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Nevada Test Site Environmental Report 2009

National Nuclear Security Administration

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New Name for the Nevada Test Site

On August 23, 2010, the U.S. Department of Energy, National Nuclear Security Administration announced the renaming of the Nevada Test Site to the **Nevada National Security Site**. Because this document reports on calendar year 2009 activities, the Nevada Test Site name has not been changed. Next year's report will be titled the Nevada National Security Site Environmental Report.

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Executive Summary

The *Nevada Test Site Environmental Report 2009* was prepared to meet the information needs of the public and the requirements and guidelines of the U.S. Department of Energy (DOE) for annual site environmental reports. It was prepared by National Security Technologies, LLC (NSTec), for the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO). This and previous years' Nevada Test Site Environmental Reports (NTSERs) are posted on the NNSA/NSO website at http://www.nv.doe.gov/library/publications/aser.aspx.

Purpose and Scope of the NTSER

This NTSER was prepared to satisfy DOE Order DOE O 231.1A, "Environment, Safety and Health Reporting." Its purpose is to (1) report compliance status with environmental standards and requirements, (2) present results of environmental monitoring of radiological and nonradiological effluents, (3) report estimated radiological doses to the public from releases of radioactive material, (4) summarize environmental incidents of noncompliance and actions taken in response to them, (5) describe the NNSA/NSO Environmental Management System and characterize its performance, and (6) highlight significant environmental programs and efforts.

This NTSER summarizes data and compliance status for calendar year 2009 at the Nevada Test Site (NTS) and its two support facilities, the North Las Vegas Facility (NLVF) and the Remote Sensing Laboratory (RSL)-Nellis. It also addresses environmental restoration (ER) projects conducted at the Tonopah Test Range (TTR). Through a Memorandum of Agreement, NNSA/NSO is responsible for the oversight of TTR ER projects, and the Sandia Site Office of NNSA (NNSA/SSO) has oversight of all other TTR activities. NNSA/SSO produces the TTR annual environmental report available at http://www.sandia.gov/news/publications/environmental/index.html.

Major Site Programs and Facilities

NNSA/NSO directs the management and operation of the NTS and six sites across the nation. The six sites include two in Nevada (NLVF and RSL-Nellis) and four sites in other states (RSL-Andrews in Maryland, Livermore Operations in California, Los Alamos Operations in New Mexico, and Special Technologies Laboratory in California). Los Alamos, Lawrence Livermore, and Sandia National Laboratories are the principal organizations that sponsor and implement the nuclear weapons programs at the NTS. NSTec is the current Management and Operating (M&O) contractor accountable for the successful execution of work and ensuring that work is performed in compliance with environmental regulations. The six sites all provide support to enhance the NTS as a location for weapons experimentation and nuclear test readiness.

The three major NTS missions include National Security/Defense, Environmental Management, and Nondefense. The major programs that support these missions are Stockpile Stewardship and Management, Nonproliferation and Counterterrorism, Work for Others, Environmental Restoration, Waste Management, Conservation and Renewable Energy, Other Research and Development, and Infrastructure. The major facilities that support the programs include the U1a Facility, the Big Explosives Experimental Facility (BEEF), the Device Assembly Facility, the Joint Actinide Shock Physics Experimental Research Facility, the Radiological/Nuclear Countermeasures Test and Evaluation Complex that became operational in 2009, the Area 5 Radioactive Waste Management Complex (RWMC), the Area 3 Radioactive Waste Management Site (RWMS), and the Nonproliferation Test and Evaluation Complex (NPTEC).

Other Key Environmental Initiatives

Aside from the environmental restoration efforts to clean up legacy contamination from historical nuclear testing activities, several other environmental key initiatives are pursued. They are components of the Nondefense mission of NNSA/NSO to prevent pollution, minimize waste generation, conserve water, advance energy efficiency, reduce fossil fuel use, pursue renewable energy sources, and support the federal goals within all of these areas promulgated through executive orders and DOE orders.

Environmental Performance Measures Programs

During the conduct of the major programs mentioned above, NNSA/NSO complies with applicable environmental and public health protection regulations and strives to manage the NTS as a unique and valuable national resource. For the identification of NTS environmental initiatives, NNSA/NSO relies upon NSTec's Integrated Safety Management System (ISMS), contractual requirements, and the Environmental Management System (EMS). The ISMS is designed to ensure the systematic integration of environment, safety, and health concerns into management and work practices so that NTS missions are accomplished safely and in a manner that protects the environment. NNSA/NSO oversees ISMS implementation through the Integrated Safety Management Council.

The EMS is designed to incorporate concern for environmental performance throughout all site programs and activities, with the ultimate goal being continual reduction of program impacts on the environment. The NTS attained International Organization for Standardization (ISO) 14001 certification for its EMS in 2008, and continues to maintain certification. In addition to ISMS and EMS, two NSTec programs operate specifically to support some of the key environmental initiatives. They are the Energy Management Program and the Pollution Prevention and Waste Minimization (P2/WM) Program.

Environmental Management System

An Environmental Working Group, composed of key employees in several NSTec organizations, helps determine what EMS objectives and targets will be implemented to address specific environmental aspects of NNSA/NSO operations. These are determined on a fiscal year (FY) (October 1 through September 30) basis. The status toward meeting the FY 2009 EMS objectives and targets is summarized on page 24 of the *Nevada Test Site Environmental Report Summary 2009.*

During April and May 2009, NNSA/NSO conducted an assessment of the NTS EMS against the requirements of DOE O 450.1A, "Environmental Protection Program." There were two findings regarding existing procedural documents that were corrected by updating references to superseded documents and adding descriptions of new actions taken to comply with DOE O 450.1A. An independent audit conducted by NSTec's Performance Analysis and Improvement Division also found procedural documents that needed minor revisions. All assessment findings were resolved and closed.

Two surveillances were performed by the ISO 14001 certifying organization in 2009. The EMS program was found to meet all the requirements of the ISO 14001 standard with no major non-conformities, and it was recommended that the EMS maintain full certification. In November 2009, the 2009 Facility EMS Annual Report Data for the NTS was entered into a DOE Headquarters database. The report includes a score card section that is a series of questions regarding a site's EMS effectiveness in meeting the objectives of federal EMS directives. The NTS scored "green" (the highest score).

Energy Management Program

The NNSA/NSO Energy Management Program exists to support the Federal Energy Management Program mission through reducing the use and cost of energy in NNSA/NSO facilities. The Energy Management Program has the specific mission to implement the requirements of DOE O 430.2B, "Departmental Energy, Renewable Energy and Transportation Management." This is accomplished by advancing energy efficiency, water conservation, and the use of solar and other renewable energy sources. In 2009, the Energy Management Program developed the *FY 2010 NNSA/NSO Energy Executable Plan*, which serves as a contract between NNSA/NSO and NNSA Headquarters in terms of how to meet DOE O 430.2B. The implementation status of this plan's goals is summarized on page 23 of the *Nevada Test Site Environmental Report Summary 2009.*

P2/WM Program

The P2/WM Program has initiatives to eliminate or reduce the generation of waste, the release of pollutants to the environment, and the use of Class I ozone-depleting substances. These initiatives are identified in DOE O 450.1A and Executive Order EO 13423, "Strengthening Federal Environmental, Energy, and Transportation Management," and are pursued through source reduction, re-use, segregation, and recycling, and by procuring recycled-content materials and environmentally preferable products and services. In 2009, the P2/WM Program was compliant with the requirements for implementing P2/WM processes but did not meet a goal under EO 13423. Only 40 percent of qualified items purchased by NNSA/NSO in 2009 contained the minimum amount of recycled materials instead of the 100 percent required, if possible, under EO 13423.

The 2009 P2/WM activities resulted in reductions to the volume and/or toxicity of waste generated by NNSA/NSO activities. A reduction of 114 metric tons (mtons) (125 tons) of hazardous wastes was realized in 2009. The largest proportion of this reduction came from shipments of bulk used oil (81 mtons [89 tons]), lead acid batteries (11.1 mtons [12 tons]), and lead scrap metal (9.8 mtons [10.8 tons]) to offsite vendors for recycling. A reduction of 153.5 mtons (168.8 tons) of solid wastes was realized in 2009. The largest proportion of this reduction came from shipping 106.7 mtons (117.4 tons) of mixed paper and cardboard to a vendor for recycling and shipping 31.2 mtons (34.3 tons) of food wastes from the NTS cafeterias to a local pig farm.

Environmental Awards

The effectiveness of the NTS EMS was recognized through the receipt of several environmental awards in 2009. NNSA/NSO was awarded two DOE Office of Energy Efficiency and Renewable Energy national-level Energy Management awards:

- The *Vehicle Fleet Management Award to an Organization* was received for exceeding national goals related to alternative fuels usage.
- The *Energy Efficiency/Energy Program Management Award to a Small Group* was received for the successful integration of energy efficiency measures into the Building B-3 Remediation, Restoration, and Upgrade Project completed at the NLVF in March 2008.

Two NTS projects were recognized with DOE/NNSA/National Pollution Prevention awards:

- The Mercury Highway Repaving Project won an *Environmental Stewardship Award* in the category of Waste/Pollution Prevention. The project recycled 26.2 miles of existing pavement, which prevented almost 40,000 cubic yards of waste from being generated and disposed on the NTS. The project also saved about 4,000 gallons of gas as well as the wear on trucks that would have been required to transport the waste.
- The Pluto Facility Closure Project won a *Best-In-Class Award* in the category of recycling. It generated more than 94,000 pounds of waste (e.g., used oil, mercury-containing items, light bulbs, batteries, lead) that were all recycled at offsite facilities.

Compliance

One measure of the effectiveness of the EMS is the degree of compliance with applicable environmental laws, regulations, and policies that protect the environment and the public from the effects of NTS operations. The performance measures that are tracked annually to ensure compliance are consolidated and presented in Chapter 2, Compliance Summary. In 2009, environmental compliance was nearly 100 percent for all federal statutes, as shown below.

Federal Environmental Statute	What it Covers	2009 Status
Environmental Restoration and Waste Management		
Resource Conservation and Recovery Act (RCRA)	Generation, management, and disposal of hazardous waste (HW) and mixed low-level waste (MLLW) ("mixed" indicates a HW component) and cleanup of inactive, historical waste sites	On July 9, the final shipment of legacy transuranic (TRU) and mixed TRU waste was shipped off site to the Idaho National Laboratory, meeting the 2009 Final Site Treatment Plan milestone date of July 31 negotiated with the State of Nevada, and completing a 35-year management, characterization, and repackaging effort by NNSA/NSO. A total of 84,313 cubic feet equaling 2,292.5 tons of MLLW were received and disposed in accordance with state permits. Semiannual water samples from three groundwater monitoring wells at the Area 5 RWMC confirmed that buried MLLW remains contained. All vadose zone monitoring and post-closure inspections of historical RCRA closure sites confirmed the sites' integrity to contain HW.
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)	Cleanup of waste sites containing hazardous substances	No HW cleanup operations on the NTS are regulated under CERCLA; they are regulated under RCRA instead.
Federal Facilities Compliance Act (FFCA)	Extends enforcement authority of local, state, and federal HW management laws to federal facilities.	All 2009 milestones established under the Federal Facility Agreement and Consent Order with the State of Nevada were met for conducting corrective actions and closures of historical contaminated sites called corrective action sites (CASs). A total of 46 CASs were closed in accordance with State-approved corrective action plans.
National Environmental Policy Act (NEPA)	Projects are evaluated for environmental impacts	NNSA/NSO began preparation of a new *Site-Wide Environmental Impact Statement for the Nevada Test Site and Offsite Locations in the State of Nevada*. It will evaluate current and future NNSA/NSO operations in Nevada during the ten-year period of January 1, 2011, through December 31, 2020.
Toxic Substances Control Act (TSCA)	Management and disposal of polychlorinated biphenyls (PCBs)	Nine drums of fluorescent light ballasts containing PCBs were shipped off site to U.S. Environmental Protection Agency (EPA)–permitted disposal and treatment facilities. No inspections by state TSCA regulators were performed in 2009.
Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)	Storage and use of pesticides and herbicides	Both restricted-use and nonrestricted-use pesticides were used in 2009 and were applied by State of Nevada certified personnel. Facility inspections indicated that the storage and use of pesticides were in compliance with federal and state regulations.
Radiation Protection		
DOE O 5400.5, "Radiation Protection of the Public and the Environment"	Measuring radioactivity in the environment and estimating radiological dose to the public due to NNSA/NSO activities	Routine radiological monitoring was conducted at 19 onsite air stations, 21 offsite and 37 onsite groundwater sources, and 109 stations measuring direct gamma radiation. A combined total of 47 plant and animal samples were collected from six sites to monitor biota. The total annual dose to the maximally exposed individual (MEI) from all exposure pathways due to NNSA/NSO activities was estimated to be 6.16 mrem/yr, well below the DOE limit of 100 mrem/yr.

Federal Environmental Statute	What it Covers	2009 Status
Radiation Protection (continued)		
Atomic Energy Act (through compliance with DOE O 435.1, "Radioactive Waste Management")	Management of radioactive wastes generated or disposed on site	A total of 1,228,227 cubic feet totaling 2,313.6 tons of radioactive wastes, which included low-level waste (LLW), MLLW, and asbestiform LLW, were received and disposed on site. All volumes and weights of disposed radiological wastes for permitted disposal units were within permit limits. All vadose zone and groundwater monitoring continued to verify that disposed LLW and MLLW are not migrating to groundwater or threatening biota or the environment.
Air Quality and Protection		
Clean Air Act	Air quality and emissions into the air from facility operations	There are no major sources of criteria air pollutants and hazardous air pollutants at the NTS, NLVF, or RSL-Nellis. Nonradiological air emissions from all permitted equipment and facilities were calculated and were all below permit emission limits. No air permit exceedances, Notices of Violation, or other air quality noncompliances occurred in 2009. The NTS air permit was significantly modified in May 2009, and a new NTS air permit was issued in June 2009. The 19 onsite continuous air sampling stations detected man-made radionuclides at levels comparable to previous years and well below the regulatory dose limit for air emissions to the public of 10 mrem/yr. The estimated dose from all 2009 NTS air emissions to the MEI is 1.69 mrem/yr.
Water Quality and Protection		
Clean Water Act	Water quality and effluent discharges from facility operations	All required maintenance, monitoring, reporting, and mitigation actions were taken for permitted wastewater systems and monitoring wells. All domestic and industrial wastewater systems and groundwater monitoring well samples were within permit limits except three from the E Tunnel ponds and one from Well ER-12-1, which were all for specific conductance. Pumped groundwater samples at the NLVF were all within National Pollutant Discharge Elimination System (NPDES) permit limits. NTS operations do not require any NPDES permits.
Safe Drinking Water Act		All concentrations of regulated water contaminants in drinking water from the three permitted public water systems on the NTS were below state and federal permit limits.
Other Environmental Statutes		
Emergency Planning and Community Right-to-Know Act (EPCRA)	The public's right to know about chemicals released into the community	NNSA/NSO reported releases, waste disposal, and waste transfers of lead and mercury. As part of normal operations, 22,151 pounds (lb) of lead and 1,363 lb of mercury were received for onsite disposal, 13,008 lb of lead were released as spent ammunition at the Mercury Firing Range, which will be recycled in the future, and 7.8 lb of lead were released to the air from the Mercury Firing Range. Lead and mercury wastes generated on site and shipped off site for either disposal or recycling totaled 20,200 lb for lead and 0.92 lb for mercury. The chemical inventory for NTS, NLVF, and RSL-Nellis was updated and submitted to the State of Nevada. No releases occurred that triggered state or federal reporting requirements.

Federal Environmental Statute	What it Covers	2009 Status
Other Environmental Statutes (continued)		
Endangered Species Act (ESA)	Threatened or endangered species of plants and animals	NNSA/NSO maintained compliance with the ESA. Field surveys for 24 proposed projects were conducted to ensure no threatened desert tortoises would be harmed during land disturbance, 8 acres of tortoise habitat were, or were scheduled for disturbance, and no tortoises were harmed at or displaced from project sites. One tortoise was killed on a road and five were moved off of roads. All actions were in compliance with the U.S. Fish and Wildlife Service's requirements for work conducted in desert tortoise habitat.
National Historic Preservation Act (NHPA)	Identifying and preserving historic properties	NNSA/NSO maintained compliance with the NHPA. A total of 512 acres were surveyed for 11 proposed projects, and four prehistoric/ historical sites were identified. No sites evaluated in 2009 were determined eligible for the National Register of Historic Places.
Migratory Bird Treaty Act (MBTA)	Protecting migratory birds, nests, and eggs from harm	On the NTS, one red-tailed hawk was electrocuted by a power line, and one western burrowing owl was hit by a vehicle. One Say's phoebe nest with four chicks and two nests of unknown species, each with chicks, were protected from harm. NTS operations resulting in harm to the nests were postponed until chicks had fledged and nests were empty.

Occurrences and Unplanned Releases

No unplanned airborne releases and no unplanned releases of radioactive liquids occurred from the NTS, NLVF, or RSL-Nellis in 2009. Corrective actions were taken in 2009, however, for six environmental occurrences that were reported to the State. They included (1) a spill of spent oil in Area 6 of the NTS, (2) three radioactively contaminated fragments of legacy metal debris discovered in Area 5 of the NTS, (3) eight strips of legacy radiological material discovered in Area 2 of the NTS, (4) a sewage overflow in Area 6 of the NTS, (5) loose contaminated soil in a trailer delivering waste to the Area 5 RWMS, and (6) legacy contaminated areas on the TTR outside of a fenced contamination area.

Radiation Dose to the Public

Background Gamma Radiation – Mean background gamma radiation exposure rates on the NTS are measured at ten thermoluminescent dosimeter (TLD) stations located away from radiologically contaminated sites. The average mean exposure rate among these ten stations in 2009 was 120 milliroentgen per year (mR/yr) and ranged from 64 to 165 mR/yr (Section 6.3). This equates to an annual estimated background external dose of 64 to 165 millirem per year (mrem/yr) to a hypothetical person residing at those locations all year. The Desert Research Institute (DRI) used TLDs at offsite locations in 2009 to measure background radiation, and these measurements ranged from 77 mR/yr at Pahrump, Nevada, to 160 mR/yr at Twin Springs, Nevada (Section 7.1.2).

Public Dose from Drinking Water – Man-made radionuclides from past nuclear testing have not been detected in offsite drinking water supply wells or springs in the past or during 2009 (Section 5.1.6). The offsite public does not receive a radiation dose from NTS operations from drinking water.

Public Dose from Inhalation – The radiation dose limit to the general public via just the air transport pathway is established by the National Emission Standards for Hazardous Air Pollutants (NESHAP) under the Clean Air Act to be 10 mrem/yr. The U.S. Environmental Protection Agency (EPA), Region IX, has approved the use of six air sampling stations on the NTS (called "critical receptor" stations) to verify compliance with the NESHAP dose limit. The following radionuclides were detected at four or more of the critical receptor samplers: americium-241 (^{241}Am), plutonium-238 (^{238}Pu), plutonium-239+240 ($^{239+240}$Pu), uranium-233+234, uranium-235+236, uranium-238, and tritium (^{3}H) (Section 4.1.5). Concentrations of these radionuclides at each of the stations indicated that the NESHAP dose limit to the public was not exceeded. The Schooner station in the far northwest corner of the NTS experienced the highest concentrations of radioactive air emissions (Section 4.1.5), yet an individual residing at this station would experience a dose from air emissions of only 1.69 mrem/yr, 17 percent of the admissible dose limit. No one resides at this location, and the dose at offsite populated locations 20–80 kilometers (km) (12–50 miles [mi]) from the Schooner station would be much lower due to wind dispersion.

Public Dose from Direct Radiation – The radiation dose limit to the general public via all possible transport pathways (over and above background dose) established by DOE is 100 mrem/yr. This includes internal and external dose. Areas accessible to the public had direct external gamma radiation exposure rates in 2009 comparable to natural background rates. The TLD locations on the west and north sides of the parking area at Gate 100, the NTS entrance gate, had estimated annual mean exposures of 64 and 69 mR/yr, respectively, similar to the lower end of the range of background exposures observed on the NTS (Section 6.3.1).

Military or other personnel on the Nevada Test and Training Range (NTTR) could be exposed to direct radiation from legacy sites on Frenchman Lake playa. A TLD location near the NTS boundary with NTTR in the playa had an estimated annual exposure of 339 mR (Section 6.3.1). This represents an above-background dose of 174 to 275 mrem/yr (depending on which background radiation value is used), which would exceed the 100 mrem/yr dose limit to a member of the public. However, there are no living quarters or full-time personnel in that area.

Public Dose from Ingestion of Radionuclides in Game Animals – Game animals and small mammals (used as models for small game animals) from different contaminated NTS sites are trapped each year and analyzed for their radionuclide content to estimate the dose to hunters who might consume these animals if they moved off the NTS. In 2009, one jackrabbit and one composite small mammal sample were collected from Plutonium Valley in Area 11, and multiple composite small mammal samples were collected from the Area 3 and Area 5 Radioactive RWMSs and analyzed for radionuclide content. Based on tissue analyses from these samples, the highest annual dose to a member of the public consuming NTS jackrabbits was estimated to be 4.47 mrem/yr (Section 9.1.3).

Public Dose from Release of Property Containing Radioactive Material – No items were released from the NTS in 2009 that had residual radioactivity in excess of the default authorized limits specified in DOE O 5400.5, “Radiation Protection of the Public and the Environment.” The NNSA/NSO contribution to the total public dose from this source was therefore negligible in 2009.

Public Dose from All Pathways – The 2009 radiological monitoring data indicate that the dose to the public living in communities surrounding the NTS is not expected to be significantly higher than the previous 10 years. The public dose from all pathways in 2009 was estimated to be 6.16 mrem/yr. This is 6.2 percent of the 100 mrem/yr dose limit and about 1.8 percent of the total dose the maximally exposed individual receives from natural background radiation (340 mrem/yr) (Section 9.1.7).

Offsite Monitoring of Radiological Releases into Air

An offsite radiological air monitoring program is run by the Community Environmental Monitoring Program (CEMP) and is coordinated by DRI of the Nevada System of Higher Education under contract with NNSA/NSO (Chapter 7). It is a non-regulatory public informational and outreach program, and its purpose is to provide monitoring for radionuclides that might be released from the NTS. A network of 29 CEMP stations, located in selected towns and communities within a 160,000 square kilometer (61,776 square mile) area of southern Nevada, southeastern California, and southwestern Utah, was operated during 2009. The CEMP stations monitored gross alpha and beta radioactivity in airborne particulates using low-volume particulate air samplers, penetrating gamma radiation using TLDs, gamma radiation exposure rates using pressurized ion chamber (PIC) detectors, and meteorological parameters using automated weather instrumentation.

No airborne radioactivity related to historical or current NTS operations was detected in any of the samples from the CEMP particulate air samplers during 2009. TLD and PIC detectors measure gamma radiation from all sources: natural background radiation from cosmic and terrestrial sources and man-made sources. The offsite TLD and PIC results remained consistent with previous years’ background levels and are well within background levels observed in other parts of the United States.

Offsite Monitoring of Man-Made Radionuclides in Water

Offsite water monitoring conducted by the M&O contractor under NSTec's Routine Radiological Environmental Monitoring Plan (RREMP) and by DRI (through the CEMP) verifies that there has been no offsite migration of man-made radionuclides from NTS underground contamination areas to any public or private water supply wells or springs. Tritium was detected off site for the first time, however, at a groundwater characterization well west of the NTS boundary on NTTR. The well, ER-EC-11, is being studied by the Underground Test Area (UGTA) Sub-Project.

Under the RREMP, NSTec sampled 33 offsite locations (14 community water supply wells, 12 non-potable NNSA/NSO wells, and 7 springs) for tritium, man-made gamma-emitting radionuclides, and gross alpha and gross beta radioactivity. The DRI, through the CEMP, sampled 28 offsite private or community water supply locations (4 springs, 21 wells, and 3 surface water bodies) for tritium.

Tritium was not detected above sample-specific minimum detection concentrations (MDCs) in any of the offsite wells and springs sampled under the RREMP (Section 5.1.6). Gross alpha and gross beta radioactivity were detected in most of the well and spring samples and likely represent natural radiation sources. Only in two offsite wells (the non-potable NNSA/NSO Wells ER-OV-02 and Ash-B Piezometer #2) was gross alpha detected above the EPA maximum contaminant level (MCL) of 15 picocuries per liter (pCi/L) for drinking water. Their gross alpha levels were 19 pCi/L and 17.8 pCi/L, respectively.

Tritium concentrations for all the CEMP spring and surface water samples ranged from below the MDC to 22.4 pCi/L, well below the safe drinking water limit of 20,000 pCi/L (Section 7.2.3). The greatest activities were detected in samples from Boulder City and Henderson, where Lake Mead is the original water source. Slightly elevated tritium activities in Lake Mead have been documented in previous annual NTS environmental reports and are due to residual tritium persisting in the environment that originated from global atmospheric nuclear testing. Among the 21 offsite wells sampled under the CEMP, tritium ranged from -0.3 to 4.7 pCi/L (Section 7.2.4). Most of the samples yielded results that were statistically indistinguishable from laboratory background.

Offsite Detection of Tritium in UGTA Sub-Project Well ER-EC-11

In October 2009, sampling of the new UGTA Sub-Project well ER-EC-11, 716.3 meters (2,350 feet) west of the NTS boundary, confirmed the presence of tritium at approximately 12,500 pCi/L (Chapter 14). This is the first time that radionuclides from NTS underground tests have been detected in groundwater beyond NTS boundaries. The sampling results are consistent with UGTA's Pahute Mesa transport model, which predicted migration of tritium off the NTS within 50 years of the first nuclear detonation (1965) from the Central and Western Pahute Mesa corrective action units (Chapter 14; Figure 14-3). Well sampling results to date have not detected the presence of man-made radionuclides further downgradient of Pahute Mesa in any of the other nearby UGTA wells on the NTTR (ER-EC-1, -2A, -4, -5, -6, -7, and -8; Chapter 14, Figure 14-3). Offsite RREMP monitoring wells in Oasis Valley, even farther downgradient of Pahute Mesa, also contain no detectable man-made radionuclides.

Early in 2009, prior to the confirmatory sampling of Well ER-EC-11 in October, NNSA/NSO prepared a public presentation of the model predictions and the current state of knowledge of contaminant migration off the NTS. The presentation was given at an open house on February 18, 2009, at the Beatty Community Center in Beatty, Nevada. After the October sampling of Well ER-EC-11, a second open house in Beatty was held in April 2010 to inform the public of the most recent confirmed field sampling results. Links to the regional transport model, to the Phase I Central and Western Pahute Mesa Transport Model, and to posters presented at the April 2010 open house can be found at the NNSA/NSO Web page:
http://www.nv.doe.gov/library/publications/Environmental/April2010GWOpenHousePosters.pdf.

Onsite Monitoring of Radiological Releases into Air

Radionuclide emissions on the NTS in 2009 were predominantly from the following sources: (1) the evaporation and transpiration of tritiated water from soil and vegetation, respectively, from the Area 3 and Area 5 RWMSs, the Schooner crater in Area 20, and the Sedan crater in Area 10; (2) the resuspension of ^{241}Am, ^{238}Pu, and $^{239+240}$Pu from past nuclear testing from soil deposits on the NTS across all NTS areas; (3) the evaporation of tritiated water discharged from E Tunnel in Area 12; (4) the evaporation of ^{3}H from pumped groundwater at four UGTA Sub-Project wells in Area 20 and NTTR; and (5) the evaporation of tritiated water removed from the basement of Building A-1 at the NLVF and transported to the NTS for disposal in the Area 5 Sewage Lagoon. A network of 19 air sampling stations and a network of 109 TLDs were used to monitor diffuse onsite radioactive emissions in 2009. Total radiological atmospheric releases for 2009 (Section 4.1.9) are shown in the table below. The methods used to estimate these quantities include the use of annual field air and water monitoring data, historical soil inventory data, and accepted soil resuspension and air transport models.

^{3}H	^{85}Kr	Noble Gases (T1/2<40 days)	Short-Lived Fission and Activation Products (T1/2<3 hr)	Fission and Activation Products (T1/2>3 hr)	Total Radio-iodine	Total Radio-strontium	Plutonium	Other Actinides	Other
173	0	0	0	0	0	0	0.050 (^{238}Pu) 0.29 ($^{239+240}$Pu)	0.047 (^{241}Am)	0

Onsite Radiological Monitoring of Water

In 2009, 5 potable and 4 non-potable water supply wells, 15 monitoring wells, and 1 tritiated water containment pond system were sampled for man-made radiological contaminants. The 2009 data indicate that underground nuclear testing has not impacted the NTS potable water supply network. None of the onsite water supply wells had detectable concentrations of tritium or detectable concentrations of man-made gamma-emitting radionuclides (Section 5.1.7). Tritium values ranged from -26.3 to 7.6 pCi/L. The gross alpha and gross beta radioactivity detected in potable water supply wells represents the presence of naturally occurring radionuclides and did not exceed EPA limits.

All of the non-potable monitoring wells measured for gross alpha and gross beta had detectable levels of one or both, most likely from natural sources. None of the monitoring wells had gamma-emitting radionuclides above their respective MDCs. Of the 15 onsite monitoring wells, 11 had levels of tritium below their MDCs. Four of the monitoring wells had detectable levels of tritium above their MDCs that ranged from 33 to 339 pCi/L (Section 5.1.8). These wells (PM-1, U-19BH, UE-7NS, and WW A) are each within 1 km (0.6 mi) of a historical underground nuclear test; all have consistently had detectable levels of tritium in past years. Their tritium levels are still less than 2 percent of the EPA MCL for drinking water of 20,000 pCi/L, and tritium concentrations in these wells has been decreasing since 1999.

Five constructed basins collect and hold water discharged from E Tunnel in Area 12 where nuclear testing was conducted in the past. Tunnel effluent water was analyzed for tritium, gross alpha, and gross beta in accordance with a wastewater discharge permit. Tritium in tunnel effluent water was 477,000 pCi/L, lower than the limit allowed under the discharge permit (1,000,000 pCi/L). Gross alpha and gross beta values were also less than their permitted limits (Section 5.1.9).

The UGTA Sub-Project pumps tritiated water into lined sumps during studies conducted at contaminated post-shot or near-cavity wells on the NTS. One of these types of wells, ER-20-7, was drilled and sampled in 2009. The tritium level in this well was 18,300,000 pCi/L (Section 5.1.10). The primary purpose for Well ER-20-7 is to investigate contaminant plume migration downgradient from the TYBO and BENHAM underground nuclear tests. The TYBO and BENHAM tests were executed in drillholes U-20y and U-20c, respectively.

Onsite Nonradiological Releases into Air

The release of air pollutants is regulated on the NTS under a Class II air quality operating permit. Class II permits are issued for minor sources where annual emissions must not exceed 100 tons of any one criteria pollutant, or 10 tons of any one of the 189 hazardous air pollutants (HAPs), or 25 tons of any combination of HAPs. Criteria pollutants include sulfur dioxide, nitrogen oxides (NO_x), carbon monoxide, particulate matter, and volatile organic compounds. The NTS facilities regulated by the permit include (1) over 15 facilities/185 pieces of equipment throughout the NTS, (2) NPTEC, (3) Site-Wide Chemical Release Areas, (4) BEEF, (5) the Explosives Ordnance Disposal Unit, and (6) Explosives Activities Sites in Areas 5,14, 25, and 26.

An estimated 4.30 tons of criteria air pollutants were released on the NTS in 2009 (Section 4.2.2). The majority were NO_x from diesel generators. Total HAPs emissions from permitted operations was 0.30 tons (Section 4.2.2). Lead emissions from non-permitted activities, such weapons use, are reported to the EPA, and this quantity in 2009 was 7.8 pounds (Section 11.3). No emission limits for any criteria air pollutants or HAPS were exceeded.

One chemical test series was conducted in 2009, consisting of 25 releases of hazardous chemicals at the Area 5 NPTEC facility and 8 releases at the Port Gaston Facility in Area 25 (Section 4.2.6). An annual report of the types and amounts of chemicals released and the test plans and final analysis reports for each chemical release were submitted to the State of Nevada. No ecological monitoring was performed because each test posed a very low level of risk to the environment and biota.

Onsite Nonradiological Releases into Water

There are no liquid discharges to navigable waters, offsite surface water drainage systems, or publicly owned treatment works resulting from operations on the NTS. Therefore, no Clean Water Act National Pollutant Discharge Elimination System (NPDES) permits are required for operations on the NTS.

Industrial discharges on the NTS are limited to two operating sewage lagoon systems, the Area 6 Yucca Lake and Area 23 Mercury systems. Sewage lagoon waters are sampled for a suite of toxic chemicals only in the event of specific or accidental discharges of potential contaminants. There were no such discharges that warranted sampling in 2009 (Section 5.2.3.1). E Tunnel effluent and holding pond waters sampled for nonradiological contaminants (mainly metals), had levels of contaminants below permit limits (Section 5.2.4).

Nonradiological Releases into Air and Water at NLVF and RSL-Nellis

Sources of air pollutants at the NLVF and RSL-Nellis are regulated by permits from the Clark County Department of Air Quality and Environmental Management. The regulated sources of air emissions include such equipment/facilities as sanders, blasters, diesel generators, fire pumps, cooling towers, and boilers. The calculated total emissions of criteria pollutants at NLVF and RSL-Nellis were 0.80 and 0.88 tons per year, respectively. HAPs calculated emissions at NLVF and RSL-Nellis were 0.025 and 0.020 tons per year, respectively.

Water discharges at the NLVF are regulated by a permit with the City of North Las Vegas (CNLV) for sewer discharges and by an EPA-issued NPDES discharge permit for dewatering operations to control rising groundwater levels that surround the facility. The NPDES permit authorizes the discharge of pumped groundwater to the groundwater of the state via percolation and to the Las Vegas Wash via the CNLV storm drain system. Self-monitoring and reporting of the levels of nonradiological contaminants in sewage and industrial outfalls is conducted. In 2009, contaminant measurements were below established permit limits in all water samples from the NLVF sewage outfalls sampled (Appendix A, Section A.1.1). Water discharges at RSL-Nellis are required to meet permit limits set by the Clark County Water Reclamation District. All contaminants in the outfall samples were below permit limits (Appendix A, Section A.2.1).

Acknowledgements

Environmental Protection and Technical Services (EPTS) of National Security Technologies, LLC (NSTec), is responsible for producing this document for the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO). Environmental monitoring and compliance data were gathered through the combined efforts of several NSTec organizations in addition to EPTS: Site Services, Radioactive Waste (RW), Solid Waste Operations (SWO), Transuranic Waste Operations (TRU WO), Environmental Restoration (ER), Radiological Control (RC), Industrial Hygiene (IH), Zone 2 Construction Supervision (Z2CS), Facility and Infrastructure Planning (F&I Planning), and Performance Analysis and Improvement Division (PAID). The Water Resources and Cultural Resources divisions of the Desert Research Institute (DRI) contributed data for offsite water and air monitoring and cultural resource protection. Los Alamos National Laboratory (LANL) provided radioanalysis data for certain onsite wells sampled under the Underground Test Area Sub-Project. The Air Resources Laboratory, Special Operations and Research Division (ARL/SORD) provided summary descriptions of the Nevada Test Site climate, and the U.S. Geological Survey (USGS) provided water level and usage data for selected wells. Charles Davis of EnviroStat provided the statistical analyses, interpretation, and graphical presentation, and assisted with the write-up of the radiological monitoring data collected by EPTS.

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Sierra Cory of DM&P provided a thorough review of this document to ensure spelling, format, grammar, references, tables, figures, acronyms, table of contents, etc., were all in order.

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1.0 Introduction and Helpful Information

1.1 Site Location

The U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) directs the management and operation of the Nevada Test Site (NTS), which is located in Nye County in south-central Nevada (Figure 1-1). The southeast corner of the NTS is about 88 kilometers (km) (55 miles [mi]) northwest of the center of Las Vegas in Clark County. By highway, it is about 105 km (65 mi) from the center of Las Vegas to Mercury. Mercury, located at the southern end of the NTS, is the main base camp for worker housing and administrative operations for the NTS.

The NTS encompasses about 3,561 square kilometers (km^2) (1,375 square miles [mi^2]). It varies from 46 to 56 km (28 to 35 mi) in width from west to east and from 64 to 88 km (40 to 55 mi) from north to south. The NTS is surrounded on all sides by federal lands (Figure 1-1). It is bordered on the southwest corner by the Yucca Mountain Project Area, on the west and north by the Nevada Test and Training Range (NTTR), on the east by an area used by both the NTTR and the Desert National Wildlife Range, and on the south by Bureau of Land Management lands. The combination of the NTTR and the NTS represents one of the larger unpopulated land areas in the United States, comprising some 14,200 km^2 (5,470 mi^2).

1.2 Environmental Setting

The NTS is located in the southern part of the Great Basin, the northern-most sub-province of the Basin and Range Physiographic Province. The NTS terrain is typical of much of the Basin and Range Physiographic Province, characterized by generally north-south trending mountain ranges and intervening valleys. These mountain ranges and valleys, however, are modified on the NTS by very large volcanic calderas (Figure 1-2).

The principal valleys within the NTS are Frenchman Flat, Yucca Flat, and Jackass Flats (Figure 1-2). Both Yucca and Frenchman Flat are topographically closed and contain dry lake beds, or playas, at their lowest elevations. Jackass Flats is topographically open, and surface water from this basin flows off the NTS via the Fortymile Wash. The dominant highlands of the NTS are Pahute Mesa and Rainier Mesa (high volcanic plateaus), Timber Mountain (a resurgent dome of the Timber Mountain caldera complex), and Shoshone Mountain. In general, the slopes of the highland areas are steep and dissected, and the slopes in the lowland areas are gentle and less eroded. The lowest elevation on the NTS is 823 meters (m) (2,700 feet [ft]) in Jackass Flats in the southeast, and the highest elevation is 2,341 m (7,680 ft) on Rainier Mesa in the north-central region.

The topography of the NTS has been altered by historic U.S. Department of Energy (DOE) actions, particularly underground nuclear testing. The principal effect of testing has been the creation of numerous collapse sinks (craters) in Yucca Flat basin and a lesser number of craters on Pahute and Rainier Mesas. Shallow detonations that created surface disruptions were also performed during Project Plowshare to determine the potential uses of nuclear devices for large-scale excavation.

The reader is directed to *Attachment A: Nevada Test Site Description*, a separate file on the compact disc of this report, where the geology, hydrology, climatology, ecology, and cultural resources of the NTS are described.

1.3 Site History

The history of the NTS, as well as its current missions, directs the focus and design of the environmental monitoring and surveillance activities on and near the site. Between 1940 and 1950, the area known as the NTS was under the jurisdiction of Nellis Air Force Base and was part of the Nellis Bombing and Gunnery Range. The NTS was established in 1950 to be the primary location for testing the nation's nuclear explosive devices and supported nuclear testing from 1951 to 1992. Fact sheets on many of the historical tests and projects mentioned below can be found at http://www.nv.doe.gov/library/factsheets.aspx. The NTS currently conducts only subcritical nuclear experiments.

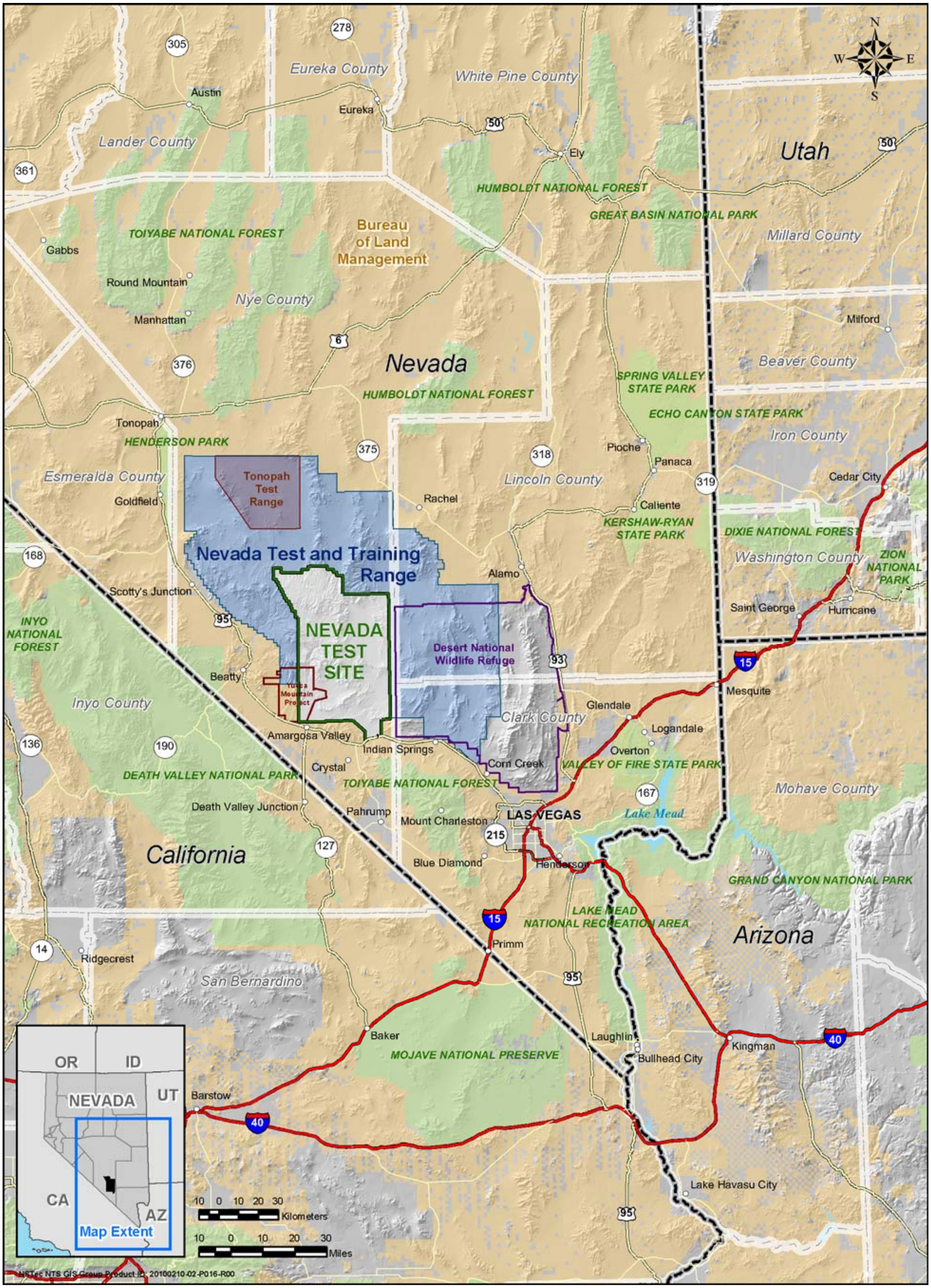

Figure 1-1. NTS vicinity map

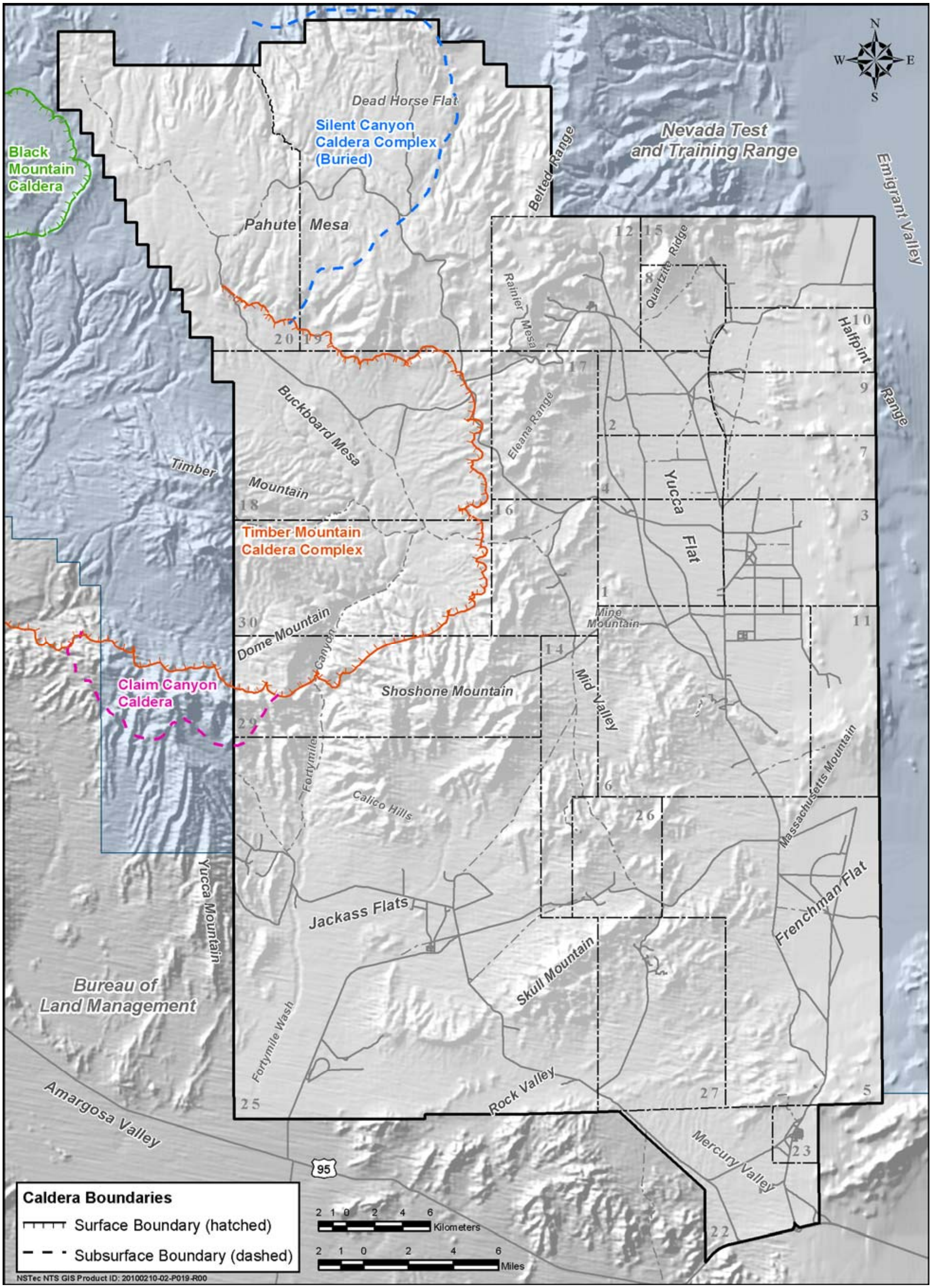

Figure 1-2. Major topographic features and calderas of the NTS

Atmospheric Tests – Tests conducted through the 1950s were predominantly atmospheric tests. These tests involved a nuclear explosive device detonated while on the ground surface, on a steel tower, suspended from tethered balloons, dropped from an aircraft, or placed on a rocket. Several tests were categorized as "safety experiments" and "storage-transportation tests," involving the destruction of a nuclear device with non-nuclear explosives. Some of these tests resulted in the dispersion of plutonium in the test vicinity. One of these test areas lies just north of the NTS boundary at the south end of the NTTR, and four others involving storage-transportation tests are at the north end of the NTTR. These test areas have been monitored for radionuclides in the past (1996–2000) in support of remediation projects, two of which were completed. The three remaining sites will be monitored again once restoration of these sites begins. All nuclear device tests are listed in *United States Nuclear Tests, July 1945 through September 1992* (U.S. Department of Energy, Nevada Operations Office, 2000).

Underground Tests – The first underground test, a cratering test, was conducted in 1951. The first totally contained underground test was in 1957. Testing was discontinued during a bilateral moratorium that began October 31, 1958, but was resumed in September 1961 after the Union of Soviet Socialist Republics resumed nuclear testing. After late 1962, nearly all tests were conducted in sealed vertical shafts drilled into Yucca Flat and Pahute Mesa or in horizontal tunnels mined into Rainier Mesa. From 1951 to 1992, a total of 828 underground nuclear tests were conducted at the NTS. Approximately one-third of these tests were detonated near or in the saturated zone (see Glossary, Appendix B); this has resulted in the contamination of groundwater in some areas. In 1996, DOE, the U.S. Department of Defense (DoD), and the State of Nevada entered into a Federal Facility Agreement and Consent Order, which established Corrective Action Units on the NTS that delineated and defined areas of concern for groundwater contamination.

Cratering Tests – Five earth-cratering (shallow-burial) tests were conducted from 1962 through 1968 as part of the Plowshare Program that explored peaceful uses of nuclear explosives. The first and highest yield Plowshare crater test, Sedan (U.S. Public Health Service, 1963), was detonated at the northern end of Yucca Flat on the NTS. The second-highest yield crater test was Schooner, located in the northwest corner of the NTS. From these tests, mixed fission products, tritium, and plutonium were entrained in the soil ejected from the craters and deposited on the ground surrounding the craters.

Other Tests – Other nuclear-related experiments at the NTS have included the BREN [Bare Reactor Experiment–Nevada] series in the early 1960s conducted in Area 4. These tests were performed with a 14-million electron volt neutron generator mounted on a 465-m (1,527-ft) steel tower to produce neutron and gamma radiation for the purpose of estimating the radiation doses received by survivors of Hiroshima and Nagasaki. The tower was moved in 1966 to Area 25 and used for conducting Operation HENRE [High-Energy Neutron Reactions Experiment], jointly funded by the DoD and the Atomic Energy Commission (AEC) to provide information for the AEC's Division of Biology and Medicine. From 1959 through 1973, a series of open-air nuclear reactor, nuclear engine, and nuclear furnace tests was conducted in Area 25, and a series of tests with a nuclear ramjet engine was conducted in Area 26. Erosion of metal cladding on the reactor fuel released some fuel particles that caused negligible deposition of radionuclides on the ground. Most of the radiation released from these tests was gaseous in the form of radio-iodines, radio-xenons, and radio-kryptons.

1.4 Site Mission

NNSA/NSO directs the management and operation of the NTS and six sites across the nation. The six sites include the North Las Vegas Facility (NLVF), Remote Sensing Laboratory (RSL)–Nellis, RSL–Andrews, Livermore Operations, Los Alamos Operations, and Special Technologies Laboratory. These sites all provide support to enhance the NTS as a site for national security and nondefense-related research, development, and testing programs. Los Alamos National Laboratory, Lawrence Livermore National Laboratory, and Sandia National Laboratories are the principal organizations that sponsor and implement the nuclear weapons programs at the NTS. National Security Technologies, LLC, is the current Management and Operating contractor accountable for the successful execution of work and ensuring that work is performed in compliance with environmental regulations. The three major NTS missions include National Security/Defense, Environmental Management, and Nondefense. The programs that support these missions are listed in the text box below.

NTS Missions and Programs

National Security/Defense Missions

Stockpile Stewardship & Management Program – Conducts high-hazard operations in support of defense-related nuclear and national security experiments and maintains the capability to resume underground nuclear weapons testing, if directed.

Nuclear Emergency Response, Nonproliferation & Counterterrorism Programs – Provides support facilities, training facilities, and capabilities for government agencies involved in emergency response, nonproliferation technology development, national security technology development, and counterterrorism activities.

Work for Others Program – Provides support facilities and capabilities for other agencies/organizations involved in defense-related activities.

Environmental Management Missions

Environmental Restoration Program – Characterizes and remediates the environmental legacy of nuclear weapons and other testing at the NTS and TTR locations, and develops and deploys technologies that enhance environmental restoration.

Waste Management Program – Manages and safely disposes of low-level waste and mixed low level waste received from DOE- and DoD-approved facilities throughout the U.S. and wastes generated in Nevada by NNSA/NSO. Safely manages and characterizes hazardous and transuranic wastes for offsite disposal.

Nondefense Missions

Infrastructure Program – Maintains the buildings, roads, utilities, and facilities required to support all NTS programs and to provide a safe environment for NTS workers.

Conservation and Renewable Energy Programs – Operates the pollution prevention program and supports renewable energy and conservation initiatives at the NTS.

Other Research and Development – Provides support facilities and NTS access to universities and organizations conducting environmental and other research unique to the regional setting.

1.5 Primary Facilities and Activities

NTS activities in 2009 continued to be diverse, with the primary one being to help ensure that the U.S. stockpile of nuclear weapons remains safe and reliable. Facilities that support the National Security/Defense missions include the U1a Facility, Big Explosives Experimental Facility, Device Assembly Facility, Joint Actinide Shock Physics Experimental Research (JASPER) Facility, and the Radiological/Nuclear Countermeasures Test and Evaluation Complex (RNCTEC) (Figure 1-3), which became operational in 2009. Facilities that support Environmental Management include the Area 5 Radioactive Waste Management Complex (RWMC) and the Area 3 Radioactive Waste Management Site (RWMS), currently in cold stand-by (Figure 1-3). Other NTS activities include demilitarization activities; controlled spills of hazardous material at the Nonproliferation Test and Evaluation Complex (NPTEC) (Figure 1-3); remediation of legacy contamination sites; processing of waste destined for the Waste Isolation Pilot Plant in Carlsbad, New Mexico, or the Idaho National Laboratory in Idaho Falls, Idaho; and disposal of radioactive and mixed waste. Land use by each of the NTS missions occurs within designated zones (Figure 1-4).

1.6 Scope of Environmental Report

This report summarizes data and the compliance status of the NNSA/NSO environmental protection and monitoring programs for calendar year 2009 at the NTS and at its two support facilities, the NLVF and RSL–Nellis. This report also addresses environmental restoration (ER) projects conducted at the Tonopah Test Range (TTR) (see Figure 1-1). Through a Memorandum of Agreement, NNSA/NSO is responsible for the oversight of TTR ER projects, and the Sandia Site Office of NNSA has oversight of all other TTR annual site environmental reports (e.g., Sandia National Laboratories, 2010), which are posted at http://www.sandia.gov/news/publications/environmental/index.html.

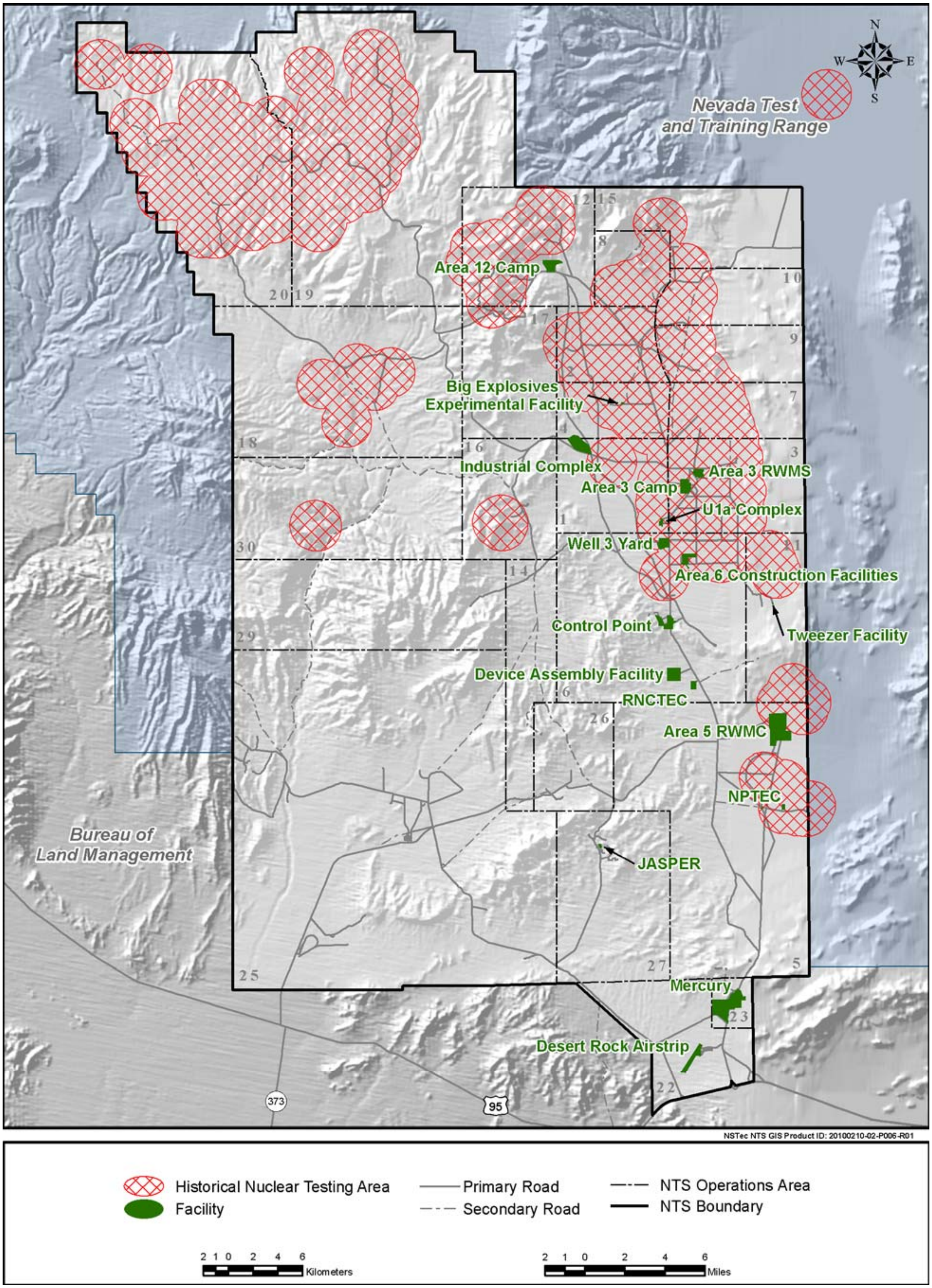

Figure 1-3. NTS operational areas, principal facilities, and past nuclear testing areas

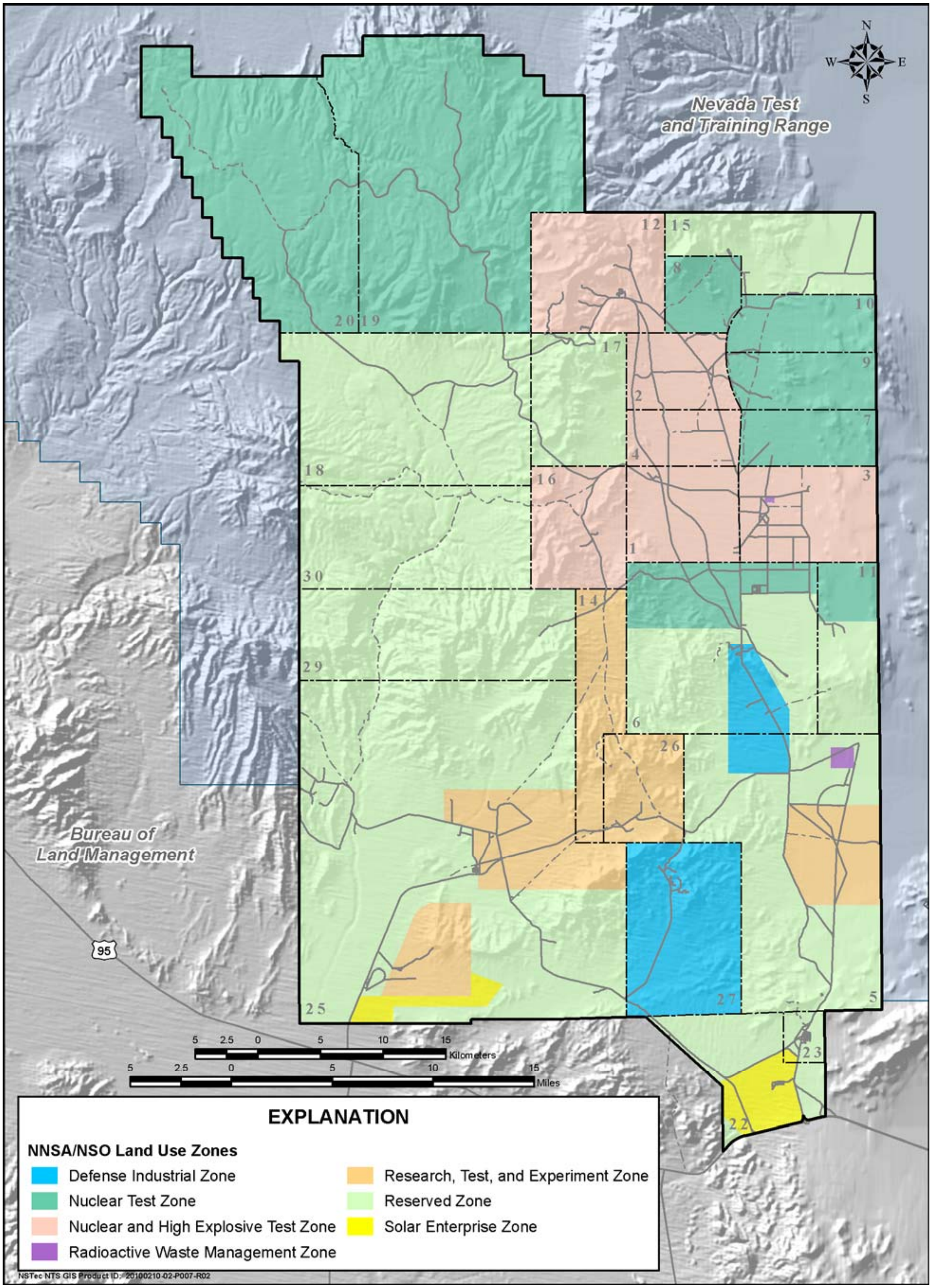

Figure 1-4. NTS land-use map (Source: DOE/NV, 1998)

1.7 Populations near the NTS

The population of the area surrounding the NTS (see Figure 1-1) is predominantly rural. Population estimates for Nevada communities are provided by the Nevada State Demographer's Office (2010). The 2009 population estimate for Nye County is 46,360, and the largest Nye County community is Pahrump (38,247), located approximately 80 km (50 mi) south of the NTS Control Point facility near the center of the NTS. Other Nye County communities include Tonopah (2,580), Amargosa (1,392), Beatty (880), Round Mountain (837), Gabbs (316), and Manhattan (135). Lincoln County to the east of the NTS includes a few small communities including Caliente (1,106), Pioche (837), Panaca (659), and Alamo (455). Clark County, southeast of the NTS, is the major population center of Nevada and has an estimated population of 1,952,040. The total annual population estimate for all Nevada counties, cities, and unincorporated towns is 2,711,206.

The Mojave Desert of California, which includes Death Valley National Park, lies along the southwestern border of Nevada. This area is still predominantly rural; however, tourism at Death Valley National Park swells the population to more than 5,000 on any particular day during holiday periods when the weather is mild.

The extreme southwestern region of Utah is more developed than the adjacent portion of Nevada. The population estimates for Utah communities are projections for 2008 made by the Utah Population Estimates Committee (2010) of the Governor's Office of Planning and Budget. The largest community is St. George, located 220 km (137 mi) east of the NTS, with an estimated population of 72,718. The next largest town, Cedar City, is located 280 km (174 mi) east-northeast of the NTS and has an estimated population of 28,667.

The northwestern region of Arizona is mostly rangeland except for that portion in the Lake Mead recreation area. In addition, several small communities lie along the Colorado River. The largest towns in the area are Bullhead City, 165 km (103 mi) south-southeast of the NTS, with an estimated population of 41,609, and Kingman, 280 km (174 mi) southeast of the NTS, with an estimated population of 29,189 (Arizona Workforce Informer, 2010).

1.8 Understanding Data in this Report

1.8.1 Scientific Notation

Scientific notation is used in this report to express very large or very small numbers. A very small number is expressed with a negative exponent, for example 2.0×10^{-5}. To convert this number from scientific notation to a more traditional number, the decimal point must be moved left by the number of places equal to the exponent (5 in this case). The number thus becomes 0.00002.

Very large numbers are expressed in scientific notation with a positive exponent. The decimal point should be moved to the right by the number of places equal to the exponent. The number 1,000,000,000 could be presented in scientific notation as 1.0×10^{9}.

1.8.2 Unit Prefixes

Units for very small and very large numbers are commonly expressed with a prefix. The prefix signifies the amount of the given unit. For example, the prefix k, or kilo-, means 1,000 of a given unit. Thus 1 kg (kilogram) is 1,000 g (grams). Other prefixes used in this report are listed in Table 1-1.

Table 1-1. Unit prefixes

Prefix	Abbreviation	Meaning
mega-	M	1,000,000 (1×10^{6})
kilo-	k	1,000 (1×10^{3})
centi-	c	0.01 (1×10^{-2})
milli-	m	0.001 (1×10^{-3})
micro-	µ	0.000001 (1×10^{-6})
nano-	n	0.000,000,1 (1×10^{-9})
pico-	p	0.000,000,000,0001 (1×10^{-12})

1.8.3 Units of Radioactivity

Much of this report deals with levels of radioactivity in various environmental media. The basic unit of radioactivity used in this report is the curie (Ci) (Table 1-2). The curie describes the amount of radioactivity present, and amounts are usually expressed in terms of fractions of curies in a given mass or volume (e.g., picocuries per liter). The curie is historically defined as the rate of nuclear disintegrations that occur in 1 gram of the radionuclide radium-226, which is 37 billion nuclear disintegrations per second. For any other radionuclide, 1 Ci is the quantity of the radionuclide that decays at this same rate. Nuclear disintegrations produce spontaneous emissions of alpha or beta particles, gamma radiation, or combinations of these.

Table 1-2. Units of radioactivity

Symbol	Name
Ci	curie
cpm	counts per minute
mCi	millicurie (1 x 10^{-3} Ci)
µCi	microcurie (1 x 10^{-6} Ci)
nCi	nanocurie (1 x 10^{-9} Ci)
pCi	picocurie (1 x 10^{-12} Ci)
aCi	attocurie (1 x 10^{-18} Ci)

1.8.4 Radiological Dose Units

The amount of ionizing radiation energy absorbed by a living organism is expressed in terms of radiological dose. Radiological dose in this report is usually written in terms of effective dose equivalent and reported numerically in units of millirem (mrem) (Table 1-3). Millirem is a term that relates ionizing radiation to biological effect or risk to humans. A dose of 1 mrem has a biological effect similar to the dose received from an approximate one-day exposure to natural background radiation. An acute (short-term) dose of 100,000 to 400,000 mrem can cause radiation sickness in humans. An acute dose of 400,000 to 500,000 mrem, if left untreated, results in death approximately 50 percent of the time. Exposure to lower amounts of radiation (1,000 mrem or less) produces no immediate observable effects, but long-term (delayed) effects are possible. The average person in the United States receives an annual dose of approximately 300 mrem from exposure to naturally produced radiation. Medical and dental X-rays, air travel, and tobacco smoking add to this total.

Table 1-3. Units of radiological dose

Symbol	Name
mrad	millirad (1 x 10^{-3} rad)
mrem	millirem (1 x 10^{-3} rem)
R	roentgen
mR	milliroentgen (1 x 10^{-3} R)
µR	microroentgen (1 x 10^{-6} R)

The unit "rad," for radiation absorbed dose, is also used in this report. The rad is a measure of the energy absorbed by any material, whereas a "rem," for roentgen equivalent man, relates to both the amount of radiation energy absorbed by humans and its consequence. A roentgen (R) is a measure of radiation exposure. Generally speaking, 1 R of exposure will result in an effective dose equivalent of 1 rem. Additional information on radiation and dose terminology can be found in the Glossary (Appendix B).

1.8.5 International System of Units for Radioactivity and Dose

In some instances in this report, radioactivity and radiological dose values are expressed in other units in addition to Ci and rem. These units are the becquerel (Bq) and the sievert (Sv), respectively. The Bq and Sv belong to the International System of Units (SI), and their inclusion in this report is mandated by DOE. SI units are the internationally accepted units and may eventually be the standard for reporting both radioactivity and radiation dose in the United States. One Bq is equivalent to one nuclear disintegration per second.

The unit of radiation absorbed dose (rad) has a corresponding SI unit called the gray (Gy). The roentgen measure of radiation exposure has no SI equivalent. Table 1-4 provides the multiplication factors for converting to and from SI units.

Table 1-4. Conversion table for SI units

To Convert From	To	Multiply By
becquerel (Bq)	picocurie (pCi)	27
curie (Ci)	becquerel (Bq)	3.7 x 10^{10}
gray (Gy)	rad	100
mrem	millisievert (mSv)	0.01
msievert (mSv)	mrem	100
picocurie (pCi)	becquerel (Bq)	0.03704
rad	gray (Gy)	0.01
sievert (Sv)	rem	100

1.8.6 Radionuclide Nomenclature

Radionuclides are frequently expressed with the one- or two-letter chemical symbol for the element. Radionuclides may have many different isotopes, which are shown by a superscript to the left of the symbol. This number is the atomic weight of the isotope (the number of protons and neutrons in the nucleus of the atom). Radionuclide symbols, many of which are used in this report, are shown in Table 1-5 along with the half-life of each radionuclide. The half-life is the time required for one-half of the radioactive atoms in a given amount of material to decay. For example, after one half-life, half of the original atoms will have decayed; after two half-lives, three-fourths of the original atoms will have decayed; and after three half- lives, seven-eighths of the original atoms will have decayed, and so on. The notation $^{236+238}$Ra and similar notations in this report (e.g., $^{239+240}$Pu) are used when the analytical method does not distinguish between the isotopes, but reports the total amount of both.

Table 1-5. Radionuclides and their half-lives

Symbol	Radionuclide	Half-Life [(a)]
^{241}Am	americium-241	432.2 yr
^{7}Be	beryllium-7	53.44 d
^{14}C	carbon-14	5,730 yr
^{134}Cs	cesium-134	2.1 yr
^{137}Cs	cesium-137	30 yr
^{51}Cr	chromium-51	27.7 d
^{60}Co	cobalt-60	5.3 yr
^{152}Eu	europium-152	13.3 yr
^{154}Eu	europium-154	8.8 yr
^{155}Eu	europium-155	5 yr
^{3}H	tritium	12.35 yr
^{129}I	iodine-129	1.6 x 10^{7} yr
^{131}I	iodine-131	8 d
^{40}K	potassium-40	1.3 x 10^{8}yr
^{85}Kr	krypton-85	10^{7} yr
^{212}Pb	lead-212	10.6 hr
^{238}Pu	plutonium-238	87.7 hr
^{239}Pu	plutonium-239	2.4 x 10^{4} yr
^{240}Pu	plutonium-240	6.5 x 10^{3} yr
^{241}Pu	plutonium-241	14.4 yr
^{226}Ra	radium-226	1.62 x 10^{3} yr
^{228}Ra	radium-228	5.75 yr
^{220}Rn	radon-220	56 s
^{222}Rn	radon-222	3.8 d
^{103}Ru	ruthenum-103	39.3 d
^{106}Ru	ruthenum-106	368.2 d
^{125}Sb	antimony-125	2.8 yr
^{113}Sn	tin-113	115 d
^{90}Sr	strontium-90	29.1 yr
^{99}Tc	technetium-99	2.1 x 10^{5} yr
^{232}Th	thorium-232	1.4 x 10^{10} yr
U [(b)]	uranium total	- - - [(c)]
^{234}U	uranium-234	2.4 x 10^{5} yr
^{235}U	uranium-235	7 x 10^{8} hr
^{238}U	uranium-238	4.5 x 10^{9} yr
^{65}Zn	zinc-65	243.9 d
^{95}Zr	zirconium-95	63.98 d

(a) From Shleien, 1992
(b) Total uranium may also be indicated by U-natural (U-nat) or U-mass
(c) Natural uranium is a mixture dominated by ^{238}U; thus, the half-life is approximately 4.5 x 10^{9} years

1.8.7 Units of Measurement

Both metric and non-metric units of measurement are used in this report. Metric system and U.S. customary units and their respective equivalents are shown in Table 1-6 on the following page.

1.8.8 Measurement Variability

There is always uncertainty associated with the measurement of environmental contaminants. For radioactivity, a major source of uncertainty is the inherent randomness of radioactive decay events.

Uncertainty in analytical measurements is also the consequence of variability related to collecting and analyzing the samples. This variability is associated with reading or recording the result, handling or processing the sample, calibrating the counting instrument, and numerical rounding.

The uncertainty of a measurement is denoted by following the result with an uncertainty value, which is preceded by the plus-or-minus symbol, ±. This uncertainty value gives information on what the measurement might be if the same sample were analyzed again under identical conditions. The uncertainty value implies that approximately 95 percent of the time, the average of many measurements would give a value somewhere between the reported value minus the uncertainty value and the reported value plus the uncertainty value.

If the reported concentration of a given constituent is smaller than its associated uncertainty (e.g., 40 ± 200), then the sample may not contain that constituent. Such low concentration values are considered to be below detection, meaning the concentration of the constituent in the sample is so low that it is undetected by the method and/or instrument.

Table 1-6. Metric and U.S. customary unit equivalents

Metric Unit	U.S. Customary Equivalent Unit	U.S. Customary Unit	Metric Equivalent Unit
Length			
1 centimeter (cm)	0.39 inches (in.)	1 inch (in.)	2.54 centimeters (cm)
1 millimeter (mm)	0.039 inches (in.)		25.4 millimeters (mm)
1 meter (m)	3.28 feet (ft)	1 foot (ft)	0.3048 meters (m)
	1.09 yards (yd)	1 yard (yd)	0.9144 meters (m)
1 kilometer (km)	0.62 miles (mi)	1 mile (mi)	1.6093 kilometers (km)
Volume			
1 liter (L)	0.26 gallons (gal)	1 gallon (gal)	3.7853 liters (L)
1 cubic meter (m^3)	35.32 cubic feet (ft^3)	1 cubic foot (ft^3)	0.028 cubic meters (m^3)
	1.35 cubic yards (yd^3)	1 cubic yard (yd^3)	0.765 cubic meters (m^3)
Weight			
1 gram (g)	0.035 ounces (oz)	1 ounce (oz)	28.6 gram (g)
1 kilogram (kg)	2.21 pounds (lb)	1 pound (lb)	0.373 kilograms (kg)
1 metric ton (mton)	1.10 short ton (2,000 lb)	1 short ton (2,000 lb)	0.90718 metric ton (mton)
Geographic area			
1 hectare	2.47 acres	1 acre	0.40 hectares
Radioactivity			
1 becquerel (Bq)	2.7×10^{-11} curie (Ci)	1 curie (Ci)	3.7×10^{-10} becquerel (Bq)
Radiation dose			
1 rem	0.01 sievert (Sv)	1 sievert (Sv)	100 rem
Temperature			
°C = (°F – 32)/1.8		°F = (°C x 1.8) + 32	

1.8.9 Mean and Standard Deviation

The mean of a set of data is the usual average of those data. The standard deviation (SD) of sample data relates to the variation around the mean of a set of individual sample results; it is defined as the square root of the average squared difference of individual data values from the mean. This variation includes both measurement variability and actual variation between monitoring periods (weeks, months, or quarters, depending on the particular analysis). The sample mean and standard deviation are estimates of the average and the variability that would be seen in a large number of repeated measurements. If the distribution shape were "normal" (i.e., shaped as ), about 67 percent of the measurements would be within the mean ± SD, and 95 percent would be within the mean ± 2 SD.

1.8.10 Standard Error of the Mean

Just as individual values are accompanied by counting uncertainties, mean values (averages) are accompanied by uncertainty. The standard deviation of the distribution of sample mean values is known as the standard error of the mean (SE). The SE conveys how accurate an estimate the mean value is based on the samples that were collected and analyzed. The ± value presented to the right of a mean value is equal to 2 x SE (2 multiplied by the SE). The ± value implies that approximately 95 percent of the time the average of many calculated means will fall somewhere between the reported value minus the 2 x SE value and the reported value plus the 2 x SE value.

1.8.11 Median, Maximum, and Minimum Values

Median, maximum, and minimum values are reported in some sections of this report. A median value is the middle value when all the values are arranged in order of increasing or decreasing magnitude. For example, the median value in the series of numbers, 1 2 3 3 4 5 5 5 6, is 4. The maximum value would be 6 and the minimum value would be 1.

1.8.12 Less Than (<) Symbol

The "less than" (<) symbol is used to indicate that the measured value is smaller than the number given. For example, <0.09 would indicate that the measured value is less than 0.09. In this report, < is often used in reporting the amounts of nonradiological contaminants in a sample when the measured amounts are less than the analytical laboratory's reporting limit for that contaminant in that sample. For example, if a measurement of benzene in sewage lagoon pond water is reported as <0.005 milligrams per liter, this implies that the measured amount of benzene present, if any, was not found to be above this level, given the sample and analysis methods used. For some constituents, the notation "ND" is also used to indicate that the constituent in question was not detected. For organic constituents, in particular, this could mean that the compound could not be clearly identified, the level (if any) was lower than the reporting limit, or (as often happens) both. The measurements of radionuclide concentrations are reported whether or not they are below the usual reporting limit (the minimum detectable concentration [see Glossary, Appendix B]).

1.8.13 Negative Radionuclide Concentrations

There is always a small amount of natural radiation in the environment. The instruments used in the laboratory to measure radioactivity in environmental media are sensitive enough to measure the natural, or background, radiation along with any contaminant radiation in a sample. To obtain an unbiased measure of the contaminant level in a sample, the natural, or background, radiation level must be subtracted from the total amount of radioactivity measured by an instrument. Because of the randomness of radioactive emissions and the very low concentrations of some contaminants, it is possible to obtain a background measurement that is larger than the actual contaminant measurement. When the larger background measurement is subtracted from the smaller contaminant measurement, a negative result is generated. The negative results are reported because they are useful when conducting statistical evaluations of the data.

1.8.14 Understanding Graphic Information

Some of the data graphed in this report are plotted using logarithmic (log) scales. Log scales are used in plots where the values are of widely different magnitudes at different locations and/or different times. Log scales use equal distances to represent equal *ratios* of values, whereas in linear scales equal distances represent equal *differences* in values. For example, a log scale would use the same distance to represent a change from 2 to 4 as a change from 10 to 20 or a change from 700 to 1,400.

For example, Figure 1-5 (Figure 4-6 in Chapter 4) shows the highest annual mean concentration of plutonium-239+240 ($^{239+240}Pu$) in air samples at any station within each of three groups of NTS areas using the log scale. Figure 1-6 shows the same data using a linear scale. The linear scale plot is dominated by three particularly high annual means (one station in Area 3 for 1987, one in Area 9 for 1972, and one in Area 19 for 1972). The log scale plot de-emphasizes those peaks and expands the portion of the plot containing lower values; in particular, it allows one to see that in the "Other" group, the high values have tended to decrease through the years.

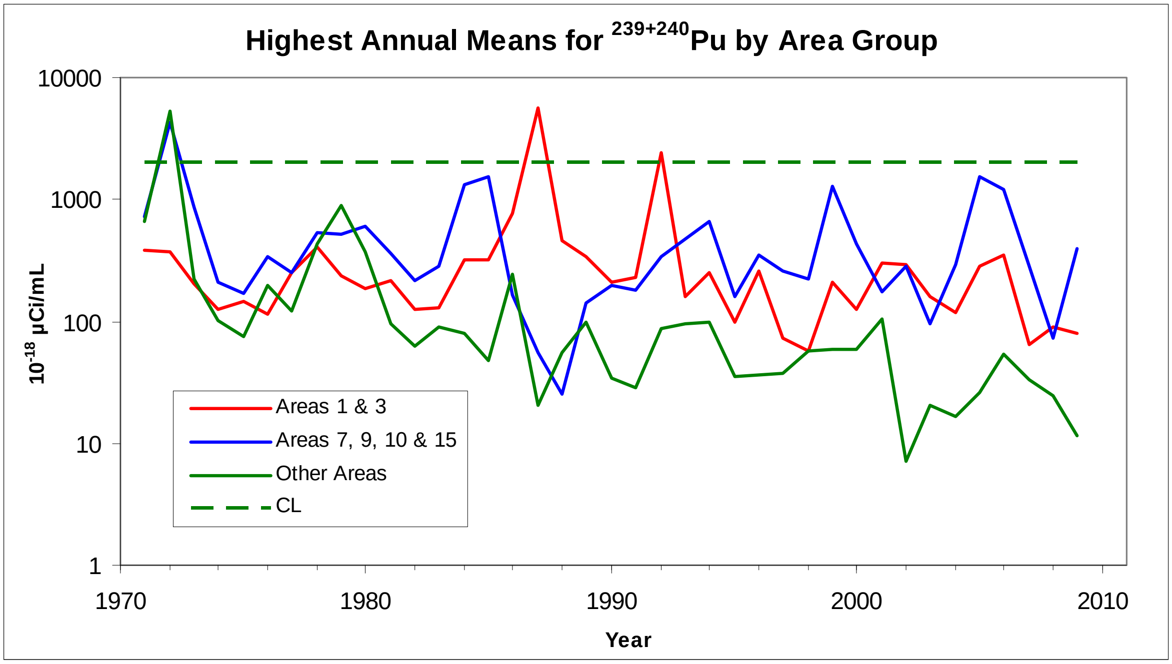

Figure 1-5. Data plotted using a log scale

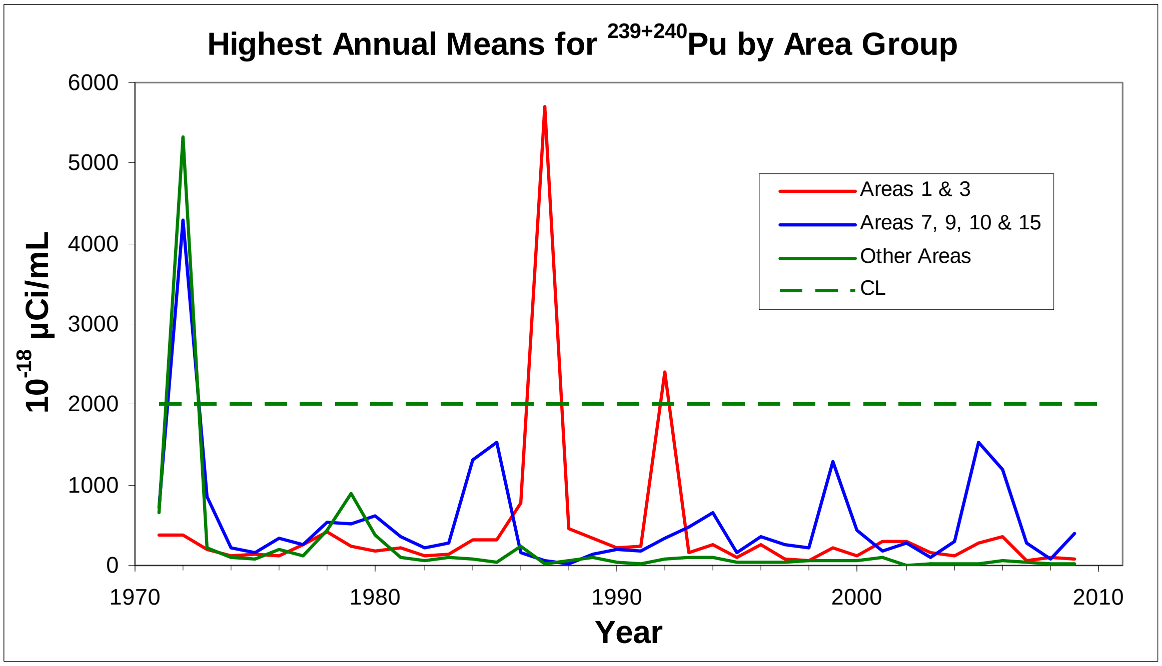

Figure 1-6. Data plotted using a linear scale

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2.0 Compliance Summary

Environmental regulations pertinent to operations on the Nevada Test Site (NTS), the North Las Vegas Facility (NLVF), and the Remote Sensing Laboratory (RSL)-Nellis are listed in this chapter. They include federal and state laws, state permit requirements, Executive Orders (EOs), U.S. Department of Energy (DOE) orders, and state agreements. They dictate how the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) conducts operations on and off the NTS to ensure the protection of the environment and the public. The regulations are grouped by topic, and each topical subsection contains a brief description of the applicable regulations, a summary of noncompliance incidents, if any, a listing of compliance reports generated during or for the reporting year, and a compliance status table. Each table lists those measures or actions that are tracked or performed to ensure compliance with a regulation. A description of the field monitoring efforts, actions, and results that support the compliance status is found in subsequent chapters of this document, as noted in the "Reference Section" column of each table. At the end of this chapter, Table 2-13 presents the list of all environmental permits issued for the NTS and the two Las Vegas area facilities.

2.1 Air Quality

2.1.1 Applicable Regulations

Clean Air Act (CAA), National Emission Standards for Hazardous Air Pollutants (NESHAP) – Title III of the CAA establishes NESHAP to control those pollutants that might reasonably be anticipated to result in either an increase in mortality or an increase in serious irreversible or incapacitating but reversible illness. Industry-wide national emissions standards were developed for 22 of 189 designated hazardous air pollutants (HAPs). Radionuclides and asbestos are among the 22 HAPs for which standards were established. NNSA/NSO NESHAP compliance activities are limited to radionuclide air monitoring and reporting/notification of asbestos abatement. The State of Nevada regulates NNSA/NSO compliance with NESHAP under the NTS's Class II Air Quality Operating Permit (No. AP9711-0549.01).

CAA, National Ambient Air Quality Standards (NAAQS) – Title I of the CAA establishes the NAAQS to limit levels of pollutants in the air for six "criteria" pollutants: sulfur dioxide, nitrogen oxides, carbon monoxide, ozone, lead, and particulate matter. Title V of the CAA authorizes states to implement permit programs to regulate emissions of these pollutants. For the NTS, there is one State-issued Class II Air Quality Operating Permit. The permit's emission limits (except ozone and lead) are based on published emission values for other similar industries and on operational data specific to the NTS. Emissions from NTS operations are calculated and submitted each year to the State. Lead emissions are reported to the State as part of the total HAPs emissions. The NTS air permit also specifies visible emissions (opacity) limits for equipment/facilities as well as requirements for recordkeeping, performance testing, opacity field monitoring, particulate monitoring, and monitoring personnel certification. NLVF and RSL-Nellis operate under air quality permits that require annual reporting of hours of operation, emission quantities of criteria pollutants and HAPs, opacity for all operating equipment, certification of personnel who monitor opacity, and summaries of significant malfunctions and repairs.

CAA, New Source Performance Standards (NSPS) –Title I of the CAA establishes the NSPS to set minimum nationwide emission limitations for air pollutants from various industrial categories of facilities. NSPS pollutants are acid mist, carbon monoxide, particulate matter, fluorides, hydrogen sulfide in acid gas, lead, nitrogen oxides, sulfur oxides, total reduced sulfur, and volatile organic compounds. The NSPS impose more stringent standards, including a reduced allowance of visible emissions (opacity), than under NAAQS. On the NTS, some screens, conveyor belts, and bulk fuel storage tanks are subject to the NSPS, which Nevada regulates under Nevada Administrative Code (NAC) 445B through the Class II Air Quality Operating Permit. No offsite facilities are subject to the NSPS.

CAA, Stratospheric Ozone Protection – Title VI of the CAA establishes production limits and a schedule for the phase-out of ozone-depleting substances (ODS). The U.S. Environmental Protection Agency (EPA) has established regulations for ODS recycling during servicing and disposal of air conditioning and refrigeration equipment, for repairing leaks in such equipment, and for safe ODS disposal. While there are no reporting requirements, recordkeeping to document the usage of ODS and technician certification is required, and the EPA may conduct random inspections to determine compliance. At the NTS, ODS are mainly used in air conditioning units in vehicles, buildings, refrigerators, drinking water fountains, vending machines, and laboratory equipment.

DOE Order 450.1A, "Environmental Protection Program" – This order Rrequires that a site's Environmental Management System (EMS) includes practices to maximize the use of safe alternatives to ozone-depleting substances (ODS).

NAC 445B, "Air Controls" – In addition to enforcing the CAA regulations mentioned above, NAC 445B.22037 requires fugitive dust to be controlled. The Class II Air Quality Operating Permit requires implementation of an ongoing control program at the NTS using the best practicable methods. Off the NTS, all NNSA/NSO surface-disturbing activities that cover five or more acres are regulated by stand-alone Class II Surface Area Disturbance (SAD) permits issued by the State. NAC 445B.22067 prohibits the open burning of combustible refuse and other materials unless specifically exempted by an authorized variance. At the NTS, Open Burn Variances are routinely obtained for various fire training and emergency management exercises.

Other Air Quality Requirements – Title V, Part 70 of the CAA requires owners or operators of air emission sources to pay annual state fees. Fees are based on a source's "potential to emit," and NTS operations are subject to these fees. In addition, NNSA/NSO must allow Nevada's Bureau of Air Pollution Control (BAPC) to conduct inspections of permitted NTS facilities and allow the Clark County Department of Air Quality and Environmental Management (DAQEM) to conduct inspections of NLVF and RSL-Nellis permitted equipment.

2.1.2 Compliance Reports

The following reports were generated for 2009 NTS operations in compliance with air quality regulations:

- *National Emission Standards for Hazardous Air Pollutants - Radionuclide Emissions, Calendar Year 2009*, submitted to EPA Region IX (National Security Technologies, LLC [NSTec], 2010b)
- *Annual Asbestos Abatement Notification Form*, submitted to EPA Region IX
- *Calendar Year 2009 Actual Production/Emissions Reporting Form,* submitted to the Nevada Division of Environmental Protection (NDEP)
- Quarterly Class II Air Quality Reports, submitted to NDEP
- Nonproliferation Test and Evaluation Complex (NPTEC) Pre-test and Post-test Reports, submitted to NDEP

The following reports were generated for 2009 operations at offsite facilities in compliance with air quality regulations:

- *Clark County Air Emission Inventory for North Las Vegas Facility,* submitted to Clark County DAQEM
- *Clark County Air Emissions Inventory for Remote Sensing Laboratory,* submitted to Clark County DAQEM
- *Calendar Year 2009 Actual Production/Emissions Reporting Form,* submitted to NDEP for UGTA SAD Permit AP9711-2622

Table 2-1. NTS compliance status with applicable air quality regulations

Compliance Measure/Actions	Compliance Limit	2009 Compliance Status	Section Reference [(a)]
Clean Air Act – NESHAP			
Annual dose equivalent from all radioactive air emissions	10 mrem/yr[(b)] (0.1 mSv/yr)	Compliant	9.1.2
Notify EPA Region IX if the number of linear feet (ft) or square feet (ft^2) of asbestos to be removed from a facility exceeds limit	260 linear ft or 160 ft^2[(c)]	Compliant	4.2.8
Maintain asbestos abatement plans, data records, activity/ maintenance records	For up to 75 years	Compliant	4.2.8
Clean Air Act – NAAQS			
Submit quarterly reports of calculated emissions at the NTS to the State	Due 30 days after end of quarter	Compliant	4.2.2
Submit annual report of calculated emissions at the NTS to the State	Due March 1	Compliant	4.2.2
Tons of emissions of each criteria pollutant produced by permitted equipment/facility at the NTS based on calculations	PTE[(d)] varies	Compliant	4.2.2; Table 4-14
Conduct and pass performance emission tests on permitted equipment	Test after 100 hours of operation, emission limits vary	Compliant	4.2.3
Number of gallons of fuel used, hours of operation, and rate of aggregate/concrete production by permitted equipment/facility at the NTS	Limit varies[(e)]	Compliant	4.2.4
Conduct opacity readings from permitted equipment/facility at the NTS, NLVF, and RSL-Nellis	Conduct quarterly at NTS, conduct when equipment is being used at NLVF and RSL	Compliant	4.2.5
Percent opacity of emissions from permitted equipment/facility at the NTS	20%	Compliant	4.2.5
Percent opacity of emissions from permitted equipment/facility at NLVF and RSL-Nellis	20%	Compliant	Appendix A: A.1.3; A.2.2
Conduct particulate monitoring for releases/detonations at the NPTEC, Big Explosives Experimental Facility, and Explosive Ordnance Disposal Unit (EODU)	Per test	Compliant	4.2.6
Submit test plans/final analysis reports for each chemical release test at NPTEC or elsewhere on NTS	Test plans due ≥ 30 days prior to test. Final reports due ≤ 30 days from end of each quarter	Compliant	4.2.6
Submit annual report of calculated emissions at the NLVF and the RSL-Nellis to Clark County	Due March 31	Compliant	Appendix A: A.1.3; A.2.2
Tons of emissions of each criteria pollutant produced by permitted equipment/facility at NLVF and RSL-Nellis based on calculations	PTE[(d)] varies	Compliant	Appendix A: A.1.3, Table A-4; A.2.2, Table A-8

Table 2-1. NTS compliance status with applicable air quality regulations (continued)

Compliance Measure/Actions	Compliance Limit	2009 Compliance Status	Section Reference[a]
Clean Air Act - NSPS			
Conduct opacity readings from permitted equipment/facility	Quarterly	Compliant	4.2.5
Percent opacity of emissions from permitted equipment/facility	10%	Compliant (No permitted equipment used)	4.2.5
Clean Air Act - Stratospheric Ozone Protection			
Maintain ODS technician certification records, approvals for ODS-containing equipment recycling/recovery, and applicable equipment servicing records	NA[f]	Compliant	4.2.7
DOE O 450.1A, "Environmental Protection Program" - ODS Reduction			
Include in the NTS EMS practices to maximize the use of safe alternatives to ODS		Compliant	3.4.2.3
Other Nevada Air Quality Permit Regulations			
Control fugitive dust for land disturbing activities	NA	Compliant	4.2.9
Allow Nevada BAPC personnel access to the NTS and Clark County DAQEM personnel access to the NLVF and RSL-Nellis to conduct inspections of facilities and operations regulated by state air permits	NA	Compliant	4.2.3; Appendix A: A.1.3; A.2.2

(a) The section(s) within this document that describe how compliance summary data were collected

(b) mrem/yr = millirem per year; mSv/yr = millisievert per year

(c) 260 linear ft or 160 ft^2 = 79.3 linear meters (m) or 14.9 square meters

(d) Potential to emit (PTE) = quantities of criteria pollutants that each facility/piece of equipment would emit annually if it were operated for the maximum number of hours specified in the state air permit

(e) Compliance limit is specific for each piece of permitted equipment/facility

(f) Not applicable

2.2 Water Quality and Protection

2.2.1 Applicable Regulations

Clean Water Act (CWA) – The CWA sets national water quality standards for contaminants in surface waters. It prohibits the discharge of contaminants from point sources to waters of the United States without a National Pollutant Discharge Elimination System (NPDES) permit. At the NTS, CWA regulations are followed through compliance with permits issued by NDEP for wastewater discharges. NTS operations do not require any NPDES permits. At the NLVF, an NPDES permit regulates the discharge of pumped groundwater (see Appendix A, Section A.1.1.2). NPDES compliance is summarized in a format requested by DOE in Table 2-2 below.

Safe Drinking Water Act (SDWA) – The SDWA protects the quality of drinking water in the United States and authorizes the EPA to establish safe standards of purity. It requires all owners or operators of public water systems (PWSs) to comply with National Primary Drinking Water Standards (health standards). State governments are authorized to set Secondary Standards related to taste, odor, and visual aspects. NAC 445A ensures that PWSs meet both primary and secondary water quality standards. The SDWA standards for radionuclides currently apply only to PWSs designated as community water systems. The PWSs on the NTS are permitted by the state as non-community water systems. However, all potable water supply wells are monitored on the NTS for radionuclides in compliance with DOE O 5400.5, "Radiation Protection of the Public and the Environment" (see Section 2.3).

NAC 445A, "Water Controls" (Public Water Systems) – This NAC enforces the SDWA requirements and sets standards for permitting, design, construction, operation, maintenance, certification of operators, and water quality of PWSs. The NTS has three PWSs and two potable water hauler trucks, which NDEP regulates through the issuance of permits.

NAC 444, "Sanitation" (Sewage Disposal) and 445A, "Water Controls" (Water Pollution Control) – This NAC regulates the collection, treatment, and disposal of wastewater and sewage at the NTS. The requirements of this state regulation are issued in permits to NNSA/NSO for the E-Tunnel Waste Water Disposal System, active and inactive sewage lagoons, septic tanks, septic tank pumpers, and a septic tank pumping contractor's license. NNSA/NSO also obtains underground injection control (UIC) permits from NDEP for tracer tests in Underground Test Area (UGTA) Sub-Project characterization wells.

NAC 534, "Underground Water and Wells" – This NAC regulates the drilling, construction, and licensing of new wells and the reworking of existing wells to prevent the waste and contamination of underground waters. NNSA/NSO complies with this NAC as a matter of comity, holding to the position that state licensing requirements do not apply to the federal government and its contractors as a matter of law under the principle of federal supremacy and associated case law. Two current operations that voluntarily comply with this NAC are the UGTA Sub-Project, which drills new wells and reworks old wells, and the Borehole Management Project, which plugs abandoned NTS boreholes.

UGTA Fluid Management Plan – UGTA Sub-Project wells are regulated by the State through an agreement between NNSA/NSO and the NDEP called the UGTA Fluid Management Plan. The plan is followed in lieu of following separate state-issued water pollution control permits for each UGTA characterization well. Such permits ensure compliance with the CWA. The plan prescribes the methods of disposing groundwater pumped from UGTA wells during drilling, development, and testing based on the levels of radiological contamination. This plan is Attachment I of the UGTA Sub-Project Waste Management Plan (U.S. Department of Energy, National Nuclear Security Administration Nevada Operations Office, 2002).

