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Nevada National Security Site Environmental Report Summary 2012

September 2013

National Nuclear Security Administration

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The information presented in this document is explained in greater detail in the ***Nevada National Security Site Environmental Report 2012*** (DOE/NV/25946--1856). A compact disc of this document is included on the back inside cover. This document can also be downloaded from the U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office at **http://www.nv.energy.gov/library/publications/aser.aspx**.

For more information about the Nevada National Security Site Environmental Report, contact **Pete Sanders** at **(702) 295-1037** or **peter.sanders@nnsa.doe.gov**.

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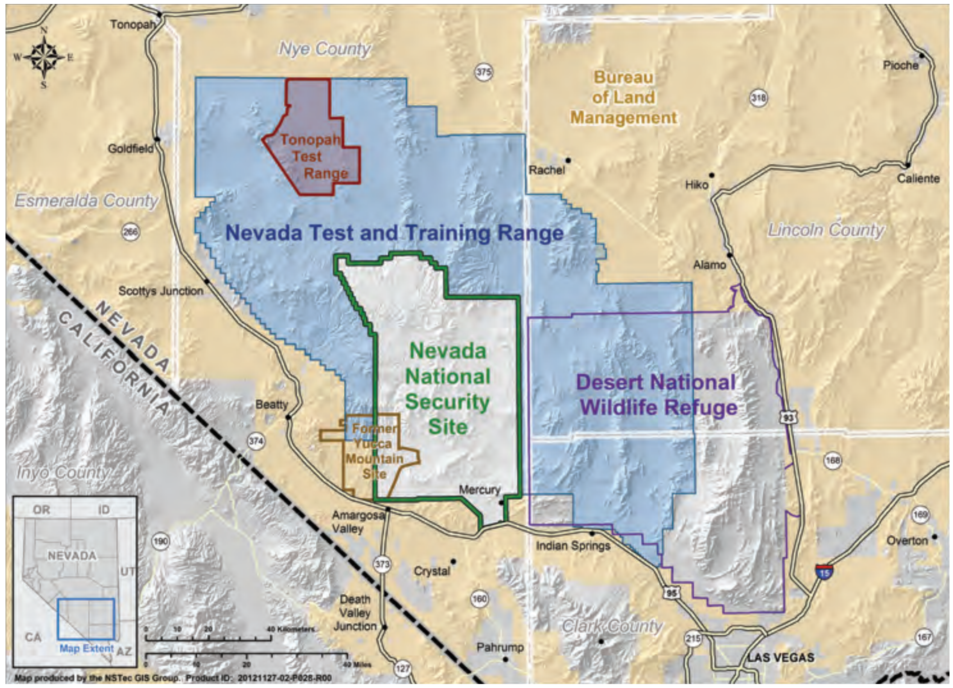
Nevada National Security Site Environmental Report Summary 2012

The U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office (NNSA/NFO), formerly the Nevada Site Office, directs the management and operation of the Nevada National Security Site (NNSS). NNSA/NFO prepares the *Nevada National Security Site Environmental Report* (NNSSER) to provide the public an understanding of the environmental monitoring and compliance activities that are conducted on the NNSS to protect the public and the environment from radiation hazards and from nonradiological impacts.

The NNSSER is a comprehensive report of environmental activities performed at the NNSS and offsite facilities over the previous calendar year. It is prepared annually to meet the requirements and guidelines of the U.S. Department of Energy (DOE) and the information needs of NNSA/NFO stakeholders. This summary provides an abbreviated and more readable version of the NNSSER. It does not contain detailed descriptions or presentations of monitoring designs, data collection methods, data tables, the NNSS environment, or all environmental program activities performed throughout the year.

The reader is provided with an electronic file of the full NNSSER and of *Attachment A: Site Description* (see attached compact disc on the inside back cover). The reader may obtain a hard copy of the full NNSSER as directed on the inside front cover of this summary report.

The NNSS is currently the nation's unique site for ongoing national security–related missions and high-risk operations. The NNSS is located about 65 miles northwest of Las Vegas. The approximately 1,360-square-mile site is one of the largest restricted access areas in the United States. It is surrounded by federal installations with strictly controlled access, as well as by lands that are open to public entry.



History of the NNSS

Between 1940 and 1950, the area now known as the NNSS was part of the Las Vegas Bombing and Gunnery Range. In 1950, the NNSS was established as the primary location for testing the nation's nuclear explosive devices. Such testing took place from 1951 to 1992.

Tests conducted through the 1950s were predominantly atmospheric tests. These involved a nuclear explosive device detonated while either 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 dispersion of plutonium in the test vicinity. Some of these test areas are on the Nevada Test and Training Range (NTTR) and on the Tonopah Test Range (TTR).

The first underground test, a cratering test, was conducted in 1951. The first fully contained underground nuclear test was conducted in 1957. Testing was discontinued during a moratorium that began October 31, 1958, but was resumed in September 1961 after tests by the Union of Soviet Socialist Republics began. Beginning in 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 below the water table.

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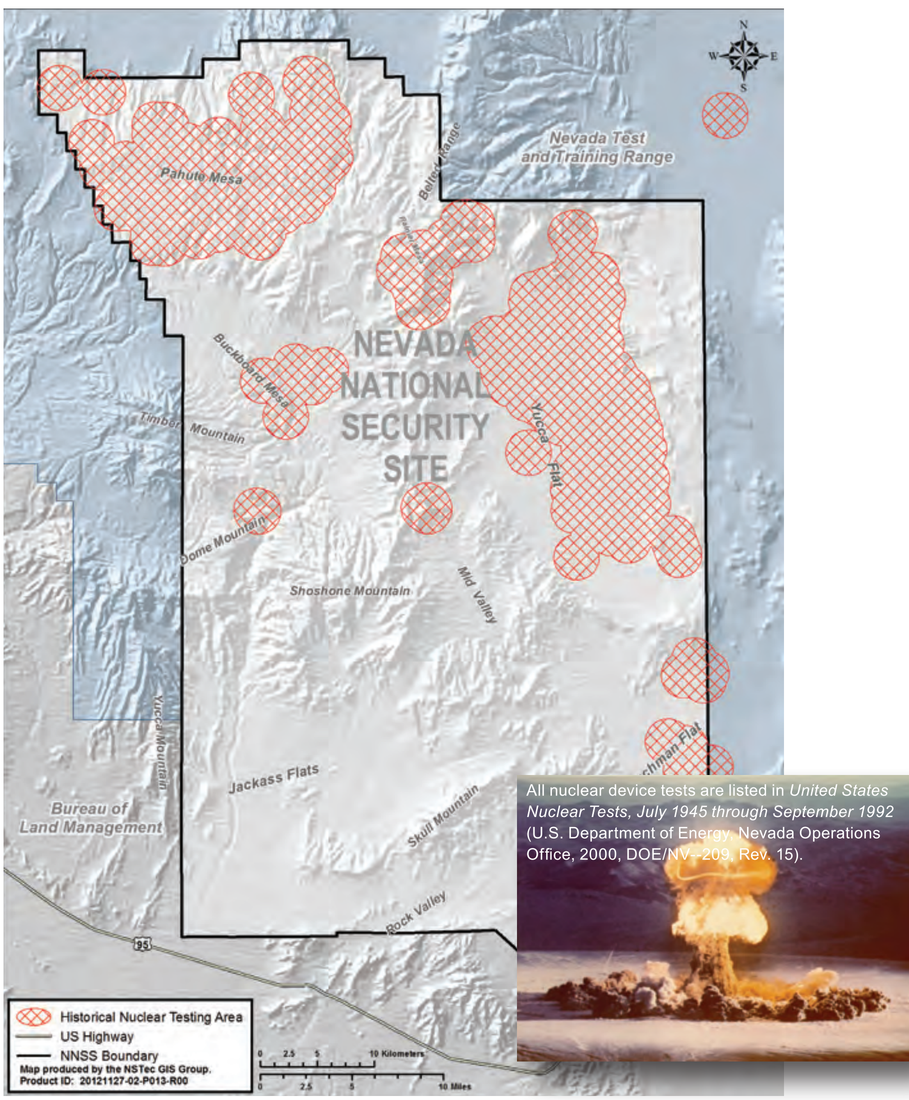
Five earth-cratering (shallow-burial) tests were conducted from 1962 to 1968 as part of the Plowshare Program, which explored peaceful uses of nuclear explosives. The first and highest yield Plowshare crater test, Sedan, was detonated at the northern end of Yucca Flat. The second-highest yield crater test was Schooner in the northwest corner of the NNSS. Mixed fission products, tritium, and plutonium from these tests were entrained in the soil, ejected from the craters, and deposited on the ground surrounding the craters.

Other nuclear-related experiments at the NNSS included the Bare Reactor Experiment–Nevada series in the 1960s. These tests were performed with a neutron generator mounted on a 1,527-foot steel tower to study neutron and gamma-ray interactions on various materials and to assess radiation doses experienced by the nuclear bomb survivors of Hiroshima and Nagasaki. From 1959 through 1973, a series of open-air nuclear reactor, engine, and furnace tests were conducted in Area 25, and a series of tests with a nuclear ramjet engine were conducted in Area 26. The tests released mostly gaseous radioactivity (radio-iodines, radio-xenons, radio-kryptons) and some fuel particles that resulted in negligible deposition on the ground.



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, DOE/NV--209, Rev. 15).

Historical Nuclear Testing Areas on and adjacent to the NNSS

NNSS – Continental Test Site

After the end of World War II, the United States tested nuclear weapons at Bikini Atoll and Enewetak in the Marshall Islands of the Central Pacific.

In June 1950, with the outbreak of hostilities in Korea and U.S. relations with the Soviet Union continuing to deteriorate, the search began for a continental test site to overcome the difficulties with remoteness and security experienced with testing in the Pacific. The final choices included Dugway Proving Ground–Wendover Bombing Range in western Utah, Alamogordo–White Sands Guided Missile Range in south-central New Mexico, and a North Site and a South Site on the Las Vegas Bombing and Gunnery Range in southern Nevada.

On December 18, 1950, President Truman approved the recommendations of Los Alamos testing officials and the Atomic Energy Commission, christening the South Site on the Las Vegas Bombing and Gunnery Range as the nation's continental test site. It was called the Nevada Proving Ground.

On January 27, 1951, an Air Force B-50D bomber dropped a 1-kiloton yield nuclear bomb over Frenchman Flat. It was the world's tenth nuclear detonation and was the first test at the newly established Nevada Test Site (NTS).

On September 23, 1992, the last underground nuclear test was conducted on the NTS, after which Congress imposed a moratorium on nuclear weapons testing. Since 1951, a total of 100 atmospheric and 828 underground nuclear weapons tests have been conducted at the NTS.

On August 23, 2010, the NTS was renamed the Nevada National Security Site to reflect the diversity of nuclear, energy, and homeland security activities conducted at the site.

Source: T. R. Fehner and F. G. Gosling, 2000. *Origins of the Nevada Test Site*, DOE/MA-0518, History Division, Executive Secretariat, Management and Administration, U.S. Department of Energy.

The NNSS Now

NNSA/NFO conducts three major missions and their programs on the NNSS. Experimental programs are sponsored principally by Los Alamos, Lawrence Livermore, and Sandia National Laboratories. During the conduct of all missions and their programs, NNSA/NFO complies with applicable environmental and public health protection regulations and strives to manage the land and facilities at the NNSS as a unique and valuable national resource. In 2012, National Security Technologies, LLC (NSTec), was the Management and Operations Contractor accountable for the successful execution of work and ensuring that work was performed in compliance with environmental regulations.

NNSS activities in 2012 continued to be diverse, with the primary goal to ensure that the existing U.S. stockpile of nuclear weapons remains safe and reliable. Other NNSS activities included weapons of mass destruction first responder training; the controlled release of hazardous material at the Nonproliferation Test and Evaluation Complex (NPTEC); remediation of legacy contamination sites; characterization of waste destined for the Waste Isolation Pilot Plant in Carlsbad, New Mexico, or the Idaho National Laboratory in Idaho Falls, Idaho; disposal of low-level and mixed low-level radioactive waste; and environmental research. Facilities and centers that support the National Security/Defense mission include the U1a Facility, Big Explosives Experimental Facility (BEEF), Device Assembly Facility (DAF), Joint Actinide Shock Physics Experimental Research (JASPER) Facility, the National Criticality Experiments Research Center (NCERC) located in the DAF, and the Radiological/Nuclear Countermeasures Test and Evaluation Complex (RNCTEC). Facilities that support the Environmental Management mission include the Area 5 Radioactive Waste Management Complex (RWMC) and the Area 3 Radioactive Waste Management Site (RWMS), which has been in cold standby since 2006.

NNSS Missions and Their Programs

National Security/Defense

Stockpile Stewardship and Management Program — Conducts high-hazard operations in support of defense-related nuclear and national security experiments.

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 agencies/organizations involved in defense-related activities.

Environmental Management

Environmental Restoration Program — Characterizes and remediates the environmental legacy of nuclear weapons and other testing at the NNSS and NTTR 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 U.S. Department of Defense (DoD)-approved facilities throughout the U.S. and wastes generated in Nevada by NNSA/NFO. Safely manages and characterizes hazardous and transuranic wastes for offsite disposal.

Nondefense

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.

Environmental Compliance

Some activities on the NNSS generate hazardous wastes or deal with cleanup and remediation of waste or legacy contamination from past work. These activities are subject to federal and state laws intended to protect the environment and public health. These laws define emission limits or prohibit the emission of toxic substances into the air, water, and ground; require plans to prevent spills, unplanned releases, and accidents; and call for programs to monitor, measure, document, and report on compliance to regulatory agencies and the public.

