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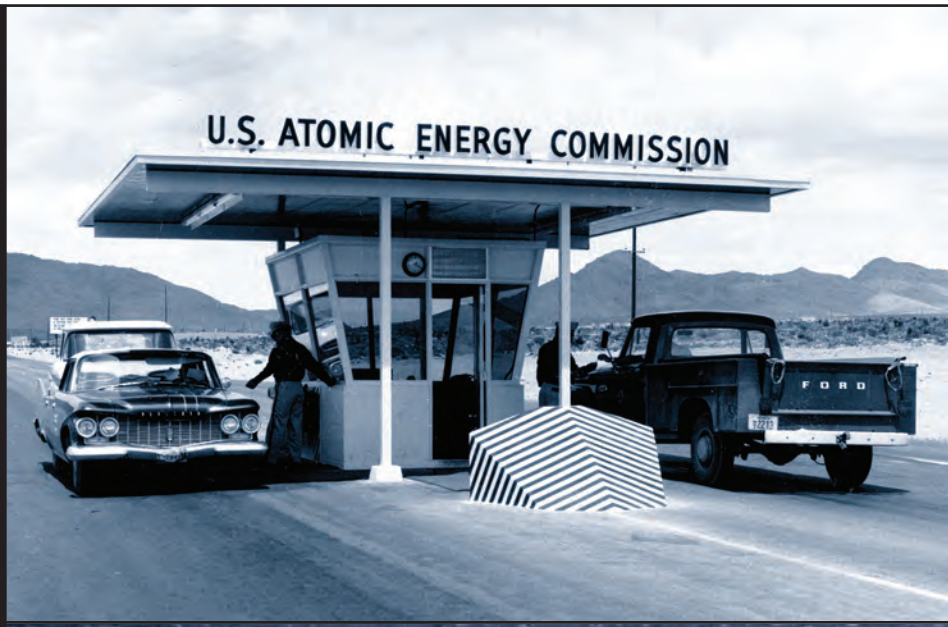
September 2022

2021

Environmental Report

Summary



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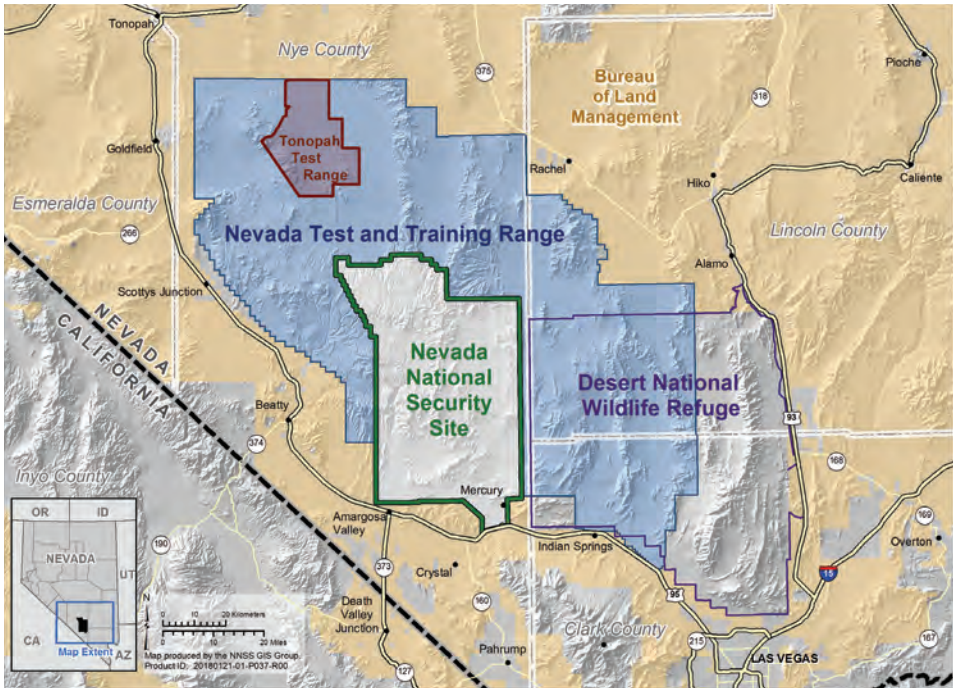
NEVADA NATIONAL SECURITY SITE

Environmental Report Summary 2021

This document is a summary of the full *2021 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 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).

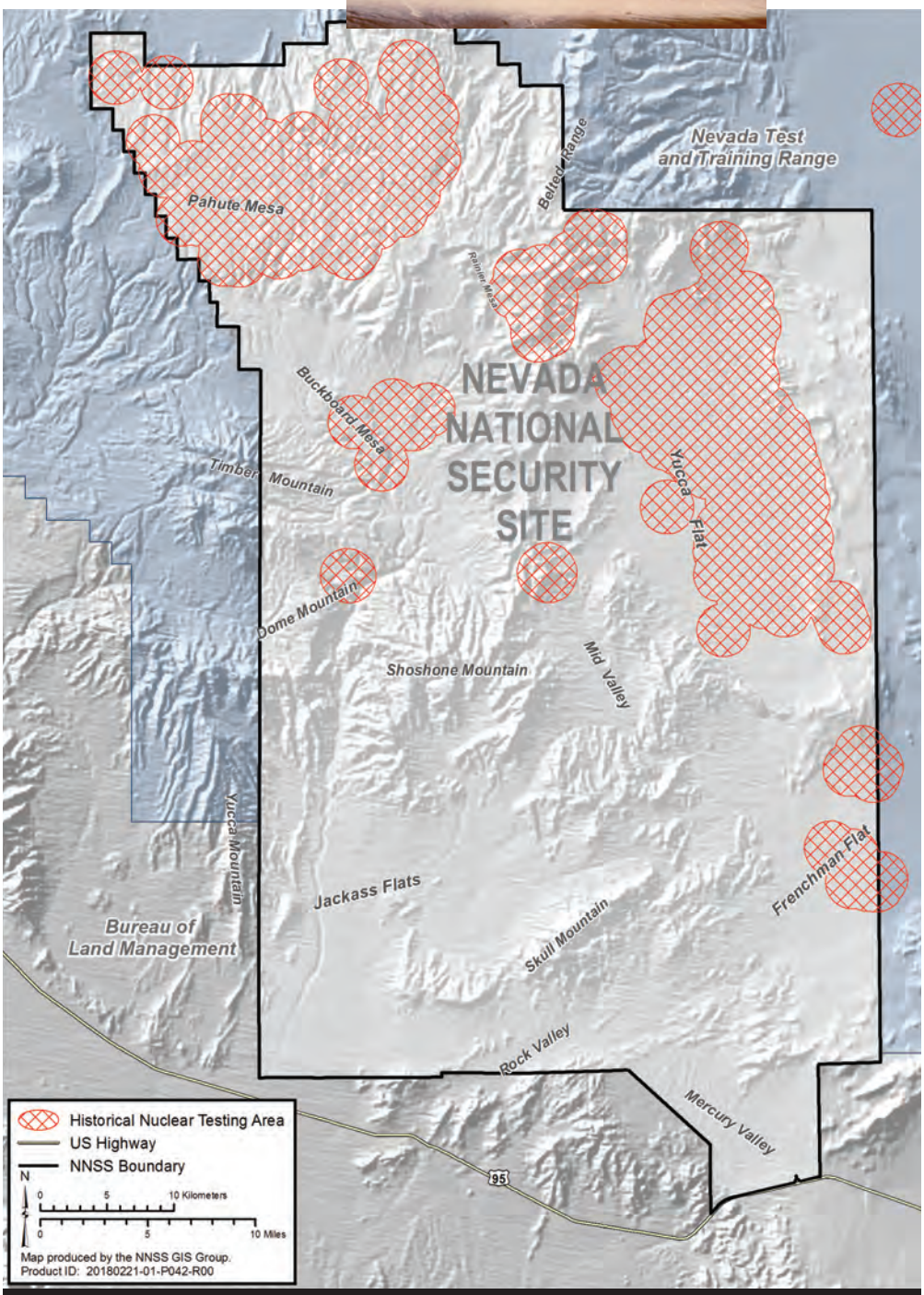
On September 23, 1992, the last underground nuclear test was conducted on the NTS, after which Congress imposed a moratorium on nuclear weapons testing. Since 1951, a total of 100 atmospheric and 828 underground nuclear tests have been conducted at the NTS.

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, radioxenons, 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).

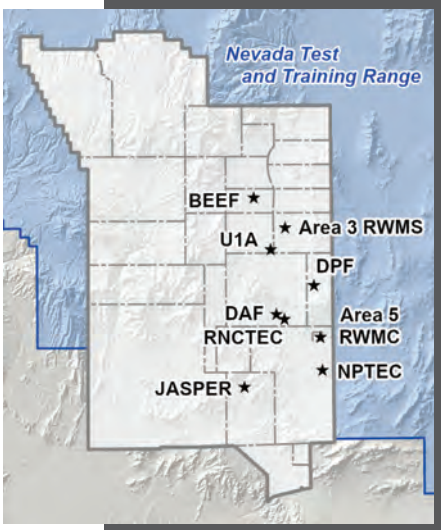


Historical Nuclear Testing Areas on and adjacent to the NNSS

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 Management and Operating (M&O) Contractor accountable for ensuring work is performed in compliance with environmental regulations.

NNSS activities in 2021 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; remediation of legacy contamination sites; characterization of waste destined for offsite disposal facilities; 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, 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 certain offsite 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

Environmental Statute or Order and What It Covers	2021 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	650,072 cubic feet of waste was disposed on site in LLW and MLLW disposal cells at the Area 5 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. No waste was disposed at the Area 3 RWMS in 2021.
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 2021 NNSS air emissions to the maximally exposed individual (MEI) is 0.056 mrem/yr.
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, wildlife 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 0.75 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	93,203 lbs of lead were released as a result of NNSS activities, which exceeded the 100 lb reporting threshold. About 63% of lead released was for offsite recycling, while nearly 100% of the remaining lead was disposed onsite.

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

Environmental Statute or Order and What It Covers	2021 Status
Endangered Species Act (ESA): Threatened or endangered species of plants and animals	Field surveys for 34 projects in desert tortoise habitat on the NNSS were conducted. There were 54.6 acres of tortoise habitat disturbed. Two juvenile tortoises were killed on NNSS roads, which were reported to the US Fish and Wildlife Service, but they did not count towards the incidental take limit. No desert tortoises were injured or killed due to project activities. Thirty desert tortoises found on or near roads were moved out of harm's way. All actions were in compliance with the NNSS Programmatic Biological Opinion requirements.
Federal Facility Agreement and Consent Order (FFACO): Cleanup of waste sites containing hazardous substances	All 2021 corrective action milestones under the FFACO were met and 3 corrective action sites were closed. To date, 2,952 of 3,044 Corrective Action Sites 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 only 8 bird deaths were documented, similar to 2020, and again the lowest recorded since 2012. Five were related to human activity (e.g., electrocutions on powerlines and vehicle collisions), and 3 died of unknown causes.
National Environmental Policy Act (NEPA): Evaluating projects for environmental impacts	53 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 6 projects were conducted, 723.8 acres were surveyed, and 139 cultural resources were identified, 84 of which were determined eligible for 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	1,887 tons of MLLW were disposed on site, 2.63 tons of HW were received for temporary onsite storage and/or treatment, 0.22 tons of MLLW, 0.59 tons of HW, and 0.175 tons of polychlorinated biphenyl waste were shipped off site for disposal, and 0.101 tons of explosive ordnance were detonated at the Explosive Ordnance Disposal Unit, all in accordance with state permits. In compliance with the June 2021 Settlement Agreement* that resolved regulatory actions resulting from the July 2019 waste issue, DOE fulfilled all the CY 2021 commitments which contribute to enhancing the rigor of waste management activities for the protection of the DOE workforce, the public, and the environment. * https://ndep.nv.gov/uploads/land-doe-aip-docs/NDEPDOEJune22SASignedF.pdf
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	18 lbs of LLW containing PCBs were disposed on site and 349 lbs were 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.

