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NEVADA NATIONAL NNSS SECURITY SITES

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2024

ENVIRONMENTAL REPORT

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NEVADA NATIONAL NNSS SECURITY SITES

2024 Environmental Report

This report was prepared for:

U.S. Department of Energy
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By:

Mission Support and Test Services, LLC
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Compiled by **Theodore Redding, Editor**

Graphic Designer: **Oscar Orozco**

Geographic Information System Specialist: **Ashley Burns**

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Contributing Subject Matter Experts

More than 30 individuals are subject matter experts from across multiple organizations and authored, co-authored, or contributed information to the chapters within this NNSSER. They are thanked and acknowledged for their support, and are identified at the beginning of each chapter.

Contributing Organizations

MSTS

Multiple departments and groups within MSTS provided subject matter experts to contribute text and data on the annual activities related to onsite radiological and non-radiological monitoring of air, water, and biota; radiological dose assessments; waste management; hazardous materials management; ecological monitoring; site sustainability; and occurrence reporting. MSTS subject matter experts also provided the descriptions of the hydrology, geology, and ecology of the NNSS, which are included in *Attachment A: Site Description*.

Navarro Research and Engineering, Inc. (Navarro)

Navarro provided input across numerous chapters and coordinated review and comment resolution with the DOE Environmental Management Nevada Program. Navarro provided data and discussion in Chapters 2, 5, and 11 regarding their design, sampling, and analysis results associated with groundwater sampling and monitoring at the NNSS, which addresses the legacy contamination of historical nuclear underground test areas (UGTAs). In Chapter 10, Navarro provided information on their administration of the Radioactive Waste Acceptance Program and related activities. In Chapter 11, Navarro provided summary information of their characterization and remediation work towards state-approved closure of UGTA, Industrial, and Soils corrective action sites, and post-closure monitoring activities. In Chapter 14, Navarro collaborated with MSTS in providing data quality assurance programmatic information and quality performance related to the UGTA groundwater samples.

Desert Research Institute (DRI)

The DRI Division of Hydrologic Sciences authored Chapters 7 and 15, reporting on their offsite radiological monitoring of air and groundwater within communities surrounding the NNSS, and on their data quality assurance program. The Division of Earth and Ecosystem Sciences authored Chapter 12, summarizing their annual activities managing cultural resources on the NNSS, and also provided the description of the prehistory and history of the NNSS, which is included in *Attachment A: Site Description*.

Nye County

Nye County provided the discussion in Chapter 7 of their sampling of wells under the Nye County Tritium Sampling and Monitoring Program.

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NOAA/ARL/SORD provided summary descriptions of the NNSS climate that are included in *Attachment A: Site Description*.

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Charles Davis of EnviroStat provided the statistical analyses, interpretation, and graphical presentations of the environmental radiological monitoring data collected by ES&H.

ES&H Support Staff

The following individuals within MSTS ES&H are responsible for the numerous tasks that are integral to the planning, collection, processing, quality assurance, and quality control of much of the environmental data provided in this NNSSER.

Elizabeth Burns was responsible for planning and developing sampling documentation, radiological monitoring data verification, validation, and review; quality assurance oversight; administration of the data management system; and assisted with field sampling.

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MSTS Report Production and Distribution Support Personnel

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Margaret Townsend conducted the necessary derivative classification review of this document, and in the process, made numerous improvements to its clarity, readability, and accuracy.

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Chapter 1: Introduction

Theodore J. Redding
Mission Support and Test Services, LLC

Charles B. Davis
EnviroStat

1.1 Site Location

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

The NNSS encompasses about 3,522 square kilometers (km^2) (1,360 square miles [mi^2]) based on the most recent land survey. It varies from 46 to 56 km (28 to 35 mi) in width from west to east and from 64 to 88 km (40 to 55 mi) from north to south. The NNSS is surrounded on all sides by lands managed by the federal government. It is bordered on the west and north by the Nevada Test and Training Range (NTTR), on the east by an area used by both the NTTR and the Desert National Wildlife Refuge, and on the south and southwest by lands managed by the Bureau of Land Management. The combination of the NTTR and the NNSS represents one of the largest unpopulated land areas in the United States, comprising some 14,200 km^2 (5,470 mi^2).

1.2 Environmental Setting

The NNSS is located in the southern part of the Great Basin, the northern-most subprovince of the Basin and Range Physiographic Province. NNSS terrain is typical of the Basin and Range Physiographic Province, characterized by generally north–south trending mountain ranges and intervening valleys. These mountain ranges and valleys, however, are modified on the NNSS by very large volcanic calderas. The principal valleys are Frenchman Flat, Yucca Flat, and Jackass Flats (Figure 1-2). Yucca Flat and Frenchman Flat are topographically and hydrographically closed and contain dry lake beds, or playas, at their lowest elevations. Jackass Flats is topographically and hydrographically open, and surface water from this basin flows off the NNSS to the south via the Fortymile Wash. The dominant highlands are Pahute Mesa and Rainier Mesa (high volcanic plateaus), Timber Mountain (a resurgent dome of the Timber Mountain caldera complex), and Shoshone Mountain. In general, the highland areas are steep and dissected, and the slopes in the lowland areas are gentle. The lowest elevation on the NNSS is 823 meters (m) (2,700 feet [ft]) in Jackass Flats in the southeast, and the highest elevation is 2,341 m (7,680 ft) on Rainier Mesa in the north-central region.

> Throughout this document, the definition of word(s) in ***bold italics*** may be found by referencing the Glossary, Appendix B.

The topography of the NNSS has been altered by historical DOE actions, particularly underground nuclear testing. The principal effect of testing was the creation of numerous collapse sinks (subsidence craters), the majority of which are in the Yucca Flat basin, with fewer on the Pahute and Rainier mesas. Shallow detonations that created surface disruptions were also performed during the ***Plowshare Program*** to explore the potential uses of nuclear devices for large-scale excavation.

The reader is directed to *Attachment A: Site Description*, a document posted to the website https://nnss.gov/publication-library/environmental-publications/, where the geology, hydrology, climatology, ecology, and cultural resources of the NNSS are further described.

1.3 Site History

The history of the NNSS and its current missions direct the focus and design of environmental monitoring and surveillance activities on and near the site. Between 1940 and 1950, the area known as the NNSS was under the jurisdiction of Nellis Air Force Base and was part of the Nellis Bombing and Gunnery Range. In 1950, the site was established as the primary location for testing the nation's nuclear explosive devices. It was named

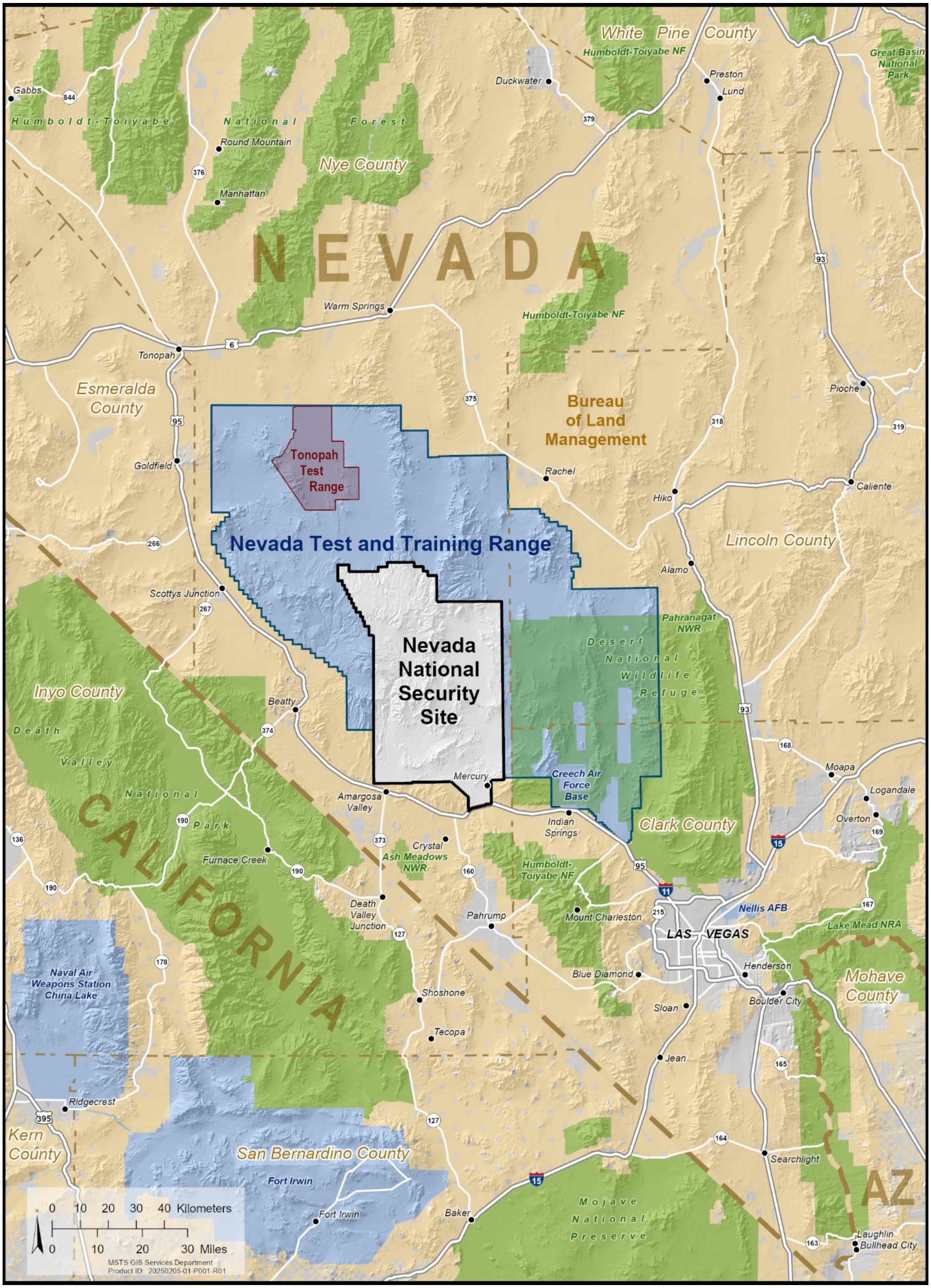


Figure 1-1. NNSS vicinity map

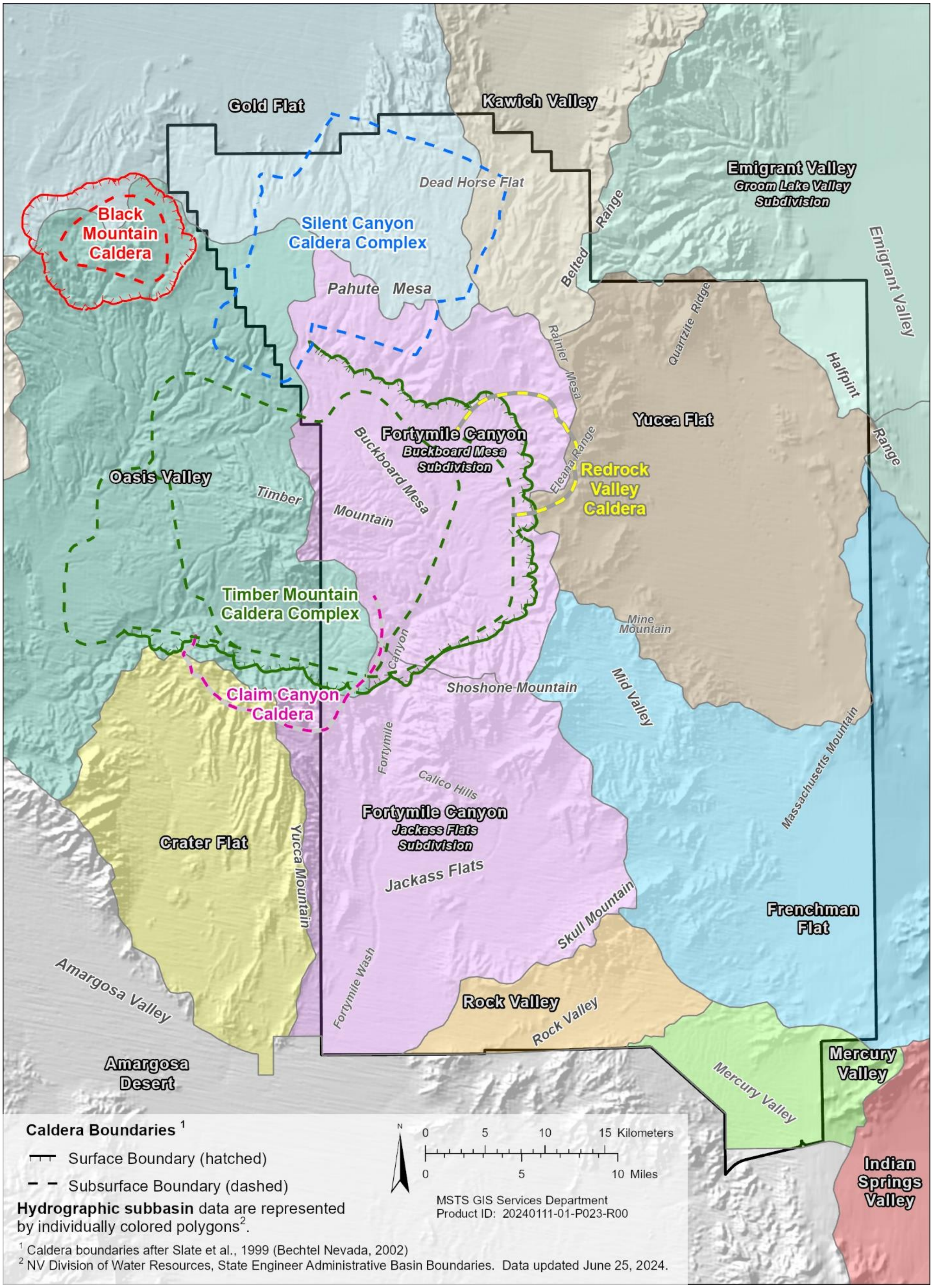


Figure 1-2. Major topographic features, calderas, and hydrographic subbasins of the NNSS

the Nevada Test Site (NTS) in 1951 and supported nuclear testing from 1951 to 1992. The types of tests conducted during this period are briefly described below. In 2010, the NTS was renamed the NNSS to reflect the diversity of nuclear, energy, and homeland security activities now conducted at the site. Experiments involving nuclear material are conducted at the NNSS, and are currently limited to ***subcritical experiments***.

Atmospheric Tests – The first test, an atmospheric nuclear explosive test, was conducted on the NTS in 1951. Tests conducted through the 1950s were predominantly atmospheric tests. They involved a nuclear explosive device detonated either on the ground surface, on a steel tower, suspended from tethered balloons, dropped from an aircraft, or placed on a rocket. Several tests, categorized as "safety experiments" and "storage-transportation tests," involved the destruction of a nuclear device with non-nuclear explosives. Some of these resulted in the dispersion of plutonium in the test vicinity. One of these test areas lies just north of the NNSS boundary at the south end of the NTTR, and four others are at the north end of the NTTR. The last above-ground test occurred in 1962. From 1951 to 1962, a total of 100 atmospheric tests were conducted at the NNSS.

Underground Tests – The first underground nuclear explosive test was a cratering test conducted in 1951. The first contained underground test was in 1957. Testing was discontinued during a bilateral moratorium that began October 1958, but was resumed in September 1961, after the Union of Soviet Socialist Republics resumed nuclear testing. After late 1962, nearly all tests were conducted in sealed vertical shafts drilled into Yucca Flat and Pahute Mesa or in horizontal tunnels mined into Rainier Mesa and Shoshone Mountain. From 1951 to 1992, a total of 828 underground nuclear tests were conducted at the NNSS. Approximately one-third of them were detonated near or in the ***saturated zone***.

Cratering Tests – Five earth-cratering (shallow-burial) nuclear explosive tests were conducted from 1962 through 1968 as part of the Plowshare Program that explored peaceful uses of nuclear explosives. The first and highest yield Plowshare crater test, Sedan, was detonated at the northern end of Yucca Flat. The second highest yield crater test was Schooner, located on Pahute Mesa. 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 Tests – Other nuclear-related experiments at the NNSS have included the BREN [Bare Reactor Experiment–Nevada] series in the early 1960s, conducted in Area 4. These tests were performed with a 14-million electron volt neutron generator mounted on a 465 m (1,527 ft) steel tower to produce neutron and gamma radiation for the purpose of estimating the radiation doses received by survivors of Hiroshima and Nagasaki. The tower was moved in 1966 to Area 25 and used for conducting Operation HENRE [High-Energy Neutron Reactions Experiment], jointly funded by the U.S. Department of Defense (DoD) and the Atomic Energy Commission (AEC) to provide information for the AEC's Division of Biology and Medicine. The BREN Tower was demolished in 2012. From 1959 through 1973, open-air nuclear reactor, nuclear engine, and nuclear furnace tests were conducted in Area 25, and tests with a nuclear ramjet engine were conducted in Area 26. Erosion of metal cladding on the reactor fuel released some fuel particles that caused negligible deposition of ***radionuclides*** on the ground. Most of the radiation released from these tests were gaseous radioactive fission products.

Fact sheets for many of the historical tests mentioned above can be found at https://nnss.gov/publication-library/fact-sheets/. All nuclear device tests are listed in *United States Nuclear Tests, July 1945 through September 1992* (NNSA/NFO 2015).

1.4 Mission

NNSA/NFO directs facility management and program operations at the NNSS, North Las Vegas Facility (NLVF) and the Remote Sensing Laboratory–Nellis (RSL-Nellis) in Nevada, as well as selected operations at five sites outside of Nevada: RSL-Andrews in Maryland, Livermore Operations and the Special Technologies Laboratory in California, and Los Alamos Operations and Sandia National Laboratories in New Mexico. Los Alamos National Laboratory, Lawrence Livermore National Laboratory, and Sandia National Laboratories are the principal organizations that sponsor and implement the nuclear experiments programs at the NNSS. Mission Support and Test Services, LLC, is the Management and Operating Contractor accountable for the successful execution of work and ensuring compliance with environmental regulations. The three major NNSS missions currently include National Security/Defense, Environmental Management, and Nondefense. The programs that support these missions are listed in the following text box.

NNSS Missions and Programs

National Security/Defense Missions

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

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

Strategic Partnership Program – Provides support facilities and capabilities for other DOE programs and federal agencies/organizations involved in defense-related activities.

Environmental Management Missions

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

Waste Management Program – Manages and safely disposes of ***low-level waste***, ***mixed low-level waste***, and classified waste/matter received from DOE- and DoD-approved facilities throughout the United States and wastes generated in Nevada by NNSA/NFO. Safely manages and characterizes ***hazardous*** and ***transuranic wastes*** for offsite disposal.

Nondefense Missions

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

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

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

1.5 Primary Facilities and Activities

NNSS facilities and centers that support the National Security/Defense missions include the following:

- Big Explosives Experimental Facility (BEEF)
- Device Assembly Facility (DAF)
- Dense Plasma Focus (DPF) Facility
- Joint Actinide Shock Physics Experimental Research (JASPER) Facility
- National Criticality Experiments Research Center (NCERC, located within the DAF)
- Nonproliferation Test and Evaluation Complex (NPTEC)
- Radiological/Nuclear Countermeasures Test and Evaluation Complex (RNCTEC)
- Radiological/Nuclear Weapons of Mass Destruction Incident Exercise Site (known as the T-1 Site)
- Principal Underground Laboratory for Subcritical Experimentation (PULSE) Complex [formerly the U1a Complex].

NNSS facilities that support Environmental Management missions include the ***Area 5 Radioactive Waste Management Complex (RWMC)*** and the Area 3 Radioactive Waste Management Site (RWMS) (Figure 1-3).

The primary NNSS activity in 2024 continued to be ensuring that the U.S. stockpile of nuclear weapons remains safe and reliable. Other 2024 NNSS activities included experiments aimed at improving arms control and nonproliferation treaty verification; weapons of mass destruction first responder training; the controlled release and monitoring of hazardous material; remediation of legacy contamination sites; processing of waste destined for the Waste Isolation Pilot Plant in Carlsbad, New Mexico, or the Idaho National Laboratory in Idaho Falls, Idaho; and disposal of low-level and mixed low-level radioactive waste.

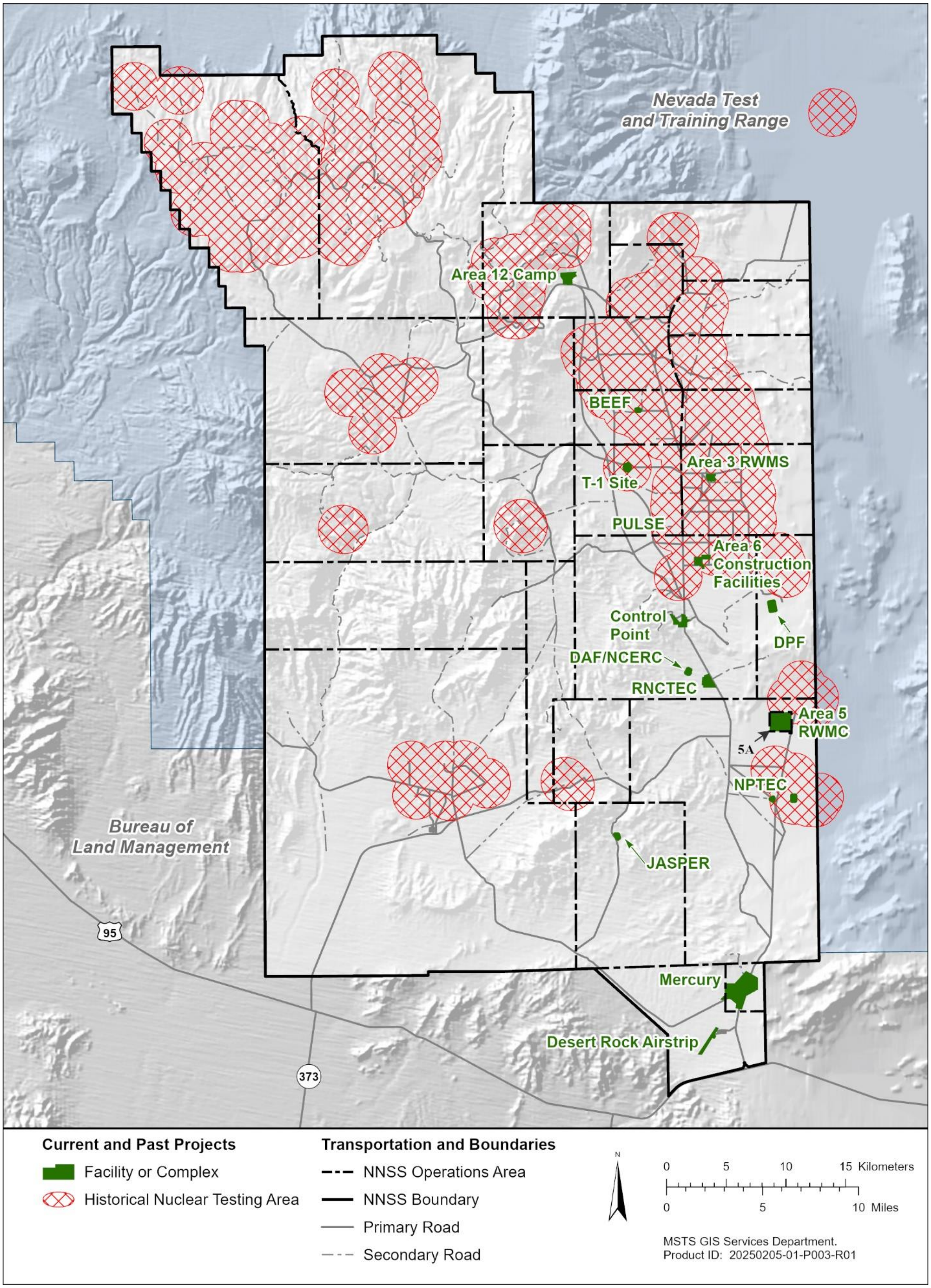


Figure 1-3. NNSS operational areas, principal facilities, and past nuclear testing areas

1.6 Scope of this Environmental Report

This report summarizes the NNSA/NFO environmental protection and monitoring programs data and the compliance status for calendar year 2024 at the NNSS and at its two support facilities, the North Las Vegas Facility and RSL-Nellis. This report also addresses environmental restoration projects conducted by the Environmental Management Nevada Program Office.

The Environmental Management Nevada Program Office is responsible for addressing environmental restoration sites on the NNSS, NTTR, and Tonopah Test Range (TTR) that are listed in the Federal Facility Agreement and Consent Order. The DOE/NNSA Sandia Field Office produces the TTR annual site environmental reports, which are posted at https://www.sandia.gov/news/publications/environmental-reports/.

