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National Nuclear Security Administration

NEVADA NATIONAL SECURITY SITE

September 2020

2019 Environmental Report Summary


R44

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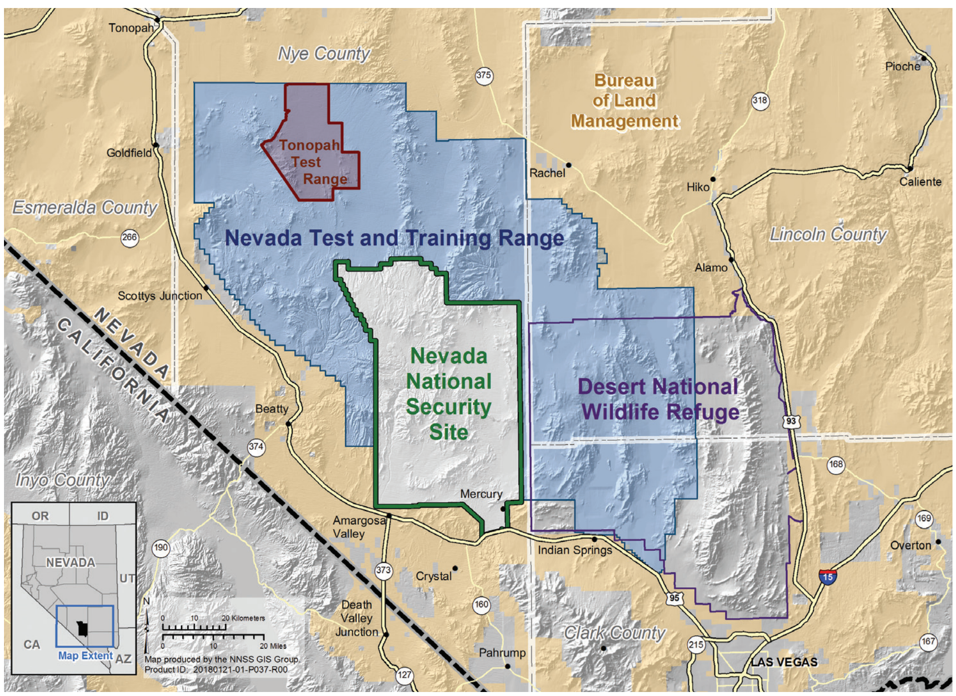
NEVADA NATIONAL SECURITY SITE

Environmental Report Summary 2019

This document is a summary of the full *2019 Nevada National Security Site Environmental Report* (NNSSER) prepared by the U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office (NNSA/NFO). This summary provides an abbreviated and more readable version of the full NNSSER. The reader is provided with an electronic file of the full NNSSER and of *Attachment A: Site Description* on a compact disc (see inside back cover). The reader may obtain a hard copy of the full NNSSER as directed on the inside back cover of this summary report.

NNSA/NFO prepares the NNSSER to provide the public an understanding of the environmental monitoring and compliance activities that are conducted on the Nevada National Security Site (NNSS) to protect the public and the environment from radiation hazards and from potential nonradiological impacts. It is a comprehensive report of environmental activities performed at the NNSS and offsite facilities over the previous calendar year.

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 which resulted in dispersion of plutonium in the test vicinity. Some of these test areas are off of the NNSS 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.

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 using a neutron generator mounted on a 1,527-foot steel tower to study neutron and

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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 renamed Nevada Test Site (NTS).

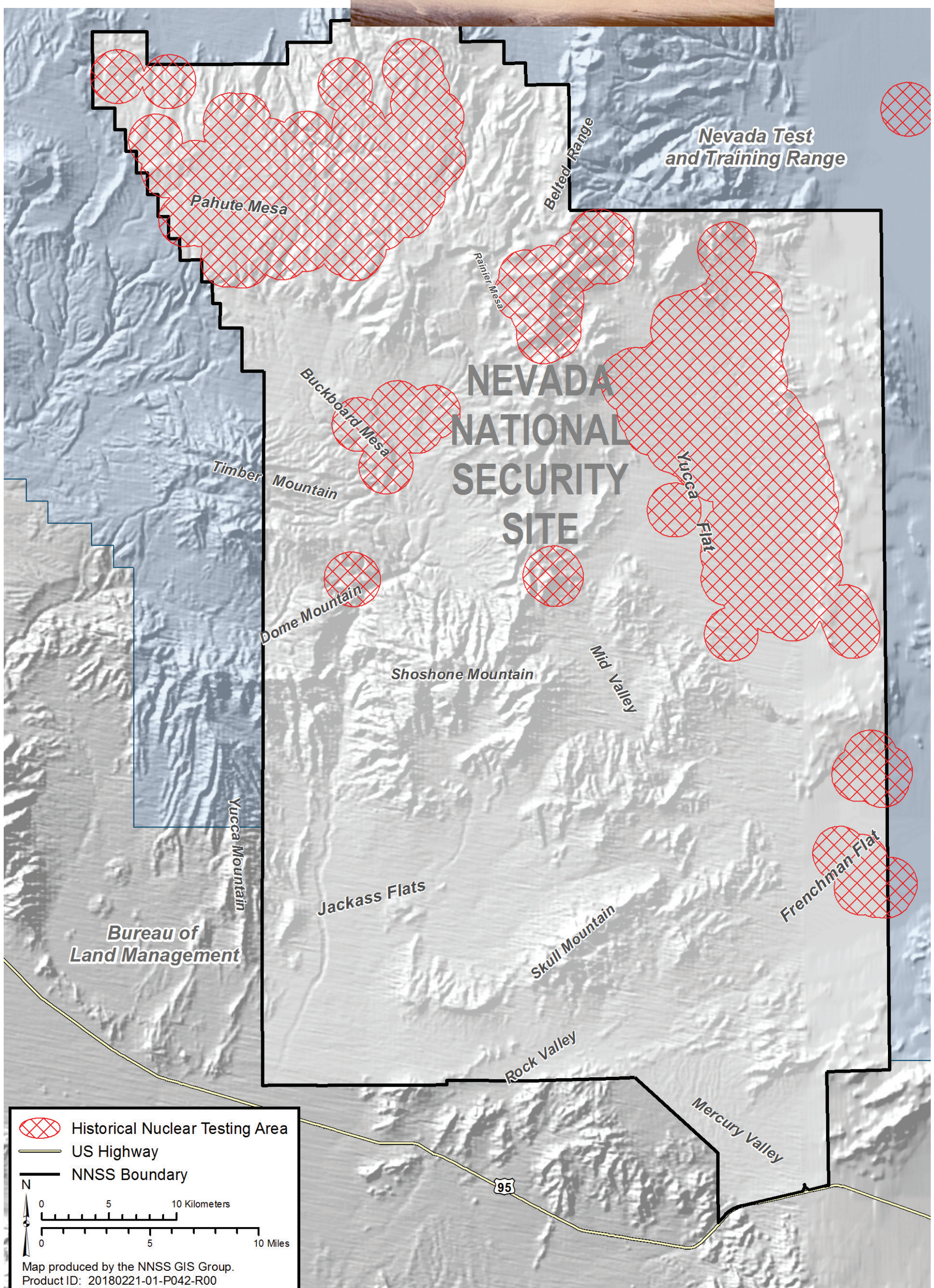
On September 23, 1992, the last underground nuclear test was conducted on the NTS, after which Congress imposed a moratorium on nuclear weapons testing. Since 1951, a total of 100 atmospheric and 828 underground nuclear weapons tests have been conducted at the NTS.

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.

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.

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 (radioiodines, radio-xenons, radiokryptons) 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 Field Office, 2015, DOE/NV--209, Rev. 16).



Historical Nuclear Testing Areas on and adjacent to the NNSS

The NNSS Now

NNSA/NFO conducts three major missions and their programs on the NNSS. Experimental programs are sponsored mainly 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. Mission Support and Test Services LLC (MSTS) is the M&O Contractor accountable for ensuring work is performed in compliance with environmental regulations.

NNSS activities in 2019 continued to be diverse, with the primary goal to ensure that the existing U.S. stockpile of nuclear weapons remains safe and reliable. Other 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), National Criticality Experiments Research Center (NCERC) located in the DAF, Joint Actinide Shock Physics Experimental Research (JASPER) Facility, Dense Plasma Focus (DPF) Facility located in the Los Alamos Technical Facility (LATF), the Radiological/Nuclear Countermeasures Test and Evaluation Complex (RNCTEC), and the Radiological/Nuclear Weapons of Mass Destruction Incident Exercise Site (known as the T-1 Site). 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).

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.

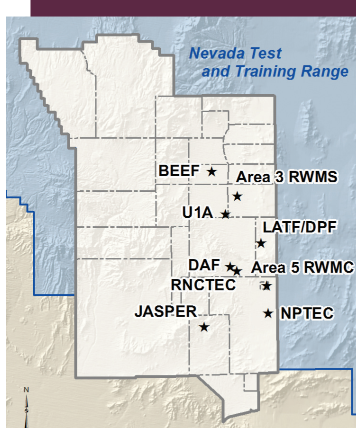
Nuclear Emergency Response, Nonproliferation, and Counterterrorism Programs — Provides support facilities, training facilities, and capabilities for government agencies involved in emergency response, nonproliferation technology development, national security technology development, and counterterrorism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

Strategic Partnership 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 corrective actions.

Waste Management Program — Manages and safely disposes of low-level waste and mixed low-level waste received from U.S. Department of Energy (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

Activities on the NNSS 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.