The U.S. Environmental Protection Agency (EPA) and the Nevada Division of Environmental Protection (NDEP) are the principal regulators of NNSS activities. These agencies issue permits, review compliance reports, participate in joint monitoring programs, inspect facilities and operations, and oversee compliance with applicable regulations.

The following table defines and summarizes 2012 results for a few of the many federal regulations with which NNSA/NFO must comply.

Summary of NNSA/NFO's Compliance with Major Federal Statutes in 2012

Environmental Statute or Order and What It Covers	2012 Status
Atomic Energy Act (through compliance with DOE O 435.1, "Radioactive Waste Management"): Management of low-level waste (LLW) and mixed low-level waste (MLLW) generated or disposed on site	806,544 cubic feet of waste was disposed on site in LLW and MLLW disposal cells at the Area 5 RWMC. Some of this volume also included classified low-level and nonradioactive items. Waste volumes were within permit limits; vadose zone and groundwater monitoring continued to verify that disposed LLW and MLLW are not migrating to groundwater or threatening biota or the environment.
Clean Air Act: Air quality and emissions into the air from facility operations	Onsite 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 millirem per year (mrem/yr). The estimated dose from all 2012 NNSS air emissions to the maximally exposed individual (MEI) is 0.17 mrem/yr. Nonradiological air emissions from permitted equipment and facilities were all below emission and opacity limits.
Clean Water Act: Water quality and effluent discharges from facility operations	All domestic and industrial wastewater systems and groundwater monitoring well samples were within permit limits for regulated water contaminants and water chemistry parameters.
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)/Superfund Amendments and Reauthorization Act (SARA): Cleanup of waste sites containing hazardous substances	No NNSS cleanup operations are regulated under CERCLA or SARA; they are regulated under RCRA instead.
DOE O 458.1, "Radiation Protection of the Public and the Environment": Measuring radioactivity in the environment and estimating radiological dose to the public due to NNSA/NFO activities	RREMP monitoring of air, water, and direct radiation was conducted. The total annual dose to the MEI from all exposure pathways due to NNSA/NFO activities was estimated to be 0.54 mrem/yr, well below the DOE limit of 100 mrem/yr.
Emergency Planning and Community Right to Know Act (EPCRA): The public's right to know about chemicals released into the community	170,486 lb of lead and 268 lb of mercury were released at the NNSS. The majority of both quantities was from the onsite disposal of cleanup and building demolition materials containing lead and mercury, which were received from other DOE facilities or generated on site.
Endangered Species Act (ESA): Threatened or endangered species of plants and animals	Field surveys for 15 proposed projects were conducted; 15.21 acres of tortoise habitat were disturbed, and no tortoises were harmed at or displaced from project sites; one tortoise was found injured on a road, and seven were moved off roads to safety. All actions were in compliance with permit requirements.
Federal Facility Agreement and Consent Order (FFACO): Cleanup of waste sites containing hazardous substances	All 2012 corrective action milestones under the FFACO were met. A total of 43 CASs were closed in accordance with state-approved corrective action plans.
Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA): Storage and use of pesticides and herbicides	Only nonrestricted-use pesticides were applied by State-certified personnel. Storage and use of pesticides were in compliance with federal and state regulations.
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, four accidental bird mortalities were documented. The NNSS Power Utilities group modified a power pole in 2012 to prevent raptor electrocution.
National Environmental Policy Act (NEPA): Evaluating projects for environmental impacts	NNSA/NFO prepared the final *Site-Wide Environmental Impact Statement for the Nevada National Security Site and Offsite Locations in Nevada*, incorporating public comments. It evaluates current and future NNSA/NFO operations in Nevada during the 10-year period beginning when the Record of Decision is published.
National Historic Preservation Act (NHPA): Identifying and preserving historic properties	Archival research for 34 proposed projects was conducted, and 206.5 acres were surveyed for 9 of the projects; 2 prehistoric sites, 2 historical sites, and 1 historic district were identified.
Resource Conservation and Recovery Act (RCRA): Generation, management, disposal of hazardous waste (HW) and MLLW and cleanup of inactive, historical waste sites	1,355 tons of MLLW were disposed on site, 6.14 tons of HW were received for onsite storage, 0.28 tons of polychlorinated biphenyl (PCB) wastes were shipped to an offsite disposal facility, and 0.39 tons of waste explosive ordnance were detonated on site, all in accordance with state permits. Groundwater monitoring of wells at the Area 5 RWMS confirmed that buried MLLW remains contained, and vadose zone monitoring and post-closure inspections of historical RCRA closure sites confirmed that buried HW remains contained.
Safe Drinking Water Act: Quality of drinking water	The concentrations of all regulated water contaminants in drinking water from the three permitted public water systems on the NNSS were below state and federal permit limits.
Toxic Substances Control Act (TSCA): Management and disposal of polychlorinated biphenyls (PCBs)	Four drums of PCB-contaminated materials were shipped off site to permitted disposal and treatment facilities.

The Legacy of NNSS Nuclear Testing

Approximately one-third of the 828 underground nuclear tests on the NNSS were detonated near or below the water table, resulting in radioactive contamination of groundwater in some areas. In addition, the 100 atmospheric nuclear tests conducted on the NNSS and numerous nuclear-related experiments resulted in radioactive contamination of surface soils, materials, equipment, and structures, mainly on the NNSS.

The NNSA/NFO Environmental Management mission was established to address this legacy contamination. Within Environmental Management, Environmental Restoration is responsible for remediating contaminated sites, and Waste Management is responsible for safely managing and disposing of radioactive waste.

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Aerial view of Yucca Flat showing subsidence craters from historical underground nuclear tests.

Legacy Contamination

Groundwater — The total amount of radiation remaining below the groundwater table is approximately 40 to 60 million Ci, based on the most recent estimate, which incorporates corrections for radioactive decay since the last underground test in 1992. The areas of known and potential groundwater contamination on the NNSS due to underground nuclear testing are called Underground Test Area (UGTA) corrective action units.

Soil — Radioactively contaminated surface soils directly resulting from nuclear weapons testing exist at over 100 locations on and around the NNSS. The soils may contain contaminants including radioactive materials, oils, solvents, and heavy metals, as well as contaminated instruments and test structures used during testing activities.

Air — Airborne radioactive contamination from the resuspension of contaminated soils at legacy sites and from current activities is monitored continuously on and off the NNSS. Airborne concentrations of monitored contaminants have been decreasing at most sample locations on the NNSS over the past decade. Total curies estimated to be released across the entire NNSS fluctuate annually; the highest annual estimates since 1992 have been 2,200 Ci for tritium, 0.40 Ci for plutonium, and 0.049 Ci for americium. In air measured in communities surrounding the NNSS, emissions from the NNSS cannot be distinguished from background airborne radiation.

Structures/Materials — There are approximately 1,850 sites where facilities, equipment, structures, and/or debris were contaminated by historical nuclear research, development, and testing activities. These structures/materials are referred to as Industrial Sites and include disposal wells, inactive tanks, contaminated buildings, contaminated waste sites, inactive ponds, muck piles, spill sites, drains and sumps, and ordnance sites.

Waste Disposal — Low-level and mixed low-level radioactive wastes have been generated by historical nuclear research, development, and testing activities and environmental cleanup activities. From the 1960s, when waste disposal began, through December 31, 2012, nearly 1.584 million cubic yards of waste have been safely disposed at the Area 3 and Area 5 RWMSs. The estimated cumulative radioactivity of all wastes at the time of disposal is 15.5 million Ci. The radioactive content of the waste decays over time, however, at a varied rate depending on the radionuclide.

Curie (Ci) is the traditional measure of radioactivity based on the observed decay rate of 1 gram of radium. One curie of radioactive material will have 37 billion disintegrations in 1 second.

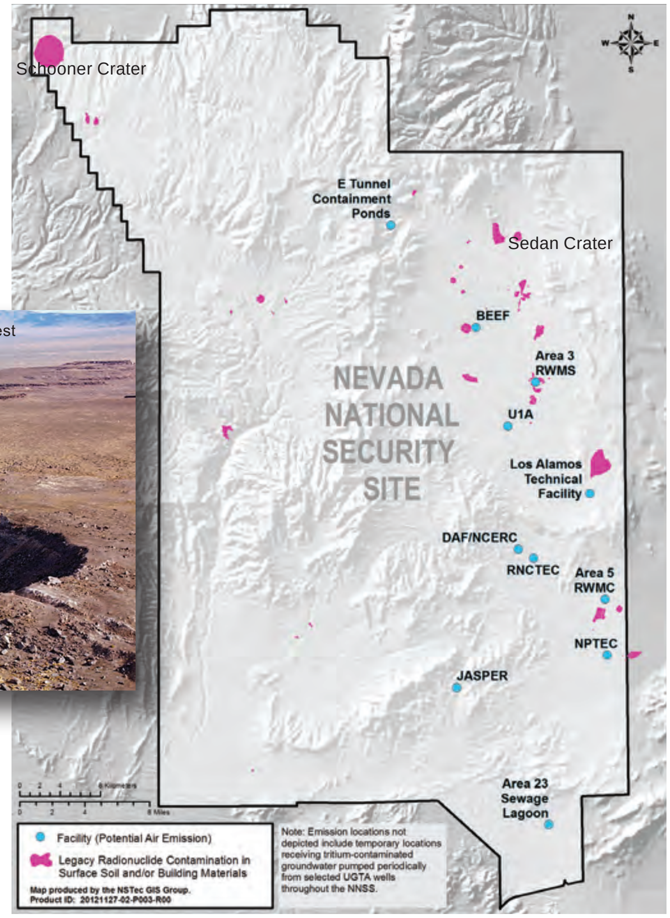
Ci

The Legacy of NNSS Nuclear Testing *... continued from Page 5*

The Federal Facility Agreement and Consent Order (FFACO) between the State of Nevada, DOE, and DoD identifies corrective action units (CAUs), which are groupings of corrective action sites (CASs) that delineate areas of historical contamination. The FFACO establishes corrective actions and schedules for the remediation and closure of CASs. Approximately 3,000 CASs have been identified, many of which have already been remediated and/or closed.

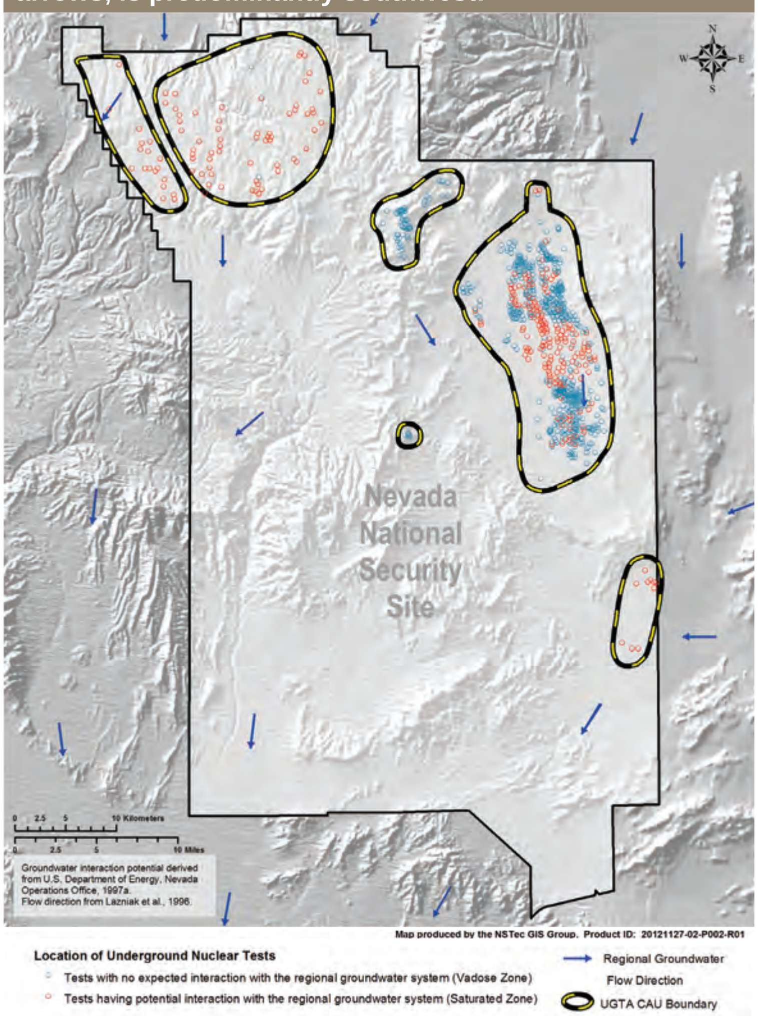
The public is kept informed of Environmental Management activities through periodic newsletters, exhibits, and fact sheets, and Environmental Management provides the opportunity for public input via the Nevada Site Specific Advisory Board, consisting of 15–20 citizen volunteers from Nevada.


Schooner Crater in Area 20 formed during a 1968 crater test exploring peaceful uses of nuclear explosives.

