ERRATA SHEET

Issue Date: July 2013

The Following Corrections Apply to: *Nevada National Security Site Environmental Report 2011*

DOE Document Number: DOE/NV/25946--1604

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The corrections shown below have been made in the subject document.

Executive Summary:

Page x, table of radiological atmospheric releases in 2011, first column for ^{3}H: 117 changed to **121**

Chapter 4:

Page 4-18, Section 4.1.9, second paragraph, first sentence:	117.427 changed to **121.427**, 117 changed to **121**
Page 4-18, Table 4-13, Annual Quantity (Ci) for ER-20-5 #1:	0.44 changed to **4.4**
Page 4-18, Table 4-13, last row, Total Curies for ^{3}H:	117 changed to **121**

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Nevada National Security Site Environmental Report 2011

September 2012

NNSA
National Nuclear Security Administration

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Disclaimer

Front cover photograph ...

Geologist Sig Drellack on Pahute Mesa collecting fracture data for input to groundwater flow and transport models for the Underground Test Area Activity. View is westward.

Front cover photo insets ***(clockwise)*** **...**

Environmental scientists Melissa Cabble and Matt Weaver sampling water for radiological analysis at the E-Tunnel containment ponds in Area 12 of the NNSS.

Radiological technician Patrick O'Brien surveying for radiation in Area 25 of the NNSS prior to plant sampling for radiological analysis.

Environmental scientists Martin Cavanaugh and Terry Sonnenburg sampling soil for radiological analysis at the North Las Vegas Facility.

Title page photograph ...

Environmental scientist Matt Weaver replacing an air particulate filter at the Area 23 Mercury Track air monitoring station.

Back cover photograph ...

Drill rig crew running pipe into the borehole at the Underground Test Area Characterization Well ER-EC-13 southwest of Area 20 on the Nevada Test and Training Range.

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Nevada National Security Site Environmental Report 2011

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Executive Summary

This report 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' reports, called Annual Site Environmental Reports (ASERs), Nevada Test Site Environmental Reports (NTSERs), and, beginning in 2010, Nevada National Security Site Environmental Reports (NNSSERs), are posted on the NNSA/NSO website at http://www.nv.energy.gov/library/publications/aser.aspx.

Purpose and Scope of the NNSSER

This NNSSER was prepared to satisfy DOE Order DOE O 231.1B, "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 NNSSER summarizes data and compliance status for calendar year 2011 at the Nevada National Security Site (NNSS) (formerly the Nevada Test Site) and its two support facilities, the North Las Vegas Facility (NLVF) and the Remote Sensing Laboratory–Nellis (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 NNSS 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 NNSS. NSTec 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 six sites all provide support to enhance the NNSS as a location for weapons experimentation and nuclear test readiness.

The three major NNSS missions include National Security/Defense, Environmental Management, and Nondefense. The major programs that support these missions are Stockpile Stewardship and Management, Nonproliferation and Counterterrorism, Nuclear Emergency Response, 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, 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. These initiatives are pursued through the Energy Management Program and the Pollution Prevention and Waste Minimization (P2/WM) Program discussed below.

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 NNSS as a unique and valuable national resource. For the identification of NNSS environmental initiatives, NNSA/NSO implements an Integrated Safety Management System (ISMS) and an 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 NNSS 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 NNSS 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 programs, the Energy Management Program and the P2/WM Program, operate specifically to support some of the key environmental initiatives.

Environmental Management System

An Environmental Working Group 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 FY 2011 targets were all met or exceeded and are summarized in Tables 3-1 and 3-2 of Chapter 3.

One surveillance and one recertification assessment was performed by the ISO 14001 certifying organization, Lloyd's Register Quality Assurance (LRQA), in 2011. The EMS program was found to meet all the requirements of the ISO 14001 standard with no major nonconformities, and in June 2011, LRQA recertified the EMS for another 3 years. A 2011 internal independent audit found minor issues that were corrected. Also, 9 internal management assessments and 79 compliance evaluations were conducted to promote continual improvement.

In December 2011, the 2011 Facility EMS Annual Report Data for the NNSS was entered into a DOE Headquarters EMS database on the FedCenter.gov website. 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 NNSS scored "green" (the highest score).

Energy Management Program

The NNSA/NSO Energy Management Program supports DOE goals that have been set to meet the requirements of DOE Order DOE O 436.1A, "Departmental Sustainability"; Executive Order EO 13423, "Strengthening Federal Environmental, Energy, and Transportation Management"; and EO 13514, "Federal Leadership in Environmental, Energy, and Economic Performance." The Energy Management Program accomplishes this by advancing energy efficiency, water conservation, and the use of solar and other renewable energy sources at the NNSS, NLVF, and RSL-Nellis. In June 2011, DOE released its 2011 Strategic Sustainability Performance Plan (SSPP) (DOE, 2011) to address the requirements of DOE O 436.1A and EO 13514 and other sustainability-related statutes within the department. In response, the Energy Management Program prepared the *FY 2012 NNSA/NSO Site Sustainability Plan* (SSP) (NSTec, 2011) that identifies NNSA/NSO specific goals. Thus far, the Energy Management Program is on track to meet the DOE long-term goals of reducing energy intensity, water intensity, and petroleum fuel use, and of increasing alternate fuel use and the acquisition of alternative fuel vehicles. The 2011 status of all the NNSA/NSO SSPs goals is summarized in Table 3-2 of Chapter 3.

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 pursued through source reduction, re-use, segregation, and recycling, and by procuring recycled-content materials and environmentally preferable products and services. In 2011, the P2/WM Program was compliant with the requirements for implementing P2/WM processes but did not meet one goal under EO 13423. Only 52.2% of qualified items purchased by NNSA/NSO in 2011 contained the minimum amount of recycled materials instead of the 100% required, if possible, under EO 13423.

The 2011 P2/WM activities resulted in reductions to the volume and/or toxicity of waste generated by NNSA/NSO activities. A reduction of 121 metric tons (mtons) (133 tons) of hazardous waste (HW) was realized in 2011. The largest proportion of this reduction came from shipments of bulk used oil (44.5 mtons [49.0 tons]), lead acid batteries (29.8 mtons [32.8 tons]), and electronic equipment (20.0 mtons [22.0 tons]) to offsite vendors for recycling. A reduction of 760.5 mtons (713.3 tons) of solid waste was realized in 2011. The largest proportion of this reduction came from 329.8 mtons (362.8 tons) of ferrous and nonferrous metal sold as scrap for recycling and 234.2 mtons (257.6 tons) of mixed paper/cardboard/aluminum cans/plastic shipped from the NLVF and 99.0 mtons (108.9 tons) of mixed paper/cardboard shipped from the NNSS to offsite vendors for recycling.

Environmental Awards

NNSA awarded NNSA/NSO with an Environmental Stewardship Award in the category of Water Resources for the NLVF Building C-1 Xeric Landscaping Project. The project replaced 35,000 square feet of grass with xeric landscaping and a drip watering system, which will save approximately 1.9 million gallons of water each year. There will also be a cost savings for avoiding lawn maintenance of $32,000 each year.

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 NNSS operations. In 2011, environmental compliance was nearly 100% for all federal statutes, as shown below and in more detail in Chapter 2, Compliance Summary.

Federal Environmental Statute	What it Covers	2011 Status
Radiation Protection		
DOE O 458.1, "Radiation Protection of the Public and the Environment" *(and its predecessor of the same name, DOE O 5400.5)*	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, 18 offsite and 24 onsite groundwater sources, and 108 stations measuring direct gamma radiation. A combined total of 16 plant samples from 3 locations and 12 animal samples from 11 locations were collected 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 0.54 millirems per year (mrem/yr), well below the DOE limit of 100 mrem/yr.
Atomic Energy Act (through compliance with DOE O 435.1, "Radioactive Waste Management")	Management of low-level radioactive waste (LLW) and MLLW generated or disposed on site	A total of 33,532 tons (1,504,412 cubic feet) of radioactive wastes, which included 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.

Federal Environmental Statute	What it Covers	2011 Status
Air Quality and Protection		
Clean Air Act: National Emission Standards for Hazardous Air Pollutants (NESHAP) National Ambient Air Quality Standards (NAAQS) New Source Performance Standards (NSPS) Stratospheric Ozone Protection	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 NNSS, NLVF, or RSL-Nellis. Nonradiological air emissions from all permitted equipment and facilities were calculated and were all below permit emission limits; emissions from permitted equipment were all below opacity limits. No air permit exceedances, Notices of Violation, or other air quality noncompliances occurred. 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 2011 NNSS air emissions to the MEI is 0.07 mrem/yr.
Water Quality and Protection		
Clean Water Act (CWA)	Water quality and effluent discharges from facility operations	All required maintenance, monitoring, and reporting were conducted for permitted wastewater systems and monitoring wells. All domestic and industrial wastewater systems and groundwater monitoring well samples were within permit limits for regulated water contaminants and water chemistry parameters. Pumped groundwater samples at the NLVF were all within National Pollutant Discharge Elimination System (NPDES) permit limits. NNSS operations do not require any NPDES permits.
Safe Drinking Water Act (SDWA)	Quality of drinking water	All concentrations of regulated water contaminants in drinking water from the three permitted public water systems on the NNSS were below state and federal permit limits.
Waste and Hazardous Materials Management and Environmental Restoration		
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)/Superfund Amendments and Reauthorization Act (SARA)	Cleanup of waste sites containing hazardous substances	No HW cleanup operations on the NNSS are regulated under CERCLA or SARA; they are regulated under the Resource Conservation and Recovery Act (RCRA) instead. The requirements of CERCLA applicable to the NNSS pertain to an emergency response program for hazardous substance releases (see Emergency Planning and Community Right-to-Know Act [EPCRA] below) 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 [FFACO]).
Federal Facility Agreement and Consent Order (FFACO)	Cleanup of waste sites containing hazardous substances	All 2011 milestones established under the FFACO 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 56 CASs were closed in accordance with State-approved corrective action plans.
Resource Conservation and Recovery Act (RCRA)	Generation, management, and/or disposal of HW and mixed low-level waste (MLLW) and cleanup of inactive, historical waste sites	A total of 1,001 tons of MLLW were received and disposed on site, 10.55 tons of HW were received for onsite storage, 6.06 tons of polychlorinated biphenyl (PCB) wastes were shipped to an offsite disposal facility, and 34.66 tons of waste explosive ordnance were detonated on site, all 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.

Federal Environmental Statute	What it Covers	2011 Status
Waste and Hazardous Materials Management and Environmental Restoration (continued)		
National Environmental Policy Act (NEPA)	Projects are evaluated for environmental impacts	The draft *Site-Wide Environmental Impact Statement for the Nevada National Security Site and Offsite Locations in Nevada* was released for public review in July 2011. Public meetings were held in September 2011 in various Nevada and Utah communities. It evaluates current and future NNSA/NSO operations in Nevada during the 10-year period beginning when the Record of Decision is published, expected in November 2012.
Toxic Substances Control Act (TSCA)	Management and disposal of PCBs	Ten drums of fluorescent light ballasts containing PCBs (9 from NNSS and 1 from NLVF) and 17 drums of PCB-contaminated soil were shipped off site to permitted disposal and treatment facilities.
Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)	Storage and use of pesticides and herbicides	Both restricted-use and nonrestricted-use pesticides were used in 2011 and were applied by State of Nevada–certified personnel. Storage and use of pesticides were in compliance with federal and state regulations.
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, mercury, and PCBs. As part of normal operations, 30,847 pounds (lb) of lead, 7,951 lb of mercury, and 5,048 lb of PCBs were received or generated on site and disposed on site; 8,690 lb of lead were released as spent ammunition at the Mercury Firing Range, which will be recycled in the future, and 5.2 lb of lead were released to the air from the Mercury Firing Range. Lead, mercury, and PCB wastes generated on site and shipped off site for disposal totaled 2,387 lb, 7,951 lb, and 3.98 lb, respectively. NNSA/NSO shipped 101,650 lb of lead and 0.02 lb of mercury off site for recycling. The chemical inventory for NNSS, NLVF, and RSL-Nellis was updated and submitted to the State of Nevada. No releases occurred that triggered state or federal reporting requirements.
Other Environmental Statutes		
Endangered Species Act (ESA)	Threatened or endangered species of plants and animals	Field surveys for 21 proposed projects were conducted, 4.68 acres of tortoise habitat were disturbed, and no tortoises were harmed at or displaced from project sites. One tortoise was killed on a road, and nine 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. Archival research for 37 proposed projects was conducted, 669 acres were surveyed for 16 of the projects, and one historical site was identified.
Migratory Bird Treaty Act (MBTA)	Protecting migratory birds, nests, and eggs from harm	During biological surveys for proposed projects, no migratory bird nests, eggs, or young were found in harm's way. However, seven red-tailed hawks and two great horned owl were electrocuted by power lines, and a poor-will was accidentally killed by a vehicle. Biologists and NNSS Power Support personnel identified ways to help mitigate raptor electrocutions and power equipment damage related to raptor nests and perches.

Occurrences and Unplanned Releases

No unplanned airborne releases and no unplanned releases of radioactive liquids occurred from the NNSS, NLVF, or RSL-Nellis in 2011. There were also no reportable environmental occurrences in 2011.

Radiation Dose to the Public

Background Gamma Radiation – Mean background gamma radiation exposure rates on the NNSS are estimated using ten thermoluminescent dosimeter (TLD) stations located away from radiologically contaminated sites. The average mean exposure rate among these ten stations in 2011 was 119 milliroentgen per year (mR/yr) and ranged from 66 to 164 mR/yr (Section 6.3). The Desert Research Institute (DRI) used TLDs at offsite locations in 2011 to measure background radiation, and these measurements ranged from 78 mR/yr at Pahrump, Nevada, to 148 mR/yr at Twin Springs, Nevada (Section 7.1.3).

Public Dose from Direct Radiation – Areas accessible to the public had direct external gamma radiation exposure rates in 2011 comparable to natural background rates. The TLD locations on the west and north sides of the parking area at Gate 100, the NNSS entrance gate, had estimated annual mean exposures of 107 and 67 mR/yr, respectively, similar to the range of background exposures observed on the NNSS (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 NNSS boundary with NTTR in the playa had an estimated annual exposure of 298 mR (Section 6.3.1). This represents an above-background exposure of 134 to 232 mrem/yr (depending on which background radiation value is subtracted), which would exceed the 100 mrem/yr dose limit if a member of the public were to reside at this location. However, there are no living quarters or full-time personnel in that area. Since the nearest resident does not live in close proximity of the site, there is no dose contribution from external gamma radiation from NNSS operations to the public.

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 2011 (Section 5.1.5). Therefore, there is no dose contribution from drinking water to the public due to NNSS operations.

Public Dose from Inhalation – The radiation dose limit to the public via the air transport pathway is established by 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 NNSS to verify compliance with this dose limit. The following radionuclides were detected at four or more of the critical receptor samplers: americium-241 (^{241}Am), cesium-134 (^{134}Cs), cesium-137 (^{137}Cs), plutonium-238 (^{238}Pu), plutonium-239+240 ($^{239+240}$Pu), uranium-233+234, uranium-235+236, uranium-238, and tritium (^{3}H) (Section 4.1.4). The ^{134}Cs and ^{137}Cs are believed to be solely from the Fukushima Daiichi nuclear power plant release that occurred in March 2011 and not NNSS related. 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 NNSS experienced the highest concentrations of radioactive air emissions (Section 4.1.5). The Gate 510 sampler, however, is the closest station to a public receptor (3.5 kilometers [km] [2.2 miles (mi)]). The estimated effective dose equivalent from air emissions for a hypothetical individual living year-round at the Gate 510 sampler would be 0.07 mrem/yr.

Public Dose from Ingestion of Radionuclides in Game Animals – Game animals and small mammals (used as models for small game animals) are analyzed for their radionuclide content to estimate the dose to the public who might consume these animals if the animals were to move off the NNSS. In 2011, Samples from two jackrabbits captured at T2 in Area 2, and opportunistic tissue samples of eight mule deer, one bighorn sheep, and blood from one live mountain lion were collected. An individual who consumes one animal of each game species sampled on the NNSS from 2001 to 2011, having the average radionuclide concentrations of these samples, may receive an estimated 0.47 mrem/yr dose (Section 9.1.1.2).

Public Dose from All Pathways – 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. The 2011 radiological monitoring data indicate that the dose to the public living in communities surrounding the NNSS is not expected to be significantly higher than the previous 10 years. The public dose from all pathways in 2011 was estimated to be 0.54 mrem/yr. This is 0.54% of the 100 mrem/yr dose limit and about 0.15% of the total dose the MEI receives from natural background radiation (360 mrem/yr) (Section 9.1.3).

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 NNSS. 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 2011. 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.

As in previous years, no airborne radioactivity related to historical or current NNSS operations was detected in any of the samples from the CEMP particulate air samplers during 2011. 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 attributable to NNSS operations remained consistent with previous years' background levels and are well within background levels observed in other parts of the United States. Airborne radioactivity from the Fukushima nuclear power plant in Japan was detectable at CEMP stations in March 2011.

Offsite Monitoring of Radionuclides in Water

Routine offsite water monitoring conducted under the *Routine Radiological Environmental Monitoring Plan* (RREMP) (Bechtel Nevada, 2003a) and conducted by DRI through the CEMP continues to verify that there are no man-made radionuclides from NNSS underground contamination areas in any public or private water supply wells or springs being monitored. Under the RREMP, 18 offsite locations (5 community water supply wells, 10 non-potable NNSA/NSO wells, and 3 springs) were sampled for tritium, man-made gamma-emitting radionuclides, and gross alpha and gross beta radioactivity. The DRI sampled 28 offsite private or community water supply locations (4 springs, 21 wells, and 3 surface water bodies) for tritium.

Tritium was detected at low levels for the second year in a row at RREMP monitoring well PM-3, a non-potable NNSA/NSO well located on the NTTR. Well PM-3 was sampled at two depths in 2011. The Underground Test Area (UGTA) Activity also sampled it at the same two depths in 2011, with similar results. At the depth of 1,560 feet (ft), RREMP duplicate samples detected 58.0 and 63.2 picocuries per liter (pCi/L) of tritium, and UGTA samples detected 36.7 and 56.7 pCi/L. At the 1,983 ft depth, RREMP samples detected 19.5 and 33.8 pCi/L of tritium, while UGTA samples detected 18.6 and 33.2 pCi/L. Hydrogeologic data west of the NNSS are sparse, and thus groundwater flow predictions are uncertain. PM-3 will continue to be monitored in 2012 to determine the tritium source. Tritium was not detected in the remainder of the offsite wells and springs sampled under the RREMP in 2011(Section 5.1.5). Gross alpha and gross beta radioactivity were detected in the majority of offsite RREMP well and spring samples and likely represent natural radiation sources; levels were all below EPA limits set for drinking water.

Tritium concentrations for all the CEMP spring and surface water samples ranged from below detection to 22.7 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 NNSS 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 4.8 pCi/L (Section 7.2.4). Most samples yielded results that were statistically indistinguishable from laboratory background.

The UGTA Activity continued their groundwater characterization work, sampling only two offsite wells, PM-3 and ER-EC-12 on the NTTR. No tritium was detected in Well ER-EC-12. 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 or in RREMP monitoring wells farther downgradient in Oasis Valley.

In May 2011, NNSA/NSO gave a third public presentation of the current state of knowledge of contaminant migration off the NNSS at the Beatty Community Center in Beatty, Nevada. Links to the regional transport model, to the Phase I Central and Western Pahute Mesa Transport Model, and to posters presented at the meeting about both the UGTA Activity wells and the offsite RREMP monitored wells can be found at the NNSA/NSO web page at http://www.nv.energy.gov/library/publications/Environmental/May2011GWOpenHousePosters.pdf.

Onsite Monitoring of Radiological Releases into Air

Radionuclide emissions on the NNSS in 2011 were from the following sources: (1) the release of tritium from laboratory operations at Building 23-652 in Mercury; (2) the evaporation of tritium from pumped groundwater at two UGTA Activity wells in Area 20 and one UGTA Activity well in Area 12; (3) 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; (4) the evaporation of tritiated water discharged from E-Tunnel in Area 12; (5) the evaporation of tritiated water removed from the basement of Building A-1 at the NLVF and transported to the NNSS for disposal in the Area 23 Sewage Lagoon; (6) the resuspension of ^{241}Am, ^{238}Pu, and $^{239+240}$Pu from past nuclear testing from soil deposits on the NNSS across all NNSS areas, and (7) the suspension of depleted uranium (DU) during experiments conducted at NPTEC in Area 5 and at the BEEF in Area 4. A network of 19 air sampling stations and a network of 108 TLDs on the NNSS were used to monitor diffuse onsite radioactive emissions. Total radiological atmospheric releases from the NNSS in curies (Ci) for 2011 (Section 4.1.9) are shown in the table below. An estimated 0.0048 Ci of tritium were released at the NLVF.

^{3}H	^{85}Kr	Noble Gases (T½* <40 days)	Short-Lived Fission and Activation Products (T½ <3 hr)	Fission and Activation Products (T½ >3 hr)	Total Radio-iodine	Total Radio-strontium	Plutonium	Other Actinides	Other
121	0	0	0	**	0	0	0.050 (^{238}Pu) 0.29 ($^{239+240}$Pu)	0.047 (^{241}Am) 0.040 (DU)	0

* T ½ = half-life

** Fission and activation products such as cobalt-60, strontium-90, cesium-137, and europium-152, -154, and -155 are in soil in various areas on the NNSS; however, their concentrations in air samples are generally below detection levels and collectively contribute less than 10% to the total dose from all radionuclide emissions based on resuspension calculations.

The mean tritium concentration from across the 19 air sampling stations was 11.22×10^{-6} pCi/mL and ranged from below detection to 166.34×10^{-6} pCi/mL at the Schooner crater station (Section 4.1.4.5). The mean annual exposure rate for direct gamma radiation at the 41 TLDs located near active projects, working personnel, and public access areas was 117 mR, approximately the same as the mean for the 10 background radiation stations of 119 mR (Section 6.3).

Onsite Radiological Monitoring of Water

In 2011, 5 potable and 4 non-potable water supply wells, 14 monitoring wells, and 1 tritiated water containment pond system were sampled for man-made radiological contaminants. The 2011 data indicate that underground nuclear testing has not impacted the NNSS 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). Gross alpha and gross beta radioactivity was detectable in the potable and non-potable water supply wells at levels below EPA limits for drinking water. The radioactivity likely represents the presence of naturally occurring radionuclides.

All 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 detectable gamma-emitting radionuclides. Of the 14 onsite monitoring wells, 11 had levels of tritium below detection and 3 had detectable levels ranging from 63.8 to 329 pCi/L (Section 5.1.7). These wells (PM-1, 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% of the EPA maximum contaminant level 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. E-Tunnel effluent water and groundwater from Well ER-12-1 are sampled for tritium every 12 and 24 months, respectively, in accordance with the wastewater discharge permit for the site. Effluent waters contained 461,000 pCi/L of tritium, lower than the 1,000,000 pCi/L limit allowed, and the well water sample contained 5.6 pCi/L of tritium, less that the 20,000 pCi/L limit allowed. Both effluent and well water samples also had gross alpha and gross beta values less than their permitted limits (Section 5.1.9).

The UGTA Activity pumps tritiated water into lined sumps during studies conducted at contaminated post-shot or near-cavity wells on the NNSS. One of these types of wells, Well ER-20-5 #1, was sampled in 2011. The tritium concentration in this well was 30,100,000 pCi/L (Section 5.1.9). Tritium was also measured in onsite UGTA wells ER-20-5 #3 (96,233 pCi/L) and ER-20-8 (2,110–2,813 pCi/L). The cluster of ER-20-5 wells in Area 20 and ER-20-8 identify a known contaminant plume from nearby underground nuclear tests.

Release of Property Containing Residual Radioactive Material

No property can be released from the NNSS unless the amount of residual radioactivity on the property is less than the authorized limits (Section 9.1.5), which are consistent with DOE O 458.1. Items proposed for unrestricted release must be surveyed to document compliance with the authorized limits. No property with residual radioactivity in excess of the limits were released from the NNSS in 2011, and no scrap metals were released from radiological areas for recycling in 2011 (Section 9.1.5).

Onsite Nonradiological Releases into Air

The release of air pollutants is regulated on the NNSS 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, 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 NNSS facilities regulated by the permit include (1) approximately 14 facilities and 150 pieces of equipment throughout the NNSS, (2) NPTEC, (3) Site-Wide Chemical Release Areas, (4) the BEEF, (5) the Explosives Ordnance Disposal Unit, and (6) Explosives Activities Sites in Areas 5, 14, 25, 26, and 27.

An estimated 25.12 tons of criteria air pollutants were released on the NNSS in 2011 (Section 4.2.3). The majority was NO_x from diesel generators. Total HAPs emissions from permitted operations was 0.04 tons (Section 4.2.3). Lead air emissions from non-permitted activities, such as weapons use, are reported to the EPA, and this quantity in 2011 was 5.2 lb (Section 13.3). No emission limits for any criteria air pollutants or HAPs were exceeded.

One chemical test series was conducted in 2011, consisting of 40 releases of chemicals at the Area 5 NPTEC facility and 1 release at the Port Gaston Facility in Area 25 (Section 4.2.7). The majority of the chemicals released were neither HAPs or criteria pollutants, and no permit limits were exceeded. No ecological monitoring was performed because each test posed a very low level of risk to the environment and biota. In 2011, explosives were detonated at seven locations on the NNSS, and no permit limits were exceeded.

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 NNSS. Therefore, no Clean Water Act NPDES permits are required for operations on the NNSS.

Industrial discharges on the NNSS 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 2011, and all water quality parameters monitored quarterly from lagoon samples were within permit limits (Section 5.2.3.1). E-Tunnel effluent and Well ER-12-1 groundwater, 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. The regulated sources of air emissions include sanders, blasters, diesel generators, fire pumps, cooling towers, and boilers. The calculated total emissions of criteria pollutants at NLVF and RSL-Nellis were 1.82 and 2.71 tons per year, respectively. HAPs calculated emissions at NLVF and RSL-Nellis were both 0.02 tons per year.

Water discharges at the NLVF are regulated by a permit with the City of North Las Vegas (CNLV) for sewer discharges and by an NPDES discharge permit issued by the Nevada Division of Environmental Protection 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 2011, contaminant measurements were below established permit limits in all water samples from the NLVF sewage outfalls sampled (Appendix A, Section A.1.1.2). Water discharges at RSL-Nellis are required to meet permit limits set by the Clark County Water Reclamation District, and all contaminants in the outfall samples were below the limits (Appendix A, Section A.2.1).

Acknowledgements

Ecological and Environmental Monitoring (E&EM) 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 E&EM: Site Services, Environmental Programs (EP), Radioactive Waste (RW), Radioactive Waste Acceptance Program (RWAP), Solid Waste Operations (SWO), Environmental Waste Operations (EWO), Water and Waste (W&W), Environmental Restoration (ER), Radiological Control (RC), Industrial Hygiene (IH), Zone 2 Construction Supervision (Z2CS), Facility and Infrastructure (F&I) Planning, and Quality and Performance Improvement Division (QPID). 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. Navarro-Intera, LLC (N-I), provided summary information of their characterization and remediation work at corrective action sites. The National Oceanic and Atmospheric Administration (NOAA) Air Resources Laboratory, Special Operations and Research Division (ARL/SORD) provided summary descriptions of the Nevada National Security Site climate that is included in *Attachment A: Site Description* on the compact disc of this report, 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 presentations, and assisted with the write-up of the radiological monitoring data collected by E&EM.

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Attachment A: Site Description (on compact disc)

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Ashley Burns of NSTec Geographic Information System (GIS) worked with all the authors to produce the high-quality GIS-generated maps and figures.

Shirley Burns of Directives Management and Publications (DM&P) provided assistance with creating the final electronic files of the report for Internet posting and burning onto compact disc.

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.

Pablo Mendez, Jeff Li, and Mark Shaw of Records, Printing, and Mail produced high-quality hard copies and compact discs of the NNSSER and the NNSSER Summary under a tight production schedule.

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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 National Security Site (NNSS), which is located in Nye County in south-central Nevada (Figure 1-1). The southeast corner of the NNSS 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 NNSS, is the main base camp for worker housing and administrative operations for the NNSS.

The NNSS encompasses about 3,522 square kilometers (km^2) (1,360 square miles [mi^2], based on the most recent land survey). 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 NNSS is surrounded on all sides by federal lands (Figure 1-1). It is bordered on the southwest corner by the former Yucca Mountain Site, 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 NNSS represents one of the largest unpopulated land areas in the United States, comprising some 14,200 km^2 (5,470 mi^2).

1.2 Environmental Setting

The NNSS is located in the southern part of the Great Basin, the northern-most sub-province of the Basin and Range Physiographic Province. The NNSS 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 NNSS by very large volcanic calderas (Figure 1-2).

The principal valleys within the NNSS 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 NNSS via the Fortymile Wash. The dominant highlands of the NNSS 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 NNSS 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 NNSS has been altered by historical 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: Site Description,* a file on the compact disc of this report, where the geology, hydrology, climatology, ecology, and cultural resources of the NNSS are described.

1.3 Site History

The history of the NNSS, 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 NNSS was under the jurisdiction of Nellis Air Force Base and was part of the Nellis Bombing and Gunnery Range. The site was established in 1950 to be the primary location for testing the nation's nuclear explosive devices. It was named the Nevada Test Site (NTS) in 1951 and supported nuclear testing from 1951 to 1992. The types of tests conducted during this period are briefly described below. On August 23, 2010, the NTS was named the NNSS to reflect the diversity of nuclear, energy, and homeland security activities now conducted at the site. Nuclear experiments conducted at the NNSS are currently limited to subcritical experiments.

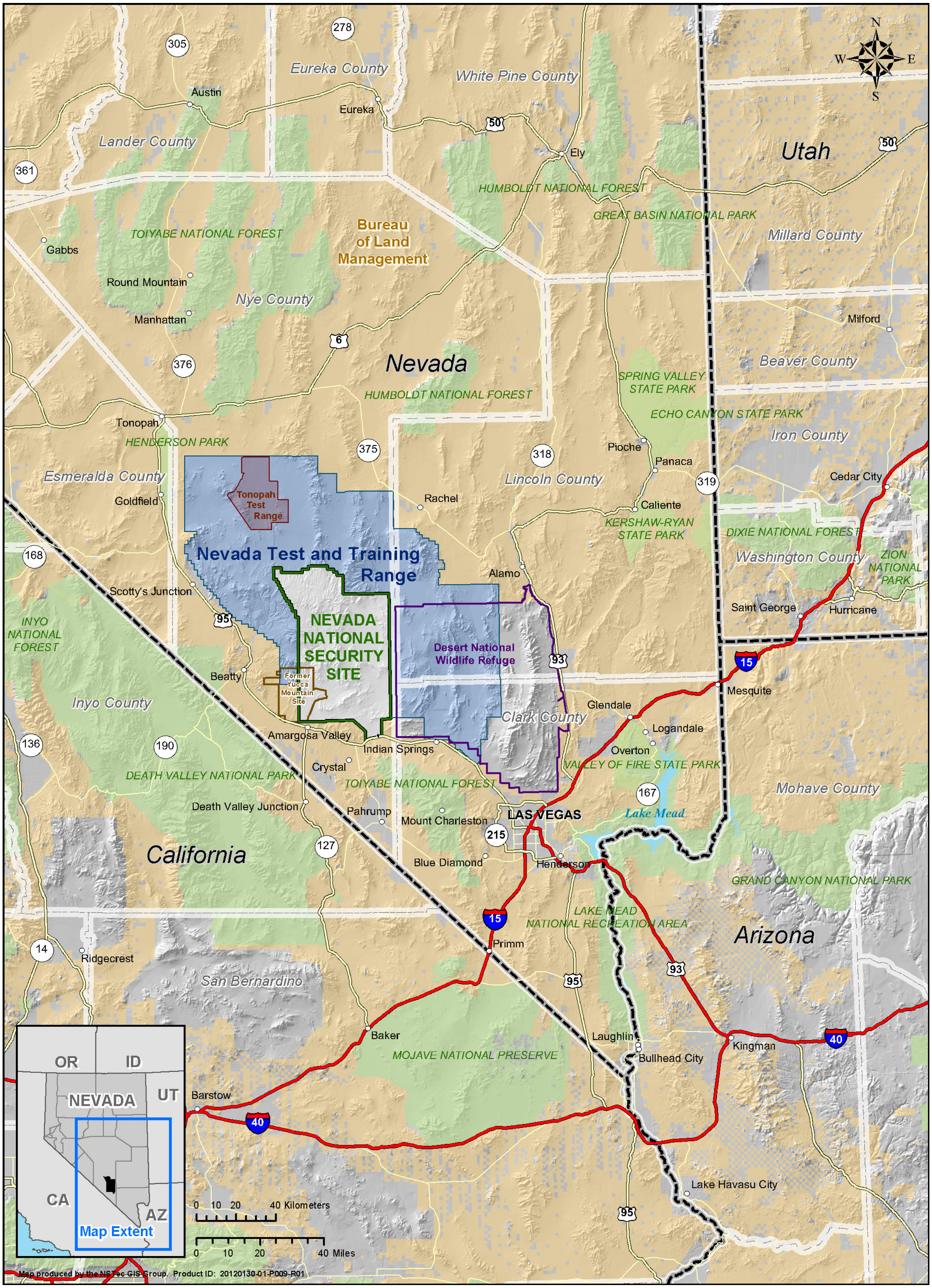


Figure 1-1. NNSS vicinity map

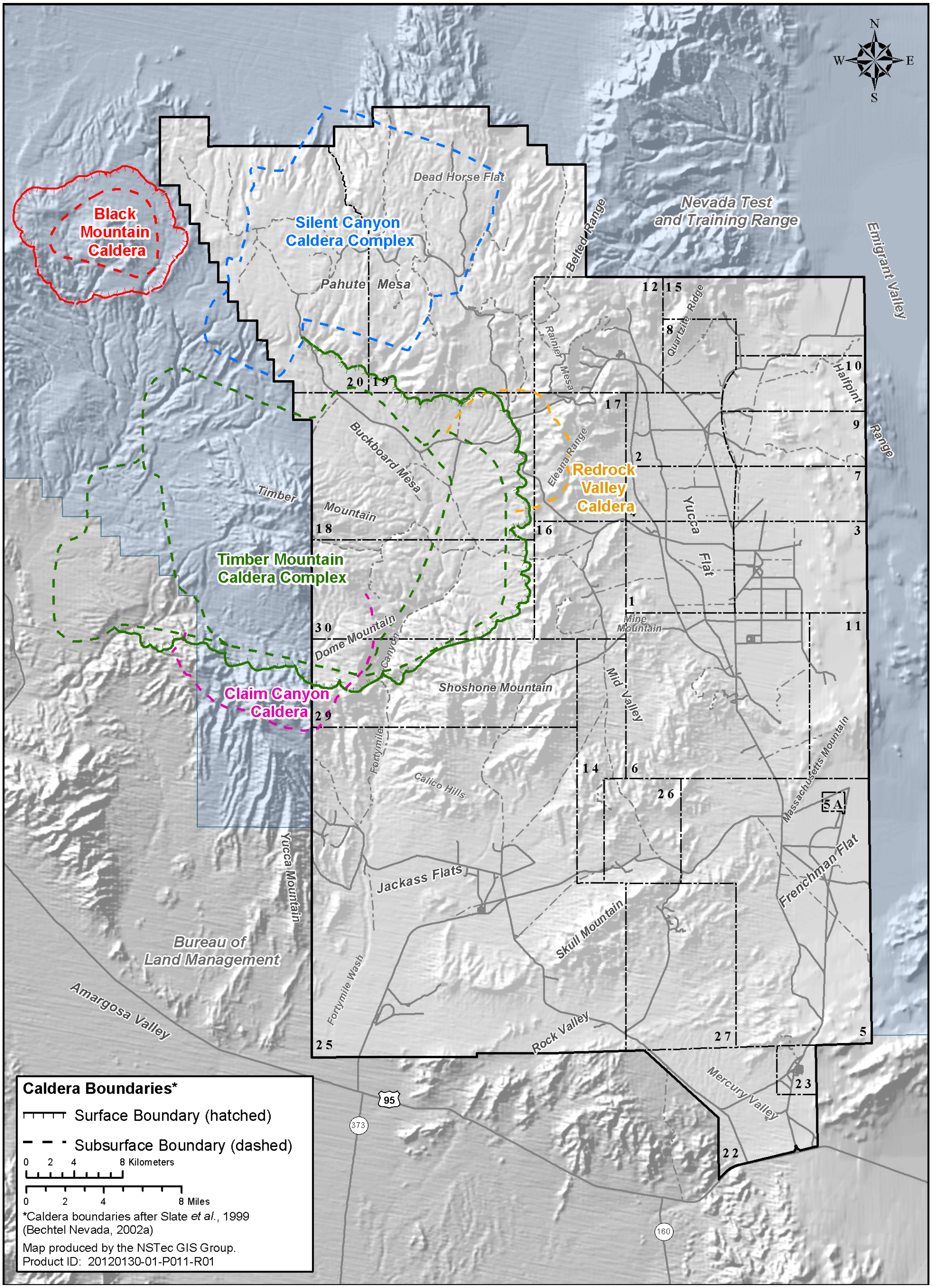


Figure 1-2. Major topographic features and calderas of the NNSS

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 NNSS 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 NNSS. 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 NNSS 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 NNSS. The second-highest yield crater test was Schooner, located in the northwest corner of the NNSS. 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 NNSS 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.

Fact sheets on many of the historical tests mentioned above can be found at http://www.nv.energy.gov/library/factsheets.aspx.

1.4 Site Mission

NNSA/NSO directs the facility management and program operations at the NNSS, North Las Vegas Facility (NLVF), and Remote Sensing Laboratory–Nellis (RSL-Nellis) in Nevada and directs selected operations at four sites outside of Nevada that include RSL-Andrews in Maryland, Livermore Operations in California, Los Alamos Operations in New Mexico, and the Special Technologies Laboratory in California. 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 NNSS. 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 NNSS missions include National Security/Defense, Environmental Management, and Nondefense. The programs that support these missions are listed in the text box below.

NNSS Missions and Programs

National Security/Defense Missions

Stockpile Stewardship and 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 and 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 DOE programs and federal 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 NNSS and Tonopah Test Range (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

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

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

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

1.5 Primary Facilities and Activities

NNSS activities in 2011 continued to be diverse. The primary activity was helping to ensure that the U.S. stockpile of nuclear weapons remains safe and reliable. Facilities that support the National Security/Defense missions include the U1a Complex, Big Explosives Experimental Facility, Device Assembly Facility, Dense Plasma Focus Facility, Joint Actinide Shock Physics Experimental Research (JASPER) Facility, Nonproliferation Test and Evaluation Complex (NPTEC), and the Radiological/Nuclear Countermeasures Test and Evaluation Complex (RNCTEC). Facilities that support Environmental Management missions 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 NNSS activities include weapons of mass destruction first responder training; the controlled release of hazardous material at NPTEC; 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 low-level and mixed low-level radioactive waste. Land use by each of the NNSS 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 2011 at the NNSS and at its two support facilities, the NLVF and RSL-Nellis. This report also addresses environmental restoration (ER) projects conducted at the TTR (see Figure 1-1). Through a Memorandum of Agreement, NNSA/NSO is responsible for the oversight of TTR ER projects, and the U.S. Department of Energy, National Nuclear Security Administration Sandia Site Office (NNSA/SSO) has oversight of all other TTR activities. NNSA/SSO produces the TTR annual site environmental reports (e.g., Sandia National Laboratories, 2012), which are posted at http://www.sandia.gov/news/publications/environmental/index.html.

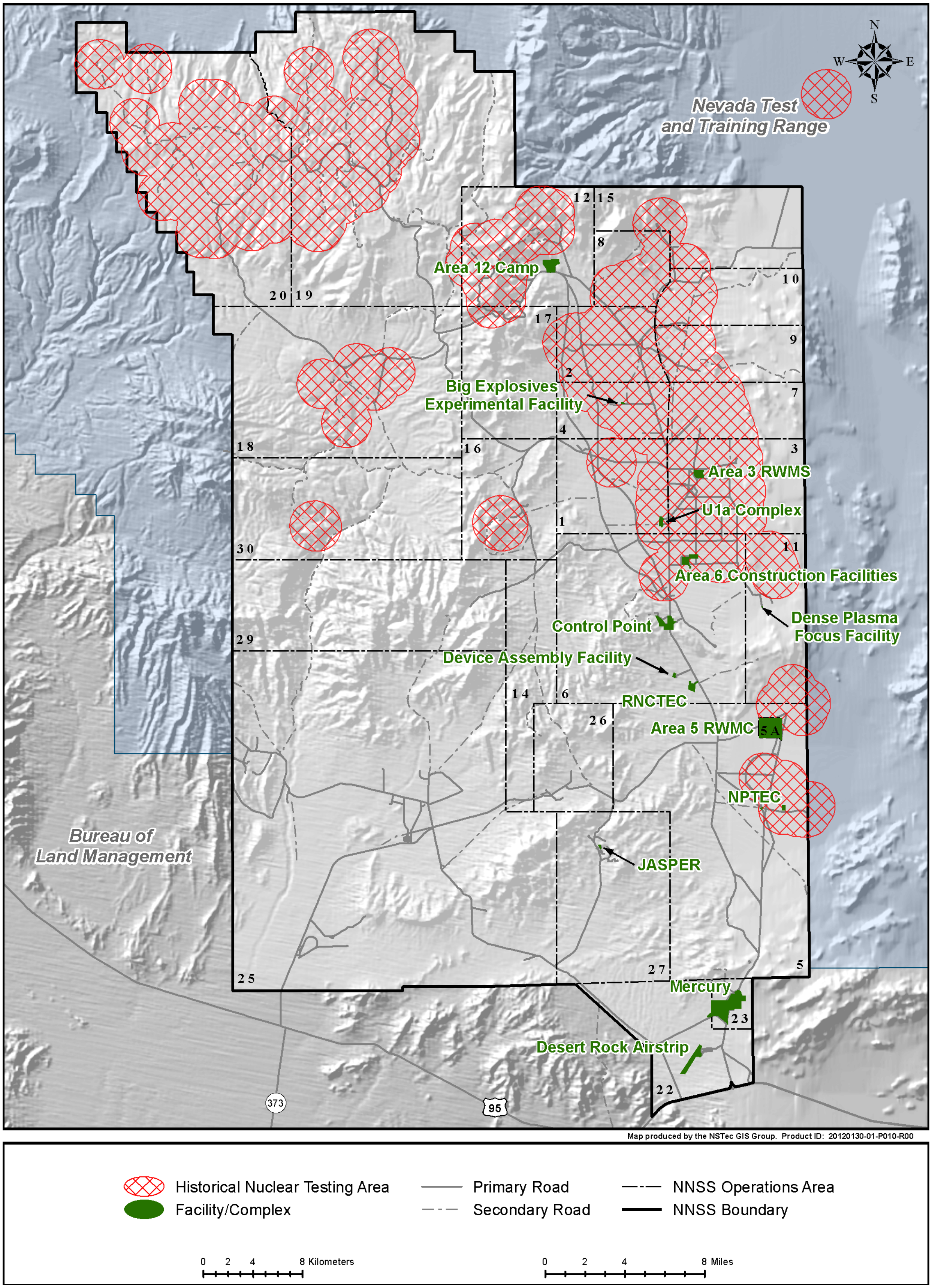


Figure 1-3. NNSS operational areas, principal facilities, and past nuclear testing areas

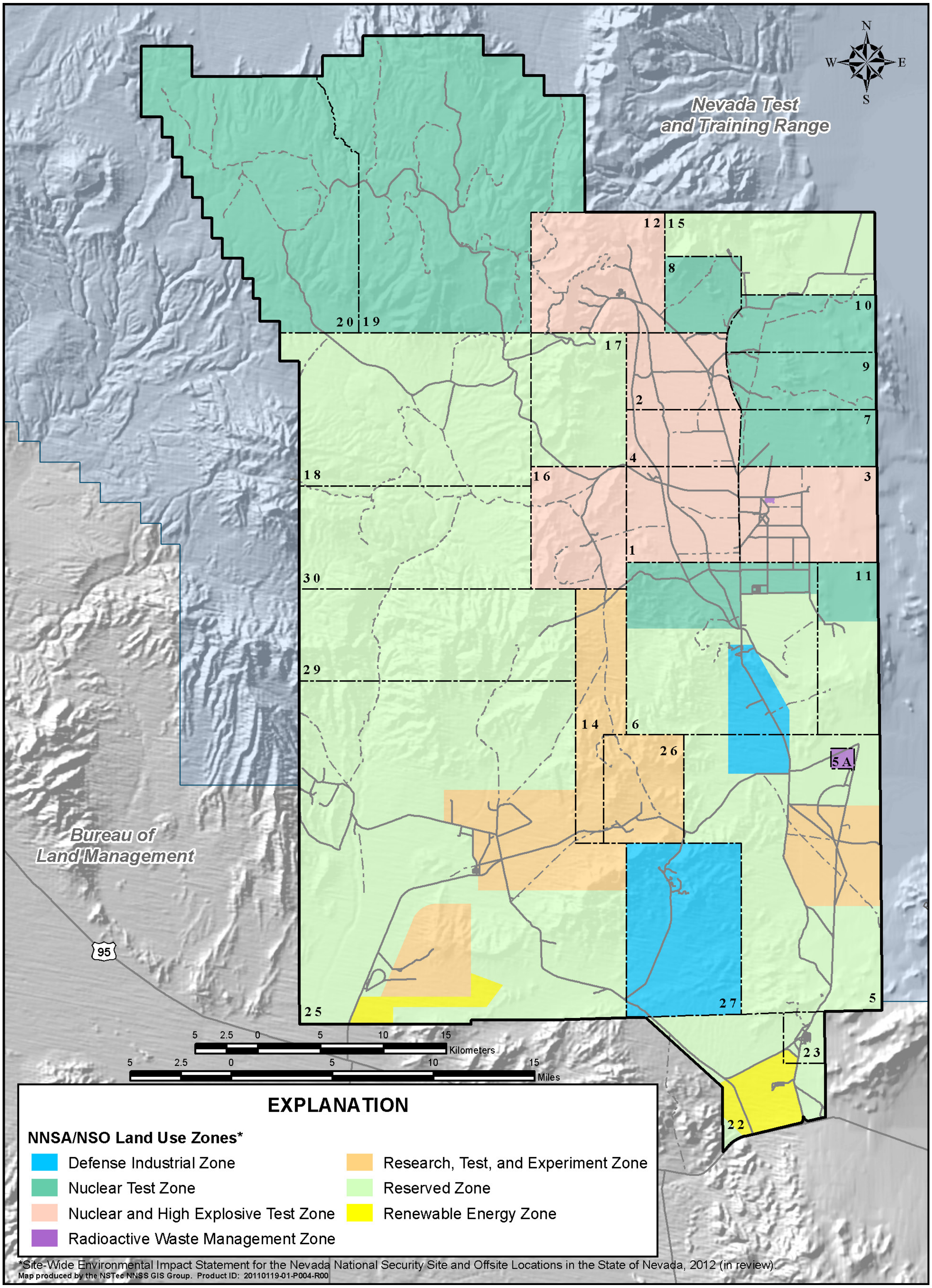


Figure 1-4. NNSS land-use map

1.7 Populations Near the NNSS

The population of the area surrounding the NNSS (see Figure 1-1) is predominantly rural. Population estimates for Nevada communities are provided by the Nevada State Demographer's Office (2011). The 2011 population estimate for Nye County is 44,513, and the largest Nye County community is Pahrump (36,995), located approximately 80 km (50 mi) south of the NNSS Control Point facility near the center of the NNSS. Other Nye County communities include Tonopah (2,346), Amargosa (1,331), Beatty (979), Round Mountain (771), Gabbs (282), and Manhattan (121). Lincoln County to the east of the NNSS includes a few small communities including Caliente (1,047), Pioche (933), Panaca (781), and Alamo (627). Clark County, southeast of the NNSS, is the major population center of Nevada and has an estimated population of 1,967,722. The total annual population estimate for all Nevada counties, cities, and unincorporated towns is 2,721,794.

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 latest population estimates for Utah communities are from the 2010 census conducted by the U.S. Census Bureau, as prepared by the Governor's Office of Planning and Budget (2011). Southern Utah's largest community is St. George, located 220 km (137 mi) east of the NNSS, with an estimated population of 72,897. The next largest town, Cedar City, is located 280 km (174 mi) east-northeast of the NNSS and has an estimated population of 28,857.

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 NNSS, with an estimated population of 39,348, and Kingman, 280 km (174 mi) southeast of the NNSS, with an estimated population of 28,029 (Arizona Department of Administration, 2011).

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 to the 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 (1×10^{-3} Ci)
µCi	microcurie (1×10^{-6} Ci)
nCi	nanocurie (1×10^{-9} Ci)
pCi	picocurie (1×10^{-12} 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 1-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% 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 (1×10^{-3} rad)
mrem	millirem (1×10^{-3} rem)
R	roentgen
mR	milliroentgen (1×10^{-3} R)
µR	microroentgen (1×10^{-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)	3.7×10^{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	1.6×10^{7} yr
^{131}I	iodine-131	8 d
^{40}K	potassium-40	1.3×10^{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	2.4×10^{4} yr
^{240}Pu	plutonium-240	6.5×10^{3} yr
^{241}Pu	plutonium-241	14.4 yr
^{226}Ra	radium-226	1.62×10^{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	2.1×10^{5} yr
^{232}Th	thorium-232	1.4×10^{10} yr
U [b]	uranium total	- - - [c]
^{234}U	uranium-234	2.4×10^{5} yr
^{235}U	uranium-235	7×10^{8} hr
^{238}U	uranium-238	4.5×10^{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 4.5×10^{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.

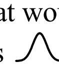
Uncertainty in analytical measurements is also the consequence of variability related to collecting and analyzing the samples. This variability is associated with reading or recording the result, handling or processing the sample, calibrating the counting instrument, and numerical rounding.

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% 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.

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)
	1.31 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)	28.35 gram (g)
1 kilogram (kg)	2.21 pounds (lb)	1 pound (lb)	0.454 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 × 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% of the measurements would be within the mean ± SD, and 95% 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 × SE. The ± value implies that approximately 95% of the time, the average of many calculated means will fall somewhere between the reported value minus the 2 × SE value and the reported value plus the 2 × 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 can be used in plots where the values are of widely different magnitudes at different locations and/or different times. In log scales equal distances represent equal ratios of values, whereas in linear scales equal distances represent equal differences in values. In a log scale an increase from 2 to 4 is shown by the same distance as an increase from 10 to 20 or from 700 to 1,400.

For example, Figure 1-5 (Figure 5-10 in Chapter 5) shows the annual means for tritium in groundwater samples from selected NNSS onsite monitoring wells using the log scale. Figure 1-6 shows the same data using a linear scale. The linear scale plot emphasizes the difference between the high early values in Well UE-7NS through 1987 and the rather lower values starting in 1991. The log scale plot de-emphasizes those high values and expands the portion of the plot containing lower values; in particular, it allows one to see the initial increase in Well WW A beginning in 1986 more clearly.

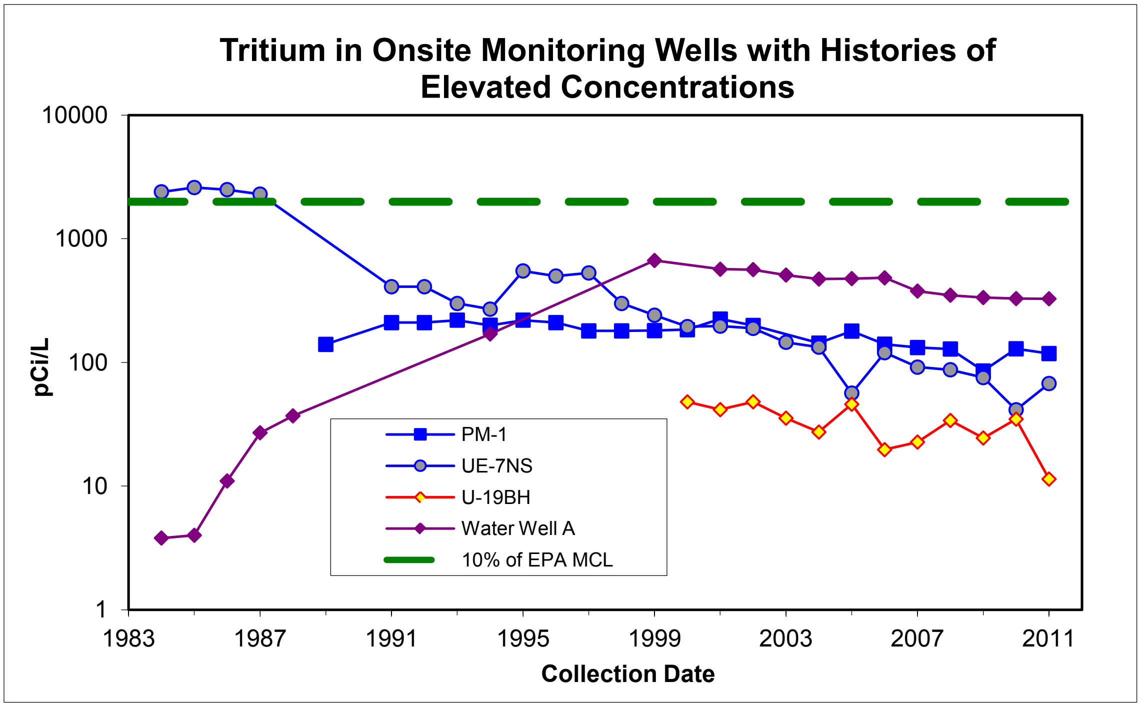


Figure 1-5. Data plotted using a log scale

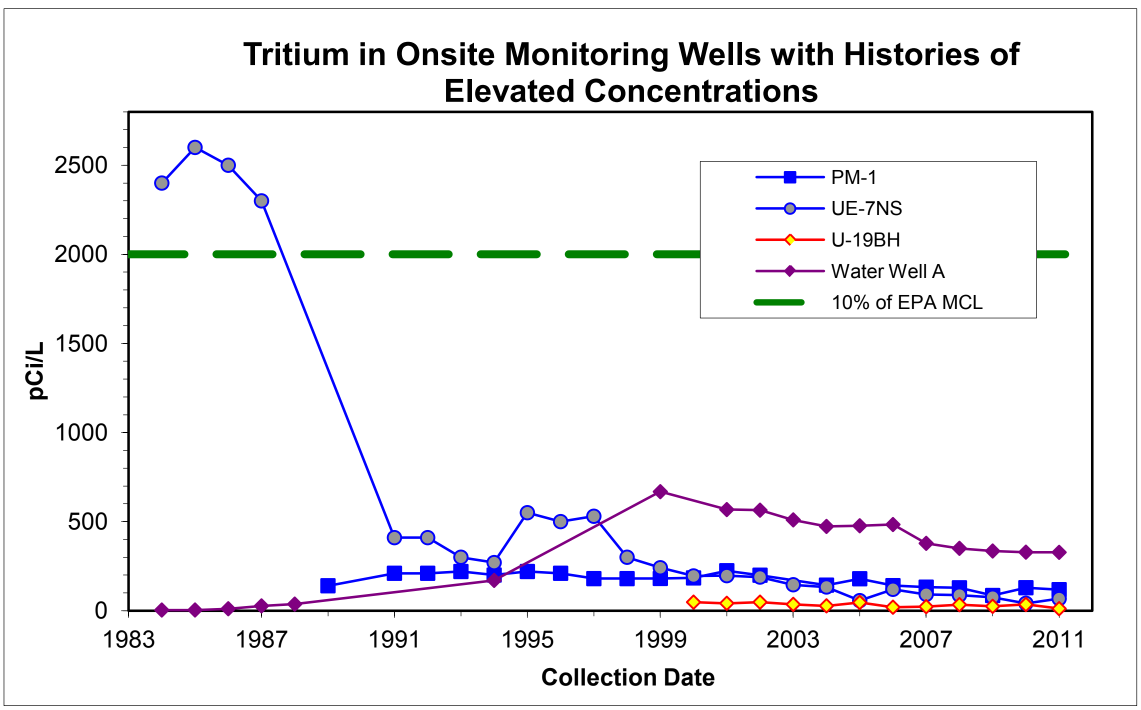


Figure 1-6. Data plotted using a linear scale

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2.0 Compliance Summary

Environmental regulations pertinent to operations on the Nevada National Security Site (NNSS), the North Las Vegas Facility (NLVF), and the Remote Sensing Laboratory–Nellis (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 NNSS 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 2-12 presents the list of all environmental permits issued for the NNSS and the two Las Vegas area facilities.

2.1 Departmental Sustainability and Pollution Prevention and Waste Minimization

2.1.1 Applicable Regulations

EO 13423, "Strengthening Federal Environmental, Energy, and Transportation Management" – This EO requires federal facilities to establish 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 436.1, "Departmental Sustainability."

EO 13514, "Federal Leadership in Environmental, Energy, and Economic Performance" – This EO expands upon the energy reduction and environmental performance requirements of EO 13423. It requires all federal agencies to establish an integrated sustainability plan towards reducing greenhouse gas (GHG) emissions, using water more efficiently, promoting pollution prevention and eliminating waste, constructing high performance sustainable buildings, purchasing energy efficient and environmentally preferred products, and reducing the use of fossil fuels through improved fleet management. The GHGs targeted for emission reductions in the EO are carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. The EO establishes GHG emission reductions as an overarching, integrating performance metric for all federal agencies. The Secretary of Energy issued a memorandum in March 2010 creating DOE goals pertaining to EO 13514. The DOE goals were first published in the 2010 Strategic Sustainability Performance Plan (SSPP) (DOE, 2010a). It commits DOE to a 28% reduction in agency GHG emissions by fiscal year (FY) 2020.The SSPP is updated each year to reflect changes in schedule, milestones, and approaches (see DOE, 2011). Site-specific goals for the NNSS that support DOE's SSPP and compliance with this EO are incorporated into NNSA/NSO's EMS.

DOE O 436.1, "Departmental Sustainability" – This new order, approved in May 2011, consolidates and streamlines the requirements of the cancelled DOE O 450.1A, "Environmental Protection Program," and the cancelled DOE O 430.2B, "Departmental Energy, Renewable Energy and Transportation Management." It incorporates and implements the requirements of EO 13514 and EO 13423 and requires each DOE site to set goals to achieve the DOE SSPP goals, use their EMS as the platform for establishing site-specific sustainability programs with objectives and measureable targets, develop and implement Site Sustainability Plans (SSPs) to put established sustainability objectives and targets into action, and use alternative financing to the maximum extent possible for sustainability projects.

Resource Conservation and Recovery Act (RCRA) – Under RCRA, generators of hazardous waste (HW) 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 U.S. Environmental Protection Agency (EPA) developed a list of types of commercially available products (e.g., copy machine paper, plastic desktop items) and specified 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 must have a procurement process in place to ensure that they purchase product types that satisfy the EPA-designated minimum percentages of recycled material.

Nevada Division of Environmental Protection (NDEP) Hazardous Waste Permit NEV HW0101 – This state permit requires NNSA/NSO to generate an Annual Summary Report, which includes waste minimization information. 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.

2.1.2 Compliance Reports

The following reports were generated in 2011 for NNSA/NSO operations on the NNSS and at the two offsite facilities in compliance with regulations related to environmental protection; renewable energy and transportation management; environmental, energy, and economic performance; and pollution prevention and waste minimization:

- *FY 2012 NNSA/NSO Site Sustainability Plan* (National Security Technologies, LLC [NSTec], 2011a)
- *FY 2011 Waste Generation and Pollution Prevention Progress Report*, submitted to DOE Headquarters (HQ) via entry into DOE HQ database
- *CY 2011 Waste Minimization Summary Report*, submitted to NDEP
- *FY 2011-0 EMS Annual Report*, submitted to DOE HQ via entry into DOE HQ database

Table 2-1. Compliance status with departmental sustainability and pollution prevention and waste minimization

Compliance Measure/Action	2011 Compliance Status	Section Reference[a]
DOE O 436.1, "Departmental Sustainability"; EO 13423, "Strengthening Federal Environmental, Energy and Transportation Management"; and EO 13514, "Federal Leadership in Environmental, Energy, and Economic Performance"		
Annually update and implement an SSP to meet sustainability targets and goals.	Compliant	3.3.1; Table 3-2
Implement a validated EMS, which is certified to or conforming to the International Organization for Standardization's (ISO) 14001:2004.	Compliant	3.6
Include objectives and targets in the EMS that contribute to achieving the DOE Sustainable Environmental Stewardship goals.	Compliant	3.3
Monitor EMS progress and make such information available annually through the EMS Compliance Reporting using the Fed Center DOE HQ database.	Compliant	3.3; Table 3-1; 3.7
Submit an FY Waste Generation and Pollution Prevention Progress Report (electronic) to DOE HQ by December 31.	Compliant	3.3.2.3
Resource Conservation and Recovery Act (RCRA)		
Have a program to reduce volume/quantity and toxicity of generated HW to the degree it is economically practicable.	Compliant	3.3.2.2; Tables 3-3 and 3-4
Have a process to ensure that EPA-designated list products are purchased containing the minimum content of recycled materials.	Compliant	3.3.2
NDEP Hazardous Waste Permit NEV HW0101		
Submit a calendar year Waste Minimization Summary Report to NDEP due March 1.	Compliant	3.3.2.3

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

2.2 Air Quality and Protection

2.2.1 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. In 2004, the regulation of HAPs emissions from emergency reciprocating internal combustion engines (RICE) was promulgated (Title 40 Code of Federal Regulations [CFR] Part 63 Subpart ZZZZ) to include major sources; since then they have been updated to include area sources and to establish standards for various sizes and types of RICE, including emergency RICE. The requirements include maintenance and recordkeeping activities as well as performance (stack) testing for some non-emergency RICE. In March 2011, the regulation of HAPs emissions from boilers was promulgated (40 CFR Part 63 Subpart JJJJJJ) for new and existing industrial, commercial, and institutional boilers located at area sources of HAPs. Requirements include initial notification, emission limits, and mandatory work practices.

NNSA/NSO NESHAP compliance activities include radionuclide air monitoring, reporting/notification of asbestos abatement, and monitoring/reporting of emissions from generators and boilers. At the NNSS, NESHAP requirements are mainly met through adherence to State of Nevada Class II Air Quality Operating Permit (AP9711-2557); all approvals, notifications, requests for additional information, and reports required under Title 40 CFR Part 61 Subpart H and Part 63 Subparts ZZZZ and JJJJJJ must be submitted to the State, with a copy to the EPA, Region IX. At NLVF and RSL-Nellis, NESHAP requirements are met through adherence to a Clark County Minor Source Permit and a Clark County Authority to Construct/Operating Permit for a Non-Major Testing Laboratory, respectively.

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 NNSS, 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 NNSS. Emissions from NNSS 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 NNSS 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. In 2006, NSPS were promulgated for new, modified, and reconstructed internal combustion engines (stationary compression ignition internal combustion engines [40 CFR Part 60 Subpart IIII]), and in 2008, NSPS for stationary spark ignition internal combustion engines were promulgated (40 CFR Part 60 Subpart JJJJ).

On the NNSS, some screens, conveyor belts, bulk fuel storage tanks, and generators are subject to the NSPS, which Nevada regulates under Nevada Administrative Code (NAC) 445B, "Air Controls," 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 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 NNSS, ODS are mainly used in air conditioning units in vehicles, buildings, refrigerators, drinking water fountains, vending machines, and laboratory equipment.

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 NNSS using the best practicable methods. Off the NNSS, all NNSA/NSO surface-disturbing activities that cover 5 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 NNSS, 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 NNSS operations are subject to these fees. In addition, NNSA/NSO must allow Nevada's Bureau of Air Pollution Control to conduct inspections of permitted NNSS facilities and allow the Clark County Department of Air Quality (DAQ) to conduct inspections of NLVF and RSL-Nellis permitted equipment.

2.2.2 Compliance Reports

The following reports were generated for 2011 NNSS operations in compliance with air quality regulations:

- *National Emission Standards for Hazardous Air Pollutants – Radionuclide Emissions, Calendar Year 2011*, submitted to EPA Region IX (NSTec, 2012a)
- *Annual Asbestos Abatement Notification Form*, submitted to EPA Region IX
- *Calendar Year 2011 Actual Production/Emissions Reporting Form*, submitted to 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
- Explosive Ordnance Disposal Unit Detonation (EODU) Proposal and Analysis Results, submitted to NDEP

The following reports were generated for 2011 operations at offsite facilities in compliance with air quality regulations:

- *Department of Air Quality Annual Emission Inventory Reporting Forms for North Las Vegas Facility*, submitted to Clark County DAQ
- *Department of Air Quality Annual Emission Inventory Reporting Forms for Remote Sensing Laboratory*, submitted to Clark County DAQ
- *Calendar Year 2011 Actual Production/Emissions Reporting Form*, submitted to NDEP for Underground Test Area (UGTA) SAD Permits AP9711-2622 and AP9711-2659

Table 2-2. NNSS compliance status with applicable air quality regulations

Compliance Measure/Actions	Compliance Limit	2011 Compliance Status	Section Reference[a]
Clean Air Act – NESHAP			
Annual dose equivalent from all radioactive air emissions	10 millirem per year	Compliant	9.1.1.1
Submit Initial Notification to EPA Region IX of applicability of "existing small area source boilers"	Due September 17, 2011	Submitted Nov. 30, 2011	--
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	Compliant	4.2.9
Maintain asbestos abatement plans, data records, activity/ maintenance records	For up to 75 years	Compliant	4.2.9
Clean Air Act – NAAQS			
Submit annual and quarterly reports of calculated emissions at the NNSS to the State	Due March 1 and 30 days after end of each quarter, respectively	Compliant	4.2.3
Submit annual report of calculated emissions at NLVF and RSL-Nellis to Clark County	Due March 31	Compliant	A.1.3; A.2.2
Tons of emissions of each criteria pollutant produced by permitted equipment/facility at the NNSS, NLVF, and RSL-Nellis based on calculations	PTE[b] varies	Compliant	4.2.3; Table 4-14; A.1.3; A.2.2
Conduct and pass performance emission tests on specified permitted equipment	Test after 100 hours of operation; emission limits vary	Compliant	4.2.4
Number of gallons of fuel used, hours of operation, and rate of aggregate/concrete production by permitted equipment/facility at the NNSS	Limit varies[c]	Compliant	4.2.5
Conduct opacity readings when in use for selected permitted equipment/facility at the NNSS, NLVF, and RSL-Nellis	Quarterly for NNSS, weekly for NLVF, daily for RSL-Nellis	Compliant	4.2.6; A.1.3; A.2.2
Percent opacity of emissions from permitted equipment/facility at the NNSS, NLVF, and RSL-Nellis	20%	Compliant	4.2.6; A.1.3; A.2.2
Conduct particulate monitoring for releases/detonations at permitted chemical release and detonation sites on the NNSS	Monitoring report due ≤ 30 days from end of each quarter	Compliant	4.2.7
Submit test plans/final analysis reports to the State for each chemical release test at permitted chemical release sites on the NNSS	Test plans due ≥ 30 days prior to tests, final reports due ≤ 30 days fromend of each quarter	Compliant	4.2.7
Rate and quantity of chemicals released at permitted chemical release sites on the NNSS	Pounds per hour and tons per year; limits vary by chemical	Compliant	4.2.7
Tons of criteria pollutant emissions produced at permitted chemical release sites on the NNSS	PTE[b] varies	Compliant	4.2.7; Table 4-14
Clean Air Act – NSPS			
Conduct opacity readings from permitted equipment/facility	Quarterly	Compliant	4.2.6
Percent opacity of emissions from permitted equipment/facility	10%	Compliant	4.2.6
Clean Air Act – Stratospheric Ozone Protection			
Maintain ODS technician certification records, approvals for ODS-containing equipment recycling/recovery, and applicable equipment servicing records	NA[d]	Compliant	4.2.8
Other Nevada Air Quality Permit Regulations			
Control fugitive dust for land-disturbing activities	NA	Compliant	4.2.10

(a) The section(s) within this document that describe how compliance summary data were collected
(b) Potential to emit = quantities of criteria pollutants that each facility/piece of equipment would emit annually if it were operated for the maximum hours specified in the air permit
(c) Compliance limit is specific for each piece of permitted equipment/facility
(d) Not applicable

2.3 Water Quality and Protection

2.3.1 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 NNSS, CWA regulations are followed through compliance with permits issued by NDEP for wastewater discharges. Because there are no wastewater discharges to surface waters on site or off site, there are no NPDES permits for the NNSS. 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 2-3 below. The EPA also requires the NLVF to maintain and implement a Spill Prevention, Control, and Countermeasure (SPCC) Plan to ensure that petroleum and non-petroleum oil products do not pollute waters of the United States via discharge into the Las Vegas Wash.

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) (see Glossary, Appendix B) 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, "Water Controls," 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, and the PWSs on the NNSS are permitted by the State as noncommunity water systems (see Glossary, Appendix B). Although not required under the SDWA, all potable water supply wells are monitored on the NNSS for radionuclides in compliance with DOE O 458.1, "Radiation Protection of the Public and the Environment" (see Section 2.4).

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 NNSS 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 NNSS. 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 permits from NDEP for tracer tests in UGTA Activity 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 Activity, which drills new wells and reworks old wells, and the Borehole Management Project, which plugs abandoned NNSS boreholes.

UGTA Fluid Management Plan – UGTA Activity wells are regulated by the State through an agreement between NNSA/NSO and 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 Activity Waste Management Plan (U.S. Department of Energy, National Nuclear Security Administration Nevada Operations Office, 2002a).

2.3.2 Compliance Reports

The following reports were generated for NNSS operations in 2011 in compliance with water quality regulations:

- *Quarterly Monitoring Reports for Nevada National Security Site Sewage Lagoons*, submitted to NDEP
- Results of water quality analyses for PWS, sent to the State throughout the year as they were obtained from the analytical laboratory
- *Water Pollution Control Permit NEV 96021, Quarterly Monitoring Report* (for first, second, and third quarters of 2011 for E Tunnel effluent monitoring), submitted to NDEP
- *Water Pollution Control Permit NEV 96021, Quarterly Monitoring Report and Annual Summary Report for E-Tunnel Wastewater Disposal System* (NSTec, 2012b), submitted to NDEP
- *Water Pollution Control Permit NEV 96021 Well ER-12-1 Groundwater Sampling Summary Report for the E-Tunnel Wastewater Disposal System* (NSTec, 2012c), submitted to NDEP

The following reports were generated for operations at the two offsite facilities in 2011 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 2-3. Summary of NPDES permit compliance at NLVF in 2011

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 2-4. NNSS compliance status with applicable water quality and protection regulations

Compliance Measure/Action	Compliance Limit	2011 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 and organic chemical contaminants and disinfection byproducts in permitted NNSS PWSs	Limit varies[(b)]	Compliant	5.2.1.1; Table 5-8
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 and SPCC Plan			
Value of water chemistry parameters measured quarterly and annually and the value of over 100 contaminants measured biennially in pumped groundwater at the NLVF	Limit varies	Compliant	Appendix A, A.1.1.2; Table A-3
Maintain and implement the SPCC Plan for the NLVF	NA	Compliant	Appendix A, 1.1.3
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
Submit quarterly monitoring reports for two active sewage lagoons (for Areas 6 and 23)	Due end of April, July, October, January	Compliant	5.2.3.1
Inspection by operator of active and inactive sewage lagoon systems	Weekly and quarterly	Compliant	5.2.3.2
Concentrations of tritium (^3H), 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	^3H: 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	5.1.8; Table 5-6; 5.2.4; Table 5-10
Concentrations of ^3H, α, β, and 16 nonradiological contaminants/water quality parameters in Well ER-12-1 water samples collected every 24 months	^3H: 20,000 pCi/L α: 15 pCi/L; β: 50 pCi/L Non-rad: Limit varies	Compliant	5.1.8; 5.2.4
Concentrations of 20 contaminants in water samples from NLVF sewage outfalls	Limit varies	Compliant	A.1.1.1; Table A-2
Concentrations of 12 contaminants in water samples from sewage outfall at the RSL-Nellis	Limit varies	Compliant	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	12.2.4
For UGTA well drilling fluids, monitor tritium (in pCi/L) and lead levels (in milligrams per liter [mg/L]), manage fluids, notify NDEP as required based on decision criteria limits	^3H >200,000 pCi/L, Lead >5 mg/L	Compliant	12.2.3
Adhere to well construction requirements/waivers, maintain records, 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

2.4 Radiation Protection

2.4.1 Applicable Regulations

Clean Air Act (CAA), National Emission Standards for Hazardous Air Pollutants (NESHAP) – NESHAP (40 CFR 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 (0.1 mSv/yr). The CLs are provided for facilities, such as the NNSS, 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 NNSS 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 contaminant 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 NNSS are the underground nuclear tests detonated near or below the water table (see Glossary, Appendix B).

DOE O 458.1 and DOE O 5400.5, "Radiation Protection of the Public and the Environment" – DOE O 458.1, approved in June 2011, supersedes DOE O 5400.5 (of the same name) and provides for an 18-month period from the time of issuance for full implementation. During 2011, NNSA/NSO continued radiation protection compliance under the requirements of DOE O 5400.5 and its flow-down procedural standards that establish requirements for (1) measuring radioactivity in the environment, (2) documenting the ALARA [as low as reasonably achievable] process for 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. Both DOE O 5400.5 and the new DOE O 458.1 set 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. Both orders call for the protection of populations of terrestrial plants and aquatic and terrestrial animals from radiological impacts through the use of DOE Standard DOE-STD-1153-2002, "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota." DOE O 458.1 includes a new requirement for DOE sites to establish and document an environmental radiological protection program.

DOE-STD-1153-2002, "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota" – This standard 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 NNSS. 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.

2.4.2 Compliance Reports

- *National Emission Standards for Hazardous Air Pollutants – Radionuclide Emissions, Calendar Year 2011,* submitted to EPA Region IX (NSTec, 2012a)
- This document, the *Nevada National Security Site Environmental Report 2011,* was generated to report 2011 compliance with DOE O 458.1 and DOE-STD-1153-2002.

Table 2-5. NNSS compliance status with regulations for radiation protection of the public and the environment

Compliance Measure	Compliance Limit	2011 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	9.1.1.1
Safe Drinking Water Act			
Annual dose to the general public from drinking water	4 mrem/yr	Compliant[(b)]	9.1.1.4
DOE O 458.1 and 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	9.1.3
Total residual surface contamination of property released off site (in disintegrations per minute per 100 square centimeters [dpm/100 cm^2])	300–15,000 dpm/100 cm^2 depending on the radionuclide	Compliant	9.1.5
DOE-STD-1153-2002, "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota"			
Absorbed radiation dose to terrestrial plants and 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	9.1.2

(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) Not applicable

2.5 Waste Management and Environmental Restoration

2.5.1 Applicable Regulations

Atomic Energy Act (AEA) of 1954 – The AEA ensures the proper management of source, special nuclear, and byproduct material. At the NNSS, AEA regulations are followed through compliance with DOE O 435.1 and 10 CFR 830, "Nuclear Safety Management."

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 the 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 NNSS subject to this order include (1) characterization of low-level 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 5 RWMS, and (3) storage of MLLW generated by DOE within the state of Nevada at the Area 5 RWMS.

Resource Conservation and Recovery Act (RCRA) – 40 CFR 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 HW to have a program in place to reduce the volume or quantity and toxicity of HW generated. Such NNSS 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 containing 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 NNSS 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 2.6) 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).

Federal Facility Compliance Act (FFCA) – The FFCA extends the full range of enforcement authorities in federal, state, and local laws for management of HW 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 time tables, and the tracking and completion of deadlines.

Federal Facility Agreement and Consent Order (FFACO), as amended – 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 NNSS, parts of the 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 Activity, the Soils Activity, and the Industrial Sites Activity, while DOE Legacy Management is responsible for the CASs at the Central Nevada Test Area and the Project Shoal Area.