2.2.2 Compliance Reports

The following reports were generated for NTS operations in 2009 in compliance with water quality regulations:

- *Quarterly Monitoring Report for Nevada Test Site Sewage Lagoons*, submitted to NDEP
- Results of water quality analyses for PWS were sent to the State throughout the year as they were obtained from the laboratory
- *Water Pollution Control Permit NEV 96021, Quarterly Monitoring Report* (for first, second, and third quarters of 2009 for E Tunnel effluent monitoring), submitted to NDEP
- *Water Pollution Control Permit NEV 96021, Quarterly Monitoring Report and Annual Summary Report for E-Tunnel Waste Water Disposal System* (NSTec, 2010c)
- *Water Pollution Control Permit NEV 96021, Well ER-12-1 Groundwater Sampling Summary Report E-Tunnel Waste Water Disposal System* (NSTec, 2010d)

The following reports were generated for operations at the two offsite facilities in 2009 in compliance with water quality regulations:

- *Self-Monitoring Report for the National Nuclear Security Administration's North Las Vegas Facility: Permit VEH-112*, submitted to the City of North Las Vegas
- Quarterly reports titled *Remote Sensing Laboratory Self Monitoring Report - Permit No. CCWRD-080*, submitted to the Clark County Water Reclamation District
- Two monitoring reports titled *Remote Sensing Laboratory Additional Monitoring Reports - Permit No. CCWRD-080*, submitted to the Clark County Water Reclamation District

Table 2-2. Summary of NPDES permit compliance at NLVF in 2009

Permit Type	Outfall	Parameter[a]	Number of Permit Exceedances	Number of Samples Taken	Number of Compliant Samples	Percent Compliance	Date(s) Exceeded	Description/ Solution
NV0023507	001 and 002	Daily maximum flow	0	365 (continuous)	365	100	NA[b]	NA
		TPH	0	1 (1/year)	1	100	NA	NA
		TSS	0	4 (1/quarter)	4	100	NA	NA
		TDS	0	4 (1/quarter)	4	100	NA	NA
		N	0	4 (1/quarter)	4	100	NA	NA
		pH	0	4 (1/quarter)	4	100	NA	NA
		Tritium	MR[c]	1 (1/year)	1	100	NA	NA

(a) TPH = total petroleum hydrocarbons, TSS = total suspended solids, TDS = total dissolved solids, N = total inorganic nitrogen
(b) NA = not applicable
(c) MR = monitor and report, no specified daily maximum or 30-day average limit, just the requirement that there shall be no discharge of substances that would cause a violation of State water quality standards

Table 2-3. NTS compliance status with applicable water quality and protection regulations

Compliance Measure/Action	Compliance Limit	2009 Compliance Status	Section Reference[(a)]
Safe Drinking Water Act and NAC 445A, "Water Controls" (Public Water Systems)			
Number of water samples containing coliform bacteria	1 per month per PWS	Compliant	5.2.1.1, Table 5-8
Concentration of inorganic, organic, and microbial contaminants and disinfection byproducts in permitted NTS PWSs	Limit varies[(b)]	Compliant	5.2.1.1, Table 5-8
Adhere to design, construction, maintenance, and operation regulations specified by permits	NA[(c)]	Compliant	5.2.1
Allow NDEP access to conduct inspections of PWS and water hauling trucks	NA	Compliant	5.2.1.2
Clean Water Act - NPDES/State Pollutant Discharge Elimination System Permits			
Value of water chemistry parameters measured quarterly and annually and the value of over 100 contaminants measure biennially in pumped groundwater at the NLVF	Limit varies	Compliant	Table 2.2, Appendix A: A.1.1.2, Table A-3
Clean Water Act and NAC 444, "Sanitation" (Sewage Disposal)			
Adhere to all design/construction/operation requirements for new systems and those specified in septic system permits, septic tank pump truck permits, and septic tank pumping contractor permit	NA	Compliant	5.2.2
Clean Water Act and NAC 445A, "Water Controls" (Water Pollution Control)			
Value of 5-day biological oxygen demand (BOD_5), total suspended solids (TSS), and pH in one sewage lagoon water sample sampled quarterly	BOD_5: varies TSS: no limit pH: 6.0–9.0 S.U.	Compliant	5.2.3.1, Table 5-9
Concentration of 29 contaminants in permitted sewage lagoons only if specific or accidental discharges of potential contaminants occur	Limit varies	Compliant	5.2.3.1 No sampling required
Inspection by operator of active sewage lagoon systems	Weekly	Compliant	5.2.3.2
Inspection by operator of inactive sewage lagoon systems	Quarterly	Compliant	5.2.3.2
Submit quarterly monitoring reports for 2 active sewage lagoons (for Areas 6 and 23)	Due end of April, July, October, and January	Compliant	5.2.3.1
Allow NDEP access to conduct inspections of active sewage lagoon systems	NA	Compliant	5.2.3.2

Table 2-3. NTS compliance status with applicable water quality and protection regulations (continued)

Compliance Measure/Action	Compliance Limit	2009 Compliance Status	Section Reference[(a)]
Clean Water Act and NAC 445A, "Water Controls" (Water Pollution Control) (continued)			
Concentrations of tritium (^{3}H), gross alpha (α), gross beta (β), (in picocuries per liter [pCi/L]); 14 nonradiological contaminants/water quality parameters collected quarterly; and flow rate, pH, and specific conductance (SC) collected monthly from E Tunnel discharge water samples	^{3}H: 1,000,000 pCi/L α: 35 pCi/L β: 100 pCi/L Non-rad: Limit varies	Compliant - All contaminants were within permit limits. One water quality indicator, SC, was below permissible limits three times.[(d)]	5.1.9, Table 5.5; 5.2.4, Table 5-10
Concentrations of ^{3}H, α, β, and 16 nonradiological contaminants/water quality parameters in well ER-12-1 water samples collected every 24 months	^{3}H: 20,000 pCi/L α: 15 pCi/L β: 50 pCi/L Non-rad: Limit varies	Compliant - All contaminants were within permit limits. SC was above permissible limits.[(d)]	5.1.9, Table 5.5; 5.2.4, Table 5-10
Concentrations of 20 contaminants in water samples from NLVF sewage outfalls and all sludge and liquid samples from the NLVF sand/oil interceptor	Limit varies	Compliant	Appendix A: A.1.1.1, Table A-2
Concentrations of 12 contaminants in water samples from sewage outfall at the RSL-Nellis	Limit varies	Compliant	Appendix A: A.2.1, Table A-7
NAC 534, "Underground Water and Wells" and UGTA Fluid Management Plan			
Maintain state well-drilling license for personnel supervising well construction/reconditioning	NA	Compliant	- -
For UGTA well drilling fluids, monitor tritium (in pCi/L) and lead levels (in milligrams per liter [mg/L]), manage the fluids, and notify NDEP as required based on the decision criteria limits in the UGTA Fluid Management Plan	Decision Criteria Limits: ^{3}H > 200,000 pCi/L, Lead > 5 mg/L	Compliant	5.1.10, Table 5-6
File notices of intent and affidavits of responsibility for plugging	NA	Compliant	- -
Adhere to well construction requirements/waivers	NA	Compliant	- -
Maintain required records and submit required reports	NA	Compliant	- -

(a) The section(s) within this document that describe how compliance summary data were collected
(b) Compliance limit is specific for each contaminant; see referenced tables for specific limits
(c) Not applicable
(d) Confirmatory samples of SC were taken and NDEP was notified according to permit requirements. Upon review of the follow-up SC measures, NDEP suspended the requirement for further monthly SC monitoring until the permit is renewed in 2013. In the meantime, SC will be monitored quarterly.

2.3 Radiation Dose Protection

2.3.1 Applicable Regulations

Clean Air Act (CAA), National Emission Standards for Hazardous Air Pollutants (NESHAP) – NESHAP (Title 40 Code of Federal Regulations [CFR] Part 61 Subpart H) establishes a radiation dose limit of 10 millirem per year (mrem/yr) (0.1 millisievert per year [mSv/yr]) to individuals in the general public from the air pathway. NESHAP also specifies "Concentration Levels for Environmental Compliance" (abbreviated as compliance levels [CLs]) for radionuclides in air. A CL is the annual average concentration of a radionuclide that could deliver a dose of 10 mrem/yr. The CLs are provided for facilities, such as the NTS, which use air sampling at offsite receptor locations to demonstrate compliance with the NESHAP public radiation dose limit. Sources of radioactive air emissions on the NTS include containment ponds, Area 5 Radioactive Waste Management Complex, Sedan crater, Schooner crater, calibration of analytical equipment, and contaminated soil at nuclear device safety test and atmospheric test locations.

Safe Drinking Water Act (SDWA) – The National Primary Drinking Water Regulations (40 CFR 141), promulgated by the SDWA, require that the maximum contaminate level goal for any radionuclide be zero. But, when this is not possible (e.g., in groundwater containing naturally occurring radionuclides), the SDWA specifies that the concentration of one or more radionuclides should not result in a whole body or organ dose greater than 4 mrem/yr (0.04 mSv/yr). Sources of radionuclide contamination in groundwater at the NTS are the underground nuclear tests detonated near or below the water table (see Glossary, Appendix B).

DOE O 450.1A, "Environmental Protection Program" – Requires federal facilities to (1) conduct environmental monitoring to detect, characterize, and respond to releases from DOE activities, (2) assess impacts, (3) estimate dispersal patterns in the environment, (4) characterize the pathways of exposure to members of the public, (5) characterize the exposures and doses to individuals and to the population, and (6) evaluate the potential impacts to the biota in the vicinity of a DOE activity. Such releases, exposures, and doses apply to radiological contaminants.

DOE O 5400.5, "Radiation Protection of the Public and the Environment" – This order and its flow-down procedural standards establish requirements for (1) measuring radioactivity in the environment, (2) applying the ALARA [as low as reasonably achievable] process to all operations, (3) using mathematical models for estimating radiation doses, (4) releasing property having residual radioactive material, and (5) maintaining records to demonstrate compliance with the requirements. This order sets a radiation dose limit of 100 mrem/yr (1 mSv/yr) above background levels to individuals in the general public from all pathways of exposure combined. It also provides the Derived Concentration Guides (DCGs) for all radionuclides. The DCGs are the annual average concentrations of a radionuclide that could deliver a dose of 100 mrem/yr.

DOE Standard DOE-STD-1153-2002, "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota" – Provides methods, computer models, and guidance in implementing a graded approach to evaluating the radiation doses to populations of aquatic animals, terrestrial plants, and terrestrial animals residing on DOE facilities. Dose limits of 1 rad per day (rad/d) (10 milligray per day [mGy/d]) for terrestrial plants and aquatic animals, and of 0.1 rad/d (1 mGy/d) for terrestrial animals are specified by this DOE standard. Dose rates below these levels are believed to cause no measurable adverse effects to populations of plants and animals.

DOE O 435.1, "Radioactive Waste Management" – This order ensures that all DOE radioactive waste is managed in a manner that is protective of the worker, public health and safety, and the environment. It directs how radioactive waste management operations are conducted on the NTS. These requirements are summarized in Section 2.4. The manual for this order (DOE M 435.1-1) specifies that operations at the Area 3 and Area 5 Radioactive Waste Management Sites (RWMSs) must not contribute a dose to the general public in excess of 25 mrem/yr.

2.3.2 Compliance Reports

In compliance with NESHAP under the CAA, the report *National Emission Standards for Hazardous Air Pollutants - Radionuclide Emissions Calendar Year 2009*, was submitted to EPA Region IX in June 2010 (NSTec, 2010b). This *Nevada Test Site Environmental Report 2009* was generated to report 2009 compliance with DOE O 5400.5 and DOE-STD-1153-2002.

Table 2-4. NTS compliance status with regulations for radiation protection of the public and the environment

Compliance Measure	Compliance Limit	2009 Compliance Status	Section Reference[(a)]
Clean Air Act - NESHAP			
Annual dose above background levels to the general public from radioactive air emissions	10 mrem/yr	Compliant	9.1.2
Safe Drinking Water Act			
Annual dose to the general public from drinking water	4 mrem/yr	Compliant[(b)]	9.1.4
DOE O 5400.5, "Radiation Protection of the Public and the Environment"			
Annual dose above background levels to the general public from all pathways	100 mrem/yr	Compliant	9.1.7
Total residual surface contamination of property released offsite (in disintegrations per minute per 100 square centimeters [dpm/100 cm^2])	300–15,000 dpm/100 cm^2 depending on the radionuclide	Compliant	9.1.6
DOE STD 1153-2002, "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota"			
Absorbed radiation dose to terrestrial plants	1 rad/d	Compliant	9.2
Absorbed radiation dose to aquatic animals	1 rad/d	Compliant	9.2
Absorbed radiation dose to terrestrial animals	0.1 rad/d	Compliant	9.2
DOE O 435.1, "Radioactive Waste Management"			
Annual dose to the general public due to RWMS operations	25 mrem/yr	Compliant[(c)]	6.3.3
DOE O 450.1A, "Environmental Protection Program"			
Conduct radiological environmental monitoring	NA[(d)]	Compliant	4.1; 5.1; 6.0
Detect and characterize radiological releases	NA	Compliant	4.1; 5.1; 6.0
Characterize pathways of exposure to the public	NA	Compliant	9.1.1
Characterize exposures and doses to individuals, the population, and biota	NA	Compliant	9.1; 9.2

(a) The section(s) within this document that describe how compliance summary data were collected
(b) Migration of radioactivity in groundwater to offsite public or private drinking water wells has never been detected
(c) Nearest populations to the Area 3 and 5 RWMSs are Amargosa Valley at 55 kilometers [km] (34 miles [mi]) away and Cactus Springs at 36 km (22 mi) away, respectively. They are too distant to receive any radiation exposure from operations at the sites.
(d) Not applicable

2.4 Radioactive and Nonradioactive Waste Management and Environmental Restoration

2.4.1 Applicable Regulations

Atomic Energy Act (AEA) of 1954 (42 United States Code Section 2011 et seq.) – The AEA ensures the proper management of source, special nuclear, and byproduct material. At the NTS, AEA regulations are followed through compliance with DOE O 435.1 and 10 CFR 830.

10 CFR 830, "Nuclear Safety Management" – This CFR establishes requirements for the safe management of work at DOE's nuclear facilities. It governs the possession and use of special nuclear and byproduct materials. It also covers activities at facilities where no nuclear material is present, such as facilities that prepare the non-nuclear components of nuclear weapons, but that could cause radiological damage at a later time. It governs the conduct of the management and operating contractor and other persons at DOE nuclear facilities, including facility visitors. When coupled with the Price-Anderson Amendments Act (PAAA) of 1988, it provides DOE with authority to assess civil penalties for violation of rules, regulations, or orders relating to nuclear safety by contractors, subcontractors, and suppliers who are indemnified under PAAA.

DOE O 435.1, "Radioactive Waste Management" – This order ensures that all DOE radioactive waste is managed in a manner that is protective of the worker, public health and safety, and the environment. Activities conducted on the NTS subject to this order include (1) characterization of low-level radioactive waste (LLW) and mixed low-level waste (MLLW) generated by DOE within the state of Nevada; (2) disposal of LLW and MLLW at the Area 3 and Area 5 RWMSs; (3) characterization, visual examination, and repackaging of transuranic (TRU) waste at the Waste Examination Facility south of the Area 5 RWMS; and (4) loading of TRU waste at the Area 5 RWMS for shipment to Idaho National Environmental Engineering Laboratory.

Resource Conservation and Recovery Act (RCRA) - 40 CFR Parts 239–282 – RCRA is the nation's primary law governing the management of solid and hazardous waste (HW). RCRA regulates the storage, transportation, treatment, and disposal of such wastes to prevent contaminants from leaching into the environment from landfills, underground storage tanks (USTs), surface impoundments, and HW disposal facilities. The EPA authorizes the State of Nevada to administer and enforce RCRA regulations. RCRA also requires generators of HWs to have a program in place to reduce the volume or quantity and toxicity of HWs generated. Such NTS programs are addressed in Sections 2.6 and 3.3.2 on Pollution Prevention and Waste Minimization.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)/Superfund Amendments and Reauthorization Act (SARA) – These acts provide a framework for the cleanup of waste sites contain-ing hazardous substances and an emergency response program in the event of a release of a hazardous substance to the environment. No HW cleanup operations on the NTS are regulated under CERCLA; they are regulated under RCRA instead. The applicable requirements of CERCLA pertain to an emergency response program for hazardous substance releases (see Emergency Planning and Community Right-to-Know Act in Section 2.5) and to how state laws concerning the removal and remediation of hazardous substances apply to federal facilities (specifically, implementation of the Federal Facility Agreement and Consent Order discussed below).

Federal Facility Compliance Act (FFCA) – The FFCA extends the full range of enforcement authorities in federal, state, and local laws for management of HWs to federal facilities. The FFCA of 1992, signed by NNSA/NSO and the State of Nevada, requires the identification of existing quantities for mixed waste, the proposal of methods and technologies of mixed waste treatment and management, the creation of enforceable timetables, and the tracking and completion of deadlines.

Federal Facility Agreement and Consent Order (FFACO), as amended (March 2010) – Pursuant to Section 120(a)(4) of CERCLA and to Sections 6001 and 3004(u) of RCRA, this consent order, agreed to by the State of Nevada, DOE Environmental Management, the U.S. Department of Defense, and DOE Legacy Management became effective in May 1996. It addresses the environmental restoration of historically contaminated sites at the NTS, parts of Tonopah Test Range, parts of the Nevada Test and Training Range (NTTR), the Central Nevada Test Area, and the Project SHOAL Area. Under the FFACO, hundreds of sites have been identified for cleanup and closure. An individual site is called a Corrective Action Site (CAS). Multiple CASs are often grouped into Corrective Action Units (CAUs). NNSA/NSO is responsible for the CASs included in the UGTA Sub-Project, the Soils Sub-Project, and the Industrial Sites Sub-Project, while DOE Legacy Management is responsible for the CASs at the Central Nevada Test Area and the Project SHOAL Area.

Settlement Agreement for Mixed Transuranic Waste – This agreement between NNSA/NSO and the State of Nevada requires NNSA/NSO to operate the Area 5 TRU Storage Pad in accordance with 40 CFR 264 Subpart I. Mixed TRU is stored in compliance with RCRA requirements and weekly inspections are conducted.

Mutual Consent Agreement – This agreement between NNSA/NSO and the State of Nevada covers the storage and management of mixed waste on the NTS that was generated or identified after March 1996. It requires NNSA/NSO to develop and submit specific treatment and disposal plans for mixed waste within nine months of identification.

NAC 444.850–444.8746, "Disposal of Hazardous Waste" – This NAC regulates the operation of HW disposal facilities on the NTS to comply with federal RCRA regulations. Through this NAC, a RCRA Part B Permit (NEV HW0021) regulates the operation of the Hazardous Waste Storage Unit (HWSU) in Area 5, the Explosive Ordnance Disposal Unit (EODU) in Area 11, and the disposal of MLLW received from DOE offsite facilities into the Pit 3 Mixed Waste Disposal Unit (P03). The state permit requires groundwater monitoring of three wells down-gradient of P03, prescribes post-closure monitoring for HW sites that were closed under RCRA prior to enactment of the FFACO, and requires preparation of an EPA Biennial Hazardous Waste Report of all HW volumes generated annually at NTS and the NLVF.

NAC 444.570–444.7499, "Solid Waste Disposal" – This Nevada regulation sets standards for solid waste management systems, including the storage, collection, transportation, processing, recycling, and disposal of solid waste. The NTS has one inactive and four active permitted landfills. Active units include the Area 5 Asbestiform Low-Level Solid Waste Disposal Unit (P06), Area 6 Hydrocarbon Disposal Site, Area 9 U10 Solid Waste Disposal Site, and Area 23 Solid Waste Disposal Site. These landfills are designed, constructed, operated, maintained, and monitored in adherence to the requirements of their state-issued permits. The Area 5 Asbestiform Low-Level Solid Waste Disposal Unit P07 is inactive.

NAC 459.9921–459.999, "Storage Tanks" – This NAC enforces the federal regulations under RCRA pertaining to the maintenance and operation of fuel tanks (including underground fuel storage tanks) so as to prevent environmental contamination. The NTS has five USTs and RSL-Nellis has seven USTs. The tanks are either (1) fully regulated under RCRA and registered with the State, (2) regulated under RCRA and registered with the State but deferred from leak detection requirements, or (3) excluded from federal and state regulation. At RSL-Nellis, NDEP allows Clark County to enforce this NAC with the issuance of county permits to NNSA/NSO.

2.4.2 Compliance Reports

The following reports were prepared in 2009 or 2010 to comply with environmental regulations for waste management and environmental restoration operations conducted on the NTS in 2009. All CAU/CAS reports prepared in 2009 in accordance with the FFACO schedule are presented in Table 10-5 of Section 10.4.1.

- *Area 5 Asbestiform Low-Level Solid Waste Disposal Annual Report for CY 2009*, submitted to NDEP
- Quarterly LLW/MLLW Disposal Reports (for all active LLW and MLLW disposal cells), submitted to NDEP each quarter
- *2009 EPA Biennial Hazardous Waste Report for the Nevada Test Site and North Las Vegas Facility*, submitted to NDEP

- *Conditionally Exempt Small Quantity Generator 2009 Hazardous Waste Report* (for the NTS and NLVF), submitted to NDEP
- *Annual Transportation Report for Radioactive Waste Shipments to and from the Nevada Test Site – Fiscal Year 2009* (NNSA/NSO, 2010)
- *Biannual Neutron Monitoring Report for the Nevada Test Site Area 9 U10 and Area 6 Hydrocarbon Landfills*
- *Nevada Test Site 2009 Data Report: Groundwater Monitoring Program Area 5 Radioactive Waste Management Site* (NSTec, 2010e)
- *Nevada Test Site 2009 Waste Management Monitoring Report, Area 3 and Area 5 Radioactive Waste Management Sites* (NSTec, 2010f)
- Post-closure monitoring reports for RCRA Part B Permit-identified CAUs
- *January–June 2009 Biannual Solid Waste Disposal Site Report for the Nevada Test Site Area 23 Sanitary Landfill*
- *July–December 2009 Biannual Solid Waste Disposal Site Report for the Nevada Test Site Area 23 Sanitary Landfill*
- *2009 Annual Solid Waste Disposal Site Report for the NTS Area 6 Hydrocarbon Landfill and Area 9 U10 Landfill*

Table 2-5. NTS Compliance status with applicable waste management and environmental restoration regulations

Compliance Measure/Action	Compliance Limit	2009 Compliance Status	Section Reference[(a)]
10 CFR 830, "Nuclear Safety Management"			
Completion and maintenance of proper conduct of operations documents required for Class II Nuclear Facility for disposal/characterization/storage of radioactive waste	Six types of guiding documents required	Compliant	10.1.1
DOE O 435.1, "Radioactive Waste Management"			
Establishment of Waste Acceptance Criteria for radioactive wastes received for disposal/storage at Area 3 and 5 RWMSs	NA[(b)]	Compliant	10.1.1
Track annual volume of disposed LLW at Area 3 and Area 5 RWMSs (in cubic meters [m^3])	NA	Compliant	10.1.3, Table 10-2
Vadose zone monitoring at Area 3 and Area 5 RWMSs	Not required by order - Performed to validate performance assessment criteria of RWMSs	Conducted	10.1.7
Resource Conservation and Recovery Act (as enforced through permits issued by the State of Nevada)			
pH, specific conductance (SC), total organic carbon (TOC), total organic halides (TOX), and tritium (^3H) and 11 general water chemistry parameters in groundwater sampled semi-annually from wells UE5 PW-1, UE5 PW-2, and UE5 PW-3 to verify performance of P03	pH: 7.6 to 9.2 SC: 0.440 mmhos/cm[(c)] TOC: 1 mg/L[(d)] TOX: 50 µg/L[(e)] H^3: 2,000 pCi/L	Compliant	10.1.6
Volume of disposed MLLW at Pit 3 Mixed Waste Disposal Unit (P03) (in cubic meters [m^3] or cubic feet [ft^3])	20,000 m^3 (706,293 ft^3)	Compliant	10.2.1
Volume of nonradioactive HW stored at the HWSU	61,600 liters (16,280 gallons)	Compliant	10.2.2
Weight of approved explosive ordnance wastes detonated at the EODU (in kilograms [kg] or pounds [lb])	45.4 kg (100 lb) at a time, not to exceed 1 detonation event/hour	Compliant	10.2.3
Submit quarterly reports of volume of wastes received at P03, HWSU, and EODU to the State of Nevada. (Requirement for quarterly reports for HWSU and EODU was waived by the State after July 2009)	Due April, July, October, January	Compliant	10.2
Submit EPA Biennial Hazardous Waste Report for NTS and NLVF to the State of Nevada	Due the following February for odd-numbered years	Compliant	10.2

Table 2-5. NTS Compliance Status with Applicable Waste Management and Environmental Restoration Regulations (continued)

Compliance Measure/Action	Compliance Limit	2009 Compliance Status	Section Reference[a]
Resource Conservation and Recovery Act (as enforced through permits issued by the State of Nevada) (continued)			
Conduct vadose zone monitoring for RCRA closure site U3ax/bl Subsidence Crater	Continuous monitoring using TDR[f] sensors	Compliant	10.4.2
Periodic post-closure site inspection of five historic RCRA closure sites (CAU 90, 91, 92, 110, 112)	NA	Compliant	10.4.2, Table 10-6
Upgrade, remove, and report on USTs at NTS and RSL-Nellis	NA	Compliant	10.3; Appendix A: A.2.4
Federal Facility Agreement and Consent Order			
Adherence to calendar year work scope for site characterization, remediation, and closures	25 CAUs identified for some phase of action	Compliant	10.4.1; Table 10-5
Post-closure monitoring and inspections of closed sites	53 CAUs required monitoring/ inspecting	Compliant	10.4.2, Table 10-7
NAC 444.750-8396, "Solid Waste Disposal"			
Track weight and volume of waste disposed each calendar year	Area 6 - No limit Area 9 - No limit Area 23 - 20 tons/day	Compliant	10.5.1
Monitor vadose zone for the Area 6 Hydrocarbon and Area 9 U10c Solid Waste disposal sites	Annually using neutron logging through access tubes	Compliant	10.5.1

(a) The section(s) within this document that describe how compliance summary data were collected
(b) Not applicable
(c) mmhos/cm = micromhos (a measure of conductance) per centimeter
(d) mg/L = milligram per liter
(e) µg/L = micrograms per liter
(f) Time domain reflectometry

2.5 Hazardous Materials Control and Management

2.5.1 Applicable Regulations

Toxic Substances Control Act (TSCA) – This act requires testing and regulation of chemical substances that enter the consumer market. Since the NTS does not produce chemicals, compliance is primarily directed toward the management of polychlorinated biphenyls (PCBs). At the NTS, remediation activities and maintenance of fluorescent lights can result in the disposal of PCB-contaminated waste and light ballasts. Disposal of these items and recordkeeping requirements for PCB activities are regulated on the NTS by the State of Nevada.

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) – This act sets forth procedures and requirements for pesticide registration, labeling, classification, devices for use, and certification of applicators. The use of certain pesticides (called "restricted-use pesticides") is regulated. The use of non-restricted–use pesticides (as available in consumer products) is not regulated. On the NTS, only non-restricted–use pesticides are applied under the direction of a State of Nevada certified applicator. Pesticide applications in food service facilities are subcontracted to State-certified vendors who provide these services.

Emergency Planning and Community Right-to-Know Act (EPCRA) – This act is a provision of the 1986 SARA Title III amendments to CERCLA. It requires that federal, state, and local emergency planning authorities be provided information regarding the presence and storage of hazardous substances and their planned and unplanned environmental releases, including provisions and plans for responding to emergency situations involving hazardous materials. EO 12856, "Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements," requires all federal facilities to comply with the provisions of EPCRA. NNSA/NSO is required to submit reports pursuant to Sections 302, 304, 311, 312, and 313 of SARA Title III described below. Compliance with these EPCRA reporting requirements is summarized in a format requested by DOE in Table 2-6.

Section 302–303, Planning Notification – Requires that the state emergency response commission and the local emergency planning committee be notified when an extremely hazardous substance (EHS) is present at a facility in excess of the threshold planning quantity. An inventory of the location and amounts of all hazardous substances stored on the NTS and at the two offsite facilities is maintained. Inventory data are included in an annual report called the Nevada Combined Agency (NCA) Report. Also, NNSA/NSO monitors hazardous materials while they are in transit on the NTS through a hazardous materials notification system called HAZTRAK.

Section 304, Extremely Hazardous Substances Release Notification – Requires that the local emergency planning committee and state emergency response agencies be notified immediately of accidental or unplanned releases of an EHS to the environment. Also, the national response center is notified if the release exceeds the CERCLA reportable quantity for the particular hazardous substance.

Section 311–312, Material Safety Data Sheet (MSDS)/Chemical Inventory – Requires facilities to provide applicable emergency response agencies with MSDSs, or a list of MSDSs for each hazardous chemical stored on site. This is essentially a one-time reporting unless chemicals or products change. Any new MSDSs are provided annually in the NCA Report. Section 312 requires facilities to report maximum amounts of chemicals on site at any one time. This report is submitted to the State Emergency Response Commission, the Local Emergency Planning Committee, and the local fire departments.

Section 313, Toxic Release Inventory (TRI) Reporting – Requires facilities to submit an annual report entitled "Toxic Chemical Release Inventory, Form R" to the EPA and to the State of Nevada if annual usage quantities of listed toxic chemicals exceed specified thresholds. Lead releases on the NTS above threshold limits are reported to the EPA and the State Emergency Response Commission in the TRI, Form R report.

NAC 555 - Control of Insects, Pests, and Noxious Weeds – This NAC provides the regulatory framework for certification of several classifications of registered pesticide and herbicide applicators in the state of Nevada. The Nevada Department of Agriculture (NDOA) administers this program and has the primary role to enforce FIFRA in Nevada. Inspections of pesticide/herbicide applicator programs are carried out by NDOA.

NAC 444, "Sanitation" - Polychlorinated Biphenyls (PCBs) – This code enforces the federal requirements for the handling, storage, and disposal of PCBs and contains record-keeping requirements for PCB activities.

State of Nevada Chemical Catastrophe Prevention Act – This act directed NDEP to develop and implement a program called the Chemical Accident Prevention Program (CAPP). The act requires registration of facilities storing EHSs above listed thresholds. NNSA/NSO submits a CAPP report to NDEP if any storage quantity thresholds are exceeded.

2.5.2 Compliance Reports

The following reports were generated for 2009 NNSA/NSO operations on the NTS and at the two offsite facilities in compliance with hazardous materials control and management regulations:

- *Nevada Combined Agency Report* **-** *Calendar Year (CY) 2009,* submitted to state and local agencies
- *Toxic Release Inventory Report, Form R for CY 2009 Operations,* submitted to the EPA and the State
- *Calendar Year (CY) 2009 Polychlorinated Biphenyls (PCBs) Report for the Nevada Test Site (NTS)*, submitted to NNSA/NSO
- *2009 Chemical Accident Prevention Program Report*, submitted to NDEP

Table 2-6. Status of EPCRA Reporting

EPCRA Section	Description of Reporting	2009 Status[(a)]
Section 302–303	Planning Notification	Yes
Section 304	EHS Release Notification	Not required
Section 311–312	MSDS/Chemical Inventory	Yes
Section 313	TRI Reporting	Yes

(a) "yes" indicates that NNSA/NSO reported under the requirements of the EPCRA section specified.

Table 2-7. NTS compliance status with applicable regulations for hazardous substance control and management

Compliance Measure/Action	Compliance Limit	2009 Compliance Status	Section Reference[a]
Toxic Substances Control Act (TSCA) and NAC 444, "Sanitation" - Polychlorinated Biphenyls			
Storage and offsite disposal of PCB materials	Required if >50 ppm[b] PCBs	Compliant	11.1
Storage and onsite disposal of PCB materials	Allowed if <50 ppm PCBs	No onsite storage or disposal	11.1
Disposal of bulk product waste containing PCBs generated by remediation and site operations	Case-by-case approval by NDEP	No such bulk product wastes were generated	11.1
Generate report of quantities of PCB liquids and materials disposed offsite during previous calendar year	Due July 1 of following year	Compliant	11.1
Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and NAC 555, "Control of Insects, Pests, and Noxious Weeds"			
Application of restricted-use pesticides is conducted under the direct supervision of a state-certified applicator	NA[c]	Compliant	11.2
Maintain state certification of onsite pesticide and herbicide applicator	NA	Compliant	11.2
Emergency Planning and Community Right-to-Know Act (EPCRA)			
Adhere to reporting requirements	NCA Report due in March for previous CY, TRI Report, Form R due July 1 for previous CY, Notification Report due immediately after a release	Compliant	11.3, Table 11-2
State of Nevada Chemical Catastrophe Prevention Act			
Registration of NTS with the state if EHSs are stored above listed threshold quantities	NDEP-CAPP[d] Report due June 21, 2009	Compliant	11.4

(a) The section(s) within this document that describe how compliance summary data were collected
(b) ppm = parts per million
(c) Not applicable
(d) Chemical Accident Prevention Program

2.6 Environmental Protection, Renewable Energy and Transportation Management, and Pollution Prevention and Waste Minimization

2.6.1 Applicable Regulations

EO 13423, "Strengthening Federal Environmental, Energy, and Transportation Management" – This EO requires federal facilities to begin establishing goals to improve efficiency in energy and water use, procure goods and services that use sustainable environmental practices, reduce amounts of toxic materials acquired and maintain a cost-effective waste prevention and recycling program, ensure construction and major renovation of buildings that incorporate sustainable practices, reduce use of petroleum products in motor vehicles and increase use of alternative fuels, and acquire and dispose of electronic products using environmentally sound practices. These goals are to be incorporated into the Environmental Management System (EMS) of each federal facility. NNSA/NSO complies with this EO through adherence to DOE O 430.2B.

EO 13514, "Federal Leadership in Environmental, Energy, and Economic Performance" – Issued in October 2009, this EO requires federal agencies to increase energy efficiency; measure, report, and reduce their greenhouse gas emissions from direct and indirect activities; conserve and protect water resources through efficiency, reuse, and stormwater management; eliminate waste, recycle, and prevent pollution; leverage agency acquisitions to foster markets for sustainable technologies and environmentally preferable materials, products, and services; design, construct, maintain, and operate high performance sustainable buildings in sustainable locations; strengthen the vitality and livability of the communities in which federal facilities are located; and inform federal employees about and involve them in the achievement of these goals. The goals of this EO will be incorporated into the EMS and implemented beginning in 2010.

DOE O 450.1A, "Environmental Protection Program" – This order requires each DOE or NNSA facility to implement an EMS and establishes the requirements for implementing EO 13423. It specifies that EMS objectives include sound stewardship practices that are protective of the air, water, land, and other natural and cultural resources impacted by DOE operations, by which DOE cost-effectively meets or exceeds compliance with applicable environmental, public health, and resource protection laws, regulations, and DOE requirements. The EMS must be fully integrated into the site Integrated Safety Management System. The EMS must include pollution prevention goals and objectives. Each DOE or NNSA site must have demonstrated validation of their EMS by an outside organization by June 30, 2009.

DOE O 430.2B, "Departmental Energy, Renewable Energy and Transportation Management" – This order provides requirements and responsibilities for DOE or NNSA sites to assist DOE in meeting its energy efficiency goals and objectives in electricity, water, and thermal consumption, conservation, and savings, including goals and objectives contained in EO 13423. This order requires sites to develop an energy management program and to have an Executable Plan for the program. An Executable Plan must be prepared each year thereafter and must be integrated with a site's Ten-Year Site Plan.

Resource Conservation and Recovery Act (RCRA) – Under RCRA, generators of hazardous waste are required to have a program in place to reduce the volume or quantity and toxicity of such waste to the degree determined by the generator to be economically practicable. The EPA was required to develop a list of types of commercially available products (e.g., copy machine paper, plastic desktop items) and then specify that a certain minimum percentage of the product type's content be composed of recycled materials if they are to be purchased by a federal agency. Federal facilities just also have a procurement process in place to ensure that they purchase product types that satisfy the EPA-designated minimum percentages of recycled material.

NDEP Hazardous Waste Permit NEV HW0021 – This state permit requires NNSA/NSO to maintain an Annual Waste Minimization Summary Report in the Facility Operating Records. This report should include a description of the efforts taken during the year to reduce the volume and toxicity of waste generated in accordance with RCRA, as well as a description of the changes in volume and toxicity of waste actually achieved during the year in comparison to previous years to the extent such information is available for the years prior to 1984.

2.6.2 Compliance Reports

The following reports were generated for 2009 NNSA/NSO operations on the NTS and at the two offsite facilities in compliance with regulations related to environmental protection, renewable energy and transportation management, and pollution prevention and waste minimization.

- *FY 2009 NNSA/NSO Energy Executable Plan*
- *FY 2009 Waste Generation and Pollution Prevention Progress Report*, submitted to DOE Headquarters (HQ) via entry into DOE HQ database
- *CY 2009 Waste Minimization Summary Report*, submitted to NDEP
- *FY 2009 EMS Annual Report*, submitted to DOE HQ via entry into DOE HQ database

Table 2-8. NTS compliance status with DOE O 450.1A, DOE O 430.2B, and EO 13423

Compliance Measure/Action	Compliance Limit/Goal	2009 Compliance Status	Section Reference[a]
EO 13423, "Strengthening Federal Environmental, Energy and Transportation Management"			
Percent of all purchased items that contain the minimum content of recycled material as specified on the EPA-designated product list	100%	40%	3.4.2
DOE O 450.1A, "Environmental Protection Program"			
Have an EMS in place and complete the Self-Declaration Protocol in accordance with agency policy or obtain third-party certification	Due June 30, 2009	Compliant	3.0
Submit a fiscal year Waste Generation and Pollution Prevention Progress Report to DOE/HQ	Due December 31, 2009	Compliant	3.4.2.1
DOE O 430.2B, "Departmental Energy, Renewable Energy and Transportation Management"			
Prepare an Energy Executable Plan integrated with the Ten Year Site Plan	Due December 31, 2009	Compliant	3.4.1
Incorporate renewable energy and transportation management goals and objectives into EMS that help meet goals of the order	NA[b]	Compliant	3.4, Table 3-1
Resource Conservation and Recovery Act (RCRA)			
Have a program in place to reduce the volume or quantity and toxicity of generated hazardous waste to the degree it is economically practicable	NA	Compliant	3.4, Table 3-1, 3.4.2
Have a process in place to ensure that EPA-designated list products are purchased containing the minimum content of recycled materials	NA	Compliant	3.4.2
NDEP Hazardous Waste Permit Number NEV HW0021			
Submit a 2009 calendar year Waste Minimization Summary Report to NDEP	Due March 1, 2010	Compliant	3.4.2.1

(a) The section(s) within this document that describe how compliance summary data were collected
(b) Not applicable

2.7 National Environmental Policy Act

Before any project or activity is initiated at the NTS, it must be evaluated for possible impacts to the environment. Under the National Environmental Policy Act (NEPA), federal agencies are required to consider environmental effects and values and reasonable alternatives before making a decision to implement any major federal action that may have a significant impact on the human environment. NNSA/NSO uses four levels of documentation to demonstrate compliance with NEPA:

- Environmental Impact Statement (EIS) – a full disclosure of the potential environmental effects of proposed actions and the reasonable alternatives to those actions. An EIS must be prepared by a federal agency when a "major" federal action that will have "significant" environmental impacts is planned.
- Environmental Assessment (EA) – a concise discussion of proposed actions and alternatives and the potential environmental effects to determine if an EIS is necessary
- Supplement Analysis (SA) – a collection and analysis of information for an action already addressed in an existing EIS or EA used to determine whether a supplemental EIS or EA should be prepared, a new EIS or EA should be prepared, or no further NEPA documentation is required
- Categorical Exclusion (CX) – a category of actions that do not have a significant adverse environmental impact based on similar previous activities and for which, therefore, neither an EA nor an EIS is required

A NEPA Environmental Evaluation Checklist (Checklist) is required for all proposed projects or activities on the NTS. The Checklist is reviewed by the NNSA/NSO NEPA Compliance Officer to determine whether the activity's environmental impacts have been addressed in existing NEPA documents. If a proposed project has not been covered under any previous NEPA analysis and it does not qualify as a CX, then a new NEPA analysis is performed. The NEPA analysis may result in preparation of a new EA or a new SA to the existing programmatic NTS EIS (U.S. Department of Energy, Nevada Operations Office [DOE/NV], 1996). The NEPA Compliance Officer must approve each Checklist before a project proceeds. Table 2-9 presents a summary of how NNSA/NSO complied with NEPA in 2009 for 64 projects.

In 2009, NNSA/NSO began preparation of a new *Site-Wide Environmental Impact Statement for the Nevada Test Site and Offsite Locations in the State of Nevada* (NTS SWEIS). It will examine existing and potential impacts to the environment that have resulted, or could result, from current and future NNSA/NSO operations in Nevada during the ten-year period from the Record of Decision, estimated to be published in 2012. The NTS SWEIS will replace the current programmatic NTS EIS (DOE/NV, 1996).

On January 14, 2010, NNSA/NSO submitted to DOE HQ the *NNSA/NSO NEPA Annual Planning Document*. It provides the status of all EA and EIS documents being developed or planned in the next 12–24 months. It provided budget and major milestone information for the NTS SWEIS.

Table 2-9. NTS NEPA compliance activities conducted in 2009

Results of NEPA Checklist Reviews / NEPA Compliance Activities
21 projects were exempted from further NEPA analysis because they were of CX status.
41 projects were exempted from further NEPA analysis due to their inclusion under previous analysis in the NTS EIS (DOE/NV, 1996) and its Record of Decision.
1 project was exempted from further NEPA analysis due to its inclusion under previous analysis in the *Environmental Assessment for Radiological/Nuclear Countermeasures Test and Evaluation Complex, Nevada Test Site* (NNSA/NSO, 2004a).
1 project was exempted from further NEPA analysis due to its inclusion under previous analysis in the *Final Environmental Assessment for Activities Using Biological Simulants and Releases of Chemicals at the Nevada Test Site* (NNSA/NSO, 2004b).
A draft programmatic SA to the 1996 NTS EIS was reviewed by DOE HQ in 2008. Instead of approving the draft SA, DOE HQ approved the preparation of the NTS SWEIS to update the existing programmatic NTS EIS (DOE/NV, 1996).

2.8 Historic Preservation and Cultural Resource Protection

2.8.1 Applicable Regulations

National Historic Preservation Act of 1966, as amended – This act presents the goals of federal participation in historic preservation and delineates the framework for federal activities. Section 106 requires federal agencies to take into account the effects of their undertakings on properties included in, or eligible for inclusion in, the National Register of Historic Places (NRHP) and to consult with interested parties. The Section 106 process involves the agency reviewing background information, identifying eligible properties for the NRHP within the area of potential effect through consultation with the Nevada State Historic Preservation Office (SHPO), making a determination of effect (when applicable), and developing a mitigation plan when an adverse effect is unavoidable. Determinations of eligibility, effect, and mitigation are conducted in consultation with the SHPO and, in some cases, the federal Advisory Council on Historic Preservation. Section 110 sets out the broad historic preservation responsibilities of federal agencies and is intended to ensure that historic preservation is fully integrated into the ongoing programs of all federal agencies. It requires federal agencies to develop and implement a Cultural Resources Management Plan, to identify and evaluate the eligibility of historic properties for long-term management as well as for future project-specific planning, and to maintain archaeological collections and their associated records at professional standards. At the NTS, a long-term management strategy includes (1) monitoring NRHP-listed and eligible properties to determine if environmental or other actions are negatively affecting the integrity or other aspects of eligibility and (2) taking corrective actions if necessary.

EO 11593, "Protection and Enhancement of the Cultural Environment" – This EO reinforces the obligation of federal agencies to conduct adequate surveys to locate any and all sites of historic value under their jurisdiction.

Archaeological Resources and Protection Act of 1979 – The purpose of this act is to secure, for the present and future benefit of the American people, the protection of archaeological resources and sites that are on public and Indian lands, and to address the irreplaceable heritage of archaeological sites and materials. It requires the issuance of a federal archaeology permit to qualified archaeologists for any work that involves excavation or removal of archaeological resources on federal and Indian lands and notification to Indian tribes of these activities. Unauthorized excavation, removal, damage, alteration, or defacement of archaeological resources is prohibited, as is the sale, purchase, exchange, transport, receipt of, or offer for sale of such resources. Criminal and civil penalties apply to such actions. Information concerning the nature and location of any archaeological resource may not be made available to the public unless the federal land manager determines that the disclosure would not create a risk of harm to the resources or site. The Secretary of the Interior is required to submit an annual report at the end of each fiscal year to Congress that reports the scope and effectiveness of all federal agencies' efforts on the protection of archaeological resources, specific projects surveyed, resources excavated or removed, damage or alterations to sites, criminal and civil violations, the results of permitted archaeological activities, and the costs incurred by the federal government to conduct this work. All archaeologists working at the NTS must have qualifications that meet federal standards and must work under a permit issued by NNSA/NSO. In the event of vandalism, NNSA/NSO would need to investigate the actions.

American Indian Religious Freedom Act of 1978 – This law established the government policy to protect and preserve for American Indians their inherent right of freedom to believe, express, and exercise the traditional religions, including but not limited to access to sites, use and possession of sacred objects, and the freedom to worship through ceremonials and traditional rites. Locations exist on the NTS that have religious significance to Western Shoshone and Southern Paiute; visits to these places involve prayer and other activities. Access is provided by NNSA/NSO as long as there are no safety or health hazards.

Native American Graves Protection and Repatriation Act (NAGPRA) of 1990 – This act requires federal agencies to identify Native American human remains, funerary objects, sacred objects, and objects of cultural patrimony in their possession. Agencies are required to prepare an inventory of human remains and associated funerary objects, as well as a summary with a general description of sacred objects, objects of cultural patrimony, and unassociated funerary objects. Through consultation with Native American tribes, the affiliation of the remains and objects are determined and the tribes can request repatriation of their cultural items. The agency is required to publish a notice of inventory completion in the Federal Register. The law also protects the physical location where human remains are placed during a death rite or ceremony. The NTS artifact collection is subject to NAGPRA, and the locations of American Indian human remains at the NTS must be protected from NTS activities.

2.8.2 Reporting Requirements

NNSA/NSO submits Section 106 cultural resources inventory reports and historical evaluations to the Nevada SHPO for review and concurrence. Mitigation plans and mitigation documents are also submitted to the Nevada SHPO, and some types of documents go to the Advisory Council on Historic Preservation and the National Park Service. Reports containing restricted data on site locations are not available to the public. Some technical reports, however, are available to the public upon request and can be obtained from the National Technical Information Service. The 2009 reports submitted to agencies are discussed in Chapter 12.

Table 2-10. NTS compliance status with historic preservation regulations

Compliance Action	2009 Compliance Status	Section Reference[(a)]
National Historic Preservation Act of 1966 and		
EO 11593, "Protection and Enhancement of the Cultural Environment"		
Maintain and implement NTS Cultural Resources Management Plan	Compliant	12.0
Conduct cultural resources inventories and evaluations of historic structures	Compliant	12.1, 12.2, Table 12-1
Make determinations of eligibility to the National Register	Compliant	12.1, Table 12-1
Make assessments of impact to eligible properties		12.2
Manage artifact collection as per required professional standards	Compliant	12.4
Archaeological Resources and Protection Act of 1979		
Conduct archaeological work by qualified personnel	Compliant	12.0
Determine if archaeological sites have been damaged	Compliant	12.3
Complete and submit Secretary of the Interior Archaeology Questionnaire	Compliant	12.3
American Indian Religious Freedom Act of 1978		
Allow American Indians access to NTS locations for ceremonies and traditional use	Compliant	12.5
Native American Graves Protection and Repatriation Act		
Consult with affiliated Native American Indian tribes regarding repatriation of cultural items	Completed	12.4
Protect Native American Indian burial locations on NTS	Compliant	12.4
Overall Requirement		
Consult with tribes regarding various cultural resources issues	Compliant	12.5

(a) The section(s) within this document that describe how compliance summary data were collected

2.9 Conservation and Protection of Biota and Wildlife Habitat

2.9.1 Applicable Regulations

Endangered Species Act (ESA) – Section 7 of this act requires federal agencies to ensure that their actions do not jeopardize the continued existence of federally listed endangered or threatened species or their critical habitat. The threatened desert tortoise is the only animal protected under the ESA that may be impacted by NTS operations. NTS activities within tortoise habitat are conducted so as to comply with the terms and conditions of Biological Opinions issued by the U.S. Fish and Wildlife Service (FWS) to NNSA/NSO.

Migratory Bird Treaty Act (MBTA) – This act prohibits the harming of any migratory bird, their nest, or eggs without authorization by the Secretary of the Interior. All but three of the 239 bird species observed on the NTS are protected under this act. Biological surveys are conducted for projects to prevent direct harm to protected birds, nests, and eggs.

Clean Water Act (CWA), Section 404, Wetlands Regulations – This act regulates land development affecting wetlands by requiring a permit obtained from the U.S. Army Corps of Engineers (USACE) to discharge dredged or fill material into waters of the United States, which includes most wetlands on public and private land. NTS projects are evaluated for their potential to disturb wetlands and their need for a Section 404 permit application. Based on recent rulings, no natural NTS wetland may meet the criteria of a "jurisdictional" wetland subject to Section 404 regulations. However, final determination from the USACE regarding the status of NTS wetlands has yet to be received.

National Wildlife Refuge System Administration Act – This act forbids a person to knowingly disturb or injure vegetation or kill vertebrate or invertebrate animals or their nests or eggs on any National Wildlife Refuge lands unless permitted by the Secretary of the Interior. The boundary of the Desert National Wildlife Refuge (DNWR), land administered within this system, is approximately 5 km (3.1 mi) downwind of the NPTEC in Area 5. Biological monitoring is conducted to verify that tests conducted at the NPTEC do not disperse toxic chemicals that could harm biota on the DNWR.

EO 11990, "Protection of Wetlands" – This EO requires governmental agencies to minimize the destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands in carrying out the agency's responsibilities, including managing federal lands and facilities. Projects are evaluated for their potential to disturb the natural water sources on the NTS. NTS wetlands are monitored to document their status and use by wildlife, even though they may not meet the criteria for "jurisdictional" status under the CWA.

EO 11988, "Floodplain Management" – This EO ensures protection of property and human well-being within a floodplain and protection of floodplains themselves. The Federal Emergency Management Agency publishes guidelines and specifications for assessing alluvial fan flooding. NNSA/NSO generally satisfies EO 11988 through DOE O 420.1B, "Facility Safety" and invoked standards. DOE O 420.1B and the associated implementation guide for mitigation of natural phenomena hazards call for a graded approach to assessing risk to all facilities (structures, systems, and components [SSC]) from potential natural hazards. Chapter 4 of DOE-STD-1020-2002, "Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities," provides flood design and evaluation criteria for SSC. Evaluations of flood hazards at the NTS are generally conducted to ensure protection of property and human well-being.

EO 13112, "Invasive Species" – This EO directs federal agencies to act to prevent the introduction of, or to monitor and control, invasive (non-native) species; to provide for restoration of native species; and to exercise care in taking actions that could promote the introduction or spread of invasive species. Land-disturbing activities on the NTS have resulted in the spread of numerous invasive plant species. Habitat reclamation and other controls are evaluated and conducted, when feasible, to control such species and meet the purposes of this EO.

DOE O 450.1A, "Environmental Protection Program" – This order requires federal facilities to address the protection of site resources from wildland and operational fires and the protection of the environment and biota from site activities. Annual surveys of vegetation fuel hazards, ecosystem mapping, surveys for protected and important species, and habitat revegetation are conducted to meet the intent of this order.

Five-Party Cooperative Agreement – This agreement between NNSA/NSO, NTTR, FWS, the Bureau of Land Management (BLM), and the State of Nevada Clearinghouse calls for cooperation in conducting resource inventories and developing resource management plans for wild horses and burros and maintaining favorable habitat on federally withdrawn lands for these animals. BLM considers NTS a zero herd-size management area. NNSA/NSO consults with BLM regarding any issue of NTS horse management. Biologists conduct periodic horse census surveys on the NTS.

NAC 503.010–503.104, "Protection of Wildlife" – This code identifies Nevada animal species, both protected and unprotected, and prohibits the harm of protected species without special permit. Over 200 bird species and 1 bat species on the NTS are state-protected. Biological surveys are conducted for projects to prevent direct harm to protected birds, nests, eggs, and protected bats.

NAC 527, "Protection and Preservation of Timbered Lands, Trees and Flora" – This code requires that the State Forester Firewarden determine the protective status of Nevada plants and prohibits removal or destruction of protected plants without special permit. Currently, no state-protected plants are known to occur on the NTS. Annual reviews of the status of NTS plants are conducted.

2.9.2 Compliance Reports

The following reports were prepared in 2009 or 2010 to meet regulation requirements or to document compliance for all activities conducted in 2009:

- *Annual Report of Actions Taken Under Authorization of the Biological Opinion on NTS Activities (File Nos. 84320-2008-F-0416 and B-0015) – January 1, 2009 Through December 31, 2009*
- *Annual Report for Handling Permit S31808*, submitted to Nevada Division of Wildlife
- *Annual Report for Federal Migratory Bird Scientific Collecting Permit MB008695-0*, submitted to FWS Portland Office
- *Annual Report for Federal Migratory Bird Special Purpose Possession Permit (Dead Permit) MB037277-1*, submitted to FWS Portland Office

Table 2-11. NTS compliance status with applicable biota and wildlife habitat regulations

Compliance Measure/Action	Compliance Limit	2009 Compliance Status	Section Reference[a]
Endangered Species Act – 1996 Opinion for NTS Programmatic Activities			
Number of tortoises accidentally injured or killed due to NTS activities, per year	3	Compliant	13.1
Number of tortoises captured and displaced from project sites, per year	10	Compliant	13.1
Number of tortoises taken since 1992 by way of injury or mortality on NTS paved roads by vehicles other than those in use during a project	Unlimited	Compliant	13.1
Number of total acres (ac) of desert tortoise habitat disturbed during NTS project construction since 1992	3,015 ac	Compliant	13.1
Follow the 23 terms and conditions of the Biological Opinion during construction and operation of NTS projects	NA[b]	Compliant	13.1
Conduct biological surveys at proposed project sites to assess presence of protected species	NA	Compliant	13.2
Migratory Bird Treaty Act			
Number of birds/nests/eggs harmed by NTS project activities	0	2 accidental bird deaths	13.3.2.3
National Wildlife Refuge System Administration Act			
Number of animals, their nests, or eggs killed and amount of vegetation disturbed or injured on System lands (the DNWR) as a result of NTS activities	0	Compliant	13.6
Wild Free-Roaming Horse and Burro Act and Five-Party Cooperative Agreement			
Number of horses harassed or killed due to NTS activities	0	Compliant	13.3.2.6
Cooperate in conducting resource inventories and developing resource management plans for horses on the NTS, NTTR, and DNWR	NA	Compliant	13.3.2.6; Table 13-5
EO 11988, “Floodplain Management”			
Conduct flood hazard assessments	NA	NA – No floodplain projects	- -
Clean Water Act, Section 404 -Wetlands Regulations and EO 11990, “Protection of Wetlands”			
Number of wetlands disturbed by NTS activity	NA	0	13.3.4
EO 13112, “Invasive Species”			
Evaluate feasibility of conducting habitat reclamation and other controls to control spread of invasive species	NA	Compliant	13.1, 13.4
NAC 503.010–503.104 and NAC 527 - Nevada Protective Measures for Wildlife and Flora			
Number of state-protected animals harmed or killed and number of state-protected plants collected or harmed due to NTS activities	0	2 accidental bird deaths	13.3.2.3

(a) The sections within this document that describe how compliance summary data were collected
(b) Not applicable

2.10 Occurrences, Unplanned Releases, and Continuous Releases

2.10.1 Applicable Regulations

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) – Continuous release reporting under Section 103 requires that a non-permitted hazardous substance release that is equal to or greater than its reportable quantity be reported to the National Response Center. The EPA requires all facilities that release a hazardous substance meeting the Section 103(f) requirements to report annually to EPA and perform an annual evaluation of releases. CERCLA requirements applicable to NTS operations also pertain to an emergency response program for hazardous substance releases to the environment (see discussion of EPCRA in Section 2.5).

Emergency Planning and Community Right-to-Know Act (EPCRA) – This act is described in Section 2.5. See Table 2-5 for summary of compliance to EPCRA pertaining to unplanned environmental releases of hazardous substances.

40 CFR 302.1–302.8, "Designation, Reportable Quantities, and Notification" – This CFR requires facilities to notify federal authorities of spills or releases of certain hazardous substances designated under CERCLA and the CWA. It specifies what quantities of hazardous substance spills/releases must be reported to authorities and delineates the notification procedures for a release that equals or exceeds the reportable quantities.

DOE O 231.1A, "Environment, Safety, and Health Reporting" – This order includes the requirement for reporting environmental occurrences. Along with DOE M 231.1-2, "Occurrence Reporting and Processing of Operations Information," it requires the establishment and maintenance of a system for reporting operations information related to DOE-owned and leased facilities, for processing that information to identify the root causes of environmental occurrences, and for providing appropriate corrective action for such occurrences.

NAC 445A.345–445.348, "Notification of Release of Hazardous Substane" – This NAC requires state notification for the unplanned or accidental releases of specified quantities of pollutants, hazardous wastes, and contaminants.

Water Pollution Control General Permit GNEV93001 – This general wastewater discharge permit issued by the State to the NTS specifies that no petroleum products will be discharged into treatment works without first being processed through an oil/water separator or other approved methods. It also specifies how NNSA/NSO shall report each bypass, spill, upset, overflow, or release of treated or untreated sewage.

Other NTS Permits/Agreements – As with General Permit GNEV93001, other state permits and agreements are cited in previous subsections of this chapter (e.g., FFACO) that specify that accidents or events of non-compliance must be reported. These include events that may create an environmental hazard.

2.10.2 Compliance Status

There are no continuous releases on the NTS or at the NLVF and RSL-Nellis.

In 2009, six reportable environmental occurrences happened. They included a spill of spent oil in Area 6 (reported in *Nevada Test Site Environmental Report 2008* [NSTec, 2009a]), discoveries of legacy metal debris in Areas 5 and 2, a sewage overflow in Area 6, loose contaminated soil in a trailer delivering waste to the Area 5 RWMS, and legacy contaminated areas on the Tonopah Test Range outside of a fenced contamination area. All six are described in Table 2-12.

Table 2-12. Environmental occurrences in 2009

Description of Occurrence	Reporting Criteria[(a)]	Corrective Actions Taken
ORPS Number/Date of Occurrence: EM--NVSO-NST-NTS-2009-0001, December 31, 2008		
Spent oil spill in Area 6. This occurrence was reported in Table 2-10 of NSTec, 2009a.		
ORPS Number/Date of Occurrence: EM--NVSO-NST-NTS-2009-0002, February 26, 2009		
On February 18, 2009, NSTec Radiological Control Technicians (RCTs) surveyed a scrap metal pile in an unoccupied area of Area 5. The metal was slated for disposal. Three fragments of legacy metal debris that were radioactively contaminated were identified. The metal debris originated from past NTS activities. Surveys noted both fixed and removable contamination but there was no personnel contamination.	6B(4) - Identification of onsite radioactive contamination greater than 10 times the total contamination values in 10 CFR 835 Appendix D[(b)] and that is found outside of the following locations: Contamination Areas, High Contamination Areas, Airborne Radioactivity Areas, Radiological Buffer Areas, and areas controlled in accordance with 10 CFR 835.1102(c). For tritium, the reporting threshold is 10 times the removable contamination values in 10 CFR Part 835, Appendix D.	The items were segregated and the area was posted as a Radiological Contamination Area pending further surveys.
ORPS Number/Date of Occurrence: NA--NVSO-NST-NTS-2009-0003, February 26, 2009		
On February 25, 2009, NSTec RCTs were performing pre-work surveys at CAU 166 in Area 2 and identified eight strips of legacy radiological material. There was no personnel contamination. These strips are expected to be depleted uranium due to the location of the CAU. The metal debris originated from past NTS activities.	6B(4) - Identification of onsite legacy radioactive contamination greater than 10 times the total contamination values in 10 CFR 835 Appendix D[(b)] and that is found outside of the following locations: Contamination Areas, High Contamination Areas, Airborne Radioactivity Areas, Radiological Buffer Areas, and areas controlled in accordance with 10 CFR 835.1102(c). For tritium, the reporting threshold is 10 times the removable contamination values in 10 CFR Part 835, Appendix D.	The existing fencing around the site was repaired and the area posted "Caution Radioactive Material" pending further evaluation. RCTs performed a walk-around of the perimeter approximately 15 feet out from the fence and found no similar material.
ORPS Number/Date of Occurrence: NA--NVSO-NST-NTS-2009-0005, May 6, 2009		
On May 6, 2009, a sewage overflow was discovered by an NSTec maintenance worker during a routine monthly preventive maintenance visit to the Area 6 lift station. The sewage spill was approximately 6 feet in diameter and 8 inches deep. Approximately 30 gallons were released. There appeared to have been several sewage overflows over a period of time. An investigation revealed that the pumps and alarm in the lift station were disabled, causing the lift station to fill with sewage and overflow.	5A(4) - Any release (onsite or offsite) of a hazardous substance, material, waste, or radionuclide from a DOE facility that must be reported to outside agencies in a format other than routine periodic reports. (However, oil spills of less than 10 gallons and with negligible environmental impact need not be reported in ORPS.)	The affected areas were disinfected. NSTec Maintenance started the pumps and the lift station operated normally. Initial notification was made to the NNSA/NSO who then notified NDEP.

Table 2-12. Environmental occurrences in 2009 (continued)

Description of Occurrence	Reporting Criteria[a]	Corrective Actions Taken
ORPS Number/Date: NA--NVSO-NST-NTS-2009-0006, May 21, 2009		
On May 21, 2009, a small pile of loose contaminated soil was discovered on the floor of a shipping trailer delivering mixed waste for disposal to Area 5. The shipment came from Advance Mixed Waste Treatment Project in Idaho.	10(2) - An event, condition, or series of events that does not meet any of the other reporting criteria, but is determined by the Facility Manager or line management to be of safety significance or of concern to other facilities or activities in the DOE complex.	The soil was placed into a plastic bag and sent for analysis. Personnel and equipment were monitored and no contamination was detected. The trailer floor was re-surveyed as clean after the removal of the soil. The Advance Mixed Waste Treatment Project was notified of the soil analysis results.
ORPS Number/Date of Occurrence: EM--NVSO-NST-TTRN-2009-0001, October 7, 2009		
On October 6, 2009, during a radiological survey, Navarro Nevada Environmental Services radiological control personnel identified legacy radioactive contamination hot spots outside of a fenced contamination area on the Tonopah Test Range. The material was determined to be contaminated with Pu-239/Am-241.	6B(4) - Identification of onsite radioactive contamination greater than 10 times the total contamination values in 10 CFR 835 Appendix D[b] and that is found outside of the following locations: Contamination Areas, High Contamination Areas, Airborne Radioactivity Areas, Radiological Buffer Areas, and areas controlled in accordance with 10 CFR 835.1102(c). For tritium, the reporting threshold is 10 times the removable contamination values in 10 CFR Part 835, Appendix D.	Notifications were made and a survey of an approximate 15-foot radius was performed at each location with all readings less than minimum detectable activity. Each location was posted as a Radioactive Material Area.

(a) Reporting requirements provided in DOE M 231.1-2, "Occurrence Reporting and Processing of Operations Information"

(b) 10 CFR 835 Appendix D total concentration limits can be found at http://www.lbl.gov/ehs/orps/pdf/radContamination.pdf, as accessed on June 18, 2010.

2.11 Environment, Safety, and Health Reporting

2.11.1 Applicable Regulations

DOE O 231.1A, "Environment, Safety and Health Reporting" – This order calls for the "timely collection, reporting, analysis, and dissemination of information on environment, safety, and health issues as required by law or regulations or as needed to ensure that the DOE and the NNSA are kept fully informed on a timely basis about events that could adversely affect the health and safety of the public or the workers, the environment, the intended purpose of DOE facilities, or the credibility of the Department." The order specifically requires DOE and NNSA sites to prepare an annual calendar year report, referred to as the Annual Site Environmental Report (ASER).

DOE M 231.1-1A Chg 2, "Environment, Safety and Health Reporting Manual" – This manual provides detailed requirements for implementing DOE O 231.1A.

The data to be included in an ASER are air emissions, effluent releases, environmental monitoring, and estimated radiological doses to the public from releases of radioactive material at DOE or NNSA sites. The annual report must also summarize environmental occurrences and responses reported during the calendar year, confirm compliance with environmental standards and requirements, and highlight significant programs and efforts. Environmental performance indicators and/or performance measures programs are to be included. The breadth and detail of this reporting should reflect the size and extent of programs at a particular site. The ASER for the calendar year is to be completed and made available to the public by October 1 of the following year. DOE's Office of Analysis is to issue annual guidance to all field elements regarding the preparation of the report.

For NNSA/NSO, reporting is accomplished through the publication of the NTS ASER, which is titled the Nevada Test Site Environmental Report (NTSER).

2.11.2 Compliance Status

In 2009, the 2008 NTSER was prepared. It was published and posted on the NNSA/NSO, NSTec, and DOE Office of Scientific and Technical Information Web sites by September 10, 2009. The 2008 NTSER was mailed to all recipients (on a compact disc accompanied by a 22-page summary) on September 23, 2009.

2.12 Summary of Permits

Table 2-13 presents the complete list of all federal and state permits active during calendar year 2009 that were issued to NNSA/NSO and to NSTec for NTS, NLVF, and RSL-Nellis operations and which have been referenced in previous subsections of this chapter. The table includes those pertaining to air quality monitoring, operation of drinking water and sewage systems, hazardous materials and hazardous waste management and disposal, and endangered species protection. Reports associated with these permits are submitted to the appropriate designated state or federal office. Copies of reports may be obtained upon request.

Table 2-13. Environmental permits required for NTS and NTS site facility operations

Permit Number	Description	Expiration Date	Reporting
Air Quality	**NTS**		
AP9711-2557	NTS Class II Air Quality Operating Permit	June 25, 2014	March
09-30	NTS Open Burn Variance, Fire Extinguisher Training (Various Locations)	March 14, 2010	None
09-08	NTS Open Burn Variance, Support Drills/Exercises, A-5	January 14, 2010	None
09-31	NTS Open Burn Variance, NTS, A-23, Facility #23-T00200 (NTS Fire & Rescue Training Center)	March 14, 2010	None
	UGTA Offsite		
AP9711-2622	NTTR Class II Air Quality Operating Permit, Surface Area Disturbance, Well ER-EC-12	November 4, 2014	March
	NLVF		
Facility 657, Mods. 4/5	Clark County Authority to Construct/Operating Permit for a Non-Major Commercial Building	None	March
	RSL-Nellis		
Facility 348, Mod. 3	Clark County Authority to Construct/Operating Permit for a Non-Major Testing Laboratory	None	March
Drinking Water	**NTS**		
NY-0360-12NTNC	Areas 6 and 23	September 30, 2010	None
NY-4098-12NC	Area 25	September 30, 2010	None
NY-4099-12NC	Area 12	September 30, 2010	None
NY-0835-12NP	NTS Water Hauler #84846	September 30, 2010	None
NY-0836-12NP	NTS Water Hauler #84847	September 30, 2010	None
Septic Systems/ Pumpers	**NTS**		
NY-1054	Septic System, Area 3 (Waste Management Offices)	None	None
NY-1069	Septic System, Area 18 (820th Red Horse Squadron)	None	None
NY-1076	Septic System, Area 6 (Airborne Response Team Hangar)	None	None
NY-1077	Septic System, Area 27 (Baker Compound)	None	None
NY-1079	Septic System, Area 12 (U12g Tunnel)	None	None
NY-1080	Septic System, Area 23 (Building 1103)	None	None
NY-1081	Septic System, Area 6 (Control Point-170)	None	None
NY-1082	Septic System, Area 22 (Building 22-01)	None	None
NY-1083	Septic System, Area 5 (Radioactive Material Management Site)	None	None
NY-1084	Septic System, Area 6 (Device Assembly Facility)	None	None
NY-1085	Septic System, Area 25 (Central Support Area)	None	None
NY-1086	Septic System, Area 25 (Reactor Control Point)	None	None
NY-1087	Septic System, Area 27 (Able Compound)	None	None
NY-1089	Septic System, Area 12 (Camp)	None	None
NY-1090	Septic System, Area 6 (Los Alamos National Laboratory Construction Camp Site)	None	None
NY-1091	Septic System, Area 23 (Gate 100)	None	None

Table 2-13. Environmental permits required for NTS and NTS site facility operations (continued)

Permit Number	Description	Expiration Date	Reporting
Septic Systems/ Pumpers (cont.)	**NTS**		
NY-1103	Septic System, Area 22 (Desert Rock Airport)	None	None
NY-1106	Septic System, Area 5 (Hazmat Spill Center)	None	None
NY-1110-HAA-A	Individual Sewage Disposal System, A-12, Building 12-910	None	None
NY-1112	Commercial Sewage Disposal System, U1a, Area 1	None	None
NY-1113	Commercial Sewage Disposal System, Area 1, Building 121	None	None
NY-1124	Commercial Individual Sewage Disposal System, NTS, Area 6	None	None
NY-1128	Commercial Individual Sewage Disposal System, NTS, Area 6, Yucca Lake Project	None	None
NY-17-03313	Septic Tank Pumper E 106785	July 31, 2010	None
NY-17-03315	Septic Tank Pumper E 107105	July 31, 2010	None
NY-17-03317	Septic Tank Pumper E-105918	July 31, 2010	None
NY-17-03318	Septic Tank Pumping Contractor (one unit)	July 31, 2010	None
NY-17-06838	Septic Tank Pumper E-106169	July 31, 2010	None
NY-17-06839	Septic Tank Pumper E-107103	July 31, 2010	None
Wastewater Discharge	**NTS**		
GNEV93001	Water Pollution Control General Permit	August 5, 2010	Quarterly
NEV96021	Water Pollution Control for E-Tunnel Waste Water Disposal System and Monitoring Well ER-12-1	October 1, 2013	Quarterly
	NLVF		
VEH-112	NLVF Wastewater Contribution Permit	December 31, 2013	Annually
NV0023507	North Las Vegas National Pollutant Discharge Elimination System Permit	November 2, 2011	Quarterly
	RSL-Nellis		
CCWRD-080	Industrial Wastewater Discharge Permit	June 30, 2009	Quarterly
Hazardous Materials	**NTS**		
2058	NTS Hazardous Materials	February 28, 2010	Annually
2059	Nonproliferation Test and Evaluation Complex	February 28, 2010	Annually
	NLVF		
2045	NLVF Hazardous Materials Permit	February 28, 2010	Annually
	RSL-Nellis		
2055	RSL Hazardous Materials Permit	February 28, 2010	Annually
Hazardous Waste	**NTS**		
NEV-HW0021	NTS Hazardous Waste Management Permit (RCRA)	December 1, 2010	Biennially
0510003453	Utah Generator Site Access Permit	November 1, 2008	None
Waste Management	**NTS**		
SW 13 000 01	Area 5 Asbestiform Low-Level Solid Waste Disposal Site	Post-closure[a]	Annually
SW 13 097 02	Area 6 Hydrocarbon Disposal Site	Post-closure	Annually
SW 13 097 03	Area 9 U10c Solid Waste Disposal Site	Post-closure	Annually
SW 13 097 04	Area 23 Solid Waste Disposal Site	Post-closure	Biannually
	RSL-Nellis		
U1576-33N-01	RSL-Nellis Waste Management Permit-Underground Storage Tank	December 31, 2010	None

Table 2-13. Environmental permits required for NTS and NTS site facility operations (continued)

Permit Number	Description	Expiration Date	Reporting
Endangered Species/Wildlife			
File Nos. 84320-2008-F-0416 and B-0015	U.S. Fish and Wildlife Service – Desert Tortoise Incidental Take Authorization (Biological Opinion for Programmatic NTS Activities)	February 12, 2019	Annually
MB008695-0	U.S. Fish and Wildlife Service – Migratory Bird Scientific Collecting Permit	March 31, 2012	Annually
MB037277-1	U.S. Fish and Wildlife Service – Migratory Bird Special Purpose Possession – Dead Permit	March 31, 2009 (permit renewal requested but not issued for remainder of 2009)	Annually
S31808	Nevada Division of Wildlife – Scientific Collection of Wildlife Samples	December 31, 2010	Annually

(a) Permit expires 30 years after closure of the landfill

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3.0 Environmental Management System

The U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) conducts activities on the Nevada Test Site (NTS) while ensuring protection of the environment, the worker, and the public. This is accomplished through the implementation of an Environmental Management System (EMS). An EMS is a business management practice that incorporates concern for environmental performance throughout an organization, with the ultimate goal being continual reduction of the organization's impact on the environment. An EMS ensures that environmental issues are systematically identified, controlled, and monitored, and it provides mechanisms for responding to changing environmental conditions and requirements, reporting on environmental performance, and reinforcing continual improvement. The NTS EMS incorporates environmental stewardship goals that are identified in the federal EMS directives applicable to all U.S. Department of Energy (DOE) and U.S. Department of Energy, National Nuclear Security Administration (NNSA) sites (see Section 2.6).

National Security Technologies, LLC (NSTec), the current Management and Operating contractor for the NTS, designed an EMS to meet the 17 requirements of the globally recognized International Organization for Standardization (ISO) 14001 Environmental Management Standard. In June of 2008, NSTec obtained ISO 14001 certification. NSTec's progress in developing the EMS is provided in past annual NTS environmental reports available on the NNSA/NSO Web site at http://www.nv.doe.gov/library/publications/aser.aspx. This chapter describes the 2009 progress made towards improving overall environmental performance and meeting sustainable environmental stewardship goals.

3.1 Environmental Policy

The NSTec Environmental Protection Policy is posted on the NSTec Programs Internet Web site, which is available to the public (http://www.nstec.com/programs/index.htm). The policy contains the following key goals and commitments:

- Protect environmental quality and human welfare by implementing EMS practices.
- Identify and comply with all applicable DOE orders and federal, state, and local environmental laws and regulations.
- Identify and mitigate environmental aspects early in project planning.
- Establish environmental objectives, targets, and performance measures.
- Collaborate with employees, customers, subcontractors, and key suppliers on sustainable development and pollution prevention efforts.
- Communicate and instill an organizational commitment to environmental excellence in company activities through processes of continual improvement.

3.2 Environmental Aspects

NSTec evaluates whether operations have an environmental aspect and implements the EMS to minimize or eliminate any potential impacts. Operations are evaluated by performing Hazard Assessments, preparing Health and Safety Plans and Execution Plans, and preparing and reviewing National Environmental Policy Act documents. All of these documents require that mitigation actions be identified to minimize the risk of adverse impacts. NSTec has determined that the following aspects of site operations have the potential to affect the environment:

Significant aspects:

- Air emissions
- Drinking water contamination
- Energy, fuel, and water use
- Environmental restoration
- Historical groundwater contamination
- Hazardous, radioactive, and mixed waste management (generation, storage, and disposal)
- Wastewater management (generation and disposal)

Other aspects:

- Building construction, renovation, and demolition
- Electronics stewardship
- Industrial chemical storage and use
- Non-hazardous waste management (generation, storage, and disposal)
- Purchase of materials and equipment
- Recycling and management of surplus property and materials
- Resource protection (cultural, biological, and raw materials)
- Surface water and stormwater runoff

3.3 Environmental Objectives, Targets, and Programs

An Environmental Working Group (EWG), composed of key employees in several NSTec organizations, determines what EMS objectives and targets will be implemented to address specific environmental aspects of NNSA/NSO operations. These are determined on a fiscal year (FY) (October 1 through September 30) basis. The EWG meets monthly, and targets are tracked by the various responsible NSTec organizations. The FY 2009 EMS objectives and targets are presented in Table 3-1. Those selected in 2009 to be implemented and tracked in FY 2010 are presented in Table 3-2. Several programs exist or were formed to address the specific goals of DOE Order DOE O 430.2B, "Departmental Energy, Renewable Energy and Transportation Management," and DOE O 450.1A, "Environmental Protection Program" (see Section 2.6). These include the NSTec Energy Management Program, the Pollution Prevention Program, and the EWG.

Table 3-1. FY 2009 EMS objectives and targets

Environmental Aspect	Objective	Target	Result
Air Emissions	Reduce hazardous emissions.	Replace three fuel burning boilers with high efficiency electric boilers.	**PARTIAL SUCCESS –** Two boilers were replaced at Building 23-754. The third boiler was removed and not replaced in FY 2010.
Drinking Water Contamination	Upgrade water system to stabilize pressures and reduce maintenance.	Replace approximately 823 meters (2,700 feet) of waterline in Area 6.	**PARTIAL SUCCESS –** Most of the work was completed, but was finished in FY 2010.
Energy and Fuel Use	Reduce energy use.	Reduce electrical energy use per gross square foot by 3% in comparison to the FY 2008 baseline.	**EXCEEDED TARGET –** Actual total reduction was 20.1%.
	Increase the percentage of alternate fuel use relative to overall fuel consumption.	Increase alternative fuel use at the NTS by at least 10% over FY 2008 usage.	**EXCEEDED TARGET –** Final E-85 percentage increase was 27.6%.
Environmental Restoration	Close/remediate sites identified in the Federal Facility Agreement and Consent Order (FFACO).	Complete closures of four corrective action units (CAUs) on schedule: CAUs 107, 134, 139, and 166.	**MET TARGET –** All four CAU closures met the FFACO schedules.
Groundwater Protection	Protect groundwater quality.	Prepare 80 unneeded boreholes for plugging and plug 74.	**MET TARGET –** Prepared 80 and plugged 74 boreholes.
Hazardous, Radioactive, and Mixed Waste Management	Reduce environmental contamination risk at vulnerable sites.	Take identified corrective actions to mitigate top priorities from the Vulnerable Sites List. This is a prioritized list of sites that need some type of identified corrective action to remove or reduce the risk of an environmental problem (usually a chemical release).	**MET TARGET –** Three sites were remediated.

Table 3-1. FY 2009 EMS objectives and targets (continued)

Environmental Aspect	Objective	Target	Result
Non-hazardous Waste Management	Reuse excavated soil from excavation of a new disposal cell in Area 5.	Reuse 100% of the soil excavated from Pit 17 as cover material in other Area 5 disposal cells.	**MET TARGET –** All of the excavated soil (168 cubic yards) was used for waste cover or fill material.
	Reuse pavement removed from roads.	Use a process that removes existing pavement and some subsurface, grinds up the material, and then applies the material as replacement subsurface.	**MET TARGET –** 26.2 miles of existing pavement were recycled as road bed material under new pavement.
Water Usage	Reduce water usage.	Reduce water usage by 2% below FY 2008 usage.	**EXCEEDED TARGET –** Actual total reduction was 4.4%.

Table 3-2. FY 2010 proposed objectives and targets

Environmental Aspect	Objective	Target
Energy Use	Reduce energy use.	Take actions to keep energy usage at or below the FY 2009 level.
		Perform High Performance Sustainable audits on 20% of enduring buildings.
Fuel Use	Increase use of alternative fuels.	E-85 fuel to be 35% of total E-85 and gasoline fuel used at the NTS.
	Decrease petroleum fuel use.	Reduce usage of unleaded and diesel fuels by 2% of that used in FY 2009.
Environmental Restoration	Remediate sites identified in the FFACO.	Meet the FY 2009 FFACO deadlines for CAU 563.
Groundwater Protection	Protect groundwater quality.	Prepare 60 boreholes for plugging and plug 50 boreholes.
Hazardous, Radioactive, and Mixed Waste Management	Reduce environmental contamination risk at vulnerable sites.	Take identified corrective actions to mitigate top priorities from the Vulnerable Sites List.
Water Usage	Reduce water usage.	Take actions to keep water usage at or below the FY 2009 level.

3.3.1 Renewable Energy and Transportation Management

The Energy Management Program, under the NSTec Operations and Infrastructure Directorate, has the specific mission to implement the requirements of DOE O 430.2B. An Energy Management Council (EMC), composed of key employees in various NSTec organizations affected by the order, meets monthly to discuss goals and progress toward completion. In December 2009, the Energy Management Program developed the *FY 2010 NNSA/NSO Energy Executable Plan* (NSTec, 2009b), which serves as a contract between NNSA/NSO and NNSA Headquarters in terms of how to meet DOE O 430.2B. The plan is organized into seven sections and discusses goals in terms of current status, projects completed in FY 2009, and projects planned for FY 2010. Table 3-3 summarizes the initial implementation status of each goal as reported in the Energy Executable Plan. The FY EMS objectives and targets (Tables 3-1 and 3-2) mirror annual energy goals in the Energy Executable Plan to ensure consistency. EMC members are also members of the EWG.

Table 3-3. FY 2009 NNSA/NSO Energy Executable Plan goals summary

Goal	Energy Executable Plan's Status with Meeting Goal
Energy Efficiency	On track to meet goal of reducing energy intensity by 30% by 2015. By end of FY 2009, energy intensity was reduced by 23% from the FY 2003 baseline.
Renewable Energy	Investigating a renewable energy facility on the NTS. Full funding to build a Solar Demonstration Zone will achieve the goal of having 7.5% of NTS's annual electricity and thermal consumption supplied by an onsite renewable energy source. Renewable energy credits were purchased to offset this requirement for 2010–2011.
Water	Met 2015 goal and working to exceed goal. Continuing to install water meters, using best management practices for water efficiency, and conducting water study in 2010.
Transportation/Fleet Management	Met and likely to exceed goals of reducing fleet's total consumption of petroleum products by 2% annually by 2015 and increasing non-petroleum–based fuel consumption by 10% annually. Goal of 75% of all light vehicles purchased are alternative fuel vehicles (AFVs) met in FY 2009 when 100% of all light vehicles purchased were AFVs. This brings the percentage of AFVs in the light duty vehicle fleet to 51.4%
High Performance Sustainable Buildings (HPSB)	Plan meets goal for new buildings. An HPSB Plan was developed in August 2009. Ten buildings totaling 468,337 square feet have been identified as meeting the Leadership in Energy and Environmental Design requirements for new buildings or for retro-commissioning to ensure 15% of buildings can be classified as HPSB by the end of FY 2015.

3.3.2 Pollution Prevention and Waste Minimization

The Pollution Prevention/Waste Minimization (P2/WM) Program has initiatives to eliminate or reduce the generation of waste, the release of pollutants to the environment, and the use of Class I ozone-depleting substances (ODS). These initiatives are pursued through source reduction, re-use, segregation, and recycling, and by procuring recycled-content materials and environmentally preferable products and services. They also ensure that proposed methods of treatment, storage, and disposal of waste minimize potential threats to human health and the environment. These initiatives address the requirements of DOE orders, federal laws, and state regulations applicable to operations on the NTS (see Section 2.6). The following strategies are employed to meet P2/WM goals:

Source Reduction – Waste minimization activities eliminate or reduce the generation of radioactive, hazardous, or solid waste and/or reduce the toxicity of those wastes. The preferred method of waste minimization is source reduction, i.e., the minimization or elimination of waste before it is generated by a project or operation. Examples include chemical substitution, process modification, and segregation. NNSA/NSO's Integrated Safety Management System requires that every project/operation address waste minimization issues during the planning phase and ensure that adequate funds are allocated to perform any identified waste minimization activities.

Recycling – For wastes that are generated, an aggressive recycling program is maintained. Items recycled through the NNSA/NSO recycling program in 2009 included paper, cardboard, aluminum cans, toner cartridges, inkjet cartridges, used oil, food waste from the cafeteria, plastic, scrap metal, computer equipment, rechargeable batteries, lead-acid batteries, fluorescent light bulbs, mercury lamps, metal hydride lamps, and sodium lamps.

An effective recycling program is NSTec's Material Exchange Program. Created in 1998, the Material Exchange Program diverts supplies, chemicals, and equipment from landfills. These unwanted items are made available through electronic mail or postings on the intranet Material Exchange Database so that individuals in need can obtain the items at no cost. These materials are destined for disposal, either as solid or hazardous waste, as a result of process modification, discontinued use, or shelf-life expiration. If items are not placed with another user, they can be returned to the vendor for recycle/reuse or given to other DOE sites, other government agencies, or local schools. In 2009, funding for an employee to actively manage this program was dropped, and no materials were recycled through the program in 2009. From its inception in 1998, the Material Exchange Program has diverted 194 metric tons (mtons) (213 tons) of chemicals, office supplies, and equipment from disposal in solid and hazardous waste landfills.

NSTec Property Management manages an Excess Property Program. New users may include NSTec employees, employees from NNSA/NSO and other NTS contractors/laboratories, other DOE sites, other federal agencies, state and local government agencies, and local schools. If new users are not found for these items, they are made available to the public for recycle/reuse through periodic Internet sales.

Environmentally Preferable Purchasing – Section 6002 of the Resource Conservation and Recovery Act (RCRA), as amended (Title 42 United States Code [USC] Section 6962), requires federal agencies to develop and implement an affirmative procurement program (APP). NNSA/NSO maintains an APP that stimulates a market for recycled content products and closes the loop on recycling. RCRA 42 USC 6962 requires the U.S. Environmental Protection Agency (EPA) to develop a list of items containing recycled materials that should be purchased. The EPA is also required to determine what the minimum content of recycled material should be for each item. Federal facilities are required to ensure that a process is in place for purchasing the EPA-designated items containing the minimum content of recycled materials. Executive Order (EO) 13423, "Strengthening Federal Environmental, Energy, and Transportation Management," goes one step further and requires federal facilities to ensure, where possible, that 100 percent of purchases of items from the EPA-designated list contain recycled materials at the specified minimum content. Of these items NNSA/NSO purchased from the EPA-designated list in 2009, about 40 percent contained recycled materials at the specified minimum content.

Employee and Public Awareness – The NNSA/NSO P2/WM initiatives also include an employee and public awareness program. Awareness of P2/WM issues is accomplished by dissemination of articles through electronic mail, contractor and NNSA/NSO newsletters, the maintenance of a P2/WM intranet Web site, employee training courses, and participation at employee and community events. These activities are intended to increase awareness of P2/WM and environmental issues and highlight the importance of P2/WM for improving environmental conditions in the workplace and community.

3.3.2.1 Major P2/WM Accomplishments

In November 2009, NSTec completed the FY 2009 Waste Generation and Pollution Prevention Progress Report for the NTS. This was done by entering the site's data, including annual recycling totals and waste minimization accomplishments, into the DOE Headquarters electronic database. NSTec also submitted the calendar year 2009 Waste Minimization Summary Report to NNSA/NSO in February 2010 for its subsequent transmittal to the Nevada Division of Environmental Protection. There were three major P2/WM accomplishments in 2009 that were reported to DOE Headquarters:

- A total of 26.2 miles of NTS roadway from Mercury to Gate 700 was repaved using a recycling technique that prevented waste disposal. The Mercury Highway Repaving Project relied on roadbed modification, which recycled the existing pavement. The process consisted of pulverizing and grinding some of the road's sub-base, to which cement and water were added and then compacted to create a very stable new roadbed. Then, 3 inches of new asphalt was applied on top of the modified roadbed. The project resulted in a smoother and safer road and prevented almost 40,000 cubic yards of waste from being generated and sent to the Area 9 U10 Solid Waste Disposal Site. The project also saved about 4,000 gallons of gas and the wear on trucks that would have been required to transport the waste. This project was an environmental target for FY 2009.
- The Pluto Disassembly Facility in Area 26 of the NTS was closed under the FFACO using careful project planning to maximize the amount of materials that could be recycled. From May 2008 to February 2009, Navarro Nevada Environmental Services, LLC, and NSTec designed the clean closure plans. The Pluto Facility Closure Project generated more than 94,000 pounds of waste, which included used oil, mercury-containing items, universal waste (light bulbs, batteries), and lead, that were all recycled at offsite facilities.
- The NSTec Acquisitions Group of the Information Technology Department developed a database for implementing a Software Asset Management (SAM) Program. The SAM Program's mission is to identify software used within the NSTec computing environment, document and tag each software purchase, and recapture unused software licenses for redeployment. In 2009, the Acquisitions Group redeployed over 100 software programs, with an average cost of $400 per software package, for a cost savings of $40,000.

3.3.2.2 Waste Reductions

P2/WM techniques and practices are evaluated for all activities that may generate waste. Those that are implemented result in reductions to the volume and/or toxicity of waste generated on site. Table 3-4 shows a summary of the waste reduction activities during 2009. An estimated reduction of 114.0 mtons (125 tons) of hazardous wastes (including RCRA, Toxic Substance Control Act, and State-regulated hazardous wastes) and 153.5 mtons (168.9 tons) of solid waste (sanitary waste) occurred in 2009, all from recycling and reuse. Table 3-5 compares the amounts of radioactive, hazardous, and solid wastes reduced in 2009 to the amounts in prior years.

Table 3-4. Waste reduction activities in 2009

Activity	Reduction (mtons)[a]
Hazardous Waste	
Bulk used oil was sent to an offsite vendor for recycling.	81.0
Lead acid batteries were shipped to an offsite vendor for recycling.	11.1
Lead scrap metal was shipped to an offsite vendor for recycling.	9.8
Computer equipment was returned to the vendor where it is refurbished and sold for reuse.	8.6
Spent fluorescent light bulbs, mercury lamps, metal hydride lamps, and sodium lamps were sent to an offsite vendor for recycling.	3.0
Rechargeable batteries were sent to an offsite vendor for recycling.	0.5
	114.0
Solid Waste	
Mixed paper and cardboard were sent off site for recycling.	106.7
Food waste from the cafeterias was sent off site to be reused as pig feed for a local pig farmer.	31.2
Shipping materials including pallets, styrofoam, bubble wrap, and shipping containers were reused.	5.6
Scrap non-ferrous metal was sold to a vendor for recycling.	7.8
Spent toner cartridges were sent off site for recycling.	0.9
Scrap ferrous metal was sold to a vendor for recycling.	0.7
Aluminum cans were sent off site for recycling.	0.6
Total	**153.5**

(a) 1 mton = 1.1 ton

Table 3-5. Quantities of waste reduced through P2/WM activities by waste type and year

Calendar Year	Radioactive (m^3)	Hazardous (mtons)	Solid (mtons)
2009	45.2	114.0	153.5
2008	28.9	268	311
2007	0	167	1,698
2006	0	149	803
2005	0	13,992	1,194
2004	0	115	1,438
2003	40.0	207	1,547
2002	63.2	177	904

1 cubic meter (m^3) = 1.3 cubic yards
1 mton = 1.1 ton

3.3.2.3 Ozone Depleting Substance Reductions

DOE O 450.1A requires that a site’s EMS include practices to maximize the use of safe alternatives to ODS. Also, EO 13423 has a requirement to reduce ODS at all DOE sites and to phase out the procurement of Class I ODS for all non-exempted uses by December 31, 2010. In 2009, the NTS achieved this procurement phase-out. In 2009, only environmentally preferable alternatives to ODS were purchased. All procurement of freons must be approved by the environmental oversight organization, which verifies that only approved products are purchased.

Existing freons in equipment are being phased out as equipment is drained for repair or replaced by new equipment with approved alternative freons. During 2009, the last of the halon at the NTS was removed when the remaining halon fire extinguishers were drained and the halon was sent to the Department of Defense Depot in Richmond, Virginia.

3.4 Legal and Other Requirements

Environmental requirements that apply throughout the NSTec enterprise are documented and available through the NSTec Homepage, company policies and procedures, and the NSTec Prime Contract. NSTec complies with all applicable laws and regulations. Baseline laws and regulations are supplemented on an activity-specific basis as needed. NSTec executive management and NNSA/NSO develop, update, and approve NSTec company directives to meet all legal requirements through controlled processes.

Company planning documents, policies, and procedures implement the directives in the NSTec Prime Contract, as applicable. Procedures exist at both the company and organization levels. These documents integrate legal, regulatory, and other company-accepted standards and operating practices into daily work planning and execution activities. Programs conforming to company business management, quality assurance, and environment, safety, and health management processes have been established to ensure that company-accepted standards are implemented, business objectives are achieved, and the workers, public, and environment are protected.

NSTec operates within the constraints of various federal, state, and local environmental permits. These permits often prescribe operational controls, records management, and monitoring and measuring requirements. A current list of the environmental permits is maintained on an Environmental Services Web page. Approved operations and maintenance plans may also exist to comply with permit and non-permit regulatory requirements. There are regulatory agreements, agreements in principle between NNSA/NSO and the State of Nevada, memoranda of understanding, and tenant support agreements that are considered in planning and executing work.

3.5 EMS Competence, Training, and Awareness

All NSTec personnel received ISO 14001 awareness training in 2008 provided by an environmental subcontractor as part of obtaining certification. EMS awareness is also included as part of the orientation training required for all new NSTec employees. A working group representing all parts of the company was formed to assist in meeting the requirements of the ISO standard to achieve certification; working group members received a week of training on the environmental and quality ISO standards. Ongoing EMS awareness is accomplished by putting environmental articles in two different electronic newsletters and another published newsletter that is mailed to NSTec employees' homes. Focused environmental briefings are sometimes given at tail-gate meetings in the field prior to work with high or non-routine environmental risk.

3.6 Audits and Assessments

NNSA/NSO conducted an assessment from April 13 to May 27, 2009, of the NTS EMS against the requirements of DOE O 450.1A. The results of that assessment determined that the NTS EMS meets the requirements of the order, assists NNSA/NSO in meeting their environmental requirements, and is integrated into the site's Integrated Safety Management System. There were two findings from the assessment, which were entered into the corrective action tracking system, caWeb, as a single issue. Both findings involved revising existing documents to update references to superseded documents and to describe new actions taken to comply with DOE O 450.1A. Those corrections were made and the caWeb issue was closed.

The ISO 14001 certifying organization for NSTec conducts semi-annual surveillances of the EMS. Findings and recommendations in those reports are also entered and tracked in caWeb. Corrective actions taken to close the issues help to continually improve the EMS program. The NSTec EMS Description document states that an independent internal audit of portions of the EMS program will be performed each year. The 2009 independent audit conducted by NSTec's Performance Analysis and Improvement Division found a few cases where documents were outdated or needed minor revisions. These were entered and tracked in caWeb until the issue was closed.

Additionally, NSTec's Environmental Protection and Technical Services Department conducts internal management assessments and compliance evaluations on focused portions of the EMS program. These assessments and evaluations determine the extent of compliance with environmental compliance and identify areas for overall improvement.

3.7 EMS Effectiveness

The ISO 14001 certification of the EMS program has enabled NSTec to continually improve its environmental program, and also enabled NNSA/NSO to declare meeting DOE orders and executive orders requirements. The ISO 14001 certifying organization stated after both 2009 semi-annual surveillances that the EMS program remains effective and that certification is maintained.

The EMS training and awareness discussed in Section 3.5 have improved the overall environmental knowledge of the workforce. Many times the operational workers in the company, rather than the environmental organization, identify problems and recommend preventive or corrective actions. These actions driven by the EMS program have improved performance and reduced costs frequently.

Environmental targets established each year as a key program within the EMS have assisted in remediating high-risk facilities and storage areas; reducing water, fuel, and energy usages; avoiding waste production; recycling wastes generated from environmental restoration activities; purchasing environmentally preferable products; and making infrastructure improvements on environmental systems such as water lines and boilers.

One of the benefits of the EMS program is a monthly meeting between the NSTec Executive Leadership Council and the environmental organization that coordinates the EMS. Each meeting includes a discussion of current issues, status of key activities and reports, schedule and/or results of external assessments, and status of open caWeb issues. Quarterly status reports on environmental target performance and updates to environmental metrics being tracked for trending are also presented. This monthly EMS briefing has been recognized as a best practice by the ISO 14001 assessor, and is an excellent way to inform upper management of emerging issues and obtain their input and support. NNSA/NSO environmental staff members also attend these briefings, so they also can contribute input, observe management involvement, and participate in emerging issue discussions and decisions.

On November 17, 2009, the 2009 Facility EMS Annual Report Data for the NTS was entered into a DOE Headquarters database. This database gathers information in several EMS areas from all DOE sites to produce a combined report reflecting DOE's overall performance compared to other federal agencies. The report includes a score card section, which is a series of questions regarding a site's EMS effectiveness in meeting the objectives of federal EMS directives. The NTS scored "green" (the highest score).

3.8 Awards and Recognition

NNSA/NSO received two DOE Office of Energy Efficiency and Renewable Energy national-level Energy Management awards in 2009. NNSA/NSO was selected to receive the *Vehicle Fleet Management Award to an Organization* for exceeding national goals related to alternative fuels usage. In 2009, NNSA/NSO was also recognized with the *Energy Efficiency/Energy Program Management Award to a Small Group* for successful integration of energy efficiency measures into the Building B-3 Remediation, Restoration, and Upgrade Project completed at the North Las Vegas Facility in FY 2008. Winners were formally acknowledged on August 12, during the 2009 DOE Energy Management Awards ceremony that followed the GovEnergy Conference held in Providence, Rhode Island. NTS team members on the Building B-3 Remediation, Restoration, and Upgrade Project received a 2009 Federal Energy and Water Management award during an October 28 DOE and Federal Interagency Energy Policy Committee luncheon ceremony. The award recognized the contribution they made toward the efficient use of energy in the federal sector during FY 2008.

Two FY 2009 NTS projects were recognized with DOE/NNSA/National Pollution Prevention awards. The Mercury Highway Repaving Project won an Environmental Stewardship award in the category of Waste/Pollution Prevention. The Pluto Facility Closure Project won a Best-In-Class award in the category of Recycling. Section 3.3.2.1 of this chapter describes these projects.

4.0 Radiological and Nonradiological Air Monitoring

Section 4.1 presents the results of radiological air monitoring conducted on the Nevada Test Site (NTS) to verify compliance with radioactive air emission standards (see Section 2.1). Sources of radioactive air emissions from the NTS include evaporation of tritiated water from containment ponds; diffusion of tritiated water vapor from the soil at the Area 3 Radioactive Waste Management Site (RWMS), the Area 5 Radioactive Waste Management Complex (RWMC) (see Glossary, Appendix B), Sedan crater, and Schooner crater; release of tritium gas during equipment calibrations; and resuspension of contaminated soil at historical nuclear device safety test locations and atmospheric test locations. Radiological air monitoring is conducted by National Security Technologies, LLC (NSTec), Environmental Protection and Technical Services (EPTS). Measurements of radioactivity in air samples are used to assess radiological dose to the general public in the vicinity of the NTS. The assessed dose to the public from all exposure pathways (air, water, direct radiation exposure, and consumption of game animals) is presented in Chapter 9.

The U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) has also established an air monitoring program to monitor radionuclides in air within communities adjacent to the NTS. This independent program, the Community Environmental Monitoring Program, is managed by the University of Nevada's Desert Research Institute (DRI) of the Nevada System of Higher Education. DRI's 2009 offsite air monitoring results are presented in Chapter 7.

Section 4.2 presents the results of nonradiological air quality assessments conducted on the NTS to ensure compliance with current air quality permits (see Section 2.1). NTS operations that are potential sources of nonradiological air pollution include aggregate production, surface disturbance (e.g., construction), release of fugitive dust from driving on unpaved roads, use of fuel-burning equipment, open burning, venting from bulk fuel storage facilities, explosives detonations, and releases of various chemicals during testing at the Nonproliferation Test and Evaluation Complex (NPTEC) or at other release areas. Air quality assessments are conducted by NSTec EPTS personnel.

4.1 Radiological Air Monitoring

U.S. Department of Energy (DOE) Order DOE O 5400.5, "Radiation Protection of the Public and the Environment," and the Clean Air Act (CAA) National Emission Standards for Hazardous Air Pollutants (NESHAP) require air monitoring for radiological emissions at the NTS. Radiological air monitoring is conducted to ensure that no significant emission source that contributes to calculable offsite exposures is ignored and that the NTS remains in compliance with the requirements of DOE O 5400.5 and the CAA. To accomplish this, an air surveillance network consisting of air particulate and atmospheric moisture samplers has been established. The objectives and design of the network are described in detail in the *Routine Radiological Environmental Monitoring Plan* (Bechtel Nevada, 2003a). The network monitors airborne radioactivity near NTS sites at which radioactivity from past nuclear testing was deposited on and in the soil, at NTS operating facilities that may produce radioactive air emissions, and along the NTS boundaries.

Diffuse radionuclide sources from historic nuclear testing activities on the Tonopah Test Range (TTR) (Clean Slate 1, 2, and 3) are reported by Sandia National Laboratories (SNL) in the TTR annual environmental report (SNL, 2010). Two air monitoring stations were established at TTR in 2008 to collect data on potential suspension properties from the Clean Slate sites. Data collection continued in 2009 to assess current site conditions in preparation for monitoring when active site remediation begins. Monitoring efforts are reported by SNL in the TTR annual environmental report (SNL, 2010). Historical sites on the Nevada Test and Training Range (NTTR) (Double Tracks and Project 57) are currently not being monitored; however, air sampling was conducted at Double Tracks during 1996–1999 in support of its remediation and at Project 57 in 1997–2000 for surveillance purposes. NTTR air sampling results were reported in past NTS Annual Site Environmental Reports available at http://www.nv.doe.gov/library/publications/environmental.aspx.

Data from all current sampling stations are analyzed to meet the specific goals listed below. Also listed below are the analytes monitored in order to perform dose assessments. These are the radionuclides most likely to be present in the air as a result of past or current NTS operations, selected based on NTS inventories of radionuclides in surface soil (McArthur, 1991) and upon their volatility and availability for resuspension; half-lives for these radionuclides are found in Table 1-5. Uranium is included on this list because depleted uranium (DU) ordnance was used during exercises in Areas 5, 20, and 25. Air samples from selected sampling locations in the vicinity of these areas only are analyzed for uranium. Also, gross alpha and gross beta readings are used in air monitoring as a rapid screening measure.

Radiological Air Monitoring Goals	***Analytes Monitored***
Measure radionuclide concentrations in air at or near historical or current operation sites that have the potential to release airborne radioactivity to (1) detect and identify local and site-wide trends, (2) quantify radionuclides emitted to air, and (3) detect accidental and unplanned releases. Determine if radioactive air emissions from past or present NTS activities result in a radiation dose, called the effective dose equivalent (EDE) (see Glossary, Appendix B), to any member of the public that exceeds the NESHAP standard of 10 millirem per year (mrem/yr) (0.1 millisievert per year [mSv/yr]). Provide point source operational monitoring as required under NESHAP for any facility that has the potential to emit radionuclides into the air and cause a dose greater than 0.1 mrem/yr (0.001 mSv/yr) to any member of the public. Provide the inhalation exposure pathway data to determine if the total radiation dose to any member of the public from all pathways (air, water, food) exceeds the DOE O 5400.5 standard of 100 mrem/yr (1 mSv/yr).	Americium-241 (^{241}Am) Cesium-137 (^{137}Cs) Tritium (^{3}H) Plutonium-238 (^{238}Pu) Plutonium-239+240 ($^{239+240}$Pu) Uranium-233+234 ($^{233+234}$U) Uranium-235+236 ($^{235+236}$U) Uranium-238 (^{238}U) Gross alpha radioactivity Gross beta radioactivity $^{239+240}$Pu, $^{233+234}$U, and $^{235+236}$U are reported as the sum of isotope concentrations because the analytical method cannot readily distinguish the individual isotopes.