The following table defines and summarizes 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 2019

Environmental Statute or Order and What It Covers	2019 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	963.004 cubic feet of waste was disposed on site in LLW and MLLW disposal cells at the Area 5 RWMC and Area 3 RWMS. 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 2019 NNSS air emissions to the maximally exposed individual (MEI) is 0.057 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 the Resource Conservation and Recovery Act (RCRA) instead *(see below)*.
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	Radiological 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 0.49 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 toxic chemicals being stored, released to the environment, and/or managed through recycling or treatment	69,009 lb of lead, 125 lb of mercury, 26 lb of polychlorinated biphenyls (PCBs), and 116 lb of polycyclic aromatic hydrocarbons (PACs) were released as a result of NNSS activities. About 65% of lead released was for offsite recycling, while nearly 100% of remaining chemicals were released onsite. No releases exceeded reportable thresholds in 2019.
Endangered Species Act (ESA): Threatened or endangered species of plants and animals	Field surveys for 26 projects in desert tortoise habitat on the NNSS were conducted, no tortoises were harmed or displaced from project sites. No acres of tortoise habitat was disturbed. Two desert tortoises were killed on roads, and no tortoises were injured or killed due to project activities. 56 desert tortoises found near roads were moved out of harms way. All actions were in compliance with permit requirements.
Federal Facility Agreement and Consent Order (FFACO): Cleanup of waste sites containing hazardous substances	All 2019 corrective action milestones under the FFACO were met and 2 corrective action sites were closed. To date, 2,158 of 3,044 have been 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	No projects harmed bird nests or eggs and 17 accidental human-related bird deaths were documented (e.g., electrocutions on powerlines and vehicle collisions).
National Environmental Policy Act (NEPA): Evaluating projects for environmental impacts	39 proposed projects/activities were reviewed under the NEPA compliance procedures and none required further NEPA analysis.
National Historic Preservation Act (NHPA): Identifying and preserving historic properties	Field surveys and historical evaluations for 15 projects were conducted, 1,409 acres were surveyed, and 120 cultural resources were identified, 55 of which were determined eligible to the National Registry of Historic Places.
Resource Conservation and Recovery Act (RCRA): Generation, management, disposal of hazardous waste (HW) and MLLW and cleanup of inactive, historical waste sites	861 tons of MLLW were disposed on site, 2.54 tons of HW were received for temporary onsite storage and/or treatment, and 1.78 tons of HW were shipped off site for disposal, 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	All three permitted public water systems on the NNSS met applicable national and state water quality standards.
Toxic Substances Control Act (TSCA): Management and disposal of PCBs	26 lb of LLW containing PCBs were disposed on site and 0.31 lb was shipped off site to an approved PCB disposal facility.

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. The Environmental Management (EM) Nevada Program 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.

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.

Legacy Contamination

Groundwater — The total amount of radiation remaining below the groundwater table is approximately 20 to 25 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 Ci estimated to be released across the entire NNSS fluctuate annually; the highest annual estimates since 1992 have been 2,240 Ci for tritium, 0.40 Ci for plutonium, and 0.069 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 1,865 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, 2019, over 1.8 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 1.7 million Ci. The radioactive content of the waste decays over time, however, at a varied rate depending on the radionuclide.

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, the majority of which have already been remediated and/or closed. The public is kept informed of EM Nevada Program activities through periodic newsletters, exhibits, and fact sheets, and EM Nevada Program provides the opportunity for public input via the Nevada Site Specific Advisory Board (NSSAB), consisting of 15–20 citizen volunteers from Nevada.

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

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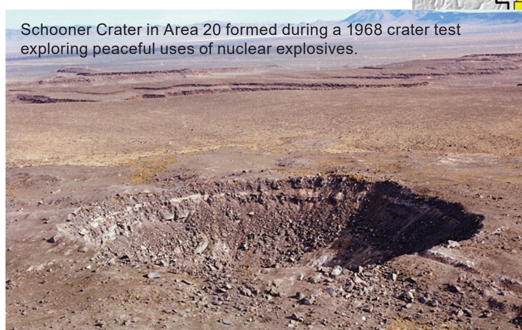
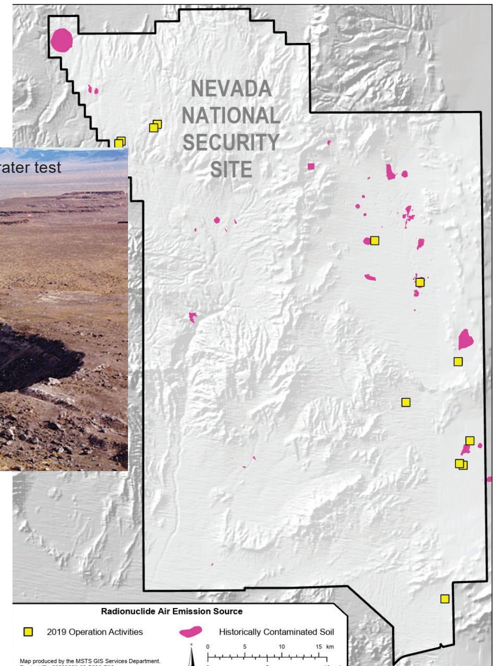
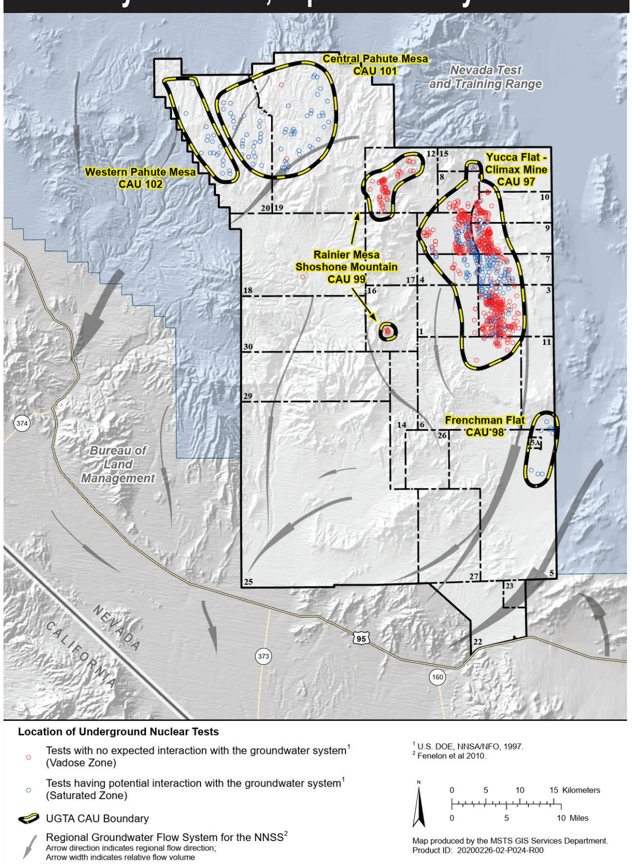

Schooner Crater in Area 20 formed during a 1968 crater test exploring peaceful uses of nuclear explosives.



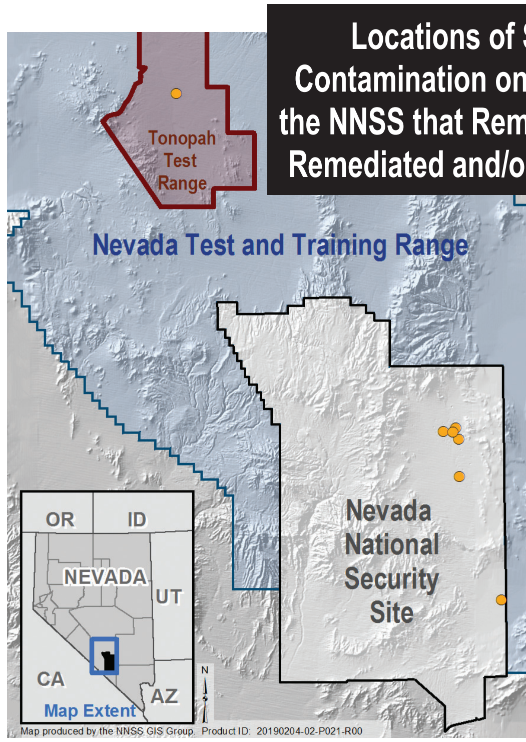
Sources of Radiological Air Emissions on the NNSS

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



Areas of Potential Groundwater Contamination on the NNSS

Locations of Soil Contamination on and off the NNSS that Remain to be Remediated and/or Closed



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 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, and 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.

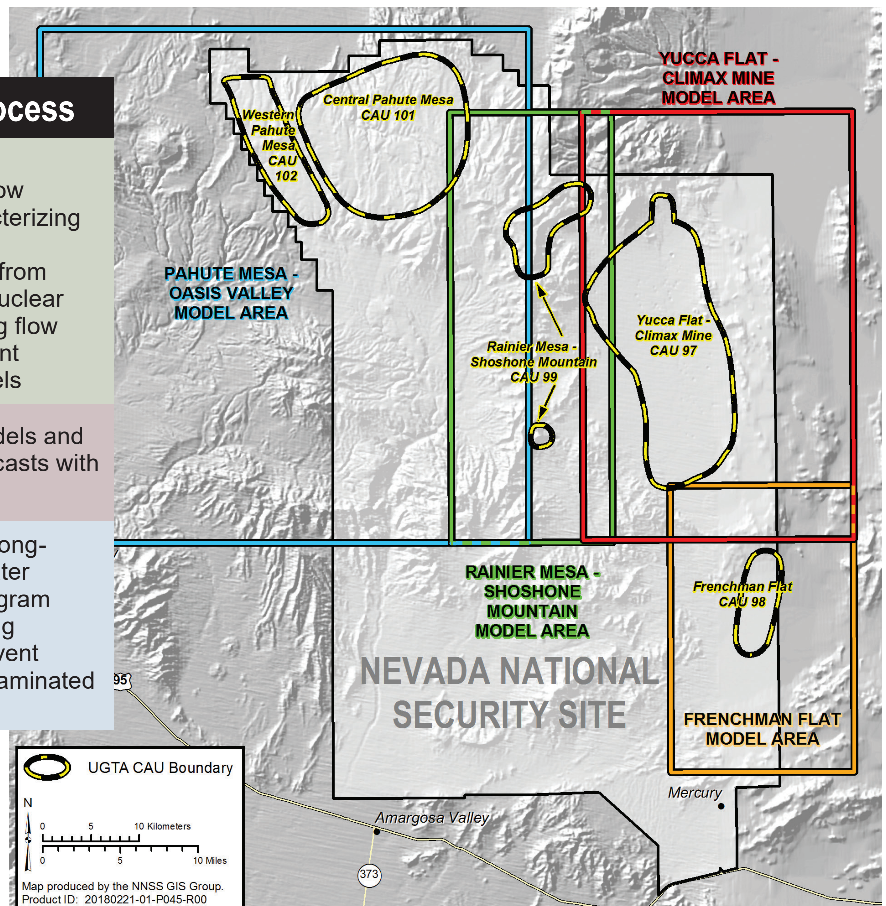
Cleanup and Closure of Corrective Action Sites

UGTA Sites

The EM Nevada Program 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 be used to forecast 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. The progress towards closure of each UGTA CAU is summarized below. The design and results to date of all wells in NNSA/NFO's groundwater sampling network are presented on Pages 18 and 19.