NAC 444.850–444.8746, "Disposal of Hazardous Waste" – This NAC regulates the operation of HW disposal facilities on the NNSS to comply with federal RCRA regulations. Through this NAC, RCRA Part B Permit NEV HW0101 regulates the operation of the Hazardous Waste Storage Unit (HWSU) in Area 5, the Explosive Ordnance Disposal Unit (EODU) in Area 11, the storage of onsite and offsite MLLW in designated Area 5 locations prior to treatment and/or disposal, and the disposal of MLLW received from DOE offsite facilities into Cell 18, the recently permitted Mixed Waste Disposal Unit. The state permit requires groundwater monitoring of three wells downgradient of the MLLW disposal cells, prescribes post-closure monitoring for HW sites that were closed under RCRA prior to enactment of the FFACO, and requires preparation of an EPA Hazardous Waste Report of all HW and MLLW volumes generated and disposed annually at NNSS and all HW generated annually at the NLVF.

NAC 444.570–444.7499, "Solid Waste Disposal" – This NAC sets standards for solid waste management systems, including the storage, collection, transportation, processing, recycling, and disposal of solid waste. The NNSS 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 NNSS 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 the Southern Nevada Health District to enforce this NAC with the issuance of county permits to NNSA/NSO.

2.5.2 Compliance Reports

The following reports were prepared and submitted to NDEP to comply with environmental regulations for waste management and environmental restoration operations conducted on the NNSS in 2011.

- *Nevada National Security Area 5 Solid Waste Disposal Annual Reports for Pit 20 and Pit 6,* submitted to NDEP
- NNSS Quarterly Volume Reports (for all active LLW and MLLW disposal cells), submitted to NNSA/NSO
- *2011 Nevada Division of Environmental Protection and Environmental Protection Agency Biennial Report for the Nevada National Security Site*, submitted to NDEP
- *Conditionally Exempt Small Quantity Generator 2011 Hazardous Waste Report* (for the NNSS and NLVF)
- *Annual Transportation Report for Radioactive Waste Shipments to and from the Nevada National Security Site – Fiscal Year 2011* (NNSA/NSO, 2012)
- *Annual Summary/Waste Minimization Report Calendar Year 2011, RCRA Permit for a Hazardous Waste Management Facility Permit Number NEV HW0101* (NSTec, 2012d)
- *Nevada National Security Site 2011 Data Report: Groundwater Monitoring Program Area 5 Radioactive Waste Management Site* (NSTec, 2012e)
- *Nevada National Security Site 2011 Waste Management Monitoring Report, Area 3 and Area 5 Radioactive Waste Management Sites* (NSTec, 2012f)
- Post-closure monitoring reports for RCRA Part B Permit-identified CAUs

- *Biannual Neutron Monitoring Report for the Nevada National Security Site Area 9 U10 and Area 6 Hydrocarbon Landfills*
- *January–June 2011 Biannual Solid Waste Disposal Site Report for the Nevada National Security Site Area 23 Sanitary Landfill*
- *July–December 2011 Biannual Solid Waste Disposal Site Report for the Nevada National Security Site Area 23 Sanitary Landfill*
- *2011 Annual Solid Waste Disposal Site Report for the NNSS Area 6 Hydrocarbon Landfill and Area 9 U10 Landfill*

The following Environmental Restoration reports for CAUs were submitted to NDEP in 2011 in accordance with the FFACO schedule.

- *CAU 98: Frenchman Flat, Corrective Action Decision Document/Corrective Action Plan (CADD/CAP) Rev 0*
- *CAU 99: Rainier Mesa/Shoshone Mountain, Phase I Flow and Transport Model Presentation #1*
- *CAU 99: Rainier Mesa/Shoshone Mountain, Phase I Source Term Rev 0*
- *CAU 104: Area 7 Yucca Flat Atmospheric Test Sites, Corrective Action Investigation Plan (CAIP)*
- *CAU 106: Areas 5, 11 Frenchman Flat Atmospheric Sites, CAIP Rev 1*
- *CAU 106: Areas 5, 11 Frenchman Flat Atmospheric Sites, Corrective Action Decision Document/Closure Report (CADD/CR)*
- *CAU 116: Area 25 Test Cell C Facility, CR*
- *CAU 365: Baneberry Contamination Area, CAIP*
- *CAU 366: Area 11 Plutonium Valley Dispersion Sites, CAIP*
- *CAU 365: Baneberry Contamination Area, CADD/CR*
- *CAU 367: Area 10 Sedan, Ess and Uncle Unit Craters, CADD/CR*
- *CAU 372: Area 20 Cabriolet/Palanquin Unit Craters, CADD/CR*
- *CAU 374: Area 20 Schooner Unit Crater, CADD/CR*
- *CAU 375: Area 30 Buggy Unit Craters, CADD/CR*
- *CAU 417: Central Nevada Test Area – Surface, Draft Post-Closure Inspection Report*
- *CAU 447: Project Shoal Area – Subsurface. Draft Surface Geophysics Survey Report*
- *CAU 465: Hydronuclear, Streamlined Approach for Environmental Restoration (SAFER) Plan*
- *CAU 539: Areas 25 and 26 Railroad Tracks, CR*
- *CAU 544: Cellars, Mud Pits, and Oil Spills, CR*
- *CAU 547: Miscellaneous Contaminated Waste Sites, CADD/CAP*
- *CAU 561: Waste Disposal Areas, CADD/CR*
- *CAU 562: Waste Systems, CAP*
- *CAU 566: EMAD Compound, CR*
- *CAU 574: Neptune, SAFER Plan*

Table 2-6. NNSS compliance status with applicable waste management and environmental restoration regulations

Compliance Measure/Action	Compliance Limit	2011 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	6 types of guiding documents required	Compliant	10.1.6
DOE O 435.1, "Radioactive Waste Management"			
Establishment/maintenance of Waste Acceptance Criteria for radioactive wastes received at Area 3 and 5 RWMSs	NA[b]	Compliant	10.1.4
Track annual volume of LLW and MLLW disposed at Area 3 and Area 5 RWMSs (in cubic meters [m^3])	NA	Compliant	10.1.1; Table 10-1
Vadose zone monitoring at Area 3 and Area 5 RWMSs, not required by order, but performed to validate performance assessment criteria of RWMSs	NA	Conducted	10.1.8
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 Cell 18, the new Area 5 MWDU[c]	pH: 7.6 to 9.2 SC: 0.440 mmhos/cm[d] TOC: 1 mg/L[e]; TOX: 50 µg/L[f] H^3: 2,000 pCi/L	Compliant	10.1.7
Volume of MLLW disposed in Cell 18 (the Area 5 MWDU)	25,485 m^3 (899,994 ft^3)	Compliant	10.1.1; Table 10-1
Volume of nonradioactive HW stored at the HWSU	61,600 liters (16,280 gallons)	Compliant	10.2.2; Table 10-4
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; Table 10-4
Submit an annual report to the State of Nevada for volumes in m^3 of wastes received at the Area 5 MWSU[g], HWSU, EODU, and Cell 18.	Due April, July, October, January; annual report due March 1	Compliant	10.2
Submit Annual Hazardous Waste Report for NNSS and NLVF to the State of Nevada	Due the following February	Compliant	10.2
Conduct vadose zone monitoring for RCRA closure site U-3ax/bl Subsidence Crater	Continuous monitoring using TDR[h] sensors	Compliant	10.1.8
Periodic post-closure site inspection of five historic RCRA closure sites (CAUs 90, 91, 92, 110, 112)	NA	Compliant	11.1.1
Upgrade, remove, and report on USTs at NNSS and RSL-Nellis	NA	Compliant	10.3
Federal Facility Agreement and Consent Order			
Adherence to calendar year work scope for site characterization, remediation, closures, and post-closure monitoring and inspection	23 CAUs identified for some phase of action in 2011, 62 CAUs for monitoring or inspection	Compliant	11.1; 11.2; 11.3
NAC 444.750-8396, "Solid Waste Disposal"			
Track weight and volume of waste disposed each calendar year	Areas 6 and 9 – No limit Area 23 – 20 tons/day	Compliant	10.4.1
Monitor vadose zone for the Area 6 Hydrocarbon and Area 9 U10c Solid Waste disposal sites	Annually using neutron logging through access tubes	Compliant	10.4.1

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

2.6 Hazardous Materials Control and Management

2.6.1 Applicable Regulations

Toxic Substances Control Act (TSCA) – This act requires testing and regulation of chemical substances that enter the consumer market. Because the NNSS does not produce chemicals, compliance is primarily directed toward the management of polychlorinated biphenyls (PCBs). At the NNSS, 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 NNSS 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 NNSS, both restricted-use and non-restricted–use pesticides are applied under the direction of a State of Nevada–certified applicator.

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 13514 requires all federal facilities to report in accordance with the requirements of Sections 301 through 313 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 Table 2-7.

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 NNSS 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 NNSS 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. Toxic chemical releases on the NNSS 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 recordkeeping 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 Highly Hazardous Substances (HHS) above listed thresholds. NNSA/NSO submits an annual CAPP registration report to NDEP.

2.6.2 Compliance Reports

The following reports were generated for 2011 NNSA/NSO operations on the NNSS and at the two offsite facilities in compliance with hazardous materials control and management regulations:

- *Nevada Combined Agency Report - Calendar Year (CY) 2011,* submitted to state and local agencies
- *Toxic Release Inventory Report, Form R for CY 2011 Operations,* submitted to the EPA and the State
- *Calendar Year (CY) 2011 Polychlorinated Biphenyls (PCBs) Report for the Nevada National Security Site (NNSS)*, submitted to NNSA/NSO
- *2011 Chemical Accident Prevention Program Report*, submitted to NDEP

Table 2-7. Status of EPCRA reporting

EPCRA Section	Description of Reporting	2011 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 2-8. NNSS compliance status with applicable regulations for hazardous substance control and management

Compliance Measure/Action	Compliance Limit	2011 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	13.1
Storage and onsite disposal of PCB materials	Allowed if <50 ppm PCBs	No onsite storage or disposal	13.1
Onsite disposal of bulk product waste containing PCBs generated by remediation and site operations	Case-by-case approval by NDEP	No bulk product wastes were generated for onsite disposal	13.1
Generate report of quantities of PCB liquids and materials disposed off site during previous calendar year	Due July 1 of following year	Compliant	13.1
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	13.2
Maintain state certification of onsite pesticide and herbicide applicator	NA	Compliant	13.2
Emergency Planning and Community Right-to-Know Act (EPCRA)			
Adhere to reporting requirements	NCA Report due March 1 for previous CY; TRI Report, Form R due July 1 for previous CY; Notification Report due immediately after a release	Compliant	13.3
State of Nevada Chemical Catastrophe Prevention Act			
Registration of NNSS with the State if highly hazardous substances are stored above listed threshold quantities	NDEP-CAPP[d] Report due June 21 for previous period of June 1 through May 31	Compliant	13.4

(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

2.7 National Environmental Policy Act

DOE O 451.1B, "National Environmental Policy Act Program," establishes DOE requirements and responsibilities for implementing the National Environmental Policy Act of 1969 (NEPA), the Council on Environmental Quality Regulations Implementing the Procedural Provisions of NEPA (40 CFR 1500–1508), and the DOE NEPA Implementing Procedures (10 CFR 1021). Under 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. Before any project or activity is initiated at the NNSS, it is evaluated for possible impacts to the 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 NNSS. The Checklist is reviewed by the NNSA/NSO NEPA Compliance Officer to determine if 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 NNSS EIS (U.S. Department of Energy, Nevada Operations Office [DOE/NV], 1996a). 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 2011.

The draft *Site-Wide Environmental Impact Statement for the Nevada National Security Site and Offsite Locations in Nevada* (NNSS Site-Wide EIS) was released for public review in July 2011. Public meetings were held in September 2011 in various Nevada and Utah communities. It will replace the current programmatic NNSS EIS (DOE/NV, 1996a) and address impacts from NNSA/NSO operations in Nevada for the 10-year period from the Record of Decision, which is expected to be published in November 2012.

On January 20, 2012, NNSA/NSO submitted to DOE HQ the *NNSA/NSO NEPA Annual Planning Document*. It provides the status of all EAs and EISs being developed or planned in the next 12–24 months and the budget and major milestone information for the NNSS Site-Wide EIS.

Table 2-9. NNSS NEPA compliance activities conducted in 2011

Results of NEPA Checklist Reviews/NEPA Compliance Activities
6 projects were exempted from further NEPA analysis because they were of CX status.
40 projects were exempted from further NEPA analysis due to their inclusion under previous analysis in the NNSS EIS (DOE/NV, 1996a) 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, 2004b).
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 National Security Site* (NNSA/NSO, 2004a).
1 project, the Solar Demonstration Project, was eliminated; therefore, the planned EA was cancelled.

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 NNSS, 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 directs the federal agencies to inventory their cultural resources and establish policies and procedures to ensure the protection, restoration, and maintenance of federally owned sites, structures, and objects of historical, architectural, or archaeological significance.

DOE Policy DOE P 141.1, "Department of Energy Management of Cultural Resources" – The purpose of this policy is to ensure that DOE programs, including the NNSA, integrate cultural resources management into their missions and activities.

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 NNSS 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 ceremonial and traditional rites. Locations exist on the NNSS 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 is 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 NNSS artifact collection is subject to NAGPRA, and the locations of American Indian human remains at the NNSS must be protected from NNSS 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 Office of Scientific and Technical Information. The 2011 reports submitted to agencies are discussed in Chapter 15.

Table 2-10. NNSS compliance status with applicable historic preservation regulations

Compliance Action	2011 Compliance Status	Section Reference[(a)]
National Historic Preservation Act of 1966; EO 11593, "Protection and Enhancement of the Cultural Environment"; and DOE P 141.1, "Department of Energy Management of Cultural Resources"		
Maintain and implement NNSS Cultural Resources Management Plan	Compliant	15.0
Conduct cultural resources inventories and evaluations of historic structures	Compliant	15.1, 15.2; Table 15-1; Table 15-2
Make determinations of eligibility to the National Register	Compliant	15.1; Table 15-1
Make assessments of impact to eligible properties	Compliant	15.1
Manage artifact collection as per required professional standards	Compliant	15.5
Archaeological Resources and Protection Act of 1979		
Conduct archaeological work by qualified personnel	Compliant	15.0
Document occurrences of damage to archaeological sites	Compliant	15.1
Complete and submit Secretary of the Interior Archaeology Questionnaire	Compliant	15.4
American Indian Religious Freedom Act of 1978		
Allow American Indians access to NNSS locations for ceremonies and traditional use	Compliant	15.6
Native American Graves Protection and Repatriation Act		
Consult with affiliated American Indian tribes regarding repatriation of cultural items	Compliant	15.6
Protect American Indian burial locations on NNSS	Compliant	15.6
Overall Requirement		
Consult with tribes regarding various cultural resources issues	Compliant	15.6

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 NNSS operations. NNSS 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 5 of the 239 bird species observed on the NNSS are protected under this act. Biological surveys are conducted for projects to prevent direct harm to protected birds, nests, and eggs. Biologists periodically collect game birds for radiological analysis under a federal migratory bird collection permit.

Bald Eagle Protection Act – This act prohibits the capture or harming of bald and golden eagles without special authorization. Both bald and golden eagles occur on the NNSS. Biological surveys are conducted for projects to prevent direct harm to eagles and their nests and eggs.

Wild Free-Roaming Horse and Burro Act – This act makes it unlawful to harm wild horses and burros. It requires the U.S. Bureau of Land Management (BLM) to protect, manage, and control wild horses and burros within designated herd management areas (HMAs) in a manner that is designed to achieve and maintain a thriving natural ecological balance. Although the NNSS is not within an active HMA, a Five-Party Cooperative Agreement exists between NNSA/NSO, NTTR, FWS, BLM, and the State of Nevada Clearinghouse that calls for cooperation in conducting resource inventories and developing resource management plans for wild horses and burros and maintaining favorable habitat for them on federally withdrawn lands. BLM considers the NNSS a zero herd-size management area. NNSA/NSO consults with BLM regarding any issue of NNSS horse management. Biologists conduct periodic horse census surveys on the NNSS.

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. NNSS projects are evaluated for their potential to disturb wetlands and their need for a Section 404 permit application. Based on recent rulings, no natural NNSS wetland may meet the criteria of a "jurisdictional" wetland subject to Section 404 regulations. However, final determination from the USACE regarding the status of NNSS 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 kilometers (3.1 miles) 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 NNSS. NNSS 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 NNSS are generally conducted to ensure protection of property and human well-being.

EO 13186, "Responsibilities of Federal Agencies to Protect Migratory Birds" – Directs federal agencies to take certain actions to further implement the MBTA if agencies have, or are likely to have, a measurable negative effect on migratory bird populations. It also directs federal agencies to support the conservation intent of the MBTA and conduct actions, as practicable, to benefit the health of migratory bird populations. NNSS projects are evaluated for their potential to impact such bird populations.

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 NNSS 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 458.1, "Radiation Protection of the Public and the Environment" – This order, approved in June 2011, requires the establishment and implementation of procedures and practices to ensure that populations of terrestrial plants and aquatic and terrestrial animals within local ecosystems are protected. This order specifically addresses their protection from any radiological impacts of DOE/NNSA activities (see Section 2.4.1). Ecosystem mapping and surveys for protected and important species are conducted on the NNSS to identify the biota and ecosystems that may be impacted by both radiological and other NNSS activities.

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. Biologists periodically conduct live trapping and release of bats, rodents, reptiles, and desert tortoises under a State wildlife handling permit. Over 200 bird species, 1 reptile species, 6 bat species, and 2 small mammal species on the NNSS are state-protected. Biological surveys are conducted for projects to prevent direct harm to protected birds, nests, eggs, and protected animals.

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 NNSS. Annual reviews of the status of NNSS plants are conducted.

2.9.2 Compliance Reports

The following reports were prepared in 2011 or 2012 to meet regulation requirements or to document compliance for all activities conducted in 2011:

- *Annual Report of Actions Taken under Authorization of the Biological Opinion on NNSS Activities (File Nos. 84320-2008-F-0416 and B-0015) – January 1, 2011, through December 31, 2011*
- *Annual Report for Handling Permit S33994*, submitted to Nevada Division of Wildlife
- *Annual Report for Federal Migratory Bird Scientific Collecting Permit MB008695-0*, submitted to FWS Portland Office

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

Compliance Measure/Action	Compliance Limit	2011 Compliance Status	Section Reference[(a)]
Endangered Species Act – 1996 Opinion for NNSS Programmatic Activities			
Number of tortoises accidentally injured or killed due to NNSS activities and number captured and displaced from project sites	Limit varies by project/activity	Compliant	16.1
Number of tortoises taken by way of injury or mortality on NNSS paved roads by vehicles other than those in use during a project	4 per year not to exceed 15 by 2019	Compliant	16.1
Number of total acres (ac) of desert tortoise habitat disturbed during NNSS project construction from 2009 to 2019	2,710 ac	Compliant	16.1
Follow all terms and conditions of the Biological Opinion during construction and operation of NNSS projects	NA[(b)]	Compliant	16.1
Conduct biological surveys at proposed project sites to assess presence of protected species	NA	Compliant	16.2
Migratory Bird Treaty Act			
Number of birds/nests/eggs harmed by NNSS project activities	0	10 accidental bird deaths	16.3; Table 16-2; Figure 16-2
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 NNSS activities	0	Compliant	16.7
Wild Free-Roaming Horse and Burro Act and Five-Party Cooperative Agreement			
Number of horses harassed or killed due to NNSS activities	0	Compliant	16.3; Table 16-2
Cooperate in conducting resource inventories and developing resource management plans for horses on the NNSS, NTTR, and DNWR	NA	Compliant	16.3; Table 16-2
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 NNSS activity	NA	0	16.3; Table 16-2
EO 13112, "Invasive Species"			
Evaluate feasibility of conducting habitat reclamation and other controls to control spread of invasive species	NA	Compliant	16.5
NAC 503.010–503.104 and NAC 527 - Nevada Protective Measures for Wildlife and Flora			
Number of state-protected animals harmed, killed, or collected and number of state-protected plants harmed or collected due to NNSS activities	Without special permit: 0 Under permit: 10 collections each per year of jackrabbits, cottontail rabbits, mourning doves, chukar, quail, and 15 of selected bat species Unlimited capture/releases of bats, rodents, reptiles	480 capture/releases of reptiles; collection of 5 skinks	16.3; Table 16-2;

(a) The sections within this document that discuss the compliance summary data

(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 the EPA and perform an annual evaluation of releases. CERCLA requirements applicable to NNSS 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 a 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 231.1B, "Environment, Safety, and Health Reporting" – This order includes the requirement for reporting environmental occurrences. Along with DOE O 232.2, "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 Substance" – 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 NNSS specifies that no petroleum products will be discharged into treatment works without first being processed through an oil/water separator or other approved method. It also specifies how NNSA/NSO shall report each bypass, spill, upset, overflow, or release of treated or untreated sewage.

Other NNSS 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 NNSS or at the NLVF and RSL-Nellis.

In 2011, no reportable environmental occurrences happened.

2.11 Environment, Safety, and Health Reporting

2.11.1 Applicable Regulations

DOE O 231.1B, "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 O 232.2, "Environment, Safety and Health Reporting Manual" – This order replaced DOE M 231.1-2 (of the same name) in 2011, although its requirements were not effective until January 1, 2012. The manual provided detailed requirements for implementing DOE O 231.1B during 2011.

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 NNSS ASER, which is titled the Nevada National Security Site Environmental Report (NNSSER).

2.11.2 Compliance Status

In 2011, the NNSSER was published under the title *Nevada National Security Site Environmental Report 2010* (NSTec, 2011b). It was published and posted on the NNSA/NSO and DOE Office of Scientific and Technical Information websites by September 23, 2011. The 2010 NNSSER was mailed to all recipients (on a compact disc accompanied by a 24-page summary) by September 29, 2010, and a subset of individuals on distribution also received a hardcopy of the full 2010 NNSSER.

2.12 Summary of Permits

Table 2-12 presents the complete list of all federal and state permits active during calendar year 2011 for NNSS, NLVF, and RSL-Nellis operations and that 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 HW management and disposal, and endangered species protection. Some 2011 permit names retain the "NTS" acronym for the NNSS because they have not been officially changed with the regulatory agencies. Reports associated with permits are submitted to the appropriate designated state or federal office. Copies of reports may be obtained upon request.

Table 2-12. Environmental permits required for NNSS and NNSS site facility operations

Permit Number	Permit Name or Description	Expiration Date	Reporting
Air Quality	**NNSS**		
AP9711-2557	NTS Class II Air Quality Operating Permit	June 25, 2014	Annually
10-27 and 11-23	NTS Open Burn Variance, Fire Extinguisher Training (Various Locations)	March 16, 2011/ March 17, 2012	None
10-26 and 11-24	NTS Open Burn Variance, NNSS, A-23, Facility #23-T00200 (NNSS Fire & Rescue Training Center)	March 16, 2011/ March 17, 2012	None
	UGTA Offsite		
AP9711-2622	NTTR Class II Air Quality Operating Permit, Surface Area Disturbance, Well ER-EC-12	November 4, 2014	Annually
AP9711-2659	NTTR Class II Air Quality Operating Permit, Surface Area Disturbance, Wells ER-EC-13 and ER-EC-15	March 5, 2015	Annually
	NLVF		
Source 657	Clark County Minor Source Permit, Source: 657	November 1, 2015	Annually
	RSL-Nellis		
Facility 348, Mod. 3	Clark County Authority to Construct/Operating Permit for a Non-Major Testing Laboratory	None	Annually
Drinking Water	**NNSS**		
NY-0360-12NTNC	Areas 6 and 23	September 30, 2011/2012	None
NY-4098-12NC	Area 25	September 30, 2011/2012	None
NY-4099-12NC	Area 12	September 30, 2011/2012	None
NY-0835-12NP	NNSS Water Hauler #84846	September 30, 2011/2012	None
NY-0836-12NP	NNSS Water Hauler #84847	September 30, 2011/2012	None
Septic Systems/Pumpers	**NNSS**		
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
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, NNSS, Area 6	None	None
NY-1128	Commercial Individual Sewage Disposal System, NNSS, Area 6, Yucca Lake Project	None	None
NY-17-06839	Septic Tank Pumper E 106785	July 31, 2011/2012	None
NY-17-06839	Septic Tank Pumper E 107105	July 31, 2011/2012	None

Table 2-12. Environmental permits required for NNSS and NNSS site facility operations (continued)

Permit Number	Permit Name or Description	Expiration Date	Reporting
Septic Systems/Pumpers (cont.)	**NNSS**		
NY-17-06839	Septic Tank Pumper E-105918	July 31, 2011/2012	None
NY-17-06839	Septic Tank Pumping Contractor (one unit)	July 31, 2011/2012	None
NY-17-06839	Septic Tank Pumper E-106169	July 31, 2011/2012	None
NY-17-06839	Septic Tank Pumper E-107103	July 31, 2011/2012	None
Wastewater Discharge	**NNSS**		
GNEV93001	Water Pollution Control General Permit	August 5, 2010/2015	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/ June 24, 2017	Quarterly
	RSL-Nellis		
CCWRD-080	Industrial Wastewater Discharge Permit	June 30, 2011/2012	Quarterly
Hazardous Materials	**NNSS**		
14490	NNSS Hazardous Materials	February 28, 2011/2012	Annually
14492	Nonproliferation Test and Evaluation Complex	February 28, 2011/2012	Annually
	NLVF		
14493	NLVF Hazardous Materials Permit	February 29, 2011/2012	Annually
	RSL-Nellis		
14496	RSL-Nellis Hazardous Materials Permit	February 29, 2011/2012	Annually
Hazardous Waste	**NNSS**		
NEV HW0101	RCRA Permit for NNSS Hazardous Waste Management (Area 5 Mixed Waste Disposal Unit, Area 5 Mixed Waste Storage Unit, Hazardous Waste Storage Unit, and Explosive Ordnance Disposal Unit)	April 20, 2016	Biennially and annually
Waste Management	**NNSS**		
SW 523	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, 2011	None
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 NNSS 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, 2010 (permit renewal requested)	Annually
S33994	Nevada Division of Wildlife – Scientific Collection of Wildlife Samples	December 31, 2011	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 National Security Site (NNSS) while ensuring the protection of the environment, the worker, and the public. This is accomplished, in part, 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. National Security Technologies, LLC (NSTec), the current Management and Operating contractor for the NNSS, designed an EMS to meet the 17 requirements of the globally recognized International Organization for Standardization (ISO) 14001:2004 Environmental Management Standard, and in 2008 the EMS obtained ISO 14001:2004 certification. In June 2011, it was re-certified for another 3-year period.

The EMS incorporates environmental stewardship goals that are identified in federal EMS directives applicable to all U.S. Department of Energy (DOE) and U.S. Department of Energy, National Nuclear Security Administration (NNSA) sites. In 2011, they included DOE Order DOE O 436.1A, "Departmental Sustainability"; Executive Order EO 13423, "Strengthening Federal Environmental, Energy, and Transportation Management"; and EO 13514, "Federal Leadership in Environmental, Energy, and Economic Performance" (see Section 2.1). This chapter describes the 2011 progress made towards improving overall environmental performance and meeting sustainable environmental stewardship goals. Reported progress applies to operations on the NNSS as well as support activities conducted at the NNSA/NSO-managed North Las Vegas Facility (NLVF) and Remote Sensing Laboratory–Nellis (RSL-Nellis). NNSA/NSO uses this annual NNSS environmental report as the mechanism to communicate to the public the components and status of the EMS, which is a requirement for ISO 14001:2004 certification.

3.1 Environmental Policy

The NSTec environmental policy, approved by NNSA/NSO, 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

Operations are evaluated to determine if they have an environmental aspect, and the EMS is implemented 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 identification of mitigation actions to minimize the risk of adverse impacts. Site operations have been determined to have the following environmental aspects:

Significant aspects:

- Air emissions
- Drinking water system maintenance
- Energy and fuel use
- Environmental restoration
- Non-hazardous waste management (generation, storage, and disposal)
- Greenhouse gas emissions
- Groundwater protection

- Hazardous, radioactive, and mixed waste management (generation, storage, and disposal)
- Wastewater management (generation and disposal)
- Water Use

Other aspects:
- Building construction and renovation
- Electronics stewardship
- Industrial chemical storage and use
- Purchase of materials and equipment
- Building demolition
- 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) 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. These targets are tracked by the various responsible operational groups, and reported quarterly to an Executive Leadership Council. Some EMS targets mirror the sustainability goals of DOE O 436.1A, EO 13514, and EO 13423. The Energy Management Program (EMP) and the Pollution Prevention and Waste Minimization (P2/WM) Program address the specific efficiency and sustainability goals of these orders. FY 2011 EMS objectives and targets and those identified for FY 2012 tracking are shown in Table 3-1.

Table 3-1. FY 2011 NNSA/NSO EMS objectives and targets

FY 2011 Objective	FY 2011 Target	FY 2011 Target Status	FY 2012 Target
Protect groundwater quality.	Prepare 41 boreholes for plugging and plug 57 boreholes.	41 boreholes were prepped and 62 were plugged.	Prepare 14 boreholes for plugging and plug 24 boreholes.
Remediate sites identified in the Federal Facility Agreement and Consent Order (FFACO).	Meet FY 2011 FFACO deadlines: Complete Corrective Action Plan by May 9, 2011, for Corrective Action Unit (CAU) 562; submit completed Closure Report to the State by September 30, 2011, for CAU 116.	All milestones were met.	Meet FY 2012 milestones for CAUs 547, 548, and 562.
Purchase products that meet DOE Environmentally Preferable Purchasing (EPP) standards (see Section 3.3.2).	Include in all subcontracts the requirement to meet DOE EPP standards.	Requirement was added to subcontract templates.	Add 10 substitute environmentally preferred products for purchasing.
	Achieve 50% increase in number of bio-based janitorial supplies.	Substitutes were found for 8 of 15 products.	
Reduce the risk of releasing refrigerants to the atmosphere.	Complete draining refrigerant from 112 tanks of 62 chillers or put them on a maintenance schedule.	All 62 chillers were drained and draining was completed ahead of schedule.	
Reduce energy use. Increase use of renewable fuels. Decrease use of petroleum-based fuels. Reduce water usage.	See Table 3-2 for the status of these FY 2011 targets, which mirror the site sustainability goals tracked under the EMP.	**FY 2012 EMS Targets for Energy and Fuel Use:** Install British thermal unit (BTU) sub-meters on boilers. Perform high performance sustainable audits on 25% of enduring buildings. Perform upgrades and submit at least one building for Energy Star status. Modify the Area 6 Gas Station to be able to dispense E-85 fuel.	

3.3.1 Energy Management Program

NNSA/NSO's goal is to implement DOE's Strategic Sustainability Performance Plan goals by reducing the use of energy and water at NNSA/NSO facilities, which can be achieved by advancing energy efficiency, water conservation, and the use of solar and other renewable energy sources. The EMP is performance oriented and strives to ensure continuous life-cycle, cost-effective improvements to increase energy efficiency and effective management of energy, water, and transportation fleets, while increasing the use of clean energy sources. NNSA/NSO currently uses electricity, fuel oil, and propane at NNSS and RSL-Nellis facilities. At the NLVF, electricity, fuel oil, and natural gas are used. NNSA/NSO vehicles and equipment are powered by unleaded gasoline, diesel, bio-diesel, E-85, and jet fuel. All water used at the NNSS is groundwater, and water used at the NLVF and RSL-Nellis is predominately surface water from Lake Mead. Water consumption data for the NNSS are not available because only a few of the NNSS facilities have water meters installed. Instead, water well production, which is tracked with flow meters on each well, is used to estimate consumption on the NNSS. The NLVF and RSL-Nellis buildings all have water meters.

In June 2011, DOE released its 2011 Strategic Sustainability Performance Plan (SSPP) (DOE, 2011) to address the requirements of DOE O 436.1A and EO 13514 and other sustainability related statutes within the department. The *FY 2012 NNSA/NSO Site Sustainability Plan* (SSP), completed in December 2011 (NSTec, 2011a), serves as a contract between NNSA/NSO and NNSA Headquarters in terms of how to meet the DOE SSPP goals, and satisfies the requirement of EO 13423 for an Energy Management Plan. The SSP describes the program, planning, and budget assumptions as well as each DOE SSPP goal, NNSA/NSO's current performance status for each DOE SSPP goal, and planned actions to meet each goal. To implement the SSP, an Energy Management Council (EMC) meets monthly to discuss the requirements and track and facilitate their completion. The EMC and the EWG coordinate to ensure that all EMS-tracked objectives and targets mirror overlapping annual goals in the SSP. Table 3-2 includes a summary of the SSP goals and the status in FY 2011 of reaching them.

Table 3-2. NNSA/NSO Site Sustainability Plan goals and FY 2011 performance status

DOE Agency Goal[(a)]	NNSA/NSO Performance Status
GOAL 1: SCOPE 1 & 2 GREENHOUSE GAS (GHG) REDUCTION	
28% reduction of Scope 1 and 2 GHG emissions[(b)] by FY 2020, from an FY 2008 baseline	The FY 2008 baseline was revised in FY 2011, based on guidance from DOE; it was determined to be 47,454 $mTCO_2e$[(c)]; FY 2011 emissions were 43,515 $mTCO_2e$, a 17% reduction from the revised FY 2008 baseline. This number does not include, however, fugitive GHG emissions[(b)]; a baseline inventory for fugitive GHG emissions and a system for their quantification will be established in FY 2012.
30% reduction of energy intensity in buildings (BTUs per square foot of building space) by FY 2015, from an FY 2003 baseline *(Also identified as an NNSA/NSO EMS target)*	Reduced energy intensity overall by 28.64% from the baseline. FY 2011 actions included installation of new air conditioners, solar screens, cool roofs, use of reflective paint, and lowering hot water heater temperatures.
Metering of individual buildings or processes for 90% of electricity (by October 2012) and for 90% of steam, natural gas, and chilled water[(d)] (by October 2015)	94% of electricity is metered; 100% of natural gas is metered; BTU meters for chilled water systems and advanced electrical meters will be installed as funding permits.
Cool roofs (see Glossary, Appendix B), unless determined uneconomical, for roof replacements, and new roofs must have a thermal resistance of at least R-30	Cool roofs have been installed on buildings since FY 2005; 2 cool roof replacements were made in FY 2011; by the end of FY 2011, 863,322 gross square feet (gsf) of building space is under cool roofs, representing 28.9% of all NNSA/NSO building gsf.
7.5% of a site's annual electricity consumption from renewable sources[(e)] by FY 2010 (or 3.75% if electricity is produced from renewable sources on site)	0.5% of power produced on site is from 153 photovoltaic and 25 wind turbine systems that provide power to environmental air samplers and remote communications sites; renewable energy credits were purchased, representing 8% of NNSA/NSO's annual electrical consumption, allowing NNSA/NSO to meet this goal; a new solar hot water heater was installed in Building 23-710 in Mercury.
10% annual increase in fleet alternative fuel consumption by FY 2015, relative to an FY 2005 baseline (i.e., FY 2011 increase should be 60% above the FY 2005 baseline) *(Also identified as an NNSA/NSO EMS target)*	Exceeded goal; consumption in FY 2011 was 132% above the FY 2005 baseline due to the increased use of biodiesel (B20) and E-85 gasoline and the reduction in fleet size. All diesel fuel used by NNSA/NSO fleet vehicles contains 20% bio-fuel and 80% petroleum and the E-85 fuel contains 85% ethanol and 15% petroleum. A second E-85 station is planned for the NNSS in Area 6 in FY 2012.
2% annual reduction in fleet petroleum consumption by FY 2015, relative to an FY 2005 baseline (i.e., FY 2011 consumption should be 12% less than the FY 2005 baseline) *(Also identified as an NNSA/NSO EMS target)*	Exceeded goal; consumption in FY 2011 was 46% less than the FY 2005 baseline due to use of B20 and E-85 and the overall reduction in fleet size and fuel consumption.
75% of light duty vehicle purchases must consist of alternative fuel vehicles (AFVs) by FY 2000 and thereafter	In FY 2011, 53.5% of all light duty vehicle acquisitions (68 out of 127) were AFVs; the other 59 vehicles were hybrid electric vehicles (HEVs), which use unleaded gasoline and are therefore not considered AFVs.

Table 3-2. NNSA/NSO Site Sustainability Plan goals and FY 2011 performance status (continued)

DOE Agency Goal[a]	NNSA/NSO Performance Status
GOAL 1: SCOPE 1 & 2 GHG REDUCTION (continued)	
Reduce fleet inventory by 35% by 2015 relative to an FY 2005 baseline; however, NNSA's complex-wide goal, agreed to by the Secretary of Energy, is to reduce the fleet by 15% by FY 2015 relative to the FY 2005 baseline and by 4% from FY 2010 to FY 2011	The FY 2005 baseline is 1,083 vehicles; fleet inventory in FY 2011 was 978 vehicles, a 9.7% reduction from the FY 2005 baseline; fleet was reduced by 1% from FY 2010 to FY 2011.
Reduce fugitive emissions of sulfur hexafluoride (SF_6)[f], a non-combustion GHG, through the use of capture and storage equipment for recovery and reuse	Actions taken in FY 2011 included planning the removal of unmaintained equipment containing SF_6, developing company procedures to monitor, measure, and capture SF_6 gas, and training personnel in gas capture.
GOAL 2: SCOPE 3 GHG REDUCTION & DEVELOP AND MAINTAIN GHG INVENTORY	
13% reduction in Scope 3[b] GHG emissions by FY 2020, from an FY 2008 baseline	The FY 2008 baseline was determined to be 14,398 $mTCO_2e$; FY 2011 emissions were 2,377 $mTCO_2e$, an 83% reduction from the baseline. This number does not include fugitive GHG emissions[b].
Reduce GHG emissions related to employee commuting by promoting carpooling, use of public transportation, teleworking, and alternative work schedule programs	Chartered buses are provided to transport employees from the Las Vegas area to the NNSS, and the cost of bus tickets are covered by a "location allowance" paid to employees.
Reduce GHG emissions related to business air and ground travel by increasing teleconferencing/web-based meetings, reducing air and car travel, promoting public or group transportation, researching establishment of a government rate for HEV and plug-in HEV rentals, utilizing hybrid taxi fleets, and changing travel policies	Teleconferencing and video conferencing are promoted to reduce travel. NSTec's Travel Office does not allow upgrades from mid-sized rental vehicles to larger ones except when multiple employees will be sharing the vehicle, thereby reducing ground-travel GHG emissions.
Reduce contracted wastewater treatment and municipal solid waste disposal.	Contracted wastewater treatment and solid waste disposal is used only at NLVF and RSL-Nellis; the NNSS operates its own systems and diverts various waste streams (see Goal 5). NLVF and RSL-Nellis have a recycling program in place for aluminum cans, glass, paper, cardboard, and plastic bottles through the waste disposal company Republic Services. NNSA/NSO will continue to focus on expanding waste reduction, introducing environmentally focused product packaging requirements for acquired products, purchasing environmentally preferable products, and increasing reusability or recyclability requirements in procurement practices.
Reduce transmission and distribution losses	To accomplish this goal, NNSA/NSO must reduce its consumption of purchased electricity; NNSA/NSO will continue to focus on reducing electricity usage, increasing onsite generation of renewable energy/electricity, and implementing efficiency programs to reduce electricity consumption.
GOAL 3: HIGH-PERFORMANCE SUSTAINABLE DESIGN/GREEN BUILDINGS & REGIONAL/ LOCAL PLANNING	
All new construction and major renovations greater than $5 million are to achieve the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) Gold certification. Buildings less than $5 million must meet the Guiding Principles for Federal Leadership in High Performance Sustainable Buildings design (Interagency Sustainability Working Group [ISWG], 2008)	No such construction or major renovations occurred in FY 2011, and no new construction is planned for FY 2012.
15% of existing buildings larger than 5,000 gsf to be compliant with the Guiding Principles for Federal Leadership in High Performance Sustainable Buildings design (ISWG, 2008) by FY 2015	4.4% of NNSA/NSO enduring buildings over 5,000 gsf meet the Guiding Principles; 5.6% (by gsf) meet the Guiding Principles. In FY 2011, the Nevada Support Facility at the NLVF achieved Energy Star certification, and the determination of its LEED certification is pending with the Green Building Council.
Participate in regional transportation planning	In FY 2011, NNSA/NSO signed a contract with the Regional Transportation Authority to use the Northwest Regional Transportation Center in northwest Las Vegas as a site to park fleet vehicles instead of having to travel an additional 25 miles (roundtrip) to the NLVF.

Table 3-2. NNSA/NSO Site Sustainability Plan goals and FY 2011 performance status (continued)

DOE Agency Goal[(a)]	NNSA/NSO Performance Status
GOAL 4: WATER USE EFFICIENCY AND MANAGEMENT	
26% reduction in water intensity[(g)] by FY 2020 from an FY 2007 baseline *(Also identified as an NNSA/NSO EMS target)*	Water intensity on the NNSS was 48.43 in FY 2011, a 31.4% reduction from the FY 2007 baseline of 70.58; potable water production[(h)] was reduced by 26.22% across all NNSA/NSO facilities from the FY 2007 baseline; the new water-efficient car wash at the NNSS saved 89,000 gallons in FY 2011 (see Section 14.4, Groundwater Conservation, for a listing of other 2011 accomplishments).
20% reduction in water consumption of industrial, landscaping, and agricultural water by FY 2020, from an FY 2010 baseline	FY 2011 non-potable water production showed a 15% increase from the FY 2010 baseline due to end point leaks, which are scheduled for repair in FY 2012.
GOAL 5: POLLUTION PREVENTION/WASTE MINIMIZATION	
Minimize generation of waste and pollutants through source reduction	Requisition Compliance Review (RCR) approvals of chemical purchases and environmental review of projects facilitate minimizing the generation of waste and pollutants through source reduction.
Maintain cost-effective waste prevention and recycling programs	Continued to implement cost-effective recycling within the P2/WM Program (see Section 3.3.2).
Divert at least 50% of non-hazardous solid waste, excluding construction and demolition materials and debris, from disposal by the end of FY 2015	35.3% of non-hazardous solid waste was diverted from disposal through recycling (see Section 3.3.2.2). Meeting this goal by the end of FY 2015 will require increased employee awareness and participation in waste stream segregation.
Divert at least 55% of construction and demolition materials and debris from disposal by the end of FY 2015	A management assessment found that the process to track this goal is not in place; in FY 2012, a baseline will be established for the diversion of construction waste; a process was developed to address the current backlog of those materials that cannot be cleared for unrestricted reuse or recycling; subcontract templates for new construction and demolition work were modified to include request for material recycling.
Reduce printing paper use and acquire uncoated printing and writing paper containing at least 30% post-consumer fiber	Default settings for printers and copiers are set to duplex; all printers purchased must have automatic duplexing capability; purchased printing paper is required to meet the uncoated and fiber content goals.
Reduce and minimize the quantity of toxic and hazardous chemicals and materials acquired, used, and disposed of	RCR approval of chemical purchases and environmental review of projects are strategies used to reduce and minimize the quantity of toxic and hazardous chemicals and materials acquired, used, or disposed of.
Increase the diversion of compostable and organic material from the waste stream	The majority of food waste at the NNSS was collected and taken to a local Native American tribe for composting.
Implement integrated pest management and other appropriate landscape management practices to reduce and eliminate the use of toxic and hazardous chemicals and materials	Only native landscaping exists at the NNSS, and xeric landscaping is predominant at the NLVF and RSL-Nellis. Most herbicide use is around buildings and other structures for fire prevention, and most pesticide use is inside buildings. Herbicides and pesticides used are environmentally friendly.
Increase agency use of acceptable alternative chemicals and processes in keeping with agency's procurement policies	RCR approvals of chemical purchases and environmental review of projects facilitate meeting this goal. In 2011, eight new environmentally preferable products were added to NSTec's Just-In-Time Procurement Catalog items as substitutes for less acceptable products.
Decrease agency use of chemicals where such decrease will assist agency in achieving GHG reduction targets	GHG reduction chemicals are used for equipment whenever possible, and some equipment is modified to be able to use non-GHG chemicals.
Report in accordance with the requirements of the Emergency Planning and Community Right-to-Know Act (EPCRA)	A hazardous substance inventory database is updated annually, and information is provided to the State (see Section 13.3 for 2011 EPCRA compliance activities).

Table 3-2. NNSA/NSO Site Sustainability Plan goals and FY 2011 performance status (continued)

DOE Agency Goal[(a)]	NNSA/NSO Performance Status
GOAL 6: SUSTAINABLE ACQUISITION	
Ensure that 95% of new contract actions require the supply or use of products and services that are energy efficient, water efficient, bio-based, environmentally preferable, non–ozone depleting, contain recycled content, or are non-toxic or less toxic alternatives; update affirmative procurement plans (i.e., green purchasing plans or EPP plans), policies, and programs to ensure that all federally mandated designated products and services are included in all relevant acquisitions	NSTec developed language to include in all applicable subcontracts that will require NSTec subcontractors to meet DOE's sustainable acquisition goals. A sustainability review was added to the procurement process to ensure that the supply or use of products and services meet this goal.
GOAL 7: ELECTRONIC STEWARDSHIP AND DATA CENTERS	
Ensure procurement preference for Electronic Product Environmental Assessment Tool (EPEAT)[(i)] registered electronic products	100% of the 2,100 leased computers managed by NSTec for NNSA/NSO are EPEAT registered and Energy Star qualified.
Enable power management, duplex printing, and other energy-efficient or environmentally preferable features on all eligible DOE electronic products	All data centers were sub-metered in FY 2011 to determine monthly Power Utilization Effectiveness (PUE); leased personal computers began to be replaced with leased thin client terminals that reduce energy use by 85%; printers and copiers are set to duplex by default; digital storage of records and files and the use of thinner paper are encouraged; electronic document management, display, and storage have been implemented; the applicability of electronic filing and transmittal of documents continues to be assessed.
Attain a maximum annual weighted average PUE for data centers of 1.4 by FY 2015	Power meters were installed in late FY 2011 in Building C-1 (NLVF) and Building 23-725 (Mercury) data centers. PUE will be calculated for FY 2012 when sufficient data has been received.
Employ environmentally sound disposition of excess or surplus electronic products	All leased computer equipment contracts require that returned equipment be refurbished and reused, disassembled, and the parts reused or recycled through a recycler certified by the International Association of Electronic Recyclers.
Reduce the use of office paper and reduce energy consumption of data center and server operations	All leased computers are Energy Star 4.0 compliant and EPEAT registered; continued investigating the feasibility of using virtual servers and of transferring data centers located at the NLVF to a commercial data farm.
GOAL 8: SITE INNOVATION	
Innovation to enhance efficiency gains, expand clean energy, evolve sustainable campuses, and engage employees and the DOE community	Building 550 at the NNSS was used as a test facility for a low-cost energy saving initiative; its energy usage was monitored for 12 months after its exterior was painted with an insulated paint additive to increase its insulation factor. Monitoring results indicated minimal energy use savings (1%–2%).
DOE facility energy managers to be Certified Energy Managers by September 2012, and pursue energy management training and outreach among employees	The NNSA/NSO Energy Program Manager is expected to be certified in FY 2012; NSTec facility managers received training in energy topics during quarterly meetings in 2011; an employee incentive program continued to award individual and team performance in sustainability actions and ideas; a behavior-based energy awareness program was developed along with a character icon to promote the program called The Green Reaper; outreach program continued with *The Joule* newsletter, speaker forms, and activities.

(a) These are department-wide goals of the DOE (DOE, 2011), which NNSA/NSO (or any single DOE site) is not required to specifically meet. NNSA/NSO is committed, however, towards striving to meet these department target goals.

(b) The GHGs targeted for emission reductions are carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. Scope 1 GHG emissions include direct emissions from sources that are owned or controlled by a federal agency. Scope 2 includes direct emissions resulting from the generation of electricity, heat, or steam purchased by a federal agency. Scope 3 includes emissions from sources not owned or directly controlled by a federal agency but related to agency activities, such as vendor supply chains, delivery services, employee business air and ground travel, employee commuting, contracted solid waste disposal, contracted waste water discharge, and transmission and distribution losses related to purchased electricity. Fugitive GHG emissions are uncontrolled or unintentional releases from equipment leaks, storage tanks, loading, and unloading.

Table 3-2. NNSA/NSO Site Sustainability Plan goals and FY 2011 performance status (continued)

(c) $mTCO_2e$ = metric tons of carbon dioxide equivalents.

(d) Chilled water in this goal refers to having BTU meters on systems that deliver chilled water to air conditioning coils to cool buildings.

(e) 9.6% of purchased electrical power for NNSA/NSO facilities comes indirectly from renewable energy sources through the purchase of power from NV Energy, who acquires 12% of their power from renewable sources such as plants using geothermal-, solar-, hydro-, and bio-fuel. DOE Headquarters requires, however, that this SSP goal must be met from a direct renewable energy supply or supplies.

(f) SF_6 is commonly used as an electric insulator (dielectric medium) in accelerators, switchgear, and high-voltage power supplies. Releases result from maintenance, equipment failure, and gas seepage.

(g) Water use intensity is potable gallons consumed per total gross square footage of facility space.

(h) On the NNSS, water pumped from onsite water wells (i.e., water production) was used to estimate water consumption because the majority of NNSS facilities do not have water meters.

(i) Funded by the U.S. Environmental Protection Agency (EPA), EPEAT is a procurement tool to help large-volume purchasers in the public and private sectors evaluate, compare, and select desktop computers, notebooks, and monitors based on their environmental attributes.

3.3.2 Pollution Prevention and Waste Minimization 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 (ODS). These initiatives are pursued through source reduction, reuse, 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 DOE SSP sustainability goals and the requirements of DOE orders, federal laws, and state regulations applicable to operations at the NNSS, NLVF, and RSL-Nellis (see Section 2.6). The following strategies are employed to meet P2/WM goals:

Source Reduction – 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. 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 some recyclable waste streams generated, NNSA/NSO maintains a recycling program. Items recycled in 2011 included paper, cardboard, aluminum cans, glass, 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. A process was developed in 2011 to be able to release scrap metals from radiological areas for recycling. Metal from these areas of the NNSS had not been previously released for recycling (see Section 9.1.5).

One recycling program is the Material Exchange Program. Created in 1998, the Material Exchange Program diverts supplies, chemicals, and equipment from landfills. These unwanted, but usable, items are made available through electronic mail or postings on the intranet so that individuals in need can obtain the items at no cost. 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 2011, 0.11 metric tons (mtons) (0.12 tons) of materials were recycled through the program. From its inception in 1998, the Material Exchange Program has diverted 194 mtons (213 tons) of chemicals, office supplies, and equipment from disposal in solid and hazardous waste landfills.

There is also an Excess Property Program that provides excess property to NNSA/NSO employees or subcontractors, laboratories, other DOE sites, other federal agencies, state and local government agencies, and local schools. If new users are not found, excess property is made available to the public for recycle/reuse through periodic Internet sales.

Environmentally Preferable Purchasing (EPP) – The Resource Conservation and Recovery Act (RCRA), as amended, 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. The U.S. Environmental Protection Agency (EPA) maintains a list of items containing recycled materials that should be purchased. The EPA determines what the minimum content of recycled material should be for each item. Federal facilities must have a process in place for purchasing the EPA-designated items containing the minimum content of recycled materials. EO 13423 requires federal facilities to ensure, where possible, that 100% of purchases of items on the EPA-designated list contain recycled materials at the specified minimum content. Of these items that NNSA/NSO purchased in 2011, about 52.2% contained recycled materials at the specified minimum content. The U.S. Department of Agriculture now designates types of materials that have a required minimum amount of bio-based chemicals. Products that meet this requirement are being added to procurement lists, and the percentage of those that are purchased will be tracked in 2012.

3.3.2.1 Reduction of Ozone-Depleting Substances

The EMS includes practices to maximize the use of safe alternatives to ODS. 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. The NNSS achieved this procurement phase-out in 2009. In 2011, only environmentally preferable alternatives to Class I ODS were purchased. All procurement of refrigerants containing ODS (referred to as ODS refrigerants) must be approved by the environmental oversight organization, which verifies that only approved products are purchased. Existing ODS refrigerants in equipment are being phased out as equipment is drained for repair or replaced by new equipment with approved alternative refrigerants. Drained ODS refrigerants can be reused, however, if needed for existing, operating equipment. There are no halon-containing fire extinguishers or equipment remaining at the NNSS or NLVF. All halons have been removed from RSL-Nellis, with the exception of halon fire extinguishers in the aircraft.

3.3.2.2 Reduction of Wastes

Table 3-3 shows a summary of the routine waste reduction activities during 2011. An estimated 121.0 mtons (133.1 tons) of hazardous wastes (including RCRA, Toxic Substance Control Act, and state-regulated hazardous wastes) and 760.5 mtons (836.6 tons) of solid waste (sanitary waste) were diverted from disposal facilities in 2011 from these activities, all through recycling and reuse. Table 3-4 compares the amounts of radioactive, hazardous, and solid wastes reduced in 2011 to the amounts in prior years.

Table 3-3. Waste reduction activities in 2011

Activity	Reduction (mtons)[(a)]
Hazardous Waste	
Bulk used oil sent to an offsite vendor for recycling	44.5
Lead acid batteries shipped to an offsite vendor for recycling	29.8
Electronic equipment, including computer towers, monitors, laptops, and televisions, sent to an offsite vendor for recycling	20.0
Scrap lead sent to an offsite vendor for recycling	15.0
Rechargeable batteries sent to an offsite vendor for recycling	0.19
Spent fluorescent light bulbs, mercury lamps, metal hydride lamps, and sodium lamps sent to an offsite vendor for recycling	0.94
Refrigerant sent to an offsite vendor for recycling	0.09
Diesel fuel #2 filtered and cleaned for reuse onsite	10.5
Total	**121.0**
Solid Waste	
Single stream mixed paper/cardboard/cans/plastic sent off site for recycling	234.2
Mixed paper and cardboard sent off site for recycling	99.0
Mixed paper and electronic media from Shred Day activities sent off site for recycling	21.9
Food waste from the NNSS cafeterias sent off site to be used as compost	11.6
Tires sent off site for recycling	28.8
Shipping materials including pallets, styrofoam, bubble wrap, and shipping containers reused	11.6
Aluminum cans and plastic sent off site for recycling	0.38

Table 3-3. Waste reduction activities in 2011 (continued)

Activity	Reduction (mtons)[(a)]
Solid Waste (continued)	
Ferrous and nonferrous metal sold as scrap for recycling	329.8
Spent toner cartridges sent off site for recycling	1.51
Electronic equipment sold for reuse	17.7
Communication devices returned to vendor for reuse	1.9
Office equipment and supplies recycled on site through the Material Exchange Program	0.11
Spent brass from shooting range returned to vendor	2.0
Total	**760.5**

(a) 1 mton = 1.1 ton

Table 3-4. Quantities of waste reduced through P2/WM activities by waste type and year

	Waste Reduction		
Calendar Year	**Radioactive (mtons)[(a)]**	**Hazardous (mtons)**	**Solid (mtons)**
2011	0.07	121.0	760.5
2010	0	138.8	648.5
	Radioactive (m^3)[(b)]		
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

(a) 1 mton = 1.1 ton

(b) The unit of measure for the quantity of radioactive waste reduced was changed in 2010 from cubic meter to metric ton

(c) 1 cubic meter (m^3) = 1.3 cubic yards

3.3.2.3 Major P2/WM Accomplishments

In December 2011 NNSA/NSO submitted the FY 2011 Waste Generation and Pollution Prevention Progress Report for the NNSS, NLVF, and RSL-Nellis. This was done by entering the sites' data, including annual recycling totals and waste minimization accomplishments, into the DOE Headquarters' Pollution Prevention Tracking and Reporting System electronic database. NNSA/NSO also submitted the calendar year (CY) 2011 Waste Minimization Summary Report to NNSA/NSO in February 2012 for its subsequent transmittal to the Nevada Division of Environmental Protection on February 16, 2012. There were also eight major P2/WM accomplishments in 2011 that were reported to DOE Headquarters, three of which involved the diversion of solid and hazardous waste streams (demolition rubble, Freon, and lead bricks) not included in the routine recycling/reuse activities shown in Tables 3-3 and 3-4. The eight major P2/WM accomplishments included:

- Remediation of the Pluto Facility generated 6,850 cubic yards of demolition rubble. Through an innovative approach to characterize the rubble, it was determined that it met the radiological release criteria for onsite disposal. The rubble was used as fill during closure of the 92-Acre Area at the Area 5 Radioactive Waste Management Site (RWMS) and saved $1.35 million in disposal costs.
- Employee awareness training was used to change employee behaviors (e.g., turning off lights/electrical equipment at the end of the day) and used efficient resource management techniques (e.g., phasing the timing of upgrades for water/energy efficient equipment with their repair or maintenance schedules). Both of these

actions aided NNSA/NSO in being on or ahead of schedule in meeting many of the FY 2015 and FY 2020 DOE sustainability goals.

- A character icon named The Green Reaper was created and is being used in a behavior-based energy awareness program for employees that targets the reduction of energy use.
- 1,700 gallons of ODS refrigerants were removed from 62 chillers that were no longer needed. This removed the chance of fugitive emissions and made the ODS refrigerants available for use in existing older pieces of equipment that must use this type of refrigerant until they can be replaced.
- 7.1 tons (6.4 mtons) of lead bricks were removed from two rooms in Building 23-650 in Mercury and were sold rather than disposed as hazardous waste. The rooms are now available for use since the health hazard associated with the lead has been eliminated.

The Green Reaper

- Closure of the 92-Acre Area waste disposal site at the Area 5 RWMS was closely coordinated with the Nevada Division of Environmental Protection, resulting in an innovative closure design and cost-efficient construction. Instead of the standard multi-layer landfill cover made up of geosynthetic membranes and compacted clay, an evapotranspirative cover of native soil and native vegetation was used, which resulted in a cost savings of $12 million and the efficient use of energy and resources.
- A study was conducted in 2011 that determined that the water and chemicals in the RSL Cooling Tower could be used 50% longer before being discharged, which will result in a water savings of 595,000 gallons per year.
- The NLVF Building C-1 Xeric Landscaping Project replaced grass with xeric landscaping and saved 1.9 million gallons of water and $32,000 in operational costs.

3.3.3 Other Environmental Programs

Multiple programs that serve to protect public health and the environment are implemented on the NNSS (Table 3-5). They address the environmental protection actions supported under the EMS as specified in DOE orders and federal environmental protection statutes. Work conducted in CY 2011 by these programs is summarized throughout various chapters of this report (see Table 3-5, "Section Reference" column).

Table 3-5. Major environmental programs of NNSA/NSO

NNSA/NSO Environmental Program	Environmental Protection Action Addressed	Program Description	Section Reference[(a)]
Routine Radiological Environmental Monitoring Program	Conduct environmental monitoring to detect releases from DOE activities Estimate contaminant dispersal patterns in the environment Characterize the pathways of exposure to members of the public Estimate the exposures and doses to individuals and nearby populations	Monitors direct ambient radiation and monitors man-made radionuclides in air, groundwater, surface water, and biota samples Identifies pathways of exposure to the public Estimates dose to public from NNSA/NSO air emissions, groundwater contamination, direct radiation, and ingestion of NNSS game animals	Sections 4.1, 5.1, 6.0, 8.0, 9.1
Underground Test Area Activity	Conduct environmental monitoring to detect, characterize, and respond to releases to groundwater from DOE activities Estimate contaminant dispersal patterns in the environment	Characterizes radiological groundwater contamination from past NNSS activities and develops contaminant flow models needed to design a network of long-term monitoring wells for the protection of public and private water supply wells	Section 12.0

Table 3-5. Major environmental programs of NNSA/NSO (continued)

NNSA/NSO Environmental Program	Environmental Protection Action Addressed	Program Description	Section Reference[(a)]
Industrial Sites Activity	Conduct environmental monitoring to detect, characterize, and respond to releases from DOE activities	Characterizes and remediates contamination from radiological and hazardous wastes or materials located at past NNSS industrial sites	Section 11.1
Soils Activity	Conduct environmental monitoring to detect, characterize, and respond to releases from DOE activities	Characterizes and remediates radiological soil contamination from past NNSS activities	Section 11.2
Community Environmental Monitoring Program	Conduct environmental monitoring to detect releases from DOE activities	Monitors ambient gross alpha and beta radioactivity, gamma radiation, and gamma-emitting radionuclides in offsite community air sampling stations and tritium in offsite water supply sources	Section 7.0
Radiological Waste Management	Public health and environmental protection and compliance	Manages and safely disposes of low-level waste and mixed low-level waste generated by NNSA/NSO, other DOE, and selected U.S. Department of Defense operations	Section 10.1
Air Quality Protection (Non-radiological)	Conduct environmental monitoring to detect releases from DOE activities Conform to Nevada's air quality implementation plan to attain and maintain national ambient air quality standards	Collects and reports air quality data to ensure that NNSA/NSO operations comply with all air quality permits and federal and state standards	Section 4.2
Water Quality Protection (Non-radiological)	Conduct environmental monitoring to detect releases from DOE activities Comply with water quality standards	Collects and reports drinking water and wastewater quality to ensure that NNSA/NSO operations comply with all water quality permits and federal and state standards	Section 5.2
National Environmental Policy Act Compliance	Assess environmental impacts of NNSA/NSO activities	Assesses the environmental effects, values, and reasonable alternatives of proposed projects before deciding to implement any major NNSA/NSO action	Section 2.7
Cultural Resources Management Program and Historic Preservation	Assess environmental impacts of NNSA/NSO activities Identify and protect cultural resources	Collects and provides information used to evaluate and mitigate potential impacts of proposed projects on NNSS cultural resources and ensures compliance with all state and federal requirements pertaining to cultural resources on the NNSS	Section 15.0
Ecological Monitoring and Compliance Program	Assess environmental impacts of NNSA/NSO activities Evaluate the potential impacts to biota in the vicinity of a DOE activity Protect natural resources	Collects ecological information used to evaluate and mitigate potential impacts of proposed projects on NNSS ecosystems and biota and ensures compliance with all state and federal requirements to protect NNSS biota and habitats	Section 16.0
Emergency Services and Operations Support – Wildland Fire Management	Protect site resources from wildland fires	Minimizes the vulnerability of NNSS personnel, property, and wildlife to wildland fire damage	Section 16.6
Groundwater Protection Program	Implement a site-wide approach for groundwater protection	Integrates site-wide groundwater-related activities across multiple programs	Section 14.0

Table 3-5. Major environmental programs of NNSA/NSO (continued)

NNSA/NSO Environmental Program	Environmental Protection Action Addressed	Program Description	Section Reference[(a)]
Hazardous Materials Management	Assist in meeting the chemical emergency planning, release, and reporting requirements of the EPCRA and the Pollution Prevention Act of 1990	Safely manages hazardous materials used and stored for NNSA/NSO activities	Section 13.0
Hazardous and Solid Waste Management	Public health and environmental protection and compliance	Safely manages and disposes of hazardous and solid wastes generated by NNSA/NSO operations	Section 10.2, 10.3, 10.4
Meteorological Monitoring	Public health and environmental protection	Conducted by the Air Resources Laboratory, Special Operations and Research Division (SORD) of the National Oceanic and Atmospheric Administration; provides air dispersion and atmospheric sciences support to NNSA/NSO operations at the NNSS and elsewhere, as needed	Section A.3 of *Attachment A: Site Description* (electronic file included on compact disc of this report); see also SORD website http://www.sord.nv.doe.gov
Quality Assurance Program	Ensure that analytical work for environmental and effluent monitoring supports data quality objectives, using a documented approach for collecting, assessing, and reporting environmental data	Ensures that quality is integrated into the environmental monitoring data collected and analyzed	Sections 17.0 and 18.0

(a) The section(s) within this document that present environmental protection and compliance activities of the listed program

3.4 Legal and Other Requirements

NNSA/NSO and its contractors comply with all applicable laws and regulations. Baseline laws and regulations are supplemented on an activity-specific basis as needed. Operating directives and procedures are developed to meet all legal requirements through controlled processes. Company planning documents, policies, and procedures implement the directives, 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 standards are implemented, business objectives are achieved, and the workers, public, and environment are protected.

NNSA/NSO and its contractors operate within the constraints of various federal, state, and local environmental permits. These permits often prescribe operational controls, records management, and monitoring and measuring requirements. 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 14001:2004 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; and working group members received 1 week of training on the environmental and quality ISO standards. Ongoing EMS awareness is accomplished by publishing environmental articles in electronic newsletters and in a printed newsletter that is mailed to NSTec employees' homes. Focused environmental briefings are given at tail-gate meetings in the field prior to work with high or non-routine environmental risk. Awareness training was again provided to employees prior to the ISO 14001 recertification assessment conducted in March 2011.

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 website, 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.

3.6 Audits and Operational Assessments

The ISO 14001 certifying organization conducts semi-annual surveillances on focused portions of the EMS. Findings and recommendations in those reports are also entered and tracked in the companywide issues tracking system, caWeb. Corrective actions taken to close the issues help to continually improve the EMS program. In 2011, a surveillance was conducted in January and a recertification assessment was conducted in March. The EMS passed the recertification assessment, and on June 21, 2011, the ISO 14001:2004 certification was extended for 3 more years.

The EMS Description document states that an independent internal audit of portions of the EMS program will be performed each year. A 2011 independent audit conducted by NSTec's Quality & Performance Improvement Division found a few minor issues, and these were entered into caWeb for tracking until the issues are closed.

Additionally, NSTec's Environment, Safety, Health, and Quality Division 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 and Reporting

The ISO 14001:2004 certification of the EMS program has enabled NNSA/NSO to declare that they have met executive and DOE order requirements. The ISO 14001:2004 certifying organization stated after the March recertification assessment that the EMS program remains effective and that certification is renewed.

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.

The establishment of annual environmental EMS targets assists in 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 14001:2004 assessor, and is an excellent way to inform upper management of emerging issues and obtain their input and support. NNSA/NSO representatives also attend these briefings, so they can contribute input, observe management involvement, and participate in emerging issue discussions and decisions.

On December 6, 2011, the 2011 Facility EMS Annual Report Data for the NNSS was entered into the DOE Headquarters EMS database accessed through the FedCenter.gov website (http://www.fedcenter.gov/programs/ems/).

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 NNSS scored "green" (the highest score).

3.8 Awards and Recognition

NNSA awarded NNSA/NSO with an Environmental Stewardship Award in the Category of Water Resources for the NLVF Building C-1 Xeric Landscaping Project. The project replaced 35,000 square feet of grass with xeric landscaping and a drip watering system, which will save approximately 1.9 million gallons of water each year. There will also be a cost savings for avoiding lawn maintenance of $32,000 each year.

4.0 Air Monitoring

Section 4.1 presents the results of radiological air monitoring conducted on the Nevada National Security Site (NNSS) to verify compliance with radioactive air emission standards. Measurements of radioactivity in air samples are also used to assess radiological dose to the general public. The assessed dose to the public from all exposure pathways is presented in Chapter 9. Section 4.2 presents the results of nonradiological air quality assessments that are conducted to ensure compliance with NNSS air quality permits (see Section 2.2).

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

4.1 Radiological Air Monitoring

NNSS sources of radioactive air emissions include evaporation of tritiated water from containment ponds; diffusion of tritiated water vapor from soil at the Area 3 Radioactive Waste Management Site (RWMS), the Area 5 Radioactive Waste Management Complex (RWMC), Sedan Crater, and Schooner Crater; release of tritium gas during equipment calibrations; release of and resuspension of contaminated soil at historical nuclear device safety test and atmospheric test locations; and release of radionuclides from current facility operations (Figure 4-1). The NNSS air monitoring network consists of samplers placed near sites of soil contamination, at facilities that may produce radioactive air emissions, and along the NNSS boundaries. The objectives and design of the network are described in the *Routine Radiological Environmental Monitoring Plan* (Bechtel Nevada, 2003a).

Data from NNSS sampling stations are analyzed to meet the specific goals listed below. The analytes monitored to perform dose assessments are also listed; these include the radionuclides most likely to be present in the air as a result of past or current NNSS operations, based on inventories of radionuclides in surface soil (McArthur, 1991), and on the volatility and availability of radionuclides for resuspension (see Table 1-5 for the half-lives of these radionuclides). Uranium is included because depleted uranium (DU) is used during exercises in specific areas of the NNSS; samples from stations near these areas are analyzed for uranium. Gross alpha and 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. Measure radionuclide concentrations in air to determine if the air pathway dose to any member of the public from past or current NNSS activities complies with the Clean Air Act (CAA) National Emission Standards for Hazardous Air Pollutants (NESHAP) standard of 10 millirem per year (mrem/yr) (0.1 millisievert per year [mSv/yr]) (see Chapter 9 for the estimate of public dose from the air pathway). 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 (0.1 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) complies with the 100 mrem/yr standard set by U.S. Department of Energy (DOE) Order DOE O 458.1, "Radiation Protection of the Public and the Environment" (see Chapter 9 for estimates of dose from all pathways).	Americium-241 (^{241}Am) Cesium-134 (^{137}Cs) 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.

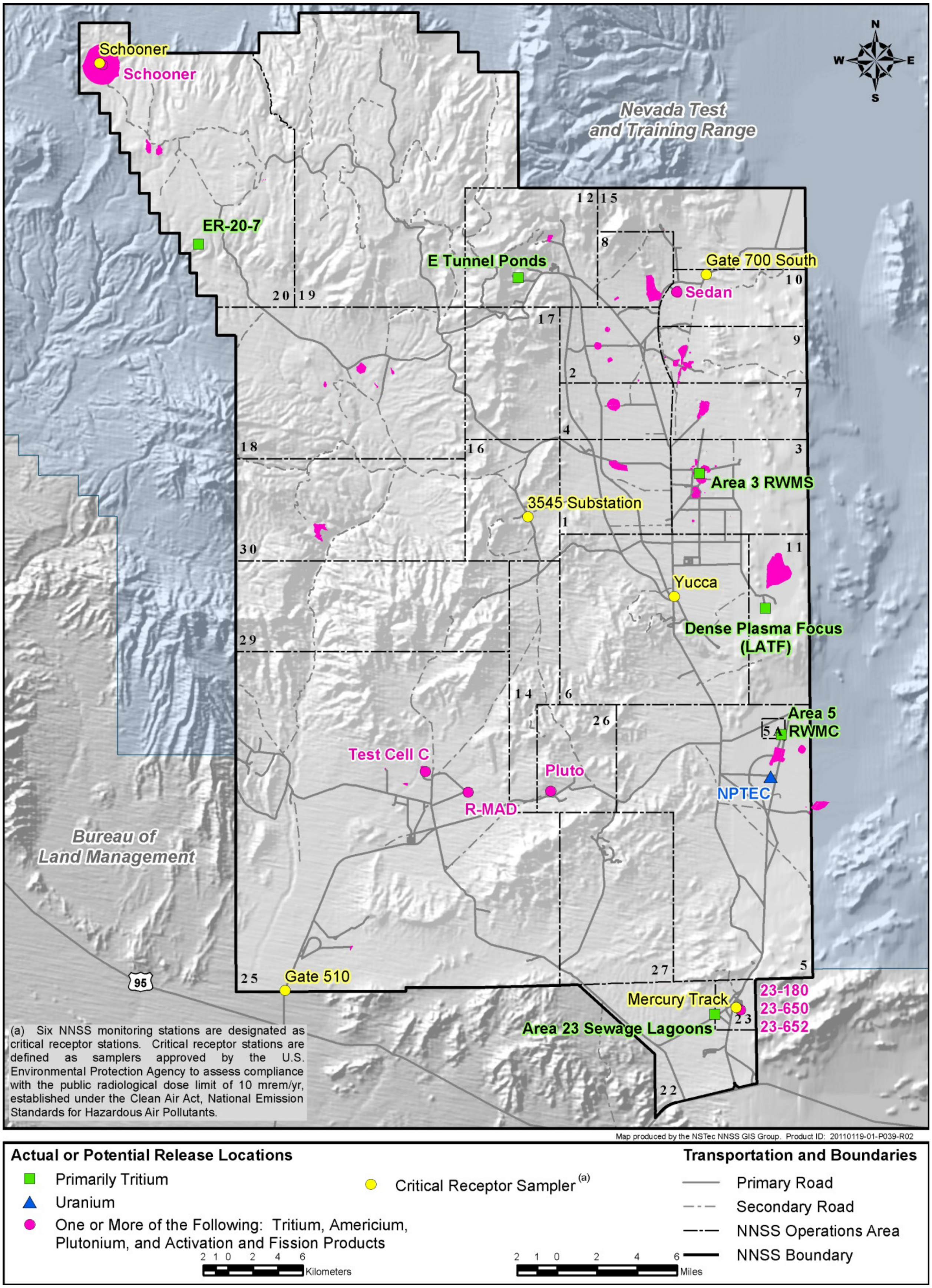

Figure 4-1. Sources of radiological air emissions on the NNSS in 2011

4.1.1 Monitoring System Design

Environmental Samplers – There are 19 environmental sampling stations; 15 have both air particulate and tritium (atmospheric moisture) samplers, 3 stations have only air particulate samplers, and 1 station has only a tritium sampler (Figure 4-2). They are located throughout the NNSS in or near the highest diffuse radiation sources. Predominant winds were a factor in station placement (for NNSS wind rose data, see Section A.3 of *Attachment A: Site Description*, included as a separate file on the compact disc of this report). Diffuse radiation sources include areas with (1) radioactivity in surface soil that can be resuspended by the wind, (2) tritium in water (tritiated water) transpiring or evaporating from plants and soil at the sites of past nuclear tests, and (3) tritiated water evaporating from ponds receiving water either from contaminated wells or from tunnels that cannot be sealed. 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% 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 in order to avoid exceeding regulatory dose limits.

Critical Receptor Samplers – Six of the 19 environmental sampler stations having both air particulate and tritium samplers, which are located near the boundaries and center of the NNSS, are approved by the U.S. Environmental Protection Agency (EPA) Region IX as critical receptor samplers (Figure 4-2). 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 CLs 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 CL and then adding the fractions together, is less than 1.0 at all stations.

Point-Source (Stack) Sampler – One facility on the NNSS, the Joint Actinide Shock Physics Experimental Research (JASPER) facility in Area 27 (Figure 4-2), requires stack monitoring while operating because it has the potential to emit airborne radionuclides that could result in an offsite radiation dose ≥0.1 mrem/yr. JASPER did not operate during 2010, but it resumed operations in March 2011.

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

Radionuclide	Concentration (× 10^{-15} microcuries/milliliter [µCi/mL])	
	NESHAP Concentration Level for Environmental Compliance (CL)[a]	10% of Derived Concentration Guide (DCG)[b]
^{241}Am	1.9	2
^{137}Cs	19	40,000
^{3}H	1,500,000	10,000,000
^{238}Pu	2.1	3
^{239}Pu	2	2
^{233}U	7.1	9
^{234}U	7.7	9
^{235}U	7.1	10
^{236}U	7.7	10
^{238}U	8.3	10

Note: Both the CL values and 10% of the DCG values represent an annual average resulting in a total effective dose equivalent (TEDE) of 10 mrem/yr, the federal dose limit to the public from all radioactive air emissions. They are computed using different dose models; the more conservative CLs are used in this report.