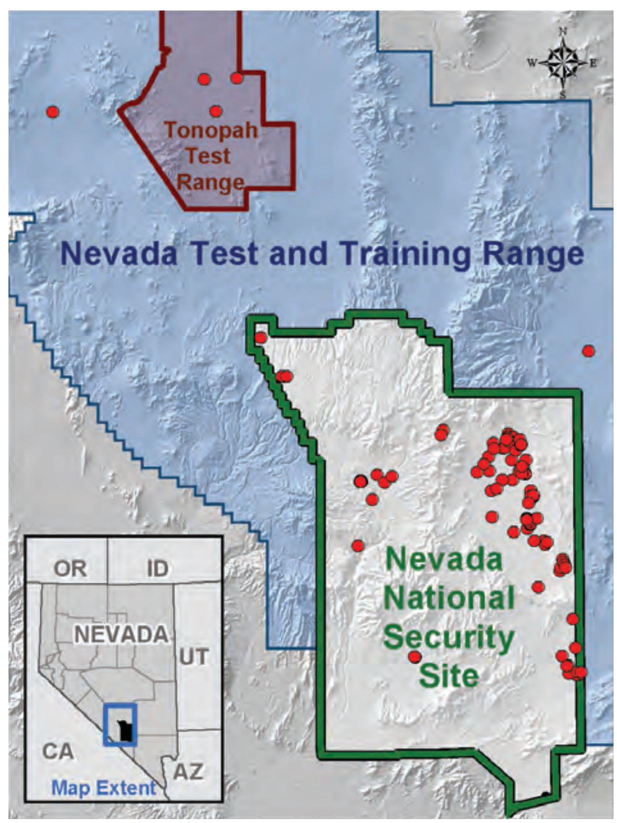


Sources of Radiological Air Emissions on the NNSS

The direction of groundwater flow, shown by the blue arrows, is predominantly southwest.



Areas of Potential Groundwater Contamination on the NNSS



Locations of Soil Contamination on and off the NNSS

The Legacy of NNSS Nuclear Testing
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Numerous man-made and naturally occurring radionuclides occur on the NNSS. The radionuclides produce ionizing radiation in the form of alpha particles, beta particles, and gamma rays, which are emitted from the unstable radionuclides as they decay to form more stable atoms. Almost all human exposure to ionizing radiation (82% in the United States) comes from natural sources that include cosmic radiation from outer space, terrestrial radiation from materials like uranium and radium in the earth, and naturally occurring radionuclides in food, water, and the aerosols and gases in the air we breathe. Man-made sources and applications of ionizing radiation in our everyday life include smoke detectors, X-rays, CT scans, and nuclear medicine procedures. For people living in areas around the NNSS, less than 2% of their total radiation exposure is attributable to past nuclear testing or to current NNSS activities.

Forms of Radiation

Alpha particles are heavy, positively charged particles given off by some decaying atoms. Alpha particles can be blocked by a sheet of paper. Atoms emitting alpha particles are hazardous only if they are swallowed or inhaled.

Beta particles are electrons or positrons (positively charged electrons) ejected from the nucleus of a decaying atom. More penetrating than alpha radiation, beta particles can pass through several millimeters of skin. A sheet of aluminum only a fraction of an inch thick will stop beta radiation. Beta particles can damage skin but are most hazardous if the beta-emitting atoms are swallowed or inhaled.

Gamma rays are waves of pure energy similar to X-rays, light, microwaves, and radio waves. Gamma rays are emitted by certain radionuclides when their nuclei transition from a higher to a lower energy state. They can readily pass into the human body. They can be almost completely blocked by about 40 inches of concrete, 40 feet of water, or a few inches of lead. Gamma rays can be both an external and internal hazard.

X-rays are a more familiar form of electromagnetic radiation, usually with a limited penetrating power, typically used in medical or dental examinations. Television sets, especially color, give off soft (low-energy) X-rays; thus, they are shielded to greatly reduce the risk of radiation exposure.

Neutrons are uncharged heavy particles contained in the nucleus of every atom heavier than ordinary hydrogen. They induce ionization only indirectly in atoms that they strike, but they can damage body tissues. Neutrons are released, for example, during the fission (splitting) of uranium atoms in the fuel of nuclear power plants. They can also be very penetrating. In general, efficient shielding against neutrons can be provided by materials containing hydrogen, such as water. Like gamma rays, neutrons are both an external and internal hazard.

Radionuclides Detected on the NNSS

	Name*	Abbreviation	Primary Type(s) of Radiation	Major NNSS Source
Man-Made	Americium-241	^{241}Am	Alpha, gamma	In soil at and near legacy sites of aboveground nuclear testing. Detected in soil and air.
	Cesium-137	^{137}Cs	Beta, gamma	
	Plutonium-238	^{238}Pu	Alpha	
	Strontium-90	^{90}Sr	Beta	
	Cobalt-60	^{60}Co	Gamma	In soil at and near legacy sites of aboveground nuclear testing. Detected in soil.
	Europium-152	^{152}Eu	Gamma	
	Europium-155	^{155}Eu	Gamma	
	Plutonium-239+240	$^{239+240}Pu$	Alpha	In soil at and near legacy sites of plutonium dispersal experiments. Detected in soil and air.
	Tritium	^{3}H	Beta	In groundwater in areas of underground nuclear tests, in surface ponds used to contain contaminated groundwater, in soil at nuclear test locations, in waste packages buried in pits at waste management sites. Detected in groundwater and air.
Naturally Occurring	Beryllium-7	^{7}Be	Gamma	Produced by interactions between cosmic radiation from the sun and the earth's upper atmosphere. Detected in air.
	Potassium-40	^{40}K	Beta, gamma	Naturally occurring in the earth's crust. Detected in groundwater, soil, and air.
	Radium-226	^{226}Ra	Alpha, gamma	
	Thorium-232	^{232}Th	Alpha	
	Uranium-234**	^{234}U	Alpha	
	Uranium-235**	^{235}U	Alpha, gamma	
	Uranium-238**	^{238}U	Alpha	

*The number given with the name of the radionuclide is the atomic mass number, which is the total number of protons and neutrons in the nucleus of the atom. Atoms with the same number of protons are the same element; atoms of the same element with different mass numbers are called isotopes of one another.

**These uranium isotopes, though of natural origin, can also be detected at specific NNSS locations where man-made depleted uranium has been released during experiments, resulting in an alteration of the relative amounts of each isotope.

Cleanup and Closure of Corrective Action Sites

UGTA Sites

Environmental Restoration gathers data to characterize the groundwater aquifers beneath the NNSS and adjacent lands. The data are used to develop hydrogeologic models for the CAUs and the larger UGTA model areas that will predict the groundwater movement and transport of radiological contaminants from the CAUs. Closure of the UGTA CAUs under the FFACO will involve long-term groundwater monitoring because cost-effective technologies have not been developed to effectively remove or stabilize the radiological contaminants produced during historical underground nuclear testing.

Pahute Mesa–Oasis Valley Model Area – A Phase II hydrogeologic field investigation for this model area was initiated in 2009. Twelve sites for new Phase II wells were proposed and prioritized. The top ten of the twelve sites were selected for drilling with the available resources. Four wells were drilled in 2009, four were drilled in 2010, and the final two were drilled in 2012. All Phase II well locations were selected to yield the maximum amount of information to support groundwater flow and contaminant transport modeling. Some may also be used as long-term groundwater monitoring wells.

One Environmental Restoration mission is to identify contaminant boundaries for the UGTA CAUs and then implement an effective long-term monitoring system, which will protect the public from exposure to groundwater contaminated by historical underground nuclear testing.

Within this model area, Well ER-EC-11 on the NTTR was found to have 13,180 picocuries per liter (pCi/L) of tritium when it was sampled in October 2009. The well is located approximately 2,350 feet west of the NNSS boundary and approximately 2 miles from the nearest underground nuclear tests BENHAM and TYBO conducted in 1968 and 1975, respectively. Well ER-EC-11 is the first offsite well in which radionuclides from underground nuclear testing activities at the NNSS have been detected. This finding was not unexpected because the flow and transport model for the area, published in 2009, predicts that tritium contamination above the Safe Drinking Water Act limit of 20,000 pCi/L should be present off the NNSS *(see figure on next page)*. Well ER-EC-11 was not sampled in 2012.

In 2012, well development, testing, and sampling were accomplished as planned for ER-EC-12, ER-EC-13, and UE-20n#1, and preliminary groundwater samples were collected from ER-20-11 and ER-EC-14.

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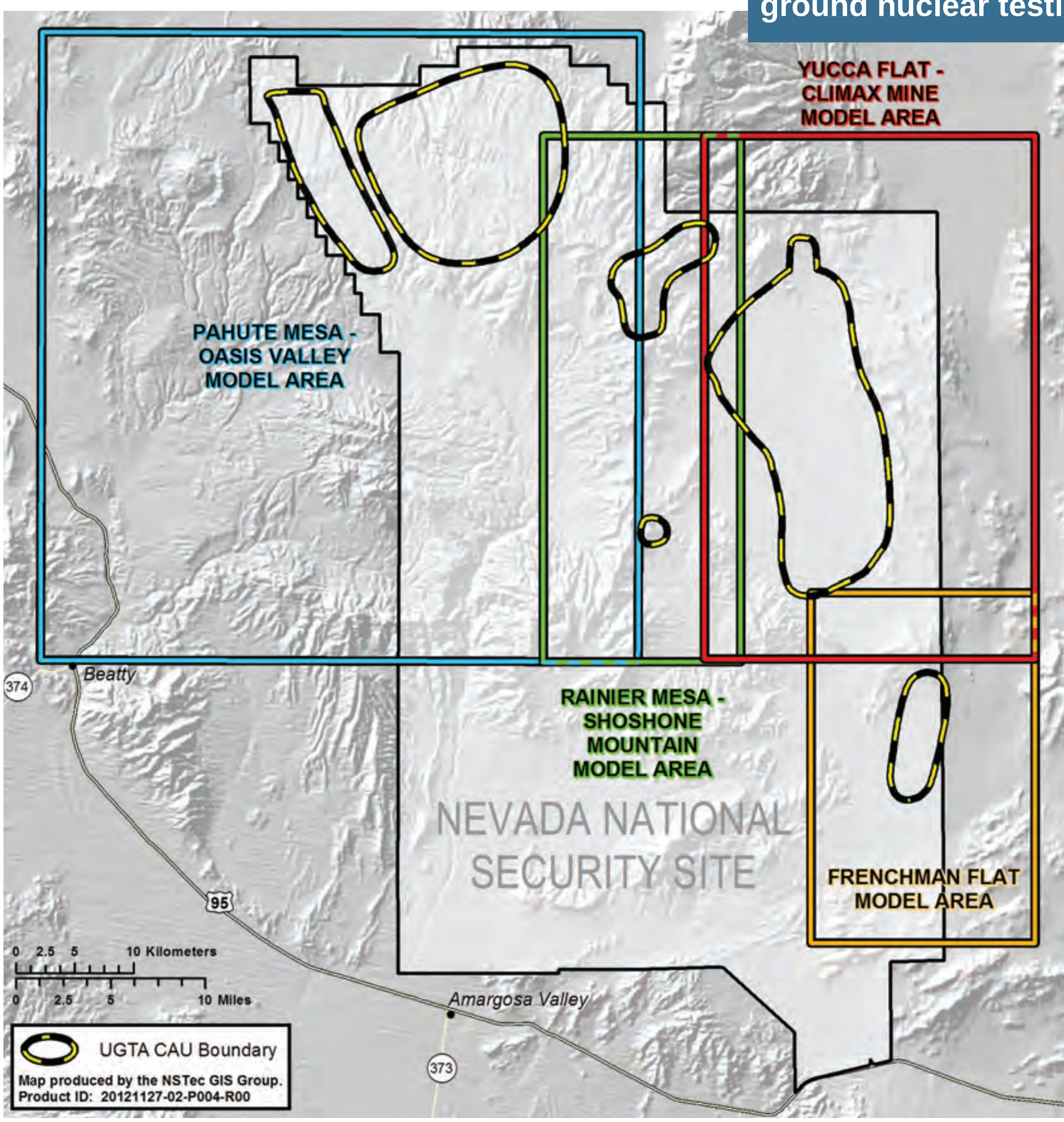

Location of UGTA Activity CAUs and Model Areas

Well sample analyses to date have not detected the presence of man-made radionuclides farther downgradient from Pahute Mesa in the 10 nearby UGTA wells on the NTTR (ER-EC-1, -2A, -4, -5, -6, -7, -8, -13, -14, and -15). However, a marginally measureable amount of tritium was reported for the March 2012 sampling of ER-EC-12 (4.2 pCi/L). Additional sampling of ER-EC-12 will occur over the next several years in order to determine if this tritium detection was a false positive.

In September 2012, NNSA/NFO gave a fourth public presentation of the model predictions and the current state of knowledge of contaminant migration off the NNSS. The presentation was given in Amargosa Valley, Nevada.

Frenchman Flat Model Area – Two new model evaluation wells, ER-5-5 and ER-11-2, were drilled in the summer of 2012, and a well drilling and completion document was prepared for the wells. Well development, hydrologic testing, and sampling of these two wells are planned for 2013. Their data will be compared to the existing framework models and modeling forecasts. The Frenchman Flat CAU is the first of the five UGTA CAUs at the NNSS to progress to the model-evaluation stage.

Rainier Mesa–Shoshone Mountain Model Area – Work on the CAU-scale and sub-CAU-scale models was completed in 2012. The ensemble of models was subjected to several cycles of internal reviews and presentations to the Nevada Division of Environmental Protection. Compiling the data packages and writing the flow and transport model document began in 2012.

Yucca Flat–Climax Mine Model Area – The compilation of the Yucca Flat–Climax Mine CAU flow and transport model document was the main focus of work in 2012 for this UGTA Model Area. The document was completed in 2012. It is expected to be reviewed and accepted by the State of Nevada by the end of 2013.