UGTA Sites Closure Process

Investigation Stage	Characterizing groundwater flow system, characterizing groundwater contamination from underground nuclear testing, building flow and contaminant transport models
Model Evaluation	Evaluating models and modelling forecasts with field data
Closure Stage	Implementing long-term groundwater monitoring program and establishing controls to prevent access to contaminated groundwater



Location of UGTA Activity CAUs and Model Areas

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Central and Western Pahute Mesa CAUs – These CAUs are in the middle of the investigation stage of the closure process. The Phase I Central and Western Pahute Mesa Transport Model, completed in 2009, forecasts that tritium in groundwater may migrate off the northwestern boundary of the NNSS within 50 years of the first nuclear detonation (in 1965) and that offsite concentrations of tritium may be above the Safe Drinking Water Act limit of 20,000 picocuries per liter (pCi/L) *(see figure below).*

A Phase II Central and Western Pahute Mesa Corrective Action Investigation Plan (CAIP), completed in 2009, outlines the field investigation program that is currently being implemented. The program's objective is to collect additional data to test the assumptions of the Phase I groundwater flow

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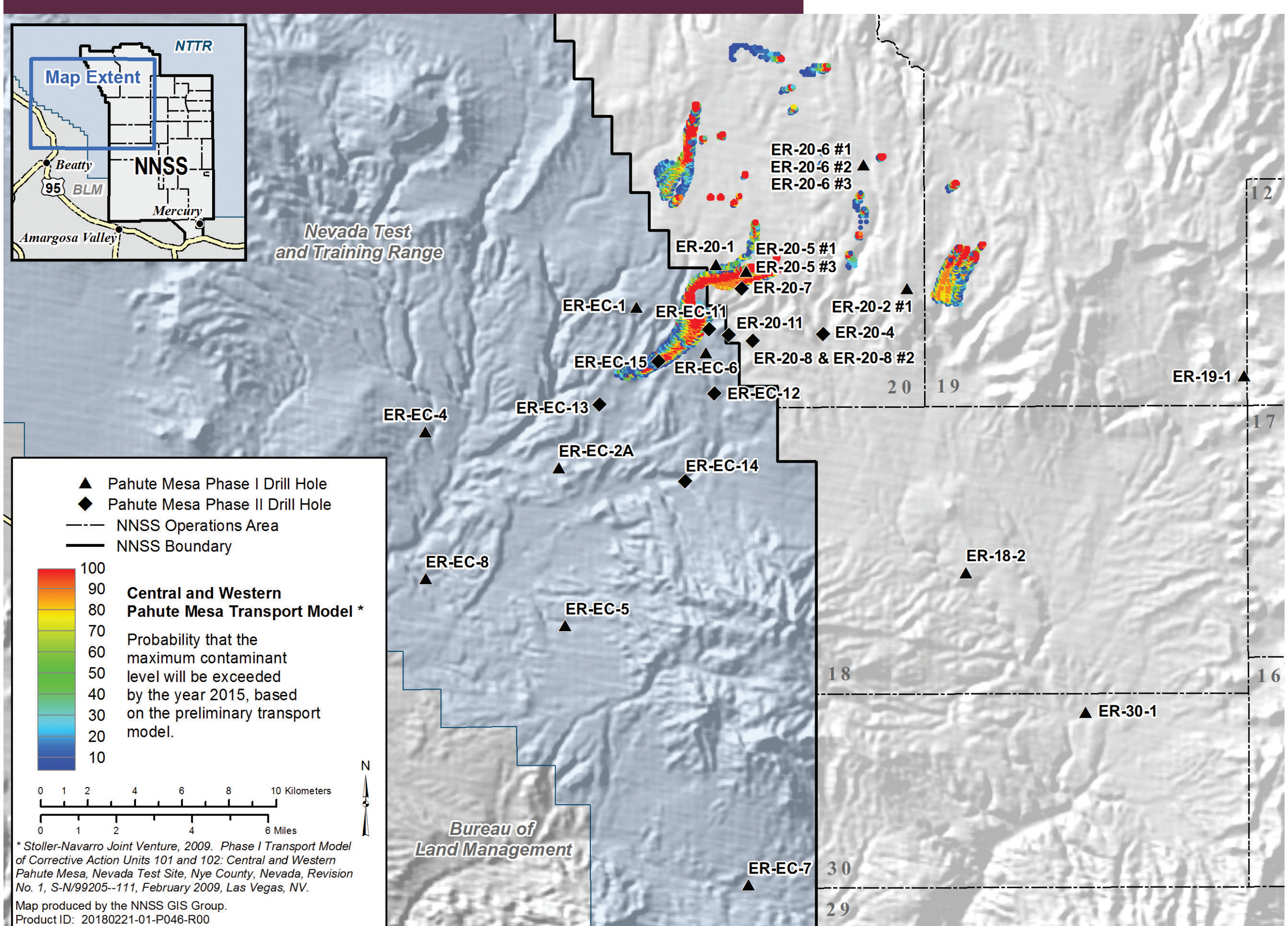
Pahute Mesa Groundwater Monitoring Results in Perspective

- Based on conservative scientific calculations and sampling results, it will take at least 100 years for tritium to reach the closest public land boundary.
- In approximately 100 years, the concentration of tritium is estimated to be in compliance with safety standards at the closest public land boundary.
- In approximately 200 years, the concentration of tritium will be nearly zero at the closest public land boundary.



Results of 2009 Phase I Central and Western Pahute Mesa Transport Modeling

and contaminant transport models, improve data quality, and increase confidence in the transport model results used to forecast contaminant boundaries. Twelve new wells were proposed, eleven of which have been drilled. The new Phase II wells have yielded valuable new information regarding radionuclide migration within this CAU.

Newly drilled well ER-20-12 on Pahute Mesa after sunset.

Other Phase II investigations continued through 2019 including groundwater sampling, measuring water levels, and a variety of analysis to evaluate the Phase II geologic, hydrologic, and chemistry data.

Post-closure monitoring of the Frenchman Flat CAU continued in 2019. Seventeen wells were sampled for either water quality and/or water level. Water quality results are consistent with the groundwater flow and radionuclide transport models. The use restrictions continue to prevent exposure of the public, workers, and the environment to contaminants of concern by preventing the use of potentially contaminated groundwater within the Frenchman Flat CAU.

Consistent with the transport model forecast, tritium was detected in well ER-EC-11 on the NTTR in 2009. It 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. ER-EC-11 has the highest concentration of tritium (18,400 pCi/L measured in 2017) among the offsite NTTR wells. Elevated tritium in ER-EC-11 and in a cluster of five Area 20 monitoring wells represents the downgradient extension of the Benham-Tybo contaminant plume. Data from these wells indicate that the contaminant plume forecasted by the Phase I model may be more southerly than previously modeled. Phase II flow and transport modeling will include the new data from the Phase II drilling initiative, and will reflect recent tritium measurements. In 2019, sampling occurred at locations at or downgradient of Pahute Mesa.

Frenchman Flat CAU – This CAU is the first CAU to reach the closure stage and

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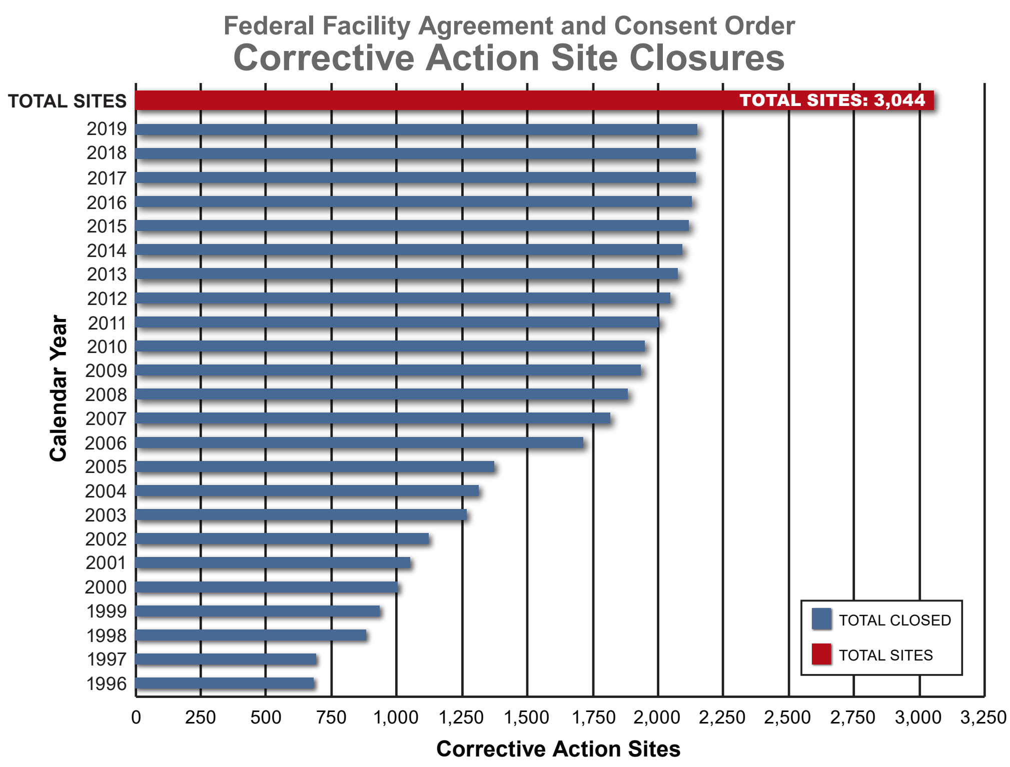
NNSS Scientist Jenny Chapman (foreground) discusses groundwater characterization at Frenchman Flat with a resident of Amargosa Valley, Nevada, at the 2016 NNSS Groundwater Open House.

the start of longterm, or post-closure monitoring. The Closure Report was approved in 2016 and is the culmination of 20 years of characterization, modeling, and model evaluation. The Report describes the final contaminant, use restriction, and regulatory boundaries. It also prescribes a monitoring program for the first 5 years which includes sampling for water quality, water level, and institutional control monitoring.