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

(b) From DOE-STD-1196-2011, "Derived Concentration Technical Standard"; see Glossary, Appendix B for definition

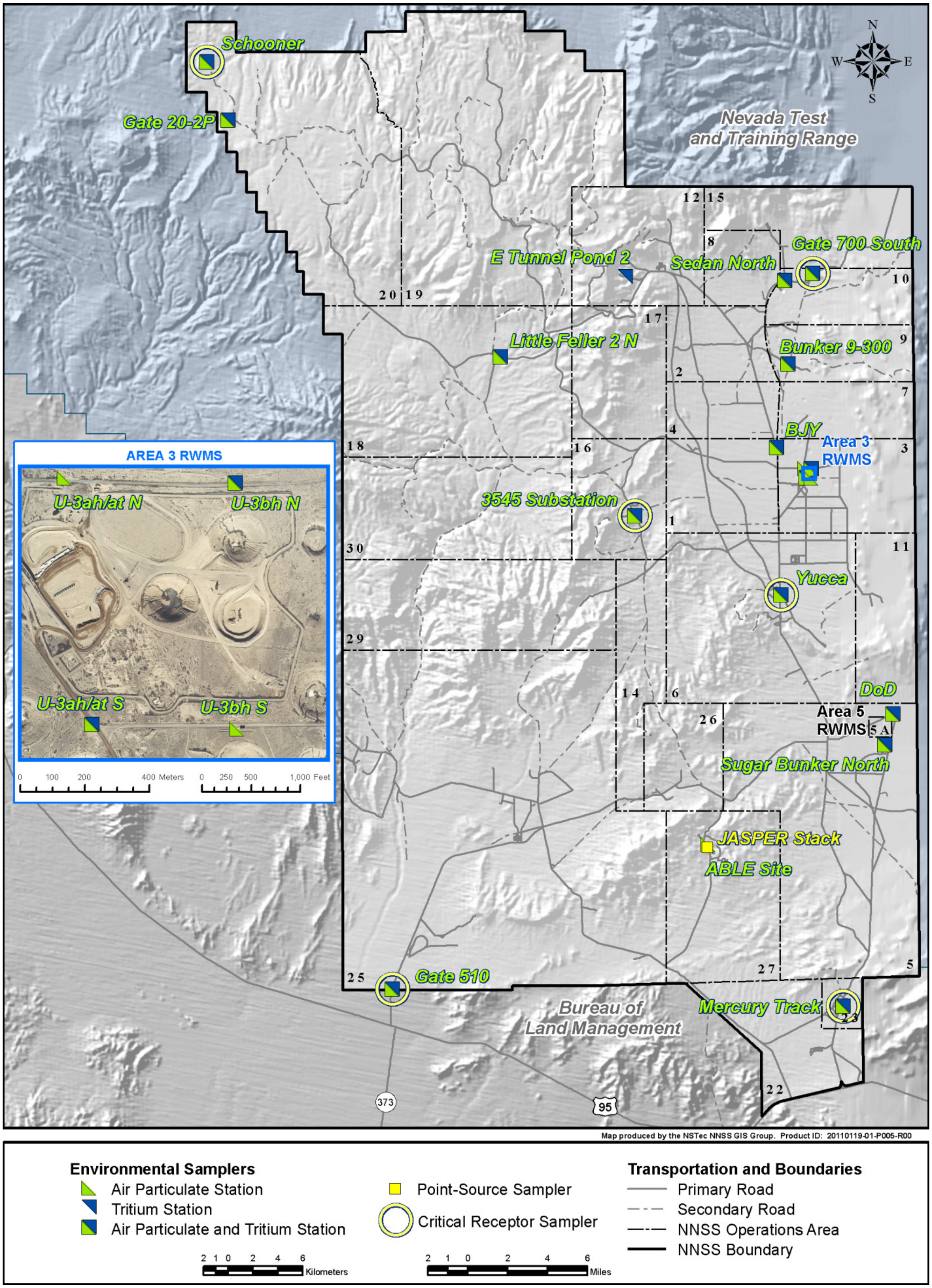

Figure 4-2. Radiological air sampling network on the NNSS in 2011

4.1.2 Air Particulate and Tritium Sampling Methods

A weekly sample is 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 timer 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 7-day sampling period. The air sampling rates are measured at the start and end of each sampling period with mass-flow meters that are calibrated annually.

The filters are analyzed for gross alpha and gross beta radioactivity after a 5-day holding time to allow for the decay of naturally occurring radon progeny. The filters collected within each month are composited for each station, analyzed by gamma spectroscopy for gamma-emitting radionuclides, 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 activities using DU, the filter composites from Sugar Bunker North (Area 5), Yucca (Area 6), Gate 700 S (Area 10), 3545 Substation (Area 16), Gate 20-2P (Area 20), Gate 510 (Area 25), and ABLE Site (Area 27) are also analyzed for uranium isotopes by alpha spectroscopy.

Tritiated water vapor in the form of $^3H^3HO$ or ^3HHO (collectively referred to as HTO) is sampled continuously over 2-week periods at each tritium sampling station. Tritium samplers are 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 2-week sampling period). The HTO is 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 are exchanged biweekly. An aliquot of the total moisture collected is 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 frequently incorporated into the analytical suites. Chapter 17 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 2011 annual average radionuclide concentrations at each air sampling station are presented in the following sections. The annual average concentration for each radionuclide was calculated from uncensored analytical results for individual samples; i.e., values less than their analysis-specific minimum detectable concentrations (MDCs; see Glossary, Appendix B) were included in the calculation.

In graphs of concentration data, the CL (second column of Table 4-1) or a fraction of the CL is included as a green horizontal line. For graphs displaying individual measurements, the CL or fraction thereof is shown for reference only, rather than to demonstrate compliance with NESHAP dose limits, because assessment of NESHAP compliance is based on annual average concentrations rather than individual measurements.

For convenience in reporting, values shown in the tables in the following sections are frequently formatted to a greater number of significant digits than can be justified by the inherent 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

Nearly all of the elevated radionuclide concentrations in the 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 low-level radioactive waste burial. The exceptions involve elevated ^{137}Cs and gross beta measurements resulting from the Fukushima Daiichi nuclear power plant event in Japan.

4.1.4.1 Americium-241

The mean ^{241}Am concentration for environmental sampler stations is 15.99 × 10^{-18} µCi/mL, somewhat higher than in 2010 (6.99 × 10^{-18} µCi/mL) and 2009 (6.33 × 10^{-18} µCi/mL), but still less than 1 % of the CL. As usual, the highest concentrations are detected at the Bunker 9-300 sampling station in Area 9 (Table 4-2 and Figure 4-3). This sampler is located within areas of known soil contamination from past nuclear tests. The annual mean concentration at Bunker 9-300 is 93.31 × 10^{-18} µCi/mL, 4.9% of the CL. In Figure 4-3, the measurements at Bunker 9-300 are shown individually. The plot also shows the mean monthly concentrations at other stations, with vertical bars extending from the lowest to highest measurements at the other stations.

Table 4-2. Concentrations of ^{241}Am in air samples collected in 2011

			^{241}Am (× 10^{-18} µCi/mL)			
Area	**Sampling Station**	**Number of Samples**	**Mean**	**Standard Deviation**	**Minimum**	**Maximum**
1	BJY	12	11.74	5.10	5.13	20.95
3	U-3ah/at N	12	18.89	13.79	3.45	56.94
3	U-3ah/at S	12	38.01	30.66	8.90	105.41
3	U-3bh N	12	14.00	10.19	-0.65	30.62
3	U-3bh S	12	11.91	6.21	0.00	22.58
5	DoD	12	6.15	3.62	-0.84	13.66
5	Sugar Bunker N	12	5.36	3.91	0.00	11.38
6	Yucca*	12	8.89	5.59	0.00	19.29
9	Bunker 9-300	12	93.31	61.03	3.68	231.01
10	Gate 700 S*	12	4.96	4.52	-2.34	12.90
10	Sedan N	12	23.61	30.94	3.05	101.46
16	3545 Substation*	12	5.46	5.05	-6.23	13.79
18	Little Feller 2 N	12	7.24	3.28	0.00	12.01
20	Gate 20-2P	12	4.44	3.24	0.00	9.07
20	Schooner*	12	10.63	9.10	2.64	34.98
23	Mercury Track*	12	10.50	13.46	0.00	51.44
25	Gate 510*	12	7.00	3.12	-0.88	10.87
27	ABLE Site	12	5.66	4.25	0.00	12.45
All Environmental Locations		**216**	**15.99**	**27.33**	**-6.23**	**231.01**
27	JASPER stack	10	150.80	151.09	-29.94	381.91
CL = 1,900 × 10^{-18} µCi/mL						
*** EPA-approved Critical Receptor Station**						

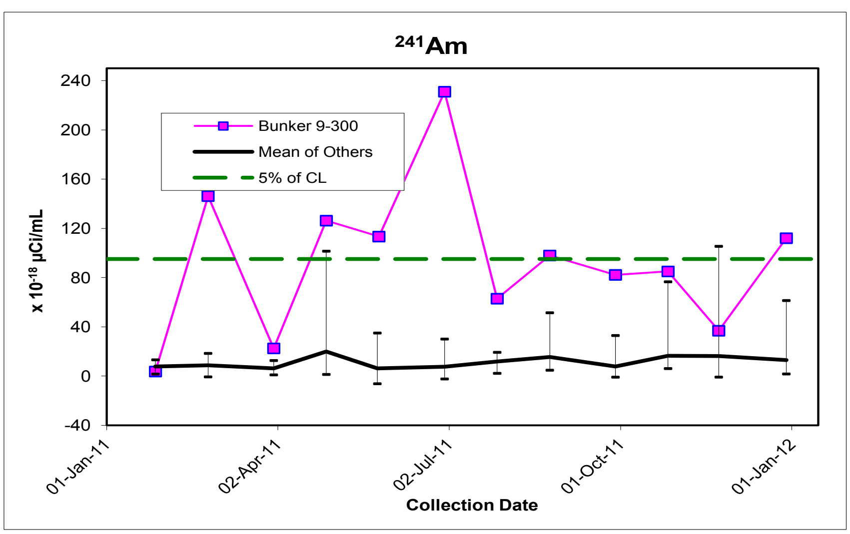

Figure 4-3. Concentrations of ^{241}Am in air samples collected in 2011

4.1.4.2 Cesium

During 2011, both ^{134}Cs and ^{137}Cs were high at all stations during March, with lower values in April (Figure 4-4) and returning to not detected for the remainder of the year. The timing of the higher values coincide with detections across the western United States (Leon et al., 2011), including those made by the EPA (2011) and the Desert Research Institute (Community Environmental Monitoring Program, 2011) and are due to the Fukushima Daiichi nuclear power plant event in Japan. Because ^{137}Cs data are more complete for the year (^{134}Cs is not reported from the laboratory when not detected), only ^{137}Cs data are listed in Table 4-3. If the March and April Japan-related results were omitted, the overall mean measurement for environmental stations would be -2.10×10^{-17} µCi/mL, with the overall maximum being 92.67×10^{-17} µCi/mL. These values are consistent with those of prior years.

Table 4-3. Concentrations of ^{137}Cs in air samples collected in 2011

Area	Sampling Station	Number of Samples	^{137}Cs ($\times 10^{-17}$ µCi/mL) Mean	Standard Deviation	Minimum	Maximum
1	BJY	12	76.78	272.22	-31.50	938.43
3	U-3ah/at N	12	74.80	264.83	-55.77	907.98
3	U-3ah/at S	12	86.48	277.62	-21.82	965.22
3	U-3bh N	12	89.04	306.76	-39.38	1060.14
3	U-3bh S	12	101.13	347.69	-20.25	1203.40
5	DoD	12	80.21	277.24	-31.80	957.32
5	Sugar Bunker N	12	88.71	310.84	-39.27	1072.85
6	Yucca*	12	91.44	313.02	-30.29	1082.68
9	Bunker 9-300	12	83.92	268.47	-35.23	934.07
10	Gate 700 S*	12	94.42	306.66	-16.76	1066.93
10	Sedan N	12	82.33	297.62	-40.41	1024.90
16	3545 Substation*	12	85.94	314.90	-30.94	1083.29
18	Little Feller 2 N	12	68.49	222.20	-22.07	770.25
20	Gate 20-2P	12	73.67	249.51	-20.64	862.85
20	Schooner*	12	68.23	239.76	-22.93	827.78
23	Mercury Track*	12	105.57	368.85	-17.52	1276.12
25	Gate 510*	12	91.63	279.24	-21.58	975.02
27	ABLE Site	12	86.45	321.25	-35.03	1103.48
All Environmental Locations		**216**	**84.96**	**281.60**	**-55.77**	**1276.12**
27	JASPER stack	10	-131.98	463.18	-984.93	687.12
CL = 1,900 × 10^{-17} µCi/mL						
*** EPA-approved Critical Receptor Station**						

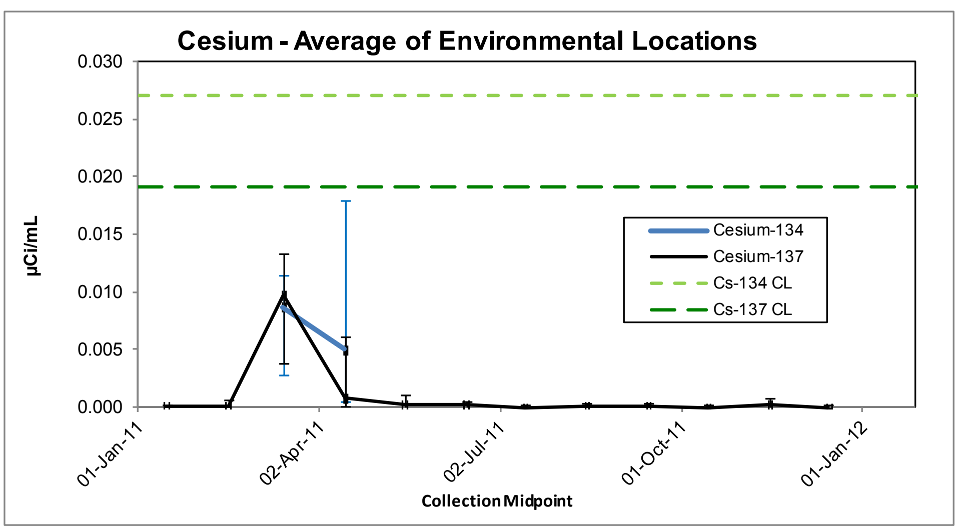

Figure 4-4. Concentrations of cesium in air samples collected in 2011

4.1.4.3 Plutonium Isotopes

The overall mean concentration for ^{238}Pu at environmental stations during 2011 (3.72 × 10^{-18} µCi/mL) is somewhat higher than was measured for 2010 (1.88 × 10^{-18} µCi/mL) and 2009 (1.15 × 10^{-18} µCi/mL), as is the case for ^{241}Am. Bunker 9-300 (Area 9) measurements are slightly higher than those of other stations, although not so prominently as is the case with ^{241}Am and $^{239+240}$Pu (see Figure 4-5). The highest mean concentration at environmental stations is only 0.4% of the CL.

Plutonium isotopes $^{239+240}$Pu (analytical methods cannot readily distinguish between ^{239}Pu and ^{240}Pu) are of greater abundance and hence greater interest. The overall mean of 70.2 × 10^{-18} µCi/mL is higher than the means for recent years, but lower than those of 2006 and 2005 (138 and 148 × 10^{-18} µCi/mL, respectively). The location with the highest mean, as expected, is Bunker 9-300 (581 × 10^{-18} µCi/mL, 29.1% of the CL; see Table 4-5 and Figure 4-6). The higher plutonium values at this station are due to diffuse sources of radionuclides from historical nuclear testing in Area 9 and surrounding Areas 4 and 7.

The temporal patterns for ^{241}Am, $^{239+240}$Pu, and to some extent ^{238}Pu at Bunker 9-300, shown in Figures 4-3, 4-6, and 4-5, respectively, are correlated. This is 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 that of ^{241}Am is 432 years. Consequently, the amount of ^{241}Am will gradually increase as ^{241}Pu decays; then it will decrease at a rate of half every 432 years.

Table 4-4. Concentrations of ^{238}Pu in air samples collected in 2011

			^{238}Pu (× 10^{-18} µCi/mL)			
Area	**Sampling Station**	**Number of Samples**	**Mean**	**Standard Deviation**	**Minimum**	**Maximum**
1	BJY	12	3.32	2.83	-1.15	6.89
3	U-3ah/at N	12	2.91	3.65	-3.74	9.25
3	U-3ah/at S	12	5.35	3.32	0.00	12.79
3	U-3bh N	12	2.98	3.88	-2.91	9.16
3	U-3bh S	12	3.70	1.48	1.24	6.41
5	DoD	12	1.87	2.42	-2.36	4.70
5	Sugar Bunker N	12	4.41	4.11	-2.91	11.54
6	Yucca*	12	2.84	2.19	-0.30	6.49
9	Bunker 9-300	12	8.81	5.75	0.00	18.48
10	Gate 700 S*	12	2.71	6.08	-11.84	14.69
10	Sedan N	12	5.11	6.11	-2.93	16.85
16	3545 Substation*	12	3.00	2.69	-1.56	7.97
18	Little Feller 2 N	12	1.92	2.97	-5.23	5.42
20	Gate 20-2P	12	2.02	2.74	-3.93	5.87
20	Schooner*	12	7.73	8.96	0.00	34.98
23	Mercury Track*	12	2.30	2.90	-2.93	5.82
25	Gate 510*	12	3.26	4.54	-2.93	14.10
27	ABLE Site	12	2.76	2.74	-4.40	5.06
All Environmental Locations		**216**	**3.72**	**4.49**	**-11.84**	**34.98**
27	JASPER stack	10	48.68	73.49	-60.12	161.66
CL = 2,100 × 10^{-18} µCi/mL						
*** EPA-approved Critical Receptor Station**						

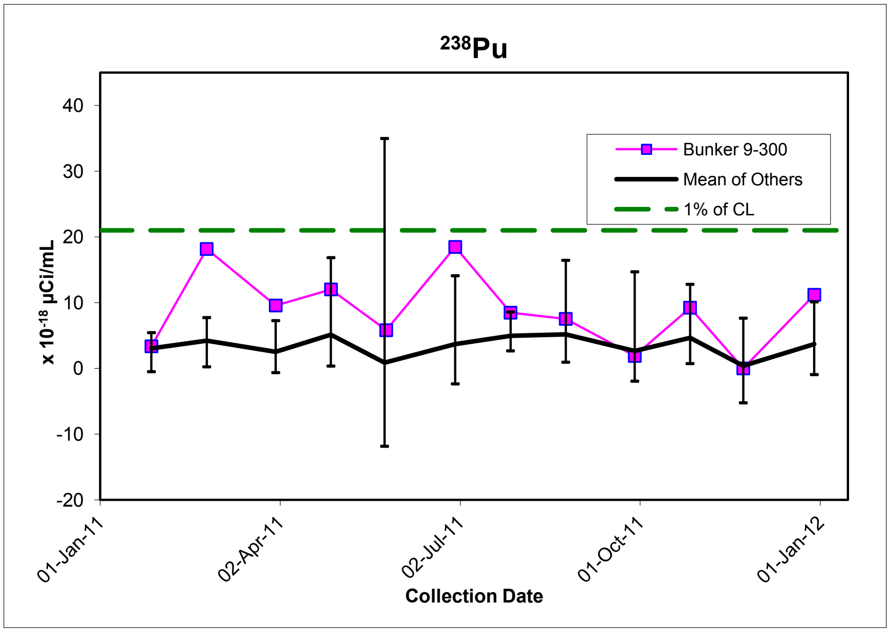

Figure 4-5. Concentrations of ^{238}Pu in air samples collected in 2011

Table 4-5. Concentrations of $^{239+240}$Pu in air samples collected in 2011

Area	Sampling Station	Number of Samples	$^{239+240}$Pu ($\times 10^{-18}$ µCi/mL) Mean	Standard Deviation	Minimum	Maximum
1	BJY	12	48.32	52.63	5.06	165.93
3	U-3ah/at N	12	94.39	100.90	6.82	360.69
3	U-3ah/at S	12	243.67	276.57	1.54	1006.59
3	U-3bh N	12	68.76	61.19	1.23	176.49
3	U-3bh S	12	53.22	46.00	2.03	136.38
5	DoD	12	6.01	3.76	0.00	11.38
5	Sugar Bunker N	12	3.95	1.84	0.67	7.20
6	Yucca*	12	15.90	12.77	5.80	53.32
9	Bunker 9-300	12	581.31	394.22	13.42	1476.13
10	Gate 700 S*	12	13.31	11.28	-0.54	40.20
10	Sedan N	12	81.14	164.47	2.81	597.70
16	3545 Substation*	12	4.36	2.26	0.50	7.03
18	Little Feller 2 N	12	5.09	3.53	1.74	12.74
20	Gate 20-2P	12	4.62	3.09	-0.27	10.98
20	Schooner*	12	3.90	5.50	-4.06	19.43
23	Mercury Track*	12	26.61	76.45	0.00	268.88
25	Gate 510*	12	2.97	1.37	1.02	6.21
27	ABLE Site	12	5.56	5.19	1.38	20.43
All Environmental Locations		**216**	**70.17**	**182.34**	**-4.06**	**1476.13**
27	JASPER stack	10	99.04	137.56	-23.16	387.52
CL = 2,000 $\times 10^{-18}$ µCi/mL						
*** EPA-approved Critical Receptor Station**						

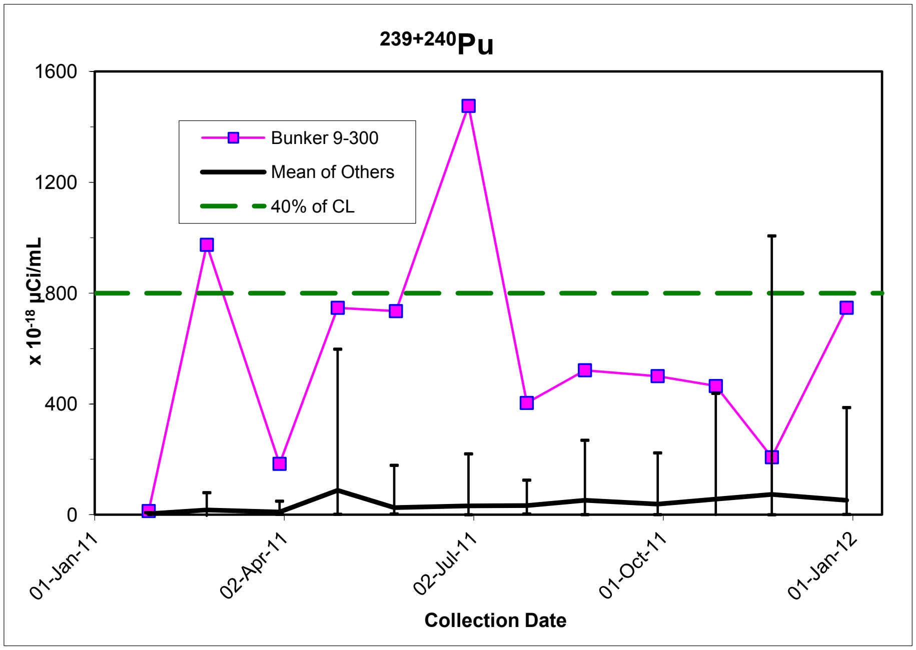

Figure 4-6. Concentrations of $^{239+240}Pu$ in air samples collected in 2011

Figure 4-7 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 44 locations, Figure 4-7 shows the average (geometric mean) trend lines for Areas 1 and 3; Area 5; Areas 7, 9, 10, and 15; as well as other areas. Areas 1, 3, 7, 9, 10, and 15, in the northeast portion of the NNSS, have a legacy of soil contamination from surface and atmospheric nuclear tests and safety shots. The average annual rates of decline for these groups range from 2.1% (Areas 1 and 3) and 3.1% (Areas 7, 9, 10, and 15) to over 12% ("Other Areas" group). This equates to an environmental half-life in air for $^{239+240}Pu$ of 32.9 years for Areas 1 and 3; 22.2 years for Areas 7, 9, 10, and 15; and about 5 years for the "Other Areas" group. Declining rates are not attributed to radioactive decay, as the physical half-lives of ^{239}Pu and ^{240}Pu are 24,110 and 6,537 years, respectively. The decreases are primarily due to immobilization and dilution of Pu particles in soil resulting in reduced concentrations suspended in air. The half-life of the less abundant ^{238}Pu is 88 years.

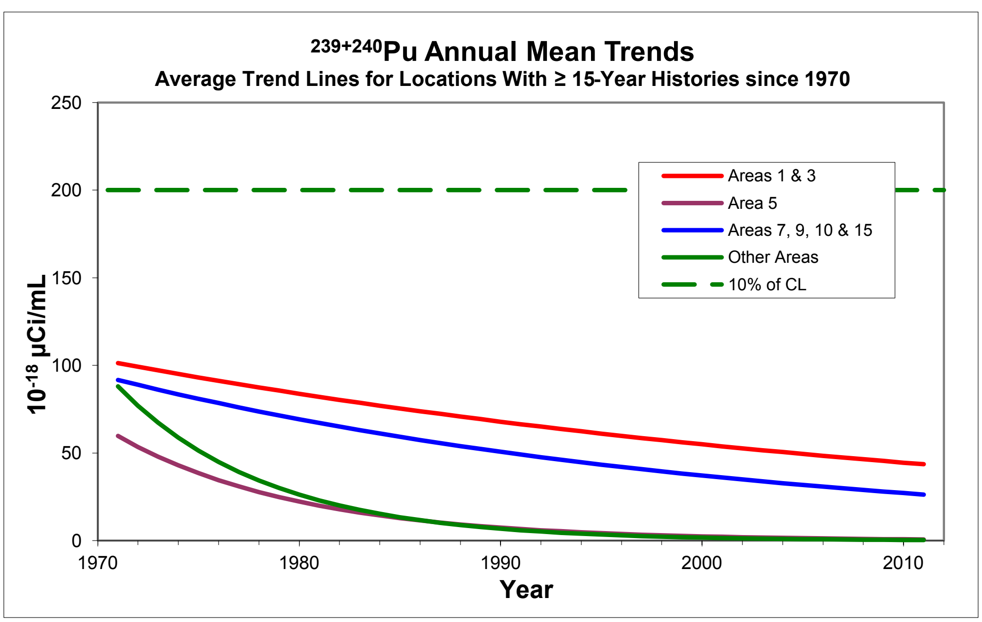

Figure 4-7. Average trends in $^{239+240}Pu$ in air annual means, 1971–2011

4.1.4.4 Uranium Isotopes

Uranium analyses by radiochemistry are performed for samples from seven stations; Gate 700 S (Area 10) was added in 2011 to the stations previously used. Exercises using DU ordnance have been conducted in the past in Areas 20 and 25. The annual mean concentrations are shown in Table 4-6; note that the scale factor in Table 4-6 is the same for $^{233+234}U$ and ^{238}U but an order of magnitude lower for $^{235+236}U$. Mean concentrations of $^{233+234}U$ and ^{238}U are somewhat higher than in 2009 and 2010; the mean concentration of $^{235+236}U$ remains about the same. These are 3.3% to 3.6% of the CL for $^{233+234}U$, 2.9 to 3.0% of the CL for ^{238}U, and 0.2% of the CL for $^{235+236}U$.

Table 4-6. Concentrations of uranium isotopes in air samples collected in 2011

Area	Sampling Station	Number of Samples	Mean	Standard Deviation	Minimum	Maximum
			$^{233+234}U$ by Radiochemistry (× 10^{-17} µCi/mL)			
5	Sugar Bunker N	12	24.64	3.61	18.94	31.47
6	Yucca*	12	25.24	2.09	22.01	28.08
10	Gate 700 S*	9	24.08	4.45	16.14	31.83
16	3545 Substation*	12	25.02	4.64	16.65	32.77
20	Gate 20-2P	12	23.44	2.53	19.54	26.48
25	Gate 510*	12	24.88	3.66	16.75	30.26
27	ABLE Site	12	25.19	3.05	19.10	29.27
All Environmental Locations		**81**	**24.66**	**3.42**	**16.14**	**32.77**
CL = 710 × 10^{-17} µCi/mL						
			$^{235+236}U$ by Radiochemistry (× 10^{-18} µCi/mL)			
5	Sugar Bunker N	12	11.79	8.07	0.00	25.02
6	Yucca*	12	11.77	5.20	0.00	17.54
10	Gate 700 S*	9	14.54	10.73	0.00	38.28
16	3545 Substation*	12	9.98	7.02	-2.35	19.27
20	Gate 20-2P	12	11.19	7.95	-1.96	25.11
25	Gate 510*	12	15.62	7.18	3.68	26.33
27	ABLE Site	12	12.72	7.16	-1.97	25.63
All Environmental Locations		**81**	**12.44**	**7.55**	**-2.35**	**38.28**
CL = 7,100 × 10^{-18} µCi/mL						
			^{238}U by Radiochemistry (× 10^{-17} µCi/mL)			
5	Sugar Bunker N	12	24.31	3.00	21.08	31.80
6	Yucca*	12	24.17	2.74	19.69	29.29
10	Gate 700 S*	9	24.69	2.75	21.06	30.78
16	3545 Substation*	12	24.27	2.93	18.52	27.91
20	Gate 20-2P	12	24.56	3.98	15.97	30.45
25	Gate 510*	12	24.84	2.72	21.12	30.15
27	ABLE Site	12	24.48	3.42	18.78	31.30
All Environmental Locations		**81**	**24.49**	**3.01**	**15.97**	**31.80**
CL = 830 × 10^{-17} µCi/mL						
*** EPA-approved Critical Receptor Station**						

The ratios of the uranium isotope concentrations are given in Table 4-7. Table 4-8 presents the values expected of those ratios for uranium from different sources. Natural uranium is believed to be the predominant source of uranium in air samples based on the mean $^{235+236}U/^{238}U$ ratio being most consistent with natural uranium, although the mean $^{233+234}U/^{238}U$ ratio is below the target values for both natural and depleted uranium.

Table 4-7. Observed values of uranium isotope ratios in 2011

	Isotope Ratio Values	
	$^{233+234}U$ / ^{238}U	$^{235+236}U$ / ^{238}U
Mean (95% CI)	1.02 (0.98, 1.06)	0.051 (0.043, 0.059)

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 NNSS (Table 4-9). The highest mean concentration was detected at the Schooner station (166 × 10^{-6} picocuries per milliliter [pCi/mL]). The next highest are 4.3 × 10^{-6} pCi/mL at E Tunnel Pond and 3.6 × 10^{-6} pCi/mL at Sedan. The Schooner Crater mean is somewhat lower than in recent years, and the others are similar to values seen in recent years. Figure 4-8 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 is 11.1% of the CL; mean concentrations at other locations are less than 0.3% of the CL.

Table 4-9. Concentrations of ^{3}H in air samples collected in 2011

Area	Sampling Station	Number of Samples	^{3}H Concentration (× 10^{-6} pCi/mL) Mean	Standard Deviation	Minimum	Maximum
1	BJY	26	0.59	0.62	-0.42	2.23
3	U-3ah/at S	26	0.61	0.79	-0.57	2.48
3	U-3bh N	26	0.30	0.55	-0.67	1.52
5	DoD	26	0.25	0.40	-0.48	1.07
5	Sugar Bunker N	26	0.25	0.46	-0.84	1.16
6	Yucca*	26	0.24	0.38	-0.30	0.96
9	Bunker 9-300	25	1.13	1.09	-0.48	3.58
10	Gate 700 S*	26	0.18	0.33	-0.34	0.90
10	Sedan N	26	3.63	3.64	-0.10	11.59
12	E Tunnel Pond	26	4.29	3.21	0.70	12.37
16	3545 Substation*	26	0.21	0.35	-0.54	0.90
18	Little Feller 2 N	25	0.10	0.34	-0.74	0.76
20	Gate 20-2P	26	0.32	0.30	-0.45	1.16
20	Schooner*	26	166.34	188.53	7.03	562.36
23	Mercury Track*	26	0.13	0.34	-0.53	0.72
25	Gate 510*	26	0.21	0.33	-0.38	0.95
All Environmental Locations		**414**	**11.22**	**61.41**	**-0.84**	**562.36**
CL = 1,500 × 10^{-6} pCi/mL						
*** EPA-approved Critical Receptor 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. At E Tunnel Pond, this increase is due to the rate of evaporation increasing as the temperature increases. At Schooner and Sedan, increased tritium emissions are likely due to the movement of relatively deep soil moisture (> 2 m) containing relatively high concentrations of tritium to the surface when temperatures are the highest and when shallow (< 2 m) soil moisture is the lowest. Rainfall can temporarily suppress these emissions by diluting the shallow soil moisture. Figure 4-8 shows the relationship between tritium and average daily temperature at Schooner Crater. Figure 4-9 shows the amount of precipitation occurring during monitoring periods in and around Pahute Mesa; note the dip in tritium emissions following the rains of the first few and last few days of July.

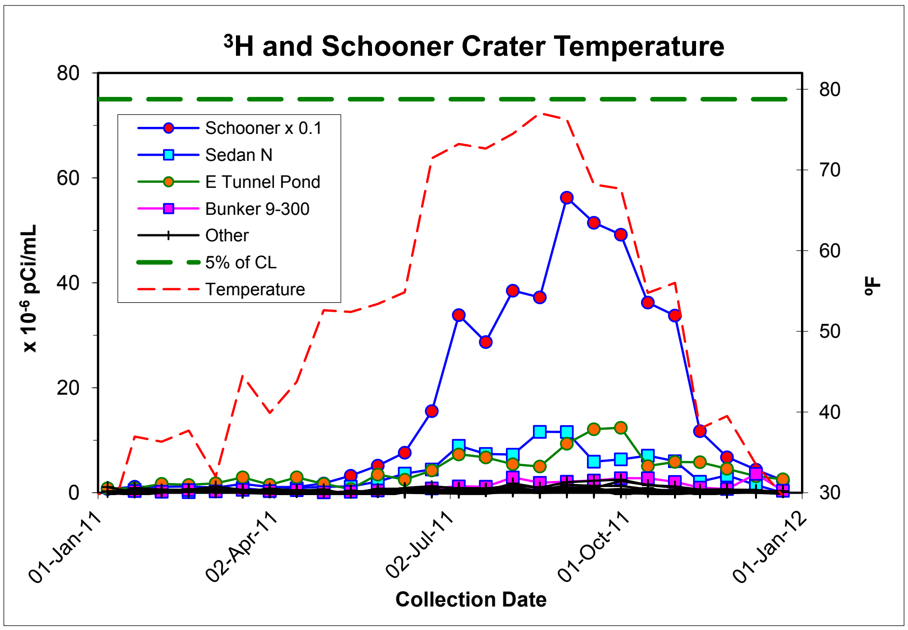

Figure 4-8. Concentrations of ^{3}H in air samples collected in 2011 with Schooner Crater average air temperature per collection period

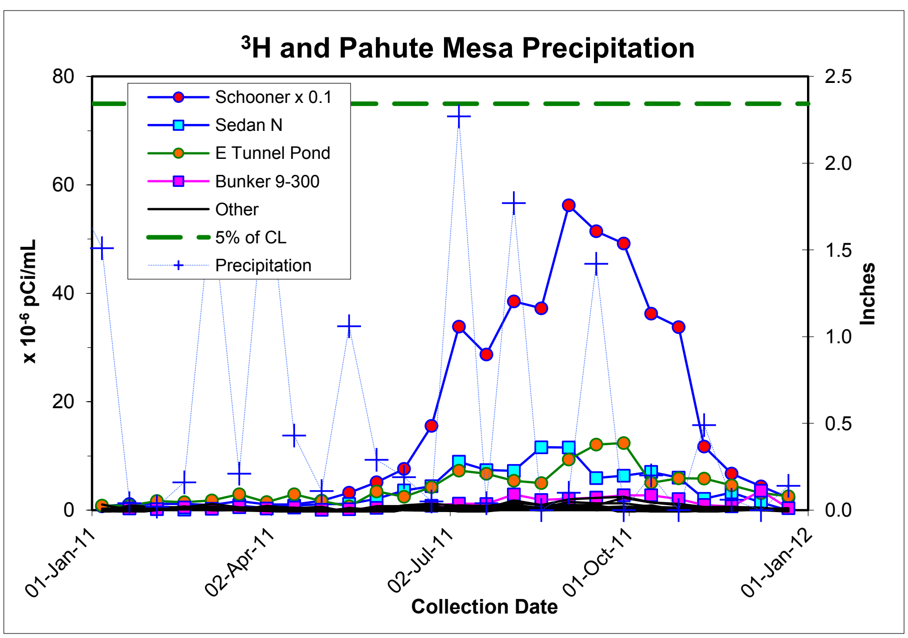

Figure 4-9. Concentrations of ^{3}H in air samples collected in 2011 with Pahute Mesa precipitation

Figure 4-10 shows average (geometric mean) long-term trends for the annual mean tritium levels at locations with at least 7-year histories since 1989. Tritium measurements have been decreasing fairly rapidly at most locations; the overall (excluding Schooner) average decline rate is around 15% per year.

Figure 4-11 shows the annual maxima for all stations by area group. The relatively high values in 1997 and 1998 occurred at the Area 6 Decon Pad. The exception to the generally decreasing trend occurs at Schooner. As Figure 4-12 shows, Schooner tritium data do not show a consistent trend; rather, tritium emissions appear to be related to the average temperatures on Pahute Mesa during the summer months.

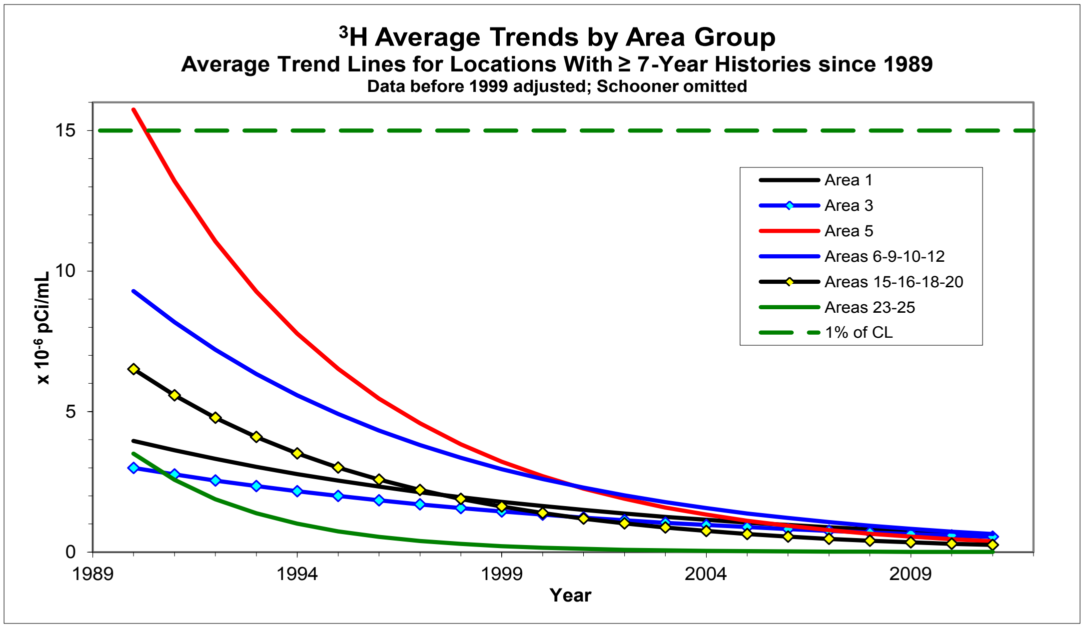

Figure 4-10. Average trends in ^{3}H in air annual means, 1990–2011, Schooner Crater excluded

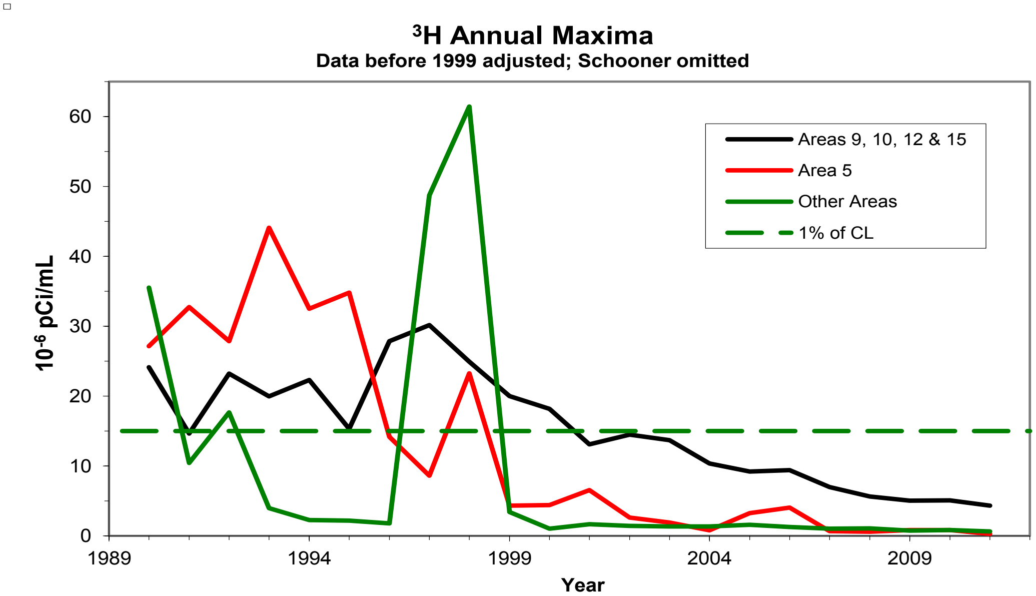

Figure 4-11. Annual maxima in ^{3}H in air annual means, 1990–2011, Schooner Crater excluded

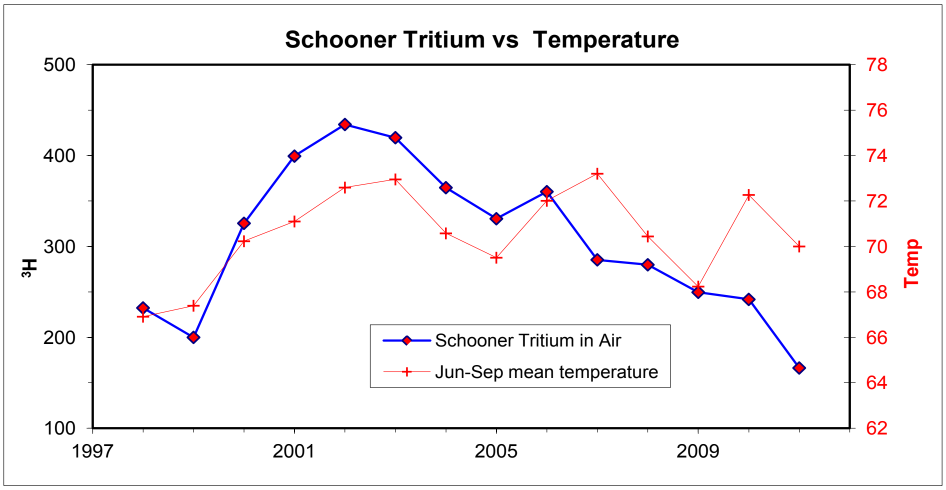

Figure 4-12. ^{3}H at Schooner Crater and June–September mean temperatures at Schooner/Pahute Mesa, 1998–2011

4.1.4.6 Gross Alpha and Gross Beta

The gross alpha and gross beta radioactivity in air samples collected in 2011 are shown 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 5 days after weekly sample collection to identify any increases requiring investigation.

Overall, the gross alpha mean for 2011 is a bit higher than in 2010, and slightly lower than that of 2009. The distribution of measurement means across the network is comparable with those of the past few years. During the last two weeks of March, the gross beta levels were elevated due to the Fukushima Daiichi nuclear power plant event in Japan, returning to historically normal levels in May. Otherwise, the gross beta measurements resembled those of prior years: the mean values are similar, and there are no stations with data that stand out from the rest.

Table 4-10. Gross alpha radioactivity in air samples collected in 2011

			Gross Alpha ($\times 10^{-16}$ µCi/mL)			
Area	**Sampling Station**	**Number of Samples**	**Mean**	**Standard Deviation**	**Minimum**	**Maximum**
1	BJY	52	22.76	15.29	-5.81	88.24
3	U-3ah/at N	51	23.04	12.57	1.12	49.99
3	U-3ah/at S	51	26.34	20.52	-4.58	121.10
3	U-3bh N	52	18.59	13.61	-5.55	49.87
3	U-3bh S	51	21.64	11.59	0.00	42.73
5	DoD	52	22.24	10.84	-2.29	48.83
5	Sugar Bunker N	52	22.82	13.04	-7.27	46.42
6	Yucca*	52	20.92	11.65	-8.97	48.52
9	Bunker 9-300	52	34.13	31.86	6.80	188.04
10	Gate 700 S*	52	16.87	10.60	-14.62	37.33
10	Sedan N	51	19.84	12.76	-7.01	57.20
16	3545 Substation*	51	15.62	12.05	-10.85	49.12
18	Little Feller 2 N	52	19.19	11.98	0.00	52.96
20	Gate 20-2P	51	14.94	10.54	-6.98	40.15
20	Schooner*	50	17.94	11.60	-9.94	50.35
23	Mercury Track*	52	20.38	14.46	-8.45	52.81
25	Gate 510*	52	18.91	12.08	-16.10	56.41
27	ABLE Site	52	18.07	10.36	-3.35	43.41
All Environmental Locations		**928**	**20.80**	**15.11**	**-16.10**	**188.04**
27	JASPER Stack	39	730.22	4117.26	-1403.22	25173.58

*** EPA-approved Critical Receptor Station**

Table 4-11. Gross beta radioactivity in air samples collected in 2011

Area	Sampling Station	Number of Samples	Gross Beta (× 10^{-15} µCi/mL) Mean	Standard Deviation	Minimum	Maximum
1	BJY	52	25.44	21.24	10.26	133.49
3	U-3ah/at N	51	25.35	21.47	10.82	130.25
3	U-3ah/at S	51	25.65	22.39	8.95	134.67
3	U-3bh N	52	25.69	21.85	8.79	135.36
3	U-3bh S	51	26.80	26.48	10.97	168.68
5	DoD	52	27.18	24.94	8.62	161.15
5	Sugar Bunker N	52	27.30	22.77	12.45	139.63
6	Yucca*	52	26.61	22.50	12.02	137.30
9	Bunker 9-300	52	25.43	22.76	9.94	140.51
10	Gate 700 S*	52	25.09	22.06	10.15	135.94
10	Sedan N	51	25.55	23.76	10.86	139.79
16	3545 Substation*	51	23.97	21.47	9.80	128.63
18	Little Feller 2 N	52	23.44	19.13	10.47	117.01
20	Gate 20-2P	51	24.07	18.36	9.70	113.55
20	Schooner*	50	24.39	19.15	10.78	119.66
23	Mercury Track*	52	26.52	25.22	6.56	146.31
25	Gate 510*	52	25.61	19.59	10.75	116.72
27	ABLE Site	52	25.78	23.09	10.18	145.90
All Environmental Locations		**928**	**25.55**	**22.05**	**6.56**	**168.68**
27	JASPER Stack	39	7.05	225.43	-954.28	993.66

*** EPA-approved Critical Receptor Station**

4.1.5 *Air Sampling Results from Critical Receptor Samplers*

The following NNSS-related radionuclides were detectable at one or more of the critical receptor samplers: ^{241}Am, ^{238}Pu, $^{239+240}$Pu, $^{233+234}$U, $^{235+236}$U, ^{238}U, and tritium. All measured concentrations of these radionuclides were well below their CLs during 2011. The uranium isotopes have been attributed to naturally occurring uranium (see Section 4.1.4.4). The concentration of each measured radionuclide (excluding uranium) at each of the six critical receptor stations is divided by its respective CL (see Table 4-1) to obtain a "percent of CL." These are 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 (Table 4-12). The highest radiation total effective dose equivalent (TEDE) (see Glossary, Appendix B) at a critical receptor location would be approximately 1.22 mrem from air to a hypothetical individual residing at Schooner for the entire calendar year. A more realistic estimate of dose to the offsite public would come from using the 0.007 sum of fractions from the Gate 510 sampler, which is closest to the nearest public receptor (about 3.5 kilometers [2.2 miles]). The estimated TEDE from air emissions for a hypothetical individual living year-round at the Gate 510 sampler would be 0.07 mrem/yr.

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

Radionuclides Included in Sum of Fractions[(a)]	NNSS Area	Sampling Station	Sum of Fractions of Compliance Levels (CLs)
^{241}Am, ^{238}Pu, $^{239+240}$Pu, ^{3}H	6	Yucca	0.014
	10	Gate 700 S	0.011
	16	3545 Substation	0.007
	20	Schooner	0.122[(b)]
	23	Mercury Track	0.020
	25	Gate 510	0.007

(a) $^{233+234}$U, $^{235+236}$U, and ^{238}U are not included in sum of fractions. If they were, the sum of fractions increases to 0.066, 0.055, and 0.058 for Yucca, 3545 Substation, and Gate 510, respectively.
(b) This equates to a hypothetical receptor at this location receiving a TEDE of 1.22 mrem from air.

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

The JASPER facility resumed operations in March 2011. During 2011, four monthly composite samples had ^{241}Am results greater than the sample specific MDC. One of these samples also had a $^{239+240}$Pu result greater than the MDC. However, there is an indication that these results are biased high because these analytes were also detected in the method blanks. The average concentrations of these radionuclides in air for the 10 months of operations (March–December) were low: 7.94% and 4.95% of the CLs for ^{241}Am and $^{239+240}$Pu, respectively. The annual means for 12 months are slightly lower. Because of the low concentrations and the high likelihood that these results are biased high, they were not included in the emission totals (see Section 4.1.9).

4.1.7 Emission Evaluations for Planned Projects

During 2011, NESHAP evaluations were completed for six research projects conducted in 2011 or planned for 2012: a linear accelerator project in Area 6, a tunnel experiment in Area 12, soil core handling at the Area 12 Core Library, two experiments at the Big Explosives Experimental Facility (BEEF) in Area 4, and a noble gas migration experiment in Area 20. The 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, the EPA requires approval prior to operation and point-source operational monitoring. The predicted radiation dose at the nearest NNSS boundary for each potential release was less than the 0.1 mrem/yr level specified in 40 CFR 61.96. It was therefore concluded that these activities constituted minor sources. The detailed air emission dose evaluations for each project are reported separately in the NESHAP annual report for 2011 (National Security Technologies, LLC [NSTec], 2012a). All projects evaluated were determined to be minor emission sources.

4.1.8 Unplanned Releases

There were no unplanned radionuclide releases in 2011. Multiple wildland fires did occur on the NNSS in 2011, but results from high-volume air samplers deployed to monitor two of the largest fires did not indicate any man-made radionuclides present. Also, routine air monitoring results throughout the year were not significantly elevated, so radionuclide emissions from these fires were negligible.

4.1.9 Estimate of Total NNSS Radiological Atmospheric Releases in 2011

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 NNSS:

- 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, 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, 1983), and equation parameters derived at the NNSS (U.S. Department of Energy, Nevada Operations Office, 1992)

NNSS emission sources identified in 2011 are presented in Table 4-13. Their locations in relation to critical receptor air monitoring locations are shown in Figure 4-1. The amounts of ^{241}Am, ^{238}Pu, and $^{239+240}$Pu emissions from soil resuspension are the sum of emission rates computed for each area of the NNSS with surface contamination (Areas 1–13, 15–20, and 30). Other radionuclides (cobalt-60, strontium-90, cesium-137, 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 10% to the total dose to the public.

In 2011, an estimated 121.427 Ci of radionuclides were released as air emissions; 121 Ci were tritium (Table 4-13). Descriptions of the methods used for estimating the quantities shown in Table 4-13 are reported in NSTec (2012a).

Table 4-13. Radiological atmospheric releases from the NNSS for 2011

Emission Source[(a)]	**Nuclide**	**Annual Quantity (Ci)**
Legacy Weapon Test and Plowshare Crater Locations		
Sedan	^{3}H	25
Schooner	^{3}H	12
Grouped Area Sources – All NNSS Ops Areas	^{241}Am	0.047
Grouped Area Sources – All NNSS Ops Areas	^{238}Pu	0.050
Grouped Area Sources – All NNSS Ops Areas	$^{239+240}$Pu	0.29
Defense, Security, and Stockpile Stewardship		
BEEF	DU	0.040
NPTEC	DU	0.00015
Groundwater Characterization/Control or Remediation Activities		
<u>Environmental Restoration Projects</u>		
E-Tunnel Ponds	^{3}H	7.6
<u>UGTA Sub-Project Wells</u>		
ER-20-5 #1	^{3}H	4.4
ER-20-5 #3	^{3}H	0.009
ER-20-8 (Upper zone)	^{3}H	0.035
U-12n Vent Hole #2	^{3}H	0.00006
<u>NLVF Groundwater Control</u>		
Area 23 Sewage Lagoons	^{3}H	0.00045
Radioactive Waste Management		
Area 3 RWMS	^{3}H	68
Area 5 RWMC	^{3}H	3.5
Support Facility Operations		
Building 23-652	^{3}H	negligible
Emanation from Building Materials		
Building A-01, basement ventilation, NLVF	^{3}H	0.0048
Total Curies: ^{3}H: 121 ^{241}Am: 0.047 ^{238}Pu: 0.050	**$^{239+240}$Pu: 0.29**	**DU: 0.040**

(a) All locations are on the NNSS except for Building A-01.

4.1.10 Environmental Impact

The concentrations of man-made radionuclides in air on the NNSS are all less than the regulatory concentration limits specified by federal regulations. Also, air monitoring data at the six critical receptor samplers indicate that the radiological dose to the general public from the air pathway is below the NESHAP standard of 10 mrem/yr (see Chapter 9 for a discussion of dose to the public from all pathways). Nearly all radionuclides detected by environmental air samplers in 2011 appear to be from two sources: (1) legacy deposits of radioactivity on and in the soil from past nuclear tests and (2) the upward flux of tritium from the soil at sites of past nuclear tests and low-level radioactive waste burial. The exception in 2011 was elevated cesium observed for 2 months, which was a result of the Fukushima Daiichi nuclear power plant event in Japan. Long-term trends of $^{239+240}$Pu and tritium in air continue to show a decline with time. Radionuclide concentrations in plants and animals on the NNSS and their potential impact are discussed in Chapter 8.

4.2 Nonradiological Air Quality Assessment

NNSS 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 NPTEC or at other release areas. 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 NNSS. 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 NNSS are conducted 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 NNSS 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 NNSS equipment meet the opacity criteria to comply with NAAQS and NSPS. Ensure that NNSS 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

4.2.1 Permitted NNSS Facilities

NNSA/NSO maintains a Class II Air Quality Operating Permit (AP9711-2557) for NNSS 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 NNSS facilities regulated by permit AP9711-2557 include the following:

- Approximately 14 facilities/150 pieces of equipment in Areas 1, 5, 6, 12, 23, 25, 26, 27 and 29
- Chemical Releases at NPTEC in Area 5 and in Port Gaston in Area 26
- Site-Wide Chemical Releases (conducted throughout the NNSS)
- Big Explosives Experimental Facility (BEEF) in Area 4
- Explosives Ordnance Disposal Unit (EODU) in Area 11
- Explosives Activities Sites at NPTEC in Area 5, High Explosives Simulation Test (HEST) in Area 14, Test Cell C in Area 25, Port Gaston in Area 26, and Baker in Area 27

4.2.2 Permit Maintenance Activities

The NNSS air permit (AP9711-2557) was modified twice in 2011. In February 2011, the Nevada Division of Environmental Protection (NDEP) issued a modification that increased emission allowances at the BEEF. The modification also included the addition of five generators and a paint spray booth. Operating hours were revised for three groups of generators and for all boilers. In March 2011, six more generators were added to the permit and two were deleted. Emissions were revised for the chemical releases at NPTEC and Port Gaston and for the Site-Wide Chemical Release Areas.

In 2011, a Class II Surface Area Disturbance (SAD) permit for activities off the NNSS was obtained by the UGTA Activity to regulate the release of fugitive dust during construction of the Well ER-EC-14 drill site and access road. The well is located west of the NNSS on the NTTR.

4.2.3 Emissions of Criteria Air Pollutants and Hazardous Air Pollutants

A source's regulatory status is determined by the maximum number of tons of criteria air 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 NNSS facilities and equipment. Each year, the State issues to NNSA/NSO Actual Production/Emissions Reporting Forms for the NNSS 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 air pollutants and HAPs are calculated and reported to the State. The State uses the 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 air pollutant, NNSS 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 13.3).

Quarterly reports of emission quantities were submitted to NDEP in April, July, and October 2011, and January 2012. The Calendar Year 2011 Actual Production/Emissions Reporting Form was submitted in February 2012.

Records examined in 2011 for permitted facilities and equipment indicated that all operational parameters were being properly tracked. A total of 25.14 tons of criteria air pollutants were emitted from NNSS permitted facilities and equipment in 2011 (Table 4-14). No PTEs were exceeded. The majority of the emissions were NO_X from diesel generators. Only 0.032 tons of HAPs were released in 2011. Table 4-15 shows the calculated tons of air pollutants released on the NNSS since 2001. Tons of emissions for most pollutants generally decreased from 2001 through 2007, but increased from 2008 through 2011. The decrease may be due to reduced project activities and less use of large diesel generators that emitted large quantities of pollutants. In recent years, additional generators have been added to the permit to either support project activities or to provide backup electrical power, which could account for an increase in emissions. The fluctuation in VOC emissions over the past 10 years is mainly due to variations in NPTEC chemical releases.

Field measurements of particulate matter equal to or less than 10 microns in diameter (PM10) are required for BEEF, NPTEC, EODU, and the explosives pads located at the HEST Facility, Test Cell C, Port Gaston, and Baker. 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 4.3).

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 through issuance of an Open Burn Variance prior to each burn. Open Burn Variances must be renewed annually. At the NNSS, they are issued annually to NNSA/NSO for fire extinguisher training and for support-vehicle live-fire training activities. There were 23 fire extinguisher training sessions and 25 vehicle burns conducted in 2011. Quantities of criteria air pollutants produced by open burns are not required to be calculated or reported.

Table 4-14. Tons of criteria air pollutant emissions released on the NNSS from permitted facilities operational in 2011

	Calculated Tons[(a)] of Emissions									
	Particulate Matter (PM10)[(b)]		Carbon Monoxide (CO)		Nitrogen Oxides (NO_X)		Sulfur Dioxide (SO_2)		Volatile Organic Compounds (VOCs)	
Facility	**Actual**	**PTE[(c)]**	**Actual**	**PTE**	**Actual**	**PTE**	**Actual**	**PTE**	**Actual**	**PTE**
Construction Equipment										
Wet Aggregate Plant	0.18	6.80	NA[(d)]	NA	NA	NA	NA	NA	NA	NA
Concrete Batch Plant	0.57	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	0.64	NA	NA	NA	NA	NA	NA	NA	NA
Paint Spray Booth	NA	NA	NA	NA	NA	NA	NA	NA	0.002	0.21
Fuel Burning/Storage										
Diesel Fired Generators	1.23	3.26	3.52	13.41	15.81	60.66	1.19	2.61	1.64	3.57
Gasoline Fired Generators	0.02	0.12	0.15	1.17	0.23	1.85	0.01	0.10	0.31	2.52
Boilers	0.03	0.33	0.15	0.97	0.33	3.88	0.01	0.01	0.02	0.11
Bulk Gasoline Storage Tank	NA	NA	NA	NA	NA	NA	NA	NA	0.003	1.249
Bulk Diesel Fuel Storage Tank	NA	NA	NA	NA	NA	NA	NA	NA	0.014	0.017
Chemical Releases										
NPTEC	<0.00	3.00	<0.00	3.26	<0.00	3.02	<0.00	3.00	<0.00	10.00
Port Gaston	NR[(e)]	NR	NR	NR	NR	NR	NR	NR	0.004	10.00
Detonations										
BEEF	0.37	1.80	<0.00	1.99	<0.00	0.50	<0.00	0.04	<0.00	0.03
Port Gaston	0.000	0.210	0.023	1.485	0.006	0.085	0.001	0.010	0.000	0.013
EODU	<0.00	1.68	<0.00	0.21	<0.00	0.07	<0.00	0.01	<0.00	0.01
Total by Pollutant	**2.40**	**44.54**	**3.69**	**21.33**	**16.15**	**68.22**	**1.20**	**5.68**	**1.68**	**25.21**
Total Emissions	**25.12 Actual, PTE 164.97**									

(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 air 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 established in the air permit
(e) Not released: the chemicals released did not include the specified pollutant and, therefore, no emission limit for the pollutant was established for the test.

Table 4-15. Criteria air pollutants and HAPs released on the NNSS since 2001

	Total Emissions (tons/yr)[(a)]										
Pollutant	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Particulate Matter (PM10)[(b)]	2.05	3.61	2.39	0.94	0.84	0.69	0.54	0.22	0.49	1.09	2.40
Carbon Monoxide (CO)	4.84	4.6	1.79	0.24	0.15	0.43	0.51	0.94	0.55	1.33	3.70
Nitrogen Oxides (NO_X)	22.23	21.09	8.11	1.01	0.69	2.02	1.21	3.36	2.45	6.09	16.15
Sulfur Dioxide (SO_2)	1.68	1.62	0.76	0.12	0.04	0.03	0.01	0.06	0.10	0.36	1.20
Volatile Organic Compounds (VOCs)	2.01	2.1	1.21	4.60	1.94	1.40	1.14	0.60	0.71	0.33	1.68
Hazardous Air Pollutants (HAPs)[(c)]	0.03	0.01	0	0.41	0.05	1.87	0.02	0.09	0.30	0.02	0.04

(a) For mtons, multiply tons by 0.9072
(b) Particulate matter equal to or less than 10 microns in diameter
(c) The site-wide PTE for HAPs is 8 tons per individual HAP and 23.3 tons for all HAPS combined.

4.2.4 Performance Emission Testing and State Inspection

The NNSS air permit requires performance emission testing of equipment that vents emissions through stacks (called "point sources"). The tests must be conducted once during the 5-year life of the NNSS 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. No performance emission tests were conducted in 2011. A State inspection was conducted on November 2, 2011, which included an examination of some of the equipment and logbook records for the aggregate plant, concrete batch plant, and cementing services. No findings or violations were identified.

4.2.5 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. 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 the tank is filled. If this is not possible, then calculations are performed by using industry standards and the hours of operation. In 2011, 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).

4.2.6 Opacity Readings

Personnel that take opacity readings must be certified semiannually by a qualified organization. Visual opacity readings are taken every 15 seconds, and a minimum of 24 consecutive readings is required. The average of the 24 readings must not exceed the permit-specified limit (20% for NAAQS, 10% for NSPS). The NNSS 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. In 2011, four employees on the NNSS were certified by Carl Koontz Associates to take opacity readings. Readings were taken for the following NNSS facilities regulated under the NAAQS opacity limit of 20%: Area 1 Concrete Batch Plant, Area 1 Wet Aggregate Plant, Area 6 Storage Silos, and diesel generators located in Mercury and Area 6. Readings for these facilities ranged from 0% to 10%. NNSS equipment that is regulated by the 10% opacity limit under the NSPS includes miscellaneous conveyor belts, screens and hoppers, and the Area 1 Pugmill. None of this equipment was used in 2011.

4.2.7 Chemical Releases and Detonations Reporting

The NNSS air permit regulates the release of chemicals at specific locations under three separate "systems": NPTEC in Area 5 (System 29), Site-Wide Releases throughout the NNSS (System 81), and Port Gaston in Area 26 (System 95). The types and amounts of chemicals that may be released vary depending on the system. In 2011, the Tarantula VI chemical test series was conducted at the Area 5 NPTEC and consisted of 40 releases. One release was also conducted at the Port Gaston Facility as part of the same series. The majority of the chemicals released were neither HAPS nor criteria pollutants, with the exception of VOCs, which were released at Port Gaston (see Table 4-14). No permit limits were exceeded.

Explosives detonations can take place at seven locations on the NNSS (BEEF in Area 4, EODU in Area 11, NPTEC in Area 5, Port Gaston in Area 26, HEST in Area 14, Test Cell C in Area 25, and Baker in Area 27). BEEF is permitted to detonate large quantities of explosives (up to 41.5 tons per detonation with a limit of 50.0 tons per 12-month period), while the other locations are limited to much smaller quantities (1 ton per detonation with a limit of 10 tons per 12-month period). Permitted limits exist also for the amounts of criteria air pollutant and HAP emissions generated by the detonations. In 2011, explosives were detonated at BEEF, EODU, and Port Gaston, and no permit limits were exceeded (see Table 4-14).

PM10 monitoring was conducted for each chemical release test and detonation at NPTEC, Port Gaston, EODU and BEEF in 2011. Monitoring was conducted in accordance with permit requirements.

In addition to annual reporting, the NNSS air quality operating permit requires the submittal of test plans and final analysis reports to the State for detonations and chemical releases 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. Completion reports are submitted to NNSA/NSO for transmittal to NDEP's Bureau of Air Pollution Control at the end of each calendar quarter for all chemical releases and detonations. All required reports were submitted prior to their deadlines.

4.2.8 ODS Recordkeeping

At the NNSS, 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, classified as ODS, have been used in the past in fire extinguishers and deluge systems, but all known occurrences of these halons have been removed from the NNSS. ODS recordkeeping requirements applicable to NNSS operations include maintaining for 3 years evidence of technician certification, recycling/recovery equipment approval, and servicing records for appliances containing 22.7 kilograms (50 pounds) or more of refrigerant. Compliance with recordkeeping and certification requirements is verified through periodic self-assessments. The EPA may conduct random inspections to determine compliance with ODS regulations under the CAA.

In April 2011, an auditor for the International Organization for Standardization (ISO) 14001 Environmental Management Standard conducted a recertification of the EMS, which included a review of ODS program recordkeeping requirements. No nonconformities against the ODS program were noted.

4.2.9 Asbestos Abatement

A Notification of Demolition and Renovation Form is submitted to the EPA at least 10 working days prior to the start of a demolition or renovation project if the quantities of asbestos-containing material (ACM) to be removed are estimated to equal or exceed 260 linear feet, 160 square feet, or 1 cubic meter. Small asbestos abatement projects are conducted throughout the year consisting of the removal of lesser quantities of ACM within a single facility per project, and a Notification of Demolition and Renovation Form is not required for these projects.

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 ACM 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.

A total of two Notification of Demolition and Renovation Forms were submitted during 2011. This included one demolition project and one renovation project. Each project was performed in a closely supervised and rigidly controlled environment, and personal air monitoring and/or environmental air sampling were conducted. The remaining asbestos abatement activities throughout the NNSS complex were minor in scope, involving the removal of quantities of ACM less than the reporting threshold per facility. ACM were buried in both the Area 9 U10c and Area 23 solid waste disposal sites. Asbestos abatement records continued to be maintained as required.

4.2.10 Fugitive Dust Control

The NNSS 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. At the NNSS, the main method of dust control is the use of water sprays. During 2011, personnel observed operations throughout the NNSS that included the Area 1 Batch Plant and various trenching and digging activities. Fugitive dust was noted during trenching that took place in Mercury. The operation was shut down and then resumed after water was sprayed on affected areas. Water controls were used thereafter to control the dust.

Off the NNSS, 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. In 2009, 2010, and 2011 SADs were issued for the construction and operation of UGTA Activity wells on NTTR: ER-EC-12, ER-EC-13, ER-EC-14 and ER-EC-15. No excessive fugitive dust from these activities was noted, and all requirements of the SADs were met.

4.2.11 Environmental Impact

During 2011, NNSS activities produced a total of 25.14 tons of criteria air pollutants and 0.04 tons of HAPs. These small quantities had little, if any, impact to air quality on the NNSS and at offsite locations. Emissions of pollutants for 2011 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 16.7). 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.

5.0 Water Monitoring

This chapter presents the results of radiological and nonradiological water monitoring on and adjacent to the Nevada National Security Site (NNSS). The U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) monitors water to comply with applicable state and federal water quality and water protection regulations and U.S. Department of Energy (DOE) directives (see Section 2.2) and to address the concerns of stakeholders residing in the vicinity of the NNSS. Waters routinely monitored include surface water and groundwater, including natural springs, drinking water wells, non-potable groundwater wells, and water discharged into domestic and wastewater systems on the NNSS. Routine radiological monitoring of these water sources is conducted under the *Routine Radiological Environmental Monitoring Plan* (RREMP) (Bechtel Nevada [BN], 2003a). In addition to the routine annual onsite monitoring conducted by NNSA/NSO, the Nevada State Health Division's Bureau of Health Care Quality and Compliance is allowed access to the NNSS to independently sample onsite water supply wells at its discretion (see, e.g., National Security Technologies, LLC [NSTec], 2008a).

The Community Environmental Monitoring Program, established by NNSA/NSO, annually performs independent monitoring of offsite springs and water supply systems in communities surrounding the NNSS. This independent community outreach program is managed by the Desert Research Institute (DRI). The reader is directed to Chapter 7 for the presentation of this program's water monitoring activities in 2011.

5.1 Radiological Surface Water and Groundwater Monitoring

Radionuclides have been detected in the groundwater in some areas of the NNSS as a result of historical underground nuclear tests. Between 1951 and 1992, 828 of these tests were conducted, and approximately one-third were detonated near or in the saturated zone (U.S. Department of Energy, Nevada Operations Office [DOE/NV], 1996a; 2000). The Federal Facility Agreement and Consent Order (FFACO) established corrective action units (CAUs) that delineate areas of concern for radiological groundwater contamination on the NNSS (DOE/NV, 1996a). Figure 5-1 shows the locations of underground nuclear tests and the identified CAUs. The reader is directed to *Attachment A: Site Description* included on the compact disc version of this report, which provides a thorough description of the complex hydrogeological conditions of the NNSS in which underground nuclear testing was conducted.

The Underground Test Area (UGTA) Activity is tasked with developing CAU-specific models of groundwater flow and transport of radionuclides and with identifying contaminant boundaries where the presence of radiological contaminants exceed the Safe Drinking Water Act limits or are likely to exceed those limits at any time within a 1,000-year period. Chapter 12 of this report describes the UGTA Activity's goals and progress towards reaching them. Chapter 12 also presents the results of 2011 groundwater sampling and analyses of UGTA characterization wells.

In contrast with the UGTA Activity, the RREMP (BN, 2003a) directs routine radiological monitoring of existing available groundwater wells to meet the objectives shown in the text box below. In the future, the RREMP well monitoring objectives will become more integrated with those of the UGTA Activity as groundwater characterization and contaminant transport studies reach their completion and long-term groundwater monitoring networks for each CAU contaminant boundary are identified and established. In early 2012, NNSA/NSO held meetings with UGTA and RREMP participants and with the Nevada Division of Environmental Protection (NDEP). Meeting discussions focused on identifying wells of mutual interest for shared objectives and increasing collaborative efficiencies between the two programs. As a consequence, there will likely be some changes to the RREMP offsite non-potable monitoring well and onsite monitoring well networks in 2012.

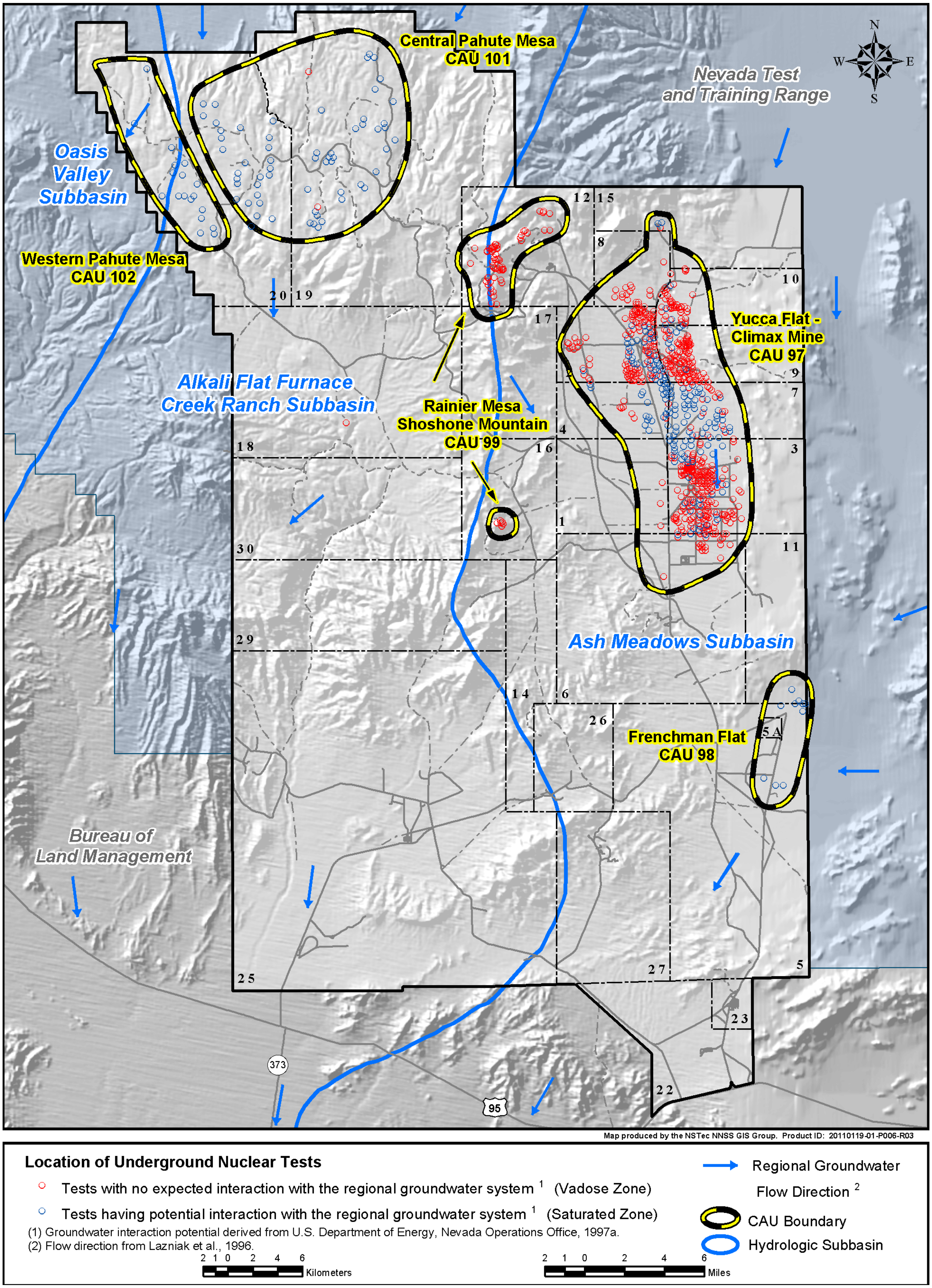

Figure 5-1. Areas of potential groundwater contamination on the NNSS

Radiological Surface Water and Groundwater Monitoring Program Goals	***Analytes Monitored***
Measure radionuclide concentrations in offsite and onsite water supply wells to (1) monitor for trends, (2) compare concentrations with the safe drinking water standards established by the U.S. Environmental Protection Agency (EPA) under the Safe Drinking Water Act, and (3) provide data to determine compliance with the dose limits to the general public set by DOE Order DOE O 458.1, "Radiation Protection of the Public and the Environment" (see Chapter 9 for the estimate of public dose from the water pathway). Collect and analyze water samples to determine if radionuclide concentrations in surface waters on the NNSS expose animals to doses less than 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 (see Section 9.2 for biota dose estimates). Determine if permitted facilities on the NNSS are in compliance with permit discharge limits for radionuclides. Determine if radionuclide concentrations in natural springs and non-potable water wells (monitoring wells) indicate that NNSA/NSO activities have had an impact on the environment.	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 RREMP Water Monitoring Locations

The RREMP monitoring well network includes onsite and offsite wells selected from those 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 as well as offsite springs. The purpose of monitoring is to detect man-made radionuclides in wells that are downgradient from the UGTA CAUs (i.e., contaminant migration) 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 for current investigations by the UGTA Activity are added if they do not have high concentrations of radionuclides 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 12). Wells in the RREMP network will be evaluated as candidate elements of the long-term monitoring program as UGTA CAUs proceed to closure.

Table 5-1 lists water sources currently sampled under the RREMP. They include 54 wells and 8 springs or surface waters that are sampled at frequencies ranging from once every 3 months to once every 3 years for specified radiological and water chemistry parameters. Figure 5-2 shows the location of wells, and Figure 5-3 shows the locations of surface waters (e.g., springs, containment ponds) sampled within the RREMP monitoring network.

Onsite springs are sampled for radionuclides only on request by NNSA/NSO and are not listed in Table 5-1. Ten NNSS springs have been monitored periodically and reported in past annual environmental reports. They include Cane, Captain Jack, Cottonwood, Gold Meadows, John's, Tipipah, Topopah, Tub, Twin, and Whiterock springs; see Figure A-4 of *Attachment A: Site Description* included on the compact disc of this report for the location of NNSS springs and seeps. The groundwater that feeds the onsite springs is locally derived and is not hydrologically connected to any of the aquifers that may be impacted by underground nuclear tests. Detectable man-made radionuclides in onsite springs are primarily from historical atmospheric testing activities, including radioactive fallout.

