculated value among all transports.

[b] Note that the likelihood of rail accidents is less than 10^{-7} per year and, therefore, rail accident impacts are not shown.

[c] Population extends at a uniform density to a radius of 50 miles. The weather condition was assumed to be Pasquill Stability Class D with a windspeed of 8.8 miles per hour. Unless otherwise noted, the population doses and risks are presented for an urban area on the transportation route.

[d] The maximally exposed individual was assumed to be 330 feet downwind from the accident and exposed to the entire plume of the radioactive release. The weather condition was assumed to be Pasquill Stability Class F with a windspeed of 2.2 miles per hour.

[e] Population dose and risk are for a suburban area along the route. The probability of a maximum foreseeable accident in an urban area along the transportation route is less than 10^{-7} per year. The cited likelihood of an accident is for the Expanded Operations Alternative. The likelihood of accidents under the No Action and Reduced Operations Alternatives is 1.2×10^{-6} per year.

The following assumptions were used to estimate the consequences of maximum reasonably foreseeable offsite transportation accidents:

- The accident is the most severe with the highest release fraction; the highest severity category of accident is a high-impact and high-temperature fire accident.
- The individual is 330 feet downwind from a ground release accident.
- The individual is exposed to airborne contamination for 2 hours and ground contamination for 24 hours with no interdiction or cleanup. A stable weather condition (Pasquill Stability Class F) with a windspeed of 2.2 miles per hour was considered.
- The population is a uniform density within a 50-mile radius, and is exposed to the entire plume passage and 7 days of ground exposure without interdiction and cleanup. A neutral weather condition (Pasquill Stability Class D) with a windspeed of 8.8 miles per hour was considered. As

the consequence would be proportional to the population density, the accident was assumed to occur in an urban[3] area with the highest density (see Table E–1).

- The number of containers involved in the accident is listed in Table E–2. When multiple Type B or shielded Type A shipping casks are transported in a shipment, a single cask was assumed to have failed in the accident. It is unlikely that a severe accident would breach multiple casks.

Table E–16 provides the estimated dose and risk to an individual and population from a maximum foreseeable truck or rail transportation accident with the highest consequences under each alternative and disposal option. The highest consequences for the maximum foreseeable accident are from accidents involving LLW and MLLW in a 20-foot ISO container in a severe impact in conjunction with a long-duration fire. The calculated population doses are based on the maximum population density.

Table E–17 shows the risks of transporting offsite LLW and MLLW waste over a 10-year period (the number of shipments and associated risks do not take into account shipments of LLW and MLLW that have been analyzed in other National Environmental Policy Act documents). Results are presented by segment. For example, for rail-to-truck transport, the first segment shown represents transportation of waste from the U.S. regions by rail to a transfer station. The second segment represents transportation of waste from the transfer station by truck to Las Vegas. The third segment represents transportation of waste from Las Vegas to the NNSS using several possible routes through Las Vegas. Results are presented in this manner to allow the addition of results for a particular route. Note that there are results from transporting waste to Parker and West Wendover under the Constrained Case to allow for comparisons of rail impacts.

Chapter 5, Tables 5–12 and 5–13, summarize the cumulative range of impacts for transporting LLW and MLLW for the total shipping campaign. These impacts are comparable to the impacts associated with constrained transport of these wastes under the Expanded Operations Alternative.

[3] *If the likelihood of accident in an urban area is less than 1 in 10 million per year, then the accident was evaluated for a suburban area.*

Table E–17 Risks of Transporting Radioactive Waste Under Each Alternative – Unconstrained Case [a]

Transfer Station** or Las Vegas Entry Point (truck)	Transport Mode or Route	Number of Shipments	One-Way Kilometers Traveled (million)	One-Way Miles Traveled (million)	Incident-Free Conditions				Accident Conditions	
					Crew		Population			
					Dose (person-rem)	Risk [b]	Dose (person-rem)	Risk (LCF)	Radiological Risk (LCF) [b]	Roundtrip Nonradiological Risk (fatalities)
Rail-to-Truck: To Las Vegas										
Apex**	Rail [c]	27,000	81.2	50.5	1,100	0.6	330	0.2	8×10^{-5}	13
	Truck after [d]	footnote e	-	-	-	-	-	-	-	-
Arden**	Rail [c]	27,000	82.0	51.0	1,100	0.6	330	0.2	8×10^{-5}	13
	Truck after [d]	footnote e	-	-	-	-	-	-	-	-
Kingman**	Rail [c]	27,000	74.3	46.2	980	0.6	330	0.2	8×10^{-5}	12
	Truck after [d]	54,000	8.21	5.10	210	0.1	46	0.03	3×10^{-5}	0.3
Parker**	Rail [c]	27,000	83.7	52.0	1,100	0.6	340	0.2	9×10^{-5}	13
	Truck after [d]	54,000	16.5	10.3	420	0.3	86	0.05	2×10^{-5}	0.5
West Wendover**	Rail [c]	27,000	68.6	42.6	920	0.6	250	0.2	6×10^{-5}	11
	Truck after [d]	54,000	31.2	19.4	780	0.5	140	0.08	1×10^{-5}	0.9
Rail-to-Truck: From Las Vegas Entry Points to the NNSS										
Apex to the NNSS	via C-215 to US 95	54,000	8.37	5.20	210	0.1	37	0.02	6×10^{-6}	2×10^{-5}
	via I–15 to US 95	54,000	8.37	5.20	450	0.3	150	0.09	6×10^{-5}	3×10^{-5}
Arden to the NNSS	via I–15 to US 95	54,000	8.75	5.44	220	0.1	52	0.03	6×10^{-5}	2×10^{-5}
	via I–215 to C–215 to US 95	54,000	10.2	6.34	320	0.2	73	0.04	1×10^{-5}	3×10^{-5}
	through Pahrump	54,000	10.2	6.34	370	0.2	80	0.05	1×10^{-5}	3×10^{-5}
Henderson to the NNSS (from Kingman/Parker)	via I–515 to US 95	54,000	8.97	5.57	230	0.1	60	0.04	9×10^{-5}	3×10^{-5}
	via I–215 to I–15 to US 95	54,000	9.40	5.84	350	0.2	110	0.07	9×10^{-5}	3×10^{-5}
	via I–215 to C–215 to US 95	54,000	9.61	5.97	360	0.2	95	0.06	4×10^{-5}	3×10^{-5}
	through Pahrump	54,000	11.2	6.96	420	0.2	110	0.06	4×10^{-5}	3×10^{-5}
Rail-to-Truck Constrained Case: Representing Impacts of Routes from U.S. Regions to the NNSS [f]										
Parker**	Rail	25,000	78.8	49.0	1,000	0.6	330	0.2	8×10^{-5}	12
	Truck after	51,000	27.6	17.1	710	0.4	140	0.08	4×10^{-5}	0.8

*Transfer Station** or Las Vegas Entry Point (truck)*	*Transport Mode or Route*	*Number of Shipments*	*One-Way Kilometers Traveled (million)*	*One-Way Miles Traveled (million)*	*Incident-Free Conditions*				*Accident Conditions*	
					Crew		*Population*			
					Dose (person-rem)	*Risk* [b]	*Dose (person-rem)*	*Risk (LCF)*	*Radiological Risk (LCF)* [b]	*Roundtrip Nonradiological Risk (fatalities)*
West Wendover**	Rail	1,600	0.81	0.50	14	0.008	5.8	0.003	6×10^{-7}	0.1
	Truck after	3,100	2.33	1.45	37	0.02	7.7	0.005	7×10^{-7}	0.07
Total	Rail	27,000	79.6	49.5	1,000	0.6	340	0.2	8×10^{-5}	13
	Truck after	54,000	30.0	18.6	750	0.4	140	0.09	4×10^{-5}	0.9
Truck Only Transport										
Truck only transport to:	Apex	24,000	60.0	37.3	910	0.5	220	0.1	2×10^{-4}	2
	Arden	3,000	2.51	1.56	32	0.02	12	0.007	4×10^{-6}	0.1
	Henderson	27,000	79.4	49.3	2,900	2	480	0.3	1×10^{-4}	3
Apex to the NNSS	via C–215 to US 95	24,000	3.65	2.27	50	0.03	11	0.007	3×10^{-6}	2×10^{-5}
	via I–15 to US 95	24,000	3.70	2.30	120	0.07	37	0.02	3×10^{-5}	3×10^{-5}
Arden to the NNSS	via I–15 to US 95	3,000	0.49	0.30	6.1	0.004	2.7	0.002	3×10^{-6}	2×10^{-5}
	via I–215 to C–215 to US 95	3,000	0.57	0.35	12	0.007	4.6	0.003	9×10^{-7}	3×10^{-5}
	through Pahrump	3,000	0.57	0.35	14	0.009	5.2	0.003	7×10^{-7}	3×10^{-5}
Henderson to the NNSS	via I–515 to US 95	27,000	4.55	2.83	160	0.1	37	0.02	4×10^{-5}	3×10^{-5}
	via I–215 to I–15 to US 95	27,000	4.77	2.96	220	0.1	59	0.04	3×10^{-5}	3×10^{-5}
	via I–215 to C–215 to US 95	27,000	4.88	3.03	220	0.1	51	0.03	2×10^{-5}	3×10^{-5}
	through Pahrump	27,000	5.71	3.55	260	0.2	57	0.03	2×10^{-5}	3×10^{-5}

C = Clark County Route; I = Interstate; LCF = latent cancer fatality; NNSS = Nevada National Security Site; rem = roentgen equivalent man; US = U.S. Route.

[a] Low-level radioactive waste (LLW) and mixed low-level radioactive waste (MLLW) were assumed to be transported in 55-gallon drums, B-25 boxes, B-12 boxes, and 20-foot International Organization for Standardization (Sealand) containers based on historical information regarding prevalence of use.

[b] Accident dose risk can be calculated by dividing the risk values by 0.0006 (DOE 2003).

[c] These values reflect only the portion of the routes traveled by railcar.

[d] These values reflect the combined use of railcar and truck shipments to transport waste to Las Vegas.

[e] There is no truck transport to Las Vegas from Apex or Arden, based on the defined route segments.

[f] Results of transporting LLW and MLLW by rail-to-truck transport to the NNSS under the Constrained Case are presented so that the two cases can be compared.

Note: To convert kilometers to miles, multiply by 0.62137. Total may not equal the sum of the contributions due to rounding. Also due to rounding, the cited risk values may be different from multiplication of dose by the dose risk factor of 0.0006 LCFs per person-rem.

Table E–18 shows the per-shipment risk factors associated with the routes through Las Vegas. Based on these factors, one shipment of LLW or MLLW through Las Vegas would incur the greatest incident-free impact on the population along the route segment of Interstate 15 south to U.S. Route 95 to the NNSS. The smallest impact would be from Interstate 15 south to Clark County Route 215 to U.S. Route 95 to the NNSS. For accidents, the risk of an LCF from one shipment would be greatest from Arden to Interstate 215 to Clark County Route 215 to U.S. Route 95 to the NNSS. Overall, however, all of these risks are small and, viewed in relation with the overall risks associated with many shipments over the whole transportation route (from Table E–17), would not have a significant impact on these overall risks.

Table E–18 Per-Shipment Risk Factors for Routes Through Las Vegas

From Entry Point to the NNSS	*Route Through Las Vegas*	*Incident-Free Conditions*				*Accident Conditions*	
		Crewmember		*Population*			
		Dose (person -rem)	*Risk (LCF)*	*Dose (person -rem)*	*Risk (LCF)*	*Radiological Risk (LCF)*	*Traffic Fatality (roundtrip)*
Apex	via C–215 to US 95	0.021	1.2×10^{-5}	0.0037	2.2×10^{-6}	4.1×10^{-10}	2.2×10^{-5}
	via I–15 to US 95	0.044	2.7×10^{-5}	0.014	8.6×10^{-6}	4.3×10^{-9}	2.7×10^{-5}
Arden	via I–15 to US 95	0.021	1.3×10^{-5}	0.0049	2.9×10^{-6}	4.0×10^{-9}	2.5×10^{-5}
	via I–215 to C–215 to US 95	0.029	1.8×10^{-5}	0.0066	4.0×10^{-6}	1.0×10^{-9}	2.8×10^{-5}
	through Pahrump	0.034	2.0×10^{-5}	0.0074	4.4×10^{-6}	7.7×10^{-10}	2.8×10^{-5}
Henderson	via I–515 to US 95	0.022	1.3×10^{-5}	0.0056	3.4×10^{-6}	6.4×10^{-9}	3.1×10^{-5}
	via I–215 to I–15 to US 95	0.032	1.9×10^{-5}	0.0095	5.7×10^{-6}	5.8×10^{-9}	3.1×10^{-5}
	via I–215 to C–215 to US 95	0.033	2.0×10^{-5}	0.0082	4.9×10^{-6}	2.8×10^{-9}	2.9×10^{-5}
	through Pahrump	0.038	2.3×10^{-5}	0.0092	5.5×10^{-6}	2.7×10^{-9}	3.3×10^{-5}

C = Clark County Route; I = Interstate; LCF = latent cancer fatality; NNSS = Nevada National Security Site; rem = roentgen equivalent man; US = U.S. Route.

E.8 Impact of Nonradioactive Waste Transport

This section evaluates the impacts of transporting sanitary waste, hazardous wastes, and other wastes and recyclables generated at NNSS facilities to onsite or offsite disposal or reuse facilities. The impacts are evaluated based on the number of truck shipments required for each of the materials and the distances from their point of origin to disposal or reuse facilities. The truck miles for all waste shipments under each alternative were calculated based on forecasted generation rates. The truck accident and fatality rates were assumed to be those that were provided in Section E.6.2. **Table E–19** summarizes the impacts in terms of total number of miles, accidents, and fatalities for all alternatives. The results indicate that there are no large differences in the impacts among all alternatives. Under all alternatives, the expected potential traffic fatalities are very low.

Table E–19 Estimated Impacts of Nonradioactive Waste Transport

Alternative	*Total Distance Traveled (two-way miles)*	*Number of Accidents*	*Number of Fatalities*
No Action	2.0×10^{6}	1.5	0.06
Expanded Operations	3.8×10^{6}	2.8	0.11
Reduced Operations	1.8×10^{6}	1.4	0.05

Note: Includes impacts from transporting nonradioactive waste related to construction and operation of a commercial solar plant.

E.9 Conclusions

Based on the results presented in the previous section, the following conclusions have been reached (see Tables E–13 and E–17):

- It is unlikely that the transportation of radioactive waste would cause an additional fatality among workers as a result of incident-free transportation due to the implementation of administrative controls, as discussed in Section E.7.
- The highest radiological risk to the public would be under the Expanded Operations Alternative, in which about 110,000 truck shipments or 140,000 truck and rail shipments would occur. For incident-free operations, the risk to the public would be less than 1 LCF under the No Action and Reduced Operations Alternatives and about 1 LCF under the Expanded Operations Alternative. The risk of an additional fatal cancer due to an accident would be less than 1 (0.01) LCF.

The nonradiological accident risks (the potential for fatalities as a direct result of traffic or rail accidents) present the greatest risks from transport of radioactive materials and waste. The maximum risks would occur under the Expanded Operations Alternative using rail-to-truck transport. Considering that the transportation activities would occur over a 10-year period and that the average number of traffic fatalities in the United States is about 40,000 per year, the traffic fatality risks under all alternatives are small.

E.10 Long-Term Impacts of Transportation

The *Yucca Mountain EIS* (DOE 2002a) analyzed the cumulative impacts of the transportation of radioactive material, consisting of impacts of historical shipments of radioactive waste and spent nuclear fuel, reasonably foreseeable actions that include transportation of radioactive material, and general radioactive material transportation that is not related to a particular action. The collective dose to the general population and workers was the measure used to quantify cumulative transportation impacts. This measure of impact was chosen because it may be directly related to the LCFs using a cancer risk coefficient. **Table E–20** provides a summary of the total worker and general population collective doses from various transportation activities. The table shows that the impacts incurred by the proposed activities in this *NNSS SWEIS* are small compared with the overall transportation impacts related to transport of DOE-related and commercial radioactive cargoes. The total collective worker dose from all types of shipments (the alternatives in this SWEIS; historical, reasonably foreseeable actions; and general transportation) was estimated to be about 405,000 person-rem (243 LCFs) for the period 1943 through 2073 (131 years). The total general population collective dose was estimated to be about 374,000 person-rem (225 LCFs). The majority of the collective dose for workers and the general population is due to the general transportation of radioactive material. Examples of these activities are shipments of radiopharmaceuticals to nuclear medicine laboratories and shipments of commercial LLW to commercial disposal facilities. The total number of LCFs (among the workers and the general population) estimated to result from radioactive material transportation over the period between 1943 and 2073 is about 467, or an average of about 5 LCFs per year. Over this same period (131 years), approximately 73 million people would die from cancer, based on National Center for Health Statistics data. The average annual number of cancer deaths in the United States is about 554,000, with less than 1 percent fluctuation in the number of cancer fatalities in any given year (CDC 2007). The transportation-related LCFs for transporting radioactive cargo would be 0.0009 percent of the total annual number of LCFs; therefore, it is indistinguishable from the natural fluctuation in the total annual death rate from cancer.

Table E–20 Cumulative Transportation Related Radiological Collective Doses and Latent Cancer Fatalities (1943 to 2073)

Category	Collective Worker Dose (person-rem)	Collective General Population Dose (person-rem)
Transportation Impacts in this SWEIS	5,500 [a]	1,300 [a]
Other Nuclear Material Shipments [b]		
Historical	330	230
Reasonably Foreseeable Actions	24,800	35,000
General Radioactive Material Transport (1943 to 2073)	374,000	338,000
Total Collective Dose (up to 2073)	405,000	374,000
Total LCFs [b, c]	243	225

LCF = latent cancer fatality; rem = roentgen equivalent man; SWEIS = site-wide environmental impact statement.
[a] These maximum impacts are the result of the sum of impacts related to transport of all analyzed radioactive wastes and materials in the Expanded Operations Alternative, Constrained Case.
[b] The values are rounded.
[c] Total LCFs are calculated assuming 0.0006 LCFs per rem of exposure.
Source: DOE 2002a, 2008b, 2010a.

E.11 Uncertainty and Conservatism in Estimated Impacts

The sequence of analyses performed to generate the estimates of radiological risk for transportation includes (1) determination of the inventory and characteristics, (2) estimation of shipment requirements, (3) determination of route characteristics, (4) calculation of radiation doses to exposed individuals (including estimation of environmental transport and uptake of radionuclides), and (5) estimation of health effects. Uncertainties are associated with each of these steps. Uncertainties exist in the way that the physical systems being analyzed are represented by the computational models; in the data required to exercise the models (due to measurement errors, sampling errors, natural variability, or unknowns caused simply by the future nature of the actions being analyzed); and in the calculations themselves (e.g., approximate algorithms used by the computers).

In principle, one can estimate the uncertainty associated with each input or computational source and predict the resultant uncertainty in each set of calculations. Thus, one can propagate the uncertainties from one set of calculations to the next and estimate the uncertainty in the final, or absolute, result; however, conducting such a full-scale quantitative uncertainty analysis is often impractical and sometimes impossible, especially for actions to be initiated at an unspecified time in the future. Instead, the risk analysis is designed to ensure, through uniform and judicious selection of scenarios, models, and input parameters, that relative comparisons of risk among the various alternatives are meaningful. In the transportation risk assessment, this design was accomplished by uniformly applying common input parameters and assumptions to each alternative. Therefore, although considerable uncertainty is inherent in the absolute magnitude of the transportation risk for each alternative, much less uncertainty is associated with the relative differences among the alternatives in a given measure of risk.

In the following sections, areas of uncertainty are discussed for the assessment steps enumerated above. Special emphasis is placed on identifying whether the uncertainties affect relative or absolute measures of risk. The reality and conservatism of the assumptions are addressed. Where practical, the parameters that most significantly affect the risk assessment results are identified.

E.11.1 Uncertainties in Material Inventory and Characterization

Waste inventories and the physical and radiological characteristics are important input parameters to the transportation risk assessment. The potential number of shipments under all three alternatives was primarily based on the projected dimensions of package contents, the strength of the radiation field, the heat that must be dissipated, and assumptions concerning shipment capacities. The physical and radiological characteristics are important in determining the material released during accidents and the subsequent doses to exposed individuals through multiple environmental exposure pathways.

Uncertainties in the inventory and characterization are reflected in the transportation risk results. If the inventory is overestimated or underestimated, the resulting transportation risk estimates would also be overestimated or underestimated by roughly the same factor. However, the same inventory estimates were used to analyze the transportation impacts of each alternative. Therefore, for comparative purposes, the observed differences in transportation risks among the alternatives, as given in Tables E–13 and E–14, are believed to represent unbiased, reasonably accurate estimates based on current information in terms of relative risk comparisons.

E.11.2 Uncertainties in Containers, Shipment Capacities, and Number of Shipments

Transportation activities required under each alternative are based in part on assumptions concerning the packaging characteristics and shipment capacities for commercial trucks and railcars. Representative shipment capacities have been defined for assessment purposes based on probable future shipment capacities. In reality, the actual shipment capacities may differ from the predicted capacities such that the projected number of shipments and, consequently, the total transportation risk, would change. However, although the predicted transportation risks would increase or decrease accordingly, the relative differences in risks among the alternatives would remain about the same.

E.11.3 Uncertainties in Route Determination

Analyzed routes have been determined between the origin and destination sites considered in this SWEIS. The route from a given region of the United States with the highest dose risk per shipment was used to calculate cumulative dose risk from that region. The routes have been determined to be consistent with current guidelines, regulations, and practices, but may not be the actual routes that would be used in the future. In reality, the actual routes could differ from the representative ones with regard to distances and total population along the routes. Moreover, because materials could be transported over an extended time starting at some time in the future, the highway infrastructure and the demographics along routes could change. These effects have not been accounted for in the transportation assessment; however, it is not anticipated that these changes would significantly affect relative comparisons of risk among the alternatives considered in this SWEIS. Specific routes for some materials cannot be identified in advance because the routes are classified to protect national security interests.

E.11.4 Uncertainties in the Calculation of Radiation Doses

The models used to calculate radiation doses from transportation activities introduce further uncertainty into the risk assessment process. Estimating the accuracy or absolute uncertainty of the risk assessment results is generally difficult. The accuracy of the calculated results is closely related to the limitations of the computational models and to the uncertainties in each of the input parameters that the model requires. The single greatest limitation facing users of RADTRAN, or any computer code of this type, is the scarcity of data for certain input parameters. Populations (off-link and on-link) along the transportation routes, shipment surface dose rates, and individuals residing near the routes are the most uncertain data in dose calculations. In preparing these data, it was assumed that the off-link population is uniformly distributed; the on-link population is proportional to the traffic density, with an assumed occupancy of two persons per car; the shipment surface dose rate is the maximum allowed dose rate; and the potential exists for an individual to reside at the edge of the highway. It is clear that not all assumptions are accurate. For example, the off-link population is mostly heterogeneous, and the on-link traffic density varies widely within a geographic zone (i.e., urban, suburban, or rural). Finally, added to this complexity are the assumptions regarding the expected distance between the public and the shipment at a traffic stop, rest stop, or traffic jam and the afforded shielding.

Uncertainties associated with the computational models are reduced by using state-of-the-art computer codes that have undergone extensive review. Because many uncertainties are recognized but difficult to quantify, assumptions are made at each step of the risk assessment process that are intended to produce conservative results (i.e., to overestimate the calculated dose and radiological risk). Because parameters and assumptions were applied consistently to all alternatives, this model bias is not expected to affect the meaningfulness of relative comparisons of risk; however, the results may not represent risks in an absolute sense.

E.11.5 Uncertainties in Traffic Fatality Rates

Vehicle accident and fatality rates were taken from data provided in *State-Level Accident Rates for Surface Freight Transportation: A Reexamination*, ANL/ESD/TM-150 (Saricks and Tompkins 1999). Truck and rail accident rates were computed for each state based on statistics compiled by the Federal Highway Administration, Office of Motor Carriers, and Federal Railroad Administration from 1994 to 1996. The rates are provided per unit car-miles for each state, as well as national, average, and mean values. In this analysis, mean rates were used.

The analysis was based on accident data for the years 1994 through 1996. While these data may be the best available data, subsequent and future accident and fatality rates may change as a result of vehicle and highway improvements. The DOT national accident and fatality statistics for large trucks and buses indicate lower accident and fatality rates for recent years compared with those of 1994 through 1996 and earlier data (DOT 2009).

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APPENDIX F
BIOLOGICAL RESOURCES

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BIOLOGICAL RESOURCES

This appendix contains detailed information regarding species of plants and animals that inhabit or have been sited at the Nevada National Security Site (NNSS), including a list of sensitive and protected/regulated species. The locations of sensitive plant species on the NNSS are also depicted.

F.1 Sensitive and Protected/Regulated Species of Plants and Animals Known to Occur on or Adjacent to the Nevada National Security Site

Sensitive species of plants and animals are defined as species that are at risk of extinction or serious decline or whose long-term viability has been identified as a concern. They include species on the Nevada Natural Heritage Program Animal and Plant At-Risk Tracking List and bat species ranked as moderate or high in the Nevada Bat Conservation Plan Bat Species Risk Assessment. Protected/regulated species are those that are protected or regulated by Federal or state law. Some species are both sensitive and protected/regulated, such as the desert tortoise (*Gopherus agassizii*). The National Nuclear Security Administration Nevada Site Office (NNSA/NSO) reviews the status or ranking of plants and animals known to occur on the NNSS annually under its Sensitive Plant Monitoring Program and Sensitive and Protected/Regulated Animal Monitoring Program to determine whether any species' status or ranking has changed. Sources that are reviewed include the Nevada Natural Heritage Program Animal and Plant At-Risk Tracking List; *Nevada Administrative Code* 503, "Hunting, Fishing and Trapping; Miscellaneous Protective Measures," and other sources, such as input from regional biologists. In addition, the results of field surveys and monitoring at the NNSS are used as part of the review process. NNSA/NSO shares the results of field surveys and monitoring with Federal and state agencies and other biologists in the interest of ensuring adequate bases for including/excluding species and providing appropriate protective measures. The most current listing of sensitive and protected/regulated species of plants and animals known to occur on or adjacent to the NNSS and their status are shown in **Table F–1**. Because the list of sensitive and protected/regulated species may change from year to year, the most up-to-date information may be obtained by reviewing the most recent *Ecological Monitoring and Compliance Program Report*, which is available on the NNSA/NSO website at www.nv.doe.gov. The known locations of sensitive plant species populations are shown in **Figure F–1**. It is important to note that these locations may change from year to year. As noted previously, NNSA/NSO annually conducts field surveys and monitoring to maintain and update its sensitive plant database and more effectively provide an appropriate level of protection for sensitive plant species on the NNSS.

Table F–1 Sensitive and Protected/Regulated Species Known to Occur on or Adjacent to the Nevada National Security Site [a]

Common Name	***Scientific Name***	***Status*** [b]
Moss Species		
Convex entosthodon moss	*Entosthodon planoconvexus*	S, 5 years
Flowering Plant Species		
Yucca (3 species), Agave (1 species)	Agavaceae	CY
Desert or white bear poppy	*Arctomecon merriamii*	S, 10 years
Beatley milkvetch	*Astragalus beatleyae*	S, 5 years
Black woolypod or Funeral Mountain milkvetch	*Astragalus funereus*	S, 5 years
Clokey's eggvetch	*Astragalus oophorus* var. *clokeyanus*	S, 5 years
Cacti (18 species)	Cactaceae	CY
Cane Spring suncup or largeflower suncup	*Camissonia megalantha*	S, 10 years
Sanicle biscuitroot	*Cymopterus ripleyi* var. *saniculoides*	S, 10 years
Darin buckwheat	*Eriogonum concinnum*	S, 5 years
Clokey's buckwheat	*Eriogonum heermannii* var. *clokeyi*	S, 5 years

Common Name	***Scientific Name***	***Status*** [b]
Pahute green gentian	*Frasera pahutensis*	S, 10 years
Kingston Mountains bedstraw	*Galium hilendiae* ssp. *kingstonense*	S, 10 years
Inyo hulsea	*Hulsea vestita* ssp. *inyoensis*	S, 10 years
Rock purpusia	*Ivesia arizonica* var. *saxosa*	S, 5 years
Juniper, Utah	*Juniperus osteosperma*	CY
Beatley's phacelia or Beatley's scorpionflower	*Phacelia beatleyae*	S, 10 years
Death Valley beardtongue	*Penstemon fruticiformis* ssp. *amargosae*	S, 5 years
Paiute beardtongue	*Penstemon pahutensis*	S, 10 years
Clarke phacelia	*Phacelia filiae*	S, 10 years
Weasel phacelia	*Phacelia mustelina*	S, 10 years
Parish phacelia	*Phacelia parishii*	S, 10 years
Pine, singleleaf pinyon	*Pinus monophylla*	CY
Mollusk Species		
Southeast Nevada springsnail	*Pyrgulopsis turbatrix*	S, A
Reptile Species		
Western red-tailed skink	*Eumeces gilberti* ssp. *rubricaudatus*	S, E
Desert tortoise	*Gopherus agassizii*	LT, S, NPT, IA
Bird Species [c]		
Northern goshawk	*Accipiter gentilis*	S, NPS, IA
Chukar	*Alectoris chukar*	G[d]
Golden eagle	*Aquila chrysaetos*	EA, NP
Western burrowing owl	*Athene cunicularia hypugaea*	NP
Ferruginous hawk	*Buteo regalis*	S, NP, IA
Gambel's quail	*Callipepla gambelii*	G[d]
Mountain plover	*Charadrius montanus*	PT, NP
Western yellow-billed cuckoo	*Coccyzus americanus*	C, S, NPS, IA
Peregrine falcon	*Falco peregrinus*	<LE, S, NPE, IA
Bald eagle	*Haliaeetus leucocephalus*	<LT, EA, S, NPE, IA
Western least bittern	*Ixobrychus exilis* ssp. *hesperis*	S, NP, IA
Loggerhead shrike	*Lanius ludovicianus*	NPS
Sage thrasher	*Oreoscoptes montanus*	NPS
Phainopepla	*Phainopepla nitens*	S, NP, IA
Brewer's sparrow	*Spizella breweri*	NPS
Bendire's thrasher	*Toxostoma bendirei*	S, NP, IA
LeConte's thrasher	*Toxostoma lecontei*	S, NP, IA
Mammal Species		
Pronghorn antelope	*Antilocapra americana*	G
Pallid bat	*Antrozous pallidus*	M, NP, A
Townsend's big-eared bat	*Corynorhinus townsendii*	H, NPS, A
Burro	*Equus asinus*	H&B
Horse, wild	*Equus caballus*	H&B
Elk	*Cervus elaphus*	G
Spotted bat	*Euderma maculatum*	M, NPT, A
Silver-haired bat	*Lasionycteris noctivagans*	M, A
Western red bat	*Lasiurus blossevillii*	H, NPS, A
Hoary bat	*Lasiurus cinereus*	M, A
Bobcat	*Lynx rufus*	F
Dark kangaroo mouse	*Microdipodops megacephalus*	NP
Pale kangaroo mouse	*Microdipodops pallidus*	S, NP, A
California myotis	*Myotis californicus*	M, A
Small-footed myotis	*Myotis ciliolabrum*	M, A

Common Name	***Scientific Name***	***Status*** [b]
Long-eared myotis	*Myotis evotis*	M, A
Fringed myotis	*Myotis thysanodes*	H, NP, A
Yuma myotis	*Myotis yumanensis*	M, A
Desert bighorn sheep	*Ovis canadensis* ssp. *nelsoni*	G
Mule deer	*Odocoileus hemionus*	G
Western pipistrelle	*Pipistrellus hesperus*	M, A
Mountain lion	*Puma (Felis) concolor*	G
Audubon's cottontail	*Sylvilagus audubonii*	G
Nuttall's cottontail	*Sylvilagus nuttallii*	G
Brazilian free-tailed bat	*Tadarida brasiliensis*	NP
Gray fox		F
Kit fox		F

ssp = subspecies; var = variety.

[a] Source: Table 2–1 in *Ecological Monitoring and Compliance Program 2009 Report* (NSTec 2010) with some modifications based on species name changes (plants), status changes, and species inadvertently left off Table 2–1.

[b] Status Codes:

Endangered Species Act (16 U.S.C. 1531 et seq.), U.S. Fish and Wildlife Service
LT – Listed as threatened
PT – Proposed as threatened
C – Candidate for listing
<LE – Formerly listed as an endangered species
<LT – Formerly listed as a threatened species

U.S. Department of the Interior
H&B – Protected under the Wild Free-Roaming Horses and Burros Act (16 U.S.C. 1331 et seq.)
EA – Protected under the Bald and Golden Eagle Protection Act (16 U.S.C. 668 et seq.)

State of Nevada – Plants
S – Nevada Natural Heritage Program – Animal and Plant At-Risk Tracking List (NRS 527.260-.300)
CY – Protected as a cactus, yucca, or Christmas tree (NRS 527.060-.120)

State of Nevada – Animals
S – Nevada Natural Heritage Program – Animal and Plant At-Risk Tracking List and Plant and State Watch List (NRS 501)
NPE – Nevada Protected-Endangered, species protected under *Nevada Administrative Code* (NAC), Chapter 503
NPT – Nevada Protected-Threatened, species protected under NAC 503
NPS – Nevada Protected-Sensitive, species protected under NAC 503
NP – Nevada Protected, species protected under NAC 503
G – Regulated as a game species
F – Regulated as a fur-bearing species

Long-Term Plant Monitoring Status for the Nevada National Security Site
5 years – Monitored at least once every 5 years
10 years – Monitored at least once every 10 years

Long-Term Animal Monitoring Status for the Nevada National Security Site
A – Active
IA – Inactive
E – Evaluate

Nevada Bat Conservation Plan – Bat Species Risk Assessment
H – High risk
M – Moderate risk

[c] All bird species on the Nevada National Security Site are protected by the Migratory Bird Treaty Act (16 U.S.C. 703 et seq.) except chukar, Gambel's quail, English house sparrow, rock dove, and European starling.

[d] Bird species that are considered game species that are also protected under the Migratory Bird Treat Act, such as mourning dove (*Zenaida macroura*) are not included in this table.

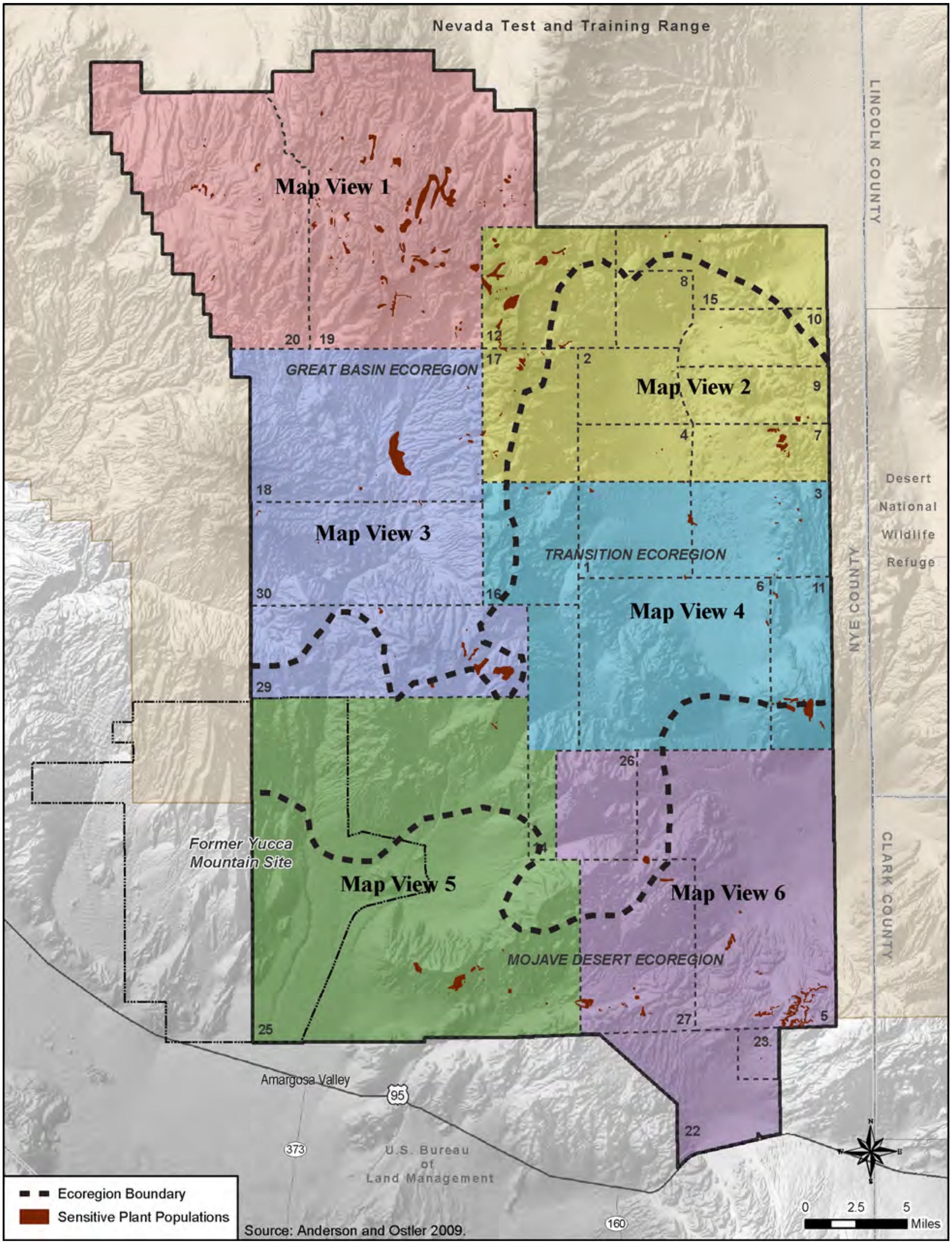

Figure F–1 Sensitive Plant Species on the Nevada National Security Site

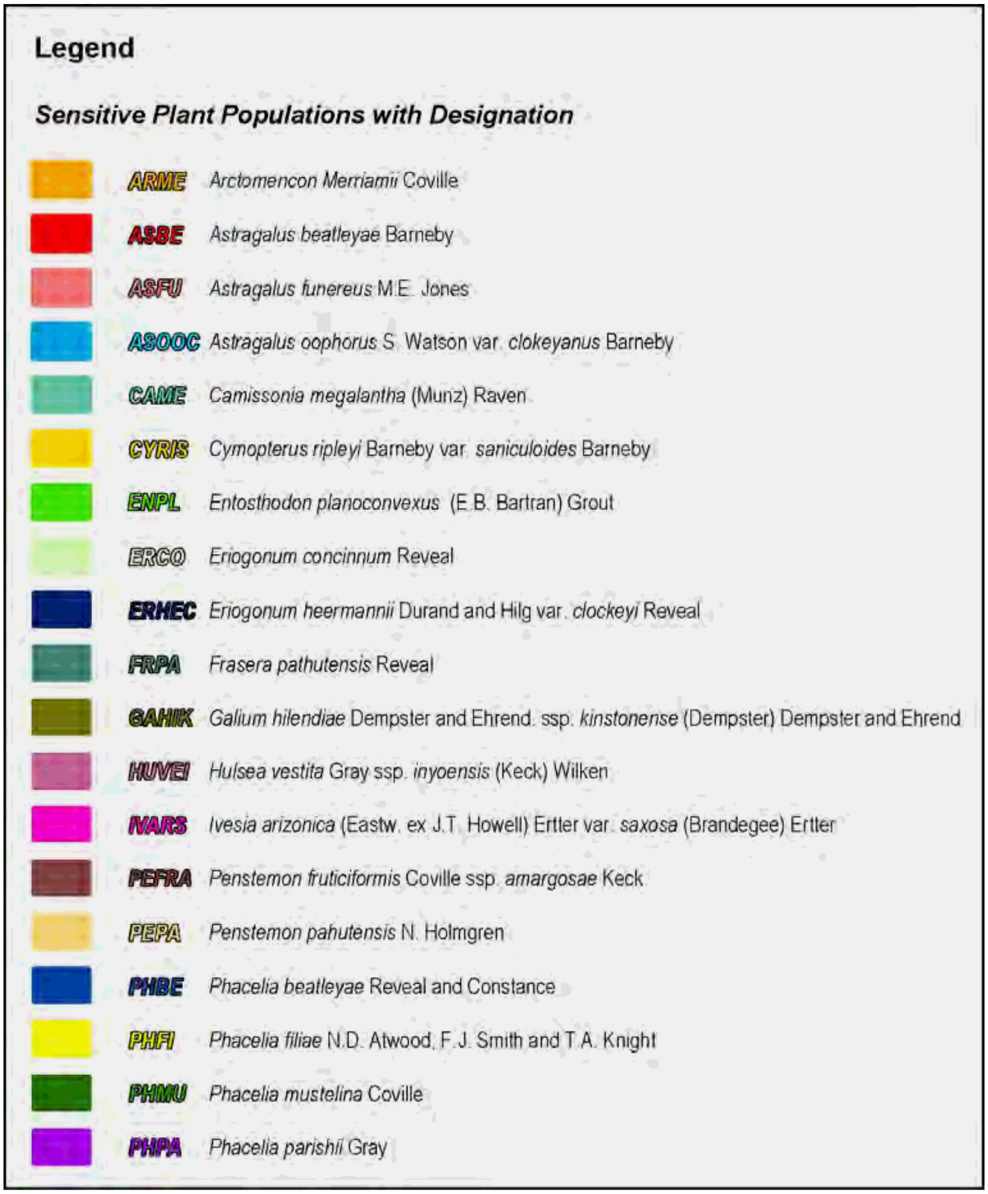

Figure F–1 Sensitive Plant Species on the Nevada National Security Site (cont'd)

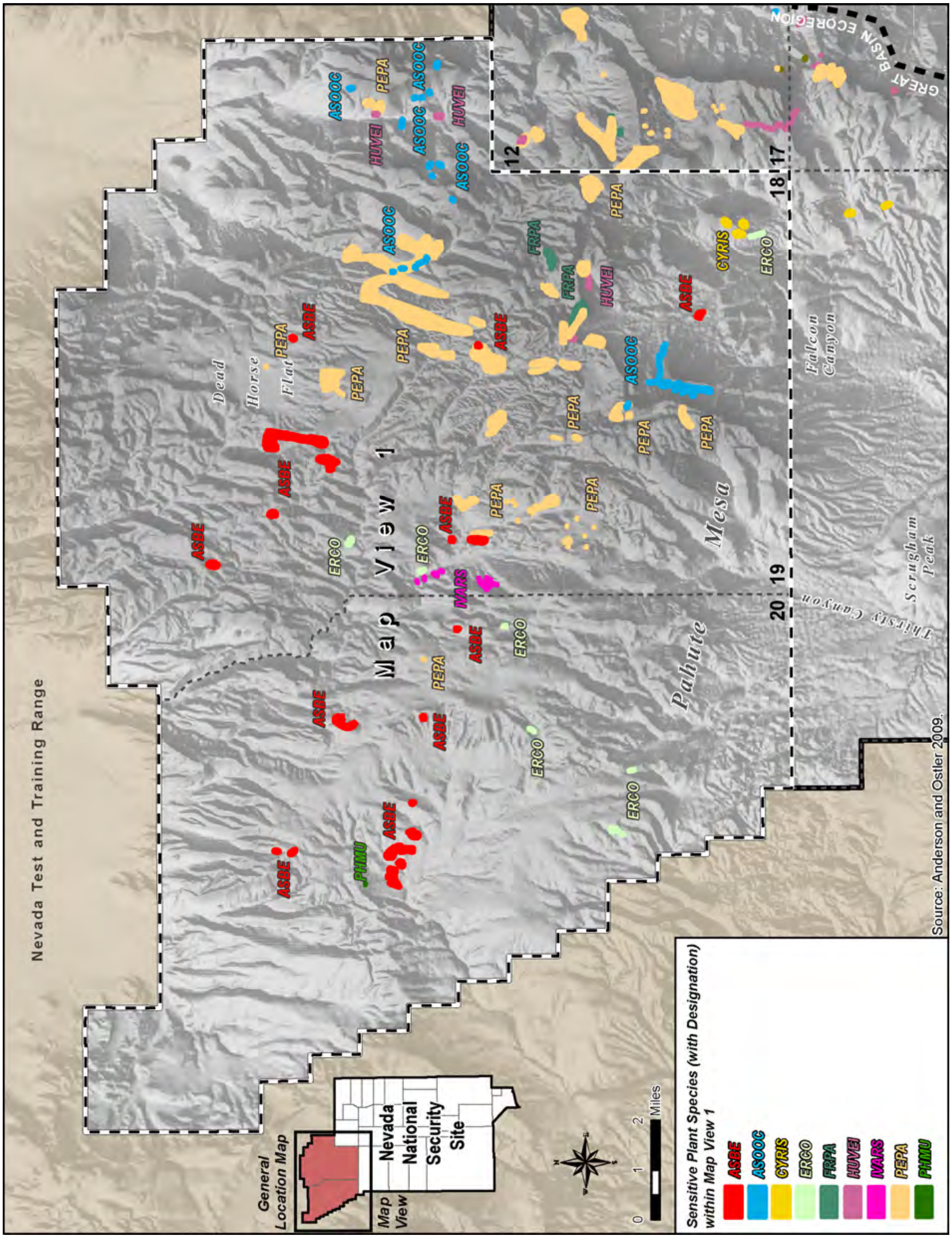

Figure F–1 Sensitive Plant Species on the Nevada National Security Site, Part 1 (cont'd)