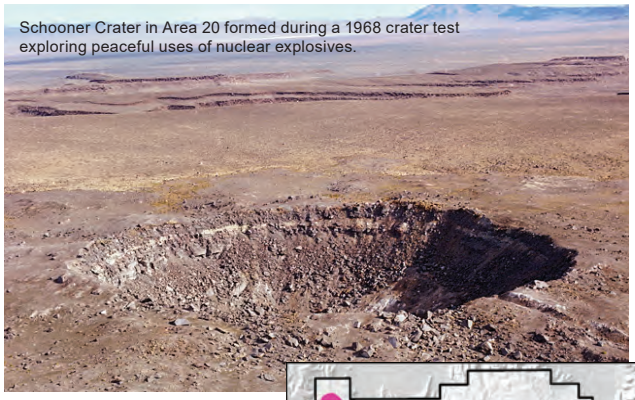
Soil — Radioactively contaminated surface soils, directly resulting from nuclear testing, exist at over 100 locations on and around the NNSS. The soils may contain contaminants including radioactive materials, oils, solvents, and heavy metals, as well as contaminated instruments and test structures used 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 0.070 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, 2021, over 1.9 million cubic yards of waste have been safely disposed at the Area 3 and Area 5 RWMSs.

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. More than 3,000 CASs have been identified, the large 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.



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

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

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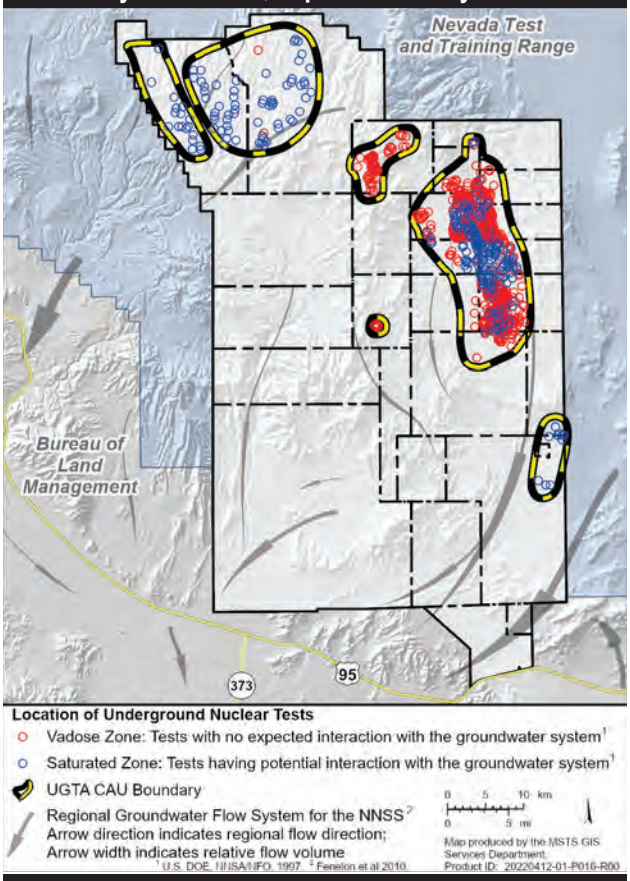
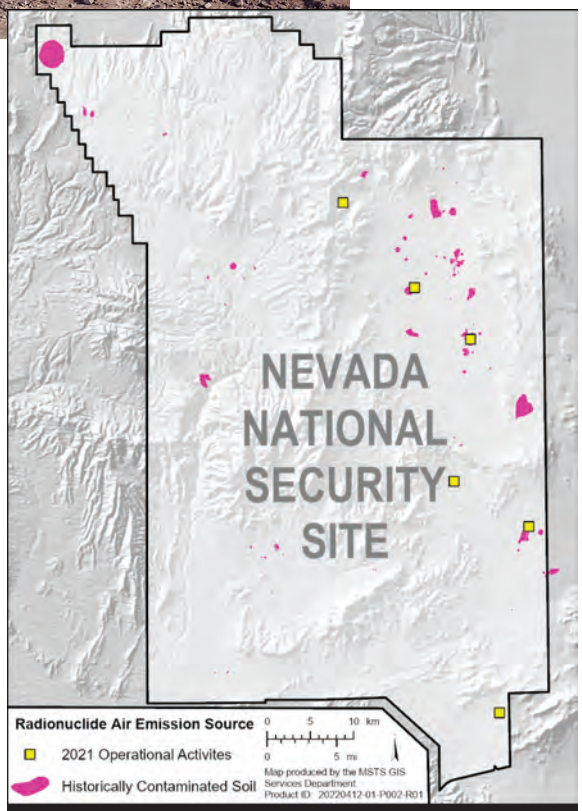
The direction of groundwater flow, shown by the arrows, is predominantly southwest.



Areas of Potential Groundwater Contamination on the NNSS



Sources of Radiological Air Emissions on the NNSS

stable atoms. Almost all human exposure to ionizing radiation 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 0.2% of their total radiation exposure is potentially 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 Monitored on the NNSS[a]

	Name[b]	Abbreviation	Primary Type(s) of Radiation	Major NNSS Sources
Man-Made	Tritium	^{3}H	Beta	Some or all of these radionuclides exist in various locations, such as 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 radioactive waste management sites, and may be monitored in water, soil and/or air (due to particulate resuspension or evaporation [Tritium]).
	Carbon-14	^{14}C	Beta	
	Chlorine-36	^{36}Cl	Beta	
	Cobalt-60	^{60}Co	Gamma	
	Strontium-90	^{90}Sr	Beta	
	Technetium-99	^{99}Tc	Beta	
	Iodine-129	^{129}I	Beta	
	Cesium-137	^{137}Cs	Beta, gamma	
	Europium-152	^{152}Eu	Gamma	
	Europium-155	^{155}Eu	Gamma	
	Americium-241	^{241}Am	Alpha, gamma	
	Plutonium-238	^{238}Pu	Alpha	
	Plutonium-239/240	$^{239+240}Pu$	Alpha	
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 water, soil, and air.
	Radium-226	^{226}Ra	Alpha, gamma	
	Thorium-232	^{232}Th	Alpha	
	Uranium-234[c]	^{234}U	Alpha	
	Uranium-235[c]	^{235}U	Alpha, gamma	
	Uranium-238[c]	^{238}U	Alpha	

[a] For samples analyzed for gamma-emitting radionuclides, any man-made radionuclide identified by the laboratory will be reported. The most common are listed.

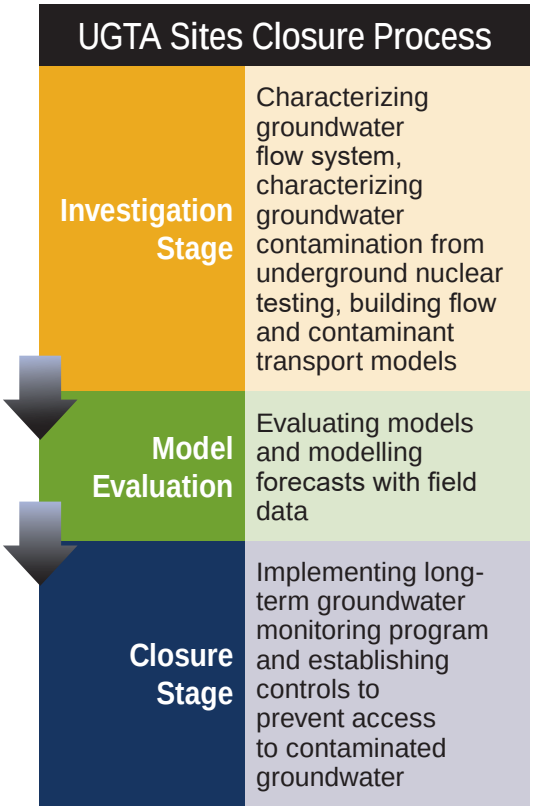
[b] The number given with the name of the radionuclide is the atomic mass number, which is the total number of protons and neutrons in the nucleus of the atom. Atoms with the same number of protons are the same element; atoms of the same element with different mass numbers are called isotopes of one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

[c] 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 groundwater flow and transport models for each CAU that forecast groundwater movement and transport of radiological contaminants from the CASs. The agreed-upon corrective action for UGTA CASs is closure in place with institutional controls and monitoring (FFACO, 1996, as amended). This corrective action is based on three assumptions: (1) groundwater technologies for removal or stabilization of subsurface radiological contamination are not cost effective; (2) because of high remediation costs, closure in place with monitoring and institutional controls is the only likely corrective action; and (3) in order for workers, the public, and the environment to be exposed to the potential risks from radiological contamination in groundwater, the contaminated groundwater must first be accessed. Three UGTA CAUs, Frenchman Flat (CAU 98), Rainier Mesa/Shoshone Mountain (CAU 99), and Yucca Flat/ Climax Mine (CAU 97), are in the closure stage. During the closure stage, contaminant, regulatory, and use-restriction boundaries are identified in agreement between DOE and NDEP. If radionuclides exceeding the agreed upon level reach the regulatory boundary, the EM Nevada Program is required to submit to NDEP a plan that meets the CAUs regulatory boundary objectives. Groundwater sampling and water-level measurements both on and off the NNSS will continue throughout the entire closure process. During 2020, groundwater sampling was focused on meeting closure objectives for Frenchman Flat, Rainier Mesa/Shoshone Mountain, and Yucca Flat/Climax Mine. In 2021, sampling activities were focused on Central and Western Pahute Mesa (CAUs 101 and 102, respectively).



Central and Western Pahute Mesa CAUs – These CAUs (comprising 82 total CASs) are in the investigation stage of the closure process. The Phase I Central and Western Pahute Mesa groundwater flow and 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 (1965) and that offsite tritium concentrations may exceed the Safe Drinking Water

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Act (SDWA) limit of 20,000 picocuries per liter (pCi/L) (see figure below). Contrary to the model forecast, validated laboratory results received to date reflect tritium concentrations within SDWA safety standards in wells beyond the NNSS boundary.

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.