4.1.1 Monitoring System Design

Environmental Samplers – There are 19 sampling stations referred to as environmental samplers. They include 3 stations that have low-volume air particulate samplers, 1 station that has a tritium sampler, and 15 stations that have both air particulate and tritium samplers (Figure 4-1). They are located throughout the NTS in or near the highest diffuse radiation sources. Predominant winds were a factor in station placement (for NTS wind rose data, see Section A.3 of Attachment A: Site Description, included as a separate file on the compact disc of this report). The sources include areas with (1) radioactivity in surface soil that can be resuspended by the wind, (2) tritium that transpires or evaporates from plants and soil at the sites of past nuclear tests, and (3) tritium that evaporates from ponds receiving tritiated water either pumped from contaminated wells or directed from tunnels that cannot be sealed shut. Sampling and analysis of air particulates and tritium were performed at these stations as described in Section 4.1.2. Radionuclide concentrations measured at these stations are used for trending, determining ambient background concentrations in the environment, and monitoring for unplanned releases of radioactivity. Air concentrations approaching 10 percent of the NESHAP Concentration Levels for Environmental Compliance (compliance levels [CLs]) (second column of Table 4-1) are investigated for causes that may be mitigated to avoid exceeding regulatory dose limits.

Critical Receptor Samplers – Six of the 15 sampling stations with both air particulate and tritium samplers, near the boundaries and the center of the NTS, are approved by the U.S. Environmental Protection Agency (EPA) Region IX as critical receptor samplers (Figure 4-1). Radionuclide concentrations measured at these stations are used to assess compliance with the NESHAP dose limit to the public of 10 mrem/yr (0.1 mSv/yr). The annual average concentrations from each station were compared with the concentration limits listed in Table 4-1. Compliance with NESHAP is demonstrated when the sum of the fractions, determined by dividing each radionuclide’s concentration by its concentration limit and then adding the fractions together, is less than 1.0 at all stations.

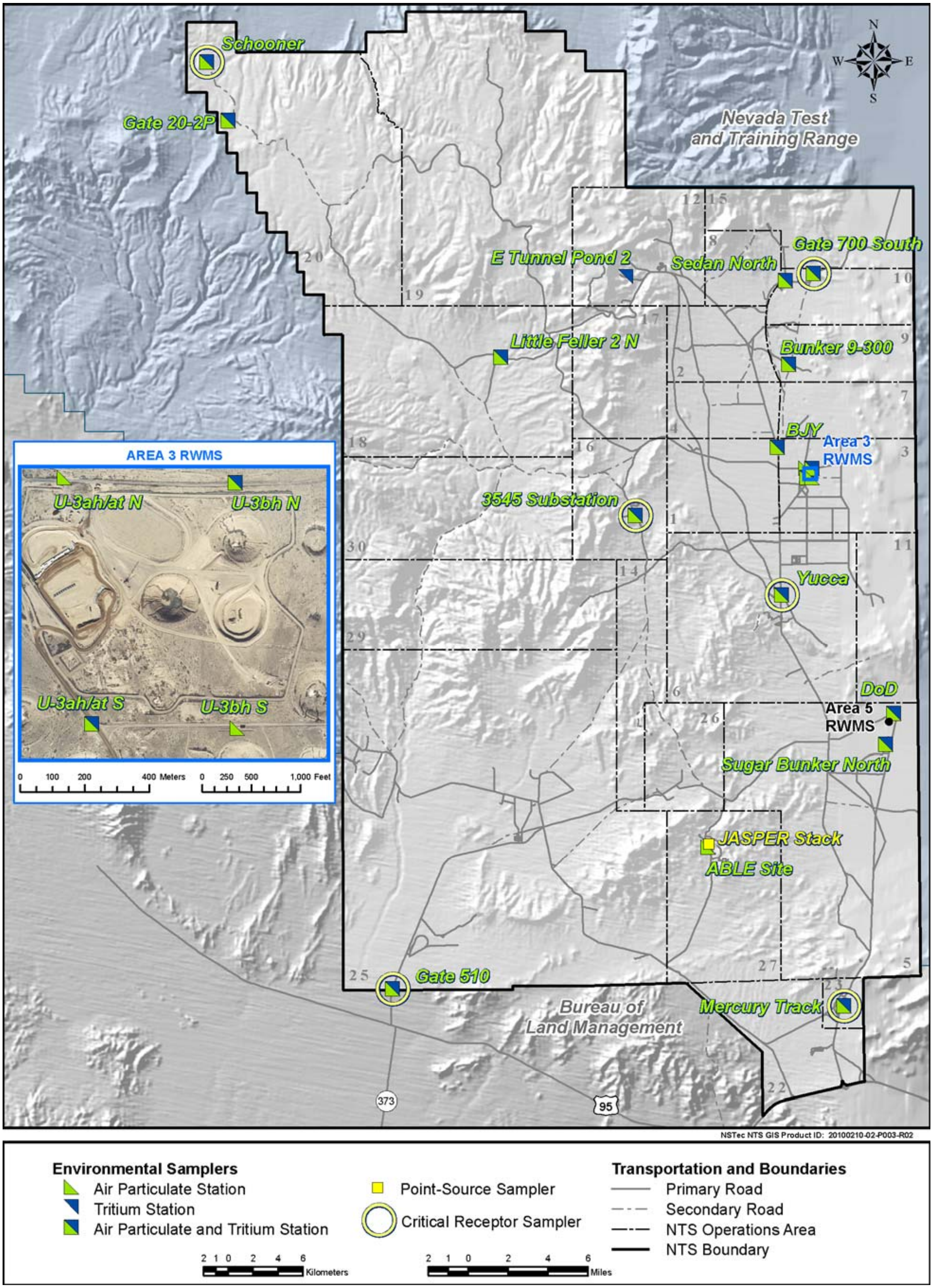

Figure 4-1. Radiological air sampling network on the NTS in 2009

Table 4-1. Regulatory concentration limits for radionuclides in air

Radionuclide	NESHAP Concentration Level for Environmental Compliance (CL)[(a)] (x 10^{-15} microcuries/milliliter [μCi/mL])
^{241}Am	1.9
^{137}Cs	19
^{3}H	1,500,000
^{238}Pu	2.1
^{239}Pu	2
^{240}Pu	2
^{233}U	7.1
^{234}U	7.7
^{235}U	7.1
^{236}U	7.7
^{238}U	8.3

Note: The CL values represent the annual average concentration that would result in an EDE of 10 mrem/yr, which is the federal dose limit to the public from all radioactive air emissions.

(a) From Table 2, Appendix E of Title 40 Code of Federal Regulations (CFR) Part 61, 1999

Point-Source (Stack) Sampler – One facility on the NTS, the Joint Actinide Shock Physics Experimental Research (JASPER) Facility in Area 27 (Figure 4-1), requires stack monitoring because it has the potential to emit airborne radionuclides that could result in an offsite radiation dose ≥ 0.1 mrem/yr. Air emissions from the facility are filtered through high-efficiency particulate air (HEPA) filters before entering the stack where air is sampled before it is released. Environmental sampling of air particulates adjacent to the facility is also performed as stated in Section 4.1.2. If air concentrations of any man-made radionuclide were found in stack monitoring samples above the minimum detectable concentration (MDC) (see Glossary, Appendix B), an assessment of offsite dose to the public would be performed to determine NESHAP compliance, and the cause of the emission would be investigated and corrective actions implemented. Due to experimental and mechanical issues, the JASPER system was disassembled in September 2009 and no operations or stack monitoring occurred from October through December 2009.

4.1.2 Air Particulate and Tritium Sampling Methods

A weekly sample was collected from each air particulate sampler by drawing air through a 10-centimeter (cm) (4-inch [in.]) diameter glass-fiber filter at a flow rate of about 85 liters per minute (L/min) (3 cubic feet [ft^3] per minute). The particulate filter is mounted in a filter holder that faces downward at a height of 1.5 meters (m) (5 feet [ft]) above ground. A run-time clock measures the operating time. The run time multiplied by 85 L/min yields the volume of air sampled, which is about 860 cubic meters (m^3) (30,000 ft^3) during a typical seven-day sampling period. The air sampling rates were measured at the start and end of each sampling period with mass-flow meters that are calibrated annually.

The 10 cm (4 in.) diameter filters were analyzed for gross alpha and gross beta radioactivity after a five-day holding time to allow for the decay of naturally occurring radon progeny. The filters collected within each month were composited for each station, analyzed by gamma spectroscopy for several analytes, and then analyzed for ^{238}Pu, $^{239+240}$Pu, and ^{241}Am by alpha spectroscopy after chemical separation. To monitor for any potential emissions from past exercises using DU, the filter composites from Sugar Bunker North (Sugar Bunker N) (Area 5), Yucca (Area 6), Substation 3545 (Area 16), Gate 20-2p (Area 20), Gate 510 (Area 25), and ABLE Site (Area 27) were also analyzed for uranium isotopes by alpha spectroscopy.

Tritiated water vapor in the form of $^3H^3HO$ or ^3HHO (collectively referred to as HTO) was sampled continuously over two-week periods at each tritium (atmospheric moisture) sampling station. Tritium samplers were operated with elapsed time meters at a flow rate of about 566 cubic centimeters per minute (1.2 ft^3 per hour). The total volume sampled is determined from the product of the sampling period and the flow rate (about 11 m^3 [14.4 cubic yards] over a two-week sampling period). The HTO was removed from the airstream by two molecular sieve columns connected in series (one for routine collection and a second to indicate if breakthrough occurred through the first column during collection). These columns were exchanged biweekly. An aliquot of the total moisture collected was extracted from the first column and analyzed for tritium by liquid scintillation counting. In all cases, measured activity in units per sample is converted to units per volume of air prior to reporting in the following sections.

Routine quality control air samples (e.g., duplicates, blanks, and spikes) are also incorporated into the analytical suites on a frequent basis. Chapter 18 contains a discussion of quality assurance/quality control protocols and procedures used for radiological air monitoring.

4.1.3 Presentation of Air Sampling Data

The annual average concentration for monitored radionuclides at each station are presented in the following sections. The annual average concentration for each monitored radionuclide was calculated from uncensored analytical results for individual samples; i.e., values less than the sample-specific MDC were included in the calculation. A column is included in each table indicating the percentage of the analytical results that were greater than their analysis-specific MDCs.

Annual average concentrations are also expressed in the tables as percentages of the CL (the second column of Table 4-1). In graphs of concentration data, the CL or some percentage of the CL is included as a green horizontal line. The CL or fraction thereof is shown in graphs for reference only and not to demonstrate compliance with NESHAP dose limits, since assessment of compliance is based upon annual average concentrations, not upon the single measurement results shown in the graphs.

For convenience in reporting, values shown in the tables in the following result sections are frequently formatted to a greater number of significant digits than can be justified by the accuracy of the measurements, which is typically two significant figures (e.g., 2500, 25, 2.5, or 0.025).

4.1.4 Air Sampling Results from Environmental Samplers

All elevated radionuclide concentrations in the 2009 air samples shown in the tables and graphs are attributed to the resuspension of legacy contamination in surface soils and to the upward flux of tritium from the soil at sites of past nuclear tests and of low-level radioactive waste burial. Monitoring results for the point-source station at JASPER are included in the tables in this section but are not included in the average of “All Environmental Locations,” as the JASPER sampler is not an ambient air monitor.

4.1.4.1 Americium-241

During 2009, the mean ^{241}Am concentration over all environmental sampler stations was 6.3 x 10^{-18} μCi/mL, similar to 2008 (4.5 x 10^{-18} μCi/mL) and lower than preceding years. The highest concentrations were found at Bunker 9-300 in Area 9 (Figure 4-2), located within areas of known soil contamination from past nuclear tests. The annual mean concentration at Bunker 9-300 was 59.1 x 10^{-18} μCi/mL, 3.1 percent of the CL. Results from the Bunker 9-300 station are displayed in Figure 4-2 along with the mean monthly concentrations at remaining stations. Mean monthly concentrations also have bars extending from the lowest to highest measurements at those stations.

Table 4-2. Concentrations of ^{241}Am in air samples collected in 2009

Area	Sampling Station	Number of Samples	^{241}Am (x 10^{-18} µCi/mL) Mean	Standard Deviation	Minimum	Maximum	% > MDC
1	BJY	11	4.81	10.03	-7.86	32.46	40.9
3	U-3ah/at N	12	8.78	8.17	0.35	27.97	50.0
3	U-3ah/at S	12	12.52	9.15	0.25	25.70	58.3
3	U-3bh N	12	2.71	3.59	-4.66	8.03	41.7
3	U-3bh S	12	4.40	4.65	-2.02	16.95	33.3
5	DoD	12	1.23	5.80	-8.20	16.29	12.5
5	Sugar Bunker N	12	1.42	4.49	-3.07	13.87	8.3
6	Yucca*	12	0.75	2.00	-2.22	4.27	4.2
9	Bunker 9-300	12	59.12	93.69	1.65	320.79	75.0
10	Gate 700 S*	12	1.21	2.25	-2.06	7.10	20.8
10	Sedan N	12	5.71	5.12	0.52	17.49	41.7
16	3545 Substation*	12	0.78	1.82	-1.69	4.65	8.3
18	Little Feller 2 N	12	3.27	5.79	-4.84	20.03	25.0
20	Gate 20-2P	12	0.65	1.24	-1.83	2.47	0.0
20	Schooner*	12	1.59	1.08	0.00	3.31	0.0
23	Mercury Track*	12	1.43	2.41	-2.49	4.91	8.3
25	Guard Station 510*	12	0.44	2.78	-3.75	4.64	8.3
27	ABLE Site	12	2.97	2.72	-1.14	7.87	20.8
All Environmental Locations		**215**	**6.33**	**25.46**	**-8.20**	**320.79**	**25.3**
27	JASPER Stack	7	-61.77	178.76	-462.93	52.02	0.0
CL = 1,900 x 10^{-18} µCi/mL							

*EPA-approved critical receptor sampler station

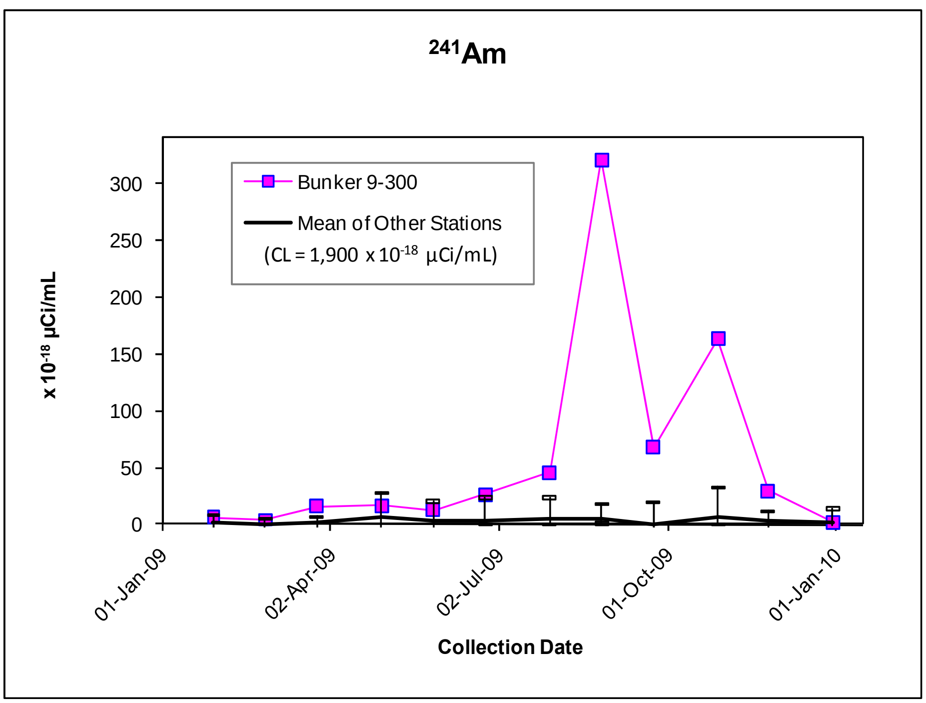

Figure 4-2. Concentrations of ^{241}Am in air samples collected in 2009

4.1.4.2 Cesium-137

No ^{137}Cs measurement was above its MDC during 2009 (Table 4-3). Mean values for all environmental samplers were near or below zero. No plot is provided because of the low measurement levels.

Table 4-3. Concentrations of ^{137}Cs in air samples collected in 2009

			^{137}Cs (x 10^{-17} µCi/mL)				
Area	**Sampling Station**	**Number of Samples**	**Mean**	**Standard Deviation**	**Minimum**	**Maximum**	**% > MDC**
1	BJY	12	-2.43	20.03	-48.21	26.50	0.0
3	U-3ah/at N	11	-0.12	23.57	-41.26	34.77	0.0
3	U-3ah/at S	12	7.25	28.11	-42.01	43.60	0.0
3	U-3bh N	12	-10.22	22.29	-57.26	37.31	0.0
3	U-3bh S	12	-7.68	37.07	-48.47	83.46	0.0
5	DoD	12	-0.03	17.87	-31.09	23.27	0.0
5	Sugar Bunker N	12	-9.34	26.56	-64.25	22.90	0.0
6	Yucca*	12	-4.09	19.47	-39.20	28.05	0.0
9	Bunker 9-300	12	-3.84	23.22	-28.31	30.70	0.0
10	Gate 700 S*	12	-18.85	20.91	-52.69	31.68	0.0
10	Sedan N	12	0.92	25.10	-68.75	31.81	0.0
16	3545 Substation*	12	-16.90	19.32	-49.39	8.71	0.0
18	Little Feller 2 N	12	2.96	19.46	-20.79	46.78	0.0
20	Gate 20-2P	12	-9.01	22.56	-44.42	22.63	0.0
20	Schooner*	12	2.28	18.69	-27.18	34.15	0.0
23	Mercury Track*	12	0.10	15.36	-30.67	28.04	0.0
25	Guard Station 510*	12	-18.85	23.87	-52.28	19.97	0.0
27	ABLE Site	12	-20.23	13.85	-43.33	1.92	0.0
All Environmental Locations		**215**	**-6.03**	**23.21**	**-68.75**	**83.46**	**0.0**
27	JASPER Stack	7	-69.59	339.65	-430.48	616.33	0.0
CL = 1,900 x 10^{-17} µCi/mL							

*EPA-approved critical receptor sampler station

4.1.4.3 Plutonium Isotopes

During 2009, the overall mean ^{238}Pu concentration for environmental stations (1.15 x 10^{-18} µCi/mL) was somewhat lower than the means of recent years (2.27, 1.90, 2.77, 2.83, and 2.32 x 10^{-18} µCi/mL in 2008, 2007, 2006, 2005, and 2004, respectively). Bunker 9-300 (Area 9) measurements were elevated in parallel with those for ^{241}Am; see Figure 4-3. The highest mean concentration at environmental stations was only 0.3 percent of the CL.

Plutonium isotopes $^{239+240}$Pu (analytical methods cannot readily distinguish between ^{239}Pu and ^{240}Pu) are of greater abundance; 42.1 percent of all measurements were above their MDCs (Table 4-5). The overall mean of 39.74 x 10^{-18} µCi/mL is higher than that of 2008 (22 x 10^{-18} µCi/mL) but similar to levels seen in several recent years (39, 48, 38, and 55 x 10^{-18} µCi/mL in 2007, 2004, 2003, and 2002, respectively) and considerably lower than those of 2006 and 2005 (138 and 148 x 10^{-18} µCi/mL, respectively). The location with the highest mean is Bunker 9-300 (394 x 10^{-18} µCi/mL, 19.7 percent of the CL; see Table 4-5), which had one monthly composite sample with a result greater than the CL (Figure 4-4). Because compliance is based on the annual average concentration, this location's $^{239+240}$Pu emissions are within compliance limits. Elevated plutonium values observed at this station are due to diffuse sources of radionuclides from historical nuclear testing in Area 9 and the station's proximity to high contamination areas.

The temporal patterns for ^{241}Am, ^{238}Pu, and $^{239+240}$Pu at Bunker 9-300 shown in Figures 4-2, 4-3, and 4-4 are correlated because ^{241}Am is the long-lived daughter product obtained when ^{241}Pu (a short-lived isotope created along with the more common Pu isotopes) decays by beta emission. Hence, $^{239+240}$Pu and ^{241}Am (and also ^{238}Pu to some extent) tend to be found together in particles of Pu remaining from past nuclear tests. The half-life of ^{241}Pu is 14.4 years, whereas the half-life of ^{241}Am is 432 years; consequently, as the ^{241}Pu decays, concentrations of ^{241}Am in NTS soils will gradually increase for about 80 years from when the ^{241}Pu was deposited and then decrease. Environmental transport processes mute this increase, however. These isotopes become airborne by soil disturbances.

Table 4-4. Concentrations of ^{238}Pu in air samples collected in 2009

			^{238}Pu (x 10^{-18} µCi/mL)				
Area	**Sampling Station**	**Number of Samples**	**Mean**	**Standard Deviation**	**Minimum**	**Maximum**	**% > MDC**
1	BJY	12	1.11	2.61	-2.63	7.16	0.0
3	U-3ah/at N	12	0.92	2.40	-3.65	4.66	16.7
3	U-3ah/at S	12	1.68	2.08	0.00	7.01	0.0
3	U-3bh N	12	0.25	1.63	-2.86	3.03	16.7
3	U-3bh S	12	0.92	1.17	-1.69	3.03	0.0
5	DoD	12	-0.38	1.70	-5.22	1.54	0.0
5	Sugar Bunker N	12	0.14	1.45	-2.46	1.85	8.3
6	Yucca*	12	0.95	1.21	0.00	2.94	0.0
9	Bunker 9-300	12	6.12	8.25	0.00	27.75	33.3
10	Gate 700 S*	12	0.60	1.53	-1.04	4.63	8.3
10	Sedan N	12	2.30	1.89	-1.01	5.43	16.7
16	3545 Substation*	12	-0.02	2.00	-3.23	2.89	0.0
18	Little Feller 2 N	12	-0.67	2.40	-6.96	2.10	0.0
20	Gate 20-2P	12	0.57	1.97	-1.55	5.53	0.0
20	Schooner*	12	1.22	2.22	-0.86	6.90	0.0
23	Mercury Track*	12	0.12	1.38	-1.62	2.93	4.2
25	Guard Station 510*	12	0.52	1.32	-1.21	3.61	8.3
27	ABLE Site	12	0.34	2.33	-1.47	7.38	0.0
All Environmental Locations		**216**	**1.15**	**4.44**	**-10.60**	**44.05**	**6.1**
27	JASPER Stack	7	7.97	19.06	-10.60	44.05	0.0
CL = 2,100 x 10^{-18} µCi/mL							

*EPA-approved critical receptor sampler station

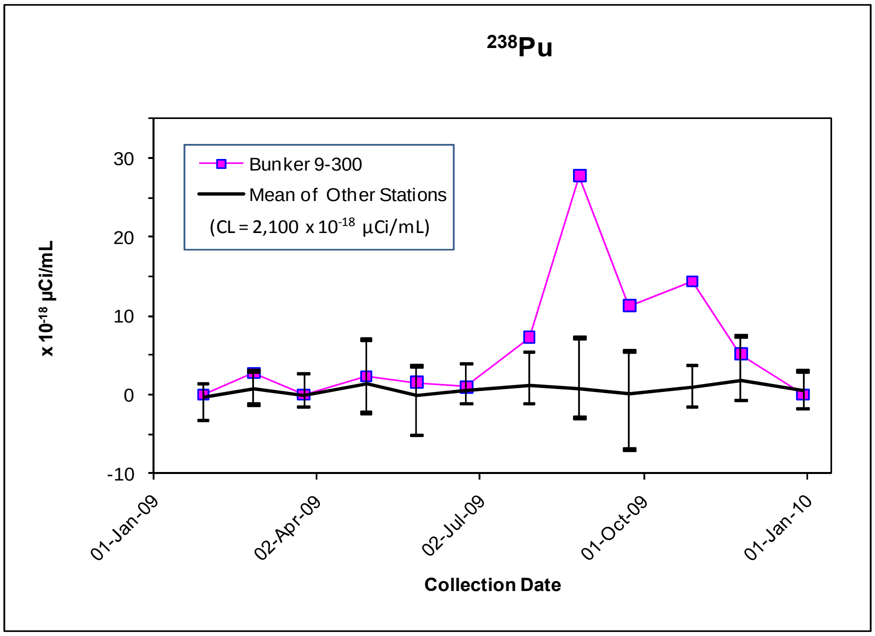

Figure 4-3. Concentrations of ^{238}Pu in air samples collected in 2009

Table 4-5. Concentrations of $^{239+240}$Pu in air samples collected in 2009

Area	Sampling Station	Number of Samples	$^{239+240}$Pu (x 10^{-18} µCi/mL) Mean	Standard Deviation	Minimum	Maximum	% > MDC
1	BJY	12	58.61	100.17	0.00	327.24	66.7
3	U-3ah/at N	12	57.56	47.11	2.09	160.83	83.3
3	U-3ah/at S	12	80.39	58.38	2.70	174.40	91.7
3	U-3bh N	12	15.84	16.64	2.48	50.35	33.3
3	U-3bh S	12	32.94	38.21	3.77	137.98	83.3
5	DoD	12	3.67	5.42	-0.64	19.89	12.5
5	Sugar Bunker N	12	2.16	2.01	0.00	7.01	16.7
6	Yucca*	12	7.04	5.82	2.78	24.49	37.5
9	Bunker 9-300	12	394.15	667.50	12.15	2324.98	100.0
10	Gate 700 S*	12	7.55	11.72	0.00	43.83	50.0
10	Sedan N	12	27.98	32.72	0.00	99.76	75.0
16	3545 Substation*	12	2.29	3.49	-2.75	9.31	8.3
18	Little Feller 2 N	12	11.37	27.96	-4.29	99.30	33.3
20	Gate 20-2P	12	1.91	1.93	-0.02	6.97	8.3
20	Schooner*	12	1.94	1.75	0.00	5.18	8.3
23	Mercury Track*	12	6.58	12.18	-1.53	40.74	25.0
25	Guard Station 510*	12	1.42	2.19	-2.32	4.04	12.5
27	ABLE Site	12	1.83	1.82	0.00	5.50	12.5
All Environmental Locations		**216**	**39.74**	**178.21**	**-4.29**	**2324.98**	**42.1**
27	JASPER Stack	7	20.54	56.30	-43.95	122.85	14.3
CL = 2,000 x 10^{-18} µCi/mL							

*EPA-approved critical receptor sampler station

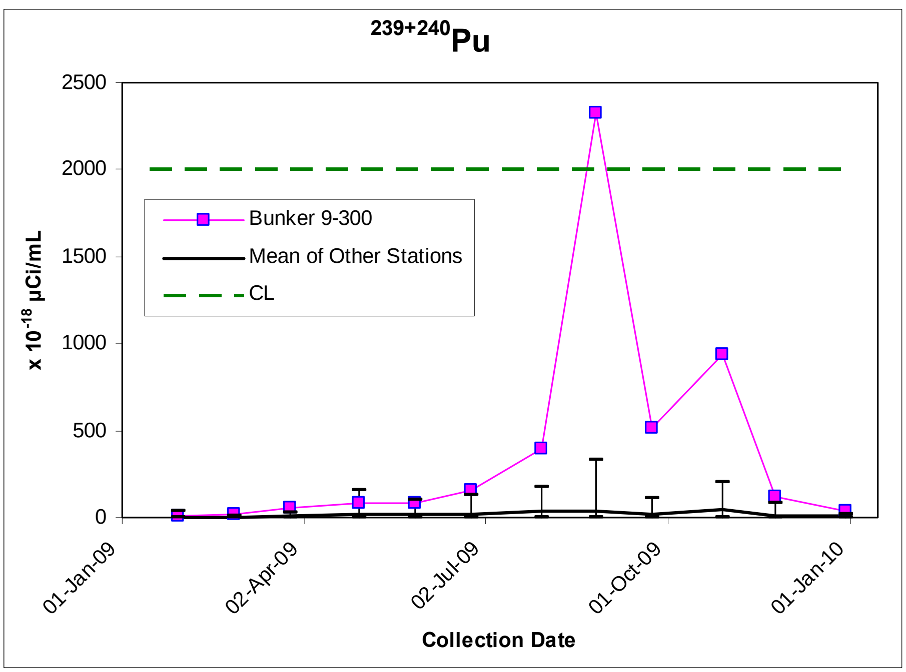

Figure 4-4. Concentrations of $^{239+240}$Pu in air samples collected in 2009

Figure 4-5 shows long-term trends in $^{239+240}Pu$ annual mean concentrations at locations with at least 15-year data histories since 1970. Rather than showing the time histories for all 43 locations, Figure 4-5 shows the average (geometric mean) trend lines for Areas 1 and 3; Areas 7, 9, 10 and 15; and other Areas for stations with at least 15-year histories in their group. Areas 1, 3, 7, 9, 10, and 15, in the northeast portion of the NTS, have a legacy of soil contamination from surface and airborne nuclear tests and safety shots. The estimated average annual rates of decline for the area groups range from 2.9 percent (Areas 1 and 3) and 3.4 percent (Areas 7, 9, 10, and 15) to 12.1 percent (Other Areas). These rates are all considerably faster than can be attributed to radioactive decay, as the half-lives of ^{239}Pu and ^{240}Pu are 24,110 and 6,537 years, respectively. The decreases are therefore attributed to immobilization of Pu particles in soil and/or decrease in activities resulting in soil resuspension. Figure 4-6 shows the annual highest mean for any station, regardless of length of history, using the same groups as Figure 4-5.

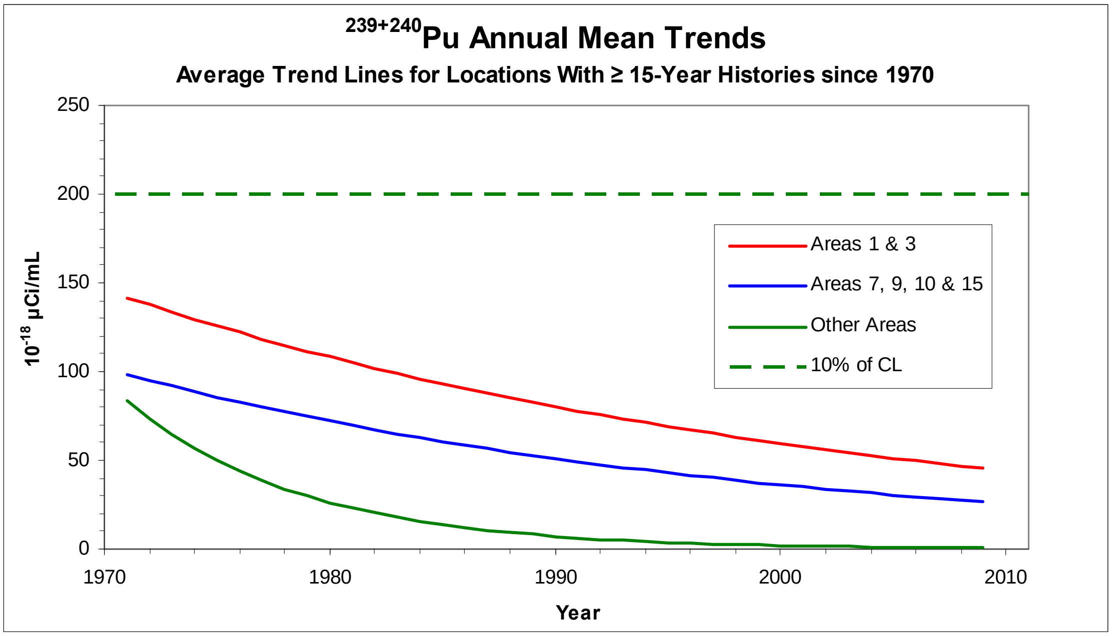

Figure 4-5. Average trends in $^{239+240}Pu$ in air annual means, 1971–2009

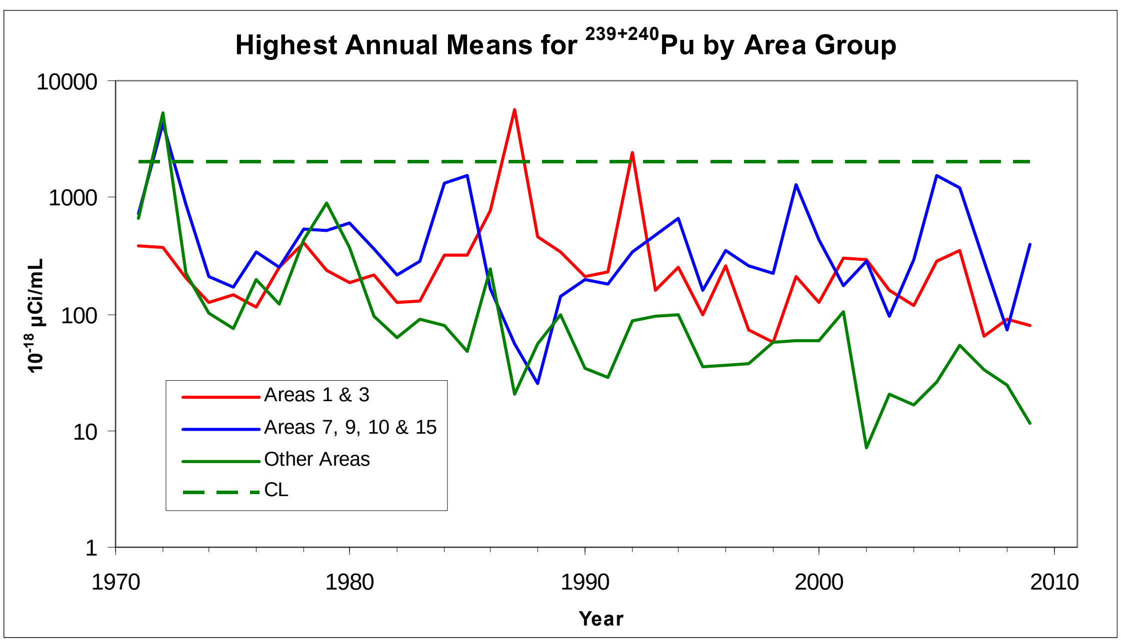

Figure 4-6. Highest annual mean concentrations of $^{239+240}Pu$ in air samples, 1971–2009

4.1.4.4 Uranium Isotopes

Uranium analyses by radiochemistry were performed for samples from six stations. In 2009, the Sugar Bunker N station was added to stations analyzed for uranium because of the potential for DU being present in the area from historical operations. The annual mean concentrations are shown in Table 4-6. All of the $^{233+234}U$ and ^{238}U measurements were above their MDCs, whereas 28 percent of measurements were above the MDC for $^{235+236}U$. Mean concentrations of $^{233+234}U$ and ^{238}U were about the same as in 2008; that for $^{235+236}U$ is slightly higher. These mean concentrations remain around 2.0–3.2 percent of the CLs for $^{233+234}U$ and ^{238}U and at most 0.22 percent of the CL for $^{235+236}U$. Concentrations are slightly higher at Sugar Bunker N than at the other stations.

Table 4-6. Concentrations of uranium isotopes in air samples collected in 2009

Area	Sampling Station	Number of Samples	Mean	Standard Deviation	Minimum	Maximum	% > MDC
			$^{233+234}U$ by Radiochemistry (x 10^{-17} µCi/mL)				
6	Yucca*	11	18.94	2.06	15.99	21.67	100.0
5	Sugar Bunker N	11	22.93	3.50	19.09	27.65	100.0
16	3545 Substation*	11	19.28	2.89	12.67	22.99	100.0
20	Gate 20-2P	11	18.00	6.58	3.09	26.31	100.0
25	Guard Station 510*	11	19.46	3.88	12.08	23.68	100.0
27	ABLE Site	11	19.34	4.00	14.34	27.63	100.0
All Environmental Locations		**66**	**19.66**	**4.20**	**3.09**	**27.65**	**100.0**
CL = 710 x 10^{-17} µCi/mL							
			$^{235+236}U$ by Radiochemistry (x 10^{-18} µCi/mL)				
6	Yucca*	12	13.28	8.00	0.00	30.32	29.2
5	Sugar Bunker N	12	15.51	14.64	1.57	55.09	41.7
16	3545 Substation*	12	10.56	6.69	2.33	28.02	8.3
20	Gate 20-2P	12	12.26	5.44	2.27	21.02	41.7
25	Guard Station 510*	12	10.73	10.87	-16.26	26.34	20.8
27	ABLE Site	12	12.02	8.50	2.62	26.99	29.2
All Environmental Locations		**72**	**12.39**	**9.33**	**-16.26**	**55.09**	**28.5**
CL = 7,100 x 10^{-18} µCi/mL							
			^{238}U by Radiochemistry (x 10^{-17} µCi/mL)				
6	Yucca*	11	17.72	2.81	13.20	22.20	100.0
5	Sugar Bunker N	11	22.36	5.39	14.41	34.01	100.0
16	3545 Substation*	11	19.27	3.17	13.72	23.75	100.0
20	Gate 20-2P	11	16.79	5.13	5.07	22.21	100.0
25	Guard Station 510*	11	18.98	2.34	14.39	21.88	100.0
27	ABLE Site	11	18.88	2.78	14.52	24.60	100.0
All Environmental Locations		**66**	**19.00**	**4.04**	**5.07**	**34.01**	**100.0**
CL = 830 x 10^{-17} µCi/mL							

*EPA-approved critical receptor sampler station

The ratios of the uranium isotope concentrations are given in Table 4-7, and Table 4-8 presents the values expected of those ratios for uranium from different sources. The median $^{235+236}U/^{238}U$ ratio is most consistent with a source of natural U. The median $^{233+234}U/^{238}U$ ratio is below the target values for both natural and DU but given high uncertainties does not necessarily indicate DU.

Table 4-7. Observed values of uranium isotope ratios in 2009

	Isotope Ratio Values	
	$^{233+234}U$ / ^{238}U	**$^{235+236}U$ / ^{238}U**
Median (95% Confidence Interval)	1.04 (1.00, 1.08)	0.068 (0.056, 0.072)

Table 4-8. Expected ratios of uranium isotopes by type of source

Source	Expected Isotope Ratios $^{233+234}U$ / ^{238}U	$^{235+236}U$ / ^{238}U
Natural	~1.29	~0.047
Enriched	~6.8	~0.19
Depleted	~1.13	~0.016

4.1.4.5 Tritium

Measurements of tritium in air vary widely across monitoring stations on the NTS. Overall, 29 percent of atmospheric moisture samples have tritium concentrations above their MDCs (Table 4-9); this proportion of detections ranges from 100 percent at Schooner to less than 10 percent at several stations. The highest mean concentration was again at the Schooner station (250 x 10^{-6} picocuries per milliliter [pCi/mL]). The next highest mean concentrations were 5.0 x 10^{-6} pCi/mL at Sedan N and 4.7 x 10^{-6} pCi/mL at E Tunnel Pond 2; all of these are similar to 2008 values. Figure 4-7 shows these data, with the Schooner data plotted at one-tenth of their actual values to allow the variation at other locations to be visible. The Schooner annual mean was 16.6 percent of the CL; mean concentrations at other locations were less than 0.4 percent of the CL.

Table 4-9. Concentrations of ^{3}H in air samples collected in 2009

Area	Sampling Station	Number of Samples	^{3}H Concentration (x 10^{-6} pCi/mL) Mean	Standard Deviation	Minimum	Maximum	% > MDC
1	BJY	23	0.55	0.61	-0.61	1.75	21.7
3	U-3ah/at S	24	0.73	0.67	-0.17	2.01	29.2
3	U-3bh N	24	0.43	0.45	-0.05	1.50	12.5
5	DoD	23	0.31	0.38	-0.26	1.37	4.3
5	Sugar Bunker N	24	0.80	0.68	-0.32	1.91	41.7
6	Yucca*	24	0.23	0.45	-0.83	1.02	4.2
9	Bunker 9-300	24	1.35	1.34	-0.45	3.99	50.0
10	Gate 700 S*	23	0.21	0.45	-0.68	1.04	0.0
10	Sedan N	24	5.04	4.68	-0.28	14.30	87.5
12	E Tunnel Pond	24	4.67	3.18	0.51	10.40	95.8
16	3545 Substation*	23	0.07	0.41	-0.72	0.96	0.0
18	Little Feller 2 N	23	0.09	0.31	-0.55	0.70	2.2
20	Gate 20-2P	24	0.36	0.42	-0.20	1.72	8.3
20	Schooner*	24	249.60	235.94	10.80	659.00	100.0
23	Mercury Track*	24	0.16	0.53	-0.51	1.99	6.3
25	Guard Station 510*	24	0.06	0.43	-0.62	0.98	0.0
All Environmental Locations		**379**	**16.76**	**84.06**	**-0.83**	**659.00**	**29.3**
CL = 1,500 x 10^{-6} pCi/mL							

*EPA-approved critical receptor sampler station

The tritium found at Schooner, Sedan N, and E Tunnel Pond 2 comes from past nuclear tests. Tritium associated with these tests quickly oxidized into tritiated water, which remains in the surrounding soil and rubble until it moves to the surface and evaporates. Higher tritium concentrations in air are generally observed during the summer months. For the E Tunnel Pond station, this increase is due to the rate of evaporation increasing as the temperature increases during the summer months. For the Schooner and Sedan stations, increased tritium emissions are likely due to the movement of soil moisture containing relatively high concentrations of tritium to the surface when temperatures are the highest and when shallow (< 2 m [6.6 ft]) soil moisture is the lowest. Rainfall can temporarily suppress these emissions by diluting the shallow soil moisture. Figure 4-7 shows the relationship between ^{3}H measurements and the average daily temperature at Pahute Mesa, where Schooner is located; Figure 4-8 shows the time and amount of precipitation events in that area.

Figure 4-9 shows average (geometric mean) long-term trends for the annual tritium levels at locations with at least seven-year histories since 1990. At most locations, the ^{3}H measurements have been decreasing fairly rapidly from year to year; the average decline rate is around 16 percent per year across all locations excluding Schooner. Declines in tritium concentrations are due to a combination of the physical decay of tritium and reduced inventory in the soil due to loss to the atmosphere through evapotranspiration. There have been no inputs of tritium from nuclear testing since 1992. The exception to the generally decreasing trend occurs at Schooner. As Figure 4-10 shows, Schooner ^{3}H data do not show a consistent trend; rather, ^{3}H emissions appear to be related to the temperatures on Pahute Mesa during the summer months. The data suggest that there may be influences due to seasonal precipitation and recharge as well.

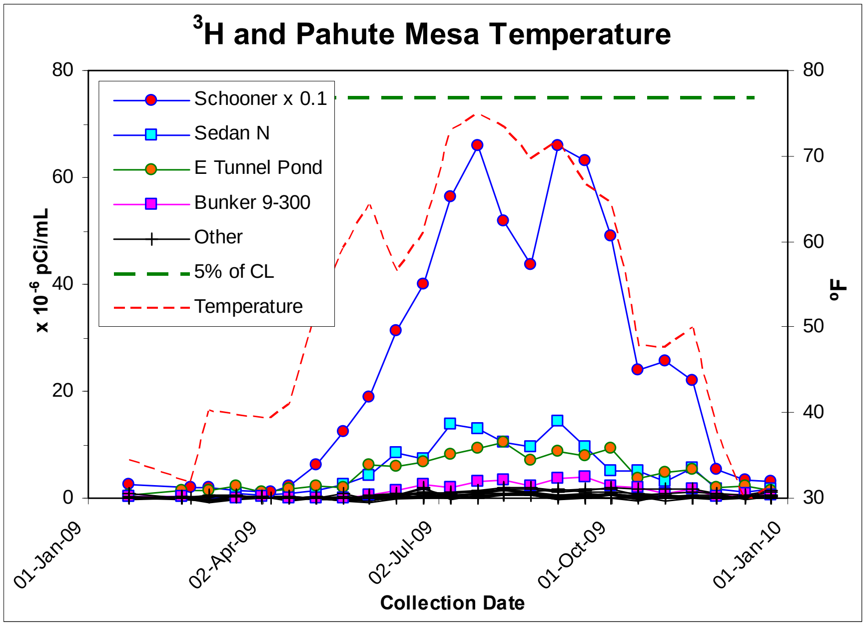

Figure 4-7. Concentrations of ^{3}H in air samples collected in 2009, with Pahute Mesa air temperature

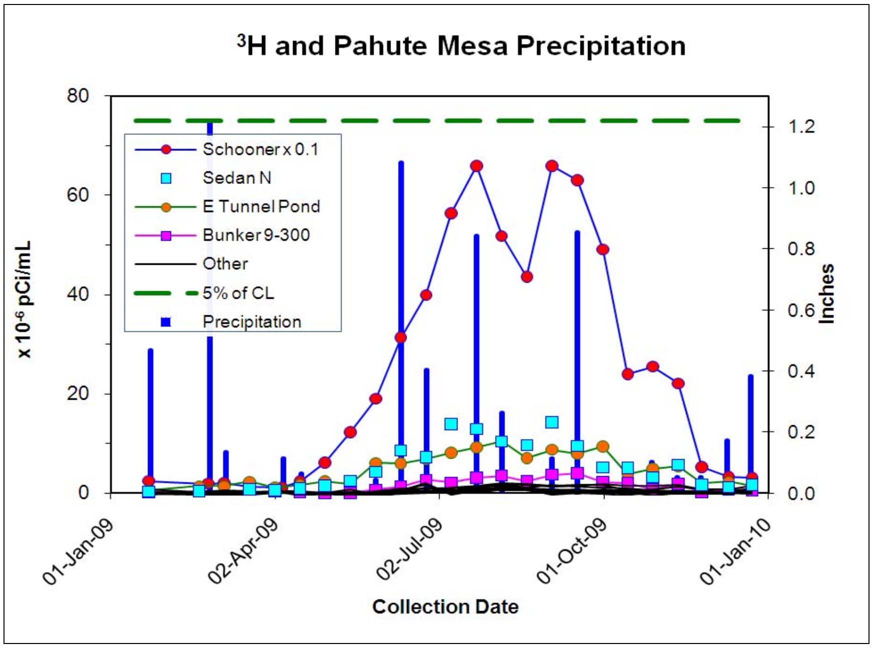

Figure 4-8. Concentrations of ^{3}H in air samples collected in 2009, with Pahute Mesa precipitation

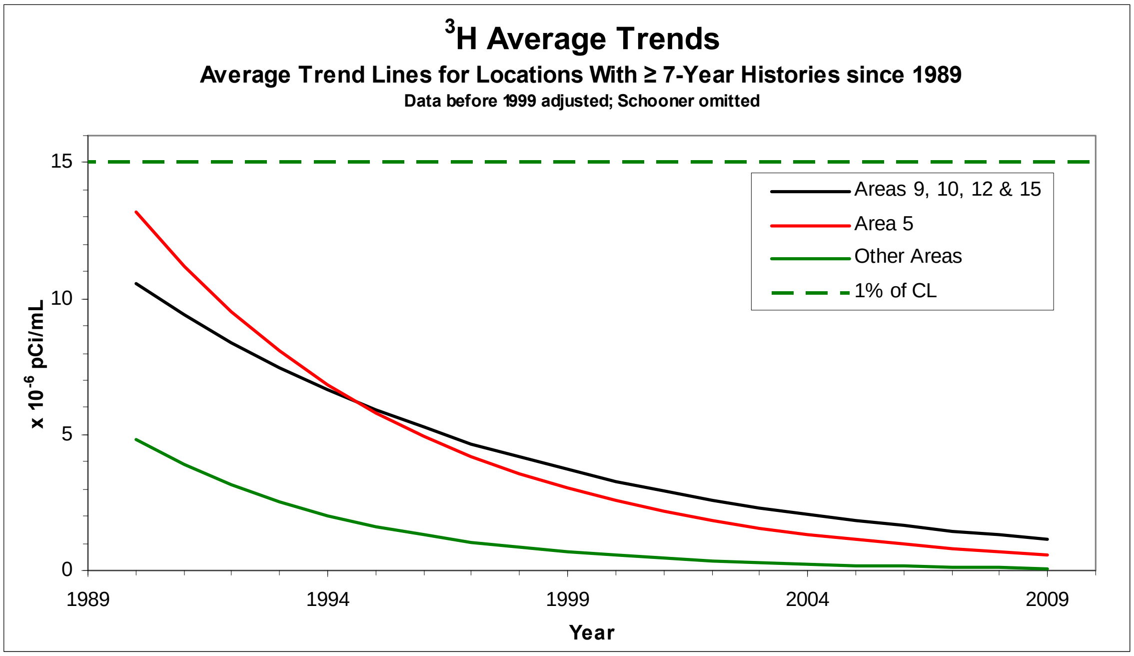

Figure 4-9. Average trends in ^{3}H in air annual means, 1990–2009, Schooner excluded

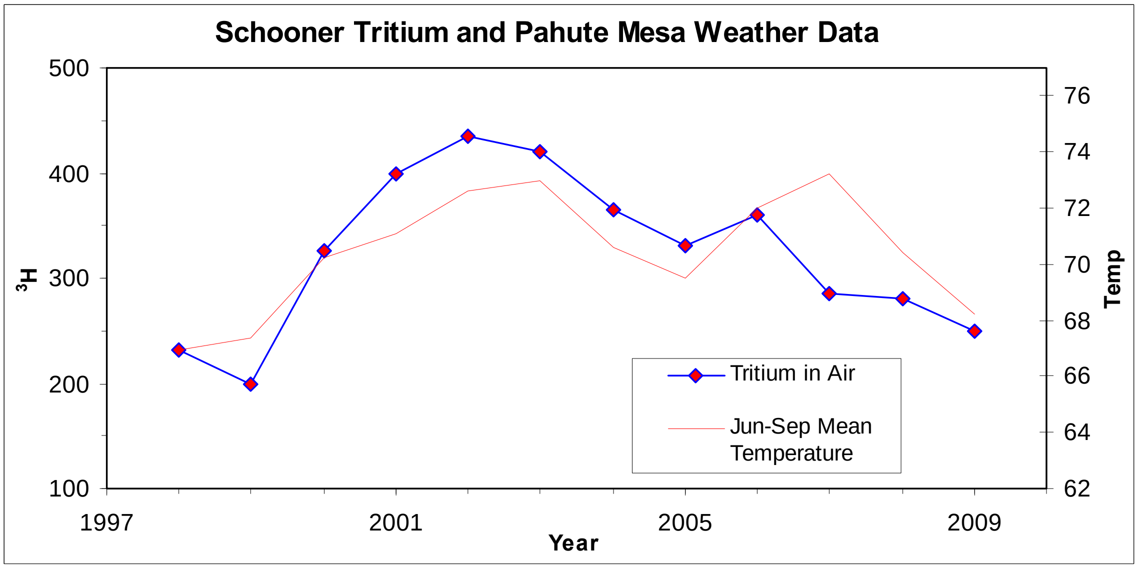

Figure 4-10. Concentrations of ^{3}H at Schooner and June–September mean temperatures at Pahute Mesa, 1998–2009

4.1.4.6 Gross Alpha and Gross Beta

Results of gross alpha and gross beta radioactivity measurements in air samples collected in 2009 are summarized in Tables 4-10 and 4-11. Because these radioactivity measurements include naturally occurring radionuclides (e.g., potassium-40, beryllium-7, uranium, thorium, and the daughter isotopes of uranium and thorium) in uncertain proportions, a meaningful CL cannot be constructed. These analyses are useful in that they can be performed just five days after sample collection to identify any increases requiring investigation.

Overall, 30 percent of gross alpha measurements were above their MDCs, comparable to 2008 and 2007 and somewhat lower than 2006 and 2005. The distribution of measurement means across the network is also similar to that of 2007, and the overall mean is comparable with those of the past few years. The highest values, in Bunker 9-300, are due to the elevated ^{241}Am, ^{238}Pu, and $^{239+240}$Pu found there during the summer months.

The gross beta measurements in 2009 resembled those of prior years: nearly all values were above their MDCs, the mean values are similar, and there are no stations with data standing out from the others.

Table 4-10. Gross alpha radioactivity in air samples collected in 2009

6			Gross Alpha (x 10^{-16} μCi/mL)					
Area	**Sampling Station**	**Number of Samples**	**Mean**	**Standard Deviation**	**Minimum**	**Maximum**	**% > MDC**
1	BJY	52	20.97	11.32	2.26	50.80	28.8
3	U-3ah/at N	52	21.72	11.91	-2.36	72.90	26.9
3	U-3ah/at S	52	25.34	12.88	3.29	58.85	36.5
3	U-3bh N	52	20.49	11.77	-3.54	46.33	28.8
3	U-3bh S	50	21.73	12.09	-5.64	49.54	28.0
5	DoD	52	19.44	9.99	0.00	44.30	28.8
5	Sugar Bunker N	52	29.05	14.38	-2.33	63.05	57.7
6	Yucca	52	22.98	9.84	1.16	48.54	29.8
9	Bunker 9-300	52	29.06	27.07	-2.31	152.84	42.3
10	Gate 700 S	51	17.13	10.21	-5.73	44.88	20.6
10	Sedan N	52	19.45	12.21	-5.76	54.96	23.1
16	3545 Substation	52	17.15	11.02	-8.16	42.21	23.1
18	Little Feller 2 N	52	19.02	11.61	-1.14	46.41	28.8
20	Gate 20-2P	51	20.27	11.81	-2.66	61.49	24.5
20	Schooner	51	18.99	9.84	0.00	38.61	25.5
23	Mercury Track	52	19.68	9.91	0.00	44.13	26.9
25	Guard Station 510	52	19.95	11.05	-2.36	38.80	33.7
27	ABLE Site	52	17.93	10.45	-2.20	45.77	24.0
All Environmental Locations		**931**	**21.14**	**13.11**	**-8.16**	**152.84**	**29.9**
27	JASPER Stack	24	-1456.35	5993.49	-29376.46	590.24	0.0

Table 4-11. Gross beta radioactivity in air samples collected in 2009

			Gross Beta (x 10^{-15} μCi/mL)				
Area	**Sampling Station**	**Number of Samples**	**Mean**	**Standard Deviation**	**Minimum**	**Maximum**	**% > MDC**
1	BJY	52	21.71	4.91	7.93	30.05	100.0
3	U-3ah/at N	52	22.11	5.12	7.44	32.08	100.0
3	U-3ah/at S	52	22.99	5.12	8.70	30.96	100.0
3	U-3bh N	52	22.35	4.86	9.12	31.32	100.0
3	U-3bh S	50	23.72	6.10	8.39	51.68	100.0
5	DoD	52	23.35	5.37	9.08	34.72	100.0
5	Sugar Bunker N	52	24.10	5.16	6.90	33.44	100.0
6	Yucca	52	23.30	5.10	8.91	33.93	100.0
9	Bunker 9-300	52	22.13	4.80	9.58	31.00	100.0
10	Gate 700 S	51	21.73	4.67	8.43	29.50	100.0
10	Sedan N	52	21.69	4.65	8.92	30.07	100.0
16	3545 Substation	52	21.44	5.49	8.47	38.76	100.0
18	Little Feller 2 N	52	20.77	4.46	8.79	28.99	100.0
20	Gate 20-2P	51	21.26	4.34	11.21	31.49	98.0
20	Schooner	51	21.63	4.22	11.43	31.31	100.0
23	Mercury Track	52	22.64	5.22	9.82	32.37	100.0
25	Guard Station 510	52	23.19	5.06	9.94	33.14	100.0
27	ABLE Site	52	21.73	4.95	7.18	30.48	100.0
All Environmental Locations		**931**	**22.32**	**5.03**	**6.90**	**51.68**	**99.9**
27	JASPER Stack	24	546.15	2774.87	-835.05	13538.33	0.0

4.1.5 Air Sampling Results from Critical Receptor Samplers

The following radionuclides were detectable at three or more of the critical receptor samplers: ^{241}Am, ^{238}Pu, $^{239+240}$Pu, $^{233+234}$U, $^{235+236}$U, ^{238}U, and ^{3}H (see Tables 4-2, 4-4, 4-5, 4-6, and 4-9, respectively). All measured concentrations of these radionuclides were well below their CLs during 2009. The uranium isotopes have been attributed to naturally occurring uranium, and hence have been monitored only at selected locations (see Section 4.1.4.4). The concentration of each measured radionuclide (excluding uranium) at each of the six critical receptor stations was divided by its respective CL (see Table 4-1) to obtain a "percent of CL." These were then summed for each station. The sum of these fractions at each critical receptor sampler is far less than 1.0, demonstrating that the NESHAP dose limit (10 mrem/yr) at these critical receptor locations was not exceeded. The highest radiation dose (EDE) at a critical receptor location would be approximately 1.69 mrem/yr for a hypothetical individual residing at Schooner.

Table 4-12. Sum of fractions of compliance levels for man-made radionuclides at critical receptor samplers

Radionuclides included in Sum of Fractions[(a)]	NTS Area	Sampling Station	Sum of Fractions of Compliance Levels (CLs)[(b)]
^{241}Am, ^{238}Pu, $^{239+240}$Pu, ^{3}H	6	Yucca	0.005
	10	Gate 700 S	0.005
	16	3545 Substation	0.002
	20	Schooner	0.169[(b)]
	23	Mercury	0.004
	25	Gate 510	0.001

(a) $^{233+234}$U, $^{235+236}$U, and ^{238}U are not included in sum of fractions. If uranium is included, the sum of fractions increases to 0.054, 0.053, and 0.053 for Yucca, 3545 Substation, and Gate 510, respectively. Isotopic uranium analyses have not been performed at the other critical receptor locations; presumably the increases in the sum of fractions would be comparable or less, at most around 0.05.

(b) This equates to a hypothetical receptor at this location receiving an EDE of 1.69 mrem/yr from the air pathway alone.

4.1.6 Air Sampling Results from Point-Source (Stack) Sampler

Analyses of the 2009 air samples from the stack sampler at the JASPER facility contained only one measurement of a man-made radionuclide, $^{239+240}$Pu, above its MDC (see Tables 4-2 through 4-5). The reported value was 69×10^{-18} µCi/mL but had an associated uncertainty of 114×10^{-18} µCi/mL, so it cannot be concluded that $^{239+240}$Pu was detected in that sample. The HEPA filters at the facility appeared to function as intended; therefore, no radionuclide emission rate or offsite dose was calculated for this potential NTS radiation source (see Chapter 9).

4.1.7 Emission Evaluations for Planned Projects

No new construction or modifications were conducted on the NTS that increased the rate of radionuclide emissions to air. However, evaluations of potential offsite dose were completed for the use of explosives during activities conducted by NPTEC at Port Gaston (Area 26), near Test Cell C (Area 25), and the High Explosives Simulation Test (HEST) Facility (Area 14). Evaluations were also conducted for Environmental Restoration planned demolition of the Engine Maintenance, Assembly, and Disassembly (Area 25), Reactor Maintenance, Assembly, and Disassembly (Area 25), and the Pluto Disassembly (Area 26) facilities. These evaluations were completed in order to determine if these projects have the potential to release airborne radionuclides that would expose the public to a dose equal to or greater than 0.1 mrem/yr. For any project or facility with this potential, NESHAP requires EPA approval prior to operation and point-source operational monitoring. The predicted radiation dose at the nearest NTS boundary for each location was a small fraction of the 0.1 mrem/yr level specified under NESHAP. The detailed air emission dose evaluations for each project are reported separately in the NESHAP annual report for calendar year 2009 (NSTec, 2010b).

4.1.8 Unplanned Releases

No unplanned radionuclide releases occurred on the NTS during 2009.

4.1.9 Total NTS Radiological Atmospheric Releases

Each year existing operations, new construction projects, and modifications to existing facilities that have the potential for airborne emissions of radioactive materials are reviewed. The following quantities are measured or calculated to obtain the total annual quantity of radiological atmospheric releases from the NTS:

- The quantity of ^{3}H gas released during laboratory or facility operations
- The quantity of ^{3}H released through evaporation from ponds or open tanks, estimated from the measured ^{3}H concentrations in water discharged into them and assuming that all water evaporates during the year
- The quantity of ^{3}H released from Area 3 RWMS, Area 5 RWMC, and from Schooner and Sedan crater sites, estimated using (1) the EPA-approved atmospheric diffusion model called CAP88-PC and (2) the annual mean concentration of ^{3}H in air measured by environmental air samplers at locations near these sources
- The quantity of other radionuclides released during environmental restoration, waste management, or research operations/activities estimated using predicted volumes of material to be moved or released, radionuclide concentrations in those materials, and emission factors supplied by the EPA (Eastern Research Group, 2004)
- The quantity of other radionuclides resuspended in air from areas of known soil contamination, calculated from an inventory of radionuclides in surface soil determined by the Radionuclide Inventory and Distribution Program (McArthur, 1991), a resuspension model (U.S. Nuclear Regulatory Commission [NRC], 1983), and equation parameters derived at the NTS (U.S. Department of Energy, Nevada Operations Office, 1992)

Emission sources on the NTS identified in 2009 are presented in Table 4-13. The amounts of ^{241}Am, ^{238}Pu, and $^{239+240}Pu$ emissions from soil re-suspension are the sum of emission rates computed for each area of the NTS with surface contamination (Areas 1–13, 15–20, and 30). Other radionuclides (cesium-60, strontium-90, europium-152, europium-154, and europium-155), although found in surface soils during past radiation surveys, were not included because combined, they contributed less than ten percent to the total dose to the public. Detailed descriptions of the methods used for estimating the quantities shown in Table 4-13 are reported in NSTec (2010b).

Table 4-13. Radiological atmospheric releases from NTS for 2009

Emission Source[(a)]	Nuclide	Annual Quantity (Ci)
Legacy Weapon Test and Plowshare Crater Locations		
Sedan	^{3}H	22
Schooner	^{3}H	83
Grouped Area Sources – All NTS Ops Areas	^{241}Am	0.047
Grouped Area Sources – All NTS Ops Areas	^{238}Pu	0.050
Grouped Area Sources – All NTS Ops Areas	$^{239+240}Pu$	0.29
Groundwater Characterization or Remediation Activities		
Environmental Restoration Projects		
E-Tunnel, Corrective Action Site 12-59-01	^{3}H	7.9
UGTA Sub-Project		
Well ER-20-7	^{3}H	27.5
Well ER-20-8	^{3}H	0.0010
Well ER-20-8 #2	^{3}H	0.0058
Well ER-EC-11, NTTR	^{3}H	0.060
NTS sewage lagoons	^{3}H	0.00036

Table 4-13. Radiological atmospheric releases from NTS for 2009 (continued)

Emission Source[a]	Nuclide	Annual Quantity (Ci)
Radioactive Waste Management		
Area 3 RWMS	^{3}H	30
Area 5 RWMC	^{3}H	2.8
Support Facility Operations		
Buildings 23-650 and 23-652	^{3}H	negligible
RAMATROL, Building 23-180	various	negligible

Source: NSTec (2010b)

(a) All locations are on the NTS except for Well ER-EC-11, which is just outside the boundary on the NTTR.

4.1.10 Environmental Impact

The concentrations of man-made radionuclides in air on the NTS were all less than the regulatory concentration limits specified by federal regulations. Long-term trends of readily detectable radionuclides in air ($^{239+240}Pu$ and tritium) continue to show a decline with time. All radionuclides detected by environmental air samplers in 2009 appear to be from legacy deposits of radioactivity on and in the soil from past nuclear tests. Radionuclide concentrations in plants and animals on the NTS and their potential impact are discussed in Chapter 8.

4.2 Nonradiological Air Quality Assessment

Nonradiological air quality assessments are conducted to document compliance with the current State of Nevada air quality permit that regulates specific operations or facilities on the NTS. The State of Nevada has adopted the CAA standards, which include NESHAP, National Ambient Air Quality Standards (NAAQS), and New Source Performance Standards (NSPS) (see Section 2.1). Specifically omitted from this section is NESHAP compliance for radionuclide emissions, which is presented in Section 4.1. Data collection, opacity readings, recordkeeping, and reporting activities related to air quality on the NTS are conducted by NSTec EPTS personnel to meet the program goals and to track the compliance measures summarized in the table below.

Air Quality Assessment Program Goals	*Compliance Measures*
Ensure that NTS operations comply with all the requirements of the current air quality permit issued by the State of Nevada. Ensure that air emissions of criteria pollutants (sulfur dioxide [SO_2]), nitrogen oxides [NO_X], carbon monoxide [CO], volatile organic compounds [VOCs], and particulate matter) do not exceed limits established under NAAQS. Ensure that emissions of permitted NTS equipment meet the opacity criteria to comply with NSPS. Ensure that NTS operations comply with the asbestos abatement reporting requirements under NESHAP. Document usage of ozone-depleting substances (ODS) to comply with Title VI of the CAA.	Tons of emissions of criteria and hazardous air pollutants produced annually Tons of explosives detonated annually Gallons of fuel burned annually Hours of operation of equipment per year Rate at which aggregate and concrete is produced Quarterly opacity readings on specified equipment Amount of asbestos in existing structures removed or scheduled for removal Maintenance of ODS usage, disposition, and certification records

NNSA/NSO maintains a Class II Air Quality Operating Permit (AP9711-2557) for NTS activities. State of Nevada Class II permits are issued for sources of air pollutants considered "minor," i.e., where annual emissions must not exceed 100 tons of any one criteria pollutant (see Glossary, Appendix B), 10 tons of any one hazardous air pollutant (HAP), or 25 tons of any combination of HAPs. The NTS facilities regulated by permit AP9711-2557 include the following:

- Over 15 facilities/185 pieces of equipment in Areas 1, 3, 5, 6, 12, 14, 23, 25, 26, and 27
- NPTEC in Area 5
- Site-Wide Chemical Release Areas
- Big Explosives Experimental Facility (BEEF) in Area 4
- Explosives Ordnance Disposal Unit (EODU) in Area 11
- Explosives Activities Sites in Areas 5, 14, 25, and 26

4.2.1 Permit Maintenance Activities

In December 2008, an application for an extensive modification of the NTS Air Quality Operating Permit was submitted to the Nevada Division of Environmental Protection (NDEP) in advance of its 2009 application for renewal. NDEP requires that all permit updates be incorporated into the existing permit prior to its renewal. The modification application included updates to equipment listings and operating parameters, revised NTS maps, facility diagrams, and air dispersion modeling. The modified NTS air permit was issued in May 2009. The 2009 permit renewal application was submitted in April 2009, and the new air permit, AP9711-2557, was issued in late June 2009.

In early June 2009, NPTEC requested permission from NDEP to detonate a small quantity of explosives in a series of tests at Port Gaston, a non-permitted location in Area 26. Since NDEP had already begun processing the 2009 permit renewal application, a separate proposal, which included a test plan, radionuclide resuspension estimations, estimated emissions, and air dispersion models, was submitted. NDEP granted permission to conduct the test, which took place in July 2009.

In September 2009, a modification application was submitted to add several low-level explosives activities locations to the new permit. The locations include NPTEC (Area 5), the HEST Facility (Area 14), Test Cell C (Area 25), and Port Gaston (Area 26). Detonations at these locations are limited to 1 ton per hour. The modified permit was issued by NDEP in February 2010.

Also in 2009, a Class II Surface Area Disturbance (SAD) permit for activities off of the NTS was obtained by the Underground Test Area (UGTA) Sub-Project to regulate the release of fugitive dust during Well ER-EC-12 construction and operation. The well is located west of the NTS on the NTTR.

4.2.2 Emissions of Criteria Air Pollutants and Hazardous Air Pollutants

A source's regulatory status is determined by the maximum number of tons of criteria pollutants and nonradiological HAPs it may emit in a 12-month period if it were operated for the maximum number of hours and at the maximum production amounts specified in the source's air permit. This maximum emission quantity, known as the potential to emit (PTE), is specified in an Air Emissions Inventory of all permitted NTS facilities and equipment. Each year, the State issues to NNSA/NSO Actual Production/Emissions Reporting Forms for the NTS air permit. They are used to report the actual hours of operation, gallons of fuel burned, etc., for each permitted facility/piece of equipment. Using these data, emissions of the criteria pollutants and HAPs are calculated and reported. The forms are completed by EPTS personnel and returned to NNSA/NSO for submittal to the State. The State uses the submitted information to determine annual maintenance and emissions fees and to document that calculated emission quantities do not exceed the PTEs. Because lead is considered a HAP as well as a criteria pollutant, NTS lead emissions for permitted operations are reported to the State as part of the total HAPs emissions. Lead emissions from non-permitted activities, such as soldering and weapons use, are covered under the Emergency Planning and Community Right-to-Know Act and are reported to the EPA (see Section 11.3).

In 2009, examination of records for permitted facilities and equipment indicated that all operational parameters were being properly tracked. A total of 3.90 metric tons (mtons) (4.30 tons) of criteria pollutants were emitted from NTS permitted facilities and equipment in 2009 (Table 4-14). No PTEs were exceeded. The majority of the emissions were NO_x from diesel generators. Only 600 pounds (0.27 mtons [0.30 tons]) of HAPs were released in 2009 (Table 4-14). Table 4-15 shows the calculated tons of air pollutants released on the NTS since 1999. Quarterly reports of emission quantities were submitted to NDEP in April, July, and October 2009, and January 2010. The Calendar Year 2009 Actual Production/Emissions Reporting Form was submitted in February 2010.

Field measurements (versus calculated emissions) of particulate matter equal to or less than 10 microns in diameter (PM10) are required for two permitted facilities: BEEF and NPTEC. A minimum of one portable PM10 sampler is required to be located at each facility. The sampling systems must operate and record ambient PM10 concentrations at least each day a detonation or chemical release occurs. The PM10 emissions are reported to the State in reports specific to each series of detonations or chemical releases (see Section 4.2.6).

Unless specifically exempted, the open burning of any combustible refuse, waste, garbage, or oil, or for salvage operations, is prohibited. Open burning for other purposes, including personnel training, is allowed if approved in advance by the State (Nevada Administrative Code [NAC] 445B.22067, "Open Burning"). Approval is denoted by the issuance of an Open Burn Variance prior to each burn. Exceptions to this include the Open Burn Variances issued to NNSA/NSO for fire extinguisher training at the NTS and for support-vehicle live-fire training evolutions. These Open Burn Variances are renewed annually and require 24-hour advance notification to the State prior to each burn. There were 19 fire extinguisher training sessions and 24 vehicle burns conducted in 2009. Quantities of criteria pollutants produced by open burns are not required to be calculated.

Table 4-14. Tons of criteria air pollutant emissions released on the NTS from permitted facilities operational in 2009

	Calculated Tons[(a)] of Emissions									
	Particulate Matter (PM10)[(b)]		Carbon Monoxide (CO)		Nitrogen Oxides (NO_X)		Sulfur Dioxide (SO_2)		Volatile Organic Compounds (VOC)	
Facility	**Actual**	**PTE[(c)]**	**Actual**	**PTE**	**Actual**	**PTE**	**Actual**	**PTE**	**Actual**	**PTE**
Wet Aggregate Plant	0.32	6.80	NA[(d)]	NA	NA	NA	NA	NA	NA	NA
Concrete Batch Plant	0.02	3.64	NA	NA	NA	NA	NA	NA	NA	NA
Cementing Services Equipment	0.01	23.18	NA	NA	NA	NA	NA	NA	NA	NA
Portable Bins (Area 6)	0.01	0.32	NA	NA	NA	NA	NA	NA	NA	NA
BEEF	0.02	8.00	0.00	0.54	0.00	0.05	0.00	0.003	0.000	0.007
Diesel Fired Generators	0.09	3.59	0.51	13.89	2.27	63.09	0.07	2.98	0.10	3.96
Boilers	0.02	0.44	0.04	1.10	0.18	4.40	0.00	0.01	0.01	0.13
Bulk Gasoline Storage Tank	NA	NA	NA	NA	NA	NA	NA	NA	0.54	1.25
Bulk Diesel Fuel Storage Tank	NA	NA	NA	NA	NA	NA	NA	NA	0.00	0.02
NPTEC	0.00	3.00	0.00	3.26	0.00	3.02	0.03	3.00	0.04	10.0
Paint Booth	NA	NA	NA	NA	NA	NA	NA	NA	0.02	1.65
Total by Pollutant	**0.49**	**48.97**	**0.55**	**18.79**	**2.45**	**70.56**	**0.10**	**5.99**	**0.71**	**17.02**
Total Emissions	**4.30 Actual, 161.33 PTE**									

(a) For metric tons (mtons), multiply tons by 0.9072
(b) Particulate matter equal to or less than 10 microns in diameter
(c) Potential to emit: the quantity of criteria pollutant that each facility/piece of equipment would emit annually if it were operated for the maximum number of hours at the maximum production rate specified in the air permit
(d) Not applicable: the facility does not emit the specified pollutant(s); therefore, there is no emission limit set forth in the air permit

Table 4-15. Criteria air pollutants and HAPS released on the NTS since 1999

	Total Emissions (tons/yr)[(a)]										
Pollutant	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Particulate Matter (PM10)[(b)]	1.7	1.46	2.05	3.61	2.39	0.94	0.84	0.69	0.54	0.22	0.49
Carbon Monoxide (CO)	1.87	2.76	4.84	4.6	1.79	0.24	0.15	0.43	0.51	0.94	0.55
Nitrogen Oxides (NO_x)	8.07	12.75	22.23	21.09	8.11	1.01	0.69	2.02	1.21	3.36	2.45
Sulfur Dioxide (SO_2)	0.42	0.98	1.68	1.62	0.76	0.12	0.04	0.03	0.01	0.06	0.10
Volatile Organic Compounds (VOCs)	1.99	1.89	2.01	2.1	1.21	4.60	1.94	1.40	1.14	0.60	0.71
Hazardous Air Pollutants (HAPs)	NR[(c)]	0.01	0.03	0.01	0	0.41	0.05	1.87	0.02	0.09[(d)]	0.30[(d)]

(a) For mtons, multiply tons by 0.9072
(b) Particulate matter equal to or less than 10 microns in diameter
(c) Not reported
(d) 98 percent of HAPs were emitted during detonations, laboratory fume hoods, and chemical release tests

4.2.3 Performance Emission Testing and State Inspection

The NTS air permit requires performance emission testing of equipment that vents emissions through stacks (called “point sources”). The tests must be conducted once during the five-year life of the NTS air permit for each specified source. Once a source accumulates 100 hours of operation (since issuance of the permit in June 2002), it must be tested within 90 days. Testing is conducted by inserting a probe into the stack while the equipment is operating. Visible emissions readings must also be conducted by a certified evaluator during the tests (see Section 4.2.5). In September 2009, performance emission tests were conducted for baghouses located at the Area 1 Batch Plant, the

Area 1 Aggregate Plant, and the Area 6 Cementing Services. The two Area 6 Device Assembly Facility (DAF) diesel generators were also tested. Emissions from all of the equipment were within the specified NTS air permit limits. A State inspection was conducted in November 2009 to verify emission units listed in the NTS air permit AP9711-2557, which was issued in June 2009. There were no findings or violations.

4.2.4 Production Rates/Hours of Operation

Compliance with operational parameters such as production rates and hours of operation is verified through an examination of the data generated for the annual report to the State. The number of hours that equipment operates throughout a year is determined either by meter readings or by recording the operating hours in a logbook each time the equipment is operated. Permit requirements specific to each piece of equipment dictate the frequency in which readings are obtained. Production rates for construction facilities such as the aggregate-producing plant are calculated using the hours of operation and amount of material produced. Logbooks are maintained to record this information. Gallons of fuel used are calculated preferably by recording tank levels each time that the tank is filled. If this is not possible, then calculations are performed by using industry standards and the hours of operation. In 2009, production rates, hours of operation, and gallons of fuel used all were within the specified permit limits and were used to calculate the tons of air pollutants emitted (see Table 4-14).

4.2.5 Opacity Readings

Under 40 CFR 60, "Standards of Performance for New Stationary Sources (NSPS)," personnel that conduct visible emissions evaluations must be certified semiannually by a qualified organization. A form similar to one appearing in 40 CFR 60 for conducting visible emissions evaluations is used to record and document the readings. Visual readings are taken every 15 seconds. A minimum of 24 consecutive readings is required for a valid reading. The average of the 24 readings must not exceed the permit-specified limit (20 percent for NAAQS, 10 percent for NSPS). The NTS air permit requires that readings be obtained once each quarter that the equipment is used and be kept on file. This applies to construction equipment only. Readings are taken for all other permitted facilities and equipment periodically but are not always recorded.

During 2009, four NSTec employees were certified by Carl Koontz Associates to conduct visible emissions evaluations at the NTS. Readings were taken for the following NTS facilities regulated under the NAAQS opacity limit of 20 percent: Area 1 Concrete Batch Plant, Area 1 Wet Aggregate Plant, Area 6 Storage Silos, Area 23 Building 650 Diesel Generator, and the two DAF Generators. Readings for these facilities ranged from 0 to 10 percent. NTS equipment that is regulated by the 10 percent opacity limit under the NSPS includes miscellaneous conveyor belts, screens and hoppers, and the Area 1 pugmill. None of this equipment was used in 2009.

4.2.6 NPTEC, BEEF, and EODU Reporting

In addition to annual reporting, the NTS air quality operating permit for NPTEC and the site-wide chemical releases requires the submittal of test plans and final analysis reports to the State for each chemical release or release series. For BEEF, quarterly test plans and final reports must be submitted for the types and weights of explosives used and estimated emissions that may be released.

In 2009, the Tarantula IV chemical test series was conducted at the Area 5 NPTEC and consisted of 25 releases. Eight releases were also conducted at the Port Gaston Facility as part of the Tarantula IV test series. A completion report was submitted to NNSA/NSO for transmittal to NDEP's Bureau of Air Pollution Control at the conclusion of each test. Tables 4-16 and 4-17 summarize the total quantities of all chemicals released during tests.

The majority of BEEF activities involve sensitive or classified information. To protect confidentiality of data, summary reports are submitted on a quarterly basis rather than for each test or test series. Table 4-18 is a summary of the general types and weights of explosives detonated during tests conducted in 2009. Emissions generated from these releases are summarized in Table 4-14.

Particulate monitoring was conducted for each test and detonation at NPTEC and BEEF in 2009. Particulate releases were within permit limits. No activities occurred at the EODU in 2009.

Table 4-16. Chemicals released during tests conducted at the Area 5 NPTEC in 2009

Chemical	Total Released (kg)	Total Released (lb)[(a)]
1,1,1,2-Tetrafluorethane	30.5	66.89
Acetic acid	18.36	40.26
Ammonia	30.8	67.54
Carbon tetrachloride	29.416	64.51
Diisopropylamine	3.88	8.51
Dimethyl methylphosphonate	36.088	79.14
Dodecane	5.836	12.80
Ethanol	21.37	46.86
Ethyl acetate	10.52	23.07
Formaldehyde	5.805	12.73
Hexafluoroethane	34.754	76.21
Hydrogen chloride	12.882	28.25
Hydrogen fluoride	6.722	14.74
Isopropyl alcohol	26.949	59.10
Kerosene	5.673	12.44
Methanol	14.807	32.47
Methyl acetate	8.51	18.66
Methyl chloride	18.862	41.36
n-Butanol	7.73	16.95
Nitrogen oxide	22.646	49.66
R410a	24.525	53.78
Sulfur dioxide	23.315	51.13
Sulfur hexafluoride	3.057	6.70
Tributyl phosphate	0.825	1.81
Triethyl amine	2.275	4.99
Triethyl phosphate	2.525	5.54

(a) 1 pound (lb) = 0.456 kilograms (kg)

Table 4-17. Chemicals released during tests conducted at the Test Cell C Facility in 2009

Chemical	Total Released (kg)	Total Released (lb)[(a)]
Acetic acid	7.655	16.79
Acetone	0.5	1.10
Benzene	20.499	44.95
Carbon tetrafluoride	27.863	61.10
Diisopropylamine	4.473	9.81
Dimethyl ether	8.455	18.54
Dodecane	5.886	12.91
Hexafluoroethane	15.448	33.88
R134a	52.721	115.62
R410a	9.317	20.43
Trichloroethylene	19.458	42.67

(a) 1 lb = 0.456 kg

Table 4-18. Types and weights of explosives detonated at BEEF in 2009

Type of Explosive	Total Released (kg)	Total Released (lb)[(a)]
TNT based	0.793	1.74
Nitramine/binder	490.177	1074.95
Pure compound	2.462	5.4

(a) 1 lb = 0.456 kg

4.2.7 ODS Recordkeeping

At the NTS, refrigerants containing ODS are mainly used in air conditioning units in vehicles, buildings, refrigerators, drinking water fountains, vending machines, and laboratory equipment. Halon 1211 and 1301, now classified as ODS, have been used in the past in fire extinguishers and deluge systems. During 2009, the last of these halons were removed from use and sent to the Department of Defense Depot in Richmond, Virginia. There are no reporting requirements for ODS, but recordkeeping to document the usage of ODS and technician certification is required. ODS recordkeeping requirements applicable to NTS operations include maintaining, for a minimum of three years, evidence of technician certification, recycling/recovery equipment approval, and servicing records for appliances containing 22.7 kg (50 lb) or more of refrigerant. Compliance with recordkeeping and certification requirements for the use and disposition of ODS is verified through periodic self-assessments. The assessments include a records review and interviews with managers and technicians associated with the use, disposition, and purchase of refrigerants. The EPA may conduct random inspections to determine compliance with ODS regulations under the CAA. There were no external or internal assessments of the NTS ODS program in 2009, but the assessor for the International Organization for Standardization (ISO) 14001 Environmental Management Standard (known as ISO 14001) is scheduled to conduct an assessment in July 2010.

4.2.8 Asbestos Abatement

A NESHAP notification is submitted annually to the EPA for the next calendar year. It provides an estimate of the quantities of asbestos-containing materials that are expected to be removed from small asbestos abatement projects. “Small projects” are those that will remove less than 260 linear feet, 160 square feet, or 1 cubic meter of asbestos-containing materials. These projections are submitted in an Annual Asbestos Abatement Notification Form. A Notification of Demolition and Renovation Form is also submitted to the EPA at least 10 working days prior to the start of each project if (1) a facility is scheduled for demolition and has no asbestos present, or (2) quantities of asbestos-containing materials to be removed are estimated to equal or exceed 260 linear feet, 160 square feet, or 1 cubic meter.

The recordkeeping requirements for asbestos abatement activities include maintaining air and bulk sampling data records, abatement plans, and operations and maintenance activity records for up to 75 years and maintaining location-specific records of asbestos-containing materials for a minimum of 75 years. Compliance is verified through periodic internal assessments. The assessments include a records review and interviews with managers and technicians associated with asbestos abatement. NNSA/NSO informal reviews are performed periodically.

The Annual Asbestos Abatement Notification Form was submitted to the EPA in November 2008 and projected that for the 2009 calendar year, no more than 250 linear feet, 150 square feet, or 1 cubic meter of asbestos-containing material would be removed from NTS facilities. However, asbestos abatement projects larger than projected arose in 2009. They included eight demolition projects, one renovation project, and one emergency renovation. A Notification of Demolition and Renovation Form was submitted to the EPA within 10 working days prior to the start of these projects. Each project was performed in a closely supervised and rigidly controlled environment. Personal air monitoring and environmental air sampling were typically conducted as well. The remaining asbestos abatement activities throughout the NTS complex were minor in scope, involving the removal of quantities of asbestos-containing materials less than the reporting threshold. Asbestos-containing materials were buried in both the Area 9 U10c and Area 23 solid waste disposal sites. Asbestos abatement records continue to be maintained as required.

4.2.9 Fugitive Dust Control

The NTS Class II Air Quality Operating Permit states that the best practical methods should be used to prevent particulate matter from becoming airborne prior to the construction, repair, demolition, or use of unpaved or untreated areas. Methods and materials that are typically used to control fugitive dust include presoaking, water spraying, using dust palliatives, gravelling or paving haul routes, revegetating, reducing vehicle speeds, and either covering stockpiles or watering them. At the NTS, the main method of dust control is the use of water sprays.

During 2009, NSTec personnel conducted several fugitive dust readings of operations throughout the NTS that included the Area 1 Aggregate Plant, the Radiological/Nuclear Countermeasures Test and Evaluation Complex, and the Area 23 Fire Station. No excessive fugitive dust was noted, although minor amounts of dust were observed during construction of the new Area 23 fire station. Water controls were in place but were increased to control the dust.

In addition to enforcing the CAA regulations mentioned above, NAC 445B.22037, "Emissions of Particulate Matter: Fugitive Dust," requires fugitive dust to be controlled. The Class II Air Quality Operating Permit requires implementation of an ongoing control program at the NTS using the best practicable methods. Off the NTS, all NNSA/NSO surface-disturbing activities that cover 5 or more acres are regulated by stand-alone Class II SAD permits issued by the State. A SAD was obtained in 2009 for construction and operation of the UGTA Sub-Project Well ER-EC-12 located west of the NTS on the NTTR. No excessive fugitive dust from these activities was noted, and all requirements of the SAD were met.

4.2.10 Environmental Impact

During 2009, NTS activities produced a total of 4.30 tons of criteria pollutants and 0.30 tons of HAPs. These small quantities had little, if any, impact to air quality on the NTS and at offsite locations. Emissions of pollutants for 2009 were significantly less than those generated during the heightened activity that occurred in the years prior to the nuclear weapons testing moratorium.

Impacts of the chemical release tests at NPTEC are minimized by controlling the amount and duration of each release. Biological monitoring at NPTEC is performed whenever there is a risk of significant exposure to downwind plants and animals from the planned tests (see Section 13.6). NSTec biologists review all chemical release test plans to determine the level of field monitoring needed for each test. To date, chemical releases at NPTEC have used such small quantities (when dispersed into the air) that downwind test-specific monitoring has not been necessary. No measurable impacts to downwind plants or animals have been observed.

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5.0 Radiological and Nonradiological Water Monitoring

This chapter presents radiological and nonradiological monitoring results for surface water and groundwater from on and off the Nevada Test Site (NTS), including water sampled from natural springs, drinking water, non-potable groundwater, and water discharged into domestic and wastewater systems on the NTS. Several programs and projects were involved in water monitoring during 2009. These included (1) routine radiological monitoring conducted by National Security Technologies, LLC (NSTec), Environmental Protection and Technical Services (EPTS) under the *Routine Radiological Environmental Monitoring Plan* (RREMP) (Bechtel Nevada [BN], 2003a); (2) water quality assessments of permitted water systems conducted by NSTec EPTS; and (3) water sampling and analysis conducted by the Underground Test Area (UGTA) Sub-Project. Water monitoring is conducted to comply with applicable state and federal regulations (see Section 2.2) as well as to address the concerns of stakeholders residing in the vicinity of the NTS. In addition, the Community Environmental Monitoring Program, established by the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO), annually performs independent monitoring of offsite springs and water supply systems in communities surrounding the NTS (see Chapter 7). This independent community outreach program is managed by the Desert Research Institute (DRI).

5.1 Radiological Surface Water and Groundwater Monitoring

Groundwater on and near the NTS is monitored for radioactivity to safeguard public health and safety and to comply with applicable federal, state, and local environmental protection regulations and U.S. Department of Energy (DOE) directives. Monitoring in the past was conducted by the U.S. Public Health Service, the U.S. Geological Survey, the U.S. Environmental Protection Agency (EPA), and others. In 1998, BN was tasked by NNSA/NSO to establish and manage an NTS integrated and comprehensive radiological environmental monitoring program. The RREMP (BN, 2003a) describes groundwater monitoring objectives, regulatory drivers, and quality assurance protocols. The monitoring program collects and analyzes water samples to meet the goals shown below. UGTA Sub-Project goals are provided in detail in Chapter 14.

Radiological Surface Water and Groundwater Monitoring Program Goals	***Analytes Monitored***
Determine if radionuclide concentrations of offsite and onsite water supply wells exceed the safe drinking water standards established by the EPA under the Safe Drinking Water Act or the dose limits to the general public set by DOE Order DOE O 5400.5, "Radiation Protection of the Public and the Environment." *(See Chapter 9 for public dose estimates based on monitoring results.)* Determine if radionuclide concentrations in surface waters on the NTS expose animals to doses that exceed those set by DOE Standard DOE-STD-1153-2002, "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota," to protect wildlife populations. Determine if permitted facilities on the NTS are in compliance with permit discharge limits for radionuclides. Determine if radionuclide concentrations in onsite and offsite natural springs and non-potable water wells (monitoring wells) indicate that NNSA/NSO activities have had an impact on the environment. Strict drinking water standards are often used as a monitoring action level for this determination.	Tritium (^{3}H) Gross alpha radioactivity Gross beta radioactivity Gamma-emitting radionuclides Plutonium-238 (^{238}Pu) Plutonium-239+240 ($^{239+240}Pu$) Carbon-14 (^{14}C) Strontium-89+90 ($^{89+90}Sr$) Technetium-99 (^{99}Tc)

5.1.1 Areas of Radiological Groundwater Contamination

The NTS is located in a complex hydrogeologic setting (see *Attachment A: Nevada Test Site Description* included on the compact disc version of this report). Within this setting, a total of 828 underground nuclear tests were conducted between 1951 and 1992. Approximately one-third of these tests were detonated near or in the saturated zone (DOE, 1996; U.S. Department of Energy, Nevada Operations Office, 2000), resulting in contamination of groundwater in some areas. The Federal Facility Agreement and Consent Order (FFACO) established Corrective Action Units (CAUs) that delineate areas of concern for groundwater contamination on the NTS (DOE, 1996). Figure 5-1 shows the locations of historical underground nuclear tests and the areas of potential groundwater contamination designated as CAUs.

5.1.2 Water Monitoring Locations

The RREMP monitoring well network includes existing onsite and offsite wells drilled in support of nuclear testing or other site missions that have met specific criteria based on monitoring objectives. It also includes some offsite private/community drinking water wells. The purpose of monitoring is to detect man-made radionuclides in wells that are downgradient from the UGTA CAUs and that penetrate an aquifer. Other selection criteria involve well condition, the ability to obtain representative water samples of acceptable quality, and well access. Sometimes new monitoring wells are added to the network. UGTA characterization wells that are no longer needed by the Sub-Project are added if they are not highly contaminated wells and they meet all other selection criteria. It is important to note that the RREMP aquifer monitoring network is an interim program and is not designed to meet the requirements of the FFACO for a long-term monitoring network for the closure of UGTA CAUs (see Chapter 14).

The RREMP (BN, 2003a) identifies 78 wells and 11 surface waters to be sampled at frequencies ranging from once every three months to once every three years. Eleven additional wells (eight offsite and three onsite) and four springs (one offsite and three onsite) have been monitored under the program; these are sampled opportunistically or at the suggestion of NNSA/NSO. Of these 104 well/spring locations, 73 have been sampled at least once since 2000, and 61 are routinely considered for monitoring under the current program. The 61 include 33 offsite locations (26 wells and 7 springs), 9 onsite water supply wells, 18 onsite monitoring wells, and 1 surface containment pond. The remaining locations in the network have not been sampled because they are either not accessible (e.g., roads washed out), they are used for other purposes, permit conditions have changed, the well column is blocked, the wells provide poor quality water samples, or they contain waters with known high levels of radiological contamination that are not expected to change.

The natural offsite springs are sampled at intervals from once a year to once every three years, and the RREMP identifies one containment pond system and three sewage lagoons that may be sampled quarterly or annually, depending on permit conditions. Only two of the three sewage lagoons are currently active, and neither requires routine radiological monitoring.

During 2009, 58 groundwater locations were sampled (Figures 5-2 and 5-3 and Tables 5-1 through 5-5):

- 14 offsite community water supply wells
- 12 offsite non-potable NNSA/NSO wells
- 7 offsite springs
- 9 onsite water supply wells (5 potable, 4 non-potable)
- 15 onsite monitoring wells
- 1 onsite surface containment pond system (E Tunnel)

The UGTA Sub-Project sampled six wells in 2009. These samples were analyzed for radionuclides; the results are presented in Section 5.1.10.

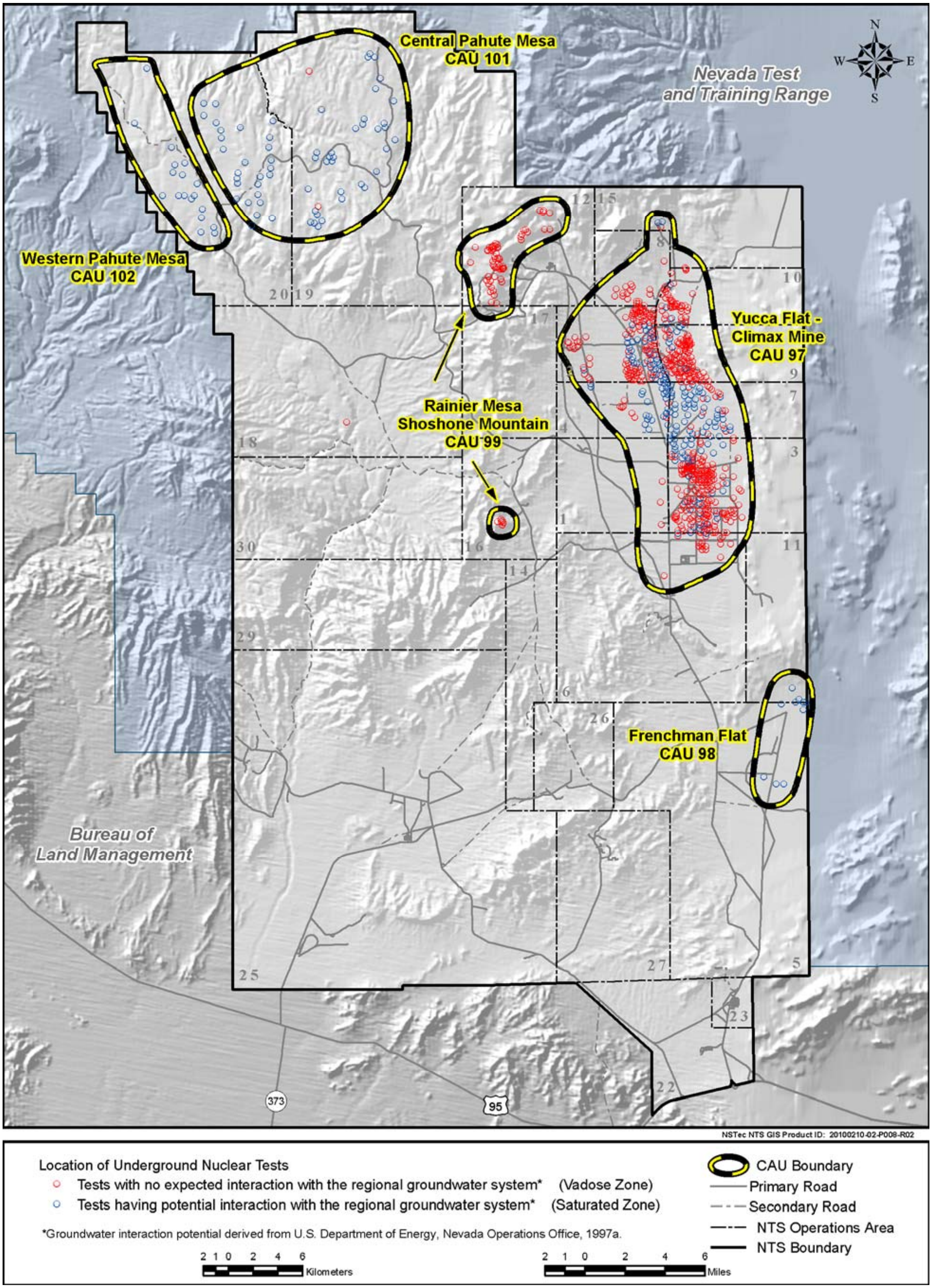

Figure 5-1. Areas of potential groundwater contamination on the NTS

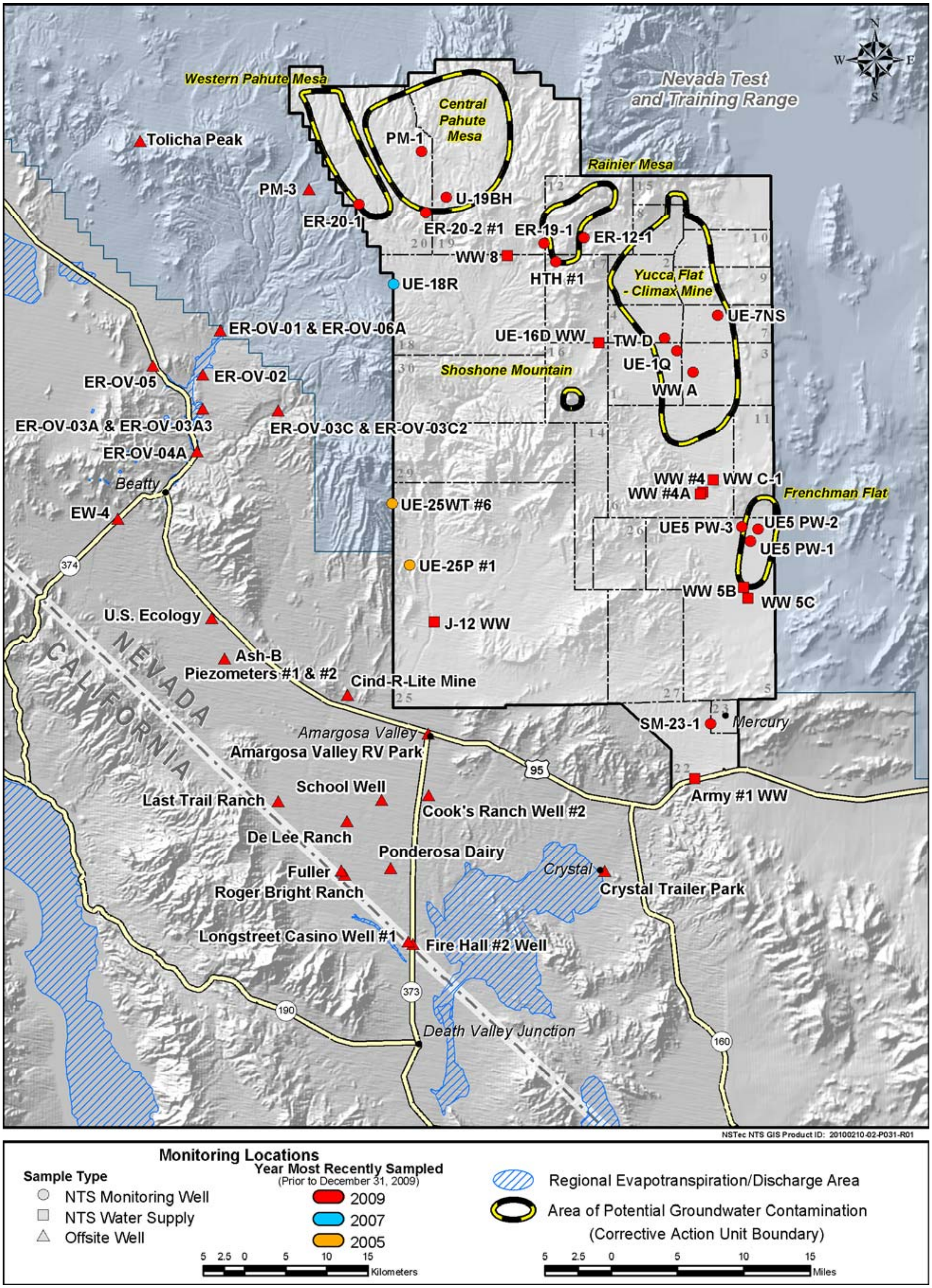

Figure 5-2. RREMP well monitoring locations sampled on and off the NTS in 2009 and in recent years

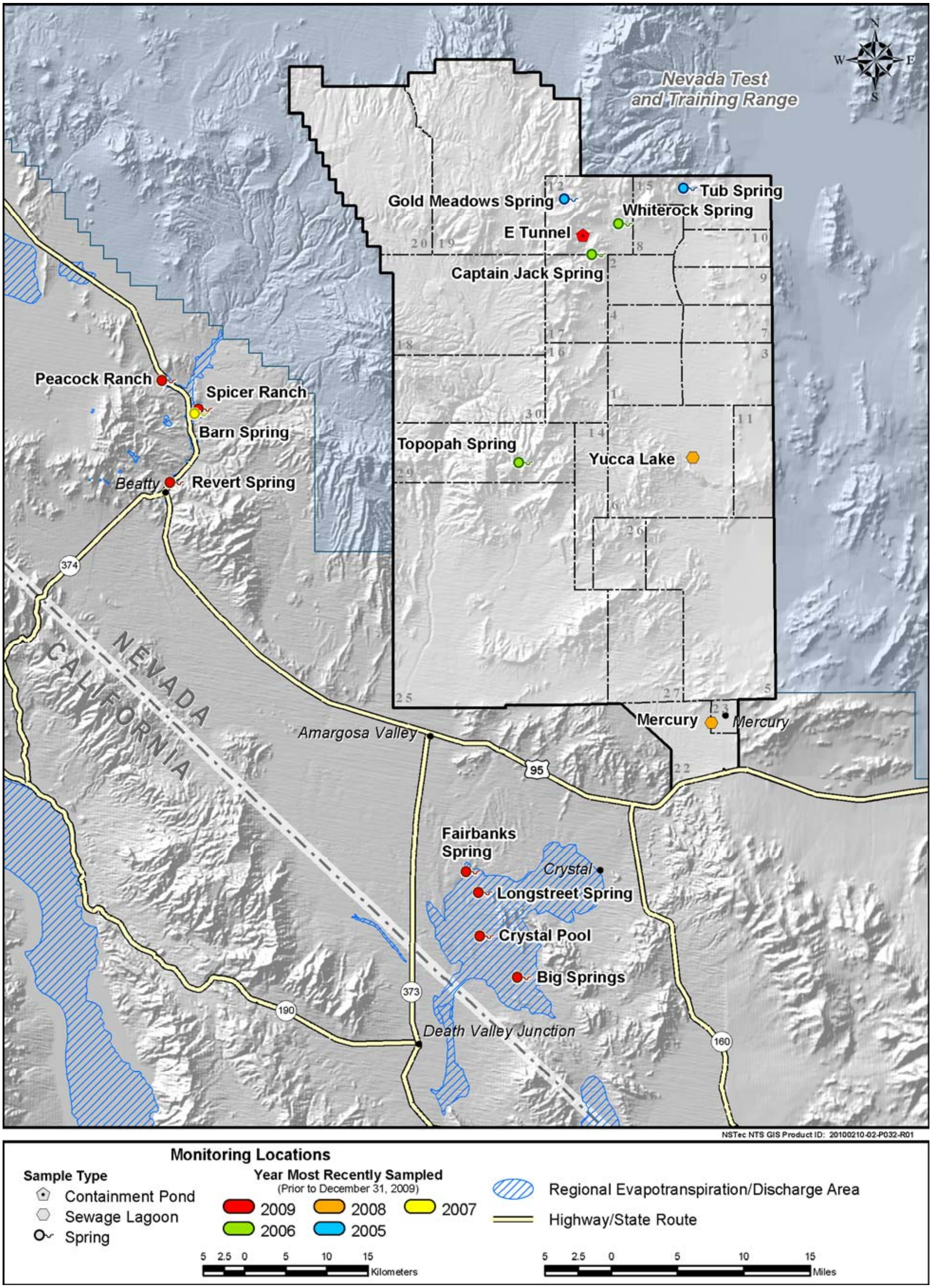

Figure 5-3. Surface water monitoring locations sampled on the NTS in 2009 and in recent years

5.1.3 Analytes Monitored

The selection of analytes for groundwater monitoring under the RREMP is based on the radiological source term from historical nuclear testing, regulatory/permit requirements, and characterization needs. The isotopic inventory remaining from nuclear testing is presented in the 1996 environmental impact statement for NTS activities (DOE, 1996) and in a Los Alamos National Laboratory (LANL) document (Bowen et al., 2001). Many of the radioactive species generated from subsurface testing have very short half-lives, sorb strongly onto the solid phase, or are bound into what is termed "melt glass" and are not available for groundwater transport in the near term (Smith, 1993; Smith et al., 1995). Tritium (^{3}H) is the radioactive species created in the greatest quantities and is widely believed to be the most mobile. Tritium is therefore the primary target analyte; every water sample is analyzed for this radionuclide. It will represent the greatest concern to users of groundwater on and around the NTS for at least the next 100 years due to its high mobility and concentration (DOE, 1996; International Technology Corporation, 1997).