During 2011, 43 locations were sampled for radionuclides (Table 5-1, Figures 5-2 and 5-3):

- 10 offsite non-potable NNSA/NSO wells
- 5 offsite community water supply wells
- 3 offsite springs
- 9 onsite water supply wells (5 potable, 4 non-potable or inactive)
- 15 onsite monitoring wells
- 1 onsite discharge system (E-Tunnel)

The UGTA Activity sampled seven wells in 2011. These samples were analyzed for radionuclides; the results are presented in Chapter 12.

Table 5-1. RREMP groundwater sources and sampling regimes

Location	Area	Tritium	Gross Alpha/ Gross Beta	Gamma Spectroscopy	Pu Isotopes	Water Chemistry[a]	Other[b]
11 Offsite Non-potable NNSA/NSO Monitoring Wells							
Ash-B	-	3 years	3 years	-	-		-
ER-OV-01	-	6 months	1 year	1 year	1 year	1 year	-
ER-OV-02	-	6 months	1 year	1 year	1 year	1 year	-
ER-OV-03A	-	1 year	2 years	-	-		-
ER-OV-03A3	-	1 year	2 years	-	-		-
ER-OV-03C	-	6 months	1 year	1 year	1 year	1 year	-
ER-OV-03C2	-	6 months	1 year	1 year	1 year	1 year	-
ER-OV-04A	-	1 year	2 years	-	-		-
ER-OV-05	-	1 year	2 years	-	-		-
ER-OV-06A	-	6 months	1 year	1 year	1 year	1 year	-
PM-3	-	1 year	2 years	2 years	2 years	2 years	3 years
15 Offsite Private/Community Drinking Water Wells							
Amargosa Valley RV Park	-	3 years	3 years	-	-	-	-
Cind-R-Lite Mine	-	3 years	3 years	-	-	-	-
Cook's Ranch Well	-	3 years	3 years	-	-	-	-
Crystal Trailer Park	-	3 years	3 years	-	-	-	-
DeLee Ranch	-	3 years	3 years	-	-	-	-
EW-4 Well	-	3 years	3 years	-	-	-	-
Fire Hall #2 Well	-	3 years	3 years	-	-	-	-
Fuller Property	-	3 years	3 years	-	-	-	-
Last Trail Ranch	-	3 years	3 years	-	-	-	-
Longstreet Casino Well	-	3 years	3 years	-	-	-	-
Ponderosa Dairy	-	3 years	3 years	-	-	-	-
Roger Bright Ranch	-	1 year	2 years	-	-	-	-
School Well	-	1 year	2 years	-	-	-	-
Tolicha Peak	-	1 year	2 years	-	-	-	-
U.S. Ecology	-	1 year	2 years	-	-	-	-
7 Offsite Springs/Surface Waters							
Big Springs	-	3 years	3 years	-	-	-	-
Crystal Pool	-	3 years	3 years	-	-	-	-
Fairbanks Spring	-	3 years	3 years	-	-	-	-
Longstreet Spring	-	3 years	3 years	-	-	-	-
Peacock Ranch	-	1 year	2 years	-	-	-	-
Revert Spring	-	1 year	2 years	-	-	-	-
Spicer Ranch	-	1 year	2 years	-	-	-	-

Table 5-1. RREMP groundwater sources and sampling regimes (continued)

Location	Area	Tritium	Gross Alpha/ Gross Beta	Gamma Spectroscopy	Pu Isotopes	Water Chemistry[(a)]	Other[(b)]
5 NNSS Permitted Drinking Water Wells[(c)]							
J-12 WW	25	3 months	3 months	1 year	1 year	1 year	3 years
WW #4	6	3 months	3 months	1 year	1 year	1 year	3 years
WW #4A	6	3 months	3 months	1 year	1 year	1 year	3 years
WW 5B	5	3 months	3 months	1 year	1 year	1 year	3 years
WW 8	18	3 months	3 months	1 year	1 year	1 year	3 years
3 NNSS Non-potable Water Wells							
UE-16D WW	16	3 months	3 months	1 year	1 year	1 year	3 years
WW 5C	5	3 months	3 months	1 year	1 year	1 year	3 years
WW C-1	6	3 months	3 months	1 year	1 year	1 year	3 years
1 NNSS Inactive Water Wells							
Army #1 WW	22	3 months	3 months	1 year	1 year	1 year	3 years
19 NNSS Monitoring Wells							
ER-12-1	12	2 years	2 years	-	-	2 years[(d)]	-
ER-19-1	19	1 year	2 years	2 years	2 years	2 years	3 years
ER-20-1	20	1 year	2 years	2 years	2 years	2 years	3 years
ER-20-2 #1	20	1 year	2 years	2 years	2 years	2 years	3 years
HTH #1	17	1 year	2 years	2 years	2 years	2 years	3 years
PM-1	20	1 year	2 years	2 years	2 years	2 years	3 years
SM-23-1	23	1 year	2 years	2 years	2 years	2 years	3 years
TW D	2	1 year	2 years	2 years	2 years	2 years	3 years
U-19BH	19	1 year	2 years	2 years	2 years	2 years	3 years
UE-18R	18	1 year[(e)]	2 years	2 years	2 years	2 years	3 years
UE-1Q	1	1 year	2 years	2 years	2 years	2 years	3 years
UE-25P #1	25	3 years[(f)]	3 years	-	-	-	-
UE-25WT #6	25	3 years[(f)]	3 years	-	-	-	-
UE5 PW-1	5	6 months	2 years	2 years	2 years	6 months[(g)]	3 years
UE5 PW-2	5	6 months	2 years	2 years	2 years	6 months[(g)]	3 years
UE5 PW-3	5	6 months	2 years	2 years	2 years	6 months[(g)]	3 years
UE-5N	5	by request	-	-	-	-	-
UE-7NS	7	1 year	2 years	2 years	2 years	2 years	3 years
WW A	3	1 year	2 years	2 years	2 years	2 years	3 years
1 Containment Pond System							
E-Tunnel[(h)]	12	1 year	1 year	-	-	1 year[(d)]	-

Shading indicates the locations that were sampled in 2011.

(a) Unless otherwise noted for certain sample locations, the RREMP water chemistry parameters include alkalinity, calcium, chloride, fluoride, magnesium, nitrate, pH, potassium, silicon, sodium, specific conductivity, sulfate, total dissolved solids, and water temperature.
(b) ^{14}C, ^{90}Sr, and ^{99}Tc
(c) Only five of the six permitted NNSS water supply wells (see Figure 5-12) are currently monitored; the permitted well, J-13 WW, is inoperable and was last sampled in 2006.
(d) The water chemistry parameters analyzed in ER-12-1 groundwater and E-Tunnel discharge point samples for the permitted E-Tunnel Waste Water Disposal System (ETDS) are arsenic, barium, cadmium chloride, chromium, copper, fluoride, iron, lead, magnesium, manganese, mercury, nitrate nitrogen, selenium, specific conductance, sulfate, and zinc.
(e) UE-18R is inaccessible due to poor road conditions; sampling will resume when road is repaired; it was last sampled in 2007.
(f) UE-25P #1 and UE-25WT #6 were last sampled in 2005; water quality is poor in both wells, and alternate monitoring well locations to replace them are being investigated.
(g) The water chemistry parameters analyzed for permitted UE-5 wells at the Area 5 Radioactive Waste Management Site (RWMS) include the RREMP parameters in footnote (a) as well as iron, manganese, total organic carbon, total organic halides, and volatile organic compounds.
(h) Discharge point of water flowing out of E-Tunnel into a series of man-made containment ponds

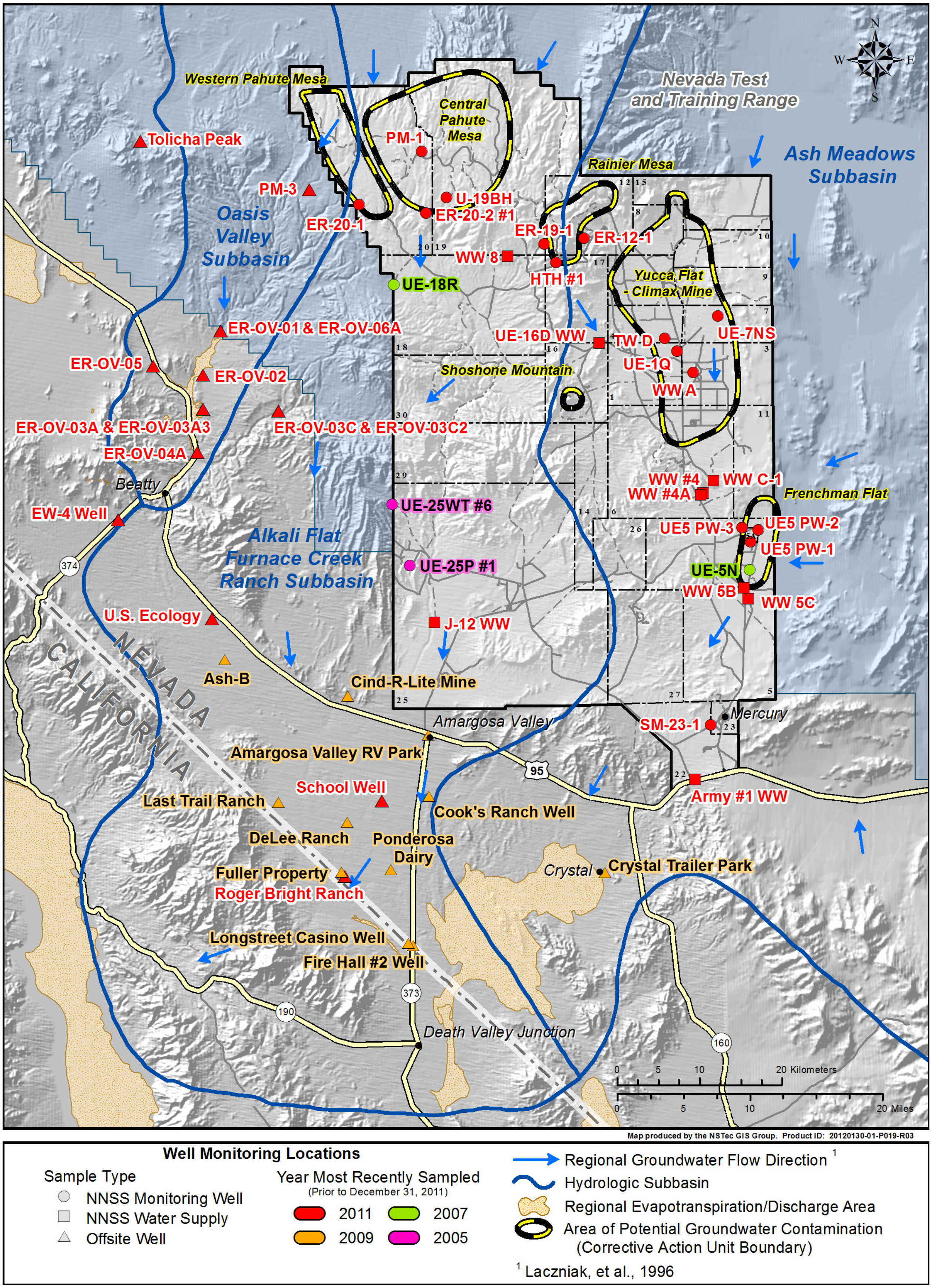

Figure 5-2. 2011 RREMP well monitoring network

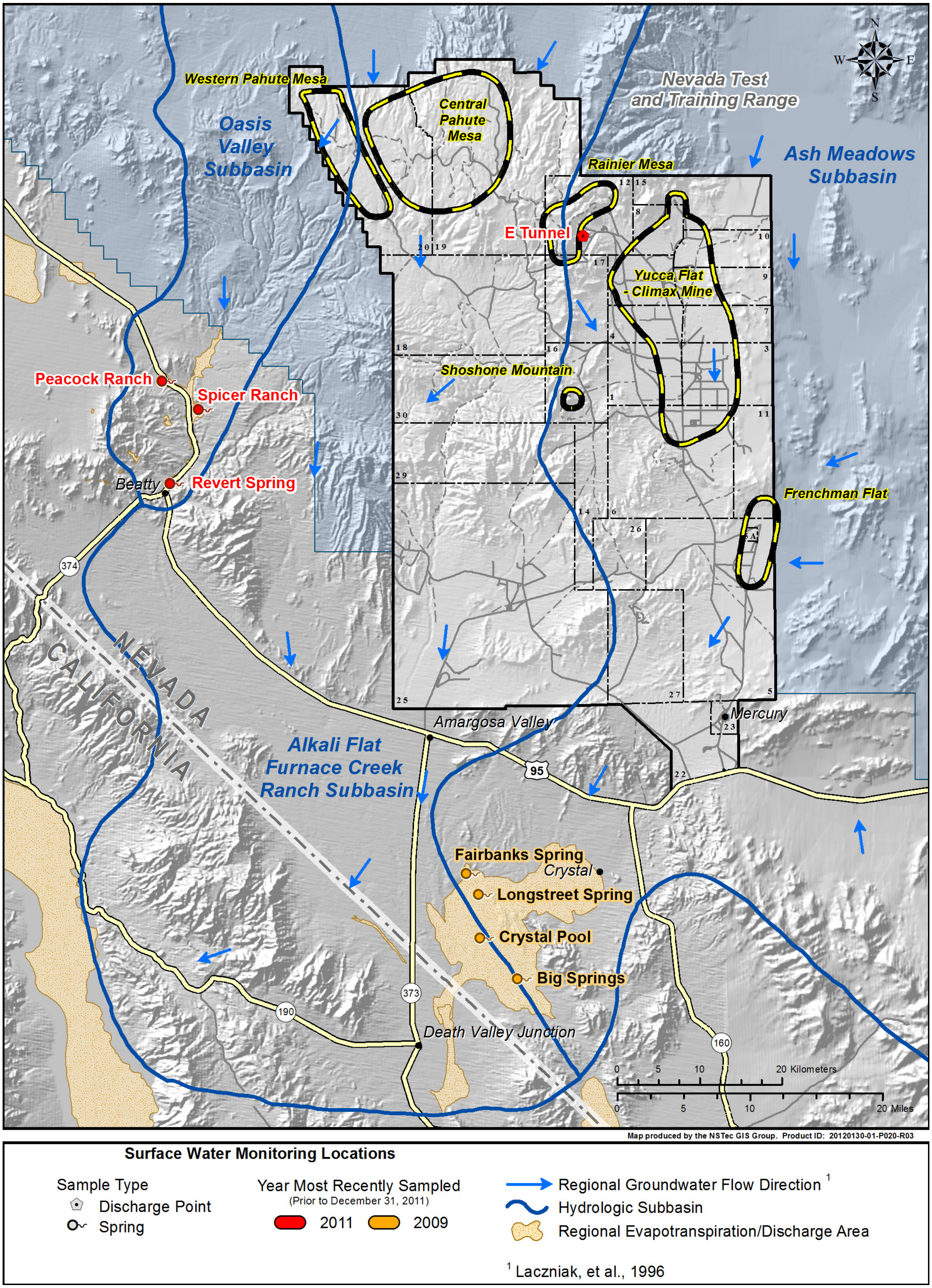

Figure 5-3. 2011 RREMP surface water monitoring network

5.1.2 RREMP Analytes Monitored

The selection of analytes for groundwater monitoring under the RREMP is based on the radiological source term from historical nuclear testing, regulatory and permit requirements, and characterization needs. The isotopic inventory remaining from nuclear testing is presented in the 1996 environmental impact statement for NNSS activities (DOE/NV, 1996a) 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 therefore 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.

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 some 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]). 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. 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.

Samples from a few wells have been known to exceed Safe Drinking Water Act (SDWA) standards, such as the EPA maximum contaminant level (MCL) for gross alpha (15 pCi/L) and the EPA level of concern (LoC) for gross beta (50 pCi/L). When this occurs, NNSA/NSO considers numerous factors in determining how to proceed, some of which include:

- If the well is a drinking water well, further analyses may be performed; the associated analytes may be more closely monitored to determine whether the exceedance was an anomaly and if the source is natural or a result of NNSA/NSO activities.
- SDWA standards for radionuclides apply only to public water systems (PWSs) designated as community water systems, and the PWSs on the NNSS are permitted by the State as non-community water systems; exceeding an MCL or LoC does not require action in accordance with the SDWA.
- If the well is not a drinking water well, then human health is not at risk, and further action may not be taken.

5.1.3 RREMP 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:

HTH #1
- 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

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

PM-3
- 475 m (1,560 ft) bgs
- 608 m (1,994 ft) bgs

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

Ash-B
- Piezometer #2 – 114 m (375 ft) bgs
- Piezometer #1 – 312 m (1,025 ft) bgs

Sampling frequencies and analyses for routine radiological water monitoring (Table 5-1) are based on location and type of sampling point as defined in the RREMP. As discussed above, tritium analyses were performed on all samples obtained during 2011. Other analyses were performed on specific samples based primarily on the RREMP schedule. Gray shading in Table 5-1 indicates the locations that were sampled during 2011; the data tables to follow give further details about analytes.

All tritium analyses (with the exception of those for E-Tunnel, ER-12-1, and UGTA characterization wells) 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). For samples with expected levels of tritium that are much higher than the laboratory's standard detection capability (i.e., E-Tunnel) or when the program goal is not to monitor for low-level concentrations of tritium (i.e., ER-12-1, UGTA wells), tritium enrichment is not performed. Sample-specific MDCs for laboratory analysis of enriched samples ranged from 14.6 to 30.3 picocuries per liter (pCi/L). The MDCs for standard (non-enriched) tritium analyses typically range from approximately 300 to 400 pCi/L, except for samples with high activity. In comparison, the EPA MCL for tritium in drinking water is 20,000 pCi/L, and the RREMP's informal "action level" (with no formal action required by regulation) is 10% of the drinking water standard, or 2,000 pCi/L, both of which are well above the MDC for laboratory analysis.

Analytical methods routinely include quality control samples such as duplicates, blanks, and spikes. Chapter 17 discusses in more detail the quality assurance and control procedures used for monitoring.

5.1.4 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 of the associated measurement process. Concentrations for man-made 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 validated values were above their sample-specific MDCs.

The "±" values presented in the data tables are the laboratory's stated 2–standard deviation "uncertainty" 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 2010 was conducted to obtain an estimate of the tritium decision level (L_C) (see Glossary, Appendix B). The analysis suggests an L_C for tritium of approximately 22.2 pCi/L, where L_C is a 99% prediction limit for any individual measurement based on background water supply well data. Alternately, a 95% prediction limit for all enriched tritium measurements (PLall), based on that background water supply well data, is approximately 31.0 pCi/L. This takes into account the total number of enriched tritium measurements made annually under the current implementation of the RREMP (99 during 2011). In comparison to the analysis uncertainty (i.e., the uncertainty associated with only the laboratory measurements for an individual sample), PLall, implicitly incorporates all uncertainties in the sampling and analysis process over multiple years of water monitoring. If all monitoring locations produced data from the same distribution as the water supply wells, there would be a 5% chance of obtaining one or more values exceeding PLall anywhere during any single year.

Figures 5-4 through 5-10 show trends over time in gross alpha and gross 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. These were averaged across locations within groups (offsite wells, offsite springs, onsite water supply wells, and onsite monitoring wells), and the annual "means of means" were plotted and connected. The vertical bars in the figures extend from the minimum to the maximum annual mean for any well or spring for each year in each group of locations.

5.1.5 Results from RREMP Offsite Wells and Springs

The 2011 and prior data indicate that groundwater sampled at offsite private/community wells (Figure 5-2) and at offsite springs (Figure 5-3) has not been impacted by past NNSS nuclear testing operations. In the offsite NNSA/NSO wells (Figure 5-2), tritium was reported slightly above the MDCs but far below the EPA MCL in Well PM-3 for both depths (Table 5-2). The UGTA Activity also sampled Well PM-3 in 2011 (see Chapter 12, Section 12.2.2) and obtained similar results. The UGTA Activity determined that additional study of this well is warranted, and has included this well for fiscal year 2012 sampling.

Gross alpha and gross beta radioactivity were detected in most offsite well samples (Table 5-2) and in offsite spring samples (Table 5-3). These likely represent the presence of naturally occurring radionuclides. Well ER-OV-02 had a gross alpha measurement of 22.3 pCi/L in 2011, slightly above the EPA MCL of 15 pCi/L; this well has had a history of sporadic MCL exceedances. Otherwise, none of the offsite water wells and springs exceeded safe drinking water standards for gross alpha and gross beta radioactivity (i.e., the 15 pCi/L EPA MCL for gross alpha and the 50 pCi/L EPA LoC for gross beta).

Table 5-2. Gross alpha, gross beta, and tritium in offsite wells in 2011

Location	Date Sampled	Concentration ± Uncertainty[a] (pCi/L)		
		Gross Alpha	Gross Beta	Tritium
Non-potable NNSA/NSO Wells				
ER-OV-01	10/24	15.0 ± 4.2	8.8 ± 2.0	−8.6 ± 6.3
	10/24 FD[b]	NA[c]	NA	−2.3 ± -5.4
ER-OV-02	10/25	22.3 ± 6.3	10.0 ± 2.2	−6.0 ± 6.2
ER-OV-03A	10/24	10.7 ± 3.5	7.3 ± 1.7	1.0 ± 6.3
ER-OV-03A3	10/24	9.7 ± 3.4	6.9 ± 1.7	−16.1 ± 6.2
ER-OV-03C	10/25	8.3 ± 2.7	2.0 ± 0.8	6.5 ± 6.5
	10/25 FD	NA	NA	2.3 ± 6.5
ER-OV-03C2	10/25	9.1 ± 2.9	1.9 ± 1.0	−6.7 ± 6.2
	10/25 FD	NA	NA	−3.7 ± 6.3
ER-OV-04A	10/25	4.0 ± 1.9	8.3 ± 2.0	3.6 ± 6.4
ER-OV-05	10/25	0.5 ± 1.1	6.7 ± 1.5	−1.5 ± 6.8
ER-OV-06A	10/24	11.9 ± 3.8	8.5 ± 1.9	−16.5 ± 6.1
	10/24 FD	NA	NA	10.2 ± 6.5
PM-3 (1,560 ft)	7/20	4.2 ± 1.2	17.5 ± 3.1	58.0 ± 20.0
	7/20 FD	NA	NA	63.2 ± 20.4
(1,994 ft)	7/20	3.9 ± 1.2	11.4 ± 2.3	19.5 ± 17.5
	7/20 FD	NA	NA	33.8 ± 18.2
Private/Community Drinking Water Wells				
EW-4 Well	11/22	NA	NA	0.0 ± 6.0
Roger Bright Ranch	11/15	6.4 ± 1.5	13.6 ± 2.7	−1.3 ± 5.9
School Well	11/15	2.0 ± 0.9	9.2 ± 1.8	−7.6 ± 5.5
Tolicha Peak	11/15	2.6 ± 0.8	4.8 ± 1.2	−7.8 ± 5.4
U.S. Ecology	11/15	7.3 ± 1.7	9.2 ± 2.0	2.6 ± 6.1

Mean MDCs were 0.7, 0.7, and 26.4 pCi/L for gross alpha, gross beta, and tritium respectively.
The yellow shaded result exceeds 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 5-3. Gross alpha, gross beta, and tritium in offsite springs in 2011

Location	Date Sampled	Concentration ± Uncertainty[(a)] (pCi/L)		
		Gross Alpha	Gross Beta	Tritium
Peacock Ranch	11/15	1.0 ± 0.8	9.7 ± 2.0	3.9 ± 6.2
Revert Spring	11/15	4.2 ± 1.3	4.8 ± 1.4	−5.2 ± 5.7
Spicer Ranch	11/15	8.3 ± 1.8	5.8 ± 1.5	2.5 ± 6.2

Mean MDCs were 0.7, 0.9, and 29.2 pCi/L for gross alpha, gross beta, and tritium respectively.
(a) ± 2 standard deviations

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

Figures 5-4 through 5-6 show the trends over time in gross alpha and gross beta radioactivity and tritium levels among the offsite wells and springs being sampled routinely. The high values above the EPA MCL seen in Figure 5-4 have been in Well ER-OV-02; gross alpha in Well ER-OV-01 also exceeded the MCL in 2000, 2002, and 2003, as did Well ER-OV-03A in 2000. Gross alpha appears to have decreased in these 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 (Figure 5-4). All gross beta values in Figure 5-5 are below the EPA LoC for drinking water, and all tritium values in Figure 5-6 are far below the EPA MCL for drinking water. All of the Oasis Valley wells are non-potable monitoring wells. They are not used for drinking water; thus, their levels of gross alpha and gross beta do not pose a threat to human health.

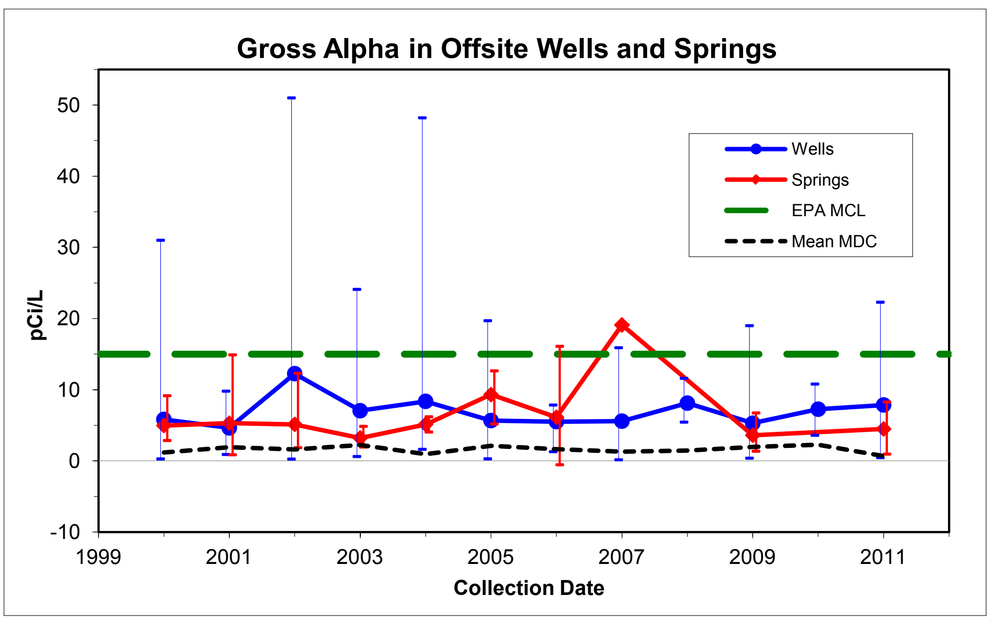

Figure 5-4. Gross alpha annual means for offsite wells and springs from 2000 through 2011

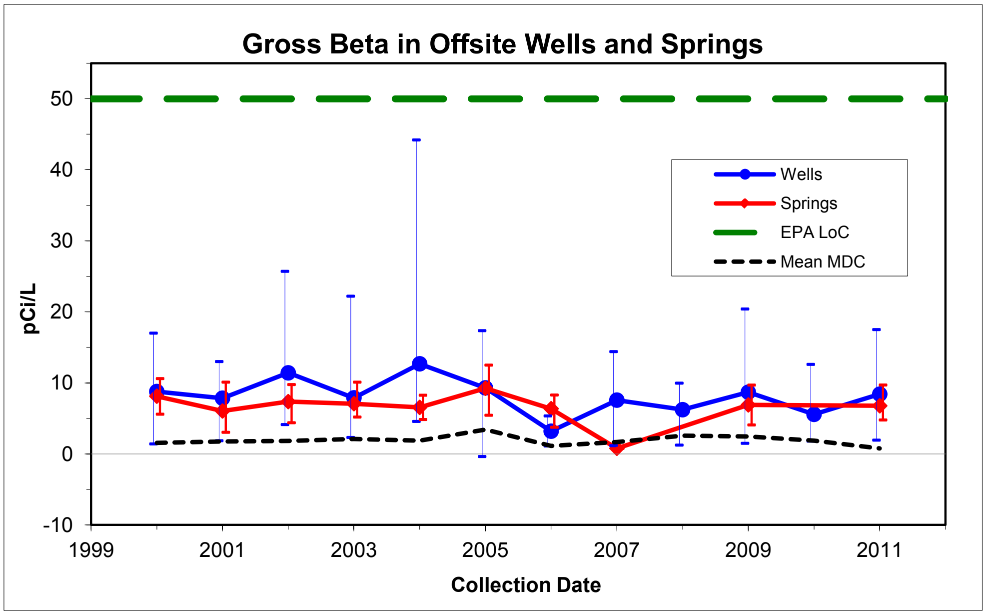

Figure 5-5. Gross beta annual means for offsite wells and springs from 2000 through 2011

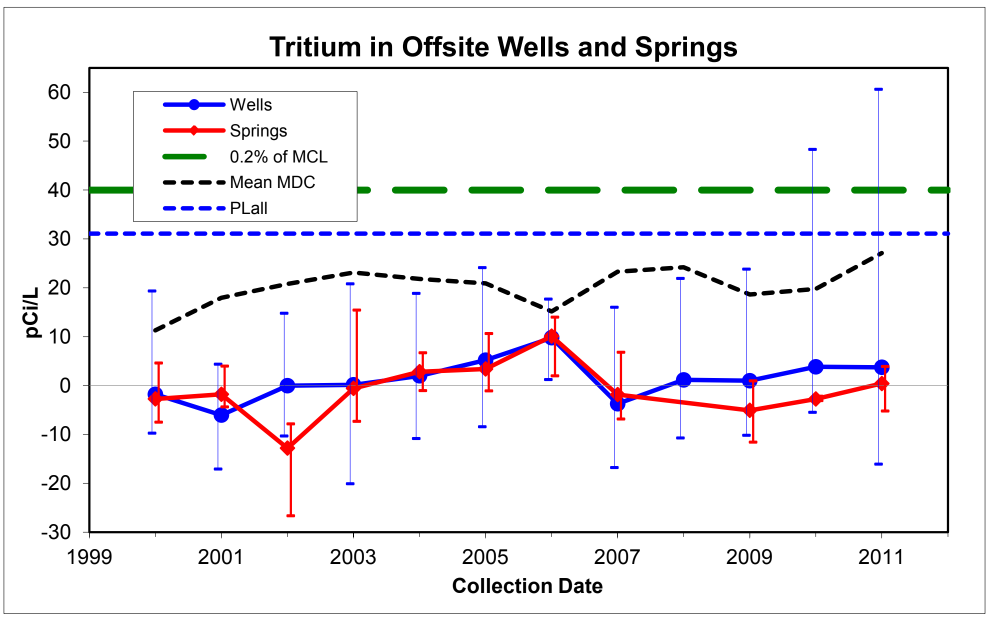

Figure 5-6. Tritium annual means for offsite wells and springs from 2000 through 2011

5.1.6 Results from RREMP NNSS Water Supply Wells

Results from the nine NNSS water wells sampled quarterly in 2011 (see Figure 5-2) continue to indicate that nuclear testing has not impacted the NNSS water supply network. No tritium measurements presented in Table 5-4 were above their MDCs and were far below the EPA MCL. Gross alpha and gross beta radioactivity were found at concentrations slightly greater than their MDCs in most 2011 samples (Table 5-4). However, no water supply samples had gross alpha measurements exceeding the EPA MCL or gross beta measurements exceeding the EPA LoC. The wells were also analyzed for gamma radionuclides, ^{238}Pu, and $^{239+240}$Pu. No man-made radionuclides were detected; therefore, the gross alpha and gross beta values greater than their MDCs likely represent the presence of naturally occurring radionuclides.

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 for gross alpha and tritium, or the EPA LoC for gross beta. A few gross alpha quarterly values did exceed the MCL; no gross beta quarterly measurements have exceeded the LoC.

Table 5-4. Gross alpha, gross beta, and tritium in NNSS water supply wells in 2011

Location	Date Sampled	Concentration ± Uncertainty[(a)] (pCi/L)		
		Gross Alpha	Gross Beta	Tritium
Permitted Potable Wells				
J-12 WW	1/11	1.3 ± 0.7	4.5 ± 1.2	5.6 ± 16.3
	4/26	1.5 ± 1.4	4.5 ± 1.6	−4.0 ± 8.9
	7/19	0.5 ± 0.5	5.1 ± 1.3	−13.9 ± 13.5
	10/18	1.1 ± 0.9	5.0 ± 1.5	−0.5 ± 7.0
WW #4	1/11	6.8 ± 1.7	5.0 ± 1.4	−5.1 ± 15.9
	4/26	6.9 ± 2.8	7.2 ± 2.2	6.6 ± 10.9
	7/19	5.9 ± 1.4	5.6 ± 1.5	16.2 ± 13.5
	10/18 FD[(b)]	NA[(c)]	NA	−8.2 ± 29.5
	10/19	6.7 ± 1.7	6.7 ± 1.7	−3.9 ± 16.1
WW #4A	1/11	7.3 ± 1.7	5.2 ± 1.4	−7.2 ± 15.9
	4/26	8.0 ± 3.1	5.2 ± 1.7	2.0 ± 11.0
	7/19	7.8 ± 1.7	7.2 ± 1.6	7.5 ± 13.0
	10/18	6.8 ± 1.8	4.9 ± 1.5	−1.5 ± 6.7
WW 5B	1/11	2.6 ± 0.9	10.4 ± 2.0	−11.3 ± 15.7
	1/11 FD	3.4 ± 1.0	10.6 ± 2.0	−4.3 ± 15.9
	4/26	3.7 ± 2.2	10.6 ± 2.7	1.9 ± 10.1
	7/19	2.8 ± 1.1	10.8 ± 2.4	3.3 ± 13.8
	7/19 FD	NA	NA	−0.3 ± 12.4
	10/18	3.9 ± 1.1	10.0 ± 2.0	0.8 ± 7.0
WW 8	1/11	0.3 ± 0.7	3.4 ± 1.2	−10.3 ± 15.8
	4/26	−0.3 ± 0.5	3.2 ± 1.7	−4.1 ± 9.1
	4/26 FD	NA	NA	−5.5 ± 8.9
	7/19	0.5 ± 0.5	2.6 ± 1.0	−7.8 ± 13.3
	10/18	−0.1 ± 0.6	4.3 ± 1.4	0.7 ± 7.0
Non-potable and Inactive Wells				
Army #1 WW	1/11	2.8 ± 0.9	4.3 ± 1.1	−4.3 ± 16.1
	4/26	5.4 ± 2.5	3.8 ± 1.5	3.2 ± 10.7
	7/19	2.5 ± 1.0	4.6 ± 1.4	0.5 ± 12.3
	10/18	2.8 ± 0.9	5.5 ± 1.4	−2.3 ± 6.8
UE-16D WW	1/11	4.7 ± 1.3	7.9 ± 1.6	−3.5 ± 16.2
	4/26	4.0 ± 2.3	5.9 ± 2.1	0.7 ± 10.5
	7/19	4.1 ± 1.3	6.0 ± 1.7	3.5 ± 12.1
	10/18	6.5 ± 1.7	7.9 ± 1.9	2.0 ± 6.8
WW 5C	1/11	5.3 ± 1.4	5.7 ± 1.4	−10.7 ± 15.7
	4/26	4.8 ± 2.5	5.1 ± 1.8	−0.5 ± 10.1
	7/19	3.6 ± 1.3	6.2 ± 2.1	−0.5 ± 12.2
	10/18	4.8 ± 1.5	7.2 ± 1.8	9.8 ± 7.3
WW C-1	1/11	7.5 ± 1.9	13.8 ± 2.7	−5.1 ± 16.0
	4/26	8.1 ± 3.5	10.0 ± 2.7	−8.8 ± 7.6
	7/19	7.8 ± 1.8	13.5 ± 2.9	−1.9 ± 14.1
	10/18	6.5 ± 1.7	14.2 ± 2.7	6.4 ± 7.0

Mean MDCs were 1.1, 1.5, and 24.9 pCi/L for gross alpha, gross beta, and tritium, respectively.
(a) ± 2 standard deviations
(b) FD = Field duplicate sample
(c) NA = Analysis not performed on this sample

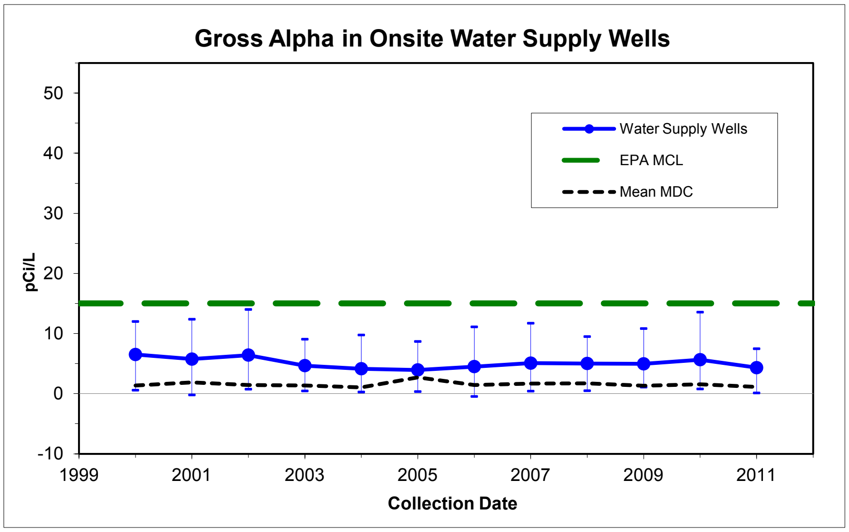

Figure 5-7. Gross alpha annual means for NNSS water supply wells from 2000 through 2011

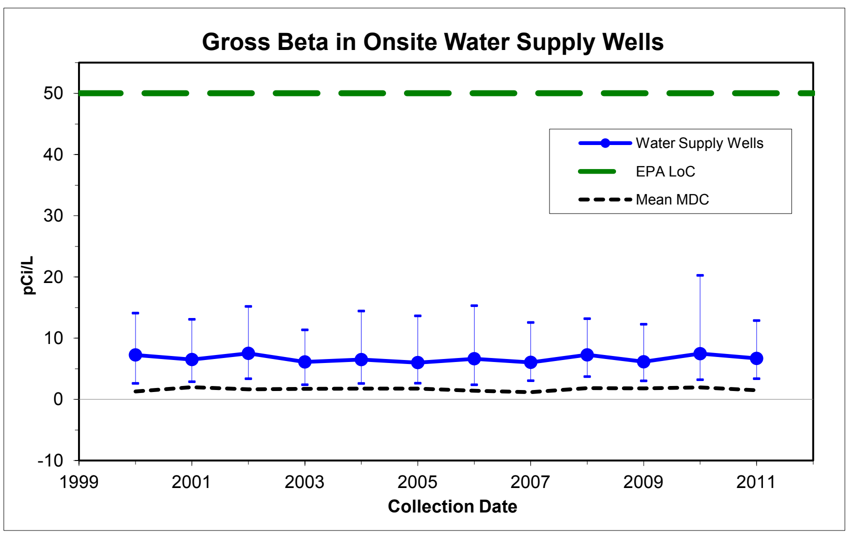

Figure 5-8. Gross beta annual means for NNSS water supply wells from 2000 through 2011

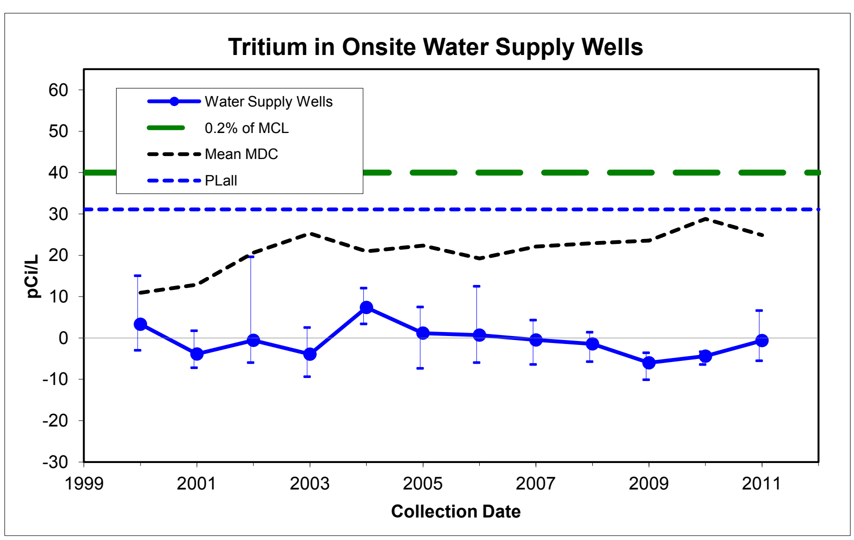

Figure 5-9. Tritium annual means for NNSS water supply wells from 2000 through 2011

5.1.7 Results from RREMP NNSS Monitoring Wells

Detectable concentrations of gross alpha and gross beta were present in water collected from NNSS onsite monitoring wells in 2011 (Table 5-5). Gross beta in one of the two samples from Well ER-19-1 (826 m [2,710 ft]) exceeded the EPA drinking water LoC. The gross alpha and gross beta radioactivity in most of these wells is likely from natural sources. No man-made gamma-emitting radionuclides were detected at concentrations above their respective MDCs in any of the NNSS monitoring wells in 2011.

Table 5-5. Gross alpha, gross beta, and tritium in NNSS monitoring wells in 2011

Location	Date Sampled	Concentration ± Uncertainty[a] (pCi/L)		
		Gross Alpha	Gross Beta	Tritium
ER-12-1[b]		11.6 ± 2.26	7.16 ± 1.76	5.6 ± 183
ER-19-1 (2,710 ft)	3/17	3.8 ± 2.1	69.2 ± 12.0	5.8 ± 11.8
	3/17 FD[c]	2.2 ± 1.5	42.0 ± 7.6	0.7 ± 10.1
(3,280 ft)	3/17	3.7 ± 2.2	17.4 ± 4.0	0.7 ± 10.5
ER-20-1	8/16	4.9 ± 2.2	4.9 ± 1.5	22.4 ± 16.9
	8/16 FD	NA[d]		0.3 ± 16.0
ER-20-2 #1	6/14	4.7 ± 1.3	9.3 ± 2.2	-6.5 ± 13.8
	6/14 FD	NA	NA	0.9 ± 14.0
HTH #1 (1,935 ft)	2/15	NA	NA	3.9 ± 17.9
(2,040 ft)	2/15	NA	NA	−14.2 ± 16.0
(2,130 ft)	2/15	NA	NA	1.3 ± 17.4
(2,300 ft)	2/15	NA	NA	−0.9 ± 17.9
PM-1	3/15	0.9 ± 1.0	2.8 ± 1.4	118.0 ± 17.4
	3/15 FD	NA	NA	118.0 ± 17.3
SM-23-1	9/21	NA	NA	−2.8 ± 6.8
	9/21 FD	NA	NA	12.5 ± 7.1
TW D	2/8	NA	NA	3.6 ± 17.8
U-19BH	5/18	NA	NA	11.4 ± 12.1
UE-1Q	2/8	NA	NA	−4.1 ± 16.5
UE5 PW-1[e]	3/8	2.7 ± 0.9	6.4 ± 1.4	2.3 ± 8.5
	3/8 FD	NA	NA	3.6 ± 9.0
	8/2	NA	NA	5.2 ± 15.9
	8/2 FD	NA	NA	−7.8 ± 15.5
UE5 PW-2[e]	3/8	3.1 ± 0.9	5.7 ± 1.3	5.3 ± 8.9
	3/8 FD	NA	NA	−2.7 ± 8.4
	8/2	NA	NA	12.2 ± 16.4
	8/2 FD	NA	NA	−8.9 ± 15.0
UE5 PW-3[e]	3/8	4.3 ± 1.1	5.8 ± 1.3	−0.4 ± 8.8
	3/8 FD	NA	NA	5.9 ± 9.0
	8/2	NA	NA	−9.9 ± 14.6
	8/2 FD	NA	NA	3.5 ± 15.5
UE-7NS	2/16	NA	NA	71.3 ± 21.0
	2/16 FD	NA	NA	63.8 ± 20.3
WW A	2/9	NA	NA	326.0 ± 55.4
	2/9 FD	NA	NA	329.0 ± 55.7

The mean MDCs were 1.4, 2.3, and 24.0 for gross alpha, gross beta, and tritium respectively.
The yellow shaded result exceeds 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 5.1.8)
(c) FD = field duplicate sample
(d) NA = Analysis not performed on this sample
(e) Compliance well for mixed low level waste disposal cells at Area 5 RWMS (see Section 10.1.7)

In 2011, tritium was detected again in three RREMP onsite monitoring wells (PM-1, UE-7NS, and WW A) (Table 5-5). Well U-19BH has also historically had concentrations above the MDC but far below the EPA MCL. These four wells are known to have, or have had, detectable concentrations of tritium, as reported in previous annual NNSS environmental reports. They are each located within 1 kilometer (km) (0.6 miles [mi]) of an historical underground nuclear test, as discussed below. Tritium concentrations in samples from these wells have been decreasing in recent years (Figure 5-10). Since 1999, estimated annual rates of decrease are 5.4%, 8.0%, 11.7%, and 6.2% for PM-1, U-19BH, UE-7NS, and WW A, respectively. These decreasing trends are statistically significant, with p-values of 0.001, 0.012, 0.000, 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. GREELEY 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 5-10). UE-7NS is the second known location on the NNSS 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 2011 (Table 5-5). Tritium histories for these other wells are shown in Figure 5-11.

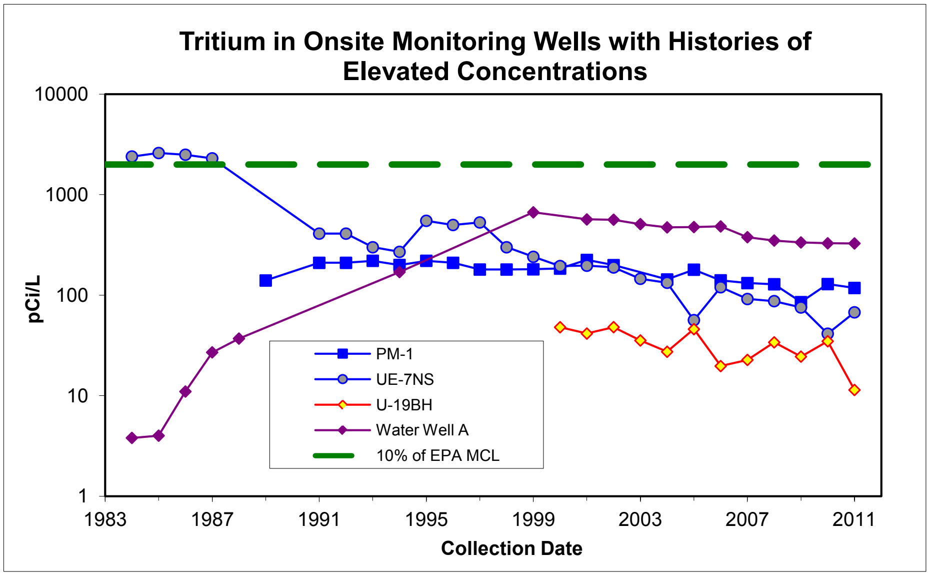

Figure 5-10. Tritium annual means for NNSS monitoring wells with histories of elevated concentrations

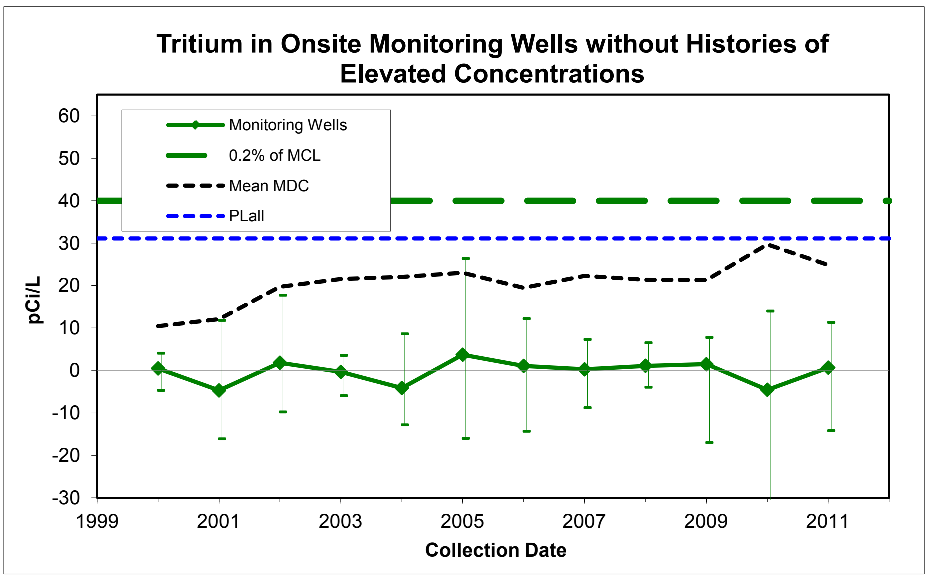

Figure 5-11. Tritium annual means for NNSS monitoring wells without histories of elevated concentrations

5.1.8 Results from E-Tunnel Waste Water Disposal System (ETDS) Monitoring

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

On October 4, 2011, the annual sampling of the ETDS discharge water was performed, and on April 13, 2011, the biennial sampling of Well ER-12-1 was performed. Tritium, gross alpha, and gross beta levels for all samples were below the limits allowed under the permit (Table 5-6).

Table 5-6. Gross alpha, gross beta, and tritium in E-Tunnel Disposal System samples in 2011

Radiological Parameter	ETDS Discharge Water Sampled Every 12 Months (October 2011)		Well ER-12-1 Groundwater Sampled Every 24 Months (April 2011)	
	Permissible Limit (pCi/L)	Measured Value (pCi/L)	Permissible Limit (pCi/L)	Measured Value (pCi/L)
Tritium	1,000,000	461,000 ± 69,900	20,000	5.6 ± 183
Gross Alpha	35.1	9.96 ± 1.83	15	11.6 ± 2.26
Gross Beta	101	4.44 ± 7.18	50	7.16 ± 1.76

Sources: (NSTec, 2012b; 2012c)

5.1.9 Environmental Impact

The radiological impact to water resources from past activities on the NNSS is from man-made radionuclides in the groundwater within the UGTA Activity CAUs (Figure 5-1) and the migration of these radionuclides downgradient from the CAUs. In 2009, sampling of the new UGTA Activity Well ER-EC-11, 716.3 m (2,350 ft) west of the NNSS boundary (Chapter 12, Figure 12-4), confirmed the presence of tritium at elevated levels around 66% of the EPA drinking water MCL. This was the first time that radionuclides from NNSS underground tests (UGTs) had been detected in groundwater beyond NNSS boundaries. Those sampling results were consistent with UGTA's Pahute Mesa transport model, which predicts migration of tritium off the NNSS within 50 years of the first nuclear detonation (1965) from the Central and Western Pahute Mesa CAUs (Chapter 12; Figure 12-5). Tritium was not found in a deeper horizon in ER-EC-11 in the 2010 sampling, and this well was not sampled in 2011. Well sampling results to date have not detected the presence of man-made radionuclides 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; see Chapter 12, Figure 12-4). Samples from offsite RREMP monitoring wells in Oasis Valley, farther downgradient of Pahute Mesa, also contain no detectable man-made radionuclides. The groundwater samples collected in July 2011 under the RREMP from PM-3 at a depth of 475.5 m (1,560 ft) were found to contain low concentrations of tritium (58.0 and 63.2 pCi/L). PM-3 is 3,261 m (10,700 ft) west of the NNSS border. It is 7.4 km (4.6 mi) northwest from Well ER-EC-11. These concentration levels are far lower than the EPA MCL of 20,000 pCi/L and the RREMP action level of 2,000 pCi/L. RREMP monitoring of PM-3 will continue in 2012, and the UGTA Activity will collect and test additional samples to help identify the source of the tritium. Sampling results will be considered in future data collection decisions and groundwater model evaluations.

On the NNSS, 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 NNSS 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 1999, their tritium concentrations have all been less than 3% of the EPA MCL for drinking water (20,000 pCi/L) and are low and/or statistically significantly decreasing, as discussed in Section 5.1.7.

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

5.2 Nonradiological Drinking Water and Wastewater Monitoring

The quality of drinking water and wastewater on the NNSS 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. NNSA/NSO ensures that such systems meet the applicable water quality standards and permit requirements (see Section 2.2). The NNSS nonradiological water monitoring goals are shown below. They are met by conducting field water sampling and analyses, performing assessments, and maintaining documentation. This section describes the results of 2011 activities. Information about radiological monitoring of drinking water on and off the NNSS and wastewater on the NNSS is presented in Sections 5.1.5, 5.1.6, and 5.1.8.

Nonradiological Water Monitoring Goals	*Compliance Measures/Actions*
Ensure that the operation of NNSS public water systems (PWSs) and private water systems (see Glossary, Appendix B) provides high-quality drinking water to workers and visitors of the NNSS.	Number of PWS samples containing coliform bacteria
Determine if NNSS PWSs are operated in accordance with the requirements in Nevada Administrative Code NAC 445A, "Water Controls," under permits issued by the State.	Inorganic chemicals, volatile organic chemicals, disinfection by-products, and Secondary Standards contaminants in PWS samples
Determine if the operation of commercial septic systems to process domestic wastewater on the NNSS meets operational standards in accordance with the requirements NAC 445A under permits issued by the State.	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
Determine if the operation of industrial wastewater systems on the NNSS meets operational standards of federal and state regulations as prescribed under the GNEV93001 state permit.	Flow rate, pH, temperature, specific conductance, and 14 contaminants (mostly metals) in E-Tunnel effluent water

5.2.1 Drinking Water Monitoring

With the addition in 2011 of a new water supply well (Well J-14, see Section 5.2.1.3), there are now seven permitted wells that supply the potable water needs of NNSS operations. These are grouped into three PWSs (Figure 5-12). The largest PWS (Area 23 and 6) serves the main work areas of the NNSS. 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 9-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 NNSS 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 (see Glossary, Appendix B) 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 2011, 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.

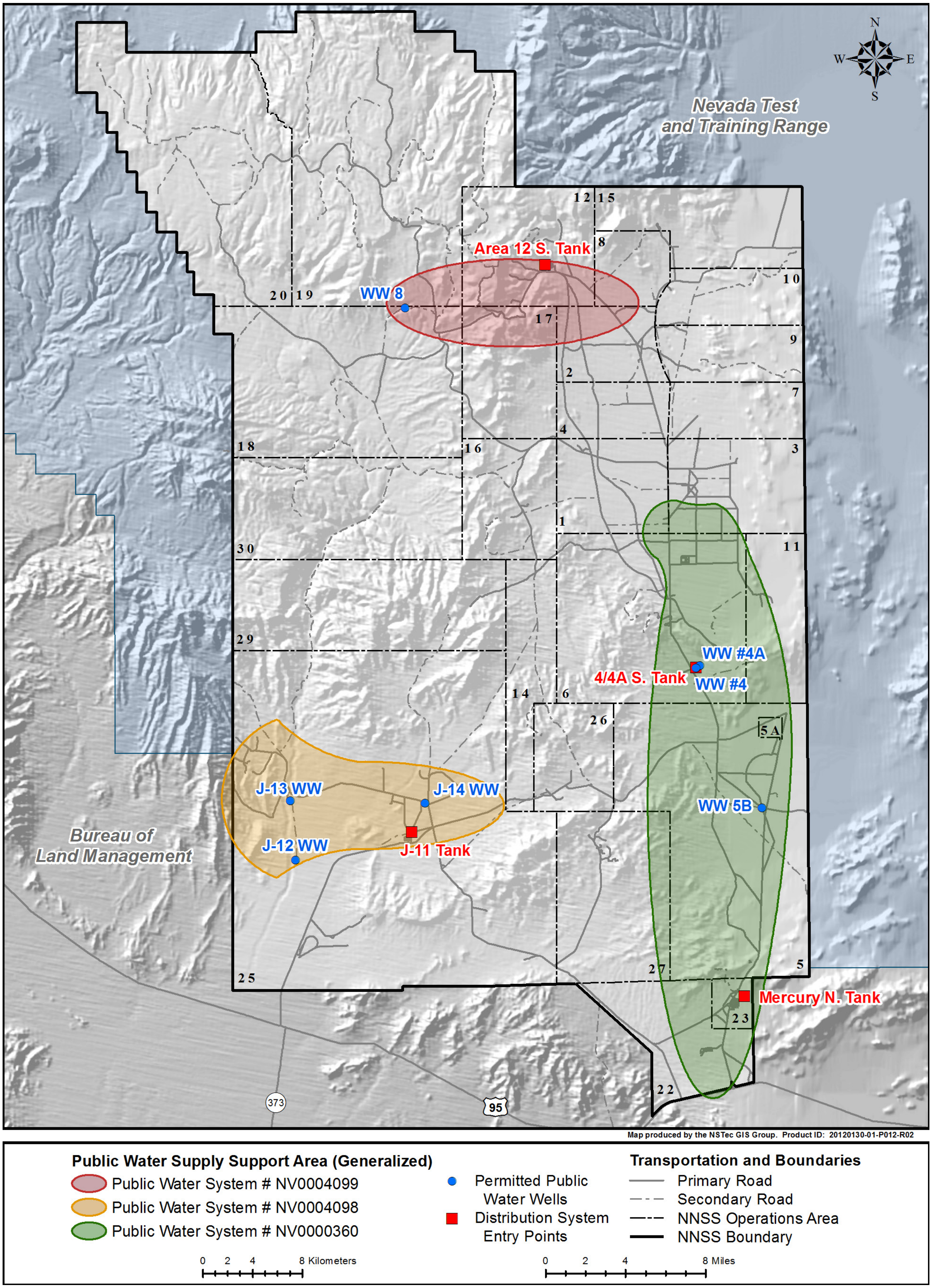

Figure 5-12. Water supply wells and drinking water systems on the NNSS

Table 5-7. 2011 monitoring parameters and sampling design for NNSS PWSs and permitted water-hauling trucks

2011 Monitoring Requirements			
PWS	**Contaminant**	**Samples/Frequency**	**Monitoring Locations**
Area 23 and 6	Coliform Bacteria	36 samples/ 3 buildings per month	Buildings 5-7, U1H restroom, 6-609, 6-900, 22-1, 23-180, 23-701, 23-777, and 23-1103
	Inorganic Chemicals: Nitrate	2 samples (1 per entry point)/ annually	Entry points: Mercury N. Tank and 4/4A S. Tank
	29 Synthetic Organic Chemicals: (Table 5-8)	1 sample/every 3 years (from alternating entry points)	Entry points: Mercury N. Tank and 4/4A S. Tank
Area 12	Coliform Bacteria	4 samples/1 per quarter	Building 12-909
	Inorganic Chemicals: Nitrate	1 sample/ every 3 years	Entry point Area 12 S. Tank
	Secondary Standards: 15 parameters (Table 5-8)	1 sample/ every 3 years	Entry point Area 12 S. Tank
Area 25	Coliform Bacteria	4 samples/1 per quarter	Building 25-3123 or 25-4222
	Inorganic Chemicals: Nitrate	1 sample/every 3 years	Entry points: J-11 Tank and J-14 Pumphouse
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

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

In 2011, 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 2011.

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

		2011 Results (mg/L)		
Contaminant	**Maximum Contaminant Level (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	Absent in all samples	Absent in all samples
Inorganic Chemicals				
Nitrate	10 (as nitrogen)	4.00 and 2.90	1.10	1.90
Secondary Standards				
Aluminum	0.2	NA[a]	0.05	NA[a]
Chloride	400	NA	8.6	NA
Copper	1.3	NA	0.0019	NA
Foaming Agents	0.5	NA	ND[b]	NA
Iron	0.6	NA	0.24	NA
Magnesium	150	NA	0.6	NA
Manganese	0.1	NA	0.0052	NA
Silver	0.1	NA	0.0011	NA
Sulfate	500	NA	15	NA
Total Dissolved Solids	1,000	NA	160	NA
Zinc	5	NA	0.005	NA
Fluoride	2	NA	0.71	NA
Color	15 units	NA	ND	NA
Odor	3	NA	1.0	NA
pH	6.5 to 8.5	NA	8.02	NA

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

Contaminant	Maximum Contaminant Level (mg/L)	2011 Results (mg/L)		
		Area 23 and 6 PWS	Area 12 PWS	Area 25 PWS
Synthetic Organic Chemicals				
1,2-Dibromo-3-chloropropane	0.002	< 0.0002	NA	NA
2,4,5-TP	0.05	< 0.0002	NA	NA
2,4-D	0.07	< 0.0001	NA	NA
Atrazine	0.003	< 0.0001	NA	NA
Benzo(a)pyrene	0.0002	< 0.00002	NA	NA
bhc-gamma (Lindane)	0.0002	< 0.00002	NA	NA
Carbofuran	0.04	< 0.0009	NA	NA
Chlordane	0.002	< 0.0002	NA	NA
Dalapon	0.2	< 0.001	NA	NA
Di(2-ethylhexyl) adipate	0.4	< 0.0006	NA	NA
Di(2-ethylhexyl) phthalate	0.006	< 0.0006	NA	NA
Dinosab	0.007	< 0.0002	NA	NA
Diquat	0.02	< 0.0004	NA	NA
Endothall	0.1	< 0.009	NA	NA
Endrin	0.002	< 0.00001	NA	NA
Ethylene dibromide	0.00005	< 0.00001	NA	NA
Glyphosate	0.7	< 0.006	NA	NA
Heptachlor	0.0004	< 0.00004	NA	NA
Heptachlor epoxide	0.0002	< 0.00002	NA	NA
Hextachlorobenzene	0.001	< 0.0001 and 0.0000092	NA	NA
Hextachlorocyclopentadiene	0.05	< 0.0001	NA	NA
Lasso	0.002	< 0.0002	NA	NA
Methoxychlor	0.04	< 0.0001	NA	NA
Oxamyl	0.2	< 0.002	NA	NA
Pentachlorophenol	0.00004	< 0.00004	NA	NA
Picloram	0.5	< 0.0001	NA	NA
Simazine	0.004	< 0.00007	NA	NA
Total PCBs	0.0005	< 0.0001	NA	NA
Toxaphene	0.003	< 0.001	NA	NA

(a) NA = Not applicable
(b) ND = Not detected

5.2.1.2 State Inspections

Periodically, NDEP conducts a sanitary survey of the permitted NNSS 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 5 years. In 2011, NDEP performed a sanitary survey of the PWSs (the previous survey had been conducted in 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 2011, and permits were renewed.

5.2.1.3 New Water Supply Well Construction

A new water supply well, Well J-14, which was designed and drilled in 2010, and a new water pipeline from the well, also designed in 2010, were connected to the Area 25 PWS in August 2011; it came on line, providing water to the Area 25 PWS, in March 2012. Well J-14 is located in Area 25, approximately 2,560 m (8,400 ft) north-northeast of Well J-11 and the J-11 Tank (see Figure 5-12). The new well and pipeline will reduce leaks and system maintenance and repair costs. Construction, development, testing, and completion of the well were in accordance with industry standards and satisfied the requirements of applicable portions of NACs 534 and 445A (see Section 2.3.1).

5.2.2 Domestic Wastewater Monitoring

A total of 23 permitted septic systems for domestic wastewater are being used on the NNSS (Figure 5-13). 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 Solid Waste Department; the remaining 16 systems fall under the supervision and management of the buildings' facility manager. The permitted septic systems are inspected periodically for sediment loading and are pumped as required. The NNSS Management and Operations contractor maintains a septic pumping contractor permit issued by the State. The State conducts onsite inspections of pumper trucks and pumping contractor operations. NNSS 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 2011, there were no compliance actions relating to domestic wastewater on the NNSS.

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 2011.

5.2.3 Industrial Wastewater Monitoring

Industrial discharges on the NNSS are limited to two operating sewage lagoon systems: Area 6 Yucca Lake and Area 23 Mercury (these lagoon systems also receive domestic wastewater) (Figure 5-13). 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. The laboratories used approved analytical methods listed in NAC 445A and 40 CFR 141. 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 2011, 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 2011 and in January 2012.

Table 5-9. Water quality analysis results for NNSS sewage lagoon influent waters in 2011

		Minimum and Maximum Values from Quarterly Samples	
Parameter	**Units**	**Area 6 Yucca Lake**	**Area 23 Mercury**
BOD_5 (Permit Limit)	mg/L	113–211 (No Limit)	46.7–462 (No Limit)
BOD_5 Mean Daily Load[(a)] (Permit Limit)	kg/d	0.24–1.24 (8.66)	4.09–39.24 (115.4)
TSS (Permit Limit)	mg/L	92–244 (No Limit)	46–462 (No Limit)
pH (Permit Limit)	S.U.[(b)]	8.05–8.61 (6.0–9.0)	8.15–8.78 (6.0–9.0)

(a) BOD_5 Mean Daily Load in kilograms per day (kg/d) = (mg/L BOD × liters per day (L/d) average flow × 3.785)/10^6

(b) Standard units of pH

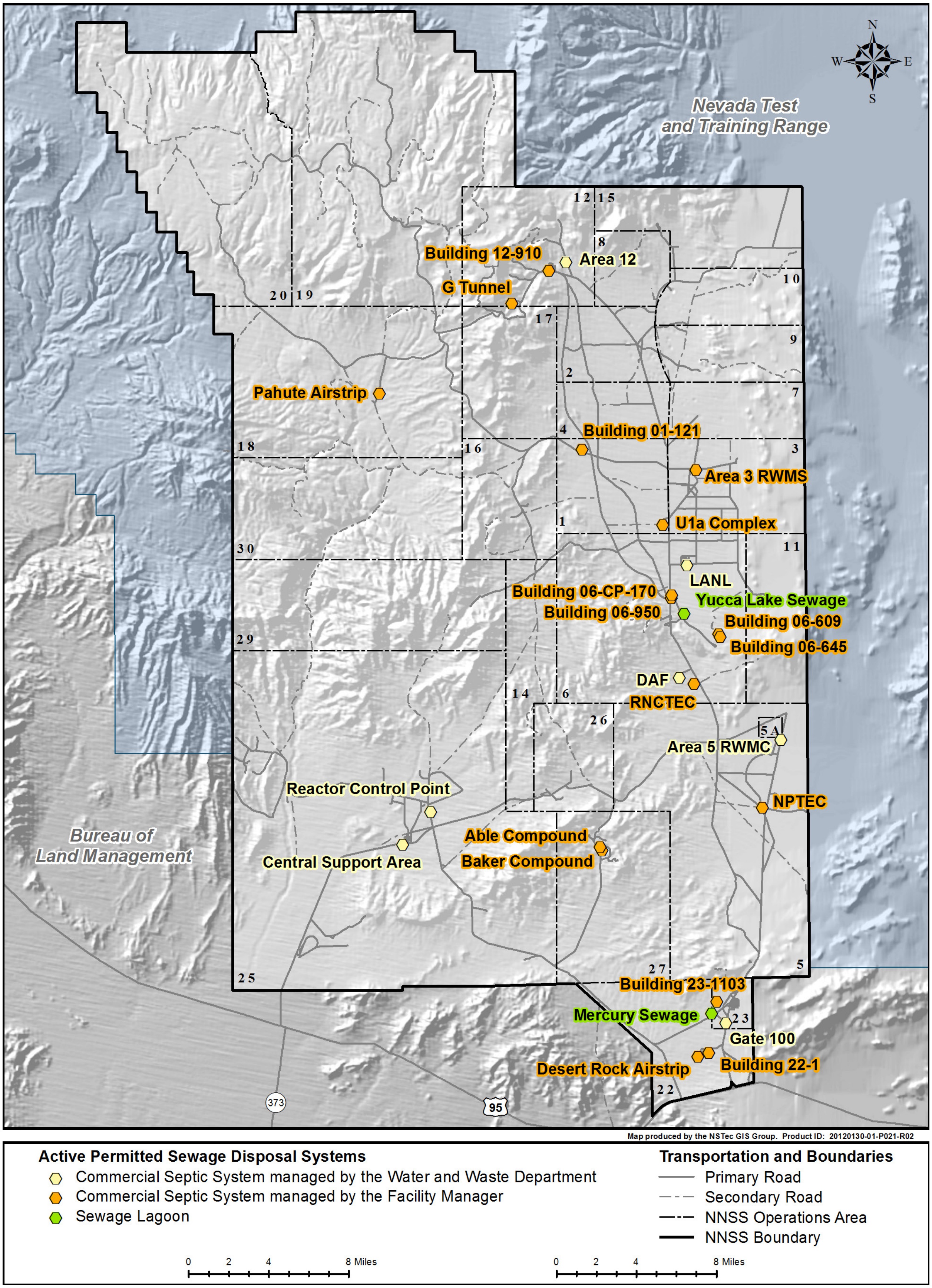

Figure 5-13. Active permitted sewage disposal systems on the NNSS

Toxicity monitoring of influent waters of the lagoons was not conducted in 2011. The permit requires that the lagoons be sampled and analyzed for the 29 contaminants shown in Table 4-10 of the *Nevada Test Site Environmental Report 2008* (NSTec, 2009) only in the event of specific or accidental discharges of potential contaminants. There were no such discharges that warranted sampling in 2011.

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 NNSS 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. NNSS personnel conducted weekly and quarterly inspections throughout the year, and NDEP conducted its annual inspection in December 2011. 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 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 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. The permit requires ETDS discharge waters to be monitored every 12 months for radiological parameters (see Section 5.1.8, Table 5-6) and for the nonradiological parameters listed in Table 5-10. It also requires Well ER-12-1 to be sampled for the same parameters but at a frequency of once every 24 months. The ETDS is also monitored monthly for flow rate, pH, temperature, and specific conductance (SC) of the discharge water and the total volume and structural integrity of the holding ponds. Monitoring data are reported to the NDEP BFF in annual and quarterly reports.

On October 4, 2011, monitoring personnel sampled the ETDS discharge water, and all nonradiological parameters were within the threshold limits specified by the permit (Table 5-10). All 2011 monthly measurements and observations demonstrated compliance with permit limits and specifications, with the exception of SC measurements at the ETDS discharge point. Eleven of the monthly SC measures were below the lower permit limit of 400 microsiemens per centimeter (µS/cm), ranging from 373.0 to 386.1 µS/cm; the March sample (446.4 µS/cm) was within permit limits. NDEP determined, after evaluating NNSA/NSO's study of this parameter, that these measurements should continue to be collected. NDEP suspended the permit requirement for follow-on monitoring, and will reevaluate the permit limits for SC when the permit is renewed in 2013.

On April 13, 2011, Well ER-12-1 was sampled, and the sample was within permit limits for all nonradiological parameters except specific conductance, which was slightly higher than the permissible limit (Table 5-10).

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

	ETDS Discharge Water Sampled Every 12 Months (October 2011)		**Well ER-12-1 Groundwater Sampled Every 24 Months (April 2011)**	
Nonradiological Parameter	**Threshold (mg/L)**	**Measured Value (mg/L)**	**Threshold (mg/L)**	**Measured Value (mg/L)**
Cadmium	0.045	0.000515	0.005	< 0.001
Chloride	360	9.42	250	15.6
Chromium	0.09	0.000782[(a)]	0.09	< 0.003
Copper	1.2	0.00155[(a)]	1.2	< 0.003
Fluoride	3.6	< 0.50	3.6	< 0.50
Iron	5.0	2.47	5.0	< 0.001
Lead	0.014	< 0.001	0.014	0.0012[(a)]
Magnesium	135	1.2	135	62.7
Manganese	0.25	0.0281	0.25	0.187
Mercury	0.0018	< 0.00006	0.0018	< 0.0002

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

Nonradiological Parameter	ETDS Discharge Water Sampled Every 12 Months (October 2011) Threshold (mg/L)	ETDS Discharge Water Sampled Every 12 Months (October 2011) Measured Value (mg/L)	Well ER-12-1 Groundwater Sampled Every 24 Months (April 2011) Threshold (mg/L)	Well ER-12-1 Groundwater Sampled Every 24 Months (April 2011) Measured Value (mg/L)
Nitrate nitrogen	9	1.29	9	< 0.05
Selenium	0.045	< 0.003	0.045	< 0.01
Sulfate	450	16.6	450	381
Zinc	4.5	0.111	4.5	0.0126
pH (S.U.)[b]	6.0–9.0	7.39	6.5–8.5	7.79
Specific conductance (μS/cm)[c]	400–500	386.9	400–1,000	1,017

(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, 2012b; 2012c)

5.2.5 Environmental Impact

The results of all drinking water and wastewater monitoring in 2011 were within permit limits. In the past, some drinking water standards in NNSS 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 NNSS operations is expected to be co-located with the radiological contamination that has occurred from historical underground nuclear testing within the UGTA Activity 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 Activity 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 NNSS 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 12). 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 Activity and Industrial Sites Activity, 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 11). 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 NNSS.

6.0 Direct Radiation Monitoring

U.S. Department of Energy (DOE) Orders DOE O 458.1, "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 National Security Site (NNSS) environment could potentially be deposited in humans and animals through inhalation and ingestion. Chapters 4, 5, and 8 present the results of monitoring radionuclides in air, water, and biota, respectively, on the NNSS; 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. External dose comes from direct ionizing radiation from all sources on the NNSS, including natural radioactivity from cosmic and terrestrial sources as well as man-made radioactive sources. This chapter presents the data obtained to assess external dose during 2011.

Direct radiation monitoring is conducted to assess the external radiation environment, detect changes in that environment, respond to releases from U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) activities, and measure gamma radiation levels near potential exposure sites. In addition, DOE O 458.1 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 external dose that comes from background radiation versus NNSS operations.
Measure external radiation in order to assess the potential external dose to a member of the public from all NNSA/NSO operations at the NNSS and determine if the total dose (internal and external) complies with the 100 millirem per year (mrem/yr) (1 millisievert [mSv]/yr) dose limit of DOE O 458.1 (see Chapter 9 for estimates of public dose).
Measure external radiation in order to assess the potential external dose to a member of the public from operations at the Area 3 and Area 5 Radioactive Waste Management Sites (RWMSs) and determine if the total dose complies with 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" (see Chapter 9 for estimates of public dose).
Monitor operational activities involving radioactive material, radiation-generating devices, and accidental releases of radioactive material to ensure exposure to members of the public are kept ALARA as stated in DOE O 458.1.
Determine if the absorbed radiation dose (in a unit of measure called a rad [see Glossary, Appendix B]) from external radiation exposure to NNSS terrestrial plants and aquatic animals is less than 1 rad per day (1 rad/d) (0.01 gray/d), and if the absorbed radiation dose to NNSS terrestrial animals is less than 0.1 rad/d (1 milligray/d) (limits prescribed by DOE O 458.1 and DOE Standard DOE-STD-1153-2002, "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota") (see Section 9.2 for biota dose assessments).
Determine the patterns of exposure rates through time at various soil contamination areas in order to characterize releases in the environment.

An offsite monitoring program has been established by NNSA/NSO to monitor direct radiation in communities adjacent to the NNSS. The Desert Research Institute (DRI) conducts this monitoring as part of its Community Environmental Monitoring Program (CEMP). DRI's 2011 direct radiation monitoring results are presented in Sections 7.1.2 and 7.1.3; see also Figures 6-2 and 6-3 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 to living tissue as 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

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

TLDs measure ionizing radiation exposure from all sources. The TLD used is the Panasonic UD-814AS, which has three calcium sulfate elements housed in an air-tight, water-tight, ultraviolet-light–protected case. 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 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 108 active environmental TLD locations on the NNSS (Figure 6-1) during 2011. They include the following numbers and types of locations:

- Background (B) – 10 locations where radiation effects from NNSS operations are negligible.
- Environmental 1 (E1) – 41 locations where there is no measurable radioactivity from past operations but are of interest due to the presence of people 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, but measurements at one location, RWMS NW Corner, were not taken in 2011 due to the site being disturbed.
- 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.