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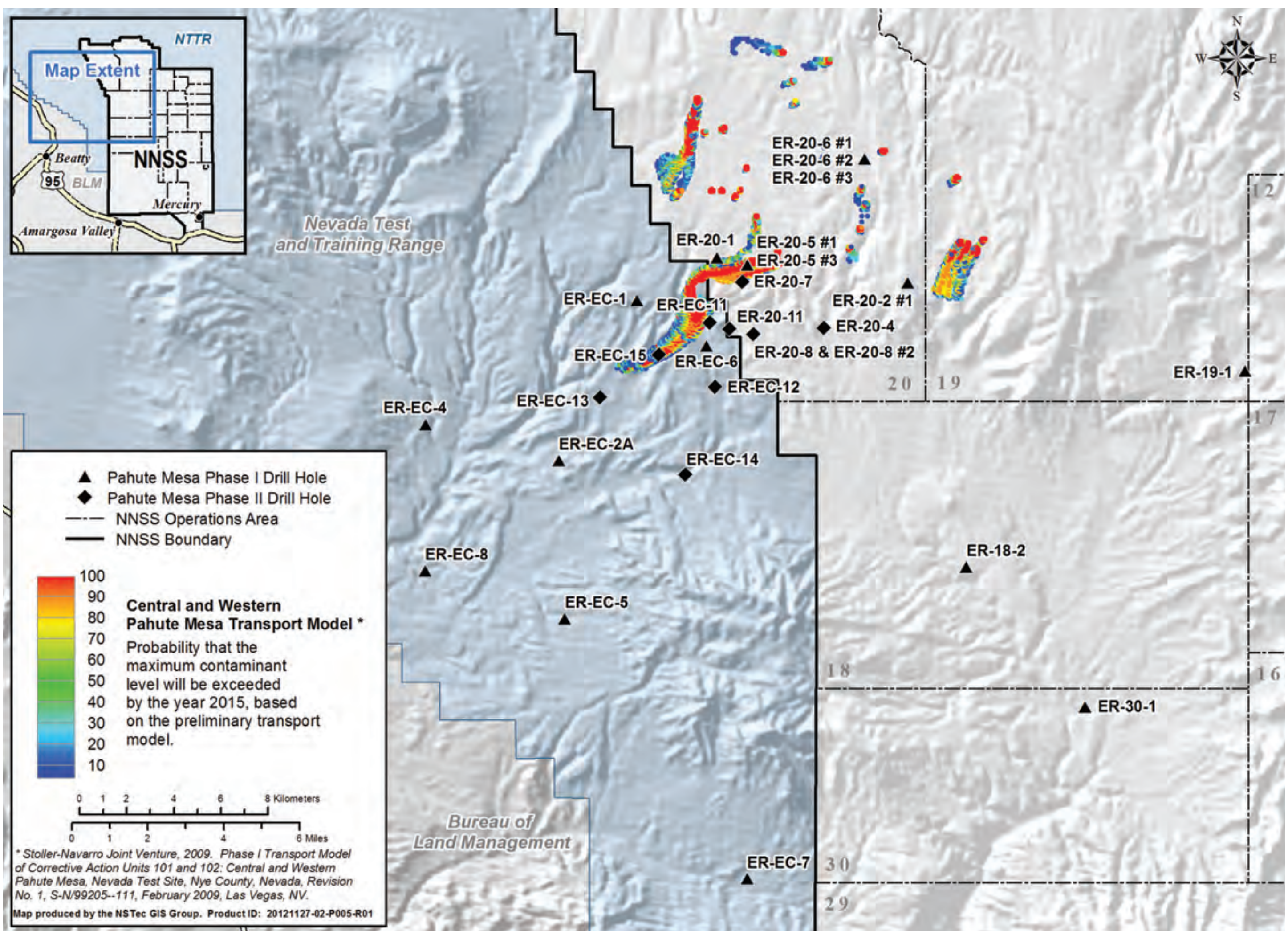


Results of Phase I Central and Western Pahute Mesa Transport Modeling

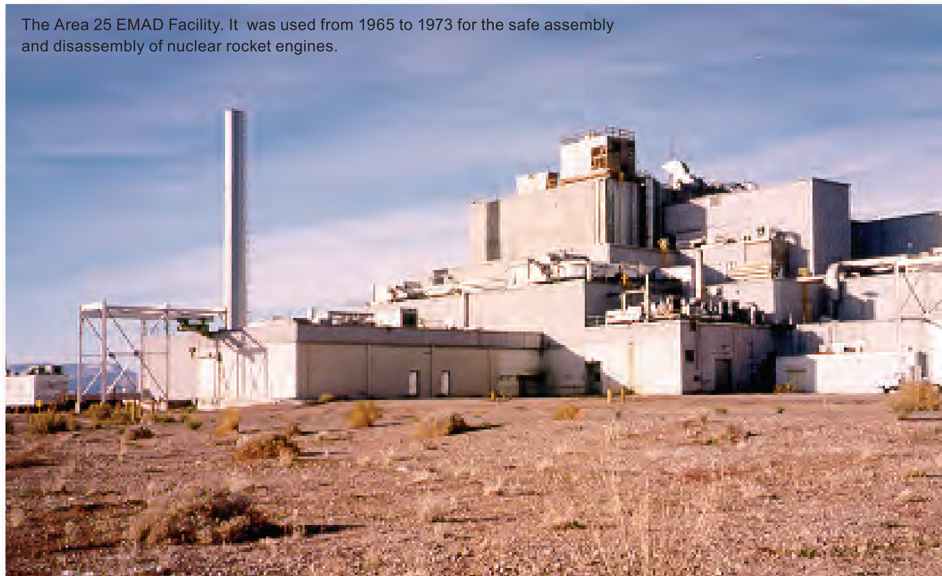
Soils Sites

There are 131 Soils CASs for which NNSA/NFO is responsible to characterize, manage, and, where necessary, clean up. Some of these sites occur on TTR and NTTR. Corrective actions range from the removal of soil to closure in place with restricted access controls such as fencing and posting. Historical research and the preparation of short summary reports of research findings have been completed for all 131 CASs. In 2012, 6 Soils CASs from 2 CAUs on the NNSS were closed, and 64 CASs from 7 CAUs, part of which were on TTR and NTTR, were investigated as progress towards closure. Closure of CASs on the TTR and NTTR require negotiation with the State of Nevada and the U.S. Department of Defense. As of December 31, 2012, closure of 47 Soils CASs have been approved by the State in accordance with the FFACO. The anticipated date for completing the closure of all Soils CASs is 2022, and 84 Soils CASs remain to be formally closed.

Industrial Sites

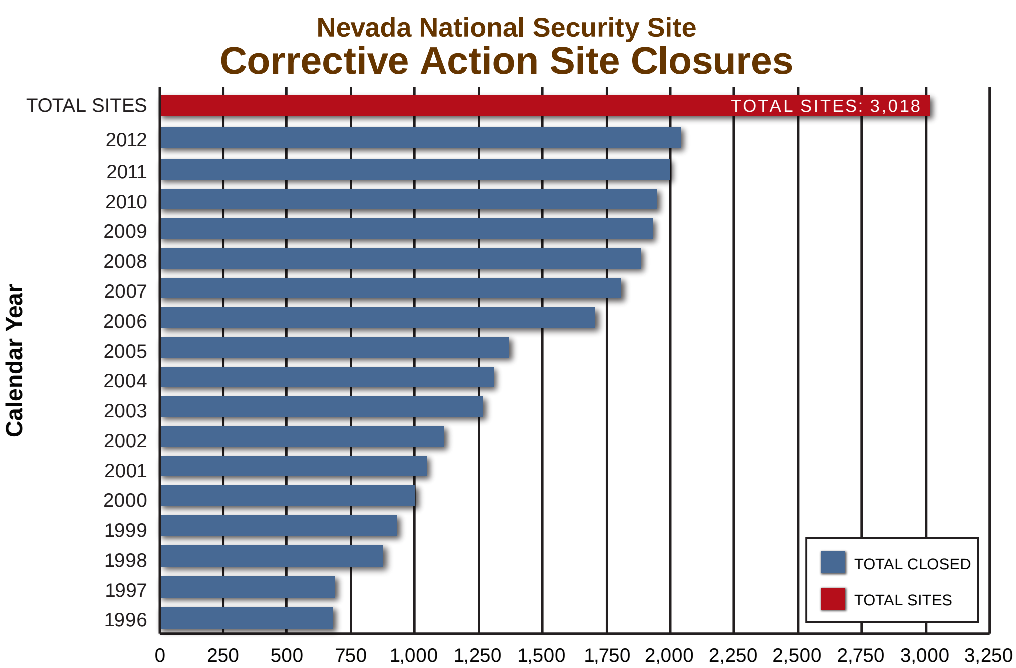
There are 1,861 Industrial Sites for which NNSA/NFO is responsible to safely close. Closure strategies have included the removal and disposal of debris, complete excavation of the site, decontamination and decommissioning activities, closure in place, no further action, and subsequent monitoring.

In 2012, 37 Industrial Sites CASs from 4 CAUs were closed and 1 CAS was investigated as progress towards closure. Only two Industrial Sites CAUs remain to be closed: CAU 114, the Area 25 Engine Maintenance, Assembly, and Disassembly (EMAD) Facility, and CAU 572, the Test Cell C Ancillary Buildings and Structures. They represent the final 8 Industrial Sites CASs to be closed. Their closure will occur prior to the end of the NNSS Environmental Restoration Activity, which is currently planned for 2027. As of December 31, 2012, closures of 1,853 CASs have been approved by the State in accordance with the FFACO.


The Area 25 EMAD Facility. It was used from 1965 to 1973 for the safe assembly and disassembly of nuclear rocket engines.

Restoration Progress under FFACO

In 2012, 43 CASs were closed and all 2012 FFACO cleanup and closure activity milestones were met. The majority of the remaining CASs are UGTA CASs for which closure in place with long-term monitoring is the corrective action.

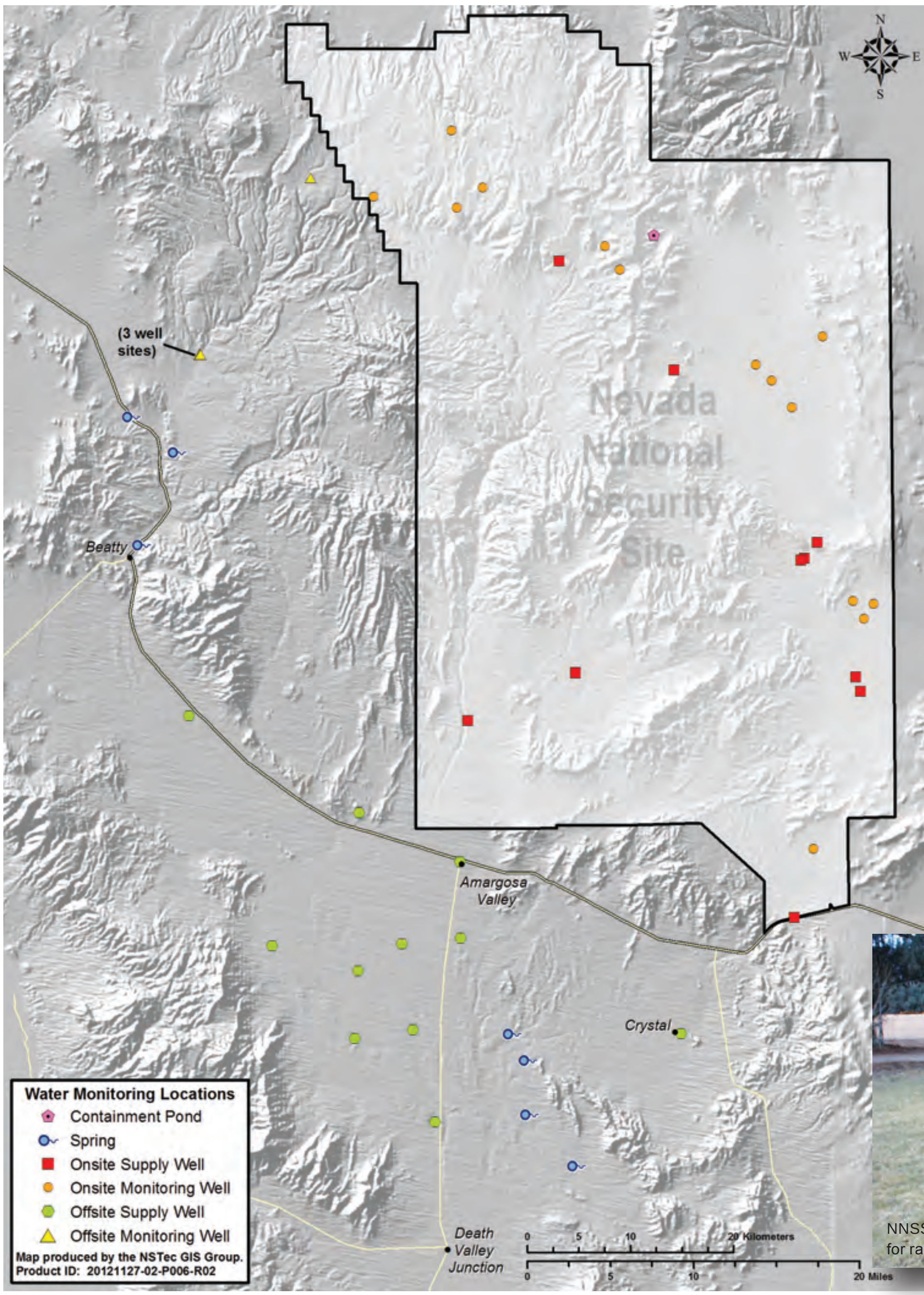


Radiological Monitoring of Groundwater

NNSA/NFO's comprehensive Routine Radiological Environmental Monitoring Plan (RREMP) includes sampling and analysis of groundwater and natural springs on and off of the NNSS. The purpose of monitoring is to detect man-made radionuclides in wells that are downgradient from the UGTA CAUs and that penetrate an aquifer. Monitoring is also conducted to verify that offsite wells and springs used by the public for drinking water do not contain man-made radionuclides due to NNSS past or present activities.