Phase II of the investigation stage was initiated in 2009. Eleven new wells were drilled, developed, tested, and sampled as part of the Phase II investigations. Consistent with the model forecast, tritium was detected in 2009 at the Phase II offsite well ER-EC-11 located on the U.S. Air Force-controlled Nevada Test and Training Range (NTTR). 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,

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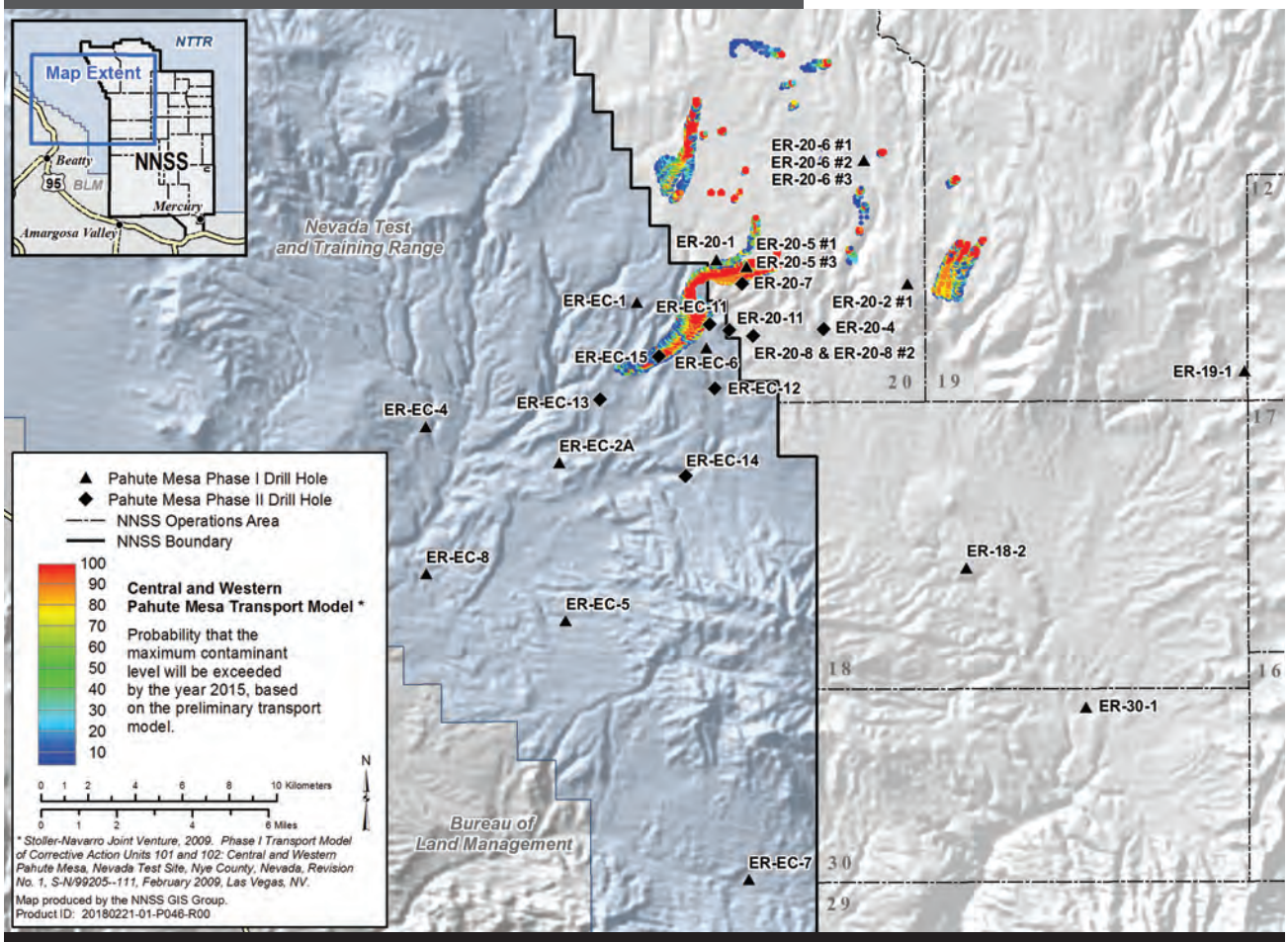
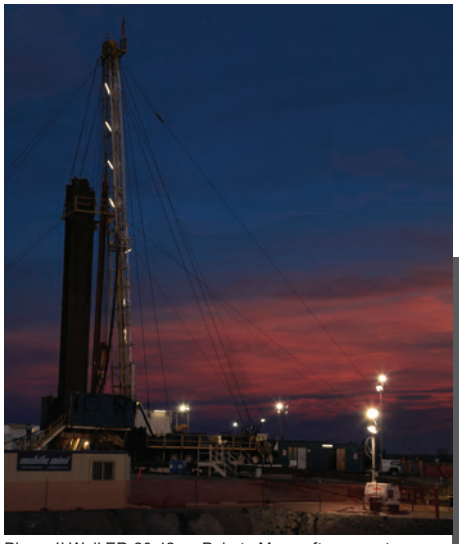


Results of 2009 Phase I Central and Western Pahute Mesa Transport Modeling

conducted in 1968 and 1975, respectively. Laboratory results for ER-EC-11 were within SDWA safety standards, including the highest measurement of tritium (18,400 pCi/L in 2017) among the offsite NTTR wells. Elevated tritium in ER-EC-11 and in a cluster of six Area 20 monitoring wells potentially represents the downgradient extension of the Benham-Tybo contaminant plume. Groundwater sampling results from these wells indicate that the contaminant plume may be more southerly, and the tritium concentrations lower, than previously forecasted.



Phase II Well ER-20-12 on Pahute Mesa after sunset.

Data collection, evaluation, and documentation for the Phase II Central and Western Pahute Mesa investigation stage were completed in 2021. The new data and evaluation results have been integrated into a hydrologic conceptual model of groundwater flow and contaminant transport in the Pahute Mesa – Oasis Valley groundwater flow system and used to develop a draft Phase II groundwater flow and contaminant transport model.

In 2021, the data collection, evaluation, and documentation for Phase II of the investigation stage were completed. The new data and evaluation results were integrated into a conceptual model of groundwater flow and contaminant transport in the Pahute Mesa – Oasis Valley groundwater flow system and used to support Phase II numerical modeling. A data completion assessment was also finalized and used as the basis for the NDEP decision that no significant data gaps exist that could affect the efficiency of the modeling studies. The draft Phase II groundwater flow and contaminant transport model was completed in 2021.

Eight wells including thirteen separate intervals were also sampled in the Pahute Mesa CAUs. These locations are on the NNSS or NTTR and are known to contain, or potentially contain, test-related radionuclides. The results are used to build confidence in the model forecasts of the potential extent of contamination over the next 1,000 years (i.e., contaminant boundaries).

NNSS Scientists prepare to collect water samples in 2021 from UE-19h on Pahute Mesa.

Frenchman Flat CAU

– This CAU was the first to reach the closure stage and the start of long term, or post-closure monitoring. The Closure Re-

Continued on Page 16 ...

port 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.

In 2021, the 5-year monitoring data were evaluated to support recommendations for future monitoring and to ensure that the closure decisions remain protective. Future monitoring requirements will be documented in an update to the Closure Report that will require NDEP approval before implementation. The 2021 evaluation showed that 1) radionuclide results are consistent with the forecasted slow rates of radionuclide migration and with the contaminant boundaries; 2) water-level monitoring locations provide useful long-term data to assess changes to the Frenchman Flat groundwater flow system; and 3) 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.

The Frenchman Flat CAU regulatory boundary objective is to protect receptors downgradient of the Rock Valley fault system from radionuclide contamination. Although contaminants resulting from underground nuclear tests are not forecasted to migrate out of the basin within the next 1,000 years, the Rock Valley fault system is the expected groundwater migration pathway. All monitoring results indicate that the regulatory boundary objective has
been met.

Post-closure monitoring results for the Frenchman Flat, Rainier Mesa/Shoshone Mountain, and Yucca Flat/Climax Mine CAUs were published in 2021. Monitoring results are consistent with the groundwater flow and contaminant transport models. No new radionuclide detections were observed during post-closure monitoring. Use restrictions continue to prevent exposure of the public, workers, and the environment to potentially contaminated groundwater within these CAUs.

Rainier Mesa–Shoshone Mountain CAU

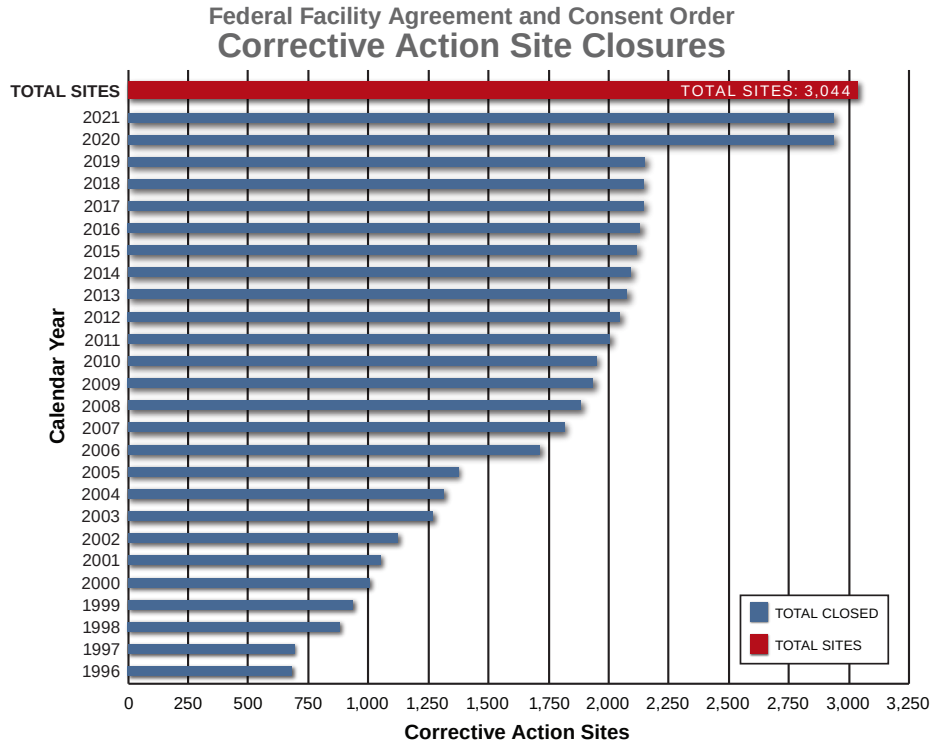
– The Closure Report for this CAU (comprising 66 CASs) was approved by NDEP in 2020 and includes a description of the monitoring program, use-restriction and regulatory boundaries, and land-use restrictions. This CAU is unique when compared to other UGTA CAUs because most of its CASs are associated with nuclear tests conducted in tunnels rather than in vertical shafts. The monitoring network includes 16 locations for water-level and/or water-quality measurements.

Sampling for tritium is required every 6 years; additional radionuclides are analyzed at three locations that sample water from the tunnels. Water levels will be measured annually. Separate regulatory boundaries were established for Rainier Mesa and Shoshone Mountain. The regulatory boundary objective for Rainier Mesa is to protect groundwater receptors from radionuclide contamination within the three groundwater basins downgradient of Rainier Mesa and the regulatory boundary objective

Continued on Page 17 ...

for Shoshone Mountain is to verify that radionuclide contamination does not reach the lower carbonate aquifer (i.e., the regional aquifer) below Shoshone Mountain.

In 2021, the monitoring results (water quality, water level, and institutional control) were published in the post-closure monitoring report. While tritium was observed in the samples from the tunnels where testing occurred, it was not present in monitoring locations downgradient of the tunnels. The results are consistent with the forecasted contaminant boundaries for this CAU and indicate that the regulatory boundary objectives have been met.