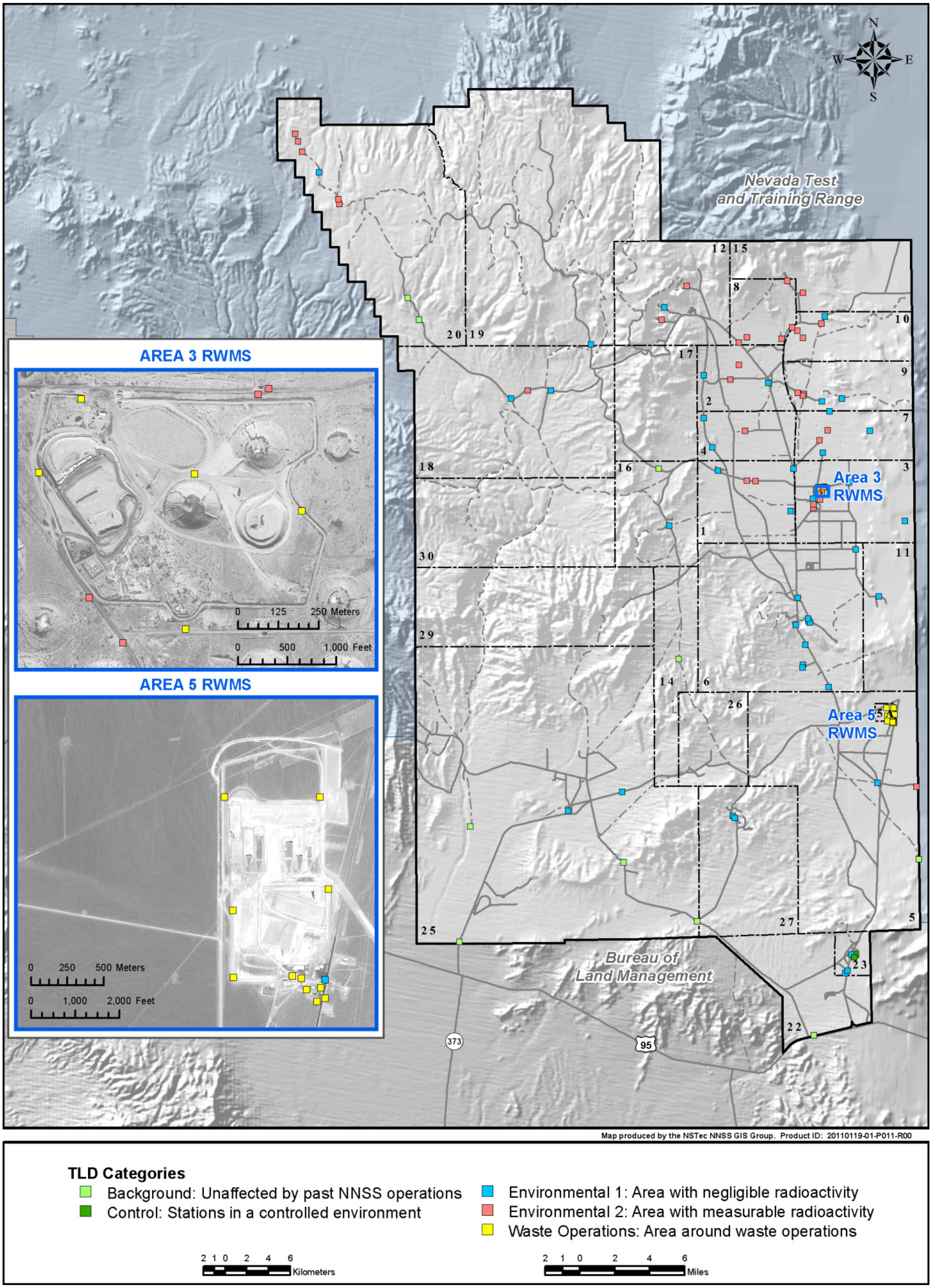

Figure 6-1. Location of TLDs on the NNSS

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 the detection and estimation of any systematic variation that might be introduced by the measurement process itself.

Both TLDs of each pair provided data for 431 of the 436 possible quarterly measurements (109 locations for 4 quarters) in 2011. Measurements were not made at the A5 RWMS NW Corner TLD location because the location was disturbed, and the TLDs were missing from the Stake K-25 location at the end of the 2nd quarter. Overall, 98.9% of all planned measurements were successful. Agreement between results provided by the paired TLDs was very good, with an average relative percent difference between measurements of 3.2% during 2011. The quarter-to-quarter coefficient of variation (CV, identical to the relative standard deviation) ranged from 1.7% to 11.4% (median = 5.1%) over all locations, with the exclusion of Gate 100 Truck Parking 1 (see the discussion in Section 6.3.1).

As directed by the RREMP, QA and quality control (QC) protocols, including Data Quality Objectives, have been developed and are maintained as essential elements of direct radiation monitoring. 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 (see Chapter 17). 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; this is the metric used to determine compliance with federal annual dose limits.

6.3 Results

Estimated annual exposures for all TLD locations are given in Table 6-1. Summary statistics for the five location types are given in Table 6-2 and Figure 6-2. During 2011, the average of the estimated annual exposures among the 10 background locations was 119 mR, ranging from 66 to 164 mR (Table 6-2). A 95% prediction interval for annual exposures based on the 2011 estimated mean annual exposures at the background locations (95% PI from B) is 41.0 to 196.8 mR. This interval predicts mean annual background exposure at locations where radiation effects from NNSS operations are negligible.

For comparison, the CEMP's estimated annual exposure in Las Vegas, Nevada (at 617 m [2,025 ft] elevation), was 92 mR during 2011 (see Table 7-3). Estimated exposures at CEMP locations ranged from 78 mR at Pahrump, Nevada (804 m [2,639 ft] elevation), to 148 mR at Twin Springs, Nevada (1,568 m [5,146 ft] elevation). There is a mild increasing relationship between natural background exposure and elevation (Figure 6-3). The NNSS background locations with lowest and highest exposures are at elevations 1,087 m (3,568 ft) (Area 5, 3.3 Mi SE of Aggregate Pit) and 1,737 m (5,700 ft) (Area 20, Stake A-112), respectively.

Exposure estimates at all locations include contributions from natural sources. It is important to note that the DOE dose limits to the public are for dose over and above what may be received from natural sources.

Table 6-1. Annual direct radiation exposures measured at TLD locations on the NNSS in 2011

NNSS Area	Station	Location Type[(b)]	Number of Quarters	Estimated Annual Exposure (mR)[(a)] Mean[(c)]	Minimum[(c)]	Maximum[(c)]
5	3.3 Mi SE of Aggregate Pit	B	4	66	62	69
14	Mid-Valley	B	4	146	137	154
16	Stake P-3	B	4	119	110	126
20	Stake A-112	B	4	164	146	173
20	Stake A-118	B	4	156	147	165
22	Army #1 Water Well	B	4	85	83	88
25	Gate 25-4-P	B	4	131	123	140
25	Guard Station 510	B	4	129	122	141
25	Jackass Flats & A-27 Roads	B	4	83	78	87
25	Skull Mtn Pass	B	4	109	107	111
23	Building 650 Dosimetry	C	4	61	58	63
23	Lead Cabinet, 1	C	4	26	25	28
23	Lead Cabinet, 2	C	4	26	25	28
23	Lead Cabinet, 3	C	4	26	25	29
23	Lead Cabinet, 4	C	4	27	26	28
23	Lead Cabinet, 5	C	4	27	25	29
1	BJY	E1	4	120	111	126
1	Sandbag Storage Hut	E1	4	116	108	121
1	Stake C-2	E1	4	121	114	126
2	Stake M-140	E1	4	137	127	145
2	Stake TH-58	E1	4	96	93	101
3	LANL Trailers	E1	4	123	118	130
3	Stake OB-20	E1	4	93	89	97
3	Well ER 3-1	E1	4	130	119	141
4	Stake TH-41	E1	4	112	109	116
4	Stake TH-48	E1	4	121	114	129
5	Water Well 5B	E1	4	115	108	119
6	CP-6	E1	4	73	68	78
6	DAF East	E1	4	102	94	105
6	DAF North	E1	4	103	96	106
6	DAF South	E1	4	137	128	145
6	DAF West	E1	4	87	79	92
6	Decon Facility NW	E1	4	130	117	140
6	Decon Facility SE	E1	4	134	121	144
6	Stake OB-11.5	E1	4	132	120	138
6	Yucca Compliance	E1	4	94	83	101
6	Yucca Oil Storage	E1	4	102	94	110
7	Reitmann Seep	E1	4	129	121	135
7	Stake H-8	E1	4	131	123	137
9	Papoose Lake Road	E1	4	90	83	94
9	U-9CW South	E1	4	106	98	111
9	V & G Road Junction	E1	4	118	111	125
10	Gate 700 South	E1	4	131	122	137
11	Stake A-21	E1	4	133	123	138
12	Upper N Pond	E1	4	133	126	137
16	3545 Substation	E1	4	142	131	149

Table 6-1. Annual direct radiation exposures measured at TLD locations on the NNSS in 2011 (continued)

NNSS Area	Station	Location Type[b]	Number of Quarters	Estimated Annual Exposure (mR)[a] Mean[c]	Minimum[c]	Maximum[c]
18	Stake A-83	E1	4	150	138	157
18	Stake F-11	E1	4	149	138	158
19	Stake P-41	E1	4	158	149	169
20	Stake J-41	E1	4	141	128	147
23	Gate 100 Truck Parking 1	E1	4	107	71	129
23	Gate 100 Truck Parking 2	E1	4	67	64	72
23	Mercury Fitness Track	E1	4	61	58	64
25	HENRE	E1	4	125	118	133
25	NRDS Warehouse	E1	4	125	120	133
27	Cafeteria	E1	4	115	110	121
27	JASPER-1	E1	4	115	109	120
1	Bunker 1-300	E2	4	123	115	129
1	T1	E2	4	252	235	263
2	Stake L-9	E2	4	167	160	170
2	Stake N-8	E2	4	458	433	480
3	Stake A-6.5	E2	4	140	132	145
3	T3	E2	4	328	311	348
3	T3 West	E2	4	325	304	337
3	T3A	E2	4	360	326	383
3	T3B	E2	4	461	432	484
3	U-3co North	E2	4	182	168	195
3	U-3co South	E2	4	144	136	156
4	Stake A-9	E2	4	571	529	588
5	Frenchman Lake	E2	4	298	248	322
7	Bunker 7-300	E2	4	218	202	231
7	T7	E2	4	117	109	121
8	Baneberry 1	E2	4	347	330	357
8	Road 8-02	E2	4	127	120	133
8	Stake K-25	E2	3	105	98	112
8	Stake M-152	E2	4	161	151	171
9	B9A	E2	4	131	125	140
9	Bunker 9-300	E2	4	126	122	130
9	T9B	E2	4	471	435	503
10	Circle & L Roads	E2	4	119	114	121
10	Sedan East Visitor Box	E2	4	136	128	143
10	Sedan West	E2	4	227	216	234
10	T10	E2	4	247	230	254
12	T-Tunnel #2 Pond	E2	4	243	218	265
12	Upper Haines Lake	E2	4	110	105	118
15	EPA Farm	E2	4	118	114	122
18	Johnnie Boy North	E2	4	145	133	153
20	Palanquin	E2	4	217	202	225
20	Schooner-1	E2	4	600	551	647
20	Schooner-2	E2	4	250	237	257
20	Schooner-3	E2	4	145	138	155
20	Stake J-31	E2	4	162	148	172

Table 6-1. Annual direct radiation exposures measured at TLD locations on the NNSS in 2011 (continued)

NNSS 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	134	152
3	A3 RWMS East	WO	4	137	129	144
3	A3 RWMS North	WO	4	130	121	141
3	A3 RWMS South	WO	4	324	309	334
3	A3 RWMS West	WO	4	131	124	136
5	A5 RWMS East Gate	WO	4	104	98	107
5	A5 RWMS Expansion NE	WO	4	141	135	151
5	A5 RWMS Expansion NW	WO	4	152	140	161
5	A5 RWMS NE Corner	WO	4	128	119	134
5	A5 RWMS NW Corner	WO	0	NM[d]	NM	NM
5	A5 RWMS South Gate	WO	4	109	104	117
5	A5 RWMS SW Corner	WO	4	127	122	133
5	Building 5-31	WO	4	108	98	113
5	WEF East	WO	4	129	121	137
5	WEF North	WO	4	119	109	129
5	WEF South	WO	4	128	117	134
5	WEF West	WO	4	123	119	127

(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 NNSS 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.
(d) Not measured. The TLD location was disturbed, so no measurements could be taken at this location during 2011.

Table 6-2. Summary statistics for 2011 mean annual direct radiation exposures by TLD location type

Location Type	Number of Locations	Estimated Annual Exposure (mR)		
		Mean	Minimum	Maximum
Background (B)	10	119	66	164
Control (C)	6	32	26	61
Environmental 1 (E1)	41	117	61	158
Environmental 2 (E2)	35	238	105	600
Waste Operations (WO)	16	139	104	324

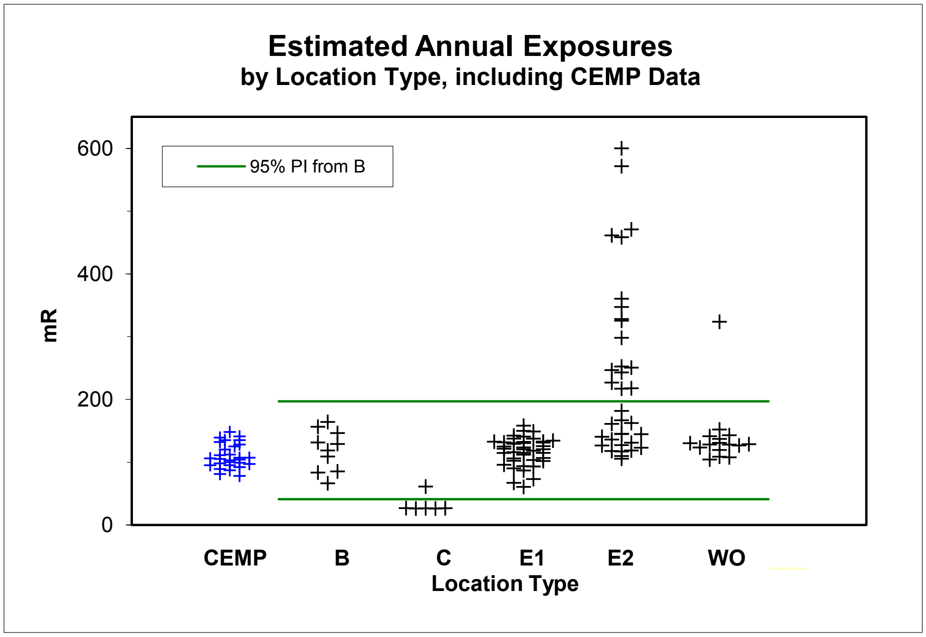

Figure 6-2. 2011 annual exposures on the NNSS, by location type, and off the NNSS at CEMP stations

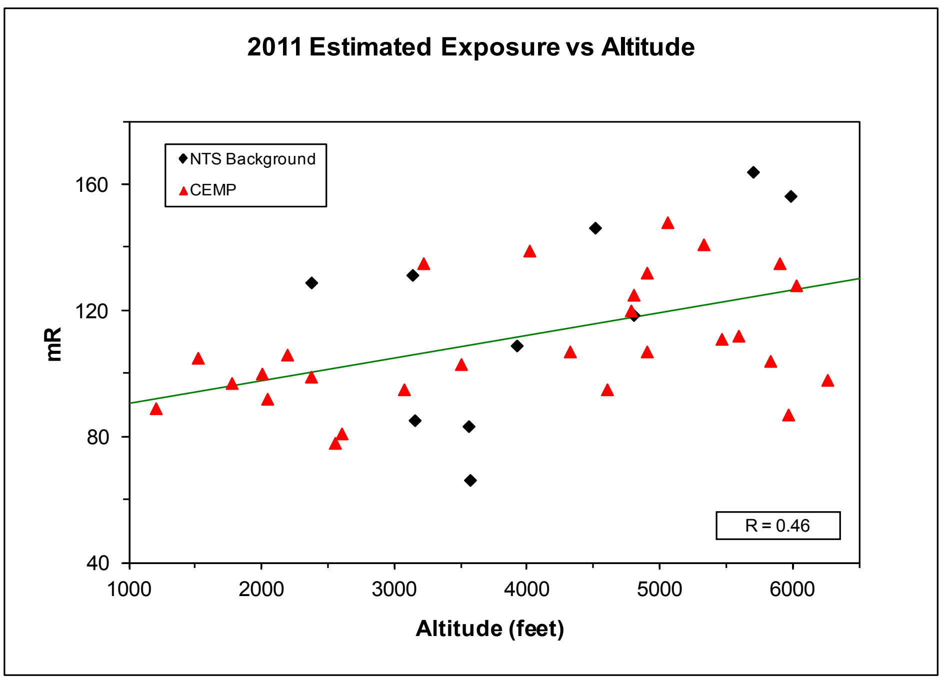

Figure 6-3. Correlation between 2011 annual exposures at NNSS and CEMP TLD locations and altitude

6.3.1 Potential Exposure to the Public along the NNSS Boundary

Most of the NNSS is not accessible to the public, as only the southern portion of the NNSS borders public land. Therefore, the only place the public has unlimited access is along the southern end of the NNSS. Gate 100 is the primary entrance point to the NNSS. 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 NNSS. Two TLD locations were established in October 2003 to monitor this truck parking area. The TLDs at the north end of the parking area (Gate 100 Truck Parking 2) had an estimated annual exposure of 67 mR, with quarterly estimates varying between 64 and 72 mR. These values are similar to the lower end of the range of background exposures observed at the NNSS.

The TLD location on the west side of the parking area (Gate 100 Truck Parking 1) has had elevated exposure levels at various times in its history, as documented in previous annual environmental reports. Its average value for 2011 was 107 mR, with quarterly estimates of 112, 115, 71, and 129 mR. These are all within the range of background variation; however, the first, second, and fourth quarter values are higher than those at Truck Parking 2 and the nearby Mercury Fitness Track station, likely due to exposure to waste shipments.

While the public has access only to the southern portions of the NNSS borders, others may have access to other boundaries of the NNSS. The great majority of the NNSS 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 (1 mSv/yr) public dose limit. Nuclear tests on the NTTR (Double Tracks and Project 57) consisted of experiments where weapons were exploded conventionally 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, 2012).

A radioactive material area boundary extends beyond the NNSS in the Frenchman Lake region of Area 5 along the southeast boundary of the NNSS. This region was a location of atmospheric weapons testing in the 1950s and 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 2011 was 298 mR. This has been consistently declining over time, down from 411 mR in 2004. The resulting estimated above-background dose during 2011 would be approximately 134 to 232 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 non-radiation workers in this vicinity. Workers specially trained and outfitted as radiation workers, although they do not work in the vicinity, have a higher allowable dose limit of 5,000 mrem per year, which would not be exceeded in the vicinity of the Frenchman Lake TLD.

Based on these results, the potential external dose to a member of the public due to past or present operations at the NNSS does not exceed 100 (mrem/yr) (1 mSv/yr) and exposures are kept ALARA, as required by DOE O 458.1.

6.3.2 Exposures from NNSS Operational Activities

During 2011, there were 41 TLDs in locations where there is negligible radioactivity from past operations but where monitoring is of interest due to the presence of personnel or the public in the area and/or the potential for receiving radiation exposure from current operations (E1 locations). The mean estimated annual exposure at these locations was 117 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 and E1 locations (Figure 6-2); the estimated annual exposures at all E1 locations are within the 95% PI of B. E1 location exposures were also comparable with the offsite exposures reported by the CEMP stations, as shown in Figure 6-2.

6.3.3 Exposures from 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 NNSS boundaries that control entry, no member of the public could access these areas for significant periods of time. However, TLDs are placed at the RWMSs to show the potential dose from external radiation to a hypothetical person residing year-round at each RWMS.

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 have been filled with LLW and then covered with clean soil. As a result, exposures inside the Area 3 RWMS are low when compared with average exposures at the fence line or in Area 3 outside the fence line.

Annual exposures during 2011 in and around the Area 3 RWMS are shown in Figure 6-4. The exposures measured inside the Area 3 RWMS and three of four measurements at the boundary were within the range of background exposures. The one location on the RWMS boundary (A3 RWMS South) that has an estimated exposure above the range of NNSS background is 160 m (525 ft) from where two atmospheric nuclear weapon tests occurred. The three E2 TLD locations outside the RWMS that are also above the range of NNSS background (Figure 6-4) are a similar distance from the same atmospheric test location but on the other side, further from the RWMS boundary. Based on these measurements, it does not appear that waste buried at the Area 3 RWMS would have contributed external exposure to a hypothetical person residing at the Area 3 RWMS boundary during 2011.

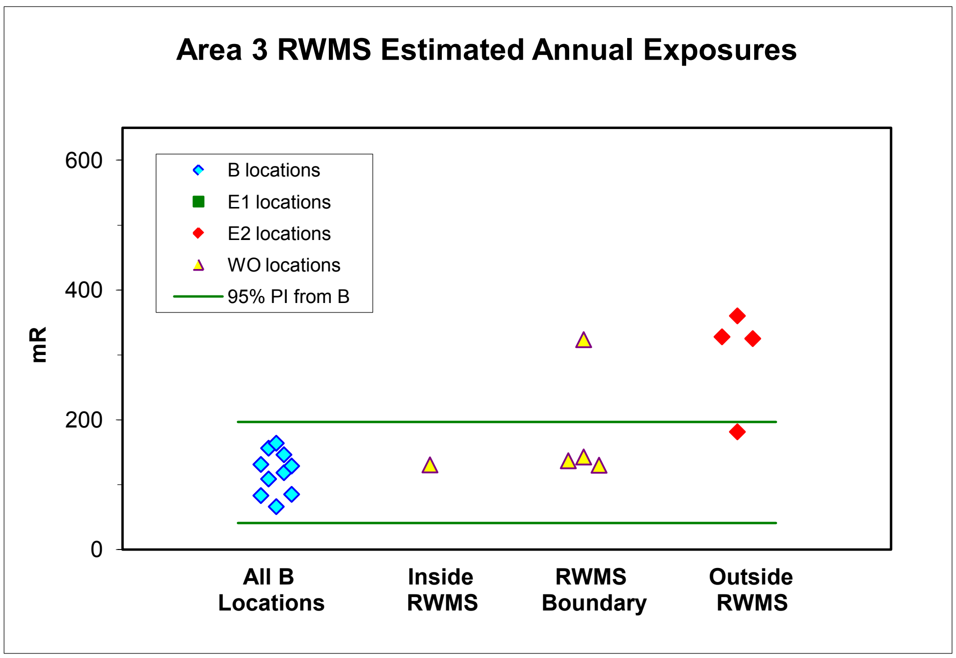

Figure 6-4. 2011 annual exposures in and around the Area 3 RWMS and at background locations

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 2011, estimated annual exposures at Area 5 RWMS TLD locations were within the range of exposures measured at NNSS background locations (Figure 6-5). The one location outside the Area 5 RWMS (Frenchman Lake) that has an estimated exposure above background levels is within 0.5 km (0.3 mi) of six atmospheric tests in Frenchman Lake Playa.

Based on these results, the potential external dose to a member of the public from operations at the Area 3 and Area 5 RWMSs does not exceed the 25 mrem/yr (0.25 mSv/yr) dose limit to members of the public, specified in DOE M 435.1-1. See Section 9.1.2 of this report for a summary of the potential dose to the public from the RWMSs from all exposure pathways.

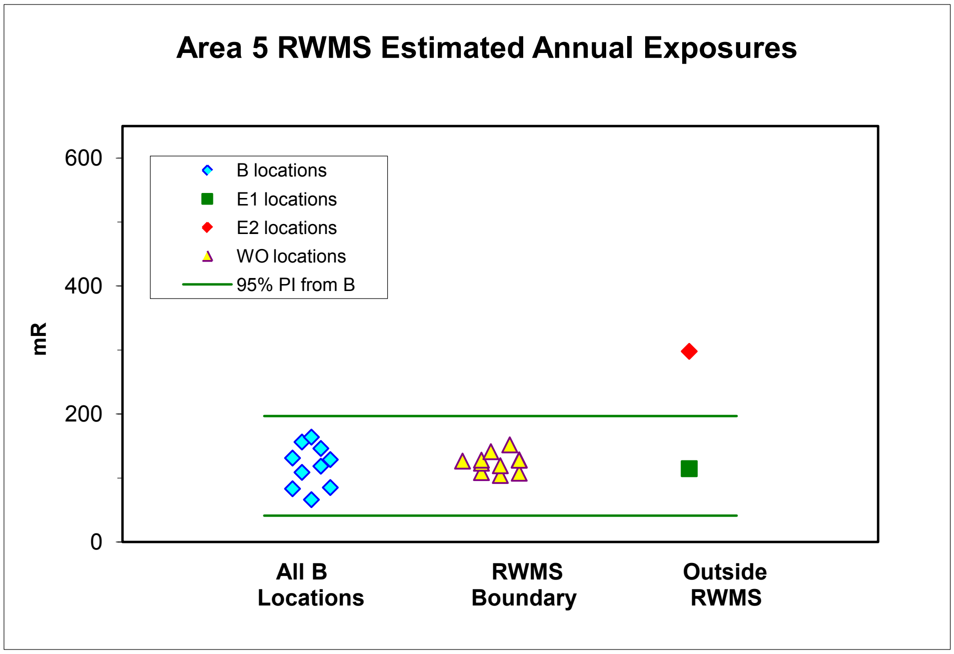

Figure 6-5. 2011 annual exposures around the Area 5 RWMS and at background locations

6.3.4 Exposures to NNSS Plants and Animals

The highest exposure rate measured at any TLD location during 2011 was 647 mR/yr (1.77 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 near the ground (e.g., 3 centimeters [1.2 in.]) where small plants and animals reside. The daily exposure rate near the ground surface would be less than 2% 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 NNSS monitoring locations are low compared with the dose limit. Dose to biota from both internal and external radionuclides is presented in Chapter 9.

6.3.5 Exposure Patterns in the Environment over Time

Direct radiation monitoring is conducted to help characterize releases from NNSA/NSO activities. Continued monitoring of exposures at locations of past releases on the NNSS helps to accomplish this. Small quarter-to-quarter changes are normally seen in exposure rates from all locations. During 2011, the CVs for measurements between quarters averaged 5.4%.

Long-term trends are displayed in Figure 6-6 by location type for locations that have been monitored for at least 10 years. As expected, the B and C 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 annual exposures at E1 locations decreased an average of 0.37% per year, those at E2 locations decreased 1.78% per year on average, and those at WO locations decreased 0.71% per year on average. Annual exposures decreased 3.51% per year on average at those locations with significant added man-made radiation, which are the E2 and WO locations with 2011 exposure rates higher than the 95% PI of B. These average rates of decay are very similar to those measured from 2008 through 2010. The observed decreases are due to a combination of natural radioactive decay and the dispersal and shielding of radionuclides in the environment.

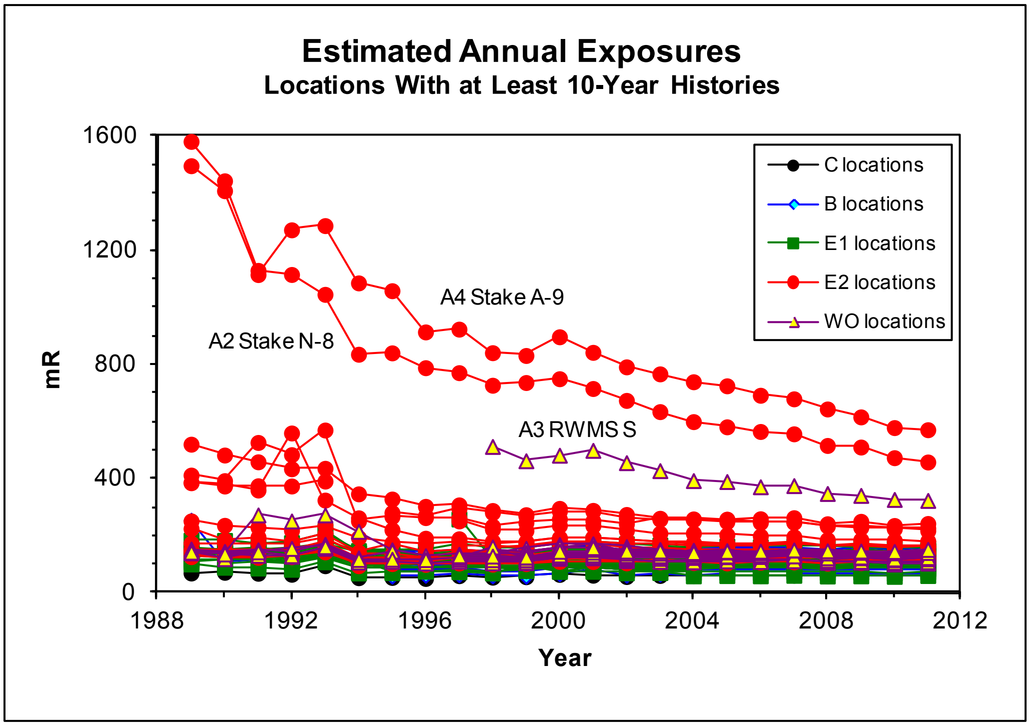

Figure 6-6. Trends in direct radiation exposure measured at TLD locations

The Schooner-1 location, which has the highest exposure of any current NNSS location, is not included in Figure 6-6 because it was established in 2003 and does not yet have a 10-year history. The two highest exposures shown in Figure 6-6, Stake A-9 in Area 4 and Stake N-8 in Area 2, are decreasing by 3.95% and 4.68% per year, respectively; these correspond to half-lives of about 17 and 14 years. The location with the next highest exposure shown in Figure 6-6 is the WO location A3 RWMS South, with estimated annual exposures decreasing by 3.63% per year.

6.4 Environmental Impact

Direct radiation exposure to the public from NNSS operations during 2011 was negligible. Radionuclides historically released to the environment on the NNSS 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 than 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 NNSS.

7.0 Community Environmental Monitoring Program

Environmental monitoring oversight for the Nevada National Security Site (NNSS) 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 NNSS 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 (EPA) Region IX. 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 air monitoring 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 website at http://www.cemp.dri.edu/. A detailed informational background narrative about 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.

> Unique to the air monitoring goals and actions of CEMP in 2011, was the request from NNSA/NSO to determine if airborne radiation from the Fukushima Nuclear Power Plant accident in Japan on March 11, 2011, could be detected in Nevada. The actions taken in response to this request and the monitoring results are presented in Section 7.1.

CEMP Goals	***Analytes Monitored***	
Monitor offsite environmental conditions and communicate environmental data relevant to past and continuing activities at the NNSS	In Air:	In Water:
Engage the public hands-on in monitoring environmental conditions in their communities relative to activities at the NNSS	Gross alpha radioactivity	Tritium (^{3}H)
Communicate environmental monitoring data to the public in a transparent and accessible manner	Gross beta radioactivity	
Provide an educated, trusted, local resource for public inquiries and concerns regarding past and present activities at the NNSS	Gamma-emitting radionuclides	
	Ambient gamma radiation	
	Meteorological parameters	

7.1 Offsite Air Monitoring

During 2011, 29 CEMP stations managed by DRI composed the Air Surveillance Network (ASN) (Figure 7-1). The ASN stations include various types of equipment as described below. The CEMP station in Beatty, Nevada, is shown in Figure 7-2.

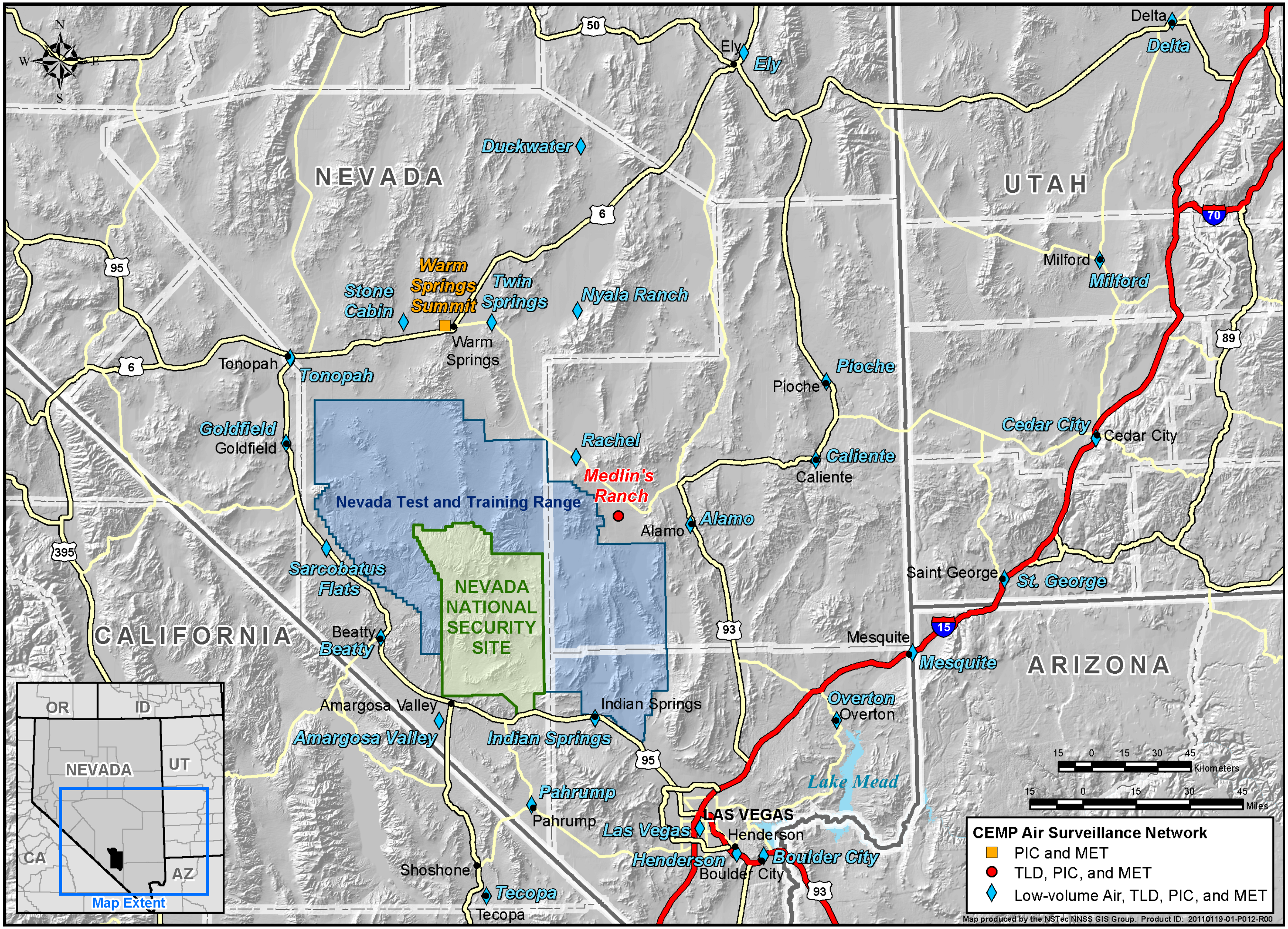

Figure 7-1. 2011 CEMP Air Surveillance Network

Figure 7-2. CEMP Station in Beatty, Nevada

CEMP Low-Volume Air Sampling Network – During 2011, 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 2011. Duplicate air samples were collected from up to three ASN stations each week. The duplicate samplers are operated at randomly selected stations for 3 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 7 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 used to measure both individual and population external exposure to ambient radiation from natural and artificial sources. In 2011, 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. 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 an 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 Sampling Methods

During 2011, CEMP air samples were collected on a bi-weekly basis. This sampling frequency 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.

> On March 21, 2011, the CEMP installed additional air samplers at the Las Vegas and Henderson stations to determine if radiological materials could be detected from the tsunami damaged Fukushima Nuclear Power Plant in Japan. These samplers were equipped with glass fiber filters backed by activated charcoal cartridges. This configuration allowed for the collection of air particulates as well as radioiodine not attached to dust particles. Samples were collected every 2 to 3 days for approximately 2 weeks and submitted for gamma spectroscopy analysis. In addition, the routine air filters from the CEMP sampling network for this time period were collected for individual gamma spectroscopy analysis.

The filter is mounted in a holder that faces downward at a height of approximately 1.5 meters (m) (5 feet [ft]) above the ground. The total 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.

7.1.2 Air Sampling Results

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 $1.15 \pm 0.27 \times 10^{-15}$ microcuries per milliliter (µCi/mL) ($4.26 \pm 0.99 \times 10^{-5}$ becquerels [Bq]/m^3) (Table 7-1). Gross alpha was detectable in all of the 2011 air samples, and overall, gross alpha levels of activity were 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 2011

		Concentration (× 10^{-15} µCi/mL [3.7×10^{-5} Bq/m^3])			
Sampling Location	**Number of Samples**	**Mean**	**Standard Deviation**	**Minimum**	**Maximum**
Alamo	25	1.54	0.80	0.63	3.72
Amargosa Valley	26	1.04	0.51	0.37	2.13
Beatty	26	1.23	0.54	0.52	2.46
Boulder City	26	1.44	0.77	0.51	3.62
Caliente	26	1.65	0.68	0.67	3.12
Cedar City	26	0.83	0.31	0.39	1.50
Delta	26	0.95	0.53	0.43	2.57
Duckwater	26	1.09	0.52	0.47	3.18
Ely	26	0.95	0.58	0.35	3.30
Garden Valley	26	1.01	0.38	0.38	1.93
Goldfield	26	1.05	0.32	0.48	1.88
Henderson	26	1.10	0.34	0.67	1.84
Indian Springs	26	0.90	0.32	0.37	1.46
Las Vegas	26	1.20	0.42	0.63	2.71

Table 7-2. Gross alpha results for the CEMP offsite ASN in 2011 (continued)

		Concentration (× 10^{-15} µCi/mL [3.7×10^{-5} Bq/m^3])			
Sampling Location	**Number of Samples**	**Mean**	**Standard Deviation**	**Minimum**	**Maximum**
Mesquite	26	1.32	0.78	0.46	4.23
Milford	26	0.97	0.36	0.51	2.34
Nyala Ranch	26	1.03	0.39	0.49	1.88
Overton	26	1.76	1.17	0.43	4.46
Pahrump	26	1.06	0.39	0.50	1.87
Pioche	26	0.94	0.38	0.33	2.04
Rachel	26	1.03	0.35	0.56	1.66
Sarcobatus Flats	26	1.83	1.20	0.51	4.61
Stone Cabin Ranch	26	0.91	0.35	0.47	1.99
St. George	26	1.05	0.42	0.34	2.41
Tecopa	26	1.09	0.45	0.62	2.31
Tonopah	26	1.08	0.45	0.41	2.14
Twin Springs	26	0.95	0.28	0.53	1.81

Network Mean = 1.15 ± 0.27 × 10^{-15} µCi/mL
Mean Minimum Detectable Concentration (MDC; see Glossary, Appendix B) = 0.43 × 10^{-15} µCi/mL
Standard Error of Mean MDC = 0.04 × 10^{-15} µCi/mL

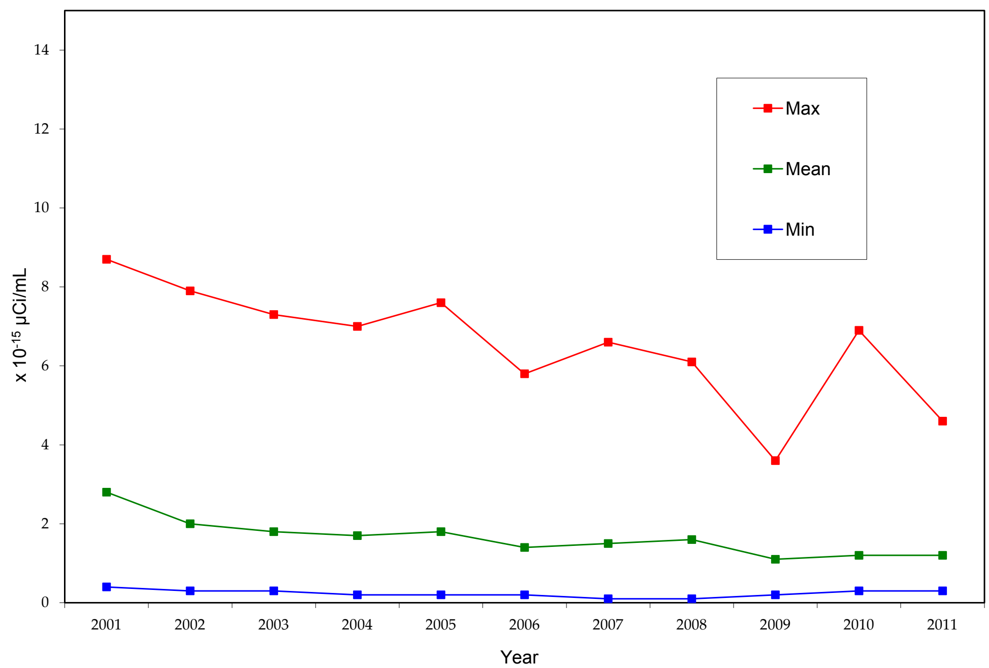

Figure 7-3. Historical trend for gross alpha analysis for all CEMP stations

The mean annual gross beta activity across all sample locations (Table 7-2) was 2.19 ± 0.019 × 10^{-14} µCi/mL (8.10 ± 0.70 × 10^{-4} Bq/m^3). Gross beta activity was detected in all air samples and, except for samples collected during the Japan nuclear accident, were similar to previous years' levels. 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 2011

		Concentration (× 10^{-14} µCi/mL [3.7 × 10^{-4} Bq/m^3])			
Sampling Location	**Number of Samples**	**Mean**	**Standard Deviation**	**Minimum**	**Maximum**
Alamo	25	2.41	1.45	1.04	8.30
Amargosa Valley	26	2.22	1.16	1.01	6.77
Beatty	26	2.10	1.10	0.98	6.41
Boulder City	26	2.46	1.07	1.29	5.89
Caliente	26	2.32	1.21	1.39	7.41
Cedar City	26	1.88	1.12	1.00	7.01
Delta	26	2.23	1.30	1.28	5.88
Duckwater	26	2.02	1.08	1.14	6.15
Ely	26	1.90	1.05	1.12	6.14
Garden Valley	26	2.12	1.29	0.87	7.76
Goldfield	26	2.09	1.11	1.12	6.03
Henderson	26	2.20	0.97	1.27	5.39
Indian Springs	26	2.17	1.42	1.16	8.37
Las Vegas	26	2.38	1.13	1.35	5.50
Mesquite	26	2.39	1.21	1.29	7.03
Milford	26	2.27	1.20	1.30	6.03
Nyala Ranch	26	2.21	0.89	1.37	4.43
Overton	26	2.56	1.27	1.35	7.19
Pahrump	26	2.23	1.42	1.11	8.55
Pioche	26	1.86	1.12	1.09	6.77
Rachel	26	2.24	1.29	1.21	7.69
Sarcobatus Flats	26	2.32	1.16	1.29	6.38
Stone Cabin	26	1.80	1.03	0.69	6.37
St. George	26	2.41	1.16	1.46	6.44
Tecopa	26	2.35	1.26	1.08	7.40
Tonopah	26	2.10	1.19	1.19	6.72
Twin Springs	26	2.06	0.94	1.15	5.23

Network Mean = 2.19 ± 0.19 × 10^{-14} µCi/mL

Mean MDC = 0.06 × 10^{-14} µCi/mL **Standard Error of Mean MDC = 0.01 × 10^{-14} µCi/mL**

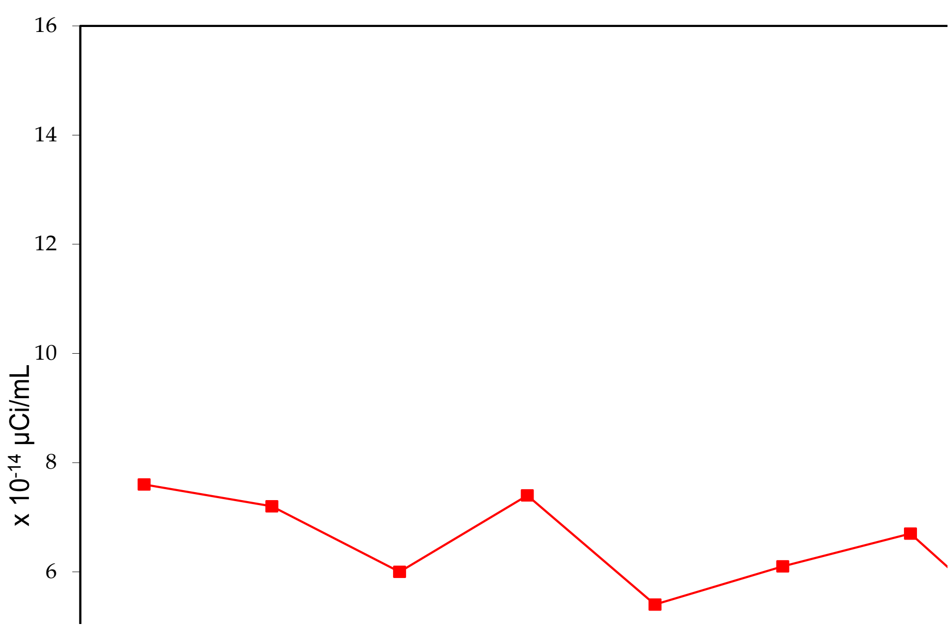

Figure 7-4. Historical trend for gross beta analysis for all CEMP stations

> Overall, the gross beta activity was notably affected by samples collected during the Fukushima accident, mainly due to the presence of cesium-134 and cesium-137 (^{134}Cs and ^{137}Cs) as well as iodine-131 (^{131}I) (see Section 7.1.1.2). This is somewhat evident in an increase of about 20 percent in the mean values, but is most noticeable in an increase in the maximum values, which are on average 2.5 times higher than previous years' data at all stations.

The mean gross alpha results show a generally decreasing trend for the past 10 years from 2001 to 2011. Likewise, except for the increase in the mean and maximum values in 2011 data due to the Japan nuclear accident, the gross beta results show a similar trend for the same time period. Although the downward trend in the mean data since 2001 for gross beta is not as pronounced, even arguably level, the maximum values do suggest a downward trend is likely. These trends are also reflected by most of the stations on an individual basis. The decreasing trends since 2001 can most likely be explained as an overall gradual decrease in severity of persistent drought conditions throughout the southwest and Great Basin states. Drought in these regions has existed to varying degrees since 1996. Variations in drought conditions could be directly responsible for increases and decreases 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 prior to 1996 (not shown).

7.1.1.2 Gamma Spectroscopy

Gamma spectroscopy analysis was performed on all samples from the low-volume air sampling network. Generally, the filters were composited by station on a quarterly basis after gross alpha/beta analysis, but in 2011, due to the Japan nuclear accident, individual filters were analyzed separately to document any radiological releases. As in previous years, man-made gamma-emitting radionuclides were not detected in any samples (excluding the Japan-related filters analyzed individually). In most of the samples, naturally occurring beryllium-7 (^{7}Be) was detectable. 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 $1.00 \pm 0.66 \times 10^{-13}$ µCi/mL.

> Gamma-emitting radionuclides detected in samples collected during the time period from March 13 to April 4, 2011, included ^{131}I, ^{134}Cs, and ^{137}Cs. While ^{131}I was detected throughout this sampling period, ^{134}Cs and ^{137}Cs were detectable for only a few days from March 23 to 28 as evidenced by the results from the two additional air samplers deployed at the Las Vegas and Henderson stations. The filters for these samplers were changed every 2 to 3 days for analysis. Of the routine CEMP air samples collected every 2 weeks, eight were chosen for immediate analysis to geographically represent the overall network (Las Vegas, Henderson, Boulder City, Pahrump, Amargosa, Duckwater, Garden Valley, and St. George), and ^{131}I, ^{134}Cs, and ^{137}Cs were detected in these samples also. The remaining samples of the network were analyzed under the routine collection procedures and schedule in place for the CEMP. Because ^{131}I had decayed to undetectable levels in these samples, only ^{134}Cs and ^{137}Cs were present. The ranges of concentrations for the man-made radioisotopes detected as a result of the Fukushima accident were as follows:
>
> ^{131}I: 4.2×10^{-14} to 1.1×10^{-12} µCi/mL
> ^{134}Cs: 4.7×10^{-15} to 7.8×10^{-14} µCi/mL
> ^{137}Cs: 6.1×10^{-15} to 9.3×10^{-14} µCi/mL
>
> The Clean Air Act's average annual exposure limits to these radionuclides were not exceeded.

7.1.3 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 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 2011 ranged from 78 milliroentgens (mR) (0.78 millisieverts [mSv]) at Pahrump, Nevada, to 148 mR (1.48 mSv) at Twin Springs, Nevada, with a mean annual exposure of 110 mR (1.10 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 2011

Sampling Location	Number of Quarters	Estimated Annual Exposure (mR)[(a)]		
		Mean[(b)]	Minimum[(b)]	Maximum[(b)]
Alamo	4	103	100	108
Amargosa Valley	4	100	79	118
Beatty	4	135	124	144
Boulder City	4	99	91	117
Caliente	4	107	100	116
Cedar City	4	87	80	92
Delta	4	95	80	116
Duckwater	4	111	101	123
Ely	4	98	89	113
Garden Valley	4	141	130	154
Goldfield	4	112	108	116
Henderson	4	106	99	117
Indian Springs	4	95	82	104
Las Vegas	4	92	81	104
Medlin's Ranch	4	125	117	133
Mesquite	4	97	88	122
Milford	4	132	120	141
Nyala Ranch	4	107	100	123
Overton	4	89	80	104
Pahrump	4	78	67	91
Pioche	4	104	96	112
Rachel	4	120	108	128
Sarcobatus Flats	4	139	124	160
Stone Cabin Ranch	4	135	119	159
St. George	4	81	68	88
Tecopa	4	105	94	113
Tonopah	4	128	119	134
Twin Springs	4	148	139	159

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

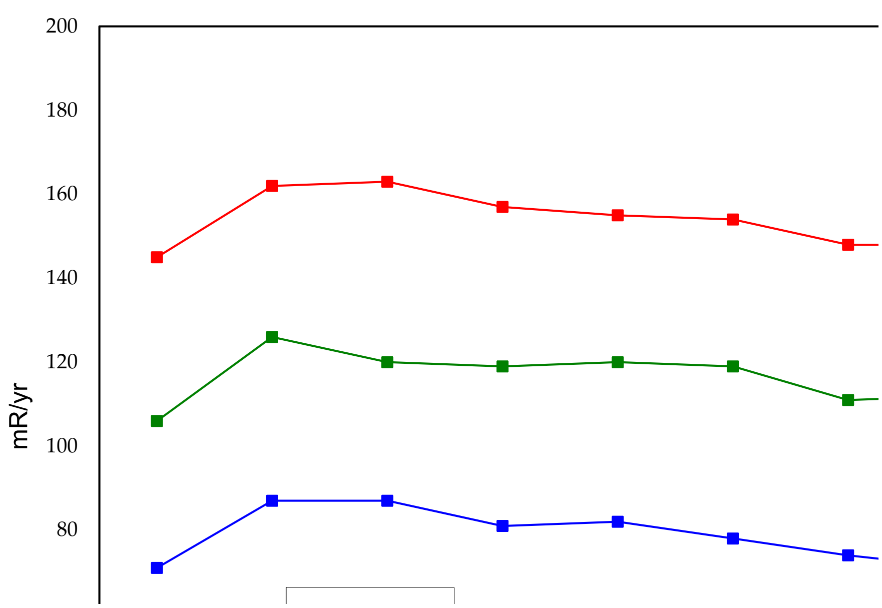

Figure 7-5. Historical trend for TLD analysis for all CEMP stations

With the exception of an increase in values from 2001 to 2002, the TLD data show a generally decreasing trend for the past 10 years from 2002 to 2011. The 2011 results are slightly higher than 2010, 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.

7.1.4 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 2011 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 71.83 mR/yr (0.72 mSv/yr) in Pahrump, Nevada, to 174.32 mR/yr (1.74 mSv/yr) at Twin Springs Ranch, 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 EPA and are shown in Table 7-5. The annual exposure levels observed at the CEMP stations in 2011 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 2011

	Daily Average Gamma Exposure Rate (µR/hr)				
Sampling Location	**Mean**	**Standard Deviation**	**Minimum**	**Maximum**	**Annual Exposure (mR/yr)**
Alamo	13.65	0.27	12.6	14.7	119.57
Amargosa Valley	11.40	0..16	10.9	11.9	99.86
Beatty	16.85	0.25	16.0	17.7	147.61
Boulder City	15.70	0.19	14.7	16.7	137.53
Caliente	16.15	0.21	15.4	16.9	141.47
Cedar City	11.15	0.24	10.3	12.0	97.67
Delta	11.6	0.29	10.4	12.8	101.62
Duckwater	12.10	1.19	7.90	16.3	106.00
Ely	12.10	0.33	10.9	13.3	106.00
Garden Valley	18.20	0.63	16.0	20.4	159.43
Goldfield	14.90	0.41	13.9	15.9	130.52
Henderson	14.30	0.18	13.3	15.3	125.27
Indian Springs	11.30	0.22	10.7	11.9	98.99
Las Vegas	11.50	0.23	10.8	12.2	100.74
Medlin's Ranch	16.80	0.33	15.80	17.8	147.17
Mesquite	11.80	0.15	11.3	12.3	103.37
Milford	17.70	0.61	16.0	19.4	155.05
Nyala Ranch	14.35	0.86	12.6	16.1	125.71
Overton	11.95	0.25	11.2	12.7	104.68
Pahrump	8.20	0.15	7.7	8.7	71.83
Pioche	14.35	0.35	13.1	15.6	125.71
Rachel	14.95	0.90	13.2	16.7	130.96
Sarcobatus Flats	16.40	0.31	15.4	17.4	143.66
Stone Cabin Ranch	16.95	0.58	15.7	18.2	148.48
St. George	10.35	0.22	9.4	11.3	90.67
Tecopa	15.95	0.68	14.0	17.9	139.72
Tonopah	16.20	0.30	15.3	17.1	141.91
Twin Springs	19.90	0.64	18.1	21.7	174.32
Warm Springs Summit	19.60	0.55	17.9	21.3	171.70

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: 5/3/2012)

7.1.5 Environmental Impact

The results of CEMP air sampling and analyses associated with the Fukushima nuclear accident in March 2011 can be accessed at http://www.cemp.dri.edu/japan_response.html.

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 impacts from radionuclides originating on the NNSS. Activity observed in gross alpha and beta analyses of low-volume air sampler filters was consistent with previous years' results, with the exception of the period immediately following the accident at Fukushima, and is within the range of activity found in other communities of the United States that are not adjacent to man-made radiation sources. Likewise, no man-made gamma-emitting radionuclides other than those associated with the accident at Fukushima were detected. 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 percent above normal average background) detected by the PICs in 2011 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 website, illustrates an example of this phenomenon.

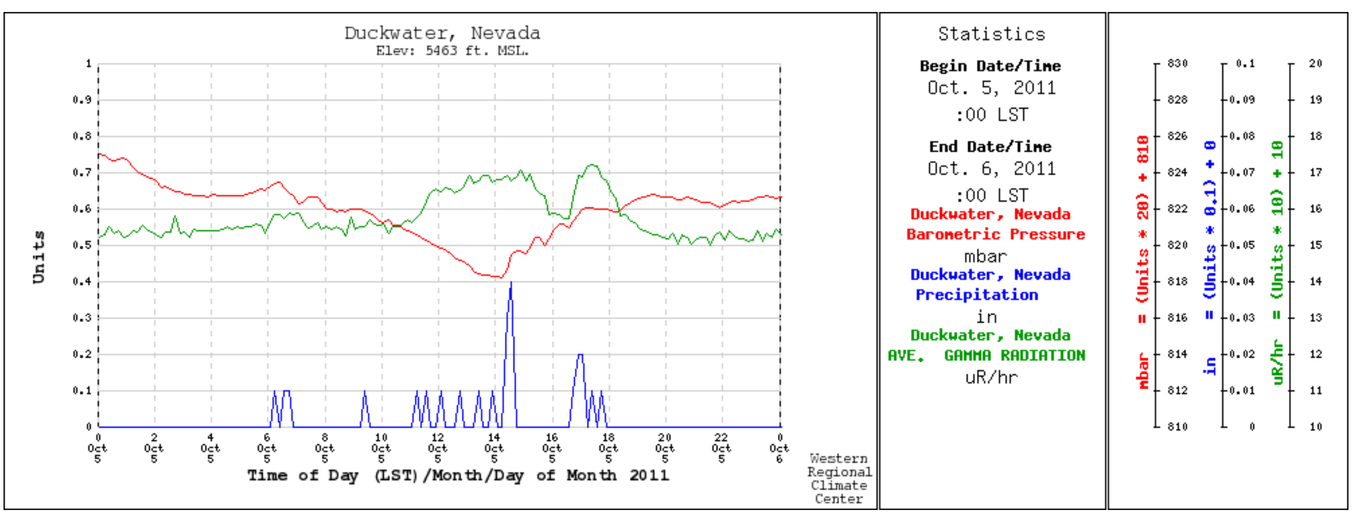

Figure 7-6. The effect of meteorological phenomena on background gamma readings

7.2 Offsite Surface and Groundwater Monitoring

The CEMP monitors offsite groundwater wells, surface waters, and springs used for water supplies in areas surrounding the NNSS. Like the CEMP air monitoring program, CEMP water monitoring is a non-regulatory public informational and outreach program. It provides the public with data regarding the presence of man-made radionuclides that could be the result of past nuclear testing on the NNSS. Water samples are collected by DRI personnel and analyzed for 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. DRI provides public access to water monitoring data through CEMP's website at http://www.cemp.dri.edu/.

7.2.1 Sample Locations and Methods

During the period of July 6 to August 30, 2011 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 Chapter 18 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 use step-by-step instructions to describe the method and materials that are required to collect field water quality samples and to 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. 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 was 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 2011 were analyzed using enriched gas proportional counting at the University of Miami Tritium Laboratory. 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 0.53 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 1.01 pCi/L. The MDC is a more rigorous threshold that dictates that the sample 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.

Table 7-6. CEMP water monitoring locations sampled in 2011

Monitoring Location Description	Latitude	Longitude	Date Sampled	Sample Collection Method
Adaven Springs	38°08.25"	−115°36.20"	8/02/2011	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"	8/26/2011	By hand from municipal water well.
Amargosa Valley school well	36°34.16"	−116°27.66"	8/19/2011	By hand at wellhead at the school.
Beatty Water and Sewer municipal water distribution system	36°50.00"	−116°49.44"	8/30/2011	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"	7/06/2011	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"	7/14/2011	By hand at well in municipal well field. Sample collected from a different well in 2011.
Cedar City municipal water supply well about 11 kilometers (km) (7 miles [mi]) west of town	37°39.39"	−113°13.15"	7/12/2011	By hand at wellhead. Sample collected from a different well in 2011.
Delta municipal well	39°20.73"	−112°32.34"	7/13/2011	By hand at wellhead. Sample collected from a different well in 2011.
Duckwater water supply well	38°55.41"	−115°41.99"	8/03/2011	By hand at faucet inside pump house.
Ely Residence	39°14.10"	−114°53.71"	8/03/2011	By hand from residence in Ely. Source of water is the municipal supply system. Springs are origin of municipal water supply.
Goldfield municipal water supply well about 18 km (11 mi) north of town	37°52.41"	−117°14.75"	8/30/2011	By hand at wellhead. Sample collected from a different well in 2011.
Henderson municipal water distribution system	36°00.43"	−114°57.95"	7/06/2011	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"	8/19/2011	By hand at wellhead.
Las Vegas Valley Water District #103	36°13.94"	−115°15.13"	8/25/2011	By hand at wellhead.
Medlin's Ranch—spring 16 km (10 mi) west of ranch house	37°24.10"	−115°32.25"	8/03/2011	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"	7/12/2011	By hand at wellhead.
Milford municipal well	38°22.88"	−112°59.78"	7/13/2011	By hand at wellhead.
Nyala Ranch water well	38°14.93"	−115°43.72"	8/02/2011	By hand from front yard hose faucet at house.

Table 7-6. CEMP water monitoring locations sampled in 2011 (continued)

Monitoring Location Description	Latitude	Longitude	Date Sampled	Sample Collection Method
Overton water well located at Arrow Canyon approximately 32 km (20 mi) west of town	36°44.06"	−114°44.87"	7/06/2011	By hand at wellhead.
Pahrump municipal water system	36°11.29"	−115°57.95"	8/25/2011	By hand at wellhead.
Pioche municipal well	37°56.97"	−114°25.76"	7/14/2011	By hand at wellhead. Sample collected from a different well in 2011.
Rachel—Little A'Le'Inn well	37°38.79"	−115°44.75"	8/03/2011	By hand from faucet inside Little A'Le'Inn Restaurant.
Sarcobatus Flats well	37°16.76"	−117°01.10"	8/30/2011	By hand at wellhead. Sample collected from a different well in 2011.
St. George municipal water distribution system	37°10.47"	−113°23.92"	7/07/2011	By hand at water treatment plant; water originates from Quail Creek Reservoir.
Stone Cabin Ranch	38°12.45"	−116°37.99"	8/03/2011	By hand from outside house faucet; water originates from spring.
Tecopa residential well	35°57.59"	−116°15.71"	8/19/2011	By hand at wellhead.
Tonopah public utilities well field located approximately 19 km (12 mi) from town	38°11.68"	−117°04.70"	8/30/2011	By hand at wellhead.
Twin Springs Ranch well	38°12.21"	−116°10.53"	8/02/2011	By hand at wellhead.

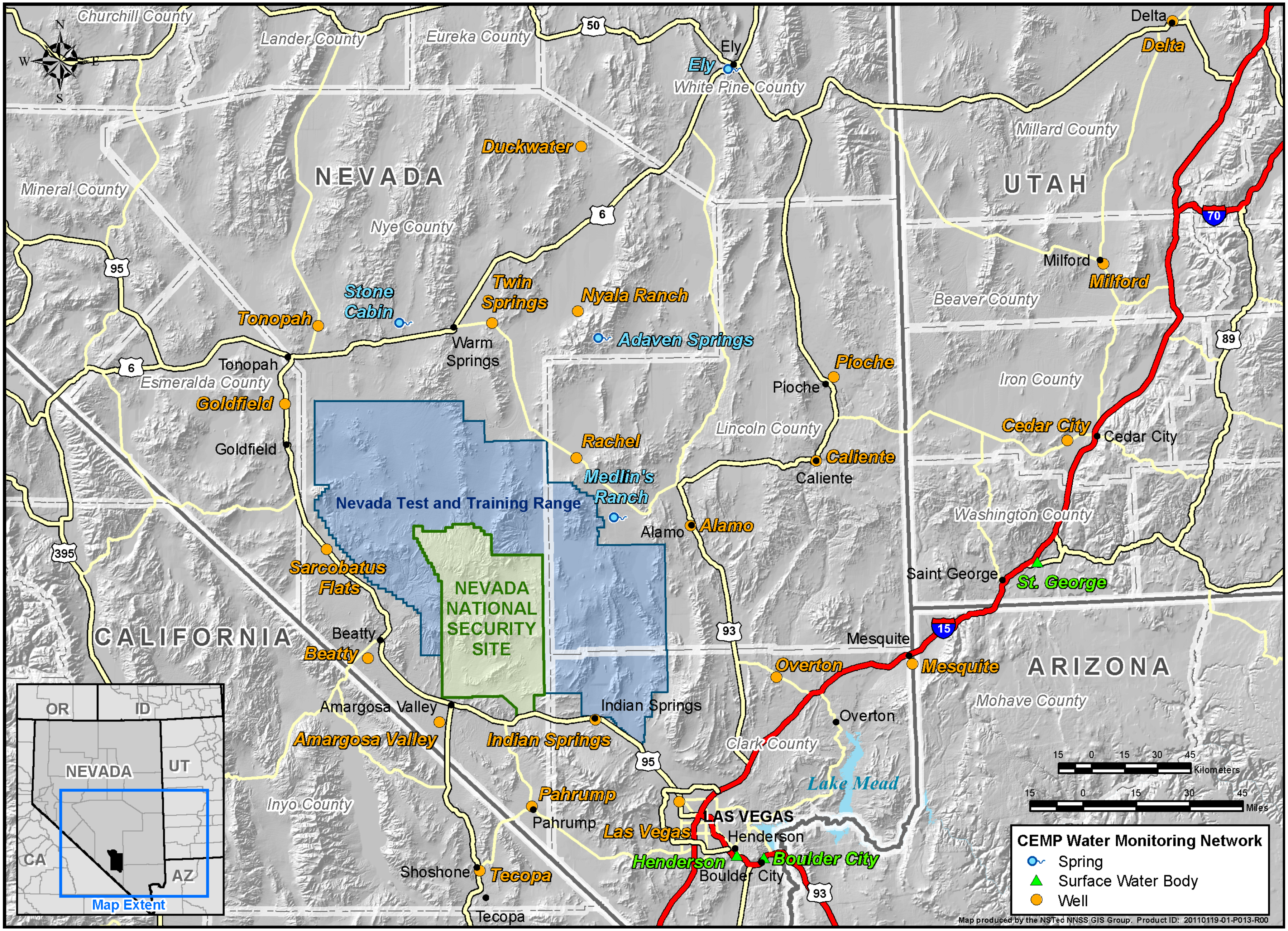

Figure 7-7. 2011 CEMP water monitoring locations

7.2.3 Results of Surface Water and Spring Discharge Monitoring

Measured tritium concentrations from the springs and surface waters sampled in 2011 ranged from just above background to 22.7 pCi/L (Table 7-7). Almost all samples yielded results that were quantifiably above background (i.e., ≥ MDC), with the exception of Stone Cabin Ranch, which had tritium activities just above the L_C and was distinguishable from background but at a confidence lower than 95%. 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 NNSS environmental reports (http://www.nv.energy.gov/library/publications/aser.aspx) and are due to a combination of the natural production of tritium in the upper atmosphere and the 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 and analyzed using enriched gas-proportional counting in 2008, 2009, and 2010, with the exception of Medlin's Ranch and the St. George municipal water system. Samples from Medlin's Ranch were slightly higher in 2010 and 2011 than in previous years (5.1 pCi/L in 2008 and 3.8 in 2009 versus approximately 8.3 pCi/L in 2010 and 2011). The sample from the St. George municipal water system was 8.5 pCi/L in 2010 versus 11.8 pCi/L in 2011. If these elevated levels persist or increase over time, it is likely due to the presence of some combination of natural atmospheric production of tritium and tritium originating from global atmospheric testing in waters that have recharged sometime over the last 60 years. The 2008 through 2011 results differ from that of previous years due to the use of an improved analytical method (enriched gas-proportional counting) rather than to any real change in the activity of the water being monitored. Public access to the monitoring data is available on the DRI CEMP website at http://www.cemp.dri.edu/.

Table 7-7. Tritium results for CEMP offsite surface water and spring discharges in 2011

Monitoring Location	**^3H ± Uncertainty [(a)] (pCi/L)**		
Adaven Springs	13.8	±	0.9
Ely municipal water source	2.6	±	0.6
Medlin's Ranch	8.3	±	0.6
Stone Cabin Ranch	0.6	±	0.6
Boulder City municipal water distribution system	22.2	±	1.5
Henderson municipal water distribution system	22.7	±	1.5
St. George municipal water distribution system	11.8	±	0.8

(a) ± 2 standard deviations
L_C = 0.53 pCi/L; MDC = 1.01 pCi/L 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 4.8 pCi/L. Most of the samples yielded results that were statistically indistinguishable from laboratory background (≤ L_C). Three exceptions were the samples obtained from Caliente (4.8 ± 0.6 pCi/L), Nyala Ranch (1.2 ± 0.6 pCi/L), and Alamo City (0.6 ± 0.6 pCi/L). The tritium activity for Caliente is similar to that detected in 2008 (5.4 pCi/L) and 2009 and 2010 (both 4.7 ± 0.6 pCi/L). Results for Nyala Ranch slightly exceeded the MDC. These results indicate that tritium present in water samples from Caliente and possibly Nyala Ranch are likely due to the presence of some combination of natural atmospheric production of tritium and tritium originating from global atmospheric testing in waters that have recharged sometime over the last 60 years. Results for Alamo City slightly exceeded the decision level (L_C), indicating that there may be tritium in the water above background. 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 2011

Monitoring Location	^{3}H ± Uncertainty (a) (pCi/L)		
Alamo City	0.6	±	0.6
Amargosa Valley	0.3	±	0.6
Beatty	0.3	±	0.6
Caliente	4.8	±	0.6
Cedar City	−0.1	±	0.6
Delta	0.0	±	0.6
Duckwater	0.2	±	0.6
Goldfield	−0.3	±	0.6
Indian Springs	−0.2	±	0.6
Las Vegas	0.4	±	0.6
Mesquite	−0.3	±	0.6
Milford	−0.2	±	0.6
Nyala Ranch	1.2	±	0.6
Overton	−0.3	±	0.6
Pahrump	−0.2	±	0.6
Pioche	0.2	±	0.6
Rachel	−0.1	±	0.6
Sarcobatus Flats	0.0	±	0.6
Tecopa	0.4	±	0.6
Tonopah	0.1	±	0.6
Twin Springs Ranch	0.1	±	0.6

(a) ± 2 standard deviations
L_C = 0.53 pCi/L; MDC = 1.01 pCi/L for all samples

7.2.5 Environmental Impact

As in previous years, the wells and water supply systems within the CEMP monitoring network showed no evidence of tritium contamination from past underground nuclear testing on the NNSS. However, in 2009, tritium was detected off site in the Underground Test Area Sub-Project characterization well, ER-EC-11, which is approximately 700 m (2,297 ft) west of the NNSS on the Nevada Test and Training Range (see Section 12.3.2). This is the first offsite well in which radionuclides from underground nuclear testing activities at the NNSS have been detected. The nearest CEMP water monitoring locations that are downgradient of the NNSS nuclear testing areas are Amargosa Valley and Beatty, approximately 67 km (42 mi) and 38 km (24 mi), respectively, southwest of Well ER-EC-11.

Among the CEMP offsite water monitoring locations, detectable tritium activities were most often found in surface waters that appear to be impacted by some combination of ongoing natural atmospheric production of tritium and contribution of atmospheric tritium to groundwater systems through recharge that occurred sometime over the last 60 years. This groundwater must then be contributing to the surface water body being sampled. Spring discharge or wells containing tritium are likely accessing groundwater systems that may have some component of recharge that has occurred sometime over the last 60 years. Most of the groundwater samples analyzed were below the L_C for tritium (see Table 7-8). All observed tritium in groundwater that exceeded the MDC were either upgradient of the NNSS or part of a groundwater flow system separate from the systems beneath the NNSS.

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 National Security Site (NNSS) plants and animals (biota). U.S. Department of Energy (DOE) Order DOE O 458.1, "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 NNSS land use practices discourage the harvest of plants or plant parts (e.g., pine nuts and wolf berries) for direct consumption by humans. Some edible plant material may be taken off site and consumed, but this is likely very limited. Game animals on the NNSS may travel off the site and become available through hunting for consumption by the public, which makes the ingestion of game animals the primary potential biotic pathway for potential dose to the public.

Plants and game animals are monitored under the *Routine Radiological Environmental Monitoring Plan* (RREMP) (Bechtel Nevada [BN], 2003a). They are sampled annually from contaminated NNSS sites to estimate hypothetical doses to persons consuming them, to measure the potential for radionuclide transfer through the food chain, and to determine if NNSS biota are exposed to radiation levels harmful to their own populations. Biota and soil samples from the Radioactive Waste Management Sites (RWMSs) are also periodically collected to assess 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 analysis results from 2011. Analysis results used to estimate the dose to humans consuming NNSS plants and animals and the dose to biota found in contaminated areas of the NNSS are presented in Chapter 9.

Radiological Biota Monitoring Goals	***Analytes Measured in Plant and Animal Tissues***
Collect and analyze biota samples for radionuclides to estimate the potential dose to humans who may consume plants or game animals from the NNSS (see Chapter 9 for the estimates of dose to humans). Collect and analyze biota samples for radionuclides to estimate the absorbed radiation dose to NNSS biota (see Chapter 9 for the estimates of dose to NNSS plants and animals). Collect and analyze soil samples at the Area 3 and Area 5 RWMSs to provide evidence that the burrowing activities of fossorial animals have or have not compromised the integrity of the soil covered waste disposal units.	Americium-241 (^{241}Am) Cesium-134 (^{134}Cs) Cesium-137 (^{137}Cs) Tritium (^{3}H) Plutonium-238 (^{238}Pu) Plutonium-239+240 ($^{239+240}$Pu) Strontium-90 (^{90}Sr)

8.1 Species Selection

The goal for vegetation monitoring is to sample the plants most likely to have the highest contamination within the NNSS environment. They are generally found inside demarcated radiological areas near the "ground zero" locations of historical aboveground or near-surface 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 sampled when present because they are also a source of food for wildlife. Plant parts collected for analysis represent new growth over the past year. Pine nuts, which may be consumed by humans, were last sampled in 2010; information regarding their dose to the public can be in found in the 2010 NNSS environmental monitoring report (National Security Technologies, LLC [NSTec], 2011b).

The game animals monitored to assess the potential dose to the public meet three criteria: (1) they have a relatively high probability of entering the human food chain; (2) they 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) they are sufficiently abundant at a site to acquire an adequate tissue sample for laboratory analysis. These criteria limit the candidate game animals to those listed in Table 8-1. Mule deer, pronghorn antelope, and predatory game animals such as mountain lions are only collected as the opportunity arises if they are found dead on the NNSS (e.g., from accidentally being hit by a vehicle). Tissues from 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. A mountain lion research project is being conducted on the NNSS (see Chapter 16, Table 16-2), and blood is collected from captured mountain lions and analyzed for ^{3}H before the mountain lions are released with radio-collars for study.

When determining the potential dose to biota, the goal of sampling is to select species that are most exposed and most sensitive to the effects of radiation. In general, mammals and birds are more sensitive to radiation than fish, amphibians, or invertebrates (DOE Standard DOE-STD-1153-2002, “A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota). Because of this, and because no native fish or amphibians are found on the NNSS, the species in Table 8-1 are 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 are generally selected by size with preference for larger shrubs under the assumption that they have deeper roots and therefore would be more likely to penetrate waste. Small mammals selected for sampling meet three criteria: (1) they are fossorial (i.e., burrow and live predominantly underground), (2) they have a home range small enough to ensure that they reside a majority of the time on the waste disposal site, and (3) they are sufficiently abundant at a site to acquire an adequate tissue sample for laboratory analysis. These criteria limit the animals to those listed in Table 8-1. Soils excavated by ants or small mammals are also selected for sampling on the basis of size, with preference for larger ant mounds and animal burrow sites under the assumption that these burrows are deeper and have a higher potential for penetrating waste.

Table 8-1. NNSS 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*)
	Mountain lion (*Puma concolor*)	Gambel’s quail (*Callipepla gambelii*)
	Bighorn sheep (*Ovis canadensis nelsoni*)	
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. Each year, biota from one or two of these sites are sampled, and each of the five sites are sampled once every 5 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.