Gross alpha and gross beta radioactivity analyses are also conducted on water samples from all locations in the monitoring network but less frequently than tritium at some locations. Gross alpha and gross beta radioactivity can include activity from both natural and man-made radionuclides, if any are present. Naturally occurring minerals in the water can contribute to both alpha radiation (e.g., isotopes of uranium and radium-226 [^{226}Ra]) and beta radiation (e.g., radium-228 [^{228}Ra] and potassium-40 [^{40}K]). Gamma spectroscopy analysis is also performed on water samples; this can identify the presence of specific man-made radionuclides (e.g., americium-241 [^{241}Am], cesium-137 [^{137}Cs], cobalt-60 [^{60}Co], and europium-152 and -154 [^{152}Eu and ^{154}Eu]) as well as natural radionuclides (e.g., actinium-228 [^{228}Ac], lead-212 [^{212}Pb], ^{40}K, uranium-235 [^{235}U], and thorium-234 [^{234}Th]). Specific analyses for plutonium-238 [^{238}Pu], plutonium-239+240 [$^{239+240}Pu$], carbon-14 [^{14}C], strontium-89+90 [$^{89+90}Sr$], technetium-99 [^{99}Tc], ^{241}Am, and uranium isotopes are performed on selected water samples to help characterize sampled locations. Specific radium analyses were discontinued in 2005, because previous analyses indicated that ^{226}Ra and ^{228}Ra are not major contributors to gross alpha or gross beta activity, respectively. Water analyses also include stable parameters to assist in characterizing groundwater chemistry and hydrology; these measures are not presented in this report.

5.1.4 Water Sampling/Analysis Methods

Water sampling methods are based, in part, on the characteristics and configurations of the sample locations. For example, wells with dedicated pumps may be sampled from the associated plumbing (e.g., spigots) at the wellhead, while wells without pumps may be sampled via a wireline bailer or a portable pumping system. Five of the wells are constructed to allow for sampling different horizons. The sample depths for these five wells are as follows:

<u>HTH #1</u>
- 590 meters (m) (1,935 feet[ft]) below ground surface (bgs)
- 622 m (2,040 ft) bgs
- 649 m (2,130 ft) bgs
- 701 m (2,300 ft) bgs

<u>UE-18R</u>
- 518 m (1,700 ft) bgs
- 649 m (2,130 ft) bgs

<u>PM-3</u>
- 475 m (1,560 ft) bgs
- 608 m (1,994 ft) bgs

<u>ER-19-1</u>
- 826 m (2,710 ft) bgs
- 1,000 m (3,280 ft) bgs

<u>Ash-B</u>
- Piezometer #2 - 114 m (375 ft) bgs
- Piezometer #1 - 312 m (1,025 ft) bgs

Well ER-6-1, last sampled in 2006, is also constructed to allow sampling at two depths but is not currently considered part of the routine monitoring program due to water quality concerns. All of these wells above, except UE-18R, were sampled in 2009. UE-18R is inaccessible due to a washed-out road. The remaining wells listed in Tables 5-1, 5-3, and 5-4 were sampled at single depths.

Sampling frequencies and analyses for routine radiological water monitoring are based on location and type of sampling point as defined in the RREMP. As usual, tritium analyses were performed on all samples obtained during 2009. Other analyses were performed on specific samples based primarily on the RREMP schedule.

Most tritium analyses were conducted after the samples were enriched. The enrichment process concentrates tritium in a sample to provide low minimum detectable concentrations (MDCs) (see Glossary, Appendix B). Sample-specific MDCs for laboratory analysis, reported in each results table, ranged from 11.2 to 29.9 picocuries per liter (pCi/L). The MDCs for standard (non-enriched) tritium analyses typically range from 200 to 400 pCi/L. For comparison, the EPA maximum contaminant level (MCL) for tritium in drinking water is 20,000 pCi/L; the RREMP cites an informal "action level" (with no formal action required by regulation) of 10 percent of the drinking water standard, or 2,000 pCi/L.

Analytical methods routinely include quality control samples such as duplicates, blanks, and spikes. Chapter 18 discusses in more detail the quality assurance and control procedures used for radiological water monitoring.

5.1.5 Presentation of Water Sampling Data

The following sections present values of gross alpha, gross beta, and tritium for all water samples, whether above or below their MDCs. Concentrations for man-made gamma-emitting radionuclides (^{137}Cs, ^{238}Pu, $^{239+240}$Pu, ^{14}C, $^{89+90}$Sr, and ^{99}Tc) are discussed if the analyses were performed and the values exceeded the sample-specific MDC.

The "±" values presented in the data tables are the laboratory's stated two–standard deviation "error" for each particular analysis. This does not include the uncertainty associated with sample collection or the tritium enrichment process. A statistical analysis of water supply well samples analyzed between July 1999 and December 2008 was conducted to obtain an estimate of the tritium decision level (L_C). The analysis suggests an L_C (see Glossary, Appendix B) for tritium of approximately 19.6 pCi/L, where L_C is a 99 percent prediction limit for any individual measurement based on the background water supply well data. Alternately, a 95 percent prediction limit for all enriched tritium measurements (PLall), based on that background water supply well data, is 27.2 pCi/L. This takes into account the total number of enriched tritium measurements made annually under the current implementation of the RREMP (99 during 2009). If all monitoring locations produced data from the same distribution as the water supply wells, there would be a 5 percent chance of obtaining one or more values exceeding this PLall anywhere during any one year.

Figures 5-4 through 5-9 were created to show trends over time in gross alpha and beta radioactivity and tritium levels among the RREMP sample locations that have been sampled routinely. In preparing these figures, the annual mean analyte concentration for each RREMP location was first computed for each year (2000–2009). These were averaged across locations, and the annual "means of means" were plotted and then connected. The vertical bars in the figures extend from the minimum to the maximum annual mean for any well or spring for each year.

5.1.6 Results from Offsite Wells and Springs

The 2009 data indicate that groundwater sampled at both the offsite NNSA/NSO and private/community wells (Figure 5-2) and at offsite springs (Figure 5-3) has not been impacted by past NTS nuclear testing operations. Tritium was not detected in any of the offsite wells (Table 5-1) or springs (Table 5-2) at levels above sample-specific MDCs. Gross alpha and gross beta radioactivity were detected in most offsite well and spring samples (Tables 5-1 and 5-2). These likely represent the presence of naturally occurring radionuclides. Two of the 2009 gross alpha results slightly exceeded the EPA MCL of 15 pCi/L; none of the gross beta results exceeded the EPA Level of Concern (LoC) of 50 pCi/L.

Samples from wells in Oasis Valley (ER-OV-01, ER-OV-02, ER-OV-03C, ER-OV-03C2, and ER-OV-06A) and PM-3 were analyzed for gamma-emitting radionuclides, ^{238}Pu, and $^{239+240}$Pu. No man-made radionuclides were detected.

Figures 5-4 through 5-6 show the trends over time in gross alpha and beta radioactivity and tritium levels among the offsite wells and springs being sampled routinely. The highest values for gross alpha for early years were seen in Oasis Valley well ER-OV-2, one of the wells whose 2009 gross alpha value exceeded the MCL. The other well with gross alpha exceeding the MCL in 2009 is Ash-B Piezometer #2; it does not have a history of elevated measurements. Gross alpha appears to decrease in three Oasis Valley wells (ER-OV-01, ER-OV-02, and ER-OV-03A) over time. Nearly all recent gross alpha levels are below the EPA drinking water MCL (see Figure 5-4). All gross beta values in Figure 5-5 are beneath the EPA LoC for drinking water, and all tritium values in Figure 5-6 are far below the EPA MCL for drinking water.

Table 5-1. Gross alpha, gross beta, and tritium in offsite wells in 2009

		Concentration (pCi/L)								
Monitoring Location	**Date Sampled**	**Gross Alpha**	**±[a]**	**MDC**	**Gross Beta**	**±**	**MDC**	**Tritium**	**±**	**MDC**
Non-potable NNSA/NSO Wells										
ER-OV-01	10/19	7.8	3.4	3.0	8.6	2.7	2.7	-1.3	6.0	11.3
	10/19 FD[b]	NA[c]			NA			0.8	7.2	13.0
ER-OV-02	10/20	19.0	6.0	4.4	9.0	2.7	2.8	-1.8	6.0	11.3
ER-OV-03A	10/19	9.5	3.8	1.9	5.4	2.0	2.1	-4.6	6.0	11.9
ER-OV-03A3	10/19	9.7	3.6	2.2	6.8	2.4	2.8	0.0	6.2	11.4
ER-OV-03C	10/20	11.8	4.3	3.3	4.2	2.0	2.8	1.4	6.4	11.4
ER-OV-03C2	10/20	9.3	3.6	2.8	5.2	2.2	2.9	-0.6	6.1	11.3
ER-OV-04A	10/20	2.8	2.1	2.8	6.4	2.4	3.1	3.2	6.4	11.2
ER-OV-05	10/20	3.9	2.0	1.9	9.9	2.6	2.4	3.3	6.7	11.7
ER-OV-06A	10/19	3.7	2.1	2.0	8.8	2.6	2.5	3.5	6.6	11.5
	10/19 FD	NA			NA			-0.8	8.3	15.3
PM-3 (1,560 ft bgs)	4/29	0.5	0.8	1.4	13.7	2.4	1.5	23.8	17.6	28.1
(1.994 ft bgs)	4/29	10.7	2.5	1.9	14.9	3.1	2.8	-1.1	16.0	26.8
	4/29 FD	NA			NA			10.6	17.2	28.3
EW-4	11/17	6.0	1.5	1.4	6.7	1.7	2.0	1.5	12.4	21.5
	11/17 FD	6.2	1.6	1.5	6.6	1.8	2.2	-3.0	12.5	22.1
Ash-B Piezometer #1	11/24	0.4	0.9	1.7	2.2	1.6	2.4	3.0	17.0	29.3
Piezometer #2	11/24	17.8	7.2	4.9	20.4	6.3	6.8	7.4	17.1	29.3
Private/Community Drinking Water Wells										
Amargosa Valley RV Park	11/17	0.5	0.7	1.5	1.5	1.1	2.2	6.1	12.6	21.4
Ponderosa Dairy	11/18	0.9	0.8	1.5	8.4	1.9	2.0	20.1	13.8	22.3
Cind-R-Lite Mine	11/17	3.2	1.3	1.6	4.2	1.4	2.2	-9.0	11.9	21.4
Cook’s Ranch Well #2	11/17	2.5	1.1	1.6	10.9	2.2	2.2	-6.0	12.4	22.1
Crystal Trailer Park	11/17	3.4	1.3	1.7	6.7	1.6	2.0	-3.8	12.6	22.4
De Lee Ranch	11/18	1.7	1.0	1.6	9.1	2.0	2.2	-4.0	11.8	20.9
Fire Hall #2 Well	11/18	0.8	0.9	1.7	10.8	2.2	2.0	3.0	12.9	22.2
Last Trail Ranch	11/18	6.2	1.6	1.6	9.5	2.1	2.2	1.5	12.7	22.1
Longstreet Casino Well #1	11/18	2.0	1.1	1.7	9.7	2.1	2.2	-3.0	12.6	22.1
Fuller	11/18	3.8	1.4	1.8	13.3	2.7	2.4	-6.9	11.8	21.0
Roger Bright Ranch	11/18	3.0	1.1	1.5	13.9	2.6	2.0	-3.7	12.2	21.6
School Well	11/18	1.1	0.9	1.6	10.1	2.2	2.3	4.0	13.6	23.4
Tolicha Peak	11/30	3.6	2.2	2.3	3.2	1.9	2.7	6.3	17.2	29.5
	11/30 FD	3.0	2.1	2.4	3.2	1.5	1.8	-8.6	16.6	29.4
U.S. Ecology	11/17	3.2	1.2	1.6	10.0	2.2	2.3	-10.2	11.7	21.3

Gray shaded results are considered detected; the result is greater than the sample-specific MDC.
Yellow shaded results are greater than the EPA MCL for gross alpha (15 pCi/L).
(a) ± 2 standard deviations.
(b) FD = field duplicate sample.
(c) NA = Analysis not performed on this sample.

Table 5-2. Gross alpha, gross beta, and tritium in offsite springs in 2009

		Concentration (pCi/L)								
Monitoring Location	**Date Sampled**	**Gross Alpha**	**±[(a)]**	**MDC**	**Gross Beta**	**±**	**MDC**	**Tritium**	**±**	**MDC**
Big Springs	11/18	2.9	1.1	1.5	8.5	2.0	2.3	-5.1	14.1	24.9
Crystal Pool	11/8	3.4	1.3	1.7	6.5	1.9	2.8	-10.7	16.6	29.6
Fairbanks Spring	11/18	2.9	1.1	1.3	6.9	1.9	2.6	-0.7	16.7	29.0
Longstreet Spring	11/8	3.8	1.2	1.4	6.9	1.6	1.9	-11.6	16.3	29.0
Peacock Ranch	11/7	1.4	0.9	1.5	9.7	2.1	2.3	0.9	17.2	29.9
Revert Spring	11/17	4.3	1.3	1.4	4.1	1.5	2.4	-1.3	16.3	28.5
Spicer Ranch	11/7	6.7	1.6	1.3	5.7	1.7	2.3	-7.1	16.5	29.1

Gray shaded results are considered detected; the result is greater than the sample-specific MDC.
The EPA MCL for gross alpha is 15 pCi/L, the EPA LoC for gross beta is 50 pCi/L), and the EPA MCL for tritium is 20,000 pCi/L.
(a) ± 2 standard deviations.

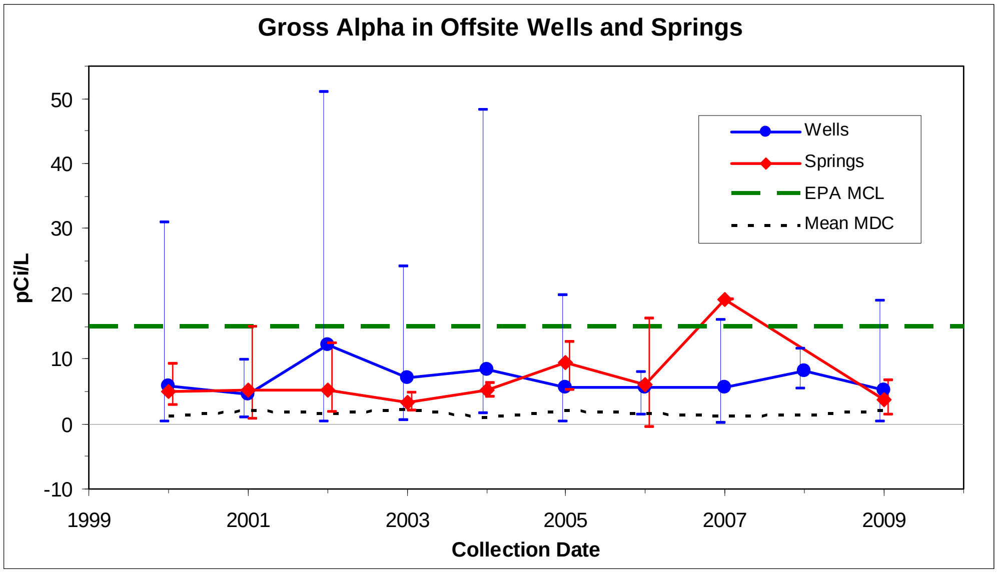

Figure 5-4. Gross alpha annual means for offsite wells and springs from 2000 through 2009

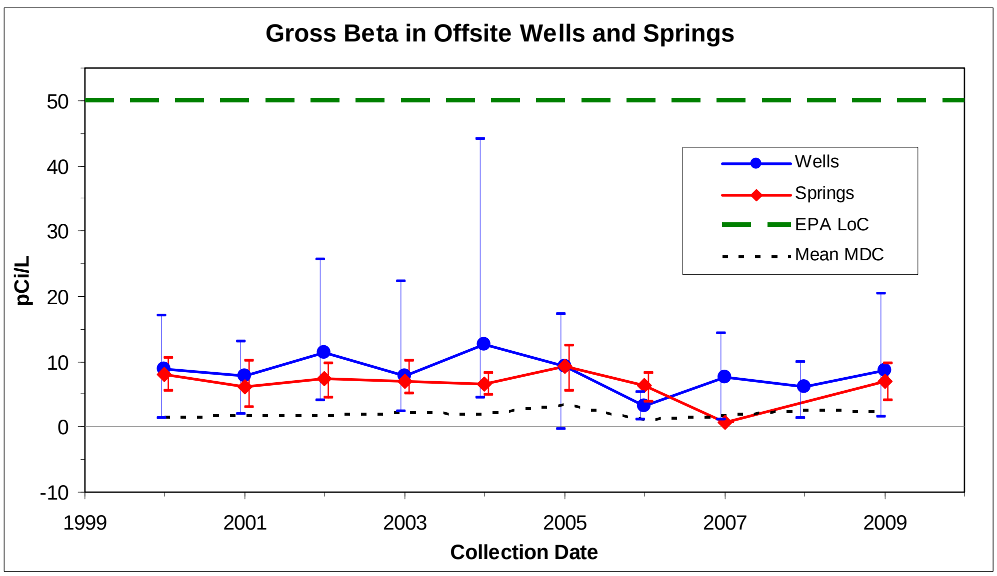

Figure 5-5. Gross beta annual means for offsite wells and springs from 2000 through 2009

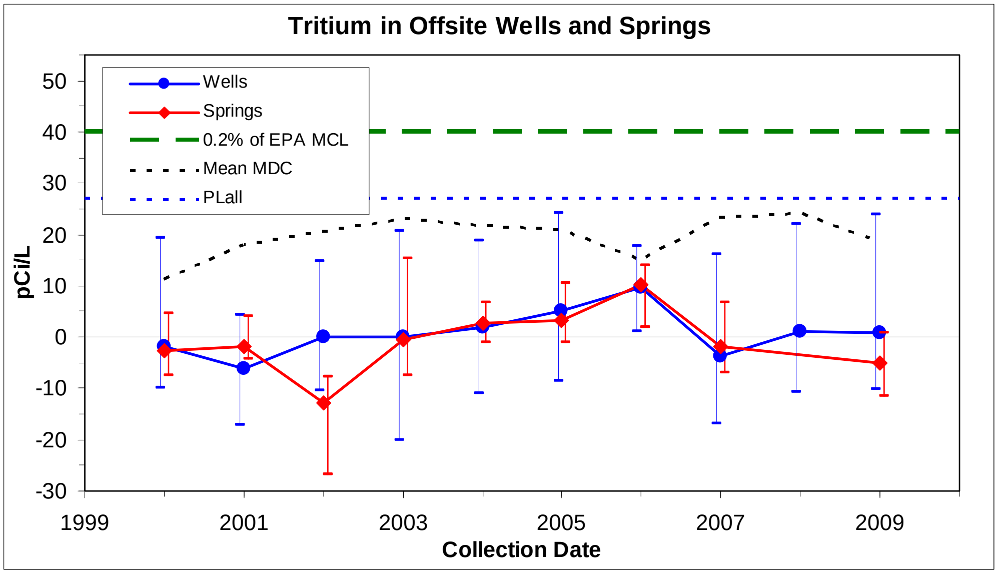

Figure 5-6. Tritium annual means for offsite wells and springs from 2000 through 2009

5.1.7 Results from NTS Water Supply Wells

Results from the nine NTS water wells sampled quarterly in 2009 (see Figure 5-2) continue to indicate that nuclear testing has not impacted the NTS water supply network. Only gross alpha and gross beta radioactivity were found at concentrations greater than their MDCs in the 2009 samples (Table 5-3). The wells were also analyzed for gamma radionuclides and ^{238}Pu and $^{239+240}$Pu, and Army #1 Water Well was also analyzed for ^{14}C, ^{90}Sr, and ^{99}Tc. No man-made radionuclides were detected; therefore, the gross alpha and gross beta values greater than the MDC likely represent the presence of naturally occurring radionuclides. None of the gross alpha or gross beta activity concentrations exceeded the EPA MCL for gross alpha or the EPA LoC for gross beta for drinking water.

No tritium measurements presented in Table 5-3 were above their MDCs. Tritium analyses of the third quarter samples (collected July 14) were considered to be of unacceptable quality and are therefore not reported in Table 5-3. Five of the eleven samples collected on July 14 had values above their MDCs, including the enrichment method blank. Also, of the ten field sample values, six exceeded L_C (see Section 5.1.5), which should occur in only around one value in a hundred. Moreover, prior and subsequent quarterly samples in 2009 were all less than their MDCs; this information establishes the basis for determining that these values were not of sufficient quality for reporting.

These nine water supply wells have been sampled routinely since 1999. None of the annual mean values shown in Figures 5-7 through 5-9 exceed the EPA MCLs (gross alpha, tritium) or EPA LoC (gross beta). A few early gross alpha quarterly values did exceed the MCL slightly (Figure 5-7). Figure 5-9 shows the trend in tritium concentrations for NTS supply wells compared to those of other onsite wells that have no history of elevated concentrations.

The Nevada State Health Division's Bureau of Health Care Quality and Compliance (HCQC) is allowed access to the NTS to independently sample the NTS water supply wells. In 2009, however, HCQC did not perform any sampling or analysis. HCQC personnel last accompanied EPTS personnel in January 2007 to sample water wells (NSTec, 2008a).

Table 5-3. Gross alpha, gross beta, and tritium in NTS water supply wells in 2009

Monitoring Location	Date Sampled	Concentration (pCi/L)								
		Gross Alpha	±[(a)]	MDC	Gross Beta	±	MDC	Tritium	±	MDC
Permitted Potable Wells										
J-12 WW (Area 25)	1/27	1.3	0.6	0.5	4.6	1.2	0.8	-2.7	14.1	23.6
	1/27 FD[(b)]	1.2	0.7	1.0	4.0	1.1	0.9	4.6	14.0	23.2
	6/9	1.1	0.6	0.8	3.9	1.3	1.4	-11.7	15.8	26.5
	7/14	1.6	0.8	0.9	4.8	1.5	1.3	--- [(C)]	---	---
	10/27	0.8	0.5	0.9	4.4	1.3	2.0	-1.3	10.4	19.5
WW #4 (Area 6)	1/27	6.3	1.7	0.7	4.8	1.3	0.8	-13.0	16.1	27.1
	6/9	6.6	1.9	1.2	4.4	1.4	1.5	-1.2	16.1	26.8
	7/14	7.1	2.0	1.0	6.7	1.9	1.4	---	---	---
	7/14 FD	6.7	2.0	1.5	5.4	1.6	1.5	---	---	---
	10/27	5.5	1.5	1.4	6.4	1.9	2.8	1.3	10.8	19.8
WW #4A (Area 6)	1/27	5.0	1.4	0.8	5.1	1.3	0.8	-9.2	14.1	23.7
	6/9	7.6	2.1	0.8	5.5	1.6	1.5	-14.4	16.8	28.2
	7/14	6.8	2.1	1.7	8.4	2.3	1.5	---	---	---
	10/27	5.9	1.6	1.4	2.9	1.7	3.1	-6.1	9.6	19.0
	10/27/27 FD	7.7	1.9	1.5	4.7	1.7	2.8	-3.7	10.3	19.9
WW 5B (Area 5)	1/27	3.7	1.2	0.8	9.5	2.3	0.8	1.1	14.1	23.4
	6/9	3.6	1.2	1.0	7.2	2.0	1.5	-26.3	16.5	27.5
	7/14	4.5	1.5	1.1	9.6	2.5	1.4	---	---	---
	10/27	2.6	1.1	1.4	9.2	2.2	2.6	-5.1	10.3	20.1
WW 8 (Area 18)	1/27	0.5	0.4	0.5	2.8	0.8	0.7	-2.9	15.7	26.1
	6/9	2.0	0.9	1.0	4.0	1.5	1.9	-10.6	16.5	27.7
	6/9 FD	1.0	0.6	0.7	2.4	1.1	1.5	-10.9	16.2	27.2
	7/14	0.9	1.1	1.8	2.4	1.2	1.6	---	---	---
	10/27	1.4	1.1	1.9	3.7	1.9	3.6	-8.1	9.7	19.7
Non-potable Wells										
Army #1 WW	1/27	3.7	1.2	0.8	4.7	1.3	0.8	2.9	16.0	26.6
(Area 22)	6/9	3.1	1.2	1.3	4.2	1.4	1.5	-17.3	16.5	27.7
	7/14	5.5	1.8	1.2	4.4	1.5	1.6	---	---	---
	10/27	2.6	0.9	1.1	5.1	1.6	2.5	0.0	10.1	18.7
UE-16D WW	1/27	6.0	1.8	0.9	5.2	1.4	1.0	-4.3	15.6	26.0
(Area 16)	6/9	4.4	1.8	2.0	4.5	2.1	2.9	-13.4	16.4	27.5
	7/14	4.3	2.4	3.3	4.3	1.9	2.5	---	---	---
	10/27	6.8	1.7	1.3	7.3	1.9	2.6	0.6	10.6	19.5
WW 5C (Area 5)	1/27	7.3	2.0	0.8	4.6	1.2	0.8	-5.5	13.9	23.3
	6/9	5.5	1.7	1.2	4.6	1.6	1.7	-5.3	15.2	25.6
	7/14	7.3	2.3	1.9	6.8	1.9	1.5	---	---	---
	10/27	3.6	1.3	1.6	6.2	1.7	2.4	0.0	10.6	19.6
WW C-1 (Area 6)	1/27	13.2	3.7	1.9	12.5	3.2	1.7	-11.8	16.4	27.5
	6/9	9.9	3.1	2.2	10.8	3.3	3.2	-10.5	16.4	27.4
	7/14	11.9	3.8	3.0	12.0	3.6	3.2	---	---	---
	10/27	8.4	2.0	1.8	13.8	2.9	2.7	7.6	11.6	19.8

Gray shaded results are considered detected; the result is greater than the sample-specific MDC.
The EPA MCL for gross alpha is 15 pCi/L, the EPA LoC for gross beta is 50 pCi/L), and the EPA MCL for tritium is 20,000 pCi/L.
(a) ± 2 standard deviations.
(b) FD = field duplicate sample.
(c) The 3rd quarter data were considered to be of unacceptable quality for reporting.

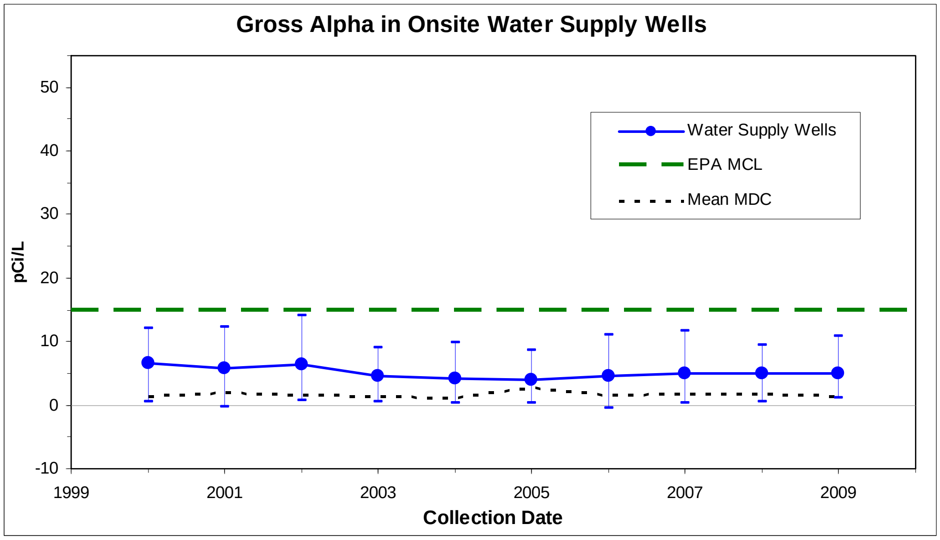

Figure 5-7. Gross alpha annual means for NTS water supply wells from 2000 through 2009

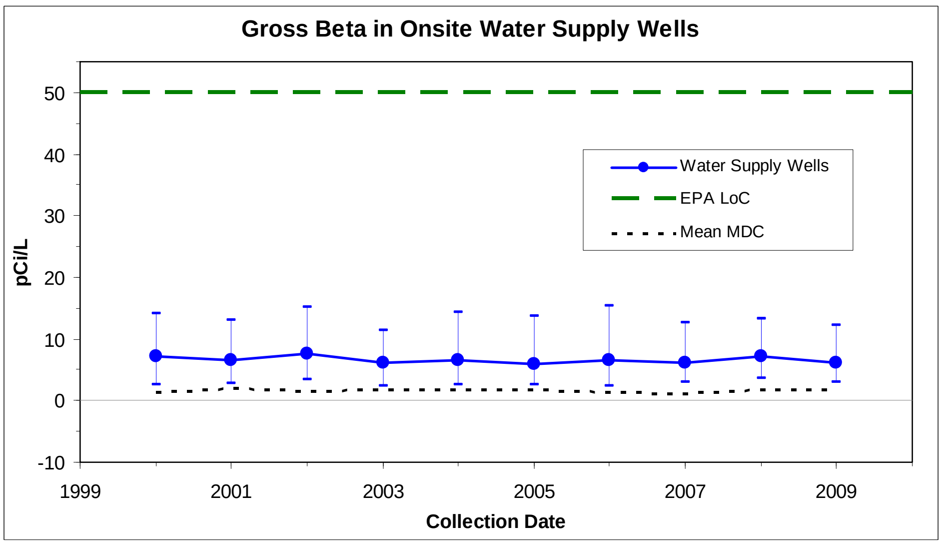

Figure 5-8. Gross beta annual means for NTS water supply wells from 2000 through 2009

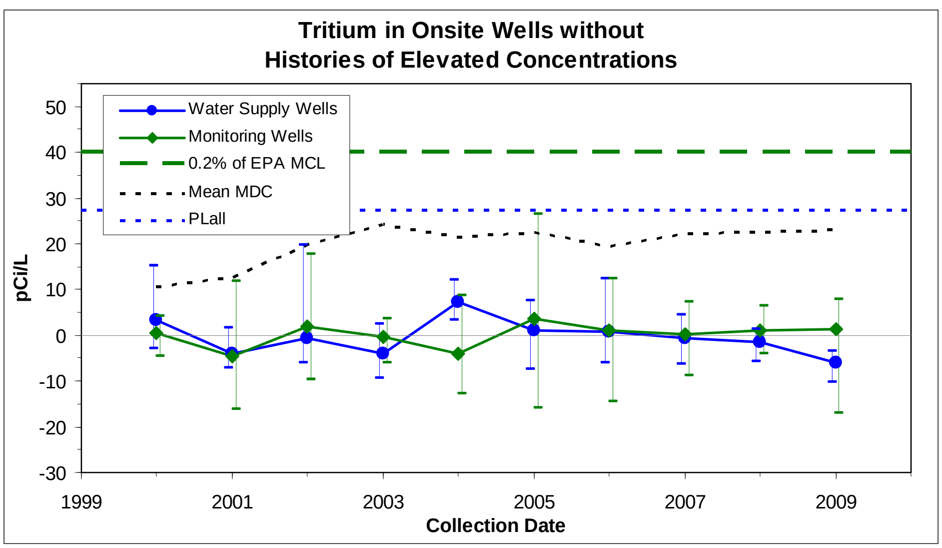

Figure 5-9. Tritium annual means for NTS wells without histories of elevated tritium concentrations

5.1.8 Results from NTS Monitoring Wells

Detectable concentrations of gross alpha and gross beta were present in water collected from NTS onsite monitoring wells in 2009 (Table 5-4). The gross alpha and gross beta radioactivity in most of these wells is likely from natural sources. The gross beta concentrations in ER-19-1 are not unexpected based on historical values, and are likely due to naturally occurring constituents (^{40}K concentrations are similar). No man-made gamma-emitting radionuclides were detected at concentrations above their respective MDCs in any of the NTS monitoring wells in 2009.

In 2009, tritium was detected in four RREMP monitoring wells (PM-1, U-19BH, UE-7NS, and WW A) (Table 5-4). They are known to have detectable concentrations of tritium, as reported in previous annual NTS environmental reports. Each of the four wells is located within 1 kilometer (km) (0.6 miles [mi]) of a historical underground nuclear test. They are discussed below.

Tritium concentrations in samples from these four wells have been decreasing in recent years (Figure 5-10). Since 1999, for example, estimated annual rates of decrease are 7.7 percent, 7.3 percent, 11.0 percent, and 6.6 percent for PM-1, U-19BH, UE-7NS, and WW A, respectively. These are all statistically significant (p-values are 0.002, 0.026, 0.004, and 0.000, respectively).

PM-1 – This well is located in the Central Pahute Mesa CAU. It is constructed with unslotted casing from the surface to 2,300 m (7,546 ft) bgs and is an open hole from 2,300 to 2,356 m (7,546 to 7,730 ft) bgs. Results from depth profile sampling below the static water level in 2001 show a decreasing tritium concentration with depth, indicating that tritium is entering the borehole near the static water level at approximately 643 m (2,109 ft) bgs. Potential sources include the underground nuclear tests FARM (U-20ab), GREELEY (U-20g), and KASSERI (U-20z). The FARM test is closest to PM-1 but is believed to be downgradient. GREELY and KASSERI tests are both upgradient from PM-1 at distances of 2,429 m (7,969 ft) and 1,196 m (3,924 ft), respectively.

U-19BH – This well is located in the Central Pahute Mesa CAU. It is an unexpended emplacement borehole. There were several nuclear detonations conducted near U-19BH, but the source of the tritium in the borehole is unclear. Previous investigations suggest that the water in the well originates from a perched aquifer, but identifying the likely source of tritium is difficult due to a lack of data regarding the perched system (Brikowski et al., 1993). The results from a tracer test conducted in the well indicate that there is minimal flow across the borehole (Brikowski et al., 1993). The lack of measurable flow in the well suggests that the chemistry of the water sampled from the borehole may not be representative of the aquifer.

UE-7NS – This well is located in the Yucca Flat CAU and was drilled 137 m (449 ft) from the BOURBON underground nuclear test (U-7n), which was conducted in 1967. This well was routinely sampled between 1978 and 1987, with the resumption of sampling in 1991. Tritium levels in this well have been decreasing in recent years (Figure 4-16). UE-7NS is the second known location on the NTS where the regionally important lower carbonate aquifer (LCA) has been impacted by radionuclides from nuclear testing (Smith et al., 1999). The first location where the LCA has been impacted by radionuclides from nuclear testing is Well UE-2CE located less the 200 m (656 ft) from the NASH test conducted in Yucca Flat in 1967. Well UE-2CE is not configured for routine sampling, however.

WW A – This well is completed in alluvium in the Yucca Flat CAU. It is located within 1 km (0.6 mi) of 14 underground nuclear tests, most of which appear to be up-gradient of the well. The well has had measurable tritium since the late 1980s. The marked increase between 1985 and 1999 suggests inflow of tritium to this well from the HAYMAKER underground nuclear test (U-3aus) conducted in 1962, 524 m (1,720 ft) north of WW A. This well, which supplied non-potable water for construction, was shut down in the early 1990s.

Tritium was not detected in samples from the other RREMP onsite monitoring wells during 2009 (Table 5-4). Tritium histories for these other wells are shown in Figure 5-9.

Table 5-4. Gross alpha, gross beta, and tritium in NTS monitoring wells in 2009

		Concentration (pCi/L)								
Monitoring Location	**Date Sampled**	**Gross Alpha**	**±[(a)]**	**MDC**	**Gross Beta**	**±**	**MDC**	**Tritium**	**±**	**MDC**
ER-12-1 [(b)]	4/15	11.2	2.2	1.2	6.9	1.8	2.2	-94.0	230	390
ER-19-1 (2,710 ft bgs)	3/18	3.6	3.4	5.4	130.0	22.3	10.2	4.1	9.8	16.7
(3,280 ft bgs)	3/18	2.4	1.0	1.5	19.2	3.4	1.8	6.4	9.5	16.1
ER-20-1	5/19	3.6	1.7	1.7	3.2	1.3	1.8	-8.2	16.6	27.8
ER-20-2 #1	5/20	1.1	1.0	1.6	1.5	0.9	1.3	-17.0	16.4	27.5
HTH #1 (1,935 ft bgs)	2/25	NS			NS			6.8	9.1	15.2
(2,040 ft bgs)	2/25	NS			NS			2.6	8.6	14.8
(2,130 ft bgs)	2/25	NS			NS			7.8	11.4	19.4
(2,300 ft bgs)	2/25	NS			NS			3.7	11.0	18.8
PM-1	4/28	-0.2	0.8	1.5	6.7	1.6	1.8	85.3	22.1	27.6
SM-23-1	10/27	NS[(c)]			NS			-0.6	6.4	11.8
U-19BH	3/17	NS			NS			15.8	10.0	16.2
	3/17 FD[(d)]	NA[(e)]			NA			33.2	12.7	18.5
UE-1Q	2/10	NS			NS			2.0	15.8	26.3
UE5 PW-1[(f)]	3/10	4.2	1.5	1.6	5.5	1.7	2.6	-2.7	14.2	25.0
	3/10 FD	NA			NA			13.4	9.9	16.2
	8/18	NA			NA			-5.2	16.2	27.3
	8/18 (FD)	NA			NA			11.9	15.7	25.7
UE5 PW-2[(f)]	3/10	3.5	1.3	1.4	6.8	1.8	2.5	10.0	9.7	16.2
	3/10 (FD)	NA			NA			13.6	14.7	24.4
	8/18	NA			NA			-6.2	16.3	27.4
	8/18 (FD)	NA			NA			9.5	16.4	26.9
UE5 PW-3[(f)]	3/10	2.7	1.2	1.6	4.4	1.5	2.4	-4.4	14.0	24.6
	3/10 (FD)	NA			NA			-3.2	13.9	24.3
	8/18	NA			NA			13.3	16.9	27.6
	8/18 (FD)	NA			NA			10.5	16.4	26.8
UE-7NS	2/24	NA			NA			75.5	13.3	14.9
TW D	2/11	NS			NS			-2.1	14.2	23.8
WW A	2/10	NS			NS			339.0	54.7	22.9
	2/10 (FD)	NS			NS			331.0	54.3	26.1

Gray shaded results are considered detected; the result is greater than the sample-specific MDC.

Yellow shaded results are greater than the EPA LoC for gross beta (50 pCi/L).

(a) ± 2 standard deviations.

(b) Compliance well for the E-Tunnel Waste Water Disposal System (see Section 5.1.9). Standard (non-enriched) tritium analysis was performed.

(c) Not scheduled for analysis in 2009; schedule for analysis of this analyte is once every two years; last analyzed in 2008.

(d) FD = field duplicate sample.

(e) NA = Analysis not performed on this sample.

(f) Compliance well for validation of waste pit P03 at Area 5 RWMS (see Section 10.1.6).

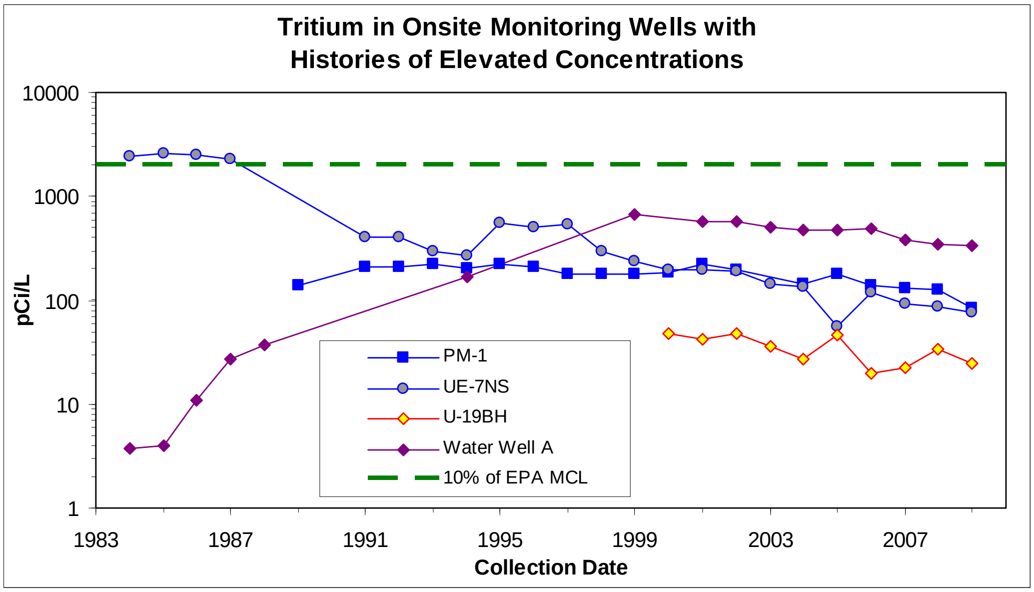

Figure 5-10. Tritium annual means for NTS monitoring wells with histories of elevated concentrations

5.1.9 Results from E Tunnel Ponds and Well ER-12-1

The NNSA/NSO manages and operates the E-Tunnel Waste Water Disposal System (ETDS) in Area 12 under a water pollution control permit (NEV 96021) issued by the Nevada Division of Environmental Protection (NDEP) Bureau of Federal Facilities (BFF). The permit governs the management of radionuclide-contaminated wastewater that drains from the E Tunnel portal into a series of holding ponds (called E Tunnel Ponds, see Figure 5-3). The permit requires Well ER-12-1 groundwater to be monitored once every 24 months and ETDS discharge waters to be monitored once every 12 months for tritium, gross alpha, and gross beta (Table 5-5) as well as for numerous nonradiological parameters (see Section 5.2.4, Table 5-10).

On April 15, 2009, EPTS personnel performed the biennial sampling of Well ER-12-1 for the permit-specified radiological and non-radiological parameters. The ETDS discharge water was sampled on October 8 and 14, 2009, for permit-specified radiological and non-radiological parameters. Tritium, gross alpha, and gross beta levels for all samples were all below the limits allowed under permit (Table 5-5).

Table 5-5. Radiological results for Well ER-12-1 groundwater and ETDS discharge samples

Radiological Parameter	Well ER-12-1 Groundwater (sampled every 24 months)(a)		ETDS Discharge Water (sampled every 12 months)(b)	
	Permissible Limit (pCi/L)	Measured Value (pCi/L)	Permissible Limit (pCi/L)	Measured Value (pCi/L)
Tritium	20,000	-94 ± 230	1,000,000	477,000 ± 72,800
Gross Alpha	15	11.2 ± 2.2	35.1	13.6 ± 2.81
Gross Beta	50	6.9 ± 1.8	101	38.9 ± 6.51

(a) sampled April 2009
(b) sampled October 2009

Sources: (NSTec, 2010c; 2010d)

5.1.10 UGTA Wells

In 2009, the UGTA Sub-Project (see Chapter 14) pumped and collected groundwater samples from six characterization wells on Pahute Mesa or immediately south of Pahute Mesa. Three of the wells are located on the Nevada Test and Training Range (NTTR) within 3.2 km (2 mi) of the NTS boundary (see Chapter 14, Figure 14-2). The two Phase I characterization wells (ER-EC-1 and ER-EC-6) were purged using downhole electric submersible pumps prior to the collection of samples. The four new Phase II wells were sampled during drilling and immediately after drilling. These wells will be sampled again in 2010 after well development and testing activities. A multi-agency team consisting of personnel from LANL and Lawrence Livermore National Laboratory (LLNL) collected the groundwater samples and analyzed them for tritium and other radionuclides. The resultant tritium concentrations are shown in Table 5-6. Well ER-EC-11 is the first well off of the NTS in which elevated tritium levels have been found.

Table 5-6. Radiochemistry results from UGTA well samples in 2009

UGTA Well	Date Sampled	^{3}H ± Uncertainty[a] (MDC) pCi/L	Laboratory
ER-20-7, Area 20	6/09	18,300,000 ± 90,000 (580)	LLNL
ER-20-8, Area 20	8/09	1,200 ± 70 (36)	LLNL
ER-20-8#2, Area 20	8/09	1,500 ± 74 (56)	LLNL
ER-EC-1, NTTR	4/09	170 ±190 (300)	NNES[b]
	4/09 FD[c]	40 ±180 (300)	NNES
ER-EC-6, NTTR	4/09	-40 ±170 (280)	NNES
	4/09 FD	-90±160 (280)	NNES
ER-EC-11, NTTR	10/09	13,180 ± 300 (97)	LLNL

Gray shaded results are considered detected; the result is greater than the sample-specific MDC.

(a) ±2 standard deviations.

(b) NNES = Navarro Nevada Environmental Services, LLC.

(c) FD = field duplicate sample.

5.1.11 Environmental Impact

The radiological impact to water resources from current and past activities on the NTS is groundwater contamination from man-made radionuclides within the UGTA Sub-Project CAUs (Figure 5-1). Sampling of the new UGTA Sub-Project well ER-EC-11, 716.3 m (2,350 ft) west of the NTS boundary (Chapter 14, Figure 14-2), has confirmed the presence of tritium at approximately 12,500 pCi/L. This is the first time that radionuclides from NTS underground tests (UGTs) have been detected in groundwater beyond NTS boundaries. The sampling results are consistent with UGTA's Pahute Mesa transport model, which predicted migration of tritium off the NTS within 50 years of the first nuclear detonation (1965) from the Central and Western Pahute Mesa CAUs (Chapter 14; Figure 14-3). Well sampling results to date have not detected the presence of man-made radionuclides farther downgradient of Pahute Mesa in any of the other nearby UGTA wells on the NTTR (ER-EC-1, -2A, -4, -5, -6, -7, and -8; Chapter 14, Figure 14-3). Offsite RREMP monitoring wells in Oasis Valley, even further downgradient of Pahute Mesa, also contain no detectable man-made radionuclides.

On the NTS, groundwater monitoring results indicate that the migration of radionuclides from UGTs is not significant in distance. UGTA Well ER-20-7, completed in 2009, intercepted a contaminant plume of tritium believed to originate from two UGTs, TYBO and BENHAM, which are about 945 m (3,100 ft) and 1,310 m (4,300 ft) from ER-20-7, respectively. Similarly, groundwater from the four RREMP monitoring wells on the NTS with detectable tritium levels (PM-1, U-19BH, UE-7NS, and WW A) are each within about 1,000 m (3,300 ft) of a UGT. Since 2000, their tritium concentrations have all been less than 3 percent of the EPA MCL of 20,000 pCi/L and are statistically significantly decreasing, as discussed in Section 5.1.8.

The NDEP-approved method of containing tritium-contaminated waters in lined sumps and in the E Tunnel ponds exposes NTS wildlife to tritium in their drinking water or aquatic habitat. The potential dose to NTS biota from the E Tunnel ponds has been assessed, and the results demonstrated that the doses to biota were much less than the limits set to protect plant and animal populations (BN, 2004a; NSTec, 2008a).

5.2 Nonradiological Drinking Water and Wastewater Monitoring

The quality of drinking water and wastewater on the NTS is regulated by federal and state laws. The design, construction, operation, and maintenance of many of the drinking water and wastewater systems are regulated under state permits. NSTec is tasked with ensuring that such systems meet the applicable water quality standards and permit requirements (see Section 2.2). The NTS nonradiological water monitoring goals are shown below. NSTec EPTS personnel meet these goals by conducting field water sampling and analyses, performing assessments, and maintaining documentation. This section describes the results of 2009 activities. Information about radiological monitoring of drinking water on and off the NTS is presented in Sections 5.1.6 and 5.1.7.

Nonradiological Water Monitoring Goals	*Compliance Measures/Actions*
Ensure that the operation of NTS public water systems (PWSs) and private water systems provide high-quality drinking water to workers and visitors of the NTS. Determine if NTS PWS are operated in accordance with the requirements in Nevada Administrative Code NAC 445A, "Water Controls," under permits issued by the State. Determine if the operation of commercial septic systems to process domestic wastewater on the NTS meets operational standards in accordance with the requirements NAC 445A under permits issued by the State. Determine if the operation of industrial wastewater systems on the NTS meets operational standards of federal and state regulations as prescribed under the GNEV93001 state permit.	Number of PWS samples containing coliform bacteria Inorganic Phase II and V chemicals; volatile organic Phase I, II, and V chemicals; disinfection by-products; and Secondary Standards contaminants in PWS samples 5-day biological oxygen demand (BOD_5), total suspended solids (TSS), pH, and 29 organic and inorganic contaminants in sewage lagoon water Inspection of sewage lagoon systems Flow rate, pH, temperature, specific conductance, and 14 contaminants (mostly metals) in E Tunnel effluent water

5.2.1 Drinking Water Monitoring

Six permitted wells supply the potable water needs of NTS operations. These are grouped into three PWSs that were operated by NSTec in 2009 (Figure 5-11). The largest PWS (Areas 23 and 6) serves the main work areas of the NTS. The PWSs are designed, operated, and maintained in accordance with the requirements in NAC 445A under permits issued by the NDEP Bureau of Safe Drinking Water (BSDW). PWS permits are renewed annually. The three PWSs must meet water quality standards for National Primary and Secondary Drinking Water Standards. They are sampled according to a nine-year monitoring cycle, which identifies the specific classes of contaminants to monitor for each drinking water source and the frequency of their monitoring.

For work locations at the NTS that are not part of a PWS, NNSA/NSO hauls potable water in two water tanker trucks. The trucks are permitted by the BSDW to haul water to a PWS, and the water they carry is subject to water quality standards for coliform bacteria. Normal use of these trucks, however, involves hauling to private water systems and to hand-washing stations at construction sites, activities not subject to permitting. NNSA/NSO renews the permits for these trucks annually, however, in case of emergency.

5.2.1.1 PWS and Water-Hauling Truck Monitoring

Table 5-7 lists the water quality parameters monitored in 2009, sample frequencies, and sample locations. At all building locations, the sampling point for coliform bacteria is one of the sinks within one of the building's bathrooms. Samples for the chemical contaminants were collected at the four points of entry to the PWSs. Although not required by regulation or permit, the private water systems were monitored quarterly for coliform bacteria to ensure safe drinking water.

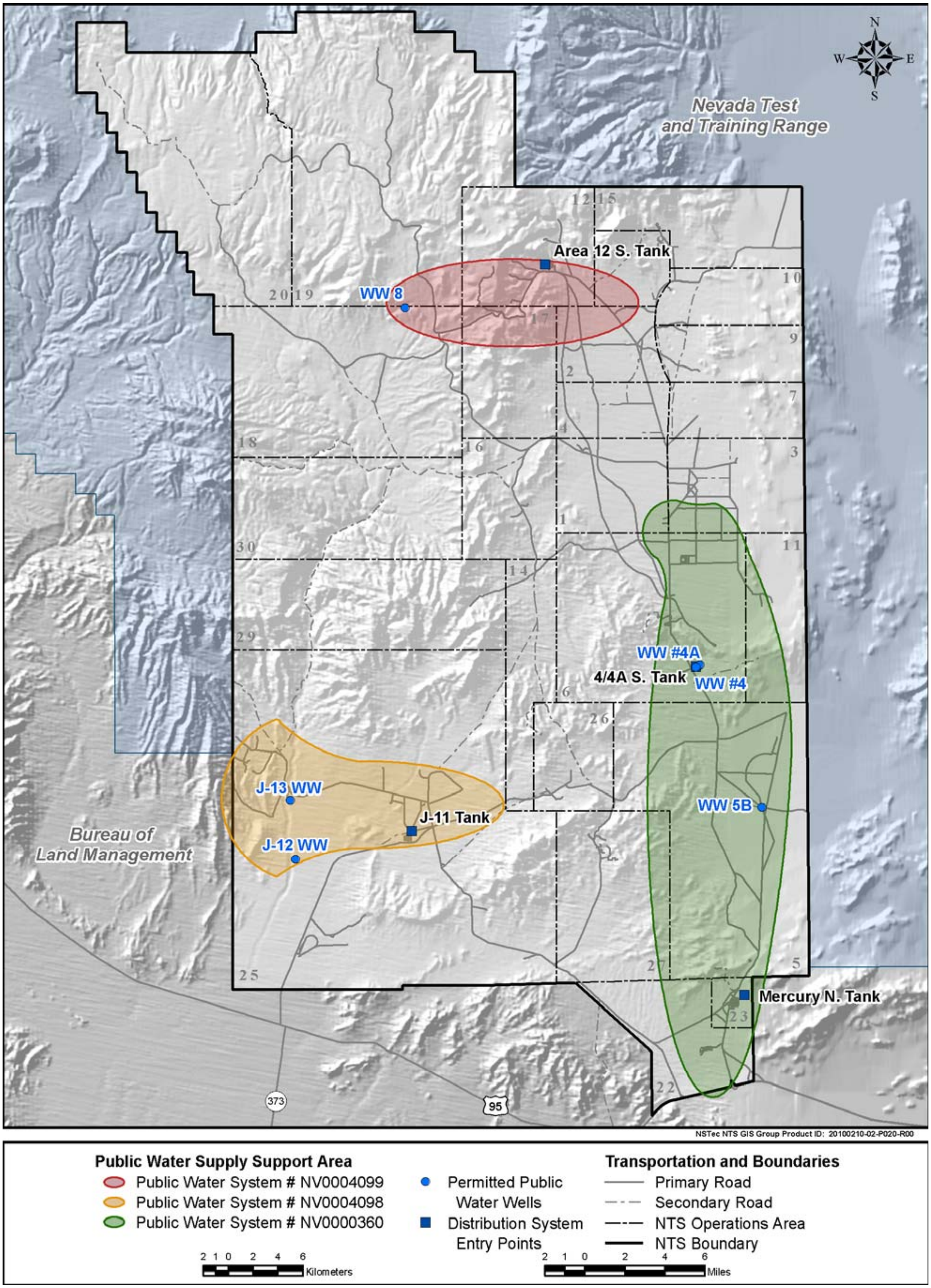

Figure 5-11. Water supply wells and drinking water systems on the NTS

Table 5-7. Monitoring parameters and sampling design for NTS PWSs and permitted water-hauling trucks

PWS	Contaminant	Samples/Frequency (2009 Monitoring Requirement)	Monitoring Locations
Area 23 and 6	Coliform Bacteria	36 samples (3 buildings per month, 4 samples per building)	Buildings 5-7, U1H restroom, 6-609, 6-900, 22-1, 23-180, 23-701, 23-777, and 23-1103
	Inorganic Phase II Chemicals: asbestos, nitrate, nitrite	1 sample (1 per entry point per year)	Entry points 4/4A S. Tank and Mercury N. Tank
	Volatile Organic Phase I and II Chemicals: xylenes	1 sample per year[(a)]	Entry point Mercury N. Tank
Area 12	Coliform Bacteria	4 samples (1 per quarter)	Building 12-30
	Disinfection By-products: trihalomethanes, haloacetic acids	1 sample every 3 years	
	Inorganic Phase II and V Chemicals: Nitrate, nitrite, arsenic	1 sample every 3 years	Entry point Area 12 S. Tank
	21 Volatile Organic Phase I, II, and V Chemicals		
	18 Synthetic Organic Phase II Chemicals		
	Secondary Standards contaminants: copper, lead, chloride	1 sample (1 per building every 3 years)	Buildings 12-30, 12-31, 12-32, 12-34, and 12-37
Area 25	Coliform Bacteria	4 samples (1 per quarter)	Building 25-4320 or 25-4221
	Inorganic Phase II Chemicals: nitrate, nitrate	1 sample every 3 years	Entry point J-11 Tank
Water-Hauling Truck			
Truck 84846 and Truck 84847	Coliform Bacteria	12 samples (1 per month for each truck)	From water tank on each truck after filling at Area 6 potable water fill stand

(a) In March 2009, NDEP notified NNSA/NSO that quarterly monitoring for xylenes, conducted from June 2008 through January 2009 (see NSTec [2009a]), could be discontinued and routine annual sampling for xylenes could be resumed (NDEP, 2009).

All water samples were collected in accordance with accepted practices and the analyses were performed by state-approved laboratories. Approved analytical methods listed in NAC 445A and Title 40 Code of Federal Regulations (CFR) Part 141, "National Primary Drinking Water Standards," were used by the laboratories.

In 2009, monitoring results indicated that the PWSs complied with National Primary Drinking Water Quality Standards and Secondary Standards (Table 5-8). Also, all water samples from the water-hauling trucks were negative for coliform bacteria in 2009.

Table 5-8. Water quality analysis results for NTS PWSs

Contaminant	Maximum Contaminant Level (mg/L)	2009 Results (mg/L)		
		Area 23 and 6 PWS	Area 12 PWS	Area 25 PWS
Coliform Bacteria	Coliforms present in 1 sample/month	Absent in all samples	Present in 1 sample from Bldg 12-30 in March	Absent in all samples
Inorganic Chemicals – Phase II				
Asbestos	7	< 0.2[(a)]	NA[(b)]	NA
Nitrate	10 (as nitrogen)	3.82 and 2.79	1.14	1.81
Nitrite	1 (as nitrogen)	ND and ND[(c)]	ND	ND
Inorganic Chemicals – Phase V				
Arsenic	0.01	NA	0.00166	NA

Table 5-8. Water quality analysis results for NTS PWSs (continued)

Contaminant	Maximum Contaminant Level (mg/L)	2009 Results (mg/L)		
		Area 23 and 6 PWS	Area 12 PWS	Area 25 PWS
Secondary Standards				
Chloride	250	NA	9.61	NA
Volatile Organic Chemicals – Phase I and II				
Vinyl chloride	0.002	NA	< 0.0002	NA
Benzene	0.005	NA	< 0.0001	NA
Carbon tetrachloride	0.005	NA	< 0.0001	NA
1, 2-Dichloroethane	0.005	NA	< 0.0002	NA
Trichloroethylene	0.005	NA	< 0.00011	NA
para-Dichlorobenzene	0.075	NA	< 0.0002	NA
1, 1-Dichloroethylene	0.007	NA	< 0.0001	NA
1, 1, 1-Trichloroethane	0.2	NA	< 0.0002	NA
cis-1, 2-Dichloroethylene	0.07	NA	< 0.00025	NA
1, 2-Dichloropropane	0.005	NA	< 0.0002	NA
Ethylbenzene	0.7	NA	0.00273	NA
Monochlorobenzene	0.1	NA	< 0.0001	NA
o-Dichlorobenzene	0.6	NA	< 0.0001	NA
Styrene	0.1	NA	< 0.0001	NA
Tetrachloroethylene	0.005	NA	< 0.0002	NA
Toluene	1	NA	< 0.0001	NA
trans-1, 2-Dichloroethylene	0.1	NA	< 0.00025	NA
Xylenes (total)	10	< 0.0005	0.0161	NA
Volatile Organic Chemicals – Phase V				
Dichloromethane	0.005	NA	< 0.00025	NA
1, 2, 4-Trichlorobenzene	0.07	NA	< 0.00025	NA
1, 1, 2-Trichloroethane	0.005	NA	< 0.00025	NA
Synthetic Organic Chemicals - Phase II				
Alachlor	0.002	NA	NA	NA
Aldicarb	0.003	NA	NA	NA
Aldicarb sulfoxide	0.004	NA	NA	NA
Aldicarb sulfone	0.002	NA	NA	NA
Atrazine	0.003	NA	NA	NA
Carbofuran	0.04	NA	NA	NA
Chlordane	0.002	NA	NA	NA
Dibromochloropropane	0.0002	NA	NA	NA
2, 4-D	0.07	NA	NA	NA
Ethylene dibromide	0.00005	NA	NA	NA
Heptachlor	0.0004	NA	NA	NA
Heptachlor epoxide	0.0002	NA	NA	NA
Lindane	0.0002	NA	NA	NA
Methoxychlor	0.04	NA	NA	NA
Polychlorinated biphenyls	0.0005	NA	NA	NA
Pentachlorophenol	0.001	NA	NA	NA
Toxaphene	0.003	NA	NA	NA
2, 4, 5-TP	0.05	NA	NA	NA
Synthetic Organic Chemicals - Phase V				
Benzo(a)pyrene	0.0002	NA	NA	NA
Dalapon	0.2	NA	NA	NA
Di (2-ethylhexyl) adipate	0.4	NA	NA	NA
Di (2-ethylhexyl) phthalate	0.006	NA	NA	NA
Dinoseb	0.007	NA	NA	NA
Diquat	0.02	NA	NA	NA
Endothall	0.1	NA	NA	NA
Endrin	0.002	NA	NA	NA

Table 5-8. Water quality analysis results for NTS PWSs (continued)

Contaminant	Maximum Contaminant Level (mg/L)	2009 Results (mg/L)		
		Area 23 and 6 PWS	Area 12 PWS	Area 25 PWS
Synthetic Organic Chemicals - Phase V (continued)				
Glyphosate	0.7	NA	NA	NA
Hexachlorobenzene	0.001	NA	NA	NA
Hexachlorocyclopentadiene	0.05	NA	NA	NA
Oxamyl (Vydate)	0.2	NA	NA	NA
Picloram	0.5	NA	NA	NA
Simazine	0.004	NA	NA	NA
Disinfection By-Products				
Total Trihalomethanes	0.08	NA	0.0078	NA
Haloacetic Acids	0.06	NA	0.0009	NA
Secondary Standards				
Copper	1.3	NA	0.0506	NA
Lead	0.015	NA	0.00785	NA

(a) Samples at both entry points were <0.02 mg/L
(b) NA = Not applicable
(c) ND = Not detected

5.2.1.2 State Inspections

Periodically, NDEP conducts a sanitary survey of the permitted NTS PWSs. It consists of an inspection of the wells, tanks, and other visible portions of each PWS to ensure that they are maintained in a sanitary configuration. As non-community water systems, the minimum survey frequency is once every five years. NDEP did not perform a sanitary survey of the PWSs in 2009. The last survey was conducted in November 2008, and there were no significant findings.

NDEP inspects the two water-hauling trucks annually at the time of permit renewal to make sure they still meet the requirements of NAC 445A. Inspections were performed in June 2009, and permits were renewed.

5.2.2 Domestic Wastewater Monitoring

A total of 23 permitted septic systems for domestic wastewater are being used on the NTS (Figure 5-12). These septic systems are permitted to handle 5,000 gallons of wastewater per day. Of the 23 permitted systems, 7 systems are under the direct control of the NSTec Solid Waste Department; the remaining 16 systems fall under the supervision and management of the building's Facility Manager. The permitted septic systems are inspected periodically for sediment loading and are pumped as required. A state-permitted septic pumping contractor is used. The State conducts onsite inspections of pumper trucks and pumping contractor operations. EPTS personnel perform management assessments of the permitted systems and services to determine and document adherence to permit conditions. The assessments are performed according to existing directives and procedures.

In 2009, the following compliance actions relating to domestic wastewater on the NTS occurred:

- On May 6, 2009, an accidental release of sewage from the Area 6 LANL septic system was reported to the State. The release was discovered during a routine monthly preventative maintenance visit to the system's lift station. The sewage spill was approximately 6 ft in diameter and 8 inches deep. Approximately 30 gallons were released. There appeared to have been several sewage overflows over a period of time. An investigation revealed that the pumps and alarm in the lift station were disabled, causing the lift station to fill with sewage and overflow. The affected areas were disinfected. NSTec Maintenance started the pumps, and the lift station operated normally.
- A septic tank pumping contractor permit (NY-17-03318), four septic tank pump truck permits (NY-17-03313, NY-17-03315, NY-17-03317, NY-17-06838), and a septic tanker permit (NY-17-06839) were approved by the State and renewed in July 2009.

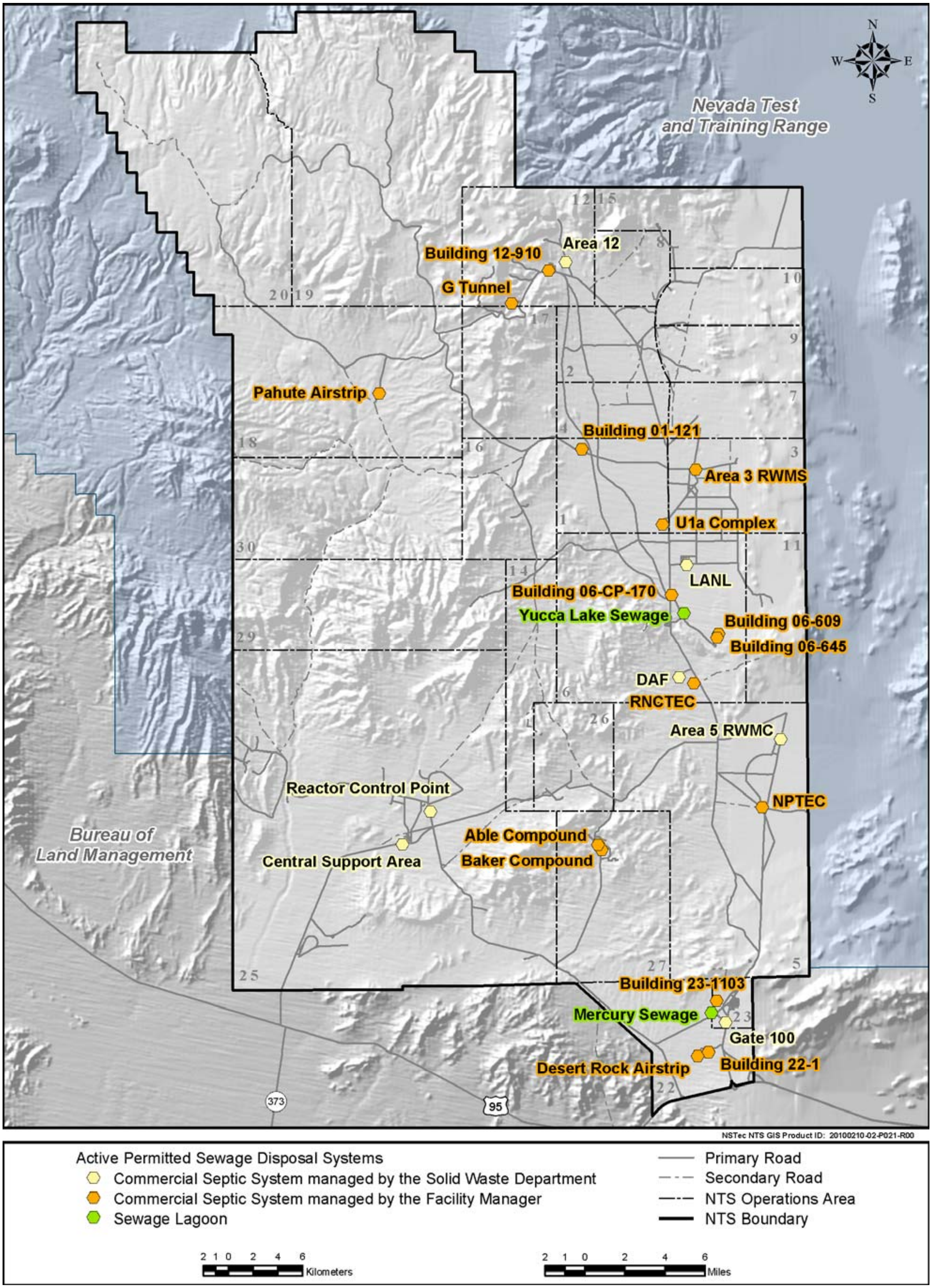

Figure 5-12. Active permitted sewage disposal systems on the NTS

5.2.3 Industrial Wastewater Monitoring

Industrial discharges on the NTS are limited to two operating sewage lagoon systems: Area 6 Yucca Lake and Area 23 Mercury (these lagoon systems also receive domestic wastewater) (Figure 5-12). The Area 6 Yucca Lake system consists of two primary lagoons and two secondary lagoons. All lagoons in this system are lined with compacted native soils that meet the State of Nevada requirements for transmissivity (10^{-7}centimeters per second). The Area 23 Mercury system consists of one primary lagoon, a secondary lagoon, and an infiltration basin. The primary and secondary lagoons have a geosynthetic clay liner and a high-density polyethylene liner. The lining of the ponds allows Area 23 lagoons to operate as a fully contained, evaporative, non-discharging system.

5.2.3.1 Quarterly and Annual Influent Monitoring

Both sewage systems are monitored quarterly for influent quality. Composite samples from each system are collected over a period of 8 hours and in accordance with accepted practices. The analyses are performed by State-approved laboratories. Approved analytical methods listed in NAC 445A and 40 CFR 141 were used by the laboratories. The composite samples are analyzed for three parameters: 5-day biological oxygen demand (BOD_5, see Glossary, Appendix B), total suspended solids (TSS), and pH. In 2009, all results for BOD_5, TSS, and pH for sewage system influent waters were within the limits established under Water Pollution Control General Permit GNEV93001 (Table 5-9). Quarterly monitoring reports of these results were submitted to NDEP in April, July, and October 2009 and in January 2010.

Table 5-9. Water quality analysis results for NTS sewage lagoon influent waters in 2009

Parameter	Units	Minimum and Maximum Values from Quarterly Samples: Area 6 Yucca Lake	Minimum and Maximum Values from Quarterly Samples: Area 23 Mercury
BOD_5	mg/L	78–280	177–282
Permit Limit	mg/L	No Limit	No Limit
BOD_5 Mean Daily Load[(a)]	kg/d	0.18–1.17	19.41–34.8
Permit Limit	kg/d	8.66	115.4
TSS	mg/L	114–326	91–332
Permit Limit	mg/L	No Limit	No Limit
pH	S.U.[(b)]	7.97–8.52	7.95–8.44
Permit Limit	S.U.[(b)]	6.0–9.0	6.0–9.0

(a) BOD_5 Mean Daily Load in kilograms per day (kg/d) = (mg/L BOD x liters per day (L/d) average flow x 3.785)/10^6
(b) Standard units of pH

Toxicity monitoring of influent waters of the lagoons, previously required annually, was not conducted in 2009. The permit's requirement for such monitoring changed in November 2008. The lagoons will be sampled for the 29 contaminants shown in Table 4-10 of the *Nevada Test Site Environmental Report 2008* (NSTec, 2009a) only in the event of specific or accidental discharges of potential contaminants. There were no such discharges that warranted sampling in 2009.

5.2.3.2 Sewage System Inspections

The sewage system operators inspect active systems weekly and inactive lagoon systems quarterly. NDEP inspects both active and inactive NTS lagoon systems annually. Onsite operators inspect for abnormal conditions, weeds, algae blooms, pond color, abnormal odors, dike erosion, burrowing animals, discharge from ponds or lagoons, depth of staff gauge, crest level, excess insect population, maintenance/repairs needed, and general conditions. Weekly and quarterly inspections were conducted by NSTec throughout the year, and NDEP conducted its annual inspection in June 2009. The inspection covered field maintenance programs, lagoons, sites, and access roads functional to operations. There were no notable findings from the onsite and NDEP inspections.

5.2.4 E-Tunnel Waste Water Disposal System (ETDS) Monitoring

NNSA/NSO manages and operates the ETDS in Area 12 under a separate water pollution control permit (NEV 96021) issued by the NDEP BFF. The permit governs the management of radionuclide-contaminated wastewater that drains from the E Tunnel portal into a series of holding ponds. The permit requires Well ER-12-1 groundwater and ETDS discharge waters to be monitored for radiological parameters (see Section 5.1.9, Table 5-5) and for the nonradiological parameters listed in Table 5-10. Monthly monitoring of the ETDS is also conducted during which personnel measure the flow rate, pH, temperature, and specific conductance (SC) of the discharge water and the total volume and structural integrity of the holding ponds. Well and ETDS monitoring data are reported to the NDEP BFF in annual and quarterly reports, respectively.

In 2009, all nonradiological parameters in the annual ETDS sample were within the threshold limits specified by the permit (Table 5-10). The annual Well ER-12-1 groundwater sample was within permit limits for all parameters except specific conductance, which was slightly higher than the permissible limit (Table 5-10). All 2009 monthly measurements and observations demonstrated compliance with permit limits and specifications, with the exception of SC measurements at the ETDS discharge point. SC measures were 395, 393, and 397 microsiemens per centimeter (µS/cm) in March, June, and July, respectively, all slightly below the lower permit limit of 400 µS/cm. NDEP determined, after evaluating NNSA/NSO and NSTec's study of this parameter, that these measurements should continue to be collected. NDEP suspended the permit requirement for follow-on monitoring, and will re-evaluate the permit limits for specific conductance when the permit is renewed in 2013.

Needed modifications to the E Tunnel containment pond system were approved by NDEP in 2008, and the construction of two earthen berms across Pond 6 were completed on January 15, 2009. The berms restore the pond's original holding capacity and reduce the risk of an uncontrolled release from the ETDS. The construction subdivided Pond 6 into three sections. The new numbering system for the impoundments is Ponds 4, 5, 6a, 6b, and 6c.

Table 5-10. Nonradiological results for Well ER-12-1 groundwater and ETDS discharge samples

	Well ER-12-1 Groundwater Sampled Every 24 Months (April 2009)		ETDS Discharge Water Sampled Every 12 Months (October 2009)	
Nonradiological Parameter	Threshold (mg/L)	Measured Value (mg/L)	Threshold (mg/L)	Measured Value (mg/L)
Cadmium	0.005	0.003	0.045	0.0010
Chloride	250	15.4	360	9.21
Chromium	0.09	0.003	0.09	0.0011[a]
Copper	1.2	0.003	1.2	0.003
Fluoride	3.6	0.25	3.6	0.25
Iron	5.0	4.56	5.0	3.34
Lead	0.014	0.003	0.014	0.0029[a]
Magnesium	135	61.4	135	1.41
Manganese	0.25	0.165	0.25	0.0348
Mercury	0.0018	0.0002	0.0018	0.0001
Nitrate nitrogen	9	0.25	9	0.29
Selenium	0.045	0.010	0.045	0.005
Sulfate	450	314	450	17.5
Zinc	4.5	0.013	4.5	0.031
pH (S.U.)[b]	6.5–8.5	7.68	6.0–9.0	7.29
Specific conductance (µS/cm)[c]	400–1,000	1,023	400–500	401.5

(a) Estimated quantity based on the minimum detection limit

(b) S.U. = standard unit(s) (for measuring pH)

(c) µS/cm = microsiemens per centimeter

Sources: (NSTec, 2010c; 2010d)

5.2.5 Environmental Impact

The results of all drinking water and wastewater monitoring in 2009 were within permit limits. In the past, some drinking water standards in NTS water supply wells or PWSs have been exceeded (e.g., arsenic in Army #1 WW and WW 5C, lead in the Area 12 PWS, elevated total dissolved solids and hardness in WW C-1). However, all were determined to have been due to natural causes or the condition of the water distribution systems themselves; they have not been the result of the release of contaminants into the groundwater from site operations. Nonradiological contamination of groundwater from NTS operations is expected to be co-located with the radiological contamination that has occurred from historical underground nuclear testing within the UGTA Sub-Project CAUs. It is expected to be minor, however, in comparison to the radiological contamination. For nuclear tests above the water table, potential nonradiological contaminants are not likely to reach groundwater because of their negligible advective and dispersive transport rates through the thick vadose zone. Water samples from UGTA Sub-Project wells, which include highly contaminated wells, have not had elevated levels of nonradiological man-made contaminants.

Well drilling, waste burial, chemical storage, and wastewater management are the only current NTS activities that have the potential to contaminate groundwater with nonradiological contaminants. This potential is very low, however, due to engineered and operational deterrents and natural environmental factors. Current drilling operations include the containment of drilling muds and well effluents in sumps (see Chapter 14). Well effluents are monitored for nonradiological contaminants (predominantly lead) to ensure that lined sumps are used when necessary. The Area 3 and Area 5 Radioactive Waste Management Sites and the solid waste landfills are designed and monitored to ensure that contaminants do not reach groundwater (see Chapter 10). In addition, the potential for mobilization of contaminants from all these sources to groundwater is negligible due to the arid climate, the extensive depth to groundwater (thickness of the vadose zone), and the proven behavior of liquid and vapor fluxes in the vadose zone (primarily upward liquid movement towards the ground surface).

The Environmental Restoration program, through the Soils Project and Industrial Sites Project, conducts cleanup and closures of historical surface and shallow subsurface contamination sites, some of which have nonradiological contaminants like metals, petroleum hydrocarbons, hazardous organic and inorganic chemicals, and unexploded ordnance (see Chapter 10). The potential for mobilization of these contaminants to groundwater is negligible due to the same regional climatic, soil, and hydrogeologic factors mentioned above.

No past or present NNSA/NSO operations are known to have contaminated natural springs or ephemeral surface waters on the NTS.

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6.0 Direct Radiation Monitoring

U.S. Department of Energy (DOE) Orders DOE O 5400.5, "Radiation Protection of the Public and the Environment," and DOE O 435.1, "Radioactive Waste Management," have requirements to protect the public and environment from exposure to radiation (see Section 2.3). Radionuclides present in the Nevada Test Site (NTS) environment could potentially be deposited in humans and animals through inhalation and ingestion. Section 4.1 and Section 5.1 present the results of monitoring radionuclides in air and water on the NTS; those results are used to estimate potential internal radiation dose to the public via inhalation and ingestion. Energy absorbed from radioactive materials outside of the body results in an external dose. During 2009, external dose was measured under the Direct Radiation Monitoring Program of National Security Technologies, LLC (NSTec), Environmental Protection and Technical Services. External dose comes from direct ionizing radiation on the NTS from all sources, including natural radioactivity from cosmic and terrestrial sources as well as man-made radioactive sources. This chapter presents the data obtained through this program.

Direct radiation monitoring is conducted to assess the external radiation environment, detect changes in that environment, and measure gamma radiation levels near potential exposure sites. DOE O 450.1A, "Environmental Protection Program," states that environmental monitoring should be conducted to detect, characterize, and respond to releases from DOE activities, assess impacts, and estimate dispersal patterns in the environment. In addition, DOE O 5400.5 states that "it is also an objective that potential exposures to members of the public be as low as is reasonably achievable (ALARA)."

Direct Radiation Monitoring Program Goals
Assess the proportion of dose to the public that comes from background radiation versus NTS operations.
Measure the potential external dose to a member of the public in order to determine if the total dose (internal and external) from all U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) operations at the NTS exceeds 100 millirem per year (mrem/yr) (1 millisievert [mSv]/yr), the dose limit of DOE O 5400.5.
Measure the potential external dose to a member of the public in order to determine if the total dose from operations at the Area 3 and Area 5 Radioactive Waste Management Sites (RWMSs) exceeds the 25 mrem/yr (0.25 mSv/yr) dose limit to members of the public, specified in DOE Manual DOE M 435.1-1, "Radioactive Waste Management Manual."
Monitor operational activities involving radioactive material, radiation-generating devices, or accidental releases of radioactive material to ensure exposure to members of the public are kept ALARA as stated in DOE O 5400.5.
Determine if the absorbed radiation dose (in a unit of measure called a rad [see Glossary, Appendix B]) from external radiation exposure to NTS terrestrial plants and aquatic animals is less than 1 rad per day (1 rad/d) (0.01 gray [Gy]/d), and if the absorbed radiation dose to NTS terrestrial animals is less than 0.1 rad/d (1 milligray [mGy]/d) (limits prescribed by DOE O 5400.5 and DOE Standard DOE-STD-1153-2002, "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota").
Determine the patterns of exposure rates through time at various soil contamination areas to fulfill the requirements of DOE O 450.1A to characterize releases in the environment.

An offsite monitoring program has been established by NNSA/NSO to monitor direct radiation within communities adjacent to the NTS. The Desert Research Institute (DRI) conducts this monitoring as part of its Community Environmental Monitoring Program (CEMP). DRI's 2009 direct radiation monitoring results are presented in Sections 7.1.2 and 7.1.3; see also Figure 6-2 of this chapter.

6.1 Measurement of Direct Radiation

Direct radiation is exposure to electromagnetic (gamma and X-ray) radiation. Electromagnetic radiation can travel long distances through air and penetrate living tissue causing ionization within the body tissues. By contrast, alpha and beta particles do not travel far in air (a few centimeters for alpha and about 10 meters (m) (33 feet [ft]) for beta particles). Alpha particles deposit only negligible energy; they rarely penetrate the outer dead layer of skin. Beta particles are generally absorbed in the layers of skin immediately below the outer layer.

Direct radiation exposure is usually reported in the unit milliroentgen (mR), which is a measure of exposure in terms of numbers of ionizations in air. The dose in human tissue resulting from an exposure from the most common radionuclides can be approximated by equating a 1 mR exposure with a 1 mrem (0.01 mSv) dose.

6.2 Thermoluminescent Dosimetry Surveillance Network Design

Monitoring is performed on the NTS because some NTS areas have elevated radiation levels resulting from historical weapons testing, current and past radioactive waste management activities, and/or current operations involving radioactive material or radiation-generating devices. A surveillance network of thermoluminescent dosimeter (TLD) sampling locations has been established on the NTS. The objectives and design of the network are described in detail in the *Routine Radiological Environmental Monitoring Plan* (RREMP) (BN, 2003a).

TLDs measure ionizing radiation exposure from all sources. The TLD used is the Panasonic UD-814AS, which consists of four elements housed in an air-tight, water-tight, ultraviolet-light–protected case. A lightly shielded lithium borate element could be used to check low-energy radiation levels; this is not used in NTS monitoring. Measurements from the three calcium sulfate elements are averaged to assess penetrating gamma radiation.

A pair of TLDs is placed at 1.0 ± 0.3 m (28 to 51 inches [in.]) above the ground at each monitoring location; these are exchanged for analysis quarterly. Analysis of TLDs is performed using automated TLD readers calibrated and maintained by the NSTec Radiological Control Department. Reference TLDs are exposed to 100 mR from a cesium-137 radiation source under tightly controlled conditions. These are read along with TLDs collected from the network to calibrate their responses.

There were 109 active environmental TLD locations on the NTS (Figure 6-1) during 2009. They include the following numbers and types of locations:

- Background (B) – 10 locations where radiation effects from NTS operations are negligible.
- Environmental 1 (E1) – 41 locations where there is no measurable radioactivity from past operations but that are of interest due to the presence of the public in the area and/or the potential for increased radiation exposure from a current operation.
- Environmental 2 (E2) – 35 locations where there is measurable added radioactivity from past operations; these locations are of interest to monitor direct radiation trends in the area. Some locations fitting this description are grouped with the waste operations category below.
- Waste Operations (WO) – 17 locations in and around the Area 3 and Area 5 RWMSs.
- Control (C) – 5 locations in Building 652 and 1 location in Building 650 in Mercury. Control TLDs are kept in stable environments and are used as a quality check on the TLDs and the analysis process.

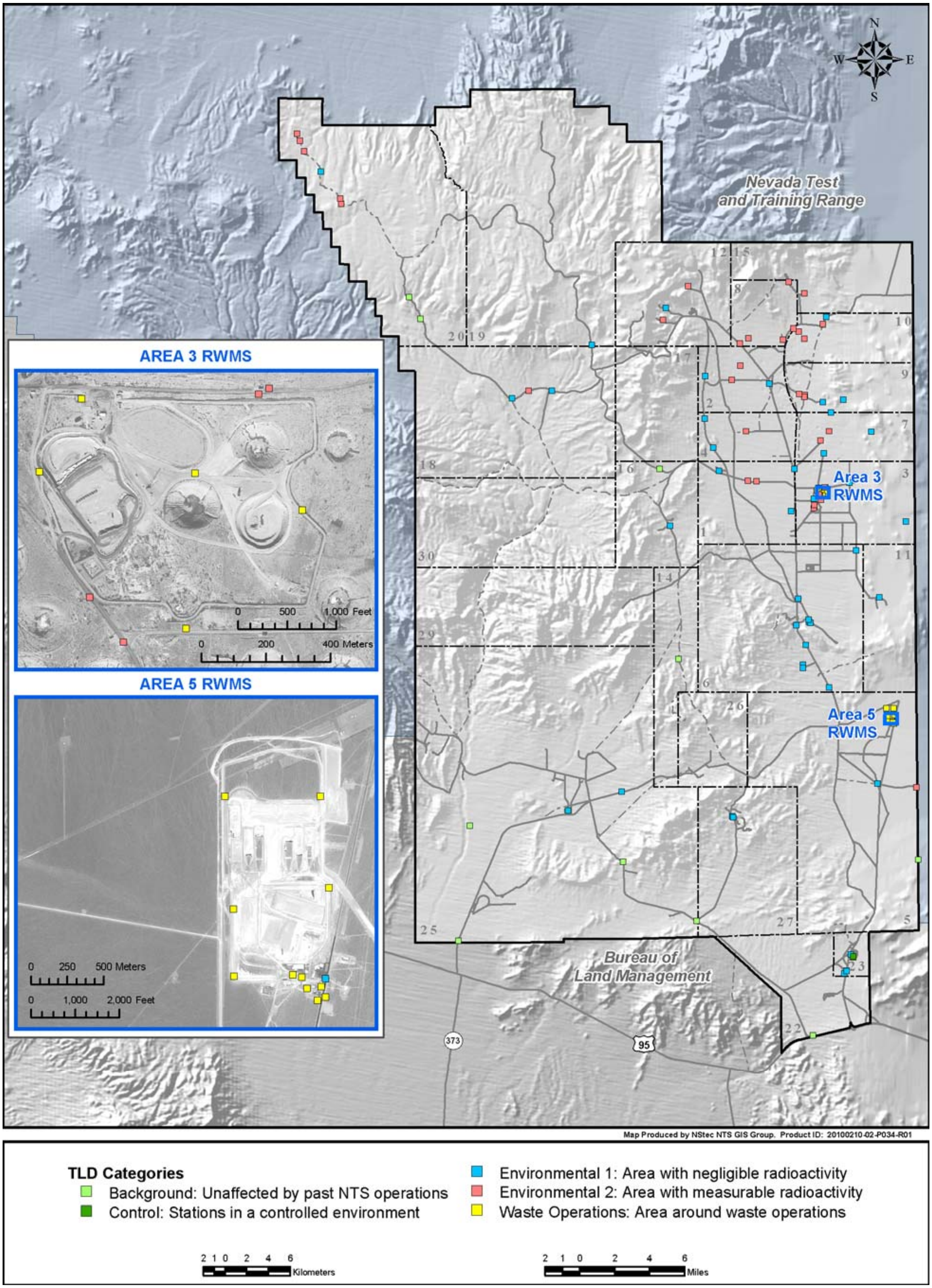

Figure 6-1. Location of TLDs on the NTS

6.2.1 Data Quality

Quality assurance (QA) procedures for TLD monitoring of ambient radiation involve comparing the data from paired TLDs at each location to estimate measurement precision, comparing current and past measurements at each location, and reviewing data from the TLDs in control locations. Five of the six control locations are shielded; the sixth is unshielded, located in Mercury in Building 650. These locations allow one to detect and estimate any systematic variation that might be introduced by the measurement process itself.

At least one TLD of each pair provided data for each of the 436 possible quarterly measurements; both provided data for 432 of these. Four TLDs were found on the ground or damaged. Agreement between results provided by the paired TLDs was very good, with an average relative percent difference between measurements of 2.3 percent during 2009. The quarter-to-quarter coefficient of variation (CV, identical to the relative standard deviation) ranged from 0.3 to 6.5 percent (median = 1.8 percent) over all locations including control locations. For comparison, CV values for control locations have ranged from 1.2 to 10.0 percent in recent years; CVs at control locations tend to be higher than those at environmental locations because the exposure rates are much lower due to shielding.

At a programmatic level, quality assurance (QA) and quality control (QC) protocols, including Data Quality Objectives, have been developed and are maintained as essential elements of direct radiation monitoring, as directed by the RREMP. The QA/QC requirements established for the monitoring program include the use of sample packages to thoroughly document each sampling event, rigorous management of databases, and completion of essential training. The Radiological Control Department maintains certification through the U.S. Department of Energy Laboratory Accreditation Program for dosimetry.

6.2.2 Data Reporting

Direct radiation is recorded as exposure per unit time in milliroentgens per day (mR/d), calculated by dividing the measured exposure per quarter for each TLD by the number of days the TLD was exposed at its measurement location. These are multiplied by 365 to obtain annualized values. The estimated annual exposure is the average of the quarterly annualized values; it is used to determine compliance with federal annual dose limits.

6.3 Results

Estimated annual exposures for all TLD locations are summarized in Table 6-1. Summary statistics for the five location types are given in Table 6-2. During 2009, the average of the estimated annual exposures among the 10 background locations was 120 mR and ranged from 64 to 165 mR (Table 6-2). A 95 percent prediction interval (PI) for annual exposures, based on the 2009 estimated mean annual exposures at the background locations, is 39.8 to 199.6 mR (the “95% PI from B” shown in Figures 6-2, 6-3, and 6-4). This interval predicts mean annual exposures at locations where radiation effects from NTS operations are negligible.

For comparison, the CEMP’s estimated annual exposure in Las Vegas, Nevada (at 622 m [2,040 ft] elevation) was 98 mR during 2009 (see Table 7-3). Estimated exposures at CEMP locations ranged from 77 mR at Pahrump (777 m [2,550 ft] elevation) to 160 mR at Twin Springs (1541 m [5,055 ft] elevation). There is an increasing relationship between exposure and elevation. On the NTS, background locations with lowest and highest exposures are at elevations 1,087 m (3,568 ft) (for the station named “Area 5, 3.3 Mi SE of Aggregate Pit”) and 1,737 m (5,700 ft) (for the station named “Area 20, Stake A-112”), respectively. Exposure estimates at all locations on the NTS include the contribution from natural sources. It is important to note that the DOE dose limits to the public are for dose over and above what the public may receive from natural sources.

Table 6-1. Annual direct radiation exposure rates measured at TLD locations on the NTS in 2009

				Estimated Annual Exposure (mR)[(a)]		
NTS Area	**Station**	**Location Type[(b)]**	**Number of Quarters**	**Mean[(c)]**	**Minimum[(c)]**	**Maximum[(c)]**
5	3.3 Mi SE of Aggregate Pit	B	4	64	62	68
14	Mid-Valley	B	4	147	145	148
16	Stake P-3	B	4	121	119	124
20	Stake A-112	B	4	165	162	168
20	Stake A-118	B	4	158	153	161
22	Army #1 Water Well	B	4	87	85	92
25	Gate 25-4-P	B	4	135	133	137
25	Gate 510	B	4	130	128	132
25	Jackass Flats & A-27 Roads	B	4	82	81	83
25	Skull Mtn Pass	B	4	109	108	109
23	Building 650 Dosimetry	C	4	61	60	63
23	Lead Cabinet, 1	C	4	26	25	28
23	Lead Cabinet, 2	C	4	26	25	26
23	Lead Cabinet, 3	C	4	27	25	28
23	Lead Cabinet, 4	C	4	27	26	28
23	Lead Cabinet, 5	C	4	26	25	27
1	BJY	E1	4	119	118	121
1	Sandbag Storage Hut	E1	4	116	113	118
1	Stake C-2	E1	4	122	118	125
2	Stake M-140	E1	4	135	134	136
2	Stake TH-58	E1	4	96	93	99
3	LANL Trailers	E1	4	125	124	126
3	Stake OB-20	E1	4	90	88	91
3	Well ER 3-1	E1	4	127	124	128
4	Stake TH-41	E1	4	113	111	115
4	Stake TH-48	E1	4	121	119	125
5	Water Well 5B	E1	4	114	110	119
6	CP-6	E1	4	72	69	77
6	DAF East	E1	4	98	95	102
6	DAF North	E1	4	103	101	106
6	DAF South	E1	4	140	136	145
6	DAF West	E1	4	86	84	90
6	Decon Facility NW	E1	4	132	130	134
6	Decon Facility SE	E1	4	135	134	136
6	Stake OB-11.5	E1	4	132	129	135
6	Yucca Compliance	E1	4	95	94	96
6	Yucca Oil Storage	E1	4	101	99	103
7	Reitmann Seep	E1	4	129	126	131
7	Stake H-8	E1	4	131	130	133
9	Papoose Lake Road	E1	4	90	87	93
9	U-9CW South	E1	4	105	103	107
9	V & G Road Junction	E1	4	116	115	116
10	Gate 700 South	E1	4	130	128	133
11	Stake A-21	E1	4	134	129	136
12	Upper N Pond	E1	4	132	129	136
16	3545 Substation	E1	4	144	138	148

Table 6-1. Annual direct radiation exposure rates measured at TLD locations on the NTS in 2009 (continued)

				Estimated Annual Exposure (mR)[(a)]		
NTS Area	Station	Location Type[(b)]	Number of Quarters	Mean[(c)]	Minimum[(c)]	Maximum[(c)]
18	Stake A-83	E1	4	148	146	150
18	Stake F-11	E1	4	149	145	152
19	Stake P-41	E1	4	160	157	164
20	Stake J-41	E1	4	142	140	144
23	Gate 100 Truck Parking 1	E1	4	64	61	71
23	Gate 100 Truck Parking 2	E1	4	69	68	70
23	Mercury Fitness Track	E1	4	59	56	62
25	HENRE	E1	4	127	124	129
25	NRDS Warehouse	E1	4	124	123	126
27	Cafeteria	E1	4	114	114	115
27	JASPER-1	E1	4	117	115	120
1	Bunker 1-300	E2	4	123	120	125
1	T1	E2	4	273	267	277
2	Stake L-9	E2	4	172	171	173
2	Stake N-8	E2	4	511	503	518
3	Stake A-6.5	E2	4	143	139	145
3	T3	E2	4	355	344	364
3	T3 West	E2	4	348	343	359
3	T3A	E2	4	380	371	386
3	T3B	E2	4	504	495	513
3	U-3co North	E2	4	186	182	189
3	U-3co South	E2	4	144	143	145
4	Stake A-9	E2	4	616	585	635
5	Frenchman Lake	E2	4	339	336	343
7	Bunker 7-300	E2	4	229	225	232
7	T7	E2	4	117	116	118
8	Baneberry 1	E2	4	367	362	374
8	Road 8-02	E2	4	128	124	130
8	Stake K-25	E2	4	105	103	107
8	Stake M-152	E2	4	163	160	166
9	B9A	E2	4	134	131	135
9	Bunker 9-300	E2	4	127	125	129
9	T9B	E2	4	505	487	522
10	Circle & L Roads	E2	4	122	120	123
10	Sedan East Visitor Box	E2	4	136	134	138
10	Sedan West	E2	4	234	231	238
10	T10	E2	4	251	248	256
12	T-Tunnel #2 Pond	E2	4	250	235	260
12	Upper Haines Lake	E2	4	111	109	116
15	EPA Farm	E2	4	115	112	120
18	Johnnie Boy North	E2	4	148	145	153
20	Palanquin	E2	4	228	216	236
20	Schooner-1	E2	4	671	627	699
20	Schooner -2	E2	4	258	252	264
20	Schooner -3	E2	4	144	141	147
20	Stake J-31	E2	4	166	162	170

Table 6-1. Annual direct radiation exposure rates measured at TLD locations on the NTS in 2009 (continued)

NTS Area	Station	Location Type[(b)]	Number of Quarters	Estimated Annual Exposure (mR)[(a)] Mean[(c)]	Minimum[(c)]	Maximum[(c)]
3	A3 RWMS Center	WO	4	143	140	147
3	A3 RWMS East	WO	4	135	134	136
3	A3 RWMS North	WO	4	127	125	129
3	A3 RWMS South	WO	4	341	335	347
3	A3 RWMS West	WO	4	128	127	129
5	A5 RWMS East Gate	WO	4	108	101	115
5	A5 RWMS Expansion NE	WO	4	142	140	144
5	A5 RWMS Expansion NW	WO	4	146	145	147
5	A5 RWMS NE Corner	WO	4	128	125	132
5	A5 RWMS NW Corner	WO	4	127	126	128
5	A5 RWMS South Gate	WO	4	110	107	112
5	A5 RWMS SW Corner	WO	4	127	124	131
5	Building 5-31	WO	4	107	105	110
5	WEF East	WO	4	128	123	131
5	WEF North	WO	4	123	121	125
5	WEF South	WO	4	134	128	140
5	WEF West	WO	4	125	121	128

(a) To obtain daily exposure rates, divide exposure measures by 365
(b) Location types:
B: Background locations
C: Control locations
E1: Environmental locations with exposure rates near background but monitored for potential for increased exposure rates due to NTS operations
E2: Environmental locations with measurable radioactivity from past operations, excluding those designated WO
WO: Locations in or near waste operations
(c) Mean, minimum, and maximum values from quarterly estimates. In general, each quarterly estimate is the average of two TLD readings per location

Table 6-2. Summary statistics for 2009 mean annual direct radiation exposure by TLD location type

Location Type	Number of Locations	Estimated Mean Annual Exposure (mR) Mean	Minimum	Maximum
Background (B)	10	120	64	165
Control (C)	6	32	26	61
Environmental 1 (E1)	41	116	59	160
Environmental 2 (E2)	35	252	105	671
Waste Operations (WO)	17	140	107	341

6.3.1 Potential Exposure to the Public along the NTS Boundary

Most of the NTS is not accessible to the public, as only the southern portion of the NTS borders public land. Therefore, the only place the public has potential for exposure to direct radiation from the NTS is along the southern boundary.