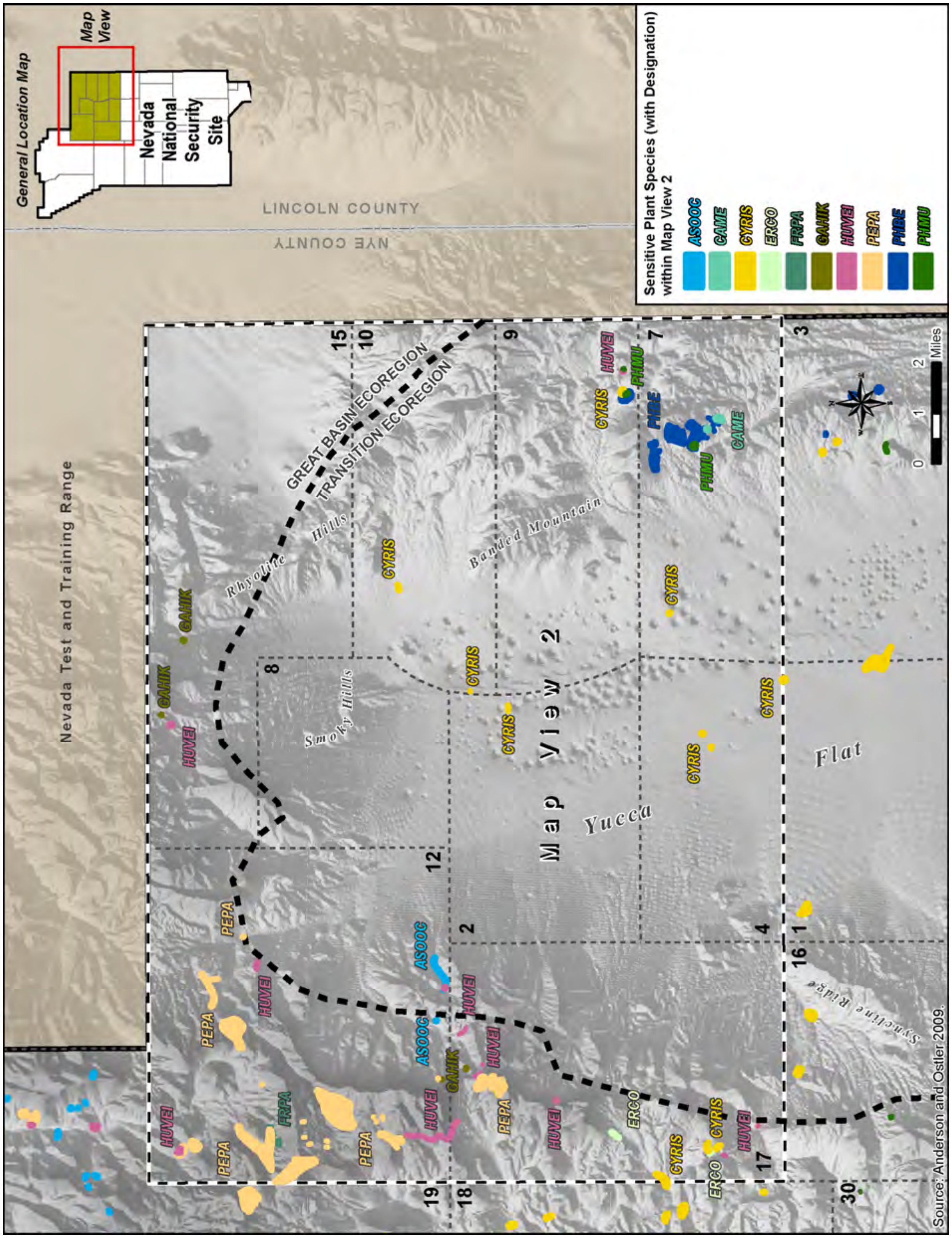

Figure F–1 Sensitive Plant Species on the Nevada National Security Site, Part 2 (cont'd)

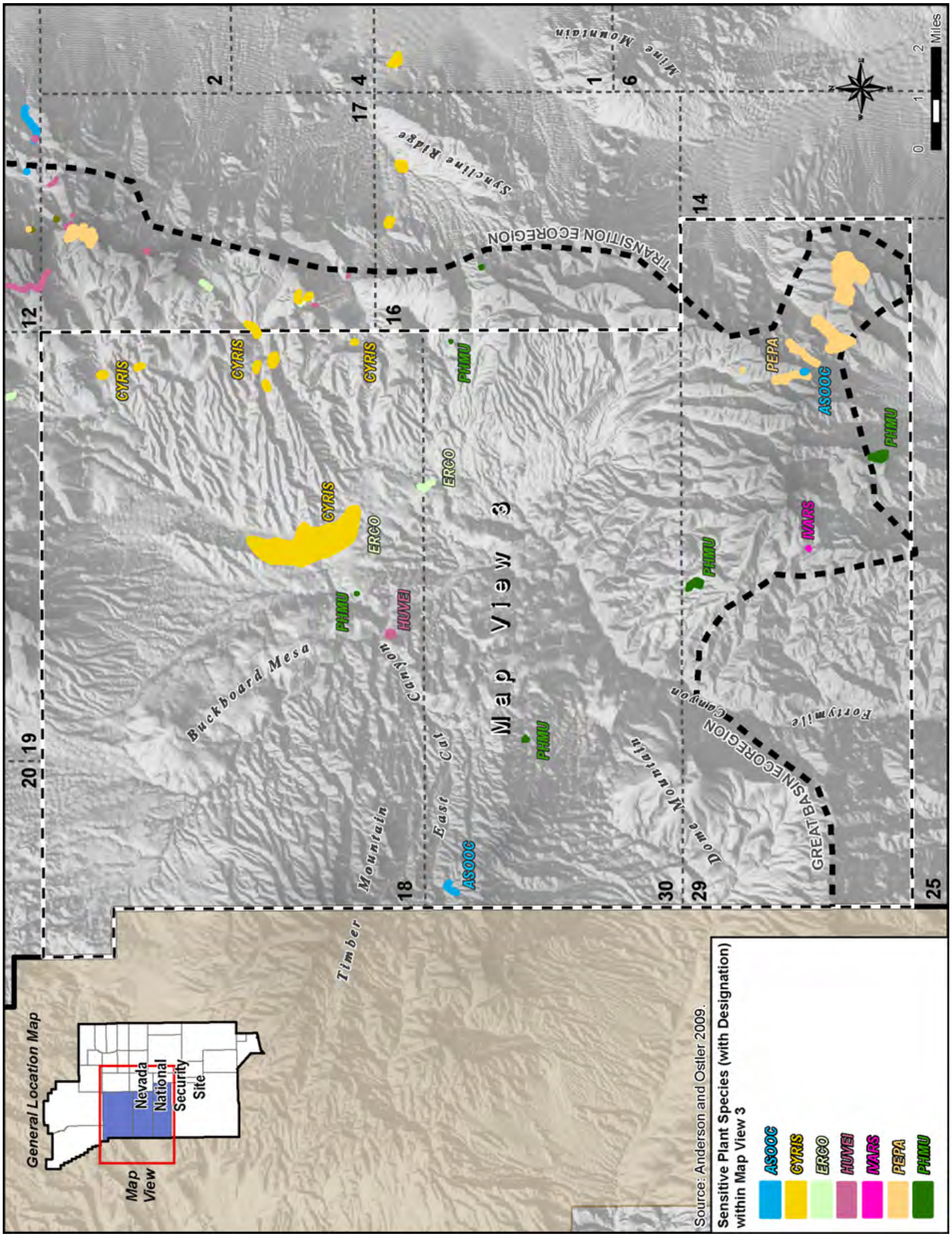

Figure F–1 Sensitive Plant Species on the Nevada National Security Site, Part 3 (cont'd)

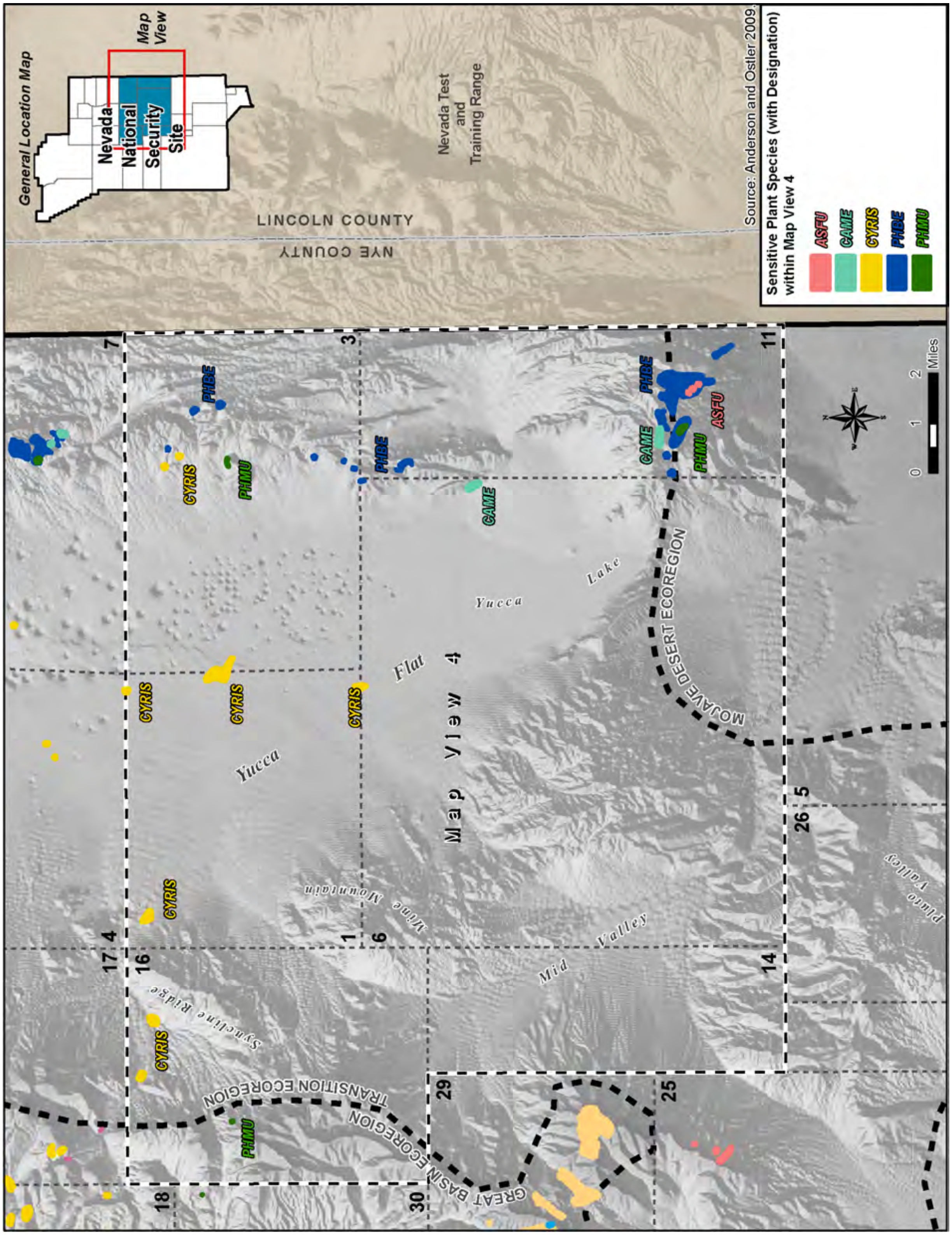

Figure F–1 Sensitive Plant Species on the Nevada National Security Site, Part 4 (cont'd)

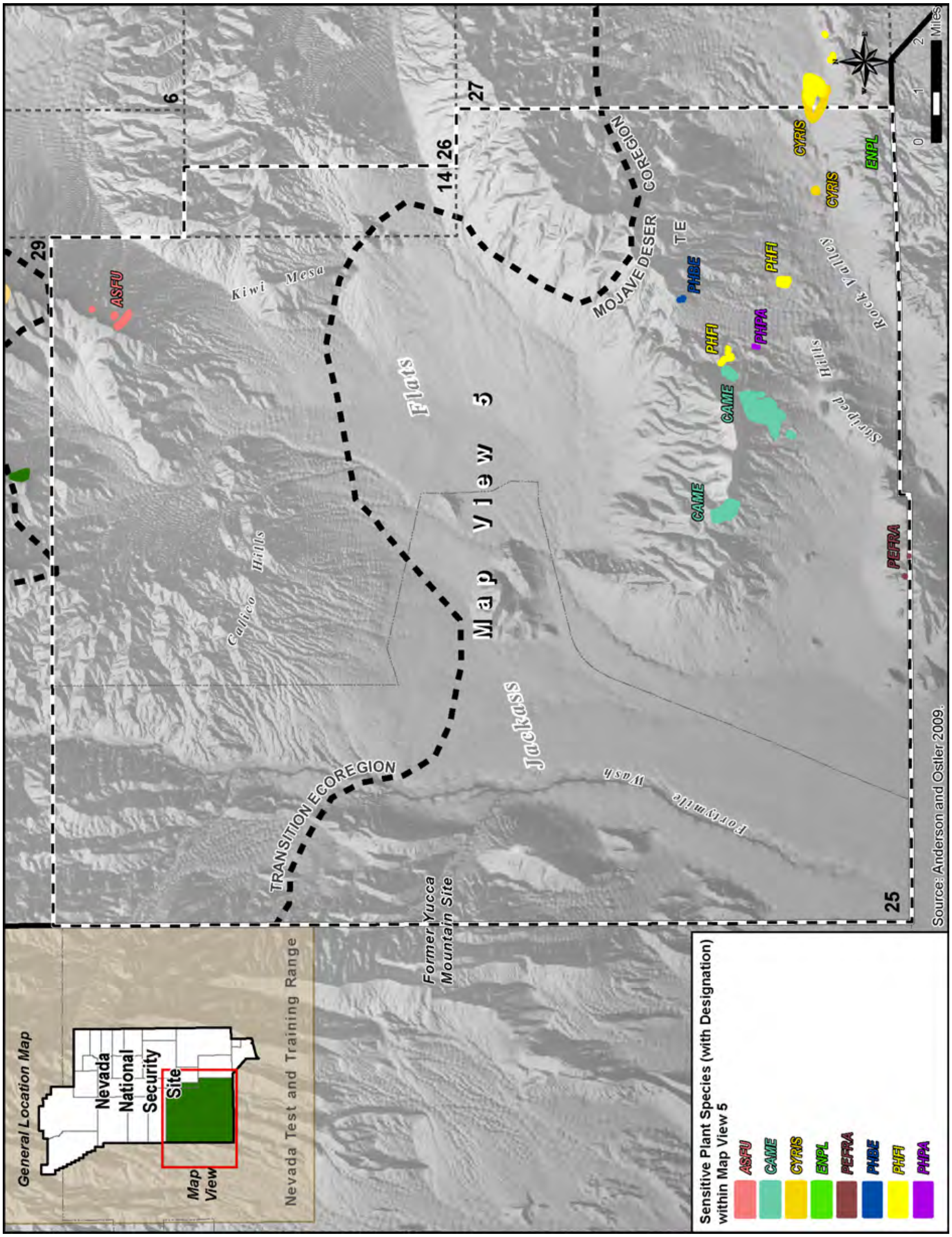

Figure F–1 Sensitive Plant Species on the Nevada National Security Site, Part 5 (cont'd)

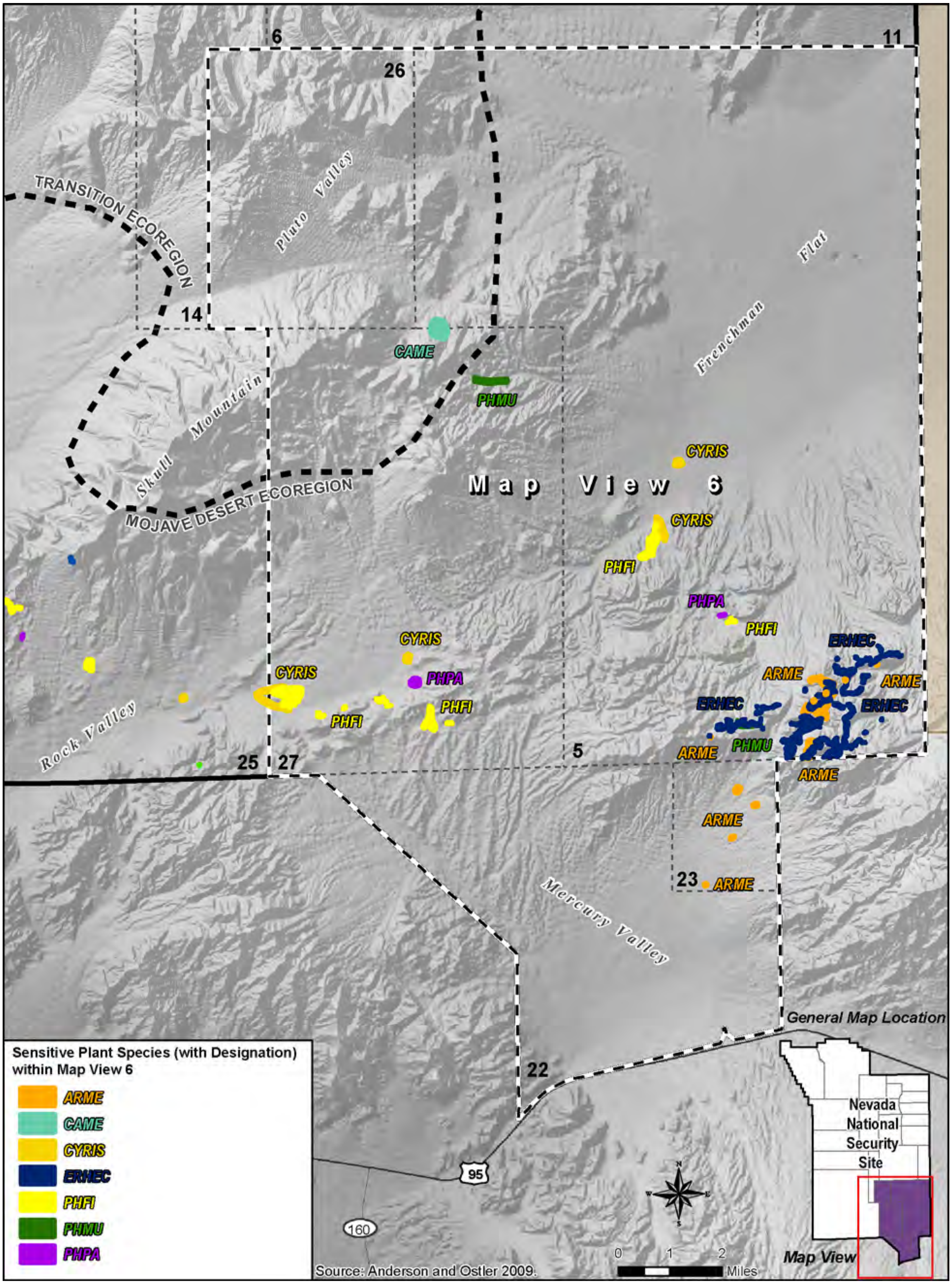

Figure F–1 Sensitive Plant Species on the Nevada National Security Site, Part 6 (cont'd)

Tables F–2 and **F–3** are derived from *Ecology of the Nevada Test Site: An Annotated Bibliography* (Wills and Ostler 2001). The tables list all species of nonvascular and vascular plants, respectively, that have been identified at the NNSS. The species are arranged alphabetically within their respective kingdom and division (for nonvascular plants) and family (for vascular plants) rather than their taxonomic order to help the reader more readily locate particular plant names. The most current genus and species (and variety, where appropriate) names follow (Ostler et al. 2000). The names of species that were not verified in Wills and Ostler 2001 are indicated by an asterisk.

Table F–2 Nonvascular Flora Species of the Nevada National Security Site

KINGDOM FUNGI		
Alternaria tenuissima	*Curvularia* sp. *	*P. granulatum*
Antrodia serialis	*Cylindrocarpon heteronemum* *	*P. janthinellum*
Aspergillus fumigatus	*Fomitopsis pinicola*	*P. lanosum*
A. niger	*F. rosea*	*P. oxalicum*
A. niveus	*Fusarium semitectum*	*P. restrictum*
A. ochraceus	*Geotrichum* sp. *	*P. urtica* *
A. restrictus	*Glipcladium penicilloides* *	*Phoma* sp.
*A. sulfurous**	*G. roseum* *	*Poria carbonica*
A. ustus	*Gloeocladium* sp. *	*P. placenta*
A. versicolor	*Gymnoascus* sp. *	*P. vaillantii*
A. wentii	*Hormiscium* sp. *	*Pullularia pullulans*
Botrytis bassiana *	*Leucogyrophana mollusca* *	*Pythium mammillatum* *
Bourdotia eyrei *	*Mucor* sp.	*Rhizopus stolonifer* *
Cephalosporium sp.	*M. corticolus* *	*Serpula himantioides*
Cephalosporium acremonium	*M. spinescens* *	*Sporotrichum epigaeum* *
C. humicola *	*M. varians* *	*Stachybotrys chartarum*
Chaetomium aureum	*Myrothecium verrucaria* *	*Stemphylium ilicis* *
C. spirale	*Osteina obducta*	*Stysanus medicus* *
Choanephora sp.	*Paecilomyces inflatus* *	*Syncephalastrum racemosum*
Circinella muscae *	*P. terricola* *	*Tetracoccosporium paxianum* *
Cladosporium cladosporioides	*Papularia* sp. *	*Trichoderma harzianum*
C. herbarum	*Papulospora sepedonioides* *	*T. viride*
Coccosporium sp. *	*Paxillus panuoides*	*Tyromyces transmutans* *
Cunninghamella bainieri *	*Penicillium* sp. *	
C. microspora *	*P. avellanea* *	
KINGDOM MONERA		
Division Bacteria (Bacteria)		
Streptomyces sp.		
Division Cyanophycota (Blue-Green Algae)		
Anacystis montana	*Nodularia sphaerocarpa*	*P. autumnale*
Calothrix sp.	*Nostoc* sp.	*Plectonema boryanum*
Coccochloris elabens	*N. commune*	*P. nostocorum*
C. stagnina	*N. enthophytum* *	*Schizothrix accutissima* *
Homoeothrix janthina	*Nostoc humifusum* *	*S. californica* *
Leptolyngbya tenuis	*Oscillatoria* sp.	*S. macbridei* *
Lyngbya sp.	*O. brevis*	*Scytonema hofmannii*
Microcoleus paludosus	*Phormidium* sp.	*Symploca kieneri*
M. vaginatus		

KINGDOM PLANTAE		
Division Bacillariophyta (Diatoms)		
Achnanthes exigua	*Gomphonema parvulum*	*N. gracilis*
A. lanceolata	*Hantzschia* sp.	*N. linearis*
A. minutissima	*Melosira granulata*	*N. palea*
A. saxonica	*Meridion circulare*	*N. tryblionella*
Amphora submontana	*Navicula cryptocephala*	*Pinnularia* sp.
Asterionella formosa	*N. cuspidata* var. *ambigua*	*P. abaujensis* var. *subundulata*
Denticula elegans	*Navicula laevissima*	*P. viridis* var. *minor*
Epithemia adnata var. *proboscidea* *	*N. minima*	*Stauroneis anceps*
E. sorex	*N. rhynchocephala* var. *amphiceras*	*Stephanodiscus niagarae*
Fragilaria sp.	*Nitzschia* sp.	*Surirella ovalis*
F. construens	*N. amphibia*	
Division Chlorophycota (Green Algae)		
Ankistrodesmus falcatus	*Haematococcus lacustris*	*Protosiphon cinnamomeus* *
Bulbochaete sp.	*Microthamnion kuetzingianum*	*Scenedesmus acutus*
Chara sp.	*Oedogonium* sp.	*S. bijuga*
Chlamydomonas sp.	*Oocystis borgei*	*Spirogyra jurgensii*
Chlorella vulgaris	*O. crassa*	*Stigeoclonium* sp.
Closterium turgidum	*Pandorina morum*	*Ulothrix* sp.
Cosmarium sp.	*Protococcus grebillei* *	
Franceia droescheri	*Protoderma viride*	
Division Xanthophyta (Yellow-Green Algae)		
Vaucheria sp.		

sp = species (singular); var = variety.
* Designates species in which the listing was unable to be verified or updated.
Source: Wills and Ostler 2001.

Table F–3 Vascular Flora Species of the Nevada National Security Site

DIVISION CONIFEROPHYTA (CONFIERS)

Cupressaceae – Cypress Family
Juniperus osteosperma

Pinaceae – Pine Family
Pinus monophylla

DIVISION GNETOPHYTA (GNETOPHYTES)

Ephedraceae – Mormon-Tea Family
Ephedra funerea
E. nevadensis
E. torreyana
E. viridis

DIVISION MAGNOLIOPHYTA (FLOWERING PLANTS)

Monocotyledons

Agavaceae – Century-Plant Family
Agave utahensis var. *eborispina*
Yucca baccata var. *vespertina*
Bolboschoenus robustus
Y. brevifolia
Y. schidigera

Cyperaceae – Sedge Family
Carex alma
C. douglasii
C. occidentalis
C. praegracilis
Eleocharis macrostachya
E. parishii
E. paulustris
Schoenoplectus acutus var. *acutus*

Juncaceae – Rush Family
Juncus balticus
J. longistylis
J. saximontanus

Liliaceae – Lily Family
Allium nevadense
A. scorodoprasum
Androstephium breviflorum
Calochortus bruneaunis
C. flexuosus
Dichelostemma pulchellum
Fritillaria atropurpurea
Zigadenus paniculatus

Poaceae – Grass Family
Achnatherum aridum
A. coronatum
A. hymenoides
A. parishii
A. parishii var. *parishii*
A. pinetorum
A. speciosum
A. thurberianum
Agropyron cristatum
Agrostis exarata var. *monolepis*
A. semiverticillata
Aristida adscensionis
A. arizonica
A. purpurea

Poaceae – Grass Family (cont'd)
A. purpurea var. *fendleriana*
A. purpurea var. *longiseta*
A. purpurea var. *nealleyi*
A. purpurea var. *wrightii*
Avena sativa
Blepharidachne kingii
Bouteloua barbata
B. gracilis
B. trifida
Bromus anomalus
B. berterianus
B. carinatus
B. cartharticus
B. diandrus
B. japonicus
B. rubens
B. tectorum
Chloris virgata
Cynodon dactylon
Dactylis glomerata
Deschampsia caespitosa
D. danthonioides
Digitaria sanguinalis
Distichlis spicata

Poaceae – Grass Family (cont'd)
Echinochloa crusgalli
Elymus elymoides ssp. *elymoides*
E. multisetus
Eragrostis barrelieri
Erioneuron pilosum
E. pulchellum
Festuca pratensis
Hesperostipa comata ssp. *Comate*
Hordeum jubatum
H. murinum ssp. *glaucum*
Koeleria macrantha
Leptochloa uninervia
Leymus cinereus
L. triticoides
Lolium arundinacea
L. perenne ssp. *multiflorum*
Monroa squarrosa
Muhlenbergia porteri
M. richardsonis
Pascopyrum smithii
Piptatherum micrantha
Pleuraphis jamesii
P. rigida
Poa annua

Poaceae – Grass Family (cont'd)	**Poaceae – Grass Family (cont'd)**	**Poaceae – Grass Family (cont'd)**	**Potamogetonaceae – Pondweeds**
P. bigelovii	*Puccinellia distans*	*S. flexuosus*	*Potamogeton pectinatus*
P. fendleriana	*Schismus arabicus*	*Tridens muticus*	
P. pratensis	*Setaria pumila*	*Vulpia microstachys*	**Typhaceae - Cattail Family**
P. secunda	*Sorghum halepense*	*V. myuros*	*Typha domingensis*
Polypogon interruptus	*Sporobolus cryptandrus*	*V. octoflora*	*T. latifolia*
P. monspeliensis			
Dicotyledons			
Amaranthaceae – Amaranth Family	**Asclepiadaceae – Milkweed Family**	**Asteraceae – Aster Family (cont'd)**	**Asteraceae – Aster Family (cont'd)**
Amaranthus albus	*Asclepias erosa*	*Balsamorhiza hookeri* var. *neglecta*	*Crepis intermedia*
A. blitoides	*Cynanchum utahense*	*Brickellia arguta*	*C. occidentalis* ssp. *occidentalis*
A. californicus		*B. atractyloides*	*C. runcinata* ssp. *hallii*
A. fimbriatus	**Asteraceae – Aster Family**	*B. californica*	*Encelia virginensis* var. *virginensis*
	Acamptopappus shockleyi	*B. desertorum*	*Enceliopsis nudicaulis* var. *nudicaulis*
Anacardiaceae – Sumac Family	*Achillea millefolium* var. *lanulosa*	*B. incana*	*Ericameria cooperi*
Rhus trilobata var. *anisophylla*	*Acroptilon repens*	*B. longifolia*	*E. cuneatus*
	Adenophyllum cooperi	*B. longifolia* var. *multiflora*	*E. linearifolius*
Apiaceae – Carrot Family	*Agoseris glauca* var. *laciniata*	*B. microphylla* var. *scabra*	*E. nanus*
Apium graveolens	*Ambrosia acanthicarpa*	*B. microphylla* var. *watsonii*	*E. nauseosa*
Berula erecta	*A. dumosa*	*B. oblongifolia* var. *linifolia*	*E. nauseosa* ssp. *consimilis* var. *leiosperma*
Cymopterus aboriginum	*A. eriocentra*	*Calycoseris parryi*	*E. nauseosa* ssp. *nauseosa* var. *hololeuca*
C. gilmanii	*Amphipappus fremontii* var. *fremontii*	*C. wrightii*	*E. paniculata*
C. globosus	*Anisocoma acaulis*	*Chaenactis carphoclinia*	*E. parryi* var. *nevadensis*
C. purpurascens	*Antennaria dimorpha*	*C. douglasii*	*E. teretifolia*
C. ripleyi	*A. rosea*	*C. fremontii*	*E. watsonii*
C. ripleyi var. *saniculoides*	*Artemisia bigelovii*	*C. macrantha*	*Erigeron aphanactis*
Daucus carota	*A. dracunculus*	*C. stevioides*	*E. breweri* var. *porphyreticus*
Lomatium foeniculaceum ssp. *fimbriatum*	*A. ludoviciana*	*C. xantiana*	*E. concinnus* var. *concinnus*
L. nevadense var. *nevadense*	*A. ludoviciana* ssp. *incompta*	*Chaetadelphia wheeleri*	*E. divergens*
L. scabrum	*A. nova*	*Chrysothamnus gramineus*	*Eriophyllum pringlei*
Pteryxia hendersonii	*A. spinescens*	*C. greenei*	*Geraea canescens*
	A. tridentata ssp. *tridentata*	*C. viscidiflorus* ssp. *puberulus*	*Glyptopleura marginata*
Apocynaceae – Dogbane Family	*Atrichoseris platyphylla*	*C. viscidiflorus* ssp. *viscidiflorus*	*Gnaphalium palustre*
Amsonia tomentosa	*Baccharis emoryi*	*C. v.* ssp. *viscidiflorus* var.*stenophyllus*	*Grindelia squarrosa* var. *serrulata*
	Baileya multiradiata	*Cirsium neomexicanum*	*Gutierrezia microcephala*
	B. pleniradiata	*Conyza canadensis*	*G. sarothrae*

Asteraceae – Aster Family (cont'd)	**Asteraceae – Aster Family (cont'd)**	**Boraginaceae – Borage Family**	**Boraginaceae – Borage Family (cont'd)**
Hazardia brickellioides	*Porophyllum gracile*	*Amsinckia tessellata*	*Tidestromia oblongifolia* ssp. *oblongifolia*
Hecastocleis shockleyi	*Prenanthella exigua*	*Cryptantha ambigua*	*Tiquilia canescens* var. *canescens*
Helianthus annuus	*Psathyrotes annua*	*C. angustifolia*	*T. nuttallii*
H. petiolaris ssp. *fallax*	*P. ramosissima*	*C. barbigera*	*T. plicata*
H. petiolaris ssp. *petiolaris*	*Pseudognaphalium stramineum*	*C. circumscissa*	
Heliomeris multiflora var. *nevadensis*	*Psilostrophe cooperi*	*C. confertiflora*	**Brassicaceae – Mustard Family**
Heterotheca villosa var. *hispida*	*Rafinesquia neomexicana*	*C. decipiens*	*Arabis dispar*
Hulsea vestita ssp. *inyoensis*	*Senecio integerrimus* var. *exaltatus*	*C. dumetorum*	*A. glaucovalvula*
Hymenoclea salsola	*S. multilobatus*	*C. flavoculata*	*A. holboellii* var. *pinetorum*
Hymenopappus filifolius var. *megacephalus*	*S. spartioides*	*C. gracilis*	*A. inyoensis*
Hymenoxys cooperi var. *cooperi*	*Sonchus asper*	*C. humilis*	*A. pendulina*
Isocoma acradenius var. *eremophilus*	*Stephanomeria exigua* ssp. *exigua*	*C. maritima*	*A. perennans*
Iva nevadensis	*S. parryi*	*C. micrantha*	*A. pulchra* var. *gracilis*
Lactuca serriola	*S. pauciflora*	*C. nevadensis* var. *nevadensis*	*A. pulchra* var. *munciensis*
Leucelene ericoides	*S. spinosa*	*C. pterocarya*	*A. shockleyi*
Lygodesmia dianthopsis	*Stylocline micropoides*	*C. racemosa*	*Brassica geniculata*
Machaeranthera canescens ssp. *canescens*	*S. psilocarphoides*	*C. recurvata*	*Caulanthus cooperi*
M. gooddingii	*Syntrichopappus fremontii*	*C. scoparia*	*C. crassicaulis* var. *glaber*
M. gracilis	*Tetradymia axillaris* var. *axillaris*	*C. utahensis*	*C. pilosus*
Malacothrix coulteri	*T. canescens*	*C. virginensis*	*Descurainia pinnata* ssp. *glabra*
M. glabrata	*T. glabrata*	*C. watsonii*	*D. pinnata* ssp. *halictorum*
M. sonchoides	*Thymphylla pentachaeta* var. *belenidium*	*Lappula occidentalis* var. *occidentalis*	*D. sophia*
Monoptilon bellidiforme	*Townsendia scapigera*	*Lithospermum ruderale*	*Draba cuneifolia* var. *cuneifolia*
M. bellioides	*Uropappus linearifolia*	*Pectocarya heterocarpa*	*D. cuneifolia* var. *integrifolia*
Pectis papposa	*Xanthium strumarium* var. *canadense*	*P. platycarpa*	*Guillenia lasiophylla*
Perityle megalocephala var. *intricata**	*Xylorhiza tortifolia* var. *imberbis*	*P. recurvata*	*Hirschfeldia incana*
P. megalocephala var. *megalocephala*		*P. setosa*	*Lepidium flavum* var. *flavum*
Petradoria pumila		*Plagiobothrys arizonicus*	*L. fremontii*
Peucephyllum schottii		*P. jonesii*	*L. lasiocarpum*
Pleurocoronis pluriseta		*P. kingii*	*L. montanum* var. *canescens*

Brassicaceae – Mustard Family (cont'd)

L. perfoliatum
Lesquerella kingii ssp. *kingii*
L. ludoviciana
Malcolmia africana
Physaria chambersii
Sibara rosulata
Sisymbrium altissimum
S. irio
Stanleya elata
S. pinnata var. *pinnata*
Streptanthella longirostris
Streptanthus cordatus var. *cordatus*
Thelypodium laxiflorum
Thysanocarpus curvipes
T. laciniatus

Buddlejaceae – Butterfly-Bush Family

Buddleja utahensis

Cactaceae – Cactus Family

Echinocactus polycephalus
Echinocereus engelmannii
E. engelmannii var. *armatus*
E. engelmannii var. *chysocentrus*
E. engelmannii var. *engelmannii*
E. triglochidiatus var. *melanacanthus*
Escobaria vivipara var. *deserti*
E. vivipara var. *rosea*
Mammillaria tetrancistra
Opuntia basilaris var. *basilaris*
O. echinocarpa var. *echinocarpa*

Cactaceae – Cactus Family (cont'd)

O. erinacea var. *erinacea*
O. erinacea var. *ursina*
O. polyacantha var. *rufispina*
O. pulchella
O. ramosissima
Sclerocactus polyancistrus

Campanulaceae – Bellflower Family

Nemacladus glanduliferus var. *orientalis*
N. rubescens
N. sigmoideus

Capparaceae – Caper Family

Cleome lutea

Caprifoliaceae – Honeysuckle Family

Symphoricarpos longiflorus
S. rotundifolius var. *parishii*

Caryophyllaceae – Pink Family

Arenaria congesta var. *subcongesta*
A. kingii ssp. *compacta*
A. macradenia
A. m. ssp. *macradenia* var. *macradenia*
Scopulophila rixfordii
Silene verecunda ssp. *andersonii*

Celastraceae – Staff-tree Family

Mortonia utahensis

Chenopodiaceae – Goosefoot Family

Atriplex argentea ssp. *expansa*
A. canescens var. *canescens*
A. confertifolia
A. elegans var. *fasciculata*
A. hymenelytra
A. lentiformis ssp. *lentiformis*
A. polycarpa
Bassia hyssopifolia
Chenopodium album
C. album var. *missouriense*
C. atrovirens
C. berlandieri var. *sinuatum*
C. berlandieri var. *zschackei*
C. fremontii
C. incanum
C. leptophyllum
C. pratericola
C. simplex
C. strictum ssp. *glaucophyllum*
Grayia spinosa
Halogeton glomeratus
Kochia americana
K. iranica
K. scoparia
Krascheninnikovia lanata
Monolepis spathulata
Salsola kali ssp. *tragus*
S. paulsenii
Suaeda moquinii

Convolvulaceae – Morning-Glory Family

Convolvulus arvensis

Crossosomataceae – Crossosoma Family

Glossopetalon spinescens var. *aridum*

Cuscutaceae – Dodder Family

Cuscuta denticulata
C. denticulata var. *vetchii*

Euphorbiaceae – Spurge Family

Chamaesyce albomarginata
C. fendleri
C. micromera
C. parishii
C. serpyllifolia ssp. *serpyllifolia*
C. setiloba
Stillingia spinulosa

Fabaceae – Pea Family

Astragalus acutirostris
A. beatleyae
A. beckwithii
A. calycosus var. *calycosus*
A. casei
A. didymocarpus var. *dispermus*
A. funereus
A. layneae
A. lentiginosus var. *fremontii*
A. lentiginosus var. *micans*
A. lentiginosus var. *variabilis*
A. minthorniae var. *villosus*
A. mohavensis var. *mohavensis*
A. newberryi
A. newberryi var. *castoreus*
A. newberryi var. *newberryi*

Fabaceae – Pea Family (cont'd)

A. nyensis
A. oophorus var. *clokeyanus*
A. purshii var. *lectulus*
A. purshii var. *tinctus*
A. tidestromii
Dalea mollissima
D. searlsiae
Lathyrus hitchcockianus
Lotus humistratus
Lupinus argenteus ssp. *artenteus* var. *laxiflorus*
L. aridus
L. brevicaulis
L. caudatus
L. concinnus ssp. *orcuttii*
L. flavoculatus
L. holmgrenanus
L. microcarpus
L. palmeri
L. shockleyi
L. subvexus
L. uncialis
Medicago sativa
Melilotus indicus
M. officinalis
Peteria thompsonae
Prosopis glandulosa var. *torreyana*
Psorothamnus fremontii var. *fremontii*
P. polydenius
Trifolium andersonii

Fagaceae – Beech Family

Quercus gambelii

Gentianaceae – Gentian Family

Frasera albomarginata
F. pahutensis

Geraniaceae – Geranium Family

Erodium cicutarium

Grossulariaceae – Currant Family

Ribes cereum var. *cereum*
R. velutinum var. *velutinum*

Hydrangeaceae – Hydrangea Family

Fendlerella utahensis

Hydrophyllaceae – Waterleaf Family

Eucrypta micrantha
Nama aretioides
N. demissum var. *demissum*
N. densum
N. depressum
N. pusillum
Phacelia affinis
P. ambigua
P. beatleyae
P. bicolor
P. calthifolia
P. crenulata var. *crenulata*
P. cryptantha
P. curvipes
P. distans
P. fremontii
P. lemmonii
P. mustelina

Hydrophyllaceae – Waterleaf Family (cont'd)

P. parishii
P. pedicellata
P. peirsoniana
P. rotundifolia
P. saxicola
P. tetramera
P. vallis-mortae var. *vallis-mortae*
Tricardia watsonii

Krameriaceae – Krameria Family

Krameria erecta

Lamiaceae - Mint Family

Hedeoma nanum ssp. *californicum*
Marrubium vulgare
Monardella glauca
Salazaria mexicana
Salvia columbariae var. *columbariae*
S. dorii ssp. *dorrii* var. *dorrii*

Linaceae – Flax Family

Linum lewisii

Loasaceae – Losa Family

Eucnide urens
Mentzelia albicaulis
M. congesta
M. montana
M. nitens
M. obscura
M. oreophila
M. reflexa
M. veatchiana

Loasaceae – Losa Family (cont'd)

Petalonyx nitidus
P. thurberi ssp. *thurberi*

Malvaceae – Mallow Family

Eremalche exilis
E. rotundifolia
Malva parviflora
Sphaeralcea ambigua ssp. *ambigua*
S. ambigua ssp. *monticola*
S. ambiguua var. *rugosa*
S. emoryi
S. grossulariaefolia ssp. *pedata*
S. parvifolia

Molluginaceae – Carpet-Weed Family

Mollugo cerviana

Nyctaginaceae – Four o'clock Family

Abronia elliptica
A. turbinata
Allionia incarnata
Mirabilis bigelovii
M. bigelovii var. *bigelovii*
M. multiflora var. *glandulosa*
M. pudica
Oxybaphus comatus
Selinocarpus nevadensis
Senecio flaccidus var. *douglasii*

Oleaceae – Olive Family

Forestiera pubescens var. *pubescens*
Fraxinus anomala
F. velutina
Menodora spinescens

Onagraceae – Evening Primrose Family

Camissonia boothii ssp. *condensata*
C. boothii ssp. *intermedia*
C. brevipes ssp. *brevipes*
C. brevipes ssp. *pallidula*
C. californica
C. chamaenerioides
C. claviformis ssp. *integrior*
C. heterochroma
C. kernensis ssp. *gilmanii*
C. megalantha
C. munzii
C. parvula
C. pterosperma
C. pusilla
C. refracta
C. walkeri ssp. *tortilis*
Epilobium ciliatum
E. glaberrimum
Gaura coccinea
Gayophytum decipiens
G. diffusum ssp. *parviflorum*
G. racemosum
G. ramosissimum
Oenothera caespitosa ssp. *marginata*
O. californica spp. avita
O. deltoides ssp. *deltoides*
O. pallida ssp. *pallida*
O. primiveris

Orobanchaceae – Broom-Rape Family

Orobanche cooperi
O. corymbosa
O. fasciculata

Papaveraceae – Poppy Family

Arctomecon merriamii
Argemone corymbosa
A. munita ssp. *rotundata*
Eschscholzia glyptosperma
E. minutiflora
E. multiflora ssp. *covillei*

Plantaginaceae – Plantain Family

Plantago ovata
P. patagonica

Polemoniaceae – Phlox Family

Collomia tenella
Eriastrum eremicum
E. sparsiflorum
E. wilcoxii
Gilia aliquanta ssp. *breviloba*
G. brecciarum ssp. *brecciarum*
G. campanulata
G. cana ssp. *speciformis*
G. cana ssp. *triceps*
G. clokeyi
G. filiformis
G. hutchinsifolia
G. inconspicua
G. latifolia
G. leptomeria
G. malior
G. modocensis

Polemoniaceae – Phlox Family (cont'd)

G. nyensis
G. ophthalmoides
G. ripleyi
G. scopulorum
G. sinuata
G. stellata
G. transmontana
Ipomopsis congesta
I. depressa
I. polycladon
Langloisia setosissima
L. setossima ssp. *punctata*
Leptodactylon pungens
Linanthus arenicola
L. bigelovii
L. demissus
L. dichotomus
L. jonesii
L. nuttallii ssp. *nuttallii*
L. septentrionalis
Loeseliastrum schottii
Navarretia breweri
Phlox gracilis ssp. *humilis*
P. hoodii ssp. *lanata*
P. stansburyi

Polygalaceae – Milkwort Family

Polygala heterorhyncha
P. subspinosa

Polygonaceae – Buckwheat Family

Centrostegia thurberi
Chorizanthe brevicornu var. *brevicornu*
C. brevicornu var. *spathulata*
C. rigida
C. watsonii
Eriogonum baileyi var. *baileyi*
E. brachyanthum
E. brachypodum
E. caespitosum
E. cernuum var. *cernuum*
E. cernuum var. *viminale*
E. concinnum
E. deflexum
E. deflexum var. *baratum*
E. deflexum var. *deflexum*
E. deflexum var. *nevadense*
E. esmeraldense var. *esmeraldense*
E. fasciculatum var. *polifolium*
E. glandulosum
E. heermannii var. *argense*
E. heermannii var. *heermannii*
E. heermannii var. *sulcatum*
E. hookeri
E. howellianum
E. inflatum
E. insigne
E. maculatum
E. microthecum var. *lapidicola*
E. microthecum var. *simpsonii*
E. nidularium
E. nummulare
E. nutans var. *nutans*
E. ovalifolium var. *ovalifolium*
E. palmerianum
E. pusillum

Polygonaceae – Buckwheat Family (cont'd)
- *E. racemosum*
- *E. reniforme*
- *E. saxatile*
- *E. thomasii*
- *E. trichopes*
- *E. umbellatum*
- *E. umbellatum* var. *dichrocephalum*
- *E. umbellatum* var. *subaridum*
- *E. umbellatum* var. *vernum*
- *E. umbellatum* var. *versicolor*
- *E. wrightii* var. *subscaposum*
- *Oxytheca perfoliata*
- *Polygonum argyrocoleon*
- *P. aviculare*
- *P. douglasii* ssp. *johnstonii*
- *P. pensylvanicum*
- *Rumex crispus*
- *R. salicifolius*

Portulacaceae – Purslane Family
- *Cistanthe monandra*
- *C. parryi* var. *nevadense*
- *Claytonia perfoliata* ssp. *perfoliata*
- *Lewisia rediviva* var. *minor*

Ranunculaceae – Buttercup Family
- *Anemone tuberosa*
- *Aquilegia formosa* var. *formosa*
- *Delphinium andersonii*
- *D. parishii* ssp. *parishii*
- *Ranunculus andersonii*

Rhamnaceae – Buckthorn Family
- *Ceanothus greggii* ssp. *vestitus*

Rosaceae – Rose Family
- *Amelanchier pallida*
- *A. utahensis*
- *Cercocarpus intricatus*
- *C. ledifolius* var. *ledifolius*
- *Chamaebatiaria millefolium*
- *Coleogyne ramosissima*
- *Fallugia paradoxa*
- *Holodiscus discolor*
- *Ivesia arizonica* var. *saxosa*
- *I. sabulosa*
- *Peraphyllum ramosissimum*
- *P. caespitosum*
- *Potentilla biennis*
- *Prunus fasciculata*
- *Purshia glandulosa*
- *P. stansburiana*
- *P. tridentata*
- *Rosa woodsii*

Rubiaceae – Madder Family
- *Galium aparine*
- *G. bifolium*
- *G. hilendiae* ssp. *hilendiae*
- *G. hilendiae* ssp. *kingstonense*
- *G. magnifolium*
- *G. stellatum*

Rutaceae – Rue Family
- *Thamnosma montana*

Salicaceae – Willow Family
- *Populus fremontii* ssp. *fremontii*
- *Salix exigua*
- *S. gooddingii*

Saxifragaceae – Saxifrag Family
- *Lithophragma tenellum*

Scrophulariaceae – Figwort Family
- *Castilleja applegatei*
- *C. applegatei* ssp. *martinii*
- *C. linariaefolia*
- *Collinsia parviflora*
- *Keckiella rothrockii* ssp. *rothrockii*
- *Mimetanthe pilosus*
- *M. bigelovii* var. *bigelovii*
- *M. densus*
- *M. guttatus*
- *M. montioides*
- *M. rubellus*
- *M. spissus*
- *M. suksdorfii*
- *Mohavea breviflora*
- *Neogaerrhinum filipes*
- *Penstemon albomarginatus*
- *P. angustifolius* var. *venosus*
- *P. floridus* var. *austinii*
- *P. fruticiformis* ssp. *amargosae*
- *P. humilis* ssp. *humilis*
- *P. pahutensis*
- *Penstemon palmeri*
- *P. petiolatus*
- *P. rostriflorus*
- *P. thurberi*
- *Saircocarpus kingii*
- *Scrophularia desertorum*
- *Veronica americana*
- *V. anagallis-aquatica*
- *V. peregrina* ssp. *xalapensis*

Solanaceae – Potato Family
- *Datura wrightii*
- *Lycium andersonii*
- *L. pallidum* var. *oligospermum*
- *L. shockleyi*
- *Nicotiana attenuata*
- *N. trigonophylla* var. *trigonophylla*
- *Physalis crassifolia*
- *Solanum americanum*

Tamaricaceae – Tamarisk Family
- *Tamarix ramosissima*

Ulmaceae – Elm Family
- *Ulmus minor*
- *U. parvifolia*

Verbenaceae – Verbena Family
- *Verbena bracteata*

Viscaceae – Christmas Mistletoe Family
- *Arceuthobium divaricatum*
- *Phoradendron juniperinum*

Zannichelliaceae – Horned Pondweed Family
- *Zannichellia palustris*

Zygophyllaceae – Creosote-Bush Family
- *Larrea tridentata*
- *Tribulus terrestris*

DIVISION PTERIDOPHYTA (FERNS)
Pteridaceae – Maidenhair Fern Family
Argyrochosma jonesii
Cheilanthes covillei
C. parryi
Pellaea mucronata ssp. *mucronata*
P. truncata
Pentagama triangularis
P. triangularis ssp. *triangularis*

ssp = subspecies; var = variety.
Source: Wills and Ostler 2001.