Yucca Flat–Climax Mine CAU

– The Closure Report for this CAU (comprising 720 CASs) was approved by NDEP in 2020 and includes a description of the monitoring program; contaminant, use-restriction, and regulatory boundaries; and land-use restrictions. The monitoring network includes 10 sampling locations and 20 water-level monitoring wells (25 total intervals). Samples will be collected and analyzed for tritium every 6 years and water levels will be measured annually. In addition, one well in southern Yucca Flat will be sampled annually for the first 6 years of closure.

The regulatory boundary objective for the Yucca Flat-Climax Mine CAU is to verify that radionuclide contamination from this CAU is contained within the Yucca Flat basin, thus not impacting the Frenchman Flat lower carbonate aquifer or downgradient receptors. The lower carbonate aquifer is a regional aquifer and is the only pathway out of Yucca Flat. The regulatory boundary aligns with the southern extent of the Yucca Flat hydrographic basin (Basin 159) and supports the regulatory boundary objective.

In 2021, the monitoring results (water quality, water level, and institutional control) were published in the post-closure monitoring report. Except for two wells, no tritium has been observed in the Yucca Flat/Climax Mine monitoring locations. The tritium levels in the two

Continued on Page 18 ...

Restoration Progress under FFACO

In 2021, 3 CASs were closed and all FFACO milestones were met. To date, 2,952 of 3,044 CASs have been closed in accordance with state-approved corrective action plans.

wells are less than 0.1 percent of the SDWA safety standard. The tritium in one location, near an underground nuclear test, has been decreasing since 1978 when the well was used for a radionuclide migration experiment. An additional concentration step (i.e., enrichment process) is required to detect the low concentration of tritium at the second location. Tritium at this well has been reported since 1964 and is being measured annually to evaluate the continued trend. The monitoring results are consistent with the forecasted contaminant boundaries for this CAU and indicate that the regulatory boundary objectives have been met.

Industrial Sites and Soils

Corrective actions have been completed, with characterization and closure of 2,156 Industrial Sites and Soils CASs on and off the NNSS. Closure strategies include removal of debris, excavation of soil, decontamination and decommissioning of facilities, and closure-in-place with subsequent monitoring. The contaminants of concern include hazardous chemicals/materials, unexploded ordnance, and low-level radiological materials. Clean closures are those where pollutants, hazardous materials, radiological materials, and solid wastes have been removed and properly disposed, and where removal of all contaminants to concentrations agreed upon between DOE and NDEP is verified in accordance with corrective action plans approved under the FFACO. Closure-in-place entails the stabilization or isolation of pollutants, hazardous materials, radiological materials, and solid wastes, with or without partial treatment, removal activities, and/or post closure monitoring in accordance with corrective actions plans approved under the FFACO.

Post-closure monitoring requirements are established as needed to provide long-term protection of the public and the environment. Post-closure inspections are required for 138 closed FFACO CASs (non-RCRA sites) and eight CASs (RCRA sites) identified in the RCRA Part B Permit. In 2021, the EM Nevada Program conducted inspections at 114 closed CASs managed under the FFACO, and at the eight RCRA Part B Permit CASs. The results were published in annual inspection reports.

In 2021, the Closure Report for three CASs in CAU 577 was approved by NDEP. The corrective actions for these CASs included construction of RCRA compliant closure covers over the waste disposal cells and revegetation of the closure covers. Corrective actions for the remaining two CASs in CAU 577 will follow final receipt of waste in the disposal cells, which is expected to be in 2022 for the first CAS and 2023 for the second CAS. Eight additional Industrial Sites CASs from two other CAUs remain to be closed. Both CAUs are located on the NNSS: Area 25 Engine Maintenance, Assembly, and Disassembly Facility (CAU 114) and Test Cell C Ancillary Buildings and Structures (CAU 572). Their closures will occur prior to the end of the EM Nevada Program mission, which is currently planned for 2030.

Closure of Three CASs in CAU 577 in 2021

The Closure Report for three CASs in CAU 577 was approved by NDEP. The corrective actions for these CASs included construction of RCRA compliant closure covers over the waste disposal cells and revegetation of the closure covers.

Radiological Monitoring of Groundwater

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 is known to exceed its allowable drinking water limit in wells down gradient of underground nuclear testing.

For decades NNSA/NFO and EM Nevada Program have sampled groundwater from wells on and off the NNSS to detect radionuclides that may be present due to historical underground nuclear testing. More than 100 wells are available for sampling by NNSA/NFO and the EM Nevada Program to meet various objectives. NNSA/NFO and EM Nevada Program 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 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

In November 2020, the Plan was updated to focus on the Central and Western Pahute Mesa CAUs (CAUs 101/102) which are the only UGTA CAUs that have yet to enter the closure stage. Sampling

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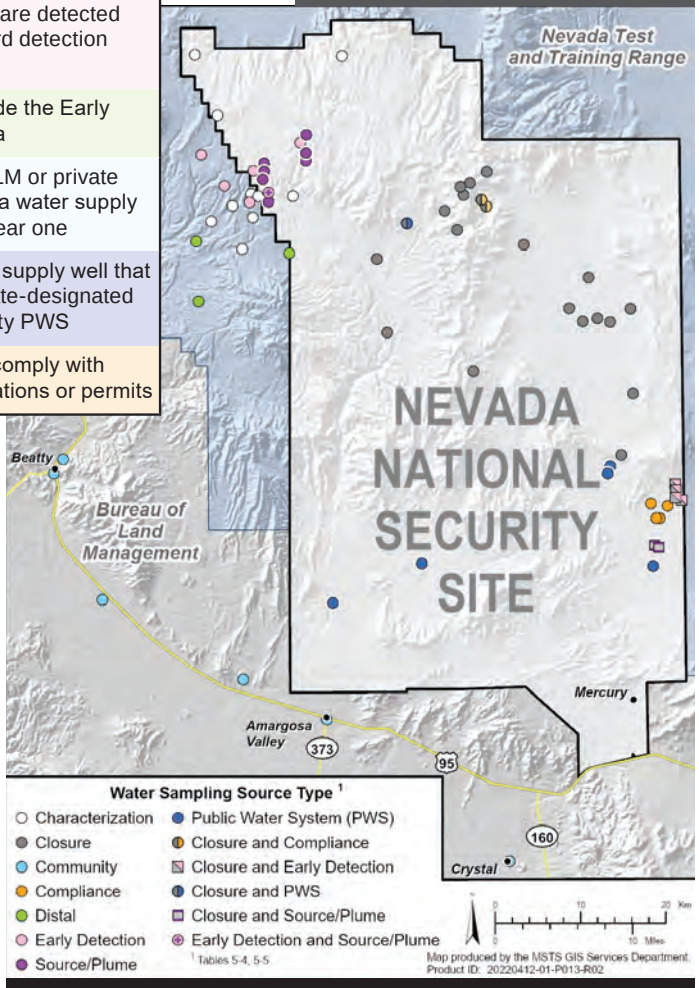
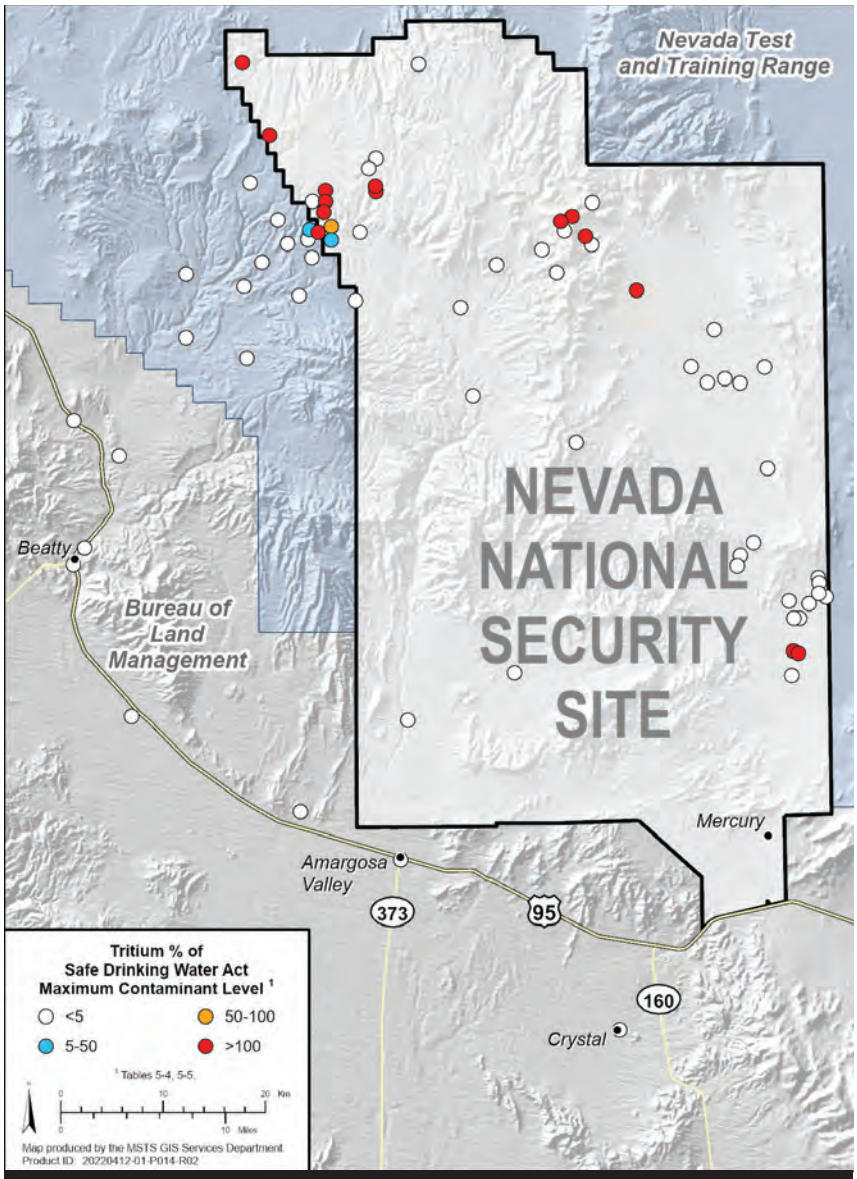


NNSA/NFO and EM NV Program Water Sampling Network



Tritium in NNSA/NFO Groundwater Monitoring Wells

for CAUs in the closure stage is described within the closure reports. Groundwater sampling on the NNSS for compliance is performed according to the various permits, and sampling for other environmental objectives is documented in various procedures.

The water sampling network under the Plan consists of sampling locations categorized into four types: Characterization, Source/Plume, Early Detection, and Distal locations.

The tritium analysis results for all sampling locations in the network are shown on the map to the left. 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). Tritium 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.