1.7 Populations Near the NNSS

The population of the area surrounding the NNSS is predominantly rural. The most recent population estimates for Nevada communities are for 2024 and are provided by the Nevada State Demographer's Office (2024). The most recent population estimate for Nye County is 51,802, and the largest Nye County community is Pahrump (43,563), located approximately 80 km (50 mi) south of the NNSS Control Point facility (near the center of the NNSS). Other Nye County communities include Tonopah (2,851), Amargosa (1,662), Beatty (1,049), Round Mountain (706), Gabbs (199), and Manhattan (66). Lincoln County to the east of the NNSS includes a few small communities, including Caliente (1,034), Panaca (847), Pioche (1,049), and Alamo (656), and Esmeralda County includes Goldfield (364) and Silver Peak (72). Clark County, southeast of the NNSS, is the major population center of Nevada and has an estimated population of 2,392,490. The total annual population estimate for all Nevada counties, cities, and towns is 3,282,911.

The Mojave Desert, which includes Death Valley National Park, lies along the southwestern border of Nevada. This area is still predominantly rural; however, tourism at Death Valley National Park increases the population during holiday periods when the weather is mild.

The extreme southwestern region of Utah is more developed than the adjacent portion of Nevada. The latest population estimates for Utah communities are taken from the Utah Department of Workforce Services (2025). Southern Utah's largest community is St. George, located 220 km (137 mi) east of the NNSS, with an estimated population of 106,288. The next largest town, Cedar City, is located 280 km (174 mi) east-northeast of the NNSS and has an estimated population of 40,885.

The northwestern region of Arizona is mostly rangeland except for that portion in the Lake Mead recreation area. In addition, several small communities lie along the Colorado River. The largest towns in the area are Bullhead City, 206 km (128 mi) south-southeast of the NNSS, with an estimated population of 43,578, and Kingman, 280 km (174 mi) southeast of the NNSS, with an estimated population of 35,657 (Arizona Office of Economic Opportunity 2024).

1.8 Understanding Data in This Report

1.8.1 Scientific Notation

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

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

Table 1-1. Unit prefixes

Prefix	Abbreviation	Meaning
mega-	M	1,000,000 (1×10^{6})
kilo-	k	1,000 (1×10^{3})
centi-	c	0.01 (1×10^{-2})
milli-	m	0.001 (1×10^{-3})
micro-	µ	0.000001 (1×10^{-6})
nano-	n	0.000000001 (1×10^{-9})
pico-	p	0.000000000001 (1×10^{-12})

1.8.2 Unit Prefixes

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

1.8.3 Units of Radioactivity

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

Table 1-2. Units of radioactivity

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

1.8.4 Units of Radiological Dose

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

Table 1-3. Units of radiological dose

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

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

1.8.5 International System of Units for Radioactivity and Dose

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

Table 1-4. Conversion table for SI units

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

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

1.8.6 Radionuclide Nomenclature

Radionuclides are frequently expressed with the one- or two-letter chemical symbol for the element. Radionuclides may have many different ***isotopes***, which are usually shown by a superscript to the left of the symbol. This number is the atomic weight of the isotope (the number of protons and neutrons in the nucleus of the ***atom***). Radionuclide symbols, many of which are used in this report, are shown in Table 1-5 along with the ***half-life*** of each radionuclide. The half-life is the time (measured in years [yr], days [d], hours [h], or seconds [s]) required for one-half of the radioactive atoms in a given amount of material to decay. For example, after one half-life, half of the original atoms will have decayed; after two half-lives, three-fourths of the original atoms will have decayed; and, after three half-lives, seven-eighths of the original atoms will have decayed, and so on. The notation $^{226+228}$Ra and similar notations in this report (e.g., $^{239+240}$Pu) are used when the analytical method does not distinguish between the isotopes, but reports the total amount of both.

1.8.7 Units of Measurement

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

1.8.8 Measurement Variability

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

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

The uncertainty of a measurement is denoted by following the result with an uncertainty value, which is preceded by the plus-or-minus symbol, ±. This uncertainty value gives information on what the measurement might be if the same sample were analyzed again under identical conditions. The uncertainty value implies that approximately 95% of the time, the average of many measurements would give a value somewhere between the reported value minus the uncertainty value and the reported value plus the uncertainty value. If the reported concentration of a given constituent is smaller than its associated uncertainty (e.g., 40 ± 200), then the sample may not contain that constituent.

Table 1-5. Radionuclides and their half-lives (in alphabetical order by symbol)

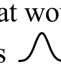
Symbol	Radionuclide	Half-Life [(a)]
^{241}Am	americium-241	432.2 yr
^{7}Be	beryllium-7	53.22 d
^{14}C	carbon-14	5.70×10^3 yr
^{36}Cl	chlorine-36	3.01×10^5 yr
^{134}Cs	cesium-134	2.1 yr
^{137}Cs	cesium-137	30.2 yr
^{51}Cr	chromium-51	27.7 d
^{60}Co	cobalt-60	5.3 yr
^{152}Eu	europium-152	13.5 yr
^{154}Eu	europium-154	8.6 yr
^{155}Eu	europium-155	4.8 yr
^{3}H	tritium	12.3 yr
^{129}I	iodine-129	1.6×10^7 yr
^{131}I	iodine-131	8 d
^{40}K	potassium-40	1.3×10^8 yr
^{85}Kr	krypton-85	10.8 yr
^{212}Pb	lead-212	10.6 hr
^{238}Pu	plutonium-238	87.7 yr
^{239}Pu	plutonium-239	2.4×10^4 yr
^{240}Pu	plutonium-240	6.5×10^3 yr
^{241}Pu	plutonium-241	14.4 yr
^{226}Ra	radium-226	1.6×10^3 yr
^{228}Ra	radium-228	5.75 yr
^{220}Rn	radon-220	56 s
^{222}Rn	radon-222	3.8 d
^{103}Ru	ruthenium-103	39.3 d
^{106}Ru	ruthenium-106	373.6 d
^{125}Sb	antimony-125	2.8 yr
^{113}Sn	tin-113	115 d
^{90}Sr	strontium-90	28.8 yr
^{99}Tc	technetium-99	2.1×10^5 yr
^{232}Th	thorium-232	1.4×10^{10} yr
U [(b)]	uranium total	- - - [(c)]
^{234}U	uranium-234	2.4×10^5 yr
^{235}U	uranium-235	7×10^8 yr
^{238}U	uranium-238	4.5×10^9 yr
^{65}Zn	zinc-65	244.1 d
^{95}Zr	zirconium-95	63.98 d

(a) Source: International Commission on Radiological Protection (2008)
(b) Total uranium may also be indicated by U-natural (U-nat) or U-mass
(c) Natural uranium is a mixture dominated by ^{238}U; thus, the half-life is approximately 4.5×10^9 years

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

Metric Unit	U.S. Customary Equivalent Unit	U.S. Customary Unit	Metric Equivalent Unit
Length			
1 centimeter (cm)	0.39 inches (in.)	1 inch (in.)	2.54 centimeters (cm)
1 millimeter (mm)	0.039 inches (in.)		25.4 millimeters (mm)
1 meter (m)	3.28 feet (ft)	1 foot (ft)	0.3048 meters (m)
	1.09 yards (yd)	1 yard (yd)	0.9144 meters (m)
1 kilometer (km)	0.62 miles (mi)	1 mile (mi)	1.6093 kilometers (km)
Volume			
1 liter (L)	0.26 gallons (gal)	1 gallon (gal)	3.7853 liters (L)
1 cubic meter (m^3)	35.32 cubic feet (ft^3)	1 cubic foot (ft^3)	0.028 cubic meters (m^3)
	1.31 cubic yards (yd^3)	1 cubic yard (yd^3)	0.765 cubic meters (m^3)
Weight			
1 gram (g)	0.035 ounces (oz)	1 ounce (oz)	28.35 gram (g)
1 kilogram (kg)	2.21 pounds (lb)	1 pound (lb)	0.454 kilograms (kg)
1 metric ton (mton)	1.10 short ton (2,000 lb)	1 short ton (2,000 lb)	0.90718 metric ton (mton)
Area			
1 hectare	2.47 acres	1 acre	0.40 hectares
1 square meter (m^2)	10.76 square feet (ft^2)	1 square foot (ft^2)	0.09 square meters (m^2)
Radioactivity			
1 becquerel (Bq)	2.7×10^{-11} curie (Ci)	1 curie (Ci)	3.7×10^{10} becquerel (Bq)
Radiation dose			
1 rem	0.01 sievert (Sv)	1 sievert (Sv)	100 rem
Temperature			
°C = (°F − 32)/1.8		°F = (°C × 1.8) + 32	

1.8.9 Mean and Standard Deviation

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

1.8.10 Standard Error of the Mean

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

1.8.11 Median, Maximum, and Minimum Values

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

1.8.12 Less Than (<) Symbol

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

1.8.13 Negative Radionuclide Concentrations

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

1.9 Document Availability

This report, the *Attachment A: Site Description*, and the *Summary* documents are posted to the website https://nnss.gov/publication-library/environmental-publications/. The previous 10 years' documents can be accessed at the following DOE Office of Scientific and Technical Information (OSTI) websites. Additional document availability information is printed on the inside of each document's back cover.

Table 1-7. Document OSTI website links

Calendar Year	Full Report	Attachment A	Summary Report
2023	https://www.osti.gov/biblio/2447746	https://www.osti.gov/biblio/2447956	https://www.osti.gov/biblio/2447964
2022	https://www.osti.gov/biblio/2004659	Included in the Full Report	https://www.osti.gov/biblio/2318458
2021	https://www.osti.gov/biblio/1889386	Included in the Full Report	https://www.osti.gov/biblio/1895374
2020	https://www.osti.gov/biblio/1822366	Included in the Full Report	https://www.osti.gov/biblio/1825073
2019	https://www.osti.gov/biblio/1668029	https://www.osti.gov/biblio/1668049	https://www.osti.gov/biblio/1668337
2018	https://www.osti.gov/biblio/1567854	https://www.osti.gov/biblio/1567858	https://www.osti.gov/biblio/1567855
2017	https://www.osti.gov/biblio/1473920	https://www.osti.gov/biblio/1473975	https://www.osti.gov/biblio/1473979
2016	https://www.osti.gov/biblio/1379434	https://www.osti.gov/biblio/1379961	https://www.osti.gov/biblio/1379960
2015	https://www.osti.gov/biblio/1327205	https://www.osti.gov/biblio/1327206	https://www.osti.gov/biblio/1327207
2014	https://www.osti.gov/biblio/1228062	https://www.osti.gov/biblio/1228067	https://www.osti.gov/biblio/1543329

1.10 References

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Chapter 2: Compliance Summary

Laura O'Neill
Desert Research Institute

Savitra M. Candley, Jill S. Dale, Manuel de Cespedes Molina, Desiree M. Demers, Delane P. Fitzpatrick-Maul, Andrea L. Gile, Derek B. Hall, Jeanette A. Hannon, Kyle A. Jones, Erika Lomeli-Uribe, Amanda M. Rasmussen, Karlita L. Simper, Brian G. Verheyen, and Ronald W. Warren
Mission Support and Test Services, LLC

Cheryl M. Hebner and Dona F. Murphy
Navarro Research and Engineering, Inc.

Environmental regulations pertinent to operations at the Nevada National Security Site (NNSS), the North Las Vegas Facility (NLVF), and the Remote Sensing Laboratory–Nellis (RSL-Nellis) include federal, state, and local environmental regulations; site-specific permits; and binding interagency agreements. The environmental regulations dictate how the U.S. Department of Energy (DOE), National Nuclear Security Administration Nevada Field Office (NNSA/NFO) conducts operations to ensure the protection of the environment and the public. In 2024, NNSA/NFO operated in compliance with the requirements defined in this framework. Instances of noncompliance are reported to regulatory agencies and corrected; they are also reported in this chapter.

As in previous years, radiological air emissions from current and past NNSA/NFO operations were well below the U.S. Environmental Protection Agency (EPA) ***dose***[1] limit set for the public, and the DOE dose limits set for the public and for plants and animals on or adjacent to the NNSS. Emissions of non-radiological air pollutants from permitted equipment/facilities at the NNSS, the NLVF and RSL-Nellis were within permit limits.

No man-made ***radionuclides*** were detected in any of the three state-permitted ***public water systems (PWSs)*** on the NNSS. Water samples from the NNSS PWSs met National Primary Drinking Water Standards (health standards) and Nevada Secondary Drinking Water Standards (related to taste, odor, and visual aspects).

Required groundwater monitoring at wells near the ***Area 5 Radioactive Waste Management Complex (RWMC)*** continued to demonstrate that groundwater quality is not affected by disposal of low-level radioactive waste (LLW), mixed low-level radioactive waste (MLLW), and classified waste that contains hazardous and/or radioactive constituents. Wastewater discharges at the NNSS, NLVF, and RSL-Nellis met site-specific state permit requirements, including those of a National Pollutant Discharge Elimination System (NPDES) permit issued for groundwater pumping activities at the NLVF.

In June 2024, the State of Nevada Division of Environmental Protection (NDEP) confirmed that DOE satisfied all obligations under the June 2021 Settlement Agreement[2] to resolve regulatory actions resulting from the July 2019 waste issue. The thirty-four corrective actions implemented by DOE under the Settlement Agreement contribute to enhancing the rigor of waste management activities for the protection of the DOE workforce, the public, and the environment.

In 2024, seven environmental occurrences were reportable under the requirements DOE Order DOE O 232.2A, "Occurrence Reporting and Processing of Operations Information," and one environmental issue was reported to the EPA and the DOE Headquarters (HQ) Noncompliance Tracking System (NTS) (Table 2-7). Forty-two hazardous substance spills occurred in 2024: 37 at the NNSS, 4 at the NLVF, and 1 at RSL-Nellis. Four spills were

[1] The definition of word(s) in ***bold italics*** may be found by referencing the Glossary, Appendix B.
[2] The Settlement Agreement and Administrative Order can be found at https://ndep.nv.gov/uploads/land-doe-aip-docs/NDEPDOEJune22SASignedF.pdf.

reportable (Table 2-7), and the other spills were small-volume releases either to containment areas or to other surfaces. All spills were cleaned up.

2.1 Compliance with Requirements

The federal, state, and local environmental statutes and regulations under which NNSA/NFO operates are summarized in Table 2-1, along with a discussion of NNSA/NFO's compliance status with each. In addition, the EPA offers the Enforcement and Compliance History Online (ECHO) website to search for facilities and assess their compliance with environmental regulations and to investigate pollution sources, examine and create enforcement-related maps, or explore the state's performance (https://echo.epa.gov/).

Abbreviations for Regulators

Federal
ACHP Advisory Council on Historic Preservation
CEQ Council on Environmental Quality
DOE U.S. Department of Energy
DOI U.S. Department of Interior
EPA U.S. Environmental Protection Agency
FWS U.S. Fish and Wildlife Service

State/County
CCDAQ Clark County Division of Air Quality
NDEP Nevada Division of Environmental Protection
NDA Nevada Department of Agriculture
NDOF Nevada Department of Forestry
NDOW Nevada Department of Wildlife
NSHPO Nevada State Historic Preservation Office

The NNSA/NFO ECHO facilities are:

ECHO Facility Name	Facility Registry Service ID	Program Area
Nevada National Security Site	110070604714	Resource Conservation and Recovery Act
North Las Vegas Facility	110021279007	Resource Conservation and Recovery Act
Nevada Test Site	110001136716	Clean Air Act, Resource Conservation and Recovery Act

Table 2-1. Federal, state, and local environmental laws and regulations applicable to NNSA/NFO

Description of Law/Regulation [(a)(b)]	2024 Compliance Status
National Environmental Policy Act (NEPA), 42 USC 4321 et seq. (1969) **• CEQ: 40 CFR 1500-1508 • DOE: 10 CFR 1021, DOE P 451.1**	
NEPA requires federal agencies to consider environmental and related social and economic effects and reasonable alternatives before making a decision to implement a major federal action. Title 10 ***Code of Federal Regulations (CFR)*** Part 1021, "National Environmental Policy Act Implementing Procedures," establishes procedures that the DOE must use to comply with NEPA. DOE Policy DOE P 451.1, "National Environmental Policy Act Compliance Program," establishes DOE internal requirements and responsibilities for implementing NEPA.	The NNSA/NFO NEPA Compliance Officer reviews Environmental Evaluation Checklists, which are required for all proposed projects/activities on the NNSS and determines if the activity's environmental impacts require additional NEPA analysis and documentation. In 2024, 39 proposed projects/activities required analysis and documentation under NEPA compliance procedures, and all were exempt from any further NEPA review (Section 2.3). In 2024, NNSA/NFO also completed a Supplement Analysis (SA) of the 2013 Site-Wide Environmental Impact Statement for the Continued Operation of the Department of Energy / National Nuclear Security Administration Nevada National Security Site and Off-site Locations in the State of Nevada (NNSS SWEIS). The Amended Record of Decision for the Continued Operation of the Nevada National Security Site and Off-Site Locations in the State of Nevada was published in the Federal Register on July 30, 2024 (volume 89, number 146). The SA assessed the potential environmental impacts of projects/changes that have occurred at the Nevada National Security Site (NNSS) and offsite locations in the State of Nevada, since publication of the SWEIS and Record of Decision, or are expected to occur within approximately

Table 2-1. Federal, state, and local environmental laws and regulations applicable to NNSA/NFO

Description of Law/Regulation [(a)(b)]	2024 Compliance Status
	the next five years. Based on the analysis, NNSA determined that the potential impacts associated with the actions and operations evaluated in the SA would not be significantly different than impacts presented in the SWEIS; would not constitute a substantial change to the actions evaluated in the SWEIS relevant to environmental concerns; there were no significant new circumstances or information relevant to environmental concerns; and no additional NEPA documentation was required at that time.
Air Quality	
Clean Air Act, 42 USC 7401 et seq. (1970) **• EPA: 40 CFR 50, 60, 61, 63, 80, 82, and 98 • NDEP: NAC 445B**	
The Clean Air Act and Nevada's Air Control laws regulate air pollutant release through permits and air quality limits. Radionuclide emissions are regulated via National Emission Standards for Hazardous Air Pollutants (NESHAP) authorizations. Emissions of ***criteria pollutants*** are regulated via National Ambient Air Quality Standards authorizations. Criteria and ***designated pollutants*** emitted from various industrial categories of facilities are regulated via New Source Performance Standards authorizations. The Clean Air Act also establishes production limits and a schedule for the phase-out of ***ozone depleting substances***. Nevada Administrative Code (NAC) Chapter 445B, "Air Controls," enforces Clean Air Act regulations and requires fugitive dust control and open burn authorizations.	No major source of air pollutants occurs at the NNSS. Federal and state air quality regulations are met through a State of Nevada Class II Air Quality Operating Permit and various project-specific state-issued permits (Table 2-2). NESHAP compliance activities include radionuclide air monitoring, reporting asbestos abatement, monitoring and reporting emissions from generators and boilers, and management of gasoline/diesel storage tanks. National Ambient Air Quality Standards emission limits (except ozone and lead) are based on published values for similar industries and operational data specific to the NNSS. Some screens, conveyor belts, bulk fuel storage tanks, and generators are subject to New Source Performance Standards. At NLVF and RSL-Nellis, air quality regulations are met through Clark County Minor Source permits. NNSA/NFO pays annual state fees based on all sources' "***potential to emit***," surface area disturbance acreage, and number of emission units. Nevada's Bureau of Air Pollution Control inspects permitted NNSS facilities and Clark County inspects NLVF and RSL-Nellis permitted equipment. All approvals, notifications, requests for additional information, and reports required under the Clean Air Act are submitted to NDEP, Clark County, and/or EPA Region 9. In 2024, all applicable requirements for monitoring, operating, and reporting for the NNSS Class II Air Quality Operating Permit were met. In 2024, monitored radioactive air emissions at compliance locations were below NESHAP limits (Section 4.1). All non-radiological air emission limits, monitoring, record keeping, training, and reporting requirements of state and county air permits were met at the NNSS (Section 4.2), NLVF, and RSL-Nellis (Appendix A).

Table 2-1. Federal, state, and local environmental laws and regulations applicable to NNSA/NFO

Description of Law/Regulation [a][b]	2024 Compliance Status
Water Quality	
Clean Water Act, 33 USC 1251 et seq. (1972) **• EPA: 40 CFR 109-140, 230, 231, 401, and 403 • NDEP: NAC 444, 445A, and 534**	
The Clean Water Act and Nevada's Water Pollution Control laws seek to improve surface water quality by establishing standards and a system of permits. They prohibit the discharge of contaminants from ***point sources*** to waters of the United States without an NPDES permit. NAC 444, "Sanitation (Sewage Disposal)," and NAC 445A, "Water Controls (Water Pollution Control)," regulate the collection, treatment, and disposal of wastewater and sewage. NAC 534, "Underground Water and Wells," regulates the drilling, construction, and licensing of new wells and the reworking of existing wells to prevent the waste and contamination of groundwater. NLVF and RSL-Nellis implement a Spill Prevention, Control, and Countermeasure Plan required by the EPA to ensure that petroleum and non-petroleum oil products do not pollute waters of the United States via discharge into the Las Vegas Wash. In addition to federal and state laws, NLVF and RSL-Nellis are regulated by the City of North Las Vegas and the Clark County Water Reclamation District (CCWRD), respectively.	NNSA/NFO does not hold an NPDES permit for NNSS operations because there are no discharges to waters of the United States on or off the NNSS from NNSA/NFO activities. Wastewater discharges are managed on the NNSS in accordance with NDEP-issued permits that include the E Tunnel Wastewater Disposal System, active and inactive sewage lagoons, septic tanks, septic tank pumpers, and a septic tank pumping contractor's license (Section 5.2). NNSA/NFO reports unplanned releases of hazardous substances to NDEP as required under NAC 445A. No such releases occurred in 2024 (Section 2.5). NNSA/NFO complies with NAC 534 for Underground Test Area (UGTA) activities. UGTA wells are maintained in compliance with the Clean Water Act and are regulated by the state through the UGTA Fluid Management Plan*,* an agreement between NNSA/NFO and NDEP. In 2024, UGTA well drilling fluids were monitored and managed in accordance with the plan (Section 5.1.3.8.3). The NLVF operates under a Class II Authorization to Discharge Permit issued by the City of North Las Vegas for sewer discharges, an NPDES DeMinimis permit for surface water discharge, and a No Exposure Waiver for exclusion from NPDES storm water permitting. Storm water is not contaminated by exposure to industrial activities or materials (Section A.1.2). CCWRD determined that the annual submission of a Zero Discharge Form for RSL-Nellis is sufficient to verify compliance with the Clean Water Act (Section A.2.2). In 2024, all water chemistry parameters and contaminants that required monitoring in wastewater discharges and sewage lagoons were within permit limits, and all required inspections of wastewater systems were conducted.
Safe Drinking Water Act, 42 USC 300f et seq. (1974) **• EPA: 40 CFR 141-149 • NDEP: NAC 445A**	
The Safe Drinking Water Act protects the quality of drinking water in the United States and authorizes the EPA to establish safe standards of purity. It requires all owners or operators of PWSs to comply with National Primary Drinking Water Standards (health standards). State governments are authorized to set Secondary Standards related to taste, odor, and visual aspects. NAC 445A requires that PWSs meet both primary and secondary water quality standards. The Safe Drinking Water Act standards for radionuclides currently apply only to PWSs designated as ***community water systems.*** Although not required under the act, all potable water supply wells on the NNSS are monitored for radionuclides in accordance with DOE O 458.1, "Radiation Protection of the Public and the Environment."	The NNSS supplies drinking water from onsite wells that comply with all applicable federal and state water quality standards. Three PWSs on the NNSS are permitted by the state as ***non-community water systems.*** Each source is sampled according to a monitoring cycle that identifies specific contaminants and sampling frequency, ranging from monthly, quarterly, annually, or once every 3, 6, or 9 years. NDEP also permits two potable water-hauling trucks on the NNSS. The trucks are monitored weekly for coliform bacteria and results are submitted to NDEP throughout the year as they are acquired. While some monitoring for per- and polyfluoroalkyl substances in the NNSS PWS was performed in 2020 (none were detected), no such monitoring was performed in 2024. In 2024, no man-made radionuclides from NNSA/NFO activities were detected in NNSS drinking water wells, the

Table 2-1. Federal, state, and local environmental laws and regulations applicable to NNSA/NFO

Description of Law/Regulation [(a)(b)]	2024 Compliance Status
	PWSs met all applicable primary and secondary drinking water standards, and potable water hauling trucks tested negative for coliform bacteria (Sections 5.1.3.7 and 5.2.1). Water used at the NLVF is supplied by the City of North Las Vegas, and water used at RSL-Nellis is supplied by the Southern Nevada Water Authority. The water at both locations meets or exceeds federal drinking water standards; no monitoring or reporting of water quality is required.
Energy Independence and Security Act of 2007 (Pub. L. 110-140)	
Section 438 of the act addresses storm water management and requires any development/redevelopment project involving a federal facility with a footprint over 5,000 gross square feet to maintain or restore, to the maximum extent feasible, the predevelopment hydrology of the property with regard to the rate, temperature, volume, and duration of storm water flow.	Storm water management strategies are addressed and incorporated into site design and building construction to meet requirements from the act for new developments.
Radiation Protection	
Radiation Protection of the Public and the Environment (DOE O 458.1 Change 4) **• DOE-STD-1196-2011, DOE-STD-1196-2021, and DOE-STD-1153-2019**	
DOE O 458.1 Change 4 requires DOE/NNSA sites to implement an environmental radiological protection program. It establishes requirements for (1) measuring ***radioactivity*** in the environment, (2) documenting the ***ALARA*** [as low as reasonably achievable] process for operations, (3) using mathematical models for estimating doses, (4) releasing property having residual radioactive material, and (5) maintaining records to demonstrate compliance. The EPA's ***Clean Air Package 1988 (CAP88)*** (version 4.1.1) and the ***Derived Concentration Standards***, as defined in DOE Standard DOE-STD-1196-2011 and/or DOE-STD-1196-2021, "Derived Concentration Technical Standard," are used in the design and conduct of environmental radiological protection programs. The order sets a radiation dose limit of 100 millirem/year (mrem/yr) (1 millisievert/year) above ***background*** levels to individuals in the general public from all pathways of ***exposure*** combined. It also calls for the protection of aquatic and terrestrial plants and animals from radiological impacts through the use of DOE-STD-1153-2002, "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota," which was updated under DOE-STD-1153-2019 of the same title.	NNSA/NFO has in place a radiological monitoring program and protection procedures that satisfy the requirements for a site-specific radiological protection program. Routine radiological monitoring of air, water, and biota, as well as project-specific monitoring and NESHAP evaluations of projects, are conducted. Monitoring and evaluation results document NNSA/NFO's compliance with the radiological dose limits set by DOE for the public and biota from several exposure pathways that include predominately inhalation and the ingestion of hunted NNSS game animals. Results of radiological monitoring and protective measures are described in several chapters of this report. As in previous years, the calculated dose to the public and to the biota from NNSA/NFO operations in 2024 was below all DOE dose limits set by DOE O 458.1 and DOE-STD-1153-2019, respectively. CAP88 and Residual Radioactive Biota models and Derived Concentration Standards defined in DOE-STD-1196-2011 and/or DOE-STD-1196-2021 were used to estimate dose to humans and biota based on radiological monitoring results (Sections 4.1 and 5.1, Chapters 6, 8, 9).
Waste Management and Environmental Corrective Actions	
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601 et seq (1980) **• EPA: 40 CFR 300, 302, and 355**	
CERCLA provides a framework for the cleanup of waste sites containing hazardous substances and an emergency response program in the event of a release of a hazardous substance to the environment (Emergency Planning and Community Right-to-Know Act).	No hazardous waste cleanup operations on the NNSS are regulated under CERCLA. Instead, they are regulated under the Resource Conservation Recovery Act (listed below). NNSA/NFO complies with the Emergency Planning and Community Right-to-Know Act (listed below) under CERCLA.