Use restrictions continue to prevent exposure to the public, workers, and the environment from contaminants of concern by preventing the use of potentially contaminated groundwater.

Rainier Mesa–Shoshone Mountain CAU – The *investigation stage* of the closure process for the Rainier Mesa/Shoshone Mountain CAU was completed in 2019. The closure strategy, approved by NDEP in 2013, is unique from the other UGTA CAUs. It does not require the identification of contaminant boundaries because of their expected irreducible uncertainty and cost prohibitions. Instead, it requires the development of simpler models to forecast potential distances of radionuclide transport. This new strategy is expected to save several years and several million dollars over the original process, while still protecting human health and the environment over the 1,000-year compliance period required by the FFACO. Simplified models of radionuclide transport along potential transport pathways from source locations in Rainier Mesa are being developed. Tritium levels in wells monitored in 2019 and previous years are being compared to simulation results. Documentation and peer review of the simplified models and results were complete in 2019. The NDEP will use the results and recommendations of the external Peer Review Panel to determine if the CAU 99 Flow and Transport Model meets the requirements for advancement to the closure stage.



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Yucca Flat–Climax Mine CAU – The model evaluation stage of the closure process for the Yucca Flat/Climax Mine CAU was completed in 2019. During model evaluation, hydrologic and radionuclide data were evaluated for fifteen wells that access the lower carbonate aquifer (LCA) within the Yucca Flat basin. This included three new model evaluation wells drilled near underground tests (UGTs) considered most likely to have impacted the LCA. Understanding radionuclide transport to the LCA is high priority because the LCA, a regional aquifer, is the only pathway for radionuclides to migrate out of the basin. The results of model evaluation activities were used to refine the groundwater flow and contaminant transport model. In 2019, a report describing the Yucca Flat/Climax Mine model evaluation results was completed and approved by NDEP. The next steps are to request NDEP's approval to advance this CAU to the *closure stage* and then prepare the Closure Report. These activities will take place in 2020.

Restoration Progress under FFACO

In 2019, 2 CASs were closed and all 2019 FFACO cleanup and closure activity milestones were met.

The majority (868) of the remaining 886 CASs yet to be closed are UGTA CASs for which closure-in-place with long-term monitoring is the corrective action.

Soils Sites

NNSA/NFO has identified 148 Soils CASs for which they are 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 148 CASs. In 2019, 2 were closed and work was conducted towards the closure of 7 CASs. Closure of CASs on the TTR and NTTR require negotiation with the State of Nevada and coordination with the U.S. Department of Defense. The total number of Soils CASs closed and approved by the state by the end of 2019 was 141; 7 Soils CASs remain to be formally closed. The anticipated date for completing the closure of all Soils CASs is 2027.

Continued on Page 17 ...

Industrial Sites

The EM Nevada Program identified 1,865 Industrial Sites CASs on and off the NNSS for which they are responsible for characterization and closure under the FFACO. 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.

NNSS Scientists collect water samples at Well ER-20-1, a 2,065 feet deep early detection well on Pahute Mesa in 2019.

Only eight Industrial Sites CASs from two CAUs remain to be closed. The two CAUs are located on the NNSS: CAU 114, Area 25 Engine Maintenance, Assembly, and Disassembly Facility; and CAU 572, Test Cell C Ancillary Buildings and Structures. Their closures will occur prior to the end of the EM Nevada Program Activity, which is currently planned for 2030. In 2019, no field work was conducted toward their closure. In 2019, one new CAU (CAU 577) was added that included five CASs.

Radiological Monitoring of Groundwater

For decades NNSA/NFO has sampled groundwater from monitoring wells on and off the NNSS to detect radionuclides that may be present due to historical underground nuclear testing. NNSA/NFO developed the NNSS Integrated Groundwater Sampling Plan, a comprehensive, integrated approach for collecting and analyzing groundwater samples to meet the requirements for UGTA CAU closures (*see Page 12*) and for all other compliance and environmental protection objectives.

Types of Groundwater Sampling Locations	
Characterization	Used for groundwater characterization or UGTA CAU model evaluation
Source/Plume	Located within the plume from an underground nuclear test; test-related contamination is currently present
Early Detection	Located downgradient of an underground test; no radioisotopes are detected above standard detection levels
Distal	Located outside the Early Detection area
Community	Located on BLM or private land; used as a water supply source or is near one
NNSS PWS	Potable water supply well that is part of a state-designated non-community PWS
Compliance	Monitored to comply with specific regulations or permits

Tritium is the single contaminant of concern and is analyzed in water samples from all locations. Samples may be analyzed for other radionuclides as needed, but tritium is the most mobile in groundwater and the only radionuclide known to exceed its allowable drinking water limit in wells near an underground nuclear test cavity.

The water sampling network under the Plan consists of 80 sampling locations categorized into five types: Characterization, Source/Plume, Early Detection, Distal, and Community locations. An additional six public water system (PWS) wells and five wells/surface waters are sampled to comply with specific federal/state regulations or permits.

The tritium analysis results for all sampling locations in the network are shown on the map

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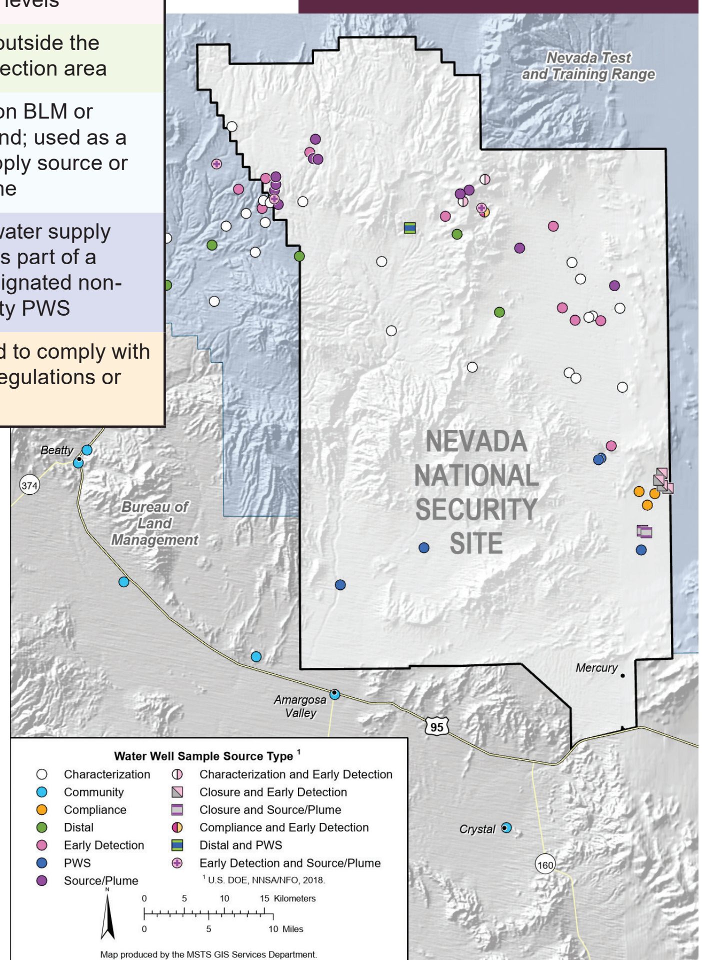
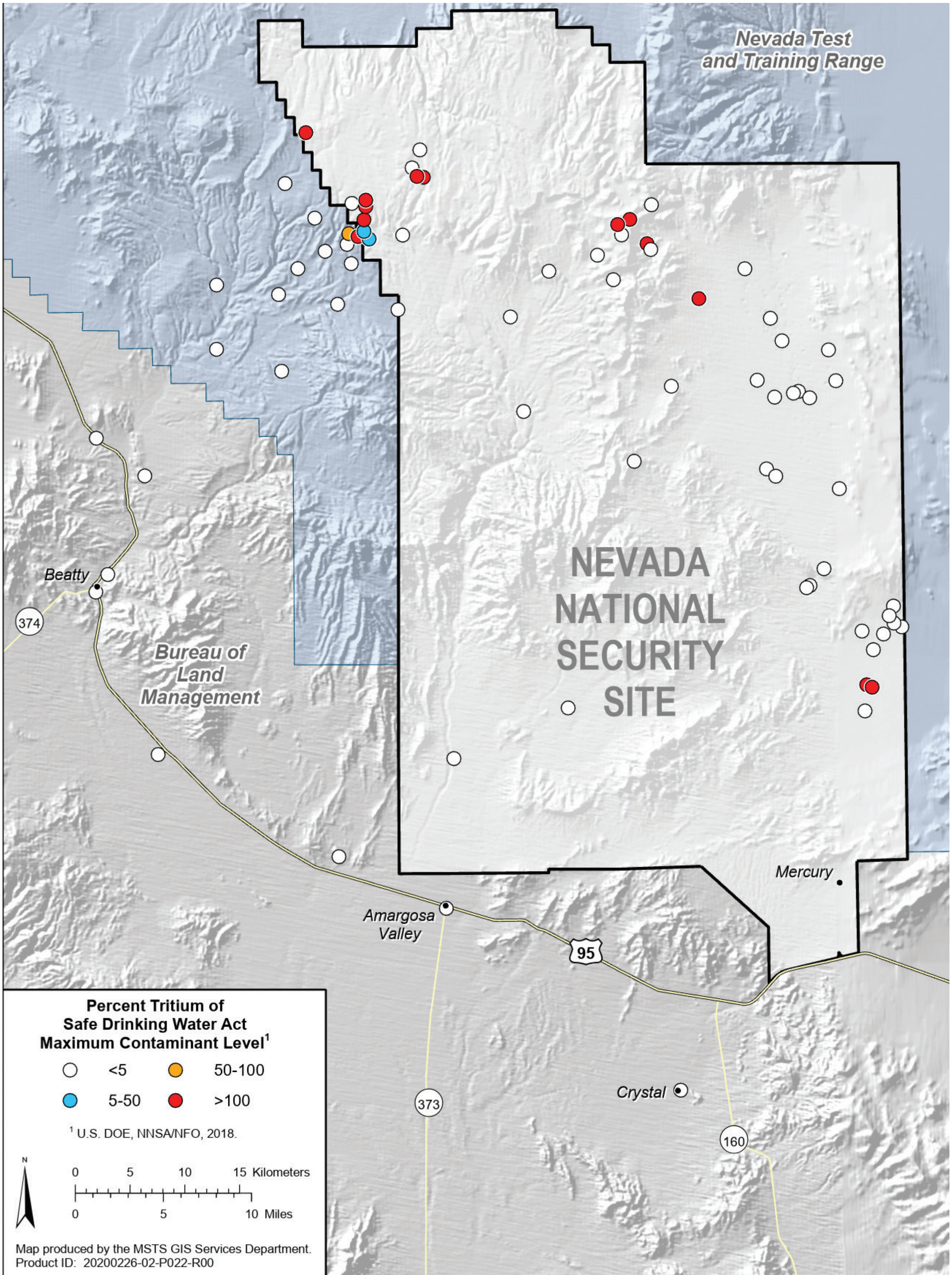