F.2 Animal Species on the Nevada National Security Site

Tables F–4 and **F–5** are derived from *Ecology of the Nevada Test Site: An Annotated Bibliography* (Wills and Ostler 2001). The tables list all species of invertebrate and vertebrate animals, respectively that have been identified at the NNSS. The listing of vertebrates is not presented in taxonomic order. Instead, phyla are listed alphabetically. Classes, orders, families, and genus/species within a family are each presented in alphabetical order. Common names have been included for all of the vertebrate species since they are used frequently and in general are not locally generally unique. The taxonomy in Tables F–4 and F–5 follows Wills and Ostler 2001 and the names of species that were not verified in that publication are indicated by an asterisk.

Table F–4 Invertebrate Animal Species of the Nevada National Security Site

PHYLUM ANNELIDA (SEGMENTED WORMS)			
Order Haplotaxida – Aquatic Earthworms			
Family Naididae			
Unknown sp.			
PHYLUM ARTHROPODA (ARTHROPODS)			
Subphylum Chelicerata			
Order Acarina – Ticks and Mites			
Family Ameroseiidae *Kleemania* sp.	**Family Dermanyssidae** *Brevisterna utahensis* * *Dermanyssus becki* *Hirstionyssus bisetosus* * *H. carnifix* * *H. hill* * *H. neotomae* * *H. triacanthus* *Ornithonyssus aridus* * *Steatonyssus antrozoi* *	**Family Ixodidae** *Dermacentor albipictus* *D. parumapertus* *Haemaphysalis leporispalustris* *Ixodes angustus* *I. kingi* *I. ochotonae* *I. pacificus* *I. sculptus* *I. spinipalpus*	**Family Listrophoridae** *Listrophorus dipodominus*
Family Argasidae *Argas persicus* *Ornithodoros kelleyi* *O. parkeri* *O. sparnus* *O. talaje* *Otobius lagphilus*	**Family Eremaeidae** *Eremaeus* sp. *	**Family Ixodorhynchidae** *Ixodorhynchus* sp.	**Family Myobiidae** *Lavoimyobia hughesi* *
Family Belbidae *Belba* sp. *Spinibdella* sp.	**Family Erthraeidae** *Hauptmannia* sp. * *Pollux* sp. *	**Family Laelaptidae** *Androlaelaps leviculus* *Eubrachylaelaps circularis* *Eubrachylaelaps debilis* *E. hollisteri* *Haemolaelaps* sp. *H. casalis* *H. glasgowi* *Hypoaspis leviculus*	**Family Nanorchestidae** *Spelorchestes* sp. *
Family Caligonellidae *Molothiognathus* sp. * *Neothrognathus* sp. *	**Family Erythraeidae** *Caeculisoma* sp. *	**Family Linotetranidae** *Linotetrans* sp. *	**Family Neophyllobiidae** *Rhinonyssidae* sp. *
Family Cosmocthoniidae *Cosmochthoniidae* sp.	**Family Gymnodamaeidae** *Joshuella striata* *		**Family Oribatulidae** *Moltoribates* sp.
Family Ctenacaridae *Aphelacarus acarinus* *	**Family Haemogamasidae** *Haemogamasus pontiger* *Ischyropoda armatus*		**Family Passalozetidae** *Passalozetes* sp.
Family Cunaxidae *Cunaxa* sp. *Cunaxoides* sp.			**Family Pterygosomidae** *Geckobiella texana* *Hirstiella* sp.
			Family Teneriffiidae *Tarsolarkus* sp. *Tarsotomus* sp.

Family Trombiculidae *Euschoengastia* sp. *E. cordiremus* *E. criceticola* *E. decipiens* *E. fasolla* *E. lacerta* *E. lanei* *E. obesa* *E. radfordi*	**Family Trombiculidae (cont'd)** *E. utahensis* *Leuwenhoekia americana* *Odontacarus arizonensis* *O. chiapansis* *O. hirsutus* *O. linsdalei* *O. micheneri* *Pseudoschongastia* sp. * *Sascarus* sp.	**Family Trombiculidae (cont'd)** *Trombicula* 4 spp. *T. arenicola* * *T. belkini* *T. jessiemae* *T. panamensis* *T. sola* * *Whartonia perplexa* *W. whartonia*	**Family Trombidiidae** *Allothrombium* sp. * **Family Tuckerellidae** *Tuckerella coleogynis*
Order Araneae – Spiders			
Family Agelenidae *Agelenopsis aperta* *Calilena restricta* **Family Anyphaenidae** *Anyphaena* sp. **Family Araneidae** *Metepeira gosoga* **Family Caponiidae** *Orthonops gertschi* *Tarsonops* sp. **Family Clubionidae** *Neoanagraphis chamberlini* *N. pearcei* **Family Corinnidae** *Castianeira descripta* *Corinna bicalcarata* **Family Cyrtaucheniidae** *Aptostichus stanfordianus*	**Family Dictynidae** *Cicurina utahana* *Dictyna calcarata* *D. personata* *D. reticulata* *D. tucsona* *Mallos mians* *M. pallidus* **Family Diguetidae** *Diguetia canities* *D. signata* **Family Filistatidae** *Kukulcania utahana* **Family Gnaphosidae** *Callilepis* sp. *Cesonia classica* *Drassodes saccatus* *Herpyllus hesperolus* *Drassyllus fractus* *D. insularis* *D. lamprus* *Gnaphosa californica* *G. hirsutipes*	**Family Gnaphosidae (cont'd)** *Haplodrassus eunis* *Micaria gosiuta* *Nodocion utus* *Scopoides naturalisticus* *Zelotes monachus* *Z. nannodes* *Z. puritanus* **Family Homalonychidae** *Homalonychus theologus* **Family Linyphiidae** *Ceraticelus nesiotes* *Disembolus stridulans* *Erigone dentosa* a *M. fillmorana* *M. fratrella* *Spirembolus* sp. *Tapinocyba* sp. *Tennesseellum formic* **Family Liocranidae** *Piabuna nanna* *Phrurotimpus* sp.	**Family Lycosidae** *Alopecosa kochi* *Geolycosa rafaelana* *Pardosa ramulosa* *Schizocosa* sp. **Family Mimetidae** *Reo eutypus* **Family Miturgidae** *Syspira eclectica* **Family Oxyopidae** *Oxyopes tridens* **Family Philodromidae** *Apollophanes texanus* *Ebo dispar* *E. merkeli* *E. mexicanus* *Philodromus histrio* **Family Pholcidae** *P. infuscatus* *Physocyclus tanneri* *Psilochorus papago* *P. utahensis*

Family Plectreuridae	**Family Sicariidae**	**Family Theridiidae**	**Family Thomisidae**
Kibramoa paiuta	*Loxosceles deserta*	*Achaearanea* sp.	*Misumenops deserti*
Plectreurys tristis		*Enoplognatha joshua*	*M. rothi*
	Family Sparassidae	*Euryopis scriptipes*	*Xysticus californicus*
Family Salticidae	*Olios fasciculatus*	*E. spinigera*	*X. iviei*
Habronattus agilis		*Latrodectus hesperus*	*X. lassanus*
H. brunneus	**Family Tetragnathidae**	*L. mactans*	
H. hirsutus	*Tetragnatha laboriosa*	*Steatoda fulva*	**Family Uloboridae**
H. oregonensis		*S. pulchra*	*Uloborus diversus*
Metacyrba arizonensis	**Family Theraphosidae**	*S. washona*	
M. taeniola	*Aphonopelma steindachneri*	*Theridion* sp.	
Metaphidippus sp.			
Peckhamia sp.			
Pellenes limatus			
Phidippus insolens			
P. johnsoni			
P. octopunctatus			
P. workmani			
P. californicus			
Order Opiliones – Harvestmen			
Family Phalangiidae			
Eurybunus riversi *			
Globipes spinulatus *			
Leiobunum townsendi *			
Order Scorpiones – Scorpions			
Family Iuridae	**Family Superstitionidae**	**Family Vaejovidae**	
Anuroctonus phaiodactylus	*Superstitionia donensis*	*Paruroctonus becki*	
H. spadix		*Paruroctonus boreas*	
Hadrurus arizonensis		*Serradigitus wupatkiensis*	
H. hirsutus		*Vaejovis confusus*	
		V. hirsuticauda	
		V. spinigeris	

Order Solpugida – Sun Spiders			
Family Ammotrechidae	**Family Eremobatidae (cont'd)**	**Family Eremobatidae (cont'd)**	**Family Eremobatidae (cont'd)**
Ammontrechula dolabra *	*E. mormonus* *	*H. californica* *	*T. attritus* *
A. lacuna *	*E. scopulatus* *	*Hemerotrecha denticulata* *	*T. bidepressus* *
A. pilosa *	*E. similis* *	*H. fruitana* *	*T. branchi* *
Branchia potens *	*E. vicinus* *	*H. jacintoana* *	*Therobates cameronensis* *
	E. zinni *	*H. proxima* *	*T. flexacus* *
Family Eremobatidae	*Eremorhax pulcher* *	*H. serrata* *	*T. nudus* *
Chanbria sp. *	*E. titania* *	*Horribates* sp. *	*T. plicatus* *
Eremobates ctenidiellus *	*Hemerotrecha branchi* *	*Therobates arcus* *	
Subphylum Crustacea			
Order Anostraca – Fairy Shrimp			
	Family Branchinectidae	**Family Thamnocephalidae**	
	Branchinecta gigas	*Thamnocephalus platyurus*	
	B. mackini		
Order Cladocera – Water Fleas			
	Family Daphniidae		
	Daphnia sp.		
Order Conchostraca – Clam Shrimp			
	Family Limnadiidae		
	Eulimnadia antlei		
Order Copepoda – Copepods			
	Family Cyclopidae	**Family Diaptomidae**	
	Cyclops sp.	*Diaptomus* sp.	
Order Decapoda – Decapods			
	Family Cambaridae		
	Unknown sp.		
Order Isopoda – Isopods			
	Family Armadillidae	**Family Porcellionidae**	
	Venezillo arizonicus	*Porcellio laevis*	
Order Notostraca – Tadpole Shrimp			
	Family Lepiduridae		
	Triops longicaudatus		

Order Ostracoda – Seed Shrimp

Family Cyprididae
Herpetocypris fretensis

Family Darwinuliidae
Darwinula stevensoni

Subphylum Hexapoda

Class Insecta – Insects

Order Blattodea – Cockroaches

Family Polyphagidae
Arenivaga apacha
A. erractica
Eremoblatta subdiaphana

Order Coleoptera – Beetles

Family Alleculidae
Hymenorus prolixus

Family Anthribidae
Trigonorhinus irregularis

Family Attelabidae
Auletobius sp.
A. humeralis

Family Brentidae
Apion albidulum
A. varicorne

Family Buprestidae
Acmaeodera sp.
A. diffusa
A. immaculata
A. lanata
A. purshiae *
Agrilus felix
Agrilus pubifrons
Anthaxia deleta
Chrysobothris arizonica
C. cuprascens
C. platti

Family Buprestidae (cont'd)
Hippomelas near obliterata
Melanophila piniedulis
Oxypteris consputa

Family Carabidae
Calosoma sp.
Harpalus sp.
Lebia sp.
Pterostichus sp.
Rhadine jejunus
R. myrmecodes

Family Cerambycidae
Moneilema gigas
M. semipunctatum
Prionus californicus

Family Chrysomelidae
Chaetocnema sp.
Chlamisus memnonia *
Diplocapsis sp.
Monoxia sp.
Octatoma sp.
Pachybrachis sp.
Trirhabda sp.

Family Cicindelidae
Cicindela sp.

Family Cleridae
Aulicus reichei *
Caccodes quadrimaculatus
Cymatodera fuchsii
C. latefascia
C. oblita *
C. uniformis
Phyllobaenus pygmaea
P. subfasciata
Priocera inornata
Trichodes ornatus

Family Coccinellidae
Hippodamia apicalis
H. convergens
H. parenthesis
H. quinquesignata
Hyperaspis pleuralis
H. quadrivittata
H. taeniata
Scymnus aridus
S. pallens

Family Curculionidae
Amotus setulosus
Anthonomus cycliferus
A. haematopus
A. hirtus
A. inermis
A near *juniperinus*
A. ochreopilosus
A. ornatulus
A. peninsularis
A. sphaeralciae
A. tenius
Apleurus angularis
Apleurus porosus
Aragnomus sp.
A. hispidulus
A. hispidus
Auleutes sp.
Brachyogmus ornatus
Ceutorhynchus adjunctus
Cimbocera buchanani
C. cazieri
Cleonidius poricollis
C. quadrilineatus
Crocidema californica
Cryptolepidus aridus

Family Curculionidae (cont'd)
Cryptolepidus leechi
C. nevadicus
Cylindrocopturus sp.
Eucyllus echinus
E. nevadensis
E. unicolor
E. vagans
Eupagoderes geminatus
E. geminatus
Lepidophorus sp.
Magdalis lecontei
Miloderes mercuryensi
Minyomerus sp.
Myrmex lineatus
Onychobarius near depressa
O. mystica
Ophryastes varius
Orimodema protracta
O. sordidus
Paracimbocera artemisiae
P. atra
Promecotarsus densus
Sirocalodes tescorum
Smicronyx sp.
S. imbricatus
Thricolepis inornata
Tychius prolixus
T. setosa
Yuccaborus frontalis
Zascelis irrorata

Family Elateridae
Horistonotus sp.

Family Elmidae
Elmira sp. *

Family Gyrinidae
Gyrinidae sp. *

Family Histeridae
Saprinus sp.

Family Leiodidae
Ptomaphagus sp.

Family Meloidae
Cysteodemus armatus
Lytta sp.
Saprinus armatus

Family Melyridae*s*
Asydates sp.
Attalus futilis
Collops punctulatu
Eutrichopleurus concinnus
Listrus sp. *
Malachius sp.
Melyrodes sp.

Family Melyridae*s*
Trichochrous varius

Family Nitidulidae
Carpophilus hemipterus
Cybocephalus californicus

Family Ochodaeidae
Ochodaeus sparsus
O. sparsus

Family Phalacridae
Phalacrus sp.

Family Scarabaeidae
Aphodius sp.
A. fucosus
A. militaris
A. near *talpoidesi*
A. nevadensis
Bothynus sp.
Chnaunanthus flavipennis
Cyclocephala longula
Diplotaxis deserta
D. haydenii
D. incuria
D. insignis
D. moerens
D. pacata
D. subangulata
Paracotalpa granicollis
Phyllophaga sp.
P. sociatus
Serica alternata
S. perigonia

Family Scolytidae
Ips confusus

Family Sulvanidae
Oryzaephilus surinamensis

Family Tenebrionidae
Alaephus nevadensis
Anemia californica
Anepsius near brunneus
Asidina semilaevis
A. semilaevis
Auchmobius subboreus
Blapstinus lecontei
B. vandykei
Bothrotes sp.
Centrioptera muricata
Chilometopon abnorme
Coelocnemis punctata
Coniontellus argutus
C. armata
Coniontis lassenica
Craniotus blaisdelli
Cryptoglossa verrucosus
Discodemus near *knausi*
Edrotes ventricosus
Eleodes armata
Eleodes near *californica*
E. carbonaria
E. concinna
E. dissimilis
E. extricata
E. grandicollis
E. hispilabris
E. longicollis
E. longipilosa
E. nevadensis
E. nigrina
E. obscura
E. omissa
E. pimelioides
E. striatipennis

Family Tenebrionidae (cont'd)	**Family Tenebrionidae (cont'd)**	**Family Tenebrionidae (cont'd)**	**Family Unknown**
E. tenebrosa	*Euschides luctatus*	*Notibius substriatus*	*Neocercopedius* sp. *
Embaphion elongatum	*Helops* sp.	*N. sulcicollis*	
Eschatomoxys wagneri	*H. attenuatus*	*Pelecyphorus actuosus*	**Family Zopheridae**
Eupsophulus castaneus	*Hylocrinus laborans*	*P. pantex*	*Zopherus uteanus*
Eusattus difficilis	*E. brunnipes*	*Philolithus pantex*	
E. dilatatus	*Lobometopon* sp.	*Steriphanus lubricans*	
E. dubius	*Metopoloba bifossiceps*	*Trichiasida acerba*	
E. elongatum	*Metoponium abnorme*	*Triorophus laevis*	
E. muricatus	*M.* near *convexicolle*	*Trogloderus costatus*	
Order Diptera – True Flies			
Family Asilidae	**Family Bombyliidae (cont'd)**	**Family Bombyliidae (cont'd)**	**Family Bombyliidae (cont'd)**
Efferia sp.	*A. parkeri*	*E. labiosus*	*L. melanosus* *
E. benedicti	*A. pavidus*	*E. litus*	*L. nigriventrus* *
E. etaminea *	*A. peodes*	*E. pulvereus*	*L. perplexus*
	A. scalaris	*Eucessia rubens*	*L. pulchrissimus*
Family Bombyliidae	*A. scriptus*	*Exepacmus johnsoni*	*L. singulatus* *
Anastoechus hessei	*A. tardus*	*Exprosopa arenicola*	*L. sororculus*
A. melanohalteralis	*A. timberlakei*	*Exprosopa caliptera*	*L. striatus*
Anthrax albofasciatus	*A. transitus*	*E. divisa*	*Mythicomyia* sp.
A. limatulus	*A. ursula*	*E. dorcadion*	*Oligodranes dolorosus*
A. nidicola	*A. varius*	*E. doris*	*Pantarbes capito*
A. oedipus	*A. vasatus*	*E. sharonae*	*P. pusio*
A. seriepunctata	*A. vittatus*	*E. utahensis*	*P. willistoni*
Aphoebantus abnormis	*A. vulpecula*	*Geminaria canalis*	*Paraconsors humeralis*
A. altercinctus	*Apolysis ater*	*G. pellucida*	*Paracosmus insolens*
A. arenicola	*A. cincturus*	*Geron argutus*	*P. morrisoni*
A. argentifrons *	*A. distinctus*	*Heterostylum robustus*	*Poecilanthrax alpha*
A. borealis	*A. fasciolus*	*H. sackeni* *	*P. apache*
A. brevistylus	*A. mus*	*H. vierecki* *	*P. californicus*
A. desertus	*Aphoebantus pulcher*	*Lepidanthrax agrestis*	*P. moffitti*
A. eremicola	*A. pullatus*	*L. angulus L. hyalinipennis*	*P. poecilogaster*
A. fumosus	*Astrophanes adonis*	*Lordotus abdominalis*	*P. willistonii*
A. interruptus	*Bombylius lancifer*	*L. albidus*	*Toxophora pellucida*
A. marcidus	*Conophorus fenestrata*	*L. apicula*	*T. vasta*
A. marginatus	*Desmatoneura argentifrons*	*L. gibbus*	*T. virgata*
A. mormon	*Dipalta serpentina*	*L. junceus*	*Villa aenea*
A. mus	*Epacmus connectens*	*L. luteolus*	*V. arizonensis* *

Family Bombyliidae (cont'd)	**Family Bombyliidae (cont'd)**	**Family Cecidomyiidae**	**Family Mydidae**
V. atrata *	*V. mira* *	*Asphondylia* sp.	*Pseudonomoneura californica*
V. cautor	*V. morio* *		
V. crocina *	*V. scitula* *	**Family Chironomidae**	**Family Syrphidae**
V. cypris *	*V. sinuosa* *	*Chironomus* sp.	*Pyritis* sp.
V. junctura *	*V. supina*		Unknown sp.
V. lepidota *	*V. utahensis* *	**Family Culicidae**	
		Culiseta sp.	
Order Embioptera – Webspinners			
Family Anisembiidae			
Dactylocerca rubra			
Order Ephemeroptera – Mayflies			
	Family Baetidae	**Family Ephemeridae**	
	Callibaetis sp.	Unknown sp	
Order Heteroptera – True Bugs			
Family Berytidae	**Family Miridae (cont'd)**	**Family Miridae (cont'd)**	**Family Miridae (cont'd)**
Jalysus wickhami	*Brooksetta chelifer*	*D. nevadensis*	*E. stigmosus*
Neides muticus	*B. nevadensis*	*D. pinicola*	*E. unipuncta*
Pronotacantha annulata	*Ceratocapsus fusiformis*	*D. schwarzii*	*Hadronema picta*
	C. nevadensis	*Dichaetocoris peregrinus*	*H. uhleri*
Family Cynidae	*C. nigrocuneatus*	*Dichrooscytus apicalis*	*Hoplomachidea consors*
Pangaeus congruus	*Chlamydatus associatus*	*D. flavivenosus*	*Largidea nevadensis*
Geocoris pallens	*C. becki*	*D. irroratus*	*Lopidea bullata*
Nysius ericae *	*Chlamydatus monilipes*	*D. junipericola*	*L. fuscosa*
	Clivinema sp.	*D. pinicola*	*Lopidea picta*
Family Miridae	*Coquillettia albella*	*Dicyphus hesperus*	*L. scutata*
Atomoscelis modesta	*C. luteiclava*	*D. ribesi*	*L. ute*
Atractotomus balli	*C. virescens*	*Europiella albipubescens*	*Lygus desertus*
A. pallens	*Daleapidea albescens*	*E. decolor*	*L. elisus*
A. prospidis	D. daleae	*E. grayiae*	*L. hesperus*
Beamerella balius	*Deraeocoris bakeri*	*E. lycii*	*Macrotylus infuscatus*
Beckocoris laticephalus	*D. brevis*	*E. nigricornis*	*M. salviae*
Bolteria juniperi	*D. bullatus*	*E. nigrofemoratus*	*Melanotrichus albocostatus*
B. speciosus	*D. juniperi*	*E. punctipes*	*M. atriplicis*
Brachyceratocoris nevadensis	*D. merinoi*	*Europiella sparsa*	*M. coagulatus*

Family Miridae (cont'd)

M. eurotiae
M. knighti
M. pallens
M. stanleyaea
M. symphoricarpi
Merinocapsus ephedrae
M. pallipes
Microphylellus symphoricarpi
Nevadocoris becki
N. bullatus
N. pallidus
Oncotylus guttulatus
Parthenicus accumulus
P. atriplicis
P. becki
P. brevicornis
P. condensus
P. covilleae
P. cuneotinctus
P. desertus
P. furcatus
P. incurvus
P. merinoi
P. miniopunctatus
P. nevadensis
P. nigripunctus
Parthenicus pictus
P. pilipes
P. pinicola
P. rubrosignatus
P. rufusculus
P. sabulosus
P. tenuis
P. trispinosus
P. utahensis

Family Miridae (cont'd)

Phoenicocoris pini
Phyllopidea hirta
P. picta
Phymatopsallus prosopidis
P. ribesi
Phytocoris albidopictus
P. albidosquamus
P. becki
P. breviatus
P. candidus
P. carnosulus
P. consors
P. cuneotinctus
P. decurvatus
P. *deserticola*
P. geniculatus
P. hirsuticus
P. inops
P. juniperanus
P. longihirtus
P. mellarius
P. minituberculatus
P. nigrolineatus
P. plenus
P. pulchellus
P. pulchricollis
P. ramosus
P. relativus
P. reticulatus
P. rostratus
P. squamosus
P. stitti
P. strigosus
P. tenuis
P. tricinctipes

Family Miridae (cont'd)

P. vanduzeei
P. ventralis
Pilophorus clavicornis
P. tibialis
Plagiognathus salviae
Platylygus vanduzeei
Polymerus relativus
Psallus atriplicis
P. purshiae
Pseudatomoscelis seriatus
Pseudopsallus daleae
Pseudopsallus plagiatus
P. puberus
P. repertus
Rhinacloa forticornis
Semium subglaber
Sericophanes nevadensis
Slaterocoris sp.
S. croceipes
S. longipennis
S. rubrofemoratus
Spanagonicus albofasciata
Stenodema virens *
Stittocapsus franseriae
Trigonotylus americanus

Family Nabidae

Nabis sp.

Family Notonectidae

Unknown sp.

Family Pentatomidae

Banasa euchlora
Brochymena sulcata
Chlorochroa sayi
Dendrocoris sp.
D. contaminatus
Prionosoma podopioides
Tepa rugulosa
Thyanta pallidovirens

Family Phymatidae

Macrocephalus sp.

Family Reduviidae

Reduvius sp.
Zelus sp.

Family Rhopalidae

Arhyssus sp.
A. lateralis
Harmostes angustatus
H. fraterculus
H. reflexulus
Liorhyssus hyalinus

Family Tingidae

Corythucha sp.
C. mollicula
C. sphaeralceae
Dictyla coloradensis
Gargaphia opacula
Teleonemia nigrina

Order Homoptera – Scale Insects			
Family Acanaloniidae	**Family Cicadellidae (cont'd)**	**Family Dictyopharidae**	**Family Issidae**
Acanalonia mollicula	*Dixianus utahnus*	*Scolops* sp.	*Hysteropterum* sp.
	Lycioides loculatus		
Family Cicadellidae	*Scaphytopius nigricollis*	**Family Flatidae**	**Family Membracidae**
Aceratagallia sp.	*S. torridus*	*Melormenis infuscata*	*Centrodontus atlas*
A. cinerea	*Spathanus acuminatus*	*Mistharnophantia sonorana*	*Multareis cornutus*
Ballana sp.	*Stragania* sp.		*Multareoides bifurcatus*
Order Hymenoptera – Ants and Wasps			
Family Andrenidae	**Family Anthophoridae (cont'd)**	**Family Formicidae (cont'd)**	**Family Formicidae (cont'd)**
Andrena sp.	*Xeromelecta californica*	*C. depilis*	*Monomorium minimum*
Calliopsis subalpinus	*Xylocopa californica*	*C. mutans*	*Myrmecocystus* sp.
Perdita sp.		*C. nocturna*	*M. comatus*
P. arcuata	**Family Apidae**	*Formica fusca*	*M. flaviceps*
P. callicerata	*Bombus morrisoni*	*F. integroides*	*M. koso*
P. chloris		*F. lasioides*	*M. lugubris*
P. fallugiae	**Family Bradynobaenidae**	*F. limata*	*M. mendax*
P. nasuta	*Chyphotes melaniceps*	*F. microgyna*	*Myrmecocystus mexicanus*
P. thermophila	*C. petiolatus*	*F. moki*	*M. mimicus*
		F. neogagates	*M. placodops*
Family Anthophoridae	**Family Colletidae**	*F. neorufibarbis*	*M. testaceus*
Anthophora sp.	*Colletes* sp.	*F. obscuripes*	*Myrmica emeryana*
A. californica	*C. eulophi*	*F. obtusipilosa*	*Neivamyrmex minor*
A. hololeuca	*Hylaeus asininus*	*F. subpolita*	*Pheidole bicarinata*
A. phenax		*Iridomyrmex humilis*	*P. desertorum*
A. porterae	**Family Formicidae**	*Lasius crypticus*	*P. inquilina*
A. urbana	*Acanthomyops interjectus*	*L. sitiens*	*P. pilifera*
Centris rhodopus	*A. latipes*	*Leptothorax* sp.	*Pogonomyrmex barbata*
Ceratina nanula	*Aphaenogaster* sp.	*L. andrei*	*P. californicus*
Diadasia australis	*A. boulderensis*	*L. nevadensis*	*P. imberbiculus*
D. diminuta	*A. megommata*	*L. nitens*	*P. magnacanthus*
Diadasia lutzi	*Camponotus hyatti*	*Leptothorax tricarinatus*	*Pogonomyrmex occidentalis*
Epeolus minimus	*C. ocreatus*	*Liometopum luctuosum*	*P. rugosus*
Melissodes subagilis	*C. semitestaceus*	*Messor* sp.	*P. salinus*
M. tristis	*C. vicinus*	*M. lariversi*	*Solenopsis aurea*
Synhalonia 4 spp.	*Conomyrma bicolor*	*M. lobgnathus*	*S. molesta*
S. quadricincta	*C. insana*	*M. pergandei*	
Triepeolus helianthi	*Crematogaster coarctata*	*M. smithi*	

Family Formicidae (cont'd)	**Family Megachilidae**	**Family Mutillidae (cont'd)**	**Family Tiphiidae**
S. salina	*Anthidium dammersi*	*Odontophotopsis armata*	*Acanthetropis aequalis*
S. xyloni	*Ashmeadiella aridula*	O. clypeatus	*A. noctivaga*
Stenama smithi	*A. australis*	*O. cookii*	*Brachycistina acuta*
	A. bigeloviae	*O. infelix*	*Brachycistis glabrella*
Family Halictidae	*A. inyoensis*	*O. mamatus*	*B. inaequalis*
Agapostemon cockerelli	*Ashmeadiella opuntiae*	*O. microdonta*	*B. ioachinensis*
A. texanus	*Dianthidium pudicum*	*O. obliquus*	*B. linsleyi*
Dufourea 2 spp.	*D. subparvum*	*O. quadrispinosa*	*B. triangularis*
Halictus tripartitus	*D. ulkei*	*O. sercus*	*Colocistis brevis*
Lasioglossum 3 spp.	*Dioxys productus*	*O. setifera*	*C. castanea*
L. albohirtus	*Heriades timberlakei*	*Sphaeropthalma brachyptera*	*C. crassa*
L. hyalinus	*Lithurge apicalis*	*S. acontius*	*Colocistis eremi*
L. incompletus	*Megachile lobatifrons*	*S. amphion*	*Quemaya paupercula*
L. microlepoides	*Osmia* sp.	*S. angulifera*	
Lasioglossum nevadensis	*O. titusi*	*Sphaeropthalma becki*	**Family Vespidae**
L. pruinosus	*Stelis* sp.	*S. blakeii*	*Vespula pensylvanica*
L. ruficornis		*S. difficilis*	
L. sisymbrii	**Family Melittidae**	*S. ferruginea*	
Nomia tetrazonata	*Hesperapis willmattae*	*S. helicaon*	
Sphecodes eustictus		*S. macswaini*	
	Family Mutillidae	*S. mendica*	
Family Ichneumonidae	*Acanthophotopsis falciformis*	*S. pallida*	
Ophion sp.	*Acrophotopsis eurygnathus*	*S. parapenalis*	
	Dasymutilla gloriosa	*S. sonora*	
	D. klugii	*S. yumaella*	
	D. paenulata	Family Platygasteridae	
	D. satanas	*Inostemma* sp.	
	Dilophotopsis concolor	*Platygaster* sp.	
Order Isoptera – Termites			
	Family Rhinotermitidae	**Family Termitidae**	
	Reticulitiermes basinensis	*Amitermes* sp.	
	R. okanaganensis		

Order Lepiodoptera – Butterflies and Moths			
Family Adelidae *Adela punctiferella* **Family Arctiidae** *Arachnis picta* *Pygarctia murina* **Family Coleophoridae*** *Coleophora* sp. **Family Gelechiidae** *Malacosoma fragilis* **Family Geometridae** *Caripeta* sp. *Claucina* sp. * *Lycia ypsilon* *Nacophora* sp. *Pero* sp. *Semiothisa* near *colorata* *S. larreana* **Family Heliodinidae** *Heliodines* near *sexpunctella* **Family Lasiocampidae** *Gloveria arizonensis*	**Family Noctuidae** *Conochares* near *arizonae* *C.* near *hutsoni* * *Grotella* sp. *Oxycnemis* near *gracillinea* *Phobolosia anfracta* *Synedoida* sp. * *Triocnemis* sp. **Family Oecophoridae** *Inga concolorella* **Family Pieridae** *Pontia protodice* **Family Psychidae** *Thyridopteryx meadii* **Family Putellidae** *Plutella maculipennis* * **Family Pyralidae** *Dichozoma parvipicta* *Dioryctria* near *gulosella* *Etiella zinckenella* *Eumysia mysiella*	**Family Pyralidae (cont'd)** *Heterographis morrisonella* *Hulstia undulatella* *Loxostege albiceralis* *Milgithea* sp. *Nephopterix bifasciella* *Ommatopteryx texana* * *Passadena flavidorsella* *Salebriacus odiosella* *Sosipatra rileyella* *Staudingeria albipenella* **Family Saturniidae** *Hemileuca nevadensis* **Family Satyridae** *Cercyonis* sp. **Family Scythrididae** *Scythris* 12 spp. **Family Sphingidae** *Celerio lineata* * *Hyles lineata* *Sphinx dollii*	**Family Tineidae** *Acrolophus* 4 spp. *A. laticapitana* *A. variabilis* *Dyotopasta yumaella* *Myrmecozela* near *obliquella* * *Tinea* sp. **Family Tortricidae** *Decodes fragariana* *Eucosma bobana* *E.* near *bolanderana* *Ofatulena duodecemstriata* *Pelochrista rorana* *Phaneta indagatricana* *p. setonana* *Platynota labiosana* *P.* near *yumana* **Family Ypsolophidae** *Ypsolopha* sp. *Y.* near *angelicella* *Y.* near *delicatella* *Y.* near *flavistrigella*

Order Mantodea – Mantids
Family Mantidae *Litaneutria minor* *Stagmomantis californica*

Order Odonata – Dragonflies and Damselflies	
Suborder Anisoptera – Dragonflies	**Suborder Zygoptera – Damselflies**
Family Libellulidae Unknown sp.	**Family Coenagrionidae** *Argia* sp.

Order Orthoptera – Grasshoppers and Crickets			
Family Acrididae	**Family Acrididae (cont'd)**	**Family Acrididae (cont'd)**	**Family Gryllacrididae (cont'd)**
Aeoloplides minor	*Ligurotettix coquilletti*	*T. pallidipennis*	*Stenopelmatus fuscus*
A. tenuipennis	*Melanoplus aridus*	*T. sparsa*	
Ageneotettix sp.	*M. complanatipes*	*Tytthotyle maculatus*	**Family Gryllidae**
A. deorum	*Mestobregma impexum*	*Xanthippus corallipes*	*Cycloptilum comprehendens*
Amphitornus coloradus	*Paraidemona punctatus*		*Gryllus assimilis*
Anconia integra	*Paropomala pallida*	**Family Eumastacidae**	*Myrmecophilus manni*
Arphia conspersa	*Poecilotettix sanguineus*	*Morsea californica*	*Oecanthus californicus*
Cibolacris parviceps	*Psoloessa delicatula*		*O. nigricornis*
Cordillacris occipitalis	*Trimerotropis albescens*	**Family Gryllacrididae**	
Derotmema delicatulum	*T. californica*	*Ceuthophilus lamellipes*	**Family Rhaphidophoridae**
Hesperotettix nevadensis	*T. cyaneipennis*	*Hemiudeopsylla fossor*	*Ceuthophilus deserticola*
H. viridis	*T. fontana*	*H. hesperus*	*C. nevadensis*
Leprus wheeleri	*T. inconspicua*	*Pristoceuthophilus pacificus*	*Gammarotettix bilobatus*
Order Phasmatodea – Walkingsticks			
Family Phasmatidae			
Parabacillus hesperus			
Pseudosermyle stramineus			
Order Siphonaptera – Fleas			
Family Ceratophyllidae	**Family Ctenophthalmidae**	**Family Ctenophthalmidae (cont'd)**	**Family Leptopsyllidae**
Aetheca wagneri	*Anomiopsyllus amphibolus*	*R. sectilis*	*Jordanopsylla allredi*
Dactylopsylla bluei	*A. amphibolus*	*Stenistomera alpina*	*Odontopsyllus dentatus*
Diamanus montanus *	*Callistopsyllus deuterus*	*S. alpina*	*Peromyscopsylla hesperomys*
Eumolpianus eumolpi	*C. deuterus*		
Foxella ignotus	*Carteretta carteri*	**Family Hystrichopsyllidae**	**Family Pulicidae**
Malaraeus euphorbi *	*Catallagia decipiens*	*Atyphloceras echis*	*Echidnophaga gallinaceus*
M. sinomus	*Epitedia wenmanni*		*Hoplopsyllus anomalus*
M. telchimun	*Megarthroglossus procus*	**Family Ichnospyllidae**	*Pulex irritans*
Orchopeas sexdentatus	*Meringis dipodomys*	*Nycteridopsylla vancouverensis*	*Spilopsyllus inaequalis*
Thrassis aridis	*M. hubbardi*		
T. bacchi	*M. parkeri*		
Traubella neotomae	*Rhadinopsylla heiseri*		
Order Thysanoptera – Thrips			
Family Phlaeothripidae	**Family Thripidae**		
Leptothrips mali	*Frankliniella minutus*		

Order Trichoptera – Caddice Flies				
Family Limnephilidae *Limnephilus* sp.				
Subphylum Myripoda				
Class Chilopoda – Centipedes				
Family Gosibiidae *Gosibius arizonensis* *	**Family Lithobiidae** *Oabius mercurialis* *	**Family Schendylidae** *Nyctunguis stenus* *	**Family Scolopendridae** *Scolopendra heros* * *S. michelbacheri*	**Family Tampiyidae** *Abatorus allredi* * *Eremorus becki* *
Class Diplopoda – Millipedes				
Family Atopetholidae *Arinolus nevadae* * *A. sequens* * *Orthichelus michelbacheri* *	**Family Leioderidae** *Titsona tida* *			
PHYLUM MOLLUSCA (MOLLUSKS)				
Class Bivalvia – Clams	**Class Gastropoda – Snails and Slugs**			
Family Pisidiidae *Pisidium* sp.	**Family Hydrobiidae** *Pyrgulopsis turbatrix*			
PHYLUM NEMATA (NEMATODES)				
Order Dorylaimida – Omnivores				
Family Leptonchidae *Leptonchus* sp.	**Family Dorylaimidae** *Pungentus* sp.	**Family Qudsianematidae** *Ecumenicus* sp. *Ecumenicus monohystera*		
Order Rhabditida – Insect-Parasitic				
Family Cephalobidae *Acrobeles complexus*	**Family Elaphonamatidae** *Elaphonema* sp			
Order Tylenchida – Plant-Parasitic				
Family Anguinidae *Ditylenchus* sp.	**Family Aphelenchidae** *Aphelenchus avenae*	**Family Aphelenchoididae** *Aphelenchoides* sp.	**Family Belonolaimidae** *Merlinius grandis*	**Family Tylenchina** *Tylenchorhynchus* 3 spp. *Tylenchorhynchus cylindricus*

sp = species (singular); spp = species (plural).
* Designates species for which the listing was unable to be verified or updated.
Source: Wills and Ostler 2001.