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Community Environmental Monitoring Program

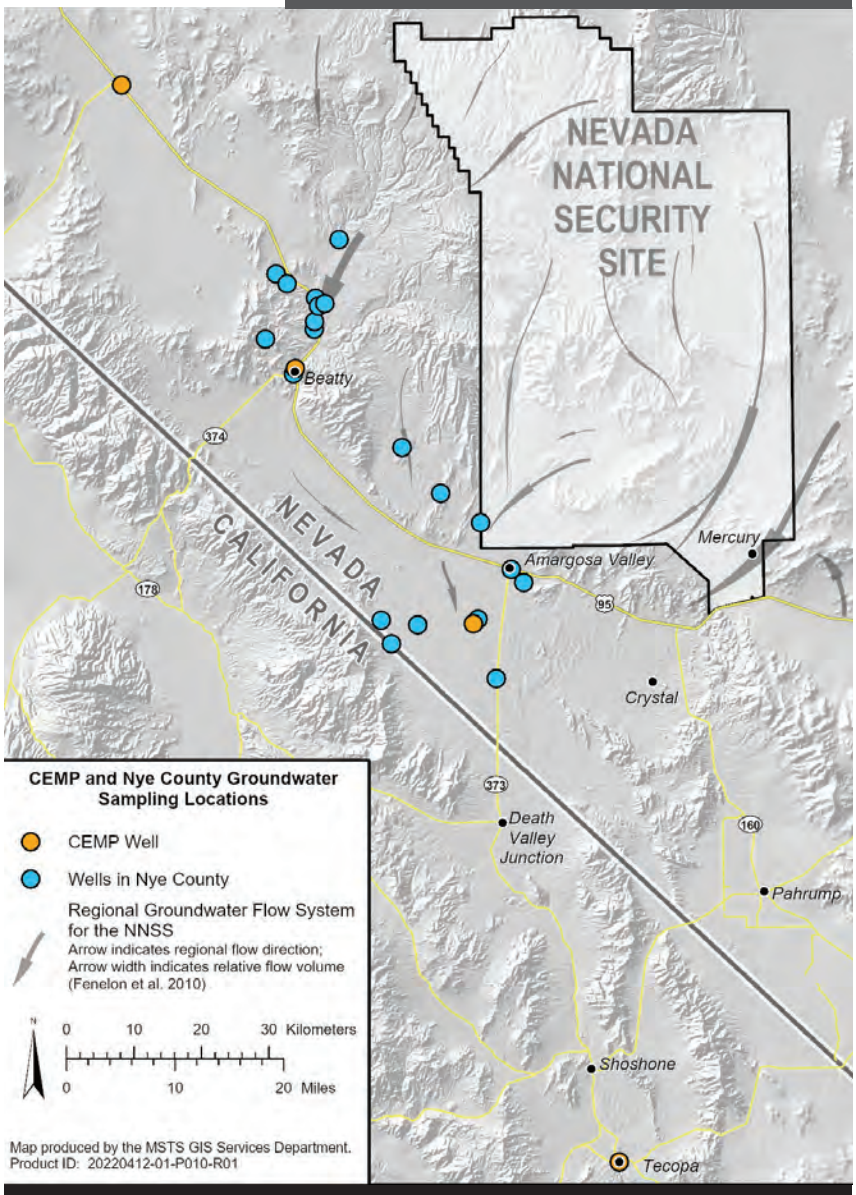
Offsite water supply wells are also monitored for the presence of tritium by the independent Community Environmental Monitoring Program (CEMP), which is coordinated by the Desert Research Institute (DRI) of the Nevada System of Higher Education under contract with NNSA/NFO. The CEMP provides the public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

In 2021, the CEMP monitored 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

The Nye County Tritium Sampling and Monitoring Program (TSaMP) was initiated in 2015 in response to the county's request to expand its support of offsite community-based monitoring of wells for ^{3}H. EM Nevada Program issued a 7-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 TSaMP sampled 20 locations (18 wells, 2 springs) in 2021. None of the 20 locations had detectable levels of tritium.

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



2021 CEMP and Nye County Water Monitoring Locations

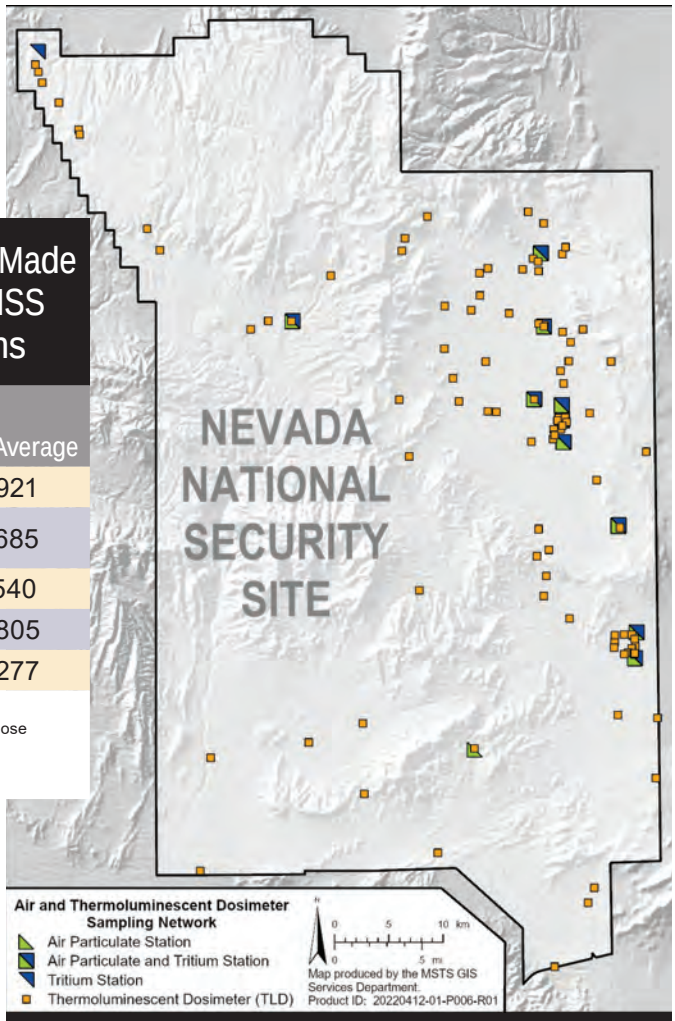
Radiological Monitoring of Air

Range in Average Concentrations of Man-Made Radionuclides in Air Samples on the NNSS in 2021 Attributable to NNSS Operations

Radionuclide	Concentration (10^{-15} µCi/mL)[a]		
	Limit[b]	Lowest Average	Highest Average
^{241}Am	1.9	-0.00280	0.07921
^{137}Cs	19	-0.04291	0.01685
^{3}H	1,500,000	-1090	117,540
^{238}Pu	2.1	-0.00196	0.00805
$^{239+240}$Pu	2.0	-0.00032	0.46277

(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.



2021 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 in Nevada, Utah, and California by the CEMP. A network of 24 CEMP stations was operational in 2021 (see map on Page 23). 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.

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Estimated Quantity of Man-Made Radionuclides Released into the Air from the NNSS in 2021 (in Curies)

	Tritium (^{3}H)	Americium (^{241}Am)	Plutonium (^{238}Pu)	Plutonium ($^{239+240}$Pu)	Noble Gases	Other Radionuclides	
	20	0.070	0.039	0.29	359	0	86.5
Half-life*	12 years	432 years	88 years	>6,500 years	<6 days	<3 hours	>3 hours

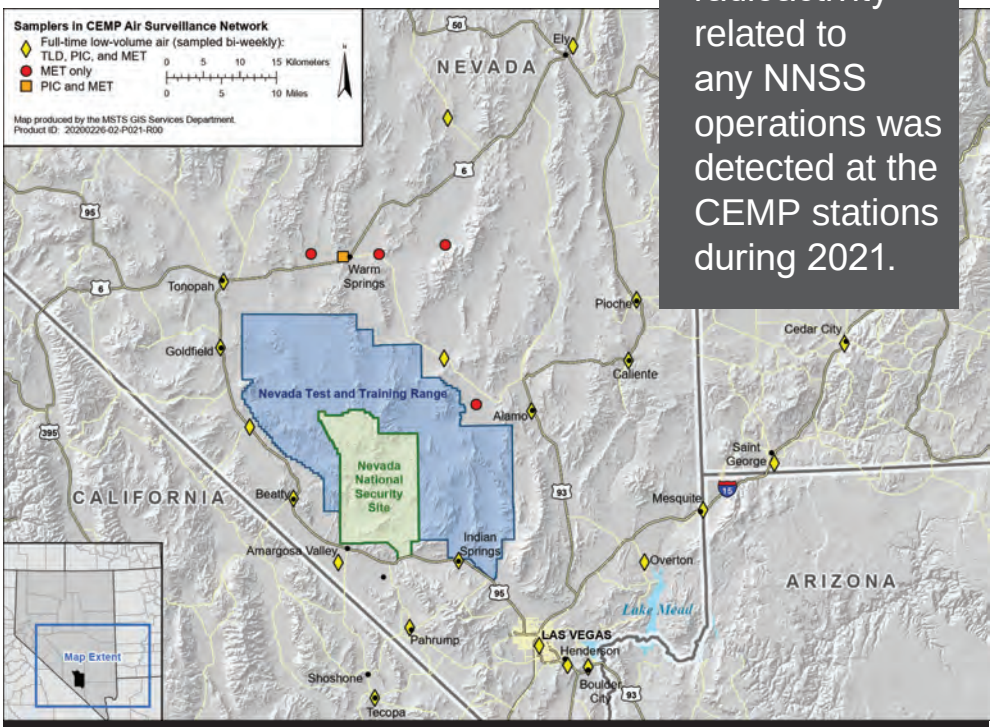
* Half-life is the time required for one-half of the radioactive atoms in a given amount of material to decay.

Several man-made radionuclides were detected at NNSS air sampling stations in 2021: none exceeded concentration levels established by the Clean Air Act. The highest average levels of ^{241}Am were detected at the Bunker 9-300 station in Area 9, ^{238}Pu at the Able Site station in Area 27, and $^{239+240}$Pu at the Bunker 9-300 station, located within areas 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. ^{137}Cs was detected in one sample during the second quarter at 19.2% above the MDC.

CEMP air monitoring station located in Tonopah, Nevada.

The total amount of man-made radionuclides emitted to the air was estimated to be 466 Ci. All radionuclides detected by environmental air samplers in 2021 are from known sources which include: (1) legacy deposits of radioactivity on and in the soil from past nuclear tests, (2) the upward flux of tritium from the soil at sites of past nuclear tests and low-level radioactive waste burial, and (3) NNSS operations.

No airborne radioactivity related to any NNSS operations was detected at the CEMP stations during 2021.



2021 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 2021, 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 407 mR/yr at Schooner, one of the legacy Plowshare sites on Pahute Mesa.