Table 2-1. Federal, state, and local environmental laws and regulations applicable to NNSA/NFO

Description of Law/Regulation [(a)(b)]	2024 Compliance Status
Resource Conservation Recovery Act (RCRA), 42 USC 6901 et seq. (1976) **• EPA: 40 CFR 259-282 • NDEP: NAC 444.570-7499, 444.850-8746, and 459.9921-999**	
RCRA and Nevada laws NAC 444.850–8746, "Disposal of Hazardous Waste"; NAC 444.570–7499, "Solid Waste Disposal"; and NAC 459.9921–999, "Storage Tanks," regulate the generation, storage, transportation, treatment, and disposal of ***solid*** and ***hazardous waste (HW)*** to prevent contaminants from leaching into the environment from landfills, underground storage tanks, surface impoundments, and HW disposal facilities. RCRA also requires HW generators to have a program to reduce the amount and toxicity of HW, and federal facilities to have a procurement process to ensure that they purchase product types that satisfy the EPA-designated minimum percentages of recycled material.	NNSA/NFO generates HW (which includes MLLW) and operates permitted HW management facilities under RCRA Part B Permit NEV HW0101 issued by NDEP (Chapter 10). In accordance with the permit, NNSA/NFO also monitors groundwater from four wells (Section 10.3.1), and conducts and reports post-closure monitoring for HW sites, including those closed under the Federal Facility Agreement and Consent Order (Chapter 11). NNSA/NFO prepares a Hazardous Waste Report of all HW and MLLW volumes generated and disposed annually at the NNSS.
Federal Facility Agreement and Consent Order (FFACO), as amended **• FFACO • NDEP**	
The FFACO was agreed to by the State of Nevada (through NDEP), DOE, and the U.S. Department of Defense in 1996. Pursuant to Section 120(a) (4) of CERCLA and to Sections 6001 and 3004(u) of RCRA, the FFACO addresses the environmental corrective actions at historically contaminated sites in Nevada for which DOE is responsible for cleanup and closure.	The DOE Environmental Management (EM) Nevada Program oversees compliance with the FFACO that identifies more than 3,000 corrective action sites (CASs) in Nevada that require cleanup and closure, and where the EM Nevada Program and the DOE Office of Legacy Management perform any required post-closure activities. As described in the FFACO, DOE follows a formal process to achieve closure with NDEP approval. Throughout the process, NDEP and the Nevada Site Specific Advisory Board (NSSAB) are kept informed of the progress made. The NSSAB is a formal DOE-chartered group composed of volunteer members who represent Nevada stakeholders and provide informed recommendations to the DOE EM Nevada Program. All FFACO milestones were met in 2024 for the characterization, remediation, closure, and post-closure monitoring and inspection of historically contaminated CASs. Through December 31, 2024, 2,954 of the 3,044 CASs have been closed (Chapter 11).
Radioactive Waste Management (DOE O 435.1 Change 2) **• DOE M 435.1-1 Change 3**	
DOE O 435.1 Change 2, "Radioactive Waste Management," requires that all DOE radioactive waste be managed in a manner that is protective of the worker, public health and safety, and the environment. It directs how radioactive waste management operations are conducted on the NNSS. The order requires that radioactive waste be managed in accordance with the requirements in DOE Manual DOE M 435.1-1 Change 3, "Radioactive Waste Management Manual," which specifies that operations at radioactive waste management facilities must not contribute a dose to the general public in excess of 10 mrem/yr through the air pathway and 25 mrem/yr through all exposure pathways (excluding dose from radon and its progeny in air). Additionally, the release of radon must be less than an average flux of 20 picocuries per square meter per second	The Area 3 and Area 5 Radioactive Waste Management Sites (RWMSs) operate as Category II Non-Reactor Nuclear Facilities. Both are designed and operated to manage and safely dispose LLW, while the Area 5 RWMS is also actively used for the disposal of MLLW, classified non-radioactive waste, and classified non-radioactive hazardous waste. The waste is generated on the NNSS and by approved generators at other DOE and select U.S. Department of Defense sites. Additionally, the Area 5 RWMS is used to manage and safely store ***transuranic*** and mixed transuranic wastes generated on the NNSS for eventual shipment to the Waste Isolation Pilot Plant in New Mexico. ***Performance Assessments*** (PAs) and ***Composite Analyses*** (CAs) for both RWMSs are reviewed annually along with any new pertinent information (e.g., waste disposed, physical

Table 2-1. Federal, state, and local environmental laws and regulations applicable to NNSA/NFO

Description of Law/Regulation [(a)(b)]	2024 Compliance Status
(pCi/m^2/s) (0.74 Becquerels [Bq]/m^2/s) at the surface of the disposal facility. Alternatively, a limit of 0.5 pCi/liter (0.0185 Bq/liter) of air may be applied at the boundary of the facility.	changes to the landfill) and a summary report is generated. The summary report for 2024 concluded that the Area 3 and Area 5 RWMS PA and associated CA assumptions and conclusions remain valid based on consideration of all changes identified or planned. The Low-Level Waste Disposal Facility Federal Review Group (LFRG), an independent group sponsored by the Office of Environmental Management, supports implementation of DOE responsibilities under DOE O 435.1. As such, the LFRG reviewed the summary report and responded with concurrence on the conclusions documented in the report. The Disposal Authorization Statements for both RWMSs also require annual reviews to track secondary or minor unresolved issues to resolution. Waste Acceptance Criteria for wastes disposed at the RWMSs are maintained and the volumes are tracked. Although not required by this DOE order, ***vadose zone*** monitoring at both RWMSs is performed to validate the performance assessment criteria of the RWMSs. In 2024, all key documents and analyses were current and all required management practices were followed (Chapter 10). The estimated radiological dose to the public in 2024 from the Area 3 and 5 RWMSs from all pathways was within regulatory limits (Section 10.4).
Hazardous Materials Control and Management	
Emergency Planning and Community Right-to-Know Act (EPCRA), 42 USC 11001 et seq. (1986) **• EPA: 40 CFR 300, 302, 355, 370, and 372**	
EPCRA requires that federal, state, and local emergency planning authorities be provided information regarding the presence and storage of hazardous substances and their planned and unplanned environmental releases, including provisions and plans for responding to emergency situations involving hazardous materials. EPCRA identifies the threshold quantities of chemicals released or stored, which trigger the reporting of this information to these authorities.	Some NNSA/NFO facilities store or use chemicals in quantities exceeding threshold quantities under EPCRA. NNSA/NFO complies with all reporting and emergency planning requirements under EPCRA and with the requirements of several state-issued hazardous materials permits: a site-wide NNSS permit, one for NLVF, and one for RSL-Nellis. In 2024, NNSA/NFO adhered to all EPCRA reporting requirements (Section 2.4.4.1). The Nevada Combined Agency Report, containing updated chemical inventories for NNSA/NFO facilities, was submitted to the State Fire Marshal, and a Toxic Release Inventory Report was submitted to EPA identifying the types and quantities of toxic chemicals that were either released by NNSA/NFO operations into the environment or released for disposal or recycling. Lead, mercury, ***polychlorinated biphenyls (PCBs)***, friable asbestos, nickel, and chromium compounds were the toxic chemicals released from the NNSS in 2024 that exceeded a reportable threshold (Section 2.4.4.1). No releases at NLVF or RSL-Nellis exceeded reportable thresholds in 2024 (Sections A.1.5 and A.2.4).
State of Nevada Chemical Catastrophe Prevention Act (NRS 459.380–3874) **• NDEP: NAC 459.952-95528**	
This act directs NDEP to develop and implement a program called the Chemical Accident Prevention Program (CAPP). It	The NNSS is a registered CAPP facility due to the oleum release process located at the Nonproliferation Test and

Table 2-1. Federal, state, and local environmental laws and regulations applicable to NNSA/NFO

Description of Law/Regulation [(a)(b)]	2024 Compliance Status
requires registration of facilities with highly hazardous substances above listed thresholds.	Evaluation Complex (NPTEC) in Area 5. NDEP conducted the Fiscal Year (FY) 2024 onsite inspection in January 2024. NDEP's report listed one required corrective action. A response was provided to NDEP in March 2024. For the reporting period June 1, 2024, through May 31, 2025, NNSA/NFO submitted the annual CAPP Registration report in June 2025 (Section 2.4.4.2).
<u>Toxic Substances Control Act (TSCA), 15 USC 2601 et seq. (1976)</u> **• EPA: CFR 700-763 • NDEP: NAC 444.842-8746**	
TSCA regulates the manufacture, use, and distribution of chemical substances that enter the consumer market. Because the NNSS does not produce chemicals, compliance is primarily directed toward the management of PCBs.	At the NNSS, remediation activities and maintenance of fluorescent light ballasts can result in the onsite disposal of PCB-contaminated waste or the offsite disposal of PCB waste not meeting permitted acceptance criteria. The NNSS also receives radioactive waste for onsite disposal that may contain regulated levels of PCBs. The onsite disposal of all PCB wastes and record-keeping requirements for PCB activities are regulated by the EPA. In 2024, PCBs were managed in compliance with TSCA and state regulations (Section 2.4.2).
<u>Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), 7 USC 136 et seq. (1996)</u> **• EPA: CFR 162-171 • NDA: NAC 555**	
FIFRA governs the manufacture, use, storage, and disposal of pesticides (including herbicides and other biocides) as well as the pesticide containers and residuals. It specifies procedures and requirements for pesticide registration, labeling, classification, and certification of applicators. NAC 555, "Nevada Control of Insects, Pests, and Noxious Weeds," regulates the certification of registered pesticide and herbicide applicators in Nevada. NDA has the primary role to enforce FIFRA in Nevada.	The use of pesticides classified as "restricted-use pesticides" is regulated. Beginning in 2015, only non-restricted-use pesticides are applied under the direction of a State of Nevada–certified applicator. In 2024, NNSA/NFO complied with all FIFRA requirements (Section 2.4.3).
Cultural Resources	
<u>National Historic Preservation Act (NHPA), as amended, 54 USC 300101 et seq. (1966)</u> **• ACHP: 36 CFR 800**	
The NHPA, as amended, identifies, evaluates, and protects historic properties eligible for listing in the National Register of Historic Places (NRHP). Such properties can be archeological sites, historic buildings and structures, historic districts, and objects, which includes artifacts, records, and material remains related to such a property. The act requires federal agencies to consider the effects of their undertakings on historic properties (Section 106), develop and implement a Cultural Resources Management Plan, to identify and evaluate the eligibility of historic properties for long-term management as well as for future project-specific planning (Section 110), and to maintain archaeological collections and their associated records at professional standards.	NNSA/NFO has established a Cultural Resources Management Program at the NNSS, which is implemented by the Desert Research Institute. The Cultural Resources Management Program ensures compliance with all regulations pertaining to cultural resources on the NNSS. Before initiating land-disturbing activities or building and structure modifications, qualified archaeologists and architectural historians conduct surveys and historical evaluations to identify important cultural resources, evaluate significance, and assess potential impacts. Consultation with 16 American Indian Tribal Nations and affiliated groups with cultural and historical ties to the NNSS is conducted to identify resources that may be of spiritual or cultural significance. NNSA/NFO's long-term management strategy includes (1) identifying, evaluating, and nominating historic properties for listing in the NRHP, (2) monitoring NRHP-listed and eligible properties to determine if environmental factors or NNSA/NFO activities are affecting the integrity or other aspects of eligibility, and (3) taking corrective actions or identifying alternative approaches as

Table 2-1. Federal, state, and local environmental laws and regulations applicable to NNSA/NFO

Description of Law/Regulation [(a)(b)]	2024 Compliance Status
	necessary. Determinations of NRHP eligibility, effect, and mitigation are conducted in consultation with NSHPO, the 16 Tribes, local governments and stakeholders, and, in some cases, the federal ACHP. To date, more than 1,400 NRHP-eligible sites/historic properties on the NNSS have been identified. In 2024, NNSA/NFO executed a programmatic agreement for undertakings on the NNSS with the NSHPO and ACHP to streamline compliance with Section 106 of the NHPA. A total of ten Section 106 and Section 110 compliance projects were completed in 2024. The projects involved 53 cultural resources, 45 of which are eligible for the NRHP (Chapter 12).
Antiquities Act (16 U.S.C. 431-433), Archaeological Resources Protection Act, as amended (16 USC 470aa–mm) **• DOI: 18 CFR 1312, 36 CFR 79, and 43 CFR 7**	
The Antiquities Act and the Archaeological Resources Protection Act, as amended, protect archaeological resources that remain in or on federal and American Indian lands and ensure that their confidentiality and characteristics are maintained. Archaeological resources are any material remains of human life or activities that are at least 100 years of age, and which are of archaeological interest. These laws require the issuance of a federal archaeology permit to qualified archaeologists to inventory, excavate, or remove archaeological resources and require notification to American Indian tribes of these activities.	Archaeologists working at the NNSS meet federal standards for professional qualifications. Procedures are in place to maintain the confidentiality of site locations and other information. A preservation in place policy is utilized, when possible, for identified cultural properties. In the event of vandalism, NNSA/ NFO investigates any impacts that may occur. The Cultural Resources Management Program curates archaeological collections from the NNSS in accordance with 36 CFR 79, “Curation of Federally Owned and Administered Archeological Collections,” and conducts American Indian consultations related to places and items of importance to the 16 Tribes culturally affiliated with NNSS lands (Chapter 12).
American Indian Religious Freedom Act, as amended (42 USC 1996)	
This law established the government policy to protect and preserve for American Indians their inherent right of freedom to believe, express, and exercise their traditional religions, including but not limited to access to sites, use and possession of sacred objects, and the freedom to worship through ceremonial and traditional rites.	Locations exist on the NNSS that have religious significance to Western Shoshone, Southern Paiute, and Owens Valley Paiute and Shoshone. Access is provided by NNSA/NFO in accordance with safety and health standards (Section 12.6).
Native American Graves Protection and Repatriation Act, as amended (25 USC 3001–3013) **• DOI: 43 CFR 10**	
The Native American Graves Protection and Repatriation Act, as amended, requires federal agencies to return certain types of Native American cultural items to lineal descendants and culturally affiliated American Indian tribes. The specified cultural items include human remains, funerary objects, sacred objects, and objects of cultural patrimony. The regulations implementing this law were revised in 2024 with an emphasis on clarifying definitions and establishing timelines for agencies to comply.	The NNSS artifact collection is subject to the act. The required inventory and summary of NNSS cultural materials accessioned into the NNSS Archaeological Collection was completed in the 1990s. The inventory list and summary were distributed to the Tribes affiliated with the NNSS and adjacent lands. Consultations followed, and all artifacts the Tribes requested were repatriated to them. This repatriation process was completed in 2002. NNSA/NFO began analyzing its collections in 2024 for compliance with the Act per the revised implementing regulations. NNSA/NFO will continue this work in 2025. (Sections 12.3).

Table 2-1. Federal, state, and local environmental laws and regulations applicable to NNSA/NFO

Description of Law/Regulation [(a)(b)]	2024 Compliance Status
Biological Resources	
Endangered Species Act, 16 USC 1531-1544 (1973) **• FWS: 50 CFR 17**	
The Endangered Species Act provides a program for the conservation of threatened and endangered plants and animals and the habitats in which they are found. The law also prohibits any action that causes "***take***" of any listed species of endangered fish or wildlife.	The threatened desert tortoise is the only resident species protected under the Endangered Species Act that may be impacted by NNSS operations. NNSS activities within tortoise habitat are conducted so as to comply with the terms and conditions of a Programmatic Biological Opinion (Opinion) (File No. 2022-0019655-S7-001) issued by FWS to NNSA/NFO to cover the term of August 27, 2019, through 2029. The allowable cumulative take under the Opinion is 31 large tortoises killed/injured and 440 large tortoises moved. Maximum habitat disturbance is set at 3,000 acres. In 2024, take included 31 large tortoises moved out of harm's way on roads, and 55.2 acres disturbed. All requirements of the Opinion were met (Chapter 13).
Nevada Department of Wildlife and Department of Forestry **• NDOW: NAC 503 •NDOF: NAC 527**	
NDOW regulations identify protected and unprotected Nevada animal species and prohibit the harm of protected species without special permit. NAC 503, "Hunting, Fishing and Trapping; Miscellaneous Protective Measures," also identifies game animals, which are managed by the state. NDOF regulations prohibit removal or destruction of state-protected plants without special permit.	State-managed and state-protected species are monitored under the Ecological Monitoring and Compliance (EMAC) Program. Some species are collected for ecological studies under an NDOW scientific collection permit. In 2024, monitoring of raptors and mule deer was conducted. NNSS biologists continued collaboration with other agency biologists with mule deer, pronghorn antelope, western burrowing owl, and mountain lion studies on and near the NNSS (Section 13.3).
Migratory Bird Treaty Act (MBTA), 16 USC 703-712 (1918) **• FWS: 50 CFR 21 •NDOW: NRS 503.050**	
The MBTA implements various treaties and conventions between the United States and Canada, Japan, Mexico, and the former Soviet Union for the protection of migratory birds. It prohibits the harming of any migratory bird, their nest, or eggs without authorization by the Secretary of the Interior. Memorandum M-37050, issued December 22, 2017, by the U.S. Department of the Interior, Office of the Solicitor, ruled that the incidental harm to migratory birds from otherwise legal activities does not violate this act. A Final Rule (Rule) published in the Federal Register on October 4, 2021 (volume 86, number 189), revoked the Rule published on January 7, 2021 (volume 86, number 4), which had the effect of returning to the practice of prohibiting incidental take, which had been in effect prior to 2017. Nevada wildlife laws protect birds included under the MBTA from purposeful harm.	Although not required under the MBTA, the EMAC Program reviews construction and demolition projects and conducts field surveys to reduce any incidental harm to migratory birds and their nests/eggs. Biologists periodically collect game birds for radiological analysis under an FWS-issued migratory bird scientific collection permit. Migratory birds found injured or dead are reported to regulators. Biologists transfer injured raptors, upon direction from the FWS, to a licensed rehabilitator, and mitigation measures to reduce accidental mortalities are pursued. In 2024, 22 migratory birds were found dead. Ten of the deaths were due to human activities (e.g., electrocution on power lines, collision with vehicles) (Section 13.3).
Responsibilities of Federal Agencies to Protect Migratory Birds **• E.O. 13186**	
This Executive Order (E.O.) directs federal agencies to take certain actions to further implement the MBTA if agencies have, or are likely to have, a measurable negative effect on migratory bird populations. It also directs federal agencies to	Biologists maintained an Avian Protection Plan that was developed in cooperation with the FWS. The focus of the plan is to reduce operational and avian risks from avian interactions with electric transmission and distribution lines on the NNSS

Table 2-1. Federal, state, and local environmental laws and regulations applicable to NNSA/NFO

Description of Law/Regulation [(a)(b)]	2024 Compliance Status
conduct actions, as practicable, to benefit the health of migratory bird populations.	as well as other non-electric sources of mortality (e.g., vehicle collisions, habitat disturbance) (Section 13.3).
<u>The Bald and Golden Eagle Protection Act, 16 USC 668a-d, 703-712</u> **• FWS: 50 CFR 22 •NDOW: NRS 503.050**	
The Bald and Golden Eagle Protection Act prohibits any form of possession or taking of both bald and golden eagles. Eagles are also protected under Nevada wildlife laws.	Compliance with the act is documented under the EMAC Program. Eagles that are occasionally electrocuted on NNSS power lines are transferred to the FWS under an FWS special purpose possession permit. No golden eagle mortalities were observed in 2024 (Section 13.3).
<u>Wild Free-Roaming Horses and Burros Act (Pub. L. 92–195)</u>	
This act makes it unlawful to harm wild horses and burros. It directs the U.S. Bureau of Land Management (BLM) and the U.S. Forest Service to protect, manage, and control wild horses and burros on lands administered by BLM and the U.S. Forest Service, in a manner that is designed to achieve and maintain a thriving natural ecological balance.	The NNSS is not within a ***BLM herd management area***. A Five-Party Cooperative Agreement exists, however, between NNSA/NFO, the Nevada Test and Training Range, FWS, BLM, and the State of Nevada, which calls for cooperation in conducting resource inventories, developing resource management plans, and maintaining favorable habitat for wild horses and burros on federally withdrawn lands. NNSA/NFO consults with BLM on NNSS horse management, and NNSS biologists conduct wild horse and burro surveys for indications of abundance, recruitment (i.e., survival to reproductive age), and distribution (Section 13.3).
<u>Invasive Species</u> **• E.O. 13112**	
This E.O. directs federal agencies to act to prevent the introduction of, or to monitor and control, invasive (non-native) species; to provide for conservation of native species; and to exercise care in taking actions that could promote the introduction or spread of invasive species.	Land-disturbing activities on the NNSS have resulted in the spread of numerous invasive plant species. Habitat reclamation and other controls are evaluated and conducted, when feasible, to control such species and meet the purposes of this E.O. (Section 13.4).
Environmental Activities and Occurrence Reporting	
<u>Environment, Safety and Health Reporting</u> **• DOE O 231.1B**	
DOE O 231.1B, "Environment, Safety and Health Reporting," requires the timely collection, reporting, analysis, and dissemination of information on environment, safety, and health as required by law or regulations or as needed to ensure that DOE is kept fully informed on a timely basis about events that could adversely affect the health and safety of the public, workers, the environment, the intended purpose of DOE facilities, or the credibility of DOE. It requires DOE and NNSA sites to prepare an annual calendar year report, referred to as the Annual Site Environmental Report.	NNSA/NFO prepares an Annual Site Environmental Report called the NNSS Environmental Report (NNSSER, i.e., this report) and provides data for DOE to prepare annual NEPA summaries and other Safety, Fire Protection, and Occupational Safety and Health Administration (OSHA) reports. The NNSSER demonstrates compliance with DOE internal standards and requirements, such as the radiation protection requirements of DOE O 458.1, and documents DOE's environmental performance to members of the public living near the NNSS and to other stakeholders.
<u>Occurrence Reporting and Processing of Operations Information</u> **• DOE O 232.2A**	
DOE O 232.2A, "Occurrence Reporting and Processing of Operations Information," requires that DOE and NNSA be informed about events that could adversely affect the health and safety of the public, workers, environment, DOE missions, or the credibility of DOE. It sets reporting criteria for unplanned environmental releases of pollutants, hazardous substances, petroleum products, sulfur hexafluoride, and per- and polyfluoroalkyl substances containing Aqueous Film	NNSA/NFO contractors enter environmental occurrences, identified as reportable in accordance with this order, into DOE's Occurrence Reporting and Processing System. Reported information includes reportable level of the identified event, notifications, and if applicable, causal factors, and corrective actions based on the report level of the event. Reportable environmental events are discussed in Section 2.5.