Table F–5 Vertebrate Animal Species (Phylum Chordata) of the Nevada National Security Site

Class Actinopterygii: Ray Finned Fish	
Order Cypriniformes – Carps	
Family Cyprinidae	
Carassius auratus	Goldfish
Order Perciformes – Perch-Like	
Family Centrarchidae	
Lepomis machrochirus	
Class Aves: Birds	
Order Anseriformes – Waterfowl	
Family Anatidae	
Aix sponsa	Wood Duck
Anas acuta	Northern Pintail
A. americana American	Wigeon
A. clypeata	Northern Shoveler
A. crecca	Green-winged Teal
A. cyanoptera	Cinnamon Teal
A. discors	Blue-winged Teal
A. platyrhynchos	Mallard
A. strepera	Gadwall
Aythya affinis	Lesser Scaup
A. americana	Redhead
A. collaris	Ring-necked Duck
A. valisineria	Canvasback
Branta Canadensis	Canada Goose
Bucephala albeola	Bufflehead
B. clangula	Common Goldeneye
Chen caerulescens	Snow Goose
Cygnus columbianus	Tundra Swan
Melanitta perspicillata	Surf Scoter
Mergus merganser	Common Merganser
M. serrator	Red-breasted Merganser
Oxyura jamaicensis	Ruddy Duck
Order Apodiformes – Swifts and Hummingbirds	
Family Apodidae	
Aeronautes saxatalis	White-throated Swift
Family Trochilidae	
Archilochus alexandri	Black-chinned Hummingbird
Calypte costae	Costa's Hummingbird
Selasphorus platycercus	Broad-tailed Hummingbird
S. rufus	Rufous Hummingbird
Order Caprimulgiformes – Goatsuckers and Allies	
Family Caprimulgidae	
Chordeiles acutipennis	Lesser Nighthawk
C. minor	Common Nighthawk
Phalaenoptilus nuttallii	Common Poorwill
Order Charadriiformes – Shorebirds, Gulls, and Alcids	
Family Charadriidae	
Charadrius alexandrinus	Snowy Plover
C. montanus	Mountain Plover
C. semipalmatus	Semipalmated Plover
C. vociferus	Killdeer
Pluvialis dominica	American Golden Plover
P. squatarola	Black-bellied Plover
Family Laridae	
Chlidonias niger	Black Tern
Larus argentatus	Herring Gull
L. californicus	California Gull
L. delawarensis	Ring-billed Gull
L. philadelphia	Bonaparte's Gull
L. pipixcan	Franklin's Gull
Sterna caspia	Caspian Tern
S. forsteri	Forster's Tern

Family Recurvirostridae	
Himantopus mexicanus	Black-necked Stilt
Recurvirostra americana	American Avocet
Family Scolopacidae	
Actitis macularia	Spotted Sandpiper
Calidris alpine	Dunlin
C. bairdii	Baird's Sandpiper
C. himantopus	Stilt Sandpiper
C. mauri Western	Sandpiper
C. melanotos	Pectoral Sandpiper
C. minutilla	Least Sandpiper
Catoptrophorus semipalmatus	Willet
Gallinago gallinago	Common Snipe
Limnodromus scolopaceus	Long-billed Dowitcher
Limosa fedoa Marbled	Godwit
Numenius americanus	Long-billed Curlew
Phalaropus lobatus	Red-necked Phalarope
P. tricolor	Wilson's Phalarope
Tringa flavipes	Lesser Yellowlegs
T. melanoleuca	Greater Yellowlegs
T. solitaria	Solitary Sandpiper
Order Ciconiiformes – Herons, Ibises, and Storks	
Family Ardeidae	
Ardea alba egretta	Great Egret
A. Herodias	Great Blue Heron
Botaurus lentiginosus	American Bittern
Bubulcus ibis	Cattle Egret
Butorides striatus *	Green-backed Heron
B. virescens	Green Heron
Egretta thula	Snowy Egret
Ixobrychus exilis	Least Bittern
Nycticorax nycticorax	Black-crowned Night-Heron
Family Ciconiidae	
Cathartes aura	Turkey Vulture
Family Threskiornithidae	
Ajaia ajaja	Roseate Spoonbill
Plegadis chihi	White-faced Ibis
Order Columbiformes – Pigeons and Allies	
Family Columbidae	
Columba livia	Rock Dove
Zenaida macroura	Mourning Dove
Order Coraciiformes – Rollers, Kingfishers, and Allies	
Family Alcedinidae	
Ceryle alcyon	Belted Kingfisher
Order Cuculiformes – Cuckoos and Allies	
Family Cuculidae	
Coccyzus americanus	Yellow-billed Cuckoo
Geococcyx californianus	Greater Roadrunner
Order Falconiformes – Diurnal Birds of Prey	
Family Accipitridae	
Accipiter cooperii	Cooper's Hawk
A. gentilis	Northern Goshawk
A. striatus	Sharp-shinned Hawk
Aquila chrysaetos	Golden Eagle
Buteo jamaicensis	Red-tailed Hawk
B. regalis	Ferruginous Hawk
B. swainsoni	Swainson's Hawk
Circus cyaneus	Northern Harrier
Haliaeetus leucocephalus	Bald Eagle
Pandion haliaetus	Osprey

Family Falconidae	
Falco mexicanus	Prairie Falcon
F. peregrinus	American Peregrine Falcon
F. sparverius	American Kestrel
Order Galliformes – Gallinaceous Birds	
Family Odontophoridae	
Callipepla gambelii	Gambel's Quail
Family Phasianidae	
Alectoris chukar	Chukar
Phasianus colchicus	Ring-necked Pheasant
Order Gaviiformes – Loons	
Family Gaviidae	
Gavia immer	Common Loon
Order Gruiformes – Rails, Cranes, and Allies	
Family Rallidae	
Fulica americana	American Coot
Gallinula chloropus	Common Moorhen
Porzana Carolina	Sora
Order Passeriformes – Perching Birds	
Family Aegithalidae	
Psaltriparus minimus	Bushtit
Family Alaudidae	
Eremophila alpestris	Horned Lark
Family Bombycillidae	
Bombycilla cedrorum	Cedar Waxwing
Family Cardinalidae	
Guiraca caerulea	Blue Grosbeak
Passerina amoena	Lazuli Bunting
P. cyanea	Indigo Bunting
Pheucticus ludovicianus	Rose-breasted Grosbeak
P. melanocephalus	Black-headed Grosbeak
Family Corvidae	
Aphelocoma californica	Western Scrub-Jay
Corvus brachyrhynchos	American Crow
C. corax sinuatus	Common Raven
Cyanocitta stelleri	Steller's Jay
Gymnorhinus cyanocephalus	Pinyon Jay
Nucifraga Columbiana	Clark's Nutcracker
Pica hudsonia	Black-billed Ma gpie
Family Emberizidae	
Amphispiza belli	Sage Sparrow
A. bilineata	Black-throated Sparrow
Calcarius lapponicus	Lapland Longspur
Chondestes grammacus	Lark Sparrow
Junco hyemalis	Dark-eyed Junco
Melospiza lincolnii	Lincoln's Sparrow
M. melodia	Song Sparrow
Passerculus sandwichensis	Savannah Sparrow
Passerella iliaca	Fox Sparrow
Pipilo chlorurus	Green-tailed Towhee
P. maculates	Spotted Towhee
Pooecetes gramineus	Vesper Sparrow
Spizella atrogularis	Black-chinned Sparrow
S. breweri	Brewer's Sparrow
S. passerine	Chipping Sparrow
Zonotrichia atricapilla	Golden-crowned Sparrow
Z. leucophrys	White-crowned Sparrow

Family Fringillidae	
Carduelis pinus pinus	Pine Siskin
C. psaltria	Lesser Goldfinch
C. tristis	American Goldfinch
Carpodacus cassinii	Cassin's Finch
C. mexicanus	House Finch
C. purpureus	Purple Finch
Coccothraustes vespertinus	Evening Grosbeak
Loxia curvirostra	Red Crossbill
Family Hirundinidae	
Hirundo rustica	Barn Swallow
Petrochelidon pyrrhonota	Cliff Swallow
Riparia riparia	Bank Swallow
Stelgidopteryx serripennis	Northern Rough-winged Swallow
Tachycineta bicolor	Tree Swallow
T. thalassina	Violet-green Swallow
Family Icteridae	
Agelaius phoeniceus	Red-winged Blackbird
Euphagus cyanocephalus	Brewer's Blackbird
Icterus bullockii	Bullock's Oriole
I. cucullatus	Hooded Oriole
I. galbula	Baltimore Oriole
I. parisorum	Scott's Oriole
Molothrus ater	Brown-headed Cowbird
Quiscalus mexicanus	Great-tailed Grackle
Q. quiscula *	Common Grackle
Sturnella neglecta	Western Meadowlark
Xanthocephalus xanthocephalus	Yellow-headed Blackbird
Family Laniidae	
Lanius ludovicianus	Loggerhead Shrike
Family Mimidae	
Dumetella carolinensis	Gray Catbird
Mimus polyglottos	Northern Mockingbird
Oreoscoptes montanus	Sage Thrasher
Toxostoma crissale	Crissal Thrasher
T. lecontei	Le Conte's Thrasher
T. rufum	Brown Thrasher
Family Motacillidae	
Anthus rubescens	American Pipit
A. spragueii	Sprague's Pipit
Family Paridae	
Baeolophus inornatus	Oak Titmouse
Poecile gambeli	Mountain Chickadee
Family Parulidae	
Dendroica coronata	Yellow-rumped Warbler
D. nigrescens	Black-throated Gray Warbler
D. pensylvanica	Chestnut-sided Warbler
D. petechia	Yellow Warbler
D. townsendi	Townsend's Warbler
Geothlypis trichas	Common Yellowthroat
Icteria virens	Yellow-breasted Chat
Oporornis tolmiei	MacGillivray's Warbler
Seiurus noveboracensis	Northern Waterthrush
Setophaga ruticilla	American Redstart
Vermivora celata	Orange-crowned Warbler
V. ruficapilla	Nashville Warbler
V. virginiae	Virginia's Warbler
Wilsonia pusilla	Wilson's Warbler
Family Passeridae	
Passer domesticus	House Sparrow

Family Ptilogonatidae	
Phainopepla nitens	Phainopepla
Family Regulidae	
Regulus calendula	Ruby-crowned Kinglet
Family Sittidae	
Sitta canadensis	Red-breasted Nuthatch
S. carolinensis	White-breasted Nuthatch
Family Sturnidae	
Sturnus vulgaris	European Starling
Family Sylviidae	
Polioptila caerulea	Blue-gray Gnatcatcher
P. melanura	Black-tailed Gnatcatcher
Family Thraupidae	
Piranga ludoviciana	Western Tanager
Family Troglodytidae	
Campylorhynchus brunneicapillus	Cactus Wren
Catherpes mexicanus	Canyon Wren
Cistothorus palustris	Marsh Wren
Salpinctes obsoletus	Rock Wren
Thryomanes bewickii	Bewick's Wren
Troglodytes aedon	House Wren
Family Turdidae	
Catharus guttatus	Hermit Thrush
C. ustulatus	Swainson’s Thrush
Ixoreus naevius	Varied Thrush
Myadestes townsendi	Townsend's Solitaire
Sialia currucoides	Mountain Bluebird
S. mexicana	Western Bluebird
Turdus migratorius	American Robin
Family Tyrannidae	
Contopus cooperi	Olive-sided Flycatcher
C. sordidulus	Western Wood Pewee
Empidonax difficilis	Pacific-slope Flycatcher
E. hammondii	Hammond's Flycatcher
E. oberholseri	Dusky Flycatcher
E. wrightii	Gray Flycatcher
Myiarchus cinerascens	Ash-throated Flycatcher
Pyrocephalus rubinus	Vermilion Flycatcher
Sayornis nigricans	Black Phoebe
S. saya	Say's Phoebe
Tyrannus forficatus	Scissor-tailed Flycatcher
T. verticalis	Western Kingbird
T. vociferans	Cassin's Kingbird
Family Vireonidae	
Vireo gilvus	Warbling Vireo
V. solitarius	Blue-headed Vireo
V. vicinior	Gray Vireo
Order Pelecaniformes – Totipalmate Swimmers	
Family Pelecanidae	
Pelecanus erythrorhynchos	American White Pelican
P. occidentalis	Brown Pelican
Family Phalacrocoracidae	
Phalacrocorax auritus	Double-crested Cormorant

Order Piciformes – Woodpeckers and Allies	
Family Picidae	
Colaptes auratus	Northern Flicker
Melanerpes lewis	Lewis's Woodpecker
Picoides scalaris	Ladder-backed Woodpecker
P. villosus	Hairy Woodpecker
Sphyrapicus nuchalis	Red-naped Sapsucker
S. thyroideus	Williamson's Sapsucker
S. varius	Yellow-bellied Sapsucker
Order Podicipediformes – Grebes	
Family Podicipedidae	
Aechmophorus occidentalis	Western Grebe
Podiceps nigricollis	Eared Grebe
Podilymbus podiceps	Pied-billed Grebe
Order Strigiformes – Owls	
Family Strigidae	
Asio flammeus	Short-eared Owl
A. otus	Long-eared Owl
Athene cunicularia	Burrowing Owl
Bubo virginianus	Great Horned Owl
Family Tytonidae	
Tyto alba	Barn-Owl
Class Lissamphibia: Amphibians	
Order Anura – Frogs and Toads	
Family Ranidae	
Rana catesbeiana	Bullfrog
Order Caudata – Salamanders and Newts	
Family Ambystomatidae	
Ambystoma tigrinum	Tiger Salamander
Class Mammalia: Mammals	
Order Artiodactyla – Hoofed Mammals	
Family Antilocapridae	
Antilocapra americana	Pronghorn Antelope
Family Bovidae	
Bos taurus	Cow
Ovis Canadensis nelsoni	Bighorn Sheep
Family Cervidae	
Cervus elaphus	Elk
Odocoileus hemionus	Mule Deer
Order Carnivora – Carnivores	
Family Canidae	
Canis latrans	Coyote
Urocyon cinereoargenteus	Grey Fox
Vulpes macrotis	Kit Fox
Family Felidae	
Felis concolor	Mountain Lion
Lynx rufus	Bobcat
Family Mustelidae	
Mustela frenata	Long-tailed Weasel
Spilogale putorius	Western Spotted Skunk
Taxidea taxus	Badger
Family Procyonidae	
Bassariscus astutus	Ring-tailed Cat

Order Chiroptera – Bats		Order Rodentia	
Family Molossidae		**Family Cricetidae**	
Tadarida brasiliensis	Brazilian Free-tailed Bat	*Lagurus curtatus*	Sagebrush Vole
Family Vespertilionidae		**Family Erethizontidae**	
Antrozous pallidus	Pallid Bat	*Erethizon dorsatum*	Porcupine
Order Rodentia	Rodents		
Eptesicus fuscus	Big Brown Bat	**Family Geomyidae**	
Euderma maculatum	Spotted Bat	*Thomomys bottae*	Botta's Pocket Gopher
Lasionycteris noctivagans	Silver-haired Bat	*T. umbrinus*	Pygmy Pocket Gopher
Lasiurus blossevillii	Western Red Bat		
L. cinereus	Hoary Bat	**Family Heteromyidae**	
Myotis californicus	California Bat	*Chaetodipus formosus*	Longtail Pocket Mouse
M.Ciliolabrum	Small-footed Myotis	*Dipodomys deserti*	Desert Kangaroo Rat
M. evotis	Long-eared Myotis	*D. merriami*	Merriam's Kangaroo Rat
M. thysanodes	Fringed Myotis	*D. microps*	Great Basin Kangaroo Rat
M. volans	Long-legged Myotis	*D. ordii*	Ord Kangaroo Rat
M. yumanensis	Yuma Myotis	*Microdipodops megacephalus*	Dark Kangaroo Mouse
Pipistrellus hesperus	Western Pipistrelle Bat	*Perognathus longimembris*	Little Pocket Mouse
		P. parvus	Great Basin Pocket Mouse
Order Insectivora – Shrews and Moles			
Family Soricidae		**Family Muridae**	
Notiosorex crawfordi	Desert Shrew	*Neotoma lepida*	Desert Woodrat
Sorex merriami	Merriam's Shrew	*Onychomys torridus*	Southern Grasshopper Mouse
S. tenellus	Inyo Shrew	*Peromyscus crinitus*	Canyon Mouse
		P. eremicus	Cactus Mouse
Order Lagomorpha – Pikas, Rabbits and Hares		*P. maniculatus*	Deer Mouse
Family Leporidae		*P. truei*	Pinon Mouse
Lepus californicus	Black-tailed Jackrabbit	*Reithrodontomys megalotis*	Western Harvest Mouse
Sylvilagus audubonii	Desert Cottontail		
S. nuttallii	Mountain Cottontail	**Family Sciuridae**	
		Ammospermophilus leucurus	White-tailed Antelope-squirrel
Order Perissodactyla – Horses		*Eutamias dorsalis*	Cliff Chipmunk
Family Equidae		*Spermophilus tereticaudus*	Round-tailed Ground Squirrel
Equus asinus	Burro	*S. townsendii*	Towsend's Ground Squirrel
E. caballus	Horse	*S. variegatus*	Rock Squirrel

Class Reptilia: Lizards, Snakes and Tortoises

Order Squamata – Lizards and Snakes

Suborder Lacertilia Lizards

Family Crotaphytidae	
Crotaphytus insularis	Great Basin Collared Lizard
Gambelia wislizenii	Long-nosed Leopard Lizard
Family Gekkonidae	
Coleonyx variegatus	Desert Banded Gecko
Family Helodermatidae	
Heloderma suspectum *	Banded Gila Monster
Family Iguanidae	
Dipsosaurus dorsalis	Desert Iguana
Sauromalus obesus	Chuckwalla
Family Phrynosomatidae	
Callisaurus draconoides	Common Zebra-tailed Lizard
Phrynosoma platyrhinos	Desert Horned lizard
Sceloporus graciosus	Sagebrush Lizard
S. magister	Yellow-backed Spiny Lizard
S. occidentalis	Western Fence Lizard
Uta stansburiana	Side-blotched Lizard
Family Scincidae	
Eumeces gilberti	Gilbert's Skink
Eumeces gilberti rubricaudatus	Western red-tailed skink
E. skiltonianus	Western Skink
Family Teiidae	
Cnemidophorus tigris	Western Whiptail Lizard
Family Xantusidae	
Xantusia vigilis	Desert Night Lizard

Suborder Serpentes – Snakes

Family Colubridae	
Arizona elegans	Desert Glossy Snake
Chionactis occipitalis	Nevada Shovel-nosed Snake
Diadophis punctatus	Ring-necked Snake
Hypsiglena torquata	Night Snake
Lampropeltis getula	California Kingsnake
Masticophis flagellum	Red Racer
M. taeniatus	Desert Striped Whipsnake
Phyllorhynchus decurtatus	Western Leaf-Nosed Snake
Pituophis catenifer	Great Basin Gopher Snake
Rhinocheilus lecontei	Western Long-nosed Snake
Salvadora hexalepis	Mohave Patch-nosed Snake
Sonora semiannulata	Great Basin Ground Snake
Tantilla hobartsmithi	Southwestern Black-headed Snake
Trimorphodon biscutatus	Western Lyre Snake
Family Leptotyphlopidae	
Leptotyphlops humilis	Western Slender Blind Snake
Family Viperidae	
Crotalus cerastes	Mojave Desert Sidewinder
C. mitchellii	Panamint Rattlesnake

Order Testudines – Turtles and Tortoises

Family Testudinidae	
Gopherus agassizii	Desert Tortoise

Source: Wills and Ostler 2001.

F.3 References

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Wills, C. A., and W. K. Ostler, 2001, *Ecology of the Nevada Test Site: An Annotated Bibliography*, DOE/NV/11718-594, Ecological Services, Bechtel Nevada, Las Vegas, Nevada, December.

Nevada Administrative Code

NAC 503, "Hunting, Fishing and Trapping: Miscellaneous Protective Measures."

United States Code

16 U.S.C. 668 et seq., Bald and Golden Eagle Protection Act.

16 U.S.C. 703 et seq., Migratory Bird Treaty Act.

16 U.S.C. 1331 et seq., Wild Free-Roaming Horses and Burros Act.

16 U.S.C. 1531 et seq., Endangered Species Act.

APPENDIX G
HUMAN HEALTH IMPACTS

APPENDIX G
HUMAN HEALTH IMPACTS

G.1 Background

G.1.1 Radiation

Radiation exposure and its consequences are topics of interest to the general public. For this reason, this *Site-Wide Environmental Impact Statement for the Continued Operation of the Department of Energy/National Nuclear Security Administration Nevada National Security Site and Off-Site Locations in the State of Nevada* provides the reader with the following information regarding the nature of radiation, the consequences of exposure to radiation, and the basic concepts used to evaluate the health effects resulting from radiation exposure.

Radiation is energy and/or mass transferred in the form of particles or waves. Globally, human beings are exposed constantly to radiation from cosmic sources (outer space); terrestrial sources, such as the Earth's rocks and soils; and radionuclides that are naturally present in the human body. 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.

All matter in the universe is composed of atoms. Radiation comes from the activity of tiny particles within an atom. An atom consists of a positively charged nucleus (the central part of an atom) and a number of negatively charged electron particles that orbit the nucleus. There are two types of particles in the nucleus: neutrons, which are electrically neutral, and protons, which are positively charged. Atoms with different numbers of protons are known as elements. There are more than 100 natural and manmade elements. An element has equal numbers of electrons and protons. When atoms of an element differ in their number of neutrons, they are called isotopes of that element. All elements have three or more isotopes, some or all of which could be unstable (i.e., change over time).

Unstable isotopes undergo spontaneous change, known as radioactive disintegration or radioactive decay. The process of continuously undergoing spontaneous disintegration is called radioactivity. The radioactivity of a material decreases with time. The time it takes a material to lose half of its original radioactivity is its half-life. An isotope's half-life is a measure of its decay rate. For example, an isotope with a half-life of 8 days will lose one-half of its radioactivity in that amount of time. In 8 more days, one-half of the remaining radioactivity will be lost, and so on. Each radioactive element has a characteristic half-life. The half-lives of various radioactive elements vary from millionths of a second to millions of years.

As unstable isotopes change into more-stable forms, they emit energy and/or particles (mass). A particle may be an alpha particle (a helium nucleus), a beta particle (an electron), or a neutron, with various levels of kinetic energy. Sometimes these particles are emitted in conjunction with gamma rays. The particles and gamma rays are referred to as "ionizing radiation." Ionizing radiation means that the particles and gamma rays can ionize, or electrically charge, an atom by stripping off one or more of its electrons. Even though gamma rays do not carry an electrical charge, they can ionize atoms by ejecting electrons as they pass through an element, indirectly causing ionization. Ionizing radiation can change the chemical composition of many things, including living tissue (organs), which can affect the way they function.

When a radioactive isotope of an element emits a particle, it changes to an entirely different element or isotope, one that may or may not be radioactive. Eventually, a stable element is formed. This transformation, which may take several steps, is known as a decay chain. For example, radium, a member of the radioactive decay chain of uranium-238, has a half-life of 1,600 years. It emits an alpha particle and becomes radon, a radioactive gas with a half-life of only 3.8 days. Radon decays first to polonium, then through a series of further decay steps to bismuth, and ultimately to a stable isotope of lead. The characteristics of various forms of ionizing radiation are briefly described below.

- Alpha (α) particles – Alpha particles are the heaviest type of ionizing radiation. They can travel only a few centimeters in air. Alpha particles lose their energy almost as soon as they collide with anything. They can be stopped easily by a sheet of paper or by the skin's surface.

- Beta (β) particles – Beta particles are much (7,300 times) lighter than alpha particles. They can travel a longer distance than alpha particles in the air. 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) rays – Gamma rays (and x-rays), unlike alpha or beta particles, are a form of electromagnetic radiation, similar to, but more energetic than, visible light. Gamma rays travel at the speed of light. Gamma radiation is very penetrating and requires a large mass, such as a thick wall of concrete, lead, or steel, to stop it.

- Neutrons (n) – Neutrons are particles that contribute to radiation exposure both directly and indirectly. The most prolific source of neutrons is a nuclear reactor. Indirect radiation exposure occurs when gamma rays and alpha particles are emitted following neutron capture in matter. A neutron has about one-quarter the mass of an alpha particle. It will travel in the air until it is absorbed by another element.

G.1.1.1 Radiation Measurement Units

During the early days of radiological experimentation, there was no precise measurement unit for radiation. Therefore, various units were used to identify the amount, type, and intensity of radiation. Amounts of radiation or its effects can be measured in units of curies, radiation absorbed dose (rad), or dose equivalent (roentgen equivalent man, or rem). These units are described below.

- Curie – The curie, named after the scientists Marie and Pierre Curie, describes the "intensity" or activity of a sample of radioactive material. The rate of decay of 1 gram of radium was the basis of this unit of measure. Because the measured decay rate kept changing slightly as measurement techniques became more accurate, 1 curie was subsequently defined as exactly 37 billion disintegrations (decays) per second.

- Rad – The rad is used to measure the physical absorption of radiation. The total energy absorbed per unit quantity of tissue is referred to as the "absorbed dose" (or simply dose). As sunlight heats pavement by giving up an amount of energy to it, radiation similarly gives up energy to objects in its path. One rad is equal to the amount of radiation that leads to the deposition of 0.01 joules of energy per kilogram of absorbing material (a joule is a metric unit of energy, equivalent to 1 watt-second or 0.239 calories of energy per kilogram of absorbing material).

- Rem – The rem is used to measure dose equivalent. The dose equivalent in rem equals the absorbed dose in rad in tissue multiplied by the appropriate quality factor (the biological effectiveness of a given type of radiation) and possibly other modifying factors. The rem is used to measure the effects of radiation on the body similar to the way degrees Celsius or Fahrenheit (°C or °F) are used to measure the effects of sunlight heating pavement. Thus, 1 rem from one type of radiation is presumed to have the same biological effects as 1 rem from any other kind of radiation. This allows comparison of the biological effects of radionuclides that emit different types of radiation. One-thousandth of a rem is called a millirem.

- Person-rem – The person-rem is used to measure collective radiation dose, i.e., the sum of the individual doses received by a population or group from exposure to a specified source of radiation.

The units of measure for radiation in the International System of Units are becquerels (used to measure source intensity [activity]), grays (used to measure absorbed dose), and sieverts (used to measure dose equivalent).

Equivalent Radiation Units in the International System of Units

Traditional Unit	International System Unit
1 curie	3.7×10^{10} becquerels (Bq)
1 rad	0.01 grays (Gy)
1 rem	0.01 sieverts (Sv)

An individual may be exposed to ionizing radiation externally (from a radioactive source outside the body) or internally (from ingesting or inhaling radioactive material). The external dose is different from the internal dose because an external dose is delivered only during the actual time of exposure to the external radiation source, while an internal dose continues to be delivered as long as the radioactive source is in the body. The dose from internal exposure is typically calculated over 50 years following the initial exposure. Both radioactive decay and elimination of the radionuclide by ordinary metabolic processes decrease the dose rate with the passage of time.

Doses projected from normal operations and from accidents are reported in terms of total effective dose equivalent, the sum of the effective dose equivalent due to penetrating radiation from sources external to the body and the committed effective dose equivalent from internal deposition of radionuclides. The committed effective dose equivalent is an estimate of the radiation dose to a person resulting from inhalation or ingestion of radioactive material that takes into account the radiation sensitivities of different organs and the time (up to 50 years) a particular substance stays in the body (further discussed in Section G.1.1.3).

G.1.1.2 Sources of Radiation

The average American receives a total dose of approximately 620 millirem per year from all sources of radiation, both natural and manmade (see **Table G–1**); approximately 311 millirem per year of this total are from natural sources (NCRP 2009). The sources of radiation can be divided into six different categories: (1) cosmic radiation, (2) external terrestrial radiation, (3) internal radiation, (4) medical diagnosis and therapy, (5) consumer products, and (6) other sources. These categories are discussed in the following paragraphs.

Table G–1 Ubiquitous Background and Manmade Sources of Radiation Exposure to Individuals Unrelated to the Nevada National Security Site

Source	*Effective Dose (millirem per year)* [a]
Ubiquitous Background	**311**
Cosmic radiation	33
External terrestrial radiation	21
Internal radiation (other than radon)	29
Radon	228
Medical	**300**
Computed tomography	147
Radiography, fluoroscopy	76
Nuclear medicine	77
Consumer	**13**
Other	**less than 1**
Total (rounded)	**620**

[a] Averages for an individual in the U.S. population.
Source: NCRP 2009.

Cosmic radiation. Cosmic radiation is ionizing radiation resulting from the energetic charged particles from space that continuously hit the Earth's atmosphere. These particles, as well as the secondary particles and photons they create, constitute cosmic radiation. Because the atmosphere provides some shielding against cosmic radiation, the intensity of this radiation increases with the altitude above sea level. The average dose to a person in the United States from this source is approximately 33 millirem per year.

External terrestrial radiation. External terrestrial radiation is the radiation emitted from the radioactive materials in the Earth's rocks and soils. The average individual dose from external terrestrial radiation is approximately 21 millirem per year.

Internal radiation. Internal radiation results from inhalation or ingestion of natural radioactive material. Natural radionuclides in the body include isotopes of uranium, thorium, radium, radon, polonium, bismuth, potassium, rubidium, and carbon. The major contributors to the annual dose equivalent for internal radioactivity are the short-lived decay products of radon, which contribute approximately 228 millirem per year. The average individual dose from other internal radionuclides is approximately 29 millirem per year.

Medical diagnosis and therapy. Radiation is an important tool for the diagnosis and treatment of medical conditions and illnesses. Diagnostic x-rays, including fluoroscopy and computed tomography, result in an average dose of 223 millirem per year. Nuclear medical procedures result in an average dose of 77 millirem per year.[1]

Consumer products. Consumer products also contain sources of ionizing radiation. In some products, such as smoke detectors and airport x-ray machines, the radiation source is essential to the product's operation. In other products, such as televisions and tobacco, the user is incidentally exposed to radiation as the products function. The average dose from consumer products is approximately 13 millirem per year.

[1] *Exposures from nuclear diagnostic and medical procedures vary over a wide range, depending on the procedure. The reported values are average annual doses in the U.S. population (NCRP 2009).*

Other sources. There are a few additional sources of radiation that contribute minor doses to individuals in the United States. The dose from nuclear fuel cycle facilities (e.g., uranium mines, mills, and fuel processing plants) and nuclear power plants has been estimated to be less than 1 millirem per year. Radioactive fallout from atmospheric atomic bomb tests, emissions from certain mineral extraction facilities, and transportation of radioactive materials contribute less than 1 millirem per year to the average dose to an individual. Air travel contributes approximately 1 millirem per year to the average dose.

G.1.1.3 Exposure Pathways

As stated earlier, an individual may be exposed to ionizing radiation both externally and internally. The different routes that could lead to radiation exposure are called exposure pathways. Each type of exposure and its associated exposure pathways are discussed separately in the following paragraphs.

External exposure. External exposure results from exposure to radiation outside the body via any of several different pathways, including exposure to a cloud of radiation passing over the receptor (an exposed individual), standing on ground that is contaminated with radioactivity, and swimming or boating in contaminated water. If the receptor departs from the source of radiation exposure, the dose rate will decrease. It was assumed that external exposure occurs uniformly during the year. The appropriate dose measure for external pathways is called the effective dose equivalent.

Internal exposure. Internal exposure results from a radiation source entering the human body through either inhalation of contaminated air or ingestion of contaminated food or water. In contrast to external exposure, once a radiation source enters the body, it remains there for a period of time that varies depending on its biological half-life (the time required for a radioactive material taken in by a living organism to be reduced to half the initial quantity by a combination of biological elimination processes and radioactive decay). The absorbed dose to each organ of the body is calculated for a period of 50 years following the intake. Various organs have different susceptibilities to harm from radiation. The calculated absorbed dose is called the committed dose equivalent; this quantity takes these different susceptibilities into account and provides a broad indicator of the risk to the health of an individual from radiation. The committed effective dose equivalent is a weighted sum of the committed dose equivalent in each major organ or tissue. The concept of committed effective dose equivalent applies only to internal pathways.

G.1.1.4 Radiation Protection Guides

Various organizations have issued radiation protection guides. The responsibilities of the main radiation safety organizations, particularly those that affect policies in the United States, are summarized below.

International Commission on Radiological Protection (ICRP). The ICRP is responsible for providing guidance in matters of radiation safety. The operating policy of this organization is to prepare recommendations that address basic principles of radiation protection, leaving to the various national protection committees the responsibility to prepare detailed technical regulations, recommendations, or codes of practice that are best suited to the needs of their countries.

National Council on Radiation Protection and Measurements. In the United States, this council is the national organization responsible for adapting and providing detailed technical guidelines to implement ICRP recommendations. The council consists of technical experts who are specialists in radiation protection and scientists who are experts in disciplines that form the basis for radiation protection.

National Research Council/National Academy of Sciences. The National Research Council, which functions under the auspices of the National Academy of Sciences, integrates the broad science and technology community with the Academy's mission to further knowledge and advise the Federal Government. The National Research Council's Committee on the Biological Effects of Ionizing Radiation (BEIR Committee) prepares reports to advise the Federal Government on the health consequences of radiation exposure.

U.S. Environmental Protection Agency (EPA). EPA has published a series of documents under the title *Radiation Protection Guidance to Federal Agencies*. This guidance is used as a regulatory benchmark by a number of Federal agencies, including the U.S. Department of Energy (DOE), for the purpose of limiting public and occupational workforce exposures to the greatest extent possible.

U.S. Nuclear Regulatory Commission (NRC). NRC regulates source materials, special nuclear materials, and byproduct materials used by commercial entities, such as nuclear power plants, either directly or through state agreements. NRC has promulgated "Standards for Protection Against Radiation" in Title 10 of the *Code of Federal Regulations* (CFR), Part 20 (10 CFR Part 20), which apply to commercial uses of the materials listed above.

U.S. Department of Energy. DOE establishes requirements for radiological protection at DOE sites in regulations and orders. Requirements for worker protection are included in "Occupational Radiation Protection (10 CFR Part 835). Radiological protection of the public and environment is addressed in *Radiation Protection of the Public and the Environment* (DOE Order 458.1).

G.1.1.5 Radiation Exposure Limits

Radiation exposure limits for members of the public and radiation workers are derived from ICRP recommendations. EPA uses National Council on Radiation Protection and Measurements and ICRP recommendations to set specific annual exposure limits (usually lower than those specified by the ICRP) in its radiation protection guidance to Federal agencies. Each regulatory organization then establishes its own set of radiation standards. The various exposure limits set by DOE and EPA for radiation workers and members of the public are given in **Table G–2**.

Table G–2 Radiation Exposure Limits for Members of the Public and Radiation Workers

Guidance Criteria (Organization)	*Public Exposure Limits at the Site Boundary*	*Worker Exposure Limits*
10 CFR Part 835 (DOE)	–	5,000 millirem per year [a]
10 CFR 835.1002 (DOE)	–	1,000 millirem per year [b]
DOE Order 458.1 (DOE) [c]	100 millirem per year (all pathways)	–
40 CFR Part 61, Subpart H (EPA)	10 millirem per year (all air pathways)	–
40 CFR Part 141 (EPA)	4 millirem per year (drinking-water pathway)	–

CFR = *Code of Federal Regulations*; EPA = U.S. Environmental Protection Agency.

[a] Although this measurement is a limit (or level) that is enforced by DOE, worker doses must be managed in accordance with as low as reasonably achievable principles. Refer to footnote b.

[b] This measurement is a control level. DOE established this level to assist in achieving its goal of maintaining radiation doses as low as reasonably achievable. DOE recommends that facilities adopt a more-limiting 500-millirem-per-year Administrative Control Level (DOE 2008). Facility operators must make reasonable attempts to maintain individual worker doses below these levels.

[c] Consistent with 10 CFR Part 20. DOE Order 458.1 invokes the requirements of 40 CFR Part 61, Subpart H, and 40 CFR Part 141 for the air pathway and drinking water, respectively.

G.1.1.6 Human Health Effects due to Exposure to Radiation

To provide the background for discussions of impacts, this section explains the basic concepts used in the evaluation of radiation effects. Radiation can cause a variety of damaging health effects in humans. The most significant effects are induced cancer fatalities, called latent cancer fatalities (LCFs) because the onset of cancer may take many years to develop after the radiation dose is received. In this site-wide environmental impact statement (SWEIS), LCFs are used to measure the estimated risk due to radiation exposure.

Cancer is a group of diseases characterized by the uncontrolled growth and spread of abnormal cells. Cancer is caused by both external factors (tobacco, infectious organisms, chemicals, and radiation) and internal factors (inherited mutations, hormones, immune conditions, and mutations that occur from metabolism). For the U.S. population of about 310 million, the American Cancer Society estimated that, in 2010, about 1,529,560 new cancer cases would be diagnosed and about 569,490 cancer deaths would occur. Approximately one-third of U.S. cancer deaths are estimated to be caused by tobacco use and about one-third are related to overweight or obesity, physical inactivity, and poor nutrition. The average U.S. resident has about 4 chances in 10 of developing an invasive cancer over his or her lifetime (44 percent probability for males, 38 percent for females). Nearly 25 percent of all deaths in the United States are due to cancer (American Cancer Society 2010).

The National Research Council's BEIR Committee has prepared a series of reports to advise the Federal Government on the health consequences of radiation exposure. Based on its 1990 report, *Health Effects of Exposure to Low Levels of Ionizing Radiation, BEIR V* (National Research Council 1990), the former Committee on Interagency Radiation Research and Policy Coordination recommended cancer risk factors of 0.0005 per rem for the public and 0.0004 per rem for working-age populations (CIRRPC 1992). In 2002, the Interagency Steering Committee on Radiation Standards (ISCORS) recommended that Federal agencies use conversion factors of 0.0006 fatal cancers per rem for mortality and 0.0008 cancers per rem for morbidity when making qualitative or semi-quantitative estimates of risk from radiation exposure to members of the general public. No separate values were recommended for workers. The DOE Office of Environmental and Policy Guidance subsequently recommended that DOE personnel and contractors use the risk factors recommended by ISCORS, stating that, for most purposes, the value for the general population (0.0006 fatal cancers per rem) could be used for both workers and members of the public in National Environmental Policy Act (NEPA) analyses (DOE 2003).

Recent publications by both the BEIR Committee and the ICRP support the continued use of the ISCORS-recommended risk values. *Health Risks from Exposure to Low Levels of Ionizing Radiation: BEIR VII Phase 2* (National Research Council 2006) reported fatal cancer risk factors of 0.00048 per rem for males and 0.00066 per rem for females in a population with an age distribution similar to that of the entire U.S. population (average value of 0.00057 per rem for a population with equal numbers of males and females). ICRP Publication 103 (Valentin 2007) recommends nominal cancer risk coefficients of 0.00041 and 0.00055 per rem for adults and the general population, respectively, and estimates the risk from heritable effects to be about 3 to 4 percent of the nominal fatal cancer risk (see **Table G–3**).

Accordingly, a risk factor of 0.0006 LCFs per rem was used in this SWEIS to estimate risk due to radiation doses from normal operations and accidents. For high individual doses (greater than or equal to 20 rem), the health risk factor was multiplied by 2 (NCRP 1993).

Using the risk factors discussed above, a calculated dose can be used to estimate the risk of an LCF. For example, if each member of a population of 100,000 people were exposed to a one-time dose of 100 millirem (0.1 rem), the collective dose would be 10,000 person-rem (100,000 persons times 0.1 rem).

Using the risk factor of 0.0006 LCFs per person-rem, this collective dose is expected to cause 6 additional LCFs in this population (10,000 person-rem times 0.0006 LCFs per person-rem).

Table G–3 Nominal Health Risk Estimators Associated with Exposure to Ionizing Radiation [a]

Exposed Population	*Cancer* [b]	*Genetic Effects*	*Total*
Worker (adult) [c]	0.00041	0.00001	0.00042
Whole	0.00055	0.00002	0.00057

[a] Risk per rem (individual dose) or person-rem (population dose). For individual doses equal to or greater than 20 rem, the health risk estimators are multiplied by 2.
[b] Risk of all cancers, adjusted for lethality and quality-of-life impacts.
[c] Ages 18–64 years.
Source: Valentin 2007:Table A.4.4.

Calculations of the number of LCFs sometimes do not yield whole numbers and may yield a number less than 1. For example, if each individual of a population of 100,000 people were to receive an annual dose of 1 millirem (0.001 rem), the collective dose would be 100 person-rem, and the corresponding risk of an LCF would be 0.06 (100,000 persons times 0.001 rem times 0.0006 LCFs per person-rem). A fractional result should be interpreted as a statistical estimate. That is, 0.06 is the average number of LCFs expected if many groups of 100,000 people were to experience the same radiation exposure situation. For most groups, no LCFs would occur; in a few groups, 1 LCF would occur; in a very small number of groups, 2 or more LCFs would occur. The average number of LCFs over all of the groups would be 0.06 (just like the average of 0, 0, 0, and 1 is 1 divided by 4, or 0.25). In the preceding example, the most likely outcome for any single group would be 0 LCFs. In this SWEIS, LCFs calculated for a population are presented as both the rounded whole number, representing the most likely outcome for that population, and the calculated statistical estimate of risk, which is presented in parentheses.

The numerical estimates of LCFs presented in this SWEIS were obtained using a linear extrapolation from the nominal risk estimated for lifetime total cancer mortality resulting from a dose of 0.1 grays (10 rad). Other methods of extrapolation to the low-dose region could yield higher or lower numerical estimates of LCFs. Studies of human populations exposed to low doses are inadequate to demonstrate the actual level of risk. There is scientific uncertainty about cancer risk in the low-dose region below the range of epidemiologic observation. However, a comprehensive review of available biological and biophysical data supports a "linear no-threshold" risk model in which the risk of cancer proceeds in a linear fashion at lower doses without a threshold and the smallest dose has the potential to cause a small increase in risk to humans (National Research Council 2006).

G.1.2 Chemicals

The reprocessing of nuclear fuels, the manufacture of nuclear materials, and the processing of fuel cycle waste entail the use of chemicals. Some of the more-hazardous chemicals could pose risks to human health, even to the point of being fatal, if they are accidentally released to the environment or if they come into contact with workers in an occupational setting. The risks from exposure are of two general types: toxic, noncarcinogenic (non-cancer-causing) effects and cancer-inducing effects. In addition, the presence of some chemicals may pose a physical hazard to humans, such as chemical burns of the skin or internal organs, explosions or thermal hazards, displacement of oxygen, or runaway chemical reactions that cause high-energy release events.

G.1.2.1 Toxic or Hazardous Chemical

Nearly every chemical that exists can be detrimental to human health under specific exposure conditions. A large number, both carcinogenic (cancer-causing) and noncarcinogenic, are specifically addressed in Occupational Safety and Health Administration (OSHA) regulations. The exposure limit or guideline for any given substance depends on the basic toxic or hazardous properties of the material; its physical properties (solid, liquid, gas, or vapor); the circumstances of exposure (inhalation, consumption of water or food, or contact with soil or contaminated surfaces); and whether the exposure occurs at a low rate during normal operations or at a high rate as a result of an accident. Occupational exposure limitations and other controls for specific toxic or hazardous chemicals are provided in various sections of the "Occupational Safety and Health Standards" (29 CFR Part 1910). Acute exposure concentration guidelines for more than 3,000 chemicals have been developed by DOE and others for use in hazard analysis and emergency planning and response (DOE 2008).

G.1.2.2 Chemical Usage

Chemical usage categories include process chemicals and nonprocess chemicals that support and maintain waste management operations. Process chemicals are those required in the direct processing of waste. The specific chemicals used depend on the specific processes chosen. The waste being processed, with its various chemical constituents, also falls into the category of process chemicals. Nonprocess chemicals that support and maintain waste management operations are typically cleaning fluids and lubricants.

G.1.2.3 Exposure Pathways

To cause toxic effects on human biological systems, chemicals must make contact with or be introduced into the body. There are three general means of entry into the body: inhalation, ingestion, and dermal (skin) contact. The effects through a particular pathway depend essentially on the properties of the toxic chemical, its concentration in one or more environmental media (air, water, and soil), and human behavior. Exposure may be dominated by contact with chemicals in a single medium or may reflect concurrent contacts with multiple media.

G.1.2.4 Chemical Exposure Limits and Criteria

Exposure to chemicals in occupational settings is limited to levels within applicable OSHA Permissible Exposure Limits (29 CFR Part 1910) or the American Conference of Governmental Industrial Hygienists Threshold Limit Values (ACGIH 2002). Exposures are typically maintained below the levels specified in these references by either engineered controls or the use of protective equipment.

The flammable and explosive hazards associated with chemicals are typically controlled through standards promulgated by OSHA (29 CFR 1910.106). These standards address chemical storage and labeling, as well as the information required to be provided to the worker.

For accidental airborne releases of hazardous chemicals into the environment, DOE has specified criteria to be used as indicators of human health impacts resulting from acute exposures (DOE Guide 151.1–2). For each specific hazardous chemical of concern, criteria are drawn from one of the following systems (listed in order of preference): the Acute Exposure Guideline Levels (AEGLs) promulgated by EPA; the Emergency Response Planning Guidelines (ERPGs), published by the American Industrial Hygiene Association; and the Temporary Emergency Exposure Limits (TEELs), developed by DOE. The system of AEGLs includes values for five exposure periods, ranging from 10 minutes to 8 hours. However, the ERPG and TEEL systems provide values only for exposures of 1 hour. To allow the systems to be used together, DOE has specified that the 1-hour (60-minute) AEGL values are to be used. For the chemicals addressed by each system, three exposure levels (i.e., thresholds), expressed in terms of airborne concentrations, have been developed. Although the specific definitions vary slightly between the systems, the levels of human health impact associated with exposure for 1 hour to each airborne concentration level can be paraphrased as follows: exposures of up to 1 hour at or below level 1 may result in mild, transient, adverse health effects; exposures of up to 1 hour above level 1 and up to level 2 should not result in irreversible or other serious health effects or symptoms that could impair a person's ability to take protective action; exposures of up to 1 hour above level 2 and up to level 3 should not result in an experience or development of life-threatening health effects; and exposures of up to 1 hour above level 3 could result in life-threatening health effects or death. DOE has specified that level 2 is the threshold above which unacceptable human health effects may be experienced. At concentrations above level 2, action should be taken to avoid, reduce, or mitigate human exposure. Level 3 has been identified as the threshold above which severe human health effects are expected.

G.1.2.5 Health Effects of Hazardous Chemical Exposure

Various chemicals invoke different types of damage to human biological systems. The harm may even vary according to the sensitivity of each individual person exposed. Hazardous chemical releases from routine operations generally are expected to result in concentrations below levels that would cause acute toxic health effects. Acute toxic health effects generally result from short-term exposure to relatively high concentrations of the toxic contaminant, such as those resulting from accidental releases. Long-term exposure to lower concentrations can produce adverse chronic health effects, both carcinogenic and noncarcinogenic. Excess incidences of cancer are the endpoint of carcinogenic effects. However, a spectrum of chemical-specific noncancer health effects (e.g., headaches, skin irritation, neurotoxicity, immunotoxicity, reproductive and genetic toxicity, liver/kidney toxicity, and developmental toxicity) could be observed due to exposure to noncarcinogenic compounds.

G.2 Radiological Impacts from Normal Operations

Estimated public radiological impacts from normal operations were determined via two separate modes: (1) the use of established dose information contained in recent documentation, including annual site environmental reports and National Emission Standards for Hazardous Air Pollutants (NESHAPs) reports; and (2) the modeling of additional sources that have not been explicitly analyzed in such reporting mechanisms. Total estimated impacts from these two modes were then summed to provide a high-sided projected aggregate of the impacts that could be incurred by the public from the alternatives analyzed in this SWEIS. The GENII [Hanford Environmental Radiation Dosimetry Software System] Version 2 (GENII-2) computer code (PNNL 2007), described in Section G.6.1, was used to model impacts from normal operations that result in more-chronic emissions. The MACCS2 [MELCOR Accident Consequences Code System] Version 1.13.1 computer code, discussed in Section G.6.2, is usually used to evaluate the impacts of accidents. It was used to assess certain normal operational impacts that are expected from planned activities such as detonations involving depleted uranium at the Big Explosives Experimental Facility (BEEF), as well as tracer experiments (for more information on these activities, see the descriptions provided in Chapter 3 and Appendix A of this SWEIS). Although MACCS2 is not conventionally utilized for modeling normal operational impacts, it was deemed more appropriate for modeling depleted uranium detonation and tracer experiment scenarios than GENII-2 due to the acute nature of the scenarios' associated puff releases.

Radiological impacts of chronic releases during normal operations were calculated using GENII-2 (PNNL 2007). Site-specific input data were used, including location, meteorology, population, and source terms.

G.2.1 GENII-2 Input Data

To perform dose assessments for this SWEIS, different types of data were collected or generated. This section discusses the various data and the assumptions that were made in performing the dose assessments.

Normal operational dose assessments were modeled for members of the general public for the Nevada National Security Site (NNSS) Dense Plasma Focus Facility (DPFF) and the North Las Vegas Facility (NLVF) to determine the incremental doses that would be associated with operations at these facilities under the alternatives addressed in this SWEIS. Incremental doses for members of the public were calculated (via GENII-2) for two different types of receptors:

- Maximally exposed individual (MEI) – The MEI for air releases was assumed to be an individual member of the public located at a position on the site boundary that would yield the highest impacts during normal operations. For a given facility (or point of release), the specific MEI location may be different than the MEI location for another facility. The MEI locations that were used for GENII-2 modeling were 9.1 miles due east of BEEF (Expanded Operations Alternative) and 1.4 miles due east of the Area 5 Radioactive Waste Management Complex (RWMC) (No Action and Reduced Operations Alternatives) for DPFF and 0.06 miles due east of NLVF. (See Section G.2.1.4 for MEI locations.)

- Population – The general population living within 50 miles of DPFF (conservatively modeled from the nearby Area 5 RWMC) and NLVF. (See Section G.2.1.2 for population distributions.)

G.2.1.1 Meteorological Data

The NNSS meteorological data used for modeling normal operational scenarios using GENII-2 were in one of two formats that are compatible with the code: joint frequency distribution format or SAMSON [Solar and Meteorological Surface Observational Network] format (PNNL 2007). The joint frequency distribution files were based on measurements taken over a period of 5 years (2004 to 2008) at the NNSS. The joint frequency distribution data from Meteorological Station 5 (located in Area 5) are presented in **Table G–4**. The data in Table G–4 are provided in terms of percentages, for which each value represents the fraction of time the wind blows in a certain direction, in a certain windspeed category, and within a certain stability class. For modeling emissions from NLVF, hourly data files (in SAMSON format) for the city of Las Vegas were acquired from EPA’s website (EPA 2010). The most recently available 5 years of data (1986 to 1990) were used to provide an average representation for Las Vegas meteorology.