In the fall of 2021, the CEMP began deploying a new type of dosimeter at CEMP stations and implemented calculation methods that more accurately reflect exposure rates at each site (see Chapter 7 for a detailed discussion). The CEMP offsite dosimeter 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 121 mR/yr level measured on the NNSS. The highest annual gamma exposure measured off site, based on the PIC detectors, was 169 mR at Warm Springs Summit, Nevada. The lowest offsite exposure rate, based on the PIC detectors, was 78 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: https://cemp.dri.edu/cemp/Radiation.html

2021 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 2021 on and off the NNSS

Location	Elevation Above Sea Level (feet)	Radiation Exposure (mR/yr)
NNSS – Schooner TLD station (highest measurement)	5,660	407
NNSS – 35 Legacy Site TLD stations (includes Schooner)	3,077–5,938	192
Las Vegas, Nevada CEMP PIC station	2,030	92
NNSS – 17 Waste Operation TLD stations	3,176–4,021	134
NNSS – 10 Background TLD stations	2,755–5,938	117
Bloomington Hills, St. George, Utah CEMP PIC station	2,706	124
Pahrump, Nevada CEMP PIC station	2,639	78
NNSS – Gate 100 Truck Parking 2	3,602	53

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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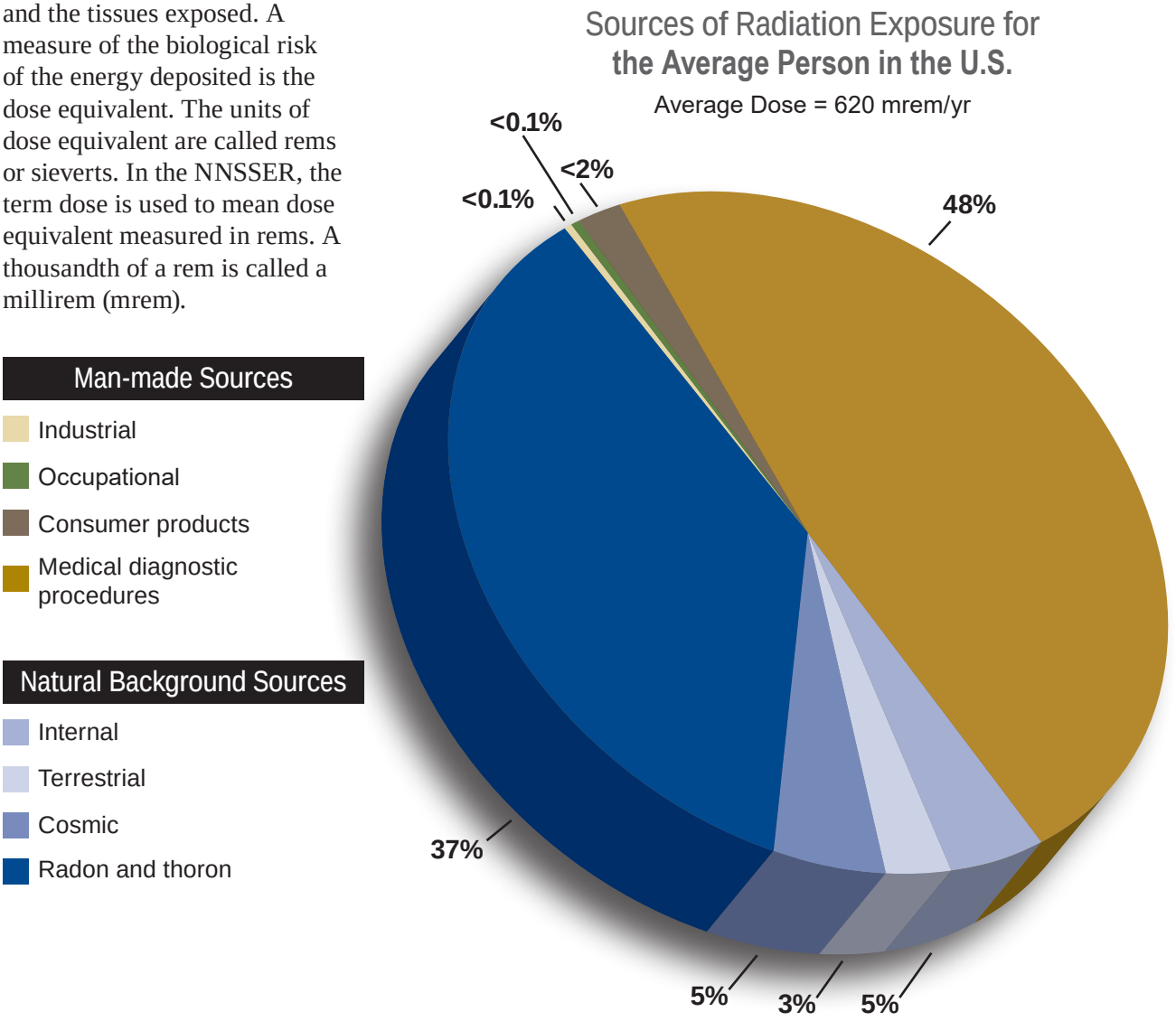


scientifically, regulators take a conservative approach and assume that there is no such thing as a 100% safe dose equivalent. It is believed that the risk of developing an adverse health effect (such as cancer) is proportionate to the amount of radiation dose received.

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

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.

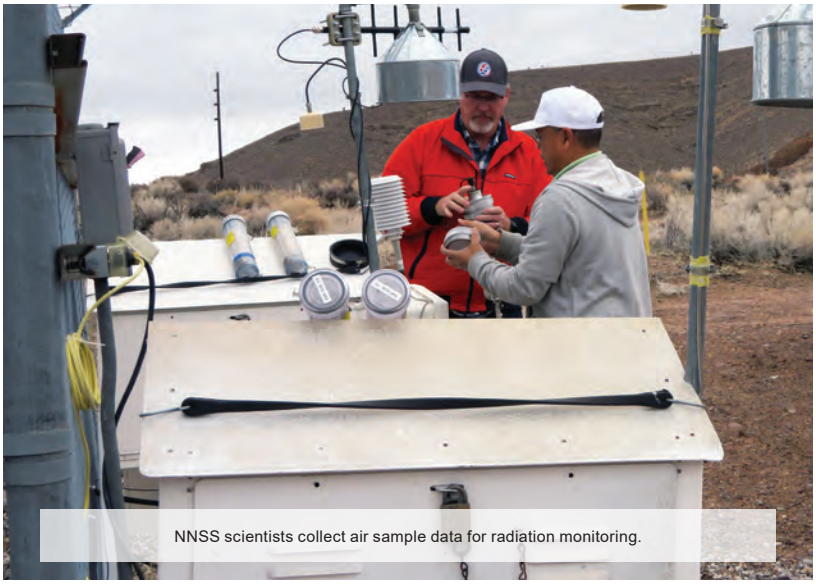
Estimating Dose to the Public from NNSS Operations

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:

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.

Estimated 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 proposed and formally submitted to the EPA in 2001. The radionuclides detected at one or more of the NNSS critical receptor samplers were ^{137}Cs, ^{241}Am, ^{238}Pu, $^{239+240}$Pu, and ^{3}H.

As in previous years, the 2021 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 2021 NNSS source were modeled using the Clean Air Package, 1988 model from EPA. The highest value is predicted to be a person residing on the Nevada Test and Training Range and received a predicted dose of 0.056 mrem/yr.

Estimated Ingestion Dose to the Public

There are three potential sources for ingestion dose to the public: eating contaminated plants and animals and drinking contaminated groundwater that comes from the NNSS.

Current NNSS land-use practices discourage the harvest of plants or plant parts for direct consumption by humans. However, it is possible that individuals with access will collect and consume edible plant material. One species in particular, the pinyon pine tree, produces pine nuts that are

Continued on Page 28 ...

harvested and consumed across the western United States. Pinyon pine trees grow throughout regions of higher elevation on the NNSS. In 2013, pine nuts were sampled from three locations on the NNSS (Area 15, Area 17, and in Area 12 near the E Tunnel Ponds). The estimated dose from consuming them was shown to be extremely low (0.00056 mrem or 0.0000056 mSv) and a negligible contribution to the total potential dose to a member of the public. No other edible plant materials have been collected for analysis on the NNSS in recent history, and no edible plants were sampled in 2021.

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 2021, tissue, bone and/or blood samples were collected from two jackrabbits from the T2 site (Area 2), one duck (green-wing teal) in Area 23, one pronghorn antelope in Area 6 (predated), and ten mule deer (six predated, two roadkill, and two died from unknown causes) in various locations. The pronghorn and nine of the deer were study animals fitted with GPS collars in 2019. Based on data from these samples, excluding the duck and pronghorn since no man-made radionuclides were detected, an individual who consumes one animal of each of the remaining sampled species from each location may receive an estimated dose of 0.17 mrem based on the averages. To put this dose in perspective, it is about 20% of the dose received from naturally occurring cosmic radiation during a 2-hour

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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 and on the NNSS.

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

Ingestion Pathway –

Members of the public may ingest game animals that have been exposed on the NNSS, have moved off the NNSS, and have then been hunted.

NNSS scientists collect plant samples at Cane Springs.

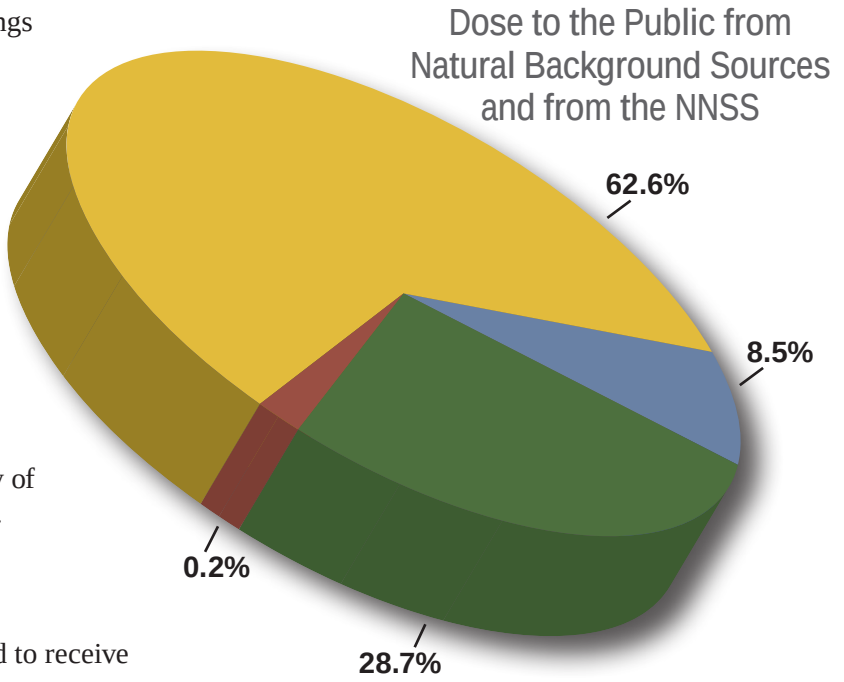
airplane flight at 39,000 feet. Consuming just one animal sampled in 2021, the maximum would come from eating 35.4 kg of meat with concentrations observed in a mule deer sampled in Area 12, and would result in a dose of 0.69 mrem. Radionuclide concentrations are also below levels considered harmful to 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.

The 2021 groundwater monitoring data indicate that groundwater from offsite private and community wells and springs has not been impacted by past NNSS nuclear testing operations. No man-made radionuclides have been detected in any sampled wells accessible to the offsite public or in sampled private wells or springs. These field monitoring data also agree with the forecasts of current groundwater flow and contaminant transport models. Therefore, drinking water from underground aquifers containing radionuclides is not a possible pathway of exposure to the public residing off site.

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."



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.

2021 Dose to the Public from All Pathways

0.75 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 12.01 tons of criteria air pollutants and 0.00007 tons of HAPs were released on the NNSS in 2021. 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 2021

Criteria Air Pollutants:	Tons
Particulate Matter[(a)]	1.67
Carbon Monoxide	1.74
Nitrogen Oxides	2.52
Sulfur Dioxide	0.56
Volatile Organic Compounds	5.52
Hazardous Air Pollutants (HAPs)	7.0×10^{-5}

(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 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 2021 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.