Table 2-1. Federal, state, and local environmental laws and regulations applicable to NNSA/NFO

Description of Law/Regulation [(a)(b)]	2024 Compliance Status
Forming Foam at DOE/NNSA sites and facilities. It also requires sites/facilities to report to DOE/NNSA any written notification received from an outside agency that the site/facility is non-compliant with a schedule or requirement.	
Quality Assurance	
<u>Quality Assurance</u> **• 10 CFR 830 Subpart A and DOE O 414.1D Change 1**	
The objective of DOE O 414.1D, "Quality Assurance," is to establish an effective management system using the performance requirements of the order, coupled with consensus standards, where appropriate, to ensure (1) products and services meet or exceed customers' expectations; (2) there is management support for planning, organization, resources, direction, and control; (3) performance and quality improvements occur by means of thorough, rigorous assessments and corrective actions; and (4) environmental, safety, and health risks and impacts associated with work processes are minimized, while maximizing reliability and performance of work products. Using a graded approach, DOE/NNSA sites must develop a quality assurance plan to establish additional process-specific quality requirements and implement the approved quality assurance plan.	NNSA/NFO and DOE EM Nevada Program have quality assurance plans in place to implement quality management methodology in adherence to this DOE order. The quality assurance plans ensure that all environmental monitoring data meet ***quality assurance*** and ***quality control*** requirements. Samples are collected and analyzed using standard operating procedures to ensure representative samples are collected and reliable, and defensible data are generated. Quality control in sub-contracted analytical laboratories is maintained through instrument calibration, efficiency and background checks, and testing for precision and accuracy. Data are verified and validated according to project-specific quality objectives before they are used to support decision-making (Chapters 14 and 15).

(a) For federal laws, a reference to its implementing regulation, which was written by the identified federal regulatory agency, is given. The regulation is identified by its CFR title and part (e.g., 10 CFR 1021 means, "Title 10 Part 1021"). CFR references can be accessed at http://www.ecfr.gov/cgi-bin/ECFR?page=browse. If no implementing regulations have been written, then N/A (not applicable) is entered.
For Nevada State laws, either the NAC or the Nevada Revised Statute (NRS) reference is given. NACs can be accessed at https://www.leg.state.nv.us/NAC/CHAPTERS.HTMl. NRSs can be accessed at https://www.leg.state.nv.us/NRS/.

(b) For federal laws, the name of the law and its reference in the ***United States Code (USC)*** by title and section is given (e.g., 42 USC 4321 et seq. means, "Title 42 Section 4321 and the following"). USC references can be accessed at http://uscode.house.gov/. If there is not a USC reference, the public law (Pub. L.) number is given.

2.2 Environmental Permits

Table 2-2 presents the complete list of all federal and state permits active during 2024 for NNSS, NLVF, and RSL-Nellis operations. The table includes those pertaining to air quality monitoring, operation of drinking water and sewage systems, hazardous materials and HW management and disposal, and endangered species protection. Reports associated with permits are submitted to the appropriate designated state or federal office. Copies of reports may be obtained upon request.

Table 2-2. Environmental permits for NNSA/NFO operations at NNSS, NLVF, and RSL-Nellis

Permit Number	Permit Name or Description	Expiration Date	Report
Air Quality			
NNSS			
AP9711-2557.02	NNSS Class II Air Quality Operating Permit	June 25, 2024	Annual
2024_0008	NNSS Open Burn Authorization, Fire Extinguisher Training (Various Locations)	December 31, 2024	N/A
2024_0009	NNSS Open Burn Authorization, Simulated Vehicle Burns, A-23, Facility #23-T00200 (NNSS Fire & Rescue)	December 31, 2024	N/A
2024_0006	NNSS Open Burn Authorization, Training at BEEF	July 31, 2024	N/A

Table 2-2. Environmental permits for NNSA/NFO operations at NNSS, NLVF, and RSL-Nellis

Permit Number	Permit Name or Description	Expiration Date	Report
	NLVF		
Source 657	Clark County Minor Source Permit	May 20, 2025	Annual
	RSL-Nellis		
Source 348	Clark County Synthetic Minor Source Permit	April 13, 2027	Annual
	Drinking Water		
	NNSS		
NY-0360-NTNC	Areas 6 and 23	September 30, 2024/2025	None
NY-4098-NC	Area 25	September 30, 2024/2025	None
NY-4099-NC	Area 12	September 30, 2024/2025	None
NY-0835-NP	NNSS Water Hauler #84846	September 30, 2024/2025	None
NY-0836-NP	NNSS Water Hauler #84847	September 30, 2024/2025	None
	Septic Systems/Pumpers		
	NNSS		
GNEVOSDS09 (general permit)		None	None
L-0271	Septic System, Area 1 (U1a & U1h)[(a)(b)]		Annual
L-0272	Septic System, Area 5 (RWMC)[(a)]		Annual
	Septic System, Area 5 (NPTEC)[(a)]		
	Septic System, Area 6 (RNCTEC)[(a)]		
	Septic System, Area 6, DAF – standby		
L-0273	Septic System, Area 6 (Area 6 Construction)[(a)(b)]		Annual
	Septic System Area 6 (Area 6 Fire Station)[(a)]		
	Septic System, Area 6 (Yucca Lake Hangar)[(a)]		
L-0274	Septic System, Area 12 (Area 12 Camp)[(a)]		Annual
	Septic System, Area 12 (Area 12 Building 12-910)[(a)]		
	Septic System, Area 18 (Area 18 Airstrip)[(a)]		Annual
L-0275	Septic System, Area 22 (Weather Station)[(a)]		
	Septic System, Area 22 (Desert Rock Airport)[(a)]		
	Septic System, Area 23 (Area 23 Gate 100)[(a)]		
	Septic System, Area 23 (Area 23 Building 23-1103)[(a)]		
L-0276	Septic System, Area 25 (Area 25 CSA)[(a)]		Annual
	Septic System, Area 25 (Area 25 RCP)[(a)]		
	Septic System, Area 27 (Area 27 Baker)[(a)]		
	Septic System, Area 27 (Area 27 JASPER)[(a)]		
NY-17-06839	Septic Tank Pumping Contractor (1 business/4 units)	July 31, 2023/2024	None
	Wastewater Discharge		
	NNSS		
GNEV93001	Groundwater Discharge Permit	January 3, 2027	Quarterly/Annual
NEV96021	Water Pollution Control for E Tunnel Wastewater Disposal System and Monitoring Well ER-12-1	February 23, 2028	Quarterly/Annual
	NLVF		
Class II ID# 036555-02	Authorization to Discharge	None	None
NVG201000 Project ID DDP-42723	NPDES DeMinimis	None	Annual
Site Number: ISW-40564	Stormwater No Exposure Waiver	None	None
	RSL-Nellis		
Not applicable	Annual certification statement of zero discharge	None	Annual
	Hazardous Materials		
	NNSS		
116741	NNSS Hazardous Materials Permit	February 28, 2025	Annual

Table 2-2. Environmental permits for NNSA/NFO operations at NNSS, NLVF, and RSL-Nellis

Permit Number	Permit Name or Description	Expiration Date	Report
	NLVF		
116759	NLVF Hazardous Materials Permit	February 28, 2025	Annual
	RSL-Nellis		
116778	RSL-Nellis Hazardous Materials Permit	February 28, 2025	Annual
	Hazardous Waste		
	NNSS		
NEV HW0101	RCRA Permit for NNSS Hazardous Waste Management (Area 5 Mixed Waste Disposal Unit, Area 5 Mixed Waste Storage Unit, Hazardous Waste Storage Unit, and Explosive Management Unit)	April 17, 2033	Biennial and annual
	Waste Management		
	NNSS		
SW 532	Area 5 Solid Waste Disposal Site	Post-closure(c)	Annual
SW 13 097 02	Area 6 Solid Waste Disposal Site	Post-closure	Annual
SW 13 097 03	Area 9 Solid Waste Disposal Site	Post-closure	Annual
SW 13 097 04	Area 23 Solid Waste Disposal Site	Post-closure	Biannual
Not Applicable	Approval to Establish a Solid Waste Incinerator – Area 25	None	None
	NLVF		
PR0029951	Restricted Waste Management Permit	December 31, 2024	None
	RSL-Nellis		
PR0064276	RSL-Nellis Waste Management Permit-Underground	December 31, 2024	None
	Endangered Species/Wildlife		
File Nos. 2022-0019655-S7-001	FWS Desert Tortoise Incidental Take Authorization (Biological Opinion for Programmatic NNSS Activities)	August 2029	Annual
MB008695-2	FWS Migratory Bird Salvage and Collection	March 31, 2020 (remains in effect until FWS issues renewal)	Annual
MB60930C-2	FWS Migratory Bird Special Purpose Utility Permit – Electric	March 31, 2028	Annual
TE83414C-1	FWS Native Threatened Species Recovery – Juvenile Tortoise Study	February 28, 2029	Annual
261454	NDOW Scientific Collection of Wildlife	December 31, 2025	Annual

(a) Name in parenthesis is the name of the septic system shown on Figure 5-6 of Chapter 5.
(b) Includes both the Area 1 U1a and U1h and Area 6 Construction Tanks 1 & 2 septic systems.
(c) Permit expires 30 years after closure of the landfill.

2.3 National Environmental Policy Act Assessments

NEPA regulations require federal agencies to evaluate the environmental effects of proposed major federal activities. The prescribed evaluation process ensures that the proper level of environmental review is performed before an irreversible commitment of resources is made. NNSA/NFO performs environmental reviews with the aid of a NEPA Environmental Evaluation Checklist (Checklist), which is required for all proposed projects or activities on the NNSS. The Checklist is reviewed by the NNSA/NFO NEPA Compliance Officer to determine if the activity's environmental impacts have been addressed in a previous NEPA assessment. If a proposed project has not been covered under any previous NEPA analysis and it does not qualify for a "Categorical Exclusion" (per 10 CFR 1021), then a new NEPA analysis is initiated. The analysis may result in preparation of a new Environmental Assessment, Environmental Impact Statement, or supplemental document to the existing programmatic *Final Site-Wide Environmental Impact Statement for the Continued Operation of the Department of Energy/National Nuclear Security Administration Nevada National Security Site and Off-site Locations in the State of Nevada* (NNSS SWEIS) (U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office 2013). The NNSA/NFO NEPA Compliance Officer must approve each Checklist before a project proceeds. Table 2-3 presents a summary of how NNSA/NFO complied with NEPA in 2024.

In 2024, NNSA/NFO also completed a Supplement Analysis of the 2013 NNSS SWEIS. The *Amended Record of Decision for the Continued Operation of the Nevada National Security Site and Off-Site Locations in the State of Nevada* was published in the Federal Register on July 30, 2024 (volume 89, number 146). The SA assessed the potential environmental impacts of projects/changes that have occurred at the NNSS and offsite locations in the State of Nevada, since publication of the SWEIS and Record of Decision, and the potential environmental impacts of projects that are expected to occur within approximately the next 5 years. Based on the analysis, NNSA determined that the potential impacts associated with the actions and operations evaluated in the SA would not be significantly different than impacts presented in the 2013 SWEIS; would not constitute a substantial change to the actions evaluated in the SWEIS relevant to environmental concerns; there were no significant new circumstances or information relevant to environmental concerns; and no additional NEPA documentation was required at this time.

Table 2-3. NNSS NEPA compliance activities

Results of NEPA Checklist Reviews/NEPA Compliance Activities
Thirty-nine (39) NEPA Checklists were reviewed (9 revisions, 30 new checklists). Of the 39 checklists: - 12 projects were exempted from further NEPA analysis because they were of Categorical Exclusion[(a)] status. - 27 projects were exempted from further NEPA analysis due to their inclusion under previous analysis in the NNSS SWEIS.

(a) "Categorical Exclusion" means a category of actions that do not individually or cumulatively have a significant effect on the human environment, and which have been found to have no such effect in procedures adopted by a federal agency in implementation of these regulations (Sec. 1507.3), and for which, therefore, neither an environmental assessment nor an environmental impact statement is required.

2.4 Hazardous Materials Control and Management

2.4.1 Hazardous Substance Inventory

Hazardous materials used or stored on the NNSS are controlled and managed through the use of a chemical inventory module of an enterprise asset management software system called Open Range. Hazardous substances used or stored by contractors and subcontractors of NNSA/NFO are entered into this database. Contractors and subcontractors are required to comply with the operational and reporting requirements of the Toxic Substances Control Act; the Federal Insecticide, Fungicide, and Rodenticide Act; the Emergency Planning and Community Right-to-Know Act; and the Nevada Chemical Catastrophe Prevention Act. Chemicals to be purchased are subject to a requisition compliance review process. Hazardous substance purchases are reviewed to ensure that toxic chemicals and products are not purchased when less hazardous substitutes are commercially available. Requirements and responsibilities for the use and management of hazardous/toxic chemicals are provided in company documents.

The inventory management system allows the tracking of chemicals from the moment they arrive at the NNSS, NLVF, or RSL-Nellis to when they are disposed, and provides an accurate account of chemicals on site. It provides chemical owners with additional information, including purchase dates, Safety Data Sheets, storage locations, and expiration dates. The system allows for chemical inventories to be utilized for emergency planning and planning for operational needs. The tracking system reduces the quantities of chemicals purchased and stored through the chemical custodians' awareness of the chemicals currently in inventory. Chemical compatibility and proper storage are routinely evaluated, which has improved NNSA/NFO's safety posture with regard to the control and management of chemicals. In 2024, the NNSS managed 2,989 chemicals in 31,762 containers.

2.4.2 Polychlorinated Biphenyls

The storage, handling, and use of PCBs are regulated under the TSCA. There are no known pieces of electrical equipment (transformers, capacitors, or regulators) containing PCBs in use at the NNSS, with the exception of PCB-containing light ballasts. The TSCA program consists mainly of properly characterizing, storing, and disposing of various PCB wastes generated on site through remediation activities at FFACO CASs (Chapter 11). PCB bulk product waste (i.e., contaminated building materials) are disposed of in the Area 5 RWMS or the Area 9 Solid Waste Disposal Site (SWDS), and light ballasts removed during normal maintenance are disposed of through an offsite approved PCB disposal facility. Soil and other remediation wastes contaminated with PCBs and large volumes of light ballasts are sent off site to an approved PCB disposal facility. Radioactive waste received from offsite waste generator facilities that contain regulated quantities of PCBs is disposed of at the Area 5 RWMS (Chapter 10) in accordance with the solid waste disposal permit SW 532, the RCRA hazardous waste management permit NEV HW0101, and/or TSCA regulations. Offsite waste generators bringing manifested PCB wastes to the NNSS for disposal are issued a Certificate of Disposal for PCBs. Onsite PCB records are maintained as required by the EPA, and PCB management activities are documented annually. If any generated PCB wastes that are above threshold levels are released, they are also reported in the Toxic Release Inventory (TRI) Report (Section 2.4.4.1, Table 2-6).

In 2024, NNSS demolition activities generated sixty-one (61) containers, 12,926 kilograms (kg) (28,496 pounds [lb]) of PCB non-leaking light ballasts, three (3) containers, 699 kg (1,541 lb) of mixed low-level PCB bulk product waste, and thirty-six (36) containers, 228,757 kg (504,323 lb) of PCB bulk product waste. Sixty-one (61) containers, 12,926 kg (28,496 lb) of PCB material were shipped off site from the Area 5 Hazardous Waste Storage Unit for treatment and/or disposal. Three (3) containers, 699 kg (1,541 lb) of PCB material were disposed of at the Area 5 Mixed Waste Disposal Unit. Thirty-six (36) containers, 228,757 kg (504,323 lb) of PCB material were disposed of in the Area 9 SWDS. These weights include the PCBs, the associated materials that are contaminated and/or cannot be separated from the PCBs, and the weight of the waste container.

A concern was raised in January 2024 on the management of potential PCB bulk product waste generated during remediation activities at Test Cell C. On March 18, 2024, this was entered into the EPA's eDisclosure system under the title "NNSS Test Cell C PCB Bulk Product storage." Due to this and other waste management issues, actions were taken to improve the waste management program. Multiple corrective actions were implemented to address the waste that had already been generated and to ensure future waste generation was in accordance with all requirements (see Table 2-7 for more information).

In 2021, the EPA conducted an inspection of PCB activities at the NNSS. The final report has not been received.

2.4.3 Pesticides

The storage and application of pesticides (e.g., insecticides, rodenticides, and herbicides) are regulated under FIFRA and NAC 555.400-510. The NDA has oversight functions to ensure compliance with FIFRA and the NAC. Internal oversight activities include screening of all purchase requisitions, review of operating procedures for handling, storing, and applying pesticide products, and monthly inspections of stored pesticides. On the NNSS, pesticides are applied under the requirements of a Nevada Pest Control Government License. This service is provided by the Mission Support and Test Services, LLC (MSTS), Waste & Water Department. The application of restricted-use pesticides was discontinued on the NNSS in 2014. Only pesticides categorized as non-restricted-use (i.e., available for purchase and application by the general public) are used. In FY 2024, non-restricted use pesticides required the same level of record keeping as restricted-use pesticides. Monthly inspections conducted in 2024 found that records were properly maintained, no restricted-use pesticides were used, and all pesticides were stored in accordance with their labeling. The State of Nevada did not conduct an inspection of restricted-use pesticide storage or use in 2024.

2.4.4 Release and Inventory Reporting

2.4.4.1 The Emergency Planning and Community Right-to-Know Act

EPCRA requires that facilities report inventories and releases of certain chemicals that exceed specific thresholds. Table 2-4 identifies the reporting requirements under EPCRA Sections 302, 304, 311, 312, and 313. Table 2-5 summarizes the applicability of the regulations to NNSA/NFO operations in 2024.

Table 2-4. Emergency Planning and Community Right-to-Know Act reporting criteria

Section	CFR Part	Reporting Criteria	Agencies Receiving Report
302	40 CFR 355: Emergency Planning Notifications	The presence of an extremely hazardous substance (EHS) in a quantity equal to or greater than the threshold planning quantity at any one time.	SERC[(a)], LEPC[(b)]
		Change occurring at a facility that is relevant to emergency planning.	LEPC
304	40 CFR 355: Emergency Release Notifications	Release of an EHS or a CERCLA hazardous substance[(c)] in a quantity equal to or greater than the reportable quantity.	SERC, LEPC
311	40 CFR 370: Safety Data Sheet Reporting	The presence at any one time at a facility of an OSHA hazardous chemical[(d)] in a quantity equal to or greater than 4,500 kg (10,000 lb) or an EHS in a quantity equal to or greater than the threshold planning quantity or 230 kg (500 lb), whichever is less.	SERC, LEPC, Local Fire Departments
312	40 CFR 370: Tier Two Report	Same as Section 311 reporting criteria above.	State Fire Marshal, SERC, LEPC, Local Fire Departments
313	40 CFR 372: TRI Report	Manufacture, process, or otherwise use at a facility, any listed TRI chemical in excess of its threshold amount during the course of a calendar year. Thresholds are 11,300 kg (25,000 lb) for manufactured or processed and 4,500 kg (10,000 lb) for otherwise used, except for persistent, bio-accumulative, toxic chemicals, which have thresholds of 45 kg (100 lb) or less.	EPA, NDEP

(a) SERC = State Emergency Response Commission.
(b) LEPC = Local Emergency Planning Commission.
(c) Hazardous substance as defined in CERCLA, 40 CFR 302.4.
(d) Hazardous chemical as defined in the Occupational Safety and Health Act, 29 CFR 1910.1200.

Table 2-5. Compliance with EPCRA reporting requirements

Section	Description of Reporting	2024 Status[(a)]
302	Emergency Planning Notification	Yes
304	EHS Release Notification	Not required
311–312	Safety Data Sheet/Chemical Inventory	Yes
313	TRI Reporting	Yes

(a) "Yes" indicates that NNSA/NFO reported under the requirements of the EPCRA section specified (Table 2-4).

NNSA/NFO produces the Nevada Combined Agency (NCA) Report, which satisfies EPCRA Section 302, 311, and 312 reporting requirements. The State Fire Marshal issues permits to store hazardous chemicals at the NNSS, NLVF, and RSL-Nellis based on the NCA Report. Due to reduction in chemicals stored at NPTEC, the facility no longer requires a separate permit, and will now be included in the NNSS report. The 2024 chemical inventory for NNSS facilities was updated and submitted to the State of Nevada in the NCA Report on February 19, 2025. No EPCRA Section 304 reporting was required in 2024 because no accidental or unplanned release of an EHS occurred at the NNSS, NLVF, or RSL-Nellis.

NNSA/NFO produces an annual TRI Report to comply with EPCRA Section 313 reporting. It identifies the reportable quantities of TRI chemicals released to the environment through air emissions, landfill disposal, and recycling. TRI chemicals that are recovered during NNSS remediation activities or become "excess" to operational needs (e.g., lead bricks, lead shielding) are sent off site for recycling, reuse, or proper disposal. Mixed wastes generated at other DOE facilities that contain TRI chemicals and are sent to the NNSS for disposal are included in the TRI Report. In 2024 at the NNSS, lead, mercury, PCBs, friable asbestos, nickel, and chromium compounds exceeded reportable toxic chemical thresholds as a result of NNSS activities (Table 2-6). No accidental or intentional releases (e.g., proper waste disposal) of toxic chemicals at NLVF or RSL-Nellis exceeded the TRI reportable thresholds in 2024. No EPCRA inspections were performed by outside regulators in 2024.

Table 2-6. Summary of reported releases at the NNSS subject to EPCRA Section 313

	Quantity[(a)] (lb)					
2024 Reported Release	**Lead**	**Mercury**	**PCBs**	**Friable Asbestos**	**Nickel**	**Chromium Compounds**
Air Emissions[(b)]	1.69	0.068	-----	-----	-----	-----
Onsite Disposal[(c)]	100,702.05	1,075.59	8.98	115,198.89	15,908.00	10,917.00
Onsite Release[(d)]	793.9	-----	-----	-----	-----	-----
Offsite Recycling[(e)]	0.00426	-----	-----	-----	-----	-----
Offsite Disposal[(f)]	26.01	0.81	1.6	-----	-----	-----
Totals	101,523.65	1,076.47	10.58	115,198.89	15,908.00	10,917.00
EPCRA Reporting Thresholds	**100**	**10**	**10**	**10,000**	**10,000**	**10,000**

(a) The weight of the chemical released, not the weight of the waste material containing the toxic chemical. Weights in the TRI Report vary from two to four decimal places.

(b) Fugitive airborne releases of lead include weapons firing at the Mercury Firing Range, chemical releases and detonations, and from stack air emissions.

(c) MLLW or HW containing lead, mercury, PCBs, friable asbestos, nickel, and chromium compounds was received and disposed in Cells 18 and 25 at the Area 5 RWMS (Section 10.1.1).

(d) Lead from spent ammunition left on the ground during firing at the Mercury Firing Range. When the firing range is closed, ammunition will be collected for recycling.

(e) Lead was recycled from three waste streams: lead-acid batteries, miscellaneous lead items, and offsite waste treatment.

(f) Lead was from lead-contaminated debris and other routinely generated waste. Mercury and PCBs were from offsite generated waste.

2.4.4.2 Nevada Chemical Catastrophe Prevention Act

This act directs NDEP to develop and implement a program called the Chemical Accident Prevention Program (i.e., CAPP). It requires registration of facilities storing or processing highly hazardous substances above listed thresholds. NPTEC in Area 5 of the NNSS is registered as a CAPP facility because of its use of the highly hazardous chemical oleum. NDEP conducted an onsite inspection of NPTEC for FY 2024 on January 11, 2024. The Site Inspection Report (dated February 6, 2024) found one corrective action required. A response was provided to the state on March 18, 2024.

NNSA/NFO is required to submit an annual CAPP registration report to the State of Nevada for the NPTEC oleum release process. The CAPP reporting period is June 1, 2024, through May 31, 2025. The CAPP registration report for NPTEC operations for the reporting period was signed on June 18, 2025, and submitted to NDEP. The report states that 4,400 lb of oleum were present during the reporting period.

2.4.4.3 Continuous Releases

Section 103(a) of CERCLA and EPA's implementing regulation (40 CFR 302.8) require that federal authorities be notified immediately whenever a reportable quantity of a hazardous substance is released into the environment, so that government response officials can evaluate the need for a response action. CERCLA Section 103(f)(2) provides relief from these immediate reporting requirements for releases of hazardous substances from facilities or vessels that are ***continuous*** and are predictable and regular in the amount and rate of emission. No continuous releases of hazardous substances are known to occur at the NNSS, NLVF, or RSL-Nellis.