Table G–4 Joint Frequency Distribution Data Files Used for Normal Operational Analyses at the Nevada National Security Site

Nevada National Security Site Meteorological Station 5 (2004–2008) Data Collected at a 10-Meter Height																	
Average Windspeed (m/s)		***Wind Direction (from)***															
	SC	***N***	***NNE***	***NE***	***ENE***	***E***	***ESE***	***SE***	***SSE***	***S***	***SSW***	***SW***	***WSW***	***W***	***WNW***	***NW***	***NNW***
0.77	A	0.13	0.12	0.1	0.08	0.03	0.06	0.05	0.08	0.13	0.17	0.16	0.19	0.2	0.14	0.14	0.2
	B	0.81	0.66	0.51	0.34	0.29	0.27	0.34	0.32	0.42	0.6	0.74	0.76	0.92	1.01	1	0.88
	C	0.09	0.08	0.1	0.1	0.14	0.08	0.09	0.07	0.1	0.09	0.13	0.13	0.09	0.07	0.11	0.12
	D	0.1	0.11	0.09	0.06	0.1	0.04	0.07	0.07	0.06	0.09	0.09	0.1	0.1	0.13	0.16	0.12
	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	F	0.29	0.32	0.32	0.47	0.57	0.49	0.44	0.33	0.26	0.33	0.4	0.3	0.2	0.2	0.28	0.28
	G	1.84	1.84	2.03	2.44	3.18	2.68	2.45	1.76	1.74	1.99	2.54	2.24	1.8	1.69	1.71	1.75
2.57	A	0.03	0.04	0.03	0.02	0.01	0.02	0.02	0.03	0.05	0.16	0.39	0.31	0.06	0.02	0.02	0.03
	B	0.22	0.23	0.18	0.11	0.08	0.06	0.09	0.15	0.15	0.35	0.85	0.53	0.16	0.22	0.4	0.28
	C	0.06	0.08	0.07	0.08	0.07	0.05	0.08	0.07	0.07	0.15	0.15	0.07	0.04	0.04	0.05	0.05
	D	0.28	0.29	0.19	0.12	0.17	0.13	0.16	0.11	0.19	0.4	0.48	0.2	0.17	0.24	0.32	0.27
	E	0.05	0.04	0.08	0.1	0.1	0.06	0.08	0.07	0.11	0.11	0.11	0.07	0.06	0.06	0.06	0.06
	F	0.45	0.47	0.44	0.46	0.51	0.56	0.52	0.4	0.47	0.62	0.67	0.34	0.28	0.28	0.33	0.38
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4.37	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	B	0.05	0.06	0.04	0.02	0.01	0.02	0.03	0.05	0.06	0.24	0.62	0.3	0.04	0.04	0.09	0.05
	C	0.15	0.15	0.06	0.03	0.06	0.03	0.07	0.04	0.08	0.4	0.84	0.33	0.04	0.03	0.09	0.08
	D	0.33	0.38	0.22	0.07	0.07	0.06	0.11	0.08	0.13	0.52	1	0.29	0.08	0.05	0.14	0.19
	E	0.5	0.63	0.34	0.14	0.1	0.08	0.08	0.07	0.16	0.52	0.77	0.28	0.09	0.1	0.11	0.17
	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.95	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	C	0.08	0.03	0.02	0	0.01	0.02	0.02	0.01	0.04	0.4	0.57	0.09	0.01	0.02	0.04	0.03
	D	0.77	1.08	0.28	0.07	0.07	0.08	0.14	0.05	0.18	1.96	3.5	0.49	0.07	0.11	0.21	0.29
	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Nevada National Security Site Meteorological Station 5 (2004–2008) Data Collected at a 10-Meter Height																	
Average Windspeed (m/s)	***SC***	***Wind Direction (from)***															
		N	***NNE***	***NE***	***ENE***	***E***	***ESE***	***SE***	***SSE***	***S***	***SSW***	***SW***	***WSW***	***W***	***WNW***	***NW***	***NNW***
9.77	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	C	0.01	0.01	0	0	0	0.01	0.01	0	0	0.05	0.02	0	0	0	0.01	0.01
	D	0.21	0.16	0.04	0	0	0.03	0.05	0.01	0.07	1.54	1	0.05	0.01	0.04	0.08	0.08
	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10.8	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	C	0	0.01	0	0	0	0	0	0	0	0.03	0	0	0	0	0.01	0.01
	D	0.04	0.01	0	0.01	0	0.01	0.04	0.01	0.07	0.57	0.13	0	0	0	0.03	0.02
	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

m/s = meters per second; SC = stability class.
Note: To convert meters to feet, multiply by 3.2808.

G.2.1.2 Population Data

Population distributions used in the impact assessments were based on U.S. Department of Commerce state population census numbers (DOC 2008; ESRI 2008) and the most recently available U.S. census information (the 2000 U.S. census). The population estimates are projected to the approximate middle year of the 10-year period of operations examined in this SWEIS (year 2016). Population distributions were spatially distributed on a circular grid with 16 directions and 10 radial distances up to 50 miles. Grids were centered at the locations from which radionuclides were assumed to be released. Population distributions centered on each potential release point are provided below in **Table G–5** and were used, as applicable, as input to either GENII-2 or MACCS2 modeling. The population estimates presented in Table G–5 differ from the 50-mile population presented in Chapter 4, Section 4.1.12. Chapter 4 describes the affected environment, and the population of 42,871 cited in Section 4.1.12 represents an estimate of the number of people living within 50 miles of the Area 6 Control Point (DOE/NV 2005).

Table G–5 Population Distribution within 50 Miles of Release Points

Direction	*Distance (miles)*									
	0–1	*1–2*	*2–3*	*3–4*	*4–5*	*5–10*	*10–20*	*20–30*	*30–40*	*40–50*
Big Explosives Experimental Facility										
NNE	0	0	0	0	0	0	0	11	30	50
NE	0	0	0	0	0	0	9	30	42	54
ENE	0	0	0	0	0	0	16	30	42	54
E	0	0	0	0	0	0	17	30	42	54
ESE	0	0	0	0	0	0	15	30	41	60
SE	0	0	0	0	0	0	9	29	38	476
SSE	0	0	0	0	0	0	0	10	588	3,707
S	0	0	0	0	0	0	0	17	908	1,429
SSW	0	0	0	0	0	0	0	0	390	557
SW	0	0	0	0	0	0	0	44	381	343
WSW	0	0	0	0	0	0	0	48	251	275
W	0	0	0	0	0	0	0	11	127	208
WNW	0	0	0	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0	0	0	0
N	0	0	0	0	0	0	0	0	0	23
Total	**0**	**0**	**0**	**0**	**0**	**0**	**66**	**290**	**2,880**	**7,290**
50-Mile Total										**10,526**
Device Assembly Facility										
NNE	0	0	0	0	0	0	3	19	38	54
NE	0	0	0	0	0	0	15	30	42	54
ENE	0	0	0	0	0	1	18	30	42	54
E	0	0	0	0	0	2	18	29	41	92
ESE	0	0	0	0	0	1	16	27	38	157
SE	0	0	0	0	0	0	13	247	1,544	824
SSE	0	0	0	0	0	0	141	1,212	2,512	1,554
S	0	0	0	0	0	0	46	760	1,124	27,598
SSW	0	0	0	0	0	0	146	640	665	123
SW	0	0	0	0	0	0	3	224	382	26
WSW	0	0	0	0	0	0	0	200	373	118
W	0	0	0	0	0	0	0	63	254	254
WNW	0	0	0	0	0	0	0	5	89	121
NW	0	0	0	0	0	0	0	0	0	0

Direction	Distance (miles)									
	0–1	*1–2*	*2–3*	*3–4*	*4–5*	*5–10*	*10–20*	*20–30*	*30–40*	*40–50*
NNW	0	0	0	0	0	0	0	0	0	0
N	0	0	0	0	0	0	0	0	0	3
Total	**0**	**0**	**0**	**0**	**0**	**4**	**419**	**3,486**	**7,144**	**31,032**
50-Mile Total										**42,085**
Joint Actinide Shock Physics Experimental Research Facility										
NNE	0	0	0	0	0	0	0	7	26	44
NE	0	0	0	0	0	0	6	30	42	54
ENE	0	0	0	0	0	0	12	30	42	54
E	0	0	0	0	0	0	13	27	38	111
ESE	0	0	0	0	0	0	36	323	634	305
SE	0	0	0	0	0	0	353	2,196	1,436	2,667
SSE	0	0	0	0	0	0	361	1,107	1,737	12,115
S	0	0	0	0	0	53	482	803	18,906	14,829
SSW	0	0	0	0	0	63	413	467	107	26
SW	0	0	0	0	0	5	173	303	28	26
WSW	0	0	0	0	0	0	56	303	132	26
W	0	0	0	0	0	0	39	278	257	133
WNW	0	0	0	0	0	0	3	78	241	239
NW	0	0	0	0	0	0	0	0	5	1
NNW	0	0	0	0	0	0	0	0	0	0
N	0	0	0	0	0	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**	**121**	**1,947**	**5,952**	**23,631**	**30,630**
50-Mile Total										**62,281**
Area 5 Radioactive Waste Management Complex										
NNE	0	0	0	0	0	2	17	30	42	54
NE	0	0	0	0	0	4	18	30	42	54
ENE	0	0	0	0	1	4	18	30	42	54
E	0	0	0	0	1	5	17	28	60	120
ESE	0	0	0	0	0	4	16	27	81	182
SE	0	0	0	0	0	4	16	651	750	1,640
SSE	0	0	0	0	0	1	42	2,144	1,471	2,963
S	0	0	0	0	0	0	300	1,037	2,938	31,820
SSW	0	0	0	0	0	0	135	801	951	2,746
SW	0	0	0	0	0	0	97	433	427	59
WSW	0	0	0	0	0	0	0	68	424	219
W	0	0	0	0	0	0	0	35	253	307
WNW	0	0	0	0	0	0	0	0	52	134
NW	0	0	0	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0	0	0	0
N	0	0	0	0	0	0	1	6	12	19
Total	**0**	**0**	**0**	**0**	**2**	**24**	**677**	**5,320**	**7,545**	**40,371**
50-Mile Total										**53,939**
Tonopah Test Range										
NNE	0	0	0	0	0	0	12	20	28	36
NE	0	0	0	0	0	0	10	20	28	50
ENE	0	0	0	0	0	0	1	16	28	40
E	0	0	0	0	0	0	0	4	19	31
ESE	0	0	0	0	0	0	0	0	0	2
SE	0	0	0	0	0	0	0	0	0	0

Direction	***Distance (miles)***									
	0–1	***1–2***	***2–3***	***3–4***	***4–5***	***5–10***	***10–20***	***20–30***	***30–40***	***40–50***
SSE	0	0	0	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0	0	0	159
SSW	0	0	0	0	0	0	0	0	72	202
SW	0	0	0	0	0	0	0	57	81	64
WSW	0	0	0	0	0	0	2	66	50	64
W	0	0	0	0	0	0	2	36	48	60
WNW	0	0	0	0	0	0	1	29	50	60
NW	0	0	0	0	0	0	9	34	3,078	52
NNW	0	0	0	0	0	0	12	20	28	37
N	0	0	0	0	0	1	12	20	28	37
Total	**0**	**0**	**0**	**0**	**0**	**1**	**61**	**322**	**3,538**	**894**
50-Mile Total										**4,816**
North Las Vegas Facility										
NNE	145	333	1,350	2,904	3,774	9,966	61	108	144	164
NE	696	3,218	2,864	4,621	2,029	13,043	142	280	377	3,056
ENE	1,641	6,436	9,684	11,061	6,665	9,180	3,554	385	539	2,853
E	2,307	7,124	7,569	3,399	4,890	24,527	1,359	382	508	424
ESE	2,682	10,581	11,894	16,806	12,754	34,331	5,024	324	397	509
SE	1,571	6,271	12,547	13,587	19,013	89,840	94,433	20,813	337	499
SSE	1,556	6,529	13,129	16,476	15,294	98,239	154,747	11,340	285	366
S	1,492	5,297	9,349	13,003	14,564	83,409	173,530	16,057	2,708	351
SSW	367	3,633	3,771	5,718	10,358	73,040	56,510	11,165	10,148	2,288
SW	479	3,497	6,277	5,795	7,774	105,909	115,422	9,053	14,713	322
WSW	729	3,238	7,524	10,291	15,079	116,209	71,713	1,164	9,718	11,155
W	750	1,821	2,477	6,182	13,803	104,554	41,276	4,787	1,021	25,794
WNW	726	4,251	8,288	9,644	7,874	61,626	35,115	660	1,693	3,025
NW	676	5,243	6,059	10,404	12,670	64,392	27,240	330	983	227
NNW	701	2,798	4,200	11,904	14,816	24,110	235	100	78	57
N	563	1,883	4,235	6,033	6,421	9,502	61	101	141	112
Total	**17,081**	**72,153**	**111,217**	**147,828**	**167,778**	**921,877**	**780,422**	**77,049**	**43,790**	**51,202**
50-Mile Total										**2,390,397**

G.2.1.3 Food Production and Consumption Data

Generic food consumption rates are available as default values in GENII-2. The default values are comparable to those established in NRC Regulatory Guide 1.109 (NRC 1977), which provides guidance for evaluating ingestion doses from consuming contaminated plant and animal food products using a standard set of assumptions for crop and livestock growth and harvesting characteristics.

Food consumption parameters used to evaluate each alternative are presented in **Tables G–6** and **G–7**.

Table G–6 GENII-2 Usage Parameters for Consumption of Plant Food (Normal Operations)

	Agriculture Characteristics		*Maximally Exposed Individual*		*General Population*	
Food Type	*Growing Time (Days)*	*Yield (kilograms per square meter)*	*Holdup Time [a] (days)*	*Consumption Rate (kilograms per year)*	*Holdup Time [a] (days)*	*Consumption Rate (kilograms per year)*
Leafy vegetables	90	1.5	1	30	14	15
Root vegetables	90	4	5	220	14	140
Fruit	90	2	5	330	14	64
Grains/cereals	90	0.8	180	80	180	72

[a] Holdup time is the time between absorption of radionuclides and consumption of a food product.
Note: To convert kilograms to pounds, multiply by 2.2046; square meters to square feet, multiply by 10.764.
Source: NRC 1977; PNNL 2007.

Table G–7 GENII-2 Usage Parameters for Consumption of Animal Products (Normal Operations)

	Stored Feed				*Fresh Forage*			
Food Type	*Diet Fraction*	*Growing Time (days)*	*Yield (kilograms per square meter)*	*Storage Time (days)*	*Diet Fraction*	*Growing Time (days)*	*Yield (kilograms per square meter)*	*Storage Time (days)*
Beef	0.25	90	0.8	180	0.75	45	2	100
Poultry	1	90	0.8	180	–	–	–	–
Milk	0.25	45	2	100	0.75	30	1.5	0
Eggs	1	90	0.8	180	–	–	–	–

	Maximally Exposed Individual		*General Population*	
Food Type	*Consumption Rate (kilograms per year)*	*Holdup Time [a] (days)*	*Consumption Rate (kilograms per year)*	*Holdup Time [a] (days)*
Beef	80	15	70	34
Poultry	18	1	8.5	34
Milk	270	1	230	3
Eggs	30	1	20	18

[a] Holdup time is the time between absorption of radionuclides and consumption of a food product.
Note: To convert kilograms to pounds, multiply by 2.2046; square meters to square feet, multiply by 10.764.
Source: NRC 1977; PNNL 2007.

G.2.1.4 Additional Modeling Parameters

Other key parameters used in GENII-2 modeling include the following:

- Potential MEI locations at the NNSS site boundary were initially evaluated for all 16 compass directions; the MEI was determined to be at the boundary location that yielded the highest total effective dose equivalent for a given release/dispersion scenario. Two locations were ultimately determined and used in the normal operations analysis (9 miles due east of BEEF and 1.4 miles due east of Area 5). These two locations and four additional MEI site boundary locations around the NNSS and the Nevada Test and Training Range (6.6 miles due east of the Device Assembly Facility [DAF], 1 mile due north of the Tonopah Test Range [TTR], 7.2 miles due east of the U1a Complex, and 7 miles south-southwest of the Joint Actinide Shock Physics Experimental Research facility [JASPER]) were ultimately determined and used for the assessment of accidents (see **Figures G–1** and **G–2**).

- Radiological airborne emissions were assumed to be released to the atmosphere at a height of 0 feet (ground level). The emissions from the normal operations activities are not from tall stacks, but occur at or near ground level, given the outdoor/open-air nature of many activities. It is noteworthy that, from a dose-modeling perspective, ground-level releases always maximize impacts on nearby noninvolved workers and typically maximize impacts on MEIs as well, depending upon how far away a site boundary is located. Impacts on offsite populations from ground-level releases (especially at appreciable distances from release locations), however, typically are lower. The primary reason behind this general pattern is that plumes that are released higher in the atmosphere (by a tall stack, buoyancy from heat, or an energetic release) carry contaminants farther before they settle out and are near the ground, where they would affect receptors.

- For GENII-2 normal operations calculations, emission of the plume was assumed to continue throughout the year. In parallel with this assumption, the following scenarios were employed: (1) all public receptors were assumed to breathe effluents from this plume throughout an entire year's time (8,760 hours); (2) the MEI was assumed to be externally exposed to the plume for 0.7 years (6,132 hours); (3) the general population was assumed to be externally exposed to the plume for 0.5 years (4,380 hours); and (4) all public receptors were assumed to be exposed to ground contamination resulting from plume deposition throughout an entire year's time (8,760 hours). Plume and ground deposition exposure parameters used in the GENII-2 model for the exposed offsite individual and the general population are provided in **Table G–8**.

- The exposed individual or population was assumed to have adult human characteristics and habits with respect to food consumption and breathing. As noted in Section G.1.3, the dose-to-risk factors used are appropriate for the age distribution of the U.S. population.

- Members of the population were assumed to spend some time indoors. This is further illustrated in Table G–8.

- A Pasquill-Gifford plume model was used for the air immersion doses.

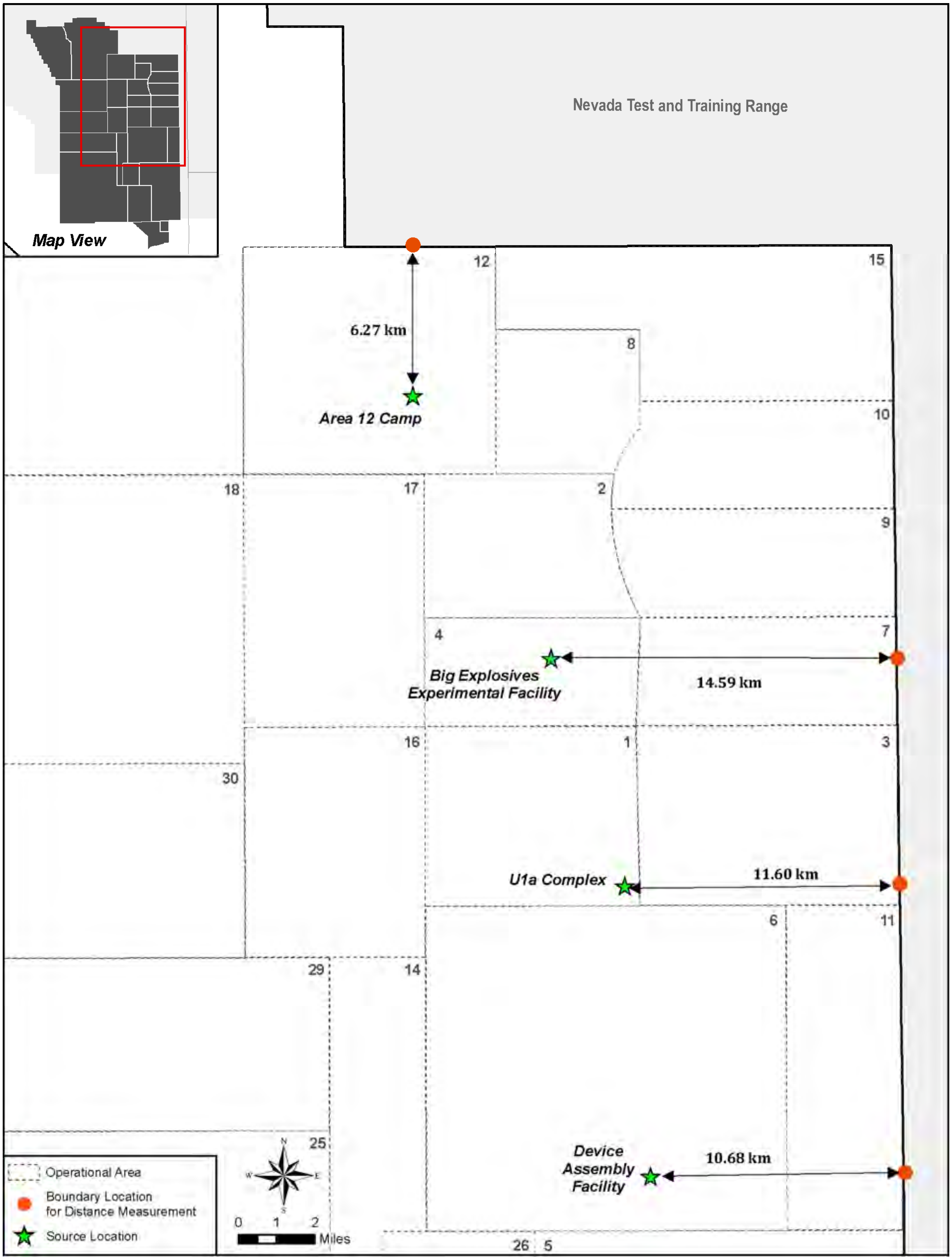

Figure G–1 Potential Source Locations and Distance from the Nevada National Security Site Boundary (North)

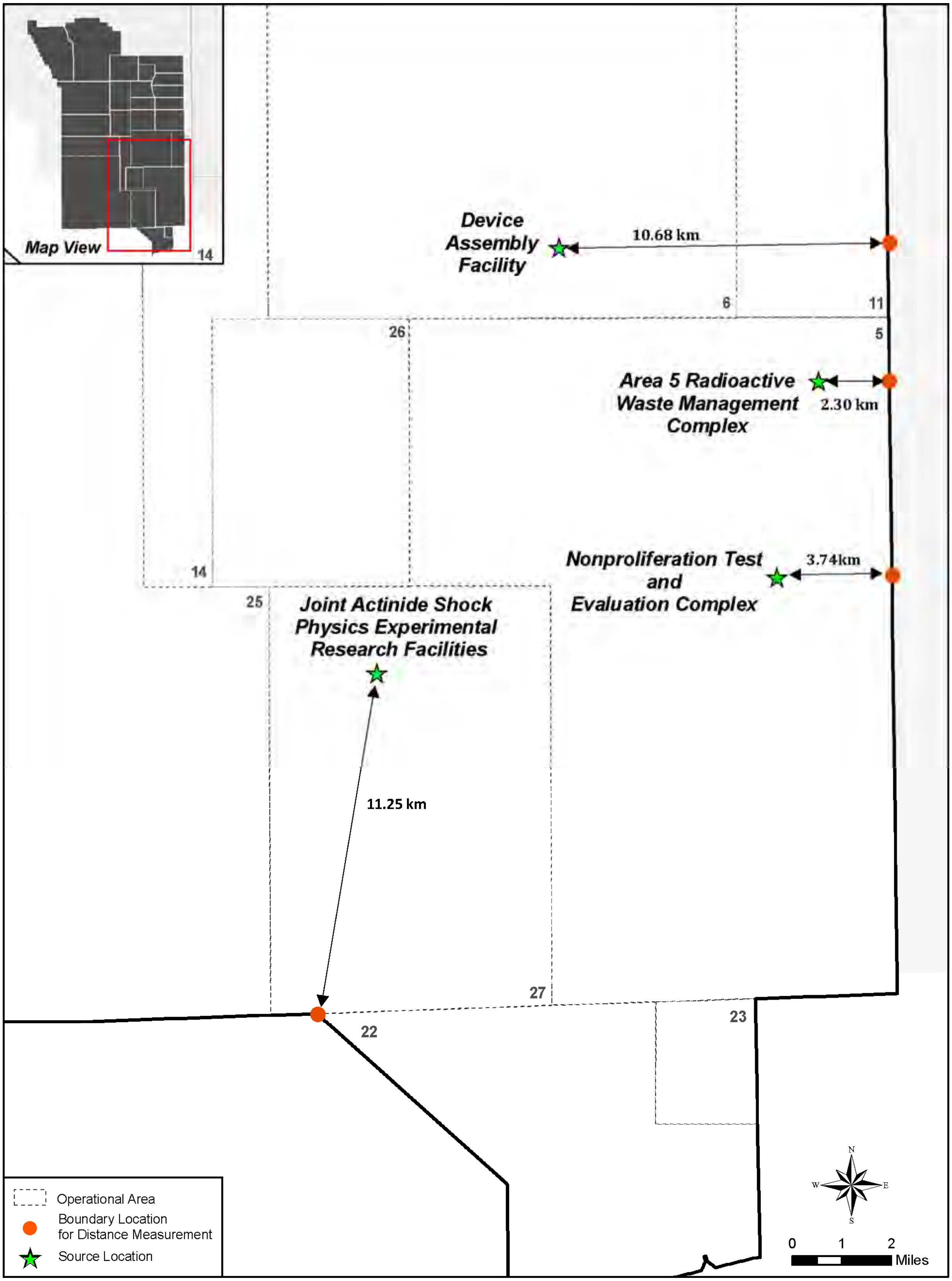

Figure G–2 Potential Source Locations and Distance from the Nevada National Security Site Boundary (South)

Table G–8 GENII-2 Usage Parameters for Exposure to Plumes (Normal Operations)

Maximally Exposed Individual				***General Population***			
External Exposure		***Inhalation of Plume***		***External Exposure***		***Inhalation of Plume***	
Plume (hours) [a]	***Ground Contamination (hours)*** [b]	***Exposure Time (hours)***	***Breathing Rate (cubic centimeters per second)***	***Plume (hours)*** [c]	***Ground Contamination (hours)*** [b]	***Exposure Time (hours)***	***Breathing Rate (cubic centimeters per second)***
6,132	8,760	8,760	270	4,380	8,760	8,760	270

[a] Assumes 70 percent of the hours per year are outdoor exposure, with the balance indoors.
[b] Assumes 70 percent reduction in dose due to shielding for time indoors.
[c] Assumes 50 percent of the hours per year are outdoor exposure, with the balance indoors.
Note: To convert cubic centimeters to cubic inches, multiply by 0.061024.
Source: NRC 1977; PNNL 2007.

G.2.2 Source Term Data

Source terms (that is, the quantities of radioactive material released to the environment over a given period) for the No Action Alternative normal operational releases were based on measured annual release quantities of all radionuclides reported in annual site environmental reports from various recent years. These annual site environmental reports identify both airborne and liquid radiological releases; however, the airborne pathway is predominant, given the arid nature of the NNSS and its surrounding areas. Source terms for the two action alternatives (Expanded Operations and Reduced Operations) were developed based on specific implementing activities described in technical reports for these alternatives and their annual estimated airborne releases for risk-dominant radionuclides. GENII-2-modeled airborne radiological releases from normal operations were estimated on an annual basis as the following: No Action at DPFF – 2,000 curies of tritium; Expanded Operations at DPFF – 20,000 curies of tritium; Reduced Operations at DPFF – 1,000 curies of tritium; all alternatives at NLVF, Building A-1 – 0.0111 curies of tritium.

MACCS2-modeled radiological releases used for calculating impacts of two other normal operational scenarios, depleted uranium explosion testing and tracer experiments, as well as postulated accidents, are discussed below in Sections G.2.3.1, G.2.3.2, and G.3, respectively.

G.2.3 Radiological Consequences from Normal Operations

Table G–9 provides the annual dose associated with airborne radiological releases from normal operations to the MEI and the total population, as well as the average dose to a member of the general population for the duration of the implementation of each alternative. Essentially 0 (0.0005) fatal cancers in the surrounding population are expected to result from the maximum annual impacts (0.89 person-rem) anticipated under the Expanded Operations Alternative at the NNSS. Similarly, essentially 0 (2×10^{-7}) fatal cancers in the surrounding population are expected to result from the annual impacts (4.1×10^{-5} person-rem) anticipated under the No Action and Reduced Operations Alternatives at NLVF.

The following sections provide additional details regarding radiological impacts on an MEI and the offsite population resulting from depleted uranium testing and tracer experiment activities. For discussions of expected activities at DPFF and environmental restoration/decontamination and decommissioning, see Chapter 3 and Appendix A of this SWEIS.

Table G–9 Annual Doses to Members of the Population from Airborne Radiological Releases (Normal Operations)

	NNSS								
	No Action			***Expanded Operations***			***Reduced Operations***		
Source	***MEI Dose (millirem per year)***	***Total Population Dose (person-rem)***	***Average Dose to Member of Population (millirem per year)***	***MEI Dose (millirem per year)***	***Total Population Dose (person-rem)***	***Average Dose to Member of Population (millirem per year)***	***MEI Dose (millirem per year)***	***Total Population Dose (person-rem)***	***Average Dose to Member of Population (millirem per year)***
Baseline (site-wide) [a]	2.6	0.47	0.011	2.6	0.47	0.011	2.6	0.47	0.011
BEEF high-explosives experiments [b]	0	0	0	0.62	0.067	0.0064	0	0	0
DPFF [c]	0.14	0.027	5.0×10^{-4}	0.6	0.27	0.0050	0.07	0.013	2.5×10^{-4}
Environmental restoration/ D&D (site-wide) [a]	<0.01	<0.002	$<4.7 \times 10^{-5}$	<0.01	<0.002	$<4.7 \times 10^{-5}$	<0.01	<0.002	$<4.7 \times 10^{-5}$
Tracer experiments [b]	N/A	N/A	N/A	<1	<0.076	<0.0014	N/A	N/A	N/A
TOTAL [d]	**2.8**	**0.5**	**0.012**	**4.8**	**0.89**	**0.024**	**2.7**	**0.48**	**0.011**

	NLVF (All Alternatives)		
Source	***MEI Dose (millirem per year)***	***Total Population Dose (person-rem)***	***Average Dose to Member of Population (millirem per year)***
Building A-1	3.5×10^{-4}	4.1×10^{-5}	1.7×10^{-8}

< = less than; BEEF = Big Explosives Experimental Facility; D&D = decontamination and decommissioning; DPFF = Dense Plasma Focus Facility; MEI = maximally exposed individual; N/A = not applicable; NLVF = North Las Vegas Facility; rem = roentgen equivalent man.

[a] Values based on the NNSS annual site environmental reports and National Emissions Standards for Hazardous Air Pollutants reports.

[b] Values modeled using the MACCS2 [MELCOR Accident Consequences Code System] computer code. For conservatism in modeling population dose impacts, tracer experiments were assumed to be conducted in Area 5 because it is closer to southern population centers than most other areas that might be used. For the MEI calculation, tracer experiments impacts were conservatively assumed to occur at the closest BEEF site boundary location (9 miles east of BEEF).

[c] Values modeled using the GENII-2 [Hanford Environmental Radiation Dosimetry Software System Version 2] computer code and were conservatively assumed to be released from Area 5, which is proximal to DPFF in Area 11. The MEI at the Area 5 site boundary location (east of the Area 5 Radioactive Waste Management Complex) was modeled for No Action and Reduced Operations; the MEI at the BEEF site boundary location (9 miles east of BEEF) was modeled for Expanded Operations.

[d] Totals may not equal the sum of the individual contributing components due to rounding.

Source: DOE/NV 2005, 2006, 2007, 2008, 2009.

G.2.3.1 Normal Radiological Impacts from Detonations of Depleted Uranium at the Big Explosives Experimental Facility

Radiological impacts from expected BEEF operations would be primarily due to detonation of depleted uranium with high explosives. Although amounts of depleted uranium and high explosives may vary by experiment, it was assumed that a typical experiment would involve 200 pounds of depleted uranium and the explosive equivalent of 600 pounds of TNT [2,4,6-trinitrotoluene].

Under the No Action Alternative and the Reduced Operations Alternative, no experiments using depleted uranium would occur at BEEF. Under the Expanded Operations Alternative, the National Nuclear Security Administration (NNSA) assumed 20 experiments using depleted uranium would occur annually at BEEF.

Because these experiments would result in a quick puff-type release of aerosolized depleted uranium with the explosion, the radiological impacts were modeled using the MACCS2 computer code, which is typically used for accident analyses.

It was conservatively assumed that 20 percent of the 200 pounds of depleted uranium would be aerosolized and respirable (DOE 1994). The site boundary location at which the highest potential combined dose would occur from depleted uranium releases at BEEF, releases associated with tracer experiments assumed to be conducted at or near BEEF, and releases from DPFF in Area 11 was determined to be 9 miles east of BEEF. The maximum combined annual dose would be approximately 2.2 millirem from the three sources under the Expanded Operations Alternative (0.62 millirem from depleted uranium, 1 millirem from tracer experiments, and 0.6 millirem from DPFF) operating at their highest expected levels. Under the No Action and Reduced Operations Alternatives, the total estimated dose to the MEI from these three activities would be 0.07 millirem per year.

The projected normal radiological release impacts on the MEI and population solely from depleted uranium experiment activities are presented in **Table G–10** under the Expanded Operations Alternative.

Table G–10 Expanded Operations Alternative Projected Annual Radiological Release Impacts from Depleted Uranium Experiments at the Big Explosives Experimental Facility

Scenario	*Release* [a] *(pounds of depleted uranium)*	*MEI Dose at 9 Miles East (millirem)*	*MEI LCF Risk*	*Population Dose within 50 Miles (person-rem)*	*Population LCFs* [b]
20 experiments at BEEF	4,000	0.62	4×10^{-7}	0.067	0 (4×10^{-5})

BEEF = Big Explosives Experimental Facility; LCF = latent cancer fatality; MEI = maximally exposed individual; rem = roentgen equivalent man.

[a] The 4,000-pound quantity is the total annual inventory. It was conservatively assumed that all of the material would be released and aerosolized. Twenty percent of the released depleted uranium was assumed to be respirable (DOE 1994). The planned usage would be 20 experiments annually, with up to 200 pounds of depleted uranium per experiment, which equates to the 4,000-pound total.

[b] The number of LCFs in the population must be a whole number. The value in parentheses is the result of multiplying the population dose by the factor of 0.0006 LCFs per person-rem.

G.2.3.2 Normal Radiological Impacts from Radioactive Tracer Experiments

Under the Expanded Operations Alternative, up to 3 underground and 12 open-air radioactive tracer experiments per year would be conducted. The highest potential for offsite radiological impacts from typical tracer experiments would be from the underground release of radioactive gases or particulates and their transport to the surface. The underground experiments present the greatest potential impact because of the quantities of radioactive materials that could be used. Of the proposed experiments, the radiological impacts on the aboveground environment and the public would be greater for Experiments 1 and 3.

With Experiment 1, a vessel of radioactive noble gases (up to 27,000 curies each of argon-37, krypton-85, xenon-127, xenon-131m, and xenon-133) would be buried underground with explosive materials, taking advantage of experiments intended for use by the seismic research community. Upon detonation of the explosives, the vessel would rupture, energetically releasing radioactive noble gases underground. These noble gases would be transported to the surface through various physical processes, and atmospheric and soil gas samples would be collected. This experiment may be performed several times in a variety of conditions (burial depth, geomorphology, explosive force, etc.). Explosions from nearly 0 up to 1 kiloton may be warranted to develop models to scale up to nuclear tests.

Experiment 3 involves releasing short-lived radioactive particulates (up to 27,000 curies each of rubidium-86, zirconium-95, technetium-99m, molybdenum-99, ruthenium-103, cesium-136, barium-140, cerium-141, neodymium-147, and samarium-153) from relatively shallow explosions. In this case, some venting to the surface is expected. This experiment may be performed several times in a variety of conditions (burial depth, geomorphology, explosive force, etc.). Explosions from nearly 0 up to 1 kiloton may be used.

Because these experiments are still at the conceptual stage, the actual amounts of radioactive materials that might reach the surface and be available for transport to the public are unknown. One of the purposes of the experiments is to develop a better understanding of the fraction of the various isotopes that would be transported from the underground explosion site to the surface. These fractions are generally expected to be quite small.

As with other NNSS experiments, such as those that occur at the Nonproliferation Test and Evaluation Complex (NPTEC), protocols and safety and environmental criteria would be developed to ensure that the public and environment are protected with each experiment. This is especially important because the specific location and geology for each experiment would likely change to better understand the factors that lead to transport of the radionuclide from the explosion site to the surface. For these experiments, the radiological source inventories would be adjusted such that the levels that reach the surface are detectable to accomplish the goals of the experiment, but are far below the levels that might cause a radiological concern for the public or environment.

For purposes of this SWEIS, it was assumed that the tracer experiments would have safety and environmental goals such that they would not present a substantial risk of causing an exceedance of the overall NNSS NESHAPs airborne radiation limit of 10 millirem per year to the MEI. Individual experiments would be designed to control the combination of explosives, quantities of radionuclides, and medium to meet the goal of 1 millirem per year for all experiments that would be conducted.

To bound the potential population doses that might occur with these releases, as well as the reasonableness of the goal of 1 millirem per year for all experiments, ground-level puff-type releases for the complete inventories of Experiments 1 and 3, assuming a release of the maximum quantity of 27,000 curies of each isotope, were modeled from Area 5 for the general population using the MACCS2 computer code. As discussed in Section G.2.3.1, however, the MEI was modeled (for the Expanded Operations Alternative) at the site boundary location (9 miles due east of BEEF) that would yield the highest combined dose from tracer and depleted uranium experiments and DPFF releases.

The totaled results from modeling a puff release of 27,000 curies of each of the short-lived radioactive particulates (rubidium-86, zirconium-95, technetium-99m, molybdenum-99, ruthenium-103, cesium-136, barium-140, cerium-141, neodymium-147, and samarium-153) and 27,000 curies of each of the radioactive noble gases (argon-37, krypton-85, xenon-127, xenon-131m, and xenon-133) are presented in **Table G–11**.

Table G–11 Projected Normal Radiological Release Impacts from Radioactive Tracer Experiments

Scenario	*Release (curies)*	*Scale Factor to Equal MEI Dose Goal*	*Noninvolved Worker*		*MEI at 9 Miles*		*Population within 50 Miles*	
			Dose (millirem)	*LCFs*	*Dose (millirem)*	*LCF Risk*	*Dose (person-rem)*	*LCFs* [a]
Total Release of All Particulates [b]	2.7×10^{5}		6.7×10^{4}	8×10^{-2}	9.9×10^{3}	6×10^{-3}	1.5×10^{3}	1 (0.9)
Total Release of All Noble Gases [b]	1.35×10^{5}		6.5×10^{3}	4×10^{-3}	1.2×10^{3}	7×10^{-4}	4.9	0 (3×10^{-3})
MEI Dose Goal for Each Experiment Type					**5.0×10^{-1}**			
Normal Operations Part Release (Particulates) = Dose Goal [c]	13.7	5.06×10^{-5}	3.4	2×10^{-6}	5.0×10^{-1}	3×10^{-7}	7.4×10^{-2}	0 (4×10^{-5})
Normal Operations Gas Release (Noble Gases) = Dose Goal [c]	58	4.30×10^{-4}	2.8	2×10^{-6}	5.0×10^{-1}	3×10^{-7}	2.1×10^{-3}	0 (1×10^{-6})
Total Dose			6.2	4×10^{-6}	1.0	6×10^{-7}	7.6×10^{-2}	0 (5×10^{-5})

LCF = latent cancer fatality; MEI = maximally exposed individual; rem = roentgen equivalent man.

[a] The number of LCFs in the population would be a whole number. The value in parentheses is the result of multiplying the population dose by the factor of 0.0006 LCFs per person-rem.

[b] Calculated results are based on the entire inventory being released by the experimental explosion. Controls to limit the release would be imposed.

[c] Based on designing experiments with an annual dose goal of 1 millirem to the MEI, the radionuclide release would be controlled to the levels indicated, resulting in the corresponding doses.

Note: Represented impacts on the MEI and population include dose components from the long-term (chronic) ingestion pathway.

G.2.3.3 Sensitivity Analysis

A sensitivity analysis was performed to determine the differences in the impacts of considering the surrounding population out to a distance of 80 miles (rather than 50 miles) from the release points for both normal operations. Normal operational releases under the Expanded Operations Alternative (e.g., tracer experiments being conducted at Area 5 [the closest modeled release point to the greater Las Vegas metropolitan area]) were considered. The total population increases from about 54,000 (at 50 miles) to about 2.3 million (at 80 miles). The population dose change from about 0.076 person-rem (for the 50-mile population) to about 0.12 person-rem (for the 80-mile population) would be an increase of about 58 percent. The population increase between a 50-mile radius and an 80-mile radius is about 4,000 percent. The average annual dose to an individual living within 50 miles of the release point would be about 0.0014 millirem; the average annual dose to a member of the population living between 50 and 80 miles of the release point would be 2×10^{-5} millirem, or about 1.4 percent of the dose to a member of the population in the first 50 miles. Thus, even though there would be a calculated increase in the population dose when considering an 80-mile radius, the increase would be due to very small incremental individual doses to a large number of people. The increased annual risk of an LCF to an individual from this small dose would be essentially 0 (8×10^{-10}).

G.3 Impacts of Accidents

G.3.1 Introduction to Accident Evaluations

This section provides information and details of the analysis of the impacts of potential facility accidents presented in Chapter 5. It includes, in Section G.3.2, an evaluation of the present applicability of the methodology and accident data that were reported in the *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada (1996 NTS EIS)* (DOE 1996b) to inform the reader of the differences in analyses between that document and this SWEIS.

The occupational and public health and safety evaluations addressed and presented in the *1996 NTS EIS* (DOE 1996b) were based on various ongoing missions, as described for each alternative, with the addition of new activities within each program. As discussed in Chapter 3 of this SWEIS, some activities analyzed in the *1996 NTS EIS* have been either completed or discontinued. Planned or proposed activities at the NNSS (and other offsite locations in Nevada) are described in detail in Chapter 3 of this SWEIS. Available accident scenario, impact, and risk information for the proposed activities was compared to the evaluations presented in the *1996 NTS EIS*. Proposed activities with a potential for accidental release of nuclear and chemical materials are discussed.

Two computer codes were used to analyze the postulated accidents and to estimate their impacts: (1) MACCS2 for radiological releases; and (2) ALOHA [Arial Locations of Hazardous Atmospheres] for chemical releases. These computer codes are described in Section G.6.

G.3.1.1 Accident Scenario Development Methodology

The methodology used to develop accident scenarios and their associated parameters involved several steps. First, other relevant EISs and the *DOE Handbook: Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities (DOE Handbook)* (DOE 1994) were evaluated to develop a list of likely accident scenarios. This evaluation examined the types of structures and equipment at the NNSS and the TTR that are expected to contain any significant residual radioactivity in the form of fixed or mobile chemical or physical forms of radionuclides. Experience from previous EISs involving nonreactor facilities was also used to establish accident scenarios. This first step led to the conclusion that accidents at the NNSS and the TTR could fall into one of the following categories:

- Drops
- Punctures
- Spills
- Leaks
- Fires
- Explosions
- Seismically induced structural failures
- Seismically induced structural failures followed by fires and/or explosions
- Nuclear criticality events
- Chemical reactions

Workers involved in project activities may experience the most severe consequences of the accidents analyzed in this SWEIS. Accidents involving exposure to radiologically contaminated solids, liquids, and volatile compounds could result in minor to significant health impacts due to external exposure, inhalation, and ingestion. Accidents involving seismic events or explosions could result in severe injury or death, most likely from physical injury. This SWEIS does not calculate any specific impacts on workers with regard to such an accident scenario because of the wide range of locations and actions of such workers and the wide range of potential impacts (identified above). All accident consequences and risks were calculated for a noninvolved worker, the MEI, and the offsite population.

G.3.1.2 Radiological Source Term Methodology

The accident source term is the amount of respirable radioactive material released to the air or particles released to the water, in terms of curies or grams, assuming the occurrence of a postulated accident. Exposures via releases to water were not considered reasonable due to the arid climate and the dearth of surface waters that leave NNSA's Nevada sites. The airborne source term is typically estimated by the following equation:

$$\text{Source term} = \text{MAR} \times \text{DR} \times \text{ARF} \times \text{RF} \times \text{LPF}$$

where:

MAR = material at risk
DR = damage ratio
ARF = airborne release fraction
RF = respirable fraction
LPF = leak path factor

The MAR is the amount of radionuclides (in curies of activity or grams for each radionuclide) available for release when acted upon by a given physical stress or accident. The MAR is specific to a given process in the facility of interest. It is not necessarily the total quantity of material present, but is that amount of material in the postulated scenario of interest that would be available for release.

The DR is the fraction of material exposed to the effects of the energy, force, or stress generated by the postulated event. For the accident scenarios discussed in this analysis, the DR value varies from 0.1 to 1.0.

The ARF is the fraction of material that becomes airborne due to the accident. In this analysis, ARFs were obtained from the *DOE Handbook* (DOE 1994).

The RF is the fraction of airborne radionuclides that can be transported as particles through air and inhaled into the human respiratory system and is commonly assumed to include particulate matter with an aerodynamic diameter of 10 micrometers or less.

The LPF is the fraction of airborne material that is transported from a source through some confinement mechanism to the environment.

G.3.1.3 Accident Source Terms

After the spectrum of accidents was identified, it was necessary to estimate a release fraction for each of the accidents. Release fraction estimates were developed based on review of available information on facility design and operation, as well as information in the *DOE Handbook* (DOE 1994), relevant EISs (DOE 1995, 1996b, 1998, 1999, 2001, 2002a, 2002b, 2004b, 2004c, 2007a), and various hazards analyses and documented safety analyses developed for the NNSS and TTR facilities (e.g., DOE 1996a, 2010a; LLNL 2005, 2006, 2007; NSTec 2008, 2009a, 2009b, 2009c, 2009d, 2010a; SAIC 1996; SNL 2005). The release fractions selected were also reviewed against each other to ensure that the relative magnitude was considered reasonable.

The release fraction is the fraction of MAR that becomes airborne and could be inhaled by humans, causing a radiation dose. It is calculated by multiplying the four factors, DR, ARF, RF, and LPF.

G.3.1.4 Accident Frequency

The annual frequency of each accident is used to calculate the annual risk of an LCF associated with each accident. The annual accident risk was calculated by multiplying the accident risk of an LCF by the annual frequency of the accident. Each specific accident's annual frequency was determined using data from operational experience or from an analysis of the sequence of events necessary for the accident to occur. In general, accidents with an annual frequency of less than 1×10^{-6} per year or 1 in 1 million are not analyzed in this appendix because they are so unlikely to occur that their risks are extremely small; exceptions to this, however, include scenarios involving (1) aircraft crashes and (2) DAF.

G.3.2 Data and Analysis Changes from the *1996 NTS EIS*

The *1996 NTS EIS* (DOE 1996b) analyzed radiological and chemical accident scenarios for several alternatives, including the Expanded Use Alternative. The accident scenarios for the Expanded Use Alternative were re-evaluated 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) and the *Draft Supplement Analysis for the Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada* (DOE 2007a).

Since 1996, NNSA has prepared (or updated) and reviewed safety analyses, such as hazards analyses and document safety analyses, or NEPA documents, such as environmental assessments.

For this SWEIS, the accident scenarios and potential source terms from the *1996 NTS EIS* and subsequent supplement analyses were reviewed and evaluated to determine whether changes in operations at the NNSS and offsite locations, as well as changes in accident analysis methodology, indicated a need for a revision of the calculated accident consequences and risks to the public and noninvolved workers. The radiological and chemical accidents addressed in the *1996 NTS EIS* and other NEPA documents considered and evaluated in this SWEIS are presented in **Table G–12**.