Domestic wastewater on the NNSS is discharged to 17 active permitted septic systems, which are permitted to process / store up to 5,000 gallons of wastewater per day. A septic tank pumping contractor is permitted to pump out and dispose of the wastewater. Inspections of the trucks and maintenance and assessments of the septic systems is performed to demonstrate compliance with permit conditions.

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 2021 for biochemical 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. All parameters were within the threshold 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. The Cultural Resources Management Program (CRMP) is implemented by DRI to meet this requirement.

In 2021, DRI completed cultural resources inventories and architectural surveys for six projects in nine areas of the NNSS that had the potential to impact cultural resources. DRI surveyed over 723 acres and identified/recorded 139 cultural resources, 84 of which were determined to be eligible for the National Register of Historic Places (NRHP). Documented cultural resources consist of prehistoric and historic sites, buildings, and structures. In accordance with the National Historic Preservation Act, NNSA/NFO consults with the Nevada State Historic Preservation Office (SHPO) regarding the adequacy of the identification efforts, eligibility determinations, and findings of effect prior to initiating an undertaking that has the potential to affect historic properties.

In 2021, DRI completed an identification, evaluation, and finding of effect report for the proposed decommissioning and removal of the historic 138-kilovolt (kV) transmission line that provides power to the NNSS. A 26.2-mile segment of line located within the Mission Corridor of the NNSS is proposed for replacement. Although the historic transmission line was previously determined not individually eligible for listing in the NRHP, it does contribute to historic districts on the NNSS and, therefore, is treated as an eligible historic property. The NNSA/NFO is consulting with the SHPO regarding a memorandum of agreement to mitigate and resolve the adverse effects.

DRI also conducted two inventories to evaluate the impacts on historic properties from installing the new 138 kV power transmission system. These inventories covered proposed modifications to the original proposal. For the first inventory, the NNSA/NFO expanded the scope of the transmission system replacement an additional 2.95 miles from the Tweezer Substation to the U1a Complex. DRI identified 17 resources that are either eligible for the NRHP or unevaluated, including the historic 138 kV power line and two historic districts. The NNSA/NFO determined the proposed undertaking would have an adverse effect on the historic power line. The NNSA/NFO is consulting with the SHPO regarding a memorandum of agreement to mitigate and resolve the adverse effects.

Skyraider drone crash including radial engine (DRI 2020)

The second inventory covered a modification of the initial design for a 0.57-mile segment through Yucca Pass in Area 6. This modification would realign the footprint of the proposed line from an initial route through the foothills at the

Continued on Page 32 ...

north end of CP Hogback to one that goes straight through Yucca Pass, paralleling the east side of Mercury Highway. Of the 19 historic properties and unevaluated resources identified, the proposed undertaking would have an adverse effect on five historic properties: the historic 138 kV power line and the unrecorded Reynolds Electrical and Engineering Company's Maintenance Compound and its associated resources. The NNSA/NFO is consulting with the SHPO regarding a memorandum of agreement to mitigate and resolve the adverse effects. The original alignment would have had an adverse effect on the well-known News Nob; however, the modified alignment removes the segment that passes over News Nob.

DRI completed an identification, evaluation, and finding of effect report for the Seismic and Diagnostic Monitoring SPE-FAR Rock Valley Experiment in Area 27. The project proposed to place geophones aligned with 27-01 Road and Rock Valley Road and between the roads. Geophones would also be installed along a sensor line extending to the northern section of the project area. DRI conducted an archival review and pedestrian inventory and identified 18 resources consisting of six archaeological sites and 12 isolated finds. Of the six sites, three were determined eligible for the NRHP for their potential to yield important data. Three geophones were proposed for location within the boundaries of one of these sites. The project was then modified, so there will be no effect on historic properties.

In May 2021, the Cherrywood Fire burned 21,022 acres in Areas 18 and 30 of the NNSS. DRI assessed the potential for fire effects on 16 historic properties identified within the burn area from archival information in the DRI CRMP Geographic Information System (GIS) Database and the Nevada Cultural Resources Information System. Site 26NY12845 contained an historic wood wagon, which was destroyed by the fire. Other at-risk sites included scatters of flaked stone artifacts, temporary camps, rockshelters, and rock writings, especially pictographs. Depending on the temperature and duration of the burn, wildfires can cause effects to flaked stone artifacts. Fires of even limited duration and intensity can significantly impact rock writings by causing rock surfaces to spall and smoke, soot, and ash to damage the images.

DRI also compiled a list of properties near the burn area that could be impacted by post-fire undertakings. A series of NRHP-eligible sites around Buckboard Mesa, along Fortymile Canyon, and at the head of Chukar Canyon were recommended for avoidance during any post-fire activities. Big George Cave and Ricegrass Village are of particular importance. DRI also recommended an assessment of the impacts associated with the temporary construction of the Bureau of Land Management's fire camp at the historic Camp Desert Rock in Area 22.

NNSA/NFO entered into one Memorandum of Agreement with the SHPO in 2021 for the demolition of 14 buildings and structures in Area 6. DRI prepared reports to fulfill the mitigation stipulated in the MOA included a boundary report for the Control Point historic district, an architectural survey describing the Control Point's origin, history, layout, and functions during the Cold War nuclear testing program, and supplemental documentation of the Device Assembly Building and the Yucca Flat Weather Station.

Pursuant to Section 110 of the NHPA, DRI evaluated an aviation crash site in Area 1. A study area of 0.55 acres delineated the extent of the debris scatter and established a boundary for documentation of the site. The Douglas AD-2 Skyraider drone crash site is eligible for the NRHP as a physical remnant of Project 5.1 "Atomic Weapons Effects on AD Type Aircraft in Flight," one of a series of military effects studies conducted as part of Shot Simon during Operation Upshot-Knothole in 1953. Furthermore, the site is eligible because closer examination of the debris could address important research questions concerning the Type 1 Remote Control Equipment developed by the Naval Air Experimental Station that was onboard to remotely pilot the aircraft.

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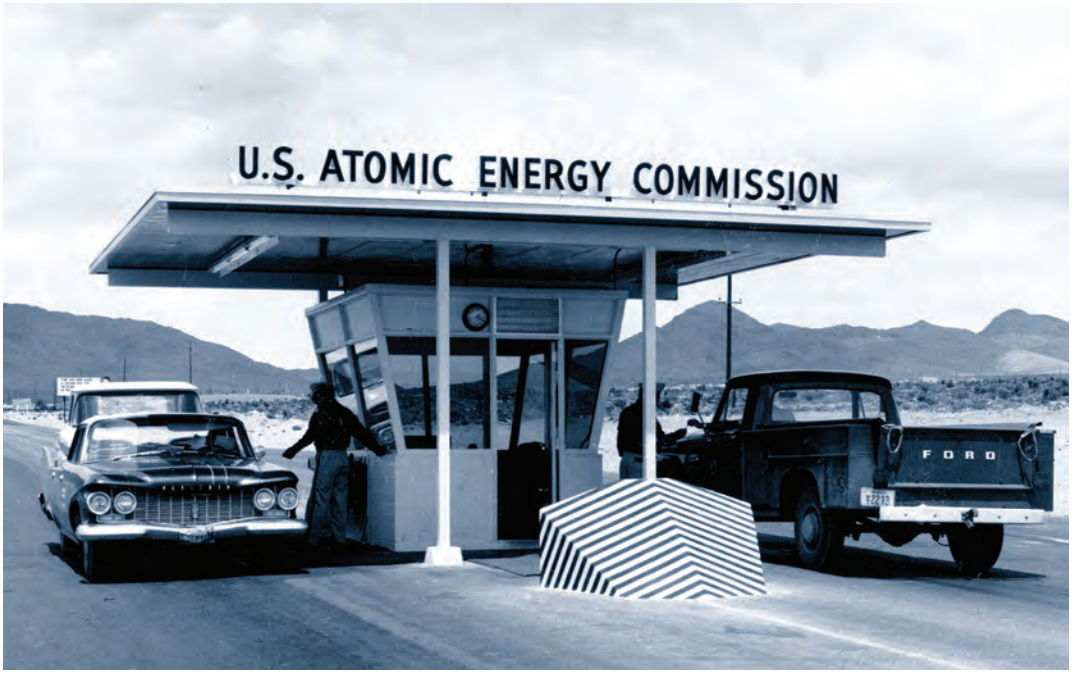


The Main Gate facing northeast, 1965 (Nuclear Testing Archive 64-074)

In 2018, the NNSA/NFO executed a programmatic agreement (PA) with the SHPO that specifies the approach NNSA/NFO will take to streamline the Section 106 compliance process for modernization activities in Mercury. Pursuant to the PA, in 2021, DRI completed research, building survey, and required mitigation documentation for one undertaking in Mercury: the replacement of the Guard Shack at the Main Gate.

DRI continues to maintain and manage the NNSS archaeological collections and associated records consistent with all professional standards. These collections contain more than 467,000 artifacts.

NNSA/NFO's American Indian Consultation Program (AICP) serves to facilitate government-to-government consultation with 16 Tribes culturally affiliated with the NNSS. The AICP Coordinator joins ten other Tribes currently serving from New Mexico, Idaho, Washington, Oregon, and New York on the State Tribal Government Working Group (STGWG). The STGWG works closely with various DOE sites throughout the U.S. The AICP Coordinator is also appointed to the Nevada Site Specific Advisory Board to serve as a liaison giving advisory insight into activities conducted on the NNSS.

In 2021 NNSA/NFO supported the goals of the AICP by:

- interacting with the AICP Coordinator to identify topics of interest and enhance communications with Tribal representatives
- participating in the annual Tribal Update Meeting, which assembles Tribal representatives from the 16 culturally affiliated Tribal governments
- participating in Tribal Planning Committee (TCP) meetings
- supporting two NNSS visits to Areas 1 and 5, Ricegrass Village, and the Cherrywood Fire burn area
- continuing to support a tribal revegetation project at the Area 5 RWMC.

In 2021, 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 43 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.

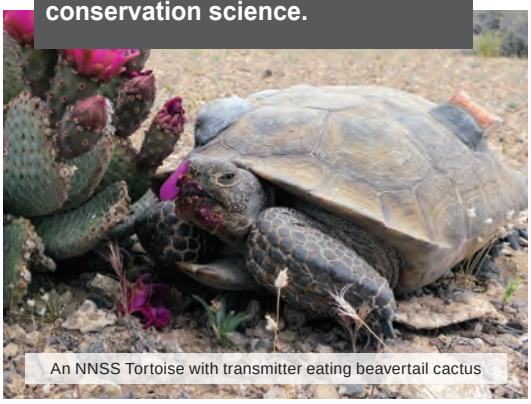
The desert tortoise is the only resident species on the NNSS listed under the Endangered Species Act as threatened. Habitat of the desert tortoise is in the southern portion of the NNSS. Activities conducted in desert tortoise habitat must comply with the terms and conditions of a Biological Opinion issued to NNSA/NFO by the U.S. Fish and Wildlife Service. In 2021, no desert tortoises were accidentally injured or killed at a project site, nor were any found, captured, or displaced from project sites. There were 41 sightings of desert tortoises on roads on the NNSS. Of the 41 sightings, two were roadkills, one was a predation, and 25 of the tortoises, thought to be in harm's way, were moved.