NNSA/NFO Water Sampling Network



Tritium in NNSA/NFO Groundwater Monitoring Wells

on Page 19. The well sites are color coded based on the tritium concentration of their most recent water sample. The maximum contaminant level (MCL) allowed for tritium in drinking water, set by the EPA under the Safe Drinking Water Act (SDWA), is 20,000 pCi/L. The color codes represent tritium levels expressed as a percentage of this MCL. For example, the 5%–50% category means that tritium was found to be between 5% to 50% of the MCL, or between 1,000 and 10,000 pCi/L.

The 13 wells that currently exceed the SDWA MCL (coded red on the map) are all located on the NNSS and are either Source/Plume or Characterization wells. All Community sampling locations, which are on Bureau of Land Management (BLM) or private land, have undetectable levels of tritium (coded white on the map). Characterization well ER-EC-11 on the NTTR just west of the NNSS is the only offsite well in the network that has tritium concentrations greater than 10,000 pCi/L (coded yellow on the map). Tritum has not been detected in any NNSS PWS wells, and all wells and surface waters that are monitored to ensure compliance with NNSS permits had either undetectable levels of tritium or tritium levels that were below permit limits.

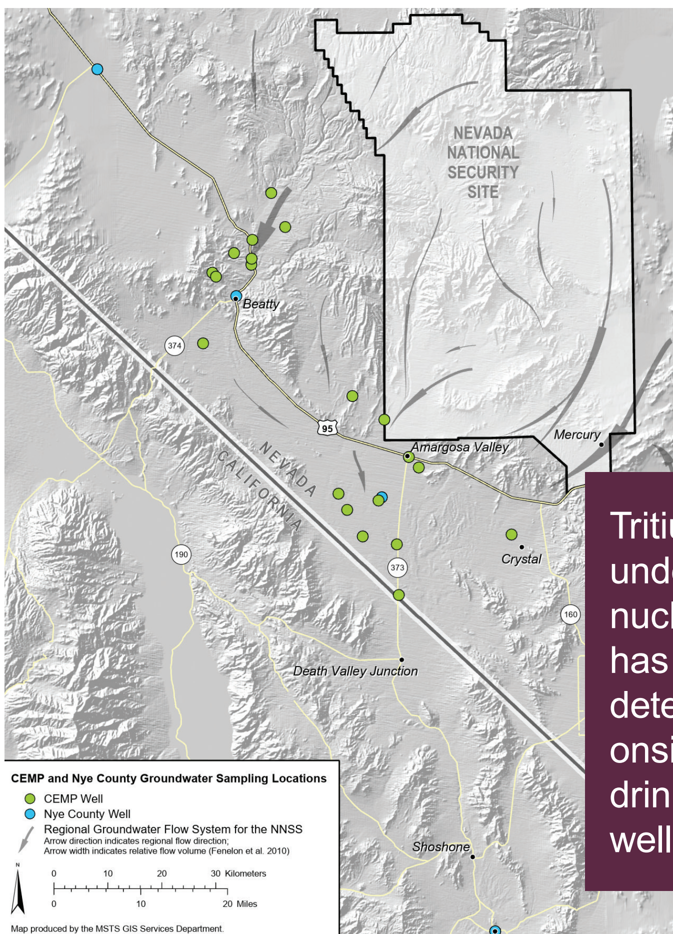
Community Environmental Monitoring Program

Offsite water supply wells 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.

In 2019, the CEMP monitored four groundwater wells in communities located within the regional groundwater flow system that are downgradient or perceived to be downgradient of the NNSS. As in previous years, none of these wells had detectable levels of tritium.

Nye County Tritium Sampling and Monitoring Program

In 2015, NNSA/NFO expanded its support of offsite community-based monitoring of wells in Nye County. NNSA/NFO and EM Nevada Program issued a 5 year grant to Nye County to monitor tritium annually in 10 wells downgradient from the NNSS in the first year and up to 20 wells annually thereafter. The grant also supports Nye County's involvement in technical reviews of the UGTA sites closure process. The Nye County Tritium Sampling and Monitoring Program sampled 20 locations (17 wells, 3 springs) in 2019. None of the 20 locations had detectable levels of tritium.



2019 CEMP and Nye County Water Monitoring Locations

Tritium from underground nuclear testing has not been detected in any onsite or offsite drinking water wells.

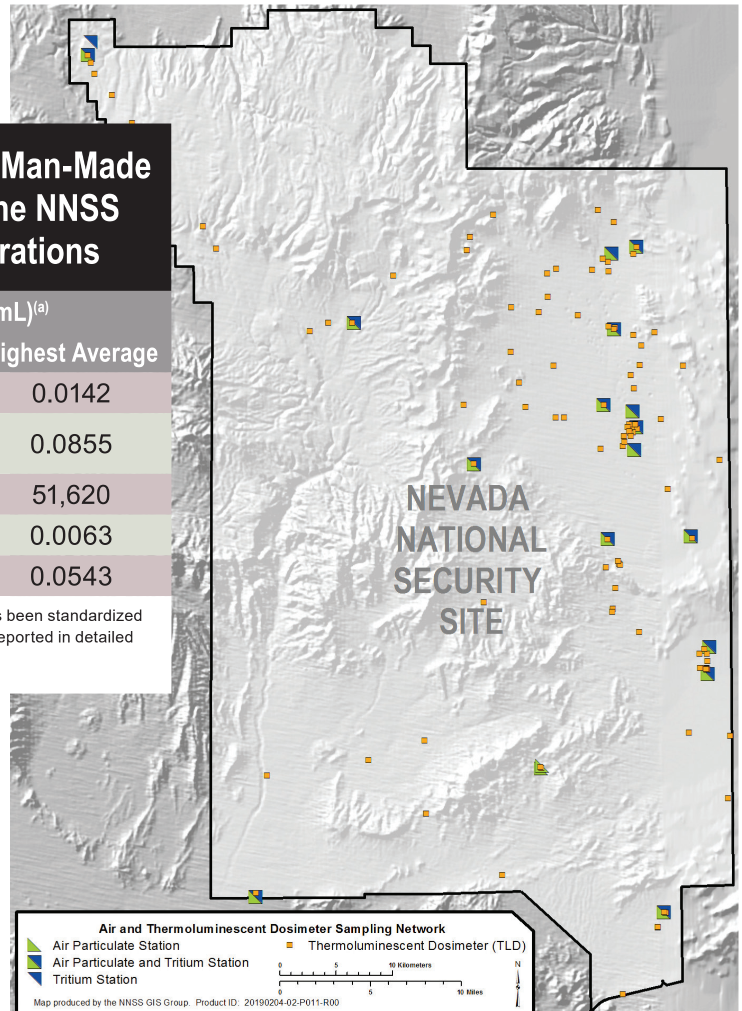
Radiological Monitoring of Air

Range in Average Concentrations of Man-Made Radionuclides in Air Samples on the NNSS in 2019 Attributable to NNSS Operations

	Concentration (10^{-15} µCi/mL)[a]		
Radionuclide	Limit[b]	Lowest Average	Highest Average
^{241}Am	1.9	-0.00425	0.0142
^{137}Cs	19	-0.1105	0.0855
^{3}H	1,500,000	20	51,620
^{238}Pu	2.1	-0.0024	0.0063
$^{239+240}$Pu	2.0	-0.0014	0.0543

(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.



2019 NNSS Air Sampling Network

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 18 air sampling stations and a network of 105 thermoluminescent dosimeters (TLDs) are located throughout the NNSS (see map to the right). NNSS air sampling stations monitor tritium in water vapor, man-made radionuclides, and gross alpha and beta radioactivity in airborne particles. The TLD stations monitor direct gamma radiation exposure.

Radioactive emissions are also monitored at stations in selected towns and communities within 240 miles of the NNSS by the CEMP. A network of 24 CEMP stations was used in 2019 (see map on Page 22). The CEMP stations monitor gross alpha and beta radioactivity in airborne particles 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.

Continued on Page 22 ...

Several man-made radionuclides were detected at NNSS air sampling stations in 2019: none exceeded concentration limits established by the Clean Air Act. The highest average levels of 241Am, 238Pu, and 239+240Pu 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. 137Cs and 60Co were found in only one quarterly sample at levels slightly above detection limits.