Table G–12 Accident Scenarios Involving Release of Radioactive or Chemical Material Considered in the *1996 NTS EIS* (Expanded Use Alternative)

1996 NTS EIS Identification Number	*Scenario Description* [a]	*Accident Type*	*Scenarios Evaluated since the 1996 NTS EIS* [b]
NNSS Activities	**National Security/Defense Mission**		
DPR1	P-Tunnel: mechanical release of plutonium during handling	Rad	Considered/Evaluated
DPR2	DAF: explosion involving 55 pounds of high explosives and 5 kilograms of plutonium	Rad	Considered/Evaluated
DPR5	Area 27: explosion in interim-stored nuclear weapons	Rad	Not Applicable
DPR6	Accidental venting from an underground test (fast and slow)	Rad	Not Applicable
WFOR1	BEEF: 100-curie tritium release	Rad	Considered/Evaluated – normal release – not an accident
WFOR2	BEEF: 1,000-curie tritium release	Rad	Considered/Evaluated – normal release – not an accident
WFOH1	BEEF: heavy metal release	Chemical	Considered/Evaluated – normal release – not an accident
WHOH2	BEEF: beryllium and depleted uranium release	Chemical	Considered/Evaluated – normal release – not an accident
NNSS Activities	**Environmental Management Mission**		
WMR1	Area 5: explosion/fire in two TRU waste containers	Rad	Considered/Evaluated
WMR2	Area 5: explosion/fire in multiple TRU waste containers	Rad	Considered/Evaluated
WMR3	Area 5: airplane crash into TRU waste storage unit	Rad	Considered/Evaluated
WMH1	Area 5: explosion/fire in two hazardous waste containers	Chemical	Considered/Evaluated
WMH2	Area 5: explosion/fire in multiple hazardous waste containers	Chemical	Considered/Evaluated
WMH3	Area 5: airplane crash into hazardous waste storage unit	Chemical	Considered/Evaluated
ERR1	Environmental restoration waste spill in plutonium-contaminated soil (evaluated for both the NNSS and the TTR)	Rad	Considered/Evaluated
ERR2	Environmental restoration waste fire in plutonium-contaminated soil (evaluated for both the NNSS and the TTR)	Rad	Considered/Evaluated
ERR3	Airplane crash into environmental restoration site containing plutonium-contaminated soil (evaluated for both the NNSS and the TTR)	Rad	Considered/Evaluated
ERH1	Fire involving one container-equivalent in composite hazardous environmental restoration site at the NNSS	Chemical	Considered/Evaluated
ERH2	Fire involving multiple container-equivalents in composite hazardous environmental restoration site at the NNSS	Chemical	Considered/Evaluated
ERH3	Airplane crash into composite hazardous environmental restoration site at the NNSS	Chemical	Considered/Evaluated
NDRDH1	NPTEC: spill of one container of hazardous chemicals	Chemical	Considered/Evaluated [c]
NDRDH2	NPTEC: tank failure	Chemical	Considered/Evaluated [c]
NDRDH3	NPTEC: airplane crash into tank farm area	Chemical	Considered/Evaluated [c]
TTR Activities	**National Security/Defense Mission**		
DPR3	TTR: mechanical release of plutonium from test assembly	Rad	Not Applicable
DPR4	TTR: failure of artillery fired atomic projectile during firing	Rad	Not Applicable
DPH1	TTR: explosion of rocket test assembly containing depleted uranium and beryllium	Chemical	Not Applicable
DPH2	TTR: rocket propellant storage area fire	Chemical	Not Applicable

***1996 NTS EIS* Identification Number**	***Scenario Description* [a]**	***Accident Type***	***Scenarios Evaluated since the 1996 NTS EIS* [b]**
TTR Activities	**Environmental Management Mission**		
ERR1	Environmental restoration waste spill in plutonium-contaminated soil (evaluated for both the NNSS and the TTR)	Rad	Considered/Evaluated
ERR2	Environmental restoration waste fire in plutonium-contaminated soil (evaluated for both the NNSS and the TTR)	Rad	Considered/Evaluated
ERR3	Airplane crash into environmental restoration site containing plutonium-contaminated soil (evaluated for both the NNSS and the TTR)	Rad	Considered/Evaluated

BEEF = Big Explosives Experimental Facility; DAF = Device Assembly Facility; NNSS = Nevada National Security Site; NPTEC = Nonproliferation Test and Evaluation Complex (originally the Liquefied Gaseous Fuels Spill Test Facility, then the National HAZMAT Spill Center, and now NPTEC); Rad = radiological; TTR = Tonopah Test Range; TRU = transuranic.

[a] Scenarios drawn from DOE 1996b unless otherwise indicated.

[b] Scenarios were considered/evaluated in this SWEIS except for scenarios that are no longer applicable (e.g., activities have ceased or operations have changed) unless otherwise indicated.

[c] Scenarios drawn from DOE 2004b.

The evaluation of accidents consisted of three principal steps:

1. Determine whether any changes in operations at the NNSS would result in new accident scenarios or whether the operations evaluated in the *1996 NTS EIS* are no longer applicable.

2. Evaluate the *1996 NTS EIS* accident scenarios to assess whether there have been changes in the assumptions or input parameters that would affect their consequences or risks.

3. Analyze accident consequences and risks, as appropriate, if changes have been noted in Steps 1 or 2.

Radiological accident scenarios from the *1996 NTS EIS* (DOE 1996b) were examined in this SWEIS for determination of their applicability and were evaluated in terms of the factors that affect their calculated radiation doses, LCFs, and annual LCF risk to both the public and noninvolved workers. Accident locations were assumed to be at DAF (Area 6), the TTR, JASPER (Area 27), the Area 5 RWMC, Area 3, and BEEF (Area 4). Similarly, chemical accident scenarios addressed in the *1996 NTS EIS* (Expanded Use Alternative) were reviewed and evaluated.

Several new facilities with the potential for radiological and chemical accidents that might affect the public or noninvolved workers have become operational since the *1996 NTS EIS*. Each of these was considered in this appendix to determine if they might present a risk to the public or the environment.

Accidents analyzed for this SWEIS were categorized by two mission areas served by operations at the facility where the accident was postulated. At the NNSS, these missions are the National Security/Defense Mission and Environmental Management Mission; those associated with the Nondefense Mission were identified, but were not analyzed. Different levels of activity would exist for each of these missions under the three alternatives. The differences in the levels of activities delineated under the three alternatives in Chapter 3 of this SWEIS affect the number of tests or experiments, but not the fact that the same facility operations would occur. Many of the differences in activities among the three alternatives do not affect baseline quantities of radiological or chemical substances (i.e., MAR).

Proposed activities under each of the alternatives were reviewed and compared with the activities identified in the *1996 NTS EIS*, as well as the safety basis and NEPA documents for specific activities and facilities at the NNSS and other Nevada facilities overseen by DOE and NNSA. Accident scenarios analyzed for this SWEIS were developed using the presence of these substances (i.e., the potential MAR for release to the environment from an accident event) and a means for their release to the environment. Accident analyses from the *1996 NTS EIS*, along with updated documents for NNSS facilities and new NNSS operations, formed the basis for selecting accident scenarios for each alternative. **Table G–13** identifies the facilities and locations for which accidents were evaluated under each alternative. Accidents evaluated in prior NEPA documents, as shown in Table G–12, that were carried forward in this SWEIS would occur at one of the facilities or locations listed in Table G–13.

For most facilities, some operations would occur under each of the alternatives and the potential accident scenarios would be similar. The levels of activities would vary among the alternatives, which can potentially influence a quantitative variation in an accident's probability of occurrence. These changes in probability would typically be on the order of less than a factor of 2 in situations where the overall uncertainty in probability is typically plus or minus a factor of 10. Thus, for the majority of cases, the differences in accident types, source terms, consequences, probabilities, and, ultimately, risk do not vary substantially among the alternatives. In this SWEIS, substantial differences in accident types or risks are highlighted as those discriminators that might be important in making decisions among the alternatives.

Table G–13 Accident Scenario Location and Applicability under Each Alternative

Facility or Function	*NNSS Area*	*No Action Alternative*	*Reduced Operations Alternative*	*Expanded Operations Alternative*
NNSS – National Security/Defense Mission				
Device Assembly Facility	6	✓	✓	✓
Criticality Experiments Facility	6	✓	✓	✓
JASPER	27	✓	✓	✓
Tracer experiments	multiple locations	N/A	N/A	✓
Big Explosives Experimental Facility	4 and other locations	N/A	N/A	✓
Radiological/Nuclear Countermeasures Test and Evaluation Complex	6	✓	✓	✓
Nonproliferation Test and Evaluation Complex	5	✓	✓	✓
U1a Complex	1	✓	✓	✓
Atlas Facility	6	✓	✓	✓
Dense Plasma Focus Facility	11	✓	✓	✓
G-Tunnel	12	✓	N/A	✓
NNSS – Environmental Management Mission				
Waste management	3, 5, 6	✓	✓	✓
Environmental restoration	N/A	✓	✓	✓
TTR/NTTR – National Security/Defense Mission				
TTR	TTR	✓	✓	✓
TTR – Environmental Management Mission				
Environmental restoration	TTR/NTTR	✓	✓	✓

JASPER = Joint Actinide Shock Physics Experimental Research Facility; N/A = not applicable; NNSS = Nevada National Security Site; NTTR = Nevada Test and Training Range; TTR = Tonopah Test Range.

After a review of ongoing and planned activities and projects at the NNSS under each of the alternatives, no new accident scenarios with high consequences or risks were identified for this SWEIS. Although the activities at the site have changed since the *1996 NTS EIS*, the potential consequences for the offsite public and onsite workers were found to be dominated by some of the same accidents identified in the *1996 NTS EIS*. Aircraft accidents were initially screened as initiating events in numerous scenarios under all missions for both the *1996 NTS EIS* and this SWEIS. In the final analysis, they were evaluated under the Environmental Management Mission as reasonably foreseeable from a probabilistic basis. However, a number of changes in assumptions and analytical input parameters were identified that affect the calculated radiological and chemical accident public and noninvolved worker consequences and risks. In addition, the computer models used to evaluate radiological and chemical consequences were changed.

An accident's risk (i.e., number of LCFs) is the product of its probability and consequences. Although the risks for some radiological accident scenarios changed for this SWEIS, the absolute magnitude of the risks of the largest accidents remained very small, principally due to the remote location of activities, the low probabilities (frequencies) of such accidents, or both. The aforementioned "largest accidents," although exhibiting high consequences, also have extremely low probabilities, resulting in very small overall risk values.

In general, the chemical accident analysis for this SWEIS resulted in comparable or lower health consequences for an MEI and noninvolved worker than projected in the *1996 NTS EIS*; because of the localized nature of chemical accidents and the remote locations where they might occur, offsite populations would not be affected by chemical accidents.

G.3.3 Nevada National Security Site Radiological and Chemical Accident Scenarios and Source Terms

Current safety basis and NEPA analyses were reviewed for each of the proposed activities under the No Action, Expanded Operations, and Reduced Operations Alternatives to identify the accident scenarios for the NNSS and other Nevada locations. The following sections summarize the findings and identify the consequences- and risk-dominant scenarios for each site.

In cases where there might be substantial differences in accident types or risks among the alternatives, those differences are highlighted as discriminators that may be important in making decisions among the alternatives.

Because of the sensitive nature of some of the work at the NNSS and the supporting safety documents, this section reports the conclusions of the supporting safety documents, but does not report the sensitive details regarding the material inventories or the exact nature of what might be required to propagate the accident identified. Similarly, the material released is often reported in terms of plutonium-239–equivalent masses. In these cases, the isotopic characteristics of the material may be different from plutonium-239, but the radiological impacts can be represented by a dose-equivalent mass of plutonium-239.

G.3.3.1 Nevada National Security Site National Security/Defense Mission

Since the *1996 NTS EIS*, Stockpile Stewardship and Management Program activities at the NNSS have changed substantially, such that some of the activities in the *1996 NTS EIS* that resulted in high-consequence accidents no longer occur. For example, nuclear weapons are no longer stored in the Area 27 storage bunker.

The activities that would result in higher offsite radiological consequences are accidents at DAF that might result in the explosive dispersal of plutonium from the facility. Other experimental activities, such as those at JASPER and BEEF, involve smaller quantities of radioactive material with very limited potential for accidental dispersal to have impacts on people other than involved workers. Many of the activities under the Stockpile Stewardship and Management Program have no reasonably foreseeable accident scenarios that could result in exposure to noninvolved workers or the public. Involved worker impacts were not evaluated for any accident scenarios under this program; safety programs would limit potential impacts on such workers in events where containment or mitigation was possible. In catastrophic accident scenarios, however (i.e., events that would have substantial impacts outside the facility), it was assumed that the involved worker would be subjected to severe injury or fatality from radiation or chemical exposure or physical trauma.

G.3.3.1.1 Device Assembly Facility

Based on the *1996 NTS EIS* and subsequent safety analyses (LLNL 2007; NSTec 2009b), the accidents with the highest potential consequences that are associated with the National Security/Defense Mission at the NNSS are accidents at DAF in Area 6. In these cases, there are larger quantities of both radioactive materials and explosives in close proximity, so there is a potential mechanism to disperse the radioactive material and release it to the atmosphere. Because DAF was designed for these activities, all of the accidents that would result in the release of radioactive material to the environment would require multiple failures of safety systems and are, therefore, extremely unlikely. These accidents would more likely fall in the "beyond extremely unlikely" category because they have probabilities in the range of 10^{-6} to 10^{-7} per year or lower. If one of these explosive dispersal-type accidents were to occur within DAF, 1 to 5 kilograms of plutonium could be released within the building, but would still most likely be largely confined.

A wide range of potential accident scenarios has been evaluated in DAF safety documents (NSTec 2009b), and conservative estimates of their probabilities, MAR, and potential release to the building and the environment have been developed. The operational accident with the highest combined probability and mitigated release to the environment (i.e., highest risk) is an explosion that results in about 1,000 grams of plutonium being released to the environment. The mitigated frequency is conservatively estimated to be 8×10^{-4} per year. A realistic estimate of the probability of a release of this magnitude is likely much lower.

The only credible mechanism that would result in substantial releases would be a severe seismic event that initiates an explosive dispersal event and fails the confinement functions of the building in such a manner that a release to the environment could occur. Regarding a design-basis earthquake with a return interval of about 2,000 years, neither an explosive dispersal within the building or failure of confinement is expected. At some much lower probability, a seismic event could be postulated that initiates both the accident and failure of confinement. This probability is estimated to be much lower than 10^{-6} per year. For purposes of this SWEIS, a beyond-design-basis earthquake was postulated to initiate an explosive dispersal of plutonium within the building, and confinement was postulated to fail in such a manner that 1 to 5 kilograms of plutonium might be released to the environment. The estimated probability range of this seismically induced accident and failure of confinement is estimated to be in the 10^{-6} to 10^{-7} per year or lower range. DAF was specifically designed to isolate activities and potential accidents occurring in one cell or bay from the balance of the facility. Therefore, an accident, such as an explosion in one part of the facility that initiates an explosion in another location in the facility, was not considered a credible accident sequence.

More-severe accidents at DAF have much lower probabilities than explosions that would disperse plutonium. The highest-potential-consequence accident postulated in the DAF safety analyses is an inadvertent nuclear detonation. The physical conditions that would be required to get the plutonium and explosive materials in a configuration that might result in a nuclear yield are extraordinarily unlikely. It is much more likely that accidents involving both high explosives and plutonium would result in explosive dispersal of plutonium with no nuclear yield. An inadvertent nuclear yield accident is considered in the DAF safety analyses as a beyond-design-basis accident, and safety controls are in place to prevent such an accident. The safety controls that prevent the explosive dispersal of plutonium would also prevent the even less likely conditions that might result in an inadvertent detonation. The DAF safety analyses indicate that "this event has a vanishingly small likelihood (i.e., well below 10^{-6} per year)" and is at least two orders of magnitude less likely than a high-explosives dispersal accident (LLNL 2007; NSTec 2009b). When the mitigation controls are considered, the likelihood of an inadvertent nuclear yield occurring as a result of an accident is expected to be far below the 10^{-6} to 10^{-7} per year range and is not considered further in this SWEIS.

G.3.3.1.2 Criticality Experiments Facility located at the Device Assembly Facility

Since the *1996 NTS EIS*, the Criticality Experiments Facility was moved from Los Alamos National Laboratory to DAF. The decision to move this facility was made after completion of the *Final Environmental Impact Statement for the Proposed Relocation of Technical Area 18 Capabilities and Materials at the Los Alamos National Laboratory* (DOE 2002b). Operations at the Criticality Experiments Facility have also been the subject of safety analyses (LLNL 2006; NSTec 2010a). The maximum foreseeable accident for the Criticality Experiments Facility is a reactivity-induced accident that could result in a release equivalent to about 2.6 grams of plutonium to the environment. Two beyond-design-basis accidents, with an estimated probability of less than 10^{-6} per year, an unmitigated vault fire and an excess reactivity insertion with the Godiva critical assembly (one of the critical experiment apparatuses employed at DAF), were conservatively estimated to result in releases equivalent to about 130 grams and 250 grams of plutonium, respectively.

G.3.3.1.3 Joint Actinide Shock Physics Experimental Research Criticality Experiments Facility located at the Device Assembly Facility

Since the *1996 NTS EIS*, JASPER was constructed in Area 27 of the NNSS. Prior to operation, hazards analyses were performed for JASPER, a documented safety analysis (LLNL 2005; NSTec 2008) was developed, and controls were identified to prevent or mitigate all hazards based on the DOE risk-based approach. These analyses considered the complete spectrum of hazards and accidents that could result from facility operations or external initiators that would result in potential accident consequences for workers, the public, and the environment. A number of radionuclides (including plutonium-238, plutonium-239, various isotopes of uranium, and, to a lesser degree, other actinides) may be used as target materials in shock physics experiments. These actinides would be impacted by projectiles within a primary target chamber nested inside of a secondary confinement chamber.

The maximum foreseeable accidents identified were a failure of the ultrafast closure valve system that would result in the release of 8.82×10^{-4} grams of plutonium-239 and 4.78×10^{-6} grams of plutonium-238 to the environment, and a target building fire that would potentially release 6×10^{-6} grams of plutonium-239 and 2.1×10^{-7} grams of plutonium-238. The estimated frequency of the ultrafast closure valve system failure accident is 10^{-1} to 10^{-2} per year; the estimated frequency of the target building fire accident is 10^{-4} to 10^{-6} per year. The worst consequence for the environment would be minor local contamination. The risks to the public from JASPER operations would be minimal.

G.3.3.1.4 Tracer Radionuclides Experiments

As discussed in the normal operations section, under the Expanded Operations Alternative, up to 3 underground and 12 open-air radioactive tracer experiments per year would be conducted. These experiments are not included under the No Action and Reduced Operations Alternatives. The details of how these experiments would be conducted and the exact radionuclide inventories to be used have not been established. Under normal operations, the large curie releases of noble gases or particulates would occur underground and only a very small fraction would reach the surface. The exact operational details that would occur under the Expanded Operations Alternative would dictate the actual potential for accidental releases. To bound the potential accident impacts of the proposed tracer radionuclide experiments, an aboveground explosion involving the maximum proposed inventory of each of the short-lived radioactive particulates (up to 27,000 curies each of rubidium-86, zirconium-95, technetium-99m, molybdenum-99, ruthenium-103, cesium-136, barium-140, cerium-141, neodymium-147, and samarium-153) was postulated for initial analysis in this SWEIS. This should be an easily prevented accident; therefore, the accident probability falls into the extremely unlikely category, 10^{-4} to 10^{-6} per year. Even though the configuration of the tracer experiments are not known, it is likely that they would be designed to efficiently aerosolize a measurable quantity of the particulates; therefore, it was assumed that 1 to 10 percent of the particulates would be aerosolized and respirable in a surface accident. For purposes of performing a conservative analysis of the potential impacts of a surface accident, 10 percent of the particulates were assumed to become airborne and respirable.

The impact results, per isotope, from modeling a puff release of 27,000 curies of each of the short-lived radioactive particulates (rubidium-86, zirconium-95, technetium-99m, molybdenum-99, ruthenium-103, cesium-136, barium-140, cerium-141, neodymium-147, and samarium-153) and 27,000 curies of each of the radioactive noble gases (xenon-127, xenon-131m, xenon-133, krypton-85, and argon-37) are presented in **Table G–14**.

Table G–14 Tracer Experiment Full-Scale Results per Isotope

		Noninvolved Worker at 110 Yards		*MEI at 1.4 Miles*		*Population within 50 Miles*	
Scenario	*Release (curies)*	*Dose (rem)*	*LCF Risk*	*Dose (rem)*	*LCF Risk*	*Dose (person-rem)*	*LCFs* [a]
Rubidium-86	2.7×10^4	4.4	3×10^{-3}	2.0×10^{-1}	1×10^{-4}	3.7×10^{-1}	0 (2×10^{-4})
Zirconium-95	2.7×10^4	21	2×10^{-2}	9.6×10^{-1}	6×10^{-4}	1.7	0 (1×10^{-3})
Technetium-99m	2.7×10^4	0.17	1×10^{-4}	8.4×10^{-3}	5×10^{-6}	1.3×10^{-2}	0 (8×10^{-6})
Molybdenum-99	2.7×10^4	3.1	2×10^{-3}	1.4×10^{-1}	9×10^{-5}	2.6×10^{-1}	0 (2×10^{-4})
Ruthenium-103	2.7×10^4	13	8×10^{-3}	6.0×10^{-1}	4×10^{-4}	1.1	0 (6×10^{-4})
Cesium-136	2.7×10^4	8.6	5×10^{-3}	1.8	1×10^{-3}	3.2	0 (2×10^{-3})
Barium-140	2.7×10^4	4.8	3×10^{-3}	2.2×10^{-1}	1×10^{-4}	4.0×10^{-1}	0 (2×10^{-4})
Cerium-141	2.7×10^4	5.3	3×10^{-3}	2.5×10^{-1}	1×10^{-4}	4.4×10^{-1}	0 (3×10^{-4})
Neodymium-147	2.7×10^4	5.2	3×10^{-3}	2.4×10^{-1}	1×10^{-4}	4.3×10^{-1}	0 (3×10^{-4})
Samarium-153	2.7×10^4	1.3	8×10^{-4}	6.0×10^{-2}	4×10^{-5}	1.1×10^{-1}	0 (6×10^{-5})
Total Release of All Particulates	**2.7×10^5**	**67**	**4×10^{-2}**	**4.5**	**3×10^{-3}**	**8.1**	**0 (5×10^{-3})**
Argon-37	2.7×10^4	1.4×10^{-7}	8×10^{-11}	2.3×10^{-8}	1×10^{-11}	6.0×10^{-8}	0 (4×10^{-11})
Krypton-85	2.7×10^4	4.5×10^{-2}	3×10^{-5}	1.3×10^{-3}	8×10^{-7}	3.8×10^{-3}	0 (2×10^{-6})
Xenon-127	2.7×10^4	5.5	3×10^{-3}	2.5×10^{-1}	2×10^{-4}	4.6×10^{-1}	0 (3×10^{-4})
Xenon-131m	2.7×10^4	3.6×10^{-1}	2×10^{-4}	1.7×10^{-2}	1×10^{-5}	3.0×10^{-2}	0 (2×10^{-5})
Xenon-133	2.7×10^4	6.5×10^{-1}	4×10^{-4}	3.0×10^{-2}	2×10^{-5}	5.4×10^{-2}	0 (3×10^{-5})
Total Release of All Noble Gases	**1.3×10^5**	**6.5**	**4×10^{-3}**	**3.0×10^{-1}**	**2×10^{-4}**	**5.5×10^{-1}**	**0 (3×10^{-4})**

LCF = latent cancer fatality; MEI = maximally exposed individual; rem = roentgen equivalent man.

[a] The number of LCFs in the population would be a whole number. The value in parentheses is the result of multiplying the population dose by the factor of 0.0006 LCFs per person-rem.

Note: Impacts for an acute accident release do not include the long-term (chronic) ingestion pathway; actions would be taken to ensure doses from this pathway were a small fraction of the dose from the plume. In contrast, for normal operational tracer experiment impacts presented in Table G–11, the ingestion pathway was included.

Based on the results of this modeling, surface releases of particulates would have greater radiological impacts than releases of comparable quantities of noble gases.

G.3.3.1.5 Big Explosives Experimental Facility

Details of the BEEF analyses are presented in Appendix F of the *1996 NTS EIS*. Since the *1996 NTS EIS*, BEEF has been operational in Area 4 of the NNSS. Prior to operation, hazards analyses were performed for BEEF, a safety analysis was developed, and controls were identified to prevent or mitigate all hazards based on a DOE risk-based approach. These analyses considered the complete spectrum of hazards and accidents that could result from the operations or external initiators that would result in potential accident consequences for workers, the public, and the environment. For these experiments, the releases are intentional and no reasonably foreseeable accidents were identified that would have substantial impacts on noninvolved workers, the public, or the environment.

As discussed above, detonation of depleted uranium was considered for normal operational impacts from explosive operations at BEEF exclusively. For those analyses, it was assumed that a typical experiment would involve 200 pounds of depleted uranium and the explosive equivalent of 600 pounds of TNT.

Results of the analysis for a single BEEF experiment using depleted uranium are shown in **Table G–15**. For the analysis of an accident at BEEF, it was assumed that all of the depleted uranium becomes aerosolized and respirable, rather than only 20 percent, as was assumed for normal operations.

Involved worker impacts were not evaluated under this mission; rather, safety programs are present to limit potential impacts on such workers in the event that containment and/or mitigation are possible. However, in scenarios of catastrophic proportion (i.e., events that would yield extremely high impacts on noninvolved workers), it was assumed that the involved worker would be subjected to prompt fatality from radiation overdose, physical trauma, or another life-threatening episode.

Table G–15 Big Explosives Experimental Facility Experiment with Depleted Uranium

Scenario	***Release [a] (pounds of depleted uranium)***	***Noninvolved Worker at 110 Yards***		***MEI at 1.4 Miles***		***Population within 50 Miles***	
		Dose (rem)	***110-yard LCFs***	***Dose (rem)***	***LCF Risk***	***Dose (person-rem)***	***LCFs [b]***
BEEF (MEI at 9 miles)	200	0.0012	7×10^{-7}	0.00015	9×10^{-8}	0.017	0 (1×10^{-5})

BEEF = Big Explosives Experimental Facility; LCF = latent cancer fatality; MEI = maximally exposed individual; rem = roentgen equivalent man.

[a] For the accident analysis, impacts are calculated assuming that all of the depleted uranium becomes airborne and is respirable. Per DOE Handbook 3010 (DOE 1994), the fraction that might be respirable with an explosive release is 20 percent. The 20 percent fraction is applied to the BEEF experiment normal operational values presented in Table G–10.

[b] The number of LCFs in the population would be a whole number. The value in parentheses is the result of multiplying the population dose by the factor of 0.0006 LCFs per person-rem.

No accidents were identified that would result in higher radiological releases/impacts than those identified as part of normal operations.

G.3.3.1.6 Radiological/Nuclear Countermeasures Test and Evaluation Complex

The Radiological/Nuclear Countermeasures Test and Evaluation Complex is located near DAF in Area 6. The potential for accidents and public health and safety impacts associated with operation of the facility was considered in the *Radiological/Nuclear Countermeasures Test and Evaluation Complex, Nevada Test Site, Final Environmental Assessment* (DOE 2004c), as well as safety basis documents (NSTec 2009c). Because the activities involve nondestructive evaluation and observations of sealed containers and shipping containers, no reasonably foreseeable accidents were identified that would have substantial impacts on noninvolved workers, the public, or the environment.

G.3.3.1.7 Nonproliferation Test and Evaluation Complex

The potential human health impacts of tests and experiments involving the release of biological simulants and low concentrations of chemicals at various locations within the NNSS were evaluated in the 2004 *Final Environmental Assessment for Activities using Biological Simulants and Releases of Chemicals* (DOE 2004b). That environmental assessment stated, "During releases, administrative and access controls, and area monitoring would prevent exposures to involved and non-involved workers and the general public. No impacts to involved or uninvolved workers or the public from injury or illness would be expected…"

For these experiments, the releases are intentional and no reasonably foreseeable accidents were identified that would have substantial impacts on workers or the general public. The evaluations indicate that reasonable controls and safety programs would continue to ensure that any potential human health risks to involved workers, onsite personnel, and the public from accidents would be minimal. Criteria established in the environmental assessment for experimental releases include limiting concentrations of hazardous material beyond controlled areas to acceptable limits.

Future experimental activities could include evaluating the potential impacts of a release of larger quantities of chemicals such as chlorine. Any such proposed experiments would undergo a thorough environmental and safety review prior to authorization of a test involving larger quantities of hazardous materials. In most cases, an accident involving such hazardous materials would release the materials in an unplanned and uncontrolled manner. As such, proper procedures may not be in place, workers may not be properly sheltered, and weather conditions may not be the same as those for planned experiments. Accidents involving hazardous materials have the potential to affect both involved and noninvolved workers and to release the materials at a higher rate than planned in a controlled experiment.

To evaluate the potential environmental impacts of future experiments at the NNSS involving hazardous chemicals, two accident scenarios involving large accidental releases of chlorine gas were postulated in this SWEIS. The first scenario was an accidental release of chlorine gas from a tractor-trailer tank car engaged in transporting the material on site, or a handling accident involving unloading such a tank, either of which results in the release of the contents of a 20-ton tank car. The second scenario was the catastrophic accidental release of the contents of a 90-ton railcar used to store chlorine for experiments at NPTEC. Both of these accidents are in the "extremely unlikely" to "beyond extremely unlikely" frequency categories, i.e., in the 10^{-4} to 10^{-6} per year frequency range or beyond.

G.3.3.1.8 Other Nevada National Security Site National Security/Defense Mission Activities

Other National Security/Defense Mission activities that might occur under each of the alternatives that were also reviewed include the following:

- Pulsed-power experiments at the Atlas Facility
- Plasma physics and fusion experiments
- Stockpile management activities, including:
  - Disposition of damaged U.S. nuclear weapons
  - Staging, disassembly, modification, and maintenance of nuclear weapons

   - Quality assurance testing of weapons components
   - Storage and staging of special nuclear material, including pits

- G-Tunnel operations
- U1a Complex operations

Hazard, safety, and environmental analyses, as appropriate, were performed for each of these operations (e.g., DOE 2001, NSTec 2009d). These analyses showed that any radiological or chemical releases to the environment from normal operations would be small and would be accounted for in the site baseline dose (see Table G–9). No reasonably foreseeable accidents were identified that would have substantial impacts on noninvolved workers, the public, or the environment beyond those already identified. The impacts of accidents involving these activities would be less than or comparable to other activities that were evaluated in more detail in this SWEIS (e.g., potential accident scenarios associated with DAF operations). Existing safety analyses for these activities indicate that reasonable controls are and would continue to be in place to ensure that any potential human health risks to workers, onsite personnel, and the public from accidents would be minimal.

In addition to these existing facilities, development and evaluation of a new, portable high-energy accelerator capable of producing up to 60 megaelectron volt x-rays for active interrogation or radiography of items in support of the U.S. Department of Defense (DOD) and U.S. Department of Homeland Security (DHS) has been proposed. This would be similar to existing accelerators used radiography at the Device Assembly Facility and the Radiological/ Nuclear Countermeasures Test and Evaluation, but would have higher accelerator energy to enable better radiography of items under examination. The DOD and DHS plans call for the active interrogation activities to be conducted in a variety of outdoor locations at the NNSS that are reflective of real-world conditions where the system could be used; that is, using mobile accelerator (x-ray) units using a variety of targets that could be either fixed or mobile. Special nuclear material or other radioactive materials would be used in the process as targets. Initially, the nuclear or radioactive materials would be in either sealed sources or Type B containers, and accelerator energies would be limited to no more than 60 megaelectron volts. As the project progresses, larger energies and other nuclear materials containerization concepts would be considered. Safety controls would be similar to other portable outside radiography activities. The direct beam presents a hazard to anyone within its path, but is easily controlled and managed. Because of the energy of the proposed unit, its range would be longer than some units, so, as with all radiography devices, care would have to be exercised to ensure a clear beam path. The potential for accidents and public health and safety impacts associated with operation of the accelerator are similar to the active interrogation operations that were considered in the *Radiological/Nuclear Countermeasures Test and Evaluation Complex, Nevada Test Site, Final Environmental Assessment* (DOE 2004c), as well as safety basis documents for the existing facility (NSTec 2009c) and the new accelerator (NSTec 2010b, 2010c). Because the activities involve nondestructive evaluation and observations of sealed containers and shipping containers, no reasonably foreseeable accidents were identified that would have substantial impacts on noninvolved workers, the public, or the environment (NSTec 2010b, 2010c).

G.3.3.2 Nevada National Security Site Environmental Management Mission

The *1996 NTS EIS* identified maximum reasonably foreseeable accidents for the Environmental Management Mission as an explosion, fires, and aircraft crashes into the Area 5 waste management areas; spills and fires associated with containers of contaminated soils; or an aircraft crash in an area of the NNSS with contaminated soils. Based on more-recent safety analyses, these accidents are still considered the maximum reasonably foreseeable scenarios.

G.3.3.2.1 Radioactive and Hazardous Waste Facilities in Nevada National Security Site Areas 3 and 5

The *1996 NTS EIS* accidents for the Environmental Management Mission were an explosion, fires, and aircraft crashes in the Area 5 waste management areas, identified as accident scenarios WMR1, WMR2, WMR3, WMH1, WMH2, and WMH3. These accident scenarios are still considered relevant. Since the *1996 NTS EIS*, additional safety analyses for the Area 3 and 5 radioactive waste management facilities have been developed, including a documented safety analysis. Activities that have a potential for accidents that might result in high offsite radiological consequences all involve an impact and a subsequent fire involving containers with large quantities of radioactive material. In all cases, these containers are designed and maintained in such a configuration that vehicle impacts are very unlikely, and rupture of a container and subsequent fire are even less likely. All of the accidents that might result in a substantial release of radioactive materials from the container are categorized as “extremely unlikely” or beyond, in the 10^{-4} to 10^{-6} per year or lower probability range. Because wastes are typically stored in containers that would be appropriate for over-the-road transportation, the likelihood that an onsite impact would substantially damage one or more containers is low. Many of the activities under the Waste Management Program have no reasonably foreseeable accident scenarios that could result in exposure to noninvolved workers or the public**.**

Based on recent safety analyses (DOE 2010a), accidents that are extremely unlikely (10^{-4} to 10^{-6} per year), but still credible, include vehicle impacts and fires in containers of low-level radioactive waste or transuranic material, and a design-basis earthquake. Similar events were postulated for the Area 3 hazardous waste storage area. Radiological accidents such as a vehicle impact or fire were postulated to result in a release equivalent to about 24 to 126 grams of plutonium to the environment.

For the Area 3 hazardous waste storage area, the accidents identified in the *1996 NTS EIS* are still considered conservative. Based on current or reasonably foreseeable levels of activity at Area 3, the quantities of hazardous materials assumed in the *1996 NTS EIS* would not be present under the any of the alternatives.

G.3.3.2.2 Nevada National Security Site Environmental Restoration Program

Since the *1996 NTS EIS*, Environmental Restoration Program activities at the NNSS have continued such that the accidents identified in the *1996 NTS EIS* continue to represent maximum reasonably foreseeable accidents for these activities. Because the waste packages and waste handling and storage practices are designed for these activities, all of the accidents that would result in a release of radioactive material to the environment would require multiple failures of safety systems and, therefore, are extremely unlikely. The accidents analyzed involve the release of radioactive material due to a single-container spill, a multiple-container fire, and an aircraft crash into multiple containers. Only small quantities of radiological materials would be involved and potentially released, and there would be extremely low radiological and chemical risks to noninvolved workers and the public.

The *1996 NTS EIS* evaluated three classes of events for Environmental Restoration Program activities for plutonium contamination at the NNSS: an abnormal event (frequency range of 10^{-3} per year or greater), which is represented by the spill of one container of environmental restoration waste; a design-basis event (frequency range of 10^{-6} to 10^{-3} per year), which is represented by a fire involving the contents of three containers (or a front-end loader) of environmental restoration waste; and a beyond-design-basis accident in which a military aircraft crash results in a large fire that involves contaminated soil (i.e., an aircraft crash that is categorized and analyzed as an "initiating event"). Since the *1996 NTS EIS*, annual sortie operations at Nellis Air Force Base have increased from 16,000 to 27,000 per year (USAF 2007), or by a factor of 1.69. Thus, the estimated probability of the aircraft crash, based on the approximately

27,000 sorties per year (USAF 2007) assumed to occur over or near the NNSS, has increased from 7×10^{-7} per year to 1.2×10^{-6} per year.

Review of ongoing and projected environmental restoration activities at the NNSS indicates that these are still reasonable accident types for all of the SWEIS alternatives. The *1996 NTS EIS* assumed maximum soil contamination levels of 2,000 picocuries per gram at the NNSS. Current information indicates that the maximum existing contamination at the TTR is 51,200 picocuries of plutonium-239 per gram of soil at Clean Slate 3 GZ Mound; therefore, the source terms for this SWEIS were increased proportionally.

G.3.4 Remote Sensing Laboratory Radiological and Chemical Accident Scenarios

No credible accidents that would present other than negligible radiological or hazardous chemical impacts on or risks to involved or noninvolved workers, the public, or the environment were identified for the Remote Sensing Laboratory under any of the alternatives.

G.3.5 North Las Vegas Facility Radiological and Chemical Accident Scenarios

Discussions were held with facility personnel at the A-01 building concerning the inventories of radionuclide sources and their typical operational practices. These discussions indicated that all of the sources were "sealed" and packaged in such a manner that they were not vulnerable to the range of operational events, external events, or natural phenomena events. No safety basis or NEPA documents were identified.

A wide range of accidents at NLVF was considered, including accidents involving sealed sources, as well as airplane crashes. All potential scenarios, however, were found to be of such low probability that they were ultimately eliminated (i.e., screened out) from detailed evaluation in this SWEIS. Therefore, it was concluded that no credible accidents that would present other than negligible radiological or hazardous chemical impacts on or risks to the noninvolved worker, the public, or the environment were applicable to NLVF under the any of the alternatives.

G.3.6 Tonopah Test Range Radiological and Chemical Accident Scenarios

G.3.6.1 Tonopah Test Range National Security/Defense Mission

Stockpile Stewardship and Management Program. Since the *1996 NTS EIS*, Stockpile Stewardship and Management Program activities at the TTR have changed substantially such that the activities that resulted in the maximally reasonably foreseeable accidents identified in the *1996 NTS EIS* no longer occur. For example, the activity that resulted in the maximum reasonably foreseeable radiological accident, the failure of an artillery-fired test assembly, no longer occurs or is expected under any of the alternatives evaluated in this SWEIS.

Under each of the alternatives in this SWEIS, the maximum reasonably foreseeable accident involved the release of radioactive and toxic material due to a structural failure, drop, seismic event, fire, explosion, or aircraft impact involving a joint test assembly, which is part of the nuclear explosive-like assembly. Only small quantities of uranium, lithium, and beryllium would be involved and potentially released. Radiological and chemical impacts on noninvolved workers and the public would be minimal (DOE 1996a; SNL 2005).

The TTR safety analysis does consider a range of fire and explosion-type events involving rocket, missiles, and artillery rounds. The most serious events involve the ignition of high explosives or propellants. The mitigated consequences of these events are typically negligible outside of the local area, but could result in worker fatalities. Safety programs are in place to prevent or mitigate these events (SNL 2005).

G.3.6.2 Tonopah Test Range Environmental Management Mission

Since the *1996 NTS EIS*, Environmental Restoration Program activities at the TTR have continued such that the accidents identified in the *1996 NTS EIS* continue to represent those activities proposed under all alternatives in this SWEIS. The accidents involve the release of radioactive material due to a single-container spill, a multiple-container fire, and an aircraft crash into multiple containers. Because the waste packages and waste handling and storage practices are designed to mitigate most of these events, most of the accidents that would result in the release of radioactive material to the environment would require multiple failures of safety systems and, therefore, are extremely unlikely. Only small quantities of radiological materials would be involved and potentially released. The analyzed accident for which waste packages and waste handling and storage practices are not designed involves an aircraft crash followed by a fire, which is an extremely unlikely event. Radiological and chemical risks of these accidents to noninvolved workers and the public would be minimal.

The *1996 NTS EIS* evaluated three classes of events for Environmental Restoration Program activities for plutonium contamination at the TTR: an abnormal event (frequency range of 10^{-3} per year or greater), which is represented by the spill of one container of environmental restoration waste; a design-basis event (frequency range of 10^{-6} to 10^{-3} per year), which is represented by a fire involving the contents of three containers (or a front-end loader) of environmental restoration waste; and a beyond-design-basis accident in which a military aircraft crash results in a large fire that involves contaminated soil. The estimated probability of the aircraft crash, based on the approximately 16,000 sorties per year that occur over the TTR and are also assumed to occur over the NNSS, was 1×10^{-6} per year. Since the *1996 NTS EIS*, the annual sortie operations at Nellis Air Force Base have increased from 16,000 to 27,000 per year (USAF 2007), or by a factor of 1.69. Thus, the estimated probability of the aircraft crash, based on the approximately 27,000 sorties per year assumed to occur over the TTR (USAF 2007), has increased from 1×10^{-6} per year to 1.7×10^{-6} per year.

Review of ongoing and projected environmental restoration activities at the TTR indicates that these are still reasonable accident types for each of the proposed SWEIS alternatives. The *1996 NTS EIS* assumes maximum soil contamination levels of 2,000 picocuries per gram at the NNSS. Current information indicates that the maximum existing contamination at the TTR is 51,200 picocuries of plutonium-239 per gram of soil at Clean Slate 3 GZ Mound; therefore, the source terms for this SWEIS were increased proportionally.

G.3.7 Radiological and Chemical Accident Impacts

Accident consequences and risks are a function of the source term, number, and location of worker and public dose receptors; meteorology; LCF dose-to-risk conversion factor; and annual accident frequency. Source terms, the location of the MEI, and meteorology data were updated from those used in the *1996 NTS EIS* accident assessment scenarios (DOE 1996a); furthermore, the total 50-mile population, dose-to-LCF risk conversion factor, public dose receptor breathing rate, and certain accident frequencies have also changed. The population changed because the *1996 NTS EIS* population was based on the 1990 census, whereas this SWEIS uses an updated population based on the 2000 census that is extrapolated to the year 2016. The dose-to-LCF conversion factor used in this SWEIS (0.0006 fatal cancers per person-rem) changed due to updated information on cancer rates in exposed populations that was evaluated by a U.S. intergovernmental task force and resulted in new recommended factors (DOE 2003). The changes in public breathing rate are based on DOE accident dose calculation methodology recommendations for the MACCS2 computer code (DOE 2004a). The higher aircraft sortie rate from Nellis Air Force Base resulted in higher accident frequencies for three scenarios (USAF 2007).

The mean consequences of accidental radiological releases, given variations in meteorological conditions at the time of the accident, are calculated as radiological doses in terms of rem. The mean consequences, or the expected consequences of the accident, are an appropriate statistic for use in risk estimates. The consequences are also expressed as the additional potential or likelihood of death from cancer for the noninvolved worker and the MEI, as well as the expected number of incremental LCFs among the exposed population. For purposes of this SWEIS, long-term impacts due to ingestion of radioactive materials accidentally released are not reported because it is reasonable to assume that interdiction would occur to minimize any longer-term doses due to accidents.

G.3.7.1 Nevada National Security Site Radiological and Chemical Accident Results

The analysis results for the NNSS accident scenarios are presented in **Table G–16**. The results are presented in terms of the total effective dose equivalent for the 50-mile radius population, the MEI, and a noninvolved worker, as well as the LCF risks associated with these doses. LCF risks were calculated using the risk factor of 0.0006 LCF per rem discussed in Section G.1.1.3. The risk factor was doubled to 0.0012 LCF per rem for doses greater than 20 rem (NCRP 1993).

A large accidental chlorine gas release from NPTEC was postulated to illustrate the maximum credible accident involving hazardous chemicals with future NNSS operations. No other new chemical accident scenarios are expected for this SWEIS. However, a comparison of the ERPG values used in the *1996 NTS EIS* (NIOSH 1990) against those currently recommended by DOE (DOE 2007b) shows that a number of ERPG values have decreased. These lower ERPG values may affect the consequences of chemical accidents; therefore, all chemical accident consequences were re-analyzed using the ALOHA Version 5.2.3 computer code (EPA 2004) (see Section G.6.3).

As discussed above, chemicals were analyzed using the chemical accident scenarios addressed in the *1996 NTS EIS* (Expanded Use Alternative). In general, different source terms, meteorological dispersion parameters, and receptor locations were applied for this SWEIS compared to the *1996 NTS EIS*. The chemical accident scenarios and their acute health effects on the noninvolved worker and MEI are presented for both the *1996 NTS EIS* and this SWEIS in **Table G–17**. Because multiple chemicals are involved in each accident scenario, the ERPG levels indicated in Table G–17 reflect the highest ERPG level for the noninvolved worker and the MEI for any of the chemicals.