The RREMP monitoring well network includes existing onsite and offsite wells drilled in support of nuclear testing or other site missions. Sometimes new monitoring wells are added to the network. UGTA characterization wells that are no longer needed by UGTA are added if they are not hot wells (i.e., if their tritium levels are less than 400,000 pCi/L). The RREMP and its network of aquifer monitoring wells satisfy the Agreement in Principle with the State of Nevada in which NNSA/NFO has agreed to implement "an appropriate monitoring plan for groundwater on and adjacent to the NNSS." It is important to note that the RREMP network of monitoring wells is not designed to meet the requirements of the FFACO for a long-term monitoring network for the closure of UGTA CAUs.

Offsite water supply wells and springs are also monitored for the presence of tritium by the independent Community Environmental Monitoring Program (CEMP), which is coordinated by the Desert Research Institute (DRI) of the Nevada System of Higher Education under contract with NNSA/NFO. The CEMP provides the public with these data as part of a non-regulatory public informational and outreach program.



2012 NNSA/NFO Water Monitoring Locations

Offsite Monitoring

In 2012, NNSA/NFO sampled for the presence of tritium in 11 offsite private/community water supply wells, 4 offsite non-potable NNSA/NFO monitoring wells, and 7 offsite springs used as water supplies *(see map at left)*.

In 2012, the CEMP offsite water sampling locations included 21 wells, 3 surface water supply systems, and 4 springs located in selected towns

NNSS scientists sampling an offsite private well for radioanalysis.

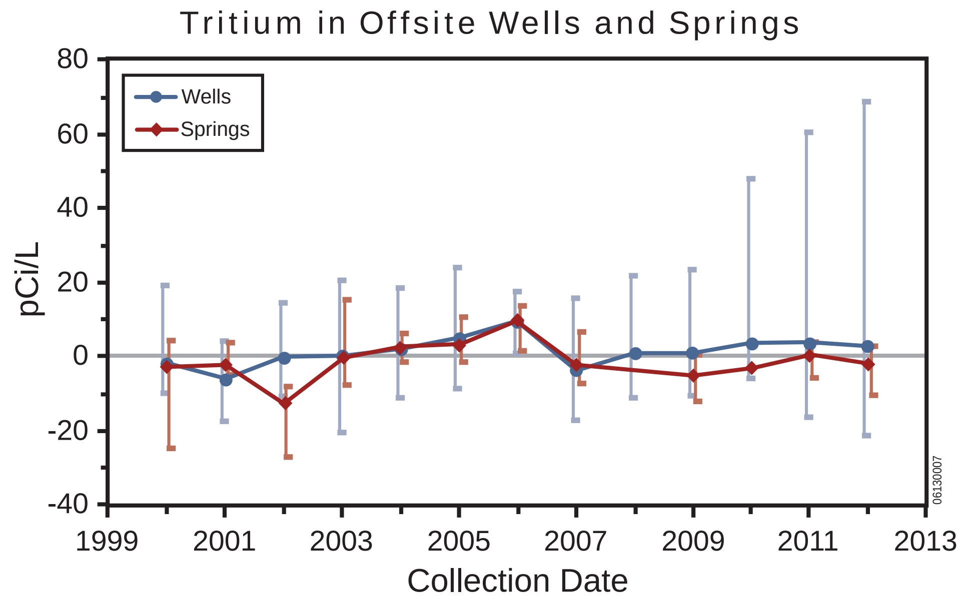
Continued on Page 12 ...

and communities within 240 miles of the NNSS *(see map below).*

Offsite water supply samples collected by NNSA/NFO and the CEMP had levels of tritium either below laboratory background levels or at very low detectable levels (<30 pCi/L). The highest detectable levels (21.9 and 22.5 pCi/L) were in CEMP surface water samples from Boulder City and Henderson, Nevada, respectively, which originated from Lake Mead. The detectable levels represent residual tritium persisting in the environment that originated from global atmospheric nuclear testing.

In the offsite non-potable wells, tritium was detected in samples from the RREMP monitoring well PM-3 (73.4 pCi/L being the highest concentration among the four samples analyzed). Sampling and more extensive analyses will occur in the future to help identify the source of the tritium.

The graph on this page shows the trend over time in tritium levels among all the RREMP offsite wells and springs that have been sampled routinely since 2000.



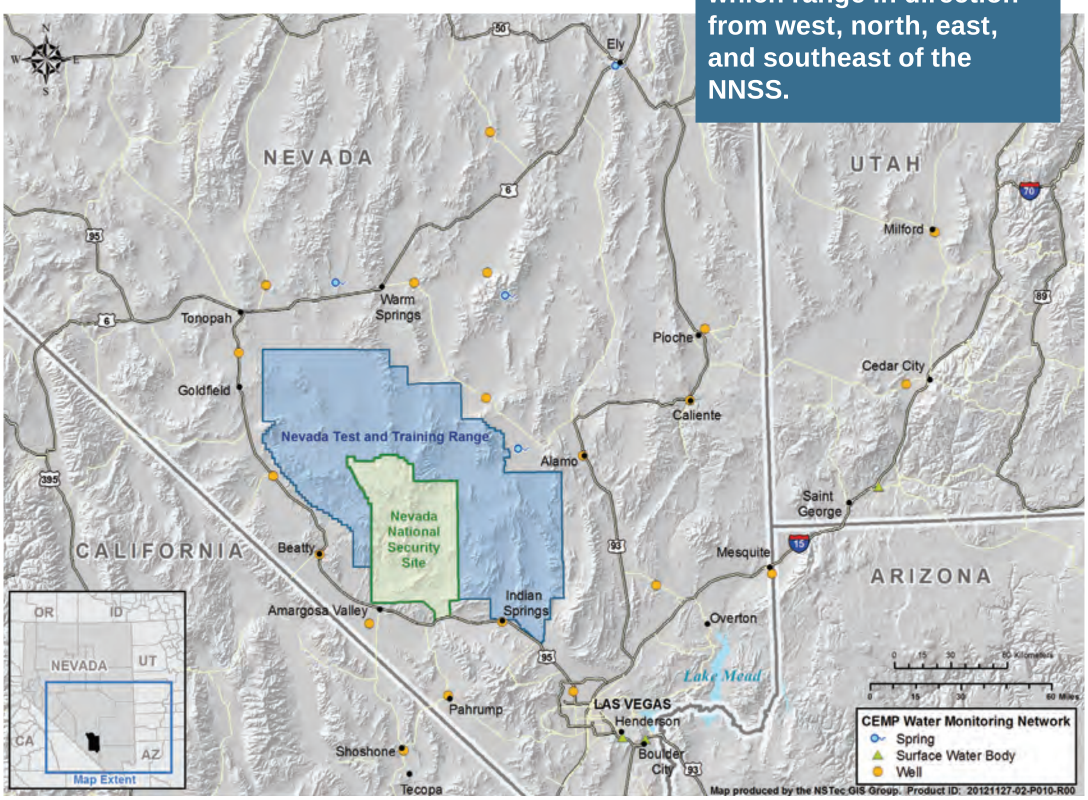
Range in Groundwater Tritium Levels Measured off the NNSS in 2012	
Offsite Supply Wells	−11.6 to 3.9 pCi/L
Offsite Springs/Surface Waters	0.4 to 22.5 pCi/L
Offsite NNSA/NFO Monitoring Wells	−26.0 to 73.4 pCi/L

Note: Negative numbers indicate measured levels below measured natural background levels (see Section 1.8.13 of the full NNSSER report for a discussion of negative numbers).

Based on current models, the predominant direction of groundwater flow away from the UGTA CAUs is southwest *(see Page 6)*. Man-made radionuclides from the UGTA CAUs are not expected to be found in CEMP-monitored wells, which range in direction from west, north, east, and southeast of the NNSS.

Onsite Monitoring

The purpose of monitoring on the NNSS is to (1) ensure that NNSS drinking water is safe, (2) determine if permitted facilities on the NNSS are in compliance with permit discharge limits for radionuclides, (3) estimate radiological dose to onsite wildlife using natural and man-made water sources, and (4) determine if groundwater is being protected from disposed radioactive wastes at the Area 3 and Area 5 RWMSs. *Continued on Page 13 ...*



2012 CEMP Water Monitoring Locations

Radiological Monitoring of Groundwater ...
continued from Page 12

In 2012, 6 potable water supply wells, 4 non-potable/inactive water supply wells, 14 monitoring wells, and 1 tritiated water containment pond system were sampled. All samples were monitored for tritium. All water supply wells were also monitored for gross alpha and gross beta radioactivity.

NNSS Water Supply Wells

The 2012 data continue to indicate that underground nuclear testing has not impacted the NNSS drinking water supply network. None of the onsite water supply wells had detectable concentrations of tritium. The gross alpha and gross beta radioactivity detected in potable water supply wells represent the presence of naturally occurring radionuclides.

NNSS Monitoring Wells

Some migration of radionuclides from the underground test areas to NNSS monitoring wells has occurred, although the migration distances appear to be very short. Three onsite monitoring wells (PM-1, UE-7NS, and WW A) had detectable concentrations of tritium ranging from 94 to 355 pCi/L, all well below the drinking water limit of 20,000 pCi/L. Each of these wells is located within 0.6 miles of a historical underground test. Tritium concentrations in these wells have been decreasing in recent years; the estimated rates of decrease since 1999 range from 5.3% to 9.9% and are consistent with the natural decay rate of tritium.

In 2012, all the other onsite monitoring wells sampled had tritium levels below detection.

Containment Ponds

A series of five constructed ponds collect and hold water discharged from E-Tunnel in Area 12 where nuclear testing was conducted in the past. The water is perched groundwater that has percolated through fractures in the tunnel system. Monitoring of the effluent waters from E-Tunnel is conducted to determine if radionuclides or other contaminants exceed the allowable contaminant levels regulated under a state water pollution control permit. Tritium concentrations in tunnel effluent waters in 2012 were lower than the permit limit. The E-Tunnel containment ponds are fenced and posted with radiological warning signs. Given that the ponds are available to wildlife, game animals are periodically sampled to assess the potential radiological dose to humans via ingestion of game animals exposed to these ponds and to evaluate the radiological impacts to wildlife.

Tritiated water is also pumped into sumps during UGTA groundwater characterization activities. If the tritium level exceeds 400,000 pCi/L in water that is purged from an UGTA well during drilling and or sampling operations, the contaminated water is pumped from the wells and diverted to lined sumps (containment ponds) for evaporation, as required by the State. During 2012, water containing tritium was pumped from two drill holes. Water from one of the wells, UE-20n#1, had a tritium concentration of 47,400,000 pCi/L and was contained in a lined sump. The tritium in this well is associated with a known contaminant plume from the nearby historical underground nuclear test, CHESHIRE.

No drinking water wells on the NNSS contained detectable tritium.

Tank and booster station for NNSS public water supply well WW #4A in Area 6.

Range in Groundwater Tritium Levels Measured on the NNSS in 2012

Onsite Supply Wells	−23.4 to 11.3 pCi/L
Onsite Monitoring Wells	−9.4 to 355* pCi/L

*Three onsite monitoring wells had detectable levels of tritium; all three are within 1 kilometer (0.6 miles) of underground nuclear tests.

Note: Negative numbers indicate measured levels below measured natural background levels (see Section 1.8.13 of the full NNSSER report for a discussion of negative numbers).

NNSS scientists sampling E-Tunnel containment ponds for radioanalysis.