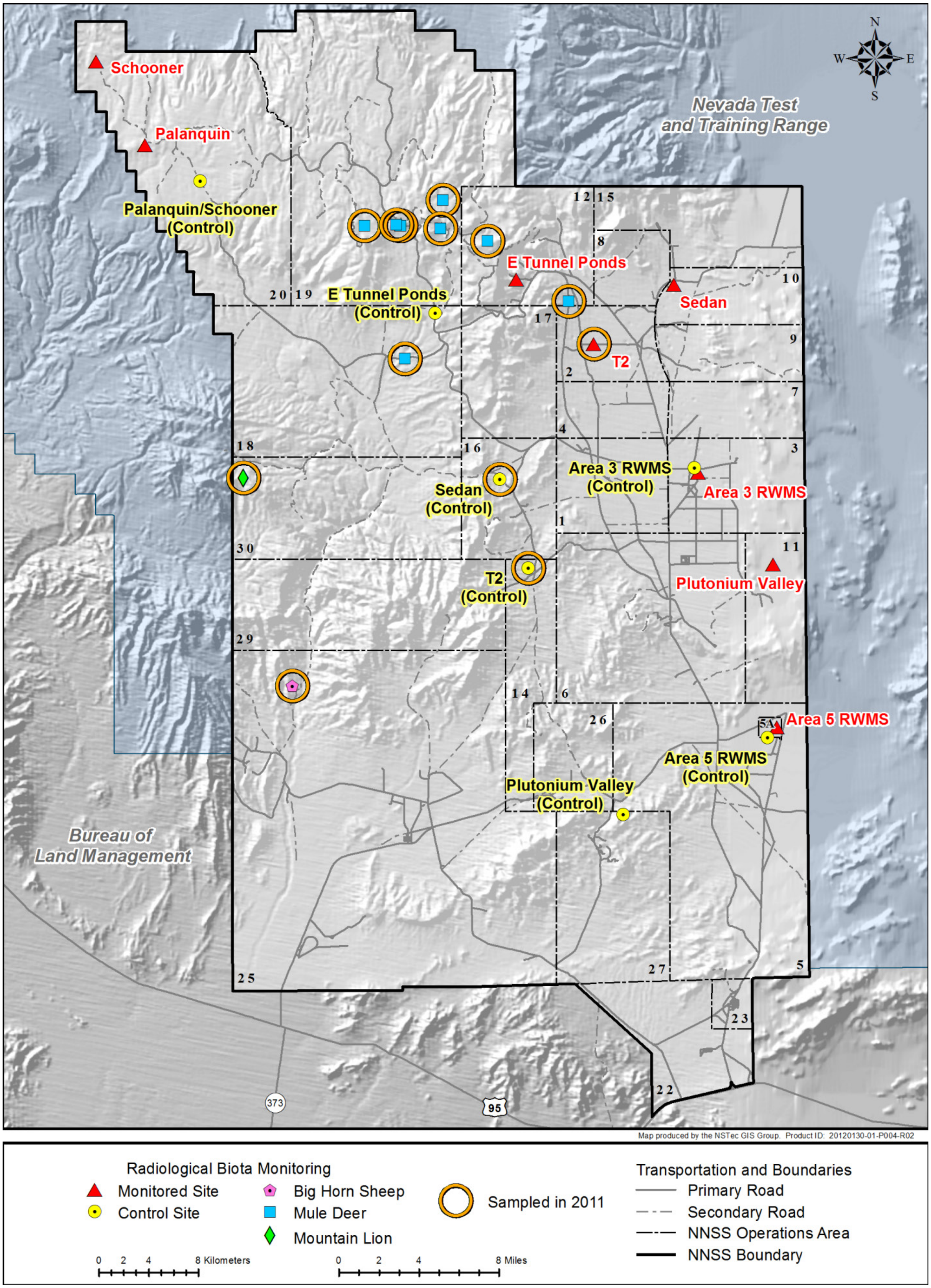

Figure 8-1. Radiological biota monitoring sites on the NNSS

- **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 NNSS. 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 2010.
- **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 NNSS. The associated monitoring site is Sedan Crater in Yucca Flat. It was last sampled in 2010.
- **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 NNSS. 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 due 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 sampled in 2011.
- **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 last sampled for biota in 2009.

Soil sampling is also conducted periodically at radioactive waste disposal locations on the NNSS 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 last 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 last sampled in 2009.

8.3 2011 Biota Sampling and Analysis

In 2011, the T2 site and its control site (Mid-Valley) were sampled for plants and animals (Figure 8-1). In addition, the control location for the Sedan site was sampled during 2011 to follow up on anomalous ^{3}H results from samples collected from that location during 2010 (NSTec, 2011b).

The T2 site is located in Area 2 in the north central portion of the NNSS (Figure 8-1). Four nuclear weapons tests were conducted on the surface of the T2 site from 1952 to 1957 (U.S. Department of Energy, Nevada Operations Office, 2000). All of these weapons were placed on towers and totaled 99 kilotons. Contamination remaining from these tests is primarily ^{241}Am, ^{137}Cs, ^{3}H, $^{239+240}$Pu, and ^{90}Sr. A control area for T2 is located about 18 kilometers (km) (11.2 miles [mi]) south-southwest of the sample site in Mid-Valley, Area 14. Any candidate game species shown in Table 8-1 are likely to be present at the T2 and control sites.

The Sedan control site is located near Tippipah Spring in Area 16, about 20 km (12.6 mi) southwest of the Sedan crater (Figure 8-1). ^{3}H concentrations in plant samples collected in 2010 were abnormally high, so more plant samples, along with a sample of water from Tippipah Spring, were collected in 2011 to assess the previous results.

In 2011, no biota or soil sampling was conducted at the Area 3 or Area 5 RWMSs. The last sampling of the RWMSs in 2009 did not suggest that burrowing animals had come into contact with buried waste (NSTec, 2010).

8.3.1 Plants

On July 21, 2011, eight plant samples were collected from the T2 control site and two plant samples and one water sample were collected from the Sedan control site. On June 28, 2011, six plant samples were collected from the T2 site. Sampled species represent the dominant vegetation at each site (Table 8-2). Plants were sampled over an area of about 0.011 square kilometers (0.004 square miles) near the center of the T2 Radioactive Material Area (RMA). All samples consisted of about 150 to 500 grams (5.3 to 17.6 ounces) 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.

Plant leaves and stems from the sites were hand-picked and stored in airtight mylar 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 the samples by distillation, and the water and dried plant tissues were submitted to a commercial laboratory for analysis. Water from plants was analyzed for ^{3}H. Dried plant tissue was submitted for ^{241}Am, ^{90}Sr, uranium, plutonium, and gamma spectroscopy analysis.

Table 8-2. Plant species sampled in 2011

Common Name	Scientific Name	Name Code	T2	T2 Control	Sedan Control
Basin big sagebrush	*Artemisia tridentata*	ARTR		x	
Virgin River brittlebush	*Encelia virginensis*	ENVI	x		
Rubber rabbitbrush	*Ericameria nauseosus*	ERNA	x	x	x
White burrobush	*Hymenoclea salsola*	HYSA	x		
Baltic rush	*Juncus balticus*	JUBA			x
Desert globe mallow	*Sphaeralcea ambigua*	SPAM		x	
Tumblemustard	*Sisymbrium altissimum*	SIAL		x	

As expected, concentrations of man-made radionuclides were generally higher in samples from the T2 site compared with the T2 control site (Table 8-3). The T2 site had positive detections (i.e., radionuclide concentrations greater than their laboratory-reported minimum detectable concentrations [MDC; see Glossary, Appendix B) of ^{3}H, ^{90}Sr, ^{238}Pu, $^{239+240}$Pu, and ^{241}Am.

The Sedan control site plant samples had very low concentrations of all radionuclides, with only one rubber rabbitbrush sample having a ^{241}Am result just above its MDC (Table 8-3). In 2010, ^{3}H was measured in plant samples from the Sedan control site, but it was believed to be due to cross-contamination with samples from E Tunnel Ponds during storage prior to distillation (NSTec, 2011b). The collected plant samples had been stored in a freezer in sealed plastic bags adjacent to one another. Sample storage and handling procedures were revised to ensure that field specimens from contaminated sites and their control sites are stored separately or are processed immediately

^{3}H was not detected in the plant samples or in the Tippipah Spring water sample collected from the Sedan control site in 2011. This is consistent with sample results prior to 2010. Because ^{3}H in the 2010 samples from this site were elevated, laboratory experiments were conducted in 2011 to recreate possible cross-contamination scenarios that might explain the 2010 results. In all cases, the experiments did not demonstrate a mechanism for sample cross-contamination. The 2010 Sedan control sample plant results are considered anomalous; there is no consistent evidence that the Sedan control site is contaminated with ^{3}H.

Table 8-3. Concentrations of man-made radionuclides in plants sampled in 2011

	Radionuclide Concentrations ± Uncertainty[a]				
Sample	**^{3}H(pCi/L)[b]**	**^{90}Sr (pCi/g)[c]**	**^{238}Pu (pCi/g)**	**$^{239+240}$Pu (pCi/g)**	**^{241}Am (pCi/g)**
T2					
ENVI #1	7,600 ± 1,210	0.078 ± 0.033	0.013 ± 0.006	0.029 ± 0.010	0.007 ± 0.004
ENVI #2	8,300 ± 1,310	0.348 ± 0.087	0.006 ± 0.004	0.027 ± 0.010	0.012 ± 0.006
ERNA #1	5,890 ± 953	0.427 ± 0.108	0.009 ± 0.006	0.015 ± 0.008	0.005 ± 0.004
ERNA #2	3,070 ± 540	0.007 ± 0.039	0.009 ± 0.005	0.015 ± 0.007	0.006 ± 0.004
HYSA #1	17,000 ± 2,630	0.154 ± 0.047	0.010 ± 0.006	0.018 ± 0.009	0.013 ± 0.007
HYSA #2	12,800 ± 2,000	0.350 ± 0.088	0.004 ± 0.004	0.012 ± 0.007	0.006 ± 0.005
Average MDC[d]	325	0.049	0.004	0.005	0.003
T2 Control					
ARTR #1	34 ± 192	0.005 ± 0.039	0.006 ± 0.005	0.004 ± 0.004	0.005 ± 0.005
ARTR #2	150 ± 200	-0.012 ± 0.031	0.003 ± 0.004	0.003 ± 0.004	0.0060 ± 0.005
ERNA #1	238 ± 202	0.029 ± 0.040	0.007 ± 0.004	0.004 ± 0.003	0.003 ± 0.004
ERNA #2	64 ± 196	-0.016 ± 0.037	0.002 ± 0.004	0.001 ± 0.004	0.005 ± 0.004
SIAL #1	-36 ± 190	-0.027 ± 0.039	0.003 ± 0.003	0.003 ± 0.003	0.003 ± 0.003
SIAL #2	-25 ± 189	-0.006 ± 0.037	0.001 ± 0.003	0.003 ± 0.004	0.008 ± 0.006
SPAM #1	133 ± 195	0.014 ± 0.033	0.005 ± 0.004	0.003 ± 0.005	0.005 ± 0.004
SPAM #2	19 ± 191	-0.016 ± 0.033	0.005 ± 0.004	0.003 ± 0.004	0.004 ± 0.004
Average MDC	322	0.060	0.005	0.005	0.005
Sedan Control					
ERNA	111 ± 197	0.000 ± 0.046	0.001 ± 0.003	0.003 ± 0.003	0.006 ± 0.005
JUBA	49 ± 194	-0.014 ± 0.050	0.003 ± 0.003	0.001 ± 0.003	0.005 ± 0.004
Average MDC	324	0.080	0.004	0.004	0.004

[a] ± 2 standard deviations
[b] Picocuries per liter water from sample
[c] Picocuries per gram dry weight of sample
[d] The average sample-specific MDC

8.3.2 Animals

State and federal permits were secured to trap specific small mammals and birds in 2011 and to opportunistically sample large mammal mortalities (e.g., from vehicles or from predation) on the NNSS. Permission was also obtained to acquire samples of blood from radio-collared mountain lions. Attempts were made to trap small mammals and birds at the T2 and T2 control locations from July 12 through October 19, 2011. Only two jackrabbits were trapped from the T2 site, and no animals were collected from the T2 control site. Tissue samples were opportunistically collected from nine large mammals: eight mule deer (two accidentally hit by vehicles and six preyed upon by mountain lions) and one desert bighorn sheep killed by a mountain lion. A blood sample was also collected from one radio-collared mountain lion captured on the NNSS in April 2011 (Table 8-4).

Because of the small volume of blood sampled, it was only analyzed for ^{3}H content. For most samples from the carcasses of mountain lion kills, very little tissue was available for analysis. Due to the small sample sizes of these tissues and the relatively high potential for cross-contamination between them and the surrounding soil, only water distilled from the carcass tissue remains were analyzed for ^{3}H content. Any adequate muscle tissue samples from large mammals were homogenized, as were the whole bodies of each jackrabbit. 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, the jackrabbits were homogenized to give a more conservative (higher) estimate of potential dose to someone consuming them (see Section 9.1.1.2). Water was distilled from the homogenized samples and submitted to a laboratory for ^{3}H analysis, and the remaining dry tissue samples were submitted for ^{241}Am, ^{90}Sr, plutonium, and gamma spectroscopy analysis.

Table 8-4. Animal samples collected in 2011

Location	Sample	Collection Date	Sample Description
T2	Jackrabbit #1	7/20/2011	Whole body
	Jackrabbit #2	7/12/2011	Whole body
Opportunistic Sampling			
Area 12	Mule Deer #1	2/15/2011	Muscle tissue collected from an adult male mule deer; killed by a vehicle
Area 19	Mule Deer #2	5/25/2011	Water from tissue collected from a mule deer fawn; killed by a mountain lion
Area 19	Mule Deer #3	6/04/2011	Muscle tissue collected from an adult female mule deer; killed by a mountain lion
Area 19	Mule Deer #4	6/16/2011	Water from tissue collected from a mule deer fawn; killed by a mountain lion
Area 19	Mule Deer #5	7/02/2011	Water from tissue collected from a mule deer fawn; killed by a mountain lion
Area 19	Mule Deer #6	7/14/2011	Water from tissue collected from a mule deer fawn; killed by a mountain lion
Area 12	Mule Deer #7	7/24/2011	Water from tissue collected from a mule deer fawn; killed by a mountain lion
Area 18	Mule Deer #8	11/30/2011	Muscle tissue collected from an adult male mule deer; killed by a vehicle
Area 25	Bighorn Sheep	2/24/2011	Water from tissue collected from a big horn sheep; killed by a mountain lion
Area 30	Mountain Lion	4/19/2011	Blood sample taken from a captured mountain lion (~5–6 years old); released with radio-collar

Man-made radionuclides were detected in both jackrabbits collected at T2 and in only one mule deer (Mule Deer #3) (Table 8-5). Because the jackrabbits were collected from the T2 RMA, it is not unexpected that multiple radionuclides were detected in them. ^{137}Cesium was detected in all three of the T2 animal samples in which gamma spectroscopy analysis was run, and ^{3}H, ^{134}Cs, and $^{293+240}$Pu were detected in two of these samples. Both ^{134}Cs and ^{137}Cs were released in large quantities from the Fukushima Daiichi Nuclear Power Plant accident in Japan on March 11, 2011. Both of these gamma-emitting radionuclides were detected across the northern hemisphere (Bolsunovsky and Dementyev, 2011; Thakur et al., 2012), and their detection in the NNSS animal samples is believed to be a result of the Japan release. The plant samples collected on the NNSS, however, did not yield any positive cesium results, which is expected due to the small-sized plant samples and bioaccumulation in the herbivorous animals. The animals consume relatively large amounts of plants daily, whereas the plant samples were relatively small. Had much larger numbers of plants been used in the composite samples, it is likely that cesium would have been detected.

The ^{3}H detected in Mule Deer #3 suggests that this animal was exposed to NNSS-related radionuclides while all of the other mule deer, the bighorn sheep, and the mountain lion may not have been.

Table 8-5. Concentrations of man-made radionuclides detected in animals sampled in 2011

	Radionuclide Concentrations ± Uncertainty[(a)]			
Sample	**^{3}H(pCi/L)[(b)]**	**^{134}Cs (pCi/g)[(c)]**	**^{137}Cs (pCi/g)**	**$^{239+240}$Pu (pCi/g)**
T2				
Jackrabbit #1	399 ± 242	0.079 ± 0.034	0.153 ± 0.039	0.015 ± 0.008
Jackrabbit #2	292 ± 233	0.073 ± 0.065	0.136 ± 0.064	0.010 ± 0.006
Opportunistic Sampling				
Mule Deer #1 (Area 12)	182 ± 214	-0.009 ± 0.034	-0.007 ± 0.026	0.001 ± 0.005
Mule Deer #2 (Area 19)	28 ± 343	NM[(d)]	NM	NM
Mule Deer #3 (Area 19)	456 ± 254	0.079 ± 0.050	0.104 ± 0.040	0.000 ± 0.003
Mule Deer #4 (Area 19)	-168 ± 338	NM	NM	NM
Mule Deer #5 (Area 19)	60 ± 344	NM	NM	NM
Mule Deer #6 (Area 19)	100 ± 345	NM	NM	NM
Mule Deer #7 (Area 12)	159 ± 122	NM	NM	NM
Mule Deer #8 (Area 18)	-3 ± 193	NM	NM	0.002 ± 0.003
Bighorn Sheep (Area 25)	280 186	NM	NM	NM
Mountain Lion (Area 30)	863 ± 863	NM	NM	NM
Average MDC[(e)]	361	0.060	0.046	0.007

(a) ± 2 standard deviations (b) Picocuries per liter water from sample
(c) Picocuries per gram dry weight for jackrabbit samples and picocuries per gram wet weight for deer samples.
(d) Not measured due to inadequate sample size.
(e) Average sample-specific MDC. For ^{3}H, it does not include the mountain lion, which had a high MDC of 1,432 pCi/L.

8.4 Data Assessment

Biota sampling results confirm that man-made radionuclide concentrations are generally higher at the selected biota monitoring locations identified in Section 8.2 compared with their control locations or other locations distant from operational activities. This was observed in 2011 at T2 and its control site. Though certain radionuclides are elevated, the levels detected pose negligible risk to humans and biota. The potential dose to a person consuming these animals is well below dose limits to members of the public (see Section 9.1.1.2). Also, radionuclide concentrations were below levels considered harmful to the health of the plants or animals; the dose resulting from observed concentrations was less than 2% of dose limits set to protect populations of plants and animals (see Section 9.2).

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 Orders DOE O 435.1, "Radioactive Waste Management;" and DOE O 458.1, "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 National Security Site (NNSS), and existing data from past inventories of the radionuclide content of NNSS surface soils. The 2011 data used are presented in Chapters 4 through 8 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 NNSS complies with 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) comply with 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 NNSS 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 NNSS operations complies with the limit of 100 mrem/yr (1 mSv/yr) established by DOE O 458.1.	Total effective dose equivalent (TEDE) (see Glossary, Appendix B) for an offsite resident from all path-ways, in mrem/yr (or mSv/yr)
Determine if the radiation dose (in a unit of measure called a rad [see Glossary, Appendix B]) to NNSS biota complies with the following limits set by 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 Dose to the Public

This section identifies the possible pathways by which the public could be exposed to radionuclides due to past or current NNSS activities. It describes how field monitoring data are used with other NNSS data sources (e.g., radio-nuclide inventory data) to provide input to the dose estimates and presents the estimated 2011 public dose attributable to NNSA/NSO activities from each pathway and all pathways combined. The public dose due to radioactive waste operations on the NNSS is also assessed, and a description of the program that controls the release of NNSS materials having residual radioactivity into the public domain is provided.

9.1.1 Dose from Possible Exposure Pathways

As prescribed in the *Routine Radiological Environmental Monitoring Plan* (Bechtel Nevada, 2003a), air, groundwater, and biota are routinely sampled 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 NNSS operations include the following:

- Inhalation of, ingestion of, or direct external exposure to airborne radionuclide emissions transported off site by wind
- Ingestion of wild game animals that drink from surface waters and eat vegetation containing NNSS-related radioactivity
- Ingestion of plants containing NNSS-related radioactivity
- Drinking 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 NNSS

The subsections below address all of the potential pathways and their contribution to public dose estimated for 2011.

9.1.1.1 Dose from NNSS Air Emissions

Six air particulate and tritium (^{3}H) sampling stations located near the boundaries and the center of the NNSS are approved by the U.S. Environmental Protection Agency (EPA) Region IX as critical receptor samplers to demonstrate compliance with the NESHAP public dose limit of 10 mrem/yr (0.1 mSv/yr) from air emissions. Analysis of air particulate and ^{3}H data obtained at these six stations was performed in 2011 (see Chapter 4, Sections 4.1.4 and 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]) (see 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 TEDE 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 in samples from at least one of the six critical receptor samplers: tritium (^{3}H), cesium-134 (^{134}Cs), cesium-137 (^{137}Cs), americium-241 (^{241}Am), plutonium-238 (^{238}Pu), and plutonium-239+240 ($^{239+240}Pu$) (see Section 4.1.4). The ^{134}Cs and ^{137}Cs are believed to be solely from the Fukushima Daiichi nuclear power plant release that occurred in March 2011. All concentrations of these radionuclides were well below their CLs, and the sum of fractions for each location were all less than 1.0 (see Section 4.1.5, Table 4-12). As in previous years, the 2011 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 NNSS had the highest sum of fractions for critical receptor locations, 0.122 (Table 4-12). Scaling this 0.122 sum of fractions to the 10 mrem/yr limit gives an estimated TEDE of 1.22 mrem/yr from air emissions for a hypothetical individual living year-round at this station. Air concentrations drop relatively quickly with distance from contaminated locations. The Gate 20-2P sampler, which is 5.0 kilometers (km) (3.1 miles [mi]) south-southeast of the Schooner sampler, had a sum of fractions of only 0.006. A more realistic estimate of dose to the maximally exposed individual (MEI; see Glossary, Appendix B) off site would be to use the 0.007 sum of fractions from the Gate 510 sampler (Table 4-12), which is closest to the nearest public receptor (about 3.5 km [2.2 mi]). The estimated TEDE from air emissions for a hypothetical individual living year-round at the Gate 510 sampler would be 0.07 mrem/yr. More detailed information regarding the estimation of the airborne dose to the public in 2011 from all activities conducted by the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) on the NNSS and its Nevada support facilities are reported in National Security Technologies (NSTec) (2012a).

9.1.1.2 Dose from Ingestion of Wild Game from the NNSS

Two game species, mule deer and mourning doves, have been shown to travel off the NNSS and be available to hunters (Giles and Cooper, 1985; NSTec, 2009). Because of this, game animals on the NNSS 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 NNSS. In 2011, animals sampled from contaminated locations, or sampled animals potentially visiting contaminated locations, consisted of two jackrabbits from the T2 site in Area 2, two mule deer from Area 12, one mule deer from Area 18, five mule deer from Area 19, one bighorn sheep from Area 25, and one mountain lion from Area 30. Samples from each of these animals were analyzed for radionuclide content (see Section 8.3.2, Table 8-5).

The potential dose to an individual from consuming game animals sampled during 2011 was calculated using the following assumptions:

- An individual consumes 20 jackrabbits over the year (the possession limit set for this species by the Nevada Division of Wildlife), each having 550 grams (g) of meat.
- An individual consumes all meat from one mule deer during the year.
- Each consumed jackrabbit contains the average concentration of each radionuclide detected in the samples from that species from the sample location.
- The consumed mule deer contains radionuclides at the same concentrations as those detected in Mule Deer #3 sampled from Area 19. This was the only mule deer to have radionuclide concentrations above the minimum detectable concentration.
- The moisture content of the jackrabbits is 51.5%, and the moisture content of the mule deer meat is 70%.

The committed effective dose equivalent (CEDE; see Glossary, Appendix B) was calculated using dose conversion factors (EPA, 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. Because no man-made radionuclides were detected in the bighorn sheep or mountain lion samples (see Section 8.3.2, Table 8-5), dose from consuming these animals was not calculated and is not included in the table. The potential CEDE was approximately the same from eating 20 jackrabbits from the T2 site containing average radionuclide concentrations (0.30 mrem [0.0030 mSv) versus eating one mule deer with radionuclide concentrations equal to that observed in Mule Deer #3 from Area19 (0.31 mrem [0.0031 mSv]). Both are only 0.3% of the annual dose limit for members of the public. If someone were to consume just one jackrabbit from T2, the potential dose would be about 0.015 mrem (0.00015 mSv).

Table 9-1. Hypothetical dose to a human consuming animals sampled from the NNSS in 2011

	Average Radionuclide Concentrations [(a)]			Dose Conversion Factor (mrem/pCi ingested)[(b)]	CEDE (mrem)	Sum of CEDE (mrem)
T2						
Jackrabbit	^{3}H	346	pCi/L[(c)]	0.000000064	0.000125	0.30
	^{134}Cs	0.076	pCi/g[(d)]	0.000073300	0.029739	
	^{137}Cs	0.145	pCi/g[(d)]	0.000050000	0.038569	
	$^{239+240}$Pu	0.013	pCi/g[(d)]	0.003537200	0.236033	
Opportunistic Sampling						
Mule Deer #3 (Area 19)	^{3}H	456	pCi/L[(c)]	0.000000064	0.000574	0.31
	^{134}Cs	0.079	pCi/g[(e)]	0.000073300	0.162719	
	^{137}Cs	0.104	pCi/g[(e)]	0.000050000	0.146120	

(a) Average radionuclide concentration in jackrabbits from T2 and in just Mule Deer #3 because all other deer did not have detected man-made radionuclides.
(b) Dose conversion factors for human ingestion are from Federal Guidance Report No. 11 (EPA, 1988). Assumed meat from 20 rabbits (550 g each) and meat from one adult female mule deer (28.1 kg) was consumed.
(c) pCi/L is concentration in water from animal; water content = 51.5% by weight for the whole body jackrabbit and 70% for the mule deer meat
(d) pCi/g for jackrabbit is per gram dry weight
(e) pCi/g for the mule deer is per gram wet weight

Radionuclides contributing the most dose were $^{239+240}$Pu in jackrabbits and ^{134}Cs in the mule deer (^{134}Cs and ^{137}C are likely not from an NNSS source). ^{3}H was present at much higher concentrations than other nuclides; however, ^{3}H gives relatively little 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 three times higher than from consuming 20 jackrabbits from T2 or one mule deer from Area 19.

Table 9-2 presents the hypothetical CEDE for humans consuming various species of NNSS wildlife based on animals sampled from 2001 through 2011. The average CEDE by species ranges from 0.001 mrem/yr for mountain lions to 0.92 mrem/yr for jackrabbits. The highest estimated CEDE for any one species and location is 4.47 mrem (0.0447 mSv) from Plutonium Valley jackrabbits, as estimated from 2009 samples (NSTec, 2010). This represents 4.47% of the annual dose limit for members of the public. If an individual were to consume just one jackrabbit from Plutonium Valley having similar tissue radionuclide levels, the potential dose would be about 0.22 mrem (0.0022 mSv), which is 0.22% of the annual dose limit for members of the public, or approximately 22% of the dose one would receive from naturally occurring cosmic radiation during a 2-hour airplane flight at 39,000 feet. If an individual were to consume just one animal of each species with average concentrations based on samples collected from 2001 through 2011, this individual may receive an estimated 0.47 mrem/yr (0.0047 mSv/yr) dose (Table 9-2).

Table 9-2. Hypothetical CEDE from ingesting NNSS wildlife based on samples with detected radionuclides

Game Animal	Sample Location	Year Sampled	High Estimate of the Number of Animals Consumed by an Individual (State of Nevada Possession Limit)	CEDE (High Estimate) (mrem)	CEDE (Consumption of One Animal) (mrem)
Chukar	E Tunnel	2001	12 (breast meat only)	0.070	**0.0058**
Cottontail rabbit	Schooner Crater	2008	20 (all muscle tissue)	0.47	**0.024**
Gambel's quail	T2	2002	20 (all muscle tissue)	0.080	**0.0040**
Jackrabbit	Area 3 RWMS	2009	20 (all muscle tissue)	0.59	0.030
Jackrabbit	Area 5 RWMS	2009	20 (all muscle tissue)	0.15	0.0075
Jackrabbit	Plutonium Valley	2009	20 (all muscle tissue)	4.5	0.22
Jackrabbit	Sedan	2005	20 (all muscle tissue)	0.32	0.016
Jackrabbit	Sedan	2010	20 (all muscle tissue)	1.7	0.083
Jackrabbit	T2	2002	20 (all muscle tissue)	0.11	0.0055
Jackrabbit	T2	2006	20 (all muscle tissue)	0.040	0.0020
Jackrabbit	T2	2011	20 (all muscle tissue)	0.030	0.0015
			All Jackrabbits Average	0.92	**0.046**
			Minimum	0.030	0.0015
			Maximum	4.5	0.22
Mourning dove	E-Tunnel	2000	20 (all muscle tissue)	0.16	0.0080
Mourning dove	E-Tunnel	2002	20 (all muscle tissue)	0.020	0.0010
Mourning dove	E-Tunnel	2003	20 (all muscle tissue)	0.015	0.00075
Mourning dove	E-Tunnel	2007	20 (all muscle tissue)	0.0095	0.00048
Mourning dove	Palanquin	2003	20 (all muscle tissue)	0.013	0.00065
Mourning dove	Pu-Valley	2004	20 (all muscle tissue)	0.005	0.00025
Mourning dove	Schooner Crater	2008	20 (all muscle tissue)	0.0002	0.00001
Mourning dove	Sedan	2005	20 (all muscle tissue)	0.0098	0.00049
Mourning dove	Well U-20n PS#1DDH	2003	0.30	0.015	0.01495
			All Mourning Doves Average	0.059	**0.0030**
			Minimum	0.0	0.000010
			Maximum	0.30	0.015
Mountain lion	Areas 8, 12, and 30	2010	1 (all muscle tissue)	0.0010	**0.0010**
Mule deer	Area 19	2011	1 (all muscle tissue)	0.31	**0.31**
Pronghorn antelope	Area 5	2003	1 (all muscle tissue)	0.064	0.064
Pronghorn antelope	Area 5	2007	1 (all muscle tissue)	0.091	0.091
			All Pronghorns Average	0.078	**0.078**
			Minimum	0.064	0.064
			Maximum	0.091	0.091
Total (from consumption of one of each game species having individual doses shown in bold)					**0.47**

9.1.1.3 Dose from Ingestion of Plants from the NNSS

Current NNSS land use practices discourages the harvest of plants or plant parts for direct consumption by humans. However, it may be possible that individuals with access collect edible plant material for consumption. One species in particular, the pinyon tree, produces pine nuts, which are harvested and consumed across the western United States. Pinyon trees grow in multiple locations on the NNSS. No edible plants were sampled in 2011. The only samples of edible plants collected on the NNSS in recent history were pine nuts sampled in 2010. Dose from consuming these was shown to be extremely low and was a negligible contribution to the total potential dose to a member of the public (NSTec, 2011b).

9.1.1.4 Dose from Drinking Contaminated Groundwater

The 2011 groundwater monitoring data indicate that groundwater from offsite private and community wells and offsite springs has not been impacted by past NNSS nuclear testing operations (see Sections 5.1.6 and 7.2.3). No man-made radionuclides have been detected in any wells accessible to the offsite public or in private wells or springs. Therefore, drinking water from underground aquifers containing radionuclides is not a possible pathway of exposure to the public residing off site.

9.1.1.5 Dose from Direct Radiation Exposure along NNSS Borders

The direct exposure pathway from gamma radiation to the public is monitored annually (see Chapter 6). In 2011, the only place where the public had the potential to be exposed to direct radiation from NNSS operations is at Gate 100, the primary entrance to the site on the southern NNSS border. Trucks hauling radioactive materials, primarily low-level waste (LLW) 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 due to NNSS activities. However, no member of the public resides or remains full-time at the Gate 100 truck parking area. Therefore, dose from direct radiation is not included as a possible pathway of exposure to the public residing off site.

9.1.2 Dose from Waste Operations

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 10 mrem through the air pathway and 25 mrem through all pathways for a 1,000-year compliance period after closure of the disposal units. Given that the RWMSs are located well within the NNSS 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 2011, external radiation from waste operations measured near the boundaries of the Area 3 and Area 5 RWMSs could not be distinguished from background levels at those locations (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 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, 12% of their CLs (for $^{239+240}$Pu at U-3ah/at S; see Chapter 4, Table 4-5). Scaling this to the 10 mrem dose that the CL represents would be < 2 mrem to a hypothetical person residing near the boundaries of the RWMS, and the dose would be much lower to the offsite public.

There is no exposure, and therefore no dose, to the public from groundwater beneath waste disposal sites on the NNSS. Groundwater monitoring indicates that no man-made radionuclides have been detected in wells accessible to the offsite public or in private wells or springs (see Sections 5.1.6 and 7.2.3). 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 10.1.7 and 10.1.8). Based on these results, potential doses to members of the public from LLW disposal facilities on the NNSS from all pathways are negligible.

9.1.3 Total Offsite Dose to the Public from all Pathways

The DOE-established radiation dose limit to a member of the general public from all possible pathways as a result of DOE facility operations is 100 mrem/yr (1 mSv/yr) excluding background radiation, while considering air transport, ingestion, and direct exposure pathways. For 2011, the only plausible pathways of public exposure to man-made radionuclides from current or past NNSS 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 2011 dose to the MEI residing off site.

In the recent past, the MEI from the air pathway was considered a hypothetical person residing at the critical receptor station with the highest dose (Schooner). However, in an effort to give a more realistic estimate, the 0.07 mrem/yr (0.0007 mSv/yr) dose estimate for the Gate 510 critical receptor station is used for the dose estimate for an offsite MEI (see Section 4.1.1.1). If the offsite MEI is assumed to also eat wildlife from the NNSS, additional dose would be received. Based on radionuclide levels in 2011 samples and the assumption that this person consumes 20 jackrabbits from T2 or one mule deer from Area 19, this individual may receive an estimated additional 0.31 mrem/yr (0.0031 mSv/yr) dose (Table 9-1). If this person consumed one animal of each game species with average concentrations based on samples collected from 2001 to 2011 (Table 9-2), this individual may receive an estimated additional 0.47 mrem/yr (0.0047 mSv/yr) dose (Table 9-2). Both wildlife consumption scenarios are conservative estimates. Based on the second conservative scenario, if all dose from consuming wildlife were received in one year, the total effective dose equivalent (EDE) (see Glossary, Appendix B) to this hypothetical MEI from all exposure pathways combined and solely due to NNSA/NSO activities would be 0.54 mrem/yr (0.0054 mSv/yr) (Table 9-3). The total dose of 0.54 mrem/yr is 0.54% of the DOE limit of 100 mrem/yr and about 0.15% of the total dose the MEI receives from natural background radiation (360 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 (98.99 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 31 mrem/yr and 229 mrem/yr, respectively, using the approximations by the National Council on Radiation Protection and Measurements (2006).

Table 9-3. Estimated radiological dose to a hypothetical maximally exposed member of the general public from 2011 NNSS operations

Pathway	Dose to MEI (mrem/yr)	Dose to MEI (mSv/yr)	Percent of DOE 100 mrem/yr Limit
Air[(a)]	0.07	0.0007	0.07
Water[(b)]	0	0	0
Wildlife[(c)]	0.47	0.0047	0.47
Direct[(d)]	0	0	0
All Pathways	0.54	0.0054	0.54

(a) Based on annual average concentrations at the compliance station nearest the offsite public (Section 4.1.5, Table 4-12).
(b) Based on all offsite groundwater sampling in 2011 (Section 5.1.5).
(c) Assumes the MEI consumes one of each species sampled on the NNSS and having average concentrations shown in Table 9-2.
(d) Based on 2011 gamma radiation monitoring data at the NNSS entrance (Section 6.3.1).

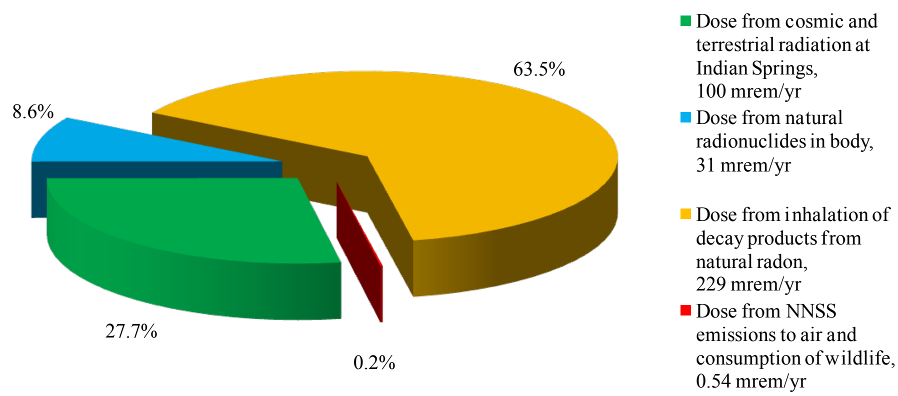

Figure 9-1. Comparison of radiation dose to the MEI from the NNSS and natural background (percent of total)

9.1.4 Collective Population Dose

The collective population dose to residents within 80 km (50 mi) of the NNSS emission sources was not estimated in 2011 because this assessment depends upon CAP88-PC estimations, which were not calculated. DOE approved the discontinuance of reporting collective population dose from NNSS operations after 2004 because it is so low for the NNSS. It has been below 0.6 person-rem/yr for the period from 1992, when it was first calculated and reported to DOE, through 2004 (Figure 9-2). The relatively large increase in collective population dose seen in 1994 in Figure 9-2 was due to two changes. The first was the inclusion of plutonium resuspension in air from soils across all areas of the NNSS instead of from soils from only a few areas of the NNSS in 1992 and 1993. The second was a large increase in the surrounding population in 1994, as Pahrump's population increased by 7,000 and the population of Tonopah (4,200) was added to the calculation.

DOE recommended 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 NNSS activities or the population within 80 km (50 mi) of the NNSS increase significantly (e.g., ≥ 50%), both of which are estimated annually (see Section 1.7 for population estimates).

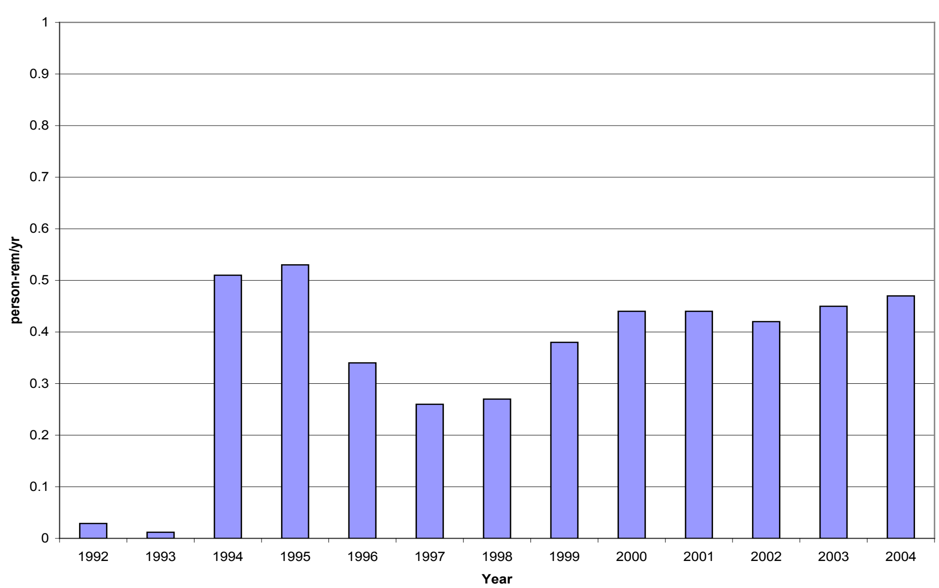

Figure 9-2. Collective population dose within 80 km (50 mi) of NNSS emission sources from 1992 to 2004

9.1.5 Release of Property Containing Residual Radioactive Material

The release of property off the NNSS that contains residual radioactive material is controlled. No vehicles, equipment, structures, or other materials can be released from the NNSS unless the amount of residual radioactivity on such items is less than the authorized limits. The default authorized limits are specified in the *Nevada Test Site Radiological Control Manual* (NNSA/NSO, 2010a) and are consistent with DOE O 458.1. These limits are shown in Table 9-4. Items proposed for unrestricted release must be surveyed to document compliance with the authorized limits.

Government vehicles and equipment are routinely released or excessed when they are no longer needed by NNSS 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 9-4. No items with residual radioactivity in excess of the limits specified in Table 9-4 were released from the NNSS in 2011.

Table 9-4. Allowable total residual surface contamination for property released off NNSS

	Residual Surface Contamination (dpm/100 cm^2)[a]		
Radionuclide	**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
^{3}H 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)

In 2000, DOE placed a moratorium on the release of scrap metal from radiological areas for recycling. In 2010, DOE Headquarters held a workshop and provided more specific guidance on which materials are restricted from recycling. In 2011, NNSS accelerated site cleanup efforts using this more specific guidance. As a result, the cleanup effort will include, beginning in 2012, the release and recycling of some materials that were previously being held due to the moratorium, but no longer required to be held, and do not exceed the residual surface contamination limits specified in Table 9-4. No scrap metals were released from radiological areas for recycling in 2011.

9.2 Dose to Aquatic and Terrestrial Biota

DOE requires that their facilities 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.

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

A comprehensive biota dose assessment for the NNSS 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 NNSS was not likely to exceed dose limits. Data from monitoring air, water, and biota across the NNSS do not suggest that NNSS surface contamination conditions have worsened; therefore, this biota dose evaluation conclusion remains the same for 2011.

9.2.1 2011 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 internal dose to biota sampled in 2011, the RESRAD-BIOTA, Version 1.21, computer model (DOE, 2004b) was used. Maximum concentrations of man-made radionuclides detected in plant and animal tissue (see Section 8.3.1, Table 8-3, and Section 8.3.2, Table 8-5) were used as input to the model. External dose was based on the maximum exposure rate measured by a thermoluminescent dosimeter (TLD) near the biota sampling site. The TLD site used was the Stake N-8 location at the T2 site in Area 2 and the Stake P-41 location in Area 19 (see Chapter 6, Table 6-1).

The 2011 site-specific estimated dose rates to biota were all below the DOE limits for both plants and animals (Table 9-5). The highest was predicted for plants near the T2 site in Area 2 followed by animals in the same location. External dose contributed more than 88% of the total dose for all locations.

Table 9-5. Site-specific dose assessment for terrestrial plants and animals sampled in 2011

	Estimated Radiological Dose (rad/d)					
	To Plants[(a)]			**To Animals[(a)]**		
Location	**Internal**	**External**	**Total**	**Internal**	**External**	**Total**
Area 2 (plants and animals near T2)	0.00017	0.00131	0.00148	0.00004	0.00131	0.00135
Area 19 (based on Mule Deer #3)	--------------------NM[(b)]--------------------			0.0000062	0.00046	0.00047
DOE Dose Limit:			**1**			**0.1**

(a) For information on plants and animals sampled, see Chapter 8
(b) Not measured; no plants sampled in Area 19 during 2011

9.2.2 Dose Assessment Summary

Radionuclides in the environment from past or present NNSS activities result in a 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 2011 was 0.38% of the dose limit set to protect human health. Dose to biota at the NNSS sites sampled in 2011 were less than 2% of dose limits set to protect plant and animal populations. Based on the low potential doses from NNSS radionuclides, impacts from those radionuclides are expected to be negligible.

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10.0 Waste Management

Several federal and state regulations govern the safe management, storage, and disposal of radioactive, hazardous, and solid wastes generated or received on the Nevada National Security Site (NNSS) (see Section 2.5). This chapter describes the waste management operations conducted under the Environmental Management Program of the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) and summarizes the activities performed in 2011 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 Goals	*Compliance Measures/Actions*
Manage and safely dispose of low-level waste (LLW), mixed low-level waste (MLLW), and hazardous waste (HW) generated by NNSA/NSO, other U.S. Department of Energy (DOE), or selected U.S. Department of Defense (DoD) operations. Manage and safely store transuranic (TRU) and mixed transuranic (MTRU) wastes generated onsite for eventual shipment to the Waste Isolation Pilot Plant (WIPP) in Carlsbad, New Mexico. Ensure that wastes received for storage and/or disposal meet NNSS waste acceptance criteria. Evaluate, design, construct, maintain, and monitor closure covers for radioactive waste disposal units at the Area 3 and Area 5 Radioactive Waste Management Sites (RWMSs). Manage radiation doses from the Area 3 and Area 5 RWMSs to the levels specified in DOE Manual DOE M 435.1-1, "Radioactive Waste Management Manual." Manage and safely dispose of solid/sanitary wastes generated by NNSA/NSO operations. Manage underground storage tanks (USTs) to prevent environmental contamination. Ensure that disposal systems meet performance objectives.	Maintain documents required for a Category II Non-Reactor Nuclear Facility established for radioactive waste management and disposal operations Perform site characterizations for proposed new waste disposal systems Acceptance criteria for radioactive wastes received for disposal Volume of disposed LLW Volume of disposed MLLW Volume of stored HW and MLLW Weight of approved explosive ordnance wastes detonated Weight and volume of solid waste disposed Soil moisture in the vadose zone Tritium (^{3}H), pH, specific conductance, total organic carbon, and total organic halides in groundwater Direct radiation at thermoluminescent dosimeter (TLD) stations Tritium, gross alpha/beta, and gamma emitters at air monitoring stations

10.1 Radioactive Waste Management

The NNSS Radioactive Waste Management facilities include the Area 3 RWMS and the Area 5 Radioactive Waste Management Complex (RWMC) (see Glossary, Appendix B). The Area 5 RWMC is composed of the Area 5 RWMS and the Waste Examination Facility. The Area 3 RWMS and the Area 5 RWMC operate as Category II Non-Reactor Nuclear Facilities. They are designed and operated to perform four functions:

- Dispose of LLW and MLLW from NNSA/NSO activities performed on the NNSS and performed off site 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, including former sites or projects operated by DOE or its predecessor agencies.
- Dispose of LLW and MLLW designated as classified material by DoD.
- Store and manage TRU wastes generated by ongoing NNSS projects in preparation for final disposal at WIPP.

All generators of waste streams must demonstrate eligibility to ship waste to the NNSS for disposal, submit profiles characterizing specific waste streams, meet the NNSS 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 for LLW disposed after 1988. 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.

10.1.1 Area 5 RWMS

The Area 5 RWMS is an NNSA/NSO-owned radioactive waste disposal facility. The Area 5 RWMS is approximately 740 acres (ac), which includes 200 ac of historical and active disposal cells used for burial of both LLW and MLLW, and approximately 540 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 "92-Acre Area" consists of 31 disposal cells (pits and trenches) and 13 Greater Confinement Disposal (GCD) boreholes, and was used for disposal of waste in drums, soft-sided containers, large cargo containers, and boxes. The 92-Acre Area was filled and permanently closed in 2011. Closure covers for the 92-Acre Area were seeded in the fall of 2011, and plants are expected to become established in the spring of 2012. Three new cells immediately north and west of the 92-Acre Area have been receiving wastes since 2010. They include two LLW cells (Cells 19 and 20) and a specialized MLLW cell (Cell 18), which can receive radioactive and mixed wastes contaminated with polychlorinated biphenyls (PCBs) or with asbestos. 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 and site cleanup activities. Disposal activities are projected to continue through 2027.

Disposal Cell 18 is operated under a Resource Conservation and Recovery Act (RCRA) Part B Permit (NEV HW0101), which authorizes the disposal of up to 25,485 cubic meters (m^3) (874,509 cubic feet [ft^3]) of MLLW. In 2011, Cell 18 received 1,001 tons of MLLW (Table 10-1). A total of 1,507 m^3 of MLLW have been disposed in Cell 18 over its lifetime. Quarterly reports were submitted to the State of Nevada in 2011 to document the weight of MLLW received each quarter at Cell 18.

In 2011, the Area 5 RWMS received shipments containing a total of 42,600 m^3 (1,504,412 ft^3) of radioactive wastes for disposal (Table 10-1). The majority of disposed LLW and MLLW was received from offsite generators. Only 2,213 m^3 (78,163 ft^3) of the wastes disposed in 2011 were generated on site. The volumes and numbers of waste shipments during fiscal year 2011 (October 1–September 30) are reported in an annual report (NNSA/NSO, 2012).

Table 10-1. Radioactive waste received and disposed at the Area 5 RWMS in 2011

Waste Type	Disposal Cell(s)	Permitted Limit (m^3)	2011 Quantities Received and Disposed	
			m^3 (ft^3)[(a)]	tons[(b)]
LLW	P12–P17, Cells 19, 20	NA[(c)]	40,845 (1,442,439)	32,479.6
MLLW[(d)]	Cell 18	25,485	1,507 (53,233)	1,001
Asbestiform LLW	P06A, Cell 20	NA	247.5 (8,740)	51.4
Totals			42,600 (1,504,412)	33,532

(a) LLW disposal is regulated by DOE, and totals reported are based on volume (m^3).
(b) Fees paid to the State of Nevada for HW generated at NNSS and MLLW wastes received for disposal are based on weight (tons).
(c) Not applicable.
(d) MLLW contains a hazardous component that is regulated by the State of Nevada (see Section 10.2).

10.1.2 Area 3 RWMS

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, 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	U-3az
U-3bh	(Corrective Action Unit 110)	U-3bg

10.1.3 Waste Characterization

Waste Generator Services (WGS) characterizes LLW and MLLW generated by DOE primarily at the NNSS 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 2011, LLW and MLLW were characterized by WGS for the following general waste stream categories:

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

10.1.4 Verification of Waste Acceptance Criteria

Waste verification is an inspection process that confirms the waste stream data supplied by WGS or by another waste generator before MLLW is accepted for disposal at the NNSS. Verification uses Real-Time Radiography (RTR), visual inspection, and/or chemical screening on a designated percentage of MLLW. The objectives of waste verification include identifying prohibited waste forms, verifying that certain MLLW treatment objectives are met, confirming that waste containers do not contain free liquids, and ensuring that waste containers are at least 90% full, per RCRA and State of Nevada requirements.

Verification for onsite generated waste includes visual inspection, RTR, and chemical screening. Verification of offsite generated waste received at the NNSS includes only RTR because the waste packages are not opened at the NNSS. Offsite verification is also performed at a generator facility or a designated treatment, storage, or disposal facility and can include both physical and chemical verification.

In 2011, offsite visual verification was completed on 58 MLLW packages from 10 separate waste streams. Offsite chemical screening was completed on two waste streams. Onsite visual verification was completed on one package containing two onsite waste streams. No onsite RTR was conducted on MLLW packages, and no MLLW packages were rejected during 2011.

10.1.5 TRU Waste Operations

The TRU Pad/Transuranic Pad Cover Building (TPCB) at the Area 5 RWMC is a RCRA-permitted facility designed for the safe storage of TRU and MTRU waste. The TPCB accepts TRU/MTRU waste from NNSS generators including the Joint Actinide Shock Physics Experimental Research (JASPER) facility. The TPCB stores the waste until it is characterized for disposal at the WIPP in Carlsbad, New Mexico. In 2011, the TRU waste remaining in storage at the TPCB consisted of two experimental spheres from LLNL and 18 standard waste boxes from JASPER.

10.1.6 Maintenance of Key Documents

Table 10-2 lists the key documents that must be current and in place for RWMS disposal operations to occur. In 2011, all of these key documents were maintained and one was revised.

Table 10-2. Key documents required for Area 3 RWMS and Area 5 RWMS disposal 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, June 2006
Performance Assessment/Composite Analysis for Area 3 RWMS, Revision 2.1, October 2000
2010 Annual Summary Report for Area 3 and 5 RWMSs at NNSS (Review of Performance Assessments and Composite Analyses), March 2011
Composite Analysis
Composite Analysis for Area 5 RWMS, September 2001
Performance Assessment/Composite Analysis for Area 3 RWMS, Revision 2.1, October 2000
NNSS Waste Acceptance Criteria
NNSS Waste Acceptance Criteria, Revision 8-01, January 2011
Integrated Closure and Monitoring Plan
Closure Plan for the Area 3 RWMS at the NNSS, September 2007
Closure Plan for the Area 5 RWMS at the NNSS, September 2008
Auditable Safety Analysis
Documented Safety Analysis (DSA) for the NNSS Area 3 and 5 Radioactive Waste Facilities, Revision 5, Change Notice 2, August 2011
Safety Evaluation Report (SER) Addendum C, Revision 0 for the Visual Examination and Repackaging Building Addendum to the Area 5 RWMC DSA and Technical Safety Requirements (TSR) for the Area 5 RWMC TRU Waste Activities, September 2008
Visual Examination and Repackaging Building Addendum to the Area 5 RWMC DSA, Revision 0, July 2008
SER Addendum C, Revision 0 for the NNSS Area 3 and 5 Radioactive Waste Facility DSA, Revision 5, Change Notice 3, and TSR Revision 7, Change Notice 3, January 2012
TSR for the Area 5 RWMC TRU Waste Activities, Revision 10, Change Notice 3, December 2011
TSR for the Area 3 and 5 RWMS LLW Activities, Revision 7, Change Notice 3, December 2011
Authorization Agreement for Area 5 RWMC, January 2007

10.1.7 Groundwater Monitoring

Disposal Cell 18 is operated according to RCRA standards for the disposal of MLLW. 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 Cell 18 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 are 3 of the 19 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 the Nevada Division of Environmental Protection (NDEP) for these three wells in 1998. Samples collected semi-annually in 2011 from the wells had contaminant levels below their ILs (Table 10-3). Static levels and general water chemistry parameters are also monitored. All sample analysis results are presented in National Security Technologies, LLC (NSTec) (2012e). Table 5-5 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 2011

Parameter	Investigation Level (IL)	Sample Levels
pH	< 7.6 or > 9.2 S.U.[(a)]	8.22 to 8.39 S.U.
Specific conductance (SC)	0.440 mmhos/cm[(b)]	0.358 to 0.381 mmhos/cm
Total organic carbon (TOC)	1 mg/L[(c)]	<0.5 to 0.59 mg/L
Total organic halides (TOX)	50 µg/L[(d)]	< 5 to <13.3 µg/L
Tritium (^3H)	2,000 pCi/L[(e)]	-3.17 to 2.97 pCi/L

(a) S.U. = standard unit(s) (for measuring pH) (b) mmhos/cm = millimhos per centimeter Source: NSTec, 2012e
(c) mg/L = milligrams per liter (d) µg/L = microgram(s) per liter (e) pCi/L = picocuries per liter

10.1.8 Vadose Zone Monitoring of Closure Covers

Monitoring of the vadose zone (unsaturated zone above the water table) is conducted at the RWMC to demonstrate that (1) 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) 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, and (3) automated monitoring systems in the closure covers on Pits P01, P03, P04, and P05; the floor of P05 underneath the waste; and in the vegetated closure cover on U-3ax/bl. In 2011, closure covers were constructed over the 92-Acre Area of the Area 5 RWMS, and most of the VZM monitoring components were destroyed during their construction. The monitoring components were redesigned and reestablished after construction was complete.

Soil gas monitoring for tritium at Well GCD-05 (one of the 13 GCD boreholes in the 92-Acre Area) was discontinued when the 92-Acre Area was closed. Descriptions of the VZM components and the results of monitoring in 2011 are reported in NSTec (2012f). All VZM results in 2011 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.

10.1.9 Assessment of Radiological Dose to the Public

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 10 millirem (mrem) through the air pathway and 25 mrem through all pathways for a 1,000-year compliance period after closure of the disposal units. Given that the RWMSs are located well within the NNSS boundaries, no members of the public can currently access these areas for significant periods of time to acquire a dose exceeding the 10 or 25 mrem annual limit. To document compliance with DOE M 435.1-1, however, the possible pathways for radionuclide movement from waste disposal facilities are monitored. Long-term compliance with the DOE M 435.1-1 dose limits is evaluated by performance assessment modeling.

10.1.9.1 Dose from Air and Direct Radiation

Air samplers operate continuously to collect air particulates and atmospheric moisture near each RWMS. These samples are analyzed for radionuclides, and results are used to assess potential dose. Details of the air sampling and a summary of the analysis results can be found in Chapter 4. The four air monitoring locations at the Area 3 RWMS are U-3bh N, U-3bh S, U-3ah/at N, and U-3ah/at S. The two air monitoring locations at the Area 5 RWMS are DoD and Sugar Bunker. The dose from the air pathway was estimated from air monitoring results from these six stations.

Mean concentrations of radionuclides in air at the Area 3 and Area 5 RWMS environmental sampler locations were far below the established National Emission Standards for Air Pollutants (NESHAP) Concentration Levels for Environmental Compliance (CLs) (Table 10-4). The highest concentration of any radionuclide among the six RWMS air sampler locations was 1.011 × 10^{-15} µCi/mL for ^{137}Cs at the U-3bh S location, which is only 5% of the CL for ^{137}Cs (Table 10-4). For the actinides (americium [Am], cesium [Cs], and plutonium [Pu]), these values are up to four times higher than in 2010, tritium is somewhat lower, and the uranium (U) isotopes are about the same. The exception is ^{137}Cs, which is 100 times higher due to the high values in March caused by the Fukushima Daiichi power plant event. However, scaling these concentrations to the 10 mrem dose that the CLs represent would mean that a hypothetical person residing near the boundaries of the RWMS would receive an annual dose of < 1 mrem/yr, and the annual dose would be much lower to the offsite public.

Table 10-4. Concentrations of radionuclides in Area 3 and Area 5 RWMS air samples collected in 2011

	Concentration (× 10^{-15} microcuries/milliliter [µCi/mL])		
Radionuclide	**NESHAP Concentration Level for Environmental Compliance (CL)[(a)]**	**Highest Concentration Among RWMS Samplers**	**RWMS Sampler with Highest Concentration**
^{241}Am	1.9	0.0380	U-3ah/at S
^{137}Cs	19	1.011	U-3bh S
^{3}H	1,500,000	605.9	U-3ah/at S
^{238}Pu	2.1	0.005345	U-3ah/at S
^{239}Pu	2	0.237 ($^{239+240}$Pu)	U-3ah/at S
^{233}U ^{234}U	7.1 7.7	0.2464 ($^{233+234}$U)	Sugar Bunker N[(b)]
^{235}U ^{236}U	7.1 7.7	0.01179 ($^{235+236}$U)	Sugar Bunker N[(b)]
^{238}U	8.3	0.2431	Sugar Bunker N[(b)]

Note: The CL values represent an annual average concentration that would result in a total effective dose equivalent of 10 mrem/yr, the federal dose limit to the public from all radioactive air emissions.
(a) From Table 2, Appendix E of 40 CFR 61, “National Emission Standards for Hazardous Air Pollutants,” 1999.
(b) Sugar Bunker N was the only RWMS air sampler location at which uranium isotopes were analyzed.

TLDs are used to measure ionizing radiation exposure in and around each RWMS. These TLDs have three calcium sulfate elements used to measure the total exposure rate from penetrating gamma radiation that includes background radiation. The penetrating gamma radiation makes up the deep dose, which is compared to the 25 mrem/yr limit when background exposure is subtracted. Details of the direct radiation monitoring can be found in Chapter 6. During 2011, the external radiation measured near the boundaries of the Area 3 and Area 5 RWMSs 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 no dose to the offsite public.

10.1.9.2 Dose from Groundwater

Groundwater and VZM at the RWMSs is conducted to verify the performance of waste disposal facilities. Such monitoring has not detected the migration of radiological wastes into groundwater (see Sections 10.1.7 and 10.1.8). Also, the results of monitoring offsite public and private wells and springs (see Sections 5.1.5 and 7.2) indicate that man-made radionuclides have not been detected in any public or private water supplies. Based on these results, potential doses to members of the public from LLW disposal facilities on the NNSS from groundwater, and from all pathways combined, are negligible.

10.2 Hazardous Waste Management

HW regulated under RCRA is generated at the NNSS from a broad range of activities, including onsite laboratories, site and vehicle maintenance, communications operations, and environmental restoration of historical contaminated sites (see Chapter 11). The RCRA Part B Permit NEV HW0101 regulates the operation of the Area 5 Mixed Waste Disposal Unit (or Cell 18), the Hazardous Waste Storage Unit (HWSU), and the

Explosive Ordnance Disposal Unit (EODU) facilities. Included in the RCRA Part B permit is authorization for the storage of MLLW at the Mixed Waste Storage Unit (MWSU) composed of the following four facilities at the Area 5 RWMC: the TPCB and TRU Pad, the Sprung Instant Structure Building, the Visual Examination and Repackaging Building, and the Drum Holding Pad. The RCRA permit requires preparation of a U.S. Environmental Protection Agency Biennial Hazardous Waste Report of all HW volumes generated and disposed or stored at the NNSS. This report is prepared for odd-numbered years only. It was prepared for 2011 and submitted to the State of Nevada on February 14, 2012. The annual waste volume report to the State of Nevada, which is due March 1 and which includes volumes of wastes received at the Area 5 MWSU, HWSU, EODU, and Cell 18 during the previous year, has been combined with the annual waste minimization report. This report for 2011 was submitted to NNSA/NSO on February 16, 2012 (NSTec, 2012d).

10.2.1 MLLW and MTRU Facilities

In 2011, the Area 5 MWSU received shipments of 75.7 m^3 (2,673 ft^3) of MLLW from offsite generators and 10.36 m^3 (365.86 ft^3) of MLLW that were generated on site, all of which totaled 74 tons. Of the MLLW received, 1,273 ft^3 weighing 1,001 tons were disposed in Cell 18 in 2011 (Table 10-5).

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 NNSA/NSO environmental restoration sites off the NNSS (e.g., at the Tonopah Test Range) or generated at the North Las Vegas Facility are direct-shipped to approved disposal facilities. HW generated on the NNSS 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 NNSS for the temporary storage of HW prior to direct shipment off site or to the HWSU.

In 2011, a total of 10.55 tons of HW and PCB wastes were received for storage at the HWSU (Table 10-5). Twenty-six drums of PCB wastes (17 of PCB-contaminated soil and 9 of fluorescent light ballasts containing PCBs) totaling 6.06 tons were shipped off site in 2011. This offsite shipment included 0.18 tons that had been received at the HWSU in 2010. In 2011, no HW or PCB wastes were direct-shipped from NNSS waste accumulation areas. One drum of PCB light ballasts from the NLVF was direct-shipped to a disposal facility. No storage limits were exceeded at any NNSS SAAs or HWAAs. Quarterly 2011 hazardous waste volume reports were submitted on time to NDEP.

10.2.3 EODU

Conventional explosive wastes are generated at the NNSS from explosive operations at construction and experiment sites, the NNSS 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 2011, 34.66 tons of waste explosive ordnance were detonated at the EODU (Table 10-5). No more than 100 pounds at a time were detonated, and no more than one detonation event per hour occurred.

Table 10-5. Hazardous waste managed at the NNSS in 2011

Permitted Unit	Total Waste Managed (tons)
Cell 18	1,001
MWSU	74
HWSU	4.49
HWSU – PCB Waste	6.06
SAAs and HWAAs	0[(a)]
EODU	34.66

(a) Tons shipped directly off site from SAAs and/or HWAAs.

10.3 Underground Storage Tank (UST) Management

RCRA regulates the storage, transportation, treatment, and disposal of hazardous wastes to prevent contaminants from leaching into the environment from USTs. Nevada Administrative Code NAC 459.9921–459.999, "Storage Tanks," enforces the federal regulations under RCRA pertaining to the maintenance and operation of underground storage tanks and the regulated substances contained in them so as to prevent environmental contamination.

NNSA/NSO operates one deferred UST and three excluded USTs at the Device Assembly Facility; one fully regulated UST at the Area 6 Helicopter pad, which is not in service; and three fully regulated USTs, one deferred UST, and three excluded USTs at the Remote Sensing Laboratory–Nellis (RSL-Nellis). The Southern Nevada Health District (SNHD) has been given oversight authority of USTs in Clark County by NDEP. In 2011, SNHD inspected the fully regulated and deferred USTs at RSL-Nellis. No deficiencies were noted. No USTs were upgraded or removed in 2011.

10.4 Solid and Sanitary Waste Management

10.4.1 Landfills

The NNSS has three landfills for solid waste disposal that were operated in 2011. The landfills are regulated and permitted by the State of Nevada (see Table 2-13 for list of permits). No liquids, HW, 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 and asbestos waste under certain circumstances.
- 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 2011 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 10-6. An average of 1.95 tons/day was disposed at the Area 23 landfill, well within permit limits. State inspections of the three permitted landfills were conducted in 2011 and no non-compliance issues were noted.

Table 10-6. Quantity of solid wastes disposed in NNSS landfills in 2011

Metric Tons (Tons) of Waste		
Area 6 Hydrocarbon Disposal Site	**Area 9 U10c Solid Waste Disposal Site**	**Area 23 Solid Waste Disposal Site**
109 (120)	2,595 (2,860)	353 (389)

10.4.2 Sewage Lagoons

The NNSS also has two state-permitted sewage lagoons that were operated in 2011. 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.

11.0 Environmental Restoration

The Environmental Restoration Activity is charged with evaluating and implementing corrective actions on portions of the Nevada National Security Site (NNSS), the Nevada Test and Training Range (NTTR), and the Tonopah Test Range (TTR) that have been impacted by atmospheric and underground nuclear tests conducted from 1951 to 1992. The activity is the responsibility of the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) Environmental Management (EM) Operations Activity. Cleanup strategies and corrective actions are developed based on the nature and extent of contamination and the risks posed by that contamination. In all, the activity is responsible for approximately 3,000 corrective action sites (CASs) in Nevada. The CASs may be contaminated with radioactive and/or nonradioactive wastes. For efficiency in managing the corrective actions, multiple CASs are grouped into corrective action units (CAUs) according to location, physical and geological characteristics, and/or contaminants.

In April 1996, the U.S. Department of Energy (DOE), the U.S. Department of Defense, and the State of Nevada entered into a Federal Facility Agreement and Consent Order (FFACO) to address the environmental restoration of CASs at the NNSS, parts of the TTR, parts of the NTTR, the Central Nevada Test Area, and the Project Shoal Area. Appendix VI of the FFACO (as amended), describes the strategy that will be employed to plan, implement, and complete environmental corrective actions.

Environmental restoration activities follow a formal work process, which is described in the FFACO. The State of Nevada is a participant throughout the closure process, and the Nevada Site Specific Advisory Board (NSSAB) is kept informed of the progress made. The NSSAB is a formal volunteer group of interested citizens and representatives who provide informed recommendations to NNSA/NSO's EM Program. The NSSAB's comments are strongly considered throughout the corrective action process.

Environmental Restoration Goals
Characterize and remediate sites contaminated by NNSA/NSO nuclear testing activities. Remediate sites in accordance with FFACO-approved planning documents. Conduct post-closure monitoring of sites in accordance with FFACO site closure documents.

CASs are broadly organized into four categories based on the source of contamination: Industrial Sites, Soils Sites, Underground Test Area (UGTA) Sites, and Nevada Off-Sites. Nevada Off-Sites are CASs associated with underground nuclear testing at the Project Shoal Area and the Central Nevada Test Area, located in northern and central Nevada, respectively. These offsite CASs are managed by the DOE Office of Legacy Management. The other three categories of CASs are managed under the NNSA/NSO Industrial Sites Activity, the Soils Activity, and the UGTA Activity, respectively. Figures 11-1 and 11-2 show the locations of the CASs managed by NNSA/NSO.

In 2011, Navarro-Intera, LLC, conducted site characterization and site closure activities at CASs, while the NNSS Management and Operating contractor, National Security Technologies, LLC, conducted site restoration, soil remediation, site closures, and some facility decontamination and decommissioning activities. This section summarizes Environmental Restoration Activities conducted in 2011.

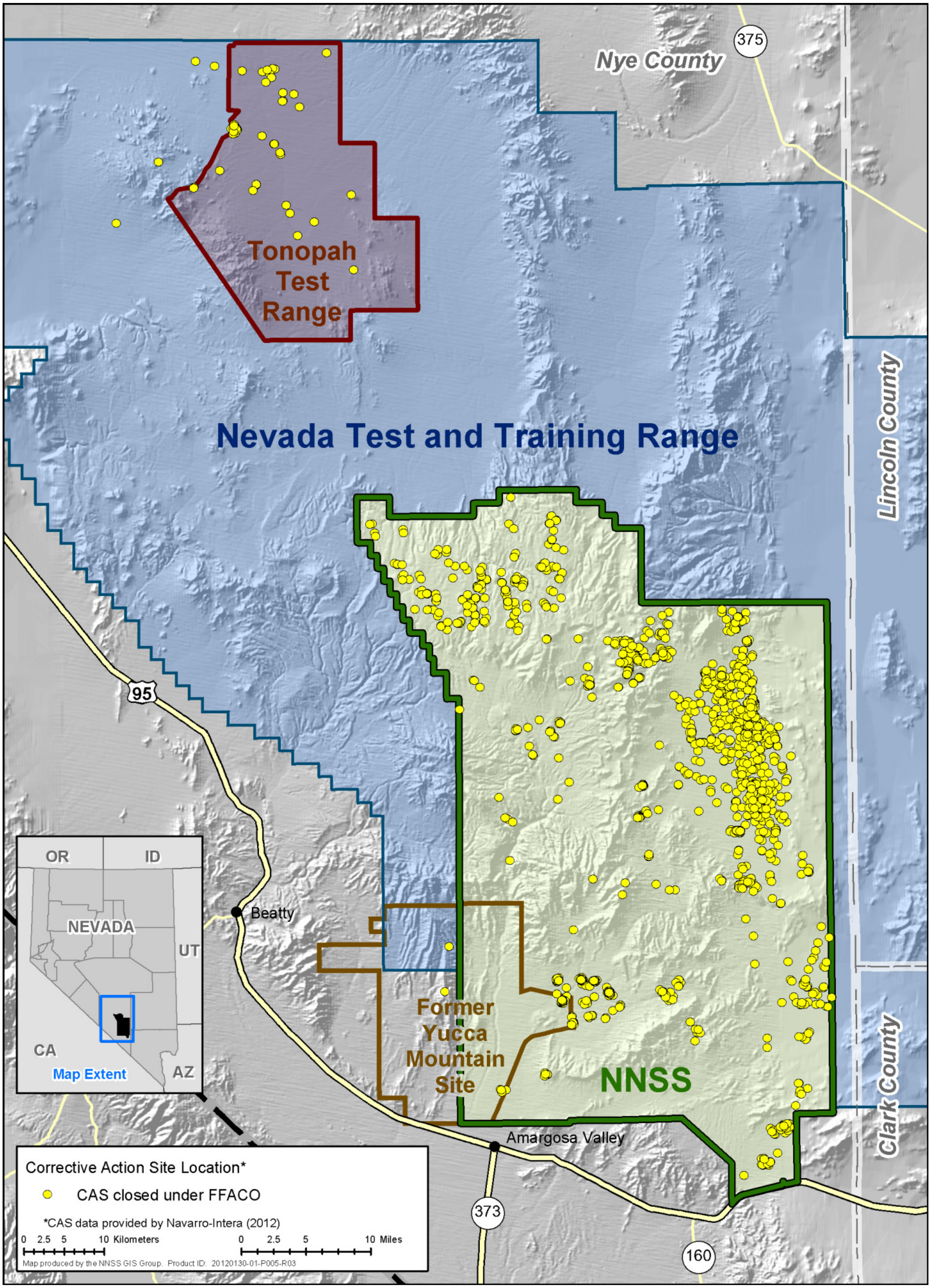

Figure 11-1. Location of CASs managed by NNSA/NSO that are closed

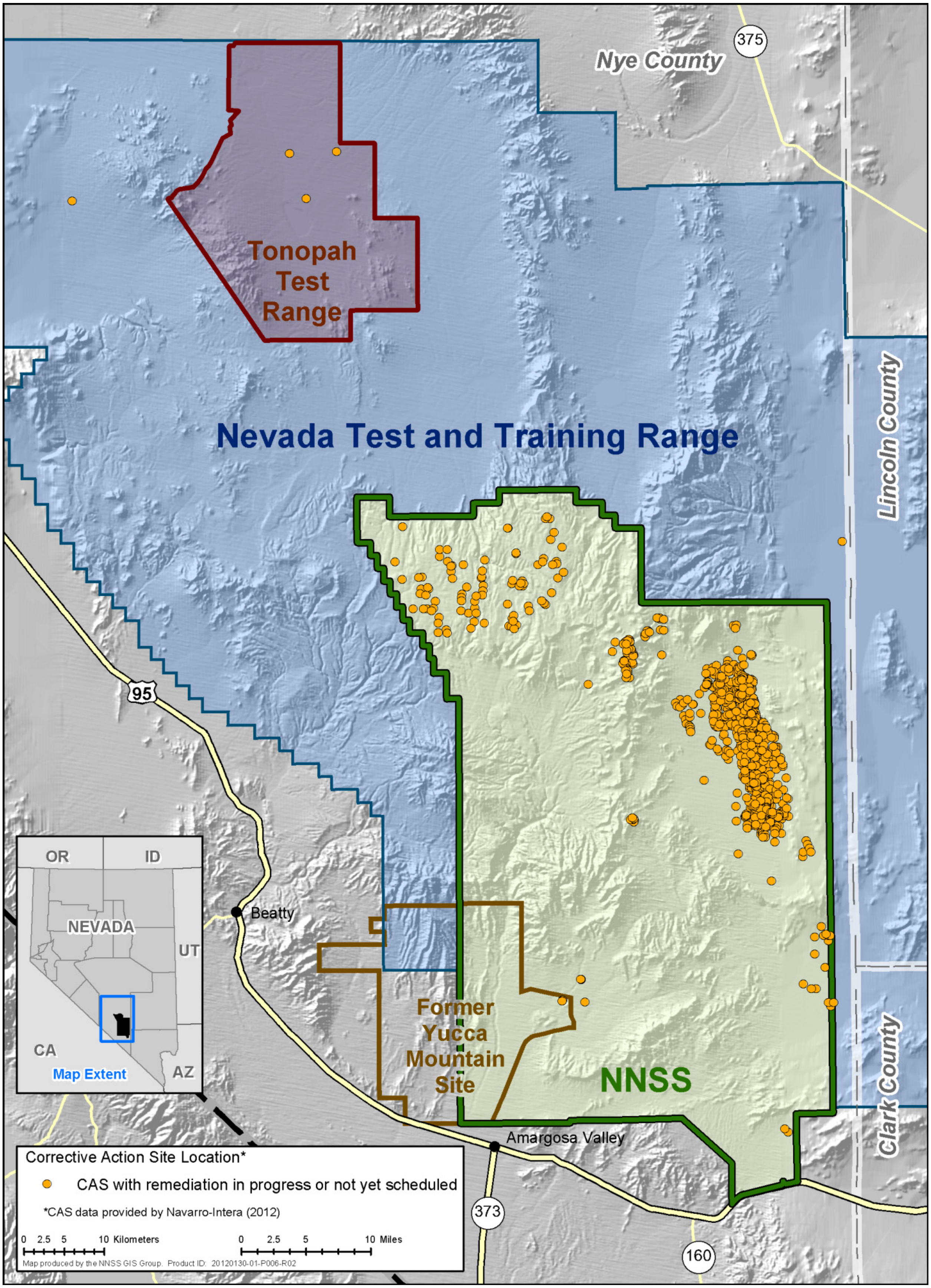

Figure 11-2. Location of CASs managed by NNSA/NSO that are not closed

11.1 Industrial Sites Activity

Industrial Sites are facilities and land that may have become contaminated as a result of activities conducted in support of nuclear testing, and include disposal wells, inactive tanks, contaminated waste sites, inactive ponds, muck piles, spill sites, drains and sumps, and ordnance sites. In total, 1,858 Industrial Sites have been identified for which NNSA is responsible. All but 45 sites have been formally closed. Closure approaches may entail the removal and disposal of debris, complete excavation of the site, decontamination and decommissioning activities, closure in place (see footnote b of Table 11-1), no further action, and subsequent monitoring. Radioactive wastes generated at Industrial Sites are disposed at the Area 5 Radioactive Waste Management Site (see Section 10.1). Hazardous wastes generated at the CASs are either direct-shipped to approved disposal facilities or are temporarily stored at the NNSS prior to shipment off site (see Section 10.2). Beyond remediation, the ultimate goal of the Industrial Sites Activity within Environmental Restoration is to ensure that any necessary long-term surveillance and maintenance programs are in place to protect the safety of the public and the environment. The Industrial Sites Activity is scheduled to be completed in 2013, with two exceptions: closing CAU 114, the Area 25 Engine Maintenance, Assembly, and Disassembly (EMAD) Facility, and CAU 572, the Test Cell C Ancillary Buildings and Structures, which will be completed prior to the end of the NNSS Environmental Restoration Program, which is currently planned for completion in 2027. In 2011, 35 Industrial Sites CASs were closed (Table 11-1), and 38 CASs were investigated and/or remediated as progress towards closure (Table 11-2).