2.4.5 Underground Storage Tank Management

RCRA regulates the storage of regulated substances to prevent contaminants from leaching into the environment from underground storage tanks (USTs). NAC 459.9921–459.999, "Storage Tanks," enforces the federal regulations under RCRA pertaining to the maintenance and operation of USTs and the regulated substances contained in them, in order to prevent environmental contamination. NNSA/NFO operates one fully regulated UST and three excluded USTs at the Device Assembly Facility, and one fully regulated UST, four excluded USTs, and three temporarily closed USTs at RSL-Nellis.

NDEP has oversight authority of the NNSS USTs, and the Southern Nevada Health District (SNHD) has oversight authority of USTs in Clark County (see Section A.2.3 of Appendix A regarding UST management at RSL-Nellis). NDEP did not conduct an inspection of the regulated UST at the NNSS in 2024.

The SNHD has oversight authority of the RSL-Nellis USTs in Clark County. The UST program at RSL-Nellis consists of four excluded tanks, one regulated diesel tank, and three temporarily closed USTs (one unleaded gasoline, one diesel fuel, and one used oil). The fully regulated UST is operated under the RSL-Nellis UST Permit PR0064276. The fully regulated active and temporarily closed tanks are inspected annually by the SNHD; on January 8, 2025, the SNHD conducted an inspection and no findings were identified.

2.5 Environmental Occurrences

DOE O 232.2A defines an occurrence as "a documented evaluation of a reportable occurrence that is prepared in sufficient detail to enable the reader to assess its significance, consequences, or implications and to evaluate the actions being proposed or employed to correct the condition or to avoid recurrence."

In 2024, and seven environmental occurrences were reportable under the requirements of the order, and one environmental issue was reported to the EPA and the DOE HQ NTS. Forty-two hazardous substance spills occurred in 2024: 37 at the NNSS, 4 at the NLVF, and 1 at RSL-Nellis. Four spills were reportable (Table 2-7), and the other spills were small-volume releases either to containment areas or to other surfaces. All spills were cleaned up.

Table 2-7. Environmental occurrences and issues reported in 2024

Description of Occurrence	Reporting Criteria[a]	Corrective Actions Taken
Report Number/Date of Occurrence: EM--NVSO-NAVR-NNSS-2024-0001, January 22, 2024		
On January 10, 2024, at approximately 0800, liquid mercury was observed dripping out of a 1/4-inch copper tube onto a metal plate covering a pipe chase at the Area 25, Test Cell C Water Tower. The tubing is attached to a small reservoir approximately 10 feet above the ground on one of the downcomer legs of the water tank. The reservoir appeared to be empty and the system had been inoperable for many years. There was no indication that a substance would be inside of the tubing. The tank was being prepped for explosive demolition and the tubing cut to make room for preparation of cutting the downcomer leg with a metal torch. The mercury was contained to the metal plate and did not spill onto areas of adjacent soil. The spill was not initially determined a “release” to the environment, as the mercury was contained on the steel plate structure of the water tower. The total amount of liquid leaked from the tubing was approximately 4 fluid ounces equaling to approximately 3.52 lb of mercury. The reportable quantity is 1 lb. The original cut of the tubing occurred at 0730 and liquid was not observed to be dripping until 0800. No personnel were near or beneath the tubing when the liquid began to drip.	5A(1) - Any release (onsite or offsite) of a hazardous or extremely hazardous substance, including radionuclides from a DOE facility above federally permitted releases in a quantity equal to or exceeding the federal reportable quantities specified (See specifications in 40 CFR Part 302, Designation, Reportable Quantities, and Notification; 40 CFR Part 355, Emergency Planning and Notification; and CERCLA Section 101(10), Federally Permitted Releases.)	The area was restricted while notifications to project environmental personnel and management were made. The following notifications were made: The State of Nevada Emergency Response Commission was notified of the spill. NDEP# 240110-02. The National Response Center was notified of the spill. Incident Report #1388658. Approval was given to clean up the mercury with a mercury spill kit and the appropriate personal protective equipment (PPE). The cleanup was performed and all waste materials were properly disposed.
Report Number/Date of Occurrence: NTS-EM-EMCBC-NAV-NTS-2024-0010913, January 31, 2024		
On January 31, 2024, a concern was raised on the management of waste potentially containing PCB Bulk Product waste generated during remediation activities at the Test Cell C facility. Observation of activities indicated that potential PCB Bulk Product waste may not have been managed consistent with federal regulations that provide specific requirements or allow for a regulator-approved variance for on-site storage prior to packaging and disposition (40 CFR 761.65 Storage for disposal (c)(9) and (c)(9)(i)).	While this issue did not meet reporting criteria for DOE O 232.2A, it was reported to the EPA and the DOE HQ NTS.	The Nevada Environmental Program Services (NEPS) contractor immediately responded by initiating a work pause, issuing interim guidance for authorizing waste management activities, establishing integrated project teams to include disposal authority representatives, and conducted sampling to confirm the presence and levels of PCBs. On March 18, 2024, this was entered into the EPA’s eDisclosure system under the title “NNSS Test Cell C PCB Bulk Product storage.” Corrective actions were confirmed to be complete and the issue closed following months of coordination with the disposal authority, issuance of updated procedures, execution of new and updated training, addition of resources, implementation of work controls to ensure potential PCB Bulk Product waste is properly managed, and extensive reviews performed to verify compliance.

Table 2-7. Environmental occurrences and issues reported in 2024

Description of Occurrence	Reporting Criteria[(a)]	Corrective Actions Taken
Report Number/Date of Occurrence: NA--NVSO-MSTS-LV-2024-0001, June 17, 2024		
During a quarterly walkdown of the RSL-Nellis facility hangar and equipment, the Facility Manager and Safety/Industrial Hygiene Professional discovered a minor leak underneath one of the two permanent aircraft hangar Aqueous Film Forming Foam (AFFF) systems. (NOTE: These systems were previously red-tagged on 10/12/2022 due to DOE/HQ per-and polyfluoroalkyl substances [PFAS]/AFFF guidance). Notifications were made to the Environmental Compliance (EC) Manager for confirmation. On Monday, June 17, 2024, at approximately 0800 hours, it was determined by the EC Manager that a small leak was occurrence reportable under criterion 5A(5) as a release of PFAS-containing AFFF. The leak was identified as coming from the drain plug of a tank with a containment volume of 30-50 gallons within the RSL-Nellis hangar. The amount of material released is approximately 2 ounces. The leak is a very slow leak (1 drip per week) that has developed over time due to the material remaining in the tank and gelling.	5A(5) - Any release or spill (onsite or offsite) of per-and polyfluoroalkyl substances (PFAS)-containing Aqueous Film Forming Foam (AFFF).	This occurrence was entered into the MSTS issue resolution and improvement system (referred to as CaWeb) and assigned Issue #37477 in the category of Trend Only. A catch basin and secondary confinement was placed under both drain plugs to catch any additional leakage. The released material was properly cleaned up and all generated waste was disposed through the Nellis Air Force Base waste program.
Report Number/Date of Occurrence: NA--NVSO-MSTS-NNSS-2024-0007, June 27, 2024		
A suspected AFFF leak was identified on 6/27/2024 at approximately 1320 hours, during a routine pressure test of the fire suppression system (FSS) by the Sprinkler Fitters in the riser room of building 06-922 at the NNSS. BACKGROUND: The AFFF system was installed for a specific project in the facility. The riser room at 06-922 contains two 600-gallon tanks with inner bladders that contain AFFF product surrounded by water along with associated piping to the FSS. The piping and tanks were tagged out of service on 9/19/2018 to prevent any AFFF from being deployed during use of the FSS upon completion and dismantlement of the project. EC was notified to confirm if the leak was AFFF-related. EC inspected the riser room and identified three different leaks, one at the end of the pipe that had previously been capped and one from the bottom of each storage tank. The source of the leaks from the tanks could not be readily identified, but was suspected to be from a drain valve from the inner bladders. Between the two tanks it is estimated that there is a total of 175 gallons of AFFF inside the tanks. The total estimated volume of AFFF that was leaked is approximately a half gallon.	5A(5) - Any release or spill (onsite or offsite) of per-and polyfluoroalkyl substances (PFAS)-containing Aqueous Film Forming Foam (AFFF).	This was entered to CaWeb and assigned Issue # 37537 and categorized as a Track Until Fixed. Corrective actions included cleanup of the leaked AFFF and surrounding area. All generated waste and PPE were stored as there currently is no authorized disposal for PFAS-contaminated material and debris. The tanks and piping in the riser room will be inspected weekly to verify any additional leakage and clean up any identified seepage. This will continue until an authorized disposal path is agreed upon with DOE/HQ. All other AFFF tanks and associated piping at NNSS locations are subject to monthly inspections to verify the absence of leaking AFFF. Inspections will continue until a disposal plan is approved for AFFF- and PFAS-contaminated material and the tanks and associated piping that contain AFFF have been removed. In addition to Building 06-922, AFFF tanks are located at Buildings 06-CP-41 and 06-609 at the NNSS and at the RSL-Nellis facility.

Table 2-7. Environmental occurrences and issues reported in 2024

Description of Occurrence	Reporting Criteria[a]	Corrective Actions Taken
Report Number/Date of Occurrence: NA--NVSO-MSTS-NNSS-2024-0010, August 22, 2024		
On Thursday, August 22, 2024, at approximately 1321 hours, while monitoring the Wildland Fire Detection Camera System on the NNSS, the Operations Command Center identified smoke plumes in Area 20. NNSS Fire and Rescue (F&R) units verified a Wildland Fire; however, due to the terrain, was not able to gain access to the fire. (NOTE: the fire was named "Ribbon Wildfire." This wildland fire is in the remote mountainous northwest region of the 1,360-square-mile site.) At approximately 1557 hours, an Operational Emergency not requiring classification was declared based on "wild land fire requiring time-urgent response from an off-site agency." The NNSS F&R Chief contacted the BLM Las Vegas Field Office Manager and requested aerial tanker assets from the BLM Wildland fire division. The fire was estimated at 300 acres and all employees were directed to avoid Area 20 until notified. On August 25, 2024, 1545 hours, the Area 20 fire was declared 100% contained with 7,890 acres burned. On August 26, 2024, the abnormal event investigation was initiated. NOTE: Initially the cause of the fire was unknown, but subsequent investigation indicated the fire was likely initiated by a flare from an aircraft operating over the Nevada Test and Training Range. NOTE: The NNSS and the Nevada Test and Training Range share a north/south border in this location. Area 20 was evacuated and barricaded with no access by non-response personnel to the area during the duration of the fire. No cause was identified; however, for purpose of this report, A7B1C01, Weather or Ambient Conditions were less than adequate due to the high winds.	1(1) - An Operational Emergency, Alert, Site Area Emergency, or General Emergency as defined in DOE O 151.1D.	MSTS took no corrective actions beyond the response to extinguish the fire.

Table 2-7. Environmental occurrences and issues reported in 2024

Description of Occurrence	Reporting Criteria[a]	Corrective Actions Taken
Report Number/Date of Occurrence: NA--NVSO-MSTS-NNSS-2024-0012, September 23, 2024		
On September 23, 2024, at 1515 hours, an employee discovered a suspected AFFF leak from a sprinkler head in building 06-922 at the NNSS. The Facility Manager investigated and saw a puddle approximately 1 foot in diameter with one drop every 3 seconds. The sprinkler head is about centerline North/South/East/West at the highest point of the overhead. MSTS EC, Maintenance, and Sprinkler Fitters were notified. A Sprinkler Fitter was able to bleed off some of the pressure, dropping the pressure by 30 pounds, which slowed the leak down to about one drop every 5 seconds. A bucket was placed underneath the sprinkler to contain the leak until the sprinkler head can be evaluated and repaired or replaced. The total estimated volume of AFFF that was leaked at the time of discovery was approximately 1 quart. Note: The building was being reconfigured for a new project; however, no work was being done in the area. BACKGROUND: The facility was built in 2003 with the AFFF system originally installed for a specific project in the facility, although it is not currently in service. The piping and AFFF tanks were tagged out of service 9/19/2018 to prevent any AFFF from being deployed during use of the FSS at 06-922. In 2022, EC determined there was highly diluted AFFF in the fire suppression lines, which is almost de minimis, as tested 8/3/22 (there was a concern of PFAS/AFFF contamination in the fire suppression lines).	Minor release of per-and polyfluoroalkyl substances (PFAS) containing aqueous film forming foam (AFFF).	This was entered to CaWeb and assigned Issue # 37844 and categorized as Track Until Fixed. Corrective actions (cleanup, waste storage, monthly inspections) taken for NA--NVSO-MSTS-NNSS-2024-0007 were implemented for this occurrence as well. In addition, the Sprinkler Fitters changed out a T-section and installed a new sprinkler head.

Table 2-7. Environmental occurrences and issues reported in 2024

Description of Occurrence	Reporting Criteria[(a)]	Corrective Actions Taken
Report Number/Date of Occurrence: NA--NVSO-MSTS-NNSS-2024-0017, October 14, 2024		
On October 8, 2024, the MSTS EC department found recordkeeping irregularities during a management assessment involving the Anduril Project on the NNSS. This resulted in seven NNSS Air Permit potential excess emissions forms being sent to the NDEP Bureau of Air Pollution Control, 24-Hour and/or 15-Day Post Notification of Excess Emission for seven of nine rented generators. BACKGROUND: The EC air permit subject matter expert conducted a management assessment (NNSS Air Permit Modification Implementations, MA-24-12B5-002, dated September 25, 2024). The project had 12 generators added in the June 2023 NNSS Air Permit Modification and worked with EC to develop operating parameters and obtain required equipment information. When the modification was approved on April 8, 2024, only nine generators remained on site (these were subject to full permit requirements, recordkeeping, preventive maintenance, etc.). Routine data calls and communication from EC occurred to document operating hours for the remaining nine generators. During the management assessment it was identified that the reported operating hours did not make sense, in that the reported values exceeded the possible hours for the reported timeframe. It was determined that many of the generators were switched out (like for like) and the hour meters readings were from different equipment. The generator change-outs were not documented, nor were the specific generator hour meter readings noted. The project provided an estimate of total hours each generator operated from April 2024 to November 2024; these estimates indicated that seven out of the nine generators had excess emissions. Identified causes were that the equipment users did not provide accurate information on annual operational hours needs during the permitting process. Additionally, inaccurate recordkeeping by generator operator for continual verification against operating hours was discovered. The project stated that all of their rented generators would be removed from the NNSS by November 30, 2024. No injuries were reported and there was no impact to mission facilities or assets.	5A(2) - Any release (onsite or offsite) of a pollutant from a DOE facility that is above levels or limits specified by outside agencies in a permit, license, or equivalent authorization, when reporting is required in a format other than routine periodic reports.	This was entered to CaWeb and assigned Issue #37841 as Track Until Fixed. The generators were evaluated and 7 out of 9 were determined to have excess air emissions, above permitted limits. Excess Emission Notification Forms were completed and sent to the State of Nevada. The generators were removed from the facility in November of 2024, and will be removed in the next NNSS Air Permit Modification Application.

Table 2-7. Environmental occurrences and issues reported in 2024

Description of Occurrence	Reporting Criteria[(a)]	Corrective Actions Taken
Report Number/Date of Occurrence: EM--NVSO-NAVR-NNSS-2024-0002, December 4, 2024		
The NEPS Annual Independent Assessment for LLW Certification was conducted October 21, 2024, through November 14, 2024. A formal out-brief was provided by the Assessment Team on November 14, 2024. The assessment issued findings that identified discrepancies between the source Technical Basis Document and the isotopic decay percentages used in waste package classification. NEPS has been conducting informational gathering and has been discussing the assessment findings internally and reviewing those to the applicable requirements. Further discussion on November 21, 2024, relevant to the assessment findings led Navarro to declare a Formal Occurrence at 1100 on November 21, 2024.	10(1) - An event, condition, or series of events that does not meet any of the other reporting criteria, but is determined by the Facility Manager or line management to be of safety significance or of concern for that facility or other facilities or activities in the DOE complex.	Immediately self-suspended waste shipments, conducted fact-finding, and performed an extent of condition and Causal Analysis. NEPS determined all waste disposed was within the limits of the approved profile and the disposal facility. Corrective actions implemented included reviewing and updating technical basis documents for affected waste profiles as well as processes and procedures to preclude recurrence and reinstate approval to ship waste.

(a) Reporting requirements provided in DOE O 232.2A can be found at https://www.directives.doe.gov/directives-documents/200-series/0232.2-BOrder-a-chg1-minchg.

2.6 Environmental Reports Submitted to Regulators

Numerous reports were prepared to meet regulation requirements or to document compliance for NNSA/NFO and DOE EM Nevada Program activities. These reports and the federal or state regulators to whom they were submitted are listed in Table 2-8.

Table 2-8. List of environmental reports submitted to regulators for activities in 2024

Regulator(s)	Report
Air Quality	
EPA Region 9, NDEP	National Emission Standards for Hazardous Air Pollutants – Radionuclide Emissions, Calendar Year 2024
	Annual Asbestos Abatement Notification Form
NDEP	2024 Emissions Inventory Report, Emissions Summary for NNSA Site (A0027)
	Annual Summary Report for Big Explosives Experimental Facility (BEEF) and the Calico Hills Explosives Operating Area
CCDAQ	Clark County Division of Air Quality Annual Emission Inventory Reporting Form for North Las Vegas Facility
	Clark County Division of Air Quality Annual Emission Inventory Reporting Form for Remote Sensing Laboratory
Water Quality	
NDEP	Public Water Systems results of water quality analyses, sent to the state throughout the year as they were obtained from the analytical laboratory
	Water Pollution Control Permit GNEV93001, Quarterly Monitoring Reports and Annual Summary Report for Nevada National Security Site Sewage Lagoons
	Water Pollution Control Permit NEV 96021, Quarterly Monitoring Reports and Annual Summary Report for E Tunnel Wastewater Disposal System

Table 2-8. List of environmental reports submitted to regulators for activities in 2024

Regulator(s)	Report
Waste Management	
NDEP	Annual Neutron Monitoring Reports for the Nevada National Security Site, Nevada, Area 6 Hydrocarbon and Area 9 U10c Landfills
	Area 6 Annual Solid Waste Disposal Site (SWDS) Report for the Nevada National Security Site – January 1, 2024, through December 31, 2024
	Area 9 Annual Solid Waste Disposal Site (SWDS) Report for the Nevada National Security Site – January 1, 2024, through December 31, 2024
	Area 23 Semi-Annual Solid Waste Disposal Site (SWDS) Report for the Nevada National Security Site – January 1, 2024, through June 30, 2024
	Area 23 Semi-Annual Solid Waste Disposal Site (SWDS) Report for the Nevada National Security Site – July 1, 2024, through December 31, 2024
	Environmental Monitoring and Post-Closure Report for Permitted Sites on the Nevada National Security Site, Calendar Year 2024
	Fiscal Year 2023 Annual Summary Report for the Area 3 and Area 5 Radioactive Waste Management Sites at the Nevada National Security Site, Nye County, Nevada (February 2024)
	Fiscal Year 2023 Radioactive Waste Acceptance Program Annual Report, Rev. 0 (January 2024)
	Fiscal Year 2024 Annual Summary Report for the Area 3 and Area 5 Radioactive Waste Management Sites at the Nevada National Security Site, Nye County, Nevada (February 2025)
	Fiscal Year 2024 Radioactive Waste Acceptance Program Annual Report, Rev. 0 (January 2025)
	Nevada National Security Site Annual Summary/Waste Minimization Report Calendar Year 2024 (February 2025)
Environmental Corrective Actions	
NDEP	Addendum to Underground Test Area (UGTA) Closure Report for Corrective Action Unit 98: Frenchman Flat Nevada National Security Site, Nevada, Rev. 0 (February 2024)
	Calendar Year 2023 Underground Test Area Annual Sampling Letter Report Nevada National Security Site, Nevada, Rev. 1 (August 2024)
	Calendar Year 2024 Underground Test Area Annual Sampling Letter Report Nevada National Security Site, Nevada, Rev. 1 (August 2025)
	Corrective Action Decision Document/Corrective Action Plan for Corrective Action Units 101 and 102: Central and Western Pahute Mesa Nevada National Security Site, Nevada, Rev. 1 (January 2024)
	Closure Report for Corrective Action Unit 578: Miscellaneous Inactive Sites Nevada National Security Site, Nevada, Rev. 0 (January 2024)
	CY 2023 Post-Closure Monitoring Letter Report for Corrective Action Unit (CAU) 98, Frenchman Flat; CAU 97, Yucca Flat/Climax Mine; and CAU 99, Rainier Mesa/Shoshone Mountain, Rev. 1 (May 2024)
	Federal Facility Agreement and Consent Order (FFACO), November 2024 Appendices Update
	Federal Facility Agreement and Consent Order Nevada National Security Site Use Restriction Management Plan, Rev. 0 (June 2024)
	Final CY 2024 Post-Closure Monitoring Letter, Rev. 1 (July 2025)
	Non-Resource Conservation and Recovery Act Corrective Action Unit (CAU) Post-Closure Inspection Report, Nevada National Security Site, Nevada For Calendar Year 2023, Rev. 0 (May 2024)
	Non-Resource Conservation and Recovery Act Corrective Action Unit (CAU) Post-Closure Inspection Report, Nevada National Security Site, Nevada For Calendar Year 2024, Rev. 0 (May 2025)
	Underground Test Area Activity Quality Assurance Plan Nevada National Security Site, Nevada, Rev. 1 (March 2024)
	Underground Test Area Calendar Year 2022 Quality Assurance Report Nevada National Security Site, Nevada, Rev. 1 (March 2024)

Table 2-8. List of environmental reports submitted to regulators for activities in 2024

Regulator(s)	Report
Hazardous Materials Management	
EPA, NDEP	Toxic Release Inventory Report, Form Rs for CY 2024
NDEP	Chemical Accident Prevention Program (CAPP) 2024 Registration
State Fire Marshal, EPA	Nevada Combined Agency Hazmat Facility Report – Calendar Year (CY) 2024
Cultural and Natural Resources	
FWS	Annual Report of Actions Taken under Authorization of the Biological Opinion for NNSS Activities (File No. 8ENVS00-2019-F-0073) – January 1, 2024, through December 31, 2024
	Annual report for Migratory Bird Scientific Collecting Permit MB008695-2
	Annual report for Migratory Bird Special Purpose Utility Permit – Electric MB60930C-1
	Annual report for Native Threatened Species – Recovery Threatened Wildlife (Juvenile tortoise) permit TE83414C-1
NDOW	Annual report for Scientific Collection Permit 261454
NNSA/NFO	American Indian Consultation Program Annual Report Fiscal Year 2024. Desert Research Institute Cultural Resources Report LR070124-1. Desert Research Institute, Las Vegas.[a]
	American Indian Consultation Program FY 2024 Tribal Planning Committee Spring Field Visit Assessment at the Kawich Cabin and Prehistoric Site and the Gold Meadow Springs and NAGPRA Repatriation Area. Desert Research Institute Report No. LR043024-2.[a]
	American Indian Consultation Program FY 2024 Tribal Planning Committee Fall Field Visit Assessment at Bighorn Sheep Rockshelter and Topopah Spring DRI Report No. LR121323-1.[a]
	American Indian Consultation Program FY 2024 Tribal Planning Committee First Quarterly Meeting Report. Desert Research Institute American Indian Consultation Program Report LR121223-1. Desert Research Institute, Las Vegas.[a]
	American Indian Consultation Program FY 2024 Tribal Planning Committee Second Quarterly Meeting Report. Desert Research Institute American Indian Consultation Program Report LR022224-1. Desert Research Institute, Las Vegas.[a]
	American Indian Consultation Program FY 2024 Tribal Planning Committee Third Quarterly Meeting Report. Desert Research Institute American Indian Consultation Program LR043024-1. Desert Research Institute, Las Vegas.[a]
	American Indian Consultation Program FY 2024 Tribal Planning Committee Fourth Quarterly Meeting Report. Desert Research Institute American Indian Consultation Program LR081324-1. Desert Research Institute, Las Vegas.[a]
	Cultural Resource Management Program Curation Compliance Annual Report Fiscal Year 2024. Desert Research Institute Curation Report LR080224-1. Desert Research Institute, Las Vegas.
	Cultural Resources Management Program Geographic Information System Database Annual Report Fiscal Year 2024. Desert Research Institute GIS Database Report LR090124-1. Desert Research Institute, Las Vegas.
	U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office American Indian Consultation Program Annual Tribal Update Meeting Summary. Prepared by the Desert Research Institute, Las Vegas.[a]
NSHPO	A Section 110 Evaluation of the Huron King Test Chamber, Area 3, Nevada National Security Site, Nye County, Nevada (Revised). Desert Research Institute Cultural Resources Report SR092922-1. Desert Research Institute, Las Vegas.
	Annual Report on Progress in the Implementation of the Mercury Programmatic Agreement Covering FY 2024 Activities. Desert Research Institute Cultural Resources Report LR071724-1. Desert Research Institute, Las Vegas
	Annual Report on Progress in the Implementation of the Nevada National Security Site Programmatic Agreement Covering FY 2024 Activities. Desert Research Institute Report LR080724-1. Desert Research Institute, Las Vegas.
	Finding of Adverse Effect and Proposed Mitigation for the Mercury Solar Photovoltaic Array and Battery Energy Storage System, Area 23, Nevada National Security Site, Nye County, Nevada. Desert Research Institute Report LR102523-1. DOE/NV89233122CNA000255-19-FOE Desert Research Institute, Las Vegas.
	Finding of Adverse Effect and Proposed Mitigation for the Removal of Three Primary Resources and Twenty-Four Accessory Resources within the Mercury Historic District, Area 23, Nevada National Security Site, Nye County,