Table G–16 Nevada National Security Site Radiological and Chemical Facility Accidents, Source Terms, and Consequences

		Onsite Worker	*Offsite Population*	
Accident	***Source Term***	***Noninvolved Worker at 110 Yards [a, b] (100 meters)***	***Maximally Exposed Individual [b]***	***Population to 50 Miles [c]***
National Security/ Defense Mission				
DAF explosion involving 55 pounds high explosives and release of 1 kilogram plutonium	1,000 grams plutonium equivalent	6.5 rem 0.004 LCF	0.18 rem 0.0001 LCF	23 person-rem 0 (0.01) LCF
DAF design-basis earthquake	5,000 grams plutonium equivalent	2800 rem 1[d] LCF	0.86 rem 0.0005 LCF	113 person-rem 0 (0.07) LCF
Criticality Experiments Facility Godiva-burst reactivity-induced accident	2.6 grams plutonium equivalent	1.5 rem 0.0009 LCF	0.00045 rem 3×10^{-7} LCF	0.059 person-rem 0 (4×10^{-5}) LCF
Criticality Experiments Facility beyond-design-basis vault fire – unmitigated	130 grams plutonium equivalent	74 rem 0.09 LCF	0.022 rem 1×10^{-5} LCF	2.9 person-rem 0 (0.002) LCF
Criticality Experiments Facility beyond-design-basis Godiva excess reactivity insertion	250 grams plutonium equivalent	130 rem 0.2 LCF	0.048 rem 3×10^{-5} LCF	6.3 person-rem 0 (0.004) LCF
JASPER UCVS failure	8.82×10^{-4} grams Pu-239 4.78×10^{-6} grams Pu-238	9.1×10^{-4} rem 5×10^{-7} LCF	2.9×10^{-7} rem 2×10^{-10} LCF	9.9×10^{-5} person-rem 0 (6×10^{-8}) LCF
JASPER target building fire	3.78×10^{-7} curies Pu-239 3.57×10^{-6} curies Pu-238	2.5×10^{-5} rem 2×10^{-8} LCF	8.0×10^{-9} rem 5×10^{-12} LCF	2.8×10^{-6} person-rem 0 (2×10^{-9}) LCF
Bounding tracer radionuclide experiments surface explosion Areas 5, 12, 15, 16, 19, 20 (results for Area 5)	2,700 curies each of Rb-86, Zr-95, Tc-99m, Mo-99, Ru-103, Cs-136, Ba-140, Ce-141, Nd-147, and Sm-153	6.7 rem 0.008 LCF	0.45 rem 3×10^{-4} LCF	0.81 person-rem 0 (5×10^{-4})LCF
NPTEC catastrophic chlorine gas release from 90-ton railcar (chemical accident)	90 tons of chlorine gas	Potential worker fatalities to about 5 miles downwind without evacuation	Chlorine gas concentrations at levels that pose an irritant, but most likely in unoccupied areas	
Environmental Management Mission – Waste Management				
Area 5 transuranic waste container – vehicle impact and fire	23.79 grams plutonium equivalent	7.9 rem 0.005 LCF	0.36 rem 2×10^{-4} LCF	0.65 person-rem 0 (0.0004) LCF
Area 5 – classified transuranic material container - vehicle impact and fire	65.7 grams plutonium equivalent	20.5 rem 0.02 LCF	0.83 rem 5×10^{-4} LCF	1.8 person-rem 0 (0.001) LCF
Area 5 design-basis earthquake	1.58 grams plutonium equivalent	0.49 rem 0.0003 LCF	0.02 rem 1×10^{-5} LCF	0.043 person-rem 0 (3×10^{-5}) LCF
Area 5 TRUPACT Type A container drop, breach, and fire	126 grams plutonium equivalent	39 rem 0.05 LCF	1.6 rem 1×10^{-3} LCF	3.4 person-rem 0 (0.002) LCF

		Onsite Worker	**Offsite Population**	
Accident	**Source Term**	**Noninvolved Worker at 110 Yards [a, b] (100 meters)**	**Maximally Exposed Individual [b]**	**Population to 50 Miles [c]**
Environmental Management Mission – Environmental Restoration [e]				
One-container spill	Curies: U-234 1.10×10^{-10} U-235 8.45×10^{-12} U-238 7.94×10^{-10} Pu-238 1.74×10^{-8} Pu-239 1.59×10^{-6} Pu-240 1.54×10^{-7} Pu-241 4.10×10^{-6} Pu-242 3.33×10^{-12} Am-241 1.02×10^{-7}	1.0×10^{-5} rem 6×10^{-9} LCF	4.8×10^{-7} rem 3×10^{-10} LCF	8.7×10^{-7} person-rem 0 (5×10^{-10}) LCF
Three-container fire	Curies: U-234 9.73×10^{-10} U-235 7.68×10^{-11} U-238 7.17×10^{-9} Pu-238 1.54×10^{-7} Pu-239 1.43×10^{-5} Pu-240 1.38×10^{-6} Pu-241 3.58×10^{-5} Pu-242 3.07×10^{-11} Am-241 9.22×10^{-7}	8.8×10^{-5} rem 5×10^{-8} LCF	3.6×10^{-6} rem 2×10^{-9} LCF	7.8×10^{-6} person-rem 0 (5×10^{-9}) LCF
Aircraft crash and fire	Curies: U-234 1.08×10^{-5} U-235 8.19×10^{-7} U-238 7.68×10^{-5} Pu-238 1.69×10^{-3} Pu-239 1.56×10^{-1} Pu-240 1.51×10^{-2} Pu-241 4.10×10^{-1} Pu-242 3.07×10^{-7} Am-241 1.02×10^{-2}	1.0 rem 6×10^{-4} LCF	0.0474 rem 3×10^{-5} LCF	0.090 person-rem 0 (5×10^{-5}) LCF

Ba = barium; Ce = cerium; Cs = cesium; DAF = Device Assembly Facility; JASPER = Joint Actinide Shock Physics Experimental Research; LCF = latent cancer fatality; Mo = molybdenum; Nd = neodymium; NPTEC = Nonproliferation Test and Evaluation Complex; Pu = plutonium; Rb = rubidium; rem = roentgen equivalent man; Ru = ruthenium; Sm = samarium; Tc = technetium; TRUPACT = Transuranic Packaging Transporter; UCVS = ultrafast closure valve system; Zr = zirconium.

[a] Individual radiation doses in excess of a few hundred rem would result in acute (near-term) health effects or even death from causes other than cancer. In some cases, medical intervention may be effective in reducing the dose, mitigating health impacts, or both. The listed doses are calculated assuming that no protective action occurs during the period of exposure and that no subsequent medical intervention occurs.

[b] Increased risk of an LCF to an individual, assuming the accident occurs.

[c] Increased number of LCFs for the offsite population, assuming the accident occurs. The number of LCFs in the population would be a whole number. The value in parentheses is the result of multiplying the population dose by the factor of 0.0006 LCFs per person-rem.

[d] Because this represents the increased likelihood of an individual developing an LCF, a value of 1 indicates that the person would likely develop a cancer. The value cannot exceed 1.

[e] Environmental restoration activities conservatively assumed to be located at the Area 5 Radioactive Waste Management Complex. This location has the closest proximity to a site boundary (1.4 miles to the east) of all potential environmental restoration areas and is also closest to the bulk of the population centers.

Note: The dose at 110 yards is highly dependent on the modeling assumptions, especially the energy involved and, hence, the effective release height. Very high doses might be expected if the release were mostly at near-ground level. If lots of energy were assumed, the plume might rise to sufficient height that it might pass over the 110-yard location and not reach the ground for several hundred yards. Thus the dose at 110 yards should only be used as an indicator of potential doses.

Table G–17 Comparison of Chemical Accident Health Consequences

Scenario Identification and Location	*Accident Annual Frequency* [a]	*Noninvolved Worker, 1996 NTS EIS* [a]	*Noninvolved Worker, this SWEIS*	*MEI, 1996 NTS EIS* [a]	*MEI, this SWEIS*
DPH1, TTR	6×10^{-6}	ERPG-2	ERPG-3	ERPG-3	ERPG-3
DPH2, TTR	1.6×10^{-6}	ERPG-1	None	ERPG-1	None
WMH1, Area 5	2.96×10^{-2}	ERPG-3	ERPG-3	None	None
WMH2, Area 5	8×10^{-5}	ERPG-3	ERPG-3	None	None
WMH3, Area 5	1×10^{-7} (EIS) 1.7×10^{-7} (SWEIS)	ERPG-3	ERPG-3	ERPG-1	None
ERH1, TTR or NTTR	0.11	ERPG-3	ERPG-3	None	None
ERH2, TTR or NTTR	8×10^{-5}	ERPG-3	ERPG-3	None	None
ERH3, TTR or NTTR	7×10^{-7} (EIS) 1.2×10^{-6} (SWEIS)	ERPG-3	ERPG-3	None	None
NDRDH1, Area 5	1.7×10^{-2}	ERPG-3	ERPG-3	ERPG-1	None
NDRDH2, Area 5	1×10^{-4}	ERPG-3	ERPG-3	ERPG-1	None
NDRDH3, Area 5	1×10^{-7} (EIS) 1.7×10^{-7} (SWEIS)	ERPG-3	ERPG-3	ERPG-2	ERPG-1
WFOH1, Area 4	1×10^{-3} to 1×10^{-2}	ERPG-1	ERPG-2	None	None
WFOH2, Area 4	1×10^{-4} to 1×10^{-3}	ERPG-3	ERPG-3	None	None
Nonproliferation Test and Evaluation Complex	1×10^{-4} to 1×10^{-6} or lower	Not included	ERPG-3	Not included	ERPG-1 possible

EIS = environmental impact statement; MEI = maximally exposed individual; NTTR = Nevada Test and Training Range; SWEIS = site-wide environmental impact statement; TTR = Tonopah Test Range.
[a] Source: DOE 1996a, 1996b; USAF 2007.
ERPG-1 Values: Exposure to airborne concentrations greater than ERPG-1 values for a period greater than 1 hour results in an unacceptable likelihood that a person would experience mild transient adverse health effects or perception of a clearly defined objectionable odor.
ERPG-2 Values: Exposure to airborne concentrations greater than ERPG-2 values for a period greater than 1 hour results in an unacceptable likelihood that a person would experience or develop irreversible or other serious health effects or symptoms that could impair one's ability to take protective action.
ERPG-3 Values: Exposure to airborne concentrations greater than ERPG-3 values for a period greater than 1 hour results in an unacceptable likelihood that a person would experience or develop life-threatening health effects.

The analysis for this SWEIS shows that most of the chemical accidents result in concentrations above ERPG-3 values for the noninvolved worker. The noninvolved worker assumed to be 110 yards from the release is the modeling construct used in accident impact analyses. It is unlikely that there would be noninvolved workers near the postulated accident. The accident scenario with the highest frequency that could result in a noninvolved worker fatality is ERH1 at the TTR or Nevada Test and Training Range, which has an estimated annual frequency of 0.11 (1 chance in 9).

The only accident scenario that exceeds ERPG-3 values for the MEI is DPH1 at the TTR. This accident scenario has an estimated annual frequency of 6×10^{-6} per year, equivalent to 1 chance in 167,000 that this accident would occur. Accident scenario NDRDH3 could result in mild transient adverse health consequences for the MEI. Accident scenario NDRDH3 has an estimated annual frequency of 1.7×10^{-7} per year, equivalent to 1 chance in 5.9 million that it would occur. The NPTEC chlorine accident would also potentially exceed ERPG-3 concentrations for the MEI. The estimated annual frequency of this accident is up to 1×10^{-4} per year, equivalent to 1 chance in 10,000. All other chemical accidents result in no health effects on the MEI. Several accident scenarios (DPH2, WMH3, NRDH1, and NRDH2) that resulted in health consequences for the MEI in the *1996 NTS EIS* were shown to have no health consequences in the analyses performed for this SWEIS. The lower consequences for these accident scenarios are due to the different values used in the analysis of ERPG-1 in this SWEIS for the chemicals involved, as well as the assumption of neutral 50 percent meteorology for the noninvolved worker and

MEI in this SWEIS (the *1996 NTS EIS* assumed stable 95 percent meteorology). The assumption of 50 percent meteorology is consistent with other current DOE NEPA hazardous chemical accident analyses. In general, the chemical accident analysis results in this SWEIS show lower health consequences for the noninvolved worker and MEI than the analysis results in the *1996 NTS EIS*.

Table G–18 shows the facility accident risks to the offsite population, the MEI, and a noninvolved worker after accounting for the estimated frequency of the postulated accidents. The accident presenting the highest risk to the offsite population would be the DAF accident involving about 55 pounds of high explosives and 1 kilogram of plutonium. For the offsite population, there would be an increased risk of 1×10^{-5} (1 in 100,000) per year of operation of a single LCF occurring in the population. The annual risk of an LCF from this accident would be 9×10^{-8} (about 1 in 11 million) for the MEI. The annual risk of an LCF to the noninvolved worker would be about 3×10^{-6} (about 1 in 330,000).

Table G–18 Nevada National Security Site Radiological and Chemical Facility Accident Risks

		Onsite Worker	*Offsite Population*	
Accident	***Frequency (events per year)***	***Noninvolved Worker at 110 Yards (100 meters)*** [a]	***Maximally Exposed Individual*** [a]	***Population to 50 Miles*** [b]
National Security/ Defense Mission				
DAF explosion involving 55 pounds of high explosives and release of 1 kilogram of plutonium	8×10^{-4} or lower	3×10^{-6}	9×10^{-8}	1×10^{-5}
DAF beyond-design-basis earthquake	$<10^{-6}$ to 10^{-7}	1×10^{-6}	5×10^{-10}	7×10^{-8}
Criticality Experiments Facility Godiva-burst reactivity-induced accident	10^{-2} to 10^{-4}	9×10^{-6}	3×10^{-9}	4×10^{-7}
Criticality Experiments Facility beyond-design-basis vault fire – unmitigated	$<10^{-6}$	9×10^{-8}	1×10^{-11}	2×10^{-9}
Criticality Experiments Facility beyond-design-basis Godiva excess reactivity insertion	$<10^{-6}$	2×10^{-7}	3×10^{-11}	4×10^{-9}
JASPER UCVS Failure	10^{-1} to 10^{-2}	5×10^{-8}	2×10^{-11}	6×10^{-9}
JASPER Target Building Fire	10^{-4} to 10^{-6}	2×10^{-12}	5×10^{-16}	2×10^{-13}
Bounding Tracer Experiment surface explosion of short-lived particulates (Expanded Operations Alternative only)	10^{-4} to 10^{-6}	4×10^{-7}	3×10^{-8}	5×10^{-8}
Environmental Management Mission – Waste Management				
Area 5 transuranic waste container - vehicle impact and fire	10^{-4} to 10^{-6}	5×10^{-7}	2×10^{-8}	4×10^{-8}
Area 5 – Classified transuranic material container – vehicle impact and fire	10^{-4} to 10^{-6}	2×10^{-6}	5×10^{-8}	1×10^{-7}
Area 5 design-basis earthquake	5×10^{-4}	2×10^{-7}	5×10^{-9}	2×10^{-8}
Area 5 TRUPACT Type A container drop, breach and fire	10^{-4} to 10^{-6}	5×10^{-6}	1×10^{-7}	2×10^{-7}
Environmental Management Mission – Environmental Restoration				
One-container spill	3×10^{-2}	2×10^{-10}	9×10^{-12}	2×10^{-11}
Three-container fire	4×10^{-6}	2×10^{-13}	8×10^{-15}	2×10^{-14}
Aircraft crash and fire	1.2×10^{-6}	7×10^{-10}	4×10^{-11}	6×10^{-11}

< = less than; DAF = Device Assembly Facility; JASPER = Joint Actinide Shock Physics Experimental Research; TRUPACT = Transuranic Packaging Transporter; UCVS = ultrafast closure valve system.

[a] Increased risk of an LCF to an individual per year.

[b] Increased number of LCFs for the offsite population per year. The number of LCFs in the population would be a whole number. The value in parentheses is the result of multiplying the population risk by the factor of 0.0006 LCFs per person-rem.

Table G–18 shows that the accident with the highest risk to an MEI would be a TRUPACT [Transuranic Packaging Transporter] container drop and breach, followed by a fire. The risk to the MEI would be highest for this accident because it is postulated to occur in Area 5 and the distance to the site boundary is shorter than the distance from DAF to the site boundary. In the analysis, an MEI was assumed to live at the site boundary, 1.4 miles east of the accident location. This is a conservative assumption because the land beyond the site boundary is part of the Nevada Test and Training Range and is closed to the public. For the offsite population, there would be an increased risk of 2×10^{-7} (1 in 5 million) per year of operation of a single LCF occurring in the population. The annual risk of an LCF to the MEI from this accident would be 1×10^{-7} (about 1 in 10 million). The annual risk of an LCF to the noninvolved worker would be about 5×10^{-6} (about 1 in 500,000).

G.3.7.1.1 Nevada National Security Site National Security/Defense Mission

Stockpile Stewardship and Management Program.

The accidents that would result in the highest offsite radiological consequences are those that are postulated to occur at DAF. These include an accident that might result in the explosive dispersal of plutonium from the building or a design-basis earthquake. The other experimental activities, such as those at JASPER, the U1a Complex, and BEEF, involve smaller quantities of radioactive material with very limited potential for accidental dispersal in quantities that would affect persons other than involved workers. Many of the activities under the Stockpile Stewardship and Management Program have no reasonably foreseeable accident scenarios that could result in exposure to the public or noninvolved workers.

The accidents with the highest potential consequences, as shown in Table G–18, are those associated with accidents at DAF. In these cases, there are larger quantities of both radioactive materials and explosives in close proximity, so there is a potential mechanism to disperse the radioactive material and release it to the atmosphere. Because DAF was designed for these activities, all of the accidents that would result in a release of radioactive material to the environment would require multiple failures of safety systems and, therefore, are extremely unlikely. The accident with the highest combined probability and mitigated release to the environment (maximum reasonably foreseeable accident) at DAF is the explosive dispersal of about 1 kilogram of plutonium to the environment. The estimated probability of this type of event is in the range of 8×10^{-4} or lower per year of operation. If the accident were to occur, the MEI would receive a dose of 0.86 rem, which corresponds to an LCF risk of 0.0005 (1 chance in 2,000). The offsite population within 50 miles would receive a dose of 113 person-rem; the calculated number of LCFs associated with this dose is 0.07, implying that the most likely outcome would be no additional LCFs in the exposed population. An involved worker within DAF could be fatally injured in the explosion. A noninvolved worker outside of DAF could receive a dose of 2,800 rem, which would result in an acute fatality due to receipt of a lethal dose. When the annual probability of the accident occurring is taken into account, the increased risk of an LCF to the MEI would be 3×10^{-7} (1 chance in 3.3 million); the increased risk of a single LCF in the exposed population would be 4×10^{-5} (1 chance in 25,000); and the increased risk of an LCF to a noninvolved worker would be 0.0005 (1 chance in 2,000).

More-severe accidents at DAF would have much lower probabilities than the explosions that result in dispersion of plutonium. As discussed in Section G.3.3.1.1, the accident with the highest potential consequences that was postulated in the DAF safety analyses is an inadvertent nuclear detonation. The physical conditions that would be required to get the plutonium and explosive materials in a configuration that might result in a nuclear yield are extraordinarily unlikely. It is much more likely that accidents involving both high explosives and plutonium would result in explosive dispersal of plutonium with no nuclear yield. An inadvertent nuclear yield accident is considered in the DAF safety analyses as a beyond-design-basis accident, and safety controls are in place to prevent such an accident. The safety controls that prevent the explosive dispersal of plutonium would also prevent the even less likely conditions that might result in an inadvertent detonation. The DAF safety analyses indicate that "this event has a vanishingly small likelihood (i.e., well below 10^{-6} per year)" and at least two orders of magnitude less likely than a high-explosives dispersal accident. When the mitigation controls are considered, the likelihood of an inadvertent nuclear yield occurring as a result of an accident is expected to be far below the 10^{-6} to 10^{-7} per year range and is not considered further in this SWEIS.

Nonproliferation Test and Evaluation Complex. A large accidental chlorine gas release from a railcar at NPTEC was postulated to illustrate the maximum credible accident involving hazardous chemicals to be used in future NNSS operations.

Future experimental activities could include evaluating the potential impacts of releases of larger quantities of chemicals such as chlorine. It is anticipated that any such proposed experiments would undergo a thorough environmental and safety review prior to authorization of a test involving larger quantities of hazardous materials. Most experiments at NPTEC are designed to release chemical or biological simulants to the environment. In most cases, an accident involving such hazardous materials would release the materials in an unplanned and uncontrolled manner. As the proper test procedures may not be in place under accident conditions, workers may not be properly sheltered, and weather conditions may not be the same as those for the planned experiments. Therefore, accidents involving hazardous materials have the potential to affect both involved and noninvolved workers and to release the materials at a higher rate than that planned in the controlled experiment.

To evaluate the potential environmental impacts of future experiments at the NNSS involving hazardous chemicals, two accident scenarios involving large accidental releases of chlorine gas were postulated in this SWEIS. The first scenario was an accidental release of chlorine gas from a tractor-trailer tank car engaged in transporting the material on site, or a handling accident involving unloading such a tank, either of which would result in the release of the contents of a 20-ton tank car. The second scenario was the catastrophic accidental release of the contents of a 90-ton railcar used to store chlorine for experiments at NPTEC. Both of these accidents are in the "extremely unlikely" to "beyond extremely unlikely" frequency category, i.e., in the 10^{-4} to 10^{-6} per year frequency range or beyond.

Catastrophic accidents involving a full, 90-ton railcar of chlorine have resulted in fatalities, including a January 6, 2005, accident involving three 90-ton chlorine railcars in Graniteville, South Carolina. In that accident, about 60 tons of chlorine escaped through a fist-sized hole in one of the railcars and nine people were killed (NTSB 2005).

Potential impacts of an accidental chlorine release from a railcar are highly dependent on the specific conditions of the accident because chlorine within the tank car exists as both a liquid and gas. Release rates are highly dependent on the size of the hole in the tank and the vertical height of the hole above the bottom of the tank. If the hole is below the liquid level, typically about a third of the vertical height, releases will be in liquid form. The rate that the released liquid evaporates and forms a heavier-than-air cloud depends on the ambient conditions (wind, temperature, and topography). Emergency response guidance (DOT 2008, page 300) indicates that, for large spills, first responders should isolate the area of the spill in all directions for 200 meters (2000 feet) and then protect persons downwind for 2.2 miles (3.5 kilometers) under daytime conditions and for 5.0 miles (8.0 kilometers) under nighttime conditions. An incident involving a railcar would be considered a potentially very large spill.

The ALOHA modeling results, assuming the release occurs quickly over 1 hour, indicate that potentially fatal concentrations (exceeding EPRG-3 levels) could extend downwind for 5 to 6 miles under typical daytime conditions and for more than 6 miles under typical nighttime conditions. Concentrations that could lead to potentially serious impacts (exceeding EPRG-2) could extend downwind even further, potentially affecting noninvolved workers. Concentrations that could lead to odor and irritation (exceeding EPRG-1) could extend off site. Because of the nature of chlorine and the complexities of trying to model the dispersion of the heavier-than-air gas, substantial uncertainties are associated with these results.

Nuclear Emergency Response, Nonproliferation, and Counterterrorism Programs. No reasonably foreseeable major accident scenarios that could result in exposure to noninvolved workers or the public were identified for the ongoing or near-term activities of the Nuclear Emergency Response, Nonproliferation, and Counterterrorism Programs that are proposed under the No Action Alternative. The activities involving radiological materials utilize sealed sources or well-packaged, unopened materials for which substantial radiological accidents are not expected.

If the need arose for the disposition of nuclear and radiological dispersion devices, the impacts of an accident would be comparable to those resulting from an intentional destructive act. Potential impacts of intentional destructive acts were evaluated in a separate, classified appendix to this SWEIS.

Work for Others. No reasonably foreseeable major accident scenarios that could result in exposure to noninvolved workers or the public were identified for the ongoing or near-term Work for Others Program activities hosted by NNSA. Activities at shared facilities, such as BEEF, NPTEC, the Radiological/Nuclear Countermeasures Test and Evaluation Complex, and the T-1 Training Area present minimal risks to noninvolved workers and the public.

G.3.7.1.2 Nevada National Security Site Environmental Management Mission

Waste Management Program. The accident with the highest potential consequences, as shown in Table G–17, would be the drop and breach of a TRUPACT container, followed by a fire. This accident is postulated to result in the dispersal of up to 126 grams of plutonium. The estimated probability of this type of event is in the range of 10^{-4} to 10^{-6} per year of operation. If this accident were to occur, the offsite population within 50 miles would receive a dose of 3.4 person-rem; the calculated number of LCFs associated with this dose is 0.002, implying that the most likely outcome would be no additional LCFs in the exposed population. The MEI would receive a dose of 1.6 rem, which corresponds to an LCF risk of 0.001 (1 chance in 1,000). A noninvolved worker within Area 5 could receive a dose of 39 rem. This dose could result in radiological injury without prompt medical treatment and represents an LCF risk of 0.05 (1 chance in 20). When the probability of the accident occurring is taken into account, the increased annual risk of a single LCF occurring in the offsite population would be 2×10^{-7} (1 chance in 5 million). The annual risk of an LCF to the MEI would be 1×10^{-7} (1 chance in 10 million) and the increased risk of an LCF to a noninvolved worker would be 5×10^{-6} (1 chance in 200,000).

The following section, which evaluates potential accidents involving Environmental Restoration Program activities, includes a scenario in which an airplane crashes into environmental restoration waste containers in Area 5. A similar accident was not evaluated for Waste Management Program activities because other accidents with large releases have a higher estimated frequency (by two orders of magnitude) than an airplane crash.

Environmental Restoration Program. Accidents postulated for Environmental Restoration Program activities involve the release of radioactive material due to a single-container spill, a multiple-container fire, and an aircraft crash into multiple containers. These accidents could happen any place on the NNSS where environmental remediation occurs. For purposes of analysis, these accidents were modeled as occurring at the Area 5 RWMC; because this location is towards the southern end of the site and near the site boundary, the calculated population and MEI doses would be higher than if these accidents were assumed to occur in most other locations at the NNSS. Only small quantities of radiological materials would be involved and potentially released. Radiological and chemical impacts on noninvolved workers and the public would be minimal.

The accident with the highest consequences for Environmental Restoration Program activities at the NNSS would be an aircraft crash and fire. The estimated probability of this type of event is 1.2×10^{-6} (1 chance in 833,000) per year of operation. If this accident were to occur, the offsite population within 50 miles would receive a dose of 0.090 person-rem; the calculated number of LCFs associated with this dose is 5×10^{-5}, implying that the most likely outcome would be no additional LCFs in the exposed population. The MEI would receive a dose of 0.047 rem, with a corresponding LCF risk of 3×10^{-5} (1 chance in 33,000). A noninvolved worker outside the immediate area of the crash could receive a dose of 1.0 rem, with an associated LCF risk of 6×10^{-4} (1 chance in 1,700). When the probability of the accident is taken into consideration, the risk to the offsite public or a noninvolved worker would be essentially 0 (less than 7×10^{-10}, or 1 chance in 1 billion).

Nondefense Mission. No reasonably foreseeable major accident scenarios that could result in exposure to noninvolved workers or the public were identified for the ongoing or near-term Nondefense Mission activities proposed for the NNSS under the No Action Alternative.

G.3.7.2 Tonopah Test Range Radiological Accident Results

The results for TTR accident scenarios are presented in **Table G–19**. Results are presented in terms of the total effective dose equivalent to the 50-mile radius population, the MEI, and a noninvolved worker, as well as the LCF risks associated with these doses. The LCF risks for all accidents were calculated using the risk factor of 0.0006 LCF per rem discussed in Section G.1.1.3.

Table G–20 shows the facility accident risks to the offsite population, the MEI, and a noninvolved worker after accounting for the estimated frequency of the postulated accidents; the risks from all accidents are extremely small. The accident presenting the highest risk would be an aircraft crash into environmental restoration waste containers, followed by a fire. The annual risk of a single LCF occurring in the offsite population as a result of this accident would increase to 1×10^{-11} (1 in 100 billion) per year of operation. The annual risk to the MEI of an LCF would be 3×10^{-13} (1 in 3 trillion). The annual risk of an LCF to a noninvolved worker would be about 2×10^{-9} (1 in 500 million).

Table G–19 Tonopah Test Range Radiological and Chemical Facility Accidents, Probabilities and Consequences

Accident	Source Term		Noninvolved Worker at 110 Yards [a, b]	Offsite Population: Maximally Exposed Individual [a, b]	Offsite Population: Population to 50 Miles [c]
National Security/ Defense Mission					
Joint Test Assembly – radiological	 Uranium-234 Uranium-235	Curies 2.48×10^{-2} 7.8×10^{-5}	0.075 rem 5×10^{-5} LCF	1.7×10^{-5} rem 1×10^{-8} LCF	5.9×10^{-4} person-rem 0 (4×10^{-7}) LCF
Joint Test Assembly – chemical	 Lithium Beryllium	Grams 20 5	Lithium: 0.295 mg/m^3 << 55 mg/m^3 IDLH, but > than 0.025 mg/m^3 OSHA limit Beryllium: 0.074 mg/m^3 << 10 mg/m^3 IDLH, but >0.002 mg/m^3 OSHA limit	Lithium: ~0 mg/m^3 << 55 mg/m^3 IDLH Beryllium: ~0 mg/m^3 << 10 mg/m^3 IDLH	–
Sealed source aircraft impact – fire	 Cobalt-60	Curies 1.89×10^{-3}	1.2×10^{-5} rem 7×10^{-9} LCF	2.5×10^{-9} rem 2×10^{-12} LCF	1.1×10^{-7} rem 0 (7×10^{-11}) LCF
Environmental Management Mission – Environmental Restoration					
One-container spill	 Uranium-234 Uranium-235 Uranium-238 Plutonium-238 Plutonium-239 Plutonium-240 Plutonium-241 Plutonium-242 Americium-241	Curies: 1.10×10^{-10} 8.45×10^{-12} 7.94×10^{-10} 1.74×10^{-8} 1.59×10^{-6} 1.54×10^{-7} 4.10×10^{-6} 3.33×10^{-12} 1.02×10^{-7}	1.5×10^{-5} rem 9×10^{-9} LCF	3.4×10^{-9} rem 2×10^{-12} LCF	1.2×10^{-7} person-rem 0 (7×10^{-11}) LCF
Three-container fire	 Uranium-234 Uranium-235 Uranium-238 Plutonium-238 Plutonium-239 Plutonium-240 Plutonium-241 Plutonium-242 Americium241	Curies: 9.73×10^{-10} 7.68×10^{-11} 7.17×10^{-9} 1.54×10^{-7} 1.43×10^{-5} 1.38×10^{-6} 3.58×10^{-5} 3.07×10^{-11} 9.22×10^{-7}	1.2×10^{-4} rem 7×10^{-8} LCF	2.5×10^{-8} rem 2×10^{-11} LCF	1.1×10^{-6} person-rem 0 (7×10^{-10}) LCF
Aircraft crash and fire 25.6 × *1996 NTS EIS* 1×10^5 × single-container spill	 Uranium-234 Uranium-235 Uranium-238 Plutonium-238 Plutonium-239 Plutonium-240 Plutonium-241 Plutonium-242 Americium-241	Curies: 1.08×10^{-5} 8.19×10^{-7} 7.68×10^{-5} 1.69×10^{-3} 1.56×10^{-1} 1.51×10^{-2} 4.10×10^{-1} 3.07×10^{-7} 1.02×10^{-2}	1.5 rem 9×10^{-4} LCF	0.00034 rem 2×10^{-7} LCF	0.012 person-rem 0 (7×10^{-6}) LCF

> = greater than; << = much less than; IDLH = Immediate Danger to Life and Health; LCF = latent cancer fatality; mg/m^3 = milligrams per cubic meter; OSHA = Occupational Safety and Health Administration; rem = roentgen equivalent man.

[a] Individual radiation doses in excess of a few hundred rem would result in acute (near-term) health effects or even death from causes other than cancer. In some cases, medical intervention may be effective in reducing the dose, mitigating health impacts, or both. The listed doses are calculated assuming that no protective action occurs during the period of exposure and that no subsequent medical intervention occurs.

[b] Increased risk of an LCF to an individual, assuming the accident occurs.

[c] Increased number of LCFs for the offsite population, assuming the accident occurs. The number of LCFs in the population would be a whole number. The value in parentheses is the result of multiplying the population dose by the factor of 0.0006 LCFs per person-rem.

Table G–20 Tonopah Test Range Radiological and Chemical Facility Accident Risks

Accident	Frequency (events per year)	Onsite Worker: Noninvolved Worker at 110 Yards [a]	Offsite Population: Maximally Exposed Individual [a]	Offsite Population: Population to 50 Miles [b]
National Security/ Defense Mission				
Joint Test Assembly radiological	6×10^{-6}	3×10^{-10}	6×10^{-14}	2×10^{-12}
Joint Test Assembly chemical	6×10^{-6}	Lithium: 0.295 mg/m^3 << 55 mg/m^3 IDLH, but > than 0.025 mg/m^3 OSHA limit Beryllium: 0.074 mg/m^3 << 10 mg/m^3 IDLH, but > 0.002 mg/m^3 OSHA limit	Lithium: ~0 mg/m^3 << 55 mg/m^3 IDLH Beryllium: ~0 mg/m^3 << 10 mg/m^3 IDLH	–
Sealed source aircraft impact – fire	10^{-4} to 10^{-6}	7×10^{-13}	2×10^{-16}	7×10^{-15}
Environmental Management Mission – Environmental Restoration				
One-container spill 25.6 × *1996 NTS EIS*	3×10^{-2}	3×10^{-10}	6×10^{-14}	2×10^{-12}
Three-container fire 25.6 × *1996 NTS EIS* 9 × single-container spill	4×10^{-6}	3×10^{-13}	8×10^{-17}	3×10^{-15}
Aircraft crash and fire 25.6 × *1996 NTS EIS* 1×10^5 × single-container spill	1.7×10^{-6}	2×10^{-9}	3×10^{-13}	1×10^{-11}

> = greater than; << = much less than; IDLH = Immediate Danger to Life and Health; mg/m^3 = milligrams per cubic meter; OSHA = Occupational Safety and Health Administration.

[a] Increased risk of an LCF to an individual per year.

[b] Increased number of LCFs for the offsite population per year. The number of LCFs in the population would be a whole number. The value in parentheses is the result of multiplying the population risk by the factor of 0.0006 LCFs per person-rem.

G.3.7.2.1 Tonopah Test Range National Security/Defense Mission

Stockpile Stewardship and Management Program. The accident postulated for Stockpile Stewardship and Management Program operations at the TTR involved a release of radioactive and toxic material due to a structural failure, drop, seismic event, fire, explosion, or aircraft impact involving a joint test assembly, which is part of a nuclear explosive-like assembly. Only small quantities of uranium, lithium, and beryllium would be involved and potentially released. If an accident were to occur, the offsite population dose would be 5.9×10^{-4}, which would have the expected result of 0 LCFs (calculated number of 4×10^{-7}). The dose and risk of an LCF to the MEI would be 1.7×10^{-5} rem and 1×10^{-8} (1 chance in 100 million), respectively. The dose and risk of an LCF to the noninvolved worker MEI would respectively be 0.075 rem and 5×10^{-5} (1 chance in 20,000). When the estimated annual frequency of the accident of 6×10^{-6} is considered, the risk to the offsite public and the worker is essentially 0.

G.3.7.2.2 Tonopah Test Range Environmental Management Mission

Waste Management Program. No reasonably foreseeable accident scenarios that could result in exposure to noninvolved workers or the public were identified for the ongoing or near-term Waste Management Program activities at the TTR.

Environmental Restoration Program. Environmental restoration activities at the TTR would involve the cleanup of contaminated surface soil. All of the postulated accidents for environmental restoration activities would result in very low consequences and essentially no risk to the offsite public or a noninvolved worker. Regarding Environmental Restoration Program activities at the TTR, the accident with the greatest impacts would be an aircraft crash and fire. The estimated probability of this type of accident is in the range of 1.7×10^{-6} (1 chance in 590,000) per year of operation. If this accident were to occur, the offsite population within 50 miles would receive a dose of 0.012 person-rem; the calculated number of LCFs associated with this dose is 7×10^{-6}, implying that the most likely outcome would be no additional LCFs in the exposed population. The MEI would receive a dose of 0.00034 rem, with a corresponding LCF risk of 2×10^{-7} (1 chance in 5,000,000). A noninvolved worker outside the immediate area of the crash could receive a dose of 1.5 rem, with an associated LCF risk of 9×10^{-4} (1 chance in 1,100). When the probability of the accident is taken into consideration, the risk to the offsite public or a noninvolved worker would be essentially 0.

G.3.7.2.3 Tonopah Test Range Nondefense Mission

No reasonably foreseeable accident scenarios that could result in exposure to noninvolved workers or the public were identified for the ongoing or near-term Nondefense Mission activities at the TTR.

G.3.8 Accident Radiological and Chemical Impacts Conclusion

As discussed above, radiological analyses of the accidents at the NNSS and TTR for all three alternatives were performed using the MACCS2 computer code. As shown in the prior tables, radiation doses were calculated for the MEI, noninvolved worker, and the population within 50 miles. Doses were converted to LCFs and annual risk, based on 0.0006 LCFs per rem and the annual frequency for each accident scenario. The highest accident consequences and risks to the MEI and population under each alternative are summarized in **Table G–21**. For purposes of comparison, Table G–21 also shows the doses an individual and the population within 50 miles would receive from natural background radiation.

An evaluation of the nature and quantity of toxic chemicals was performed to determine whether a postulated accident could cause a release of these chemicals that could result in a hazard to workers or the public. Although the annual frequency of a postulated accident involving the release of toxic chemicals is equivalent to the radiological release accidents, in most cases, the relatively low quantity and physical characteristics of the toxic chemicals preclude any significant health hazards in the event of an accidental release of toxic liquids or gases. An accident resulting in a large chlorine release was postulated that could result in significant impacts on onsite workers and lesser effects at offsite locations.

Table G–21 Highest Accident Radiological Consequences and Risks to the Public

Receptor/ Accident	*Parameter*	*No Action Alternative*	*Reduced Operations Alternative*	*Expanded Operations Alternative*
MEI/Area 5 TRUPACT Type A container, drop, breach, and fire	dose (rem)	1.6	Same as No Action	Same as No Action
	LCF if the accident occurs	0.001		
	annual risk	3×10^{-7}		
	dose from natural background radiation	0.36		
Population/DAF	dose (person-rem)	113		
	LCF if the accident occurs	0 (0.07)		
	annual risk	3×10^{-5}		
	dose from natural background radiation [a]	15,000		

DAF = Device Assembly Facility; LCF = latent cancer fatality; MEI = maximally exposed individual; rem = roentgen equivalent man; TRUPACT = Transuranic Packaging Transporter.

[a] Based on an annual average natural background dose of 0.355 rem per person (see Table 4–51 of this SWEIS) and a population within 50 miles of DAF of 42,085.

Note: Different accident scenarios can represent the highest consequences (dose and LCFs if accident occurs) and risks (annual risk).

G.4 Industrial Accidents

Annual industrial accidents were projected according to recent U.S. Bureau of Labor Statistics and DOE accident statistics. The fatal occupational injury rate was estimated for the construction activities using a rate of 3.7 fatalities per 100,000 full-time equivalent workers for the commercially constructed solar facility and a rate of 1.1 fatalities per 100,000 full-time equivalent workers for NNSA construction activities (DOE 2010b; DOL 2010a). Accident rates across the DOE complex are lower than those of general industry. Estimates of fatalities are shown in **Table G–22**. **Table G–23** shows the projected total recordable cases (TRCs) and the days away from work, restricted duty, or transferred (DART) cases. The rates used for the solar power facility, based on general industry, are 4.1 TRCs and 2.1 DART cases per 200,000 hours worked (DOL 2010b). The rates used to project incidences for NNSA activities are 1.5 TRCs and 0.7 DART cases per 200,000 hours worked.

Table G–22 Project Annual Incidences of Fatal Industrial Accidents

Location/Activity	*No Action Alternative*	*Expanded Operations Alternative*	*Reduced Operations Alternative*
Nevada National Security Site Construction (per year)	0.0	0.029 [a]	0.0
Commercial Solar Power Generation Facility Construction (per construction project)	0.055 [b]	0.10 [c]	0.041 [d]

[a] Based on 250 full-time equivalent workers per year.
[b] Based on 500 full-time equivalent workers for a 35-month construction period.
[c] Based on 750 full-time equivalent workers for a 42-month construction period.
[d] Based on 400 full-time equivalent workers for a 32-month construction period.
Sources: DOE 2010b; DOL 2010a.

Table G–23 Projected Annual Incidences of Nonfatal Industrial Accidents

Location/Activity	*No Action Alternative*		*Expanded Operations Alternative*		*Reduced Operations Alternative*	
	TRC	DART	TRC	DART	TRC	DART
Nevada National Security Site – Site Operations	26	11	32	14	23	10
Nevada National Security Site – Construction	0	0	3.8	1.7	0	0
Commercial Solar Power Generation Facility – Operations	6.2	3.2	8.3	4.2	5.2	2.7
Commercial Solar Power Generation Facility – Construction (per project duration) [a]	60	31	110	56	44	23
North Las Vegas Facility – Site Operations	22	9.5	27	12	20	8.6
Remote Sensing Laboratory – Site Operations	2.0	0.9	2.0	0.9	2.0	0.9
Tonopah Test Range Industrial – Site Operations	1.6	0.7	0.7	0.3	0.6	0.3

DART=days away, restricted, or transferred; TRC=total recordable cases.
[a] Based on 500 full-time equivalent workers for a 35-month construction period for the No Action Alternative; 750 full-time equivalent workers for a 42-month construction period for the Expanded Operations Alternative; and 400 full-time equivalent workers for a 32-month construction period for the Reduced Operations Alternative.
Sources: DOE 2010b; DOL 2010a.

G.5 Intentional Destructive Acts

NNSA has prepared a separate, classified analysis of the potential impacts of intentional destructive acts related to activities at the NNSS. Intentional destructive acts involving NLVF activities were also considered. There were no intentional destructive acts postulated to occur at the Remote Sensing Laboratory or the TTR that would result in greater impacts than those evaluated for the NNSS and NLVF. NNSA will consider the analysis when developing the Record of Decision for this SWEIS.

G.6 Computer Code Descriptions

G.6.1 GENII-2 Computer Code Description

Radiological impacts of releases during normal operations were calculated using GENII-2 (PNNL 2007). GENII-2 is designed to model atmospheric and liquid releases of radionuclides and their human health consequences. Site-specific input data were used, including location, meteorology, population, and source terms. This section briefly describes GENII-2 and outlines the approach used for normal operations.

The GENII-2 computer model, developed by Pacific Northwest National Laboratory, is an integrated system of computer modules that analyzes environmental contamination resulting from acute or chronic releases to, or initial contamination of, air, water, or soil. The model calculates radiation doses to individuals and populations. The GENII-2 computer model is well documented for assumptions, technical approach, method, and quality assurance issues. The GENII-2 computer model has gone through extensive quality assurance and quality control steps, including comparing results from model computations with those from hand calculations and performing internal and external peer reviews (PNNL 2007).

Available release scenarios include chronic and acute releases to water or to air (ground-level or elevated sources), and initial contamination of soil or surfaces. GENII-2 implements NRC models for surface-water doses that were developed using the LADTAP computer code. Exposure pathways include direct exposure via water (swimming, boating, and fishing), as well as soil, air, inhalation, and ingestion. GENII Version 1.485 implemented dosimetry models recommended by the ICRP in Publications 26, 30, and 48 and approved for use by DOE Order 458.1. GENII-2 implements these models, as well as those of ICRP Publications 56 through 72 and the related risk factors published in Federal Guidance Report No. 13 (EPA 1999). Risk factors in the form of EPA-developed slope factors (a special subset of the Federal Guidance Report No. 13 values) are also included. These dosimetry and risk models are considered state of the art by the international radiation protection community and have been adopted by most national and international organizations as their standard dosimetry methodology (EPA 1999; PNNL 2007).

GENII-2 consists of four independent atmospheric models, one surface water model, three independent environmental accumulation models, one exposure module, and one dose/risk module, each with a specific user interface code. The computer programs are of several types: user interfaces (i.e., interactive, menu-driven programs to assist the user with scenario generation and data input), internal and external dose factor libraries, environmental dosimetry programs, and file-viewing routines. The Framework for Risk Analysis in Multimedia Environmental Systems Program serves as the interface for operating GENII-2. For maximum flexibility, the code has been divided into several interrelated, but separate, exposure and dose calculations (PNNL 2007).

G.6.2 MACCS2 Code Description

The MACCS2 computer code V.1.13.1 (Chanin and Young 1997) was used to estimate the radiological doses and health effects that could result from postulated accidental releases of radioactive materials to the atmosphere. MACCS2 was used to analyze the health impacts of postulated accidents. MACCS2 uses actual hourly meteorological data (i.e., windspeed, wind direction, rainfall, atmospheric dispersion stability) from the site. The use of actual hourly data is more accurate in calculating the probabilistic dose distribution for accident analyses. MACCS2 has the capability to model the effects of population evacuation or relocation during or after an accident. Nevertheless, for the purpose of realistically and conservatively predicting potential population movement in response to an accident, it was assumed that no evacuation or relocation would take place.

The specification of the release characteristics, designated a "source term," can consist of up to four Gaussian plumes that are often referred to simply as "plumes." The radioactive materials released were modeled assuming they would be dispersed into the atmosphere while being transported by the prevailing wind. During transport, particulate material can be modeled as being deposited on the ground. The extent of this deposition can depend on precipitation. If contamination levels exceed a user-specified criterion, mitigating actions can be triggered to limit radiation exposure.

Atmospheric conditions during an accident scenario's release and subsequent plume transport are taken from an annual, hourly meteorological data file. Scenario initiation was assumed to be equally likely during any hour contained in the file's data set, with plume transport governed by the succeeding hours. The model was applied by calculating the exposure to each receptor for accident initiation during each hour of the 8,760-hour data set. The mean results of these samples, which include contributions from all meteorological conditions, are presented in this SWEIS. Data sets from nearby Meteorological Stations 5, 6, 26, and 49 were used in assessing impacts for the various modeled accident locations across the NNSS and the TTR.

Two aspects of the code's structure are important to understanding its calculations: (1) the calculations are divided into modules and phases, and (2) the region surrounding the facility is divided into a polar-coordinate grid. These concepts are described in the following sections.

MACCS2 is divided into three primary modules: ATMOS, EARLY, and CHRONC. The three phases following an accident are defined as the emergency, intermediate, and long-term phases. The relationships among the code's three modules and the three phases of exposure are summarized in the following text. In this SWEIS, the ATMOS and EARLY modules were used to evaluate the potential impacts during the emergency phase of an accident. This is the phase during which a receptor would receive the largest radiation dose.

The ATMOS module performs all of the calculations pertaining to atmospheric transport, dispersion, and deposition, as well as the radioactive decay that occurs before release and while the material is in the atmosphere. It uses a Gaussian plume model with Pasquill-Gifford dispersion parameters. The phenomena treated include building wake effects, buoyant plume rise, plume dispersion during transport, wet and dry deposition, and radioactive decay and in-growth. Local topography is not modeled for calculating atmospheric dispersion, which results in conservatively higher plume concentrations, doses, and risks to the public. The results of the calculations are stored for subsequent use by EARLY and CHRONC. In addition to the air and ground concentrations, ATMOS stores information on wind direction, arrival and departure times, and plume dimensions.