2012 Monitoring Results for E-Tunnel Effluent Waters

Parameter	Permit Limit (pCi/L)	Average Measured Concentration (pCi/L)
Tritium	1,000,000	419,000
Gross Alpha	35	9
Gross Beta	100	33

Radiological Monitoring of Air

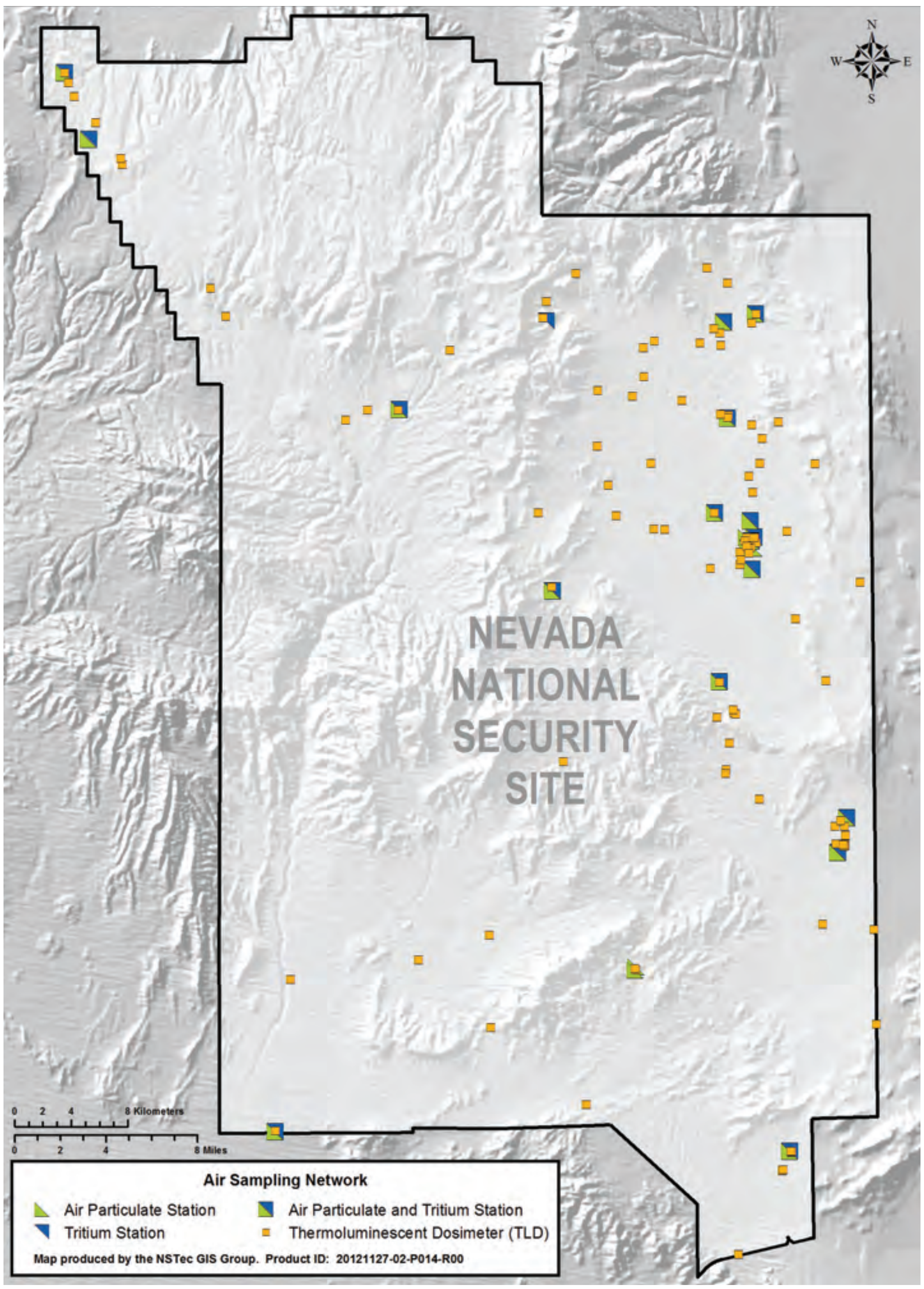
NNSS radioactive emissions are monitored to determine the public dose from inhalation and to ensure compliance with the National Emission Standards for Hazardous Air Pollutants (NESHAP) under the Clean Air Act. A network of 22 air sampling stations and a network of 108 thermoluminescent dosimeters (TLDs) are located throughout the NNSS *(see map below)*. NNSS air sampling stations monitor tritium in water vapor, man-made radionuclides, and gross alpha and beta radioactivity in airborne particulates. The TLD stations monitor direct gamma radiation exposure.

Range in Average Concentrations of Man-Made Radionuclides in Air Samples on the NNSS in 2012 Attributable to NNSS Operations

	Concentration (10^{-15} μCi/mL)[a]		
Radionuclide	Limit[b]	Lowest Average	Highest Average
^{241}Am	1.9	0.001	0.104
^{3}H	1,500,000	130	157,570
^{238}Pu	2.1	−0.002	0.009
$^{239+240}$Pu	2.0	0.002	0.698

(a) The scale of concentration units for radionuclides shown in the table has been standardized to 10^{-15} microcuries per milliliter (μCi/mL). This scale may differ from those reported in detailed radionuclide-specific data tables in the NNSSER.

(b) The concentration established by NESHAP as the compliance limit.



2012 NNSS Air Sampling Network

Radioactive emissions are also monitored at stations in selected towns and communities within 240 miles of the NNSS by the CEMP. A network of 29 CEMP stations is used *(see map on Page 15)*. The CEMP stations monitor 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 (MET) parameters using automated weather instrumentation.

Monitoring NNSS Air Sampling Stations

Several man-made radionuclides were detected at NNSS air sampling stations in 2012: ^{241}Am, ^{3}H, ^{238}Pu, and $^{239+240}$Pu. None, however, exceeded concentration limits established by the Clean Air Act. The highest average levels of ^{241}Am, ^{238}Pu, and $^{239+240}$Pu were detected at Bunker 9-300 in Area 9, located within an area of known soil contamination from past nuclear tests. The highest average level of tritium was detected at Schooner, site of the second-highest yield Plowshare cratering experiment on the NNSS, where tritium-infused ejecta surrounds the crater.

The total amount of man-made radionuclides emitted to the air from

Continued on Page 15 ...

all sources on the NNSS in 2012 was estimated to be 228 Ci. In 2012, these sources included contaminated soils at Schooner and Sedan craters, Area 3 and Area 5 RWMSs, and legacy sites; contaminated groundwater held in containment ponds or lagoons; and tests at BEEF and NPTEC. A research project in Area 6 released 4,926 Ci of other radionuclides that all had short half lives of <6 hours and that were not available to contribute dose to the public at the distances over which they have to travel to reach the public. Over the past 10 years, total emissions have ranged from 117 to 625 Ci for tritium, 0.039 to 0.049 Ci for ^{241}Am, and 0.24 to 0.39 Ci for $^{239+240}$Pu. Emissions of ^{238}Pu are estimated to have remained consistent at about 0.050 Ci over the same time frame.

Estimated Quantity of Man-Made Radionuclides[a] Released into the Air from the NNSS in 2012 (in Curies)

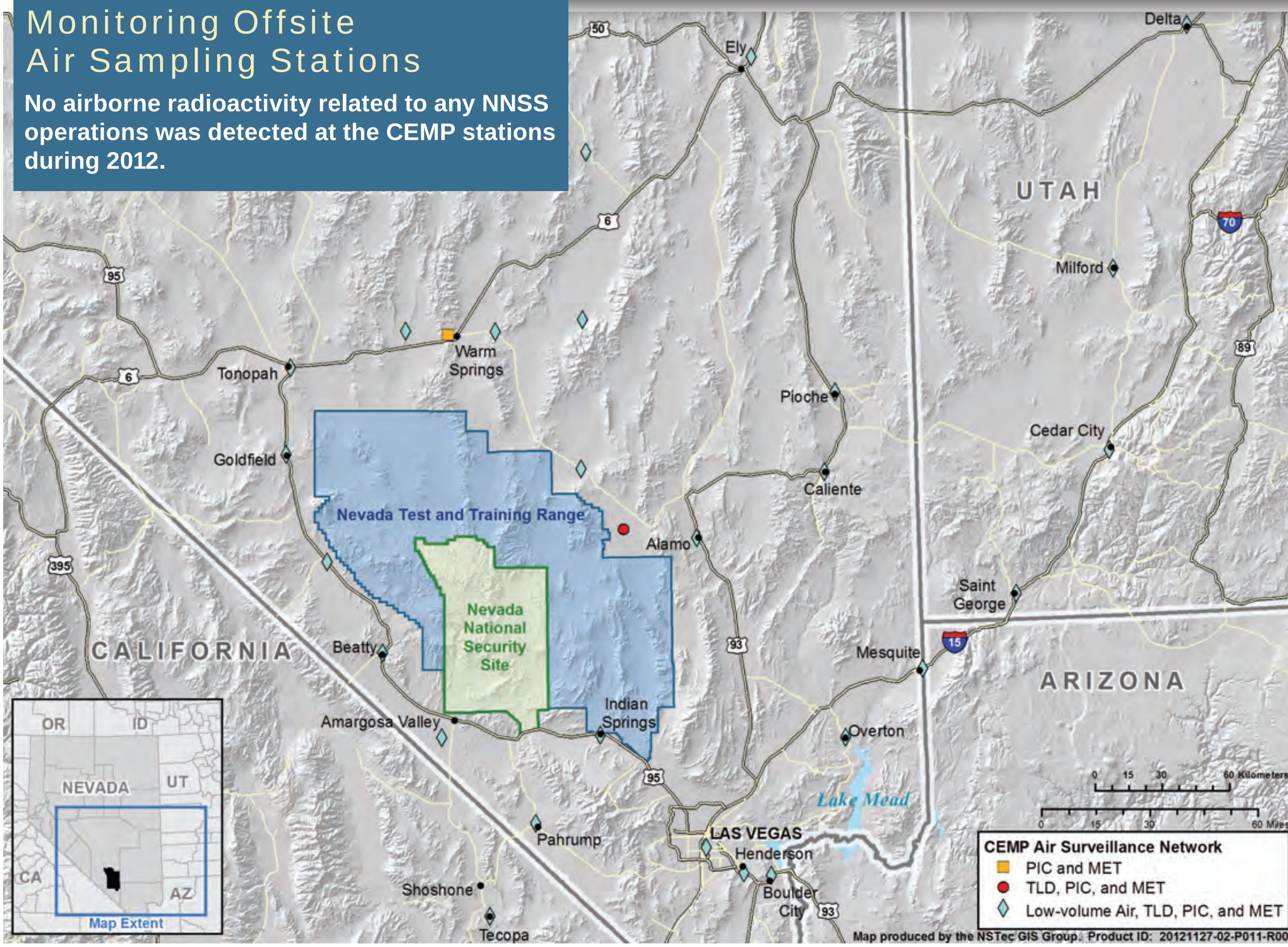
Tritium (^{3}H)	Americium (^{241}Am)	Plutonium (^{238}Pu)	Plutonium ($^{239+240}$Pu)	Depleted Uranium (DU)
228	0.047	0.050	0.29	0.061

(a) Includes only those radionuclides that have a half life >6 hours and that are available to contribute dose to the public.

CEMP air monitoring station located in Indian Springs, NV, at the Indian Springs High School.

Monitoring Offsite Air Sampling Stations

No airborne radioactivity related to any NNSS operations was detected at the CEMP stations during 2012.



2012 CEMP Air Surveillance Network

Direct Radiation Monitoring

Ten NNSS TLD stations are located where radiation effects from past or present NNSS operations are negligible, and therefore measure only natural background levels of gamma radiation from cosmic and terrestrial sources. In 2012, the mean measured background level from the ten stations was 120 milliroentgens per year (mR/yr). This is well within the range of variation in background levels observed in other parts of the U.S. of similar elevation above sea level. Background radiation varies not only by elevation but by the amounts of natural radioactive materials in soil and rock in different geographic regions.

The highest estimated mean annual gamma exposure measured at a TLD station on the NNSS was 570 mR/yr at Schooner, one of the legacy Plowshare sites on Pahute Mesa. The lowest was 63 mR/yr in Mercury at the fitness track. The mean annual gamma exposure at 17 TLD locations near the Area 3 and Area 5 RWMSs was 138 mR/yr, and at the 35 TLD locations near known legacy sites (including Schooner), it was 231 mR/yr.

The CEMP offsite TLD and PIC results remained consistent with previous years' background radiation levels and are also well within the range of variation in background levels observed in other parts of the U.S. and with the 120 mR/yr level measured on the NNSS. The highest total annual gamma exposure measured off site, based on the PIC detectors, was 174 mR at Warm Springs Summit (at 7,570 feet elevation). The lowest offsite exposure rate, based on the PIC detectors, was 72 mR at Pahrump, Nevada (at 2,639 feet elevation).

Greater Roadrunner *(Geococcyx californianus)*

2012 NNSS Background Gamma Radiation

120 mR/yr — This is the mean background radiation measured at 10 TLD stations in areas isolated from past and present nuclear activities.

Average Background Radiation of Selected U.S. Cities (Excluding Radon)

City	**Elevation Above Sea Level** (feet)	**Radiation** (mR/yr)
Denver, CO	5,280	164.6
Wheeling, WV	656	111.9
Rochester, NY	505	88.1
St. Louis, MO	465	87.9
Portland, OR	39	86.7
Los Angeles, CA	292	73.6
Fort Worth, TX	650	68.7
Richmond, VA	210	64.1
New Orleans, LA	39	63.7
Tampa, FL	0	63.7

Source: http://www.wrcc.dri.edu/cemp/Radiation.html, as accessed on June 27, 2013

Range in Average Direct Radiation Measured in 2012 on and off the NNSS

Location	**Elevation Above Sea Level** (feet)	**Radiation Exposure** (mR/yr)
NNSS - Schooner TLD station	5,660	570
NNSS - 35 Legacy Site TLD stations (includes Schooner)	3,077–5,938	231
Warm Springs Summit, Nevada CEMP PIC station	7,570	174
Twin Springs, Nevada CEMP PIC station	5,146	171
NNSS - 17 Waste Operation TLD stations	3,176–4,021	138
NNSS - 10 Background TLD stations	2,755–5,938	120
St. George, Utah CEMP PIC station	2,688	88
Pahrump, Nevada CEMP PIC station	2,639	72
NNSS Mercury Fitness Track TLD station	3,769	63

Understanding Radiation Dose

Dose is a generic term to describe the amount of radiation a person receives. The energy deposited indicates the number of molecules disrupted. The energy the radiation deposits in tissue is called the absorbed dose. The units of measure of absorbed dose are the rad or the gray. The biological effect of radiation depends on the type of radiation (alpha, beta, gamma, or X-ray) and the tissues exposed. A measure of the biological risk of the energy deposited is the dose equivalent. The units of dose equivalent are called rems or sieverts. In the NNSSER, the term dose is used to mean dose equivalent measured in rems. A thousandth of a rem is called a millirem, abbreviated as mrem.