Table 2-8. List of environmental reports submitted to regulators for activities in 2024

Regulator(s)	Report
	Nevada. Desert Research Institute Cultural Resources Finding of Effect Report LR040224-1-FOE. DOE/NV/89233122CNA000255-18-FOE. Desert Research Institute, Las Vegas.
	Fiscal Year 2024 Annual Historic Properties Monitoring Summary, Nevada National Security Site, Nye County, Nevada. Desert Research Institute Cultural Resources Report LR052124-1. Desert Research Institute, Las Vegas.
	Identification and Evaluation for the Demolition of Four Cap and Magazine Storage Buildings in Area 12, Nevada National Security Site, Nye County, Nevada. Desert Research Institute Report SR011024-1. Desert Research Institute, Las Vegas.
	Identification and Evaluation for the Mercury Solar Photovoltaic Array and Battery Energy Storage System, Area 23, Nevada National Security Site, Nye County, Nevada. Desert Research Institute Report SR102523-1. Desert Research Institute, Las Vegas.
	Mitigation for the Mercury Airstrip, Area 23, Nevada National Security Site, Nye County, Nevada. Desert Research Institute Report LR102523-1-MIT. DOE/NV89233122CNA000255-19-MIT. Desert Research Institute, Las Vegas.
	Mitigation for Removal of Building 01-103 in the Area 1 Subdock, Nevada National Security Site, Nye County, Nevada. Desert Research Institute Cultural Resources Report LR090123-1-MIT. Desert Research Institute, Las Vegas.
	Mitigation for Removal of Building 01-202681 in the Main Storage Yard of the Area 1 Subdock, Nevada National Security Site, Nye County, Nevada. Desert Research Institute Cultural Resources Report LR090123-2-MIT. Desert Research Institute, Las Vegas.
	Mitigation for the Removal of Three Primary Resources and Twenty-Four Accessory Resources within the Mercury Historic District, Area 23, Nevada National Security Site, Nye County, Nevada. Desert Research Institute Cultural Resources Finding of Effect Report LR040224-1-MIT. Desert Research Institute, Las Vegas.
	Pluto Test Bunker Facility: An Architectural Survey of the Pluto Test Bunker Facility, Nevada National Security Site, Nye County, Nevada. Desert Research Institute Cultural Resources Report TR125. Desert Research Institute, Las Vegas.
	Supplemental Identification, Evaluation, and Finding of Effect for Additional Proposed Demolition at U12g Tunnel, Area 12, Nevada National Security Site, Nye County, Nevada. Desert Research Institute Report SR011024-2. Desert Research Institute, Las Vegas.
Public Notifications/Reports	
DOE	Nevada National Security Sites Environmental Report 2023 (September 2024)
Environmental Occurrences	
DOE	See Section 2.5 for Occurrence Reporting and Processing System Reports

(a) Reports developed under the American Indian Consultation Program.

2.7 References

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office, 2013. *Final Site-Wide Environmental Impact Statement for the Continued Operation of the Department of Energy/National Nuclear Security Administration Nevada National Security Site and Off-Site Locations in the State of Nevada*. DOE/EIS-0426, Las Vegas, NV.

Chapter 3: Environmental Management System

Savitra M. Candley, Delane P. Fitzpatrick-Maul, and Karlita L. Simper
Mission Support and Test Services, LLC

The U.S. Department of Energy (DOE), National Nuclear Security Administration Nevada Field Office (NNSA/NFO) conducts activities on the Nevada National Security Site (NNSS) while ensuring the protection of the environment, the worker, and the public. The NNSS Management and Operating (M&O) Contractor's policies and directives promote, guide, and regulate NNSS environmental aspects in order to protect the environment and public health. Mission Support and Test Services, LLC (MSTS), established an Environmental Management System (EMS) in accordance with International Organization for Standardization Standard ISO-14001:2015 during the last quarter of 2019. An EMS conformance audit occurred in 2024, and the EMS was found to be conformant.

This chapter describes the fiscal year (FY) 2024 progress made towards improving overall environmental performance and discusses various activities of the MSTS Sustainability Division. The Division has the specific mission to support and track DOE's complex-wide sustainability goals. Reported progress applies to operations on the NNSS as well as support activities conducted at the NNSA/NFO-managed North Las Vegas Facility (NLVF), Remote Sensing Laboratory–Nellis (RSL-Nellis), and additional outlying sites. NNSA/NFO uses this annual environmental report as the mechanism to communicate to the public the components and status of the EMS and the Sustainability Program.

3.1 Environmental Policy

MSTS's environmental commitments are incorporated into an Environmental Protection Policy approved by NNSA/NFO. The policy applies to all MSTS operations, projects, facilities, and personnel, including subcontractors. The EMS implements this policy and is incorporated into MSTS's Integrated Safety Management System. MSTS evaluates its operations, identifies aspects that can impact the environment, qualitatively assesses the potential impacts, and manages those aspects appropriately. In addition, the MSTS policy is designed to:

- Protect environmental quality and human welfare by implementing EMS practices that conform to the ISO-14001:2015 Standard.
- Minimize environmental impacts caused by NNSS activities and services by preventing pollution and protecting the natural environment.
- Use sustainable practices, including the purchase of sustainable products to prevent degradation of natural resources.
- Continually improve the EMS by reviewing performance and making adjustments to achieve established objectives.
- Operate in compliance with applicable federal, state, and local regulations and contractual requirements related to environmental protection and performance.
- Rigorously review operations and correct non-compliance as discovered.

3.2 Significant Environmental Aspects

Six significant environmental aspects were identified for FY 2024 based on company processes, missions, and activities, including potential emergency situations and abnormal conditions. Environmental aspects, such as energy use and sustainable acquisition, are addressed in Section 3.5.1.

Significant environmental aspects for FY 2024 were as follows:

1. Hazardous, radiological, and mixed waste generation and management
2. Industrial chemical storage and use

3. Air emissions
4. Cultural resources
5. Wastewater management (generation and disposal)
6. Energy use (fuel use, electricity, propane)

3.3 Environmental Objectives and Targets

Environmental objectives and targets were developed to address significant environmental aspects for which MSTS had the ability to effect a change (Table 3-1). Energy use is addressed separately in Section 3.5.1. Each objective and target is an opportunity to affect a significant environmental aspect by improving compliance, reducing impacts to operations, or enacting process improvements. Measurable milestones were developed for each target. Two objectives were established for developing per- and polyfluoroalkyl substances (PFAS) oversight and a baseline, as well as improving waste management and pollution prevention programs. Regarding the PFAS Objective, two Targets were achieved with the development of a disposal/storage method consistent with DOE guidance and disposal of a removed aqueous film forming foam (AFFF) system. Other PFAS Targets are in process and pertain to the actual disposal. The Pollution Prevention and Waste Management Objective was met.

Table 3-1. Environmental Objectives and Targets

FY 2024 Objective	Target	Significant Environmental Aspect
Goals in green are met or exceeded		
Improve Environmental Performance through Pollution Prevention (continued from 2023)	• Develop list of AFFF systems ready for removal, including the points of contact • Develop disposal/storage method consistent with DOE disposal guidance • As funding allows, remove one AFFF fire suppression system tank • Dispose of the removed system and AFFF • Develop an action plan to remove and dispose or store remaining systems and AFFF	Industrial Chemical Storage and Use
Pollution Prevention and Improvement of Waste Management	• Develop a training plan for waste management at the NNSS • Update the MSTS waste management company directive (CD) • Communicate CD updates	Hazardous Waste

3.4 Legal and Other Requirements

MSTS environmental compliance requirements are documented in the M&O Prime Contract. Included is DEAR [U.S. Department of Energy Acquisition Regulation] Clause 970.5204-2, "Laws, Regulations, and DOE Directives," which requires compliance with all applicable laws and regulations. These baseline directives are supplemented on an activity-specific basis as needed. M&O Contractor executive management and NNSA/NFO develop, update, and approve these standards through controlled processes. The M&O Contractor must also work to applicable Air Force Directives at RSL-Andrews and RSL-Nellis.

Environmental management performance-related needs and expectations of NNSA/NFO and M&O Contractor parent companies are identified in the M&O Contract, agreements, and the MSTS Board of Managers recommendations. These are considered when developing compliance obligations. The needs and expectations of interested parties include clean-up of contaminated sites, community air and groundwater monitoring, safe handling of hazardous and radioactive waste, compliance with environmental regulations, and host site environmental operating provisions.

MSTS has a process to review changes in federal, state, and local environmental regulations and to communicate those changes to affected staff and organizations.

DOE publishes an annual Sustainability Plan that identifies sustainability goals, reports targets pursued, and summarizes the overall goals of all Nuclear Security Enterprise Sustainability Divisions (Section 3.5.1). DOE is committed to transitioning to carbon-pollution-free energy sources, a zero-emissions fleet, and a net-zero building portfolio.

DOE also plans to meet these challenges by reducing pollution, procuring sustainably sourced supplies and equipment, educating its workforce on sustainability and climate change, and engaging stakeholders and the public in its work across the mission portfolio.

3.5 Environmental Management System Programs

NNSS 5- to 10-Year Major Initiatives

Mercury Modernization – create a modern, welcoming campus to support the goals and operations of the NNSS.

PULSE Master Planning – plan for existing and future conditions of all buildings and infrastructure, personnel, space needs, and mission requirements at PULSE [Principal Underground Laboratory for Subcritical Experimentation] (formerly the U1a Complex until November 2023).

DAF Master Planning – early planning for improved operations to support new capabilities and increased capacity for additional programs at the DAF [Device Assembly Facility].

Footprint Management – aggressive consolidation and modernization of facilities at the NNSS, NLVF, and planning for a new Northwest Las Vegas complex to reduce the footprint and provide sustainable infrastructure to support mission needs.

NNSS Solar Projects –Planning for new solar Photo Voltaic (PV) projects at the NNSS to cover power usage for the site.

Sustainability Strategies

- Provide sustainable facilities and equipment that meet requirements until at least the 2080s.
- Improve energy efficiency and strive to create some of the first net-zero energy buildings in the NNSA complex.
- Reduce the overall size of Mercury by consolidating operations.
- Complete utility/infrastructure upgrades and consolidations across the campus.
- Dispose of excess facilities.

3.5.1 Sustainability Division

The Sustainability Division has the specific mission to support and track DOE's complex-wide sustainability goals. The program strives to ensure continuous life cycle, cost-effective improvements to increase energy efficiency; increase the effective management of energy, water, and transportation fleets; and increase the use of clean energy sources for NNSA/NFO operations. NNSA/NFO currently uses electricity, fuel oil, and propane at the NNSS facility. At the NLVF and RSL-Nellis facilities, electricity and natural gas are used. NNSA/NFO vehicles and equipment are powered by unleaded gasoline, diesel, bio-diesel, E-85, and jet fuel. All water used at the NNSS is groundwater, and water used at the NLVF and RSL-Nellis is predominantly surface water from Lake Mead.

Each FY, the Sustainability Division produces an NNSA/NFO Site Sustainability Plan (SSP) (MSTS 2024). The SSP describes the program, planning, and budget assumptions as well as NNSA/NFO's performance for the previous year for each DOE goal, and planned actions to meet each goal during the next year. To implement the SSP, an Energy Management Council meets bi-monthly to track requirements and progress and facilitate goal achievement. Table 3-2 includes a summary of the DOE goals and NNSA/NFO's FY 2024 performance.

Table 3-2. DOE Sustainability Goals

DOE Goal [(a)]	NNSA/NFO FY 2024 Performance	Planned Efforts
Goals in green are met or exceeded		
Energy Management		
Reduce energy use intensity (Btu [British Thermal Unit] per gross square foot [gsf]) in goal-subject buildings.	- Status: 19.6% increase from the FY 2015 baseline - FY 2024 Actual: Increased Energy Use Intensity = 80,747 167,105/2,070 million Btu per 1,000 square feet	- Continue completing International Organization for Standardization 50001 "Energy Management" Ready program tasks - Continue Roof Assets Management Program - Continue Cooling and Heating Asset Management Program (CHAMP) participation - Analyze a potential methodology to normalize energy usage
Achieve a net-zero emissions building portfolio by 2045 through building electrification and other efforts.	- Status: NNSS currently has two net-zero facilities	- Continue solar planning activities - Ensure current and new construction are all electric designs
Energy Independence and Security Act Section 432 continuous (4-year cycle) energy and water evaluations.	- Goal met - Status: FY 2024 Year 4 of the 4-year cycle was completed: 33 assessments were conducted	- 54 assessments are planned for FY 2025 - Ensure estimates are developed for Energy Conservation Measures (ECMs) to meet new requirements per Energy Act of 2020
Meter all individual buildings for electricity, natural gas, steam, and water, where cost-effective and appropriate.	- Two new buildings metered for electricity and water - Appropriate buildings metered: Electric: 33/39=85% Gas: 10/10=100% Water: 14/36=39%	- Continue electric metering as budgets allow - Review specs of all new facilities for water meter scope - Install water meters in preparation for High Performance Sustainable Building certifications, as budget allows
Water Management		
Reduce potable water use intensity (gallons [gal] per gsf).	- Goal met - Status: 37.3% increase from last year, -4.4% reduction from the baseline 2007 - FY 2024 Actual: 184,690,000 gal / 2,545,322 gsf	- Complete Water Management Plan - Complete Water Balance and Water Availability Study - Complete FY 2023 and FY 2024 water projects - Conduct water audits - Review/update the site's water management procedures
Reduce non-potable freshwater consumption (gal) for industrial, landscaping, and agricultural.	- Status: 142.84% increase from 2010 baseline - FY 2024 Actual: 133,350,000 gal	- Continue to look for non-potable water reduction strategies - Analyze a potential methodology to normalize water usage - Ensure stormwater management requirements are met, where applicable
Waste Management		
Reduce non-hazardous solid waste sent to treatment and disposal facilities.	- Diverted 39.3% of non-hazardous solid waste - Added multiple battery box facility participants - Increased recycling efforts through excess	- Increase recycle bin and cardboard locations, where needed - Complete waste audit and recycle process improvement evaluation - Complete assessment of operations security landfill diversion
Reduce construction and demolition materials and debris sent to treatment and disposal facilities.	- Diverted 5.1% of construction waste - Increased construction and demolition activity on site - Increased data collection to include more construction projects	- Review current construction procedures to ensure recycling on all jobs - Improve tracking processes and efforts
Fleet Management		
Reduce petroleum consumption to 850,532 gal.	- Goal met - FY 2024 Actual: 376,473 gal, 71.67% below the baseline	- Maintain Goal

Table 3-2. DOE Sustainability Goals

DOE Goal [(a)]	NNSA/NFO FY 2024 Performance	Planned Efforts
Goals in green are met or exceeded		
Increase alternative fuel consumption, at least 150,859 gal.	- Goal met - Exceeds the 10% FY 2024 Actual: 369,793 gal	- Maintain Goal
Achieve 100 percent zero-emission vehicle acquisitions by 2035, including 100 percent zero emission light-duty vehicle acquisitions by 2027.	- FY 2024: 84% of light-duty vehicles received were zero-emission vehicles - Hosted NNSA 2024 Fleet and Sustainability Summit. Leidos Electric Vehicle Supply Equipment (EVSE) Assessment was conducted - Planned/Designed (three EVSE) at 23-460 - Incorporating National Renewable Energy Laboratory comments in EVSE Plan	- Install Electric Vehicle Charging Stations (EVCSs), as funding allows - Review other methods for EVSE installations - Explore other EVSE funding opportunities - Complete the updating of the 5-year EVCS plan
Clean and Renewable Energy		
Increase consumption of clean and renewable electric energy.	- Status: 48% of energy consumption is from clean and/or renewable electric energy sources - Consumption breakdown: 1% onsite carbon pollution-free electricity (CFE), 31% grid-supplied CFE, 17% Western Area Power Administration, 52% grid supplied fossil-based electricity - Fire Station No.1 PV produced 736 megawatt-hours (MWh); off grid solar estimated at 253 MWh - Developed bundled four-site solar and battery energy storage system procurement and conceptual design - Engaged in Cleanup to Clean Energy Initiative	- Support PV solar project activities - Investigate participation in the vertically integrated CFE Tariff program - Evaluate dual use of onsite-produced CFE - Investigate incorporation of CFE into backup power for remote Information Technology (IT) communication sites - Integrate energy forecast into annual program planning processes
Increase consumption of clean and renewable non-electric thermal energy.	- Not Applicable	- Continue to review options for non-electric thermal usage
Sustainable Buildings		
Increase the number of owned buildings that are compliant with the Guiding Principles for Sustainable Buildings.	- Goal met - There are 18 certified facilities - Recertified 4 existing facilities using 2020 Guiding Principles - Two new construction facilities in progress for third-party certification - Received Green Lab recertification at Green level for 23-652 Environmental Monitoring	- Continue to certify new building using third party certification assessors - Re-certify existing High Performance Sustainable Building facilities by FY 2025
Acquisition & Procurement		
Promote sustainable acquisition and procurement to the maximum extent practicable, ensuring all sustainability clauses are included as appropriate.	- Goal met - Relevant sustainable acquisition clauses are included in applicable subcontracts - Increased employee awareness of sustainable purchase requirements and options	- Plan to meet 95% goal - Closely evaluate applicable subcontract documents for sustainable clauses and provisions - Plan to have 100% of applicable contracts - Continue to promote sustainable acquisition and perform subcontract document reviews - Identify, flag, and capture more products in Oracle system - Monitor PFAS purchases closely

Table 3-2. DOE Sustainability Goals

DOE Goal [(a)]	NNSA/NFO FY 2024 Performance	Planned Efforts
Goals in green are met or exceeded		
Investments: Improvement Measures, Workforce and Community		
Implement life-cycle cost effective efficiency and conservation measures with appropriated funds and/or performance contracts.	- Proposed preferred option to Contracting Officer Representative (COR) for Shooting Range lighting replacement for Energy Savings Performance Contract (ESPC) Delivery Order 2 (DO2) scope - Supported Year 14 ESPC DO2 Measurement and Verification activities - Conducted virtual and in person Energy Action Month (EAM) and Earth Day activities - Continued the Acts of Sustainability employee outreach program - Evaluated placement of two SafeNest bins one at NNSA/NFO and the other at North Las Vegas to assist with waste diversion number - Included two EVSE projects in the Construction Acceleration Planning Process - Received Community and Junior College Trade Occupation Program Grant	- Continue maintaining Measurement and Verification activities for ESPC DO2 - Determine solution for COR support - Finalize solution for Energy Service Company Shooting Range solar lighting replacement issue - Continue to incorporate sustainability projects into the Construction Acceleration Planning Process - Review and update current ECM project list - Continue employee training and outreach activities (EAM, Earth Day, Acts of Sustainability, International Facility Management Association tours/training, Energy Exchange, etc.)
Electronics Stewardship and Data Centers		
Electronics stewardship from acquisition, operations, to end of life.	- Disposition goal met. All electronic equipment that passes excess screening gets e-recycled. Asset and Material Management partnered with Blind Center of Nevada for e-recycling of monitors - 6% of computers and monitors have power management enabled - 100% of printers have duplex printing enabled - IT received Electronic Product Environmental Assessment Tool (EPEAT) Award	- Continue to ensure 100% of used electronics are reused or recycled - Continue to ensure the maximum amount of EPEAT electronics are purchased - Assess IT processes for opportunities to enable power management - Continue to ensure the maximum amount of printers have duplex printing enabled
Increase energy and water efficiency in high-performance computing and data centers.	- Unable to start energy performance collection with current data centers	- Planning migration of primary data center to energy efficient co-located data center - Planning migration of demand response data center to energy efficient modular data center
Adaptation & Resilience		
Implement climate adaptation and resilience measures.	- Conducted combined Earthquake and Extreme Event drill on site. - Participated in U.S. Department of Energy, Headquarters Eagle Horizon-24 Continuity of Operations Functional Exercise and Accountability Drill - Developing an Emergency Management Organizational Strategic Plan and a discussion-based sitewide evacuation drill for wildfire scenario	- Integrate extreme weather events in Continuity of Operations Program (COOP) drills and exercises - Air Resources Laboratory/Special Operations and Research Division – continue collecting and reporting data - Install new weather station and new sensors - Incorporate recovery into full-scale exercises - Implement DOE Order DOE O 151.1C, “Comprehensive Emergency Management System,” Continuity Programs requirements; update local COOP and mission essential function plans - Review/update resiliency solutions - Continue to update the COOP plans and documents

Table 3-2. DOE Sustainability Goals

DOE Goal [a]	NNSA/NFO FY 2024 Performance	Planned Efforts
Goals in green are met or exceeded		
	- Completed operational readiness of the PULSE facility (Bldgs. 01-350 and 23-462) - Continued joint operation with Nevada Test and Training Range on wildland fire fuels control - Updated resiliency solutions - Installed two new solar weather stations - Participated in the Continuity of Operations Program Subcommittee's 2024 Pursuits & Progress meeting held in Los Alamos, New Mexico, in October 2024	- Continue with Land Management Council and Wildland Fire Risk mitigation programs - Execute quarterly Continuity of Operations accountability drills - Develop a process to track and quantify effectiveness of resiliency measures
Reduce Scope 1 & 2 greenhouse gas (GHG) emissions[b].	- Goal met - Status: 64.5% below the baseline - Actual: 23,272 metric tons carbon dioxide equivalent ($MtCO_2e$) - Scope for solar was developed - Installed energy efficient equipment upgrades: 19 facilities received one or more heating, ventilation, and air conditioning replacements - Hazardous Material Management headed initiative to expand tracking of outlying sites' chemicals	- Increase development of energy efficient projects - Review equipment replacement options to more energy efficient equipment - Maximize CHAMP project execution
Reduce Scope 3 GHG emissions[b].	- Goal met - Status: 64.9% below the baseline - Actual: 15.192 $MtCO_2e$ - Continued telework - Regional Transportation Commission's Club Ride program updated system to streamline employee reporting - Working with Procurement to better track emissions	- Increase use of tele/video conferencing - Utilize more renewable energy to eliminate large transmission and distribution losses - Increase ride-share/carpool efforts - Research efficiencies for better tracking and reporting

(a) The DOE goals and performance listed are identified in the NNSS Site Sustainability Plan 2025, which is based on the DOE Sustainability Performance Division FY 2025 Site Sustainability Plan Instructions (August 2024).

(b) The GHGs targeted for emission reductions are carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and SF_6. Scope 1 GHG emissions include direct emissions from sources that are owned or controlled by a federal agency. Scope 2 includes direct emissions resulting from the generation of electricity, heat, or steam purchased by a federal agency. Scope 3 includes emissions from sources not owned or directly controlled by a federal agency but related to agency activities, such as vendor supply chains, delivery services, employee business air and ground travel, employee commuting, contracted solid waste disposal, contracted wastewater discharge, and transmission and distribution losses related to purchased electricity. Fugitive GHG emissions are uncontrolled or unintentional releases from equipment leaks, storage tanks, loading, and unloading.

3.5.2 Pollution Prevention and Waste Minimization (P2/WM)

The P2/WM Program has initiatives to eliminate or reduce the generation of waste and the release of pollutants to the environment. These initiatives are pursued through source reduction, reuse, segregation, and recycling, and by procuring recycled-content materials and sustainable products and services. The initiatives also ensure that proposed methods of treatment, storage, and waste disposal minimize potential threats to human health and the environment. These initiatives address the goals and the requirements of the DOE Sustainability Report and Implementation Plan (DOE 2020), DOE orders, and federal and state regulations applicable to operations at the NNSS, NLVF, and RSL-Nellis (Table 2-1).

Strategies to meet P2/WM goals include:

Source Reduction – The preferred method of waste minimization is source reduction, i.e., to minimize or eliminate waste before it is generated by a project or operation. NNSA/NFO's Integrated Safety Management System requires every project/operation to identify waste minimization opportunities during the planning phase and allocate adequate funds for waste minimization activities.