Estimated Quantity of Man-Made Radionuclides Released into the Air from the NNSS in 2019 (in Curies)

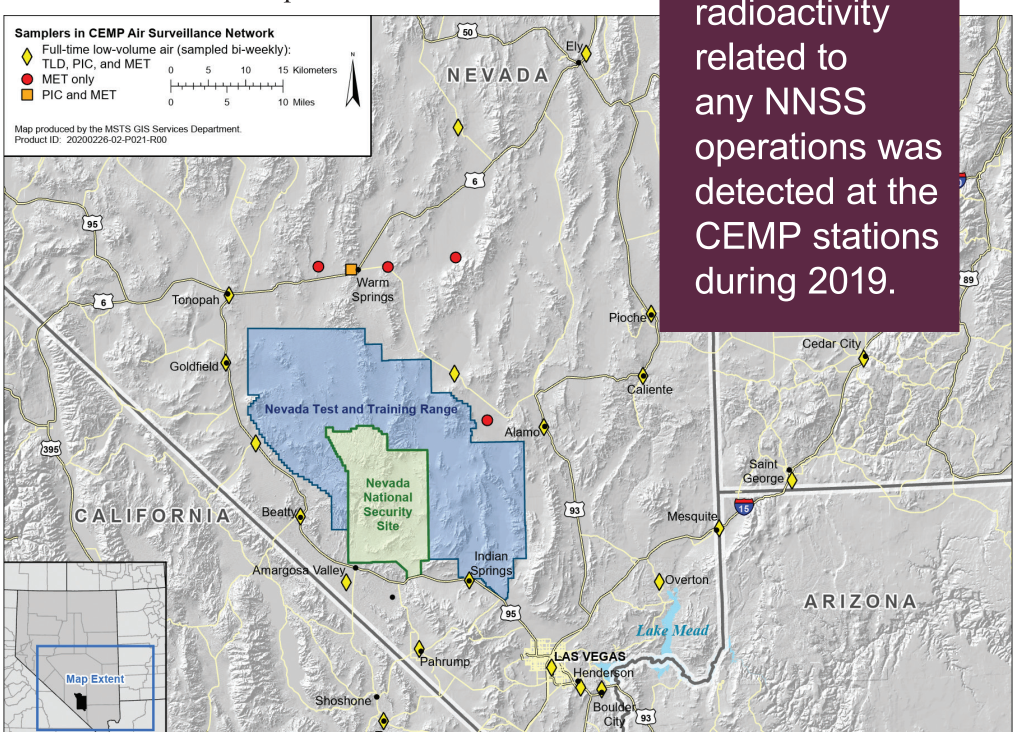
	Tritium (^{3}H)	Americium (^{241}Am)	Plutonium (^{238}Pu)	Plutonium ($^{239+240}$Pu)	Noble Gases	Other Radionuclides	
	689	0.070	0.040	0.29	183	796	43.7
Half-life*	12 years	432 years	88 years	>6,500 years	<11 years	<3 hours	>3 hours

* Half-life is the time required for one-half of the radioactive atoms in a given amount of material to decay.

CEMP air monitoring station located in Delta, Utah.

The total amount of man-made radionuclides emitted to the air from tritium, americium, and plutonium was estimated to be 1,260 Ci. Nearly all radionuclides detected by environmental air samplers in 2019 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. Over the past 10 years, total annual emissions have ranged from 42 to 1,312 Ci for tritium, 0.039 to 0.070 Ci for 241Am, 0.040 to 0.050 Ci for 238Pu, and 0.24 to 0.39 Ci for 239+240Pu.

No airborne radioactivity related to any NNSS operations was detected at the CEMP stations during 2019.



2019 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 2019, the mean measured background level from the 10 stations was 117 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 424 mR/yr at Schooner, one of the legacy Plowshare sites on Pahute Mesa.

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 117 mR/yr level measured on the NNSS. The highest annual gamma exposure measured off site, based on the PIC detectors, was 177 mR at Warm Springs Summit, Nevada. The lowest offsite exposure rate, based on the PIC detectors, was 74 mR at Pahrump, Nevada.

Average Background Radiation of Selected U.S. Cities (Excluding Radon)
Ranked from Highest to Lowest

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
Las Vegas, NV	2,030	69.5
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 August 8, 2019

2019 NNSS Background Gamma Radiation

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

TLD station (post with TLD attached) located at Schooner Crater.

Average Direct Radiation Measured in 2019 on and off the NNSS

Location	Elevation Above Sea Level (feet)	Radiation Exposure (mR/yr)
NNSS - Schooner TLD station (highest measurement)	5,660	424
NNSS - 35 Legacy Site TLD stations (includes Schooner)	3,077–5,938	198
Las Vegas, Nevada CEMP PIC station	2,030	97
NNSS - 17 Waste Operation TLD stations	3,176–4,021	133
NNSS - 10 Background TLD stations	2,755–5,938	117
Bloomington Hills, St. George, Utah CEMP PIC station	2,706	126
Pahrump, Nevada CEMP PIC station	2,639	74
NNSS Mercury Fitness Track TLD station (lowest measurement)	3,769	57

Understanding Radiation Dose

Dose is a generic term to describe the amount of radiation a person receives. The energy deposited generally correlates with the number of molecules potentially affected. 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 (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: https://www.epa.gov/radiation/radiation-sources-and-doses). Whether there is a “safe” radiation dose equivalent is a controversial subject. Because the topic has yet to be settled

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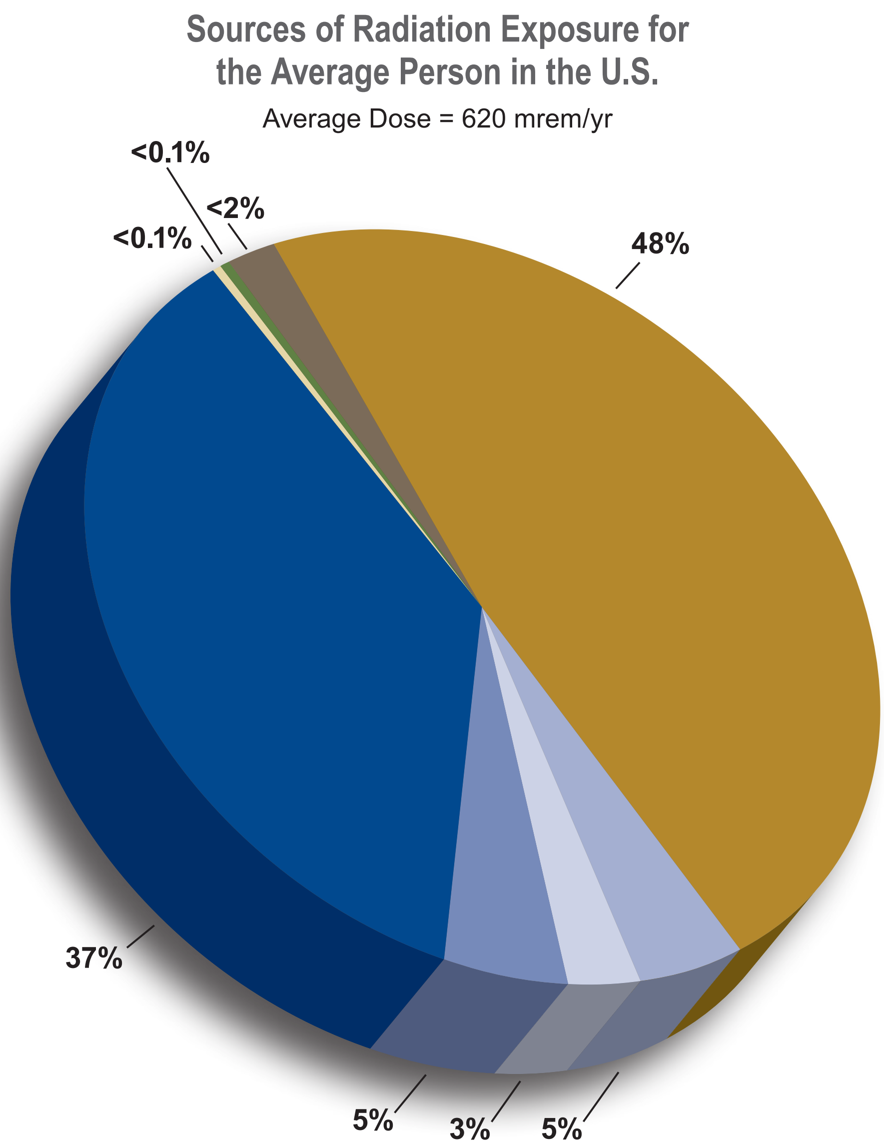


Man-made Sources

- Industrial
- Occupational
- Consumer products
- Medical diagnostic procedures

Natural Background Sources

- Internal
- Terrestrial
- Cosmic
- Radon and thoron

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.

Average Doses from Radiation Sources

Source	Dose (mrem)
Living near a nuclear power station *(annual)*	<1
Chest X-ray *(single procedure)*	10
Terrestrial radioactivity *(annual)*	21
Radiation in the body *(annual)*	29
Cosmic *(at sea level) (annual)*	30
Mammogram *(single procedure)*	42
Cosmic *(in Denver) (annual)*	80
Head CT scan *(single procedure)*	200
Radon in average U.S. home *(annual)*	228
Upper gastrointestinal X-ray with fluoroscopy *(single procedure)*	600
Whole body CT scan *(single procedure)*	1,000

Source: https://www.epa.gov/radiation/radiation-sources-and-doses#tab-2, as accessed on August 8, 2019.

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.

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:

Estimated 2019 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 one or more of the NNSS critical receptor samplers were 241Am, 238Pu, 239+240Pu, and 3H.

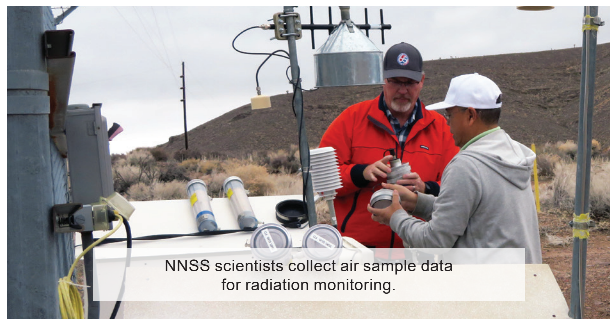
As in previous years, the 2019 data from the six critical receptor samplers show that the NESHAP dose limit to the public of 10 mrem/yr was not exceeded. The radioactive air emissions from each 2019 NNSS source were modeled using the Clean Air Package, 1988 model from EPA. The highest value is predicted to be a person residing in Amargosa Valley and received a predicted dose of 0.06 mrem/yr.