Gate 100 is the primary entrance point to the NTS. The outer parking areas are accessible to the public. Trucks hauling radioactive materials, primarily low-level waste (LLW) destined for disposal in the RWMSs, often park outside Gate 100 while waiting to enter the NTS. Two TLD locations were established in October 2003 to monitor this truck parking area. The TLDs at the west side of the parking area (Gate 100 Truck Parking 1) had an estimated annual exposure of 64 mR, and those at the north end of the parking area (Gate 100 Truck Parking 2) had an estimated annual exposure of 69 mR, with quarterly estimates varying between 61 and 70 mR. These values are similar to the lower end of the range of background exposures observed at the NTS.

While the public has access only to the southern portions of the NTS borders, others may have access to other boundaries of the NTS. The great majority of the NTS is bounded by the Nevada Test and Training Range (NTTR). Military or other personnel on the NTTR who are not classified as radiation workers would also be subject to the 100 mrem/yr public dose limit. Nuclear tests on the NTTR (Double Tracks and Project 57) consisted of experiments where weapons were conventionally exploded without going critical (safety experiments). These areas, therefore, have primarily alpha-emitting radionuclides that do not contribute significantly to external dose. Historical nuclear testing activities also occurred on the Tonopah Test Range (TTR) (Clean Slate 1, 2, and 3) located in the northwest portion of the NTTR. Radiation exposure rates are measured on and around the TTR and the results are reported by Sandia National Laboratories (SNL) in the TTR annual environmental report (SNL, 2010).

A radiological boundary extends beyond the NTS in the Frenchman Lake region of Area 5 along the southeast boundary of the NTS. This region was a location of atmospheric weapons testing in the 1950s, and it is inaccessible to the public. A TLD location was established there in July 2003 to characterize direct radiation levels from this legacy soil contaminated area and to assess the external dose to personnel not classified as radiation workers who may visit the area. The estimated annual exposure to a hypothetical person at the Frenchman Lake TLD location during 2009 was 339 mR. This has been consistently declining over time, down from 411 mR in 2004. The resulting above-background dose during 2009 would be approximately 174 to 275 mrem, depending on which background value is subtracted. This would exceed the 100 mrem dose limit to a person residing year-round at this location, but there are no living quarters or full-time workers in this vicinity.

6.3.2 Exposures from NTS Operational Activities

During 2009 there were 41 TLDs in locations where there is negligible radioactivity from past operations but where monitoring is of interest due to either the presence of personnel or the public in the area and/or due to the potential for receiving radiation exposure from current operations (E1 locations). The mean estimated annual exposure at these locations was 116 mR, approximately the same as the mean estimated annual exposure at background locations (see Table 6-2). Overall, annual exposures were not different between B (background) and E1 locations (Figure 6-2); the estimated annual exposures at all E1 locations were within the background-based 95 percent PI. These were also comparable with the off-NTS exposures reported by the CEMP stations.

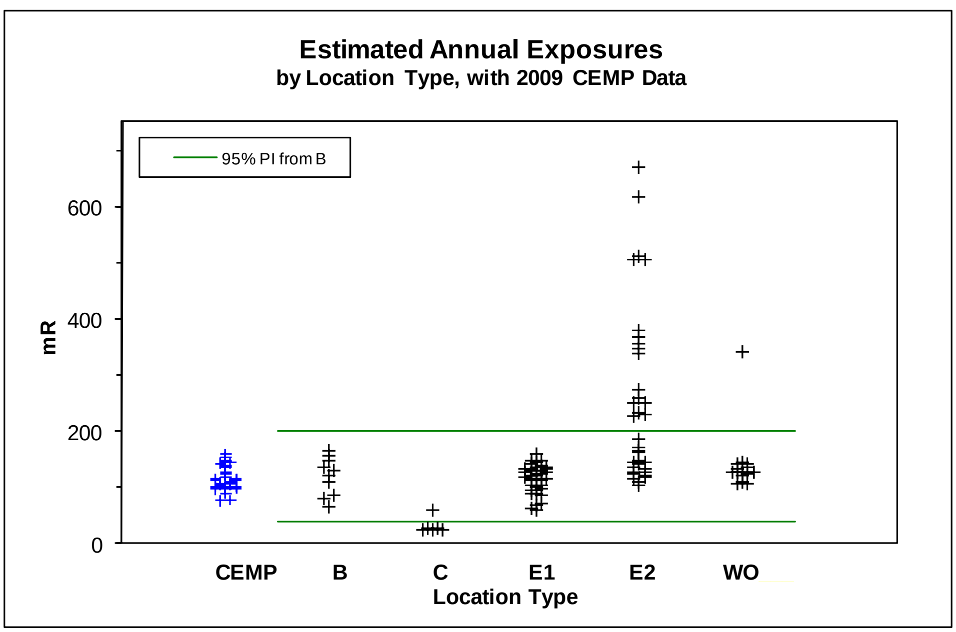

Figure 6-2. 2009 annual exposure rates on the NTS, by location type, and off the NTS (CEMP stations)

6.3.3 Exposure Rates at RWMSs

DOE M 435.1-1 states that LLW disposal facilities shall be operated, maintained, and closed so that a reasonable expectation exists that annual dose to members of the public shall not exceed 25 mrem from all exposure pathways combined. Given that the RWMSs are located well within the NTS boundaries, no members of the public could access these areas for significant periods of time. External exposures are still measured by TLDs located at the RWMSs, however, to show the potential dose from external radiation to a hypothetical person residing year-round at each RWMS (see Section 9.1.6 of this report for a summary of the potential dose to the public from the RWMSs from all exposure pathways).

The Area 3 RWMS is located in Yucca Flat. Between 1952 and 1972, 60 nuclear weapons tests were conducted within 400 m (1,312 ft) of the Area 3 RWMS boundary. Fourteen of these tests were atmospheric tests that left radionuclide-contaminated surface soil and, therefore, elevated radiation exposures across the area. Waste pits in the Area 3 RWMS are subsidence craters from seven subsurface tests, which are being filled with LLW. These are then covered with clean soil, resulting in lower exposures inside the Area 3 RWMS compared with the average exposures at the fence line or in Area 3 outside the fence line.

Annual exposures during 2009 in and around the Area 3 RWMS are shown in Figure 6-3. The exposures measured inside the Area 3 RWMS and three of four measurements at the boundary were within the range of background exposures. The estimated exposure above the range of NTS background levels at one location on the RWMS boundary is associated with historical aboveground nuclear weapon test locations. Under these conditions, current Area 3 RWMS operations would have contributed negligible external exposure to a hypothetical person residing at the Area 3 RWMS boundary during 2009.

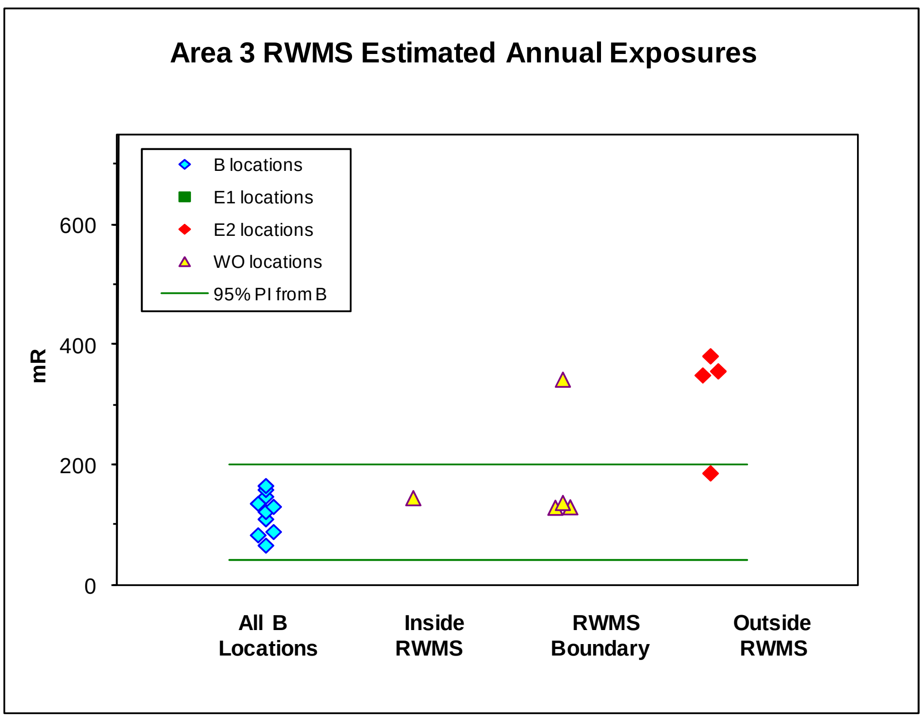

Figure 6-3. 2009 annual exposure rates in and around Area 3 RWMS and at background locations

The Area 5 RWMS is located in the northern portion of Frenchman Flat. Between 1951 and 1971, 25 nuclear weapons tests were conducted within 6.3 kilometers (km) (3.9 miles [mi]) of the Area 5 RWMS. Fifteen of these were atmospheric tests, and of the remaining ten, nine released radioactivity to the surface, which contributes to exposures in the area. No nuclear weapons testing occurred within the boundaries of the Area 5 RWMS. During 2009, estimated annual exposures at Area 5 RWMS TLD locations were within the range of exposures measured at NTS background locations (Figure 6-4). The one exposure rate measured outside the RWMS in Area 5 that was higher than background levels was within 0.5 km (0.3 mi) of six atmospheric tests in Frenchman Lake Playa.

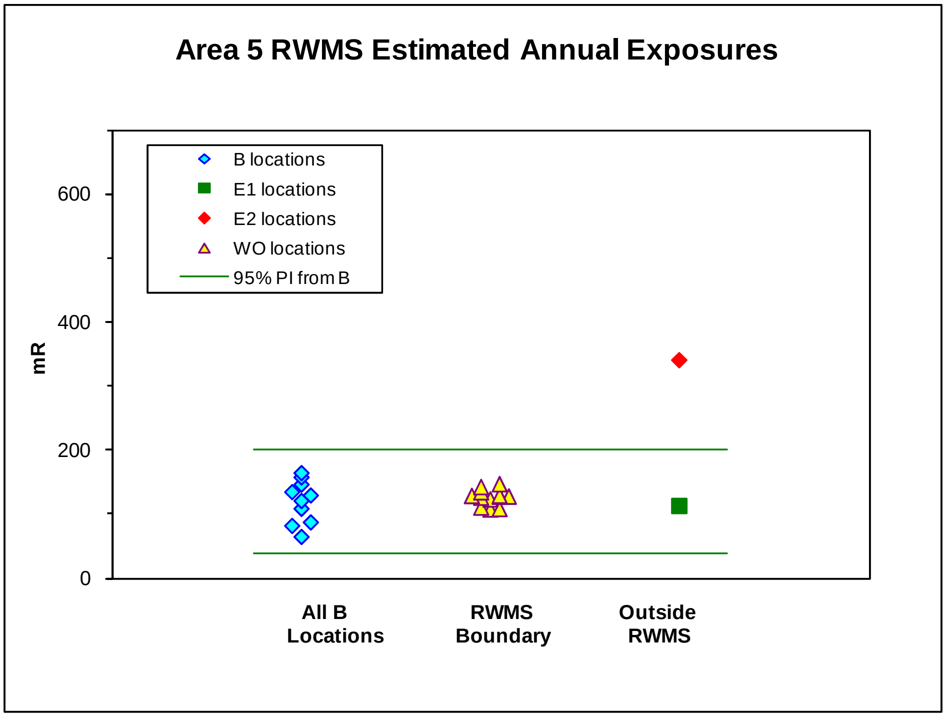

Figure 6-4. 2009 annual exposure rates around Area 5 RWMS and at background locations

6.3.4 Exposure Rates for NTS Plants and Animals

The highest exposure rate measured at any TLD location during 2009 was 699 mR/yr (1.92 mR/d) at the Schooner-1 location during the second quarter (Table 6-1). Given such a large area source, there is very little difference between the exposure measured at a height of 1 m (3.3 ft) and that measured at an elevation near the ground (e.g., 3 centimeters [1.2 in.]) where small plants and animals reside. The daily exposure rate at the Schooner-1 location at a height of 1 m or near the surface would be approximately 2 percent of the most stringent total dose rate to biota, which is the 0.1 rad/d (approximately 100 mR/d) limit to terrestrial animals stated in DOE-STD-1153-2002. Hence, doses to plants and animals from external radiation exposure at NTS monitoring locations are low compared with the dose limit. Dose to biota from both internal and external radionuclides is discussed in Chapter 8.

6.3.5 Exposure Rate Patterns in the Environment over Time

DOE O 450.1A states that environmental monitoring should be conducted in order to characterize releases from DOE activities. Continued monitoring of exposures at locations of past releases on the NTS helps to accomplish this. Small quarter-to-quarter changes are normally seen in exposure rates from all locations. During 2009, the CVs for measurements within a quarter averaged 2 percent.

Long-term trends are displayed in Figure 6-5 by location type for locations that have been monitored for at least 10 years. As expected, the C and B locations show virtually no net change through time due to the protected locations and lack of added man-made radionuclides. Among all locations with at least 10-year data histories, the exposure rates at E1 locations decreased 0.4 percent per year; the rates at E2 locations decreased 1.9 percent per year on average, and the rates at WO locations decreased 0.7 percent per year on average. Exposure rates decreased 3.6 percent per year on average at those locations with significant added man-made radiation, which are the E2 and WO locations with 2009 exposure rates higher than the background-based PI.

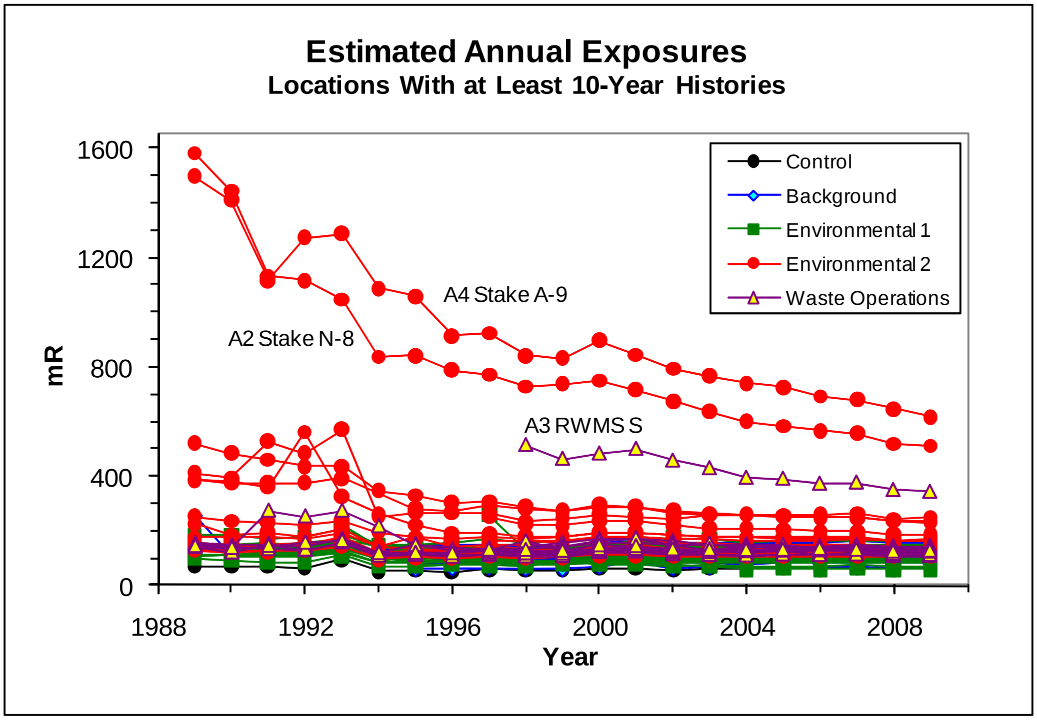

Figure 6-5. Trends in direct radiation exposure measured at TLD locations

The Schooner-1 location, which has the highest exposure of any current NTS location, is not included in Figure 6-5 because it was established in 2003 and does not yet have a 10-year history. The two highest exposures shown in Figure 6-5, Stake A-9 in Area 4 and Stake N-8 in Area 2, are decreasing by 4.0 and 4.8 percent per year, respectively; these correspond to half-lives of about 17 and 14 years. The next highest exposures shown in Figure 6-5 are at the WO location RWMS South in Area 3; these are decreasing by 3.7 percent per year. The observed decreases are due to a combination of natural radioactive decay and the dispersal of radionuclides in the environment.

6.4 Environmental Impact

Direct radiation exposure to the public from NTS operations in 2009 was negligible. Radionuclides historically released to the environment on the NTS have resulted in localized elevated exposures. These areas of elevated exposure are not open to the public, nor do personnel work in these areas full-time. Overall exposures at the RWMSs appear to be generally lower inside and at the boundary compared with those outside the RWMSs. This is likely due to the presence of radionuclides released from historical testing distributed throughout the area around the RWMSs compared with the clean soil used inside the RWMSs to cap waste pits. The external dose to plants and animals at the location with the highest measured exposure was a small fraction of the dose limit to biota; hence, no detrimental effects to biota from external radiation exposure are expected at the NTS.

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7.0 Community Environmental Monitoring Program

Community oversight for the Nevada Test Site (NTS) is provided through the Community Environmental Monitoring Program (CEMP), whose mission is to monitor and communicate environmental data that are relevant to the safety and well-being of participating communities and their surrounding areas. Previously, the CEMP network functioned as a first line of offsite detection of potential radiation releases from underground nuclear tests at the NTS, and it can be outfitted to fulfill this role again should underground testing resume. It currently exists as a non-regulatory public informational and outreach program, although quarterly reporting of monitoring data is furnished to the Nevada Division of Environmental Protection and the U.S. Environmental Protection Agency Region IX as a supplemental requirement to NTS onsite monitoring. The CEMP is sponsored by the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO), and is administered and operated by the Desert Research Institute (DRI) of the Nevada System of Higher Education.

Monitored and collected data include, but are not necessarily limited to, background and airborne radiation data, meteorological data, and tritium concentrations in community and ranch drinking water. Network stations, located in Nevada, Utah, and California, are managed by local citizens, many of them high school science teachers, whose routine tasks are to ensure equipment is operating normally and to collect air filters and route them to the DRI for analysis. These Community Environmental Monitors (CEMs) are also available to discuss the monitoring results with the public and to speak to community and school groups. DRI's responsibilities include maintaining the physical monitoring network through monthly visitations by environmental radiation monitoring specialists, who also participate in training and interfacing with CEMs and interacting with other local community members and organizations to provide information related to the monitoring data. DRI also provides public access to the monitoring data through maintenance of a project Web site at http://www.cemp.dri.edu/. A detailed informational background narrative about of the CEMP can be found at http://www.cemp.dri.edu/cemp/moreinfo.html along with more detailed descriptions of the various types of sensors found at the stations and on outreach activities conducted by the CEMP.

7.1 Offsite Air Monitoring

During 2009, 29 CEMP stations managed by DRI composed the Air Surveillance Network (ASN) (Figure 7-1). The ASN stations include various equipment as described below. The Mesquite, Nevada, CEMP station is shown in Figure 7-2.

CEMP Low-Volume Air Sampling Network – During 2009, the CEMP ASN included continuously operating low-volume particulate air samplers located at 27 of the 29 CEMP station locations. No low-volume air samplers were located at Medlin's Ranch or Warm Springs Summit, Nevada, during 2009. Duplicate air samples were collected from up to three ASN stations each week. The duplicate samplers are operated at randomly selected stations for three months (one calendar quarter) before being moved to a new location.

Glass-fiber filters from the low-volume particulate samplers are collected by the CEMs and mailed to DRI, where they are prepared and forwarded to an independent laboratory to be analyzed for gross alpha and gross beta activity. Samples are held for a minimum of seven days after collection to allow for the decay of naturally occurring radon progeny. Upon completion of the gross alpha/beta analyses, the filters are returned to DRI to be composited on a quarterly basis for gamma spectroscopy analysis.

CEMP Thermoluminescent Dosimetry Network – Thermoluminescent dosimetry is another of the essential components of environmental radiological assessments. This is used to determine both individual and population external exposure to ambient radiation from natural and artificial sources. In 2009, this network consisted of fixed environmental thermoluminescent dosimeters (TLDs) at 28 of the 29 CEMP stations (see Figure 7-1). A TLD is not currently deployed at Warm Springs Summit due to limited access during the winter months. The TLD used is a Panasonic UD-814AS. Within the TLD, a slightly shielded lithium borate element is used to check low-energy radiation levels while three calcium sulfate elements are used to measure penetrating gamma radiation. For quality assurance (QA) purposes, duplicate TLDs are deployed at three randomly selected environmental stations.

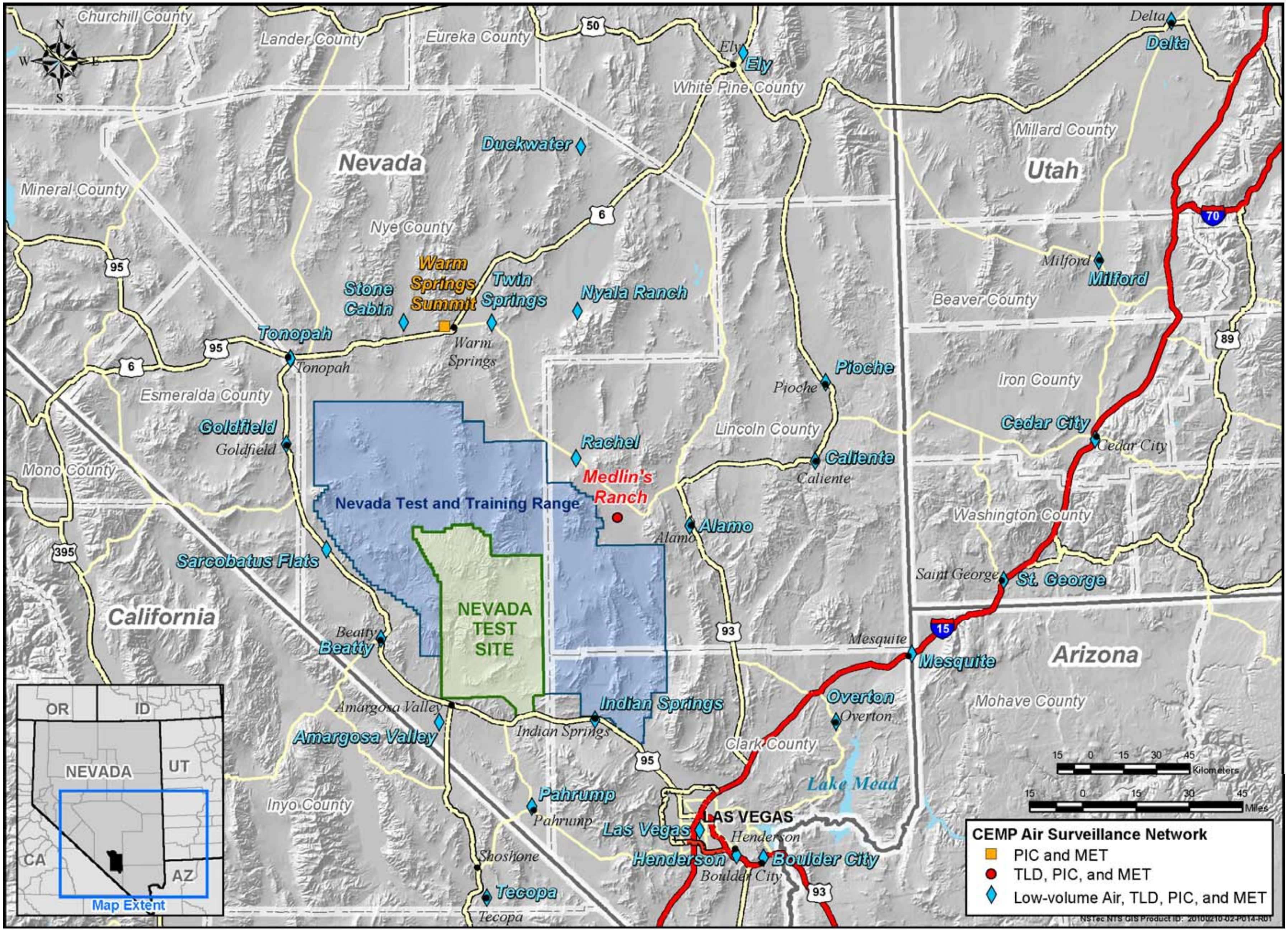

Figure 7-1. 2009 CEMP Air Surveillance Network

Figure 7-2. CEMP Station at Mesquite, Nevada

An average daily exposure rate was calculated for each quarterly exposure period. The average of the quarterly values was multiplied by 365.25 days to obtain the total annual exposure for each station.

CEMP Pressurized Ion Chamber (PIC) Network – The PIC detector measures gamma radiation exposure rates and, because of its sensitivity, may detect low-level exposures that go undetected by other monitoring methods. PICs are in place at all 29 stations in the CEMP network (see Figure 7-1). The primary function of the PIC network is to detect changes in ambient gamma radiation due to human activities. In the absence of such activities, ambient gamma radiation rates vary naturally among locations, reflecting differences in altitude (cosmic radiation), radioactivity in the soil (terrestrial radiation), and slight variations at a single location due to weather patterns. Because a full suite of meteorological data is recorded at each CEMP station, variations in PIC readings caused by weather events such as precipitation or changes in barometric pressure are more readily identified. Variations can be easily viewed by selecting a station location on the Graph link from the CEMP home page, http://www.cemp.dri.edu/, then selecting the desired variables.

CEMP Meteorological (MET) Network – Because changing weather conditions can have a significant effect on measurable levels of background radiation, meteorological instrumentation is in place at each of the 29 CEMP stations. The MET network includes sensors that measure air temperature, humidity, wind speed and direction, solar radiation, barometric pressure, precipitation, and soil temperature and moisture data. All of these data can be observed real-time at the onsite station display, and archived data are available by accessing the CEMP home page at http://www.cemp.dri.edu/.

7.1.1 Air Particulate Sampling Results

2009 was the first full year in which CEMP air samples were collected on a bi-weekly basis. This sampling frequency, which began in the last quarter of 2008, results in the possible collection of 26 samples per year for each station. Samples of airborne particulates from CEMP ASN stations were collected by drawing air through a 5-centimeter (2-inch) diameter glass-fiber filter at a constant flow rate of 49.5 liters (1.75 cubic feet [ft^3]) per minute at standard temperature and pressure. The actual flow rate and total volume were measured with an in-line air-flow calibrator.

The filter is mounted in a filter holder that faces downward at a height of approximately 1.5 meters (m) (5 feet [ft]) above the ground. The total actual volume of air collected ranged from approximately 1,030 to 1,290 cubic meters (m^3) (36,000 to 45,000 ft^3), depending on the elevation of the station and changes in air temperature and/or pressure.

7.1.1.1 Gross Alpha and Gross Beta

Analyses of gross alpha and beta in airborne particulate samples are used to screen for long-lived radionuclides in the air. The mean annual gross alpha activity across all sample locations was $1.07 \pm 0.24 \times 10^{-15}$ microcuries per milliliter (µCi/mL) ($3.96 \pm 0.89 \times 10^{-5}$ Becquerels [Bq]/m^3) (Table 7-1). Most of the results for 2009 exceeded the analytical minimum detectable concentration (MDC) (see Glossary, Appendix B) and, overall, are similar to results from previous years. Figure 7-3 shows the long-term maximum, mean, and minimum alpha trend for the CEMP stations as a whole.

Table 7-1. Gross alpha results for the CEMP offsite ASN in 2009

		Concentration (x 10^{-15} µCi/mL [3.7 x 10^{-5} Bq/m^3])			
Sampling Location	**Number of Samples**	**Mean**	**Standard Deviation**	**Minimum**	**Maximum**
Alamo	25	1.56	0.82	0.70	3.26
Amargosa Valley	25	1.12	0.49	0.56	2.88
Beatty	26	1.19	0.44	0.51	2.24
Boulder City	26	1.09	0.35	0.26	1.57
Caliente	24	1.51	0.55	0.74	2.60
Cedar City	26	0.90	0.23	0.55	1.49
Delta	26	1.04	0.51	0.42	2.39
Duckwater	26	1.09	0.51	0.45	2.51
Ely	25	0.94	0.41	0.40	2.12
Garden Valley	26	0.86	0.22	0.39	1.35
Goldfield	26	0.97	0.24	0.58	1.35
Henderson	26	1.11	0.43	0.67	2.75
Indian Springs	25	0.91	0.20	0.59	1.37
Las Vegas	26	1.34	0.67	0.57	2.87
Mesquite	26	1.21	0.56	0.40	2.25
Milford	26	1.06	0.41	0.25	1.88
Nyala Ranch	26	0.65	0.23	0.25	1.12
Overton	25	1.39	0.64	0.53	3.56
Pahrump	26	0.90	0.27	0.49	1.48
Pioche	26	0.79	0.24	0.15	1.26
Rachel	24	0.92	0.32	0.45	1.89
Sarcobatus Flats	25	1.64	0.70	0.70	3.30
Stone Cabin Ranch	26	0.83	0.25	0.32	1.17
St. George	26	1.01	0.28	0.51	1.56
Tecopa	25	1.07	0.31	0.46	1.61
Tonopah	25	1.07	0.51	0.40	2.60
Twin Springs	26	0.85	0.30	0.45	1.84
Network Mean = $1.07 \pm 0.24 \times 10^{-15}$ µCi/mL					
Mean MDC = 0.25 x 10^{-15} µCi/mL		**Standard Error of Mean MDC = 0.04 x 10^{-15} µCi/mL**			

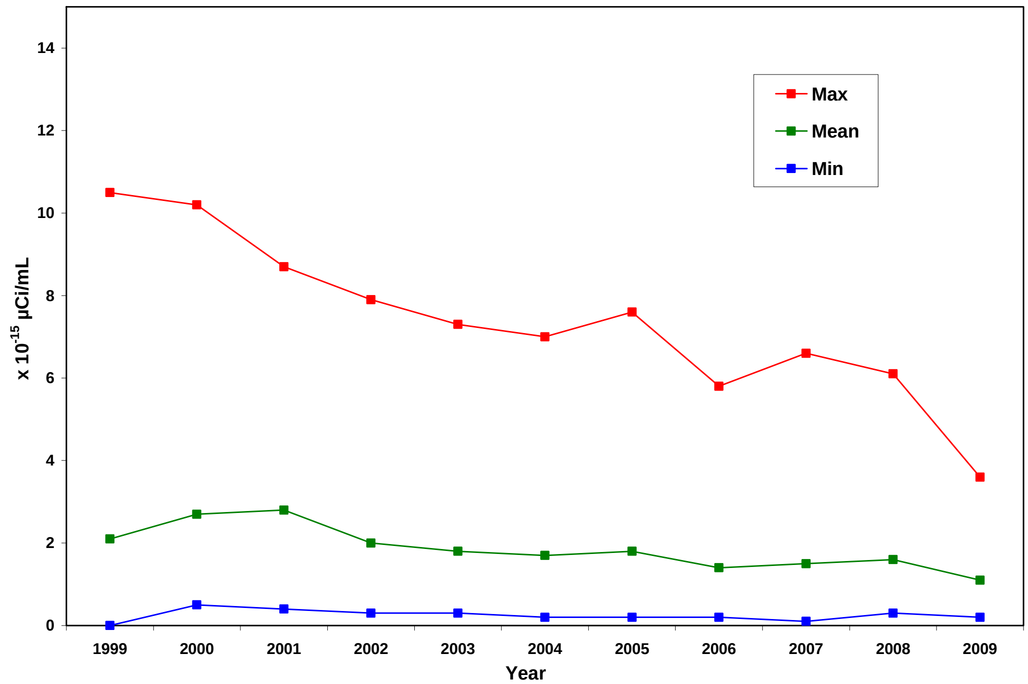

Figure 7-3. Historical trend for gross alpha analysis for all CEMP stations

The mean annual gross beta activity across all sample locations (Table 7-2) was $1.99 \pm 0.18 \times 10^{-14}$ µCi/mL ($7.36 \pm 0.67 \times 10^{-4}$ Bq/m^3). Most of these results also exceeded the MDC, and are similar to previous years' data. Figure 7-4 shows the long-term maximum, mean, and minimum beta trend for the CEMP stations as a whole.

Table 7-2. Gross beta results for the CEMP offsite ASN in 2009

Sampling Location	Number of Samples	Concentration (x 10^{-14} µCi/mL [3.7 x 10^{-4} Bq/m^3])			
		Mean	Standard Deviation	Minimum	Maximum
Alamo	25	2.12	0.57	1.27	3.36
Amargosa Valley	25	2.07	0.46	1.44	3.37
Beatty	26	1.86	0.32	0.98	2.44
Boulder City	26	2.19	0.45	1.26	3.20
Caliente	24	2.17	0.45	1.21	3.16
Cedar City	26	1.83	0.30	1.15	2.22
Delta	26	2.11	0.59	1.38	3.43
Duckwater	26	1.94	0.48	1.28	3.46
Ely	25	1.84	0.34	1.13	2.30
Garden Valley	26	1.89	0.35	1.21	2.73
Goldfield	26	1.88	0.34	1.30	2.55
Henderson	26	2.12	0.43	1.13	3.01
Indian Springs	25	1.93	0.37	1.06	2.58
Las Vegas	26	2.11	0.38	1.31	2.83
Mesquite	26	2.26	0.52	1.32	3.77
Milford	26	2.18	0.59	1.36	3.73
Nyala Ranch	26	1.67	0.54	1.04	3.80
Overton	25	2.23	0.50	1.32	3.16
Pahrump	26	1.97	0.39	1.17	2.80
Pioche	26	1.81	0.34	1.21	2.61

Table 7-2. Gross beta results for the CEMP offsite ASN in 2009 (continued)

Sampling Location	Number of Samples	Concentration (x 10^{-14} µCi/mL [3.7 x 10^{-4} Bq/m^3])			
		Mean	Standard Deviation	Minimum	Maximum
Rachel	24	1.85	0.36	1.27	2.50
Sarcobatus Flats	25	2.04	0.37	1.32	2.61
Stone Cabin	26	1.65	0.25	1.01	2.20
St. George	26	2.24	0.51	1.29	3.54
Tecopa	25	2.21	0.41	1.25	2.94
Tonopah	25	1.81	0.35	1.08	2.42
Twin Springs	26	1.88	0.48	1.24	3.46
Network Mean = 1.99 ± 0.18 x 10^{-14} µCi/mL					
Mean MDC = 0.04 x 10^{-14} µCi/mL		**Standard Error of Mean MDC = 0.002 x 10^{-14} µCi/mL**			

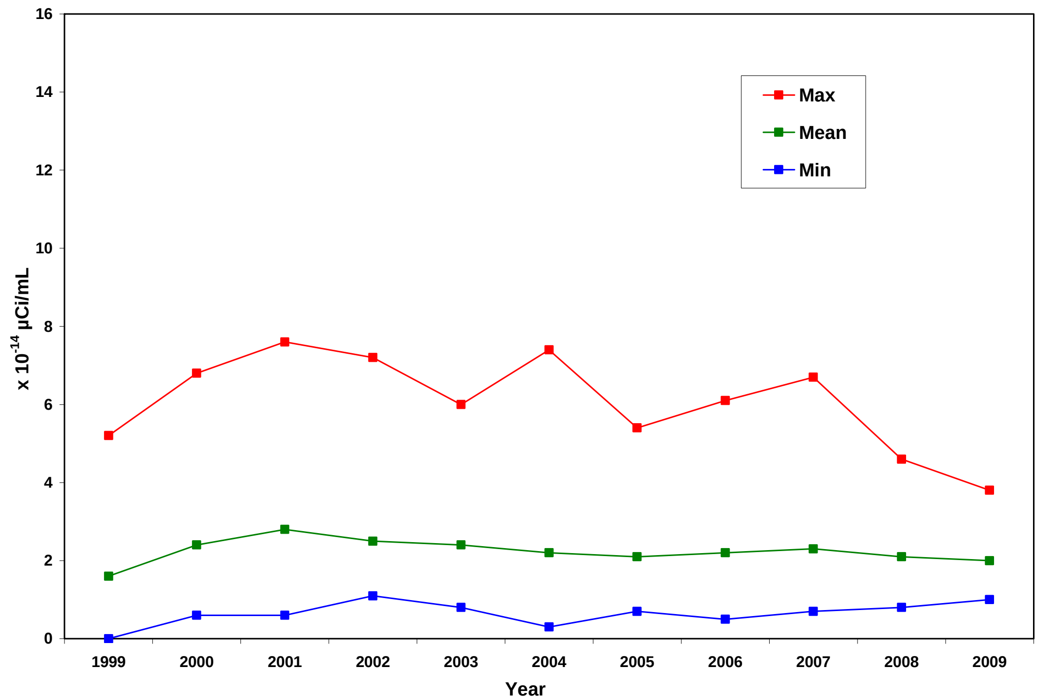

Figure 7-4. Historical trend for gross beta analysis for all CEMP stations

The mean gross alpha results show a generally increasing trend from 1998 to 2001 before slightly trending downward the last eight years. Likewise, the gross beta results show a similar trend from1998 to 2001. Although the downward trend in the mean data since 2001 is not as pronounced, even arguably level, the maximum values do suggest a downward trend is also likely. These trends are also reflected by most of the stations on an individual basis. This trend is most likely explained as being a result of persistent drought conditions throughout the southwest and Great Basin states. Drought in these regions has existed to varying degrees since 1996. These dry conditions could be directly responsible for an increase in suspended air particles collected by the air sampling network. The slight decrease in mean values since 2001 may indicate a minor change in the severity of drought conditions, but overall remain greater than pre-drought values (not shown).

7.1.1.2 Gamma Spectroscopy

Gamma spectroscopy analysis was performed on all samples from the low-volume air sampling network. The filters were composited by station on a quarterly basis after gross alpha/beta analysis. As in previous years, all samples were gamma-spectrum negligible with respect to man-made radionuclides (i.e., gamma-emitting radionuclides were not detected). In most of the samples, naturally occurring beryllium-7 (^{7}Be) was detected above the analytical MDC. This radionuclide is produced by cosmic ray interaction with nitrogen in the atmosphere. The mean annual activity for ^{7}Be for the sampling network was $1.16 \pm 0.24 \times 10^{-13}$ μCi/mL.

7.1.2 TLD Results

TLDs measure ionizing radiation from all sources, including natural radioactivity from cosmic or terrestrial sources and from man-made radioactive sources. The TLDs are mounted in a plexiglass holder approximately 1 m (3.3 ft) above the ground and are exchanged quarterly. TLD results are not presented for the Warm Springs Summit, Nevada, station at this time because its access is limited in the winter months. This does not allow for a proper quarterly change of the TLD as required. The total annual exposure for 2009 ranged from 77 milliroentgens (mR) (0.77 millisieverts [mSv]) at Pahrump, Nevada, to 160 mR (1.60 mSv) at Twin Springs, Nevada, with a mean annual exposure of 118 mR (1.18 mSv) for all operating locations. Results are summarized in Table 7-3 and are consistent with previous years' data. Figure 7-5 shows the long-term trend for the CEMP stations as a whole.

Table 7-3. TLD monitoring results for the CEMP offsite ASN in 2009

Sampling Location	Number of Quarters	Estimated Annual Exposure (mR)[(a)]		
		Mean[(b)]	Minimum[(b)]	Maximum[(b)]
Alamo	4	114	112	116
Amargosa Valley	4	109	103	114
Beatty	4	140	137	145
Boulder City	4	101	89	106
Caliente	2	120	112	128
Cedar City	4	97	92	100
Delta	4	99	88	108
Duckwater	4	115	104	123
Ely	4	106	84	114
Garden Valley	4	149	142	158
Goldfield	4	124	120	128
Henderson	4	115	96	139
Indian Springs	4	101	90	119
Las Vegas	4	98	93	103
Medlin's Ranch	4	136	119	150
Mesquite	4	101	90	112
Milford	4	145	132	153
Nyala Ranch	4	105	102	110
Overton	4	90	89	91
Pahrump	4	77	75	78
Pioche	4	114	108	124
Rachel	4	143	137	145
Sarcobatus Flats	4	153	149	157
Stone Cabin Ranch	4	144	119	158
St. George	4	78	72	84
Tecopa	4	108	103	111
Tonopah	4	128	116	141
Twin Springs	4	160	154	168

(a) To obtain daily exposure rates, divide annual exposure rates by 365
(b) Mean, minimum, and maximum values are from quarterly estimates

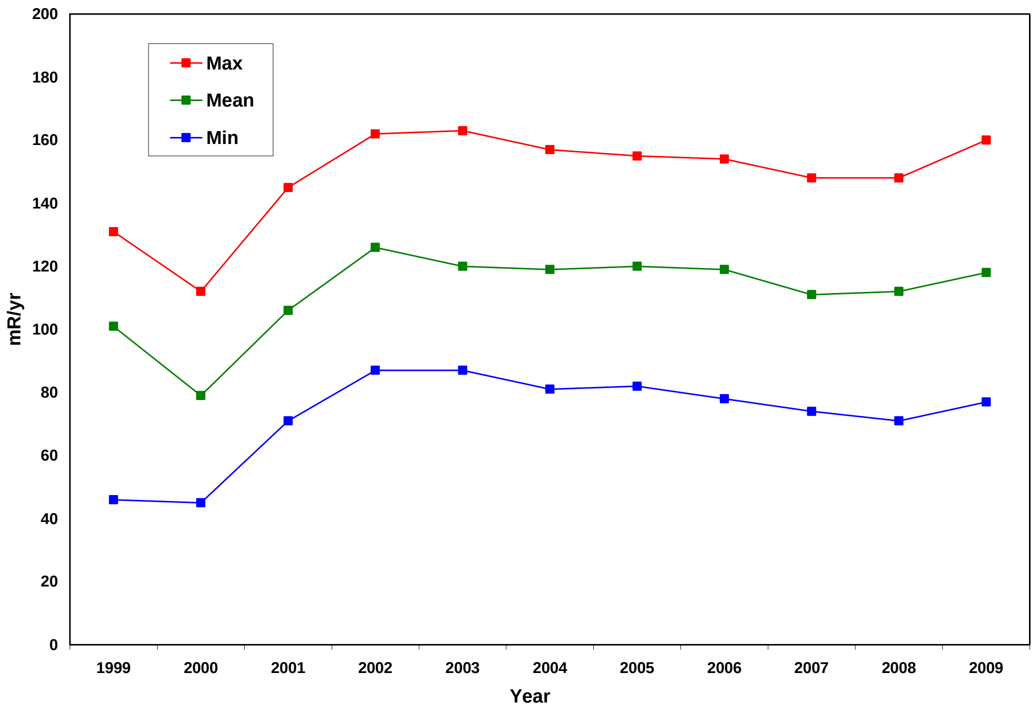

Figure 7-5. Historical trend for TLD analysis for all CEMP stations

With the exception of the dip in 2000, the TLD data also show a generally increasing trend from 1999 to 2002 before showing a slight decrease the last following six years. The 2009 results are slightly higher than 2008, but continue to be consistent with previous data. The TLD trends generally mirror those for gross alpha and beta analyses. This again may be consistent with minor changes in drought conditions observed in the regions around the monitoring network as described in Section 7.1.1.1.

7.1.3 PIC Results

The PIC data presented in this section are based on daily averages of gamma exposure rates from each station. Table 7-4 contains the maximum, minimum, and standard deviation of daily averages (in microroentgens per hour [µR/hr]) for the periods during 2009 when telemetry data were available. It also shows the average gamma exposure rate for each station during the year (in µR/hr) as well as the total annual exposure (in milliroentgens per year [mR/yr]). The exposure rate ranged from 73.15 mR/yr (0.73 mSv/yr) in Pahrump, Nevada, to 180.46 mR/yr (1.80 mSv/yr) in Warm Springs Summit, Nevada. Background levels of environmental gamma exposure rates in the United States (from combined effects of terrestrial and cosmic sources) vary between 49 and 247 mR/yr (BEIR III, 1980). Averages for selected regions of the United States were compiled by the U.S. Environmental Protection Agency and are shown in Table 7-5. The annual exposure levels observed at the CEMP stations in 2009 are well within these United States background levels, and are consistent with previous years' exposure rates.

Table 7-4. PIC monitoring results for the CEMP offsite ASN in 2009

Sampling Location	Daily Average Gamma Exposure Rate (µR/hr)				Annual Exposure (mR/yr)
	Mean	Standard Deviation	Minimum	Maximum	
Alamo	13.85	0.28	12.9	14.8	121.33
Amargosa Valley	12.45	0.16	11.9	13.0	109.06
Beatty	17.15	0.27	16.3	18.0	150.23
Boulder City	15.30	0.17	14.8	15.8	134.03
Caliente	15.85	0.35	14.6	17.1	138.85
Cedar City	11.20	0.27	10.2	12.2	98.11
Delta	12.10	0.34	11.3	12.9	106.00
Duckwater	15.55	0.45	11.9	17.2	136.22
Ely	12.60	0.35	11.4	13.8	110.38
Garden Valley	18.10	0.72	15.6	20.6	158.56
Goldfield	15.20	0.44	13.4	17.0	133.15
Henderson	13.95	0.16	13.5	14.4	122.20
Indian Springs	11.40	0.23	10.8	12.0	99.86
Las Vegas	10.55	0.14	10.2	10.9	92.42
Medlin's Ranch	17.25	0.38	15.9	18.6	151.11
Mesquite	11.80	0.15	11.3	12.3	103.37
Milford	17.65	0.49	16.0	19.3	154.61
Nyala Ranch	14.25	0.48	12.8	15.7	124.83
Overton	10.20	0.20	9.6	10.8	89.35
Pahrump	8.35	0.16	7.9	8.8	73.15
Pioche	13.95	0. 36	12.8	15.1	122.20
Rachel	15.45	0.34	14.3	16.6	135.34
Sarcobatus Flats	19.50	0.39	16.6	22.4	170.82
Stone Cabin Ranch	17.25	0.73	15.2	19.3	148.04
St. George	9.60	0. 35	8.6	10.6	84.10
Tecopa	15.15	0.29	14.1	16.2	132.71
Tonopah	16.35	0.40	14.8	17.9	143.23
Twin Springs	19.50	0.69	17.4	21.6	170.82
Warm Springs Summit	20.60	0.58	18.9	22.3	180.46

Table 7-5. Average natural background radiation for selected U.S. cities (excluding radon)

City	Radiation (mR/yr)
Denver, CO	164.6
Fort Worth, TX	68.7
Las Vegas, NV	69.5
Los Angeles, CA	73.6
New Orleans, LA	63.7
Portland, OR	86.7
Richmond, VA	64.1
Rochester, NY	88.1
St. Louis, MO	87.9
Tampa, FL	63.7
Wheeling, WV	111.9

Source: http://www.wrcc.dri.edu/cemp/Radiation.html. "Radiation in Perspective," August 1990 (Access Date: 3/22/2010)

7.1.4 Environmental Impact

Results of analyses conducted on data obtained from the CEMP network of low-volume particulate air samplers, TLDs, and PICs showed no measurable evidence at CEMP station locations of offsite impact from radionuclides originating on the NTS. Activity observed in gross alpha and beta analyses of low-volume air sampler filters was consistent with previous years' results and are within the range of activity found in other communities of the United States that are not adjacent to man-made radiation sources. Also, no man-made gamma-emitting radionuclides were detected. Likewise, TLD and PIC results remained consistent with previous years' background levels and are well within average background levels observed in other parts of the United States (see Table 7-5).

Occasional elevated gamma readings (10%–50% above normal average background) in 2009 were always associated with precipitation events and/or low barometric pressure. Low barometric pressure can result in the release of naturally occurring radon and its daughter products from the surrounding soil and rock substrates. Precipitation events can result in the "rainout" of globally distributed radionuclides occurring as airborne particulates in the upper atmosphere. Figure 7-6, generated from the CEMP Web site, illustrates an example of this phenomenon.

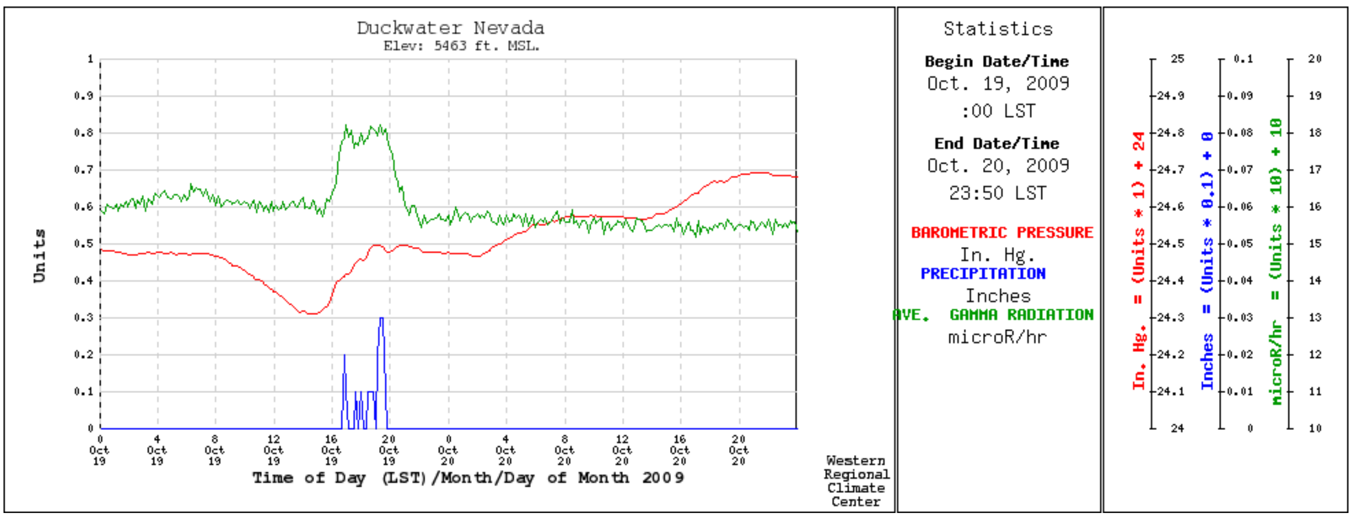

Figure 7-6. The effect of meteorological phenomena on background gamma readings

7.2 Offsite Surface and Groundwater Monitoring

During 2009, DRI was tasked by NNSA/NSO to provide independent verification of the tritium activity within some of the offsite groundwater wells, surface waters, and springs used for water supplies in areas surrounding the NTS. Samples collected by DRI personnel provide, in some years, a direct comparison to the results obtained by National Security Technologies, LLC (NSTec), under the *Routine Radiological Environmental Monitoring Plan.* In 2009, however, DRI and NSTec did not sample from the same offsite water sources (see Section 5.1). The sole analyte for this project was tritium. Tritium is one of the most abundant radionuclides generated by an underground nuclear test and, because it is a constituent of the water molecule itself, it is also one of the most mobile.

7.2.1 Sample Locations and Methods

During the period of June 16 to August 11, 2009, DRI sampled 4 springs, 21 wells, and 3 surface water bodies either directly or through municipal water supply systems. Sample locations were selected based upon input from the CEMs and local ranch owners participating in the CEMP project. All wells were sampled using downhole submersible pumps.

Samples from surface water bodies were obtained via discharge from a faucet or valve connected to the water supply system that pumps that body of water. Springs were sampled by hand along surface drainage that emanates from the spring orifice, or from the water supply system connected to the spring discharge. Each well was pumped a minimum of 5 to 15 minutes prior to sampling to purge water from the pump tubing and well annulus. This process ensured that the resultant sample was representative of local groundwater. Table 7-6 lists all of the sample points, their locations, the date they were sampled, and the sampling method. The locations of the sample points are shown in Figure 7-7.

7.2.2 Procedures and Quality Assurance

DRI used several methods to ensure that radiological results reported herein conform to current QA protocols (see Section 19.0 for a detailed description of the CEMP QA program). This was achieved through the use of standard operating procedures, field QA samples, and laboratory QA procedures. DRI's standard operating procedures describe the method and materials, using step-by-step instructions, that are required to collect field water quality samples and protect the samples from tampering and environmental conditions that may alter their chemistry.

The second tier of QA used on this project consisted of field QA samples, specifically field blanks, duplicates, and spiked samples. The intent of field blanks was to provide direct measures of the contribution of radioactive material that was derived from the bottles, sampling equipment, and the environment to the activity of tritium measured within the samples. Duplicate samples were collected to establish a measure of the repeatability of the analysis. Spiked samples consisted of samples that had the appearance of being routine CEMP samples, yet actually consisted of water containing a known quantity of tritium in it. Twelve samples (30% of the sample load) were collected for the purposes of meeting field QA requirements. The third tier of QA used on this project were laboratory QA controls, which consisted of the utilization of published laboratory techniques for the analysis of tritium, method blanks, laboratory control samples, and laboratory duplicates. The laboratory QA samples provide a measure of the accuracy and the confidence of the reported results.

Samples collected in 2009 were analyzed using enriched gas proportional counting at the University of Miami. CEMP tritium samples taken prior to 2008 were analyzed using gas proportional counting or enriched liquid scintillation counting. The enriched gas proportional counting process significantly lowers the detection limit, improving confidence in the reported results, especially for those samples containing little or no tritium. The decision level (L_C) (see Glossary, Appendix B) for enriched gas proportional counting was 0.54 picocuries per liter (pCi/L). The L_C is the sample activity required such that 95% of the laboratory's repeated measures of background are exceeded. The L_C is established solely based on the variability of multiple measures of samples used to establish laboratory background. If a sample exceeds this threshold, then it is considered to be distinguishable from background. The MDC (see Glossary, Appendix B) for tritium was approximately 1.0 pCi/L. The MDC is a more rigorous threshold that dictates the sample to be distinguishable from background at a confidence of 95%. The MDC considers both the variability associated with multiple measures of the background as well as the variability associated with multiple measures of the sample itself.

7.2.3 Results of Surface Water and Spring Discharge Monitoring

Measured tritium (^3H) concentrations from the springs and surface waters sampled in 2009 ranged from below MDC to 22.4 pCi/L (Table 7-7). Almost all samples yielded results that quantifiably exceeded background (i.e., ≥ MDC), with the exception of Stone Cabin Ranch, which had tritium activities less than the L_C and was therefore indistinguishable from background. The greatest activities were detected in samples from Boulder City and Henderson, which originated from Lake Mead. Slightly elevated tritium activities in Lake Mead are documented in previous annual NTS environmental reports (e.g., Bechtel Nevada [BN], 2004a; 2005a; BN and NSTec, 2006; NSTec, 2007a; 2008a; 2009a) and are due to residual tritium persisting in the environment that originated from global atmospheric nuclear testing. All tritium results were well below the safe drinking water limit of 20,000 pCi/L.

All samples were analyzed for the presence of trends with respect to samples collected in previous years. The results are consistent with samples collected in 2008 and analyzed using enriched gas-proportional counting. The 2008 and 2009 results differ from that of previous years due to the use of an improved analytical method rather than any real change in the activity of the water being monitored.

Table 7-6. CEMP water monitoring locations sampled in 2009

Monitoring Location Description	Latitude	Longitude	Date Sampled	Sample Collection Method
Adaven Springs	38 08.25	-115 36.20	7/06/2009	By hand from stream discharging from spring orifice.
Alamo city water supply system—source of water is municipal well field	37 21.84	-115 10.20	6/16/2009	By hand from municipal water well; sampled new well location this year.
Amargosa Valley school well	36 34.16	-116 27.66	8/05/2009	By hand at wellhead at the school.
Beatty Water and Sewer municipal water distribution system	36 50.00	-116 49.44	7/21/2009	By hand at holding tank containing municipal well water at corner of Rhyolite and Bullfrog. Coordinates refer to location of well supplying water to the holding tank.
Boulder City municipal water distribution system	35 59.74	-114 49.90	6/30/2009	By hand from a drinking fountain inside Hemenway Park; water originates from Lake Mead.
Caliente municipal water supply well	37 37.01	-114 30.44	6/16/2009	By hand at well in municipal well field; sampled new well location this year.
Cedar City municipal water supply well about 11 kilometers (km) (7 miles [mi]) west of town	37 39.84	-113 13.03	6/18/2009	By hand at wellhead.
Delta municipal well	39 21.85	-112 34.46	6/17/2009	By hand at wellhead; sampled new well location this year.
Duckwater water supply well	38 55.41	-115 41.99	7/07/2009	By hand at faucet inside pump house.
Ely municipal water source	39 13.80	-114 54.01	7/07/2009	By hand from sump located in spring discharge area. Springs are used as municipal water supply.
Goldfield municipal water supply well about 18 km (11 mi) north of town	37 52.41	-117 14.96	7/21/2009	By hand at wellhead.
Henderson municipal water distribution system	36 00.43	-114 57.95	6/30/2009	By hand from faucet inside building of College of Southern Nevada; water originates from Lake Mead.
Indian Springs municipal well	36 34.15	-115 40.25	8/05/2009	By hand at wellhead; sampled new well location this year.
Las Vegas Valley Water District #103	36 13.94	-115 15.13	8/11/2009	By hand at wellhead.
Medlin's Ranch—spring 16 km (10 mi) west of ranch house	37 24.10	-115 32.25	7/07/2009	By hand at kitchen faucet; water originates from spring 16 km (10 mi) west of ranch.
Mesquite municipal water supply well 3 km (2 mi) southeast of town	36 46.40	-114 03.26	8/11/2009	By hand at wellhead.
Milford municipal well	38 22.88	-112 59.78	6/17/2009	By hand at wellhead.
Nyala Ranch water well	38 14.93	-115 43.72	7/06/2009	By hand from front yard hose faucet at house.
Overton water well located at Arrow Canyon approximately 32 km (20 mi) west of town	36 44.06	-114 44.87	8/11/2009	By hand at wellhead.
Pahrump municipal water system	36 11.29	-115 57.95	8/05/2009	By hand at wellhead.

Table 7-6. CEMP water monitoring locations sampled in 2009 (continued)

Monitoring Location Description	Latitude	Longitude	Date Sampled	Sample Collection Method
Pioche municipal well	37 56.98	-114 25.78	6/16/2009	By hand at wellhead.
Rachel—Little Ale Inn well	37 38.79	-115 44.75	7/22/2009	By hand from faucet inside Lil Ale Inn Restaurant.
Sarcobatus Flats well	37 16.78	-117 01.92	7/21/2009	By hand at wellhead.
St. George municipal water distribution system	37 10.47	-113 23.92	6/18/2009	By hand at water treatment plant; water originates from Quail Creek Reservoir.
Stone Cabin Ranch	38 12.45	-116 37.99	7/07/2009	By hand from outside house faucet; water originates from spring.
Tecopa Residential Well	35 57.59	-116 15.71	8/05/2009	By hand at wellhead.
Tonopah public utilities well field located approximately 19 km (12 mi) from town	38 11.68	-117 04.70	7/22/2009	By hand at wellhead.
Twin Springs Ranch Well	38 12.21	-116 10.53	7/07/2009	By hand from wellhead.

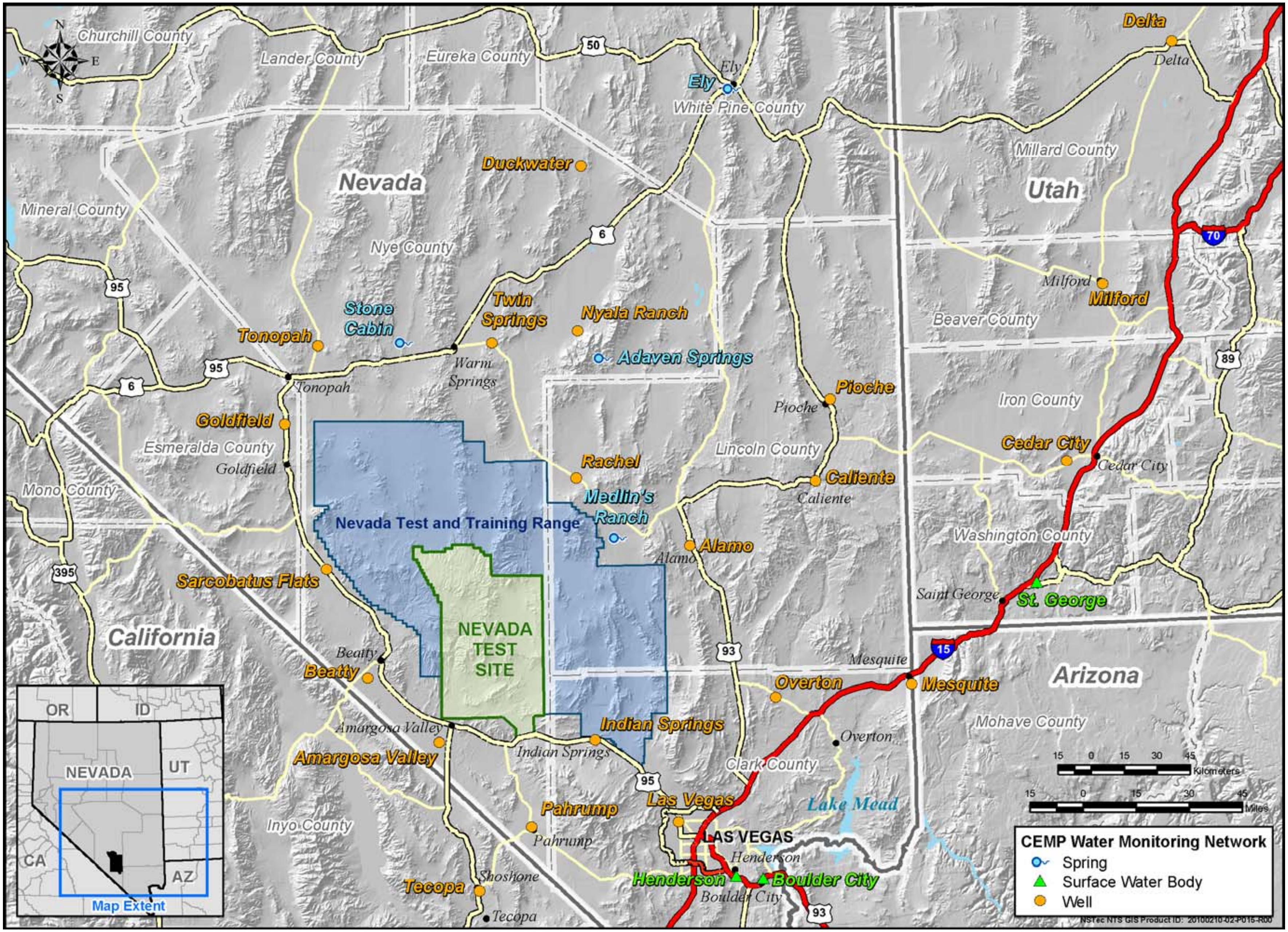

Figure 7-7. 2009 CEMP water monitoring locations

Table 7-7. Tritium results for CEMP offsite surface water and spring discharges in 2009

Monitoring Location	^{3}H ± Uncertainty [(a)] (pCi/L)		
Adaven Springs	12.4	±	0.8
Ely municipal water source	2.7	±	0.6
Medlin's Ranch	3.8	±	0.6
Stone Cabin Ranch	0.5	±	0.6
Boulder City municipal water distribution system	21.6	±	1.4
Henderson municipal water distribution system	22.4	±	1.5
St. George municipal water distribution system	9.3	±	0.7

(a) ± 2 standard deviations
L_C = 0.54 pCi/L; MDC = 1.04 pCiL for all samples

7.2.4 Results of Groundwater Monitoring

The results for the 21 groundwater tritium analyses from the University of Miami Tritium Laboratory are presented in Table 7-8. The measured activities ranged from -0.3 to 4.7 pCi/L. Most of the samples yielded results that were statistically indistinguishable from laboratory background (≤ L_C). The exceptions were samples obtained from Caliente, Las Vegas, and Nyala Ranch. Of these samples, only one exceeded the MDC (1.0 pCi/L). This sample was from Caliente (4.7 ± 0.6 pCi/L). The tritium activities for Caliente were similar to those detected in 2008 (5.4 pCi/L) and are likely due to tritium originating from atmospheric testing in waters that have recharged sometime over the last 50 years. All groundwater samples were well below the safe drinking water limit of 20,000 pCi/L.

Table 7-8. Tritium results for CEMP offsite wells in 2009

Monitoring Location	^{3}H ± Uncertainty [(a)] (pCi/L)		
Alamo City	0.4	±	0.6
Amargosa Valley	-0.1	±	0.6
Beatty	0.1	±	0.6
Caliente	4.7	±	0.6
Cedar City	-0.1	±	0.6
Delta	-0.1	±	0.6
Duckwater	0.1	±	0.6
Goldfield	0.0	±	0.6
Indian Springs	- 0.3	±	0.6
Las Vegas	0.8	±	0.6
Mesquite	-0.1	±	0.6
Milford	0.0	±	0.6
Nyala Ranch	0.5	±	0.6
Overton	0.1	±	0.6
Pahrump	0.1	±	0.6
Pioche	-0.1	±	0.6
Rachel	-0.1	±	0.6
Sarcobatus Flats	0.3	±	0.6
Tecopa	0.4	±	0.6
Tonopah	-0.3	±	0.6
Twin Springs Ranch	0.0	±	0.6

± 2 standard deviations
L_C = 0.54 pCi/L; MDC = 1.04 pCi/L for all samples

7.2.5 Environmental Impact

Results of the CEMP tritium analyses conducted on selected offsite groundwater wells and water supply systems surrounding the NTS showed no evidence of tritium migration off site via groundwater. Detectable activities (≥ MDC) were most often found in surface waters and in spring discharge emanating from small local groundwater systems located in recharge areas. Most of the groundwater samples analyzed were below the L_C for tritium (see Table 7-8). The greatest observed activity, 4.7 pCi/L for Caliente, is upgradient of the NTS and may be due to localized recharge.

8.0 Radiological Biota Monitoring

Historical atmospheric nuclear weapons testing, outfalls from underground nuclear tests, and radioactive waste disposal sites provide sources of potential radiation contamination and exposure to Nevada Test Site (NTS) plants and animals (biota). U.S. Department of Energy (DOE) Order DOE O 5400.5, "Radiation Protection of the Public and the Environment," requires that all DOE sites monitor radioactivity in the environment to ensure that the public does not receive a radiological dose greater than 100 millirems per year (mrem/yr) from all pathways of exposure, including the ingestion of contaminated plants and animals. DOE also requires monitoring to determine if the radiological dose to aquatic and terrestrial biota on site exceeds DOE-established limits expressed in rad (for radiation absorbed dose, see Glossary, Appendix B) per day (rad/d).

Current NTS land use precludes the harvest of plants or plant parts (e.g., pine nuts and wolf berries) for direct consumption by humans. Therefore, the ingestion of game animals is the primary potential biotic pathway for radionuclide contamination from the NTS to the public. Game animals on the NTS may travel off the site and become available, through hunting, for consumption by the public. Game animals are therefore monitored under the *Routine Radiological Environmental Monitoring Plan* (RREMP) (Bechtel Nevada [BN], 2003a). In 2009, National Security Technologies, LLC (NSTec), Environmental Protection and Technical Services conducted the monitoring.

Plants and game animals are sampled annually from contaminated NTS sites to estimate hypothetical doses to hunters (i.e., the public), measure the potential for radionuclide transfer through the food chain, and determine if NTS biota are exposed to radiation levels harmful to their own populations. Biota and soil samples are also taken from Radioactive Waste Management Sites (RWMSs) as a measure of the integrity of waste disposal cells. This chapter describes the biota monitoring program designed to meet public and environmental radiation protection regulations (see Section 2.3) and presents the field sampling and analyses results from 2009. Analyses results used to estimate the dose to humans consuming game animals from the NTS and to biota found in contaminated areas of the NTS are presented in Section 9.0.

Radiological Biota Monitoring Goals	***Analytes Measured in Plant and Animal Tissues***
Determine if the potential dose to humans consuming game animals from the NTS is less than 100 mrem/yr, the limit set by DOE O 5400.5. Determine if the absorbed radiation dose to NTS biota is less than the limits set by DOE O 5400.5 and DOE Standard DOE-STD-1153-2002, "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota:" < 1 rad/d for terrestrial plants and aquatic animals < 0.1 rad/d for terrestrial animals Demonstrate that the integrity of waste disposal units at the Area 3 and Area 5 RWMSs are not compromised by the burrowing activities of fossorial animals and that they are maintained in accordance with Performance Assessments.	Americium-241 (^{241}Am) Cesium-137 (^{137}Cs) Cobalt-60 (^{60}Co) Europium-152 (^{152}Eu) Europium-154 (^{154}Eu) Tritium (^{3}H) Plutonium-239+240 ($^{239+240}$Pu) Strontium-90 (^{90}Sr)

8.1 Species Selection

The goal for vegetation monitoring is to sample the most contaminated plants within the NTS environment. They are generally found inside demarcated radiological areas near the "ground zero" locations of historical aboveground nuclear tests. The species selected for sampling represent the most dominant life forms (e.g., trees, shrubs, herbs, or grasses) at these sites. Woody vegetation (i.e., shrubs versus forbs or grasses) is sampled because it is reported to have deeper penetrating roots and higher concentrations of ^{3}H (Hunter and Kinnison, 1998). Woody vegetation also is a major source of browse for game animals that might potentially migrate off site. Grasses and forbs are also sampled when present, however, because they are also a source of food for wildlife. Plant parts collected for analysis represent new growth over the past year.

The game animals monitored to assess the potential dose to the public had to meet three criteria: (1) have a relatively high probability of entering the human food chain; (2) have a home range that overlaps a contaminated site and, as a result, have the potential for relatively high radionuclide body burdens from exposure to contaminated soil, air, water, or plants at the contaminated site; and (3) be sufficiently abundant at a site to acquire an adequate tissue sample for laboratory analysis. These criteria limited the candidate game animals to those listed in Table 8-1. Mule deer and pronghorn antelope are only collected as the opportunity arises if they are found dead on the NTS (e.g., from accidentally being hit by a vehicle). Tissues from other game species, such as predators, or species analogous to big game, such as feral horses, may be collected opportunistically as well. If game animals are not sufficiently abundant at a particular site, or at a particular time, non-game small mammals may be used as an analog.

The goal of sampling animals for the purpose of determining potential dose to biota is to select species that are most exposed and most sensitive to effects from radiation. In general, mammals and birds are more sensitive to radiation than fish, amphibians, or invertebrates (DOE-STD-1153-2002). Because of this, and because no native fish or amphibians are found on the NTS, the species in Table 8-1 are also used to assess potential dose to animals.

The sampling strategy used to assess the integrity of radioactive waste containment includes sampling plants, animals, and soil excavated by ants or small mammals on top of waste covers. Plants were generally selected by size with preference to larger shrubs under the assumption they have deeper roots and therefore would be more likely to have penetrated waste. Small mammals had to meet three criteria: (1) be fossorial (i.e., burrow and live predominantly underground), (2) have a home range small enough to ensure it resides for most of its time on the waste disposal site, and (3) be sufficiently abundant at a site to acquire an adequate tissue sample for laboratory analysis. These criteria limited the animals to those listed in Table 8-1. Soils excavated by ants or small mammals were also selected for sampling on the basis of size, with preference to larger ant mounds and animal burrow sites under the assumption that these burrows were deeper and had a higher potential for penetrating waste.

Table 8-1. NTS animals monitored for radionuclides

Small Mammals	Large Mammals	Birds
Game Animals Monitored for Dose Assessments		
Cottontail rabbit (*Sylvilagus audubonii*)	Mule deer (*Odocoileus hemionus*)	Mourning dove (*Zenaida macroura*)
Jackrabbit (*Lepus californicus*)	Pronghorn antelope (*Antilocapra americana*)	Chukar (*Alectoris chukar*)
		Gambel's quail (*Callipepla gambelii*)
Animals Monitored for Integrity of Radioactive Waste Containment or as Game Animal Analogs		
Kangaroo rats (*Dipodomys* spp.)		
Mice (*Peromyscus* spp.)		
Antelope ground squirrel (*Ammospermophilus leucurus*)		
Desert woodrat (*Neotoma lepida*)		

8.2 Site Selection

The monitoring design focuses on sampling sites that have the highest concentrations of radionuclides in other media (e.g., soil and surface water) and have relatively high densities of candidate animals. The RREMP identifies five contaminated sites and their associated control sites at which biota are sampled once every five years. They are E Tunnel Ponds, Palanquin Crater, Sedan Crater, T2, and Plutonium Valley (Figure 8-1), and each is associated with one type of a legacy contamination area (see bulleted list below). The control site selected for each contaminated site has similar biological and physical features. Control sites are sampled to document the radionuclide levels representative of background.

- **Runoff areas or containment ponds associated with underground or tunnel test areas.** Contaminated water draining from test areas can form surface water sources that are important given the limited availability of surface water on the NTS. Therefore, they have a high potential for transferring radionuclides to plants and wildlife seeking surface water. The associated monitoring site is E Tunnel Ponds below Rainier Mesa. It was last sampled in 2007.

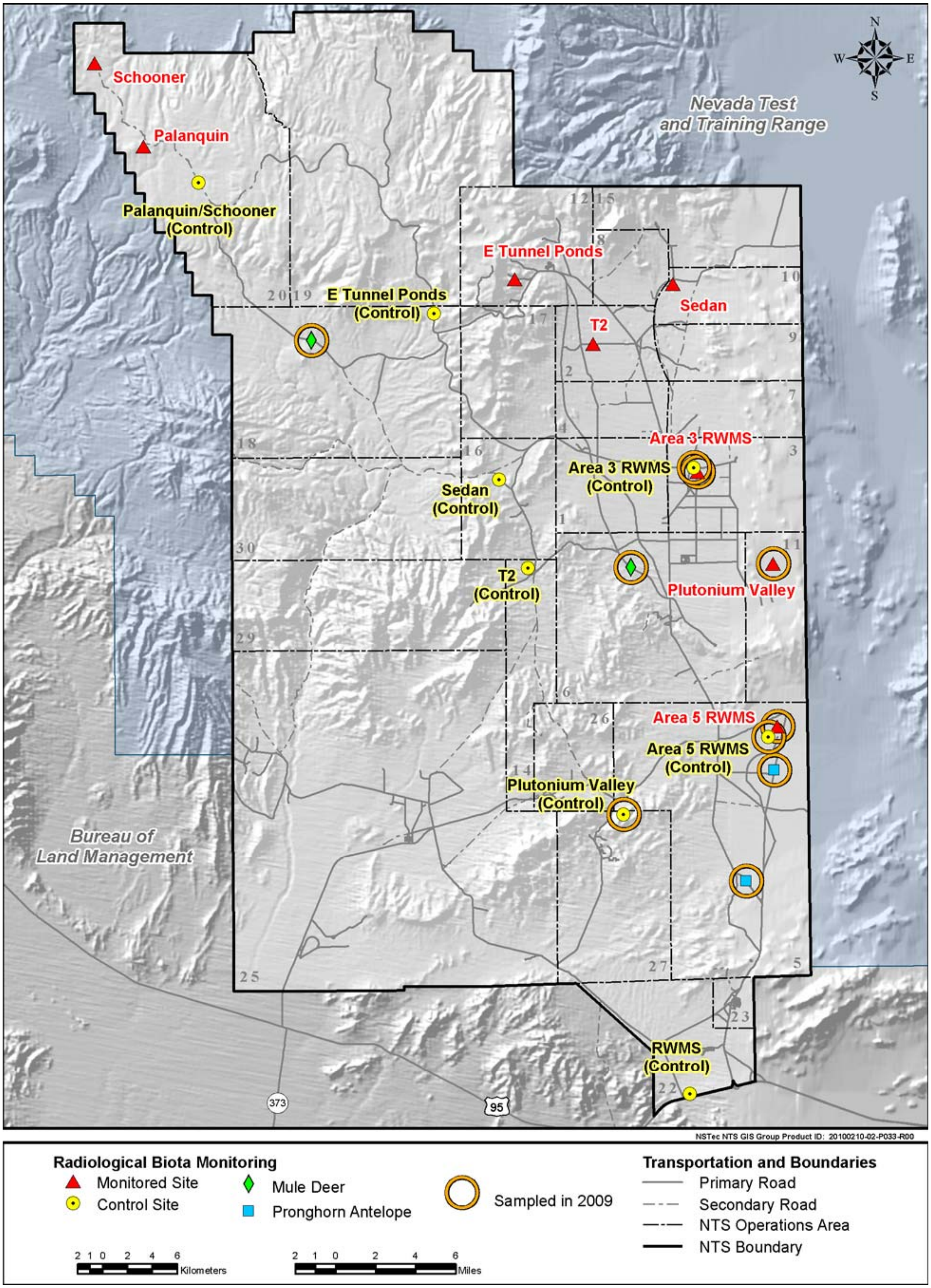

Figure 8-1. Radiological biota monitoring sites on the NTS

- **Plowshare sites in alluvial fill at lower elevations with high surface contamination.** Subsurface nuclear detonations at these sites have distributed contaminants over a wide area, usually in the lowest precipitation areas of the NTS. The associated monitoring site is Sedan Crater in Yucca Flat. It was last sampled in 2005.
- **Plowshare sites in bedrock or rocky fill at higher elevations with high surface contamination.** Subsurface nuclear detonations at these sites distributed contaminants over a wide area, usually in the highest precipitation areas of the NTS. Through 2007, the associated monitoring site was Palanquin Crater. It was last sampled in 2003. Schooner Crater was added as a biota sampling site and was last sampled in 2008.
- **Atmospheric test areas.** These sites have highly disturbed soils due to the removal of topsoil during historical cleanup efforts and to the sterilization of soils from heat and radiation during testing. The same areas were often used for multiple nuclear tests. The associated monitoring site is T2 in Yucca Flat. It was last sampled in 2006.
- **Aboveground safety experiment sites.** These areas are typified by current radioactive soil contamination, primarily in the form of plutonium and uranium. The associated monitoring site is Plutonium Valley in Area 11. It was sampled in 2009.

In addition to RREMP sampling locations, biota sampling is also conducted periodically at radioactive waste disposal locations on the NTS to assess whether fossorial small mammals are being exposed to buried wastes and, therefore, whether the integrity of waste containment is compromised. Two radioactive waste disposal facilities are sampled:

- **Area 3 RWMS.** Waste disposal cells within the Area 3 RWMS are subsidence craters resulting from underground nuclear testing. Two closed cells containing bulk low level radioactive waste are craters U-3ax and U-3bl, which were combined to form the U-3ax/bl disposal unit (Corrective Action Unit 110). U-3ax/bl is covered with a vegetated, native alluvium closure cover that is at least 2.4 meters (m) (8 feet [ft]) thick. It was sampled in 2009.
- **Area 5 RWMS.** Waste disposal has occurred at the Area 5 RWMS since the early 1960s. There are 11 closed disposal cells containing bulk low-level radioactive waste. The cells are unlined pits and trenches that range in depth from 4.6 to 15 m (15 to 48 ft). The unvegetated soil cover caps for the pits and trenches are approximately 2.4 m (8 ft) thick. Three pits and one trench were sampled in 2009.

8.3 2009 Biota Sampling and Analysis

In 2009, Plutonium Valley was sampled (Figure 8-1). Plutonium Valley is located in Area 11 on the eastern edge of the NTS at an elevation of 1,250 m (4,100 ft). Four safety experiments were conducted in Plutonium Valley from November 1, 1955, through January 18, 1956, in which conventional explosives were used on nuclear weapons. In one of these tests, there was a slight yield that resulted in the production of fission products (e.g., ^{137}Cs and ^{90}Sr), but the primary contaminant produced and dispersed in the area was plutonium. A control area for Plutonium Valley is located about 24 kilometers (km) (14.9 miles [mi]) southwest of the sample site (Figure 8-1). Any of the candidate game species is likely to be present in Plutonium Valley or at the control site.

The Area 3 RWMS, Area 5 RWMS, and their control sites were also sampled in 2009 (Figure 8-1). The Area 3 RWMS is in Yucca Flat at an elevation of 1,223 m (4,012 ft). Yucca Flat was one of several primary nuclear test areas. Between 1952 and 1972, 60 nuclear weapons tests were conducted within 400 m (1,312 ft) of the Area 3 RWMS boundary. Fourteen of these tests were atmospheric, which left primarily ^{3}H, ^{90}Sr, ^{137}Cs, ^{152}Eu, $^{239+240}$Pu, and ^{241}Am in the surface soil across the area. Sampling in 2009 was conducted on the U-3ax/bl cover. The control location was approximately 50 m (164 ft) north of the northwest corner of the Area 3 RWMS.

The Area 5 RWMS is in northern Frenchman Flat at an elevation of 962 m (3,156 ft) and consists of numerous landfill pits, trenches, and boreholes. Buried radioactive materials at the Area 5 RWMS consists primarily of ^{3}H, ^{90}Sr, ^{137}Cs, uranium (various isotopes), plutonium (various isotopes), and ^{241}Am. No nuclear weapons testing occurred within the boundaries of the Area 5 RWMS, but there were 10 underground tests within 4.3 km (2.7 mi) and 14 atmospheric tests within 7 km (4.3 mi). Sampling was conducted on Pits 1, 2, and 5 and Trench 6. The control location was 0.4 km (0.25 mi) west of the southwest corner of the Area 5 RWMS.

8.3.1 Plants

Plant sampling at Plutonium Valley occurred on July 21, 2009, and at the control site on July 22, 2009. Twelve samples were collected from each location. Plants were sampled over an area of about 0.053 square kilometers (km^2) (0.021 square miles [mi^2]) inside the Plutonium Valley Contamination Area (Figure 8-2). Plants were collected over a smaller area (0.008 km^2 [0.003 mi^2]) at the control site due to higher plant densities there. All samples consisted of about 150 to 500 grams (g) (5.3 to 17.6 ounces [oz]) of fresh-weight plant material and were composites of material from many plants of the same species found generally within 5 m (16 ft) of each other. The species sampled represent the dominant vegetation at each site (Table 8-2).

Plant sampling at the Area 3 and Area 5 RWMS took place August 31, 2009. Three plants were sampled from each of the RWMSs and RWMS control locations (Table 8-2 and Figure 8-3). The control location plants were composited in order to make one sample having 150 to 500 g (5.3 and 17.6 oz) of fresh-weight plant material.

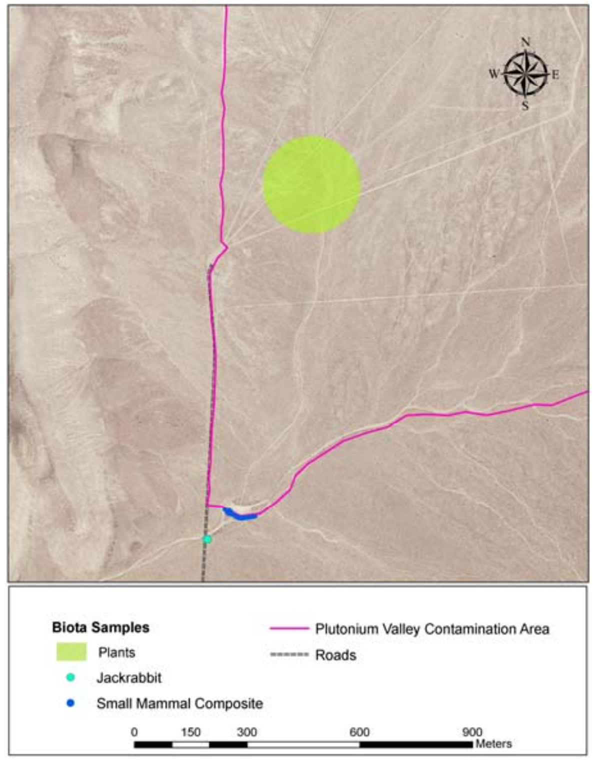

Figure 8-2. Plant and animal sample locations in Plutonium Valley, 2009

Plant leaves and stems were hand-plucked and stored in airtight plastic bags. Rubber gloves were used by samplers and changed between each composite sample. Samples were labeled and stored in an ice chest. Within 4 hours of collection, the samples were delivered to the laboratory. Water was separated from plant samples by distillation; however, four samples from Plutonium Valley and two samples from the Plutonium Valley Control location (all grasses) were so dry that no water could be obtained. Water and dried plant tissues were submitted to a commercial laboratory for analysis of radionuclides. Water from plants was analyzed for ^{3}H, and dried plant tissue was analyzed for gamma-emitting radionuclides, ^{90}Sr, uranium, plutonium, and ^{241}Am.

Table 8-2. Plant species sampled in 2009

Common Name	Scientific Name	Name Code	Plutonium Valley	Plutonium Valley Control	Area 3 RWMS	Area 3 RWMS Control	Area 5 RWMS	Area 5 RWMS Control
Indian ricegrass	*Achnatherum hymenoides*	ACHY	X					
Four-wing saltbush	*Atriplex canescens*	ATCA	X	X	X			
Shadscale saltbush	*Atriplex confertifolia*	ATCO			X			
Saltbush (unknown species)	*Atriplex* spp.	Atriplex spp.					X	X
Red brome	*Bromus rubens*	BRRU	X					
Cheatgrass	*Bromus tectorum*	BRTE		X				
Yellow spiderflower	*Cleome lutea*	CLLU		X				
Nevada buckwheat	*Eriogonum deflexum*	ERDI	X	X				
Burrobush	*Hymenoclea salsola*	HYSA	X	X				
Winterfat	*Krascheninnikovia lanata*	KRLA			X			
Creosote bush	*Larrea tridentata*	LATR						X
Basin wildrye	*Leymus cinereus*	LECI		X				
Bashful four o'clock	*Mirabilis pudica*	MIPU	X					
Russian thistle	*Salsola paulsenii*	SAPA					X	
Russian thistle (unknown species)	*Salsola* spp.	Salsola spp.				X		

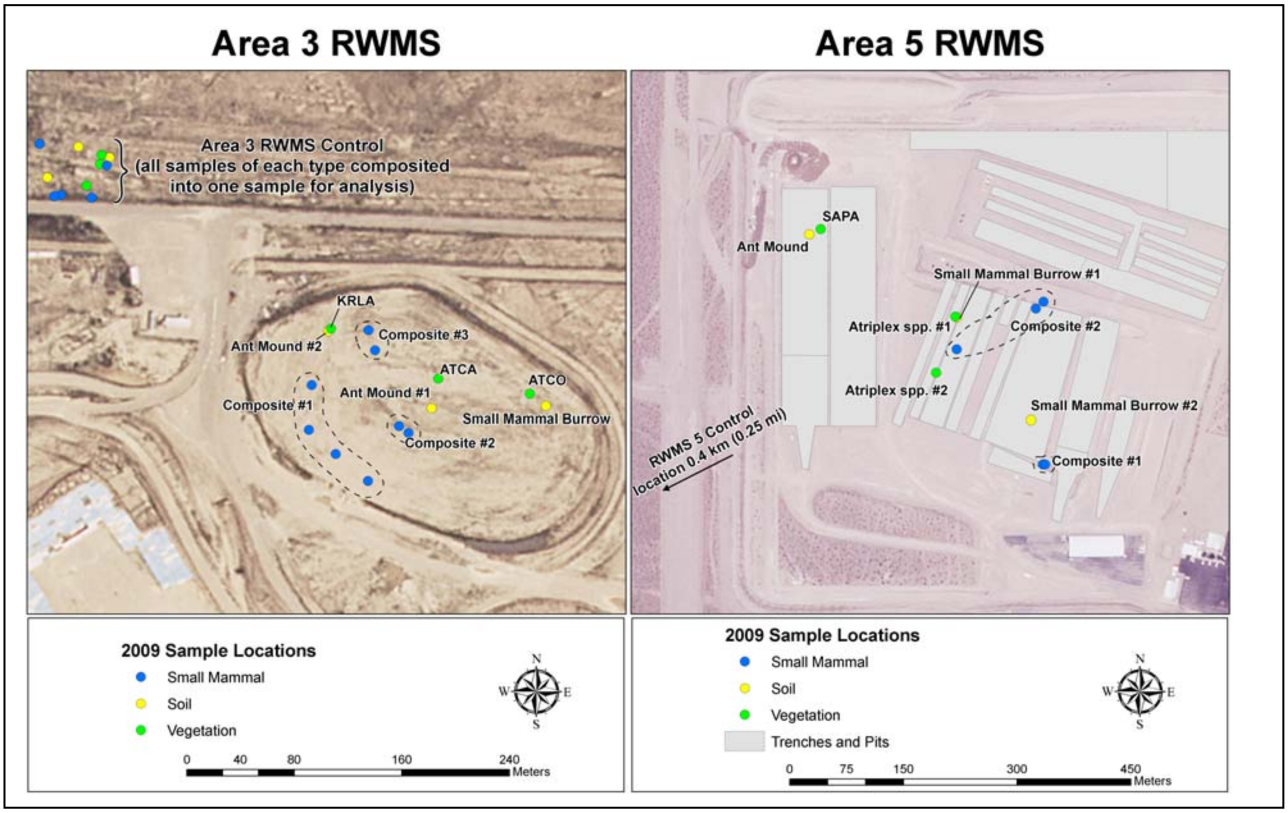

Figure 8-3. Plant, animal, and animal-excavated soil sampling at the Area 3 and Area 5 RWMS

Results of radiological analyses of plant samples are listed in Table 8-3. As expected, more man-made radionuclides were detected in higher concentrations in samples from the monitored sites (Plutonium Valley, Area 3 RMWS, and Area 5 RWMS) compared with their control sites. Radionuclides detected in the most samples were ^{3}H (100 percent of all samples from each of the Area 3 and Area 5 RWMSs), $^{239+240}$Pu (58.3, 33.3, and 66.6 percent of samples from Plutonium Valley, the Area 3 RMWS, and the Area 5 RWMS, respectively), and ^{241}Am (33.3 percent of samples from Plutonium Valley). Concentrations measured during 2009 were similar to those measured at these locations in recent years (BN, 2005a; NSTec, 2008a).

Table 8-3. Concentrations of man-made radionuclides in plants sampled in 2009

	Radionuclide Concentrations ± Uncertainty[(a)]			
Sample	**^{3}H (pCi/L)[(b)]**	**^{137}Cs (pCi/g)[(c)]**	**$^{239+240}$Pu (pCi/g)[(c)]**	**^{241}Am (pCi/g)[(c)]**
Plutonium Valley				
ACHY #1	NA[(d)]	0.036 ± 0.087	0.066 ± 0.029	0.019 ± 0.011
ACHY #2	NA	0.056 ± 0.123	0.021 ± 0.016	0.003 ± 0.007
ATCA #1	82 ± 87	0.009 ± 0.033	0.008 ± 0.009	0.000 ± 0.003
ATCA #2	46 ± 52	0.019 ± 0.040	0.017 ± 0.014	-0.002 ± 0.005
BRRU #1	NA	0.067 ± 0.158	0.094 ± 0.035	0.021 ± 0.013
BRRU #2	NA	0.078 ± 0.090	0.028 ± 0.018	0.012 ± 0.010
ERDI #1	65 ± 85	-0.024 ± 0.056	0.001 ± 0.003	-0.004 ± 0.004
ERDI #2	65 ± 85	-0.011 ± 0.045	-0.002 ± 0.004	0.000 ± 0.003
HYSA #1	60 ± 84	-0.038 ± 0.046	0.022 ± 0.015	0.000 ± 0.003
HYSA #2	85 ± 90	0.032 ± 0.034	0.081 ± 0.031	0.003 ± 0.009
MIPU #1	41 ± 49	0.001 ± 0.051	0.003 ± 0.004	0.007 ± 0.008
MIPU #2	125 ± 97	0.029 ± 0.037	0.003 ± 0.005	-0.002 ± 0.005
% Above Average MDC[(e)]:	**0% (131)**	**0% (0.106)**	**58.3% (0.011)**	**33.3% (0.011)**

Table 8-3. Concentrations of man-made radionuclides in plants sampled 2009 (continued)

Sample	Radionuclide Concentrations ± Uncertainty[(a)]			
	^{3}H (pCi/L)[(b)]	^{137}Cs (pCi/g)[(c)]	$^{239+240}$Pu (pCi/g)[(c)]	^{241}Am (pCi/g)[(c)]
Area 3 RWMS				
ATCA	1,360 ± 312	0.163 ± 0.098	0.002 ± 0.006	-0.001 ± 0.006
ATCO	72,000 ± 7,340	-0.005 ± 0.045	0.077 ± 0.032	0.001 ± 0.005
KRLA	3,460 ± 499	-0.008 ± 0.080	0.047 ± 0.025	0.010 ± 0.013
% Above Average MDC:	**100% (383)**	**33.3% (0.093)**	**66.6% (0.012)**	**0% (0.013)**
Area 5 RWMS				
Atriplex spp. #1	46,800,000 ± 4,720,000	0.022 ± 0.042	0.027 ± 0.018	0.005 ± 0.007
Atriplex spp. #2	66,200,000 ± 6,710,000	-0.005 ± 0.035	-0.001 ± 0.006	-0.002 ± 0.005
SAPA	77,200 ± 7,860	0.018 ± 0.059	0.000 ± 0.005	-0.002 ± 0.006
% Above Average MDC:	**100% (1,1901)**	**0% (0.075)**	**33.3% (0.013)**	**0% (0.011)**
Plutonium Valley Control				
ATCA#1	88 ± 86	-0.004 ± 0.044	0.002 ± 0.006	-0.002 ± 0.003
ATCA#2	104 ± 92	-0.001 ± 0.029	0.003 ± 0.005	-0.001 ± 0.004
BRTE#1	NA	-0.057 ± 0.083	0.003 ± 0.007	0.001 ± 0.004
BRTE#2	NA	0.093 ± 0.087	0.001 ± 0.005	-0.001 ± 0.004
CLLU#1	187 ± 104	0.002 ± 0.042	0.000 ± 0.005	-0.004 ± 0.004
CLLU#2	150 ± 102	0.006 ± 0.041	-0.001 ± 0.005	-0.001 ± 0.003
ERDI#1	115 ± 93	0.041 ± 0.037	-0.001 ± 0.005	0.001 ± 0.004
ERDI#2	22 ± 50	-0.004 ± 0.036	0.002 ± 0.006	-0.002 ± 0.003
HYSA#1	49 ± 86	0.019 ± 0.035	0.002 ± 0.006	-0.001 ± 0.007
HYSA#2	53 ± 84	0.003 ± 0.030	0.000 ± 0.005	-0.003 ± 0.007
LECI#1	4 ± 77	-0.035 ± 0.087	0.003 ± 0.005	-0.002 ± 0.005
LECI#2	83 ± 88	0.051 ± 0.096	0.001 ± 0.004	-0.003 ± 0.004
% Above Average MDC:	**8.3% (144)**	**0% (0.083)**	**0% (0.011)**	**0% (0.011)**
Area 3 Control				
Salsola spp. composite	38 ± 216	0.064 ± 0.101	0.008 ± 0.009	0.003 ± 0.007
% Above Average MDC:	**0% (378)**	**0% (0.064)**	**0% (0.008)**	**0% (0.016)**
Area 5 Control				
LATR/Atriplex spp. composite	33 ± 217	-0.016 ± 0.044	0.001 ± 0.006	0.001 ± 0.005
% Above Average MDC:	**0% (380)**	**0% (0.016)**	**0% (0.016)**	**0% (0.012)**

Shaded results are considered detected (results greater than the sample-specific MDC).
(a) ± 2 standard deviations
(b) picocuries per liter water from sample
(c) picocuries per gram dry weight of sample
(d) NA = Not analyzed, not enough water in sample for ^{3}H analysis
(e) MDC = minimum detectable concentration (see Glossary, Appendix B)

8.3.2 Animals

State and federal permits were secured to trap specific small mammals and birds in 2009 and to sample road-killed, large mammals. Animal trapping took place at the Plutonium Valley and Plutonium Valley Control locations from July 21, 2009, through September 3, 2009, and at the Area 3 and Area 5 RWMS locations August 31, 2009, through October 4, 2009. Animal sample locations in 2009 are displayed in Figures 8-1, 8-2, and 8-3. All animal samples are described in Table 8-4.

In the laboratory, whole bodies of animals sampled were homogenized except for big game samples that consisted of only muscle tissue. Past results have shown that radionuclide concentrations are generally higher in the skin, bone, and viscera compared with muscle. Though muscle is usually the only portion consumed by humans, whole animals were homogenized to give a more conservative (higher) estimate of potential dose to someone consuming the animals (see Section 9.1.3). Water was distilled from the samples and submitted to a laboratory for ^{3}H analysis, and the tissue samples were submitted for analysis of gamma-emitting radionuclides, uranium, plutonium, and ^{241}Am. Tissue samples were also analyzed for ^{90}Sr except those from the RWMS and RWMS Control locations because results from analyses of other radionuclides were adequate for determining whether or not biota had entered buried waste.

Table 8-4. Animal samples collected in 2009

Location	Sample Name	Sample Description
Plutonium Valley		
	Jackrabbit	one jackrabbit
	Small Mammal Composite	composite of nine antelope ground squirrels and one kangaroo rat
Plutonium Valley Control		
	Mourning Dove #1	one mourning dove
	Mourning Dove #2	one mourning dove
Area 3 RWMS		
	Composite #1	composite of four kangaroo rats
	Composite #2	composite of two antelope ground squirrels
	Composite #3	composite of one kangaroo rat and one antelope ground squirrel
Area 5 RWMS		
	Composite #1	composite of two kangaroo rats
	Composite #2	composite of three kangaroo rats
Area 3 RWMS Control		
	Composite #1	composite of two kangaroo rats and three mice
Area 5 RWMS Control		
	Composite #1	composite of four kangaroo rats
Opportunistic Sampling		
	Mule Deer (Area 18)	Adult male mule deer hit by vehicle June 21, 2009
	Mule Deer (Area 6)	Adult male mule deer hit by vehicle September 22, 2009
	Pronghorn #1 (Area 5)	Adult male pronghorn antelope hit by vehicle August 14, 2009
	Pronghorn #2 (Area 5)	Juvenile (~1 year old) pronghorn antelope hit by vehicle August 16, 2009

Man-made radionuclides were detected in all animal samples collected at Plutonium Valley, the Area 3 RWMS, and at the Area 5 RWMS, while none were detected in big-game samples (Table 8-5). Activity levels were dominated by $^{239+240}$Pu in Plutonium Valley samples and by ^{3}H in RWMS samples. Two samples, one from the Plutonium Valley Control location and one from the Area 3 RWMS Control location, had concentrations of man-made radionuclides higher than the minimum detectable concentration (MDC). Concentrations of ^{3}H were much higher in animals collected from waste covers at the Area 3 and Area 5 RWMSs compared with those at the RWMS control sites, and concentrations of $^{239+240}$Pu and ^{241}Am in animals from Plutonium Valley were higher than those in animals from the Plutonium Valley Control site. In contrast, the $^{239+240}$Pu detected in all animal samples were very similar between those at the Area 3 RWMS and the Area 3 RWMS Control site.