Recycling/Reuse – NNSA/NFO maintains a recycling program for some recyclable waste streams. Items routinely recycled include cardboard; mixed paper (office paper, shredded paper, newspaper, magazine, color print, glossy paper); plastic bottles; plastic grocery bags; elastic/plastic stretch pack; milk jugs; Styrofoam; tin and aluminum cans; glass containers; toner cartridges; cafeteria food waste; computers; software; scrap metal; rechargeable batteries; lead-acid batteries; used oil, antifreeze, and tires.

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

Sustainable Acquisition – The Resource Conservation and Recovery Act, as amended, requires federal agencies to develop and implement an affirmative procurement program. NNSA/NFO's affirmative procurement program stimulates a market for recycled-content products and closes the loop on recycling. The U.S. Environmental Protection Agency maintains a list of items containing recycled materials and what the minimum content of recycled material should be for each item. Federal facilities are required to ensure, where possible, that 100% of purchases of items on this list contain recycled materials at the specified minimum content. The U.S. Department of Agriculture designates types of materials that have a required minimum amount of bio-based chemicals. Products that meet this requirement are identified by requestors and tracked in the procurement system.

3.6 EMS Competence, Training, and Awareness

A new EMS awareness training was developed to support New Hire Training for all new employees and subcontractors. The training includes modules on EMS, Environmental Compliance, National Environmental Policy Act, Biological Resources, Cultural Resources, and Sustainability Programs. Ongoing EMS awareness is accomplished during meetings, interactions with employees during inspections, and by publishing environmental articles in electronic employee newsletters. Focused environmental briefings are given at tailgate meetings in the field prior to work with high or non-routine environmental risk.

3.7 Audits and Operational Assessments

MSTS conducts internal management assessments and compliance evaluations. These assessments and evaluations determine the extent of compliance with environmental regulations and DOE sustainability goals and identify areas for overall improvement. In FY 2024, MSTS conducted 4 internal environmental protection management assessments and approximately 100 environmental inspections.

3.8 EMS Effectiveness and Reporting

The FY 2024 Facility EMS Annual Report Data for the NNSS was entered into the DOE Headquarters EMS database during January 2025. This database gathers information in several EMS areas from all DOE sites to produce a combined report reflecting DOE's overall performance compared to other federal agencies. The report includes a scorecard section, which is a series of questions regarding a site's EMS effectiveness in meeting the objectives of federal EMS directives. The NNSS scored an "A" in FY 2024 for all five criteria: Environmental Aspects, Environmental Objectives, Operational Controls, Compliance with Regulatory Requirements/Corrective Actions, and EMS/Executive Order Goals Integration.

3.9 Awards, Recognition, and Outreach

Energy Action Month (EAM) – Over the past few years, employees have continued to actively participate in activities for both EAM and Earth Day. EAM is a time to raise awareness about the importance of the critical role we all play in sustainable acts that drive behavioral change. Every year, employees are invited to get involved and help facilitate NNSS sustainability initiatives during various EAM events during the month of October. Activities began on the first Wednesday in October and lasted the entire month. EAM activities included the following:

- NNSS employees participated in the nationwide Energy Efficiency Day. Employees were given the opportunity to educate themselves on how to "Save Money, Cut Carbon, and Breathe Easier." Activities included sharing tips, tools, and stories that promoted the multiple benefits of energy efficiency, from lowering energy costs to tips for healthier homes.
- The Sustainability Treasure Hunt gave employees the chance to test their knowledge about the Site's sustainability initiatives by answering questions about some of the initiatives that NNSS has implemented to make the site more sustainable. These answers were found in the FY 2024 NNSS Site Sustainability Plan.
- NNSS employees enjoyed a Lunch & Learn presented by the local waste disposal and recycling services company, Republic Services. Employees were educated about quick and easy ways to make a difference in their communities by following simple guidelines to become a better recycler. The Recycling Coordinator of Southern Nevada Recycling Center for Republic Services brought a wealth of recycling knowledge to communicate to employees in attendance the basics of properly preparing acceptable recyclable materials for their curbside recycling cart. One participant won the raffle prize, a composting barrel, and used it right away.

1 Employee Composting at Home

Earth Day – The Earth Day 2024 theme was Planet vs. Plastics, calling for a 60 percent global reduction in plastic production by 2040. NNSS employees learned how to reduce their plastic usage and were given the opportunity to engage in various events and activities during the entire month of April. These activities included:

- Employees and their families participated in a fun family tree planting and tree giveaway event at the Hollywood Recreational Center in Las Vegas, NV. Employees were educated about the correct method of planting a tree and how planting trees is beneficial to the environment. They also received a FREE tree of their choosing.
- Employees attended the Platinum Leadership in Energy and Environmental Design (LEED) Facility Building Tour at the Las Vegas Cyclery in Summerlin, NV. This LEED building is designed to have 100% of its energy provided throughout the calendar year by wind power, making it a Net Zero Energy Building. The tour covered the following LEED credits: Sustainable Sites, Water Efficiency, Energy & Atmosphere, Materials & Resources, and Indoor Environmental Quality. Essentially, the Las Vegas Cyclery is its own power plant.
- Employees also participated in the recycling reality check quiz to test their knowledge about the best ways to reuse materials and save our natural resources.

Overall, the Sustainability Division's goal is to continue to see the educational impacts leading to employees understanding the importance of reducing, reusing, repurposing, recycling, saving energy and water in every aspect of their lives.

3.10 References

DOE, see U.S. Department of Energy.

Mission Support and Test Services, LLC, 2024. *NNSS Site Sustainability Plan 2025*. Las Vegas, NV, December 2024.

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U.S. Department of Energy, 2020. *2020 Sustainability Report and Implementation Plan.* Report to the White House Council on Environmental Quality and Office of Management and Budget, August 2020. Available at: https://www.sustainability.gov/pdfs/doe-2020-sustainability-plan.pdf.

———, 2024. *Fiscal Year 2025 Site Sustainability Plan Instructions*. U.S. Department of Energy Sustainability Performance Office, August 2024. Available at: https://sustainabilitydashboard.doe.gov/PDF/Resources/FY%202025%20SSP%20Instructions%20Final.docx.

Chapter 4: Air Monitoring

Erika A. Lomeli-Uribe, Katherine V. Martin, Delane P. Fitzpatrick-Maul, and Ronald W. Warren
Mission Support and Test Services, LLC

Charles B. Davis
EnviroStat

This chapter is divided into two major sections that address different categories of air monitoring. Section 4.1 presents the results of radiological air monitoring conducted on the Nevada National Security Site (NNSS) by the U.S. Department of Energy (DOE), National Nuclear Security Administration Nevada Field Office (NNSA/NFO) to verify compliance with radioactive air emission standards. Measurements of ***radioactivity***[1] in air are also used to assess the radiological ***dose*** to the general public from inhalation. The assessed dose to the public from all ***exposure*** pathways is presented in Chapter 9. Section 4.2 presents the results of nonradiological air quality assessments that are conducted to ensure compliance with NNSS air quality permits.

NNSA/NFO has also established an independent Community Environmental Monitoring Program to monitor ***radionuclides*** in air in communities adjacent to the NNSS. It is managed by the Desert Research Institute (DRI) of the Nevada System of Higher Education. DRI's offsite air monitoring results are presented in Chapter 7.

4.1 Radiological Air Monitoring and Assessment

Radiological Air Monitoring Goals

Monitor air at or near historical or current operation sites to (1) detect and identify local and site-wide trends, (2) quantify radionuclides emitted to air, and (3) detect accidental and unplanned releases.

Conduct point-source operational monitoring required under National Emission Standards for Hazardous Air Pollutants (NESHAP) for any facility with the potential to emit radionuclides to the air and cause a dose greater than 0.1 millirem per year (mrem/yr) (0.001 millisievert per year [mSv/yr]) to any member of the public. Determine if the air pathway dose to the public from past or current NNSS activities complies with the Clean Air Act (CAA) NESHAP standard of 10 mrem/yr (0.1 mSv/yr). Determine if the total radiation dose to the public from all pathways (air, water, and food) complies with the 100 mrem/yr standard set by DOE Order DOE O 458.1, "Radiation Protection of the Public and the Environment."

The sources of radioactive air emissions on the NNSS include the following: (1) ***tritium (^{3}H)*** in water (tritiated water) evaporated from containment ponds; (2) tritiated water vapor diffusing from soil at the Area 3 Radioactive Waste Management Site (RWMS), the Area 5 RWMS[2], and historical surface or near-surface nuclear explosive test locations (particularly Sedan and Schooner craters); (3) resuspension of contaminated soil at historical surface or near-surface nuclear explosive test locations; and (4) radionuclides from current operations. Figure 4-1 shows locations of known radiological air emission sources in 2024 and areas of soil contamination related to historical nuclear explosive tests. The NNSS air monitoring network consists of samplers near sites of soil contamination, at facilities that may produce radioactive air emissions, and along the NNSS boundaries.

Analytes Monitored
Americium-241 (^{241}Am)
Gamma ray emitters (includes Cesium-137 [^{137}Cs])
Tritium (^{3}H)
Plutonium-238 (^{238}Pu)
Plutonium-239+240 ($^{239+240}$Pu)
Uranium-233+234 ($^{233+234}$U)
Uranium-235+236 ($^{235+236}$U)
Uranium-238 (^{238}U)
Gross alpha radioactivity
Gross beta radioactivity

Monitored ***analytes*** include radionuclides most likely to be present in air as a result of past or current NNSS operations, based on inventories of radionuclides in surface soil (McArthur 1991) and the volatility and availability of radionuclides for resuspension (Table 1-5 lists the ***half-lives*** of these radionuclides). Uranium is included because uranium (primarily ***depleted uranium [DU]***) has been used during exercises in specific areas of the NNSS. Samples from locations near these

[1] The definition of word(s) in ***bold italics*** may be found by referencing the Glossary, Appendix B.
[2] While the Area 5 RWMS is more commonly called the Area 5 Radioactive Waste Management Complex (RWMC), RWMC refers to the entire facility, including support buildings (see Figure 10-2). The RWMS refers to the disposal cells, which are the focus of monitoring.

areas are analyzed for uranium. ***Gross alpha*** and ***gross beta*** readings are used in air monitoring as a relatively rapid screening measure.

4.1.1 Monitoring System Design

Air samplers operated at a total of 18 environmental monitoring locations on the NNSS in 2024 (Figure 4-2). Of these, 16 have both air particulate and atmospheric moisture samplers, one has only an air particulate sampler (Able Site), and one has only an atmospheric moisture sampler (North Schooner). Air samplers are positioned in predominantly downwind directions from sources of radionuclide air emissions and/or are positioned between NNSS contaminated locations and potential offsite receptors. Wind rose data, showing predominant wind directions on the NNSS, are presented in Section A.3 of *Attachment A: Site Description*.[3] Most radionuclide air emission sources are ***diffuse sources*** that include areas with (1) radioactivity in surface soil that can be resuspended by the wind, (2) tritiated water transpiring or evaporating from plants and soil at the sites of past nuclear tests, and (3) tritiated water evaporating from ponds receiving water either from contaminated wells or from tunnels that cannot be sealed. Sampling and analysis of air particulates and atmospheric moisture are performed at these locations (Section 4.1.2). Radionuclide concentrations measured at these samplers are used for analyzing trends, determining ambient ***background*** concentrations in the environment, and monitoring for unplanned releases of radioactivity.

Critical Receptor Samplers[4] – Six of the sampling locations with both air particulate and atmospheric moisture samplers are located near the boundaries and in the center of the NNSS (Figure 4-2). Radionuclide concentrations measured at these locations are used to assess compliance with the NESHAP public dose limit of 10 mrem/yr (0.1 mSv/yr). The annual average concentrations from each location are compared with Title 40 ***Code of Federal Regulations (CFR)*** Part 61, Appendix E, "NESHAP Concentration Levels for Environmental Compliance" (***concentration levels [CLs]***). The CL values for radionuclides of interest are listed in Table 4-1. Compliance with NESHAP is demonstrated by comparing annual average concentrations of each detected radionuclide with its CL. If the measured concentration is less than the CL, compliance is demonstrated. If more than one radionuclide is detected, the fractions of measured concentrations to CLs are added and compliance is demonstrated if this sum is less than 1.0 at all samplers.

Table 4-1. Concentration limits for radionuclides in air

Radionuclide	Concentration (× 10^{-15} microcuries/milliliter [µCi/mL])	
	NESHAP Concentration Level for Environmental Compliance (a)	10% of Derived Concentration Standard (b)
^{241}Am	1.9	13
^{137}Cs	19	3,800
^{3}H	1,500,000	13,000,000(c)
^{238}Pu	2.1	12
^{239}Pu	2	11
^{233}U	7.1	16
^{234}U	7.7	16
^{235}U	7.1	18
^{236}U	7.7	17
^{238}U	8.3	18

(a) From Table 2, Appendix E of 40 CFR 61 (2010).
(b) From DOE Standard DOE-STD-1196-2021, "Derived Concentration Technical Standard."
(c) Tritium as water vapor (as opposed to particulate), which is applicable to NNSS emissions.

[3] Attachment A, *Site Description*, is available on the NNSA/NFO web page at https://nnss.gov/publication-library/environmental-publications/.
[4] Proposed and formally submitted to the U.S. Environmental Protection Agency (EPA) Region 9 (EPA 2001).

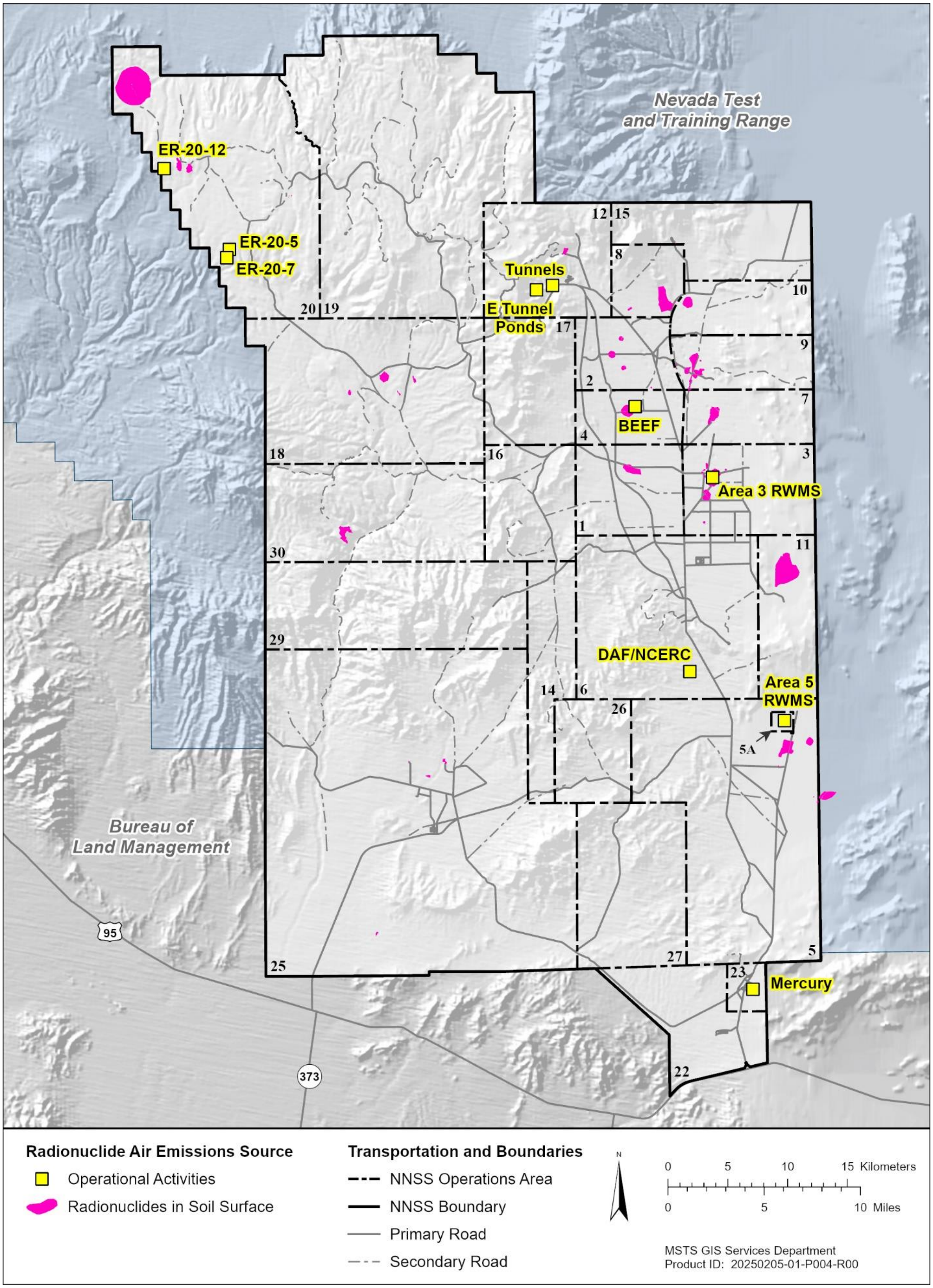

Figure 4-1. Sources of radiological air emissions on the NNSS in 2024

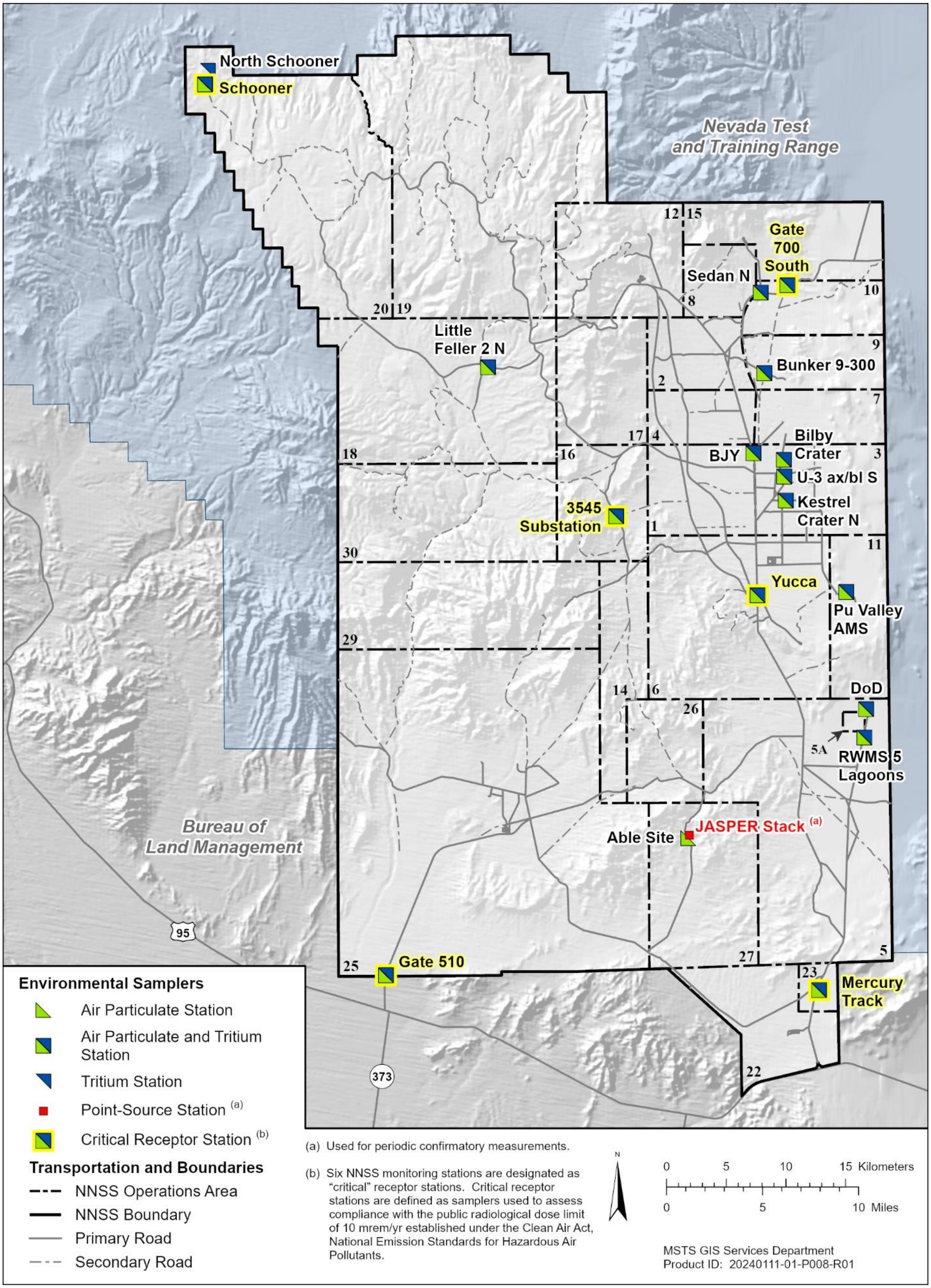

Figure 4-2. Radiological air sampling network on the NNSS in 2024

The Department of Energy has also established inhalation ***Derived Concentration Standard (DCS)*** values. They represent the annual average air concentrations that would result in an ***effective dose equivalent*** of 100 mrem/yr. Ten percent of the DCS (third column of Table 4-1) represents a 10 mrem/yr dose. It is displayed for reference. The CLs (second column) are lower, and therefore more protective. Differences between the CLs and 10% of the DCS are because the CLs represent a maximally exposed individual and consider external dose and ingestion of radionuclides deposited from air, whereas the DCS values are based only on inhalation of radionuclides in air and dose to a reference member of the population.

Point-Source (Stack) Sampler – Stack sampling is conducted at only one facility on the NNSS, the Joint Actinide Shock Physics Experimental Research facility in Area 27 (JASPER; Figure 4-2). In 2013, the potential air emissions from the facility were re-evaluated and determined to result in a potential offsite dose that is much less than the 0.1 mrem/yr threshold at which continuous stack monitoring is required under NESHAP. Therefore, only periodic sampling is recommended to verify low emissions. The sample collected during 2024 was taken February 13 through 14. No man-made radionuclides were detected in the sample, which again confirmed the 2013 assessment that this source's potential emission is less than 1% of the standard.

4.1.2 Air Particulate and Tritium Sampling Methods

A sample is collected from each air particulate sampler by drawing air through a 10-centimeter (4-inch) diameter glass-fiber filter at a flow rate of about 78 liters (2.75 cubic feet [ft^3]) per minute. The particulate filter is mounted in a filter holder that faces downward at a height of about 1.5 meters (m) (5 feet [ft]) above ground. A timer measures the operating time. The run time multiplied by the flow rate yields the volume of air sampled, which is about 1,570 cubic meters (m^3) (55,500 ft^3) during a typical 14-day sampling period. The air sampling rates are measured using mass-flow meters. The filters are collected every 2 weeks.

Filters are analyzed for gross alpha and gross beta radioactivity after an approximate 5-day holding time to allow for the decay of naturally occurring ***radon progeny***. They are then composited quarterly for each sampler. The composite samples are analyzed for gamma-emitting radionuclides (which includes ^{137}Cs) by gamma ***spectrometry,*** and for ^{238}Pu, $^{239+240}$Pu, and ^{241}Am by alpha spectrometry after chemical separation. Samples from nine locations relatively near potential sources of uranium emissions are also analyzed for uranium isotopes by alpha spectrometry. These sampling locations are: BJY (Area 1), RWMS 5 Lagoons (Area 5), Yucca (Area 6), Bunker 9-300 (Area 9), Sedan Crater N (Area 10), Gate 700 South (Area 10), 3545 Substation (Area 16), Gate 510 (Area 25), and Able Site (Area 27).

Atmospheric moisture samples, for measuring tritium in air, are collected by continuously drawing air through molecular sieve desiccant at a flow rate of about 500 cubic centimeters per minute (1.1 ft^3 per hour). The air intake is about 1.5 m (5 ft) above ground. A timer measures the operating time. The run time multiplied by the flow rate yields the volume of air sampled, which is about 11 m^3 (388 ft^3) over a 2-week sampling period. The molecular sieve desiccant is exchanged every 2 weeks. Water is extracted from the desiccant and analyzed for ^{3}H by liquid scintillation counting.

Measured radioactivity in each sample is converted to units per volume of air prior to the reporting described in the following sections.

Rotary vane pumps, designed for long-term continuous use at constant flow rates, are used. Fixed precision metal orifices installed on the pump inlet control flow rates. Specifically, these are a 0.136-inch diameter orifice (O'Keefe Controls Co. part G-136-BR) for air particulate sampling and a 0.0102-inch orifice (O'Keefe Controls Co. part G-10-BR) for atmospheric moisture sampling. The normal air flow rate produced by this setup does not vary significantly over the sampling period and meets the definition of constant flow (DOE 1981, 2015; Health Physics Society 2021).

Quality control air samples (e.g., duplicates, blanks, and spikes) are also routinely incorporated into the analytical suites. Chapter 14 contains a discussion of ***quality assurance/quality control*** protocols and procedures.