It is noted that dispersion calculations such as those used in MACCS2 are generally recognized to be less applicable within 110 yards (100 meters) of a release than they are to distances further downwind (DOE 2004a); such close-in results frequently overpredict the atmospheric concentrations because they do not account for the initial momentum or size of the release or the impacts of structures and other obstacles on plume dispersion. Most of the results presented in this SWEIS are for distances at least 110 yards (100 meters) downwind from a hypothesized release source.

The EARLY module models the period immediately following a radioactive release. This period is commonly referred to as the "emergency phase." The emergency phase begins at each successive downwind distance point when the first plume of the release arrives. The duration of the emergency phase is specified by the user and can range between 1 and 7 days. The exposure pathways considered during this period are direct external exposure to radioactive material in the plume (cloud shine), exposure from inhalation of radionuclides in the cloud (cloud inhalation), exposure to radioactive material deposited on the ground (ground shine), inhalation of resuspended material (resuspension inhalation), and skin dose from material deposited on the skin. Mitigating actions that can be specified for the emergency phase include evacuation, sheltering, and dose-dependent relocation. However, as a conservative measure, no evacuation or relocation was assumed in any of the accident scenario modeling performed for this SWEIS.

The CHRONC module performs all of the calculations pertaining to the intermediate and long-term phases. CHRONC calculates the individual health effects that result from exposures to radiation via ingestion of contaminated foodstuffs, contact with contaminated ground, and/or inhalation of resuspended materials. The CHRONC module was not utilized in any of the accident scenario modeling of this SWEIS due to the acute high exposures that are expected from a post-accident situation (i.e., direct inhalation and external [cloudshine and cloud immersion] exposure only) as compared to the lower dose long-term exposures. For the accident analyses in this SWEIS, various time segments were employed for the assumed duration(s) of the emergency phase(s), depending on specific accident scenario characteristics, such as whether there was a fire involved, the energy of the incident/plume, or other characteristics that would denote material volatility or dispersal capacity.

The intermediate phase begins at each successive downwind distance point upon conclusion of the emergency phase. The user can configure the calculations with an intermediate phase that has a duration as short as zero or as long as 1 year. In the zero-duration case, there is essentially no intermediate phase, and a long-term phase begins immediately upon conclusion of the emergency phase. Intermediate models are implemented assuming that the radioactive plume has passed and the only exposure sources (ground shine and resuspension inhalation) are from ground-deposited material.

The mitigating action model for the intermediate phase is very simple. If the intermediate phase dose criterion is satisfied, the resident population is assumed to be present and subject to radiation exposure from ground shine and resuspension for the entire intermediate phase. If the intermediate phase exposure exceeds the dose criterion, then the population is assumed to be relocated to uncontaminated areas for the entire intermediate phase.

The long-term phase begins at each successive downwind distance point upon conclusion of the intermediate phase. A number of protective measures, such as decontamination, temporary interdiction, and condemnation, can be modeled in the long-term phase to reduce doses to user-specified levels. As discussed above, however, the food ingestion pathway was not modeled.

The decisions on mitigating action in the long-term phase are based on two sets of independent actions: (1) decisions related to whether land at a specific location and time is suitable for human habitation (habitability), and (2) decisions related to whether land at a specific location and time is suitable for agricultural production (ability to farm). For this SWEIS, mitigation or special protective/remedial measures were assumed for the accident exposure calculations and, hence, the accident doses do not include contributions from long-term ingestion.

All of the calculations of MACCS2 are stored based on a polar-coordinate spatial grid with a treatment that differs somewhat between calculations of the emergency phase and calculations of the intermediate and long-term phases. The region potentially affected by a release is represented with a (r, θ) grid system centered on the location of the release. Downwind distance is represented by the radius "r." The angle, "θ," is the angular offset from the north, going clockwise.

The user specifies the number of radial divisions as well as their endpoint distances. The angular divisions used to define the spatial grid are fixed in the code. They correspond to the 16 points of the compass, each being 22.5 degrees wide. The 16 points of the compass are used in the United States to express wind direction. The compass sectors are referred to as the "coarse grid." Population values are assigned to each of these grid segments in the process of calculating the dose to the surrounding population to a distance that the user specifies. All accidents were modeled out to a distance of 50 miles from all applicable release points; however, as discussed above in the normal operations subsection, a sensitivity analysis for the DAF design-basis earthquake was performed to assess the potential differences in total population doses, given that most of the greater Las Vegas metropolitan area is included within an 80-mile, not a 50-mile, radius of most release points at the NNSS. This accident was chosen because, even though the release location is several miles farther away from the Las Vegas population than Area 5, its dose consequences are several orders of magnitude higher than the largest accident at Area 5. The difference in total population between a 50- and 80-mile radius from DAF is about 2.03 million people (~42,000 out to 50 miles and ~2.07 million out to 80 miles). An expected increase in the population dose of 1,312 person-rem (1,160 percent) occurs, from 113 person-rem to 1,425 person-rem. Because the population dose is divided by a much greater population number, however, there is an associated 77 percent decrease in the average dose to a member of the population (2.7 millirem per person to 0.63 millirem per person).

Because emergency phase calculations use dose-response models for early fatalities and early injuries that can be highly nonlinear, these calculations are performed on a finer grid basis than the calculations of the intermediate and long-term phases. For this reason, the calculations of the emergency phase are performed with the 16 compass sectors divided into 3, 5, or 7 equal angular subdivisions. The subdivided compass sectors are referred to as the "fine grid."

Lifetime doses are the conventional measure of detriment used for radiological protection. These are 50-year dose commitments to a weighted sum of tissue doses defined by the ICRP and referred to as the "effective dose equivalent." Lifetime doses may be used to calculate the stochastic health effect risk resulting from exposure to radiation. The calculated lifetime dose was used in cancer risk calculations.

G.6.3 ALOHA Code Description

Consequences of accidental chemical releases were determined using the ALOHA computer code (EPA 2004). ALOHA is an EPA- and National Oceanic and Atmospheric Administration-sponsored computer code that has been widely used in support of chemical accident responses and also in support of safety and NEPA documentation for DOE facilities. The ALOHA code is a deterministic representation of atmospheric releases of toxic and hazardous chemicals. The code can predict the rate at which chemical vapors escape (such as from puddles or leaking tanks) into the atmosphere; a specified direct release rate is also an option.

ALOHA performs calculations for chemical source terms and resulting downwind concentrations. Source term calculations determine the rate at which the chemical material is released to the atmosphere, the release duration, and the physical form of the chemical upon release.

The term "cloud" is used in this document to refer to the volume that encompasses the chemical emission. In general, the released chemical may be a gas, a vapor, or an aerosol. The aerosol release may consist of either solid (fume, dust) or liquid (fog, mist, spray) particles that are suspended in a gas or vapor medium. Liquid particles are also referred to as "droplets." The analyst specifies the chemical and then characterizes the initial boundary conditions of the chemical with respect to the environment through the source configuration input. The ALOHA code allows the source to be defined in one of four ways (direct source, puddle source, tank source, or pipe source) to model various accident scenarios. The source configuration input is used either to specify the chemical source term or to provide ALOHA with the necessary information and data to calculate transient chemical release rates and the physical state of the chemical upon release. ALOHA calculates time-dependent release rates for up to 150 time steps (EPA 2004). ALOHA then averages the release rates from the individual time steps over one to five averaging periods, each lasting at least 1 minute (EPA 2004). The five averaging periods are selected to accurately portray the peak emissions. The five average release rates are inputs to the ALOHA algorithms for atmospheric transport and dispersion (EPA 2004).

ALOHA tracks the evolution of the mean concentration field of the five separate chemical clouds and calculates the concentration at a given time and location through superimposition. ALOHA limits releases to 1 hour.

Evolution of the mean concentration field of the chemical cloud is calculated through algorithms that model the turbulent flow phenomena of the atmosphere. The prevailing wind flows and associated atmospheric turbulence serve to transport, disperse, and dilute the chemical cloud that initially forms at the source. For an instantaneous or short-duration release, the chemical cloud will travel downwind as a puff. In contrast, a plume will form for a sustained or continuous release.

The wind velocity is a vector term defined by a direction and magnitude (windspeed). The wind direction and speed determine where the puff or plume will go and how long it will take to reach a given downwind location. For sustained or continuous releases, the windspeed has the additional effect of stretching out the plume and establishing its initial dilution. It also determines the relative proportion of ambient air that initially mixes with the chemical source emission. Atmospheric turbulence causes the puff or plume to mix increasingly with ambient air and grow (disperse) in the lateral and vertical direction as it travels downwind. Longitudinal expansion also occurs for a puff. These dispersion effects further enhance the dilution of the puff or plume. The two sources of atmospheric turbulence are mechanical turbulence and buoyant turbulence. Mechanical turbulence is generated from shear forces that result when adjacent parcels of air move at different velocities (either at different speeds or directions). Fixed objects on the ground, such as trees or buildings, increase the ground roughness and enhance mechanical turbulence in proportion to their size. Buoyant turbulence arises from vertical convection and is greatly enhanced by the formation of thermal updrafts that are generated from solar heating of the ground.

The ALOHA code considers two classes of atmospheric transport and dispersion based on the assumed interaction of the released cloud with the atmospheric wind flow.

- For airborne releases in which the initial chemical cloud density is less than or equal to that of the ambient air, ALOHA treats the released chemical as neutrally buoyant. A neutrally buoyant chemical cloud that is released to the atmosphere does not alter the atmospheric wind flow; therefore, the term “passive” is used to describe the phenomenological characteristics associated with its atmospheric transport and dispersion. As a passive contaminant, the released chemical follows the bulk movements and behavior of the atmospheric wind flow.

- Conversely, if the density of the initial chemical cloud is greater than that of the ambient air, then the possibility exists for either a neutrally buoyant or a dense-gas type of atmospheric transport and dispersion. In dense-gas atmospheric transport and dispersion, the dense-gas cloud resists the influences of the hydraulic pressure field associated with the atmospheric wind, and the cloud alters the atmospheric wind field in its vicinity. Dense-gas releases can occur with gases that have a density greater than air due either to a high molecular weight or to being sufficiently cooled. A chemical cloud with sufficient aerosol content can also result in a bulk cloud density that is greater than that of the ambient air. Dense-gas releases undergo what has been described in the literature as “gravitational slumping.”

Gravitational slumping is characterized by significantly greater lateral (crosswind) spreading and reduced vertical spreading, compared to the spreading that occurs with a neutrally buoyant release.

In addition to the source term and downwind concentration calculations, ALOHA allows specification of concentration limits for the purpose of consequence assessment (such as assessment of human health risks from contaminant plume exposure). ALOHA refers to these concentration limits as "level-of-concern concentrations." Safety analysis work uses ERPGs and TEELs for assessing human health effects for both facility workers and the public. While ERPGs and TEELs are not explicitly part of the ALOHA chemical database, ALOHA allows the user to input any value, including an ERPG or TEEL value, as the level-of-concern concentration. The level-of-concern value is superimposed on the ALOHA-generated plot of downwind concentration as a function of time to facilitate comparison. In addition, ALOHA generates a footprint that shows the area (in terms of longitudinal and lateral boundaries) where the ground-level concentration reached or exceeded the level of concern during puff or plume passage (the footprint is most useful for emergency response applications).

The ALOHA code uses a constant set of meteorological conditions (such as windspeed and stability class) to determine the downwind atmospheric concentrations. The sequential meteorological data sets used for the radiological accident analyses were reordered from high to low dispersion by applying a Gaussian dispersion model (such as that used by ALOHA) to a representative downwind distance. The median set of hourly conditions for each site (that is, mean windspeed and mean stability) was used for the analysis; this is roughly equivalent to the conditions corresponding to the mean radiological dose estimates of MACCS2.

ALOHA contains physical and toxicological properties for the chemical spills included in this SWEIS and for approximately 1,000 additional chemicals. The physical properties were used to determine which of the dispersion models and accompanying parameters were applied. The toxicological properties were used to determine the levels of concern. Atmospheric concentrations at which health effects are of concern (that is, ERPG-2 or ERPG-3 levels) are used to define the footprint of concern. Because the meteorological conditions specified do not account for wind direction (that is, it is not known *a priori* in which direction the wind would be blowing in the event of an accident), the areas of concern can be defined by a circle of radius equivalent to the downwind distance at which the concentration decreases to levels less than the level of concern. In addition, the concentration at 110 yards (100 meters) (potential exposure to a noninvolved worker) and at the nearest public access, typically the site boundary distance, (exposure to the MEI) are calculated and presented.

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APPENDIX H
UNDERGROUND NUCLEAR TESTING

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This appendix provides basic information regarding underground nuclear testing, including the general steps involved in conducting a test in a vertical shaft and the associated major long-term environmental impacts. The U.S. Department of Energy (DOE) and the National Nuclear Security Administration (NNSA) are not proposing to conduct an underground nuclear test as part of this *Site-Wide Environmental Impact Statement for the Continued Operation of the Department of Energy/National Nuclear Security Administration Nevada National Security Site and Off-Site Locations in the State of Nevada*. However, in accordance with Presidential Decision Directive 15 (November 1993), DOE/NNSA must be able to resume underground nuclear weapons tests within 24 to 36 months if so directed by the President. This capability is maintained by DOE/NNSA at the Nevada National Security Site (NNSS) (formerly the Nevada Test Site).

Because NNSA must maintain its readiness to conduct an underground nuclear test, this appendix provides general information regarding the activities and generalized potential environmental impacts associated with actually conducting such a test. In the event that NNSA is directed by the President to conduct an underground nuclear test, it would be conducted at Pahute Mesa, Rainier Mesa, or Yucca Flat within the Nuclear Test Zone (Areas 7, 8, 9, 10, and 20 and the northern portions of Areas 6 and 11) or at the Nuclear and High Explosives Test Zone (Areas 1, 2, 3, 4, 12, and 16) in the northern and northwestern portions of the NNSS (see Chapter 4, Section 4.1.6.2, Figure 4–13).

The NNSS became the United States' continental nuclear weapons testing site in December 1950, when a 680-square-mile area of land was withdrawn from the 5,000-square-mile Las Vegas Bombing and Gunnery Range (now the Nevada Test and Training Range). The initial nuclear weapon test took place on January 11, 1951, as part of Operation Ranger, and was code-named "Able." Able was an air-dropped test of a small-yield (about 1 kiloton) device (Johnson et al. 2000). Between December 1951 and July 1962, 100 atmospheric nuclear tests were conducted at the NNSS. The first of 828 underground nuclear tests conducted at the NNSS, code-named "Uncle," was detonated on November 29, 1951, in Area 10. The last underground nuclear test to be conducted at the NNSS, code-named "Divider," was on September 23, 1992, in Area 3 (DOE 2000).

The primary purpose of an underground nuclear test is to obtain information related to nuclear weapons. Two basic kinds of underground nuclear tests were conducted at the NNSS: weapon effects tests and weapons development tests. In addition, among the atmospheric and underground nuclear tests that were conducted at the NNSS, 23 were tests associated with the Plowshare Program. The Plowshare tests were part of an effort to develop peaceful uses of nuclear explosions for such purposes as canal and harbor excavation and making petroleum resources more accessible (OTA 1989). In general, underground nuclear tests were conducted in shallow boreholes, deep vertical shafts, and mined tunnels (DOE 1996). Most vertical drill hole tests were conducted for the purpose of developing new weapon systems. Tunnel tests were generally conducted to evaluate the effects (radiation, ground shock, etc.) of various weapons on military hardware and systems (OTA 1989). When the device was detonated at the bottom of a vertical drill hole, data from the test were transmitted through electrical and fiber-optic cables to trailers containing recording equipment placed on the surface near "ground zero." Performance information was also determined from samples of radioactive material recovered by drilling back into the solidified melt created by the explosion (i.e., drillback operations).

Conducting an underground nuclear test is a complex endeavor requiring significant long-term planning and commitment of resources, both natural and economic. A brief, generalized description of underground nuclear testing procedures for a test in a vertical drill hole is included in **Table H–1**.

Table H–1 Underground Nuclear Weapons Testing

Underground Nuclear Weapons Testing (Tests in Vertical Drill Holes)
Step 1 – Site Selection and Drilling. Two subsets of site selection would apply to nuclear tests: (1) selection of an existing drill hole for a specific test or (2) selection of a new drill site within the Nuclear Test Zone or Nuclear and High Explosives Test Zone (see Appendix A, Figure A–1) for a specific test if an existing inventory emplacement hole were not suitable. The goal of site selection would be to optimize the various parameters so that the operational feasibility and successful containment of yields could be attained at a suitably low cost. Many factors would be considered, including: (1) scheduling of field resources; (2) test schedules; (3) the shock sensitivity of a given experiment and possible interactions with other experiments; (4) the depth range required for a suitable device emplacement; (5) geologic structure; (6) geologic material properties; (7) the depth of the water table; (8) potential drilling problems; (9) adjacent expended sites, craters, chimneys, or subsurface collapses; (10) adjacent open emplacement holes or unplugged post-shot or exploratory holes; and (11) non-test program constraints such as groundwater concerns, roads, and power lines (Olsen 1993). If drilling is required after a test location were chosen by the sponsoring national laboratory, a drilling program outlining the requirements of the specific hole would be completed. The selected site would be surveyed, staked, and checked for cultural and biological resources. When these environmental studies are completed, the site would be graded and leveled, and mud pits and a reserve drilling-fluid sump would be constructed to contain drilling fluid and cuttings. A drill rig, usually with its own power source and utilities, would be moved onto the site. Water would be trucked or piped in and mixed with drilling compounds to fill the mud pits. The hole would be drilled using standard Nevada National Security Site (NNSS) big-hole drilling techniques. A normal hole would be from 48 to 120 inches in diameter and from 600 to 2,500 feet deep. During drilling, samples of drill cuttings would be collected at 10-foot intervals and rock cores would be taken as required. After drilling is complete, geophysical logs would be run in the hole to evaluate the condition of the hole and gain a more thorough understanding of the geology. The drill site would be secured by filling the sump and installing specially designed covers over the hole.
Step 2 – Test Site Engineering and Construction. When a hole is selected as a location for a nuclear test, the area around the hole would be surveyed and staked according to the criteria set forth by the sponsoring national laboratory. Cultural and biological surveys would be rerun to determine whether the status of the area has changed. The hole would also be uncovered, and selected geophysical logs rerun in the hole to confirm its condition. Once the environmental clearances are complete, an area would be cleared and leveled for the surface ground-zero equipment and another area close to the selected site would be cleared and leveled for the recording trailer park. This would be a typical earthmoving operation; native materials would be used to top the pads or, if the active native materials are unstable, suitable fill material (Type II base and/or gravel) would be used. Onsite construction would be temporary and would be abandoned after the test is complete. Concrete pads would be placed around the surface ground zero to provide a stable platform for downhole operations, as well as a base for the assembly towers. Equipment would be moved in to emplace the nuclear device in the hole, record the data produced, and provide radiological and seismic monitoring of the site. An extensive grounding system would be used to establish baseline instrumentation grounds, which might include a pit containing saltwater. The equipment to be left in position during the detonation would be protected with an aluminum foil, hex-cell-shaped, shock-mounting material or with dense foam. A circle of radiation detectors would be placed back from the surface ground zero to detect and assess any releases from the experiment. Finally, a perimeter fence would be erected, and access both into and out of the test location would be controlled.
Step 3 – Device Delivery and Assembly. The test article would be delivered to the Device Assembly Facility, any required assembly would be performed, and the test article would be delivered to the test location accompanied by armed convoy. It would then be attached to the diagnostics canister in preparation for emplacement in the hole. Checks would be run and alignment assured. A high state of security would be maintained during all operations involving the nuclear device.
Step 4 – Diagnostic Assembly. A diagnostic canister rack would be assembled off site and transported to the test site. The size of the diagnostic canister would depend on the diameter of the borehole and may be up to almost 12 feet in diameter and 120 feet long and contain all of the instrumentation required to receive data at the time of detonation (real time). The diagnostic canister may contain lead and other materials as shielding for the detectors. After its arrival at the test location, the diagnostic canister would be installed in the assembly tower to be mated with the device on site. Instrumentation cables would be connected to the experiments and the recording trailer park. Slack in the cables would allow the diagnostic canister to be lowered into the hole.

Underground Nuclear Weapons Testing (Tests in Vertical Drill Holes)
Step 5 – Emplacement of the Experiment. The nuclear explosive and special measurement devices would be moved to the hole and lowered to the detonation position; all required diagnostic materials and instrumentation cables would also be lowered into the hole at this time. Downhole operations would be conducted according to a defined checklist and monitored by independent inspectors. The whole assembly would be placed on a set of fracture-safe beams that span the opening. Any auxiliary equipment would then be lowered into the hole, and the area would be secured. Emplacement equipment would be removed from the area, and test runs would be conducted on the downhole experiment. The hole would be stemmed (packed with material) to prevent radioactive materials from escaping during or after the experiment. Stemming materials used to backfill the hole would generally be placed in alternating layers, according to the containment design specification. Sand, gypsum, grout, cold tar, or epoxy plugs are some of the typical stemming materials that may be placed in the hole to provide impenetrable zones. The instrument cables within these zones would be sealed to prevent a radioactive gas path to the surface. Once completed, the area would be cleared of unnecessary equipment. A report would be compiled for the Containment Evaluation Panel to show that the as-built condition reflects the containment design plan.
Step 6 – Test Execution. After the Containment Evaluation Panel accepts the as-built design of the containment and all preliminary tests are successful, the nuclear device would be ready for detonation. Security operations would assure that all non-test-related personnel are evacuated prior to the detonation for security and safety reasons. The explosive would be armed. Radiation monitors would be activated, and aircraft with tracking capability would be prepared for flight in case gas and debris unexpectedly vent to the surface. Weather forecasts and fallout pattern predictions would be reviewed, after which the test device would be detonated. After the test is conducted, the test site would remain secure until it can be assured that the radiological products of the test have been contained. After a suitable time, a reentry crew would be dispatched to the site. Data would be retrieved and the condition of equipment noted. After all is assured to be secure, normal NNSS operations would resume. The site would be roped off, outlining an exclusion zone where there is danger of potential cratering.
Step 7 – Post-shot Operations. After the temperature of the cavity has cooled, a post-shot hole would be drilled into the point of the explosion to retrieve samples of the debris. These highly radioactive samples would provide important information on the test. The post-shot hole would be as small in diameter as possible and drilled at an angle to allow the drill rig to be positioned safely away from the surface ground zero. After drilling and sampling operations are complete, the drill rig and tools would be decontaminated. The site would be cleaned of residual radioactive contamination, and the hole would be plugged back to the surface. This generally completes the test operation.

Source: DOE 1996.

H.1 Disruption of the Physical Environment from Underground Nuclear Testing

Underground nuclear testing at the NNSS was conducted in six main areas: Pahute Mesa, Rainier Mesa, Yucca Flat, Frenchman Flat, Shoshone Mountain, and Buckboard Mesa (Areas 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 15, 16, 18, 19, and 20 of the NNSS) (DOE 1996; DOE/NV 2010). These tests left their mark on the NNSS, both in terms of physical disruption and a subsurface inventory of remaining radioactive isotopes.

The major impacts of an underground nuclear test on the physical environment are ground motion, disruption of the geologic media, surface subsidence, and contamination of the subsurface geologic media and surface soils (DOE 1996). Ground motion is a temporary phenomenon that, with the exception of rockfalls and minor land displacements, has not resulted in permanent effects on the NNSS or offsite areas. Creation of subsidence craters, disruption of underground geologic media, and release of radioactivity into the environment are the most significant and enduring impacts on the physical environment resulting from underground nuclear testing. The following discussion is derived from *The Containment of Underground Nuclear Explosions* (OTA 1989), unless otherwise noted, and describes the events that occur after the moment a nuclear device is detonated.

Figure H–1 shows the sequence of events that occur after an underground detonation (Step 6 in Table H–1). Within a microsecond (one-millionth of a second) of detonation, the billions of atoms involved in a nuclear explosion release their energy. Pressures within the exploding nuclear device reach several million pounds per square inch and temperatures are as high as 100 million degrees Celsius (over 180 million degrees Fahrenheit). A strong shock wave is created by the explosion and moves outward from the point of detonation.

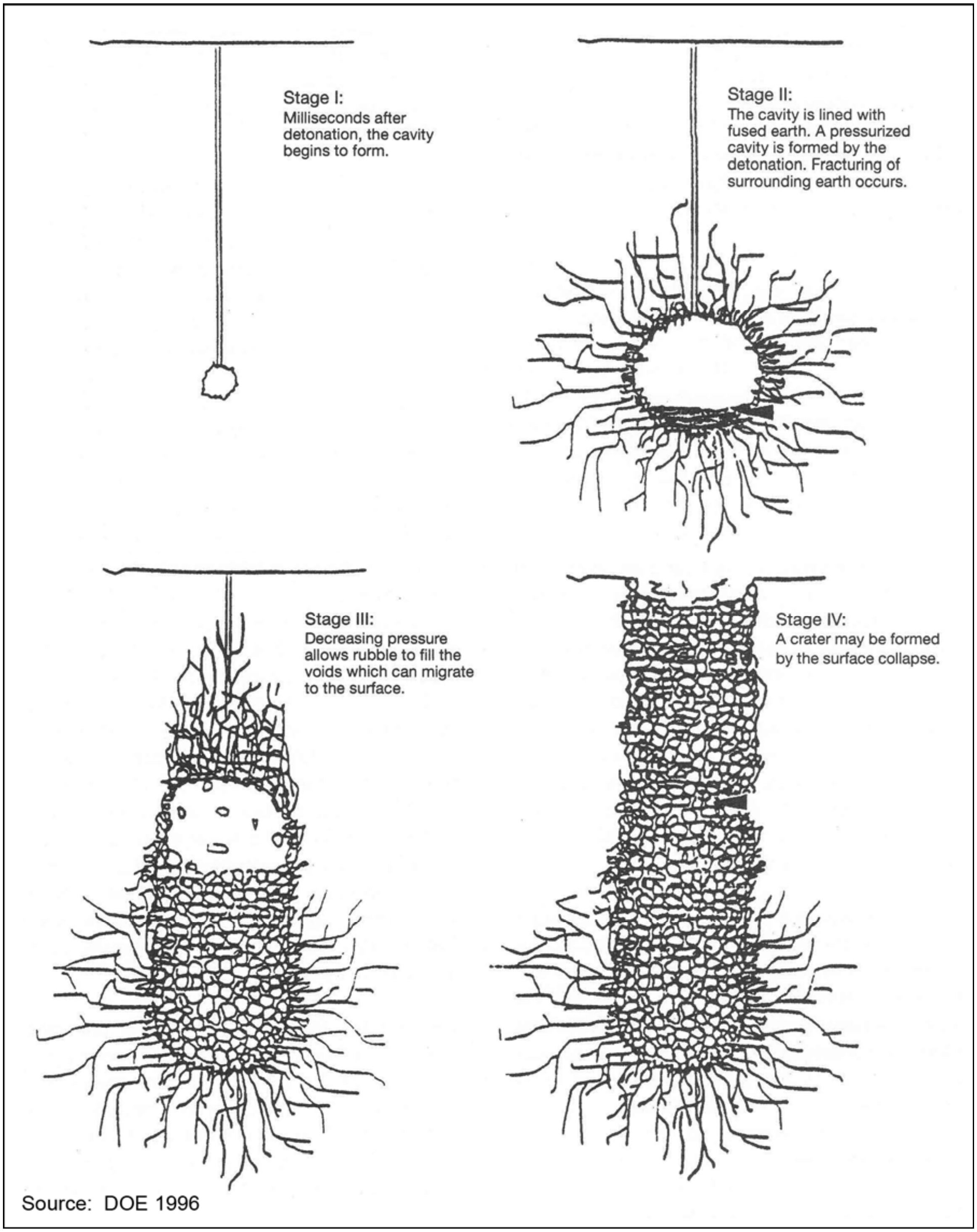

Figure H–1 Formation of an Underground Nuclear Explosive Test Cavity, Rubble Chimney, and Surface Subsidence Crater

Within tens of milliseconds (thousandths of a second) following the detonation, the nuclear device and surrounding rock are vaporized, creating a “bubble” of high-pressure steam and gas. An underground spherical cavity is formed by the pressure of this gas bubble, and the explosive momentum is imparted to the host rock.

As the cavity continues to expand, the pressure decreases and, usually within a few tenths of a second of detonation, equalizes with the pressure from the overlying rock. At this point the cavity reaches its greatest dimensions. Concurrent with this pressure decrease, the shock wave from the detonation travels outward, crushing and fracturing the rock in the near-test environment. Eventually, the shock wave weakens and the rock is no longer crushed, but is merely compressed; it then returns to its original state. This compression and relaxation phase becomes seismic waves that travel through the ground in the same manner as seismic waves formed by an earthquake.

After a few seconds, as the hot gases cool, the molten rock begins to collect and solidify on the cavity sidewalls and in a puddle at the bottom of the cavity. Most of the radioactive products of the explosion would be confined in the solidified rock in this puddle.

When the gases cool, the pressure decreases to the point where it no longer can support the overlying rock and soil and the cavity may collapse, forming a chimney upward from the cavity. The collapse occurs as the overlying rock breaks into rubble and falls into the cavity void. This process continues until either the cavity completely fills with rubble, the chimney reaches a level where the strength of the rock can support the overburden, or, as usually happens, the chimney reaches land surface. When the chimney reaches the surface, the ground sinks, forming a saucer-like subsidence crater. The crater usually forms within a few hours after the detonation, but may take months to form.

Radioactive material produced by a nuclear explosion would remain underground due to the combined effects of the sealing nature of the compressed rock around the cavity, the porosity of the rock, the depth of burial strength of the rock, and the stemming of the emplacement hole.

> Stemming consists of the placement of impenetrable plugs, located at various distances within the emplacement hole, to prevent the emplacement hole from being the path of least resistance for the flow of radioactive materials. It is also designed to prevent gases from traveling up the emplacement hole by forcing them into the surrounding rock, where they are absorbed into the pore spaces.

As noted above, the explosion creates a pressurized cavity filled with gas that is mostly steam. As the cavity pushes outward, the surrounding rock is compressed. Because there is essentially a fixed quantity of gas within the cavity, the pressure decreases as the cavity expands. Eventually, the pressure drops below the level required to deform the surrounding material. Meanwhile, the shock wave imparts outward motion to the material around the cavity. Once the shock wave passes, the material tries to return (rebound) to its original position. The rebound creates a large compressive stress field, called a “stress containment cage,” around the cavity. The physics of the stress containment cage are somewhat analogous to how stone archways support themselves. In the case of a stone archway, the weight of each stone pushes against the others and supports the archway. In the case of an underground nuclear detonation, the rebounded rock locks around the cavity, forming a stress field that is stronger than the pressure inside the cavity. The stress containment cage closes any fractures that may have begun and prevents new fractures from forming.

The predominantly steam-filled cavity eventually collapses, forming a chimney. When this collapse occurs, the steam in the cavity is condensed through contact with the cold rock falling into the cavity. The noncondensable gases remain within the lower chimney at low pressure. After the collapse, high-pressure steam is no longer present to drive gases from the cavity region to the surface.

If the test is conducted in porous material, such as alluvium or tuff, the porosity of the medium provides volume to absorb the gases produced by the explosion. For example, all of the steam generated by a 150-kiloton explosion beneath the water table could be contained in a condensed state within the volume of pore space that exists in a hemispherical pile of alluvium 200 to 300 feet high. Although most steam condenses before leaving the cavity region, the porosity of the geologic media helps contain noncondensable gases, such as carbon dioxide and hydrogen. The noncondensable gases diffuse into the interconnected pore space, and the pressure is reduced to a level that is too low to drive the fractures. The deep water table and high porosity of rocks at the NNSS would facilitate this aspect of containment.

Containment also occurs because of the pressure of the overlying rock. The depth of burial provides a stress that limits fracture growth. For example, as a fracture initiated from the cavity grows, gas seeps from the fracture into the surrounding material. Eventually, the pressure within the fracture decreases below the level needed to extend the fracture. At this point, growth of the fracture stops, and the gas simply leaks into the surrounding material.

Rock strength is another important aspect of containment, but only in the sense that an extremely weak rock (such as water-saturated clay) cannot support a stress containment cage. As a result, sites at the NNSS containing large amounts of water-saturated clay would be avoided for any test conducted in the future.

The final aspect of containment is placement of the stemming material into a vertical hole after the nuclear device has been emplaced and before detonation.

How the various containment features perform depends on many variables, including the size of the explosion, the depth of burial, the water content of the rock, and the geologic structure. Problems may occur when the containment cage does not form completely and gas from the cavity flows either through the emplacement hole or the overburden material. When the cavity collapses, the steam condenses and only noncondensable gases, such as carbon dioxide and hydrogen, remain in the cavity. Carbon dioxide forms from the vaporization of carbonate material in the rock; hydrogen forms when water reacts with the iron in the nuclear device and the diagnostics equipment. The carbon dioxide and hydrogen remain in the chimney if there is available pore space. If the quantity of noncondensable gases is large, however, they can act as a driving force to transport radioactivity through the chimney or the overlying rock. Consequently, the amount of carbonate material and water in the rock near the explosion and the amount of iron available for reaction are important considerations when evaluating containment for a particular test.

Historic deep vertical underground testing resulted in the formation of hundreds of craters at the NNSS (DOE 1996). This resulted in the "pockmarked" appearance of Yucca Flat, the location of the majority of underground nuclear tests on the NNSS, as shown in **Figure H–2**. These subsidence craters generally range from 200 to 2,000 feet in diameter and from a few feet to 200 feet deep. The size of the crater is primarily related to the depth of emplacement and the explosive energy of the device that was detonated. Crater formation occurred less frequently with tests conducted on Pahute Mesa because of the greater competency of the rocks in that area and the depths of most tests. The development of craters has been the principal consequence of underground nuclear testing on the terrain of the NNSS.

In addition to the cavity, chimney, and subsidence crater, pressure ridges and small displacement faults occurred at the surface in some cases. Surface fracturing and faulting are the result of the sudden uplift of the earth at the time of detonation and the collapse during the formation of the chimney and crater. Another permanent consequence of testing is vertical displacement along existing geologic faults, particularly along the Yucca and Carpetbagger Faults in Yucca Flat. Vertical displacement of as much as

8 feet occurred along portions of the Carpetbagger Fault (DOE 1996). Fracturing occurred on the top of Rainier Mesa due to the loss of strength in the rocks in that area (DOE 1996).

Figure H–2 Aerial View of a Portion of Yucca Flat, Nevada National Security Site

Although underground nuclear testing had long-term physical consequences on the environment, the effects of the tests were additive, rather than synergistic. That is, the sum of the effects of multiple tests did not produce unexpected consequences or consequences that were greater than the sum of the individual tests (DOE 1996).

Fracturing of the rock in the near-test environment may have resulted in some alteration of the natural permeability of the rocks underlying parts of the NNSS. The shock wave and compressive forces from a test could have increased the permeability of the rock by creating more fractures near the test or may have actually decreased permeability by widening and then closing fractures at greater distances from the test. Post-test measurements of rock samples taken from tunnel complexes generally show that the properties of the host rock are unchanged at a greater distance than three cavity radii from the point of detonation. Beyond that distance, no fracturing occurs from the detonation, but preexisting fractures are widened as the shock wave propagates through the host rock and then are closed after the shock wave has passed. In some instances, the closing of the fractures may reduce the fracture aperture and may result in some permanent reduction in the gross permeability of the rock mass. The implications of the permeability changes in the rock due to underground nuclear testing are discussed in the next section.

H.2 Radioactive Contamination of the Geologic Media and Groundwater

The second major effect of underground nuclear testing, in addition to the impacts on the physical environment, is the formation of pockets of radioactive contamination surrounding each underground test and injection of radionuclides and other contaminants into the groundwater. The total amount of radioactivity released into the underground environment during a test is called the "radionuclide source term." The source term includes numerous isotopes that are both short- and long-lived. For instance, in a 1-kiloton atmospheric detonation, an initial release of about 41 billion curies of radioactivity decays to about 10 million curies in just 12 hours (OTA 1989). All radioactive isotopes decay at specific rates. The decay process is measured in terms of "half-life." The radioactive half-life for a given radioisotope is the time for half the radioactive nuclei in any sample to undergo radioactive decay. The half-lives of radioisotopes vary tremendously. For example, polonium-216 has a half-life of about 0.15 seconds and plutonium-239, a half-life of over 24,000 years; other isotopes may have shorter or longer half-lives. As a simplified example of radioactive decay, the half-life of tritium (radioactive hydrogen) is about 12.3 years. So, beginning with an initial sample of 100 atoms of tritium, after 12.3 years there would be 50 atoms, and after another 12.3 years, about 25 atoms. This decay process continues until there are no radioactive isotopes remaining from the original sample.

In a 2001 report, scientists from Los Alamos National Laboratory and Lawrence Livermore National Laboratory calculated the underground inventory of radionuclides resulting from underground nuclear testing at the NNSS between 1951 and 1992 (Bowen et al. 2001). The radionuclide inventory was divided into six principal geographic test areas where underground nuclear testing was conducted at the NNSS: Frenchman Flat, Pahute Mesa in Area 19, Pahute Mesa in Area 20, Rainier Mesa/Shoshone Mountain, Yucca Flat (above the water table), and Yucca Flat (below the water table). Not all radionuclides produced in an underground nuclear test were included in this inventory. Radionuclides included in the inventory were: (1) residual and unburned fissile fuel and tracer materials, such as isotopes of uranium, plutonium, americium, and curium-244; (2) fission products such as cesium-137 and strontium-90; (3) tritium (a radioactive isotope of hydrogen); and (4) neutron-induced radioisotopes in device parts, external hardware, and the surrounding geologic medium (such as carbon-14, chlorine-36, and calcium-41). Radionuclides that were excluded from the inventory are (1) those with half-lives that are so short (microseconds to hours) that they decay to undetectable levels soon after the test and (2) those that are produced in such low initial abundance that they never exceed levels deemed unsafe or nonpermissible by regulatory agencies. Because no underground nuclear tests have been conducted since 1992, the radionuclide inventory has been decreasing due to the natural decay of radioactive particles.

Table H–2 provides the calculated total radionuclide source terms for the six geographic test areas and for the NNSS overall.

Table H–2 Underground Radionuclide Inventory in the Six Principal Geographic Test Areas at the Nevada National Security Site (in curies; decay corrected to September 23, 1992)

Geographic Test Areas at the NNSS	*Frenchman Flat*	*Pahute Mesa, Area 19*	*Pahute Mesa, Area 20*	*Rainier Mesa/ Shoshone Mountain*	*Yucca Flat (more than 328 feet above the water table)*	*Yucca Flat (less than 328 feet above the water table)*	*Total Inventory*
Radionuclide Inventory	190,000	19,200,000	60,900,000	887,000	15, 800,000	35,200,000	132,000,000

NNSS = Nevada National Security Site.
Note: Numbers are rounded to three significant figures.
Source: Bowen et al. 2001.

The inventory in Table H–2 represents an upper limit of the radionuclides that are potentially available for transport in the groundwater. The portion of the source term that is considered available to the groundwater regime at the NNSS is the radioactive inventory under or within 328 feet of the water table. About 30 percent of underground nuclear tests at the NNSS were conducted beneath the water table (Bowen et al. 2001). In 1996, DOE estimated, based on work by Bryant and Fabryka-Martin (1991) that about 38 percent of the underground nuclear tests at the NNSS were conducted within about 246 feet (75 meters) of the water table. Using that estimate as the basis, a conservative estimate of the potential hydrologic source term for radionuclides underground at the NNSS as of September 1992 is just over 50,000,000 curies. As noted in Bowen et al. 2001, the radionuclide source term will never be transported in its entirety; the hydrologic source term comprises only those radionuclides that are dissolved in or transportable by groundwater. Further, within the hydrologic source term, the mobility of radionuclides is moderated both by chemical kinetics and hydrology.

Most investigators have concluded that, exclusive of tritium, much of the radioactivity released during an underground nuclear test remains confined in the melted and fused rock in the detonation cavity, particularly the refractory isotope species, such as plutonium, rare earth elements, zirconium, and alkaline earth elements. The more volatile nuclides, such as alkali metals, ruthenium, uranium, antimony, tellurium, and iodine, tend to condense on the chimney rubble. The most mobile isotopes are the gaseous species, including argon, krypton, and xenon, that tend to rise through the chimney and may ultimately seep out to the surface (DOE 1996).

The mechanisms by which radionuclides can enter the groundwater include leaching from the melt glass and condensation in the cavity and chimney; injection into fractures outside the cavity during the first milliseconds after the test; and interactions between gaseous species and the groundwater.

Leaching from the rubble chimney is probably an important pathway to the groundwater for radionuclides from tests that were conducted under the water table or in or under perched aquifers. Groundwater within the cavity area was vaporized at detonation of the device, and some portion of that vapor was forced by the shock wave out of the cavity and into the surrounding host rock. With time, groundwater gradually flowed back into the cavity and chimney and came into direct contact with the radionuclides that were condensed onto the chimney rubble. Depending on the solubility of the radionuclides, the groundwater would dissolve the residues until chemical equilibrium was achieved. Once dissolved, the radionuclides would be available for migration through groundwater flow. The impacts of past underground nuclear testing are discussed in Chapter 4, Section 4.1.6.2, and Chapter 6, Section 6.3.6.2.

Leaching of radionuclides from the melt glass and cavity rubble probably has occurred to some degree. According to Borg et al. (1976), studies asserted that (1) less than 1 percent of the radionuclides in the melt glass near the bottom of the chimney would be distributed onto the chimney rubble, and (2) most of the tritium would be mixed with the water in the chimney and cavity at times for about 1 year, while some tritium may be trapped in the melt glass. Leaching of radionuclides from the melt glass probably would occur over extended periods of time, and the leachate would be available for transport through groundwater flow.

Fracture injection is the final pathway for the introduction of radionuclides into the groundwater regime. Water vapor discharged from the cavity immediately following a detonation was seismically "pumped" into the fractures formed by the test and through other fractures that were widened by the shock wave. Following the achievement of equilibrium conditions, radionuclides injected into fractures under the water table became available for transport through groundwater flow.

Tritium is one of the most mobile of the radionuclides resulting from underground nuclear testing present in the subsurface environment surrounding the detonation cavity following an underground nuclear test.

It is also present at higher concentrations (comprising about 95 percent of the total radiological source term as of September 1992 [Bowen et al. 2001]) than other radionuclides for a period of 100 to 200 years following a test, and is generally believed to be present principally as part of a free water molecule, rather than being bound in the puddle glass that contains the large majority of the radionuclides remaining after a test. Tritium is known to migrate when induced by pumping at nearby wells, while many other radionuclides remain in or near the detonation cavity (Bryant 1992). Therefore, tritium represents the radionuclide of greatest concern to users of groundwater for at least the next 100 years because of its mobility and high concentration. For these reasons, in the assessment of impacts from the groundwater pathway, tritium is the primary radionuclide used in the models that have been and are being developed to improve our understanding of the potential movement and risk associated with groundwater beneath the NNSS (see Chapter 6, Section 6.3.6.2). Bowen et al. (2001) calculated the amount of tritium in the overall NNSS radiological source term to be about 125,560,000 curies. Using the 38 percent ratio noted above, it is estimated that about 48,000,000 curies of tritium could be considered to be part of the hydrologic source term, as of September 23, 1992. Based on the radioactive decay rate (half-life) for tritium, the amount of tritium currently available as part of the hydrologic source term is considerably less than 48,000,000 curies.

H.3 References

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APPENDIX I
CONTRACTOR DISCLOSURE STATEMENTS

NEPA DISCLOSURE STATEMENT FOR PREPARATION OF A SITE-WIDE EIS FOR THE CONTINUED OPERATION OF THE DEPARTMENT OF ENERGY/ NATIONAL NUCLEAR SECURITY ADMINISTRATION NEVADA NATIONAL SECURITY SITE AND OFF-SITE LOCATIONS IN THE STATE OF NEVADA

CEQ regulations at 40 CFR 1506.5(c), which have been adopted by DOE (10 CFR 1021), require contractors who will prepare an EIS to execute a disclosure specifying that they have no financial or other interest in the outcome of the project. The term "financial interest or other interest in the outcome of the project," for the purposes of this disclosure, is defined in the March 23, 1981 guidance "Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations," 46 FR 18026-18038 at Question 17a and b.

"Financial or other interest in the outcome of the project 'includes' any financial benefit such as a promise of future construction or design work in the project, as well as indirect benefits the contractor is aware of (e.g., if the project would aid proposals sponsored by the firm's other clients)," 46 FR 18026-18038 at 18031.

In accordance with these requirements, the offeror and any proposed subcontractors hereby certify as follows: (check either (a) or (b) to assure consideration of your proposal)

(a) ___X_________ Offeror and any proposed subcontractor have no financial interest in the outcome of the project.

(b) _____________ Offeror and any proposed subcontractor have the following financial or other interest in the outcome of the project and hereby agree to divest themselves of such interest prior to award of this contract.

Financial or Other Interests:

1.
2.
3.

Certified by:

Signature

Frederick J. Carey, President
Potomac-Hudson Engineering, Inc.

Name

June 28, 2011

Date

NEPA DISCLOSURE STATEMENT FOR PREPARATION OF A SITE-WIDE EIS FOR THE CONTINUED OPERATION OF THE DEPARTMENT OF ENERGY/ NATIONAL NUCLEAR SECURITY ADMINISTRATION NEVADA NATIONAL SECURITY SITE AND OFF-SITE LOCATIONS IN THE STATE OF NEVADA

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(a) ____X____ Offeror and any proposed subcontractor have no financial interest in the outcome of the project.

(b) __________ Offeror and any proposed subcontractor have the following financial or other interest in the outcome of the project and hereby agree to divest themselves of such interest prior to award of this contract.

Financial or Other Interests:

1.
2.
3.

Certified by:

Signature

Gil Olivas
Name
Contracts Manager
SAIC

29 June 2011
Date

NEPA DISCLOSURE STATEMENT FOR PREPARATION OF A SITE-WIDE EIS FOR THE CONTINUED OPERATION OF THE DEPARTMENT OF ENERGY/ NATIONAL NUCLEAR SECURITY ADMINISTRATION NEVADA NATIONAL SECURITY SITE AND OFF-SITE LOCATIONS IN THE STATE OF NEVADA

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(a) __X____ Offeror and any proposed subcontractor have no financial interest in the outcome of the project.

(b) ________ Offeror and any proposed subcontractor have the following financial or other interest in the outcome of the project and hereby agree to divest themselves of such interest prior to award of this contract.

Financial or Other Interests:

1.
2.
3.

Certified by:

F. Michael Gray

Signature

F. Michael Gray – Vice President, Director of Contracts
Name

June 30, 2011
Date