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 2021, 12 of the 60 juveniles were still alive.

In 2021, biological surveys for the presence of sensitive and protected/regulated species and important biological resources on which they depend were conducted for 29 projects. A total of 103 acres were surveyed for these projects. Some of the sensitive species and important biological resources found included western burrowing owl sites, tortoises and tortoise sign (scat, carcasses, burrows), bat sign, several inactive bird nests, breeding bird habitat, Audubon's cottontail, predator burrows (coyote, kit fox), ungulate sign (pronghorn antelope, feral horse, feral burro, mule deer); yucca plants (Joshua tree, Mojave yucca), singleleaf pinyon, and multiple cactus species.

Surveys of sensitive and protected/regulated animals in 2021 focused on birds, bats, feral horses, mule deer, pronghorn antelope, desert bighorn sheep, and mountain lions. Field surveys for sensitive plants were conducted for Clokey's cryptantha, Lahontan beardtongue, Nye milkvetch, Beatley milkvetch, Cane Spring suncup, Clokey eggvetch, Inyo hulsea, Kingston Mountain bedstraw, Pahute green gentian, and Pahute Mesa beardtongue.

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



An NNSS Tortoise with transmitter eating beavertail cactus

NNSS biologists found feral horse distribution was concentrated around Camp 17 Pond and Gold Meadows Spring especially during the hot, dry summer months. With monitoring limited to opportunistic observations and data from camera traps, at least 24 individuals were identified including one juvenile and zero foals.

Eighteen pronghorn and 23 mule deer were captured and collared in 2019, and 8 antelope and 8 mule deer continue to be tracked 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 2020 Site Sustainability Goals.

In December 2021, the Sustainability Division completed the FY 2022 NNSA/NFO Site Sustainability Plan, which reported the 2021 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.

The **Pollution Prevention and Waste Minimization Program** helps to reduce the volume and toxicity of waste that must be disposed.

Energy **Efficiency and** Management

- Energy intensity (energy use per square foot of building space) decreased 5.8% from the FY 2015 baseline – the FY 2021 targeted DOE Strategic Sustainability Performance Plan (SSPP) goal was 15% reduction from the FY 2015 baseline.
- Based on a 2019 assessment of appropriate buildings, 80% 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. No new appropriate buildings were metered.
- 70 energy audits/assessments were conducted to further ensure that all eligible facilities under Section 432 of the Energy Independence and Security Act are assessed once every 4 years. Efficient Mobile Audit Technology was used in the field and allowed the successful upload of facility information, pictures and notes.

Water **Efficiency** and Management

- Water intensity (gallons used per total gross square feet [gsf] of facility space) was 33.7% below the FY 2007 baseline – the FY 2021 goal was met.
- Non-potable water production was 22% above the FY 2010 baseline.

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

Fleet Management

- Use of alternative fuel was 181% 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 72% 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.
- 95.54% (879) of all light duty vehicle purchases were alternative fuel vehicles – exceeds the goal of 75%.

Clean and Renewable Energy

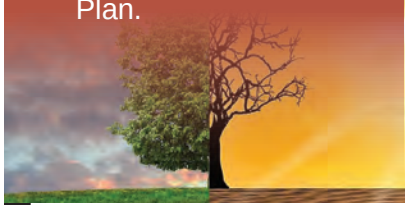
- "Renewable Electric Energy" requires that renewable electric energy account for not less than 7.5% of a total agency electric consumption by FY 2013 and each year thereafter. In FY2021, the NNSS electric consumption was offset 25.9% from a combination of solar energy, off-grid solar, and purchased Renewable Energy Credits.

Pollution Prevention and Waste Minimization

- 45.7% of non-hazardous solid waste generated at NNSA/NFO facilities was diverted from landfills – the goal is 50%.
- 11.4% of construction materials were diverted from landfills – there is no set target.

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.



High Performance Sustainable Buildings (HPSBs)

- There are 14 facilities of NNSS building inventory totaling 455,599 gsf that are HPSB certified, surpassing the goal that at least 15% (by count and square footage) of owned existing buildings are compliant with the revised Guiding Principles for High Performance Sustainable Buildings (HPSBs) by FY 2020, with annual progress thereafter.

Electronic Stewardship and Data Centers

- 100% of electronic equipment that passed excess screening criteria were sold for reuse for their original intended use or e-recycled.
- The data center Power Utilization Effectiveness goal of less than 1.5 for existing data centers was not met.

Greenhouse Gas (GHG) Emissions

- FY 2021 Scope 1 and 2 GHG emissions were 78.5% lower than the FY 2008 baseline – the goal is a 50% reduction by FY 2025.
- FY 2021 Scope 3 GHG emissions were 79.8% 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 (SF6) 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.

Natural Resources Conservation Programs and Projects

The White House issued Executive Order (E.O.) 14008 entitled ***Tackling the Climate Crisis at Home and Abroad***, in January 2021, which set a goal of conserving 30 percent of land and water by 2030, among other goals. The White House Council on Environmental Quality (CEQ) named this initiative the America the Beautiful Initiative and asked DOE (and other Federal agencies), to support it by preparing a **Conservation Action Plan** (CAP) detailing programs and projects across several discrete areas of early focus, and a **Climate Adaptation and Resilience Plan** (CARP) detailing programs and projects across five priority adaptation actions.

DOE CAP[1] and CARP[2] Elements	NNSA/NFO and DOE EM Nevada Program Contributions
The CAP areas of early focus included: ▶ Create More Parks and Safe Outdoor Opportunities in Nature-Deprived Communities ▶ Support Tribally Led Conservation and Restoration Priorities ▶ Expand Collaborative Conservation of Fish and Wildlife Habitats and Corridors ▶ Increase Access for Outdoor Recreation ▶ Incentivize and Reward the Voluntary Conservation Efforts of Fishers, Ranchers, Farmers and Forest Owners ▶ Create Jobs by Investing in Restoration and Resilience; and ▶ Other Activities Supportive of the America the Beautiful Initiative. **The CARP includes five priority adaptation** actions: 1. Assess Vulnerabilities and Implement Resilience Solutions at DOE 2. Enhance Climate Mitigation Efforts at DOE Sites 3. Institutionalize Climate Adaptation and Resilience Across DOE Policies, Directives and Processes 4. Provide Climate Adaptation Tools, Technical Support, and Climate Science Information on Adaptation and Mitigation 5. Advance Deployment of Emerging Climate Technologies	The NNSA/NFO and DOE EM Nevada Program participated in working groups and contributed **to developing the DOE CAP. In particular, NNSA/NFO and DOE EM Nevada Program identified:** ▶ The DOE EM Nevada Program Tribal Revegetation Project implemented at the Area 5 RWMC combines Tribal Ecological Knowledge (TEK) with Western scientific ecological methods to create a vegetative cover within test plots located at the RWMC. ▶ NNSA/NFO maintains a comprehensive ecological monitoring and compliance (EMAC) program consisting broadly of biological surveys of sites and sensitive and protected species and potential habitat disturbance. ▶ NNSA/NFO and DOE EM Nevada Program participate in numerous collaborative activities with other federal and state agencies including, but not limited to the U.S. Fish and Wildlife Service, Bureau of Land Management, U.S. Forest Service, U.S. Geological Survey, U.S. Air Force, Nevada Department of Wildlife, Nevada Department of Transportation, and others. ▶ The NNSS is one of the seven DOE National Environmental Research Parks (NERP), and has identified over 864,000 acres available for various ecological research objectives related to the development of energy sources, the study of environmental impacts of energy development, and for informing the public of environmental and land-use options. **The NNSA/NFO began implementing and executing some of the five priority adaptation actions provided in the CARP. In particular, NNSA/NFO and the site's Sustainability Division** actions included: ▶ Actions 1 & 4: NNSA/NFO began participating in the DOE Technical Resilience Navigator (TRN) Cohort trainings in FY21 to begin populating the tool which will help feed various information required for the Vulnerability Assessment and Resilience Plan (VARP). ▶ Action 2: NNSA/NFO continued solar project planning across the site and reengaged NREL for project planning support, and also began project activities associated with the ordering of new solar electric vehicle charging stations for the NNSS. ▶ DOE Sustainable Environmental Stewardship goals are outlined in DOE's most current Site Sustainability Plan Guidance Document and incorporated into NNSA/NFO's Site Sustainability Plan.

1. https://www.directives.doe.gov/ipt_members_area/doe-o-436-1-departmental-sustainability-ipt/background-documents/doe-conservation-action-plan
2. https://www.energy.gov/sites/default/files/2021-10/DOEClimateAdaptationandResiliencePlan.pdf

2021 Sustainability and Outreach

Energy Action Month

In October 2020, the EAM was designed to highlight the importance of energy use, and to facilitate energy efficient behaviors that will continue throughout the year. With the majority of the NNSS workforce working remotely due to COVID-19, the 2020 NNSS EAM activities were offered virtually. The Sustainability Division offered NNSS employees and their family members the opportunity to enjoy virtual EAM activities while at home. The virtual EAM Fair began on Thursday, October 1, and lasted the entire month.

Weekly events organized for EAM included a virtual booth Fair, which included local utility companies; a virtual tour of a LEED-Certified Platinum home; and an Energy Star home energy tool assessment, which provided energy efficiency improvements. Employees also enjoyed a DOE podcast about Artificial Intelligence and how it is used. In addition, activities for students included watching recycling videos, learning about different forms of energy sources, and ideas on how they could save energy in their homes. Additional games included a virtual trash challenge and Family Feud with a twist on Sustainability.

Earth Day

The NNSS's Sustainability Division invited all employees to participate in the virtual 2021 Earth Day activities. This year, Earth Day was celebrated on Thursday, April 22, and the theme was "Restore Our Earth." Each year, Earth Day continues to remind our employees to take care of our planet, understand our connection and how essential the planet is to our overall health and survival.

Many activities and information resources were available that allowed employees to celebrate Earth Day with their family and friends from home with the hope of turning actions into habits that lasted beyond Earth Day. EarthDay.Org offered a plethora of Earth Day quizzes ranging from Whale Conservation, Plastic Pollution, to Clean Energy. For employees who participated in the family activities, they made pledges to learn about the impacts of their food choices on our food system, while learning how to cook delicious plant-based meals. Some of the employees also conducted plastic audits of their homes and shared what they intended to do to become more sustainable. Additionally, a gardening activity was offered where employees were able to download a free copy of the "Almanac Farmer Growing Guide Library," which provided information about planting a garden, flowers, trees, and more.

Overall, at both outreach activities, employees were educated on how to integrate and embrace sustainability into their day-to-day activities. Through these two events, and the quarterly Safe Nest events, site employees managed to divert a total of 2,965 pounds of clothing items from the landfill.

Document Availability

Available for sale to the public from:

U.S. Department of Commerce
National Technical Information Service
5301 Shawnee Road
Alexandria, Virginia 22312

Phone: **1-800-553-6847**
Fax: **(703) 605-6880**
E-mail: **info@ntis.gov; customerservice@ntis.gov**
Downloadable (no charge) at: **https://classic.ntis.gov/search/**
Available electronically (no charge) at: **http://www.osti.gov**

Available, in paper, for a processing fee to the U.S. Department of Energy and its contractors from:

U.S. Department of Energy
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, Tennessee 37831-0062

Phone: **(865) 576-8401**
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E-mail: **reports@osti.gov**

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