Estimated 2019 Ingestion Dose to the Public

NNSS game animals include pronghorn antelope, mule deer, chukar, Gambel’s quail, mourning doves,

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.


NNSS scientists collect air sample data for radiation monitoring.

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.


NNSS Scientists conduct routine safety sampling of the public water system on the NNSS.

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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.

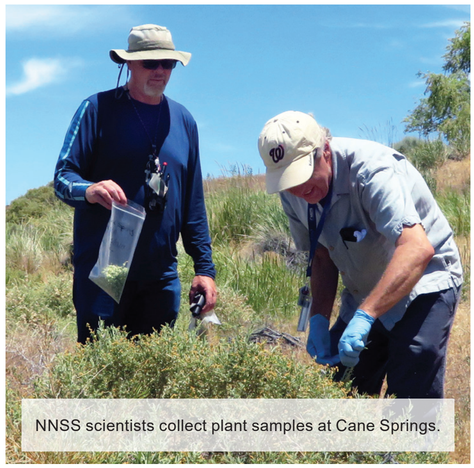
In 2019, tissue or blood samples were collected from three jackrabbits from Plutonium Valley (Area 11), one cottontail rabbit and one jackrabbit sampled from the control location (Area 27), one bobcat (Area 23) that died of natural causes, two desert tortoises killed by vehicles on roads, three pronghorn antelope killed by vehicles (one each in Areas 4, 5, and 6), blood samples from 21 mule deer and 20 pronghorn antelope captured and released as part of a habitat-use study. Based on data from these samples, the 2019 estimated dose to a hunter from ingestion of game animals from the NNSS is 0.43 mrem/yr. The potential dose to a person consuming these animals is well below dose limits to members of the public. Also, radionuclide concentrations are below levels considered harmful to the health of plants and animals; the dose resulting from observed concentrations is less than 4% of limits set to protect populations of plants and animals.

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.

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.



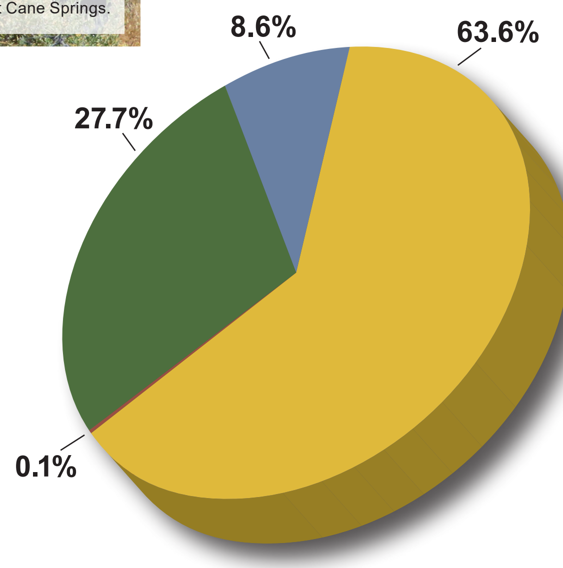
NNSS scientists collect plant samples at Cane Springs.

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."

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



2019 Dose to the Public from All Pathways

0.49 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 11.07 tons of criteria air pollutants and 0.01 tons of HAPs were released on the NNSS in 2019. The majority of the emissions were volatile organic compounds. No emission limits for any air pollutants were exceeded.

Estimated Quantity of Pollutants Released into the Air from NNSS Operations in 2019

Criteria Air Pollutants:	Tons
Particulate Matter[(a)]	0.71
Carbon Monoxide	1.48
Nitrogen Oxides	3.27
Sulfur Dioxide	0.36
Volatile Organic Compounds	5.25
Hazardous Air Pollutants (HAPs)	0.01

(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 six permitted wells that comprise three permitted public water systems (PWSs) 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 PWS. Monitoring results for 2019 indicated that water samples from the three PWSs and from the potable water hauling trucks met all applicable National Primary and Secondary Drinking Water Standards.

Industrial discharges on the NNSS are limited to three operating sewage lagoon systems: Area 6 Yucca, Area 23 Mercury, and Area 6 DAF. Under the requirements of the state operating permit, liquid discharges to these sewage lagoons were tested quarterly in 2019 for biological oxygen demand, pH, and total suspended solids. All sewage lagoon water measurements were within permit limits.

NNSS Drinking Water

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

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 2019, none of these contaminants were detected at levels that exceeded permit limits.

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.

In 2019, DRI archaeologists conducted field surveys and historical evaluations for 15 proposed NNSA/NFO projects that had the potential to impact cultural resources. DRI surveyed just over 1,408 acres and identified/recorded 120 cultural resources, 55 of which were determined to be eligible to the National Registry of Historical Places (NRHP). For these projects, recommendations for mitigating adverse effects to cultural resources are included in DRI's evaluations.

In 2019, DRI completed an inventory for the proposed installation of a new transmission line to upgrade the 138-kilovolt (kV) power transmission system at the NNSS. The inventory area included a corridor that is 37.8 kilometers long and 60 meters wide between the Mercury Switching Station in Area 23 and the Tweezer Substation in Area 6. The inventory also included 5 access road corridors, 32 pull sites, and 6 equipment laydown areas. The total area inventoried consisted of 805.38 acres. A visual impact assessment for the entire length of the proposed transmission line was conducted to assess any potential indirect effects to surrounding historic properties resulting from the proposed transmission line installation. Although NRHP eligible properties were identified along the corridor, DRI recommended modifications to the project area and provided avoidance areas to prevent adversely affecting most of these properties. Also, DRI conducted an identification and evaluation effort for a multiyear set of projects to modernize the surface infrastructure of the U1a facility. DRI identified 13 architectural resources in the project area, two of which were recommended eligible for the NRHP. A supplemental visibility analysis was conducted to assess the indirect visual impacts of the undertaking on surrounding historic properties. Finally, DRI conducted an inventory of 172.85 acres on Aqueduct Mesa in Area 12 in support of the sensor network installation for the Physics Experiment 1-Surface Diagnostics project. Nineteen prehistoric archaeological sites, including several rock rings were previously recorded in the project area and revisited by DRI to collect information to evaluate the sites for listing in the NRHP. Nine of the sites were determined eligible for the NRHP and DRI provided avoidance areas during the sensor network design phase to prevent adverse effects to these historic properties.

DRI continues to maintain and manage the NNSS Archaeological Collection, which contains over 467,000 artifacts. NNSA/NFO's American Indian Consultation Program (AICP) conducts consultations with NNSS-affiliated American Indian tribes through the Consolidated Group of Tribes and Organizations (CGTO). The CGTO Spokesperson is appointed to the State Tribal Government Working Group (STGWG), joining 10 other tribes currently serving from New Mexico, Idaho, Washington, Oregon, and New York. The STGWG works closely with various DOE sites throughout the U.S. The CGTO Spokesperson is also appointed to the NSSAB to serve as a liaison giving advisory insight into activities conducted on the NNSS.

In 2019 NNSA/NFO supported the goals of the AICP by:

- interacting with the AICP Coordinator to identify topics of interest and enhance communications with CGTO representatives
- participating in the annual Tribal Update Meeting, which assembled 25 tribal representatives from 14 of the 16 culturally affiliated tribal governments
- participating in Tribal Planning Committee (TCP) meetings
- supporting two NNSS visits to the Ammonia Tanks site, the Petroglyph and Power Rock site, the Mushroom Rock site, and the Geoglyph and Arch site
- continuing to support a tribal revegetation project at the Area 5 RWMC.

In 2019, NNSA/NFO did not receive any requests from culturally affiliated tribes to access the NNSS for ceremonial or traditional use.

Endangered Species Protection and Ecological Monitoring

The Ecological Monitoring and Compliance (EMAC) Program monitors the ecosystem of the NNSS and ensures compliance with laws and regulations pertaining to NNSS natural resources. Sensitive and protected/regulated species of the NNSS include 42 plants, 1 mollusk, 2 reptiles, 241 birds, and 23 mammals. These species are protected, regulated, or considered sensitive according to state or federal regulations and natural resource agencies and organizations.

The desert tortoise is the only resident species on the NNSS listed under the Endangered Species Act threatened. Habitat of the desert tortoise is in the southern portion 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 2019, no desert tortoises were accidentally injured or killed at a project site, nor were any found, captured, or displaced from project sites. There were 66 sightings of desert tortoises on roads on the NNSS; 56 of the tortoises, thought to be in harm's way, were moved.

Field work concluded in 2018 for the resident adult tortoise road study, but analysis of the study data continues to examine habitat use, road crossing events, movement trends, home range and mitigation strategies. Juvenile tortoises continued to be monitored as part of a collaborative effort to study survival of translocated animals.

- A radio-tracking study of adult tortoises found near roads on the NNSS, to assess the risk of road mortality and determine patterns of habitat use along roads concluded in 2018. A total of 260 road crossing events by 15 tortoises were recorded during the study. Nine tortoises were not documented to have crossed roads at all.
- In 2012, 60 juvenile tortoises were moved from captivity at the Desert Tortoise Conservation Center near Las Vegas to undisturbed tortoise habitat at the NNSS to investigate the fate of translocated individuals. The San Diego Zoo Institute for Conservation Research started the study and transferred it to NNSS biologists in 2013. At the end of 2019, 23 of the 60 juveniles were still alive.

In 2019, biological surveys for the presence of sensitive and protected/regulated species and important biological resources on which they depend were conducted for 33 projects. A total of 349 acres were surveyed for these projects. Some of the sensitive species and important biological resources found included desert tortoise burrows, burrowing owls, several bat species, Joshua trees, Mojave yucca, pine trees and many cactus species.