Table 11-1. Industrial Sites closed in 2011

CAU	CAU Description	Number of CASs	Corrective Actions	Wastes Generated
116	Area 25 Test Cell C Facility	2	Clean closure[(a)] and closure in place[(b)] with use restrictions	LLW, hydrocarbon, HW, MLLW, asbestiform[(c)], asbestiform-LLW, asbestiform-MLLW, LLW-PCB[(d)]
539	Areas 25 and 26 Railroad Tracks	2	Clean closure and closure in place with use restrictions	LLW, MLLW
544	Cellars, Mud Pits, and Oil Spills	20	Closure in place with use restrictions and no further action	Sanitary
561	Waste Disposal Areas	10	Closure in place with use restrictions, clean closure, and no further action	Sanitary, LLW
566	EMAD Compound	1	Closure in place with use restrictions	LLW, sanitary, HW, hydrocarbon, MLLW, asbestiform-LLW, PCB

(a) Clean closure is the removal of pollutants, hazardous wastes, and solid wastes at a CAS in accordance with corrective action plans.
(b) Closure in place is the stabilization or isolation of pollutants, hazardous wastes, and solid wastes, with or without partial treatment, removal activities, and/or post-closure monitoring, in accordance with corrective action plans.
(c) Waste with asbestos-containing material
(d) Low-level waste containing polychlorinated biphenyls

Table 11-2. Other Industrial Sites where work was conducted in 2011

CAU	CAU Description	Number of CASs	Activity	Wastes Generated
114	Area 25 EMAD Facility	1	Removal of chiller water system residue	Sanitary
117	Area 26 Pluto Disassembly Facility	1	Installation of concrete at previous location of building	LLW, hydrocarbon, HW, asbestiform, MLLW, PCB
547	Miscellaneous Contaminated Waste Sites	3	Investigation of internally radioactively contaminated piping, and commencement of closure in place with use restrictions	LLW
548	Areas 9, 10, 18, 19, 20 Housekeeping Sites	20	Collection of characterization samples to prepare for disposal of housekeeping debris/waste and commencement of clean closure	Sanitary
562	Waste Systems	13	Investigation of contaminated waste sites and commencement of clean closure	Sanitary

11.1.1 Post-Closure Monitoring and Inspections

Eight of nine historical waste management units on the NNSS identified for closure under the *Resource Conservation and Recovery Act* (RCRA) (see Section 2.5) have been closed (Table 11-3). The ninth site is scheduled to close in 2012. The RCRA Part B Permit for the NNSS prescribes quarterly or semi-annual post-closure monitoring for five of these sites. CAU 110, the Area 3 U-3ax/bl Subsidence Crater, also requires vadose zone monitoring (VZM) of the crater's engineered cover cap. The 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 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. In 2011, VZM results for CAU 110 indicated that surface water is not migrating into buried wastes and that the cover is functioning as designed. One report for all RCRA closure sites monitored in fiscal year (FY) 2011 (October 1–September 30) was prepared and submitted to the Nevada Division of Environmental Protection (NDEP) in January 2012.

Table 11-3. Historical RCRA closure sites and those inspected or monitored in 2011

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[a] of cover
112	Area 23 Hazardous Waste Trenches	Quarterly site inspection

(a) Vadose zone monitoring of the engineered cover cap

Post-closure inspections are also required for many of the closed remediation sites managed under the FFACO. In 2011, physical inspections were conducted at 54 closed CAUs managed under the FFACO. Several CAUs that do not require inspections were inspected as a best management practice to ensure that the signs are intact. A combined 2011 annual monitoring report for non-RCRA closure sites on the NNSS was prepared and submitted to NDEP in May 2012. A combined 2011 annual monitoring report for sites on the TTR was prepared and submitted to NDEP in March 2012.

11.2 Soils Activity

Soil Sites are CASs where nuclear tests have resulted in extensive surface and/or shallow subsurface contamination. Environmental Restoration's Soils Activity is responsible for characterizing, managing, and where necessary, cleaning up surface and shallow subsurface soils. The soils may contain contaminants including radioactive materials, oils, solvents, heavy metals, as well as contaminated instruments and test structures used during testing activities. Corrective actions range from removal of soil to closure in place with restricted access controls. There are 131 Soils Activity CASs for which NNSA/NSO is responsible and for which historical research and the preparation of short summary reports of research findings have been completed. In 2011, 21 sites on the NNSS were closed (Table 11-4). The TTR and NTTR sites require negotiation with the State of Nevada and the U.S. Department of Defense. The anticipated date for the Soils Activity closure is 2022, and 90 Soil Activity CASs remain to be closed. Table 11-5 shows the Soil Sites at which some work was performed in 2011.

Table 11-4. Soils Sites closed in 2011

CAU	CAU Description	Number of CASs	Corrective Actions	Wastes Generated
106	Areas 5 and 11 Frenchman Flat Atmospheric Sites	4	Clean closure and no further action	LLW
365	Baneberry Contamination Area	1	Closure in place with use restrictions	LLW, Sanitary
367	Area 10 Sedan, Es, and Uncle Unit Craters	4	Closure in place with use restrictions and no further action	LLW, Sanitary
372	Area 20 Cabriolet/Palanquin Craters	4	Closure in place with use restrictions	LLW, Sanitary
374	Area 20 Schooner Unit Crater	5	Closure in place with use restrictions and no further action	LLW, Sanitary
375	Area 30 Buggy Unit Craters	3	Closure in place with use restrictions and no further action	LLW, Sanitary

Table 11-5. Other Soils Sites where work was conducted in 2011

CAU	CAU Description	Number of CASs	Activity	Wastes Generated
104	Area 7 Yucca Flat Atmospheric Test Site	15	Investigate nature and extent of contamination	Sanitary
105	Area 2 Yucca Flat Atmospheric Test Sites	5	Preliminary investigations	Sanitary
366	Area 11 Plutonium Valley Dispersion Sites	6	Investigate nature and extent of contamination	LLW, Sanitary
465	Hydronuclear	4	Investigate nature and extent of contamination	Sanitary
550	Smoky Contamination Area	19	Preliminary investigations	LLW, Sanitary
569	Area 3 Yucca Flat Atmospheric Test Sites	9	Preliminary investigations	Sanitary
574	Neptune	2	Investigate nature and extent of contamination	Sanitary

Although not required under the FFACO, NNSA/NSO monitors airborne radiological contaminants on the NNSS and the Tonopah Test Range (TTR) at Soils Activity CAUs. On the NNSS, non-regulatory air monitoring stations at the Area 11 Plutonium Valley Dispersion Sites (CAU 366) were established in 2011. Their purpose is to collect data and develop an understanding of meteorological conditions, aeolian dust concentration, and runoff and radionuclide-contaminated soil transport by water in Plutonium Valley. All of these elements are important for evaluating environmental and worker health risks that may be posed by the CAU under current conditions as well as how, and if, contaminant migration could contribute to changes in the closure boundary if closure-in-place is selected for the site. The collection of air monitoring data for CAU 366 began at the end of 2011, and findings will be summarized annually in this environmental report, beginning in the 2012 report.

On the TTR, the primary purpose is to determine if there is wind transport of man-made radionuclides from contaminated soil locations associated with the Project Roller Coaster Soil CAUs, Clean Slate 1, 2, and 3. In 2008, NNSA/NSO established air monitoring stations at Clean Slate 3 and the Range Operations Center, and in 2011, a third air monitoring station was installed at Clean Slate 1. These monitoring efforts are reported by Sandia National Laboratories (SNL) in the TTR annual environmental report (SNL, 2012).

11.3 UGTA Activity

There are 878 UGTA CASs that compose 5 CAUs, all located where underground nuclear tests have resulted or might result in local or regional impacts to groundwater resources. The CASs are sites of underground nuclear tests. The CAUs and the activities conducted by the UGTA Activity in 2011 are discussed in Chapter 12.

11.4 Restoration Progress under FFACO

In 2011, 56 CASs were closed and all 2011 FFACO milestones were met. Figure 11-3 depicts the progress made since 1996 in the remediation of historically contaminated sites. The majority of the remaining CASs are UGTA CASs, for which closure in place with monitoring in perpetuity is the corrective action (see Chapter 12).

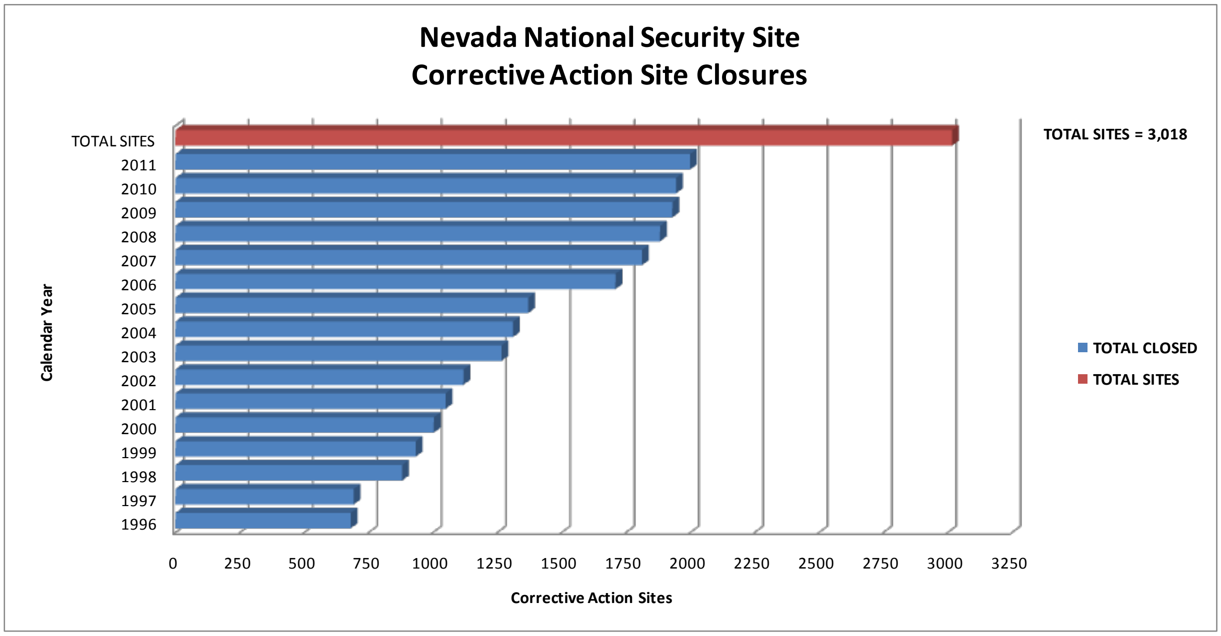

Figure 11-3. Annual cumulative totals of NNSA/NSO CAS closures

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12.0 Groundwater Characterization and Hydrogeological Modeling

From 1951 to 1992, more than 800 underground nuclear tests were conducted at the Nevada National Security Site (NNSS) (U.S. Department of Energy, Nevada Operations Office [DOE/NV], 2000). Most were conducted hundreds of feet above groundwater; however, over 200 were within or near the water table. The Underground Test Area (UGTA) Activity (formerly known as the UGTA Sub-Project) has identified areas where radionuclides have been detected in the groundwater. These areas have been organized into five UGTA corrective action units (CAUs), which are directly related to the geographical and hydrologic areas of past NNSS underground testing (Figure 12-1). The UGTA Activity gathers data to characterize the groundwater aquifers beneath the NNSS and adjacent lands for the purpose of developing models for predicting groundwater movement and the transport of radionuclides from these CAUs.

UGTA CAUs are included in the Federal Facility Agreement and Consent Order (FFACO, as amended (see Chapter 2, Section 2.5.1), which addresses the environmental restoration of historical sites impacted by U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) activities. Groundwater flow and contaminant transport models for each UGTA CAU are being developed that include a contaminant boundary forecast. Then, through an iterative process, a regulatory boundary objective statement, a regulatory boundary, and a use-restriction boundary for the individual CAUs will be defined, as required under the FFACO. Monitoring well networks will be designed consistent with FFACO requirements, installed, and used for monitoring the individual CAUs (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. The UGTA Activity is the largest component of NNSA/NSO's Environmental Management Operations and is expected to be completed in FY 2030.

The 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-Intera, LLC (N-I).

UGTA Activity Goals	***Properties/Analytes Sampled***
Drill deep wells to access groundwater and conduct hydrologic tests. Sample groundwater to test for the presence of man-made radionuclides. Assess NNSS hydrology and subsurface geology to determine possible groundwater flow rates and direction. Develop a regional three-dimensional computer groundwater model to identify any immediate risks and to provide a basis for developing more detailed CAU-specific models. Develop CAU-specific models of groundwater flow and contaminant transport that geographically cover the five former NNSS underground nuclear testing areas. Identify contaminant boundaries (which support regulatory decision-making processes) where contaminants exceed the Safe Drinking Water Act (SDWA) limits or are likely to exceed those limits at any time within a 1,000-year compliance period. Negotiate regulatory boundaries to protect the public and the environment from the effects of migration of radioactive contaminants. Negotiate use-restriction boundaries to restrict access to contaminated groundwater. Develop a long-term closure monitoring network to verify consistency with the flow and transport models, compliance to the regulatory boundary, and protection of human health and the environment.	Depth to groundwater, formation porosity and hydraulic conductivity; groundwater flow rates at wells >60 water chemistry parameters for characterization of well samples >35 man-made and natural radionuclides for characterization of groundwater samples (i.e., source-term analyses) Tritium and lead for characterization of well drilling discharge fluids 8 metals, conductivity, pH, gross alpha, gross beta, and tritium for characterization of drilling sump fluids

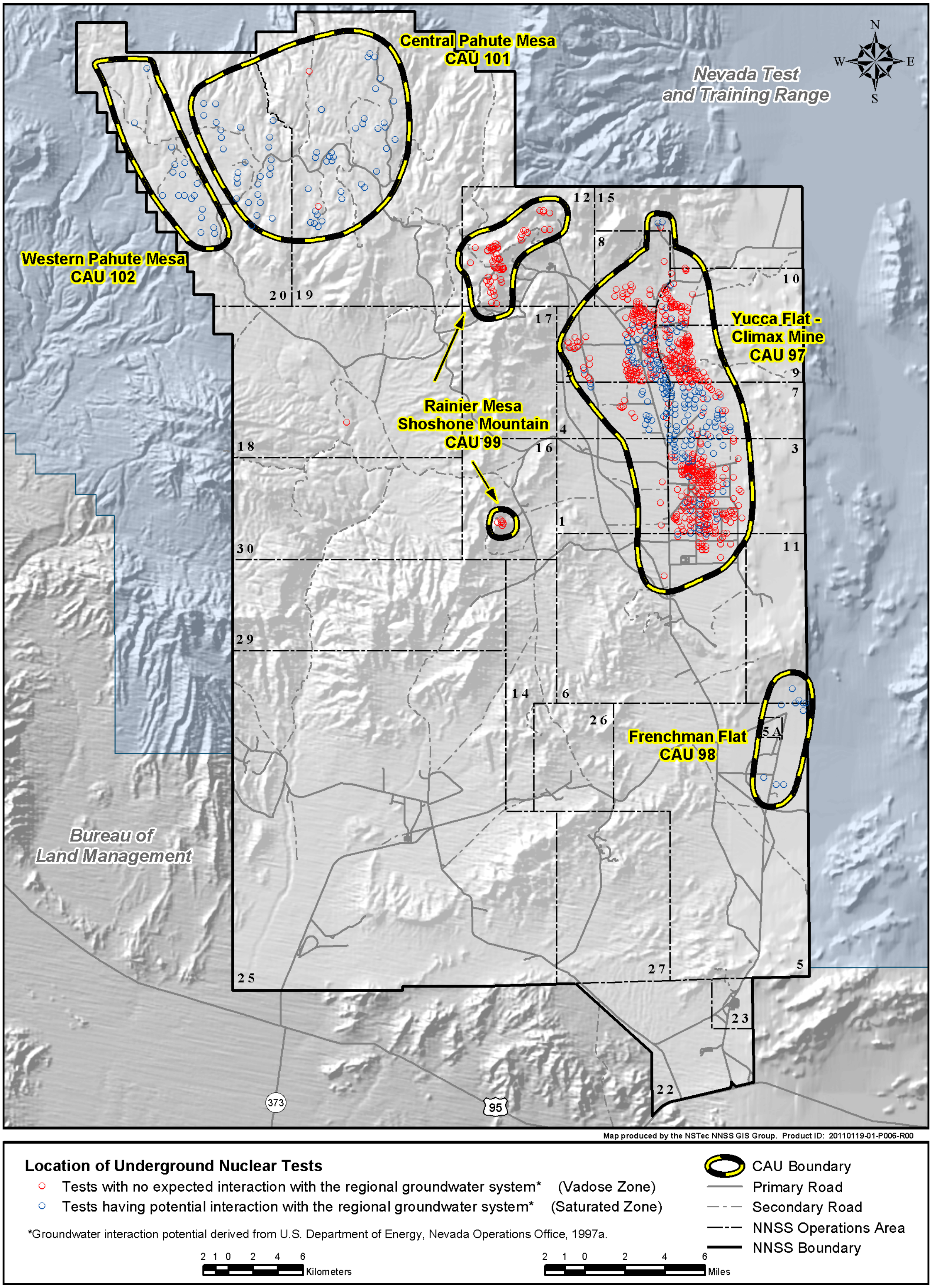

Figure 12-1. UGTA Activity CAUs on the NNSS

12.1 UGTA Model Areas and UGTA Wells

The UGTA Activity gathers information regarding the hydrology and geology of each CAU. Hydrogeologic studies use data from past testing, data obtained from drilling and testing newly constructed deep wells, and data from recompleting or rehabilitating existing wells. Data from these studies are used to produce hydrogeologic models for specific UGTA model areas that will be used to predict groundwater flow and contaminant transport. A regional three-dimensional computer groundwater model was developed (International Technology Corporation [IT], 1996; Belcher et al., 2010) to provide a basis for developing more detailed groundwater flow models for each UGTA model area. The regional groundwater subbasins and general flow directions based on the regional model and CAU models developed to date are shown in Figure 12-2. Figure 12-3 shows the UGTA model areas, and Figure 12-4 shows the new and historical wells that are managed under the UGTA Activity. UGTA wells that are not designated as source term characterization wells are made available for routine radiological monitoring (see Chapter 5).

12.2 Subsurface Investigations

Most subsurface investigations conducted by the UGTA Activity include the construction of wells that are designed to provide the maximum amount of hydrogeologic information to support the refinement of existing hydrostratigraphic framework models and to support 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 NNSS. Also of interest is determining the hydraulic properties of the volcanic aquifers in the model areas and along potential flow paths downgradient. Some wells may also be used as long-term monitoring wells.

The UGTA Activity initiated a Phase II hydrogeologic investigation for the Pahute Mesa–Oasis Valley Model Area (Figure 12-3) in 2009. The investigation is part of the Corrective Action Investigation Plan (CAIP) for the Central and Western Pahute Mesa CAUs, 101 and 102, respectively (NNSA/NSO, 2009), and is described in Section 12.3.2. No drilling has been conducted in Frenchman Flat, Yucca Flat, or Rainier Mesa in recent years. A description of the physiography, overall geology, structural setting, and hydrogeology of all of the UGTA CAUs is found in Section A.2.5 of *Attachment A: Site Description*, which is included on the compact disc of this report.

12.2.1 Well Drilling

In 2011, no new wells were drilled. Well construction data for the four Pahute Mesa Phase II wells completed in 2010 (Wells ER-20-4, ER-EC-12, ER-EC-13, and ER-EC-15) were published in individual well completion reports in 2011. Two new Pahute Mesa Phase II UGTA wells will be drilled in 2012 (ER-20-11 and ER-EC-14), and the well drilling and completion document (SNJV, 2009a) was amended in 2011 to include them (N-I, 2011a). Two new Frenchman Flat Model Evaluation wells will also be drilled in 2012 (ER-5-5 and ER-11-2).

12.2.2 Groundwater Sampling

In 2011, the UGTA Activity pumped and collected groundwater samples from one tunnel vent hole on Rainier Mesa (U12n Vent Hole #2) and five UGTA characterization wells that included four on Pahute Mesa (ER-20-4, ER-20-5 #1, ER-20-5 #3, ER-20-8) and one just south of Pahute Mesa (ER-EC-12) (Figure 12-5). Well PM-3, a monitoring well sampled under the *Routine Radiological Environmental Monitoring Plan* (RREMP) (Bechtel Nevada [BN], 2003a), was also sampled under the UGTA Activity in 2011 to verify the very low tritium levels detected in this well in 2010 and 2011 (see Section 5.1.5). Wells ER-EC-12 and PM-3 are located on the Nevada Test and Training Range (NTTR) within 3.2 kilometers (km) (2 miles [mi]) of the NNSS boundary.

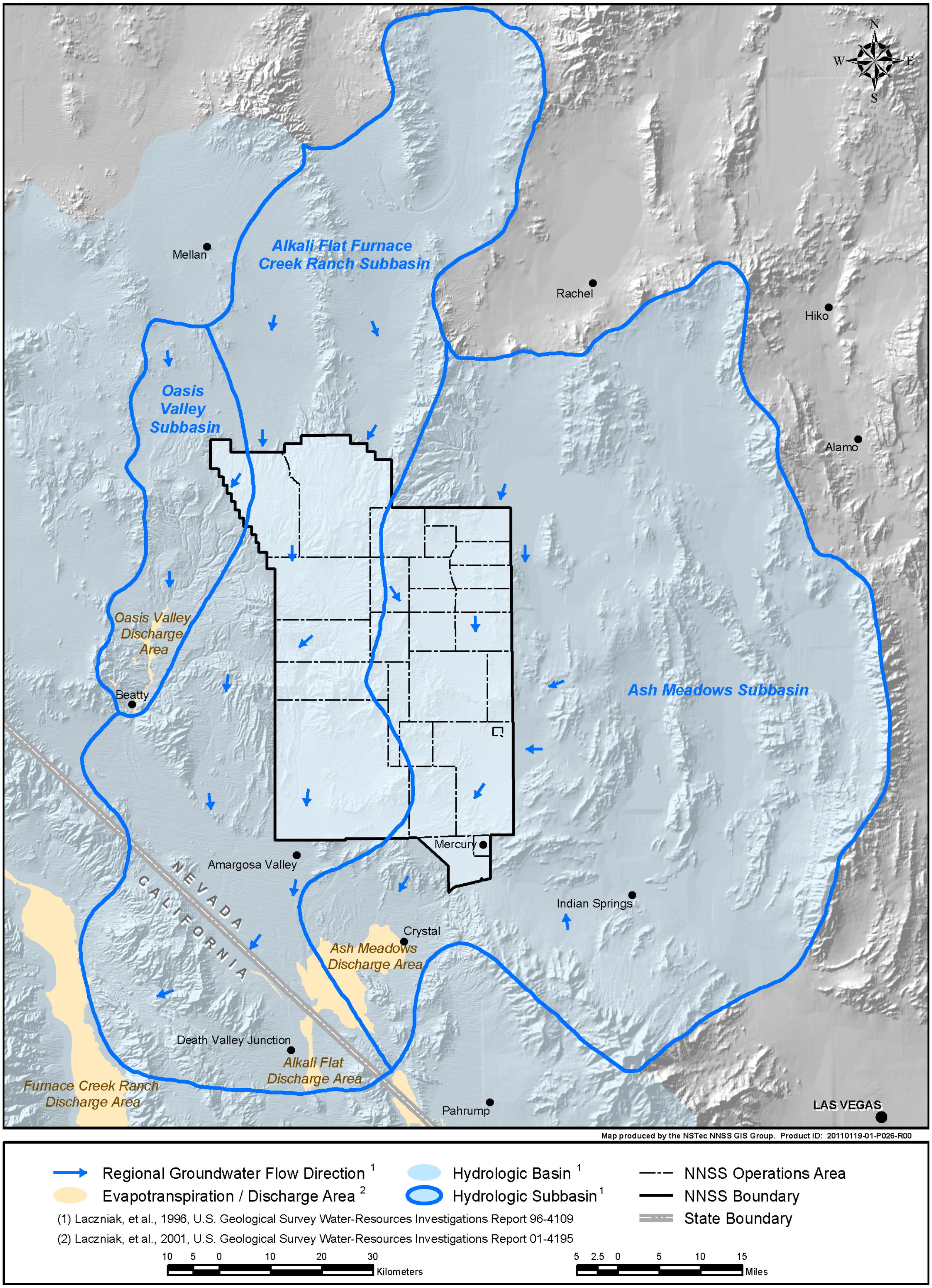

Figure 12-2. Groundwater subbasins of the NNSS and vicinity

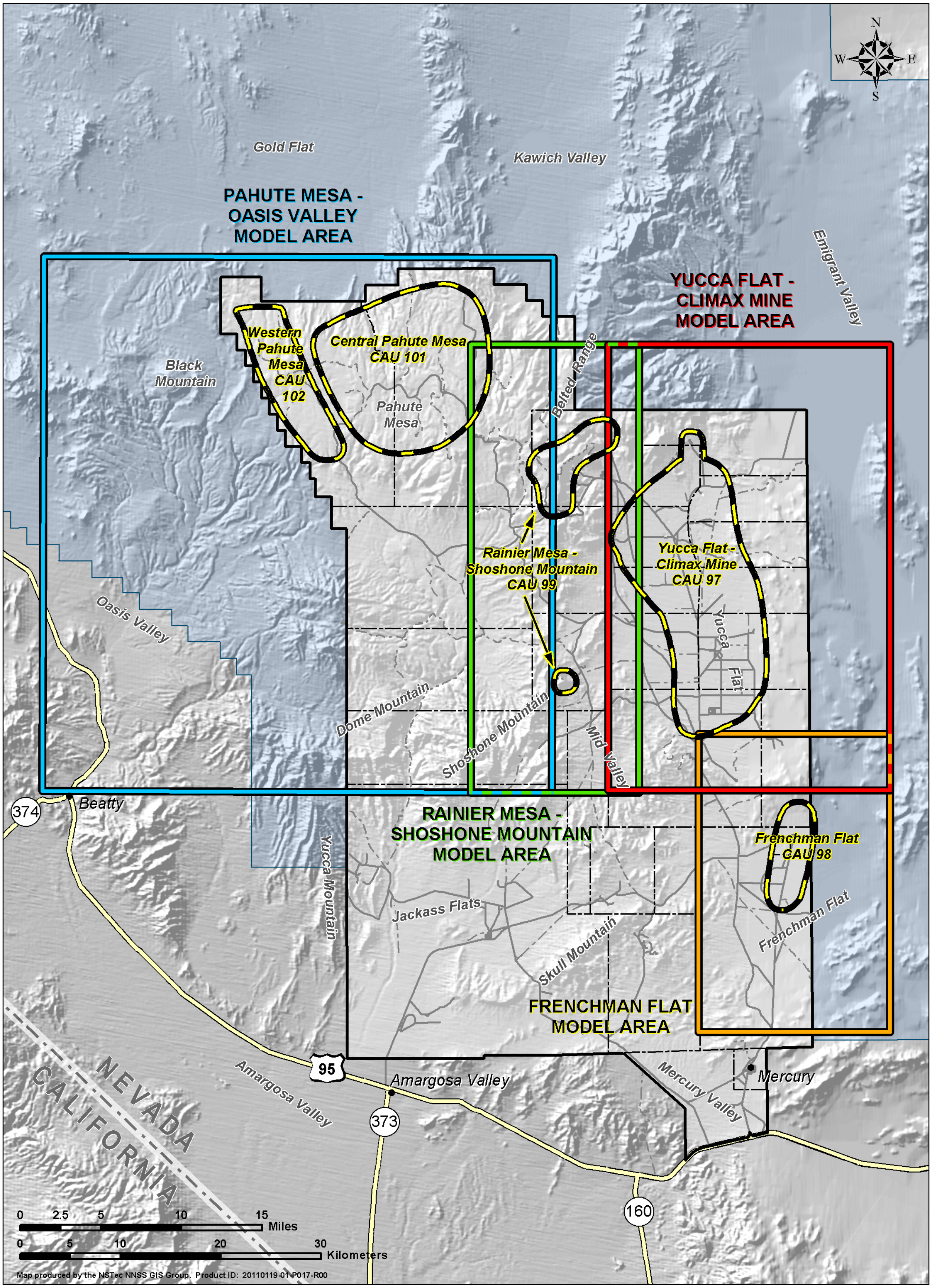

Figure 12-3. Location of UGTA model areas

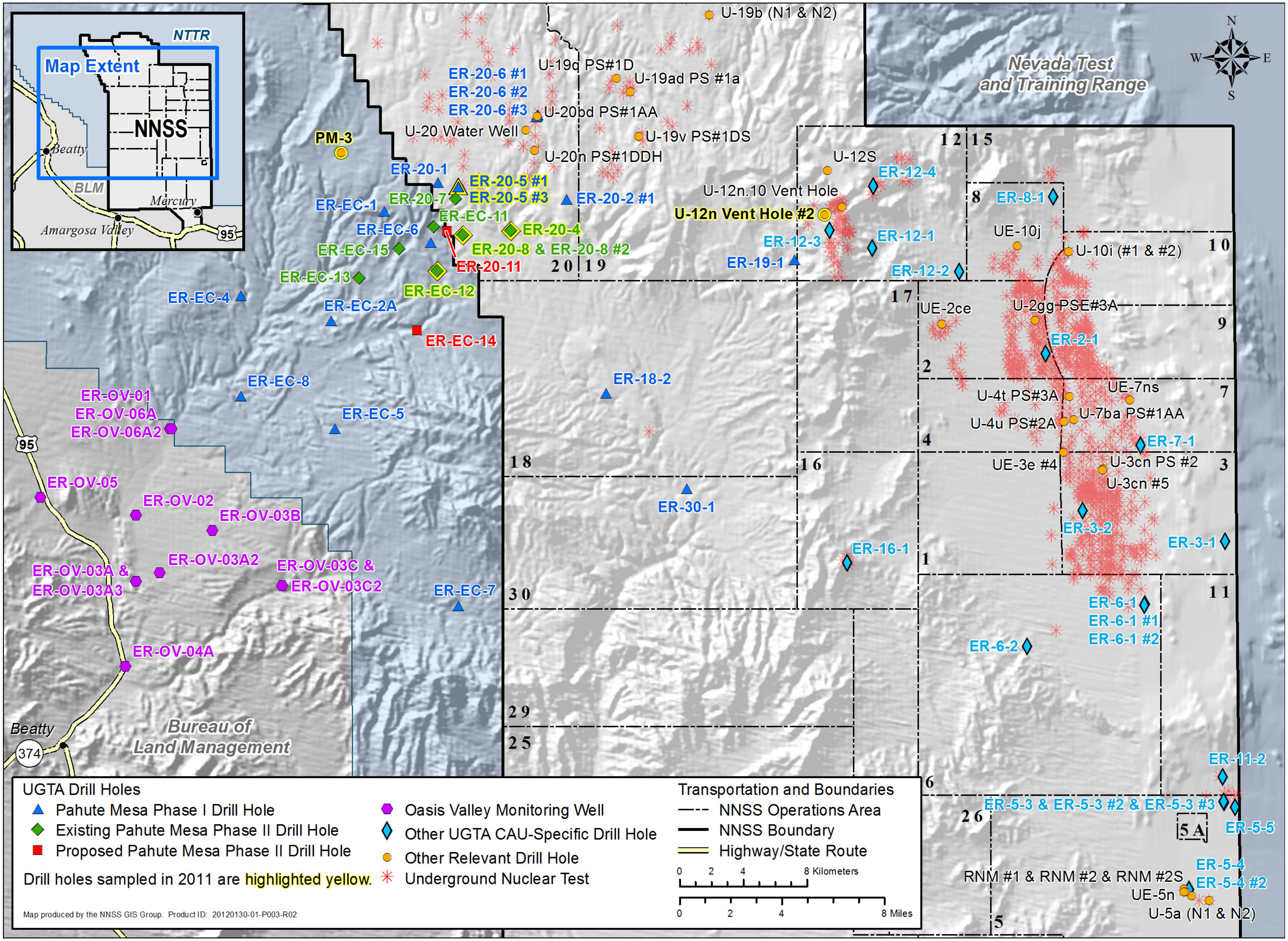

Figure 12-4. Existing and proposed UGTA Activity managed drill wells

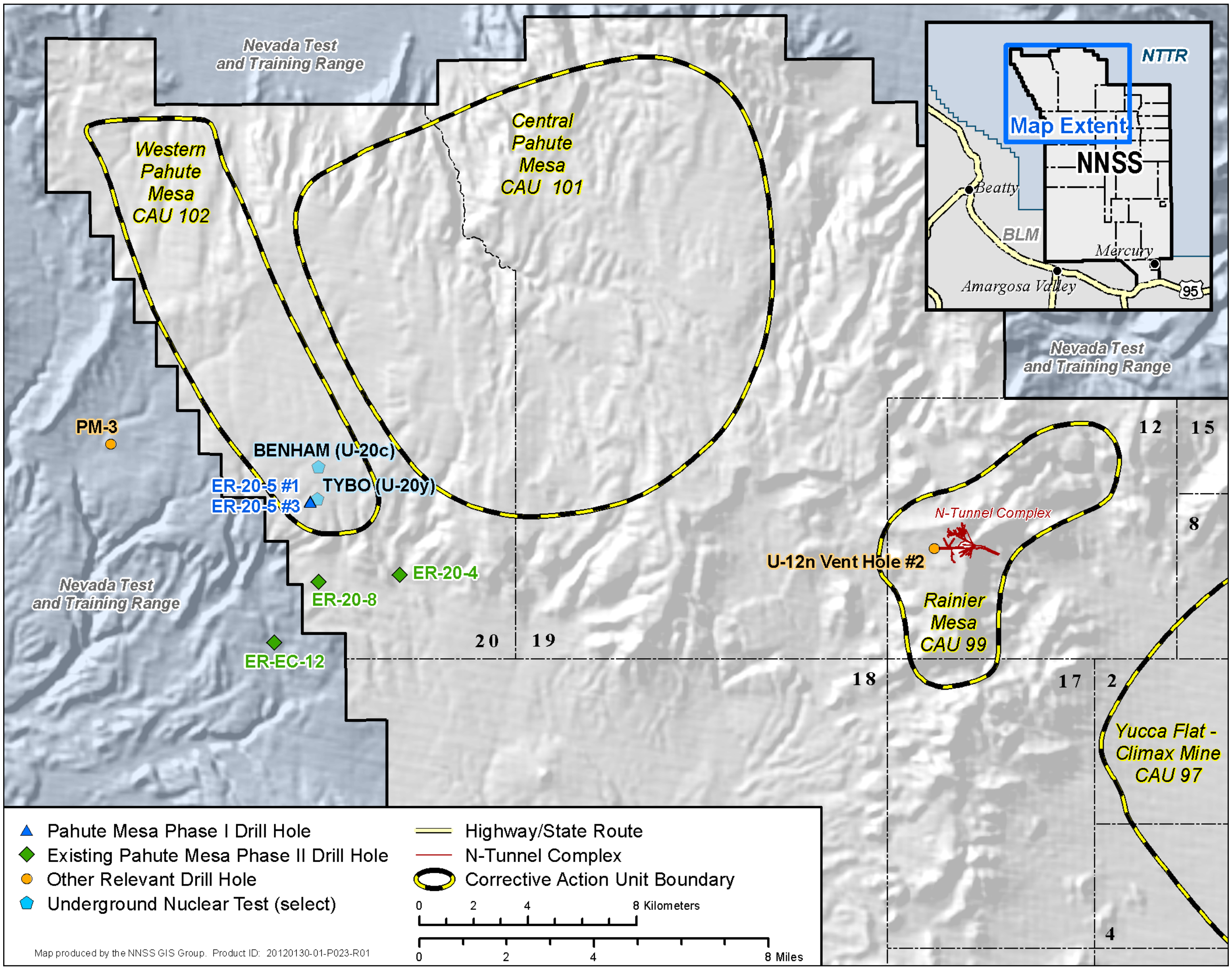

Figure 12-5. UGTA water sample locations in 2011

Wells ER-20-4, ER-20-5 #1, ER-20-5 #3, ER-20-8, and ER-EC-12 were purged using downhole electric submersible pumps prior to the collection of samples to ensure that the samples represent the unaltered groundwater condition. A multi-agency team collected the groundwater samples and analyzed them for water chemistry parameters and radionuclides. Samples were analyzed by LANL and LLNL and by a certified commercial laboratory. Samples from Wells ER-EC-12 and PM-3 were enriched to provide low minimum detectable concentrations (MDCs) (<10 picocuries per liter [pCi/L]) and, in the case of PM-3, to enable comparison of analysis results with those for this well under the RREMP. For the other UGTA characterization wells, standard (non-enriched) tritium analyses were performed, and the MDCs were 290 to 350 pCi/L, except for samples with high activity. All groundwater data are maintained in the UGTA Activity geochemical database. Tritium analysis results are shown in Table 12-1.

The tritium concentrations detected at Wells ER-20-5 #1 and #3 are associated with a known contaminant plume from nearby underground nuclear tests (DOE/NV, 1997b). This contaminant plume was subsequently encountered farther south at Well ER-20-7 (NNSA/NSO, 2010b). The plume may originate from the upgradient underground tests BENHAM (U-20c) and TYBO (U-20y) (Figure 12-5). It is likely that the low levels of tritium detected in Well ER-20-8 in 2011 indicate that Well ER-20-8 is near the leading edge of this same plume.

Table 12-1. Tritium results from UGTA groundwater characterization sources in 2011

UGTA Well, Location	Sample Depth (ft bgs)	Date Sampled	Concentration ± Uncertainty[a] (pCi/L) Tritium		
ER-20-4, Area 20	2,750	9/4	<290		
	2,750	9/4 FD[b]	<290		
ER-20-5 #1, Area 20	2,301–2,573	4/26	30,100,000	±	300,000
ER-20-5 #3, Area 20	3,430–3,882	4/26 FD	96,233	±	1,000
ER-20-8, Area 20	2,800	5/26	2,110	±	400
	2,800	5/26 FD	2,070	±	400
	2,800	6/27 FD	2,650	±	490
	2,800	6/27	2,813	±	490
	3,170	7/22	<320		
	3,170	8/8	<350		
PM-3, NTTR	1,560	7/22	36.7	±	11.1
	1,560	7/22 FD	56.7	±	17
	1,983	7/22	18.6	±	5.87
	1,983	7/22 FD	33.2	±	10.1
ER-EC-12, NTTR	1,931–2,681	11/10	<2		
U-12n Vent Hole #2, Area 12	1,219	10/5	1,030,000	±	10,400

Mean MDC varies per analysis (e.g., 2 pCi/L at ER-EC-12 to 7,547 pCi/L at U-12n Vent Hole #2)
(a) ± 2 standard deviations
(b) FD = Field duplicate sample

While the presence of tritium at PM-3 is being investigated (see Section 12.3.2), the absence of tritium at Wells ER-20-4 and ER-EC-12 is consistent with flow and transport models for Pahute Mesa. See Section 12.3.2 for further discussion of wells within the Pahute Mesa–Oasis Valley Model Area and their sampling results.

The U-12n Vent Hole #2, sampled in 2011, was an air vent for a drift within the N-Tunnel Complex of Rainier Mesa in Area 12. Several historical nuclear tests were conducted in the N-Tunnel Complex, resulting in the radiological contamination of perched groundwater within the rock strata of the complex. To prevent the discharge of contaminated groundwater from the tunnel, watertight bulkheads were installed in 1994 about 600 meters (m) (1,968.5 feet [ft]) in from the two N-Tunnel portals. The bulkheads have prevented groundwater discharge and have resulted in the flooding of the N-Tunnel complex (Russell et al., 2003). The UGTA Activity samples N-Tunnel vent holes to characterize the radiological contamination within the flooded tunnel complex. The high tritium concentration of the 2011 water sample from U-12n Vent Hole #2 (see Table 5-7) is reflective of this vent hole's close proximity to historical nuclear test locations within the N-Tunnel complex. The tritium level is about double the values obtained from water samples from sampling ports in the near-portal bulkheads.

12.2.3 Drilling Fluid and Well Sump Sampling

Discharge fluids of UGTA characterization wells being drilled are routinely sampled for tritium and lead. Fluids having ≥400,000 picocuries per liter (pCi/L) of tritium (≥20 times the Nevada Drinking Water Standards) are diverted to 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, 2002a). Discharge fluids having ≥3 milligrams per liter (mg/L) of lead (approaching the 5 mg/L Resource Conservation and Recovery Act [RCRA] concentration for hazardous waste) could result in the suspension of drilling operations. No UGTA characterization wells were drilled in 2011. However, water produced during well purging operations prior to sampling is typically directed to the existing sumps as per the UGTA Fluid Management Plan. These sumps were routinely sampled for RCRA-regulated metals as well as for gross alpha/beta and tritium. In addition to grab samples collected during well purging, a composite water sample was collected from the sumps. Test results for lead and metals were all negative. Tritium results are shown in Table 12-1.

12.2.4 Support Activities

In 2011, land, ecological, and cultural surveys were completed for proposed access roads and drill pads for the two new Pahute Mesa Phase II wells (ER-20-11 and ER-EC-14) and the two new model evaluation wells in Frenchman Flat (ER-5-5 and ER-11-2). Construction of the access roads and drill pads for all four planned wells was completed in 2011. Personnel who have responsibility for UGTA well drilling renewed their State of Nevada well drilling operations licenses in 2011.

12.3 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 hydrogeologic models, have been built (Figure 12-3):

- Frenchman Flat, CAU 98 (BN, 2005a)
- Pahute Mesa–Oasis Valley, CAUs 101 and 102 (BN, 2002)
- Rainier Mesa–Shoshone Mountain, CAU 99 (NSTec, 2007)
- Yucca Flat–Climax Mine, CAU 97 (BN, 2006)

In 2011, work was conducted for all four model areas.

12.3.1 Frenchman Flat Model Area

In 2010, NDEP accepted the Frenchman Flat flow and transport models, and a Model Evaluation Plan was prepared that describes a path forward and the evaluation of the flow and transport model forecasts for the Frenchman Flat CAU. The objectives and criteria for the Frenchman Flat CAU model evaluation wells were also developed. In 2011, data packages for quality assurance and quality control purposes were assembled, and a draft well drilling and completion criteria document (N-I, 2012) was prepared for two new model evaluation wells, ER-5-5 and ER-11-2.

A surface magnetometer survey was conducted by the USGS in the fall of 2010 in northern Frenchman Flat, and the results of this study were published in 2011 (Phillips et al., 2011). The purpose of this survey was to better define the extent of certain shallow volcanic aquifers and to help site future model evaluation/monitoring wells.

12.3.2 Pahute Mesa–Oasis Valley Model Area

The Central and Western Pahute Mesa CAIP (NNSA/NSO, 2009) outlines a campaign to drill wells to gather further data regarding the establishment of a long-term groundwater monitoring system. The UGTA Activity selected 12 proposed locations for these new Phase II wells (Figure 12-4). The Pahute Mesa drilling campaign began in May 2009. Four wells were drilled in 2009 (ER-20-7, ER-20-8, ER-20-8 #2, and ER-EC-11), four were drilled in 2010 (ER-EC-12, ER-20-4, ER-EC-13, and ER-EC-15), and two wells are planned for drilling in 2012 (ER-20-11 and ER-EC-14). In 2011, well development, testing, and sampling were accomplished as planned for Wells ER-20-4, ER-20-8, and ER-EC-12. Data from these wells will provide hydrogeologic information to support refinement of the Phase I Pahute Mesa–Oasis Valley hydrostratigraphic framework model (BN, 2002) and support subsequent Phase II groundwater flow and contaminant transport modeling.

The Phase I Central and Western Pahute Mesa Transport Model (SNJV, 2009b) supports the 1997 regional groundwater flow and tritium transport report (DOE/NV, 1997c), which predicts radionuclides in groundwater to travel off the northwestern boundary of the NNSS. The transport model predicts the migration of tritium and carbon-14 off the NNSS within 50 years of the first nuclear detonation (1965) from the Central and Western Pahute Mesa CAUs and that concentrations of tritium off site will be above the SDWA limit of 20,000 pCi/L (Figure 12-6). In May 2011, NNSA/NSO gave a third public presentation of the model predictions and the current state of knowledge of radionuclide migration off the NNSS at the Beatty Community Center in Beatty, Nevada. Links to the regional transport model, to the Phase I Central and Western Pahute Mesa Transport Model, and to posters presented at the meeting can be found at the NNSA/NSO web page http://www.nv.energy.gov/library/publications/Environmental/May2011GWOpenHousePosters.pdf.

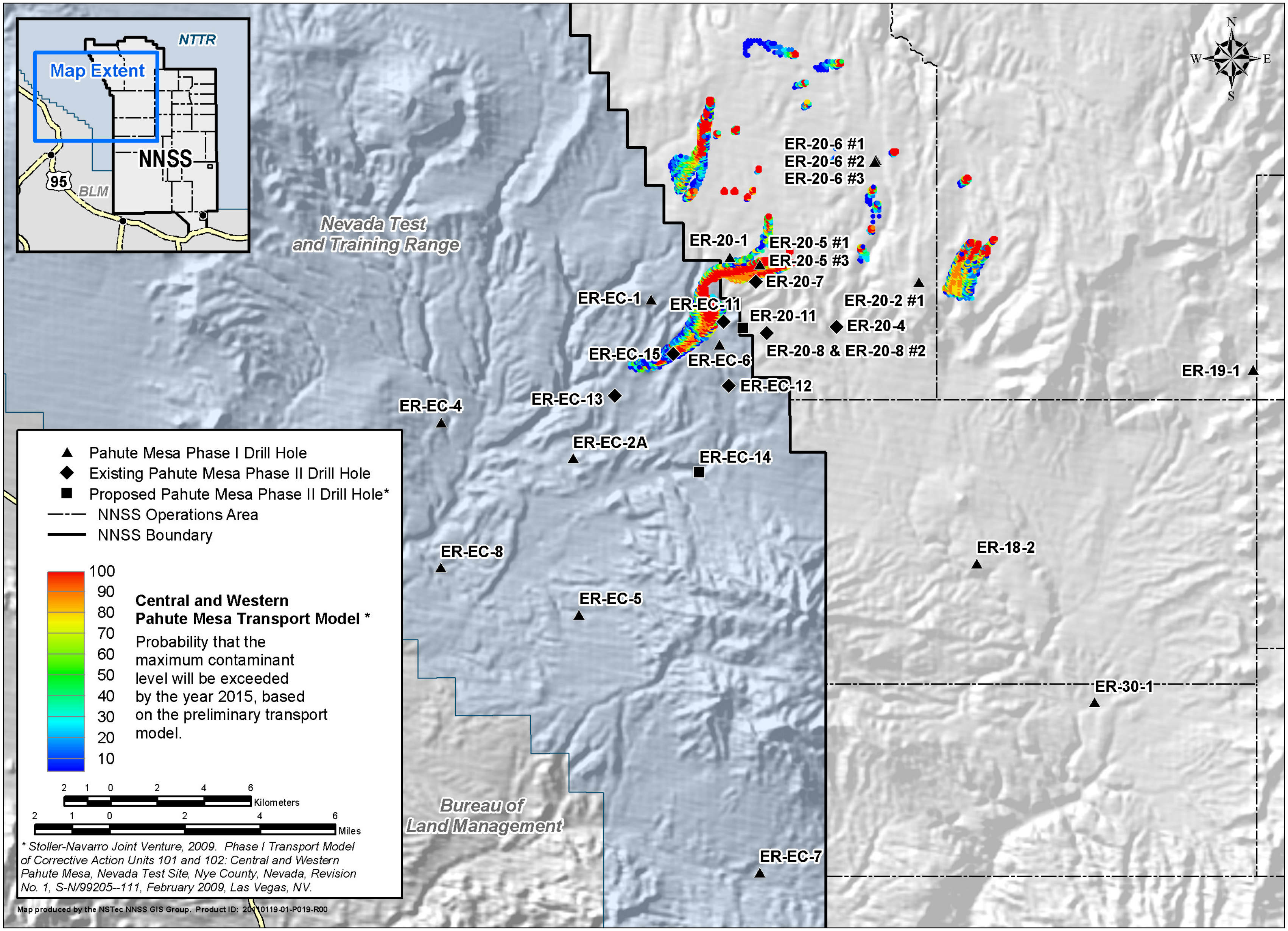

Figure 12-6. Results of Phase I Central and Western Pahute Mesa Transport Modeling

In 2011, further analysis of faults and fracture characteristics and of hydraulic properties of selected hydrostratigraphic units was conducted to support Phase II modeling, which had been recommended in 2009 by the Technical Working Group Pahute Mesa Phase II CAIP ad hoc subcommittee. The subcommittee includes the NNSA/NSO UGTA Activity director, subject matter experts consisting of UGTA Activity participants (NSTec, DRI, LLNL, LANL, N-I, and USGS), a representative from NDEP, and two representatives of the Nevada Site Specific Advisory Board.

In 2009, groundwater sampling of the NTTR Well ER-EC-11 indicated the presence of tritium at 13,180 pCi/L (NSTec, 2010). This is the first offsite well in which radionuclides from underground nuclear testing activities at the NNSS have been detected. Well ER-EC-11 is located approximately 716.3 m (2,350 ft) west of the NNSS boundary (Figure 12-4) and approximately 3.2 km (2 mi) from the nearest underground nuclear tests, BENHAM and TYBO, which were conducted in 1968 and 1975, respectively. The 2009 sampling results are consistent with the flow and transport model forecast. In 2010, a deeper zone of Well ER-EC-11 was sampled, and no tritium was detected. This was not unexpected, as the aquifer sampled is isolated from the overlying contaminated aquifer by a confining unit (see Glossary, Appendix B). Well ER-EC-11 was not sampled during 2011.

During monitoring under the *Routine Radiological Environmental Monitoring Plan* (RREMP), Well PM-3, which is 3,261 m (10,700 ft) west of the NNSS border on the NTTR, was sampled in May 2010 and July 2011, and found to have detectable levels of tritium (48.3 and 58.0 pCi/L, respectively) at the sample depth of 475.5 m (1,560 ft) (see Section 5.1.5, Table 5-2). Well PM-3 is 7,468 m (24,500 ft) northwest of ER-EC-11, and the static water level elevation at PM-3 is 57 m (188 ft) higher than at Well ER-EC-11. The depth of the sample is within zeolitic nonwelded tuff, a tuff confining unit. Hydrogeologic data west of the NNSS are sparse, and thus groundwater flow predictions are uncertain. The 2011 UGTA Activity sample analysis results from PM-3 confirmed the presence of tritium in the well, albeit at very low levels (see Table 12-1). Currently there are several developing hypotheses to explain the occurrence of tritium at PM-3. UGTA and RREMP have joined to investigate this discovery. A sampling activity is planned for the summer of 2012. Results from a more comprehensive suite of water analyses of 2012 samples are expected to provide the necessary information to identify the source of the tritium. Well sample analyses to date have not detected the presence of man-made radionuclides farther downgradient from Pahute Mesa in any of the 11 nearby UGTA wells on the NTTR (ER-EC-1, -2A, -4, -5, -6, -7, -8, -12, -13, -15, and ER-20-4; see Figure 12-4).

12.3.3 Rainier Mesa–Shoshone Mountain Model Area

The compilation, analysis, and documentation of the hydrologic and transport parameters to be used to build the flow and transport models for the Rainier Mesa–Shoshone Mountain CAU continued in 2011. LLNL continued work on the source-term model for this CAU. LANL continued work on the sub-CAU–scale model constructed for the N-Tunnel area, and DRI continued work on the sub-CAU–scale model for the T-Tunnel area. N-I continued work on the CAU-scale flow and transport model.

12.3.4 Yucca Flat–Climax Mine Model Area

UGTA Activity participants continued in 2011 to develop flow and transport models for the Yucca Flat–Climax Mine CAU. LLNL participants continued to work on a source-term model. Several supplemental analyses were started in 2011 to enhance input to the CAU models.

12.3.5 Other Activities and Studies

Compiling, evaluating, and updating the various databases continued as an ongoing effort. The water chemistry and fracture databases were expanded and updated in 2011. Efforts to compile petrographic, mineralogical, and chemical data from outcrops, tunnels, and drill cutting 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). The USGS continued their efforts in 2011 to establish a sample photo archive related to UGTA investigations.

12.3.6 UGTA Activity Publications

All reports and publications that were completed in 2011 and published by June 2012 are listed in Table 12-2. 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.

Table 12-2. UGTA Activity publications completed in 2011 and published prior to June 2012

Report	Reference
Completion Report for Wells ER-20-8 and ER-20-8#2, Corrective Action Units 101 and 102: Central and Western Pahute Mesa (OSTI ID: 1012655)	NNSA/NSO, 2011a
Completion Report for Well ER-EC-12, Corrective Action Units 101 and 102: Central and Western Pahute Mesa (OSTI ID: 1013015)	NNSA/NSO, 2011b
Completion Report for Well ER-20-4, Corrective Action Units 101 and 102: Central and Western Pahute Mesa (OSTI ID: 1013014)	NNSA/NSO, 2011c
Completion Report for Well ER-EC-13, Corrective Action Units 101 and 102: Central and Western Pahute Mesa (OSTI ID: 1015229)	NNSA/NSO, 2011d
Completion Report for Well ER-EC-15, Corrective Action Units 101 and 102: Central and Western Pahute Mesa (OSTI ID: 1015230)	NNSA/NSO, 2011e
Addendum #2 to the Central and Western Pahute Mesa Phase II Hydrogeologic Investigation Wells Drilling and Completion Criteria for Investigation Wells ER-EC-14 and ER-20-11	N-I, 2011a
Radionuclide Partitioning in an Underground Nuclear Test Cavity (OSTI ID: 1019060)	Rose et al., 2011
An Expert Elicitation Process in Support of Groundwater Model Evaluation for Frenchman Flat, Nevada National Security Site	Chapman and Pohlmann, 2011
Pahute Mesa Well Development and Testing Analyses for Wells ER-20-7, ER-20-8 #2, and ER-EC-11, Revision 1 (OSTI ID: 1031914)	N-I, 2011b
Groundwater Withdrawals and Associated Well Descriptions for the Nevada National Security Site, Nye County, Nevada, 1951–2008	Elliott and Moreo, 2011
Geology and History of the Water-Containment Ponds at U12n, U12t, and U-12e Tunnels, Rainier Mesa, Nevada National Security Site	Huckins-Gang and Townsend, 2011
A Refined Characterization of the Alluvial Geology of Yucca Flat and Its Effect on Bulk Hydraulic Conductivity	Phelps et al., 2011
A Ground-Based Magnetic Survey of Frenchman Flat, Nevada National Security Site and Nevada Test and Training Range, Nevada: Data Release and Preliminary Interpretation, Poster Presentation	Phillips et al., 2011
Assessing Hydraulic Connections Across a Complex Sequence at Volcanic Rocks – Analysis of U-20WW Multiple-Well Aquifer Test, Pahute Mesa, Nevada National Security Site, Nevada	Garcia et al., 2011
Corrective Action Decision Document/Corrective Action Plan for Corrective Action Unit 98: Frenchman Flat, Nevada National Security Site, Nevada (OSTI ID: 1022621)	NNSA/NSO, 2011f
Underground Test Area Quality Assurance Project Plan Nevada National Security Site, Nevada (OSTI ID: 1015762)	NNSA/NSO, 2011g
Frenchman Flat Model Evaluation Wells Drilling and Completion Criteria	N-I, 2012

13.0 Hazardous Materials Control and Management

Hazardous materials used or stored on the Nevada National Security Site (NNSS) 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) use 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 2.6). Chemicals to be purchased are subject to a requisition compliance review process. Hazardous substance purchases are reviewed 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 are provided in company documents and are aimed at meeting the goals shown below. The reports and activities prepared or performed in 2011 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

13.1 TSCA Program

There are no known pieces of polychlorinated biphenyl (PCB)–containing electrical equipment (transformers, capacitors, or regulators) at the NNSS. However, sometimes during demolition activities, old hydraulic systems or contaminated soils 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 at corrective action sites (CASs) during environmental restoration activities (see Chapter 11) and during maintenance activities and building decontamination and decommissioning activities. These activities can generate PCB-contaminated fluids and soil, along with bulk product waste containing PCBs.

Waste classified as bulk product waste that is generated on the NNSS 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 this 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 2011, three activities generated PCB regulated waste:

- Remediation, demolition, and renovation activities generated 3 drums of PCB light ballasts weighing 123 kilograms (kg), which were sent off site from the Area 5 Hazardous Waste Storage Unit (HWSU) for disposal in two separate shipments.
- Cleanup of Industrial Site Corrective Action Unit (CAU) 566, CAS 25-99-20, generated 17 drums (4,708 kg) of PCB-contaminated soil, which were shipped off site from the HWSU in one shipment.
- Maintenance activities at the NNSS generated 6 drums (698 kg) of PCB light ballasts, which were shipped off site from the HWSU in one shipment, and maintenance activities at the North Las Vegas Facility (NLVF) generated one drum (26 kg) of PCB light ballasts, which was direct-shipped to the disposal facility.

In 2011, NNSA/NSO discontinued the production of an annual report of PCB management activities because it is not required by the U.S. Environmental Protection Agency (EPA). Onsite PCB records continue to be maintained as required by the EPA, and PCB management activities are documented herein annually. Generated PCB wastes that are above threshold levels are also reported in the TRI Report (see Section 13.3). There were no TSCA inspections by the EPA performed at the NNSS in 2011.

13.2 FIFRA Program

In 2011, the following oversight functions were performed to ensure FIFRA compliance: (1) screened all purchase requisitions for restricted-use pesticides/herbicides and (2) reviewed operating procedures for handling, storing, and applying pesticide/herbicide products. On the NNSS, pesticides and herbicides are applied under the direction of a State of Nevada–certified applicator. This service is provided by Water and Waste (W&W). Only one restricted-use chemical is used on the NNSS, which is an herbicide for vegetation control along the edges of paved roads. It is the same herbicide used by the State of Nevada along highway shoulders. W&W maintains the appropriate Commercial Category (Industrial) certification for applying this herbicide. All other pesticides/herbicides used are categorized as non-restricted-use (i.e., available for purchase and application by the general public). Pesticide applications in NNSS food service facilities are also conducted by W&W. The State of Nevada did not conduct an inspection of pesticide storage facilities in 2011.

13.3 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, toxic). Annually, this database is updated to show the maximum amounts of chemicals that were present in each building at the NNSS, NLVF (see Section A.1.4), and the Remote Sensing Laboratory–Nellis (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 Marshal then issues permits to store hazardous chemicals on the NNSS, as well as at RSL-Nellis and NLVF. The 2011 chemical inventory for NNSS facilities was updated and submitted to the State of Nevada in the NCA Report on February 22, 2012. No accidental or unplanned release of an extremely hazardous substance occurred on the NNSS in 2011.

The hazardous substance inventory database is also used to complete the TRI Report, Form R. This report provides the 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, and recycling. Reuse of a material, however, does not constitute a release to the environment. TRI toxic chemicals that are recovered during NNSS remediation activities or become "excess" to operational needs (e.g., lead bricks, lead shielding) are sent off site for recycling, reuse, or proper disposal. Mixed wastes generated at other DOE facilities and sent to the NNSS for disposal may contain TRI toxic chemicals that must be reported in the TRI Report. Lead, mercury, and PCBs, released as a result of NNSS activities, were determined to be reportable in 2011. No release activities at NLVF or RSL-Nellis exceeded reportable thresholds in 2011. Table 13-1 lists the 2011 NNSS sources of release, disposition, and release quantities for these three reportable TRI toxic chemicals. In June 2012, NNSA/NSO submitted to the EPA the TRI Report for calendar year 2011.

No EPCRA inspections were performed by outside regulators in 2011.

Table 13-1. EPCRA reported NNSS releases and transfers of toxic chemicals in 2011

Toxic Chemical	Source	Disposition	Quantity[(a)] (pounds [lb])
Lead	Ammunition from Mercury Firing Range	Other disposal[(b)]	8,690
	Lead acid batteries and other lead generated on site	Offsite recycling	101,650[(c)]
	Hazardous waste generated on site	Offsite disposal	2,387
	Mixed waste generated off site at DOE facilities and received on site for disposal	Onsite disposal	25,042
	Mixed waste generated on site[(d)]	Onsite disposal	5,805
	Ammunition from Mercury Firing Range	Airborne release	5.2
Mercury	Hazardous waste generated on site	Offsite recycling	0.02
	Mixed waste generated off site at DOE facilities and received on site for disposal	Onsite disposal	7,951
PCBs	Mixed waste generated off site at DOE facilities and received on site for disposal	Onsite disposal	5,048
	Hazardous waste generated onsite	Offsite disposal	3.98

(a) Represents the weight of the chemical released, not the weight of the waste material containing the toxic chemical.

(b) Spent ammunition is left on the ground. When the firing range is closed, ammunition will be collected for recycling.

(c) This quantity represents three waste streams from the NNSS: 54,450 lb (24.7 metric tons [mtons]) of lead acid batteries, 33,000 lb (15 mtons) of radioactive contaminated lead, and 14,200 lb (6.4 mtons) of uncontaminated lead bricks.
NOTE: Table 3-3 of Section 3.3.2.2 of this report identifies 29.8 mtons of lead acid batteries sent off site for recycling, which includes 5.1 mtons of lead acid batteries from the NLVF and RSL-Nellis not included in the TRI Report. Also, the 14,200 lb (6.4 mtons) of uncontaminated lead bricks included in the TRI Report were sold to a vendor in 2011 but were not shipped off site until just after January 1, 2012; therefore, they were not captured in Table 3-3 of Section 3.3.2.2, but will be included in the 2012 report.

(d) Onsite mixed waste resulting from one-time events (e.g., cleanup projects and building demolition, disposal of radioactive solid lead).

HAZTRAK is a tracking system that monitors hazardous materials while they are in transit. When a truck transporting hazardous material enters the NNSS, 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.

13.4 Nevada Chemical Catastrophe Prevention Act

The Nonproliferation Test and Evaluation Complex in Area 5 of the NNSS is a Nevada Chemical Accident Prevention Program (CAPP) registered facility. NNSA/NSO is required to submit an annual CAPP Registration report to the State of Nevada whether or not a threshold was exceeded. The CAPP Registration report for operations from June 2010 through May 2011 was submitted to NDEP on June 15, 2012. No highly hazardous substances were stored in quantities that exceeded reporting thresholds.

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14.0 Groundwater Protection

This chapter presents other programs and activities of the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) that are related to the protection of groundwater that have not been discussed in previous chapters of this report (Chapter 5, Water Monitoring; Chapter 7, Section 7.2, Offsite Surface and Groundwater Monitoring; Chapter 10, Section 10.1.7, Groundwater Monitoring, and Section 10.1.8, Vadose Zone Monitoring of Closure Covers; and Chapter 12, Groundwater Characterization and Contaminant Flow Modeling).

It is the policy of NNSA/NSO to prevent pollutants, both from past and current Nevada National Security Site (NNSS) activities, from impacting the local groundwater. Groundwater-related activities, under current NNSA/NSO missions, focus on preventing groundwater contamination, protecting the public and environment from past contamination, and protecting groundwater quality and availability for current and future NNSS missions. NNSA/NSO acknowledges that the greatest potential for environmental impact at the NNSS 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, 2008), NNSA/NSO integrates site-wide groundwater-related activities across the multiple NNSA/NSO programs mentioned below and in previous chapters of this report.

Groundwater Protection Program Goals
Prevent the degradation of water quality due to NNSA/NSO activities that would be harmful to the public, the environment, or biota. Conduct research and monitoring to prevent public exposure to drinking water contaminated by past nuclear testing activities. Protect water availability for current and future NNSS activities.

14.1 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 NNSS have been identified by the State of Nevada for NNSS 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 NNSS land enforced by site security. NNSA/NSO wells that are sampled are protected through adherence to proper groundwater sampling procedures developed by each NNSS 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.

14.1.1 Borehole Management Program

More than 4,000 boreholes were drilled on and off the NNSS 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 in accordance with Nevada Administrative Code NAC 534.420–534.427 requirements, to the extent possible.

In 2011, 68 boreholes were plugged (Table 14-1), 11 of which originally penetrated the groundwater and nuclear test cavities. As of the end of 2011, a total of 809 boreholes have been plugged, 141 of which penetrated groundwater and test cavities. Since 2000, some boreholes have been removed from the plugging candidate list as they were 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 54 candidate boreholes remaining on the list, 18 of which penetrate groundwater and nuclear test cavities. The database of boreholes is maintained, and a fiscal year progress report is sent annually to the Nevada Division of Water Resources.

Table 14-1. NNSS boreholes plugged in 2011

NNSS Area	Borehole	Year Constructed	Hole Size (in.)	Original Depth (ft)	Surface Casing Size (in.)	Surface Casing Depth (ft)	Depth Plugged From to Surface (ft)
2	U-2cn PS #1A (A)	1969	9.875	1119	10.75	110	188
2	U-2e PS #4	1963	9.625	830	NA[(a)]	NA	150
2	U-2gh PS #1A	1990	9.875	1918	10.75	111	1296
3	U-3at PS #3	1963	6.125	1256	7	126	935
3	U-3az PS #1	1962	9.625	928	10.75	19	39
3	U-3az PS #2	1962	9.625	913	10.75	40	390
3	U-3bb PS #1	1962	9.625	785	10.75	43	232
3	U-3bb PS #1s	1962	9.625	886	10.75	43	290
3	U-3bb PS #2	1962	9.625	886	10.75	43	147
3	U-3bg PS #1	1963	9.625	973	10.75	66	614
3	U-3bg PS #2	1963	9.625	984	10.75	65	737
3	U-3bg PS #3	1963	3.75	72	55	7	2
3	U-3cn PS #1	1963	9.625	2022	18	484	870
3	U-3cn PS #1s	1963	9.625	2031	10.75	82	87
7	U-7v PPS #1D	1970	36	118	20	118	115
7	U-7v PPS #2D	1970	36	118	20	118	113
9	U-9e PPS #1	1961	15	210	10.75	22	2
9	U-9e PS #1	1963	9	210	10.75	16	49
9	U-9r PS #1	1962	9.625	675	4.5	675	560
9	U-9r PS #2	1962	9.625	675	4.5	675	48
12	Hagestad #1	1957	10.625	1952	5.5	1941	1055
12	Mac Exploratory Co. #1	1959	4	1200	6	40	854
12	U-12e.03AA PS	1961	6.125	1400	7	1098	934
12	U-12e.03AC PS	1961	3	1398	3	1070	980
12	U-12e.06 -1 R/C-EX	1962	6.125	3180	2.875	3178	1339
12	U-12e.07-1 Vent	1962	18	1300	13.375	1259	1158
12	U-12e.07-4 PPS	1962	9	33	10.75	12	33
12	U-12e.07-4s PPS	1962	9	1000	10.75	10	989
12	U-12e.07-5 PPS WS	1962	9	900	10.75	19	899
12	U-12e.07-6 Vent	1962	18	1287	18	1261	972
12	U-12e.10 PS #1V	1968	9.875	1514	13.375	631	332
12	U-12i.01-1 R/C	1962	13.375	647	9.625	647	117
12	U-12i.01-2 PPS W/S	1962	9	370	10.625	13	288
12	U-12i.-01-3 PPS	1962	9	595	10.75	16.5	584

Table 14-1. NNSS boreholes plugged in 2011 (continued)

NNSS Area	Borehole	Year Constructed	Hole Size (in.)	Original Depth (ft)	Surface Casing Size (in.)	Surface Casing Depth (ft)	Depth Plugged From to Surface (ft)
12	U-12i.01-5 Los Pinex	1962	30	645	34	4.5	20
12	U12j.01-1 R/C	1962	18	661	12.75	655	328
12	U-12j.01-2 / U-12j.01-2 PPS	1962	9	66	20	17	332
12	U-12j.01-3 PS	1962	9	800	4.5	786	342
12	U-12j.01-5 Los Pinex	1962	26	642	6.625	645	330
12	U-12k. 01-2 PS-WS	1962	9	735	4.5	734	735
12	U-12k.01-1 R/C	1962	13.75	623	9.625	625	316
12	U-12k.01-3 PS	1962	9	727	4.5	726	723
12	WES Hole 66-1	1966	5.5	89	NA	NA	86
12	WES Hole 66-2	1966	5.5	225	6	10	224
15	Marble #1	1959	3	378	3.75	15	90
15	Marble #2	1959	2.4	274	4	14	253
15	Marble #3	1959	3	978	4	20	18
15	Marble #4	1959	6	1187	8	7	254
15	U-15a PS #28s	1962	6.25	1016	7	748	935
15	UE-15j D-9	1969	6.75	450	7.625	6	366
15	UE-15j E-5	1969	6.75	15	NC[(b)]	NC	4
15	UE-15j F-5	1969	6.75	25	NC	NC	21
15	UE-15j G-2	1969	6.75	28	7.625	6	23
15	UE-15j I-5	1969	6.75	389	7.625	6	293
15	UE-15j K-5	1969	6.75	750	7.625	6	348
16	U-16a PS #1	1971	6.25	1150	4.5	1134	1104
16	U-16a PS #2s	1971	6.25	1150	4.5	1150	488
16	U-16a.04 PS #1V	1968	9	1149	13.375	500	1061
19	U-19ai PS #1A	1980	9.875	2271	10.75	110	1085
19	U-19i PS #2D	1968	9	2936	20	120	9
19	U-19i PS #3D	1968	9	2959	20	120	10
19	UE-19m	1966	9.875	963	13.375	833	946
20	U-20aj PS #1A	1983	9.875	2178	10.75	110	805
20	U-20bf PS #1A	1991	9.875	2598	10.75	110	1879
20	UE-20u #2	1968	3.75	1250	4.5	16	843
22	Army 6	1951	NA	1220	13	NA	305
26	Pluto 2	1962	NA	112	4.5	6	103
26	TMC 8	1962	NA	NA	3.5	NA	115

(a) NA = Information is not available
(b) NC = No casing was in the hole

14.2 Spill Prevention and Management

Procedures for the prevention, control, cleanup, and reporting of spills of hazardous and toxic materials, or any other regulated material, into the environment are established for all NNSA\NSO managed facilities. Spills include releases from underground tanks, aboveground tanks, containers, equipment, or vehicles. All users of the NNSS are instructed to prevent, control, and report spills. NNSA\NSO ensures that spills are reported to proper federal, 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, Emergency Planning and Community Right-to-Know Act, and state-specific requirements are followed. A Spill Prevention, Control, and Countermeasure (SPCC) Plan is in place for the North Las Vegas Facility (NLVF). This plan was prepared in accordance with the Clean Water Act and covers petroleum storage areas and petroleum-containing equipment, including transformers and machine tools. The NNSS does not have an SPCC because the NNSS oil storage areas do not impact any protected waterways. Established procedures for users of the NNSS as well as the NLVF ensure that surface spills or subsurface releases of contaminants do not infiltrate groundwater or flow into surface waters. There were no reportable spills in 2011.

14.3 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 NNSS. Hydrologic data are collected quarterly or semi-annually from wells on and off the NNSS. The USGS also maintains and develops the Death Valley Regional Groundwater Flow System Model (Belcher et al., 2004) and manages the NNSS well hydrologic and geologic information database.

By the end of 2011, the USGS monitored water levels in 216 wells, which included 103 on the NNSS and 113 off the NNSS. A map showing the location of monitored wells and all water-level data are posted on the USGS/ U.S. Department of Energy (DOE) Cooperative Studies in Nevada web page at http://nevada.usgs.gov/doe%5Fnv/. The water-level data are also published online at http://wdr.water.usgs.gov/, Annual Water Data Reports, which includes data from October 2010 through September 2011.

Groundwater use from water-supply wells on the NNSS is collected using flow meters, and data are reported monthly. The principal NNSS water supply wells monitored during 2011 included J-12 WW, UE-16d WW, WW #4, WW #4A, WW 5B, WW 5C, WW 8, and WW C-1 (see Chapter 5, 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 2011 have been compiled, processed, and entered onto the USGS/DOE Cooperative Studies in Nevada website at http://nevada.usgs.gov/doe_nv/wateruse/wu_map.htm. Discharge from these wells during 2011 was approximately 173.2 million gallons (Figure 14-1). Water-use data are also published online at http://wdr.water.usgs.gov/, Annual Data Reports, which includes data from October 2010 through September 2011.

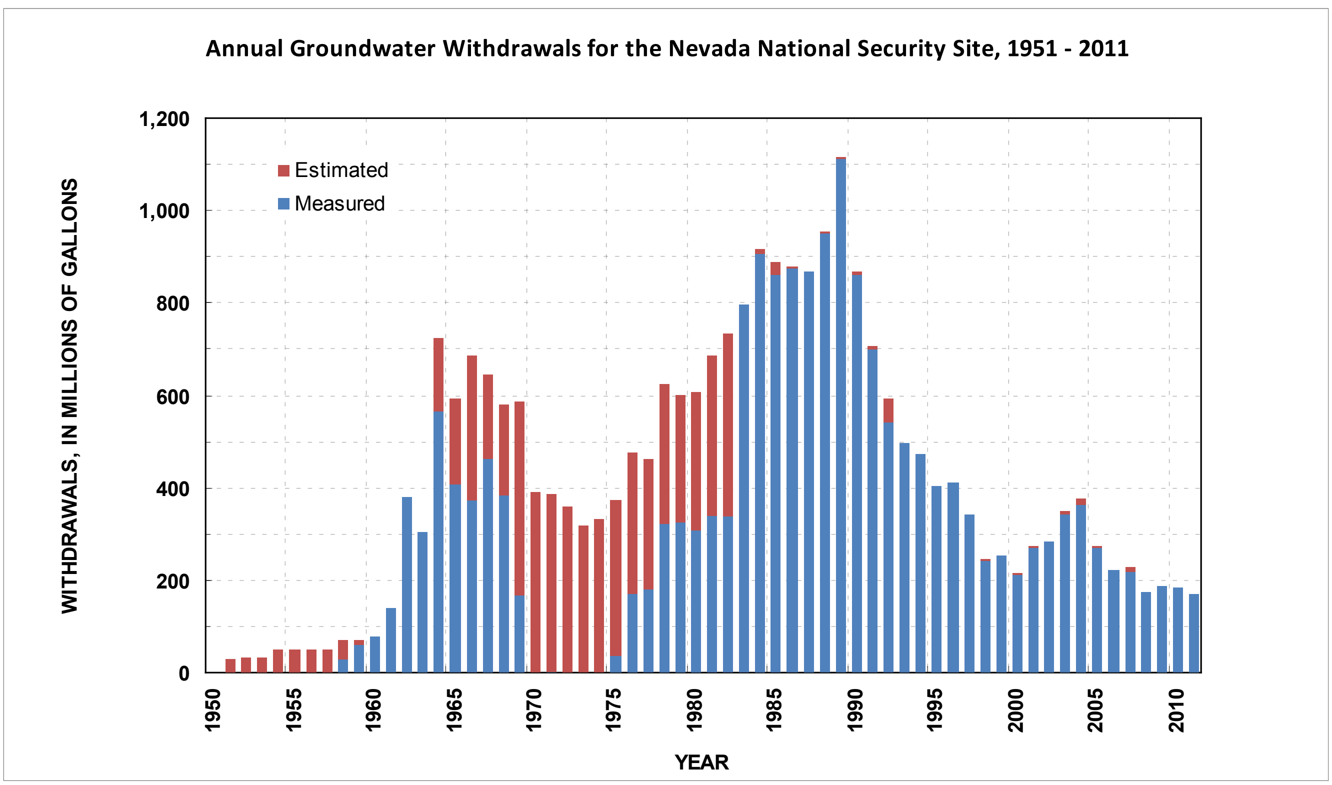

Figure 14-1. Annual withdrawals from the NNSS, 1951 to present

14.4 Groundwater Conservation

All water used by NNSA/NSO is groundwater. NNSA/NSO takes actions to conserve groundwater at the NNSS and its support facilities by addressing the water efficiency and water management goals presented in DOE's Strategic Sustainability Performance Plan (DOE, 2011) and in the *FY 2012 NNSA/NSO Site Sustainability Plan* (National Security Technologies, LLC [NSTec], 2011a). These goals include reducing both potable and non-potable water use, installing metering systems for water, auditing water use, using water-efficient products, and increasing the use of recycled, reclaimed, and grey water where possible (see Section 3.3.1, Energy Management Program, Table 3-4). Below are listed all of the groundwater conservation accomplishments of fiscal year (FY) 2011:

- Potable water consumption was reduced by 33% from the FY 2007 baseline.
- A total of 12 water meters were installed at selected buildings in Mercury on the NNSS.
- Lawn surrounding Building C-1 at the NLVF was replaced with xeric landscaping.
- Well J-14, a new potable water well located in Area 25 of the NNSS, was designed and drilled in 2010. A new pipeline connecting the well to the Area 25 Public Water System was completed in 2011 to reduce system leaks and maintenance costs. The well came on line in March 2012.
- A Water Management Plan for the NNSS was developed in August 2011. It includes a water metering plan and a comprehensive plan for future water saving measures for both potable and non-potable groundwater pumped on site, a water system configuration improvement plan, and water efficiency practices already implemented at the NNSS.