An average person in the United States receives about 310 mrem each year from natural sources and an additional 310 mrem from medical procedures and consumer products (Source: http://www.epa.gov/radiation/understand/perspective.html). Whether or not there is a "safe" radiation dose equivalent is a controversial subject. Because the topic has yet to be settled scientifically, regulators take a conservative approach and assume that there is no such thing as a 100% safe dose equivalent. It is believed that the risk of developing an adverse health effect (such as cancer) is proportionate to the amount of radiation dose received.

Many human activities increase our exposure to radiation over and above the average background radiation dose of 310 mrem per year. These activities include, for example, uranium mining, airline travel, and operating nuclear power plants. Regulators balance the benefit of these activities with the risk of increasing radiation exposures above background and, as a result, set dose limits for the public and workers specific to these activities. DOE has set the dose limit to the public from exposure to DOE-related nuclear activities to 100 mrem/yr. This is the same public dose limit set by the U.S. Nuclear Regulatory Commission (NRC) and recommended by the International Commission on Radiological Protection and the National Commission on Radiological Protection and Measurements. The NRC has set the dose limit for radiation workers to 5,000 mrem/yr. There are no common or agreed-upon dose limits for workers or the public across industries, states, or countries.

Dose — The amount of radiation a person receives.

Absorbed dose — The energy the radiation deposits in tissue, where the energy deposited indicates the number of molecules disrupted. The units of measure of absorbed dose are the rad or the gray.

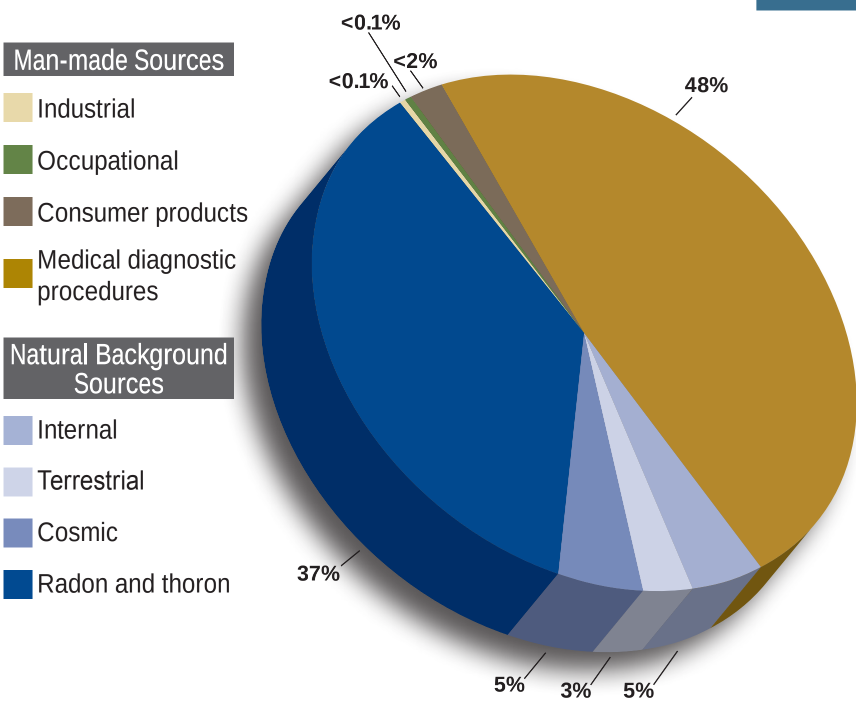
Dose equivalent — A measure of the biological risk of the energy deposited in tissue, which depends on the type of radiation (alpha, beta, gamma, or X-ray) and the tissues exposed. The units of measure of dose equivalent are called rems or sieverts.

Common Doses to the Average American

Source/Activity	Average Dose/Year (or as noted)
5-hour jet plane ride	3 mrem/5 hours
Building materials	4 mrem
Chest X-ray	8 mrem
Cosmic	30 mrem
Soil	35 mrem
Internal to our body	40 mrem
Mammogram	138 mrem
Radon gas	200 mrem
CT scan	2,500 mrem
Smoking 20 cigarettes/day	5,300 mrem to a smoker's lung
One cancer treatment	5,000,000 mrem to the tumor

Source: http://hss.energy.gov/HealthSafety/WSHP/radiation/Radiation-final-6-20.pdf, as accessed on June 1, 2013

Sources of Radiation Exposure for the Average Person in the U.S.
Average Dose = 620 mrem/yr



Estimating Dose to the Public from NNSS Operations

The release of man-made radionuclides from the NNSS has been monitored since the first decade of atmospheric testing. After 1962, nuclear tests were conducted only underground, greatly reducing the radiation exposure in the areas surrounding the NNSS. Underground nuclear testing nearly eliminated atmospheric releases of radiation but resulted in the contamination of groundwater in some areas of the NNSS. After the 1992 moratorium on nuclear testing, radiation monitoring focused on detecting airborne radionuclides that are resuspended with historically contaminated soils on the NNSS and on detecting man-made radionuclides in groundwater.

There are three pathways in this dry desert environment by which man-made radionuclides from the NNSS might reach the surrounding public:

Sedan Crater in north Yucca Flat is a source of airborne radionuclides from resuspended soil (e.g., from wind) and from evapotranspiration of tritiated water.

Air Transport Pathway – Members of the public may inhale or ingest radionuclides that are resuspended by the wind from contaminated sites on the NNSS. However, such resuspended radiation measured off and on the NNSS is much lower than natural background radiation in all areas accessible to the public.

Ingestion Pathway – Members of the public may ingest game animals that have been exposed to contaminated soil or water on the NNSS, have moved off the NNSS, and have then been hunted.

Mule deer *(Odocoileus hemionus)* observed by NNSS biologists during spotlighting census survey on Pahute Mesa.

Groundwater Pathway – Based on monitoring data, drinking contaminated groundwater is currently not a possible pathway for public exposure, given the restricted public access to the NNSS and the location of known contaminated groundwater on and off the NNSS. No man-made radionuclides have been detected in drinking water sources monitored off the NNSS, and no drinking water wells on the NNSS have measurable levels of man-made radionuclides. Radioactively contaminated groundwater was discovered in a characterization well on NTTR just west of the NNSS boundary in 2009 (Well ER-EC-11*, see Page 8)*. This well is not a source of drinking water.

NNSS scientists sampling a private water supply site for radioanalysis.

Public Dose Limits for NNSS Radiation

10 mrem/yr — This is the dose limit to the public (above natural background) from just the air transport pathway, as specified by the Clean Air Act National Emission Standards for Hazardous Air Pollutants (NESHAP).

100 mrem/yr — This is the dose limit to the public (above natural background) from all possible pathways combined, as specified by DOE O 458.1, “Radiation Protection of the Public and the Environment.”

Continued on Page 19 ...

Estimated 2012 Inhalation Dose to the Public

Compliance with radiation dose limits to the general public from the air transport pathway is demonstrated using air sampling results from six onsite "critical receptor" sampling stations, which were approved by the EPA in 2001. The radionuclides detected at four or more of the NNSS critical receptor samplers were ^{241}Am, ^{238}Pu, $^{239+240}$Pu, $^{233+234}$U, $^{235+236}$U, ^{238}U, and ^{3}H. Uranium in NNSS surface soils has generally been attributed to naturally occurring uranium.

As in previous years, the 2012 data from the six critical receptor samplers show that the NESHAP dose limit to the public of 1.10 mrem/yr was not exceeded. The Schooner critical receptor station, in the far northwest corner of the NNSS, had the highest concentrations of radioactive air emissions; an individual residing at this station would experience a dose from air emissions of 1.10 mrem/yr. A more realistic estimate of the maximum dose to a member of the offsite public would be to use the air sampling results from the Gate 510 sampling station in the far southwest corner of the NNSS, which is closest to the nearest populated place, Amargosa Valley. A person residing at the Gate 510 station would experience a dose from air emissions of 0.16 mrem/yr.

Estimated 2012 Ingestion Dose to the Public

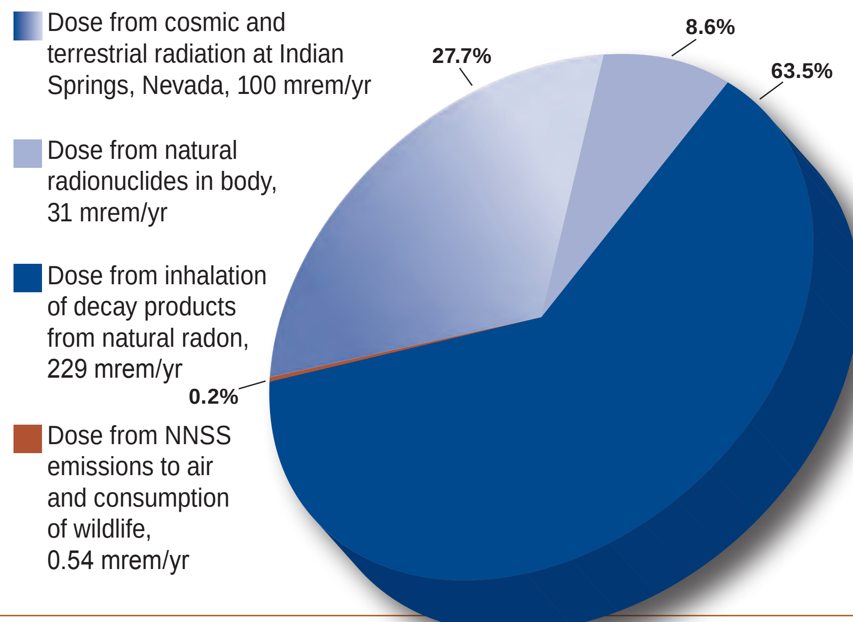
NNSS game animals include pronghorn antelope, mule deer, chukar, Gambel's quail, mourning doves, cottontail rabbits, and jackrabbits. Small game animals from different contaminated NNSS sites are trapped each year and analyzed for their radionuclide content. These results are used to construct worst-case scenarios for the dose to hunters who might consume these animals if the animals moved off the NNSS.

In 2012, two mourning doves were sampled at the E Tunnel Ponds in Area 12, which contain groundwater contaminated by tritium. Opportunistic tissue samples of nine mule and two horses, all killed by mountain lions, and one mule deer and one bobcat, both accidently killed by vehicles on roads, were collected. Blood samples from four captured mountain lions and a tissue sample from one of these mountain lions after it was found dead were also opportunistically collected for radioanalysis. Man-made radionuclides were found in both doves from the E Tunnel Ponds, in a blood sample from one mountain lion, and in four of the mule deer. The estimated dose to a hunter from eating 20 mourning doves, one mule deer, one mountain lion, and one bobcat similar to those sampled in 2012 is about 0.11 mrem. Another dose estimate can be calculated by assuming an individual in 1 year consumes one game animal of each species that has been sampled over the past 12 years on the NNSS and by assuming they all contain the average radionuclide concentrations found in each species. This dose estimate would be 0.38 mrem/yr.

Direct Exposure

No members of the public are expected to receive direct gamma radiation that is above background levels as a result of NNSS operations. Areas accessible to the public, such as the main entrance gate, had direct gamma radiation exposure rates comparable to natural background rates from cosmic and terrestrial radiation.

Dose to the Public from Natural Background Sources and from the NNSS



2012 Dose to the Public from All Pathways

0.54 mrem/yr — This is the maximum dose to the public from inhalation, ingestion, and direct exposure pathways that is attributable to NNSS operations. It is well below the dose limit of 100 mrem/yr established by DOE O 458.1 for radiation exposure to the public from all pathways combined. This total dose estimate is indistinguishable from natural background radiation experienced by the public residing in communities near the NNSS.

Nonradiological Monitoring of Air and Water

Nonradioactive Air Emissions

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," or 10 tons of any one of the 189 "hazardous air pollutants" (HAPs), or 25 tons of any combination of HAPs. Common sources of such air pollutants on the NNSS include particulates from construction, aggregate production, surface disturbances, fugitive dust from driving on unpaved roads, fuel-burning equipment, open burning, fuel storage facilities, and chemical release and detonation tests.

An estimated 21.62 tons of criteria air pollutants and 0.09 tons of HAPS were released on the NNSS in 2012. The majority of the emissions were nitrogen oxides from diesel generators. No emission limits for any air pollutants were exceeded.

Estimated Quantity of Pollutants Released into the Air from NNSS Operations in 2012

Criteria Air Pollutants:	Tons
Particulate Matter[(a)]	6.51
Carbon Monoxide	2.38
Nitrogen Oxides	10.51
Sulfur Dioxide	1.14
Volatile Organic Compounds	1.08
Hazardous Air Pollutants (HAPs)	0.09

(a) Particulate matter equal to or less than 10 microns in diameter

Nonradiological Monitoring of Drinking Water and Wastewater

NNSA/NFO operates a network of seven permitted wells that comprise three permitted public water systems on the NNSS that supply the drinking water needs of NNSS workers and visitors. NNSA/NFO also hauls potable water to work locations at the NNSS that are not part of a public water system. Monitoring results for 2012 indicated that water samples from the three public water systems and from the potable water hauling trucks met the National Primary and Secondary Drinking Water Standards.