Surveys of sensitive and protected/regulated animals in 2019 focused on birds, bats, feral horses, mule deer, desert bighorn sheep, and mountain lions. Field surveys for sensitive plants were conducted for Cane Spring suncup, Clokey's buckwheat, Inyo hulsea, and Death Valley beardtongue.

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

NNSS scientists observe a desert tortoise as it waits for rain

NNSS biologists found feral horse distribution was similar in 2019 to 2018 with concentrated activity around Camp 17 Pond and Gold Meadows Spring especially during the hot, dry summer months. A total of 57 individuals were identified in at least 7 different bands and at least 6 foals and 9 juveniles were observed.

Twenty pronghorn and 23 mule deer were captured and collared in 2019 and will be tracked for ~3yrs to determine distribution, abundance and range.

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. 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. Environmental commitments are incorporated into an Environmental Policy with goals to protect environmental quality; mitigate environmental impacts; collaborate with employees, customers, subcontractors, and suppliers on sustainable development; comply with environmental laws and regulations; and, commit to environmental excellence in company activities.

The **Energy Management Program** was formed specifically to reduce the use of energy and water in NNSA/NFO facilities, to advance the use of solar and other renewable energy sources, and to help NNSA meet DOE's 2019 Site Sustainability Goals.

In December 2019, the Energy Management Program completed the FY 2020 NNSA/NFO Site Sustainability Plan, which reported the 2019 progress toward meeting DOE's Site Sustainability Goals. Thus far, the Energy Management Program is on track to meet the majority of the DOE long-term goals (*see Pages 32, 33, and 34*).

The **Pollution Prevention and Waste Minimization Program** helps to reduce the volume and toxicity of waste that must be disposed. See Page 33 for the 2019 status towards meeting DOE long-term goals for pollution prevention and waste minimization.

Energy Efficiency and Management

- Energy intensity (energy use per square foot of building space) increased 17.5% above the FY 2015 baseline – the goal is a 25% reduction from the baseline by FY 2025.
- Based on a 2019 assessment of appropriate buildings, 81% of buildings are metered for electricity, 93% for natural gas, 0% for chilled water, 30% for potable water, and 0% for Chiller water – the goal is for all individual buildings to be metered where cost-effective and appropriate.
- 37 energy audits/assessments were conducted – meeting the goal to ensure that all eligible facilities under Section 432 of the Energy Independence and Security Act are assessed once every 4 years. The assessments identified energy conservation measures for several buildings at the NNSS and the NLVF.

Water Efficiency and Management

- ► Water intensity (gallons used per total gross square feet [gsf] of facility space) was 45% below the FY 2007 baseline – exceeding the FY 2019 goal.
- ► Non-potable water production was 63% above the FY 2010 baseline – falling signficantly short of the FY 2019 18% reduction goal.


Wildlife watering trough that replaced the closed Well 5b sump.

Fleet Management

- ► Use of alternative fuel was 305% above the FY 2005 baseline – exceeds the goal of a 10% increase above the FY 2005 baseline by FY 2015, maintaining a 10% increase thereafter.
- ► Use of petroleum was 56% less than the FY 2005 baseline – exceeds the goal of a 20% decrease from the FY 2005 baseline by FY 2015, maintaining 20% reduction thereafter.
- ► 94% (885) of all light duty vehicle purchases were alternative fuel vehicles – exceeds the goal of 75%.

Clean and Renewable Energy

- ► 11% of NNSA/NFO's annual electrical consumption is from renewable sources (acquired through the purchase of renewable energy credits) – the goal is at least 10% for FY 2019, working towards 25% by FY 2025.

Pollution Prevention and Waste Minimization

- ► 37% of non-hazardous solid waste generated at NNSA/NFO facilities was diverted from landfills through recycling – the goal is 50%.
- ► 4% of construction materials were recycled and diverted from the landfill – the goal is 50%.

High Performance Sustainable Buildings (HPSBs)

- Based on a 2019 assessment, 15% of enduring buildings larger than 5,000 gsf are compliant with the Guiding Principles (GPs) for Federal Leadership in HPSB design – on track to meet the goal to have at least 17% by FY 2025, with progress to 100% thereafter.
- The goal that all new buildings larger than 5,000 gsf entering planning be designed to achieve energy net zero is no longer a requirement, but will continue to be a path forward for the NNSS when economically feasible.
- Construction continued on the second net-zero building at the NNSS, Mercury Building 23-460, further supporting the goal that 1% of existing buildings above 5,000 gsf be energy, waste, or water net-zero buildings by FY 2025.

Electronic Stewardship and Data Centers

- Average Power Utilization Effectiveness (PUE) values range across the 3 data centers, where an ideal PUE is 1.0. The goal is a PUE of 1.2-1.4 for new data centers and a PUE less than 1.5 for existing data centers. Continue to work toward goal; the data center PUE goal of less than 1.5 for existing data centers was not met.
- All leased computers continue to be Electronic Product Environmental Assessment Tool (EPEAT) registered.
- All eligible computing systems have power management capability enabled.
- The U.S. General Services Administration (GSA) Energy Asset Disposal System program called GSAXcess® is used to recycle all eligible electronics. 100% of used electronic equipment that pass GSAXcess® screening is sold for reuse, and equipment considered high risk property is shredded through a certified recycler.

Greenhouse Gas (GHG) Emissions

- FY 2019 Scope 1 and 2 GHG emissions were 71% lower than the FY 2008 baseline – the goal is a 50% reduction by FY 2025.
- FY 2019 Scope 3 GHG emissions were 67% less than those of the FY 2008 baseline – on track to meet the goal of a 25% reduction by FY 2025.

GHG emissions targeted for reduction are carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride (SF_6) and are classified depending on their source:

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

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

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

Green Awards and Outreach

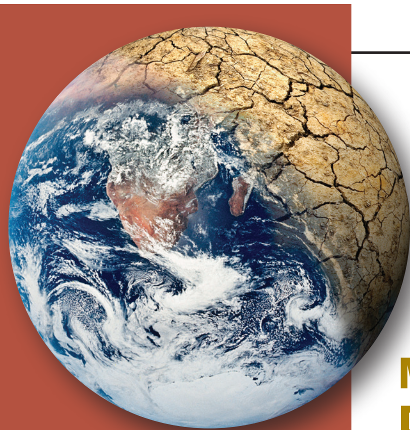
Mercury Fire Station Solar PV Demonstration Project Awards

The Solar PV Demonstration Project at the Mercury Fire Station received two awards in 2019:

1. **2019 Department of Energy Sustainability Award for Outstanding Sustainability Program/Project** – "Over the estimated 25-year life of the PV array, a savings of approximately $650,000 is expected to be realized. This project is a significant step in NNSS' long-term modernization plan that places an emphasis on sustainable buildings."

2. **2019 NNSA DOE Excellence Award, Mercury Solar Project Team** – "In recognition of outstanding teamwork and collaboration … efforts to implement solar technology in support of site modernization plans and broader, national energy goals is commendable. Your dedication and drive resulted in the first NNSA net zero energy building."

Continued on Page 36 ...

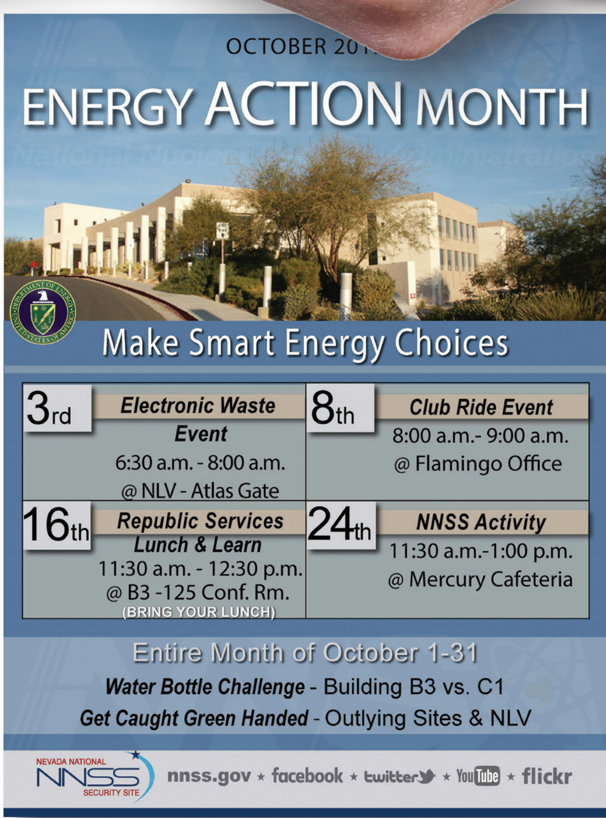


Climate Change Resilience

- Regional risks to NNSA/NFO facilities are flooding, wildland fires, facility power and water supply disruptions, and extreme weather events. Program and site evaluations are conducted, policies and procedures updated, and areas for improvement identified to ensure that NNSA/NFO missions and activities are resilient to climate change in accordance with the goals of DOE's Climate Change Adaptation Plan.

2019 Sustainability and Outreach Events

Earth Day events in 2019 included the first water bottle challenge at the NNSS between Area 6 and Area 23 and a **Just say No to Styrofoam** event at our outlying sites. Along with e-waste recycling and games at the Health and Productivity Annual Spring Fair, the activities diverted a total of 1,140 pounds of e-waste from the landfill, a 42.5% increase from 2018.



Activities for **Energy Action Month** included two carpooling events at NLVF, free indoor water audit and Retrofit kits from the Southern Nevada Water Authority, along with another e-waste event including the Nevada State Recycle Company.

Through these two annual employee outreach events, along with the site's quarterly participation with Safe Nest, site employees managed to divert a total of 3,660 pounds of clothing items and 1,890 pounds of e-waste from the landfill. Overall, at both outreach activities, our employees were educated on how to embrace and integrate sustainability into their day-to-day activities at home, as well as at work.

Document Availability

Available for sale to the public from:

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The information presented in this document is explained in greater detail in the ***Nevada National Security Site Environmental Report 2019*** (DOE/NV/03624--0899). 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.nnss.gov**.

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