The *FY 2012 NNSA/NSO Site Sustainability Plan* (NSTec, 2011a) includes the following proposed groundwater conservation actions:

- Continue to purchase and install WaterSense labeled products. Any rebates received for energy-efficient upgrades will be used to purchase and install additional meters at the NNSS and the NLVF.
- Replace two existing sumps in Area 6 with two recycled water tanks. The tanks will ensure a reduction in water loss due to evaporation, evapotranspiration, and infiltration due to degradation of the sump linings. Another sump in Area 5 will be shut down and replaced with a fill stand for use during intermittent work.
- Improve the NNSS water system and implement other NNSS water efficiency improvement measures identified in the Water Management Plan, as funding permits.

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15.0 Historic Preservation and Cultural Resources Management

The historic landscape of the Nevada National Security Site (NNSS) 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 436.1, "Departmental Sustainability," requires the development and maintenance of policies and directives for the conservation and preservation of cultural resources. On the NNSS, cultural resources are monitored, and site activities and projects comply with applicable federal and state regulations related to their protection (see Section 2.8). The Cultural Resources Management (CRM) program at the NNSS has been established and is implemented by the Desert Research Institute (DRI) to aid in the conservation and preservation of cultural resources that may be impacted by U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) activities. 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 NNSS (see Section 2.8).
Inventory and manage cultural resources on the NNSS.
Provide information that can be used to evaluate the potential impacts of proposed projects and programs to cultural resources on the NNSS 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 consultation 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) archival research, 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 2011 accomplishments is provided in this chapter. The methods used to conduct inventories and historical evaluations in support of NNSS operations were summarized in the *Nevada Test Site Environmental Report 2003* (Bechtel Nevada, 2004a). The reader is directed to the *Nevada National Security Site Environmental Report 2011 Attachment A: 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.energy.gov/library/publications/aser.aspx. Attachment A summarizes cultural resource inventories of the NNSS and describes prehistoric and historical artifacts found on the NNSS. It also contains a summary of the known human occupation and use of the NNSS from the Paleo-Indian Period, about 12,000 years ago, until the mining and ranching period of the 20th century, just before NNSS lands were withdrawn for federal use.

15.1 Cultural Resources Inventories

Cultural resources inventories are field surveys that are conducted at the NNSS 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
- Occurrences of damage to archaeological sites
- Final report on results

In 2011, DRI conducted archival research for 37 proposed NNSA/NSO projects that had the potential to impact cultural resources on the NNSS. The archival research findings led archeologists to conduct 18 field inventories and 3 historical evaluations in 2011, which are listed in Tables 15-1 and 5-2. Six of the 18 inventories and 1 historical evaluation were completed through the report phase (Table 15-1), resulting in the identification of one historic site. The other 12 cultural resources inventories and 2 two historical evaluations were completed through the fieldwork phase (Table 15-2) and resulted in the identification of 54 sites: 41 prehistoric, 12 historic, and 1 that was both prehistoric and historic. A total of 648.7 hectares (ha) (1,603.0 acres [ac]) was examined during the inventories and historical evaluations.

In 2011, there were no reported occurrences of damage to archaeological sites.

Table 15-1. 2011 cultural resources inventories and historic evaluations for which final reports were completed

Inventories and Evaluations	NNSS Area	Prehistoric/ Historical Sites Found	Cultural Resources Evaluated	Cultural Resources Determined NRHP Eligible	Area Surveyed	
					Hectares	Acres
Wireless Mesh Network Node 2	5 and 6	0	0	0	1.1	2.6
Well ER-5-5 (Milk Shake)	5	0	0	0	4.0	9.9
Well ER-11-2 (Pin Stripe)	11	0	0	0	4.0	9.9
Well ER-20-11	20	0	0	0	8.4	20.7
Army Well #6 Borehole Plugging	22	0	0	0	1.2	2.9
DTRA[(a)] Active Interrogation Testing Area	6	0	0	0	9.2	22.8
U12n Tunnel Historical Evaluation	12	1	1	1	243.1	600.8
Totals		1	1	**1**	**271.0**	**669.6**

(a) Defense Threat Reduction Agency

Table 15-2. 2011 cultural resources inventories and historic evaluations for which final reports and cultural resource evaluations to determine NRHP eligibility are pending

Inventories and Evaluations	NNSS Area	Prehistoric/ Historical Sites Found	Area Surveyed	
			Hectares	Acres
Jackass Flats Power Line	25	13	220.0	543.6
Hill 200 Power Line	5	0	13.0	32.1
Canyon Substation to J-12 Fiber Optic Line	25	5	11.0	27.2
Jackass Flats Substation to Canyon Substation Fiber Optic Line	25	7	39.0	96.4
Improvements to U12 U Tunnel	12	0	7.8	19.3
Area 12 Motor Generator Building and Boreholes	12	0	4.7	11.6
Mercury Highway to Desert Rock Airport Tower Fiber Optic Line	22	0	6.0	14.8

Table 15-2. 2011 cultural resources inventories and historic evaluations for which final reports and cultural resource evaluations to determine NRHP eligibility are pending (continued)

Inventories and Evaluations	NNSS Area	Prehistoric/ Historical Sites Found	Area Surveyed Hectares	Area Surveyed Acres
Maintenance of Fiber Optic Line from J-12 to Pole JF2B-38	25	11	18.0	44.5
Rotary Percussion Sounding System Drill Holes	15	0	3.3	8.2
Plant Stress Area	15	0	0.3	0.8
Generator Pad Extension and Borrow Pit	12	1	11.7	28.9
Well J-12 to Well J-13 Power Line	25	15	14.0	34.6
U16a Tunnel Complex Historical Evaluation	16	1	16.7	41.3
U15a and U15e Shafts Historical Evaluation	15	1	12.2	30.1
Totals		54	377.7	933.4

15.2 Evaluations of Historic Structures

The U12n Tunnel complex historical evaluation report was completed in 2011 (Drollinger et al., 2011). From 1967 to 1992, 22 nuclear and 11 high explosives tests were conducted in the U12n Tunnel. The complex is a historic landscape composed of the portal and mesa areas, encompassing an area of approximately 240 ha (600 ac). Draft historical evaluation reports were completed for the U16a Tunnel complex, the Structural Response Safety Program Structures, and the Pluto Compressor Building. Field work for the latter two historical evaluations was conducted in previous years. The U16a Tunnel complex was in operation from 1962 to 2001 for nuclear weapons effects tests and high explosive tests. Six nuclear weapons effects tests and 15 high explosives tests were conducted in the tunnel during this time frame. The Structural Response Safety Program was designed to gather ground motion and structural response data to ensure the safety of the offsite population and to minimize damage to public and private structures from ground motion caused by underground nuclear testing. Fourteen structures that were part of this program, constructed between 1963 and 1966 and used into the late 1970s, are included in the historical evaluation report. The Pluto Compressor Building was part of the Pluto complex in operation from 1958 to 1964 to develop and test nuclear reactors for ramjets to be used in long-range, low altitude missiles for the U.S. Department of Defense. The historical evaluation reports for these structures are expected to be completed in 2012.

Also in 2011, archival research and fieldwork were completed for the historical evaluation of U15a and U15e shafts. The U15a and U15e shaft 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.

15.3 General Reconnaissance

Five field activities and two preliminary assessments were conducted in 2011. One of the field activities was to monitor boreholes placed at the north end of the runway at Camp Desert Rock. A second field activity was to photograph the stanchions at the Bren Tower. The third and fourth activities involved DRI and NNSA/NSO personnel visiting Control Point 1 and Control Point 10 in Area 6 to photograph the historic material left in these two buildings. The final field activity involved DRI personnel accompanying the Chief Historian of DOE to the NNSS for a tour and to take photographs.

The preliminary assessments involved visiting the Corrective Action Sites (CASs) that are part of Corrective Action Units (CAUs) 569, 547, and 104 (Area 3 Yucca Flat Atmospheric Test Sites, Miscellaneous Contaminated Waste Sites, and Area 7 Yucca Flat Atmospheric Test Site, respectively). DRI provided recommendations regarding the presence and protection of cultural resources at the CASs.

15.4 Cultural Resources Reports

Several reports were completed in 2011. They included six inventory reports (Holz, 2011; Jones, 2011a, b, c, and d; and Rowland-Fleischmann, 2011) and three letter reports (Beck and Holz, 2011; Drollinger and Falvey, 2011; and Jones, 2011e). Specific site location information and reports containing such data are not available to the public. The data on NNSS 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.

15.5 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 NNSS Archaeological Collection currently contains over 400,000 artifacts and is curated in accordance with 36 CFR 79. Curation requirements for the NNSS Archaeological Collection include:

- Maintain a catalog of the items in the NNSS collection.
- Package the NNSS collection in materials that meet archival standards (e.g., acid-free boxes).
- Store the NNSS collection and records in a facility that is secure and has environmental controls.
- Establish and follow curation procedures for the NNSS collection and facility.
- Comply with the Native American Graves Protection and Repatriation Act (NAGPRA).

In the 1990s, the U.S. Department of Energy, Nevada Operations Office completed the required inventory and summary of NNSS cultural materials accessioned into the NNSS Archaeological Collection and distributed the inventory list and summary to the tribes affiliated with the NNSS 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.

In 2011, the NNSA/NSO artifact collections and documents for the cultural resources studies conducted on the NNSS were maintained and managed by DRI. The NNSA/NSO collection is now arranged on the shelving according to site provenience. All archival boxes containing artifacts, except for a few with specialized sizes or certain artifacts, have been replaced with plastic ones that meet or surpass archival standards (Drollinger and Falvey, 2011).

The objective in 2011 for the NNSA/NSO artifact collections and documents was to begin development of an accession database. This database will be linked to the existing artifact catalog. Towards this goal, an accession form template was drafted and linked to a Microsoft Office Access database. Artifacts are being accessioned according to site number and the date they entered the collections. In order to do this, data on the year and month of collection are being recorded from the original artifact provenience tags stored in the curation facility. The dates for approximately 30% of the collection have been compiled (Drollinger and Falvey, 2011).

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. 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.

15.6 American Indian Consultation Program

NNSA/NSO has had an active American Indian Consultation Program (AICP) since the late 1980s. The function of the program is to conduct consultation between NNSA/NSO and 16 NNSS-affiliated American Indian tribes that are collectively organized into 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. The 16 groups are listed in previous NNSS environmental reports (e.g., National Security Technologies, LLC, 2008). 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 AICP are to:

- Provide a forum for the CGTO to interface directly with NNSA/NSO and discuss issues of importance.
- Provide the CGTO with opportunities to actively participate in decisions that involve places and locations that hold cultural significance to the tribes.
- Involve the CGTO in the curation and display of American Indian artifacts.
- Enable the CGTO and its constituency to practice and participate in religious and traditional activities within the boundaries of the NNSS.
- Provide an opportunity for subgroups of the CGTO to participate in the review and evaluation of program documents and provide guidance in the interim between regularly scheduled meetings.
- Include the CGTO in the development of text in the agency's National Environmental Policy Act (NEPA) documents.

In 2011, the CGTO's American Indian Writer's Subgroup completed final edits to tribal text throughout the body of, and in a dedicated appendix to the *Draft Site-Wide Environmental Impact Statement (SWEIS) for the Nevada National Security Site and Offsite Locations in Nevada*. This text development approach was first used for the 1996 SWEIS and was used as a model by other federal agencies for similar NEPA undertakings. DOE/Environmental Management (EM) Headquarters adopted the approach for their *Greater than Class C Low Level Waste (GTTC) Environmental Impact Statement*, which included DOE facilities at Hanford in Washington, Los Alamos National Laboratories in New Mexico, and the NNSS.

In 2011, the CGTO Spokesperson attended three meetings at which they represented the perspectives of the CGTO and their involvement in NNSS activities. They included DOE's Tribal Summit in Washington, D.C., on May 4–5, 2011; the National Transportation Stakeholder's Forum in Denver on May 10–12, 2011; and the State Tribal Government Work Group Meetings held in St. Louis on May 31–June 1, 2011, and New Orleans on December 13–15, 2011. The Spokesperson's attendance at these meetings was supported by NNSA/NSO.

On October 5–6, 2011, NNSA sponsored an Annual Meeting for the CGTO in Las Vegas, Nevada, to continue DOE's commitment to uphold government-to-government relations with the culturally affiliated tribes represented by the CGTO. The meeting allowed NNSA the opportunity to provide programmatic updates and an overview of the draft SWEIS. At the conclusion of formal DOE presentations, the CGTO met in a closed session to develop recommendations and comments relating to future DOE activities and the draft SWEIS. Immediately thereafter, a special hearing was held by NNSA using a court recorder for the group to submit formal comments relating to the draft SWEIS. Thirty-one combined recommendations were presented to NNSA consisting of comments about sections of the draft SWEIS and about ways to further enhance the NNSS/NSO American Indian Program. Recommendations identified the importance of continuing government-to-government relations, holding regularly scheduled meetings, monitoring collections, visiting selected cultural resource sites, and engaging in co-management activities on the NNSS. One notable recommendation requested an opportunity for tribal representatives to meet with the Assistant Secretary of EM during a regularly scheduled visit in Nevada to discuss the progressive nature of the NNSA/NSO American Indian Program. This meeting occurred on January 25, 2012, during which the CGTO Spokesperson provided the Assistant Secretary with an overview of the NNSA/NSO American Indian Program.

In 2011, NNSA/NSO did not receive any requests from NNSS-affiliated tribes to access the NNSS for ceremonies or traditional use. However, interest in conducting a pine nut harvest on the NNSS in the future was discussed at the Annual Meeting.

In the 1990s, NNSA/NSO initiated NAGPRA consultations with NNSS-affiliated tribes regarding the NNSS artifact collection. The final repatriation of cultural items from the collection to the tribes in 2002 marked the end of the NAGPRA consultations. NNSA/NSO continues to protect NNSS American Indian burial sites and their location information.

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16.0 Ecological Monitoring

The Ecological Monitoring and Compliance (EMAC) Program provides ecological monitoring and biological compliance support for activities and programs conducted at the Nevada National Security Site (NNSS). 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 2011 accomplishments are provided in this chapter. Detailed information may be found in the most recent annual EMAC report (Hansen et al., 2012). EMAC annual reports are available at http://www.nv.energy.gov/library/publications/emac.aspx. The reader is also directed to *Attachment A: Site Description,* a separate file on the compact disc of this report, where the ecology of the NNSS is described.

Ecological Monitoring and Compliance Program Goals
Ensure compliance with all state and federal regulations and stakeholder commitments pertaining to NNSS flora, fauna, wetlands, and sensitive vegetation and wildlife habitats (see Section 2.9).
Delineate NNSS ecosystems.
Provide ecological information that can be used to evaluate the potential impacts of proposed projects and programs on NNSS ecosystems and important plant and animal species.

16.1 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 NNSS (Figure 16-1). Activities conducted in desert tortoise habitat on the NNSS 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 NNSS 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 sets 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 16-1). 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 2011, biologists conducted surveys for 21 projects that were within the distribution range of the desert tortoise. A total of 4.68 acres (ac) of desert tortoise habitat were disturbed in 2011, and no compliance limits of the Opinion were exceeded (Table 16-1). 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. In 2011, one desert tortoise was accidentally killed by a vehicle on a paved road, and nine 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 2012, NNSA/NSO submitted a report to the FWS Southern Nevada Field Office that summarizes tortoise compliance activities conducted on the NNSS from January 1 through December 31, 2011.

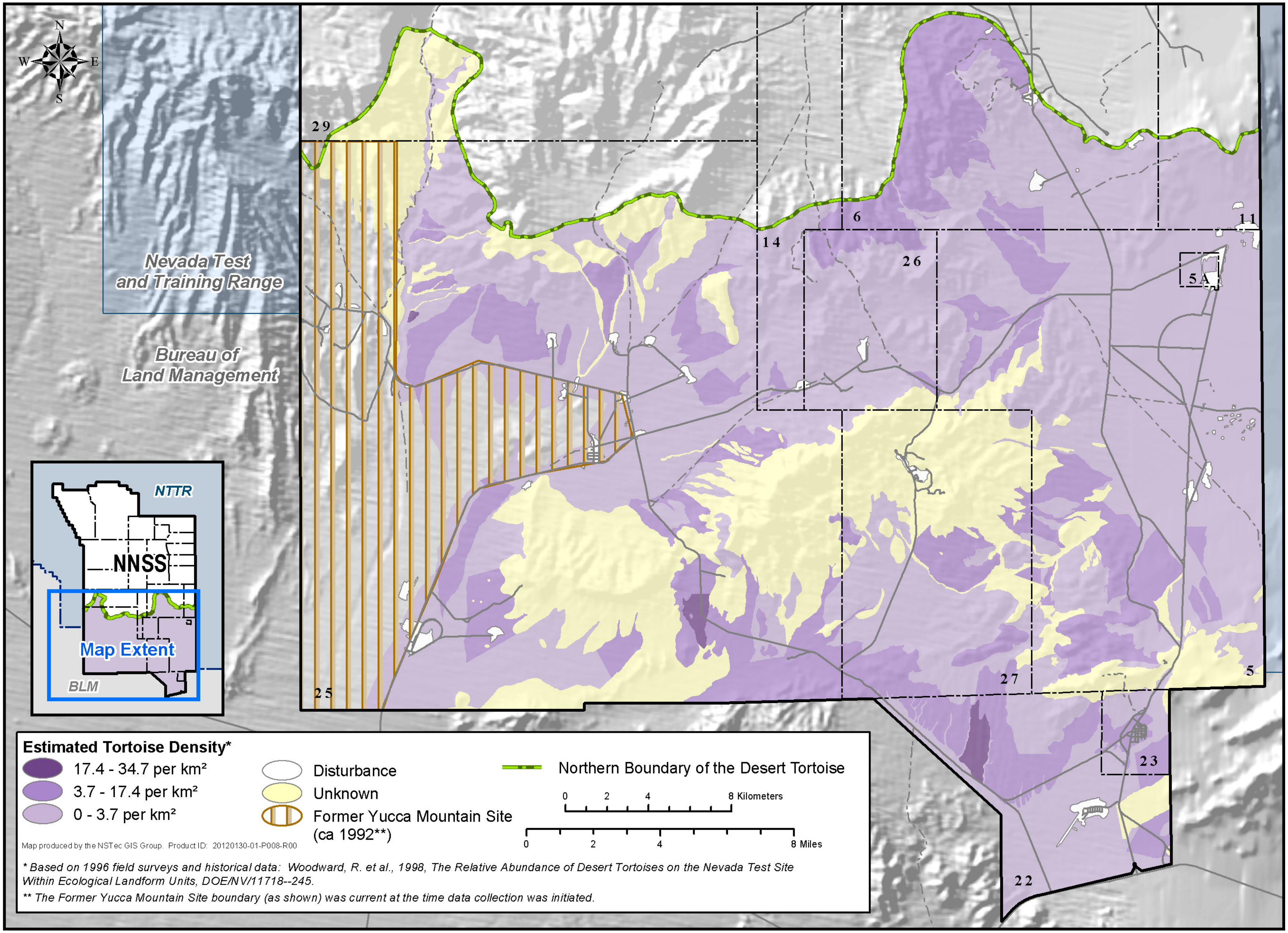

Figure 16-1. Desert tortoise distribution and abundance on the NNSS

Table 16-1. Annual totals (2011), cumulative totals (2009–2011), and compliance limits for take of acres and tortoises

Program/Activity	Acres Impacted			Tortoises Incidentally Taken: Killed or Injured			Tortoises Incidentally Taken: Other[(a)]		
	Annual Total	Cumulative Total	Permit Limit	Annual Total	Cumulative Total	Permit Limit	Annual Total	Cumulative Total	Permit Limit
Defense	0	5.61	500	0	0	1	0	0	10
Waste Management	0	0	100	0	0	1	0	0	2
Environmental Restoration	0	0	10	0	0	1	0	0	2
Nondefense Research and Development	0	0	1,500	0	0	2	0	0	35
Work for Others	4.53	129.46[(b)]	500	0	0	1	0	0	10
Infrastructure Development	0.15	0.15	100	0	0	1	0	0	10
Vehicle Traffic on Roads	-	-	-	1	4	15[(c)]	9	27	125
Totals	4.68	135.22[(b)]	2,710	1	4	22	9	27	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) Includes 118 ac proposed for disturbance by an expansion project for the Radiological/Nuclear Countermeasures Test and Evaluation Complex (RNCTEC) started in 2011, but for which most land disturbance will occur in 2012. Remuneration fees for the 118 ac were paid in 2011, and this cumulative total acreage was reported to the FWS as a 2011 impact. The Annual Total column reflects actual acres disturbed by projects in 2011.

(c) No more than 4 desert tortoises killed during any calendar year and 15 during the term of the Opinion (2009–2019).

16.2 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 plants and animals (see Section 16.3), their associated habitat, and important biological resources. Important biological resources include such things as cover sites, nest/burrow sites, roost sites, wetlands, or water sources that are vital to important species. During 2011, biological surveys for 31 projects were conducted on or near the NNSS. For some of the projects, multiple sites were surveyed. Biologists surveyed a total of 230.21 hectares (ha) (568.86 ac). A total of 21 projects were within the range of the desert tortoise. Biologists provided to project managers written summary reports of all survey findings and mitigation recommendations, which are summarized by project in Hansen et al. (2012).

16.3 Important Species and Habitat Monitoring

Important species known to occur on the NNSS include 18 sensitive plants, 1 mollusk, 2 reptiles, 236 birds, and 27 mammals. They are identified in Table A-11 of *Attachment A: Site Description* (see file on the compact disc of this document). They are classified as important due to their sensitive, protected, and/or regulatory status with state or federal agencies, and they are evaluated for inclusion in long-term monitoring activities on the NNSS.

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 NNSS. NNSA/NSO has produced numerous documents reporting the occurrence, distribution, and susceptibility to threats for predominately sensitive species on the NNSS (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 NNSS and to minimize cumulative impacts to those species as a result of NNSA/NSO activities.

Activities related to the important plants, animals, and habitats on the NNSS that occurred in 2011 are listed in Table 16-2. A description of the methods and a more detailed presentation of the results of these activities are reported in Hansen et al. (2012). A map of all the known sensitive plant populations on the NNSS is available at http://www.nv.energy.gov/library/publications/Environmental/Figures/Fig11-3.pdf.

Table 16-2. Activities conducted in 2011 for important species and habitats of the NNSS

Sensitive Plants

- Field surveys were conducted to determine the distribution of the Clokey eggvetch (*Astragalus oophorus* var. *clokeyanus*) in the Tongue Wash area of the NNSS (in Area 12 along the eastern slopes of Rainier Mesa).
- New populations of Pahute green gentian (*Frasera pahutensis*), Rock purpusia (*Ivesia arizonica* var. *saxosa*), and Weasel phacelia (*Phacelia mustelina*) were found opportunistically, all of which represented range extensions for these species, and the data were recorded in the NNSS herbarium database.
- Field surveys were conducted for Kingston Mountains bedstraw (*Galium hilendiae* ssp. *kingstonense*) in the Kingston Mountains of eastern California and on the NNSS to establish the taxonomy of the species found on the NNSS. Plant collections were made and will be sent to taxonomic experts to verify correct nomenclature.

Migratory Birds

- Ten known bird mortalities were documented (Figure 16-3). Seven red-tailed hawks (*Buteo jamaicensis*) and two great horned owl (*Bubo virginianus*) were electrocuted by power lines, and one common poorwill (*Phalaenoptilus nuttallii*) was killed by a vehicle. Biologists and Power Support personnel met to discuss measures to mitigate raptor electrocutions and power equipment damage related to raptor nests and perches. Identified measures included conducting surveys for, and removing, bird nests on power poles prior to the breeding season, monitoring the condition of insulators compromised by bird scat, and improving communications of incidents to allow prompt corrective actions. During biological surveys for proposed projects, no migratory bird nests, eggs, or young were found in 2011. Biologists ensure that migratory birds and active nests are not harmed by proposed projects and ongoing activities.

Mountain Lions (*Puma concolor*)

- A collaborative effort with Erin Boydston of the U.S. Geological Survey (USGS) continued to investigate mountain lion distribution and abundance on the NNSS using remote, motion-activated cameras. Cameras collected a total of 37 photographs/video clips from 10 of 22 camera sites.
- A collaborative effort with Dr. David Mattson of the USGS to investigate the movements, habitat use, and food habits of mountain lions on the NNSS using radio-collared individuals continued in 2011. A male was captured in April and was radio-tracked along with the two females (NNSS1 and NNSS2) captured in December 2010. The documented kills of NNSS1 included 18 mule deer and 13 desert bighorn sheep (*Ovis canadensis nelsoni*), which are the first records of a reproducing population of these sheep on the NNSS. NNSS1 gave birth to at least one cub in early September, and her estimated home range is 917 square kilometers (354 square miles). The only documented kill of NNSS2 was a coyote, and she was found dead of starvation on February 1 in the Thirsty Canyon area west of the NNSS. NNSS3 spent most of his time off the NNSS in Death Valley National Park. His estimated home range is 3,844 square kilometers (km^2) (1,484 square miles [mi^2]), which may be one of the largest documented for mountain lions.

Wild Horses (*Equus caballus*)

- The annual horse census was conducted, and 37 individuals were counted, not including foals. Six foals were observed in April through September (Figure 16-4), although only one foal was observed in November. The estimated size of the wild horse range on the NNSS was 236 km^2 (91 mi^2). Camp 17 Pond and Gold Meadows Spring continue to be important summer water sources for horses.

Mule Deer (*Odocoileus hemionus*)

- Mule deer surveys were conducted in Areas 12, 19, and 20, and the average number of deer counted was 40 deer/night, similar to 2010. Deer density ranged from 0.4 to 6.2 deer/km^2 (0.2–2.4 deer/mi^2) between different segments of the survey route and averaged about 1.9 deer/km^2 (0.7 deer/mi^2). Deer counts over the last 6 years have fluctuated greatly and show no distinctive trend.

Bats

- Bat vocalizations and concurrent climate data were collected from Camp 17 Pond.
- Eight bats were found and documented at eight NNSS buildings.

Western Red-Tailed Skink (*Plestiodon gilberti rubricaudatus*)

- Surveys for the western red-tailed skink were conducted to determine its distribution and habitat use on the NNSS. Five were captured at four sites. NNSS biologists collaborated with Dr. Jonathan Richmond of the USGS, and provided him with skink tissue samples for genetic testing.

Natural and Man-made Water Sources

- Eleven natural NNSS wetlands were monitored to document water surface area, surface flow, observed disturbances, and wildlife use and mortality. No wetlands were damaged by NNSS activities. As in previous years, a sensitive species of springsnail (*Pyrgulopsis turbatrix*) was present at Cane Spring, which is this species' only natural habitat on the NNSS.
- Man-made water sources were monitored for wildlife use and mortality. They included 27 plastic-lined sumps and 1 radioactive containment pond. No wildlife mortality was observed at any water source; their use by wildlife is presented in Hansen et al. (2012).

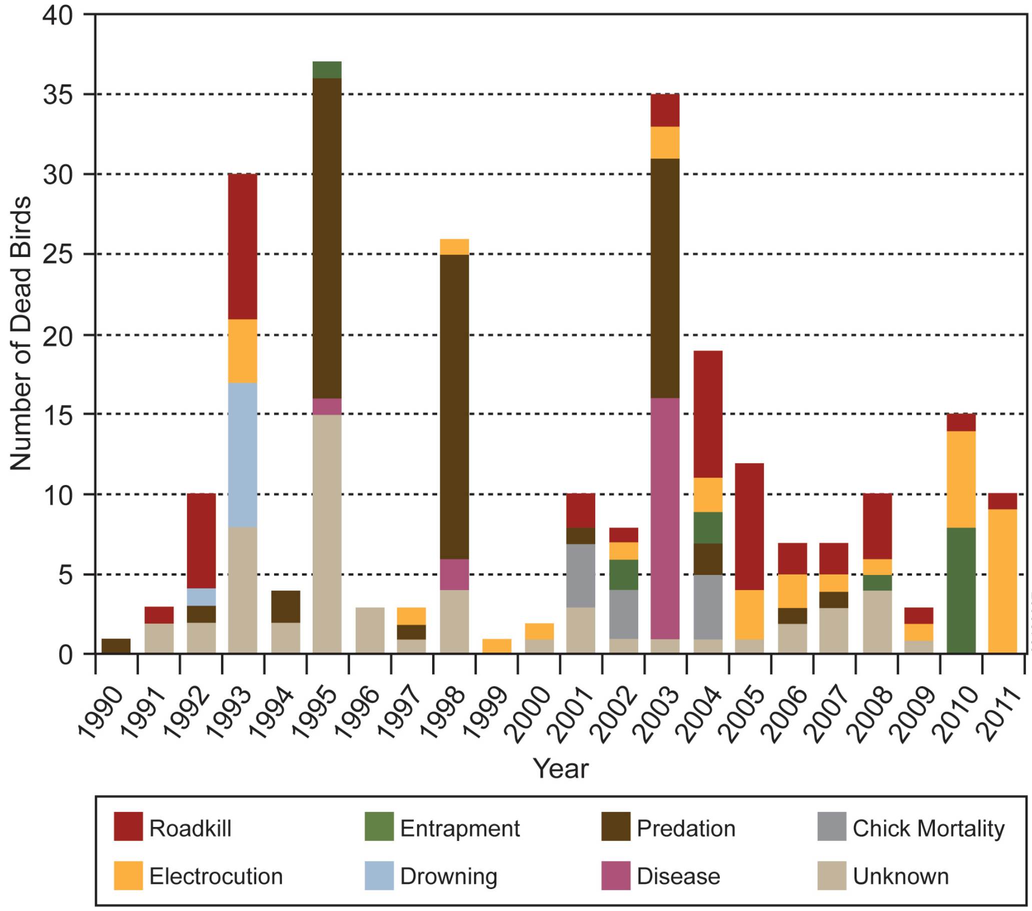

Figure 16-2. Number of bird deaths recorded on the NNSS by year and cause

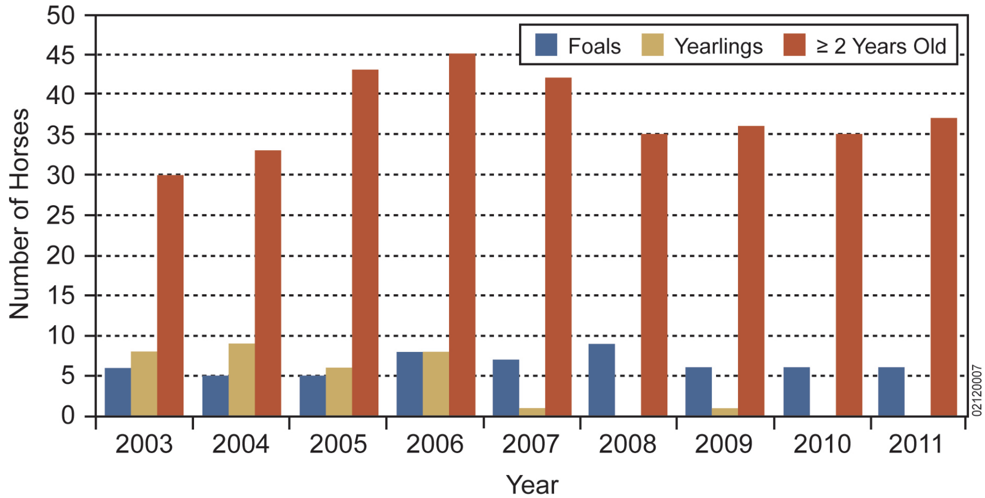

Figure 16-3. Trends in age structure of the NNSS horse population from 2003 to 2011

16.4 West Nile Virus Surveillance

West Nile virus (WNV) surveillance on the NNSS continued in 2011 for the eighth consecutive year in cooperation with the Southern Nevada Health District. Eleven sites were sampled for mosquitoes, and a total of 146 mosquitoes representing three species were captured. All specimens were negative for WNV.

16.5 Habitat Restoration 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 NNSS. Revegetation supports the intent of Executive Order 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 Opinion. 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 to protect against soil erosion and water percolation into buried waste.

In October 2011, a large-scale revegetation effort began at the Area 5 Radioactive Waste Management Complex, completing the final stage of closure on the 92-Acre Area that first began operation in the 1960s (see Section 10.1.1). Ten native shrub species, three native grasses, and three native forb species were seeded on 45 of the 92 ac. The new vegetation will provide a supplemental layer to the engineered covers that were constructed in May 2011 over 39 low-level and mixed low-level waste disposal units. The cover caps consist of a soil layer that is 2.4 meters (8 feet) thick. In December 2011, installation of a temporary irrigation system was completed, which will provide water to the 45 ac until seeds germinate and plants become established in the spring of 2012. To date, this is the largest revegetation effort of this kind at the NNSS.

In 2011, two revegetated sites on the NNSS and two on the Tonopah Test Range (TTR) were monitored. The NNSS sites were the closure cover on the U-3ax/bl disposal unit (Corrective Action Unit [CAU] 110), revegetated in 2000, and the Control Point waterline, revegetated in 2009. The TTR sites included Five Points Landfill (CAU 400), revegetated in 1997, and Rollercoaster RADSAFE (CAU 407), revegetated in 2004. Monitoring results are reported in Hansen et al. (2012).

16.6 Wildland Fire Hazard Assessment

A Wildland Fire Management Plan is maintained, which requires protection of site resources from wildland and operational fires. An annual vegetation survey to determine wildland fire hazards is conducted on the NNSS each spring. Survey findings are submitted to the NNSS Fire Marshal and summarized in the annual EMAC report (Hansen et al., 2012). In April and May 2011, NNSS biologists visited 106 roadside sampling stations to assess a fuel index that can range from 0 to 10 (lowest to highest risk of wildfires). The mean combined fuels index for all 106 sampling stations was 5.14. In 2011, there were 20 wildland fires, which burned 3,611 ha (8,923 ac). Fourteen fires were caused by lightning, five were caused by ordnance associated with training exercises, and one was caused by a bird on a power line.

16.7 Biological Monitoring of NPTEC

Biological monitoring at NPTEC in Area 5 is performed when 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 east of the NNSS border, approximately 5 kilometers (3 miles) from NPTEC. The National Wildlife Refuge System Administration Act forbids the disturbance or injury of native plants and wildlife on any National Wildlife Refuge System lands unless permitted by the Secretary of the Interior. Biological monitoring is conducted to verify that NPTEC 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 downwind and upwind of NPTEC and recording dead animals and vegetation damage. In 2011, no chemical testing that could pose significant exposures to biota was performed at NPTEC, and no baseline monitoring was conducted at control-treatment transects near NPTEC.

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) Part 830, Subpart A, "Quality Assurance Requirements," and with U.S. Department of Energy (DOE) Order DOE O 414.1, "Quality Assurance." The 10 criteria of a quality program 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 Objective (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, obtaining a measurement, 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 that 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, 2010b).

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, 2010b). 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 analytical methods to be used are also consulted in order to ensure that, as methods are revised, sample collection is performed appropriately and that viable samples are obtained.

17.2.3 Field Documentation

Field documentation is generated for each sample collection activity. This 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 field parameters have stabilized, thereby indicating that the purge water is generally representative of the aquifer, at which time sample collection 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 2.6, November 2010 (DOE, 2010b). 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 Standard ISO 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 on the part of both the laboratory and DOE. Consequently, BOA-holding laboratories are primarily those providing a wide range of analytical services to 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 as follows:

- 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 as well as 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), and analytical, geotechnical, and field parameters at the Nevada National Security 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 2011 results for field duplicates, laboratory control samples, blank analyses, 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, water, or direct radiation) 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 the laboratory's reported 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). The summary of field duplicate samples is provided in Table 17-1.

The values in Table 17-1 fall in typical ranges. The highest average RPDs are associated with two types of phenomena. RPDs for actinides, and consequently for gross alpha, can be elevated when one sampler of a pair intercepts a particle with high Am or Pu while the other sampler in the pair had a typical background value (54.3% in $^{239+240}$Pu, 39.9% in ^{241}Am, and 21.4% in gross alpha). Also, higher average RPDs are often associated with relatively few pairs having both values above their MDCs. The average RER can also be affected by particulates, as with $^{239+240}Pu$ (RER=1.44) and by small numbers of pairs overall.

Table 17-1. Summary of field duplicate samples for compliance monitoring in 2011

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	104	19	21.4	0.66
Gross beta	Air	104	103	9.8	1.11
Tritium	Air	56	10	13.6	0.82
^{241}Am	Air	24	11	39.9	0.87
^{238}Pu	Air	22	0	–	0.79
$^{239+240}Pu$	Air	24	7	54.3	1.44
$^{233+234}U$	Air	15	15	14.8	0.74
$^{235+236}U$	Air	15	3	30.0	0.70
^{238}U	Air	15	15	13.0	0.65
^{7}Be[(e)]	Air	23	23	8.5	0.90
^{134}Cs[(f)]	Air	2	2	25.9	1.83
^{137}Cs	Air	24	2	39.1	0.67
^{40}K[(e)]	Air	24	7	39.1	0.67
Gross alpha	Water	2	2	40.2	1.20
Gross beta	Water	2	2	25.4	1.99
Tritium	Water	23	4	5.1	1.15
TLD	Ambient Radiation	431	NA	3.2	0.30

(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 pairs with both values above their minimum detectable concentrations (MDCs). If either the field sample or its duplicate was reported below the MDC, the RPD was not determined. This does not apply to thermoluminescent dosimeter (TLD) measurements; since TLDs virtually always detect ambient background radiation, MDCs are not computed.

(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 1 sigma uncertainties. The RER is calculated for all sample and field duplicate pairs reported without regard to the MDC.

$$Absolute\ RER = \frac{|S - D|}{\sqrt{(SD_S)^2 + (SD_D)^2}}$$

Where: S = Sample result
D = Duplicate result
SD_S = uncertainty standard deviation of the field sample
SD_D = uncertainty standard deviation of the field duplicate

(e) ^{7}Be and ^{40}K are naturally occurring analytes included for quality assessment of the gamma spectroscopy analyses.

(f) ^{134}Cs was detected in a few samples around the time of the Fukushima Daiichi Nuclear Power Plant event in March 2011.

17.5.2.2 Laboratory Control Samples (LCSs)

An LCS is prepared from a sample matrix verified to be free from the analytes of interest, and then 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, 2010b).

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 2011 LCSs analyzed and within control limits are summarized in Table 17-2. There were no systemic issues identified in 2011 by LCS recovery data, and no failures required invalidating the associated sample data.

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 that might be introduced 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, 2010b). The following discusses the blanks routinely used during environmental monitoring activities.

- A trip blank is a sample of analyte-free media taken from the laboratory to the sampling site and returned to the laboratory unopened. A trip blank is used to document contamination attributable to shipping and field handling procedures. This type of blank is useful in documenting contamination of volatile organics samples (DOE, 2010b).
- An equipment blank is a sample of analyte-free media that has been used to rinse common sampling equipment to check effectiveness of decontamination procedures (DOE, 2010b).
- A field blank is prepared in the field by filling a clean container with purified water (appropriate for the target analytes) and appropriate preservative, if any, for the specific sampling activity being undertaken. The field blank is used to indicate the presence of contamination due to sample collection and handling (DOE, 2010b).
- A method blank is a sample of a matrix similar to the batch of associated samples 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, 2010b). The laboratory method blank data are summarized in Table 17-3.

There were no systemic issues identified in 2011 by any of the blank data, and no failures that required invalidating the associated sample data.

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 2011 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 17-2. Summary of LCSs for 2011

	Analyte	Matrix	Number of LCS Results Reported	Number Within Control Limits	Control Limits (%)
Radiological Analyses	Tritium	Air	48	48	70–130
	^{60}Co	Air	33	33	70–130
	^{137}Cs	Air	33	33	70–130
	$^{239+240}$Pu	Air	41	41	70–130
	^{241}Am	Air	76	76	70–130
	Gross alpha	Water	16	16	70–130
	Gross beta	Water	16	16	70–130
	Tritium	Water	29	29	70–130
	^{60}Co	Water	8	8	70–130
	^{90}Sr	Water	14	14	70–130
	^{137}Cs	Water	8	8	70–130
	$^{239+240}$Pu	Water	12	12	70–130
	^{241}Am	Water	8	8	70–130
	^{60}Co	Soil	5	5	70–130
	^{90}Sr	Soil	6	6	70–130
	^{137}Cs	Soil	5	5	70–130
	$^{239+240}$Pu	Soil	6	6	70–130
	^{241}Am	Soil	10	10	70–130
Nonradiological Analyses	Metals	Water	172	172	80–120
	Volatiles	Water	236	209	70–130
	Semi volatiles	Water	342	342	Laboratory specific
	Miscellaneous	Water	222	213	80–120
	Metals	Soil	3	3	75–125

Table 17-3. Summary of laboratory blank samples for 2011

	Analyte	Matrix	Number of Blank Results Reported	Number of Results < MDC
Radiological Analyses	Tritium	Air	46	46
	^{7} Be	Air	33	33
	^{60}Co	Air	26	26
	^{137}Cs	Air	33	33
	^{238}Pu	Air	25	21
	$^{239+240}$Pu	Air	25	24
	^{241}Am	Air	51	38
	Gross alpha	Water	16	16
	Gross beta	Water	16	15
	Tritium	Water	29	29
	^{60}Co	Water	9	9
	^{90}Sr	Water	10	10
	^{137}Cs	Water	9	9
	^{238}Pu	Water	9	9
	$^{239+240}$Pu	Water	9	9
	^{241}Am	Water	10	10
	^{60}Co	Soil	4	4
	^{90}Sr	Soil	4	4
	^{137}Cs	Soil	4	4
	^{238}Pu	Soil	4	4
	$^{239+240}$Pu	Soil	4	3
	^{241}Am	Soil	7	6

Table 17-3. Summary of laboratory blank samples for 2011 (continued)

	Analyte	Matrix	Number of Blank Results Reported	Number of Results < Reporting Limit
Nonradiological	Metals	Water	216	209
	Volatiles	Water	280	272
	Semi volatiles	Water	396	385
	Miscellaneous	Water	210	192
	Metals	Soil	2	2

Table 17-4. Summary of 2011 MAPEP reports

	Analyte	Matrix	Number of Results Reported	Number within Control Limits[(a)]
Radiological Analyses	Gross alpha	Filter	4	2
	Gross beta	Filter	4	2
	^{60}Co	Filter	4	4
	^{137}Cs	Filter	4	4
	^{238}Pu	Filter	4	4
	$^{239+240}Pu$	Filter	4	3
	^{241}Am	Filter	4	4
	Gross alpha	Water	4	4
	Gross beta	Water	4	4
	Tritium	Water	4	3
	^{60}Co	Water	4	4
	^{90}Sr	Water	4	4
	^{137}Cs	Water	4	4
	^{238}Pu	Water	4	4
	$^{239+240}Pu$	Water	4	4
	^{241}Am	Water	4	4
	^{60}Co	Vegetation	4	4
	^{90}Sr	Vegetation	4	4
	^{137}Cs	Vegetation	4	4
	^{238}Pu	Vegetation	4	4
	$^{239+240}Pu$	Vegetation	4	4
	^{241}Am	Vegetation	4	4
	^{60}Co	Soil	4	4
	^{90}Sr	Soil	4	4
	^{137}Cs	Soil	4	4
	^{238}Pu	Soil	4	4
	$^{239+240}Pu$	Soil	4	4
	^{241}Am	Soil	4	4
Nonradiological Analyses	Metals	Water	103	103
	Organics	Water	277	277
	Metals	Soil	107	104
	Organics	Soil	411	406

(a) Based upon MAPEP criteria

Table 17-5. Summary of inter-laboratory comparison TLD samples for the subcontract dosimetry group in 2011

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 1 standard deviation < 0.3

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 Chapter 7 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 Chapter 17.

- 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 (DQOs)

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 7.1 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 protocols 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 discs 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). The CEMP does not 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 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 an LQAP prepared by the laboratory. The elements of an 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.

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 workflow (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 2011 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); Mirion Technologies (thermoluminescent dosimeter [TLD] data); and the University of Miami Tritium Laboratory (tritium data). A brief discussion of the 2011 results for field duplicates, laboratory control samples, blank analyses, and inter-laboratory comparison studies is provided along with summary tables within this section. The 2011 CEMP radiological air and water monitoring data are presented in Chapter 7.

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 2011 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 is 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 2011

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	68.5
Gross Beta	Air	76	76	38.5
Gamma – Beryllium-7	Air	10	10	22.7
Tritium	Water	4	2	0.1
TLDs	Ambient Radiation	12	NA	2.9

(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.

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 percentage. To be considered valid, the results must fall within established control limits (or percentage ranges) for further analyses to be performed. The LCS results obtained for 2011 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 (LCSs) for CEMP monitoring in 2011

Analysis	Matrix	Number of LCS Results Reported	Number Within Control Limits[a]
Gross Alpha	Air	60	60
Gross Beta	Air	60	60
Gamma	Air	9	9
Tritium	Water	4	4

(a) Control limits are as follows: 78% to 115% for gross alpha, 87% to 115% for gross beta, 90% to 110% for gamma (^{137}Cs, ^{60}Co, ^{241}Am), and 80% to 120% 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 2011 are summarized in Table 18-3. The laboratory blank results were satisfactory with less than 3% 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 2011

Analysis	Matrix	Number of Blank Results Reported	Number within Control Limits[a]
Gross Alpha	Air	60	58
Gross Beta	Air	60	59
Gamma	Air	9	9
Tritium	Water	4	4

(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 2011 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 QA Program administered by Environmental Research Associates (ERA) and/or the Mixed Analyte Performance Evaluation Program (MAPEP) for gross alpha, gross beta, and gamma analyses. The subcontract tritium laboratory participated in 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 and tritium laboratories for CEMP monitoring in 2011

Analysis	Matrix	Number of Results Reported	Number Within Control Limits[(a)]
		MAPEP, ERA, and IAEA Results	
Gross Alpha	Air	7	7
Gross Beta	Air	7	7
Gamma	Air	5	5
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 2011

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 National Security Site (NNSS). They include the North Las Vegas Facility (NLVF) and the Remote Sensing Laboratory–Nellis (RSL-Nellis) (Figure A-1). This appendix describes all environmental monitoring and compliance activities conducted in 2011 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 NNSS project management, diagnostic development and testing, design, engineering, and procurement personnel. 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 2011 included the maintenance of one wastewater permit, one National Pollutant Discharge Elimination System (NPDES) permit, one Spill Prevention, Control, and Countermeasure (SPCC) Plan, one air quality operating permit, and 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 and plans for the NLVF in 2011

Permit Number	Description	Expiration Date	Reporting
Wastewater Discharge			
VEH-112	NLVF Wastewater Contribution Permit	December 31, 2013	Annually
NV0023507	NLVF NPDES Permit	November 2, 2011/2012	Quarterly
Oil Pollution Prevention			
National Security Technologies, LLC (NSTec) PLN-1089	SPCC Plan for North Las Vegas Complex	None	None
Air Quality			
Source 657	Clark County Department of Air Quality Minor Source Permit	November 1, 2015	Annually
Hazardous Materials			
14493	NLVF Hazardous Materials Permit	February 29, 2011/2012	Annually

A.1.1 Compliance with Water Permits

NLVF wastewater permits in 2011 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 at the facility. Discharges of sewage and industrial wastewater from the 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 the outfalls of sewage and industrial wastewater is conducted. In 2011, contaminant concentrations (in milligrams per liter [mg/L]) were below the established permit limits in all water samples taken from the two NLVF outfalls (Table A-2).

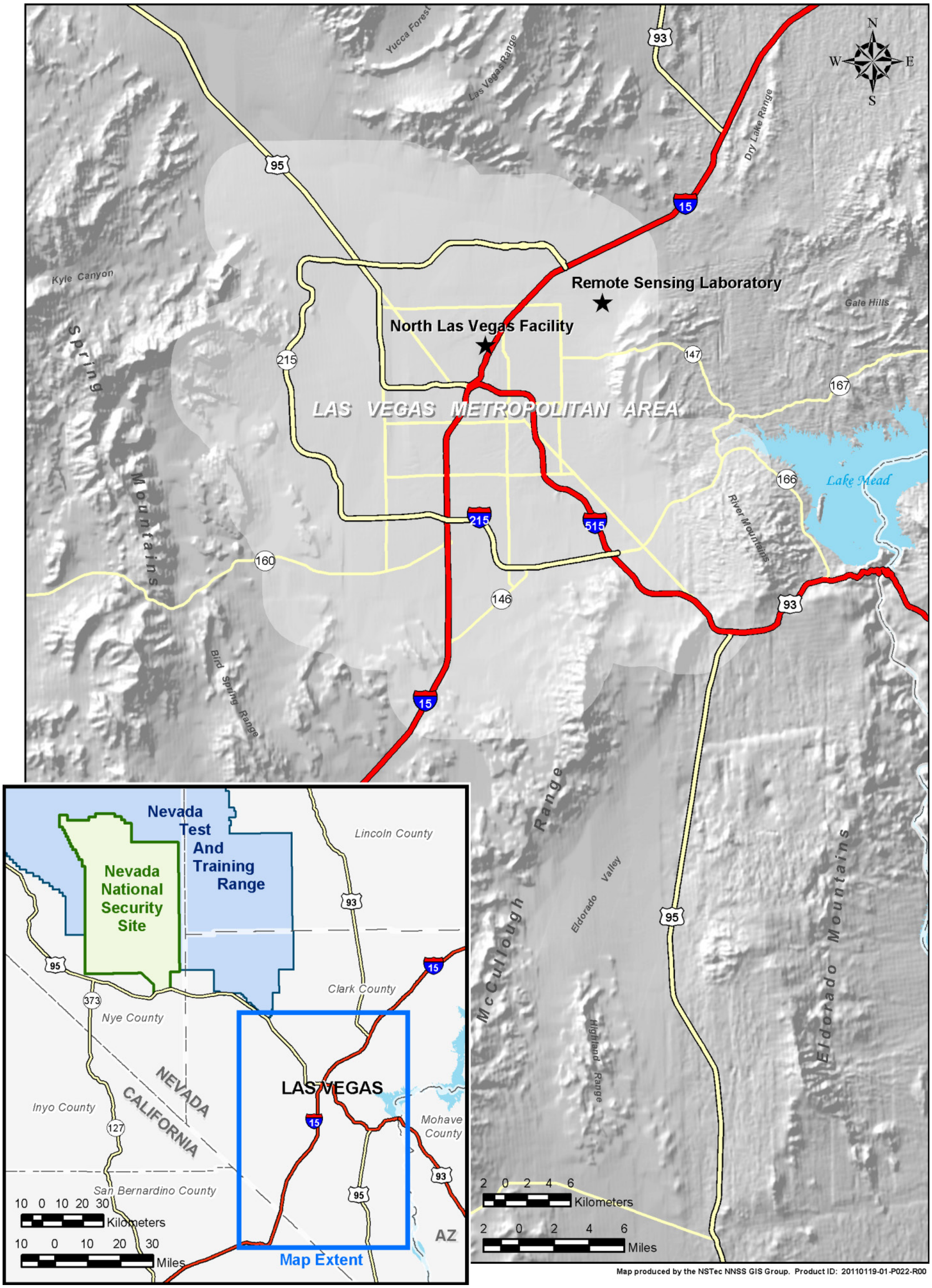

Figure A-1. Location of NNSS offsite facilities in Las Vegas and North Las Vegas

Table A-2. Results of 2011 monitoring at the NLVF for Wastewater Contribution Permit VEH-112

Contaminant	Permit Limit (mg/L)	Outfall A (mg/L)	Outfall B (mg/L)
Ammonia	61.0	24.1	23.3
Arsenic	2.3	0.00227[(a)]	0.00189[(a)]
Barium	13.1	0.123	0.155
Beryllium	0.02	<0.00025	<0.00025
Cadmium	0.15	0.0003[(a)]	0.000227[(a)]
Chromium (hexavalent)	0.10	<0.02	<0.02
Chromium (total)	5.60	0.000825[(a)]	0.00088[(a)]
Copper	0.60	0.140	0.447
Cyanide (total)	19.9	<0.00505	<0.005
Lead	0.20	0.000956[(a)]	<0.0015
Mercury	0.001	<0.0001	0.000082[(a)]
Nickel	1.10	0.00399[(a)]	0.00527[(a)]
Oil and Grease (animal or vegetable)	250	<10.0	<10.0
Oil and Grease (mineral or petroleum)	100	<10.0	<10.0
Organophosphorus or carbamate compounds	1.0	<0.01	<0.01
pH (Standard Units)	5.0–11.0	8.41	8.44
Phenols	33.6	0.0654	<0.05
Phosphorus (total)	0.50	0.28	0.26
Selenium	2.70	0.00366	0.00308
Silver	8.20	<0.001	<0.001
Zinc	13.1	0.204	0.292

(a) Estimated concentration, the concentration between the method detection limit and the method reporting limit.

In compliance with this permit, a report summarizing wastewater monitoring was generated for NLVF operations and was submitted to the CNLV on October 17, 2011. The report is titled *Self-Monitoring Report for the National Nuclear Security Administration's North Las Vegas Facility: Permit VEH-112.*

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 permit 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 2011, the four dewatering wells produced a total of about 9,464 L (2,500 gal) per day that were directed into the storage tank (Figure A-2). The average pumping rates varied from 2.8 liters per minute (lpm) (0.74 gallons per minute [gpm]) at Well NLVF-13s to 0.5 lpm (0.14 gpm) at Well NLVF-15. The average combined discharge from all four wells was about 295,262 L (78,000 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 May 2011. The results are summarized in Table A-3.

re A-2. Location of dewatering and monitoring wells around Building A-1

Table A-3. NPDES Permit NV0023507 monitoring requirements and 2011 sampling results

Parameter	Monitoring Requirements Sample Frequency	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	0.002638	0.002741	0.002266	0.002321
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	1030	1170	1170	1130
Total Inorganic Nitrogen as N (mg/L)	Quarterly	Discrete	20	1.16	1.54	1.25	1.22
pH (Standard Units)	Quarterly	Discrete	6.5–9.0	7.91	8.01	8.0	7.94
Tritium (picocuries per liter [pCi/L])	Annually (4th Qtr)	Discrete	MR[(d)]	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	0.00101
24 Pesticides/PCBs[(e)]	Biennial	Discrete	MR	NS	NS	NS	ND
Dioxins	Biennial	Discrete	MR	NS	NS	NS	ND
13 Metals**	Biennial	Discrete	MR	NS	NS	NS	ND
Arsenic				NS	NS	NS	0.0131
Copper				NS	NS	NS	0.0153
Nickel				NS	NS	NS	0.00256
Zinc				NS	NS	NS	0.0155
Cyanide	Biennial	Discrete	MR	NS	NS	NS	ND
Asbestos	Biennial	Discrete	MR	NS	NS	NS	<0.2

(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) 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
(e) PCBs = Polychlorinated biphenyls
*All 31 volatile organics were ND except chloroform as shown
**All 13 metals were ND except for arsenic, copper, nickel, and zinc as shown

A.1.2 Groundwater Control and Dewatering Operation

During 2011, 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; 2005b; NSTec, 2006b; 2008).

Groundwater monitoring for this operation includes taking periodic water-level measurements at 24 accessible wells out of the 27 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.

In 2011, about 295,262 L (78,000 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 127,568 L (33,700 gal) per month in 2011. When the A-1 Basement Sump well pump is active, the water level directly beneath Building A-1 is about 39.4 centimeters (cm) (15.5 inches [in.]) below the basement floor, as measured in a monitoring tube installed in a nearby elevator shaft. This water level reflects 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 24 accessible NLVF monitoring wells shows rising water levels that are about 1.5 meters (5 feet) higher than levels obtained over the past 10 years. The dewatering efforts must counter this rising groundwater trend. Nine of the monitoring wells have steady water levels, five have decreasing water levels, and ten have increasing water levels. The nearest monitoring wells, NLVF-1s, NLVF-12s, NLVF-12d, 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 NNSS. The sump well was turned off after the remedial operations were completed. However, beginning in early 2003, the sump well has been used 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 8 years from about 1,900 pCi/L to about 290 pCi/L (average of two analyses) in 2011 (or about 1/70th of the Safe Drinking Water Act limit of 20,000 pCi/L). The discharge is transported to the NNSS during the winter, but during the warm months, the discharge has been evaporated with an exterior array of evaporative cooling units located on the north side of Building A-1. In 2011, however, the evaporative cooling units were not used. A total of 1,530,253 L (404,250 gal) of water were pumped from the sump well and transported to the NNSS for disposal in 2011. The measured tritium concentrations of the transported water were used to estimate total curies released to the atmosphere in 2011 at the NNSS (see Section 4.1.9, Table 4-13) and at the NLVF (see Section A.1.6.1).

A.1.3 Oil Pollution Prevention

An SPCC Plan is in place for the NLVF, which was prepared in accordance with the Clean Water Act to minimize the potential discharge of petroleum products, animal fats and vegetable oils, and other non-petroleum oils and greases into waters of the U.S. (i.e., the Las Vegas Wash). The U.S. Environmental Protection Agency (EPA) requires SPCC Plans for non-transportation–related facilities having the potential to pollute waters of the U.S. and having an aggregate aboveground oil storage capacity of more than 4,997 L (1,320 gal). Oil storage facilities at the NLVF include 9 aboveground tanks, 18 transformers, 14 pieces of oil-filled machining equipment (e.g., lathes, elevators), and numerous 55 gal drums that are used to store new and used oils. These facilities/pieces of equipment are located within approved spill and storm water runoff containment structures. The SPCC specifies procedures for removing storm water from containment structures and identifies discharge countermeasures, disposal methods for recovered materials, and discharge reporting requirements.

In 2011, quarterly inspections of tanks, transformers, oil-filled equipment, and drums were conducted on March 10, May 25–26, September 22, and December 14. The inspections identified tanks requiring labeling and the need for a new drum for used cooking oil. These findings were corrected. Throughout 2011, all NLVF employees who handle oil received their required annual spill prevention and management training. On May 4, a review of the SPCC Plan was conducted, which led to a revision of the plan to reflect two aboveground tanks that had been replaced and a transformer that had been removed. Elevators were also added to the SPCC Plan based on a determination that they could be designated as oil-filled equipment. No spills were reported in 2011.

A.1.4 Compliance with Air Quality Permits

Sources of air pollutants at the NLVF are regulated by the Source 657 Minor Source Permit issued by the Clark County Department of Air Quality (DAQ) 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 2011, an old emergency generator at Building A-5 was replaced by a new one and removed from the NLVF. A request to delete it from the permit was provided to the DAQ. There were no other modifications to the permit in 2011. The DAQ requires an annual emissions inventory of criteria air pollutants and HAPs. The 2011 emissions inventory was submitted to the DAQ on March 13, 2012, which reported the estimated quantities shown in Table A-4.

Table A-4. Summary of air emissions for the NLVF in 2011

	Criteria Pollutant (Tons/yr)[(a)]					
	CO	NO_x	PM10[(b)]	SO_2	VOC	HAPs (Tons/yr)
PTE[(c)]	1.80	8.85	1.31	0.39	0.41	Not specified
Actual	0.27	1.27	0.14	0.06	0.06	0.02
Total Emissions = 1.82 Actual, 12.76 PTE						

(a) 1 ton equals 0.91 metric tons
(b) Particulate matter equal to or less than 10 microns in diameter
(c) Potential to emit: The quantity of criteria air pollutant that facilities/pieces of equipment would emit annually if they were operated for the maximum number of hours at the maximum production rate specified in the air permit

Clark County air regulations specify that the opacity from any emission unit may not exceed the Clean Air Act National Ambient Air Quality Standards (NAAQS) opacity limit of 20% for more than 6 consecutive minutes. The NLVF air permit requires that at least one visual emissions observation be performed each week for the boilers, generators, emergency fire pump, emergency generator, and the cooling towers. There are other emission units at the NLVF for which the observation frequency is not specified. If emissions are observed, then EPA Method 9 opacity readings are recorded by a certified visible emissions evaluator. If visible emissions appear to exceed the limit, corrective actions must be taken to minimize emissions. In 2011, two NLVF personnel were recertified by Carl Koontz Associates to conduct opacity readings. In 2011, readings were taken for generators and an aluminum sander; emissions were well below the NAAQS opacity limit of 20%.

A.1.5 Compliance with Hazardous Materials Regulations

In 2011, maintenance of fluorescent lights at the NLVF generated one drum (26 kilograms [57 pounds]) of PCB light ballasts, which was shipped off site to an approved PCB disposal facility. In 2011, the chemical inventory at the NLVF was updated and submitted to the State in the Nevada Combined Agency (NCA) Report on February 22, 2012. The inventory data were submitted in accordance with the requirements of the Hazardous Materials Permit 14493 (see Section 2.6, Emergency Planning and Community Right-to-Know Act, for a description of the content, purpose, and federal regulatory driver behind the NCA Report). No accidental or unplanned release of an extremely hazardous substance (EHS) occurred at the NLVF in 2011. Also, the quantities of toxic chemicals kept at the NLVF that are used annually did not exceed the specified reporting thresholds (see Section 2.6 concerning Toxic Chemical Release Inventory, Form R).

A.1.6 Southern Nevada Health District Audit of Hazardous Waste

Hazardous wastes (HWs) generated at the NLVF include such items as non-empty aerosol cans, lead debris, and oily rags. HWs are stored temporarily in satellite accumulation areas until they are direct-shipped to approved disposal facilities. The NLVF is a Conditionally Exempt Small Quantity Generator; therefore, no HW permit is required by the State of Nevada. However, once a year, the Southern Nevada Health District (SNHD) conducts an onsite audit to validate proper handling and storage. SNHD personnel conducted the annual audit on September 13, 2011, and found existing HW procedures acceptable.

A.1.7 Compliance with Radiation Protection Regulations

A.1.7.1 National Emission Standards for Hazardous Air Pollutants (NESHAP)

In compliance with NESHAP of the Clean Air Act, the radionuclide air emissions from the NLVF and the resultant radiological dose to the public surrounding the facility were assessed. 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, 1996b). 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. Since 1995, a dose assessment has been performed every year for this building.

In 2011, groundwater containing detectable levels of tritium was pumped from the sump well in the basement and transported to the NNSS for disposal. Potential emissions from this activity were estimated by applying the emission factor for liquids listed in Title 40 Code of Federal Regulations Appendix D to Part 61, "Methods for Estimating Radionuclide Emissions," to the total amount of tritium handled (tritium concentration in the groundwater multiplied by the volume). Also, the tritium emission in air coming from the building was determined by taking two air samples from the basement (from April 5 to 12 and from September 12 to 19) in order to compute average tritium emissions from the basement. A calculated annual total of 4.83 millicuries were released: virtually all from the basement air that was vented to the outside. Based on this emission rate, the 2011 calculated radiation dose to the nearest member of the general public from the NLVF was very low: 0.000024 mrem/yr (NSTec, 2012a). The nearest public place is located 100 meters (328 feet) northwest of Building A-1. This annual dose is 25% lower than the public dose estimated for the previous year of 2010 (NSTec, 2011c).

A.1.7.2 DOE O 458.1

U.S. Department of Energy (DOE) Order DOE O 458.1, "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. Direct radiation is conducted using 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 Chapter 6 of this report.

In 2011, radiation exposure was measured at two locations along perimeter fences for Buildings A-1 and C-3 and at one control location along the west fence of the C-1 Building. Annual exposure rates estimated from measurements at those 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 similar to the TLD measurement of 92 mR/yr for total annual exposure reported by the Desert Research Institute from their Las Vegas air monitoring station (see Section 7.1.3, 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 the dose due to background radiation.

Table A-5. Results of 2011 direct radiation exposure monitoring at the NLVF

Location	Number of Samples	Gamma Exposure (mR/yr)			
		Mean	Median	Minimum	Maximum
West Fence of Building C-1 (Control)	4	81	80	68	95
North Fence of Building A-1	4	62	62	58	66
North Fence of Building C-3	4	64	65	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 the 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 2011 included maintenance of a wastewater discharge permit, air quality permit, 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 2011

Permit Number	Description	Expiration Date	Reporting
Wastewater Discharge			
CCWRD-080	Industrial Wastewater Discharge Permit	June 30, 2011/2012	Quarterly
Air Quality			
Facility 348, Mod. 3	Clark County Authority to Construct/Operating Permit for a Non-Major Testing Laboratory	None	Annually
Hazardous Materials			
14496	RSL-Nellis Hazardous Materials Permit	February 29, 2011/2012	Annually
Waste Management			
U1576	RSL-Nellis Waste Management Permit – Underground Storage Tank	December 31, 2011	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 2011. All contaminants in the outfall samples were below permit limits. Quarterly reports were submitted to the CCWRD on March 2, May 12, September 12, and December 5, 2011. The CCWRD also conducted two inspections of RSL-Nellis in 2011. The inspections resulted in no findings or corrective actions for the facility.

Table A-7. Mean concentration of outfall measurements at RSL-Nellis in 2011

Contaminant/Measure	Permit Limit (mg/L)	Outfall (mg/L)
Ammonia	NL[a]	21.7
Cadmium	0.35	0.00169
Chromium (Total)	1.7	0.00251
Copper	3.36	0.388
Cyanide (Total)	1	<0.005
Lead	0.99	0.0083
Nickel	10.08	0.0133
Oil and Grease as SGT-HEM	100	<5.0
Phosphorus	NL	6.4
Silver	6.3	0.0004
Total Dissolved Solids	NL	1,121
Total Suspended Solids	NL	355
Zinc	23.06	0.381
pH (Standard Units)	5.0–11.0	8.28
Temperature (degrees Fahrenheit)	140	76.3

(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 DAQ. A modification to the permit was submitted to the DAQ in October 2011 in order to (1) increase the allowable total dissolved solids concentrations of the two cooling towers, (2) add 53 portable diesel or gasoline-fired generators (28 to be permitted and 25 to be listed as insignificant sources), and (3) remove a boiler from the permit. In accordance with the DAQ recently revised regulations, the permit will become a Minor Source Permit instead of an Authority to Construct/Operating Permit. The emissions inventory of estimated quantities of criteria air pollutants and HAPs was submitted to the DAQ on March 13, 2012, and reported the quantities shown in Table A-9.

Table A-8. Summary of air emissions for RSL-Nellis in 2011

	Criteria Pollutant (Tons/yr)[a]					
	CO	NO_x	PM10[b]	SO_2	VOC	HAPs (Tons/yr)
PTE[c]	1.82	3.06	0.61	0.07	1.34	0.60
Actual	0.77	1.72	0.09	0.03	0.08	0.02
Total Emissions = 2.71 Actual, 7.50 PTE						

(a) 1 ton equals 0.91 metric tons
(b) Particulate matter equal to or less than 10 microns in diameter
(c) Potential to emit: The quantity of criteria air pollutant that facilities/pieces of equipment would emit annually if they were operated for the maximum number of hours at the maximum production rate specified in the air permit

Clark County air regulations specify that the opacity from any emission unit may not exceed the Clean Air Act NAAQS opacity limit of 20% for more than 6 consecutive minutes. The RSL-Nellis air permit requires that equipment be observed each day it is operated. If visible emissions are observed, then EPA Method 9 opacity readings are recorded by a certified visible emissions evaluator. If visible emissions appear to exceed the limit, corrective actions must be taken to minimize emissions. In 2011, two RSL-Nellis personnel were recertified 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%.

A.2.3 Compliance with Hazardous Materials Regulations

In 2011, the chemical inventory at RSL-Nellis was updated and submitted to the State in the NCA Report on February 22, 2012, in accordance with the requirements of the Hazardous Materials Permit 14496 (see Section 2.6 of this report for a description of the content, purpose, and federal regulatory driver behind the NCA Report). No accidental or unplanned release of an EHS occurred at RSL-Nellis in 2011. Also, no annual usage quantities of toxic chemicals kept at RSL-Nellis exceeded specified thresholds (see Section 2.6 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 fully regulated 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 excluded tanks. The active tanks are inspected annually by SNHD. No deficiencies were noted during the 2011 inspection.

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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 that, 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 National Security Site at which low-level waste (LLW), mixed low-level waste (MLLW) may be received, examined, packaged, stored, or disposed. Limited quantities of onsite-generated transuranic waste (TRU) are also stored temporarily at the RWMC. 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 National Security 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.

Community water system: as defined in Nevada Revised Statute 445A.808, it is a public water system that has at least 15 service connections used by year-round residents of the area served by the system; or regularly serves at least 25 year-round residents of the area served by the system.

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.

Confining unit: a geologic unit of relatively low permeability that impedes the vertical movement of water.

Cool roof: a low-sloped roof (pitch less than or equal to 2:12) that is designed and installed with a minimum 3-year aged solar reflectance of 0.55 and a minimum 3-year aged thermal emittance of 0.75, or with a minimum 3-year aged solar reflectance index (SRI) of 64. Cool steep-sloped roofs (pitch exceeding 2:12) have a 3-year SRI of 29 or higher.

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 National Security 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 National Security 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 1 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 to 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 of 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 the 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.

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.

Non-community water system: as defined in Nevada Revised Statute 445A.828, it is a public water system that is not a community water system. Private water system: on the NNSS, a water system that is not a public water system and is not regulated under State of Nevada permits.

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.

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.

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).

Private water system: a water system that is not a public water system, as defined in Nevada Revised Statute 445A.235, and is not regulated under State of Nevada permits.

Public water system (PWS): as defined in Nevada Revised Statute 445A.235, it is a system, regardless of ownership, that provides the public with water for human consumption through pipes or other constructed conveyances, if the system has 15 or more service connections, as defined in NRS 445A.843, or regularly serves 25 or more persons. The three PWSs on the NNSS are permitted by the State of Nevada as non-community water systems.

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." 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.

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 effective dose equivalent (TEDE): The sum of the external exposures and the committed effective dose equivalent (CEDE) for internal exposures.

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; also referred to as the unsaturated zone.

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
ACM	asbestos-containing material
AEA	Atomic Energy Act
AEC	Atomic Energy Commission
AFV	alternative fuel vehicle
AICP	American Indian Consultation Program
AIWS	American Indian Writer's Subgroup
ALARA	as low as reasonably achievable
Am	americium
APP	affirmative procurement program
ARL/SORD	Air Resources Laboratory, Special Operations and Research Division
ARPA	Archaeological Resources Protection Act
ASER	Annual Site Environmental Report
ASN	Air Surveillance Network
ATM	Atomic Testing Museum
B	Background
BA	Benham aquifer
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
BTU	British thermal unit
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)
cm^2	square centimeter(s)
CNLV	City of North Las Vegas
CNTA	Central Nevada Test Area
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
CY	calendar year
DAF	Device Assembly Facility
DAQ	Department of Air Quality (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
dpm	disintegrations per minute
DQA	Data Quality Assessment
DQO	Data Quality Objective
DRI	Desert Research Institute
DSA	Documented Safety Analysis
DU	depleted uranium
E1	Environmental 1
E2	Environmental 2
EA	Environmental Assessment
E&EM	Ecological and Environmental Monitoring
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
EMAD	Engine Maintenance, Assembly, and Disassembly
EMC	Energy Management Council
EMP	Energy Management Program
EMS	Environmental Management System
EO	Executive Order
EODU	Explosive Ordnance Disposal Unit
EP	Environmental Programs
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
EPEAT	Electronic Product Environmental Assessment Tool
EPP	Environmentally Preferable Purchasing
ER	Environmental Restoration
ERA	Environmental Research Associates
ESA	Endangered Species Act
ETDS	E-Tunnel Waste Water Disposal System
Eu	europium
EWG	Environmental Working Group
EWO	Environmental Waste Operations
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
GHG	greenhouse gas
GIS	Geographic Information System
gpm	gallon(s) per minute
gsf	gross square feet
Gy	gray(s)
Gy/d	gray(s) per day
^3H	tritium
ha	hectare(s)
HAP	hazardous air pollutant
HENRE	High-Energy Neutron Reactions Experiment
HEPA	high-efficiency particulate air
HEST	High Explosives Simulation Test
HEV	hybrid electric vehicle
HHS	highly hazardous substances
HMA	Herd Management Area
HQ	Headquarters
HTO	tritiated water
HW	hazardous waste
HWAA	Hazardous Waste Accumulation Area
HWSU	Hazardous Waste Storage Unit
I	iodine
IAEA	International Atomic Energy Agency
ICPT	Integrated Contractor Purchasing Team
ID	identification number
IH	Industrial Hygiene

IL	investigation level
in.	inch(es)
ISO	International Organization for Standardization
ISWG	Interagency Sustainability Working Group
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
LEED	Leadership in Energy and Environmental Design
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
LRQA	Lloyd's Register Quality Assurance
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
MGD	million gallons per day
mg/L	milligram(s) per liter
mGy/d	milligray(s) per day
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	monitor and report
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
$mTCO_2e$	metric ton(s) of carbon dioxide equivalent
mton	metric ton(s)
MTRU	mixed transuranic
MWDU	Mixed Waste Disposal Unit
MWSU	Mixed Waste Storage Unit
µCi/mL	microcurie(s) per milliliter
µg/L	microgram(s) per liter
µR/hr	microroentgen(s) per hour
µS/cm	microseimen(s) per centimeter
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
N-I	Navarro-Intera, LLC
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
NNSS	Nevada National Security Site
NNSSER	Nevada National Security Site Environmental Report
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
NSSAB	Nevada Site Specific Advisory Board
NSTec	National Security Technologies, LLC
NTS	Nevada Test Site
NTSER	Nevada Test Site Environmental Report
NTTR	Nevada Test and Training Range
NVLAP	National Voluntary Laboratory Accreditation Program
ODS	ozone-depleting substance
OSTI	Office of Scientific and Technical Information
oz	ounce(s)
P03	Pit 3 Mixed Waste Disposal Unit
P06A	Pit 6 Asbestiform Low-Level Solid Waste Disposal Unit
P2/WM	pollution prevention/waste minimization
PA	Performance Assessment
PAAA	Price-Anderson Amendments Act
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
PUE	Power Utilization Effectiveness
PWS	public water system
QA	quality assurance
QAP	Quality Assurance Program
QAPP	Quality Assurance Program Plan
QC	quality control
QPID	Quality and Performance Improvement Division
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
RCR	Requisition Compliance Review
RCRA	Resource Conservation and Recovery Act
RCT	radiological control technician
rem	roentgen equivalent man (a unit of measure)
RER	relative error ratio
RICE	reciprocating internal combustion engines
RMA	Radioactive Material Area
RMAD	Reactor Maintenance, Assembly, and Disassembly

RNCTEC	Radiological/Nuclear Countermeasures Test and Evaluation Complex
RPD	relative percent difference
RREMP	Routine Radiological Environmental Monitoring Plan
RSL	Remote Sensing Laboratory
RTR	Real-Time Radiography
RW	Radioactive Waste
RWAP	Radioactive Waste Acceptance Program
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
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
SER	Safety Evaluation Report
SF_6	Sulfur hexafluoride
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
SPCC	Spill Prevention, Control, and Countermeasure
Sr	strontium
SRI	Solar Reflectance Index
SSC	structures, systems, and components
SSP	Site Sustainability Plan
SSPP	Strategic Sustainability Performance Plan
S.U.	standard unit(s) (for measuring pH)
Sv	sievert(s)
SWEIS	Site-Wide Environmental Impact Statement
SWO	Solid Waste Operations
T½	half-life
Tc	technetium
TDR	time domain reflectometry
TDS	total dissolved solids
TEDE	total effective dose equivalent
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
TSR	Technical Safety Requirements
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 compound
VZM	vadose zone monitoring
W&W	Waste and Water
WEF	Waste Examination Facility
WGS	Waste Generator Services
WIPP	Waste Isolation Pilot Plant
WNV	West Nile virus
WO	Waste Operations
WW	water well
yr	year(s)
Z2CS	Zone 2 Construction Supervision

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