Industrial discharges on the NNSS are limited to the two operating sewage lagoon systems, Area 6 Yucca and Area 23 Mercury. Under the requirements of the state operating permit, liquid discharges to these sewage lagoons were tested quarterly in 2012 for biological oxygen demand, pH, and total suspended solids. All sewage lagoon water measurements were within permit limits.

The discharge water from the E-Tunnel complex is sampled annually under a state water pollution control permit for 14 nonradiological contaminants, which are mainly metals. In 2012, no contaminants were detected at levels that exceeded permit limits.

NNSS Drinking Water

The public water systems that supply drinking water to NNSS workers and visitors meet all Safe Drinking Water Act standards.

Sampling well water

Managing Cultural Resources

The historical landscape of the NNSS contains archaeological sites, buildings, structures, and places of importance to American Indians and others. These are referred to as "cultural resources." NNSA/NFO requires that NNSS activities and programs comply with all applicable cultural resources regulations and that such resources on the NNSS be monitored. The Cultural Resources Management program is implemented by DRI to meet this requirement.

DRI archaeologists completed archival research for 34 proposed projects in 2012 and completed surveys of 510 acres for 9 of the projects. Field surveys for 8 projects were completed and identified two prehistoric archaeological sites. One historical evaluation of the 1957 Smoky atmospheric test location in Area 8 of the NNSS was completed. The evaluation identified two historical sites containing 1,308 artifacts and 14 features from the test and one historic district that contains 1 building and 37 structures. The Smoky test location is the most intact atmospheric nuclear testing site on the NNSS and possibly in the world. No mitigation actions to protect

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historic properties on the NNSS were required. DRI continued to maintain and manage the NNSS Archaeological Collection, which contains over 400,000 artifacts.

NNSA/NFO's American Indian Consultation Program conducts consultations with NNSS-affiliated American Indian tribes through the Consolidated Group of Tribes and Organizations (CGTO). The CGTO Spokesperson met in January 2012 with the acting DOE Deputy Assistant Secretary for Environmental Management (EM) to discuss CGTO participation in EM activities on the NNSS and involvement in DOE/EM State Tribal Government Work Group (STGWG) meetings. The STGWG is composed of tribes that work with DOE sites throughout the U.S. The CGTO Spokesperson attended four more meetings in 2012, each supported by NNSA/NFO to encourage increased tribal involvement and understanding about DOE's role in national and international activities. They included DOE's National Transportation Stakeholders Forum, two STGWG meetings, and the International Conference of Geologic Repositories held in Ontario, Canada. DOE's Office of Nuclear Energy and the U.S. Nuclear Regulatory Commission invited the CGTO Spokesperson to be a guest speaker at the international conference, which allowed the CGTO Spokesperson to represent American Indian perspectives for the U.S. in tandem with three First Nations representatives who shared their unique perspectives about geologic repositories and the importance of tribal interactions.

Endangered Species Protection and Ecological Monitoring

NNSA/NFO is committed to working collaboratively with other agencies to provide research opportunities on the NNSS that benefit ecological and conservation science.

The Ecological Monitoring and Compliance (EMAC) Program provides ecological support for activities and programs conducted on the NNSS. Important species known to occur on the NNSS include 18 sensitive plants, 1 mollusk, 2 reptiles, over 250 birds, and 27 mammals. They are classified as important due to their sensitive, protected, and/or regulatory status with state or federal agencies.

The desert tortoise is the only resident species on the NNSS that is protected under the Endangered Species Act and that can be adversely affected by NNSS activities. It is designated as a threatened species under the Act. Habitat of the desert tortoise is in the southern third of the NNSS. Activities conducted in desert tortoise habitat must comply with the terms and conditions of a Biological Opinion issued to NNSA/NFO by the U.S. Fish and Wildlife Service (FWS). In 2012, no desert tortoises were accidentally injured or killed at a project site, nor were any found, captured, or displaced from project sites. One desert tortoise was found injured on a paved road in 2012, and seven were moved out of harm's way off of roads.

Desert tortoise *(Gopherus agassizii)*

To help lower the number of desert tortoises killed on NNSS roads, site biologists developed a tortoise movements study and petitioned FWS for funds to conduct it. As a result, NNSA/NFO entered into a new collaboration with the FWS and the San Diego Zoo Institute for Conservation Research (ICR). The collaboration provides funds from the FWS to purchase radiotelemetry equipment needed for the tortoise movement study. In exchange, it makes NNSS lands available as a needed translocation research site for tortoises being held at the Desert Tortoise Conservation Center (DTCC) in Las Vegas, Nevada. The DTCC is supported by FWS funds and is operated by the San Diego Zoo ICR. The NNSS radiotelemetry study began in May 2012, and site biologists began collecting movement data from 11 adult tortoises. The San Diego Zoo ICR released 60 radio-marked juvenile desert tortoises onto the NNSS in September 2012 and is using community volunteers, university students, and San Diego Zoo researchers to conduct the work.

In 2012, biologists continued to monitor important species and biological resources on the NNSS that included sensitive plants, migratory birds, wild horses, mule deer, sensitive bats, the western red-tailed skink, and natural and man-made water sources. The collaborative effort with Dr. David Mattson of the U.S. Geological Survey (USGS) continued in 2012 to study the movements, habitat use, and food habits of

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pumas (mountain lions) on and around the NNSS. The goal for 2012 was to capture and collar four pumas and track them for at least a year. Three males and one female puma were captured and fitted with radio-collars in May and June 2012. NNSS biologists are assisting USGS by collecting information on the puma's kills.

Mountain lion trapper Brian Jansen holds the head of a healthy, anesthetized 7–9-year-old male puma weighing 143 pounds after capturing and fitting the puma with a radio-collar on May 23, 2012, on Pahute Mesa. This male is the largest puma collared and tracked on the NNSS to date. His estimated home range in 2012 was 400 square miles, about 1.8 times greater than the average home range documented in Nevada. He made a verified kill every 11 days on average, and his documented prey species included 15 mule deer, 5 horse foals, and 1 gray fox.

Environmental Stewardship

NNSA/NFO's Environmental Management System (EMS) is a business management practice that incorporates concern for environmental performance throughout the NNSS and its support facilities. The goal of the EMS is continual reduction of NNSA/NFO's impact on the environment. The EMS is designed to meet the requirements of the globally recognized International Organization for Standardization (ISO) 14001:2004 Environmental Management Standard. In 2008, the EMS obtained ISO 14001:2004 certification. Annual audits are required to maintain an EMS registration, and recertification audits of the entire EMS occur every 3 years. In 2012, an EMS recertification audit determined that NNSA/NFO remains in conformance with the ISO 14001:2004 Standard.

Through implementation of the EMS and efforts of the Energy Management Program, NNSA/NFO is helping DOE to meet their nation-wide goal of reducing greenhouse gas (GHG) emission by 28% by the year 2020 when compared to FY 2008 emissions. This goal is for Scope 1 and Scope 2 GHG emissions.

Site-specific EMS objectives and targets are developed on a fiscal year (FY) schedule (October 1 through September 30). In FY 2012, the EMS objectives included:

- **Reduce energy use.**
- **Decrease use of petroleum-based fuels.**
- **Purchase products that meet environmentally preferable purchasing standards.**
- **Protect groundwater quality through borehole plugging.**
- **Meet site remediation corrective action schedule deadlines established under the FFACO.**
- **Help NNSA meet DOE complex-wide site sustainability goals.**

The targets set for these objectives are tracked by the various responsible operational groups and reported quarterly to an Executive Leadership Council. Some EMS targets mirror the sustainable environmental stewardship goals established by DOE *(see Pages 23 and 24)*.

The Energy Management Program was formed to specifically reduce the use of energy and water in NNSA/NFO facilities and to advance the use of solar and other renewable energy sources. In December 2012, the Energy Management Program developed the FY 2013 NNSA/NFO Site Sustainability Plan, which reports the current status and planned actions toward meeting DOE's sustainability goals. Thus far, the Energy Management Program is on track to meet the majority of the DOE long-term goals *(see Pages 23 and 24)*.

The Pollution Prevention and Waste Minimization Program helps to reduce the volume and toxicity of waste that must be disposed. In 2012, 75.2 tons of hazardous waste were diverted from disposal by recycling and reuse. The largest proportion of this reduction in waste came from shipments of lead acid batteries and scrap lead to offsite vendors for recycling.

More than 1,279 tons of solid waste were diverted from landfills and either recycled or reused in 2012. Most of these materials were mixed paper, cardboard, cans, and plastic sent off site for recycling, and ferrous and nonferrous metal sold as scrap for recycling.

GHG emissions targeted for reduction are carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. For setting and tracking DOE emission reduction goals, they are classified depending on their source:

Scope 1 — direct emissions from sources owned or controlled by a federal agency.

Scope 2 — direct emissions resulting from the generation of electricity, heat, or steam purchased by a federal agency.

Scope 3 — emissions from sources not owned or directly controlled by a federal agency but related to agency activities.

Energy Efficiency and Management

- Energy intensity (energy use per square foot of building space) was 31% below the FY 2003 baseline – the goal is 30% reduction by FY 2015.
- 94% of buildings or processes are metered for electricity, and 100% are metered for natural gas – this exceeds the goal of 90% for electricity by October 2012 and 90% for natural gas by October 2015.
- Five roofs were replaced with cool roofs (solar reflective/thermal resistant). Cool roofs currently cover 23% of the gsf of all NNSA/NFO buildings.
- Through the purchase of renewable energy credits and by using photovoltaic and wind turbines that generate 0.5% of the power produced on site, NNSA/NFO met the goal of having 7.5% of its power on the NNSS come from renewable sources.

Water Efficiency and Management

- Water intensity (gallons used per total gross square feet [gsf] of facility space) was 35% below the FY 2007 baseline – exceeded the goal of 26% reduction by FY 2020.
- Non-potable water production (used to estimate consumption) was 14% below the FY 2010 baseline as a result of repairing end point leaks, closing unneeded well sumps, and replacing the sumps with metal wildlife watering troughs – the goal is 20% reduction by FY 2020.

Wildlife watering trough that replaced Well 5b sump closed in 2012.

Fleet Management

- Use of alternative fuel was 118% above the FY 2005 baseline – exceeded the goal of a 70% increase above the FY 2005 baseline for 2012.
- Use of petroleum was 50% less than the FY 2005 baseline – exceeded the goal of a 14% decrease from the FY 2005 baseline for 2012.
- 100% of light duty vehicle acquisitions were alternative fuel vehicles – exceeded the goal of 75%.
- Fleet inventory is 21.7% less than the FY 2005 baseline – exceeded the goal of a 15% reduction by FY 2015.

High Performance Sustainable Buildings (HPSBs)

- 3.4% of buildings larger than 5,000 gsf are compliant with the Guiding Principles for Federal Leadership in HPSB design – the goal is to have 15% of such buildings compliant by FY 2015.

Pollution Prevention and Waste Minimization

- 39% of non-hazardous solid waste generated at NNSA/NFO facilities was diverted from landfills through recycling – the goal is 50% by the end of FY 2015.
- 42% of construction materials were recycled and diverted from the landfill – the goal is 55% by the end of FY 2015.

Greenhouse Gas (GHG) Emissions

- A more accurate annual inventory of Scope 1 and 2 GHG emissions was conducted. It included Scope 1 fugitive GHG emissions of hydrofluorocarbons and sulfur hexafluoride that were not included in previous years' inventories nor in the FY 2008 baseline from which DOE complex-wide reduction goals are tracked. DOE's goal is to reduce GHG emissions by 28% from an FY 2008 baseline by 2020.
- FY 2012 Scope 1 and 2 GHG emissions, based on the more accurate 2012 inventory, were 0.98% greater than those of the FY 2008 baseline.
- Annual inventory of Scope 3 GHG emissions was 29.8% below the FY 2008 baseline – exceeded the goal of 13% reduction by FY 2020.

Electronic Stewardship and Data Centers

- 100% of the 2,100 leased computers are Electronic Product Environmental Assessment Tool (EPEAT) registered and Energy Star qualified.
- All data centers have been metered in order to measure their monthly Power Utilization Effectiveness (PUE) – met the goal to have all centers metered by FY 2015.
- PUE for the Building C-1 data center at the NLVF was 2.1; PUE for the data center in Building 23-725 at Mercury will be measured beginning in FY 2013 – the goal is a maximum annual weighted PUE of 1.4 for each data center by FY 2015.
- All leased computers and monitors have power management capabilities that are used – meets the goal to have 100% of computers and monitors using power management capabilities by FY 2012.

Innovation

- A cartoon character called the Green Reaper was developed to promote the reduction of energy use at work. A Green Reaper-costumed spokesperson teaches elementary school children what they can do to save energy and water at home as part of a community outreach program.

Front cover photographs ...

Wyoming Indian paintbrush *(Castilleja linarifolia)*

New Mexico thistle *(Cirsium neomexicanum)* (on left)

Virgin River brittlebush *(Encelia virginensis)* (on right)

Desert milkweed *(Asclepias erosa)*

Fremont's dalea *(Psorothamnus fremontii)*

Redspined fishhook cactus *(Sclerocactus polyancistrus)*

Wishbone-bush *(Mirabilis laevis)*

Title page photograph ...

Stansbury cliffrose *(Purshia stansburiana)*

Back cover photograph …

Joshua tree *(Yucca brevifolia)*

National Nuclear Security Administration

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