Table 8-5. Concentrations of man-made radionuclides detected in animals sampled in 2009

	Radionuclide Concentrations ± Uncertainty[a]			
Sample	**^{3}H (pCi/L)[b]**	**^{90}Sr (pCi/g)[c]**	**$^{239+240}$Pu (pCi/g)[c]**	**^{241}Am(pCi/g)[c]**
Plutonium Valley				
Jackrabbit	179 ± 223	0.012 ± 0.032	0.207 ± 0.063	0.051 ± 0.017
Small Mammal Composite	284 ± 222	0.029 ± 0.033	0.438 ± 0.092	0.078 ± 0.021
% Above MDC (Average MDC):	**0% (359)**	**0% (0.062)**	**100% (0.014)**	**100% (0.005)**
Area 3 RWMS				
Composite #1	3,410 ± 491	NA [d]	0.038 ± 0.021	0.002 ± 0.008
Composite #2	24,500 ± 2,580	NA	0.075 ± 0.031	0.008 ± 0.012
Composite #3	49,100 ± 5,030	NA	0.036 ± 0.021	0.006 ± 0.008
% Above MDC (Average MDC):	**100% (353)**		**100% (0.013)**	**0% (0.017)**
Area 5 RWMS				
Composite #1	54,900 ± 5,610	NA	-0.002 ± 0.007	0.004 ± 0.007
Composite #2	287,000 ± 29,200	NA	0.007 ± 0.010	0.001 ± 0.005
% Above MDC (Average MDC):	**100% (536)**		**0% (0.017)**	**0% (0.008)**
Plutonium Valley Control				
Mourning Dove #1	81 ± 214	0.031 ± 0.029	0.010 ± 0.007	0.004 ± 0.005
Mourning Dove #2	576 ± 246	0.109 ± 0.042	0.005 ± 0.007	0.001 ± 0.004
% Above MDC (Average MDC):	**50% (358)**	**0% (0.057)**	**0% (0.010)**	**50% (0.006)**

Table 8-5. Concentrations of man-made radionuclides detected in animals sampled in 2009 (continued)

	Radionuclide Concentrations ± Uncertainty[a]			
Sample	**^{3}H (pCi/L)[b]**	**^{90}Sr (pCi/g)[c]**	**$^{239+240}$Pu (pCi/g)[c]**	**^{241}Am(pCi/g)[c]**
Area 3 RWMS Control	166 ± 225	NA	0.065 ± 0.029	0.001 ± 0.005
% Above MDC (Average MDC):	**0% (380)**		**100% (0.009)**	**0% (0.007)**
Area 5 RWMS Control	114 ± 221	NA	0.003 ± 0.006	0.003 ± 0.008
% Above MDC (Average MDC):	**0% (379)**		**0% (0.009)**	**0% (0.013)**
Opportunistic Sampling				
Mule Deer (Area 18)	102 ± 118	-0.009 ± 0.022	0.003 ± 0.006	-0.002 ± 0.006
Mule Deer (Area 6)	0 ± 214	0.043 ± 0.035	0.007 ± 0.006	0.005 ± 0.005
Pronghorn #1 (Area 5)	126 ± 95	0.053 ± 0.065	0.000 ± 0.003	0.000 ± 0.003
Pronghorn #2 (Area 5)	174 ± 100	0.030 ± 0.061	0.000 ± 0.002	0.000 ± 0.003
% Above MDC (Average MDC):	**0% (218)**	**0% (0.24)**	**0% (0.006)**	**0% (0.008)**

Shaded results are considered detected (results greater than the sample-specific MDC).
(a) ± 2 standard deviations
(b) picocuries per liter water from sample
(c) picocuries per gram dry weight of sample
(d) NA = samples from the RWMS or RWMS Control locations were not analyzed for ^{90}Sr.

8.3.3 Soil

Sampling of soil took place on August 31, 2009. Three samples from small mammal burrows or ant nests were collected from each of the Area 3 and Area 5 RWMSs (Figure 8-3 and Table 8-6). Soil from three animal burrows was composited into one sample for each of the Area 3 and Area 5 RWMS Control locations (Table 8-6). Each sample consisted of about 500 g (17.6 oz) of dry soil, which was submitted to a commercial laboratory for analysis of gamma-emitting radionuclides, plutonium, and ^{241}Am.

Table 8-6. Animal excavated soil samples collected in 2009

Location	Sample Name	Sample Description
Area 3 RWMS		
	Ant Mound #1	Soil from an ant mound near the center of U-3ax/bl cover
	Ant Mound #2	Soil from an ant mound near northwest side of U-3ax/bl cover
	Small Mammal Burrow	Soil from a small mammal burrow (likely kangaroo rat burrow) near the northeast side of U-3ax/bl cover
Area 5 RWMS		
	Ant Mound	Soil from an ant mound on Pit 5
	Small Mammal Burrow #1	Soil from a small mammal burrow (likely kangaroo rat burrow) on Trench 6
	Small Mammal Burrow #2	Soil from a small mammal burrow (likely kangaroo rat burrow) on Pit 1
Area 3 RWMS Control		
	Area 3 Control Composite	Soil from two small mammal burrows (likely kangaroo rat burrows) and from one ant nest
Area 5 RWMS Control		
	Area 5 Control Composite	Soil from two small mammal burrows (likely kangaroo rat burrows) and from one ant nest

Man-made radionuclides were detected in all soil samples (Table 8-7). The soil sample from the Area 3 RWMS Control location had relatively high concentrations of ^{137}Cs, ^{238}Pu, $^{239+240}$Pu, and ^{241}Am (Table 8-7), likely from historical atmospheric nuclear testing in near proximity to the Area 3 RWMS. The ^{152}Eu and ^{155}Eu are both activation products common in surface soil in areas where atmospheric testing occurred.

Table 8-7. Man-made radionuclides detected in animal excavated soil samples collected in 2009

	Radionuclide Concentrations ± Uncertainty[a]					
Sample	**^{137}Cs (pCi/g)[b]**	**^{152}Eu (pCi/g)[b]**	**^{155}Eu (pCi/g)[b]**	**^{238}Pu (pCi/g)[b]**	**$^{239+240}$Pu (pCi/g)[b]**	**^{241}Am(pCi/g)[b]**
Area 3 RWMS						
Ant Mound #1	0.0340 ± 0.0424	-0.058 ± 0.116	0.029 ± 0.115	-0.0019 ± 0.0031	0.0627 ± 0.0161	0.0120 ± 0.0118
Ant Mound #2	0.0814 ± 0.0532	0.167 ± 0.149	0.025 ± 0.102	0.0000 ± 0.0017	0.0622 ± 0.0158	0.0042 ± 0.0078
Small Mammal Burrow	0.4280 ± 0.0695	1.610 ± 0.220	0.040 ± 0.128	0.0505 ± 0.0302	0.6000 ± 0.1310	0.0974 ± 0.0407
	33% (0.081)	**33% (0.190)**	**0% (0.204)**	**33% (0.0131)**	**100% (0.0112)**	**33% (0.0159)**
Area 5 RWMS						
Ant Mound	-0.0239 ± 0.0387	-0.037 ± 0.092	0.109 ± 0.089	-0.0075 ± 0.0054	0.0042 ± 0.0063	-0.0026 ± 0.0062
Small Mammal Burrow #1	0.0094 ± 0.0494	-0.089 ± 0.079	0.174 ± 0.115	-0.0019 ± 0.0033	0.0067 ± 0.0057	-0.0026 ± 0.0065
Small Mammal Burrow #2	-0.0035 ± 0.0327	0.028 ± 0.094	0.024 ± 0.087	-0.0016 ± 0.0032	0.0106 ± 0.0058	0.0024 ± 0.0070
	0% (0.053)	**33% (0.119)**	**33% (0.124)**	**0% (0.0090)**	**33% (0.0081)**	**0% (0.0136)**
Area 3 RWMS Control						
Area 3 Control Composite	0.6370 ± 0.0804	0.141 ± 0.128	0.004 ± 0.096	0.0988 ± 0.0431	6.0300 ± 0.9780	0.8380 ± 0.1850
	100% (0.054)	**0% (0.152)**	**0% (0.168)**	**100% (0.0129)**	**100% (0.0262)**	**100% (0.0206)**
Area 5 RWMS Control						
Area 5 Control Composite	0.0503 ± 0.0365	-0.018 ± 0.102	0.101 ± 0.108	0.0010 ± 0.0020	0.0275 ± 0.0107	0.0035 ± 0.0092
	0% (0.070)	**0% (0.155)**	**0% (0.198)**	**0% (0.0031)**	**100 % (0.0031)**	**0% (0.0140)**

Shaded results are considered detected (results greater than the sample-specific MDC).
[a] ± 2 standard deviations
[b] picocuries per gram dry weight of sample

8.4 Data Assessment

Biota sampling results confirm that man-made radionuclide concentrations are generally higher at monitored locations (Plutonium Valley, Area 3 RWMS, and the Area 5 RWMS) compared with their control locations. This is true for $^{239+240}Pu$ and ^{241}Am in samples from Plutonium Valley, and for ^{3}H in samples from the Area 3 and Area 5 RWMSs. Concentrations of ^{3}H in vegetation at the two RWMSs suggest the concentration of ^{3}H in soil moisture in the root zone of these plants is elevated. Due to the high mobility of ^{3}H, it does not necessarily indicate that roots have penetrated the waste zone. Soil samples do not suggest burrowing animals have come into contact with buried waste. It is likely that elevated ^{3}H concentrations in animals come from their consuming plants on the covers. Though certain radionuclides are elevated, the levels detected pose negligible risk to humans and biota. The potential dose to a person hunting and consuming these animals is well below dose limits to members of the public (see Section 9.1.3). Also, radionuclide concentrations were below levels considered harmful to the health of the plants or animals; the dose resulting from observed concentrations were less than 1 percent of dose limits set to protect populations of plants and animals (see Section 9.2).

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9.0 Radiological Dose Assessment

The U.S. Department of Energy (DOE) requires DOE facilities to estimate the radiological dose to the general public and to plants and animals in the environment caused by past or present facility operations. These requirements are specified in DOE Order DOE O 450.1A, "Environmental Protection Program;" DOE O 435.1, "Radioactive Waste Management;" and DOE O 5400.5, "Radiation Protection of the Public and the Environment" (see Section 2.3). To estimate these radiological doses, mathematical models are used along with data gathered annually on the Nevada Test Site (NTS) by National Security Technologies, LLC (NSTec), and existing data from past inventories of the radionuclide content of NTS surface soils. The 2009 data used are presented in Sections 3.0 through 8.0 of this report and include the results for onsite compliance monitoring of air, water, direct radiation, and biota, and the offsite monitoring results of air, direct radiation, and water reported by the Community Environmental Monitoring Program (CEMP). The specific goals for the dose assessment component of radiological monitoring are shown below along with the compliance measures that are calculated in order to accomplish these assessment goals.

Radiological Dose Assessment Goals	***Compliance Measures***
Determine if the maximum radiation dose to a member of the general public from airborne radionuclide emissions at the NTS is less than the Clean Air Act, National Emission Standards for Hazardous Air Pollutants (NESHAP) limit of 10 millirems per year (mrem/yr) (0.1 millisieverts per year [mSv/yr]). Determine if radiation levels from the Radioactive Waste Management Sites (RWMSs) are likely to result in a dose exceeding the 25 mrem/yr (0.25 mSv/yr) dose limit to members of the public as specified in DOE Manual DOE M 435.1-1, "Radioactive Waste Management Manual."	Annual average concentrations of radionuclides at six NTS critical-receptor air sampling locations compared to the Concentration Levels for Environmental Compliance, Table 2, Appendix E, Title 40 Code of Federal Regulations Part 61 (NESHAP)
Determine if the total radiation dose to a member of the general public from all possible pathways (direct exposure, inhalation, ingestion of water and food) as a result of NTS operations is less than the limit of 100 mrem/yr (1 mSv/yr) established by DOE O 5400.5.	Committed effective dose equivalent (CEDE) for an offsite resident from all pathways, in mrem/yr (or mSv/yr)
Determine if the radiation dose (in a unit of measure called a rad [see Glossary, Appendix B]) to NTS biota is less than the following limits set by DOE O 5400.5 and DOE Standard DOE-STD-1153-2002, "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota": < 1 rad per day (rad/d) for terrestrial plants and aquatic animals < 0.1 rad/d for terrestrial animals	Absorbed dose to onsite plants and animals, in rad/d

9.1 Radiological Dose to the Public

Several steps are taken to compute radiological dose to the public from all pathways. This section briefly describes these steps, identifies how field monitoring data interface with other NTS data sources (e.g., radionuclide inventory data) to provide input to the dose estimates, and presents the results of each step.

9.1.1 Possible Exposure Pathways to the Public

As prescribed in the *Routine Radiological Environmental Monitoring Plan* (Bechtel Nevada [BN], 2003a), NSTec routinely samples air, groundwater, and biota to document the amount of radioactivity in these media and to provide data that can be used to assess the radiation dose received by the general public from several pathways.

The potential pathways by which a member of the general public residing off site might receive a radiation dose resulting from past or present NTS operations include the following:

- Inhalation of, ingestion of, or direct external exposure to airborne radionuclide emissions transported off site by wind
- Ingestion of meat from wild game animals that drink from surface waters and eat vegetation containing NTS-related radioactivity
- Drinking contaminated water from underground aquifers containing radionuclides that have migrated from the sites of past underground nuclear tests or waste management sites
- Exposure to direct radiation along the borders of the NTS

In 2009, only the wind transport pathway and the ingestion of wild game were credible pathways of exposure to the public residing off site. The subsections below address all of the potential pathways and their contribution to public dose estimated for 2009.

9.1.2 Dose to the Public from NTS Air Emissions

Six air particulate and tritium (^{3}H) sampling stations located near the boundaries and the center of the NTS are approved by the U.S. Environmental Protection Agency Region IX as critical receptor samplers to demonstrate compliance with the NESHAP public dose limit of 10 mrem/yr from air emissions. Analysis of air particulate and ^{3}H data obtained at these six stations was performed in 2009 (Section 4.1.5). The annual average concentration of an airborne radionuclide must be less than its NESHAP Concentration Level for Environmental Compliance (abbreviated as compliance level [CL]) (Table 4-1 of Section 4.1.1). The CL for each radionuclide represents the annual average concentration of that radionuclide in air that would result in a CEDE of 10 mrem/yr. If multiple radionuclides are detected at a station, then compliance with NESHAP is demonstrated when the sum of the fractions (determined by dividing each radionuclide's concentration by its CL and then adding the fractions together) is less than 1.0.

The following man-made radionuclides were detected at three or more of the critical receptor samplers: americium-241 (^{241}Am), plutonium-238 (^{238}Pu), plutonium-239+240 ($^{239+240}$Pu), and ^{3}H (Section 4.1.5). All concentrations of these radionuclides were well below their CLs. The concentration of each man-made radionuclide measured at each critical receptor sampler was divided by its respective CL to obtain a "fraction of CL." These fractions were then summed for each location and all were less than 1.0 (Table 4-12, Section 4.1.5). As in previous years, the 2009 data from the six critical receptor samplers show that the NESHAP dose limit to the public of 10 mrem/yr was not exceeded. The Schooner critical receptor station in the far northwest corner of the NTS had the highest concentrations of radioactive air emissions, yet an individual residing at this station would experience a dose from air emissions of only 1.7 mrem/yr, 17 percent of the admissible dose limit. No one resides at this location, and the dose at offsite populated locations 20–80 kilometers (km) (12–50 miles [mi]) from the Schooner station would be much lower due to wind dispersion. More detailed information regarding the estimation of the airborne dose to the public in 2009 from U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) activities are reported in NSTec (2010b).

9.1.3 Dose to the Public from Ingestion of Wild Game from the NTS

Two game species, mule deer and mourning doves, have been shown to travel off the NTS and be available to hunters (Giles and Cooper, 1985; NSTec, 2009a). Because of this, game animals on the NTS are sampled annually near known radiologically contaminated areas to give conservative (worst case) estimates of the level of radionuclides that hunters may consume if these animals are harvested off of the NTS. In 2009, one jackrabbit and one composite small mammal sample were collected from Plutonium Valley in Area 11, and multiple composite small mammal samples were collected from the Area 3 and Area 5 RWMSs and analyzed for radionuclide content (Section 8.3.2, Table 8-5).

The potential dose to an individual from consuming these game animals was calculated using the following assumptions:

- Small mammal samples were assumed to be analogous to small game species (i.e., rabbits and jackrabbits) for dose calculations.
- An individual consumes 20 jackrabbits over the year (these numbers are the possession limits set for these species by the Nevada Division of Wildlife).
- An individual consumes a total of 10,260 grams (g) of jackrabbit meat (513 g per jackrabbit).
- Each consumed jackrabbit contains the average concentration of radionuclides that was detected in the samples collected at each location.
- The moisture content of meat consumed is 74 percent.

The CEDE was calculated using dose conversion factors (DOE, 1988) multiplied by the total activity estimated to be consumed for each of the detected radionuclides. The resultant potential doses are shown in Table 9-1. The highest estimated CEDE was 4.47 mrem (0.0447 mSv) from consuming jackrabbits from Plutonium Valley, which is only 4.47 percent of the annual dose limit for members of the public. If someone were to consume just one jackrabbit from Plutonium Valley, the potential dose would be only about 0.22 mrem (0.0022 mSv). The dose from consuming 20 jackrabbits from the Area 3 and Area 5 RWMSs would be 7 and 30 times lower, respectively.

The radionuclide contributing the most dose was $^{239+240}Pu$. ^{3}H was present at much higher concentrations than other nuclides; however, ^{3}H contributes relatively little to the dose because it only emits low energy beta particles and has a short biological half-life.

To put these potential doses in perspective, the dose from naturally occurring cosmic radiation received during a 2-hour airplane flight at 39,000 feet is about 1 mrem (0.01 mSv). This is about the same as the CEDE from consuming 4 jackrabbits from Plutonium Valley, consuming almost 34 jackrabbits from the Area 3 RWMS, or consuming 133 jackrabbits from the Area 5 RWMS.

Table 9-1. Hypothetical dose to a human consuming NTS jackrabbits sampled from the NTS, 2009

	Average Radionuclide Concentrations[(a)]			Dose Conversion Factor (mrem/pCi ingested)[(b)]	Committed Effective Dose Equivalent (CEDE) (mrem)	Sum of CEDE (mrem)
Plutonium Valley						
Jackrabbit[(c)]	$^{239+240}$**Pu**	0.323	pCi/g[(d)]	0.004300000	3.70	4.47
	^{241}**Am**	0.064	pCi/g[(d)]	0.004500000	0.77	
Area 3 RWMS						
Jackrabbit[(c)]	^{3}**H**	25,670	pCi/L[(d)]	0.000000063	0.02	0.590
	$^{239+240}$**Pu**	0.049	pCi/g[(d)]	0.004300000	0.57	
Area 5 RWMS						
Jackrabbit[(c)]	^{3}**H**	170,950	pCi/L[(d)]	0.000000063	0.15	0.15

(a) Average of animal samples collected within each location. Negative values were set to zero prior to averaging. Radionuclides not detected at a location were not included in dose estimate.
(b) Dose conversion factors for human ingestion are from DOE (1988).
(c) Hypothetical jackrabbit; the concentration is the average of all animals sampled at the location. Human dose assumes that meat from 20 jackrabbits was consumed, and the meat on each weighed 513 g.
(d) Picocuries per gram dry weight of sample. Muscle water content = 74% by weight.

9.1.4 Dose to the Public from Drinking Contaminated Groundwater

The 2009 goundwater monitoring data indicate that groundwater from offsite private and community wells and offsite springs has not been impacted by past NTS nuclear testing operations (see Section 5.1.6). No man-made radionuclides have been detected in any of the offsite public or private wells or springs. Therefore, drinking contaminated groundwater is not a possible pathway of exposure to the public residing off site.

9.1.5 Dose to the Public from Direct Radiation Exposure along NTS Borders

The direct exposure pathway from gamma radiation to the public is monitored annually (see Chapter 6.0). In 2009, the only place where the public had the potential to be exposed to direct radiation along the NTS borders was at Gate 100, the primary entrance to the site on the southern NTS border. Trucks hauling radioactive materials, primarily low-level radioactive waste being shipped for disposal at the Area 3 and Area 5 RWMSs, park outside Gate 100 while waiting for entry approval. Only during these times is there a potential for exposure to the public on the NTS. However, no member of the public resides or remains full-time at the Gate 100 truck parking area.

9.1.6 Dose to the Public from Waste Operations

DOE M 435.1-1 states that low-level waste (LLW) disposal facilities shall be operated, maintained, and closed so that a reasonable expectation exists that annual dose to members of the public shall not exceed 25 mrem. This limit is for all exposure pathways combined. Given that the RWMSs are located well within the NTS boundaries, no members of the public could access these areas for significant periods of time. However, for purposes of documenting potential impacts, the possible pathways for radionuclide movement from waste disposal facilities are monitored.

During 2009, the external radiation measured near the boundaries of the Area 3 and Area 5 RWMS could not be distinguished from background levels (see Section 6.3.3). Area 3 and Area 5 RWMS operations would have contributed negligible external exposure to a hypothetical person residing near the boundaries of these sites and certainly no dose to the offsite public.

The dose from the air pathway can be estimated from air monitoring results from stations near the RWMSs (see Chapter 4, Figure 4-1). Mean concentrations of radionuclides in air at the Area 3 and Area 5 environmental sampler locations were, at the most, 4 percent of their CLs ($^{239+240}$Pu at U-3ah/at S; see Table 9-2). Scaling this to the 10 mrem dose that the CL represents would be < 1 mrem to a hypothetical person residing near the boundaries of the RWMS, and certainly the dose would be much lower to the offsite public.

The dose to the public from groundwater that could be attributable to waste operations is negligible. Groundwater monitoring indicates that no man-made radiological contamination has been detected in offsite public and private wells or springs (see Sections 5.1.6 and 7.2). Also, groundwater and vadose zone monitoring at the RWMSs, conducted to verify the performance of waste disposal facilities, have not detected the migration of radiological wastes into groundwater (see Section 10.1.6 and 10.1.7). Based on these results, potential doses to members of the public from LLW disposal facilities on the NTS from all pathways are negligible.

9.1.7 Release of Property Containing Residual Radioactive Material

The release of property off the NTS that contains residual radioactive material is controlled. No vehicles, equipment, structures, or other materials can be released from the NTS unless the amount of radiological contamination on such items is less than the authorized limits specified in the *Nevada Test Site Radiological Control Manual* (NNSA/NSO, 2009a) as specified in DOE O 5400.5. These limits are shown in Table 9-2. Items proposed for unrestricted release must be surveyed to document compliance with the release criteria.

In 2000, DOE placed a moratorium on the release of scrap material from radiological areas for recycling, which is still in effect. Government vehicles and equipment are routinely released or excessed when they are no longer needed by NTS projects or if they are required to be replaced. They are allowed to be released based on a combination of process knowledge and direct and indirect survey results that meet the release criteria of Table 9-2.

Some building structures and items on the NTS house uncontained radioactive materials. NSTec has no plans to release such structures and items off the NTS. If, in the future, there are plans to do so, approval of alternate authorized limits specific for this release would be requested from DOE in accordance with DOE O 5400.5. No items with residual radioactivity in excess of the limits specified in Table 9-2 were released from the NTS in 2009.

Table 9-2. Allowable total residual surface contamination for property released off NTS

Radionuclide	Residual Surface Contamination ($dpm/100\ cm^2$)[a] Removable	Average[b] (Fixed & Removable)	Maximum Allowable[c] (Fixed & Removable)
Transuranics, ^{125}I, ^{129}I, ^{226}Ra, ^{227}Ac, ^{228}Ra, ^{228}Th, ^{230}Th, ^{231}Pa	20	100	300
Th-natural, ^{90}Sr, ^{126}I, ^{131}I, ^{133}I, ^{223}Ra, ^{224}Ra, ^{232}U, ^{232}Th	200	1,000	3,000
U-natural, ^{235}U, ^{238}U, and associated decay products, alpha emitters (α)	1,000 α	5,000 α	15,000 α
Beta (β)-gamma (γ) emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except ^{90}Sr and others noted above	1,000 β+γ	5,000 β+γ	15,000 β+γ
Tritium and tritiated compounds	10,000	N/A	N/A

(a) Disintegrations per minute per 100 square centimeters
(b) Averaged over an area of not more than 100 cm^2
(c) Applicable to an area of not more than 100 cm^2

Source: NNSA/NSO (2009a)

9.1.8 Total Offsite Dose to the Public from all Pathways

DOE O 5400.5 establishes a radiation dose limit to a member of the general public from all possible pathways as a result of DOE facility operations. This limit is 100 mrem/yr (1 mSv/yr) over and above background radiation and includes the air transport, ingestion, and direct exposure pathways. For 2009, the only possible pathways of public exposure to man-made radionuclides from current or past NTS activities included the air transport pathway and the ingestion of game animals. The doses from these pathways are combined below to present an estimate of the total 2009 dose to the maximally exposed individual (MEI) (see Glossary, Appendix B) residing off site.

The dose estimate for an offsite MEI from radionuclides in air is expected to be no greater than 1.69 mrem/yr (0.0169 mSv) (see Section 4.1.5). If the offsite MEI is assumed to eat 20 jackrabbits from Plutonium Valley, this individual may receive an estimated additional 4.47 mrem/yr (0.0447 mSv/yr) dose (see Table 9-1). The total CEDE to this hypothetical MEI would be 6.16 mrem/yr (0.0616 mSv/yr) (Table 9-3). The total dose of 6.16 mrem/yr is 6.2 percent of the DOE limit of 100 mrem/yr and about 1.8 percent of the total dose the MEI receives from natural background radiation (340 mrem/yr) (Figure 9-1).

Natural background radiation consists of cosmic radiation, terrestrial radiation, radiation from radionuclides within the composition of the human body (primarily potassium-40), and radiation from the inhalation of naturally occurring radon and its progeny. The cosmic and terrestrial components of background radiation shown in Figure 9-1 were estimated from the annual mean radiation exposure rate measured with a pressurized ion chamber (PIC) at Indian Springs by the CEMP (99.86 milliroentgens per year [mR/yr], rounded to 100 mR/yr; see Chapter 7, Table 7-4). The radiation exposure in air, measured by the PIC in units of mR/yr, is approximately equivalent to the unit of mrem/yr for tissue. The portion of the background dose from the internally deposited, naturally occurring radionuclides, and from the inhalation of radon and its daughters shown in Figure 9-1 were estimated at 40 mrem/yr and 200 mrem/yr, respectively, using the approximations by the National Council on Radiation Protection (1996).

Table 9-3. Estimated radiological dose to a hypothetical maximally exposed member of the general public from 2009 NTS operations

Pathway	Dose to MEI (mrem/yr)	Dose to MEI (mSv/yr)	Percent of DOE 100 mrem/yr Limit
Air[(a)]	1.69	0.0169	1.7
Water[(b)]	0	0	0
Wildlife[(c)]	4.47	0.0447	4.5
Direct[(d)]	0	0	0
All Pathways	6.16	0.0616	6.2

(a) Based on maximum observed annual average concentrations at compliance stations on the NTS (Section 4.1.5)
(b) Based on all offsite groundwater sampling in 2009 (Section 4.1.6)
(c) Assumes that the MEI consumes 20 jackrabbits from Plutonium Valley (Table 9-1)
(d) Based on 2009 gamma radiation monitoring data at NTS entrance (Section 6.3.1)

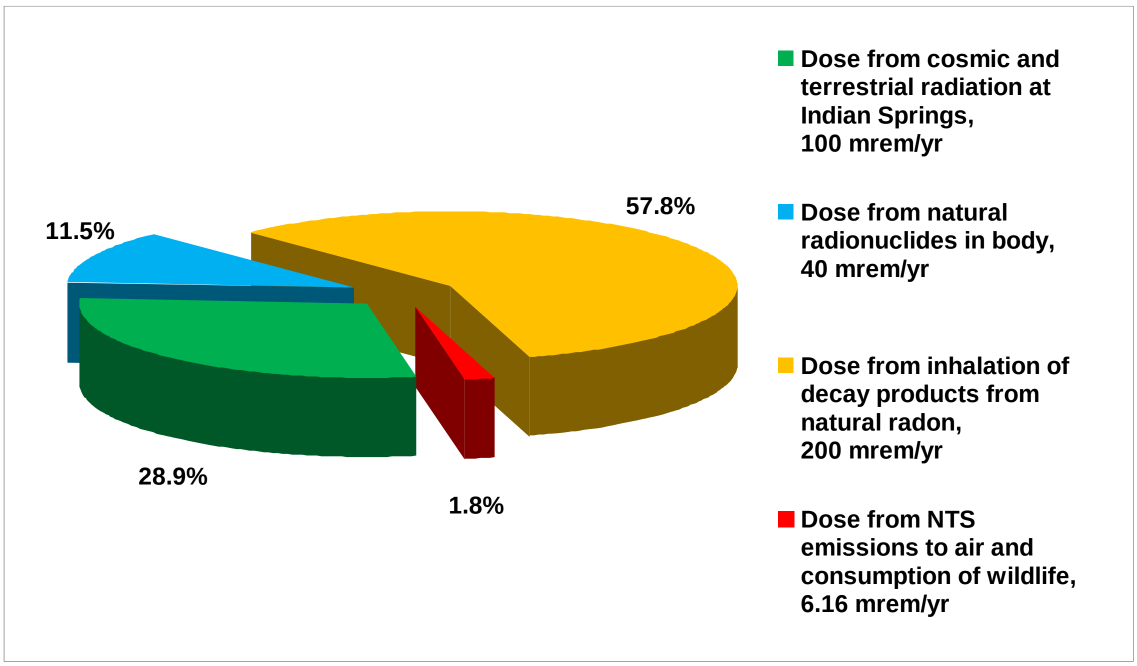

Figure 9-1. Comparison of radiation dose to the MEI from the NTS and natural background (percent of total)

9.1.9 Collective Population Dose

The collective population dose to residents within 80 km (50 mi) of the NTS emission sources was not estimated in 2009 because this assessment depends upon CAP88-PC estimations, which were not calculated. The DOE approved the discontinuance of reporting collective population dose because it is so low for the NTS. It has been below 0.6 person-rem/yr for the period 1992 to 2004 (Figure 9-2). The DOE recommended, however, that NNSA/NSO should consider reporting collective population dose once again if ever it exceeds 1.0 person-rem/yr (DOE, 2004a). It will be recalculated when either the radionuclide emissions from NTS activities or the population within 80 km of the NTS increase significantly (e.g., ≥ 50 percent), both of which are estimated annually (NSTec, 2010b),

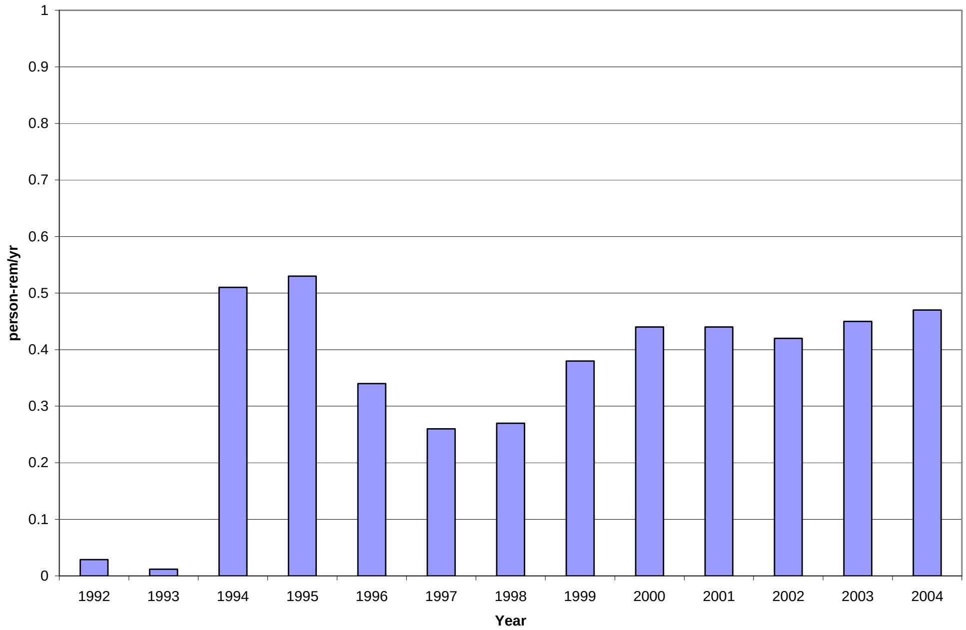

Figure 9-2. Collective population dose within 80 km of NTS emission sources from 1992 to 2004

9.2 Dose to Aquatic and Terrestrial Biota

DOE O 450.1A requires DOE facilities to evaluate the potential impacts of radiation exposure to biota in the vicinity of DOE activities. To assist in such an evaluation, DOE's Biota Dose Assessment Committee developed DOE-STD-1153-2002. This standard established the following radiological dose limits for plants and animals. Dose rates equal to or less than these are expected to have no direct, observable effect on plant or animal reproduction:

- 1 rad/d (0.01 grays per day [Gy/d]) for aquatic animals
- 1 rad/d (0.01 Gy/d) for terrestrial plants
- 0.1 rad/d (1 milligray per day) for terrestrial animals

DOE-STD-1153-2002 also provides concentration values for radionuclides in soil, water, and sediment that are to be used as a guide for determining if biota are potentially receiving radiation doses that exceed the limits. These concentrations are called the Biota Concentration Guide (BCG) values. They are defined as the minimum concentration of a radionuclide that would cause dose limits to be exceeded using very conservative uptake and exposure assumptions.

NSTec biologists use the graded approach described in DOE-STD-1153-2002. The approach is a three-step process consisting of a data assembly step, a general screening step, and an analysis step. The analysis step consists of site-specific screening, site-specific analysis, and site-specific biota dose assessment.

The following information is required by the graded approach:

- Identification of terrestrial and aquatic habitats on the NTS that have radionuclides in soil, water, or sediment
- Identification of terrestrial and aquatic biota on the NTS that occur in contaminated habitats and are at risk of exposure
- Measured or calculated radionuclide concentrations in soil, water, and sediment in contaminated habitats on the NTS that can be compared to BCG values to determine the potential for exceeding biota dose limits
- Measured radionuclide concentrations in NTS biota, soil, water, and sediment in contaminated habitats on the NTS to estimate site-specific dose to biota

A comprehensive biota dose assessment for the NTS using the graded approach was reported in the *Nevada Test Site Environmental Report 2003* (Bechtel Nevada, 2004a). This dose assessment demonstrated that the potential radiological dose to biota on the NTS was not likely to exceed dose limits. No data exist to suggest that NTS surface contamination conditions have changed; therefore, the terrestrial biota dose evaluation conclusion remains the same for 2009.

9.2.1 2009 Site-Specific Biota Dose Assessment

The site-specific biota dose assessment phase of the graded approach centers on the actual collection and analysis of biota. To obtain a predicted dose to biota sampled at Plutonium Valley and at the Area 3 and Area 5 RWMSs in 2009, the RESRAD-BIOTA, Version 1.21, computer model (DOE, 2004b) was used. Input to the model included the maximum concentrations of radionuclides in soil, as measured at the RWMSs during 2009 and as reported by McArthur and Mead (1989) for Plutonium Valley, and the maximum measured concentrations in animals and plants sampled from the monitoring site (see Section 8.3.1, Table 8-3, and Section 8.3.2, Table 8-5). Internal dose is calculated using measured concentrations in biota tissue, and external dose is predicted from the maximum soil concentrations.

The 2009 site-specific estimated dose rates to biota were all below the DOE limits for both plants and animals (Table 9-4). The highest was predicted for plants at the Area 5 RWMS, which was dominated by the internal dose from ^{3}H. The next highest dose rate was to animals at Plutonium Valley, which was dominated by internal dose from $^{239+240}Pu$. The total estimated dose rates ranged from 0.06 percent of the limit for plants at the Area 3 RWMS to 26 percent of the limit for animals at Plutonium Valley.

Table 9-4. Site-specific dose assessment for terrestrial plants and animals sampled in 2009

	Estimated Radiological Dose (rad/d)					
	To Plants[(a)]			To Animals[(a)]		
Location	**Internal**	**External**	**Total**	**Internal**	**External**	**Total**
Plutonium Valley	0.00062	0.0012	0.0018	0.0028	0.0012	0.0040
Area 3 RWMS	0.00045	0.00012	0.00057	0.00042	0.00012	0.00054
Area 5 RWMS	0.26	0.000003	0.26	0.00011	0.000003	0.00012
DOE Dose Limit:			**1**			**0.1**

(a) For information on plants and animals sampled, see Chapter 8

9.2.2 Environmental Impact

Radionuclides in the environment from past or present NTS activities result in potential dose to the public or biota much lower than dose limits set to protect health and the environment. The estimated worst case dose to the MEI for 2009 was 6.2 percent of the limits set to protect human health. Dose to biota at the NTS sites monitored during 2009 were 25.6 percent or less than the dose limits set to protect plant and animal populations. Based on the low potential doses from NTS radionuclides, impacts from those radionuclides are expected to be negligible.

10.0 Waste Management and Environmental Restoration

Several federal and state regulations govern the safe management, storage, and disposal of radioactive, hazardous, and solid wastes generated or received on the Nevada Test Site (NTS) for the purpose of protecting the environment and the public (see Section 2.4). This section describes both the waste management and environmental restoration operations conducted under the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) Environmental Management Program and summarizes the activities performed in 2009 to meet all environmental/public safety regulations. The goals of the program are shown below. The compliance measures and actions tracked and taken to meet the program goals are also listed.

Waste Management and Environmental Restoration Goals	*Compliance Measures/Actions*
Manage and safely dispose of the following wastes generated by NNSA/NSO, other U.S. Department of Energy (DOE), and selected U.S. Department of Defense (DoD) operations: Low-level waste (LLW) (see Glossary, Appendix B) Mixed low-level waste (MLLW) (see Appendix B) Hazardous waste (HW) (See Appendix B) Characterize, inspect, repackage, load, and ship remaining legacy transuranic (TRU) wastes stored on an interim basis at the NTS to either the Waste Isolation Pilot Plant (WIPP) in Carlsbad, New Mexico, or to the Idaho National Laboratory (INL). Characterize and remediate historical sites contaminated by NNSA/NSO nuclear testing activities. Manage and safely dispose of NTS solid/sanitary wastes generated by NNSA/NSO operations.	Completion/maintenance of documents required for a Category II Non-reactor Nuclear Facility established for waste disposal operations Acceptance criteria for radioactive wastes received for disposal Volume of disposed LLW Volume of stored nonradioactive HW Volume of disposed MLLW Weight of approved explosive ordnance wastes detonated Vadose zone monitoring Groundwater monitoring Site characterization, remediation, closure, and post-closure site monitoring Weight and volume of solid waste disposed

10.1 Radioactive Waste Management

U.S. Department of Energy Order DOE O 435.1, "Radioactive Waste Management," requires that DOE radioactive waste management activities be systematically planned, documented, executed, and evaluated. Radioactive waste is managed to protect the public, the environment, and workers from exposure to radiation from radioactive materials and to comply with all applicable federal, state, and local laws and regulations; executive orders; and DOE directives. In 2009, the major tasks within Radioactive Waste Management included the following:

- Verifying that NTS waste acceptance criteria are met for all wastes received and disposed
- Characterization of LLW and MLLW that has been generated by DOE projects within the state of Nevada
- Disposal of LLW and MLLW at the Area 5 Radioactive Waste Management Site (RWMS) and the Area 3 RWMS (the latter is currently inactive)
- Completing the characterization, visual examination, and repackaging of legacy TRU waste at the Waste Examination Facility (WEF) at the Area 5 Radioactive Waste Management Complex (RWMC) (see Glossary, Appendix B for the distinction between Area 5 RWMS and Area 5 RWMC)
- Completing the loading of legacy TRU waste at the Area 5 RWMC for shipment to either the WIPP or INL

10.1.1 Maintenance of Key Documents

Table 10-1 lists the key documents that must be current and in place for RWMS disposal operations to occur. In 2009, all of these key documents were maintained and one was revised.

Table 10-1. Key documents required for Area 3 RWMS and Area 5 RWMS operations

Disposal Authorization Statement
Disposal Authorization Statement for Area 5 RWMS, December 2000
Disposal Authorization Statement for Area 3 RWMS, October 1999
Performance Assessment
Addendum 2 to Performance Assessment for Area 5 RWMS, Revision 2.1, September 2005
Performance Assessment/Composite Analysis for Area 3 RWMS, Revision 2.1, October 2000
Composite Analysis
Composite Analysis for Area 5 RWMS, September 2001
Performance Assessment/Composite Analysis for Area 3 RWMS, Revision 2.1, October 2000
NTS Waste Acceptance Criteria
NTS Waste Acceptance Criteria, Revision 7-01, May 2009
Integrated Closure and Monitoring Plan
Closure Plan for the Area 3 RWMS at the NTS, September 2007
Closure Plan for the Area 5 RWMS at the NTS, September 2008
Auditable Safety Analysis
Documented Safety Analysis for the NTS Area 5 RWMC, Revision 3, November 2007
Visual Examination and Repackaging Building Addendum to the Area 5 RWMC Documented Safety Analysis, Revision 0, July 2008
Documented Safety Analysis for the NTS Area 3 RWMS, Revision 2, March 2006
Technical Safety Requirements for the Area 5 RWMC LLW Activities, Revision 5, October 2007
Technical Safety Requirements for the Area 5 RWMC TRU Waste Activities, Revision 8, July 2008
Technical Safety Requirements for the Area 3 RWMS, Revision 2, March 2006
Authorization Agreement for Area 5 RWMC, January 2007

10.1.2 Characterization of LLW and MLLW

Waste Generator Services (WGS) characterizes LLW and MLLW generated by DOE primarily at the NTS but also at selected offsite DOE locations. Characterization is performed using either knowledge of the generating process or sampling and analysis. Following the characterization of a waste stream, a Waste Profile is completed for approval by an appropriate disposal facility. The Waste Profile delineates the pedigree of the waste, including but not limited to a description of the waste generating process, physical and chemical characteristics, radioactive isotopes and their quantities, and detailed packaging information. WGS then packs and ships approved waste streams in accordance with U.S. Department of Transportation requirements to the Area 5 RWMS or to an offsite treatment, storage, or disposal facility.

In 2009, LLW and MLLW were characterized by WGS for the following general waste stream categories:

- Lead Solids
- Sealed Sources
- Miscellaneous Debris
- Hazardous Soils
- Contaminated Polychlorinated Biphenyl (PCB) Waste
- Compactable Trash
- Contaminated Soils
- Depleted Uranium
- Contaminated Asbestos Waste

10.1.3 Disposal of LLW and MLLW

The NTS RWMC, which includes the Area 3 and Area 5 RWMSs, operates as a Category II Non-reactor Nuclear Facility. The RWMC is designed and operated to perform three functions:

- Dispose of LLW and MLLW from NNSA/NSO activities performed on the NTS and offsite in the State of Nevada.
- Dispose of DOE LLW and MLLW from around the DOE complex, primarily from the cleanup of sites associated with the manufacture of weapons components and materials.
- Dispose of LLW and MLLW designated as classified material by DoD.

All generators of waste streams must demonstrate eligibility to ship waste to the NTS for disposal, submit profiles characterizing specific waste streams, meet the NTS Radioactive Waste Acceptance Criteria, and receive programmatic approval from NNSA/NSO. To assess and predict the long-term performance of LLW disposal sites, NNSA/NSO conducts a Performance Assessment (PA) and a Composite Analysis (CA). A PA is a systematic analysis of the potential risks posed by a waste disposal site to the public and to the environment. A CA is an assessment of the risks posed by all wastes disposed in a LLW disposal site and by all other sources of residual contamination that may interact with the disposal site. The RWMC receives LLW generated within the DOE complex from numerous DOE sites across the United States, LLW from DoD sites that carry a national security classification, and MLLW generated within the DOE complex for disposal.

The Area 5 RWMS includes 65 hectares (ha) (160 acres [ac]) of historical and active disposal cells used for burial of both LLW and MLLW, and approximately 235 ha (580 ac) of land available for future radioactive disposal cells. Waste disposal at the Area 5 RWMS has occurred in a 37 ha (92 ac) portion of the site since the early 1960s. This part of the Area 5 RWMS (commonly referred to as the "92-Acre Area") consists of 31 disposal cells (pits and trenches) and 13 Greater Confinement Disposal (GCD) boreholes (listed below). This site is used for disposal of waste in drums, soft-sided containers, large cargo containers, and boxes. The 92-Acre Area is expected to be filled and closed in 2011, and new cells extending to the north and west are expected to be used until planned RWMS closure after 2027. LLW and MLLW disposal services are expected to continue at the Area 5 RWMS as long as the DOE complex requires the disposal of wastes from the weapons program.

<u>31 Disposal Cells at Area 5 RWMS</u>:

6 active that receive standard LLW

1 active and permitted to receive asbestiform LLW (P06A)

1 active and permitted to receive MLLW (P03)

11 operationally closed containing LLW

11 cells operationally closed containing LLW and MLLW (Corrective Action Unit [CAU] 111)

1 operationally closed containing asbestiform LLW (P07)

<u>13 GCD Boreholes at Area 5 RWMS</u>:

4 inactive (open but have not received waste)

4 closed containing TRU waste

5 closed containing LLW

Disposal operations at the Area 3 RWMS began in the late 1960s. The Area 3 RWMS consists of seven subsidence craters configured into five disposal cells. Each subsidence crater was created by an underground weapons test. Until July 1, 2006, when the site was placed into inactive status, the site was used for disposal of bulk LLW waste, such as soils or debris, and waste in large cargo containers. The site consists of the following seven craters:

3 Disposal Cells (Inactive Status):	2 Closed Cells:	2 Undeveloped Cells:
U-3ah/at	U-3ax/bl (CAU 110)	U-3az
U-3bh		U-3bg

In calendar year 2009, the Area 5 RWMS received shipments containing a total of 34,780 cubic meters (m^3) (1,228,227 cubic feet [ft^3]) of radioactive wastes for disposal (Table 10-2). The majority of disposed LLW and MLLW were received from offsite generators. Only 1,358 m^3 (47,944 ft^3) of the LLW disposed in 2009 were generated on site. The volumes of waste shipments during fiscal year 2009 (October 1–September 30) are reported in an annual report (NNSA/NSO, 2010).

Table 10-2. Radioactive waste received and disposed at the Area 5 RWMS in 2009

Waste Type	Disposal Cell(s)	Permitted Limit (m^3)	2009 Quantities Received and Disposed	
			m^3 (ft^3)[(a)]	tons[(b)]
LLW	P10, P12, P13, P14, P15, P16	NA[(c)]	32,280 (1,139,959)	NA
MLLW[(d)]	P03	20,000	2,387.5 (84,313)	2,292.5
Asbestiform LLW	P06A	NA	112 (3,955)	21.1
Totals			34,779.5 (1,228,227)	2,313.6

(a) LLW disposal is regulated by DOE and totals reported are based on volume (m^3).
(b) Fees paid to Nevada for HW generated at NTS and MLLW wastes received for disposal are based on weight (tons).
(c) Not applicable.
(d) MLLW contains a hazardous component that is regulated by Nevada (see Section 10.2.1).

10.1.4 TRU Waste Operations

The TRU-Pad/Transuranic Pad Cover Building (TPCB) at the Area 5 RWMC is a Resource Conservation and Recovery Act (RCRA) Part B interim status facility designed for the safe storage of TRU and mixed TRU (MTRU) waste generated by Lawrence Livermore National Laboratory (LLNL) and other small-quantity sites. The TPCB accepts TRU/MTRU waste from NTS generators including the Joint Actinide Shock Physics Experimental Research (JASPER) facility. The TPCB stores the waste until it is characterized at the WEF at the Area 5 RWMC. Once characterized, the waste is loaded at the mobile loading unit for shipment either to the WIPP at Carlsbad, New Mexico, for disposal or to an interim site for further characterization. In 2009, all legacy MTRU waste was characterized, visually inspected, repackaged, and prepared for shipment. The final MTRU waste shipment was made on July 9, 2009, completing the final milestone for the Site Treatment Plan. TRU waste remaining in storage at the TPCB consists of two experimental spheres from LLNL and 18 standard waste boxes from JASPER.

10.1.5 Assessments

In 2009, assessments were conducted at the RWMC in accordance with National Security Technologies, LLC (NSTec), procedures. Schedules for management self-assessments are developed annually for the RWMC. In addition to the management self-assessments performed internally at the RWMC, assessments were also performed periodically by other NSTec organizations, NNSA/NSO, and the Nevada Division of Environmental Protection (NDEP). The results of each assessment and any required corrective action(s) were logged for NNSA/NSO in the company-wide issues tracking system known as CaWeb.

10.1.6 Groundwater Monitoring for Mixed Waste Disposal Unit (Pit P03)

P03 is operated according to RCRA Interim Status standards for the disposal of mixed LLW. Title 40 Code of Federal Regulations (CFR) Part 265, "Groundwater Monitoring," Subpart F (40 CFR 265.92) requires groundwater monitoring to verify the performance of P03 to protect groundwater from buried radioactive wastes. Wells UE5 PW-1, UE5 PW-2, and UE5 PW-3 are monitored for this purpose; these wells comprise 3 of the 18 onsite monitoring wells sampled periodically for radionuclide analyses of groundwater (see Section 5.1.8). Investigation levels (ILs) for five indicators of groundwater contamination (Table 10-3) were established by NNSA/NSO and NDEP for these three wells in 1998. Further groundwater analyses will be required if the results from all replicate samples exceed a parameter's IL. None of the samples collected semi-annually from the wells had contaminant levels above their ILs (Table 10-3). General water chemistry parameters are also monitored. All sample analysis results are presented in NSTec (2010e). Table 5-4 of Section 5.1.8 presents the tritium results for UE5 PW-1, UE5 PW-2, and UE5 PW-3.

Table 10-3. Results of groundwater monitoring of UE5 PW-1, UE5 PW-2, and UE5 PW-3 in 2009

Parameter	Investigation Level (IL)	Sample Levels
pH	< 7.6 or > 9.2 S.U.[a]	8.17 to 8.45 S.U.
Specific conductance (SC)	0.440 mmhos/cm[b]	0.363 to 0.386 mmhos/cm
Total organic carbon (TOC)	1 mg/L[c]	<0.5 to 0.69 mg/L
Total organic halides (TOX)	50 µg/L[d]	< 5 to <7.7 µg/L
Tritium (^3H)	2,000 pCi/L[e]	-6.22 to 13.6 pCi/L

(a) S.U. = standard unit(s) (for measuring pH) (b) mmhos/cm = millimhos per centimeter Source: NSTec (2010e)
(c) mg/L = milligrams per liter (d) µg/L = microgram(s) per liter (e) pCi/L = picocuries per liter

10.1.7 Vadose Zone Monitoring

Monitoring of the vadose zone (unsaturated zone above the water table) is conducted at the RWMC to demonstrate (1) that the PA assumptions at the RWMSs are valid regarding the hydrologic conceptual models used, including soil water contents, and upward and downward flux rates and (2) that there is negligible infiltration of precipitation into zones of buried waste at the RWMSs. Vadose zone monitoring (VZM) offers many advantages over groundwater monitoring, including detecting potential problems long before groundwater resources would be impacted, allowing corrective actions to be made early, and being less expensive than groundwater monitoring.

The components of the VZM program include (1) the Drainage Lysimeter Facility northwest of U-3ax/bl, (2) the Area 5 Weighing Lysimeter Facility southwest of the Area 5 RWMS, (3) automated monitoring systems in the operational covers on Pits P03, P04, and P05; the floor of P05 underneath the waste; and the vegetated closure cover on U-3ax/bl, (4) tritium monitoring via soil gas sampling at Well GCD-05 (one of the 13 GCD boreholes at the Area 5 RWMS), (5) radon flux monitoring on the U-3ax/bl cover at the Area 3 RWMS and on the P06 and P13 covers at the Area 5 RWMS, and (6) biota monitoring on U-3ax/bl cover at the Area 3 RWMS and on the pit covers at the Area 5 RWMS. Descriptions of these components and the results of monitoring in 2009 can be found in the *Nevada Test Site 2009 Waste Management Monitoring Report Area 3 and Area 5 Radioactive Waste Management Sites* (NSTec, 2010f). All VZM conducted in 2009 continued to demonstrate that there is negligible infiltration of precipitation into zones of buried waste at the RWMC and that the performance criteria of the waste disposal cells are being met to prevent contamination of groundwater and the environment.

10.2 Hazardous Waste Management

Hazardous wastes regulated under RCRA are generated at the NTS from a broad range of activities including onsite laboratories, paint shops, vehicle maintenance, communications and photo operations, and environmental restoration of historical contaminated sites (see Section 10.3). The RCRA Part B Permit (NEV HW0021) regulates the operation of three HW facilities on the NTS: P03 at the Area 5 RWMS, the Hazardous Waste Storage Unit (HWSU) in Area 5, and the Explosive Ordnance Disposal Unit (EODU) in Area 11. The permit requires preparation of a U.S. Environmental Protection Agency Biennial Hazardous Waste Report of all HW volumes generated at the NTS and at the North Las Vegas Facility during a year. This report is prepared for odd-numbered years only. It was prepared for 2009 HW volumes and submitted to the State of Nevada on February 24, 2010.

Until July 2009, quarterly reports were submitted to the State of Nevada to document the weight of HW received each quarter at these three facilities, and quarterly fees were paid to the State based on the weights of HW received. After July 2009, however, the State waived quarterly reporting and quarterly fees for the HWSU and the EODU; they were continued throughout 2009 only for mixed wastes received for disposal at P03.

10.2.1 Pit P03

Pit P03 began receiving MLLW from offsite DOE facilities in April 2006. The RCRA Part B Permit authorizes the disposal of MLLW received from DOE offsite facilities into P03 through November 2010 or until a total of 20,000 m^3 is received, whichever occurs first. P03 received a total of 2,292.44 tons (2,387.48 m^3) in 2009 (Table 10-4).

10.2.2 HWSU and Waste Accumulation Areas

The HWSU is a pre-fabricated, rigid-steel-framed, roofed shelter that is permitted to store a maximum of 61,600 liters (16,280 gallons) of approved waste at a time. HW generated at NSTec environmental restoration sites off the NTS (e.g., at the Tonopah Test Range [TTR]) or generated at the North Las Vegas Facility are direct-shipped to approved disposal facilities. HW generated on the NTS is also direct-shipped if the sites generate bulk, non-packaged HW that is not accepted at the HWSU for storage. HW would also be direct-shipped in the unlikely case when the waste volume capacity of the HWSU is approaching its permitted limits. Satellite Accumulation Areas (SAAs) and 90-day Hazardous Waste Accumulation Areas (HWAAs) are used at the NTS for the temporary storage of HW prior to direct shipment off site or to the HWSU.

In 2009, 9.13 tons of HW and PCB wastes were received for storage at the HWSU (Table 10-4). One project responsible for generating a large volume of PCBs was the NTS facility re-lighting campaign. Several facilities were re-lamped with “green” fluorescent lighting, and the old PCB ballasts were replaced with non-PCB ballasts. The HWSU received and stored drums of these old ballasts, which totaled 4.3 tons. Nine drums totaling 0.88 tons of PCB material were shipped off site in 2009. This offsite shipment included 0.14 tons that had been received in 2008 at the HWSU. In 2009, no HW was direct-shipped from NTS SAAs nor from HWAAs (Table 10-4). No storage limits were exceeded. Quarterly 2009 reports of applicable waste quantities were submitted on time to NDEP.

10.2.3 EODU

Conventional explosive wastes are generated at the NTS from tunnel operations, the NTS firing range, the resident national laboratories, and other activities. The permit allows NNSA/NSO to treat explosive ordnance wastes at the EODU by open detonation of no more than 45.4 kilograms (100 pounds) of approved waste at a time, not to exceed one detonation event per hour. In 2009, no explosive ordnance were detonated at the EODU (Table 10-4).

Table 10-4. Hazardous waste managed at the NTS in 2009

Permitted Unit	Total Waste Managed (tons)[a]
P03	2,292.44
HWSU	3.77
HWSU – PCB Waste	5.36
SAAs and HWAAs	0[b]
EODU	0

(a) Fees paid to Nevada for hazardous wastes generated at NTS and MLLW wastes received for disposal are based on weight (tons).
(b) Tons shipped directly off site from SAAs and/or HWAAs.

10.3 Underground Storage Tank (UST) Management

NNSA/NSO operates one deferred UST and three excluded USTs at the Device Assembly Facility. NNSA/NSO also maintains a fully regulated UST at the Area 6 helicopter pad, which is temporarily closed. No new USTs were installed or closed in 2009. In 2009, NDEP did not conduct any inspections of these USTs.

10.4 Environmental Restoration – Remediation of Historical Contaminated Sites

In April 1996, the DOE, the DoD, and the State of Nevada entered into a Federal Facility Agreement and Consent Order (FFACO) to address the environmental restoration of historical contaminated sites at the NTS, parts of TTR, parts of the Nellis Air Force Range (now known as the Nevada Test and Training Range), the Central Nevada Test Area, and the Project Shoal Area. These sites, known as Corrective Action Sites (CASs), may be contaminated with both radioactive and nonradioactive wastes. Appendix VI of the FFACO, as amended (March 2010), describes the strategy that will be employed to plan, implement, and complete environmental corrective actions at facilities where nuclear-related operations were conducted. Navarro Nevada Environmental Services, LLC, conducted most site characterization activities, while the NTS Management and Operating contractor (NSTec) conducted site restoration, soil remediation, and some facility decontamination and decommissioning activities in 2009.

10.4.1 Corrective Actions

The corrective action strategy is based on four steps: (1) identifying the CASs, (2) grouping the CASs into CAUs, (3) prioritizing the CAUs for funding and work, and (4) implementing the corrective action investigations (CAIs) and/or corrective actions, as applicable. A brief description of these four steps is presented in the *Nevada Test Site Environmental Report 2008* (NSTec, 2009a). CASs are broadly organized into the following four categories based on the source of contamination:

- Industrial Sites – CASs located on the NTS and TTR where activities were conducted that supported nuclear testing activities
- Underground Test Area (UGTA) Sites – CASs located where underground nuclear tests have resulted or might result in local or regional impacts to groundwater resources
- Soils Sites – CASs where tests have resulted in extensive surface and/or shallow subsurface contamination
- Nevada Off-Sites – Additional CASs associated with underground nuclear testing at the Project Shoal Area and the Central Nevada Test Area, located in northern and central Nevada, respectively

Environmental restoration activities follow a formal work process. If existing information about the nature and extent of contamination at CASs is insufficient to evaluate and select preferred corrective actions, a CAI is conducted. A Corrective Action Investigation Plan (CAIP) is prepared that provides a conceptual model of the site and defines how the site is to be characterized. Site characterization is performed and then documented in a Corrective Action Decision Document (CADD). If suitable information is available to make a decision, a remedial action alternative is selected that best provides site closure. In some instances, additional site characterization may be required before the CADD can be prepared.

If a site requires a closure action, a Corrective Action Plan (CAP) is prepared that will implement the recommended remedial action/closure alternative. Some sites also require a Post-Closure Plan and Annual Post-Closure Monitoring Reports. Once the closure is completed, a Closure Report (CR) is prepared. Some sites are closed under the Streamlined Approach for Environmental Restoration (SAFER) process identified in the FFACO. These sites typically have enough information available to remediate the site within a shorter duration.

NDEP is a participant throughout the remediation process, and the Community Advisory Board (CAB) is kept informed of the progress made. The CAB’s comments are strongly considered before final prioritization of corrective actions. A public participation working group of representatives from NNSA/NSO, the State of Nevada, and the CAB meets twice a year to discuss quarterly progress, upcoming environmental restoration activities, priority-setting activities established under the FFACO, and the level of public involvement required.

Table 10-5 lists the CAUs for which some step of the site remediation process was completed in calendar year 2009. All 2009 milestones were met. A total of 46 CASs were closed, either under the SAFER process or the complex closure process.

Table 10-5. Environmental restoration activities conducted in 2009

CAU	CAU Description	Number of CASs	Milestone	Due Date	Date Submitted	Date NDEP Approved
			DOE Industrial Sites – Defense Project			
557	Spills and Tank Sites	4	CADD/CR to State	5/31/09	5/1/09	5/14/09
562	Waste Systems	13	CAIP to State	5/31/09	4/13/09	4/28/09
563	Septic Systems	4	CAP to State	3/31/09	3/17/09	3/26/09
			DOE Industrial Sites – Environmental Restoration Project			
114	Area 25 EMAD Facility	4	SAFER Plan to State	8/17/09	8/13/09	8/24/09
116	Area 25 Test Cell C Facility	2	SAFER Plan Revision 1 to State	none	1/2/09	1/29/09
117	Area 26 Pluto Disassembly Facility	1	CR to State	11/30/09	6/29/09	7/6/09
130	Storage Tanks	7	CR to State	2/16/10	3/26/09	4/22/09
134	Aboveground Storage Tanks	4	CR to State	6/30/09	6/16/09	6/30/09
139	Waste Disposal Site	7	CR to State	8/31/09	8/6/09	8/14/09
166	Storage Yards and Contaminated Materials	7	CR to State	9/30/09	9/2/09	9/15/09
			DOE Industrial Sites – Waste Management Project			
111	Area 5 WMD Retired Mixed Waste Pits	1	CADD/CAP to State	9/30/09	7/14/09	8/19/09
			DOE Soil Sites			
107	Low Impact Soil Sites	15	SAFER Plan Revision 1 to State	none	4/2/09	5/8/09
			CR to State	7/10/09	6/25/09	7/17/09
367	Area 10 Sedan, Ess and Uncle Unit Craters	4	CAIP to State	12/31/09	12/14/09	1/20/10
370	T-4 Atmospheric Test Site	1	CAIP to State	4/30/08	4/25/08	5/7/08
371	Johnnie Boy Crater and Pin Stripe	2	CAIP to State	3/31/09	3/3/09	4/10/09
372	Area 20 Cabriolet/Palanquin Unit Craters	4	CAIP to State	6/30/09	6/16/09	7/17/09
			DOE UGTA Sites			
97	Yucca Flat/Climax Mine	720	Phase I Flow Model Status Presentation I	1/15/09	1/14/09	1/20/09
			Phase I Source Term	3/23/09	3/4/09	6/26/09
97	Yucca Flat/Climax Mine	720	Phase I Flow Model Status Presentation II	7/15/09	7/15/09	7/22/09
98	Frenchman Flat	11	Phase II Transport Model Documentation Package	9/30/09	9/30/09	11/24/09
99	Rainier Mesa/Shoshone Mountain	66	Phase I Source Term Status Presentation	1/21/09	1/21/09	1/22/09
101, 102	Central Pahute Mesa/Western Pahute Mesa	64	Begin Phase II Drilling Operations	5/28/09	5/28/09	6/25/09
			Drilling Presentation	10/27/09	10/27/09	10/28/09
			Nevada Off-Sites			
443	Central Nevada Test Area – Subsurface	3	Begin Drilling MV-4 and MV-5	5/1/09	4/23/09	5/21/09
			Draft Well Completion Report to State	12/2/09	12/1/09	12/9/09
447	Project Shoal Area – Subsurface	2	Draft Path Forward Document to State	7/20/09	7/20/09	7/23/09

10.4.2 Post-Closure Monitoring and Inspections

The RCRA Part B Permit for the NTS prescribes quarterly or semi-annual post-closure monitoring for five of eight hazardous waste sites that were closed under RCRA prior to enactment of the FFACO (Table 10-6). One of the sites, the Area 3 U-3ax/bl Subsidence Crater (CAU 110), also requires VZM. The U-3ax/bl Subsidence Crater engineered cover cap is designed to limit infiltration into the disposal unit and is monitored using time-domain reflectometry soil water content sensors buried at various depths within the waste cover to provide water content profile data. The soil water content profile data are used to demonstrate whether the cover is performing as expected. The cover cap was also revegetated with native vegetation and is periodically monitored for revegetation success (see Section 13.4).

Table 10-6. Historical RCRA closure sites

CAU	Remediation Site	Post Closure Requirements
90	Area 2 Bitcutter Containment	Semi-annual site inspection
91	Area 3 U-3fi Injection Well	Semi-annual site inspection
92	Area 6 Decon Pond	Quarterly site inspection
93	Area 6 Steam Cleaning Effluent Ponds	None
94	Area 23 Building 650 Leachfield	None
109	Area 2 U-2bu Subsidence Crater	None
110	Area 3 U-3ax/bl Subsidence Crater	Quarterly site inspection, VZM of cover
112	Area 23 Hazardous Waste Trenches	Quarterly site inspection

Under the FFACO, the CRs for many of the closed remediation sites specify that post-closure monitoring or inspections be performed. In 2009, all required post-closure monitoring and inspections were conducted as specified by the RCRA permit or by site CRs. Also, a few CAUs recently closed in 2009 were inspected as a best management practice, since these sites will require an annual site inspection within the following year. VZM results for CAU 110 indicated that surface water is not migrating into buried wastes and that the cover is functioning as designed. The 53 CAUs for which physical inspections were conducted during the 2009 post-closure inspection period are listed in Table 10-7. Some CAUs originally listed have been updated and no longer require monitoring, maintenance, or inspections. This is the result of a risk-based evaluation between current use-restriction data and final threshold contamination limits. An annual monitoring report combining all RCRA closure sites was prepared and submitted to NDEP. Similarly, a combined annual monitoring report for non-RCRA closure sites was also prepared and submitted to NDEP.

Table 10-7. Remediation sites inspected in 2009

CAU	Remediation Site	CAU	Remediation Site
005	Landfills	140	Waste Dumps, Burn Pits, and Storage Area
90	Area 2 Bitcutter Containment	143	Area 25 Contaminated Waste Dumps
91	Area 3 U-3fi Injection Well	145	Wells and Storage Holes
92	Area 6 Decon Pond Facility	151	Septic Systems and Discharge Area
107	Low Impact Soil Sites (closed in 2009, but inspected as a best management practice—annual inspection required in 2010)	165	Area 25 and 26 Dry Well and Washdown Areas
		168	Area 25 and Area 26 Contaminated Materials and Waste Dumps
110	Area 3 U-3ax/bl Subsidence Crater	204	Storage Bunkers
112	Area 23 Hazardous Waste Trenches	254	Area 25 Reactor Maintenance, Assembly, and Disassembly Decontamination Facility
113	Area 25 R-MAD Facility		
115	Area 25 Test Cell A Facility	140	Waste Dumps, Burn Pits, and Storage Area
118	Area 27 Super Kukla Facility	140	Waste Dumps, Burn Pits, and Storage Area
127	Area 25 and 26 Storage Tanks	143	Area 25 Contaminated Waste Dumps
137	Waste Disposal Sites	145	Wells and Storage Holes
139	Waste Disposal Sites (closed in 2009, but inspected as a best management practice—annual inspection required in 2010)	151	Septic Systems and Discharge Area
		165	Area 25 and 26 Dry Well and Washdown Areas
		168	Area 25 and Area 26 Contaminated Materials and Waste Dumps

Table 10-7. Remediation sites inspected in 2009 (continued)

CAU	Remediation Site	CAU	Remediation Site
204	Storage Bunkers	427	Area 3 Septic Waste Systems 2, 6 (TTR)
254	Area 25 Reactor Maintenance, Assembly, and Disassembly Decontamination Facility	453	Area 9 UXO Landfill (TTR)
261	Area 25 Test Cell A Leachfield	476	Area 12 T-Tunnel Muckpile
262	Area 25 Septic Systems and UDP	477	Area 12 N-Tunnel Muckpile
309	Area 12 Muckpiles	478	Area 12 T-Tunnel Ponds
322	Areas 1 and 3 Release Sites and Injection Wells	482	Area 15 U15a/e Muckpiles and Ponds
333	U-3auS Disposal Site (not required until 2011)	484	Surface Debris, Waste Sites, and Burn Area
357	Mud Pits and Waste Dump	487	Thunderwell Site (TTR)
370	T-4 Atmospheric Test Site (closed in 2009, but inspected as a best management practice – annual inspection required in 2010)	528	Polychlorinated Biphenyls Contamination
383	Area 12 E-Tunnel Sites	529	Area 25 Contaminated Materials
400	Bomblet Pit and Five Points Landfill (TTR)	542	Disposal Holes
404	Roller Coaster Lagoons and Trench (TTR)	543	Liquid Disposal Sites
407	Roller Coaster RadSafe Area (TTR)	545	Dumps, Waste Disposal Sites, and Buried Radioactive Materials
423	Area 3 Underground Discharge Point, Building 0360 (TTR)	546	Injection Well and Surface Releases
424	Area 3 Landfill Complexes (TTR)	551	Area 12 Muckpiles
426	Cactus Spring Waste Trenches (TTR)	552	Area 12 Muckpiles and Ponds
		554	Area 23 Release Sites
		559	T-Tunnel Compressor/Blower Pad

10.5 Solid and Sanitary Waste Management

10.5.1 Landfills

The NTS has three landfills for solid waste disposal that were operated by NSTec Waste Management in 2009. The landfills are regulated and permitted by the State of Nevada (see Table 2-13 for list of permits). No liquids, hazardous waste, or radioactive waste are accepted in these landfills. They include:

- Area 6 Hydrocarbon Disposal Site – accepts hydrocarbon-contaminated wastes, such as soil and absorbents.
- Area 9 U10c Solid Waste Disposal Site – designated for industrial waste such as construction and demolition debris.
- Area 23 Solid Waste Disposal Site – accepts municipal-type wastes such as food waste and office waste. Regulated asbestos-containing material is also permitted in a special section. The permit allows disposal of no more than an average of 20 tons/day at this site.

These landfills are designed, constructed, operated, maintained, and monitored in adherence to the requirements of their state-issued permits. NDEP visually inspects the landfills and checks the records on an annual basis to ensure compliance with the permits.

The vadose zone is monitored at the Area 6 Hydrocarbon Disposal Site and the Area 9 U10c Solid Waste Disposal Site. VZM is performed once annually in lieu of groundwater monitoring to demonstrate that contaminants from the landfills are not leaching into the groundwater. VZM in 2009 indicated that there was no soil moisture migration and, therefore, no waste leachate migration to the water table.

The amount of waste disposed of in each solid waste landfill is shown in Table 10-8. An average of 2.65 tons/day was disposed at the Area 23 landfill, well within permit limits. State inspections of the three permitted landfills were conducted in April 2009. No out-of-compliance issues were noted.

Table 10-8. Quantity of solid wastes disposed in NTS landfills in 2009

Metric Tons (Tons) of Waste		
Area 6 Hydrocarbon Disposal Site	**Area 9 U10c Solid Waste Disposal Site**	**Area 23 Solid Waste Disposal Site**
98 (108)	4,764 (5,251)	476 (525)

10.5.2 Sewage Lagoons

The NTS also has two state-permitted sewage lagoons that were operated by NSTec Waste Management in 2009. They are the Area 6 Yucca Lake and Area 23 Mercury lagoons. The operations and monitoring requirements for these sewage lagoons are specified by Nevada water pollution control regulations. Because of this, the discussion of their operations and compliance monitoring are presented in Section 5.2.3.

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11.0 Hazardous Materials Control and Management

Hazardous materials used or stored on the Nevada Test Site (NTS) are controlled and managed through the use of a Hazardous Substance Inventory database. All contractors and subcontractors of the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) utilize this database if they use or store hazardous materials. They are required to comply with the operational and reporting requirements of the Toxic Substances Control Act (TSCA); the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA); the Emergency Planning and Community Right-to-Know Act (EPCRA); and the Nevada Chemical Catastrophe Act (see Section 2.5). Chemicals to be purchased are subject to a requisition compliance review process. Environmental Protection and Technical Services (EPTS) personnel with National Security Technologies, LLC (NSTec), reviewed each chemical purchase in 2009 to ensure that toxic chemicals and products were not purchased when less hazardous substitutes were commercially available. Requirements and responsibilities for the use and management of hazardous/toxic chemicals were provided in company documents and were aimed at meeting the goals shown below. The reports and activities prepared or performed in 2009 to document compliance with hazardous materials regulations are presented below.

Hazardous Materials Control and Management Goals	***Compliance Activities/Reports***
Minimize the adverse effects of improper use, storage, or management of hazardous/toxic chemicals. Ensure compliance with applicable federal and state environmental regulations related to hazardous materials.	Use of Hazardous Substance Inventory database Annual TSCA report FIFRA management assessments Annual Nevada Combined Agency (NCA) Report Annual EPCRA Toxic Release Inventory (TRI) Report, Form R Nevada Division of Environmental Protection (NDEP) Chemical Accident Prevention Program Annual Registration Form Use of electronic Hazardous Materials Notification System (known as HAZTRAK) for tracking the movements of such materials

11.1 TSCA Program

There are no known pieces of polychlorinated biphenyl (PCB)-containing electrical equipment (transformers, capacitors, or regulators) at the NTS; however, sometimes during demolition activities, old hydraulic systems are found to contain PCB liquids. The TSCA program consists mainly of properly characterizing, storing, and disposing of various PCB wastes generated through remediation activities and maintenance of fluorescent lights. The remediation waste is generated by NSTec and Navarro Nevada Environmental Services, LLC, at Corrective Action Sites during environmental restoration activities (see Section 10.4) and during maintenance activities and building decontamination and decommissioning activities performed by NSTec. These activities can generate PCB-contaminated fluids and bulk product waste containing PCBs.

Waste classified as bulk product waste generated on the NTS by remediation and site operations can be disposed of on site in the Area 9 U10 Solid Waste Disposal Site with prior State of Nevada approval. PCB-containing light ballasts removed during normal maintenance can also go to an onsite landfill, but when remediation or upgrade activities generate several ballasts, these must be disposed of off site at an approved PCB disposal facility. Soil and other materials contaminated with PCBs must also be sent off site for disposal.

During 2009, nine drums of PCB light ballasts were generated from remediation, demolition, and renovation activities and sent off site for disposal in two shipments. On June 15, 2010, an Annual Report was generated for PCB management activities during 2009. There were no TSCA inspections by outside regulators performed at the NTS in 2009.

11.2 FIFRA Program

EPTS personnel performed the following oversight functions to ensure FIFRA compliance: (1) screened all purchase requisitions for restricted-use pesticides; (2) reviewed operating procedures for handling, storing, and applying pesticide products; and (3) conducted facility inspections for unauthorized pesticide storage/use. On the NTS, pesticides are applied under the direction of a State of Nevada certified applicator. This service was provided by Solid Waste Operations (SWO). SWO maintained appropriate Commercial Category (Industrial) certifications for applying restricted-use pesticides, although non-restricted-use pesticides are most commonly used. SWO did purchase and use restricted-use pesticides in 2009, and training was provided to affected personnel. Facility inspections were conducted and indicated that the storage and use of these pesticides were in compliance with federal/state requirements. Pesticide applications in NTS food service facilities are also conducted by SWO.

11.3 EPCRA Program

EPCRA requires that federal, state, and local emergency planning authorities be provided information regarding the presence and storage of hazardous substances and their planned and unplanned environmental releases, including provisions and plans for responding to emergency situations involving hazardous materials. NNSA/NSO prepares and submits reports in compliance with EPCRA pursuant to Sections 302, 303, 304, 311, 312, and 313 of the Superfund Amendments and Reauthorization Act, Title III (see Section 2.5.1).

In response to the EPCRA requirements, all chemicals that are purchased are entered into a hazardous substance inventory database and assigned specific hazard classifications (e.g., corrosive liquid, flammable, diesel fuel). Annually, this database is updated to show the maximum amounts of chemicals that were present in each building at the NTS, the Nonproliferation Test and Evaluation Complex (NPTEC), the North Las Vegas Facility (NLVF) (see Section A.1.4), and the Remote Sensing Laboratory (RSL)–Nellis (see Section A.2.3). This information is then used to complete the NCA Report. The NCA Report provides information to the State of Nevada, community, and local emergency planning commissions on the maximum amount of any chemical, based on its hazard classification, present at any given time during the preceding year. The State Fire Marshall then issues permits to store hazardous chemicals on the NTS, as well as at RSL-Nellis and NLVF. The 2009 chemical inventory for NTS facilities was updated and submitted to the State of Nevada in the NCA Report on February 23, 2010. No accidental or unplanned release of an extremely hazardous substance occurred on the NTS in 2009.

The hazardous substance inventory database is also used to complete the TRI Report, Form R. This report provides the U.S. Environmental Protection Agency (EPA) and the State Emergency Response Commission information on specific toxic chemicals that enter the environment above a given threshold. Toxic chemicals included in the TRI Report are typically released to the environment through air emissions, landfill disposal, application to the land, and recycling. Reuse of a material, however, does not constitute a release to the environment. TRI toxic chemicals that are recovered during NTS remediation activities or become “excess” to operational needs (e.g., lead bricks, lead shielding) are sent offsite for recycling, reuse, or proper disposal. Mixed wastes generated at other DOE facilities and sent to the NTS for disposal may contain TRI toxic chemicals that must be reported in the TRI Report. Lead and mercury, released as a result of NTS activities, were determined to be reportable in 2009. Table 11-1 lists the 2009 sources of release, disposition, and release quantities for these two TRI toxic chemicals. On June 30, 2010, NNSA/NSO submitted to EPA the TRI Report for calendar year 2009.

No EPCRA inspections were performed by outside regulators at the NTS in 2009.

Table 11-1. EPCRA reported NTS releases of toxic chemicals in 2009

Toxic Chemical	Source	Disposition	Quantity (lb)
Lead	Ammunition from Mercury Firing Range	Other disposal[a]	13,008
	Lead acid batteries	Offsite recycling	16,050[b]
	Hazardous waste generated onsite	Offsite disposal	4,150
	Mixed waste generated offsite at DOE facilities	Onsite disposal	22,151
	Ammunition from Mercury Firing Range	Airborne release	7.8
Mercury	Hazardous waste generated onsite	Offsite recycling	0.92
	Mixed waste generated offsite at DOE facilities	Onsite disposal	1,363

(a) Spent ammunition is left on the ground. When the firing range is closed, ammunition will be collected for recycling.

(b) Or 7.3 metric tons (mtons) (see Chapter 3, Table 3.4 for the total mtons of lead acid batteries shipped offsite for recycling in 2009 from the NTS, NLVF, and RSL-Nellis combined.

HAZTRAK is a tracking system that monitors hazardous materials while they are in transit. When a truck transporting hazardous material enters the NTS, all information concerning the load is entered into the tracking system. Once the delivery is complete, the information provided at the time of entry is removed from the tracking system.

11.4 Nevada Chemical Catastrophe Prevention Act

If highly hazardous substances are stored in quantities that exceed threshold quantities established by NDEP, then NNSA/NSO submits a report notifying the State of Nevada. From June 1, 2009, through May 31, 2010, NPTEC in Area 5 stored one highly hazardous substance (oleum) in a quantity that required state notification. A Nevada Chemical Accident Prevention Program Report was prepared regarding NTS operations from June 1, 2009, through May 31, 2010 and was submitted to NDEP on June 17, 2010.

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12.0 Historic Preservation and Cultural Resources Management

The historic landscape of the Nevada Test Site (NTS) contains archaeological sites, buildings, structures, and places of importance to American Indians and others. These are referred to as "cultural resources." U.S. Department of Energy (DOE) Order DOE O 450.1A, "Environmental Protection Program," requires that NTS activities and programs comply with all applicable cultural resources regulations (see Section 2.8) and that such resources on the NTS be monitored. The Cultural Resources Management (CRM) program at the NTS has been established and is implemented by the Desert Research Institute (DRI) to meet this requirement. The CRM program is designed to meet the specific goals shown below.

Cultural Resources Management Program Goals
Ensure compliance with all regulations pertaining to cultural resources on the NTS (see Section 2.8).
Inventory and manage cultural resources on the NTS.
Provide information that can be used to evaluate the potential impacts of proposed projects and programs to cultural resources on the NTS and mitigate adverse effects.
Curate archaeological collections in accordance with Title 36 Code of Federal Regulations (CFR) Part 79, "Curation of Federally-Owned and Administered Archeological Collections."
Conduct American Indian consultations related to places and items of importance to the Consolidated Group of Tribes and Organizations.

In order to achieve the program goals and meet federal and state requirements, the CRM program is multifaceted and contains the following major components: (1) inventories and historical evaluations, (2) curation of archaeological collections, and (3) the American Indian Program. The guidance for the CRM program work is provided in the *Cultural Resources Management Plan for the Nevada Test Site* (Drollinger and Beck, 2010). Historical preservation personnel and archaeologists of DRI who meet the qualification standards set by the Secretary of the Interior conduct the work, and the archaeological efforts are permitted under the Archaeological Resources Protection Act (ARPA).

A brief description of the CRM program components and their 2009 accomplishments is provided in this chapter. The methods used to conduct inventories and historical evaluations in support of NTS operations were summarized in the 2003 NTS Environmental Report (Bechtel Nevada, 2004a). The reader is directed to *Nevada Test Site Environmental Report 2009 Attachment A: Nevada Test Site Description*. It is a separate file on the compact disc of this report and is also accessible on the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) Web page http://www.nv.doe.gov/library/publications/aser.aspx. The *Nevada Test Site Description* summarizes historical cultural resource inventories of the NTS and describes prehistoric and historical artifacts found on the NTS. It also contains a summary of the known human occupation and use of the NTS from the Paleo-Indian Period, about 12,000 years ago, until the mining and ranching period of the 20th century, just before NTS lands were withdrawn for federal use.

12.1 Cultural Resources Inventories

Cultural resources inventories are conducted at the NTS to meet the requirements of the National Historic Preservation Act (NHPA) and the ARPA. The inventories are completed prior to proposed projects that may disturb or otherwise alter the environment. The following information is maintained in databases:

- Number of cultural resources inventories conducted
- Location of each inventory

- Number of acres surveyed at each project location
- Types of cultural resources identified at each project location
- Number of cultural resources determined eligible to the National Register of Historic Places (NRHP)
- Eligible properties avoided by project activities
- Cultural resources requiring mitigation to address an adverse effect
- Final report on results

In 2009, 11 cultural resources inventories and one historical evaluation were conducted for proposed projects (Table 12-1). Four prehistoric sites were identified during these inventories, and all the sites were lithic artifact scatters where people reworked or used small tools. It was determined that none of the sites were eligible to the NRHP. The historical evaluation was conducted for the U12t Tunnel Complex, which has been determined eligible to the NRHP. A total of 207.25 hectares (ha) (514.13 acres [ac]) was examined during cultural resources inventories.

Table 12-1. Summary data for cultural resources inventories and historic evaluations completed in 2009

Inventory/Evaluation	NTS Area	Prehistoric/ Historical Sites Found	Cultural Resources Evaluated	Cultural Resources Determined NRHP Eligible	Area Surveyed	
					Hectares	Acres
G-Tunnel Road Expansion	12	0	0	0	1.3	3.2
UGTA[a] Borrow Pits	20	1	1	0	3.5	8.9
Trailer Locations Wireless Mesh Network	5 and 6	0	0	0	32.21	9.58
Sirius Project	26	0	0	0	1.4	3.6
NPTEC[b] Water Main Extension	5	0	0	0	1.06	0.63
Power Pole Line	5	0	0	0	10.0	26.0
UGTA ER-EC-12 Well Pad and Access Road	NTTR[c]	0	0	0	17.0	42.1
UGTA ER-EC-13 Well Pad and Access Road	NTTR	1	1	0	26.6	65.7
UGTA ER-EC-14 Well Pad and Access Road	NTTR	1	1	0	32.2	79.4
Upgraded Access Road and Turnaround/Staging Area	30	0	0	0	3.5	9.0
Surface Scraping Project	26	0	0	0	3.68	9.1
U12t Tunnel Complex		1	1	1	74.8	184.9
Totals		**4**	**4**	**1**	**207.25**	**512.13**

(a) Underground Test Area
(b) Nonproliferation Test and Evaluation Complex
(c) Nevada Test and Training Range

12.2 Evaluations of Historic Structures

The historical evaluation report for the U12t Tunnel Complex was finalized in 2009. The complex is one of a series of tunnels used for underground nuclear weapons effects tests on the east side of Rainier and Aqueduct Mesas. Six nuclear weapons effects tests and one high explosive test were conducted within the complex from 1970 to 1987. Two conventional weapons experiments were conducted in the tunnel portal area in 1997 and 1998. The complex includes an underground tunnel with a main access drift and nine primary drifts, a substantial tailings pile fronting the tunnel portal, a series of discharge ponds down slope of the tailings pile, and two instrumentation trailer parks and 16 drill holes on top of Aqueduct Mesa. In the portal area, cultural features are mostly concrete pads and building foundation. On the mesa are drill holes, a few concrete pads, a loading ramp, and electrical equipment. The U12t Tunnel is to be left in place as a historical landscape.

In 2009, a draft historical evaluation for the U12n Tunnel Complex was completed. From 1967 to 1992, 22 nuclear and 11 high explosives tests were conducted in the U12n Tunnel. The complex is composed of the portal and mesa areas, encompassing an area of approximately 240 ha (600 ac). Research was initiated in 2009 on the historical evaluation for shafts U15a and U15e. The U15a and U15e complex was in operation from 1959 to 1967 for nuclear structural effects and cratering tests. Three nuclear tests were conducted in the shafts in 1962, 1965, and 1966. Also in 2009, archival research and fieldwork were completed for the historical evaluation of Building 2205, the Pluto Compressor Building, which is part of the Pluto complex in Area 26. The building, in operation, from 1958 to 1964, was used to develop and test nuclear reactors for ramjets to be used in long-range, low-altitude missiles for the U.S. Department of Defense. These evaluations are expected to be completed in 2010.

12.3 General Reconnaissance/Archival Research

Three field projects and 29 archival research projects were conducted in 2009. Two of the field projects focused on the photo-documentation of two nuclear testing related locations. The first was the documentation of the grouting of two metal troughs at the Little Feller II location. Little Feller II took place on July 7, 1962. This test was to determine the electronic response of typical semiconductor parts and electronic circuits exposed to the prompt gamma pulse from a near-surface nuclear detonation and to correlate the responses with those from simulated laboratory experiments. The second involved photography of the exterior of the E-MAD [Engine Maintenance, Assembly, and Disassembly] building in Area 25. The facility was part of a project that envisioned a nuclear-propelled launch vehicle for orbit around Mars, fly-by missions to Mercury and Jupiter, and eventually past Pluto and beyond our solar system. While the tests conducted did not result in a nuclear-powered mission, they were important in their far-reaching potential. The success of the project revealed that such missions were technically feasible. The project was terminated in 1973. The third project involved a field visit to Area 17 for the placement of a proposed Live Firing/Training Range.

Numerous reports were completed in 2009. They included 11 inventory reports (Holz, 2009a; b; c; d; Jones, 2009a; b; c; d; e; f; g), four letter reports (Holz, 2009e; Jones, 2009h; i; Drollinger, 2009), one monitoring report (Holz, 2009f), and one technical report (Drollinger et al., 2009). Specific site location information and reports containing such data are not available to the public. The data on NTS archaeological activities also were provided to DOE Headquarters in the formal Archeology Questionnaire for transmittal to the Secretary of the Interior and, ultimately, to the U.S. Congress as part of the Secretary of the Interior's Annual Archeology Report to Congress.

12.4 Curation

The NHPA requires that archaeological collections and associated records be maintained at professional standards; the specific requirements are delineated in 36 CFR 79. The NTS Archaeological Collection currently contains over 400,000 artifacts and is curated in accordance with 36 CFR 79. Curation requirements for the NTS Archaeological Collection include:

- Maintain a catalog of the items in the NTS collection.
- Package the NTS collection in materials that meet archival standards (e.g., acid-free boxes).
- Store the NTS collection and records in a facility that is secure and has environmental controls.
- Establish and follow curation procedures for the NTS collection and facility.
- Comply with the Native American Graves Protection and Repatriation Act.

In the 1990s, the U.S. Department of Energy, Nevada Operations Office completed the required inventory and summary of NTS cultural materials accessioned into the NTS Archaeological Collection and distributed the inventory list and summary to the tribes affiliated with the NTS and adjacent lands. Consultations followed, and all artifacts the tribes requested were repatriated to them. This process was completed in 2002; it will be repeated for new additions to the collection in the future. Known NTS locations of American Indian human remains continued to be protected from NTS activities in 2009.

All artifacts in the collection are stored in current archival-quality materials, and 30 years of archaeological survey reports, technical reports, and site records are linked to a Geographical Information System. In 2009, electronic files were created for all site forms, short reports, technical reports, letter reports, monitoring reports, historic evaluations, and Historical American Buildings Survey/Historical American Engineering Record reports

(Drollinger, 2009). Only the large records, such as U.S. Geological Survey and oversized site maps, were not converted to electronic files. Although the work schedule in the curation facility is variable, the state of the collection is monitored weekly to ensure that the materials remain in good condition.

NNSA/NSO is obtaining NTS archaeological materials from other artifact repositories in Nevada in order to assemble the entire NTS collection in the NNSA/NSO facility. In 2009, the Harry Reid Center for Environmental Studies, Division of Cultural Resources at the University of Nevada, Las Vegas, transferred to NNSA/NSO the artifacts and notes they had in storage from studies Frederick C. V. Worman conducted on the NTS. Worman was a zoologist and a vocational archaeologist employed by Los Alamos National Laboratory who conducted limited archeological surveys and excavations on the NTS during the 1960s. The artifacts and notes have been placed in the collections room of the curation facility. DRI inventoried the artifacts and created an electronic data file (Drollinger, 2009).

12.5 American Indian Program

NNSA/NSO has had an active American Indian Program since the late 1980s. The function of the program is to conduct consultations between NNSA/NSO and NTS-affiliated American Indian tribes. Consultation occurs through the Consolidated Group of Tribes and Organizations (CGTO). The CGTO is composed of 16 groups of Southern Paiute, Western Shoshone, and Owens Valley Paiute-Shoshone, along with the Las Vegas Indian Center, a Pan-Indian organization. The 16 groups are listed in previous NTS environmental reports (e.g., National Security Technologies, LLC, 2008a). A history of this program is contained in *American Indians and the Nevada Test Site, A Model of Research and Consultation* (Stoffle et al., 2001). The goals of the program are to:

- Provide a forum of the CGTO to express and discuss issues of importance.
- Provide the CGTO with opportunities to actively participate in decisions that involve places and locations that hold significance for them.
- Involve the CGTO in the curation and display of American Indian artifacts.
- Enable the CGTO and its constituency to practice their religious and traditional activities.

In 2009, at the request of DOE Environmental Management (EM) Headquarters (HQ), the American Indian Program presented a white paper on the CGTO's past participation in developing text in the *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada* (U.S. Department of Energy, Nevada Operations Office, 1996) and in a 2003 Supplement Analysis (NNSA/NSO, 2003). The NNSA/NSO model subsequently was presented to tribal, state, and federal representatives at the DOE/EM HQ-sponsored State-Tribal Government Intergovernmental Work Group meeting in Snowbird, Utah. The overview described the NTS process and benefit for consideration for an impending Environmental Impact Statement (EIS) for the Evaluation of Methods for the Disposal of Greater-Than-Class C Low-Level Waste (GTCC-LLW). The NTS process is led by the CGTO, which designates an American Indian Writer's Subgroup (AIWS) with representatives from the different tribes. The AIWS then prepares text for the document that is then reviewed and approved by the CGTO. Subsequently, DOE/EM HQ sponsored a national workshop for tribal governments in Las Vegas, Nevada. The purpose of the workshop was to ascertain tribal interest. Immediately following the meeting, the CGTO notified NNSA/NSO and DOE/EM HQ of their interest in participating. Thereafter, culturally affiliated tribes from Hanford and Los Alamos National Laboratory also adopted the NNSA/NSO AIWS model. In May 2009, the AIWS began the process by developing tribal text for the GTTC-LLW EIS.

From August 31 through September 2, 2009, NNSA/NSO hosted a Tribal Update Meeting with the CGTO. The meeting was held as a means of upholding DOE's commitment to promoting government-to-government relations and working collaboratively with culturally affiliated tribes. During the meeting, NNSA/NSO provided program updates on current and future activities including tribal involvement in the upcoming NTS Site-Wide Environmental Impact Statement (SWEIS). At the conclusion of the meeting, the CGTO presented 15 recommendations to NNSA/NSO to further enhance the NTS American Indian Program. One notable recommendation responded to the CGTO's continued interest in developing American Indian text for the NTS SWEIS. Other recommendations included the continuance of Tribal Update Meetings on an annual basis, co-management initiatives, and cultural resource management program activities.

13.0 Ecological Monitoring

U.S. Department of Energy (DOE) Order DOE O 450.1A, "Environmental Protection Program," requires ecological monitoring and biological compliance support for activities and programs conducted at DOE facilities. The National Security Technologies, LLC (NSTec), Ecological Monitoring and Compliance (EMAC) Program provides this support for the Nevada Test Site (NTS). The major sub-programs and tasks within EMAC include (1) the Desert Tortoise Compliance Program, (2) biological surveys at proposed construction sites, (3) monitoring important species and habitats, (4) the Habitat Restoration Program, (5) wildland fire hazard assessment, and (6) biological impact monitoring at the Nonproliferation Test and Evaluation Complex (NPTEC). Brief descriptions of these sub-programs and their 2009 accomplishments are provided in this chapter. More detailed information may be found in the most recent annual EMAC report (Hansen et al., 2010). EMAC annual reports are available at http://www.osti.gov/bridge. The reader is also directed to *Attachment A: Nevada Test Site Description*, a separate file on the compact disc of this report, where the ecology of the NTS is described.

Ecological Monitoring and Compliance Program Goals
Ensure compliance with all state and federal regulations and stakeholder commitments pertaining to NTS flora, fauna, wetlands, and sensitive vegetation and wildlife habitats (see Section 2.9). Delineate NTS ecosystems. Provide ecological information that can be used to evaluate the potential impacts of proposed projects and programs on NTS ecosystems and important plant and animal species.

13.1 Desert Tortoise Compliance Program

The desert tortoise is federally protected as a threatened species under the Endangered Species Act, and it inhabits the southern one-third of the NTS (Figure 13-1). Activities conducted in desert tortoise habitat on the NTS must comply with the terms and conditions of a Biological Opinion (Opinion) issued to the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) by the U.S. Fish and Wildlife Service (FWS) (FWS, 2009). The Opinion is effectively a permit to conduct activities in desert tortoise habitat in a specific manner. It authorizes the incidental "take" (accidental killing, injury, harassment, etc.) of tortoises that may occur during the activities which, without the Opinion, would be illegal and subject to civil or criminal penalties.

The Opinion states that proposed NTS activities are not likely to jeopardize the continued existence of the Mojave population of the species and that no critical habitat would be destroyed or adversely modified. It establishes compliance limits for the acres of tortoise habitat that can be disturbed, the numbers of accidentally injured and killed tortoises, and the number of captured, displaced, or relocated tortoises (Table 13-1). It also establishes mitigation requirements for habitat loss. The Desert Tortoise Compliance Program was developed to implement the Opinion's terms and conditions, document compliance actions taken, and assist NNSA/NSO in FWS consultations.

In 2009, biologists conducted surveys for 24 projects that were within the distribution range of the desert tortoise. All of the proposed projects were covered under the Opinion, and no permit limits of the Opinion were exceeded (Table 13-1). In 2009, 3.27 hectares (ha) (8.08 acres [ac]) of desert tortoise habitat was disturbed or was scheduled for disturbance. Remuneration fees for the compensation of habitat disturbance were paid and deposited into a Desert Tortoise Public Lands Conservation Fund, as required by the Opinion. A cumulative total of 129.31 ha (319.54 ac) of desert tortoise habitat has been disturbed on the NTS since issuance of the first Opinion in 1992, when the species became protected. In 2009, one desert tortoise was killed on a road and five were moved out of harm's way off of roads. At project sites, no desert tortoises were accidentally injured or killed, nor were any found, captured, or displaced from the project sites. In January 2010, NNSA/NSO submitted a report to the FWS Southern Nevada Field Office that summarized tortoise compliance activities conducted on the NTS from January 1 through December 31, 2009.

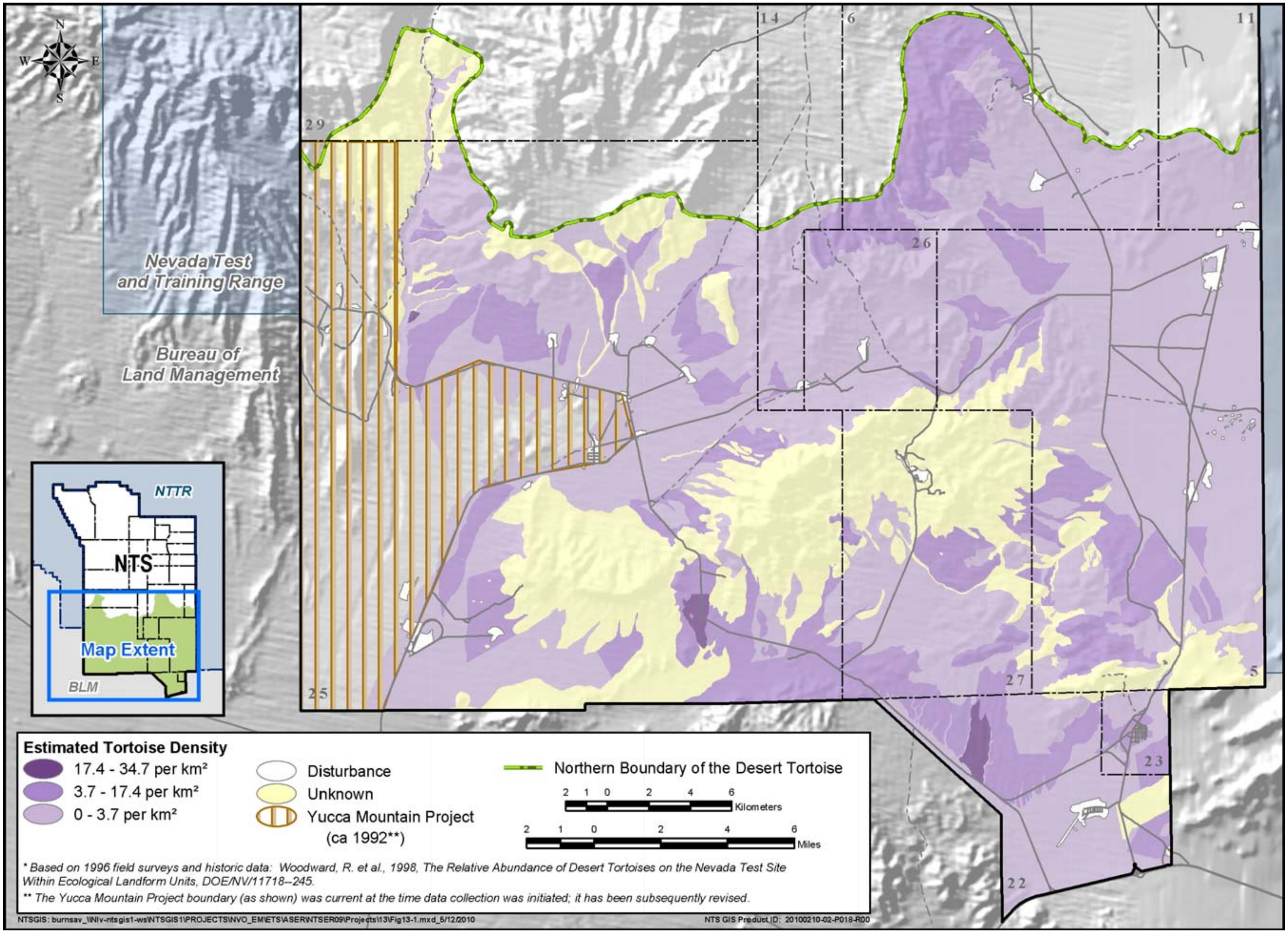

Figure 13-1. Desert tortoise distribution and abundance on the NTS

Table 13-1. Compliance limits and cumulative totals for take of acres and tortoises by NTS program

Program/Activity	Acres Impacted		Tortoises Incidentally Taken			
	Total	Permit Limit	Killed or Injured	Permit Limit	Other[(a)]	Permit Limit
Defense	5.61	500	0	1	0	10
Waste Management	0	100	0	1	0	2
Environmental Restoration	0	10	0	1	0	2
Nondefense Research and Development	0	1,500	0	2	0	35
Work-for-Others	2.47	500	0	1	0	10
Infrastructure Development	0	100	0	1	0	10
Vehicle Traffic on Roads	0	0	1	15[(b)]	5	125
Totals	8.08	2,710	1	22	5	194

(a) The number of desert tortoises that a qualified biologist can take by capture, displacement, relocation, or disruption of behavior if desert tortoises are found in harm's way within a project area or on a heavily trafficked road.

(b) No more than 4 desert tortoises killed during any calendar year and 15 during the term of the Opinion (2009-2019).

13.2 Biological Surveys at Proposed Project Sites

Biological surveys are performed at proposed project sites where land disturbance will occur. The goal is to minimize the adverse effects of land disturbance on important plant and animal species and their associated habitat, important biological resources (i.e., nest sites, active tortoise burrows), and wetlands. The important species known to occur on the NTS include 19 sensitive plants, 1 mollusk, 2 reptiles, over 250 birds, and 27 mammals. They are classified as important due to their sensitive, protected, and/or regulatory status with state or federal agencies (Tables 13-2 and 13-3). All of these species are evaluated for their inclusion in long-term monitoring activities on the NTS. Important biological resources include such things as cover sites, nest or burrow sites, roost sites, wetlands, or water sources that are vital to important species.

During 2009, biological surveys for 31 projects were conducted on or near the NTS. They are identified in Figure 13-2 by their project survey numbers of 09-01 through 09-31. One survey was conducted on the Tonopah Test Range (TTR). For some of the projects, multiple sites were surveyed. Biologists surveyed a total of 437.58 ha (1081.29 ac). A total of 24 projects were within the range of the desert tortoise. Important species and important biological resources found included two tortoise burrows, one predator burrow, two kit fox burrows, Beatley milkvetch (*Astragalus beatleyae*), Cane spring suncup (*Camissonia megalantha*), Joshua trees (*Yucca brevifolia*), Mojave Yucca (*Yucca schidigera*), cacti, potential Beatley milkvetch habitat, and possibly Tonopah milkvetch (*Astragalus pseudiodanthus*), a sensitive plant that occurs off the NTS, which was found on TTR. NSTec provided to project managers written summary reports of all survey findings and mitigation recommendations. The findings and recommendations are summarized by project in Hansen et al. (2010).

13.3 Important Species and Habitat Monitoring

Over the last three decades, NNSA/NSO has taken an active role in collecting or supporting the collection of information on the status of important plants and animals and their habitat on the NTS. Plants and animals are classified as "important" under the EMAC Program if they have a sensitive, protected, and/or regulatory status with state or federal agencies (see footnotes of Tables 13-2 and 13-3). NNSA/NSO has produced numerous documents reporting the occurrence, distribution, and susceptibility to threats for predominately sensitive species on the NTS (see *Ecology of the Nevada Test Site: An Annotated Bibliography* [Wills and Ostler, 2001]). In 1998, NNSA/NSO prepared a Resource Management Plan (U.S. Department of Energy, Nevada Operations Office, 1998). One of the natural resources goals stated in the plan is to protect and conserve sensitive plant and animal species found on the NTS and to minimize cumulative impacts to those species as a result of NNSA/NSO activities. The major accomplishments of 2009 under this EMAC task are presented below. Detailed descriptions of these actions and results can be found in Hansen et al. (2010).

Table 13-2. Important plants known to occur on or adjacent to the NTS

SENSITIVE PLANT SPECIES		
Flowering Plant Species	**Common Name**	**Status[(a)]**
Astragalus beatleyae	Beatley milkvetch	S, 5 years
Astragalus funereus	Black woolypod	S, 5 years
Astragalus oophorus var. *clokeyanus*	Clokey eggvetch	S, 5 years
Eriogonum concinnum	Darin buckwheat	S, 5 years
Eriogonum heermannii var. *clokeyi*	Clokey buckwheat	S, 5 years
Ivesia arizonica var. *saxosa*	Rock purpusia	S, 5 years
Phacelia beatleyae	Beatley scorpionflower	S, 10 years
Arctomecon merriamii	White bearpoppy	S, 10 years
Camissonia megalantha	Cane Spring suncup	S, 10 years
Cymopterus ripleyi var. *saniculoides*	Sanicle biscuitroot	S, 10 years
Frasera pahutensis	Pahute green gentian	S, 10 years
Galium hilendiae ssp. *kingstonense*	Kingston Mountains bedstraw	S, 10 years
Hulsea vestita ssp. *inyoensis*	Pumice alpinegold	S, 10 years
Penstemon fruticiformis var. *armagosae*	Death Valley beardtongue	S, 5 years
Penstemon pahutensis	Pahute Mesa beardtongue	S, 10 years
Phacelia filiae	Clarke phacelia	S, 10 years
Phacelia mustelina	Weasel phacelia	S, 10 years
Phacelia parishii	Parish phacelia	S, 10 years
Moss Species		
Entosthodon planoconvexus	Planoconvex entosthodon	S, 5 years
PROTECTED/REGULATED PLANT SPECIES		
Cactaceae	Cacti (18 species)	CY
Agavaceae	Yucca (3 species), Agave (1 species)	CY
Juniperus osteosperma	Juniper	CY
Pinus monophylla	Pinyon pine	CY

(a) Status Codes:

State of Nevada

S - Listed on the Nevada Natural Heritage Program (NNHP) Nevada Animal and Plant At-Risk Tracking List, March 2007

CY - Protected as a cactus, yucca, or Christmas tree (any evergreen tree or part thereof cut and removed from the place where grown without the foliage being removed) from unauthorized collection on public lands. Such plants are not protected from harm on private lands or on withdrawn public lands such as the NTS. They are recommended for avoidance, however, at proposed land disturbance sites at which preactivity surveys are conducted.

Long-term Sensitive Plant Monitoring Status under EMAC

5 years - Monitor a minimum of once every 5 years

10 years - Monitor a minimum of once every 10 years

Table 13-3. Important animals known to occur on or adjacent to the NTS

Mollusk Species	**Common Names**	**Status [(a)]**
Pyrgulopsis turbatrix	Southeast Nevada pyrg	S, A
Reptile Species		
Eumeces gilberti rubricaudatus	Western red-tailed skink	S, E
Gopherus agassizii	Desert tortoise	LT, NPT, S, IA
Bird Species[(b)]		
Accipiter gentilis	Northern goshawk	NPS, S, IA
Alectoris chukar	Chukar	G, IA
Aquila chrysaetos	Golden eagle	EA, NP, IA
Buteo regalis	Ferruginous hawk	NP, S, IA
Callipepla gambelii	Gambel's quail	G, IA
Coccyzus americanus	Western yellow-billed cuckoo	C, NPS, S, IA
Falco peregrinus anatum	Peregrine falcon	NPE, S, IA
Haliaeetus leucocephalus leucocephalus	Bald eagle	EA, NPE, S, IA
Ixobrychus exillis hesperis	Western least bittern	NP, S, IA
Lanius ludovicianus	Loggerhead shrike	NPS, IA
Oreoscoptes montanus	Sage thrasher	NPS, IA
Phainopepla nitens	Phainopepla	NP, S, IA
Spizella breweri	Brewer's sparrow	NPS
Toxostoma bendirei	Bendire's thrasher	NP, S, IA
Toxostoma lecontei	LeConte's thrasher	NP, S, IA
Mammal Species		
Antilocapra americana	Pronghorn antelope	G, IA
Antrozous pallidus	Pallid bat	NP, M, A
Cervus elaphus	Rocky Mountain elk	G, IA
Corynorhinus townsendii pallescens	Townsend's big-eared bat	NPS, S, H, A
Equus asinus	Burro	HB, IA
Equus caballus	Horse	HB, A
Euderma maculatum	Spotted bat	NPT, S, M, A
Lasionycteris noctivagans	Silver-haired bat	M, A
Lasiurus blossevillii	Western red bat	NPS, S, H, A
Lasiurus cinereus	Hoary bat	M, A
Lynx rufus	Bobcat	F, IA
Microdipodops megacephalus	Dark kangaroo mouse	NP, A
Microdipodops pallidus	Pale kangaroo mouse	NP, S, A
Myotis californicus	California myotis	M, A
Myotis ciliolabrum	Small-footed myotis	M, A
Myotis evotis	Long-eared myotis	M, A
Myotis thysanodes	Fringed myotis	NP, S, H, A
Myotis yumanensis	Yuma myotis	M, A
Ovis canadensis nelsoni	Desert bighorn sheep	G, IA
Odocoileus hemionus	Mule deer	G, A
Pipistrellus Hesperus	Western pipistrelle	M, A
Puma concolor	Mountain lion	G, A
Sylvilagus audubonii	Audubon's cottontail	G, IA

Table 13-3. Important animals known to occur on or adjacent to the NTS (continued)

Mammal Species (continued)	Common Names	Status [(a)]
Sylvilagus nuttallii	Nuttall's cottontail	G, IA
Tadarida brasiliensis	Brazilian free-tailed bat	NP, A
Urocyon cinereoargenteus	Gray fox	F, IA
Vulpes velox macrotis	Kit fox	F, IA

(a) Status Codes:

U.S. Fish and Wildlife Service, Endangered Species Act
LT - Listed Threatened
C - Candidate for listing

U.S. Department of Interior
EA - Protected under Bald and Golden Eagle Act
HB - Protected under Wild Free Roaming Horses and Burros Act

State of Nevada
F - Regulated as fur-bearer species
G - Regulated as game species
NPE - Species protected as endangered under Nevada Administrative Code (NAC) 503
NPT - Species protected as threatened under NAC 503
NPS - Species protected as sensitive under NAC 503
NP - Species listed as protected under NAC 503
S - Listed on NNHP's Nevada Animal and Plant At-Risk Tracking List, March 2007

Revised Nevada Bat Conservation Plan (Bradley et al., 2005) – Bat Species Risk Assessment Designations
H - High: species imperiled or at high risk of imperilment and having the highest priority for funding, planning, and conservation actions
M - Moderate: species that warrant closer evaluation, more research, and conservation actions and lacking meaningful information to adequately assess species' status

Long-term Sensitive Animal Monitoring Status under EMAC
A - Active: currently included in long-term population monitoring activities
E - Evaluate: species for which more information on distribution, abundance, and susceptibilities to threats on the NTS must be gathered before deciding to include in long-term monitoring activities
IA - Inactive: not currently included in long-term population monitoring activities

(b) All wild bird species on the NTS are protected by the Migratory Bird Treaty Act except for the following five species: Gambel's quail, chukar, English house sparrow, rock dove, and European starling.
Also, the State of Nevada protects all wild birds that are protected by federal laws in addition to the species listed in this table.

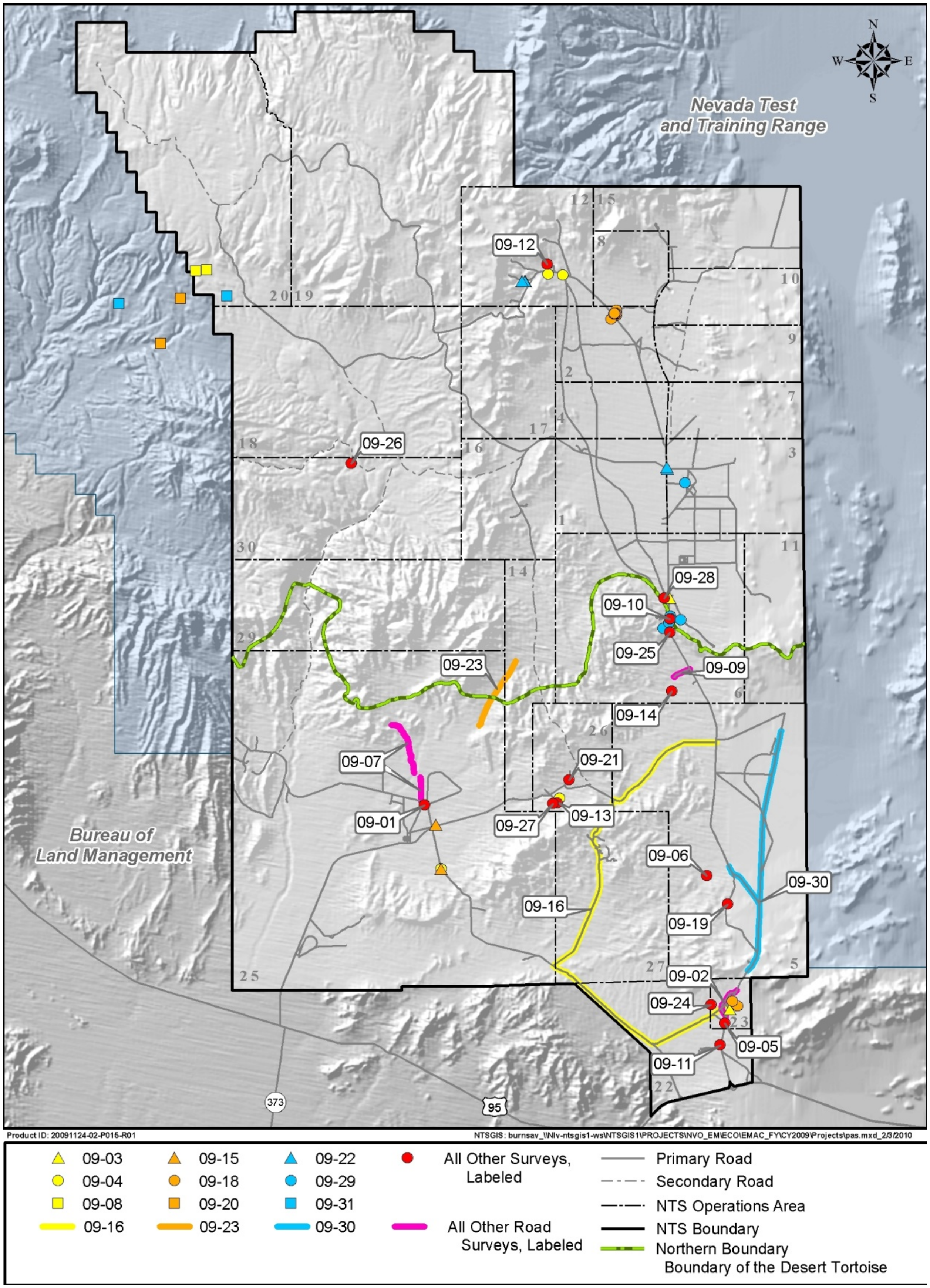

Figure 13-2. Location of biological surveys conducted on the NTS in 2009.

13.3.1 Sensitive Plants

There were no modifications in 2009 to the list of sensitive plants known to occur on the NTS (Table 13-1). Field surveys in 2009 focused on two species, Kingston Mountains bedstraw (*Galium hilendiae* ssp. *kingstonense*) and Sanicle biscuitroot (*Cymopterus ripleyi* var. *saniculoides*). Populations of Kingston Mountains bedstraw at Oak and Tub springs (Area 15) were surveyed and mapped. Several hundred individuals were found in flower and seed set at the two locations. Another population reported from Tongue Wash on the east slope of Rainier Mesa (Area 12) was surveyed, but no plants were found.

Field surveys for Sanicle biscuitroot were conducted to help resolve its taxonomy. The variety was named by R. C. Barneby in 1941 based on flower color, a dark purple, as opposed to the cream-colored flowers of Sanicle biscuitroot. Field surveys at locations of both varieties were conducted to ascertain if there was a mixing of flower colors as had previously been reported (Blomquist et al., 1995). Results of the field surveys did not provide any evidence that both varieties are commonly, or even occasionally, found at the same location. Purple colored flowers occur at lower elevations and cream colored flowers at upper elevations. Sanicle biscuitroot will continue to be considered a valid taxon and will be monitored along with other sensitive plants known to occur on the NTS.

A new location of Pumice alpinegold (*Hulsea vestita* var. *inyoensis*) was found in the Tongue Wash area while conducting surveys for Kingston Mountains bedstraw. Two new locations of Clokey eggvetch (*Astragalus oophorus* var. *clokeyanus*) were also found, one on the eastern slopes of Timber Mountain (Area 30) and one on the east slope of Rainier Mesa near Tongue Wash.

A map of all the known sensitive plant populations on the NTS is available on the NNSA/NSO Internet Web site at http://www.nv.energy.gov/library/publications/Environmental/Figures/Fig11-3.pdf.

13.3.2 Important Animals

13.3.2.1 Western Red-tailed Skink

Surveys for the western red-tailed skink *(Eumeces gilberti rubricaudatus*) (Figure 13-3) continued in 2009. Eight western red-tailed skinks were captured from six sites during 5,746 trap days at 31 sites. A total of 451 reptiles representing 11 of the 16 known lizards and 7 of the 17 known snake species on the NTS were captured or observed in 2009. Current NTS distributions of western red-tailed skinks are presented in Hansen et al. (2010). NTS biologists collaborated with Dr. Jonathan Richmond of the U.S. Geological Survey (USGS) to provide specimens for genetic testing. During western red-tailed skink trapping, the presence of other species such as mammals and birds was also documented (Hansen et al., 2010).

Figure 13-3. Adult western red-tailed skink (Photo by D. B. Hall, June 5, 2008)

13.3.2.2 Western Burrowing Owl

No surveys for western burrowing owls *(Athene cunicularia hypugaea)* were conducted in 2009; however, an opportunistic re-sighting of a banded burrowing owl was made at a burrow in Area 18. A motion-activated camera was set up at this burrow and identified an adult female with five young. This female had been captured and banded previously in July 2008 at another burrow 28 kilometers (km) (18 miles [mi]) from its 2009 nest burrow. Other 2009 opportunistic sightings included a live owl in Mercury (Area 23) and a dead owl on a road in Area 27. The current total of documented western burrowing owl locations on the NTS is 167 (50 owl sightings and 117 burrow sites). NSTec biologists authored two articles on NTS western burrowing owls, one on food habits (Hall et al., 2009) and one on burrow use (Greger and Hall, 2009).

13.3.2.3 Migratory Bird Monitoring and Protection

Most birds and their nests and eggs are protected or regulated under the Migratory Bird Treaty Act or Nevada state law (see Table 13-3). Nine raptor species are known to breed on the NTS. Opportunistic sightings of raptors were uncommon in 2009 and were recorded in a raptor sighting database. Three nests with chicks were protected from harm in 2009, including one Say's phoebe nest with four chicks and two nests of unknown species, each with chicks. NTS operations, which resulted in harm to these nests, were postponed until the chicks had fledged and the nests were empty.

Bird mortality is a measure of the impacts of NNSA/NSO activities on protected birds. Three bird mortalities were recorded in 2009: a barn owl *(Tyto alba)* from an unknown cause, a red-tailed hawk *(Buteo jamaicensis)* which was electrocuted by a powerline, and a Western burrowing owl hit by a vehicle. Figure 13-4 shows the reported number of bird mortalities on the NTS by cause since 1990.

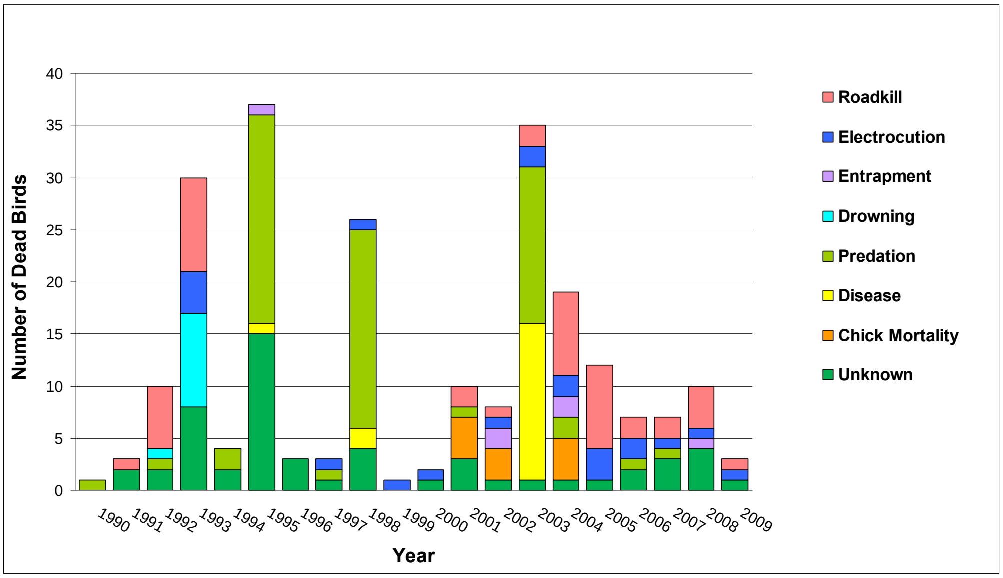

Figure 13-4. Number of bird deaths recorded on the NTS by year and cause

13.3.2.4 State-Protected Small Mammals

In 2005, the dark kangaroo mouse *(Microdipodops megacephalus)* and the pale kangaroo mouse *(M. pallidus)* were added to the list of Nevada Protected species under NAC 503 (see Table 13-3). Small mammal trapping was initiated in 2005 to help assess these species' distribution and abundance on the NTS. Trapping continued in 2009; however, these two species were not captured. Trapping results are presented in Hansen et al. (2010).

13.3.2.5 Sensitive Bats

In 2009, surveys for bats were conducted at Oak Spring (Area 15), at abandoned mines in the historical Rainstorm Mining District (Area 10), and at the two closed tunnels, 16A Tunnel and N Tunnel, at which bat-compatible closures ("bat gates") were recommended and installed. Of the 13 important bat species known to occur on the NTS (see Table 13-3), 4 were detected acoustically at Oak Spring (Hansen et al., 2010). A maternity roost of the fringed myotis (*Myotis thysanodes*) was found in an adit in the Rainstorm Mining District. An estimated 69 bats were at the roost. It is the third known fringed myotis maternity roost on the NTS and one of the few known in Nevada. Four important bat species were detected acoustically flying over or around a shaft in the Rainstorm Mining District, although no bats were observed entering or exiting the shaft. 16A Tunnel was being used by three important bat species, and video camera footage revealed numerous passes of bats through its bat gate. The tunnel is still being used as a night roost and foraging site and possibly a day roost. Six important bat species were detected at N Tunnel, and video camera and night vision goggle surveys demonstrated that the tunnel is still being used as a day roost, night roost, and foraging site. Some flights of bats through the bat gate in the north portal (main drift) of the tunnel were documented.

Acoustic (bat vocalization) data and concurrent climate data were also collected from Camp 17 Pond in 2009; however, these data have not yet been analyzed. In 2009, bats were found in nine NTS buildings. Three bats were dead and nine were alive, six of which were removed and relocated (Hansen et al., 2010).

13.3.2.6 Wild Horses

An annual horse census is conducted by driving selected NTS roads and using cameras to record individual markings of animals. The direct population count in 2009 was 37 individuals, not including foals. Six foals were observed. Foal survival is typically very low, most likely due to predation by mountain lions. Figure 13-5 shows the horse census results since 2002.

The estimated home range of 222 square kilometers (km^2) (85.7 square miles [mi^2]) in 2009 was very similar in size to the horse range in previous years. Camp 17 Pond and Gold Meadows Spring continue to be important summer water sources for horses.

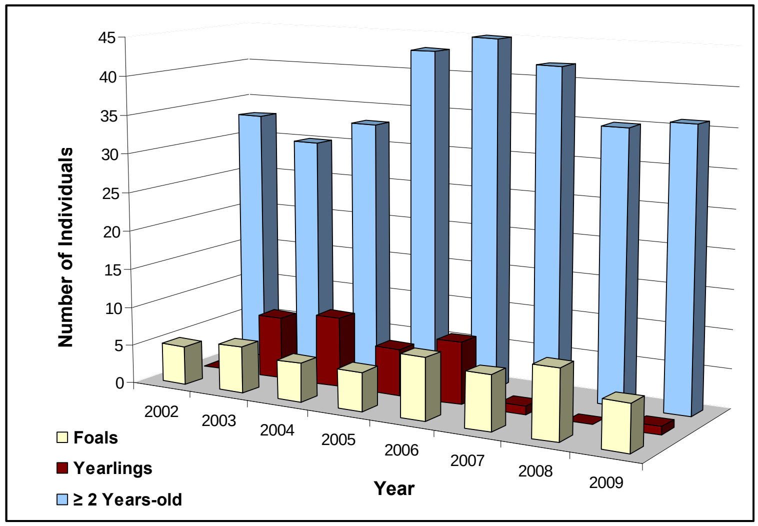

Figure 13-5. Trends in age structure of the NTS horse population from 2002 to 2009

13.3.2.7 Mule Deer

Mule deer *(Odocoileus hemionus)* abundance has been measured on the NTS during most years since 1989 by counting the number of deer sighted at night while driving along a prescribed census route. Deer counts have fluctuated from a low of 9.0 deer/night in 1999 to a high of 62.1 deer/night in 2006. The average number of deer counted in 2009 was 27 deer/night, which is a 40 percent drop from 2008. Deer density was calculated along different sections of the route and along the total route using Program Capture, Version 5.0 (Thomas et al., 2006). Deer density was fairly uniform along the routes within different regions of the northern NTS such as Rainier Mesa and Pahute Mesa. Density ranged from 1 to 2.4 deer/km^2 and averaged about 1 deer/km^2 (or 1 deer per 2.6 mi^2).

13.3.2.8 Mountain Lions

Mountain lions *(Puma concolor)* prey on wild horses, deer, antelope *(Antilocapra americana)*, and even desert tortoises and pose a potential threat to humans on the NTS. A collaborative effort continued in 2009 with Erin Boydston of the USGS to investigate mountain lion distribution and abundance on the NTS. Motion-activated cameras were set up at 22 sites, and mountain lions were detected (Figure 13-6) at 7 of the sites. A total of 117 photographs/video clips of mountain lions were taken during 120,411 camera hours, or about 1.0 photo/video clip per 1,000 camera hours. Information about distribution, abundance, and temporal activity of mountain lions can be found in Hansen et al. (2010).

Figure 13-6. Mountain lion at Topopah Spring (Photo by motion-activated camera, September 24, 2009)

A secondary objective of the camera surveys is to detect other species to better define their distributions on the NTS. A total of 4,843 photographs/video clips of at least 25 other species were taken. Some of the rarer, elusive species documented were Rocky Mountain elk (*Cervus elaphus*), desert bighorn sheep (*Ovis canadensis nelsoni*), wild burro (*Equus asinus*), bobcat (*Lynx rufus*), gray fox (*Urocyon cinereoargenteus*), badger (*Taxidea taxus*), and great blue heron (*Ardea herodias*).

13.3.2.9 Natural and Man-Made Water Sources

Natural wetlands on the NTS are monitored and protected, when feasible, as unique and important habitats for plants and wildlife in accordance with the intent of Executive Order (EO) 11990, "Protection of Wetlands." Characterization of these mesic habitats and periodic monitoring of their hydrologic and biotic parameters was started in 1997 to help identify natural fluctuations and ranges in measured parameters. In 2009, 12 wetlands were monitored to document water surface area, surface flow, observed disturbances, and wildlife use and mortality. The surface areas (in square meters [m^2]) and flow rates (in liters per minute [L/min]) were moderately low at the natural springs in 2009 (0.1–600 m^2 and 0.020–1.5 L/min where flow was measurable, respectively) (Hansen et al., 2010). No wetlands were damaged by NTS activities. As in previous years, a sensitive species of springsnail *(Pyrgulopsis turbatrix)* was present in 2009 at Cane Spring, its only natural habitat on the NTS.

Man-made water sources were monitored in 2009 for wildlife use and mortality. They included 34 plastic-lined sumps and 2 radioactive containment ponds. Three dead deer were found at the plastic-lined Well ER-20-5 sump into which well water was pumped in July, but in which no sediment escape ramps had been constructed. Sediment ramps were installed immediately upon discovery of the dead deer. No wildlife mortality was observed at the other water sources and their use by wildlife is presented in Hansen et al., 2010.

13.3.3 West Nile Virus Surveillance

West Nile virus (WNV) surveillance on the NTS continued in 2009 for the sixth consecutive year in cooperation with the Southern Nevada Health District (SNHD). Eight sites were sampled for mosquitoes during 15 surveys, and a total of 18 mosquitoes representing two species were captured. NSTec personnel took the mosquitoes to SNHD personnel for species identification and WNV testing. All tested specimens were negative for WNV.

13.4 Habitat Restoration Monitoring Program

The habitat restoration program involves the revegetation of disturbances and the evaluation of previous revegetation efforts. Sites that have been revegetated are periodically sampled and the information obtained is used to develop site-specific revegetation plans for future restoration efforts on the NTS. Revegetation supports the intent of EO 13112, "Invasive Species" to prevent the introduction and spread of non-native species and restore native species to disturbed sites. Revegetation also may qualify as mitigation for the loss of desert tortoise habitat under the current 2009 Biological Opinion from the FWS. NNSA/NSO projects for which revegetation has been pursued are lands disturbed in desert tortoise habitat, wildland fire sites, and abandoned industrial or nuclear test support sites characterized and remediated under the Environmental Restoration (ER) Program. The ER Program has also revegetated soil closure covers (or cover caps) to protect against soil erosion and water percolation into buried waste.

In 2009, land disturbed by the installation of an underground waterline was revegetated, and several previously revegetated sites, one on the NTS and five on the TTR, were monitored. The waterline installed at CP Hills in Area 6 created a linear disturbance of approximately 15 ha (7 ac). The western section of the waterline (approximately 0.4 ha [1.0 ac]) was in steep terrain and susceptible to severe water erosion and was revegetated in the fall with a mix of native plant seed.

The previously revegetated closure cover cap on the U-3ax/bl disposal unit in Area 3 was monitored. Total plant cover on the cap was 12 percent. Shadscale saltbush *(Atriplex confertifolia)* made up 94 percent of the total cover; Nevada jointfir *(Ephedra nevadensis)* and two annual buckwheat (*Eriogonum)* species contributed equally to the remaining 6 percent. Plant cover on the peripheral area was only 4 percent in 2009, all from cheatgrass *Bromus tectorum*, an annual invasive weed. Perennial plant density has declined over the last five years. In 2005, five perennial shrubs and two perennial grasses were found on the closure cover. By 2009, only three shrubs and no grasses were found. Shrub density declined from 4.7 plants/m^2 (3.9 square yards [yd^2]) in 2005 to just

1.2 plants/m^2 (1.0 yd^2) in 2009. The plant community on the U-3ax/bl closure cover cap is characterized by a combination of native perennial shrubs and annual forbs. Weedy species are present occasionally, but when present, make up on average less than 6 percent of the total cover. Even though plant cover and density have declined over the last five years, a viable perennial plant community persists.

Five TTR sites were monitored: the Bomblet Pit and Five Points Landfill (Corrective Action Unit [CAU] 400), the Roller Coaster Lagoons and Trench (CAU 404), the cover cap at Cactus Spring Waste Trenches (CAU 426), and the Roller Coaster RadSafe Area (CAU 407). The Roller Coaster RadSafe Area was revegetated in 2004, the others in 1997. Plant cover exceeded the reclamation success standard at four of these sites, ranging from one and a half times the standard at the Five Points Landfill to almost three times the success standard at the Roller Coaster Lagoons and Trench. Only at the Bomblet Pit did plant cover not meet the standard; the site reached 85 percent. Plant density at the Five Points Landfill and at the cover cap at Cactus Spring Waste Trenches was about 90 percent of the revegetation success standard. Plant density at the other sites ranged from one and a half times the standard at the Roller Coaster Lagoons and Trench to more than four times the standard at the Cactus Spring Waste Trenches staging area. Revegetation goals have been met at the Bomblet Pit, the Cactus Spring Waste Trenches, and the Roller Coaster Lagoons and Trench; revegetation success monitoring will be discontinued at these sites.

13.5 Wildland Fire Hazard Assessment

DOE O 450.1A requires protection of site resources from wildland and operational fires. An annual vegetation survey to determine wildland fire hazards is conducted on the NTS each spring. Survey findings are submitted to the NTS Fire Marshal and summarized in the annual EMAC report (Hansen et al., 2010). In April and May, NSTec biologists visited 106 NTS roadside sampling stations to assess a fuel index that can range from 0 to 10 (lowest to highest risk of wildfires) based on the presence of fine fuels and woody fuels. Fine fuels refer to fine-textured fuels, typically invasive non-native and native grasses and forbs. Woody fuels refer mainly to shrubs. Mean precipitation in 2009 was about 66 percent of average at the NTS rain gauges operated by the Air Resources Laboratory, Special Operations and Research Division. The mean combined fuels index for all 106 sampling stations was 4.52, compared to 4.81, 4.77, 5.26, 5.64, and 4.88 in 2008, 2007, 2006, 2005, and 2004, respectively. In 2009, there were 17 wildland fires for a total of about 95 ha (235 ac) burned. About 82 percent of the fires were caused by ordnance associated with training activities, while 18 percent were caused by lightning. Locations of the fires were in Area 30 (Cat Canyon) and Area 16.

13.6 Biological Monitoring of the NPTEC

Biological monitoring at NPTEC in Area 5 is performed whenever there is a risk of significant exposure to downwind plants and animals from planned test releases of hazardous materials. The Desert National Wildlife Refuge (DNWR) lies just east of the NTS border, approximately 5 km (3 mi) from NPTEC. The National Wildlife Refuge System Administration Act forbids the disturbance or injury of native vegetation and wildlife on any National Wildlife Refuge System lands unless permitted by the Secretary of the Interior. The DNWR is administered within this System. Biological monitoring is conducted to verify that approved tests do not disperse toxic chemicals that harm biota on DNWR. This is also a requirement of NPTEC's Programmatic Environmental Assessment (U.S. Department of Energy, Nevada Operations Office, 2002). Monitoring involves sampling established transects both downwind and upwind of NPTEC and recording (1) the number and type of dead animals observed, (2) the number and type of wildlife observed, and (3) the presence of observed vegetation damage.

NSTec biologists did not review any chemical spill test plans during 2009. Because no testing was performed at NPTEC and due to budget constraints, baseline monitoring was not conducted at established control-treatment transects near NPTEC in 2009.

14.0 Underground Test Area Sub-Project

From 1951 to 1992, more than 800 underground nuclear tests were conducted at the Nevada Test Site (NTS) (U.S. Department of Energy, Nevada Operations Office [DOE/NV], 2000). Most were conducted hundreds of feet above groundwater; however, over 200 were near or below the water table in the saturated zone. The Underground Test Area (UGTA) Sub-Project, the largest component of the Environmental Restoration Project, investigates areas where local or regional groundwater contamination has occurred. These areas have been organized into five UGTA Corrective Action Units (CAUs) which are directly related to the geographical and hydrologic areas of past NTS underground testing (Figure 14-1). UGTA CAUs are included in the Federal Facility Agreement and Consent Order (FFACO, as amended March 2010) between the U.S. Department of Energy, the U.S. Department of Defense, and the Nevada Division of Environmental Protection (NDEP). Completing the schedule of FFACO corrective actions for UGTA CAUs is among the highest mission priorities of the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO).

The UGTA Sub-Project gathers information regarding the hydrology and geology of each CAU and gathers data to define groundwater flow rates and direction to determine the nature and location of aquifers. Hydrogeologic studies use existing data from past testing and data obtained from drilling and testing newly constructed deep wells and from recompleting or rehabilitating existing wells. Figure 14-2 shows the new and historical wells that are managed under the UGTA Sub-Project. UGTA wells that are not designated as source term characterization wells are made available for routine radiological monitoring (see Section 5.1.2).

Data from studies are used to produce hydrogeologic models that will be used to predict groundwater flow and contaminant transport. Numerous surface and subsurface investigations and computer modeling are performed by various participating organizations including National Security Technologies, LLC (NSTec); Los Alamos National Laboratory (LANL); Lawrence Livermore National Laboratory (LLNL); the U.S. Geological Survey (USGS); the Desert Research Institute (DRI); and Navarro Nevada Environmental Services, LLC (NNES).

Surface investigations include the following:

- Evaluating discharges from springs located downgradient of the NTS
- Assessing surface geology

Subsurface investigations include the following:

- Drilling deep wells to access groundwater hundreds to thousands of feet below the surface
- Sampling groundwater to test for radioactive contaminants
- Assessing NTS hydrology and subsurface geology to determine possible groundwater flow paths and direction

Hydrogeologic modeling includes the following:

- Developing a regional three-dimensional computer groundwater model (International Technology Corporation, 1996; Belcher et al., 2004) to identify any immediate risk and to provide a basis for developing more detailed CAU-specific models
- Developing CAU-specific models of groundwater flow and contaminant transport that geographically cover the six former NTS underground nuclear testing areas
- Developing smaller scale (“sub-CAU scale”) models to investigate specific geographic areas and for sensitivity analysis to identify key uncertainties and data needs
- Identifying, through the CAU-specific models, contaminant boundaries based on the extent of contaminant migration at specified regulatory limits (exceeding the Safe Drinking Water Act limits at any time within a 1,000 year period)

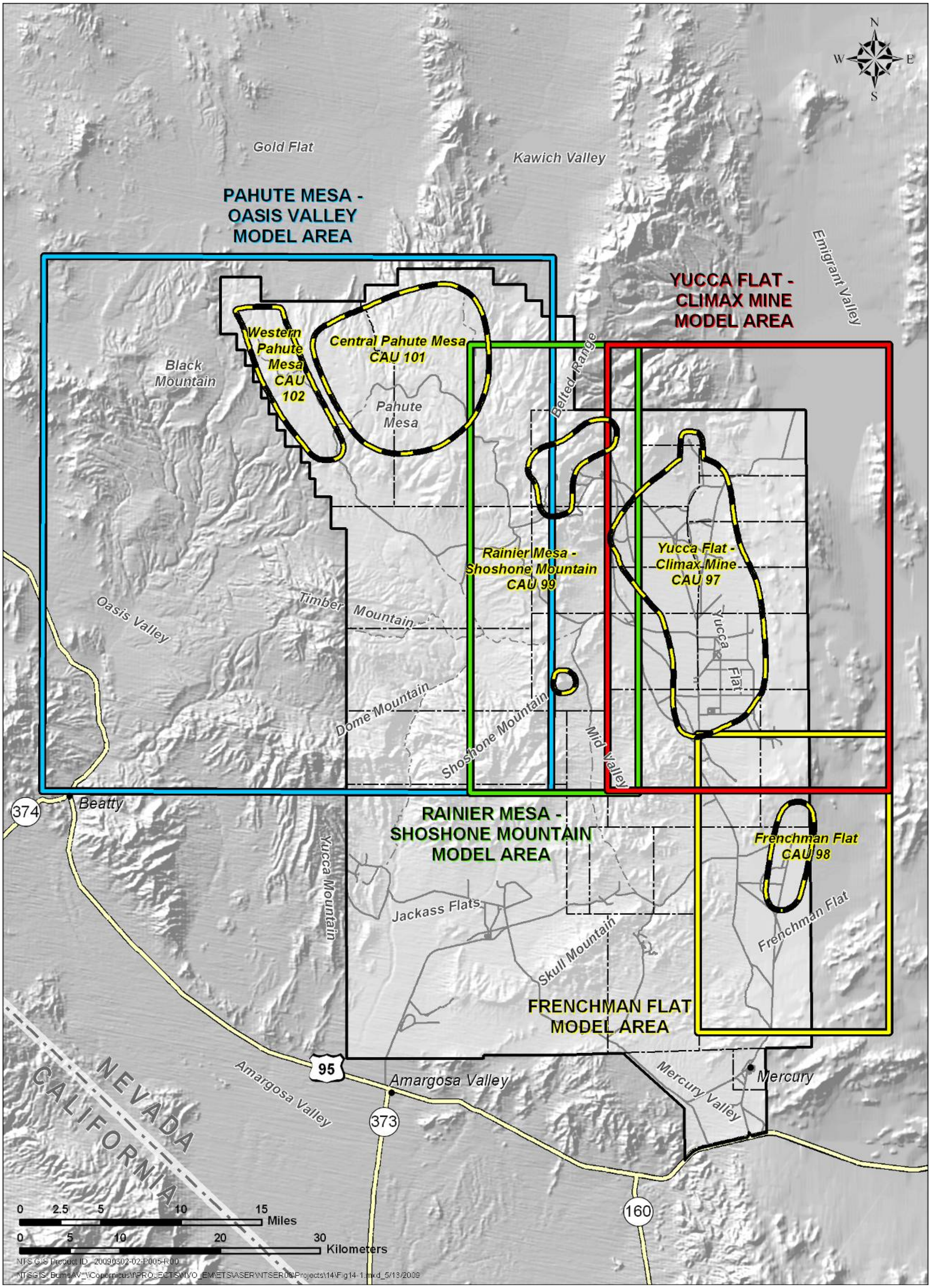

Figure 14-1. Location of UGTA Sub-Project CAUs and model areas

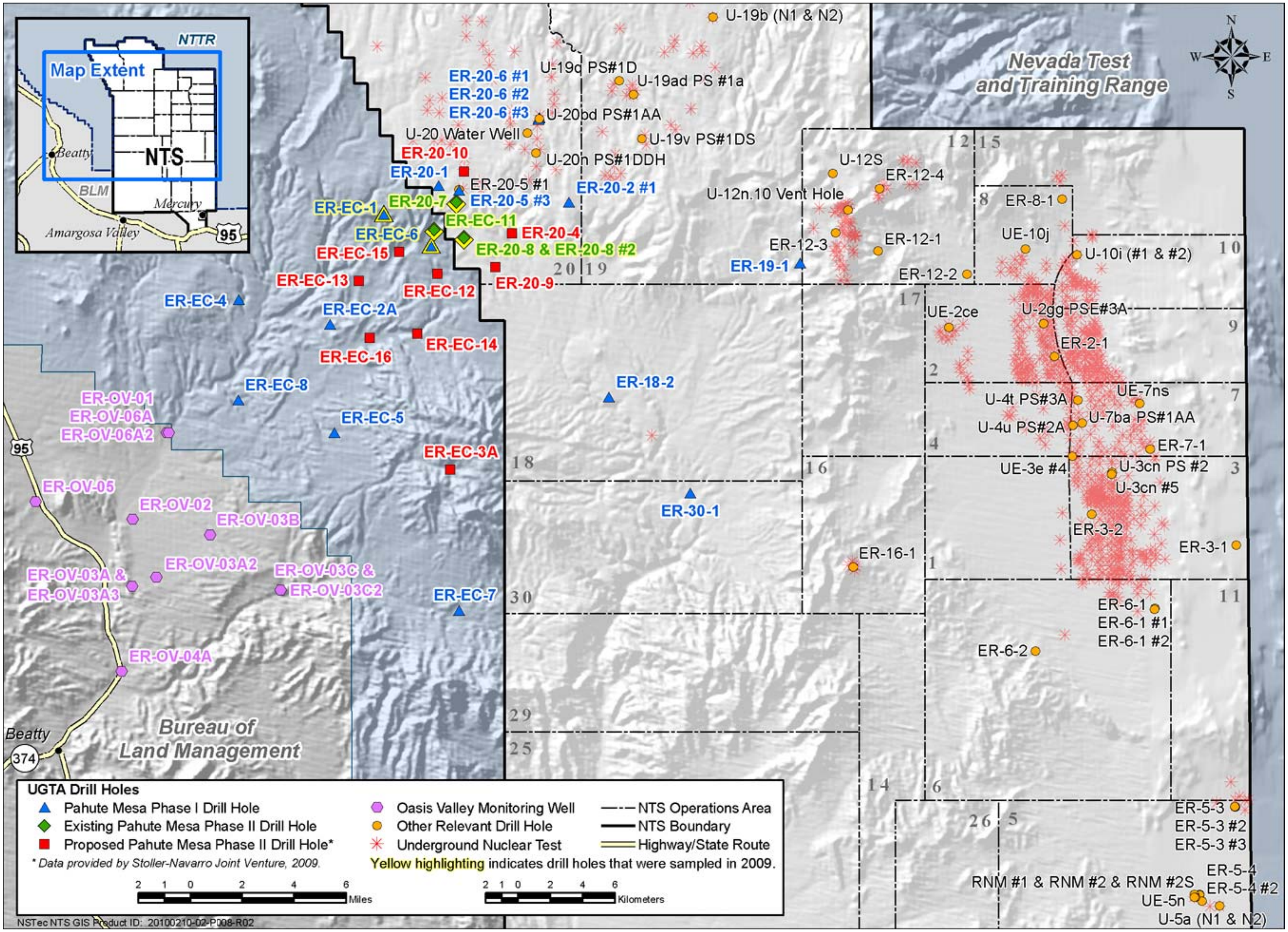

Figure 14-2. Existing and proposed UGTA Sub-Project drill holes

The final product for each UGTA CAU will be an analytical model that includes a predicted contaminant boundary and a negotiated compliance boundary. A monitoring well network will be designed and installed for each CAU and used for monitoring to ensure public health and safety (NNSA/NSO, 2006). Closure-in-place with institutional controls and monitoring is considered to be the only feasible corrective action because cost-effective groundwater technologies have not been developed to effectively remove or stabilize deep subsurface radiological contaminants.

14.1 Subsurface Investigations

In 2009, the UGTA Sub-Project initiated a Phase II hydrogeologic investigation for the Pahute Mesa–Oasis Valley Model Area (Figure 14-1). As part of this effort, 12 proposed well sites were identified (Figure 14-2). The Pahute Mesa Phase II hydrogeologic investigation is part of the Corrective Action Investigation Plan (CAIP) for the Central and Western Pahute Mesa CAUs, 101 and 102, respectively (NNSA/NSO, 2009b). The CAIP is a requirement of the FFACO. The final number of Pahute Mesa Phase II wells will be determined by NNSA/NSO. Proposed wells are selected to provide the maximum amount of hydrogeologic information to support refinement of the Phase I Pahute Mesa–Oasis Valley hydrostratigraphic framework model (Bechtel Nevada [BN], 2002) and to support subsequent Phase II groundwater flow and contaminant transport modeling. Of particular interest is the characterization of specific pathways (i.e., faults, fractured aquifers) along which radionuclides could migrate from individual underground nuclear tests away from the NTS to the accessible environment. Another goal of the hydrogeologic investigation is to determine the hydraulic properties of the volcanic aquifers in the former UGTAs and along potential flow paths downgradient. Some of the new characterization wells drilled for this investigation may also be used as long-term monitoring wells.

14.1.1 Well Drilling

In 2009, the first four Pahute Mesa Phase II wells were drilled and completed. They are ER-20-7, ER-20-8, ER-20-8#2, all in Area 20, and ER-EC-11 located on the Nevada Test and Training Range (NTTR) just west of the NTS (Figure 14-2). Preliminary evaluations of the data show that these wells are providing quality information and fulfilling their intended scientific objectives. The scientific objectives, predicted geology and hydrology, expected drilling conditions, and well construction and completion designs for the proposed Phase II wells are summarized in a well drilling and completion document (SNJV, 2009a). Well construction data for the four wells will be published in individual well completion reports in 2010.

The primary purpose for Well ER-20-7 is to investigate contaminant plume migration downgradient from the TYBO and BENHAM underground nuclear tests. The TYBO and BENHAM tests were executed in U-20y and U-20c, respectively, as encountered at Well Cluster ER-20-5 (DOE/NV, 1997b). The aquifer of interest for this well is the Topopah Spring aquifer (TSA).

Wells ER-20-8 and ER-20-8#2 are expected to provide detailed hydrogeologic information in the shallow- to intermediate-depth Tertiary volcanic section between the Silent Canyon caldera complex and the Timber Mountain caldera complex (TMCC). The site of these two wells was also expected to provide information regarding the nature and hydrologic effect of the Northern Timber Mountain moat structural zone (NTMMSZ) and the Boxcar fault. The aquifers of interest for the deeper well, ER-20-8, are the Tiva Canyon aquifer (TCA) and the TSA. The aquifer of interest for ER-20-8 #2 is the Benham aquifer (BA).

Well ER-EC-11 is expected to provide detailed hydrogeologic information for the shallow- to intermediate-depth Tertiary volcanic section in the area between Pahute Mesa and the TMCC. This site is also expected to provide stratigraphic, structural, and hydraulic information to better characterize the structure and hydrogeologic nature of the NTMMSZ. Because a contaminant plume was encountered upgradient at Well ER-20-7, Well ER-EC-11 can be used to investigate the extent and nature of the plume, as first described at Well Cluster ER-20-5 (DOE/NV, 1997b). The aquifers of interest for this well are the BA, TCA, and TSA.

14.1.2 Groundwater Sampling

In 2009, the UGTA Sub-Project pumped and collected groundwater samples from the following six characterization wells:

Phase I Wells	Phase II Wells
ER-EC-1	ER-20-7
ER-EC-6	ER-20-8
	ER-20-8#2
	ER-EC-11

Preliminary samples were collected from the four new Phase II wells during and immediately after drilling. They will be sampled again in 2010 after further well development and hydraulic testing activities. Wells ER-EC-1 and ER-EC-6 were purged using downhole electric submersible pumps prior to the collection of samples. A multi-agency team consisting of personnel from LANL and LLNL collected the groundwater samples and analyzed them for tritium and other radionuclides. The groundwater from these wells was discharged into nearby lined sumps in accordance with the Decision Criteria Limits specified in the *UGTA Fluid Management Plan* (Attachment I of U.S. Department of Energy, National Nuclear Security Administration Nevada Operations Office, 2002).

The tritium concentration at Well ER-20-7 was 18,300,000 picocuries per liter (pCi/L). This represents a contaminant plume from nearby underground nuclear test(s), which was first defined at Well Cluster ER-20-5 (DOE/NV, 1997b). Wells ER-20-8 and ER-20-8#2 had very low tritium levels (≤1,500 pCi/L), and well ER-EC-11 had a tritium level of 12,500 pCi/L, still below the Safe Drinking Water Act (SDWA) limit of 20,000 pCi/L. The tritium results indicate that these three wells are likely near the leading edge of the contaminant plume (see Section 14.2.1 for further discussion). The tritium concentrations in the two Phase I characterization wells were below detection limits. Tritium concentrations for all UGTA wells sampled are presented in Section 5.1.10 (see Table 5-6). Groundwater data are maintained by NNES in the UGTA Sub-Project geochemical database.

14.1.3 Support Activities

In 2009, land and ecological surveys were completed for the proposed access roads and drill pads for three new characterization wells: ER-EC-12, ER-EC-13, and ER-EC-16 (Figure 14-2). The surveys were conducted in anticipation of drilling the wells in 2010 (see Section 14.2.1 below). Construction of the access road and drill pad for ER-EC-12 was started in 2009.

NSTec personnel who support UGTA well drilling operations renewed their State of Nevada well drilling operations licenses in 2009.

14.2 Hydrogeologic Modeling and Supporting Studies

Construction of CAU-specific groundwater-flow and contaminant-transport models requires a hydrostratigraphic framework that depicts the character and extent of hydrostratigraphic units in three dimensions. Four hydrostratigraphic framework models, also referred to as geologic models, have been built (see the color-coded model areas in Figure 14-1). The four model areas encompass the five UGTA CAUs:

- Pahute Mesa–Oasis Valley, CAUs 101 and 102 (BN, 2002)
- Rainier Mesa–Shoshone Mountain, CAU 99 (NSTec, 2007b)
- Frenchman Flat, CAU 98 (BN, 2005b)
- Yucca Flat–Climax Mine, CAU 97 (BN, 2006)

In 2009, work was conducted for all four model areas.

14.2.1 Pahute Mesa–Oasis Valley Model Area

The final draft of the Phase I flow and transport model for the Central and Western Pahute Mesa CAUs was published in 2009 (SNJV, 2009a). The model supports the statements released in the 1997 regional groundwater flow and tritium transport report (DOE/NV, 1997c), which states that radioactively contaminated groundwater is predicted to travel off the northwestern boundary of the NTS. The transport model predicts the migration of tritium and carbon-14 off the NTS within 50 years of the first nuclear detonation (1965) from the Central and Western Pahute Mesa CAUs. The model predicts that contamination above the SDWA limit for tritium (20,000 pCi/L) should be present off the NTS (Figure 14-3).

NNSA/NSO prepared a public presentation of the model predictions and the current state of knowledge of contaminant migration off the NTS, which was given at an open house on February 18, 2009, at the Beatty Community Center in Beatty, Nevada. A second open house in Beatty was held in April 2010. Links to the regional transport model, to the Phase I Central and Western Pahute Mesa Transport Model, and to posters presented at the April 2010 open house can be found at the NNSA/NSO Web page http://www.nv.doe.gov/library/publications/Environmental/April2010GWOpenHousePosters.pdf. Figure 14-3 is adapted from one of the posters presented at the open house.

The Technical Working Group Pahute Mesa Phase II CAIP ad hoc Subcommittee reviewed the state of knowledge supporting the Phase I flow and transport model. The Subcommittee identified data needs, identified further analysis work to support Phase II modeling, and prioritized proposed drilling locations for new wells (SNJV, 2009a; NNSA/NSO, 2009b). The Subcommittee includes the NNSA/NSO UGTA Sub-Project director, subject matter experts consisting of UGTA Sub-Project participants (NSTec, DRI, LLNL, LANL, NNES, and USGS), a representative from NDEP, and two representatives of the Community Advisory Board. Based on the review, additional work activities (Phase II) were proposed in the Central and Western Pahute Mesa CAIP.

The Central and Western Pahute Mesa CAIP outlines a campaign to drill nine wells from 2009 to 2011 to gather further data regarding the establishment of a long-term groundwater monitoring system. The UGTA Sub-Project selected 12 proposed locations for these new Phase II wells (Figure 14-2). This well drilling campaign began in May 2009 with the drilling of ER-20-7, ER-20-8, ER-20-8#2, and ER-EC-11 (see Section 14.1).

Groundwater sampling of the NTTR well ER-EC-11 in October 2009 confirmed the presence of tritium at approximately 12,500 pCi/L (NNSA/NSO, 2009c). This is the first time that radionuclides from underground nuclear testing activities at the NTS have been detected in groundwater beyond the NTS boundaries. Well ER-EC-11 is located approximately 716.3 meters (2,350 feet) west of the NTS boundary (Figure 14-2) and approximately 3.2 kilometers (2 miles) from the nearest underground nuclear tests BENHAM and TYBO, which were conducted in 1968 and 1975, respectively. The 2009 sampling results are in accordance with the Pahute Mesa flow and transport model, which predicted migration of tritium off the NTS within 50 years from 1965. Well sample analyses to date have not detected the presence of man-made radionuclides farther downgradient of Pahute Mesa in any of the seven nearby UGTA wells on the NTTR (ER-EC-1, -2A, -4, -5, -6, -7, and -8; see Figure 14-3).

14.2.2 Rainier Mesa–Shoshone Mountain Model Area

The compilation, analysis, and documentation of all hydrologic and transport parameters to be used to build the flow and transport models for the Rainier Mesa–Shoshone Mountain CAU continued in 2009. An investigation of unsaturated zone travel times for the Rainier Mesa–Shoshone Mountain CAU was conducted by the USGS (Ebel and Nimmo, 2009). The investigation used a source-responsive preferential flow model. Work continued on the sub-CAU-scale models constructed for the N-Tunnel area by LANL, and for the T-Tunnel area by DRI.

14.2.3 Frenchman Flat Model Area

In 2009, the Phase II investigation for the Frenchman Flat CAU was completed, and the Phase II Transport Model was submitted to NDEP (NNES, 2010a). The total assemblage of models and documentation packages will be submitted for formal external peer review in 2010. Work on the development of objectives and criteria for the long-term monitoring well network for the Frenchman Flat CAU was completed in 2009.

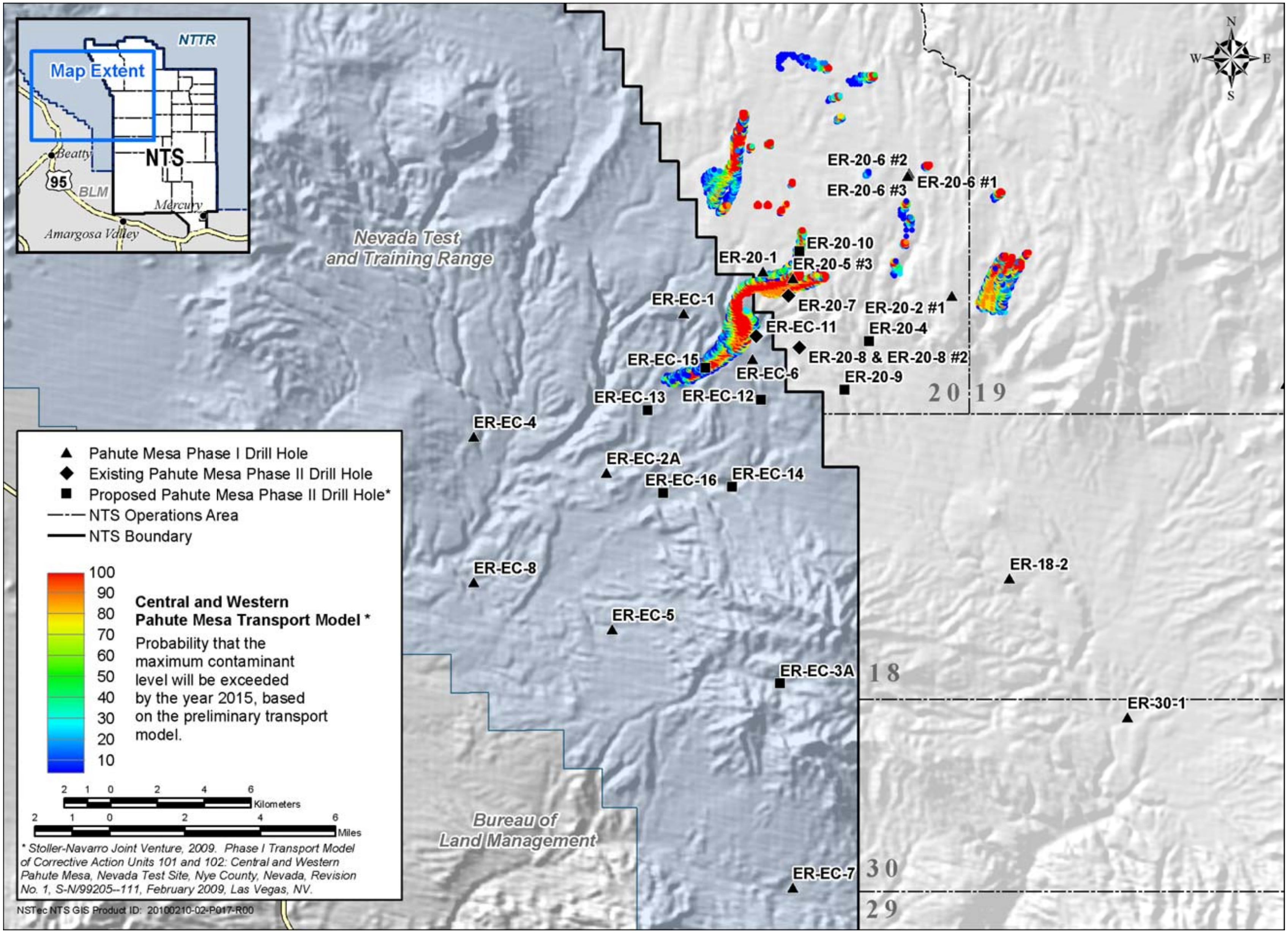

Figure 14-3. Results of Phase I Central and Western Pahute Mesa transport modeling

14.2.4 Yucca Flat–Climax Mine Model Area

UGTA Sub-Project participants continued in 2009 to develop flow and transport models for the Yucca Flat–Climax Mine CAU. LLNL participants continued to work on a source-term model. Studies are being conducted regarding radionuclide transport through NTS volcanic rocks, including the distribution of reactive minerals and their radionuclide sorption properties (Carle et al., 2008). NNES conducted temperature logging in 18 wells. These data, documented in NNES (2010b), will be used as input to the flow and transport models.

14.2.5 Other UGTA Sub-Project Modeling and Studies

UGTA Sub-Project studies not related to a particular CAU were also conducted in 2009. The USGS compiled and evaluated hydrologic data to delineate aquifers beneath the NTS and to define likely flow directions in each of the aquifers (Fenelon et al., 2010). Compiling, evaluating, and updating the various databases continued as an ongoing effort. The water chemistry and fracture databases were expanded and updated in 2009. Efforts to compile petrographic, mineralogical, and chemical data from outcrops, tunnels, and drill cuttings samples continued and will be included in updates of *A Petrographic, Geochemical, and Geophysical Database and Framework for the Southwestern Nevada Volcanic Field* (Warren et al., 2003).

All UGTA Sub-Project reports and publications that were completed in 2009 and were subsequently released by June 2010 are listed in Table 14-1. The list includes collaborative work with other programs and organizations. Some of the published technical reports can be obtained from DOE's Office of Scientific and Technical Information (OSTI) at http://www.osti.gov/bridge, and the OSTI identification number (ID) for those reports is provided. The hydrogeologic modeling deliverables that were submitted in 2009 to NDEP as FFACO deliverables are presented in Chapter 10, Table 10-5).

Table 14-1. UGTA Sub-Project publications completed in 2009 and released prior to June 2010

Report	Reference
Detailed Geophysical Fault Characterization in Yucca Flat, Nevada Test Site, Nevada (OSTI ID: 947552)	Asch et al., 2009
Letter Report: Yucca Flat Fracture Mapping	Dickerson and Hand, 2009
Estimation of Unsaturated Zone Traveltimes for Rainier Mesa and Shoshone Mountain, Nevada Test Site, Nevada, Using a Source-Responsive Preferential-Flow Model (OSTI ID: 964260)	Ebel and Nimmo, 2009
Phase II Corrective Action Investigation Plan for Corrective Action Units 101 and 102: Central and Western Pahute Mesa, Nevada Test Site, Nye County, Nevada (OSTI ID: 968999)	NNSA/NSO, 2009b
A Hydrostratigraphic System for Modeling Groundwater Flow and Radionuclide Migration at the Corrective Action Unit Scale, Nevada Test Site and Surrounding Areas, Clark, Lincoln, and Nye Counties, Nevada (OSTI ID: 950486)	NSTec, 2009c
Identification and Characterization of Hydrogeologic Units at the Nevada Test Site Using Geophysical Logs: Examples from the Underground Test Area Project (OSTI ID: 950488)	NSTec, 2009d
Observations on Faults and Associated Permeability Structures in Hydrogeologic Units at the Nevada Test Site (OSTI ID: 951600)	NSTec, 2009e
Predicted Geology of the Pahute Mesa-Oasis Valley Phase II Drilling Initiative (OSTI ID: 961537)	NSTec, 2009f
UGTA Photograph Database (OSTI ID: 961540)	NSTec, 2009g
Statistical Analysis and Geologic Evaluation of Laboratory-Derived Physical Property Data for Selected Nevada Test Site Core Samples of Non-Zeolitized Tuffs (OSTI ID: 961541)	NSTec, 2009h
Central and Western Pahute Mesa Phase II Hydrogeologic Investigation Wells Drilling and Completion Criteria	SNJV, 2009a
Phase I Transport Model of Corrective Action Units 101 and 102: Central and Western Pahute Mesa, Nevada Test Site, Nye County, Nevada (OSTI ID: 948559)	SNJV, 2009b

Table 14-1. UGTA Sub-Project publications completed in 2009 and released prior to June 2010 (continued)

Report	**Reference**
Unclassified Source Term and Radionuclide Data for Corrective Action Unit 97: Yucca Flat/Climax Mine, Nevada Test Site, Nevada (OSTI ID 963433)	SNJV, 2009c
Digitally Available Interval-Specific Rock-Sample Data Compiled from Historical Records, Nevada Test Site and Vicinity, Nye County, Nevada (OSTI ID 965976)	Wood, 2009
Uncertainty and Sensitivity of Contaminant Travel Times from the Upgradient Nevada Test Site to the Yucca Mountain Area (OSTI ID 947196)	Zhu et al., 2009

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15.0 Groundwater Protection Programs, Projects, and Activities

This chapter presents other U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) programs and 2009 activities related to the protection of groundwater that have not been discussed in previous chapters of this report (Chapter 5, Chapter 7 [Section 7.2], Chapter 10 [Sections 10.1.6 and 10.1.7], and Chapter 14).

It is the policy of NNSA/NSO to prevent pollutants, both from past and current Nevada Test Site (NTS) activities, from impacting the local groundwater. The groundwater protection goals of NNSA/NSO are to (1) prevent future groundwater contamination, (2) control existing contamination, and (3) protect groundwater quality and availability for current and future NTS missions. NNSA/NSO acknowledges that the greatest potential for environmental impact at the NTS is the resumption of underground testing of nuclear devices and their components. If such testing were resumed in the future, the groundwater protection policy of NNSA/NSO would be to minimize, rather than eliminate, the impacts of testing.

The NNSA/NSO Hydrology Program Manager communicates and helps facilitate furtherance of the NNSA/NSO groundwater protection policy and goals. In conjunction with the *Groundwater Protection Program Plan for the National Nuclear Security Administration Nevada Site Office* (NNSA/NSO, 2008b), the NNSA/NSO integrates site-wide groundwater-related activities across the multiple NNSA/NSO programs mentioned below and in previous chapters of this report.

15.1 Wellhead Protection

NNSA/NSO seeks to protect groundwater from the infiltration or introduction of contaminants at the wellhead through a variety of procedures and programs. Wellhead protection areas on the NTS have been identified by the State of Nevada for NTS water supply wells, and inventories and assessments of potential contaminant sources within these areas have been performed. Wellheads are routinely surveyed to identify potential new contaminant sources. Wellheads are protected from public access by locked well caps and by the prohibition of public access onto NTS land enforced by site security. NNSA/NSO wells that are sampled are protected through adherence to proper groundwater sampling procedures developed by each NTS contractor or tenant organization. These procedures must be identified and implemented as a condition of well access authorization under an NNSA/NSO permit called a Real Estate/Operations Permit. Also, the Borehole Management Program protects groundwater "at the wellhead" for boreholes that have been abandoned. These boreholes are plugged to prevent possible aquifer contamination. This program and their 2009 activities are described below.

15.1.1 Borehole Management Program

More than 4,000 boreholes were drilled on and off the NTS in support of nuclear testing. They include emplacement holes for nuclear devices, post-shot investigation boreholes, exploratory holes, instrument holes, potable water wells, construction water supply wells, monitoring wells, and other special purpose boreholes. In 2000, the Borehole Management Program identified 1,238 legacy boreholes as candidates for closure (plugging). Of these, 160 penetrated the groundwater and underground nuclear test cavities. Plugging may reduce the potential for boreholes to act as conduits for contaminants transported down the borehole from the surface or from contaminated aquifers to non-contaminated aquifers. They are plugged by National Security Technologies, LLC (NSTec), the Management and Operations contractor for the NTS and its support facilities, according to Nevada Administrative Code 534.420–534.427 requirements, to the extent possible.

In 2009, 79 boreholes were plugged (Table 15-1), 17 of which penetrated the groundwater and nuclear test cavities. As of January 2010, a total of 696 boreholes have been plugged, 111 of which penetrated groundwater and test cavities. Since 2000, some boreholes have been removed from the plugging candidate list as they were

Table 15-1. NTS boreholes plugged in 2009

NTS Area	Borehole	Year Constructed	Hole Size (in.)	Original Depth (ft)	Surface Casing		Depth Plugged From to Surface (ft)
					Size (in.)	Depth (ft)	
2	A02_Unknown_06	NA[(a)]	NA	NA	10.75	NA	27
2	U-2bx PS #1A	1974	9.875	763	10.75	110	60
2	U-2bz PS #1A	1973	9.875	1246	10.75	119	77
2	U-2dd #4 PS #1A	1970	9.875	1645	10.75	120	1534
2	U-2dh #3 PS #1A	1972	9.875	1072	10.75	109	57
2	U-2dm PS #1A	1972	9.875	1325	10.75	109	44
2	U-2do PS #1A	1973	9.875	1327	10.75	110	12
2	U-2dw PS #1D	1974	9.875	1417	10.75	109	38
2	U-2ea PS #1A	1973	9.875	814	10.75	118	100
2	U-2gg PS #2A	1994	9.875	2091	10.75	115	1857
2	U-9ci PS #A	1972	9.875	1045	10.75	120	550
2	UE-2ad	1972	12.25	866	13.375	78	673
3	A03_Unknown_15	NA	NA	NA	10.75	NA	7
3	U-3bs PS #2D	1966	9.875	1992	13.375	800	813
3	U-3ei PS #1D	1970	9	2031	13.375	811	775
3	U-3ej PS #1D	1969	9	1896	13.375	790	1190
3	U-3kz PS #1A	1987	9.875	1934	13.375	121	13
3	U-3kz PS #2A	1986	9.875	1850	13.375	110	13
3	U-3la PS #1A	1982	9.875	2220	13.375	122	53
4	U-4ar PS #1A	1984	9.875	1977	10.75	112	68
4	UE-4ai	1983	12.25	1170	13.375	80	1146
7	U-7ap PS #1D	1977	10.625	2335	13.375	117	45
7	U-7e PS #1D	1969	9.875	2232	13.375	850	850
7	U-7e PS #2D	1966	9.875	2324	13.375	849	1621
7	U-7i PS #1D	1966	9.875	2262	13.375	837	964
7	U-7i PS #2D	1966	9.875	2245	13.375	826	826
7	U-7m PS #2D	1967	9.875	2035	13.375	835	1404
7	U-7r PS #1D	1970	9	2307	13.375	953	470
7	U-7z PS #1D	1972	9.875	2307	13.375	108	80
8	U-8d PS #2A	1971	9.875	1147	10.75	110	487
8	U-8d PS #3A	1971	9.875	1489	10.75	110	374
8	UE-8f	1971	6.25	2248	9.625	1129	1133
9	A09_Unknown_01	NA	NA	NA	18	NA	7
9	A09_Unknown_03	NA	NA	NA	6.5	NA	24
9	A09_Unknown_05	NA	NA	NA	6.5	NA	37
9	A09_Unknown_06	NA	NA	NA	6.5	NA	40
9	A09_Unknown_07	NA	NA	NA	6.5	NA	41
9	A09_Unknown_16	NA	NA	NA	6.5	NA	25
9	A09_Unknown_17	NA	NA	NA	6.5	NA	10
9	A09_Unknown_18	NA	NA	NA	6.5	NA	38
9	A09_Unknown_19	NA	NA	NA	6.5	NA	41
9	A09_Unknown_20	NA	NA	NA	6.5	NA	42
9	U-9 ITS UE-U-29 #1	1971	12.25	1248	13.375	77	1248
9	U-9 ITS Y-30 PS	1970	9.875	997	10.75	120	779
9	U-9al PS #1A	1966	9.875	1025	10.75	114	178
9	U-9av PS #4	1963	6.25	755	10.75	89	105
9	U-9br PS #1A	1966	9.875	1106	10.75	114	224
9	U-9bs PS #1A	1965	9.875	1209	10.75	110	174
9	U-9bv PS #1A	1967	9.875	1158	10.75	137	816
9	U-9e PS #2	1963	3.75	290	4.5	190	230
10	U-10ah PS #1A	1967	9.875	1850	10.75	120	1335

Table 15-1. NTS boreholes plugged in 2009 (continued)

NTS Area	Borehole	Year Constructed	Hole Size (in.)	Original Depth (ft)	Surface Casing Size (in.)	Surface Casing Depth (ft)	Depth Plugged From to Surface (ft)
10	U-10am #3 PS #1A	1969	9.875	835	10.75	119	430
10	U-10am #4 PS #1A	1969	9.875	1080	10.75	120	782
10	U-10ap #1 PS #1A	1970	9.875	1614	10.75	120	1392
10	U-10ap #3 PS #1A	1970	9.875	1844	10.75	120	1435
10	U-10ay PS #1A	1976	9.875	1311	10.75	116	991
10	U-10ba PS #1A	1977	9.875	1127	10.75	131	979
10	U-10m PS #1A	1966	9.875	1222	10.75	111	374
10	U-10x PS #1A	1967	9.875	1103	10.75	118	485
10	U-10y PS #1A	1966	9.875	1159	10.75	119	590
18	U-18j #2	1962	6.25	210	7.625	9	85
18	UE-18e #1	1974	3	450	6	7	11
18	UE-18e #2	1974	3.895	272	4.5	8	221
18	UE-18e #3	1974	3.032	254	4.5	5	21
18	UE-18e #4	1974	3.032	241	4	3	12
18	UE-18e #5	1974	6.25	250	7	3	202
20	U-20ab PS #1D	1978	9.875	2777	10.75	102	2098
20	U-20ac PS #1D	1980	9.875	2622	10.75	118	1961
20	U-20ae PS #1D	1980	9.875	2681	10.75	135	2046
20	U-20af PS #1D	1980	9.875	2608	10.75	118	1445
20	U-20ai PS #1A	1986	9.875	2456	10.75	109	12
20	U-20ak PS #1A	1985	9.875	2434	10.75	88	1904
20	U-20an PS #1A	1985	9.875	2363	10.75	112	1876
20	U-20ap _PS #1A	1986	9.875	2509	10.75	103	1594
20	U-20as PS #1A	1986	9.875	2415	10.75	87	1636
20	U-20av PS #1A	1987	9.875	2484	10.75	109.5	400
20	U-20ay PS #1A	1988	9.875	2483	10.75	109	1958
26	TMC 13	NA	NA	NA	4.5	NA	15

(a) Not available

determined to be outside the scope of the Borehole Management Program (for example, already plugged or saved for other uses), and a number of partially-plugged or previously-unknown boreholes have been added to the list. There are 184 candidate boreholes remaining on the list, 49 of which penetrate groundwater and nuclear test cavities. The database of boreholes is maintained by NSTec. A fiscal year progress report is sent annually to the Nevada Division of Water Resources.

15.2 Spill Prevention and Management

NSTec has established procedures for the prevention, control, cleanup, and reporting of spills of hazardous and toxic materials, or any other regulated material, into the environment. Spills include releases from underground tanks, aboveground tanks, containers, equipment, or vehicles. All users of the NTS are instructed to prevent, control, and report spills. NSTec ensures that spills are reported to proper state and county regulatory agencies, if required, and are properly mitigated by removing and disposing the contaminated media. All federal and state regulations concerning spills under the Clean Water Act, the Resource Conservation and Recovery Act, Superfund Amendments and Reauthorization Act, and the Emergency Planning and Community Right-to-Know Act are followed. These activities help ensure that surface spills or subsurface releases of contaminants do not infiltrate to groundwater or flow into surface waters. Reportable spills that occurred during 2009 are described in Section 2.10 of this document.

15.3 Water Level, Temperature, and Usage Monitoring by the USGS

The U.S. Geological Survey (USGS) Nevada Water Science Center collects, compiles, stores, and reports hydrologic data used in determining the local and regional hydrogeologic conditions in and around the NTS. Hydrologic data are collected quarterly or semi-annually from wells on and off the NTS. The USGS also maintains and develops the Death Valley Regional Groundwater Flow System Model (Belcher et al., 2004) and manages the NTS well hydrologic and geologic information database.

By the end of 2009, the USGS monitored water levels in 189 wells. This included 96 wells on the NTS and 93 wells off the NTS. Also during 2009, annual temperature data were collected from wells at 1.5 and 16.8 meters (5 and 55 feet) below the water surface. A map showing the location of monitored wells and all water-level and temperature data are posted on the USGS/ Department of Energy (DOE) Cooperative Studies in Nevada Web page at http://nevada.usgs.gov/doe%5Fnv/. The water-level data are also published in the *USGS Nevada Water Science Center Annual Water-Resources Data Report* available at http://nevada.usgs.gov/.

Groundwater use from water-supply wells on the NTS is collected using flow meters that are read monthly by the NTS Management and Operating contractor and then reported to the USGS Nevada Water Science Center. The principal NTS water supply wells monitored during 2009 included J-12 WW, UE-16d WW, WW #4, WW #4A, WW 5B, WW 5C, WW 8, and WW C-1 (see Chapter 5.0, Figure 5-2). The USGS compiles the annual water-use data and reports annual withdrawals in millions of gallons. Discharge data from these wells for 2009 have been compiled, processed, and entered onto the USGS/DOE Cooperative Studies in Nevada Web site at http://nevada.usgs.gov/doe_nv/wateruse/wu_map.htm. Discharge from these wells during 2009 was approximately 190.5 million gallons (Figure 15-1).

Water-use data are also published in the USGS Nevada Water Science Center Annual Water-Resources Data Report on a water-year calendar (October–September). The Water-Year 2009 report is available at http://nevada.usgs.gov/ and includes monthly water-use data for each well listed from October 2008 through September 2009.

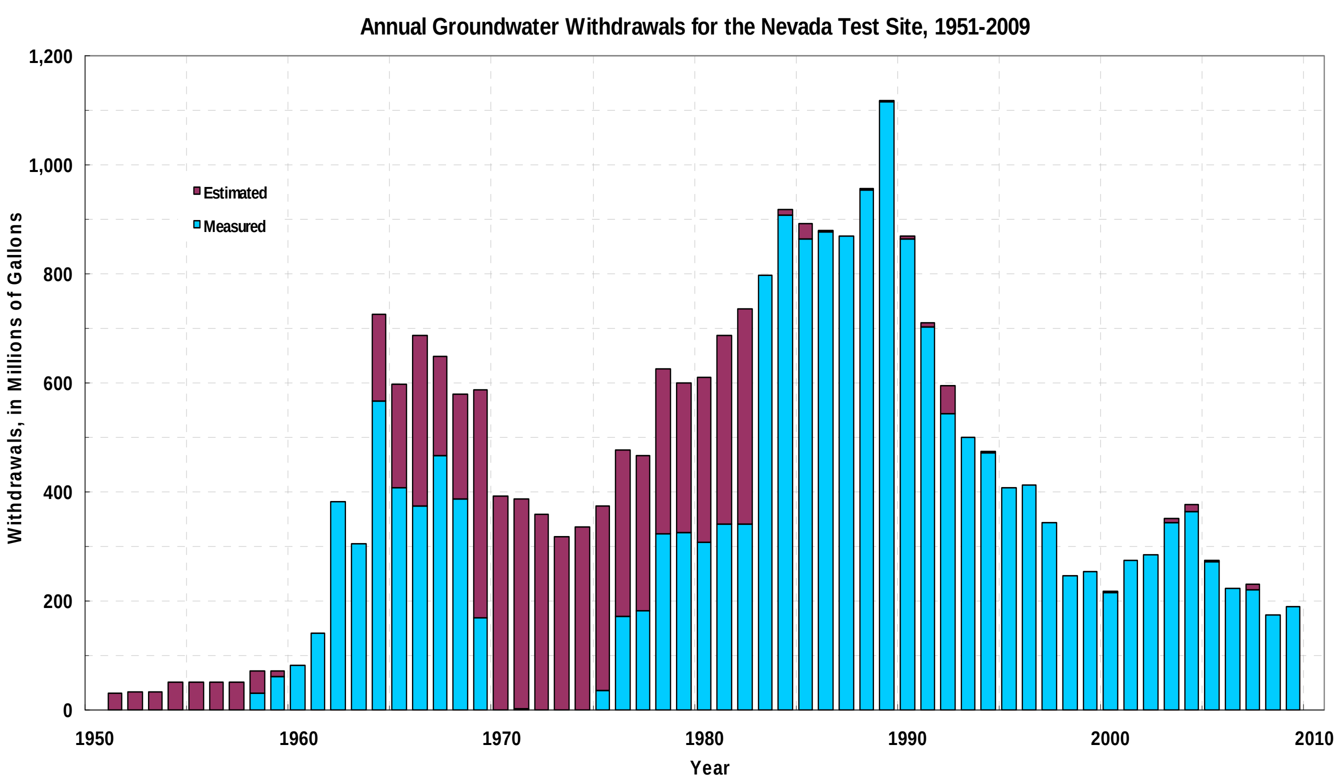

Figure 15-1. Annual withdrawals from the NTS, 1951 to present

15.4 Groundwater Conservation

DOE Order DOE O 430.2B, “Departmental Energy, Renewable Energy and Transportation Management,” includes a water conservation goal to reduce potable water use by at least 16 percent by 2015 relative to the baseline of the facility’s/site’s potable water use in fiscal year (FY) 2007. Other goals within the order that relate to water conservation include installing metering systems for water, auditing water use, using water efficient products, and increasing the use of recycled, reclaimed, and grey water where possible. In 2008, NSTec developed an *FY 2009 NNSA/NSO Energy Executable Plan* (NSTec, 2008b) that identified ways to address these water conservation goals in FY 2009. Also, the NSTec Environmental Management System (EMS) includes water conservation performance objectives to pursue compliance with DOE O 430.2B, and an EMS performance target was established for FY 2009 to reduce water usage by 2 percent below that of FY 2008 (see Section 3.3). In addition, NSTec uses Best Management Practices for groundwater conservation and water efficiency in the following areas: water management planning; information and education programs; system audits, leak detection and repair; water efficient landscaping; water efficient irrigation, toilets, urinals, faucets, showerheads, and boiler systems; use of alternate water sources; and water used for various other purposes (e.g., car wash, steam cleaning).

In 2009, NSTec prepared and submitted for NNSA/NSO several funding proposals for projects that would reduce the use of potable water. A proposal was prepared and submitted to receive American Reinvestment and Recovery Act funds for the research and development of new technology to cool and heat buildings without refrigerants or the consumption of any water. No funding was received for this proposal, and alternative funding was not pursued. Another proposal was prepared to receive funding from DOE’s Office of Energy Efficiency and Renewable Energy (EERE) to cover the cost of several water-saving projects (e.g., installing water meters to track usage). No EERE funding was received. NSTec also proposed partnering with the Southern Nevada Water Authority to replace grass landscaping with xeric landscaping. An estimated rebate of $37,000 is anticipated in FY 2010 if project funding is received and the landscaping is completed as scheduled.

Below are listed all of the groundwater conservation accomplishments of FY 2009 funded by NNSA/NSO through NSTec’s Energy Management Program:

- A total of 16 water meters were installed at selected buildings at the North Las Vegas Facility.
- Flow meters were installed on all NTS potable and non-potable fill stands for water-hauling trucks.
- Pumping of groundwater to J-13 sump was discontinued to reduce groundwater consumption through evaporation and infiltration.
- A procedure was developed to track the installation of WaterSense labeled products (e.g., bathroom faucets, toilets) or equivalent water-saving products. WaterSense labeled products meet the U.S. Environmental Protection Agency criteria for water efficiency and performance.
- The EMS performance target was exceeded; water usage in FY 2009 was 4.4 percent below that of FY 2008.
- Potholing was completed in preparation for an FY 2010 water study (see the first bulleted item below for the FY 2010 executable plan). Potholing is the process of breaking through existing asphalt to check the condition of buried pipes.

In 2009, NSTec submitted the *FY 2010 NNSA/NSO Energy Executable Plan* (NSTec, 2009b). This FY 2010 plan includes the following proposed groundwater conservation actions:

- Conducting a water study to baseline potential water reduction and identify water reduction projects
- Installation of additional water meters at the NTS
- Continued purchase and installation of WaterSense labeled products
- Replacement of the NTS car wash to reduce water use by 50 percent per car wash

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16.0 Meteorological Monitoring

16.1 Meteorological Monitoring Goals

Meteorological and climatological data are collected on the Nevada Test Site (NTS) by the Air Resources Laboratory, Special Operations and Research Division (ARL/SORD). Data are collected through the Meteorological Data Acquisition (MEDA) system, a network of over 30 mobile meteorological towers located primarily on the NTS. The MEDA system became operational in 1981, replacing an older system. MEDA is used to measure, transmit, and display vital meteorological data to SORD meteorologists and U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) colleagues. These data are used daily for operational support to a wide variety of projects on the NTS and form the climatological database for the NTS. The data are also used in safety analysis reports, emergency response activities, radioactive waste remediation projects, environmental reports, and consequence assessments. *Attachment A: Nevada Test Site Description*, Section 3.0, presents descriptive NTS climatological data collected by the MEDA system. *Attachment A* is included as a separate file on the compact disc of this 2009 report.

16.2 MEDA Station Locations

A standard MEDA unit consists of an enclosed trailer, a portable 10-meter (m) (32.8-feet [ft]) tower, meteorological instrumentation, a microprocessor, and a microwave radio transmitter powered by a battery and solar recharge system (Figure 16-1). Locations of the MEDA stations are shown in Figure 16-2. All towers were sited according to standards set by the Federal Meteorological Handbook No. 1 (National Oceanic and Atmospheric Administration, 1995) and the World Meteorological Organization (2002) so as not to be influenced by natural or man-made obstructions or by heat dissipation and generation systems. MEDA station locations are based on the following criteria: (1) access by road, (2) line-of-sight to a microwave repeater, and (3) project support. A primary goal of the network is to provide details in the surface wind field for emergency response activities related to the transport and dispersion of hazardous materials. Another primary goal is to provide data used in computing offsite radiological dose estimates.

Figure 16-1. Example of a typical MEDA station with a 10-meter tower

16.3 MEDA Station Instrumentation

MEDA station instrumentation is located on top of the tower and on booms oriented into the prevailing wind direction and at a minimum distance of two tower widths from the tower. Wind direction and speed are measured at the 10-m (32.8-ft) level, in accordance with the specifications of the the American National Standard for Determining Meteorological Information at Nuclear Facilities (American Nuclear Society, 2005).

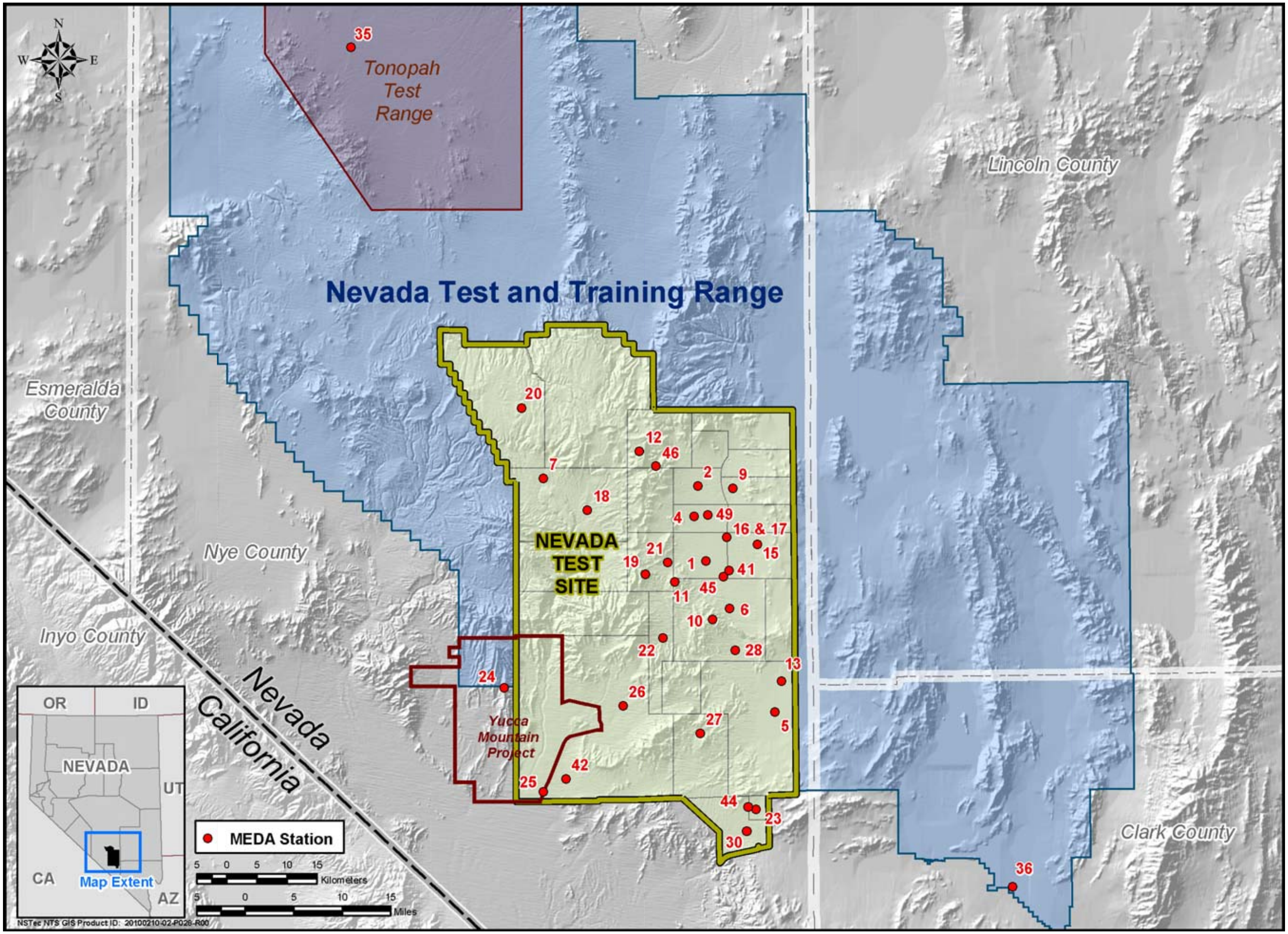

Figure 16-2. MEDA station locations on and near the NTS

Ambient temperature, relative humidity, and atmospheric pressure measurements are taken at approximately the 2-m (6.6-ft) level to be within the surface boundary layer. Observations are collected and transmitted every 15 minutes on the quarter hours. Wind data are 5-minute averages of speed and direction. The peak wind speed is the fastest instantaneous gust measured within the 15-minute time interval. Temperature, relative humidity, and pressure are instantaneous measurements.

16.4 Rain Gauge Network

ARL/SORD also operates and maintains a climatological rain gauge network on the NTS (Figure 16-3). This network consists of 16 Belford Series 5-780 Universal Precipitation Gauges and one Vaisala 44A Tipping Bucket Precipitation Gauge. The 16 Belford gauges are strip chart recorders that are manually read at least once every 30 days. The Vaisala gauge is part of the MEDA network and reports data every 15 minutes to the weather database. Once read and certified, the data are entered into the SORD precipitation climatological database. Data are recorded as daily totals. Under special circumstances, 1- to 3-hour totals can be obtained.

16.5 Data Access

The meteorological parameters measured at each station, along with other information, are listed on the SORD Web site http://www.sord.nv.doe.gov. MEDA data are also processed and archived in the ARL/SORD climatological database. Climatological data summaries are posted on the ARL/SORD Web site under the Climate section. SORD meteorologists provide specially tailored climatological summaries by request through NNSA/NSO. For new NTS projects and facility modifications that may produce radiological emissions, wind data from the MEDA stations are used to calculate potential radiological doses to members of the public residing near the NTS (see Section 4.1.7).

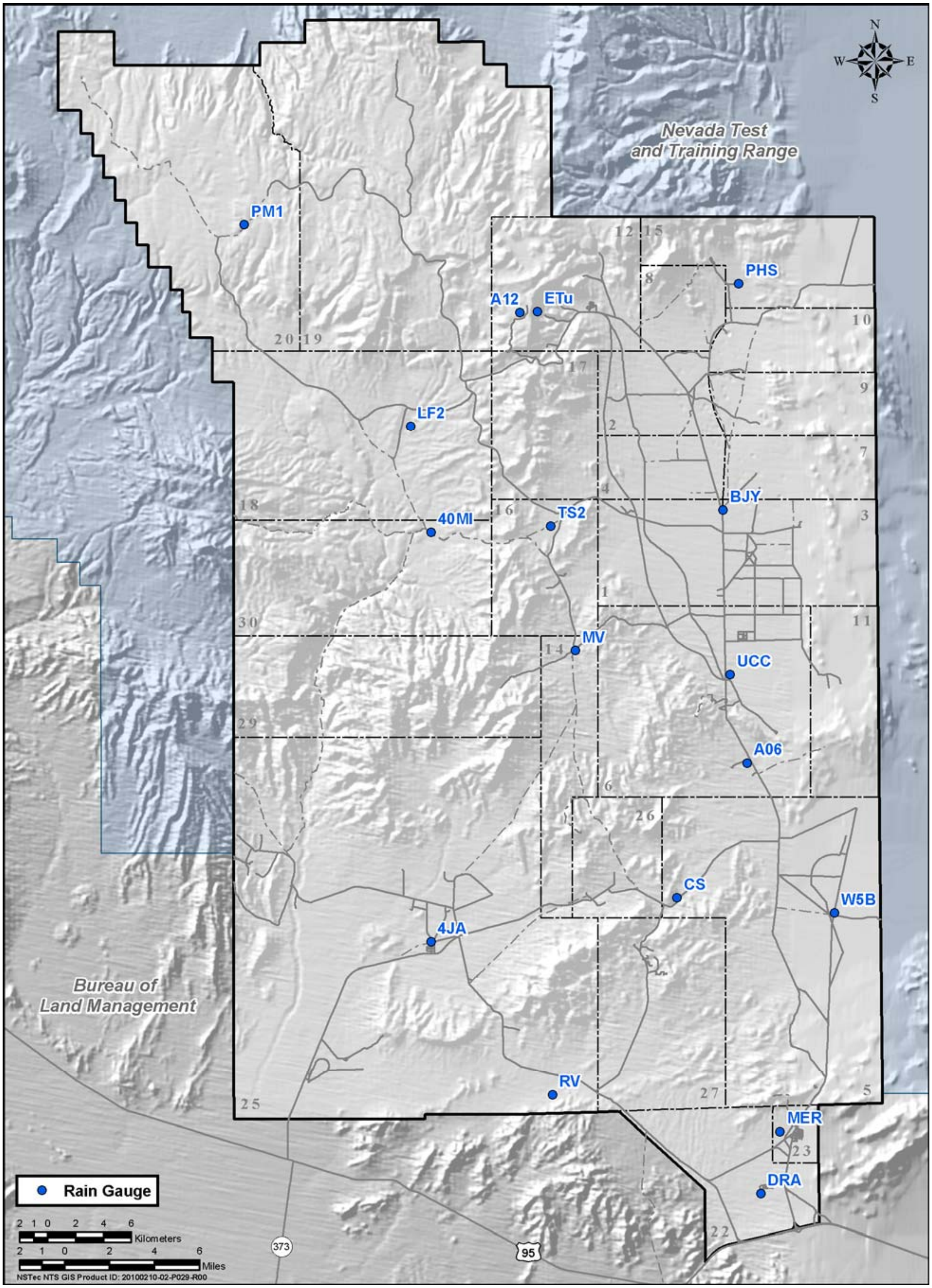

Figure 16-3. Climatological rain gauge network on the NTS

17.0 Quality Assurance Program

The National Security Technologies, LLC (NSTec), Quality Assurance Program (QAP) describes the system used by NSTec to ensure that quality is integrated into the environmental monitoring work performed for the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO). The NSTec QAP complies with Title 10 Code of Federal Regulations (CFR) 830, Subpart A, "Quality Assurance Requirements," and with U.S. Department of Energy (DOE) Order DOE O 414.1C, "Quality Assurance." The ten criteria of a quality program, which are specified by these regulations, are shown in the box below. The NSTec QAP requires a graded approach to quality for determining the level of rigor that effectively provides assurance of performance and conformance to requirements.

Required Criteria of a Quality Program

- Quality assurance program
- Personnel training and qualification
- Quality improvement process
- Documents and records
- Established work processes
- Established standards for design and verification
- Established procurement requirements
- Inspection and acceptance testing
- Management assessment
- Independent assessment

The Data Quality Objectives (DQO) process developed by the U.S. Environmental Protection Agency (EPA) is generally used to provide the quality assurance (QA) structure for designing, implementing, and improving upon environmental monitoring efforts when environmental sampling and analysis are involved. Sampling and Analysis Plans are developed prior to performing an activity to ensure complete understanding of the data use objectives. Personnel are trained and qualified in accordance with company and task-specific requirements. Access to sampling locations is coordinated with organizations conducting work at or having authority over those locations in order to avoid conflicts in activities and to communicate hazards to better ensure successful execution of the work and protection of the safety and health of sampling personnel. Sample collection activities adhere to organization instructions and/or procedures that are designed to ensure that samples are representative and data are reliable and defensible. Sample shipments on site and to offsite laboratories are conducted in accordance with the U.S. Department of Transportation and International Air Transport Association regulations, as applicable. Quality control (QC) in the analytical laboratories is maintained through adherence to standard operating procedures that are based on methodologies developed by nationally recognized organizations such as the EPA, DOE, and ASTM International. Key quality-affecting procedural areas cover sample collection, preparation, instrument calibration, instrument performance checking, testing for precision and accuracy, and laboratory data review. NSTec data users perform reviews as required by the project-specific objectives before the data are used to support decision making.

The key elements of the environmental monitoring process work flow are listed below. Each of these elements is designed to ensure the applicable QA requirements are implemented. A discussion of these elements follows.

- A **Sampling and Analysis Plan** (SAP) is developed using the EPA DQO process to ensure that clear goals and objectives are established for the environmental monitoring activity. The SAP is implemented in accordance with EPA, DOE, and other requirements addressing environmental, safety, and health concerns.
- **Environmental Sampling** is performed in accordance with the SAP and site work controls to ensure defensibility of the resulting data products and protection of the workers and the environment.
- **Laboratory Analyses** are performed to ensure that the resultant data meet DOE-, NSTec-, and regulation-defined requirements.
- **Data Review** is done to ensure that the SAP DQOs have been met, and thereby determine whether the data are suitable for their intended purpose.
- **Assessments** are employed to ensure that monitoring operations are conducted accordingly and that analytical data quality requirements are met in order to identify nonconforming items, investigate causal factors, implement corrective actions, and monitor for corrective action effectiveness.

17.1 Sampling and Analysis Plan

Most environmental monitoring is specifically mandated to demonstrate compliance with a variety of requirements including federal and state regulations and DOE orders and standards. Developing the SAP using the DQO approach ensures those requirements are considered in the planning stage. The following statistical concepts and controls are vital in designing and evaluating the system design and implementation.

17.1.1 Precision

Precision is the degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves. Precision is a data quality indicator. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms (DOE, 2009).

Practically, precision is determined by comparing the results obtained from performing analyses on split or duplicate samples taken at the same time from the same location or locations very close to one another, maintaining sampling and analytical conditions as nearly identical as possible.

17.1.2 Accuracy

Accuracy refers to the degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components that are due to sampling and analytical operations. Accuracy is a data quality indicator (DOE, 2009). Accuracy related to laboratory operations is monitored by performing measurements and evaluating results of control samples containing known quantities of the analytes of interest.

17.1.3 Representativeness

Representativeness is the degree to which a measurement is truly representative of the sampled medium or population (i.e., the degree to which measured analytical concentrations represent the concentrations in the medium being sampled) (Stanley and Verner, 1985).

At each sampling point in the sampling and analysis process, subsamples of the medium of interest are obtained. The challenge is to ensure that each subsample maintains the character of the larger sampled population. From a field sample collection standpoint, representativeness is managed through sampling plan design and execution. Representativeness related to laboratory operations concerns the ability to appropriately subsample and characterize for analytes of interest. For example, in order to ensure representative characterization of a heterogeneous matrix (soil, sludge, solids, etc.), the sampling and/or analysis process should evaluate whether homogenization or segregation should be employed prior to sampling or analysis. Water samples are generally considered homogeneous unless observation suggests otherwise. Each air monitoring station’s continuous operation at a fixed location results in representatively sampling the ambient atmosphere. Field sample duplicate analyses are additional controls allowing evaluation of representativeness and heterogeneity.

17.1.4 Comparability

Comparability refers to “the confidence with which one data set can be compared to another” (Stanley and Verner, 1985). Comparability from an overall monitoring perspective is ensured by consistent execution of the sampling design concerning sample collection and handling, laboratory analyses, and data review. This is ensured through adherence to established procedures and standardized methodologies. Ongoing data evaluation compares data collected at the same locations from sampling events conducted over multiple years and produced by numerous laboratories to detect any anomalies that might occur.

17.2 Environmental Sampling

Environmental samples are collected in support of various environmental programs. Each program executes the field sampling activities in accordance with the SAP to ensure usability and defensibility of the resulting data. The key elements supporting the quality and defensibility of the sampling process and products include the following:

- Training and qualification
- Procedures and methods
- Field documentation
- Inspection and acceptance testing

17.2.1 Training and Qualification

The environmental programs ensure that personnel are properly trained and qualified prior to doing the work. In addition to procedure-specific and task-specific qualifications for performing work, training addresses environment, safety, and health aspects to ensure protection of the workers, the public, and the environment. Recurrent training is also conducted as appropriate to maintain proficiency.

17.2.2 Procedures and Methods

Sampling is conducted in accordance with established procedures to ensure consistent execution and continuous comparability of the environmental data. The methods to be used for sample analyses are also consulted in order to ensure that viable samples are obtained.

17.2.3 Field Documentation

Field documentation is generated for each sample collection activity, and may include chain of custody, sampling procedures, analytical methods, equipment and data logs, maps, Material Safety Data Sheets, and other materials needed to support the safe and successful execution and defense of the sampling effort. Chain of custody practices are employed from point of generation through disposal (cradle-to-grave); these are critical to the defensibility of the decisions made as a result of the sampling and analysis. Sampling data and documentation are stored and archived so that they are readily retrievable for use at a later date. In many cases the data are managed in electronic data management systems. Routine assessments or surveillances are performed to ensure that sampling activities are performed in accordance with applicable requirements. Deficiencies are noted, causal factors are determined, corrective actions are implemented, and follow-up assessments are performed to ensure effective resolution. This data management approach ensures the quality and defensibility of the decisions made using analytical environmental data.

17.2.4 Inspection and Acceptance Testing

Sample collection data are reviewed for appropriateness, accuracy, and fit with historical measurements. In the case of groundwater sampling, real-time field measurements are monitored during purging to determine when parameters have stabilized, thereby indicating that the purge water is generally representative of the aquifer, at which time sampling may begin. After a sampling activity is complete, data are reviewed to ensure the samples were collected in accordance with the SAP. Samples are further inspected to ensure that their integrity has not been compromised, either physically (leaks, tears, breakage, custody seals) or administratively (labeled incorrectly) and that they are valid for supporting the intended analyses. If concerns are raised at any point during collection, the data user, in consideration of data usability, is consulted for direction on proceeding with or canceling the subsequent analyses.

17.3 Laboratory Analyses

Samples are transported to a laboratory for characterization. Several NSTec organizations maintain measurement capabilities that are generally considered "screening" operations, and may be used to support planning or preliminary decision-making activities. However, unless specifically authorized by NNSA/NSO or the regulator, all data used for reporting purposes are generated by a DOE- and NSTec-qualified laboratory whose services have been obtained through subcontracts. Ensuring the quality of procured laboratory services is accomplished through focus on three specific areas: (1) procurement, (2) initial and continuing assessment, and (3) data evaluation.

17.3.1 Procurement

Laboratory services are procured through the use of the DOE Integrated Contractor Purchasing Team (ICPT) Analytical Services Basic Ordering Agreement (BOA). The ICPT was put in place to pursue strategic sourcing opportunities that represent procurement-leveraged spending, which results in a lower total cost of ownership for DOE complex-wide site and facility contractors. Agreements placed by the ICPT have met all applicable requirements of the Competition in Contracting Act, the Federal Acquisition Regulation, the DOE Acquisition Regulations, prime contractor terms and conditions for subcontracting, and other relevant policies and procedures. As such, no further requirements apply pertaining to competition, further price analysis/justification, additional review of the terms and conditions, etc., which also saves time and effort.

The Analytical Services BOA was initially developed in 1998 by a team of contractor subject matter experts (both technical and procurement) from across the DOE complex, and BOAs were established with numerous laboratories beginning in 1999. The analytical services technical basis was initially contained in the BOA. It has been revised over the years and is currently codified in the DOE Quality Systems for Analytical Services (QSAS), revision 2.5, November 2009 (DOE, 2009). The QSAS is based on the National Environmental Laboratory Accreditation Conference Chapter 5, "Quality Systems," as implemented in 2005, based on International Organization for Standardization (ISO) Standard 17025, "General Requirements for the Competence of Testing and Calibration Laboratories." Prior to a laboratory being issued a BOA, it must be assessed to be in compliance with the QSAS. Once a BOA is issued, the laboratory is routinely audited under the DOE Consolidated Audit Program (DOECAP).

Because of the rigor involved with the ICPT BOA process, rather than issuing a Request for Proposal to several laboratories and investing the time to evaluate the proposals received, NSTec awards subcontracts to laboratories that already hold a BOA. The NSTec subcontracts cite the BOA as the base requirement and address site-specific conditions.

The process for obtaining an ICPT BOA requires significant effort both on the laboratory and DOE's part. Consequently, BOA-holding laboratories are primarily those providing a wide range of analytical services to the DOE. NSTec obtains services not available from a BOA laboratory either through an NSTec subcontract laboratory's subcontracting of the work (i.e., lower-tier subcontractor) or by subcontracting directly with the laboratory. In either case, DOE and NSTec requirements for laboratory services are established with those laboratories as well for the specific services provided.

The subcontract places numerous requirements on the laboratory, including the following:

- Maintaining the following documents:
  - A Quality Assurance Plan and/or Manual describing the laboratory's policies and approach to the implementation of QA requirements
  - An Environment, Safety, and Health Plan
  - A Waste Management Plan
  - Procedures pertinent to subcontract scope
- The ability to generate data deliverables, both hard copy reports and electronic files
- Responding to all data quality questions in a timely manner

- Mandatory participation in proficiency testing programs
- Maintaining specific licenses, accreditations, and certifications
- Conducting internal audits of laboratory operations, as well as audits of vendors
- Allowing external audits by DOECAP and NSTec, and providing copies of other audits considered by NSTec to be comparable and applicable

17.3.2 Initial and Continuing Assessment

An initial assessment is made during the request for proposal process above, including a pre-award audit. If an acceptable audit has not been performed within the past year, NSTec will consider performing an audit (or participating in a DOECAP audit) of those laboratories awarded the contract. NSTec will not initiate work with a laboratory without authorized approval of those NSTec personnel responsible for ensuring vendor acceptability.

A continuing assessment consists of the ongoing monitoring of a laboratory's performance against contract terms and conditions, of which the technical specifications are a part. Tasks supporting continuing assessment are:

- Conducting regular audits or participating in evaluation of DOECAP audit products
- Monitoring for continued successful participation in proficiency testing programs such as:
  - National Institute of Standards and Technology Radiochemistry Intercomparison Program
  - Studies that support certification by the State of Nevada or appropriate regulatory authority for analyses performed in support of compliance monitoring
- Monitoring of the laboratory's adherence to the QA requirements

17.3.3 Data Evaluation

Data products are continuously evaluated for compliance with contract terms and specifications. This primarily involves review of the data against the specified analytical method to determine the laboratory's ability to adhere to the QA/QC requirements, as well as an evaluation of the data against the DQOs. This activity is discussed in further detail in Section 17.4. Any discrepancies are documented and resolved with the laboratory, and continuous assessment tracks the recurrence and efficacy of corrective actions.

17.4 Data Review

A systematic approach to thoroughly evaluating the data products generated from an environmental monitoring effort is essential for understanding and sustaining the quality of data collected under the program. This allows the programs to determine whether the DQOs established in the planning phase were achieved and whether the monitoring design performed as intended or requires review.

Because decisions are based on environmental data, and the effectiveness of operations is measured at least in part by environmental data, reliable, accurate, and defensible records are essential. Detailed records that must be kept include temporal, spatial, numerical, geotechnical, chemical, and radiological data, and all sampling, analytical, and data review procedures used. Failure to maintain these records in a secure but accessible form may result in exposure to legal challenges and the inability to respond to demands or requests from regulators and other interested organizations.

An electronic data management system is a key tool used by many programs for achieving standardization and integrity in managing environmental data. The primary objective is to store and manage in an easily and efficiently retrievable form unclassified environmental data that are directly or indirectly tied to monitoring events. This may include information on monitoring system construction (groundwater wells, ambient air monitoring), analytical, geotechnical, and field parameters at the Nevada Test Site. Database integrity and security are enforced through the assignment of varying database access privileges commensurate with an employee's database responsibilities.

17.4.1 Data Verification

Data verification is defined as a subcontract compliance and completeness review to ensure that all laboratory data and sample documentation are present and complete. Additional critical sampling and analysis process information is also reviewed at this stage, which may include, but is not limited to, sample preservation and temperature, defensible chain-of-custody documentation and integrity, and analytical hold-time compliance. Data verification also ensures that electronic data products correctly represent the sampling and/or analyses performed and includes evaluation of QC sample results.

17.4.2 Data Validation

Data validation supplements verification and is a more thorough process of analytical data review to better determine if the data meet the analytical and project requirements. Data validation ensures that the reported results correctly represent the sampling and analyses performed, determines the validity of the reported results, and assigns data qualifiers (or “flags”), if required.

17.4.3 Data Quality Assessment (DQA)

DQA is a scientific and statistical evaluation to determine if the data obtained from environmental operations are of the right type, quality, and quantity to support their intended use. The DQA includes reviewing data for accuracy, representativeness, and fit with historical measurements to ensure that the data will support their intended uses.

17.5 Assessments

The overall effectiveness of the environmental program is determined through routine surveillance and assessments of work execution as well as review of the program requirements. Deficiencies are identified, causal factors are investigated, corrective actions are developed and implemented, and follow-on monitoring is performed to ensure effective resolution. The assessments discussed below are broken down into general programmatic and focused measurement data areas.

17.5.1 Programmatic

Assessments and audits under this category include evaluations of the work planning, execution, and performance activities. Personnel independent of the work activity perform the assessments to evaluate compliance with established requirements and report on the identified deficiencies. Organizations responsible for the activity are required to develop and implement corrective actions, with the concurrence of the deficiency originator or recognized subject matter expert. NSTec maintains the companywide issues tracking system (called caWeb) to manage assessments, findings, and corrective actions.

17.5.2 Measurement Data

This type of assessment includes routine evaluation of data generated from analyses of QC samples. QC sample data are used to monitor the analytical control on a given batch of samples and are indicators over time of potential biases in laboratory performance. Discussion of the 2009 results for field duplicates, laboratory control samples, blank analysis, and inter-laboratory comparison studies are provided and summary tables are included below.

17.5.2.1 Field Duplicates

Samples obtained at approximately the same locations and times as initial samples are termed field duplicates and are used to evaluate the overall precision of the measurement process, including small-scale heterogeneity in the medium (air, soil, water, etc.) being sampled as well as analytical and sample preparation variation. The relative error ratio (RER) compares the absolute difference of initial and field duplicate measurements to a measure of the analytical uncertainty. The absolute relative percent difference (RPD) compares the absolute difference of initial and field duplicate measurements with the average of the two measurements; it is computed only from pairs for which both values are above their respective minimum detectable concentrations (MDCs). These are provided in Table 17-1.

The values in Table 17-1 fall in typical ranges. The highest RPD (63.5 percent) is found with $^{239+240}Pu$; this is due mostly to one air sampler intercepting a particle with high Pu while the other sampler in the pair had a typical background value. The RER is also affected by this pair. The second highest RPD (45.7 percent) occurred with $^{235+236}U$; values of this analyte tend to be rather low on the whole, which tends to inflate variability measured in relative terms.

17.5.2.2 Laboratory Control Samples (LCSs)

An LCS is a sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes. It is generally used to establish intra-laboratory or analyst-specific precision and bias or to assess the performance of all or a portion of the measurement system (DOE, 2009).

The results are calculated as a percentage of the true value, and must fall within established control limits (or percentage range) to be considered acceptable. If the LCS recovery falls outside control limits, evaluation for potential sample data bias is necessary. The numbers of the 2009 LCSs analyzed and within control limits are summarized in Table 17-2.

17.5.2.3 Blank Analysis

In general terms, a blank is a sample that has not been exposed to the analyzed sample stream, and is analyzed in order to monitor contamination during sampling, transport, storage, or analysis. The blank is subjected to the usual analytical and measurement process to establish a zero baseline or background value and is sometimes used to adjust or correct routine analytical results (DOE, 2009).

Laboratory method blank data are summarized in Table 17-3. A method blank is a sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses (DOE, 2009).

17.5.2.4 Proficiency Testing Program Participation

Laboratories are required to participate in Proficiency Testing Programs. Laboratory performance supports decisions on work distribution and may also be a basis for state certifications. Table 17-4 presents the 2009 results for the Mixed Analyte Performance Evaluation Program (MAPEP) (http://www.inl.gov/resl/mapep/) administered by the Radiological and Environmental Sciences Laboratory of the Idaho National Laboratory.

Table 17-5 shows the summary of inter-laboratory comparison sample results for the NSTec Radiological Health Dosimetry Group. This internal evaluation was based on National Voluntary Laboratory Accreditation Program (NVLAP) criteria. The Dosimetry Group participated in the Battelle Pacific Northwest National Laboratory performance evaluation study program during the course of the year.

Table 17-1. Summary of field duplicate samples for compliance monitoring in 2009

Analyte	Medium	Number of Duplicate Pairs[(a)]	Number of Pairs > MDC[(b)]	Average Absolute RPD[(c)] of Pairs > MDC	Average Absolute RER[(d)] of All Pairs
Gross Alpha	Air	103	15	17.8	0.63
Gross Beta	Air	103	103	6.5	0.66
Tritium	Air	47	13	11.4	0.72
^{241}Am	Air	23	0	-	0.72
^{7}Be[(e)]	Air	24	24	9.4	0.95
^{40}K[(e)]	Air	23	5	29.9	0.74
^{238}Pu	Air	24	0	-	0.65
$^{239+240}$Pu	Air	24	5	63.4	1.40
$^{233+234}$U	Air	11	11	11.3	0.65
$^{235+236}$U	Air	12	3	60.3	1.12
^{238}U	Air	11	11	19.7	0.93
^{137}Cs	Air	24	0	-	0.91
^{235}U (gamma)	Air	24	0	-	0.69
Gross Alpha	Water	6	6	22.0	0.76
Gross Beta	Water	6	5	17.8	0.86
Tritium	Water	17	1	2.4	0.83
TLD	Ambient Radiation	433	NA	2.3	0.22

(a) Represents the number of field duplicates reported for the purpose of monitoring precision. If an associated field sample was not processed, the field duplicate was not included in this table.

(b) Represents the number of field duplicate–field sample result sets with both values above their minimum detectable concentrations (MDCs). The MDC does not apply to thermoluminescent dosimeter (TLD) measurements. If either the field sample or its duplicate was reported below the MDC, the RPD was not determined.

(c) Reflects the average absolute RPD calculated as follows:

$$Absolute\ RPD = \frac{|D - S|}{(D + S)/2}\ X\ 100$$

Where: S = Sample result
D = Duplicate result

(d) Relative error ratio (RER), determined by the following equation, is used to determine whether a sample result and the associated field duplicate result differ significantly when compared to their respective one sigma uncertainties. The RER is calculated for all sample and field duplicate pairs reported without regard to the MDC.

$$Absolute\ RER = \frac{|S - D|}{\sqrt{(TPU_S)^2 + (TPU_D)^2}}$$

Where: S = Sample result
D = Duplicate result
TPU_S = one-sigma total propagated uncertainty of the field sample
TPU_D = one-sigma total propagated uncertainty of the field duplicate

(e) ^{7}Be and ^{40}K are naturally occurring analytes included for quality assessment of the gamma spectroscopy analyses.

(f) Third quarter TLD data are omitted; see Chapter 5 discussion.

Table 17-2. Summary of LCSs for 2009

Analysis	Matrix	Number of LCS Results Reported	Number Within Control Limits	Control Limits (%)
Radiological Analyses				
Tritium	Air	69	67	70–130
^{60}Co	Air	30	30	70–130
^{137}Cs	Air	30	30	70–130
$^{239+240}$Pu	Air	44	44	70–130
^{241}Am	Air	74	72	70–130
Gross Alpha	Water	19	19	70–130
Gross Beta	Water	19	19	70–130
Tritium	Water	83	83	70–130
^{60}Co	Water	10	10	70–130
^{90}Sr	Water	3	3	70–130
^{137}Cs	Water	10	10	70–130
$^{239+240}$Pu	Water	12	12	70–130
^{241}Am	Water	10	10	70–130
^{60}Co	Soil	11	11	70–130
^{90}Sr	Soil	5	5	70–130
^{137}Cs	Soil	11	11	70–130
$^{239+240}$Pu	Soil	10	10	70–130
^{241}Am	Soil	21	21	70–130
Nonradiological Analyses				
Metals	Water	166	164	80–120
Volatiles	Water	995	963	70–130
Semi Volatiles	Water	534	530	Laboratory specific
Miscellaneous	Water	224	218	80–120
Metals	Soil	57	56	75–125
Volatiles	Soil	88	79	70–130
Semi Volatiles	Soil	188	186	Laboratory specific
Miscellaneous	Soil	4	4	75–125

Table 17-3. Summary of laboratory blank samples for 2009

Analysis	Matrix	Number of Blank Results Reported	Number of Results < MDC
Radiological Analyses			
Tritium	Air	54	53
^{7} Be	Air	24	24
^{60}Co	Air	27	27
^{137}Cs	Air	27	27
^{238}Pu	Air	27	27
$^{239+240}$Pu	Air	27	25
^{241}Am	Air	53	53
Gross Alpha	Water	16	16
Gross Beta	Water	16	16
Tritium	Water	61	60
^{60}Co	Water	9	9
^{90}Sr	Water	2	2
^{137}Cs	Water	9	9
^{238}Pu	Water	8	8
$^{239+240}$Pu	Water	8	7
^{241}Am	Water	9	9
^{60}Co	Soil	12	12
^{90}Sr	Soil	5	5
^{137}Cs	Soil	12	12
^{238}Pu	Soil	10	10
$^{239+240}$Pu	Soil	10	10
^{241}Am	Soil	22	22
Nonradiological Analyses			**Number of Results < Reporting Limit**
Metals	Water	216	210
Volatiles	Water	540	540
Semi Volatiles	Water	393	393
Miscellaneous	Water	195	194
Metals	Soil	122	121
Volatiles	Soil	122	122
Semi Volatiles	Soil	203	201
Miscellaneous	Soil	3	3

Table 17-4. Summary of 2009 MAPEP reports

Analysis	Matrix	Number of Results Reported	Number within Control Limits[a]
Radiological Analyses			
Gross Alpha	Filter	6	6
Gross Beta	Filter	6	6
^{60}Co	Filter	5	5
^{137}Cs	Filter	5	5
^{238}Pu	Filter	5	5
$^{239+240}$Pu	Filter	5	5
^{241}Am	Filter	5	5
Gross Alpha	Water	6	6
Gross Beta	Water	6	6
Tritium	Water	6	6
^{60}Co	Water	6	6
^{90}Sr	Water	6	6
^{137}Cs	Water	6	6
^{238}Pu	Water	6	6
$^{239+240}$Pu	Water	6	6
^{241}Am	Water	6	5
^{60}Co	Vegetation	6	6
^{90}Sr	Vegetation	6	6
^{137}Cs	Vegetation	6	6
^{238}Pu	Vegetation	5	5
$^{239+240}$Pu	Vegetation	5	5
^{241}Am	Vegetation	5	6
^{60}Co	Soil	6	6
^{90}Sr	Soil	6	4
^{137}Cs	Soil	6	6
^{238}Pu	Soil	5	5
$^{239+240}$Pu	Soil	5	5
^{241}Am	Soil	6	6
Nonradiological Analyses			
Metals	Water	105	105
Organics	Water	171	168
Semivolatiles	Water	425	422
Metals	Soil	111	105
Organics	Soil	450	444

(a) Based upon MAPEP criteria

Table 17-5. Summary of inter-laboratory comparison TLD samples for the subcontract dosimetry group in 2009

Analysis	Matrix	Number of Results Reported	Number Within Control Limits[a]
TLD	Ambient Radiation	29	29

(a) Based upon NVLAP criteria; absolute value of the bias plus one standard deviation < 0.3

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18.0 Quality Assurance Program for the Community Environmental Monitoring Program

The Community Environmental Monitoring Program (CEMP) Quality Assurance Program Plan (QAPP) was followed for the collection and analysis of radiological air and water data presented in Section 6.0 of this report. The CEMP QAPP ensures compliance with U.S. Department of Energy (DOE) Order DOE O 414.1C, "Quality Assurance," which implements a quality management system ensuring the generation and use of quality data. This QAPP addresses the following items previously defined in Section 17.0:

- Data Quality Objectives (DQOs)
- Sampling plan development appropriate to satisfy the DQOs
- Environmental health and safety
- Sampling plan execution
- Sample analyses
- Data review
- Continuous improvement

18.1 Data Quality Objectives

The DQO process is a strategic planning approach that is used to plan data collection activities. It provides a systematic process for defining the criteria that a data collection design should satisfy. These criteria include when and where samples should be collected, how many samples to collect, and the tolerable level of decision errors for the study. DQOs are unique to the specific data collection or monitoring activity, and are further explained in Appendices A through E of the *Routine Radiological Environmental Monitoring Plan* (Bechtel Nevada, 2003a).

18.2 Measurement Quality Objectives (MQOs)

The MQOs are basically equivalent to DQOs for analytical processes. The MQOs provide direction to the laboratory concerning performance objectives or requirements for specific method performance characteristics. Default MQOs are established in the subcontract with the laboratory, but may be altered in order to satisfy changes in the DQOs. The MQOs for the CEMP project are described in terms of precision, accuracy, representativeness, completeness, and comparability requirements. These terms are defined and discussed in Section 17.1 for onsite activities.

18.3 Sampling Quality Assurance Program

Quality Assurance (QA) in field operations for the CEMP includes sampling assessments, surveillances, and oversight of the following supporting elements:

- The sampling plan, DQOs, and field data sheets accompanying the sample package
- Database support for field and laboratory results, including systems for long-term storage and retrieval
- A training program to ensure that qualified personnel are available to perform required tasks

Sample packages include the following items:

- Station manager checklist confirming all observable information pertinent to sample collection
- An Air Surveillance Network Sample Data Form documenting air sampler parameters, collection dates and times, and total sample volumes collected
- Chain-of-custody forms

This managed approach to sampling ensures that the sampling is traceable and enhances the value of the final data available to the project manager. The sample package also ensures that the station manager Community Environmental Monitor (CEM) (see Section 6.0 for a description of CEMs) has followed proper procedures for sample collection. The CEMP Project Manager or QA Officer routinely performs assessments of the station managers and field monitors to ensure that standard operating procedures and sampling protocol are being followed properly.

Data obtained in the course of executing field operations are entered in the documentation accompanying the sample package during sample collection and in the CEMP database along with analytical results upon their receipt and evaluation.

Completed sample packages are kept as hard copy in file archives. Analytical reports are kept as hard copy in file archives as well as on read-only compact disks by calendar year. Analytical reports and databases are protected and maintained in accordance with the Desert Research Institute's Computer Protection Program.

18.4 Laboratory QA Oversight

The CEMP ensures that DOE O 414.1C requirements are met with respect to laboratory services through review of the vendor laboratory policies formalized in a Laboratory Quality Assurance Plan (LQAP). The CEMP is assured of obtaining quality data from laboratory services through a multifaceted approach involving specific procurement protocols, the conduct of quality assessments, and requirements for selected laboratories to have an acceptable QA program. These elements are discussed below.

18.4.1 Procurement

Laboratory services are procured through subcontracts. The subcontract establishes the technical specifications required of the laboratory and provides the basis for determining compliance with those requirements and evaluating overall performance. The subcontract is awarded on a "best value" basis as determined by pre-award audits. The prospective vendor is required to provide a review package to the CEMP that includes the following items:

- All procedures pertinent to subcontract scope
- Environment, Safety, and Health Plan
- LQAP
- Example deliverables (hard copy and/or electronic)
- Proficiency testing (PT) results from the previous year from recognized PT programs
- Résumés
- Facility design/description
- Accreditations and certifications
- Licenses
- Audits performed by an acceptable DOE program covering comparable scope
- Past performance surveys
- Pricing

CEMP evaluates the review package in terms of technical capability. Vendor selection is based solely on these capabilities and not biased by pricing.

18.4.2 Initial and Continuing Assessment

An initial assessment of a laboratory is managed through the procurement process above, including a pre-award audit. Pre-award audits are conducted by the CEMP (usually by the CEMP QA Officer). In no instance shall the CEMP initiate work with a laboratory without approval of the CEMP Program Manager.

A continuing assessment of a selected laboratory involves ongoing monitoring of a laboratory's performance against the contract terms and conditions, of which technical specifications are a part. The following tasks support continuing assessment:

- Tracking schedule compliance
- Reviewing analytical data deliverables
- Monitoring of the laboratory's adherence to the LQAP
- Conducting regular audits
- Monitoring for continued successful participation in approved PT programs

18.4.3 Laboratory QA Program

The laboratory policies and approach to the implementation of DOE O 414.1C must be verified in a LQAP prepared by the laboratory. The elements of a LQAP required for the CEMP are similar to those required by National Security Technologies, LLC, for onsite monitoring, and are described in Section 17.3.3.

18.5 Data Review

Essential components of process-based QA are data checks, verification, validation, and data quality assessment to evaluate data quality and usability.

Data Checks – Data checks are conducted to ensure accuracy and consistency of field data collection operations prior to and upon data entry into CEMP databases and data management systems.

Data Verification – Data verification is defined as a subcontract compliance and completeness review to ensure that all laboratory data and sample documentation are present and complete. Sample preservation, chain-of-custody, and other field sampling documentation shall be reviewed during the verification process. Data verification ensures that the reported results entered in CEMP databases correctly represent the sampling and/or analyses performed and includes evaluation of quality control (QC) sample results.

Data Validation – Data validation is the process of reviewing a body of analytical data to determine if it meets the data quality criteria defined in operating instructions. Data validation ensures that the reported results correctly represent the sampling and/or analyses performed, determines the validity of the reported results, and assigns data qualifiers (or "flags"), if required. The process of data validation consists of the following:

- Evaluating the quality of the data to ensure that all project requirements are met
- Determining the impact on data quality of those requirements if they are not met
- Verifying compliance with QA requirements
- Checking QC values against defined limits
- Applying qualifiers to analytical results in the CEMP databases for the purposes of defining the limitations in the use of the reviewed data

Operating instructions, procedures, applicable project specific work plans, field sampling plans, QAPPs, analytical method references, and laboratory statements of work may all be used in the process of data validation. Documentation of data validation includes checklists, qualifier assignments, and summary forms.

Data Quality Assessment (DQA) – DQA is the scientific evaluation of data to determine if the data obtained from environmental data operations are of the right type, quality, and quantity to support their intended use. DQA review is a systematic review against pre-established criteria to verify that the data are valid for their intended use.

18.6 QA Program Assessments

The overall effectiveness of the QA program is determined through management and independent assessments as defined in the CEMP QAPP. These assessments evaluate the plan execution work-flow (sampling plan development and execution, chain-of-custody, sample receiving, shipping, subcontract laboratory analytical activities, and data review) as well as program requirements as it pertains to the organization.

18.7 2009 Sample QA Results

QA procedures were performed by the CEMP, including the laboratories responsible for sample analyses. These assessments ensure that sample collection procedures, analytical techniques, and data provided by the subcontracted laboratories comply with CEMP requirements. Data were provided by Testamerica Laboratories and the University of Nevada, Las Vegas Radiation Services Laboratory (gross alpha/beta and gamma spectroscopy data), Global Dosimetry Solutions (thermoluminescent dosimeter [TLD] data), and the University of Miami Tritium Laboratory (tritium data). A brief discussion of the 2009 results for field duplicates, laboratory control samples, blank analyses, and inter-laboratory comparison studies is provided along with summary tables within this section. The 2009 CEMP radiological air and water monitoring data are presented in Section 7.0.

18.7.1 Field Duplicates (Precision)

A field duplicate is a sample collected, handled, and analyzed following the same procedures as the primary sample. The relative percent difference (RPD) between the field duplicate result and the corresponding field sample result is a measure of the variability in the process caused by the sampling uncertainty (matrix heterogeneity, collection variables, etc.) and measurement uncertainty (field and laboratory) used to arrive at a final result. The average absolute RPD, expressed as a percentage, was determined for the calendar year 2009 samples and is listed in Table 18-1. An RPD of zero indicates a perfect duplication of results of the duplicate pair, whereas an RPD greater than 100 percent generally indicates that a duplicate pair falls beyond QA requirements and are not considered valid for use in data interpretation. These samples are further evaluated to determine the reason for QA failure and if any corrective actions are required. Overall, the RPD values for all analyses indicate very good results, with only five alpha duplicates exceeding an RPD of 100 percent.

Table 18-1. Summary of field duplicate samples for CEMP monitoring in 2009

Analysis	Matrix	Number of Samples Reported[(a)]	Number of Samples Reported above MDC[(b)]	Average Absolute RPD of those above MDC (%)[(c)]
Gross Alpha	Air	76	76	71.8
Gross Beta	Air	76	76	30.0
Gamma - Beryllium-7	Air	12	12	12.2
Tritium	Water	4	0	NA[(d)]
TLDs	Ambient Radiation	12	12	6.9

(a) Represents the number of field duplicates reported for the purpose of monitoring precision. If an associated field sample was not processed, the field duplicate was not included in this table.

(b) Represents the number of field duplicate-field sample result sets reported above the minimum detectable concentration (MDC) (MDC is not applicable for TLDs). If either the field sample or its duplicate was reported below the detection limit, the precision was not determined.

(c) Reflects the average absolute RPD calculated for those field duplicates reported above the MDC.

(d) Not applicable.
The absolute RPD calculation is as follows:

$$Absolute\ RPD = \frac{|FD - FS|}{(FD + FS)/2}\ X\ 100\,\%$$

Where: FD = Field duplicate result
FS = Field sample result

18.7.2 Laboratory Control Samples (Accuracy)

Laboratory control samples (LCSs) (also known as matrix spikes) are performed by the subcontract laboratory to evaluate analytical accuracy, which is the degree of agreement of a measured value with the true or expected value. Samples of known concentration are analyzed using the same methods as employed for the project samples. The results are determined as the measured value divided by the true value, expressed as a percent. To be considered valid, the results must fall within established control limits (or percentage range) for further analyses to be performed. The LCS results obtained for 2009 are summarized in Table 18-2. The LCS results were satisfactory with all samples falling within control parameters for the air sample matrix.

Table 18-2. Summary of laboratory control samples (LCS) for CEMP monitoring in 2009

Analysis	Matrix	Number of LCS Results Reported	Number Within Control Limits[(a)]
Gross Alpha	Air	52	52
Gross Beta	Air	52	52
Gamma	Air	8	8
Tritium	Water	4	4

(a) Control limits are as follows: 80 to 115 percent for gross alpha, 80 to 115 percent for gross beta, 90 to 110 percent for gamma (^{137}Cs, ^{60}Co, ^{241}Am), and 80 to 120 percent for tritium.

18.7.3 Blank Analysis

Laboratory blank sample analyses are essentially the opposite of LCSs discussed in Section 18.7.2. These samples do not contain any of the analyte of interest. Results of these analyses are expected to be “zero,” or, more accurately, below the MDC of a specific procedure. Blank analysis and control samples are used to evaluate overall laboratory procedures, including sample preparation and instrument performance. The laboratory blank sample results obtained for 2009 are summarized in Table 18-3. The laboratory blank results were satisfactory with less than 5 percent of the alpha and beta blank samples outside of control parameters for the air sample matrix.

Table 18-3. Summary of laboratory blank samples for CEMP monitoring in 2009

Analysis	Matrix	Number of Blank Results Reported	Number within Control Limits[(a)]
Gross Alpha	Air	52	52
Gross Beta	Air	52	47
Gamma	Air	8	8
Tritium	Water	3	3

(a) Control limit is less than the MDC.

18.7.4 Inter-laboratory Comparison Studies

Inter-laboratory comparison studies are conducted by the subcontracted laboratories to evaluate their performance relative to other laboratories providing the same service. These types of samples are commonly known as “blind” samples, in which the expected values are known only to the program conducting the study. The analyses are evaluated and, if found satisfactory, the laboratory is certified that its procedures produce reliable results. The inter-laboratory comparison sample results obtained for 2009 are summarized in Tables 18-4 and 18-5.

Table 18-4 shows the summary of inter-laboratory comparison sample results for the Subcontract Radiochemistry Laboratories. The laboratories participated in either the Quality Assurance Program administered by Environmental Research Associates (ERA); the Mixed Analyte Performance Evaluation Program (MAPEP) for gross alpha, gross beta, and gamma analyses; and/or the International Atomic Energy Agency (IAEA) tritium inter-laboratory comparison study. The subcontractors performed very well during the year by passing all of the parameters analyzed.

Table 18-4. Summary of inter-laboratory comparison samples of the subcontract radiochemistry laboratory for CEMP monitoring in 2009

Analysis	Matrix	Number of Results Reported	Number Within Control Limits[(a)]
		MAPEP, ERA, and IAEA Results	
Gross Alpha	Air	4	4
Gross Beta	Air	4	4
Gamma	Air	3	3
Tritium	Water	6	6

(a) Control limits are determined by the individual inter-laboratory comparison study.

Table 18-5 shows the summary of the in-house performance evaluation results conducted by the Subcontract Dosimetry Group. This internal evaluation was based on National Voluntary Laboratory Accreditation Program (NVLAP) criteria and was performed biannually. The Dosimetry Group performed very well during the year, passing 20 out of 20 TLDs analyzed.

Table 18-5. Summary of inter-laboratory comparison TLD samples of the subcontract dosimetry group for CEMP monitoring in 2009

Analysis	Matrix	Number of Results Reported	Number Within Control Limits[(a)]
TLDs	Ambient Radiation	20	20

(a) Based upon NVLAP criteria; absolute value of the bias plus one standard deviation < 0.3.

Appendix A

Las Vegas Area Support Facilities

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Appendix A: Las Vegas Area Support Facilities

The U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) manages two facilities in Clark County, Nevada, that support NNSA/NSO missions on and off the Nevada Test Site (NTS). They include the North Las Vegas Facility (NLVF) and the Remote Sensing Laboratory (RSL)–Nellis (Figure A-1). This appendix describes all environmental monitoring and compliance activities conducted in 2009 at these support facilities.

A.1 North Las Vegas Facility

The NLVF is a fenced complex composed of 31 buildings that house much of the NTS project management, diagnostic development and testing, design, engineering, and procurement. The 32-hectare (80-acre) facility is located along Losee Road, a short distance west of Interstate 15 (Figure A-1). The facility is buffered on the north, south, and east by general industrial zoning. The western border separates the property from fully developed, single-family residential-zoned property. The NLVF is a controlled-access facility.

Environmental compliance and monitoring activities associated with this facility in 2009 included the maintenance of one wastewater permit, one National Pollutant Discharge Elimination System (NPDES) permit, one air quality operating permit, one hazardous materials permit (Table A-1), and the monitoring of tritium in air and ambient gamma-emissions to comply with radiation protection regulations.

Table A-1. Environmental permits for NLVF in 2009

Permit Number	Description	Expiration Date	Reporting
Wastewater Discharge			
VEH-112	NLVF Wastewater Contribution Permit	December 31, 2013	Annually
NV0023507	NLVF NPDES Permit	November 2, 2011	Quarterly
Air Quality			
Source 657, Modification (Mod.) 4/Mod. 5	Clark County Authority to Construct/Operating Permit for a Non-Major Commercial Building	None	Annually
Hazardous Materials			
2287-2045	NLVF Hazardous Materials Permit	February 28, 2010	Annually

A.1.1 Compliance with Water Permits

Wastewater permits in 2009 for NLVF included a Class II Wastewater Contribution Permit from the City of North Las Vegas (CNLV) for sewer discharges, and an NPDES permit issued by the Nevada Division of Environmental Protection (NDEP) for dewatering operations to control rising groundwater levels that surround the facility.

Discharges of sewage and industrial wastewater from NLVF are required to meet permit limits set by the CNLV. These limits support the permit limits for the Publicly Owned Treatment Works (POTW) operated by the City of Las Vegas. Regulations for wastewater discharges are codified in the municipal codes for both cities.

A.1.1.1 Wastewater Contribution Permit VEH-112

This permit specifies concentration limits for contaminants in domestic and industrial wastewater discharges. Self-monitoring and reporting of the levels of nonradiological contaminants in sewage and industrial outfalls is conducted. In 2009, contaminant concentrations (in milligrams per liter [mg/L]) were below the established permit limits in all water samples taken from the NLVF outfalls (Table A-2). In compliance with this permit, a report summarizing wastewater monitoring was generated for NLVF operations and was submitted on October 26, 2009, to CNLV. The report is titled *Self-Monitoring Report for the National Nuclear Security Administration's North Las Vegas Facility: Permit VEH-112.*

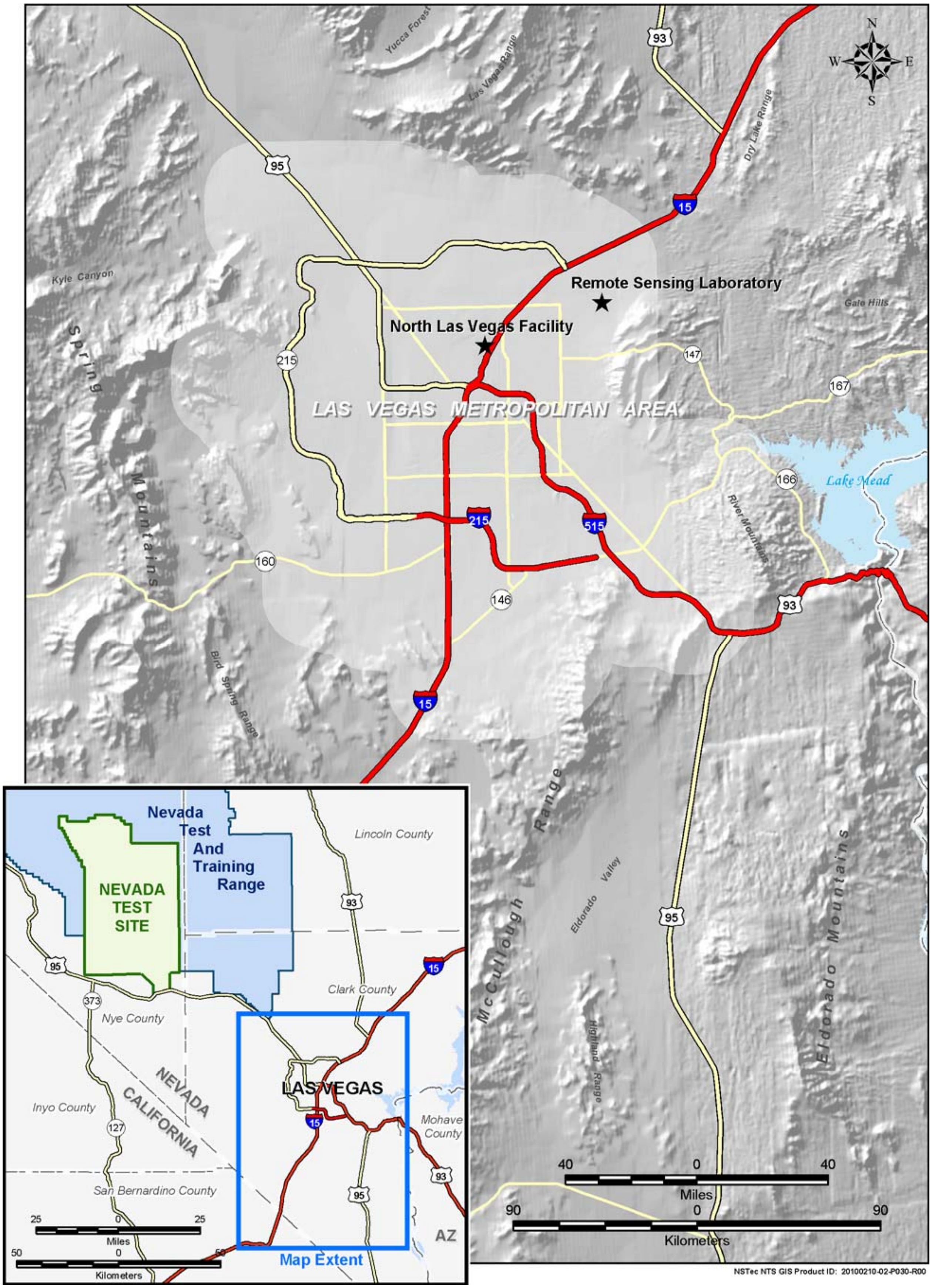

Figure A-1. Location of NTS offsite facilities in Las Vegas and North Las Vegas

Table A-2. Results of 2009 monitoring at NLVF for Wastewater Contribution Permit VEH-112

Contaminant	Permit Limit (mg/L)	Outfall A (mg/L)	Outfall B (mg/L)
Ammonia	61.0	40.9	12.8
Arsenic	2.3	0.0023	0.0026
Barium	13.1	0.150	0.209
Beryllium	0.02	<0.000125	<0.000125
Cadmium	0.15	0.00031	0.00018
Chromium (hexavalent)	0.10	<0.02	<0.02
Chromium (total)	5.60	0.00157	0.00169
Copper	0.60	0.221	0.372
Cyanide (total)	19.9	<0.005	<0.005
Lead	0.20	0.00217	0.00318
Mercury	0.001	<0.0001	<0.0001
Nickel	1.10	0.00716	0.00419
Oil & Grease (animal or vegetable)	250	1.1	<1.0
Oil & Grease (mineral or petroleum)	100	<1.0	<1.0
Organophosphorus or carbamate compounds	1.0	<0.01	<0.01
pH (Standard Units)	5.0–11.0	8.43	8.18
Phenols	33.6	0.0417	0.0775
Phosphorus (total)	0.50	3.64	1.9
Selenium	2.70	0.00297	0.00309
Silver	8.20	<0.000375	<0.000375
Zinc	13.1	0.353	0.776

A.1.1.2 National Pollution Discharge Elimination System Permit NV0023507

An NPDES permit (NV0023507) covers the dewatering operation conducted at the NLVF (see Section A.1.2). Dewatering wells (NLVF-13s, -15, -16, -17) pump groundwater into a 39,747 liter (L) (10,500 gallon [gal]) storage tank (Figure A-2). The permit allows for the discharge of water from the storage tank to the groundwater of the state via percolation, when used for landscape irrigation and dust suppression, and into the Las Vegas Wash via direct discharge into the CNLV storm water drainage system. The permit defines the discharge source via percolation as “Outfall 001” and via the storm water drainage system as “Outfall 002.” Water produced from the dewatering wells may also be used for purposes that do not require a groundwater discharge or an NPDES permit (e.g., evaporative cooling). In accordance with the permit, chemistry analyses are performed quarterly, annually, and biennially for water samples collected from the storage tank (Table A-3). The total quantities of groundwater produced and discharged and the results of groundwater chemistry analyses are reported quarterly to NDEP’s Bureau of Water Pollution Control.

In 2009, the four dewatering wells produced a total of about 10,028 L (2,649 gal) per day that were directed into the storage tank (Figure A-2). The pumping rates varied from 2.7 liters per minute (Lpm) (0.71 gallons per minute [gpm]) at Well NLVF-17 to 0.8 Lpm (0.21 gpm) at Well NLVF-15. The average combined discharge from all four wells was about 284,000 L (75,000 gal) per month. Discharge rates did not exceed the NPDES permit limits (Table A-3). Quarterly and annual water samples from the holding tank had total petroleum hydrocarbons, total suspended solids, total dissolved solids, total inorganic nitrogen (as nitrogen [N]), pH, and tritium levels that were all below permit limits (Table A-3). Biennial water sampling for the presence of over 100 analytes (listed in Attachment A of the permit) was done in January 2009. The results are summarized in Table A-3.

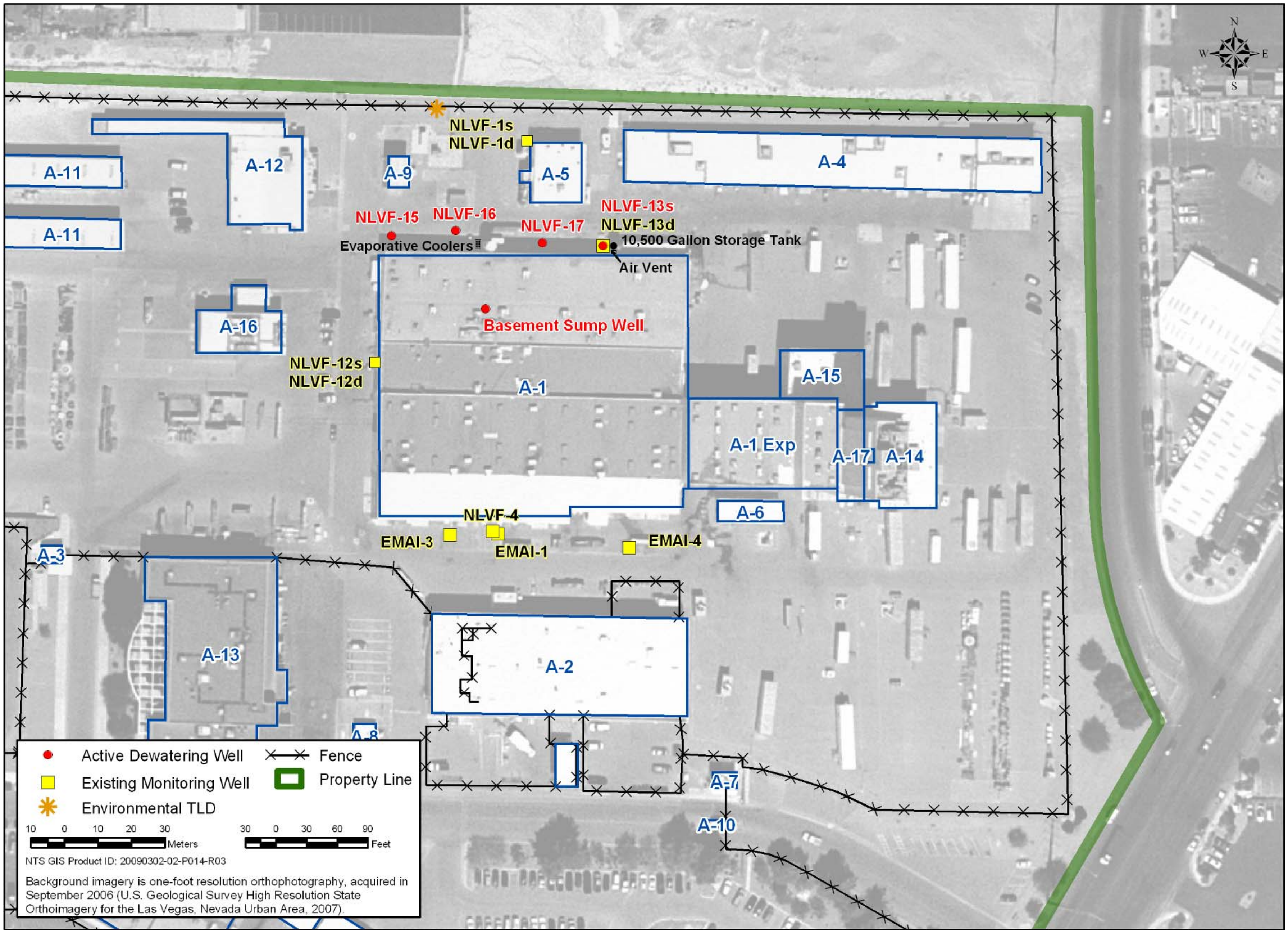

Figure A-2. **Location of dewatering and monitoring wells around Building A-1**

Table A-3. NPDES Permit NV0023507 monitoring requirements and 2009 sampling results

Parameter	Monitoring Requirements: Sample Frequency	Monitoring Requirements: Sample Type	Permit Discharge Limits Daily Maximum	Sample Results 1st Quarter	Sample Results 2nd Quarter	Sample Results 3rd Quarter	Sample Results 4th Quarter
Daily Maximum Flow (MGD)(a)	Continuous	Flow Meter	0.005184	0.002398	0.002119	0.002652	0.002391
Total Petroleum Hydrocarbons (mg/L)	Annually (4th Qtr)	Discrete	1.0	NS(b)	NS	NS	ND(c)
Total Suspended Solids (mg/L)	Quarterly	Discrete	135	ND	ND	ND	ND
Total Dissolved Solids (mg/L)	Quarterly	Discrete	1900	872	848	1,080	1,180
Total Inorganic Nitrogen as N (mg/L)	Quarterly	Discrete	20.0	1.3	0.84	0.84	1.25
pH (S.U.)(d)	Quarterly	Discrete	6.5–9.0	7.92	7.86	7.84	7.66
Tritium (picocuries per liter [pCi/L])	Annually (4th Qtr)	Discrete	MR(e)	NS	NS	NS	ND
Permit Attachment A Analytes (mg/L):							
46 Base Neutral Extractables	Biennial	Discrete	MR	NS	NS	NS	ND
12 Acid Extractables	Biennial	Discrete	MR	NS	NS	NS	ND
31 Volatile Organics*	Biennial	Discrete	MR	NS	NS	NS	ND
Chloroform				NS	NS	NS	0.0018
24 Pesticides/PCBs(f)	Biennial	Discrete	MR	NS	NS	NS	ND
Dioxins	Biennial	Discrete	MR	NS	NS	NS	ND
13 Metals**	Biennial	Discrete	MR	NS	NS	NS	ND
As				NS	NS	NS	0.012
Cu				NS	NS	NS	0.034
Ni				NS	NS	NS	0.012
Zn				NS	NS	NS	0.099
Cyanide	Biennial	Discrete	MR	NS	NS	NS	ND
Asbestos	Biennial	Discrete	MR	NS	NS	NS	ND

(a) MGD = million gallons per day
(b) NS = not required to be sampled that quarter
(c) ND = not detected; values were less than the laboratory detection limits
(d) S.U. = Standard Unit
(e) MR = monitor and report; no specified daily maximum or 30-day average limit, just the requirement that there shall be no discharge of substances that would cause a violation of state water quality standards
(f) PCBs = Polychlorinated biphenyls
*All volatile organics were ND except chloroform as shown
**All metals were ND except As, Cu, Ni, and Zn as shown

A.1.2 Groundwater Control and Dewatering Operation

During 2009, the groundwater control and dewatering project at the NLVF continued efforts to reduce the intrusion of groundwater below Building A-1. Since its inception in 2002, the project has transitioned from initial groundwater investigations and characterization phases to a long-term/permanent dewatering operational project. A review of the rising groundwater situation and past efforts to understand and remediate the problem is presented in previous reports (Bechtel Nevada [BN], 2003b; 2004b; 2005c; National Security Technologies, LLC [NSTec], 2006; 2008a).

Groundwater monitoring for this operation includes taking periodic water-level measurements at 29 NLVF monitoring wells, taking continuous water-level measurements at the A-1 Basement Sump well, measuring the total volume of discharged groundwater, and conducting groundwater chemistry analyses in accordance with the NPDES permit (see Section A.1.1.2). Groundwater data are assessed quarterly or as new data become available. This information is used to help characterize the groundwater situation, validate the conceptual hydrologic model, and evaluate the dewatering operation. The presence or absence of particular constituents or overall chemical signature could suggest or confirm source(s) of the rising near-surface groundwater. Water monitoring data are maintained in the NSTec Environmental Integrated Data Management System database.

In 2009, about 283,910 L (75,000 gal) per month were pumped from the dewatering wells. Groundwater also continued to be pumped from the A-1 Basement Sump well (Figure A-2), totaling about 986,100 L (260,500 gal) in 2009. When the A-1 Basement Sump well pump is active, the water level directly beneath Building A-1 is about 41.1 centimeters (cm) (16.2 inches [in.]) below the basement floor (as measured in a monitoring tube installed outside a nearby elevator shaft). When the pump is active, water within the A-1 Basement Sump well itself is about 244 cm (96 in.) below the basement floor. When the A-1 Basement Sump well pump is turned off for short periods of three to six days, the water in the elevator shaft-monitoring tube rises 33 cm (13 in.), to 18 cm (7 in.) below the basement floor, and water in the A-1 Basement Sump well itself rises to within 76 cm (30 in.) of the basement floor. These water level measurements reflect a drop of roughly 61 cm (24 in.) in the local water table beneath Building A-1 since full-scale dewatering operations began in 2006.

However, the general trend in the 29 NLVF monitoring wells shows rising water levels, that are about 1.5 meters (5 feet) higher than levels obtained over the past eight years. The dewatering efforts must counter this rising groundwater trend. The nearest monitoring wells, NLVF-1s, NLVF-12s, and NLVF-13d (Figure A-2), seem to be holding steady or decreasing, presumably reflecting drawdown of the local water table due to the dewatering operations at Building A-1.

A.1.2.1 Discharge of Groundwater from Building A-1 Sump Well

During 2001, the sump well was installed in the basement of Building A-1 and used in operations to remediate tritium contamination in the basement that occurred in 1995 (BN, 2000). The discharge water, which contains tritium, was disposed of at the NTS. The sump well was turned off after the remedial operations were completed. However, beginning in early 2003, the sump well has been used intermittently to help control the encroaching water below Building A-1. The water contains some residual tritium and it is segregated from the uncontaminated water from the dewatering operation, through its own disposal process. The amount of tritium in the sump well water has decreased over the last couple of years from about 1,900 pCi/L to about 900 pCi/L (average of two analyses) in 2009 (or about one-twentieth of the Safe Drinking Water Act limit of 20,000 pCi/L). The discharge is transported to the NTS during the winter, but during the warm months, the discharge is evaporated with an exterior array of evaporative units located on the north side of Building A-1. In 2009, about 402,770 L (106,400 gal) were transported to the NTS for disposal during the winter and about 583,330 L (154,100 gal) were evaporated at the NLVF during the summer months. These measured quantities of water released through evaporation and the measured tritium concentrations in these waters were used to estimate total curies released to the atmosphere in 2009 at the NTS (see Section 4.1.9, Table 4-13) and at the NLVF (see Section A.1.5.1).

A.1.3 Compliance with Air Quality Permits

Sources of air pollutants at the NLVF are regulated by the Source 657 Authority to Construct/Operating Permit issued by the Clark County Department of Air Quality and Environmental Management (DAQEM) for the emission of criteria pollutants and hazardous air pollutants (HAPs). These pollutants include sulfur dioxide (SO_2), nitrogen oxide (NO_X), carbon monoxide (CO), particulate matter (PM), volatile organic compounds (VOCs), and any of the other defined HAPs. The regulated sources of emissions at the NLVF include an aluminum sander, an abrasive blaster, diesel generators, a fire pump, cooling towers, and boilers.

In 2009, two requests for permit modifications and one for a permit revision were approved by the DAQEM. Modification (Mod.) 4 of the permit added five cooling towers and two boilers to the list of regulated sources. Mod. 5 of the permit increased the total dissolved solids content of the cooling tower waters. Mod. 5 Revision 1 of the permit removed a spray paint booth and two emergency generators.

The DAQEM requires an annual emissions inventory of critical air pollutants and HAPs. The 2009 emissions inventory was submitted to the DAQEM on March 18, 2010, and reported the estimated quantities shown in Table A-4.

Table A-4. Tons of criteria air pollutant and HAPs emissions estimated for NLVF in 2009

Criteria Pollutant (Tons/yr)[a]					**HAPs (Tons/yr)**
CO	**NO_x**	**PM10[b]**	**SO_2**	**VOC**	
0.109	0.486	0.149	0.000	0.032	0.025
Total Emissions = 0.801					

(a) 1 ton equals 0.91 metric tons
(b) Particulate matter equal to or less than 10 microns in diameter

The NLVF air permit requires that equipment be observed each day it is operated. If visible emissions are observed, then opacity readings are recorded by a certified visible emissions evaluator. In 2009, two NSTec employees from NLVF were certified by Carl Koontz Associates to conduct opacity readings. Readings were taken for generators, and their emissions were well below the Clean Air Act National Ambient Air Quality Standards (NAAQS) opacity limit of 20 percent.

A.1.4 Compliance with Hazardous Materials Regulations

In 2009, the chemical inventory at NLVF was updated and submitted to the State in the Nevada Combined Agency (NCA) Report on February 23, 2010. The inventory data were submitted in accordance with the requirements of the Hazardous Materials Permit 2287-5144 (see Section 2.5, Emergency Planning and Community Right-to-Know Act, for description of content, purpose, and federal regulatory driver behind the NCA Report). No accidental or unplanned release of an extremely hazardous substance (EHS) occurred at NLVF in 2009. Also, no annual usage quantities of toxic chemicals kept at NLVF exceeded specified thresholds (see Section 2.5 concerning Toxic Chemical Release Inventory, Form R).

A.1.5 Compliance with Radiation Protection Regulations

A.1.5.1 National Emission Standards for Hazardous Air Pollutants (NESHAP)

In compliance with NESHAP of the Clean Air Act, in 2009, NSTec assessed the radionuclide air emissions from the NLVF and the resultant radiological dose to the public surrounding the facility. NESHAP establishes a dose limit for the general public to be no greater than 10 millirems per year (mrem/yr) from all radioactive air emissions. Building A-1's basement was contaminated with tritium in 1995 when a container of tritium foils was opened, emitting about 1 curie of tritium (U.S. Department of Energy, Nevada Operations Office, 1996).

Complete cleanup of the tritium was unsuccessful due to the tritium being absorbed into the building materials. This has resulted in a continuous but decreasing release of tritium into the basement air space, which is ventilated to the outdoors., A dose assessment has been performed for this building every year since 1995.

In 2009, groundwater containing detectable levels of tritium were pumped from the sump well in the basement and allowed to evaporate from the array of evaporative units on the north side of the building beginning in April and extending into October. The tritium concentration levels in the groundwater and the volume of groundwater diverted to the evaporative units were known and were used to compute total annual tritium emissions from the evaporative units. Also, two air samples were collected from the basement (from April 6 to 9 and from September 1 to 8) in order to compute average tritium emissions from the basement. A calculated annual total of 8.7 millicuries (mCi) were released from both the evaporative units (0.53 mCi) and the basement air being vented to the outside (8.12 mCi). Based on this emission rate, the calculated radiation dose to the nearest member of the general public, located 100 meters northwest of Building A-1, was very low, at 0.000044 mrem/yr (NSTec, 2010b). This is 27% lower than the public dose estimated for the previous year of 2008 (NSTec, 2009a).

A.1.5.2 DOE O 5400.5

U.S. Department of Energy (DOE) Order DOE O 5400.5, "Radiation Protection of the Public and the Environment," specifies that the radiological dose to a member of the public from radiation from all pathways must not exceed 100 mrem/yr as a result of DOE activities. This dose limit does not include the dose contribution from natural background radiation. The Atlas A-1 Source Range Laboratory and the Building C-3 High Intensity Source Building are two NLVF facilities that use radioactive sources or where radiation-producing operations are conducted that have the potential to expose the general population or non-project personnel to direct radiation. NSTec's Environmental Protection and Technical Services (EPTS) conducts direct radiation monitoring at these locations. EPTS uses thermoluminescent dosimeters (TLDs) to monitor external gamma radiation exposure near the boundaries of these facilities. The methods of TLD use and data analyses are described in Section 6.0 of this report.

In 2009, radiation exposure was measured at two locations along the perimeter fence and at one control location along the west fence of the C-1 Building. Annual exposure rates estimated from measurements at those NLVF locations are summarized in Table A-5. The radiation exposure in air measured by the TLDs is in the unit of milliroentgens per year (mR/yr), which is considered equivalent to the unit of mrem/yr for tissue. These exposures include contributions from background radiation and are lower than the TLD measurement of 98 mR/yr for the mean annual exposure reported by the Desert Research Institute from their Las Vegas air monitoring station (see Section 7.1.2, Table 7-3). The NLVF TLD results indicate that facility activities do not contribute a radiological dose to the surrounding public that can be distinguished from that of background radiation.

Table A-5. Results of 2009 direct radiation exposure monitoring at NLVF

		Gamma Exposure (milliroentgens per year [mR/yr])			
Location	**Number of Samples**	**Mean**	**Median**	**Minimum**	**Maximum**
Control (along west fence of Building C-1)	4	69	69	65	71
North Fence of Building A-1	4	64	64	62	67
North Fence of Building C-3	4	64	64	62	66

A.2 Remote Sensing Laboratory–Nellis

RSL-Nellis is approximately 13.7 kilometers (km) (8.5 miles [mi]) northeast of the Las Vegas city center, and approximately 11.3 km (7 mi) northeast of NLVF. It occupies six facilities on approximately 14 secured hectares (35 acres) at the Nellis Air Force Base. The six NNSA/NSO facilities were constructed on property owned by the U.S. Air Force (USAF). There is a Memorandum of Agreement between the USAF and the NNSA/NSO whereby the land belongs to the USAF but is under lease to the NNSA/NSO for 25 years (as of 1989) with an option for a 25-year extension. The facilities are owned by NNSA/NSO. RSL-Nellis provides emergency response resources for weapons-of-mass-destruction incidents. The laboratory also designs and conducts field tests of counterterrorism/ intelligence technologies, and has the capability to assess environmental and facility conditions using complex radiation measurements and multi-spectral imaging technologies.

Environmental compliance and monitoring activities at RSL-Nellis in 2009 included maintenance of a wastewater contribution permit, an air quality permit, a hazardous materials permit, and a waste management permit (Table A-6). Sealed radiation sources are used for calibration at RSL-Nellis, but the public has no access to any area that may have elevated gamma radiation emitted by the sources. Therefore, no environmental TLD monitoring is conducted. However, dosimetry monitoring is performed to ensure protection of personnel who work within the facility.

Table A-6. Environmental permits for RSL-Nellis in 2009

Permit Number	Description	Expiration Date	Reporting
Wastewater Discharge			
CCWRD-080	Industrial Wastewater Discharge Permit	June 30, 2009	Quarterly
Air Quality			
Facility 348, Mod. 3	Clark County Authority to Construct/Operating Permit for a Non-Major Testing Laboratory	None	Annually
Hazardous Materials			
2287-2055	RSL-Nellis Hazardous Materials Permit	February 28, 2010	Annually
Waste Management			
U1576-33N-01	RSL-Nellis Waste Management Permit-Underground Storage Tank	December 31, 2010	None

A.2.1 Compliance with Wastewater Contribution Permit CCWRD-080

Discharges of wastewater from RSL-Nellis are required to meet permit limits set by the Clark County Water Reclamation District (CCWRD). These limits support the permit limits for the POTW operated by Clark County. The wastewater permit for this facility requires quarterly monitoring and reporting. Table A-7 presents the mean concentration of outfall measurements collected once per quarter in 2009. All contaminants in the outfall samples were below permit limits. Quarterly reports were submitted to the CCWRD on March 16, May 13, September 16, and December 22, 2009. The CCWRD also conducted two inspections of RSL-Nellis in 2009. The inspections resulted in no findings or corrective actions for the facility.

Table A-7. Mean concentration of outfall measurements at RSL-Nellis in 2009

Contaminant/Measure	Permit Limit (mg/L)	Outfall (mg/L)
Ammonia	NL[(a)]	12.5
Cadmium	0.35	0.00046
Chromium (Total)	1.7	0.0012
Copper	3.36	0.234
Cyanide (Total)	1	<0.00521
Lead	0.99	0.0022
Nickel	10.08	0.0037
Phosphorus	NL[(a)]	5.1
Silver	6.3	0.0042
Total Dissolved Solids	NL[(a)]	1,123
Total Suspended Solids	NL[(a)]	304
Zinc	23.06	0.43
pH (Standard Units)	5.0–11.0	8.13
Temperature (degrees Fahrenheit)	140	75.6

(a) No limit listed on permit

A.2.2 Compliance with Air Quality Permits

Sources of air pollutants at RSL-Nellis are regulated by the Facility 348 Authority to Construct/Operating Permit for the emission of criteria pollutants and HAPs issued by the Clark County DAQEM. One modification to the permit was approved by the DAQEM in 2009. It was issued as Mod. 3, Revision 0, in May 2009, and added two cooling towers, an aluminum sander, and a sand blaster to the regulated sources. The permit was reissued as Mod. 3, Revision 1, in July 2009 to incorporate some minor changes.

The estimated quantities of criteria air pollutants and HAPs emitted at RSL-Nellis in 2009 are presented in Table A-8. Natural gas consumption is also reported in accordance with the requirements of the consolidated air permit issued for RSL-Nellis. The emissions inventory for 2009 was submitted to the DAQEM on March 18, 2010.

Table A-8. Summary of air emissions for RSL-Nellis in 2009

Criteria Pollutant (Tons/yr)[a]					HAPs (Tons/yr)	Natural Gas Consumption (ft^3)[c]
CO	**NO_x**	**PM10[b]**	**SO_2**	**VOC**		
0.220	0.389	0.223	0.002	0.023	0.020	4,214,800
Total Emissions of Pollutants = 0.877						

(a) 1 ton equals 0.91 metric tons
(b) Particulate matter equal to or less than 10 microns in diameter
(c) Cubic feet

The RSL-Nellis air permit requires that equipment be observed each day it is operated. If visible emissions are observed, then opacity readings are recorded by a certified visible emissions evaluator. In 2009, two NSTec employees from RSL-Nellis were certified by Carl Koontz Associates to conduct opacity readings. Readings were taken for generators, a paint booth, aluminum sander, and sand blaster. Emissions for all of the equipment were well below the Clean Air Act NAAQS opacity limit of 20 percent.

A.2.3 Compliance with Hazardous Materials Regulations

In 2009, the chemical inventory at RSL-Nellis was updated and submitted to the State in the NCA Report on February 23, 2010, in accordance with the requirements of the Hazardous Materials Permit 2287-5145 (see Section 2.5 of this report for description of content, purpose, and federal regulatory driver behind the NCA Report). No accidental or unplanned release of an EHS occurred at RSL-Nellis in 2009. Also, no annual usage quantities of toxic chemicals kept at RSL-Nellis exceeded specified thresholds (see Section 2.5 concerning Toxic Chemical Release Inventory, Form R).

A.2.4 Compliance with Waste Management Regulations

The underground storage tank program at RSL-Nellis consists of three active permitted tanks (one for unleaded gasoline, one for diesel fuel, and one for used oil), one deferred tank (in accordance with Title 40 Code of Federal Regulations Part 280.10(d)) for emergency power generation, and three unregulated tanks. The active tanks are inspected annually by the Southern Nevada Health District (SNHD). In August 2009, the U.S. Environmental Protection Agency (EPA), Region IX performed the inspection and SNHD observed. A Notice of Violation was issued for deficiencies related to (1) documentation that overfill devices had been installed on the tanks, (2) annual functionality tests for the tanks' leak detection system, and (3) third-party certification of the leak sensor alarm system. The overfill device documentation was provided to the EPA inspector within the requested time frame, a functionality test of the leak detection system was conducted in October 2009, and documentation to satisfy third-party certification of the leak sensor alarm system was provided to EPA. NNSA/NSO complied with the EPA-recommended corrective actions, and the issue was closed.

Appendix B: Glossary of Terms

A

Absorbed dose: the amount of energy imparted to matter by ionizing radiation per unit mass of irradiated material, in which the absorbed dose is expressed in units of rad or gray (l rad equals 0.01 gray).

Accuracy: the closeness of the result of a measurement to the true value of the quantity measured.

Action level: defined by regulatory agencies, the level of pollutants which, if exceeded, requires regulatory action.

Alluvium: a sediment deposited by flowing water.

Alpha particle: a positively charged particle emitted from the nucleus of an atom, having mass and charge equal to those of a helium nucleus (two protons and two neutrons), usually emitted by transuranic elements.

Analyte: the specific component measured in a chemical analysis.

Aquifer: a saturated layer of rock or soil below the ground surface that can supply usable quantities of groundwater to wells and springs, and be a source of water for domestic, agricultural, and industrial uses.

Area 5 Radioactive Waste Management Complex (RWMC): the complex in Area 5 of the Nevada Test Site at which low-level waste (LLW), mixed low-level waste (MLLW), and transuranic (TRU) waste may be received, examined, packaged, stored, or disposed of. It is composed of the Area 5 Radioactive Waste Management Site (RWMS) and the Waste Examination Facility (WEF) and includes supporting administrative buildings, parking areas, and utilities. The operational units of the Area 5 RWMS include active, inactive, and closed LLW and MLLW cells and a Real Time Radiography Building. The operational units of the WEF include the TRU-Pad, TRU-Pad Cover Building, TRU Loading Operations Area, WEF Yard, WEF Drum Holding Pad, Sprung Instant Structure, and the Visual Examination and Repackaging Building.

Atom: the smallest particle of an element capable of entering into a chemical reaction.

B

Background: as used in this report, background is the term for the amounts of chemical constituents or radioactivity in the environment that are not caused by Nevada Test Site operations.

Becquerel (Bq): the International System of Units unit of activity of a radionuclide, equal to the activity of a radionuclide having one spontaneous nuclear transition per second.

Beta particle: a negatively charged particle emitted from the nucleus of an atom, having charge, mass, and other properties of an electron, emitted from fission products such as cesium-137.

Biological oxygen demand (BOD): a measure of the amount of dissolved oxygen that microorganisms need to break down organic matter in water; used as an indicator of water quality.

C

CAP88-PC: a computer code required by the U.S. Environmental Protection Agency for modeling air emissions of radionuclides.

Code of Federal Regulations (CFR): a codification of all regulations promulgated by federal government agencies.

Collective population dose: the sum of the total effective dose equivalents of all individuals within a defined population. The unit of collective population dose is person-rem or person-sievert. Collective population dose may also be referred to as "collective effective dose equivalent" or simply "population dose."

Committed dose equivalent: the dose equivalent to a tissue or organ over a 50-year period after an intake of a radionuclide into the body. Committed dose equivalent is expressed in units of rem or sievert.

Committed effective dose equivalent (CEDE): the sum of the committed dose equivalents to various tissues in the body, each multiplied by an appropriate weighting factor representing the relative vulnerability of different parts of the body to radiation. Committed effective dose equivalent is expressed in units of rem or sievert.

Compliance Level (CL): the Clean Air Act National Emission Standards for Hazardous Air Pollutants Concentration Level for Environmental Compliance. The CL value represents the annual average concentration that would result in a dose of 10 millirem per year, which is the federal dose limit to the public from all radioactive air emissions.

Cosmic radiation: radiation with very high energies originating outside the earth's atmosphere; it is one source contributing to natural background radiation.

Criteria pollutants: those air pollutants designated by the U.S. Environmental Protection Agency as potentially harmful and for which National Ambient Air Quality Standards under the Clean Air Act have been established to protect the public health and welfare. These pollutants include sulfur dioxide (SO_2), nitrogen oxides (NO_X), carbon monoxide (CO), ozone, lead, and particulate matter equal to or less than 10 microns in diameter (PM10). The State of Nevada, through an air quality permit, establishes emission limits on the Nevada Test Site for SO_2, NO_X, CO, PM10, and volatile organic compounds (VOCs). Ozone is not regulated by the permit as an emission as it is formed in part from NO_X and VOCs. Lead is considered a hazardous air pollutant (HAP) as well as a criteria pollutant, and lead emissions on the Nevada Test Site are reported as part of the total HAP emissions. Lead emissions above a specified threshold are also reported under Section 313 of the Emergency Planning and Community Right-to-Know Act.

Critical Level (L_C): the counts of radioactivity (or concentration level of a radionuclide) in a sample that must be exceeded before there is a specified level of confidence (typically 95 or 99 percent) that the sample contains radioactive material above the background; called the Critical Level (L_C) or the decision level.

Curie (Ci): a unit of measurement of radioactivity, defined as the amount of radioactive material in which the decay rate is 3.7×10^{10} disintegrations per second or 2.22×10^{12} disintegrations per minute; one Ci is approximately equal to the decay rate of one gram of pure radium.

D **Daughter nuclide:** a nuclide formed by the radioactive decay of another nuclide, which is called the parent.

Decision level: the counts of radioactivity (or concentration level of a radionuclide) in a sample that must be exceeded before there is a specified level of confidence (typically 95 or 99 percent) that the sample contains radioactive material above the background; also known as the Critical Level (L_C).

Depleted uranium: uranium having a lower proportion of the isotope ^{235}U than is found in naturally occurring uranium. The masses of the three uranium isotopes with atomic weights 238, 235, and 234 occur in depleted uranium in the weight-percentages 99.8, 0.2, and 5×10^{-4}, respectively; see Table 3-7 and related discussion.

Derived Concentration Guide (DCG): concentrations of radionuclides in water and air that could be continuously consumed or inhaled for one year and not exceed the U.S. Department of Energy primary radiation dose limit to the public of 100 millirem per year effective dose equivalent.

Dose: the energy imparted to matter by ionizing radiation; the unit of absorbed dose is the rad, equal to 0.01 joules per kilogram for irradiated material in any medium.

Dose equivalent: the product of absorbed dose in rad (or gray) in tissue and a quality factor representing the relative damage caused to living tissue by different kinds of radiation, and perhaps other modifying factors representing the distribution of radiation, etc., expressed in units of rem or sievert.

Dosimeter: a portable detection device for measuring the total accumulated exposure to ionizing radiation.

Dosimetry: the theory and application of the principles and techniques of measuring and recording radiation doses.

E **Effective dose equivalent (EDE):** an estimate of the total risk of potential effects from radiation exposure; it is the summation of the products of the dose equivalent and weighting factor for each tissue. The weighting factor is the decimal fraction of the risk arising from irradiation of a selected tissue to the total risk when the whole body is irradiated uniformly to the same dose equivalent. These factors permit dose equivalents from non-uniform exposure of the body to be expressed in terms of an EDE that is numerically equal to the dose from a uniform exposure of the whole body that entails the same risk as the internal exposure. The EDE includes the committed effective dose equivalent from internal deposition of radionuclides and the EDE caused by penetrating radiation from sources external to the body, and is expressed in units of rem or sievert.

Effluent: used in this report to refer to a liquid discharged to the environment.

Emission: used in this report to refer to a vapor, gas, airborne particulate, or radiation discharged to the environment via the air.

F **Federal facility:** a facility that is owned or operated by the federal government, subject to the same requirements as other responsible parties when placed on the Superfund National Priorities List.

Federal Register: a document published daily by the federal government containing notification of government agency actions, including notification of U.S. Environmental Protection Agency and U.S. Department of Energy decisions concerning permit applications and rule-making.

Fiscal year: the U.S. Department of Energy, National Nuclear Security Agency Nevada Site Office's fiscal year is from October 1 through September 30.

G **Gamma ray:** high-energy, short-wavelength, electromagnetic radiation emitted from the nucleus of an atom, frequently accompanying the emission of alpha or beta particles.

Gray (Gy): the International System of Units unit of measure for absorbed dose; the quantity of energy imparted by ionizing radiation to a unit mass of matter, such as tissue. One gray equals 100 rads, or 1 joule per kilogram.

Gross alpha: the measure of radioactivity caused by all radionuclides present in a sample that emit alpha particles. Gross alpha measurements reflect alpha activity from all sources, including those that occur naturally. Gross measurements are used as a method to screen samples for relative levels of radioactivity.

Gross beta: the measure of radioactivity caused by all radionuclides present in a sample that emit beta particles. Gross beta measurements reflect beta activity from all sources, including those that occur naturally. Gross measurements are used as a method to screen samples for relative levels of radioactivity.

H **Half-life:** the time required for one-half the radioactive atoms in a given amount of material to decay; for example, after one half-life, half of the atoms will have decayed; after two half-lives, three-fourths; after three half-lives, seven-eighths; and so on, exponentially.

Hazardous waste: hazardous wastes exhibit any of the following characteristics: ignitability, corrosivity, reactivity, or Extraction Procedure toxicity (yielding excessive levels of toxic constituents in a leaching test), but other wastes that do not necessarily exhibit these characteristics have been determined to be hazardous by the U.S. Environmental Protection Agency (EPA). Although the legal definition of hazardous waste is complex, according to EPA, the term generally refers to any waste that, if managed improperly, could pose a threat to human health and the environment.

High-efficiency particulate air (HEPA) filter: a throwaway, extended-media, dry-type filter used to capture particulates in an air stream; HEPA collection efficiencies are at least 99.97 percent for 0.3-micrometer diameter particles.

High-level radioactive waste:

Hydrology: the science dealing with the properties, distribution, and circulation of natural water systems.

I **Inorganic compounds:** compounds that either do not contain carbon or do not contain hydrogen along with carbon, including metals, salts, various carbon oxides (e.g., carbon monoxide and carbon dioxide), and cyanide.

Instrument detection limit (IDL): the lowest concentration that can be detected by an instrument without correction for the effects of sample matrix or method-specific parameters such as sample preparation. IDLs are explicitly determined and generally defined as three times the standard deviation of the mean noise level. This represents 99 percent confidence that the signal is not random noise.

Interim status: a legal classification allowing hazardous waste incinerators or other hazardous waste management facilities to operate while the U.S. Environmental Protection Agency considers their permit applications, provided that they were under construction or in operation by November 19, 1980, and can meet other interim status requirements.

International System of Units (SI): an international system of physical units that includes meter (length), kilogram (mass), kelvin (temperature), becquerel (radioactivity), gray (radioactive dose), and sievert (dose equivalent). The abbreviation, SI, comes from the French term Système International d’Unités.

Isotopes: forms of an element having the same number of protons in their nuclei, but differing numbers of neutrons.

L **L_C:** see Critical Level (L_C).

Less than detection limits: a phrase indicating that a chemical constituent or radionuclide was either not present in a sample, or is present in such a small concentration that it cannot be measured as significantly different from zero by a laboratory’s analytical procedure and, therefore, is not identified at the lowest level of sensitivity.

Low-level waste (LLW): defined by U.S. Department of Energy Manual DOE M 435.1-1, “Radioactive Waste Management Manual,” as radioactive waste that is not high-level radioactive waste, spent nuclear fuel, transuranic waste, byproduct material (as defined in section 11e.(2) of the Atomic Energy Act of 1954, as amended), or naturally occurring radioactive material.

Lower limit of detection: the smallest concentration or amount of analyte that can be detected in a sample at a 95-percent confidence level.

Lysimeter: an instrument for measuring the water percolating through soils and determining the dissolved materials.

M **Maximally exposed individual (MEI):** a hypothetical member of the public at a fixed location who, over an entire year, receives the maximum effective dose equivalent (summed over all pathways) from a given source of radionuclide releases to air. Generally, the MEI is different for each source at a site.

Maximum contaminant level (MCL): the highest level of a contaminant in drinking water that is allowed by U.S. Environmental Protection Agency regulation.

Minimum detectable concentration (MDC): also known as the lower limit of detection, the smallest amount of radioactive material in a sample that can be quantitatively distinguished from background radiation in the sample with 95 percent confidence.

Metric units: metric units, U.S. customary units, and their respective equivalents are shown in Table 1-6. Except for temperature for which specific equations apply, U.S. customary units can be determined from metric units by multiplying the metric units by the U.S. customary equivalent. Similarly, metric units can be determined from U.S. customary equivalent units by multiplying the U.S. customary units by the metric equivalent.

Mixed low-level waste (MLLW): waste containing both radioactive and hazardous components.

N **National Emission Standards for Hazardous Air Pollutants (NESHAP):** standards found in the Clean Air Act that set limits for hazardous air pollutants.

National Pollutant Discharge Elimination System (NPDES): a federal regulation under the Clean Water Act that requires permits for discharges into surface waterways.

Nuclide: any species of atom that exists for a measurable length of time. A nuclide can be distinguished by its atomic mass, atomic number, and energy state.

O **Offsite:** for effluent releases or in the nuclear testing area, any place outside the Nevada Test Site and adjacent Nevada Test and Training Range.

Onsite: for effluent releases or in the nuclear testing area, any place inside the Nevada Test Site and adjacent Nevada Test and Training Range.

P **Part B Permit:** the second, narrative section submitted by generators in the Resource Conservation and Recovery Act permitting process that covers in detail the procedures followed at a facility to protect human health and the environment.

Parts per million (ppm): a unit of measure for the concentration of a substance in its surrounding medium; for example, one million grams of water containing one gram of salt has a salt concentration of 1 ppm.

Perched aquifer: an aquifer that is separated from another water-bearing stratum by an impermeable layer.

Performance standards (incinerators): specific regulatory requirements established by the U.S. Environmental Protection Agency limiting the concentrations of designated organic compounds, particulate matter, and hydrogen chloride in incinerator emissions.

pH: a measure of hydrogen ion concentration in an aqueous solution. Acidic solutions have a pH from 0 to 7, basic solutions have a pH greater than 7, and neutral solutions have a pH of 7.

PM10: a fine particulate matter with an aerodynamic diameter equal to or less than 10 microns.

Point source: any confined and discrete conveyance (e.g., pipe, ditch, well, or stack).

Q **Quality assurance (QA):** a system of activities whose purpose is to provide the assurance that standards of quality are attained with a stated level of confidence.

Quality control (QC): procedures used to verify that prescribed standards of performance are attained.

Quality factor: the factor by which the absorbed dose (rad) is multiplied to obtain a quantity that expresses (on a common scale for all ionizing radiation) the biological damage to exposed persons, usually used because some types of radiation, such as alpha particles, are biologically more damaging than others. Quality factors for alpha, beta, and gamma radiation are in the ratio 20:1:1.

R **Rad:** the unit of absorbed dose and the quantity of energy imparted by ionizing radiation to a unit mass of matter such as tissue; equal to 0.01 joule per kilogram, or 0.01 gray.

Radioactive decay: the spontaneous transformation of one radionuclide into a different nuclide (which may or may not be radioactive), or de-excitation to a lower energy state of the nucleus by emission of nuclear radiation, primarily alpha or beta particles, or gamma rays (photons).

Radioactivity: the spontaneous emission of nuclear radiation, generally alpha or beta particles, or gamma rays, from the nucleus of an unstable isotope.

Radionuclide: an unstable nuclide. See nuclide and radioactivity.

Rem: a unit of radiation dose equivalent and effective dose equivalent describing the effectiveness of a type of radiation to produce biological effects; coined from the phrase "roentgen equivalent man," and the product of the absorbed dose (rad), a quality factor (Q), a distribution factor, and other necessary modifying factors. One rem equals 0.01 sievert.

Risk assessment: the use of established methods to measure the risks posed by an activity or exposure by evaluating the relationship between exposure to radioactive substances and the subsequent occurrence of health effects and the likelihood for that exposure to occur.

Roentgen (R): a unit of measurement used to express radiation exposure in terms of the amount of ionization produced in a volume of air.

S

Sanitary waste: most simply, waste generated by routine operations that is not regulated as hazardous or radioactive by state or federal agencies.

Saturated zone: a subsurface zone below which all rock pore-space is filled with water; also called the phreatic zone.

Sensitivity: the capability of methodology or instrumentation to discriminate between samples having differing concentrations or containing varying amounts of analyte.

Sievert (Sv): the International System of Units unit of radiation dose equivalent and effective dose equivalent, that is the product of the absorbed dose (gray), quality factor, distribution factor, and other necessary modifying factors; 1 Sv equals 100 rem.

Source term: the amount of a specific pollutant emitted or discharged to a particular medium, such as the air or water, from a particular source.

Specific conductance: the measure of the ability of a material to conduct electricity; also called conductivity.

Subcritical experiment: an experiment using high explosives and nuclear weapon materials (including special nuclear materials like plutonium) to gain data used to maintain the nuclear stockpile without conducting nuclear explosions banned by the Comprehensive Test Ban Treaty.

T

Thermoluminescent dosimeter (TLD): a device used to measure external beta or gamma radiation levels, and which contains a material that, after exposure to beta or gamma radiation, emits light when processed and heated.

Total dissolved solids (TDS): the total mass of particulate matter per unit volume that is dissolved in water and that can pass through a very fine filter.

Total organic carbon (TOC): the sum of the organic material present in a sample.

Total organic halides (TOX): the sum of the organic halides present in a sample.

Total suspended solids (TSS): the total mass of particulate matter per unit volume suspended in water and wastewater discharges that is large enough to be collected by a very fine filter.

Transpiration: a process by which water is transferred from the soil to the air by plants that take the water up through their roots and release it through their leaves and other aboveground tissue.

Tritium: a radioactive isotope of hydrogen, containing one proton and two neutrons in its nucleus, which decays at a half-life of 12.3 years by emitting a low-energy beta particle.

Transuranic (TRU) waste: material contaminated with alpha-emitting transuranium nuclides that have an atomic number greater than 92 (e.g., ^{239}Pu), half-lives longer than 20 years, and are present in concentrations greater than 100 nanocuries per gram of waste.

U **Uncertainty:** the parameter associated with a sample measurement that characterizes the range of the measurement that could reasonably be attributed to the sample. Used in this report, the uncertainty value is established at ± 2 standard deviations.

Unsaturated zone: that portion of the subsurface in which the pores are only partially filled with water and the direction of water flow is vertical; also referred to as the vadose zone.

V **Vadose zone:** the partially saturated or unsaturated region above the water table that does not yield water to wells.

Volatile organic compound (VOC): liquid or solid organic compounds that have a high vapor pressure at normal pressures and temperatures and thus tend to spontaneously pass into the vapor state.

W **Waste accumulation area (WAA):** an officially designated area that meets current environmental standards and guidelines for temporary (less than 90 days) storage of hazardous waste before offsite disposal.

Wastewater treatment system: a collection of treatment processes and facilities designed and built to reduce the amount of suspended solids, bacteria, oxygen-demanding materials, and chemical constituents in wastewater.

Water table: the underground boundary between saturated and unsaturated soils. It is the point beneath the surface of the ground at which natural ground water is found. It is the upper surface of a zone of saturation where the body of groundwater is not confined by an overlying impermeable formation. Where an overlying confining formation exists, the aquifer in question has no water table.

Weighting factor: a tissue-specific value used to calculate dose equivalents that represents the fraction of the total health risk resulting from uniform, whole-body irradiation that could be contributed to that particular tissue. The weighting factors used in this report are recommended by the International Commission on Radiological Protection.

Wind rose: a diagram that shows the frequency and intensity of wind from different directions at a specific location.

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Appendix C: Acronyms and Abbreviations

ac	acre(s)
Ac	actinium
AEA	Atomic Energy Act
AEC	Atomic Energy Commission
AFV	alternative fuel vehicle
AIWS	American Indian Writer's Subgroup
ALARA	as low as reasonably achievable
Am	americium
ARL/SORD	Air Resources Laboratory, Special Operations and Research Division
ARPA	Archaeological Resources Protection Act
ASER	Annual Site Environmental Report
ASN	Air Surveillance Network
BA	Benham aquifer
BAPC	Bureau of Air Pollution Control
BCG	Biota Concentration Guide
Be	beryllium
BEEF	Big Explosives Experimental Facility
BFF	Bureau of Federal Facilities
bgs	below ground surface
BLM	Bureau of Land Management
BN	Bechtel Nevada
BOA	Basic Ordering Agreement
BOD_5	5-day biological oxygen demand
Bq	Becquerel
BREN	Bare Reactor Experiment–Nevada
BSDW	Bureau of Safe Drinking Water
C	carbon
CA	Composite Analysis
CAA	Clean Air Act
CAB	Community Advisory Board
CADD	Corrective Action Decision Document
CAI	Corrective Action Investigation
CAIP	Corrective Action Investigation Plan
CAP	Corrective Action Plan
CAPP	Chemical Accident Prevention Program
CAP88-PC	Clean Air Package 1988
CAS	Corrective Action Site
CAU	Corrective Action Unit
CCWRD	Clark County Water Reclamation District
CEDE	committed effective dose equivalent
CEM	Community Environmental Monitor
CEMP	Community Environmental Monitoring Program
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CGTO	Consolidated Group of Tribes and Organizations
Ci	curie(s)
CL	compliance level (used in text for the Clean Air Act National Emission Standards for Hazardous Pollutants Concentration Level for Environmental Compliance)
cm	centimeter(s)
CNLV	City of North Las Vegas
Co	cobalt
CO	carbon monoxide
CP	Control Point
cpm	counts per minute
CR	Closure Report
CRM	Cultural Resources Management
Cs	cesium
CV	coefficient of variation
CWA	Clean Water Act
CX	Categorical Exclusion
DAF	Device Assembly Facility
DAQEM	Department of Air Quality and Environmental Management (Clark County)
DCG	Derived Concentration Guide
DM&P	Directives Management and Publications
DNWR	Desert National Wildlife Refuge
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOECAP	U.S. Department of Energy Consolidated Audit Program
DOE/NV	U.S. Department of Energy, Nevada Operations Office

DQA	Data Quality Assessment
DQO	Data Quality Objectives
DRI	Desert Research Institute
DU	depleted uranium
E1	Environmental 1
E2	Environmental 2
EA	Environmental Assessment
EDE	effective dose equivalent
EERE	Office of Energy Efficiency and Renewable Energy
EHS	extremely hazardous substance
EIS	Environmental Impact Statement
EM	Environmental Management
EMAC	Ecological Monitoring and Compliance
E-MAD	Engine Maintenance, Assembly, and Disassembly
EMC	Energy Management Council
EMS	Environmental Management System
EO	Executive Order
EODU	Explosive Ordnance Disposal Unit
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
EPTS	Environmental Protection and Technical Services
ER	Environmental Restoration
ERA	Environmental Research Associates
ESA	Endangered Species Act
ETDS	E-Tunnel Waste Water Disposal System
Eu	europium
EWG	Environmental Working Group
F&I	Facility and Infrastructure
FD	field duplicate
FFACO	Federal Facility Agreement and Consent Order
FFCA	Federal Facility Compliance Act
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
ft	foot or feet
ft^2	square feet
ft^3	cubic feet
FWS	U.S. Fish and Wildlife Service
FY	fiscal year
g	gram(s)
gal	gallon(s)
GCD	Greater Confinement Disposal
GIS	Geographic Information System
gpm	gallon(s) per minute
GTCC-LLW	Greater-Than-Class C Low-Level Waste
Gy	gray(s)
Gy/d	gray(s) per day
^3H	tritium
ha	hectare(s)
HAP	hazardous air pollutant
HCQC	Bureau of Health Care Quality and Compliance
HENRE	High-Energy Neutron Reactions Experiment
HEPA	high-efficiency particulate air
HEST	High Explosives Simulation Test
HPSB	High Performance Sustainable Building
HQ	Headquarters
HTO	tritiated water
HW	hazardous waste
HWAA	Hazardous Waste Accumulation Area
HWSU	Hazardous Waste Storage Unit
IAEA	International Atomic Energy Agency
ICPT	Integrated Contractor Purchasing Team
ID	identification number
IDL	instrument detection limit
IH	Industrial Hygiene
IL	investigation level
in.	inch(es)
INL	Idaho National Laboratory
ISMS	Integrated Safety Management System
ISO	International Organization for Standardization
IT	International Technology Corporation
JASPER	Joint Actinide Shock Physics Experimental Research
K	potassium
kg	kilogram(s)
kg/d	kilogram(s) per day

km	kilometer(s)
km^2	square kilometer(s)
L	liter(s)
LANL	Los Alamos National Laboratory
lb	pound(s)
L_C	Critical Level (synonymous with Decision Level)
LCA	lower carbonate aquifer
LCS	laboratory control sample
L/d	liter(s) per day
LLNL	Lawrence Livermore National Laboratory
LLW	low-level waste
L/min	liter(s) per minute
LoC	Level of Concern
log	logarithmic
Lpm	liter(s) per minute
LQAP	Laboratory Quality Assurance Plan
m	meter(s)
m^2	square meter(s)
m^3	cubic meter(s)
M&O	Management and Operating
MAPEP	Mixed Analyte Performance Evaluation Program
MBTA	Migratory Bird Treaty Act
mCi	millicurie(s)
MCL	maximum contaminant level
MDC	minimum detectable concentration
MEDA	Meteorological Data Acquisition
MEI	maximally exposed individual
MET	meteorological
mGy/d	milligray(s) per day
mg/L	milligram(s) per liter
mi	mile(s)
mi^2	square mile(s)
MLLW	mixed low-level waste
mm	millimeter(s)
mmhos/cm	millimhos per centimeter
Mod.	Modification
MQO	Measurement Quality Objectives
mR	milliroentgen(s)
mR/d	milliroentgen(s) per day
mR/yr	milliroentgen(s) per year
mrad	millirad(s)
mrem	millirem(s)
mrem/yr	millirem(s) per year
MSDS	Material Safety Data Sheet
mSv	millisievert(s)
mSv/yr	millisievert(s) per year
mton	metric ton(s)
MTRU	mixed transuranic
µCi/mL	microcurie(s) per milliliter
µg/L	microgram(s) per liter
µR/hr	microroentgen(s) per hour
N	nitrogen
NAAQS	National Ambient Air Quality Standards
NAC	Nevada Administrative Code
NAGPRA	Native American Graves Protection and Repatriation Act
NCA	Nevada Combined Agency
NCRP	National Council on Radiation Protection
NDEP	Nevada Division of Environmental Protection
NDOA	Nevada Department of Agriculture
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NHPA	National Historic Preservation Act
NLVF	North Las Vegas Facility
NNES	Navarro Nevada Environmental Services, LLC
NNHP	Nevada Natural Heritage Program
NNSA	U.S. Department of Energy, National Nuclear Security Administration
NNSA/NSO	U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office
NNSA/SSO	U.S. Department of Energy, National Nuclear Security Administration Sandia Site Office
NO_x	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NPTEC	Nonproliferation Test and Evaluation Complex
NRC	U.S. Nuclear Regulatory Commission
NRHP	National Register of Historic Places
NRS	Nevada Revised Statutes
NSPS	New Source Performance Standards

NSTec	National Security Technologies, LLC
NTMMSZ	Northern Timber Mountain moat structural zone
NTS	Nevada Test Site
NTSER	Nevada Test Site Environmental Report
NTS SWEIS	*Site-Wide Environmental Impact Statement for the Nevada Test Site and Offsite Locations in the State of Nevada*
NTTR	Nevada Test and Training Range
NVLAP	National Voluntary Laboratory Accreditation Program
ODS	ozone-depleting substance
OSTI	Office of Scientific and Technical Information
P03	Pit 3 Mixed Waste Disposal Unit
P06A	Pit 6 Asbestiform Low-Level Solid Waste Disposal Unit
P2	pollution prevention
P2/WM	pollution prevention/waste minimization
PA	Performance Assessment
PAAA	Price-Anderson Amendments Act
PAID	Performance Analysis and Improvement Division
Pb	lead
PCB	polychlorinated biphenyl
pCi	picocurie(s)
pCi/g	picocurie(s) per gram
pCi/L	picocurie(s) per liter
pCi/mL	picocurie(s) per milliliter
PI	prediction interval
PIC	pressurized ion chamber
PLall	prediction limit for all enriched tritium measurements
PM	particulate matter
PM10	particulate matter equal to or less than 10 microns in diameter
POTW	Publicly Owned Treatment Works
PT	proficiency testing
PTE	potential to emit
Pu	plutonium
PWS	public water system
QA	quality assurance
QAP	Quality Assurance Program
QAPP	Quality Assurance Program Plan
QC	quality control
QSAS	Quality Systems for Analytical Services
R	roentgen(s)
Ra	radium
rad	radiation absorbed dose (a unit of measure)
rad/d	rad(s) per day
RC	Radiological Control
RCD	Radiological Control Department
RCRA	Resource Conservation and Recovery Act
RCT	radiological control technician
rem	roentgen equivalent man (a unit of measure)
RER	relative error ratio
RNCTEC	Radiological/Nuclear Countermeasures Test and Evaluation Complex
RPD	relative percent difference
RREMP	Routine Radiological Environmental Monitoring Plan
RSL	Remote Sensing Laboratory
RW	Radioactive Waste
RWMC	Radioactive Waste Management Complex
RWMS	Radioactive Waste Management Site
SA	Supplement Analysis
SAA	Satellite Accumulation Area
SAD	surface area disturbance
SAFER	Streamlined Approach for Environmental Restoration
SAM	Software Asset Management
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SC	specific conductance
SD	standard deviation
SDWA	Safe Drinking Water Act
SE	standard error of the mean
SHPO	State Historic Preservation Office
SI	International System of Units
SNHD	Southern Nevada Health District
SNJV	Stoller-Navarro Joint Venture
SNL	Sandia National Laboratories
SORD	Special Operations and Research Division

SO_2	sulfur dioxide
Sr	strontium
SSC	structures, systems, and components
S.U.	standard unit(s) (for measuring pH)
Sv	sievert(s)
SWEIS	Site-Wide Environmental Impact Statement
SWO	Solid Waste Operations
Tc	technetium
TCA	Tiva Canyon aquifer
TDR	time domain reflectometry
TDS	total dissolved solids
Th	thorium
TLD	thermoluminescent dosimeter
TMCC	Timber Mountain caldera complex
TOC	total organic carbon
TOX	total organic halides
TPCB	Transuranic Pad Cover Building
TRI	Toxic Release Inventory
TRU	transuranic
TSA	Topopah Spring aquifer
TSCA	Toxic Substances Control Act
TSS	total suspended solids
TTR	Tonopah Test Range
U	uranium
UGT	underground test
UGTA	Underground Test Area
U.S.	United States
USACE	U.S. Army Corps of Engineers
USAF	U.S. Air Force
USC	United States Code
USGS	U.S. Geological Survey
UST	underground storage tank
VOC	volatile organic compounds
VZM	vadose zone monitoring
WEF	Waste Examination Facility
WGS	Waste Generator Services
WIPP	Waste Isolation Pilot Plant
WM	waste minimization
WNV	West Nile virus
WO	Waste Operations
WW	water well
yr	year(s)
Z2CS	Zone 2 Construction Supervision

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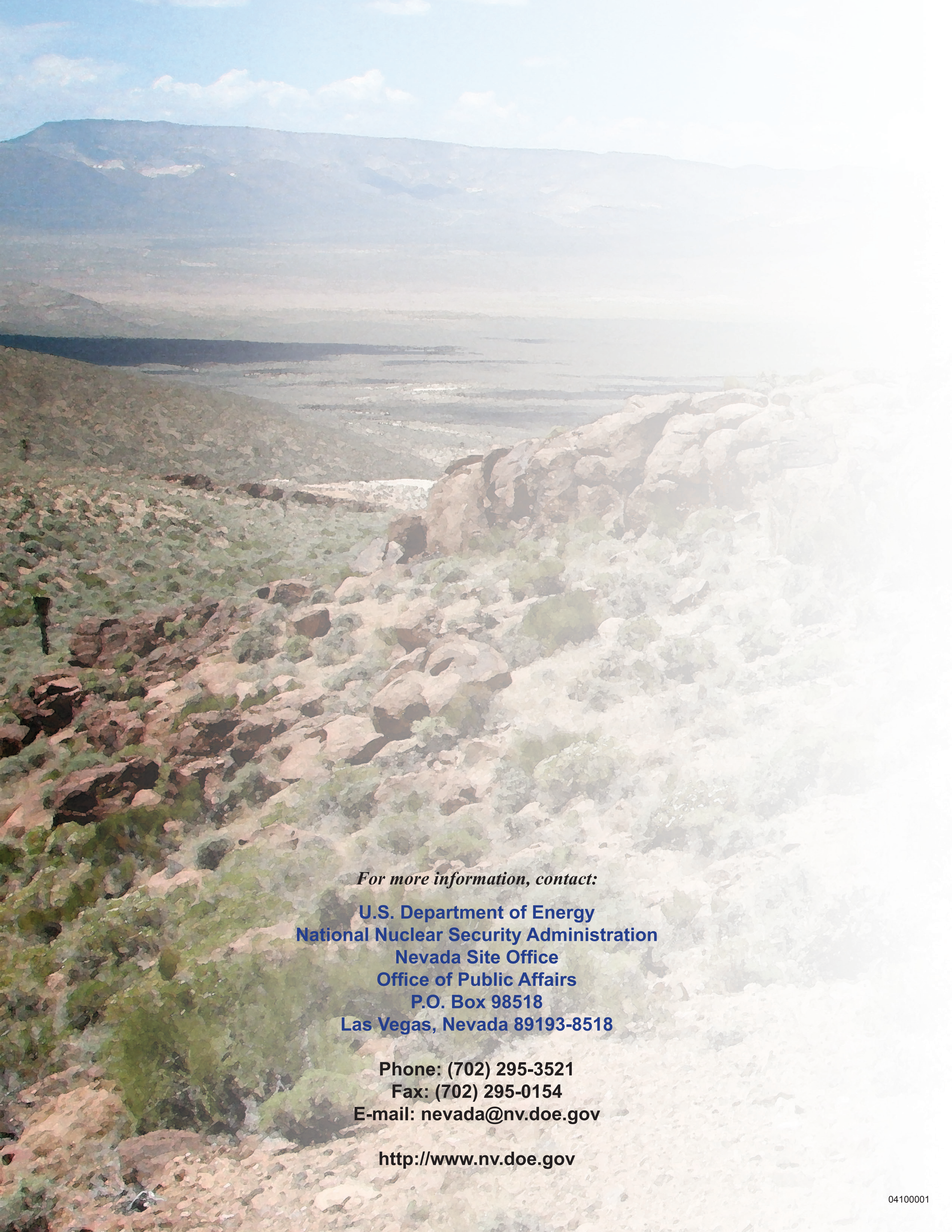

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