4.1.3 Presentation of Air Sampling Data

The 2024 annual average radionuclide concentrations at each air sampling location are presented in the following sections. The annual average (mean) concentration for each radionuclide is estimated from uncensored analytical results for individual samples; i.e., values less than their analysis-specific ***minimum detectable concentrations (MDCs)*** are included in the calculation. $^{239+240}$Pu, $^{233+234}$U, and $^{235+236}$U are reported as the sum of isotope concentrations because the analytical method cannot readily distinguish the individual ***isotopes***. Where field duplicate measurements are available, plots and summaries use the average of the regular and field duplicate measurements.

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

4.1.4 Air Sampling Results

Radionuclide concentrations in the air samples shown in the following tables and graphs are attributed to the resuspension of legacy contamination in surface soils, the upward flux of ^{3}H from the soil at sites of past nuclear tests, buried low-level radioactive waste, or NNSS operations. Tables 4-2 through 4-7 and Figures 4-3 through 4-7 include data for all environmental locations that collect air particulate samples (the North Schooner Station is excluded from these data sets because only atmospheric moisture is sampled at that location). Table 4-8 and Figure 4-10 include data for all environmental locations that collect samples to measure ^{3}H in atmospheric moisture (Able Site is excluded from this data set because only air particulates are sampled at that location).

4.1.4.1 Gross Alpha and Gross Beta

Gross alpha and gross beta radioactivity measurements in air samples collected in 2024 are summarized in Tables 4-2 and 4-3. CL values do not exist for gross alpha and gross beta concentrations in air because these radioactivity measurements include naturally occurring radionuclides (such as ^{40}K, ^{7}Be, uranium, thorium, and the ***daughter isotopes*** of uranium and thorium) in uncertain proportions. However, these analyses are useful in that results can be economically obtained just 5 days after sample collection to identify any increases requiring investigation.

Overall, the mean gross alpha and gross beta results across the network are comparable with those of the past few years.

Table 4-2. Gross Alpha radioactivity in air samples collected in 2024

			Gross Alpha (x 10^{-16} µCi/mL)			
Area	**Station**	**Number of Samples**	**Mean**	**Standard Deviation**	**Minimum**	**Maximum**
1	BJY	26	34.79	22.94	-11.10	70.07
3	Bilby Crater	26	42.15	29.27	-15.55	126.78
3	Kestrel Crater N	26	43.91	39.82	-14.64	173.03
3	U-3ax/bl S	26	43.89	30.54	-12.56	106.82
5	DoD	26	30.97	21.40	-4.79	105.06
5	RWMS 5 Lagoons	26	30.22	23.72	-12.69	95.06
6	Yucca*	26	43.13	39.28	-6.08	161.51
9	Bunker 9-300	26	117.17	65.10	2.58	237.73
10	Gate 700 S*	26	29.07	32.78	-14.63	166.15
10	Sedan N	26	38.56	24.36	-9.78	82.56
11	Pu Valley AMS	26	60.40	50.55	-15.56	227.40
16	3545 Substation*	26	26.65	17.44	-9.06	60.87
18	Little Feller 2 N	26	27.46	20.27	-13.36	72.04
20	Schooner*	26	27.89	18.40	-4.11	65.40
23	Mercury Track*	26	30.87	22.89	-6.36	79.66
25	Gate 510*	26	27.80	17.99	-10.30	67.37
27	Able Site	26	29.65	22.31	-8.17	89.06
All Environmental Locations		**442**	**40.27**	**37.79**	**-15.56**	**237.73**

* Critical Receptor Station

Table 4-3. Gross Beta radioactivity in air samples collected in 2024

Area	Station	Number of Samples	Gross Beta (x 10^{-15} µCi/mL) Mean	Standard Deviation	Minimum	Maximum
1	BJY	26	23.78	7.35	12.44	45.07
3	Bilby Crater	26	24.04	7.91	10.93	46.19
3	Kestrel Crater N	26	22.29	10.10	4.99	46.03
3	U-3ax/bl S	26	24.65	7.57	11.18	45.12
5	DoD	26	25.91	8.90	12.88	54.02
5	RWMS 5 Lagoons	26	26.09	8.49	12.88	51.36
6	Yucca*	26	25.24	8.18	13.08	49.55
9	Bunker 9-300	26	24.04	8.33	11.79	47.58
10	Gate 700 S*	26	24.35	8.38	12.95	50.75
10	Sedan N	26	24.06	7.79	12.06	45.61
11	Pu Valley AMS	26	23.74	7.97	12.14	46.37
16	3545 Substation*	26	22.87	7.59	10.85	45.32
18	Little Feller 2 N	26	22.34	7.52	11.12	44.42
20	Schooner*	26	22.91	7.99	11.33	43.43
23	Mercury Track*	26	24.39	8.03	11.33	50.10
25	Gate 510*	26	25.57	8.43	13.72	50.60
27	Able Site	26	24.15	7.58	12.19	46.16
All Environmental Locations		**442**	**24.14**	**8.08**	**4.99**	**54.02**

* Critical Receptor Station

4.1.4.2 Americium-241

The overall mean ^{241}Am concentration for environmental sampler locations was 46.45 × 10^{-18} µCi/mL in 2024. This is somewhat higher than the annual means for the previous 13 years (8.55 to 20.32 × 10^{-18} µCi/mL). Even so, the 2024 average concentration is only 2.44% of the CL (shown at the bottom of Table 4-4). In the plots (Figures 4-3, 4-4, and 4-5) for ^{241}Am and other actinides (^{238}Pu and $^{239+240}$Pu), values for Pu Valley AMS, Bunker 9-300, and Sedan N (Areas 11, 9, and 10, respectively) are shown individually, as these stations tend to have higher measurements. The highest quarterly value for ^{241}Am was 393.45 × 10^{-18} µCi/mL at Bunker 9-300 for the second quarter. Area 1 and Area 3 stations are grouped together, with a green vertical bar extending from the lowest to highest values in the quarter and all other stations are grouped similarly, using black vertical bars. Small, dashed lines connect the quarterly means. While some fraction of the CL is displayed in figures, the CL is applicable to annual average concentrations.

Table 4-4. Concentrations of ^{241}Am in air samples collected in 2024

Area	Station	Number of Samples	^{241}Am (x 10^{-18} µCi/mL) Mean	Standard Deviation	Minimum	Maximum
1	BJY	4	32.61	18.51	14.80	55.42
3	Bilby Crater	4	34.89	15.99	13.41	47.75
3	Kestrel Crater N	4	64.65	54.90	9.34	139.96
3	U-3ax/bl S	4	57.59	35.30	23.90	107.16
5	DoD	4	3.74	2.73	1.56	7.57
5	RWMS 5 Lagoons	4	7.90	5.20	2.97	13.89
6	Yucca*	4	32.74	44.74	5.89	99.41
9	Bunker 9-300	4	304.78	72.07	219.12	393.45
10	Gate 700 S*	4	7.43	7.16	0.00	16.36
10	Sedan N	4	36.45	19.19	18.59	59.18
11	Pu Valley AMS	4	176.66	143.08	43.88	350.74
16	3545 Substation*	4	4.21	1.92	1.75	6.18
18	Little Feller 2 N	4	7.40	5.54	0.00	12.91
20	Schooner*	4	7.69	2.73	3.83	10.18
23	Mercury Track*	4	2.93	2.29	1.71	6.36
25	Gate 510*	4	3.83	2.24	1.43	6.24
27	Able Site	4	4.11	4.84	-1.74	10.12
All Environmental Locations		**68**	**46.45**	**86.28**	**-1.74**	**393.45**

CL = 1900 × 10^{-18} µCi/mL

* Critical Receptor Station

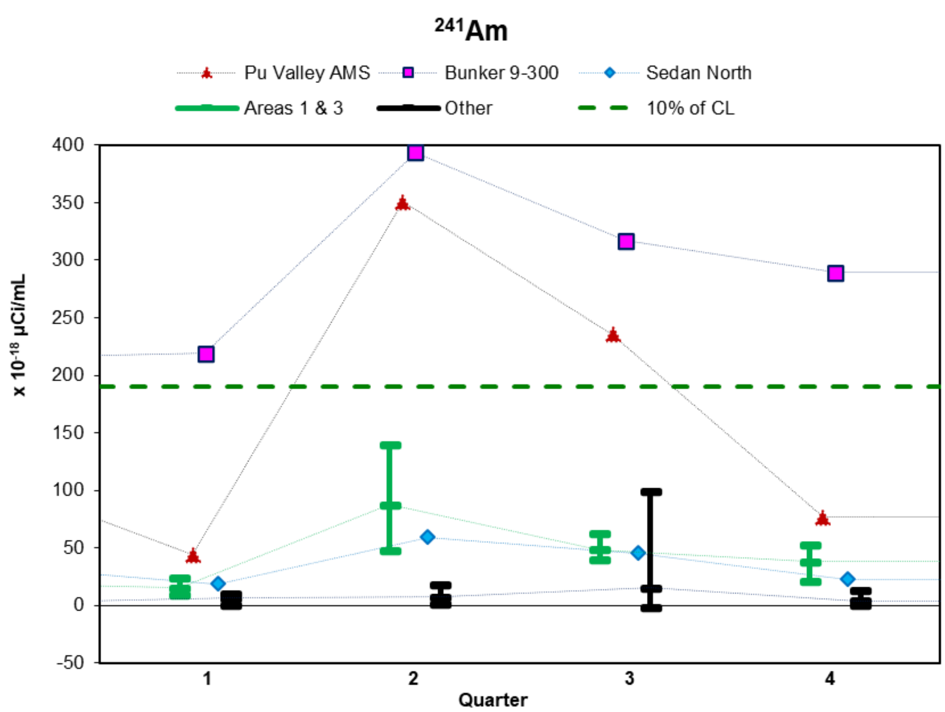

Figure 4-3. Concentrations of ^{241}Am in air samples collected in 2024

4.1.4.3 Plutonium Isotopes

The overall mean concentration for ^{238}Pu at environmental samplers in 2024 (4.95 × 10^{-18} µCi/mL) (Table 4-5) is within the range of values (0.98 to 5.54 × 10^{-18} µCi/mL) observed over the previous 13 years. The highest 2024 quarterly value (45.96 × 10^{-18} µCi/mL in quarter 4) was at Bunker 9-300 in Area 9; this is 2.2% of the CL (Figure 4-4).

The $^{239+240}$Pu isotopes are of greater abundance and hence greater interest. The overall mean of 276.90 × 10^{-18} µCi/mL in 2024 is above the range of annual mean values measured 2011 through 2023 (14.31 to 103.50 × 10^{-18} µCi/mL). This was greatly due to the Bunker 9-300 location, which had the location with the highest annual average (2314.49 × 10^{-18} µCi/mL) due to the second quarter's result (3736.87 × 10^{-18} µCi/mL). Very dry and windy conditions and this sampler's proximity to several contamination areas was likely the reason for these higher concentrations (Table 4-6 and Figure 4-5). Although this location's annual average exceeded the annual average CL value, it is not a location where the public has access or resides.

The concentrations of ^{241}Am, $^{239+240}$Pu, and to some extent ^{238}Pu, often show similar patterns through time at Bunker 9-300, Plutonium Valley AMS, and other areas of known contamination from past nuclear tests. This is because ^{241}Am is the long-lived ***daughter product*** obtained when ^{241}Pu (a short-lived isotope created along with the more common Pu isotopes) decays by beta emission. Hence $^{239+240}$Pu and ^{241}Am (and ^{238}Pu) tend to be found together in particles of Pu remaining from past tests. The half-life of ^{241}Pu is 14.4 years, whereas that of ^{241}Am is 432 years. Consequently, the amount of ^{241}Am will gradually increase temporarily as ^{241}Pu decays, and then it will decrease.

Table 4-5. Concentrations of ^{238}Pu in air samples collected in 2024

			^{238}Pu (x 10^{-18} µCi/mL)			
Area	**Station**	**Number of Samples**	**Mean**	**Standard Deviation**	**Minimum**	**Maximum**
1	BJY	4	3.44	2.20	0.43	5.52
3	Bilby Crater	4	4.69	1.92	2.02	6.27
3	Kestrel Crater N	4	5.21	3.63	1.91	9.84
3	U-3ax/bl S	4	5.82	3.36	0.84	8.05
5	DoD	4	0.46	0.65	-0.24	1.29
5	RWMS 5 Lagoons	4	0.10	0.84	-0.78	0.88
6	Yucca*	4	3.42	4.02	0.00	8.49
9	Bunker 9-300	4	29.50	13.24	13.79	45.96
10	Gate 700 S*	4	2.35	1.15	0.90	3.60
10	Sedan N	4	9.21	7.25	2.61	19.21
11	Pu Valley AMS	4	15.45	12.38	4.36	27.69
16	3545 Substation*	4	0.00	0.72	-0.67	1.02
18	Little Feller 2 N	4	0.68	1.25	-0.42	2.42
20	Schooner*	4	3.51	2.75	0.83	5.96
23	Mercury Track*	4	0.14	0.99	-0.86	1.31
25	Gate 510*	4	0.72	1.56	-0.84	2.36
27	Able Site	4	-0.46	1.23	-2.01	1.01
All Environmental Locations		**68**	**4.95**	**8.60**	**-2.01**	**45.96**

CL = 2100 × 10^{-18} µCi/mL

* Critical Receptor Station

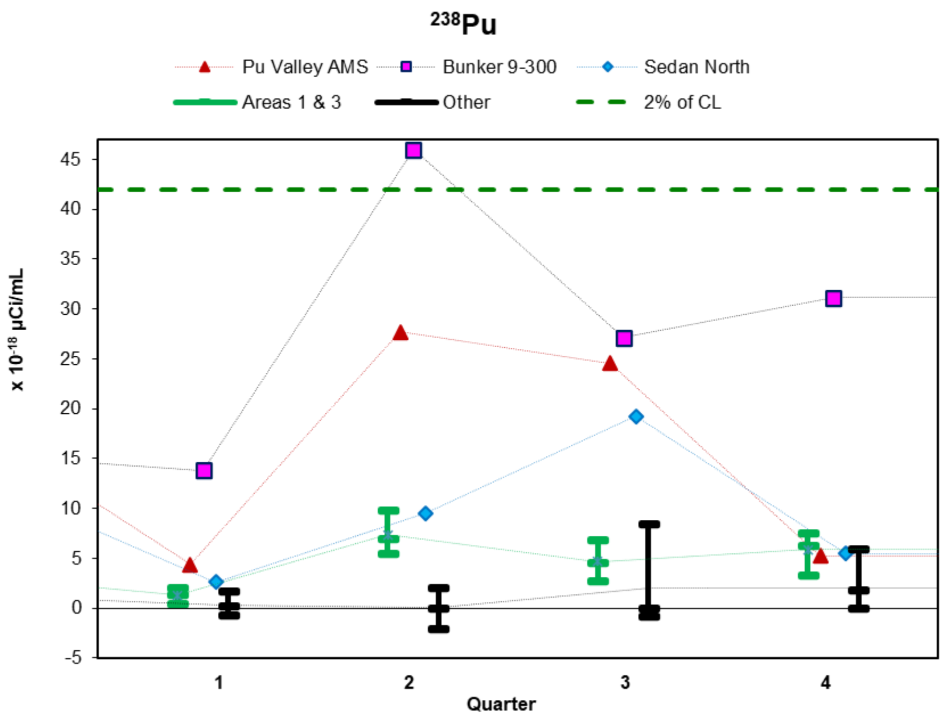

Figure 4-4. Concentrations of ^{238}Pu in air samples collected in 2024

Table 4-6. Concentrations of $^{239+240}$Pu in air samples collected in 2024

			$^{239+240}$Pu (x 10^{-18} µCi/mL)			
Area	**Station**	**Number of Samples**	**Mean**	**Standard Deviation**	**Minimum**	**Maximum**
1	BJY	4	158.78	124.13	18.73	266.37
3	Bilby Crater	4	307.94	173.73	52.14	421.85
3	Kestrel Crater N	4	350.07	334.33	17.14	814.33
3	U-3ax/bl S	4	300.74	163.28	86.93	480.49
5	DoD	4	6.08	3.26	1.87	9.80
5	RWMS 5 Lagoons	4	16.59	22.23	0.00	48.52
6	Yucca*	4	186.88	310.74	5.51	651.99
9	Bunker 9-300	4	2314.49	1053.14	1193.35	3736.87
10	Gate 700 S*	4	29.00	18.51	10.75	54.53
10	Sedan N	4	181.75	146.31	45.65	362.76
11	Pu Valley AMS	4	826.23	644.41	179.75	1577.49
16	3545 Substation*	4	1.77	1.13	0.66	3.29
18	Little Feller 2 N	4	13.46	9.56	1.67	21.33
20	Schooner*	4	6.95	8.74	0.41	19.69
23	Mercury Track*	4	3.41	1.90	1.31	5.27
25	Gate 510*	4	1.35	1.63	0.36	3.77
27	Able Site	4	1.74	1.93	-0.50	3.79
All Environmental Locations		**68**	**276.90**	**623.38**	**-0.50**	**3736.87**

CL = 2000 × 10^{-18} µCi/mL

* Critical Receptor Station

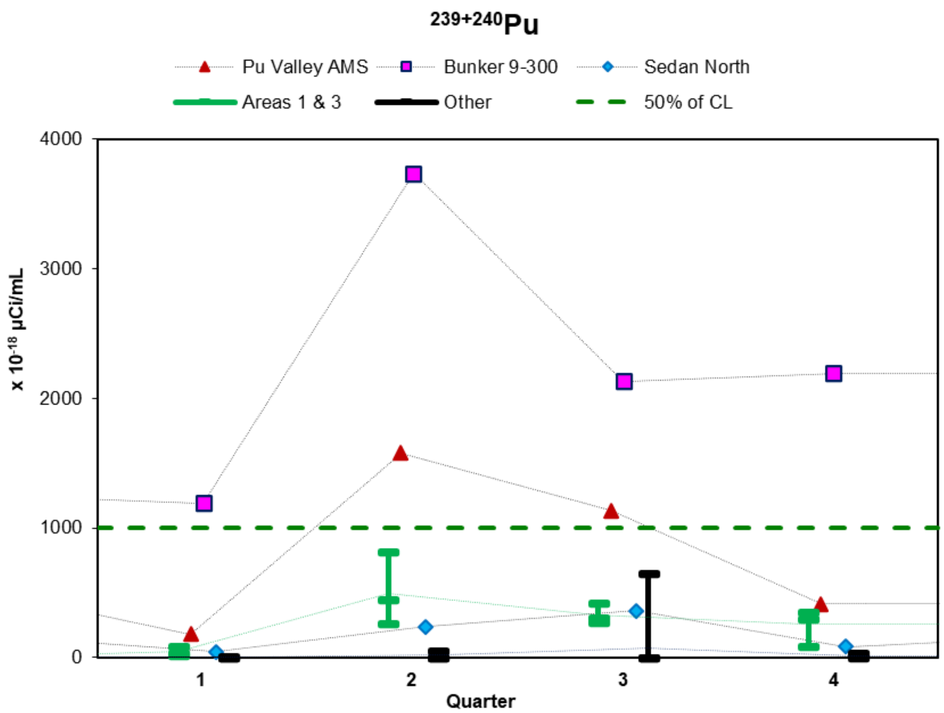

Figure 4-5. Concentrations of $^{239+240}$Pu in air samples collected in 2024

Figure 4-6 shows long-term trends in $^{239+240}$Pu annual mean concentrations at locations with at least 15-year data histories since 1971. Rather than showing the time histories for all 50 such locations, Figure 4-6 shows the average (geometric mean) trend lines for Areas 1 and 3; Area 5; Areas 7, 9, 10, and 15; and other areas. Areas 1, 3, 7, 9, 10, and 15 in the northeast portion of the NNSS have a legacy of soil contamination from surface and atmospheric nuclear tests and safety experiments. The average annual rates of decline for these groups range from 2.2% (Areas 1 and 3) and 2.1% (Areas 7, 9, 10, and 15) to 10.4% and 10.6% (the Area 5 and other area groups). This equates to an average reduction in $^{239+240}$Pu concentration by half every 31.8 years for Areas 1 and 3; 32.7 years for Areas 7, 9, 10, and 15; 6.3 years for Area 5; and 6.2 years for the other areas. Declining rates are not attributable to ***radioactive decay*** alone, as the physical half-lives of ^{239}Pu and ^{240}Pu are 24,110 and 6,537 years, respectively. The decreases are due primarily to immobilization and dilution of Pu particles in surface soil, resulting in reduced concentrations re-suspended in air. The half-life of the less abundant ^{238}Pu is 88 years.

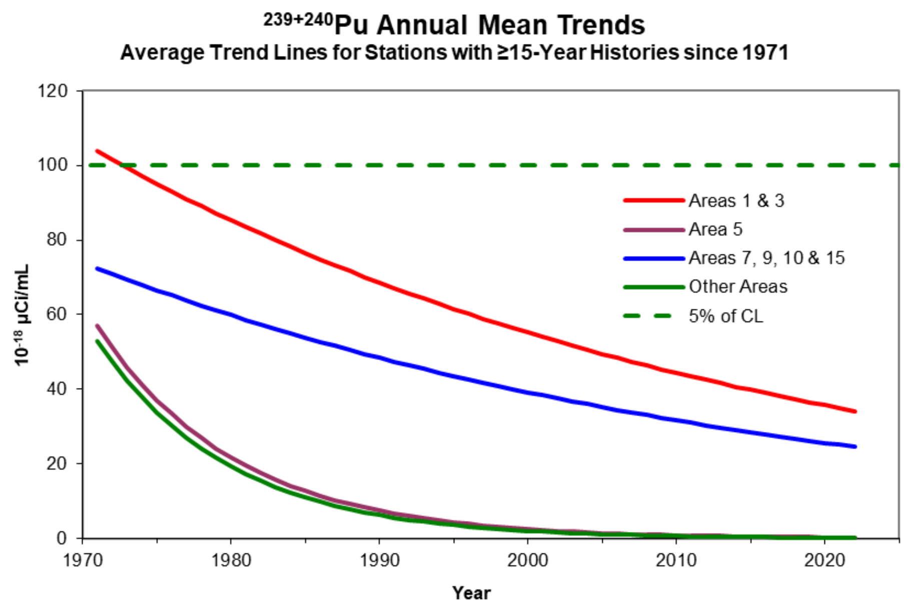

Figure 4-6. Average trends in $^{239+240}$Pu in air annual means, 1971-2024

4.1.4.4 Cesium-137

Cesium-137 was detected in seven samples during 2024. These were the second quarter values at Kestrel Crater, U-3AX/BL S, Bunker 9-300, Gate 700 S, and Sedan N; and also the first and third quarter values at Sedan N. Most were slightly above their MDCs; the only larger exceedance was at Sedan N in the third quarter, about 2.7 times its MDC. The mean, standard deviation, minimum, and maximum for all sample locations are listed in Table 4-7. The maximum quarterly concentration (Sedan N, third quarter) was 4.2% of the CL. Figure 4-7 shows all stations grouped together by quarter with a vertical bar extending from the lowest to the highest value for the quarter. The quarterly means are connected by a dotted line.

Table 4-7. Concentration of ^{137}Cs in air samples collected in 2024

			^{137}Cs (x 10^{-17} µCi/mL)			
Area	**Station**	**Number of Samples**	**Mean**	**Standard Deviation**	**Minimum**	**Maximum**
1	BJY	4	2.56	10.74	-11.36	11.28
3	Bilby Crater	4	-0.36	7.98	-5.21	11.52
3	Kestrel Crater N	4	12.79	16.30	0.00	34.48
3	U-3ax/bl S	4	5.22	11.69	-2.08	22.64
5	DoD	4	0.53	1.47	-0.57	2.66
5	RWMS 5 Lagoons	4	-12.48	11.84	-27.24	-0.22
6	Yucca*	4	-4.44	5.82	-11.50	2.22
9	Bunker 9-300	4	4.03	12.51	-5.78	21.82
10	Gate 700 S*	4	17.92	8.32	10.74	27.60
10	Sedan N	4	42.04	32.82	-0.19	79.40
11	Pu Valley AMS	4	-4.33	14.19	-22.90	10.99
16	3545 Substation*	4	-3.05	5.17	-7.94	3.82
18	Little Feller 2 N	4	12.45	7.85	5.39	23.26
20	Schooner*	4	3.90	2.61	0.92	7.27
23	Mercury Track*	4	-1.51	5.07	-8.83	1.96

Table 4-7. Concentration of ^{137}Cs in air samples collected in 2024

Area	Station	Number of Samples	^{137}Cs (x 10^{-17} µCi/mL) Mean	Standard Deviation	Minimum	Maximum
25	Gate 510*	4	-3.45	12.87	-15.05	14.83
27	Able Site	4	-5.61	9.23	-18.63	2.67
All Environmental Locations		**68**	**3.90**	**16.28**	**-27.24**	**79.40**

CL = 1900 × 10^{-17} µCi/mL

* Critical Receptor Station

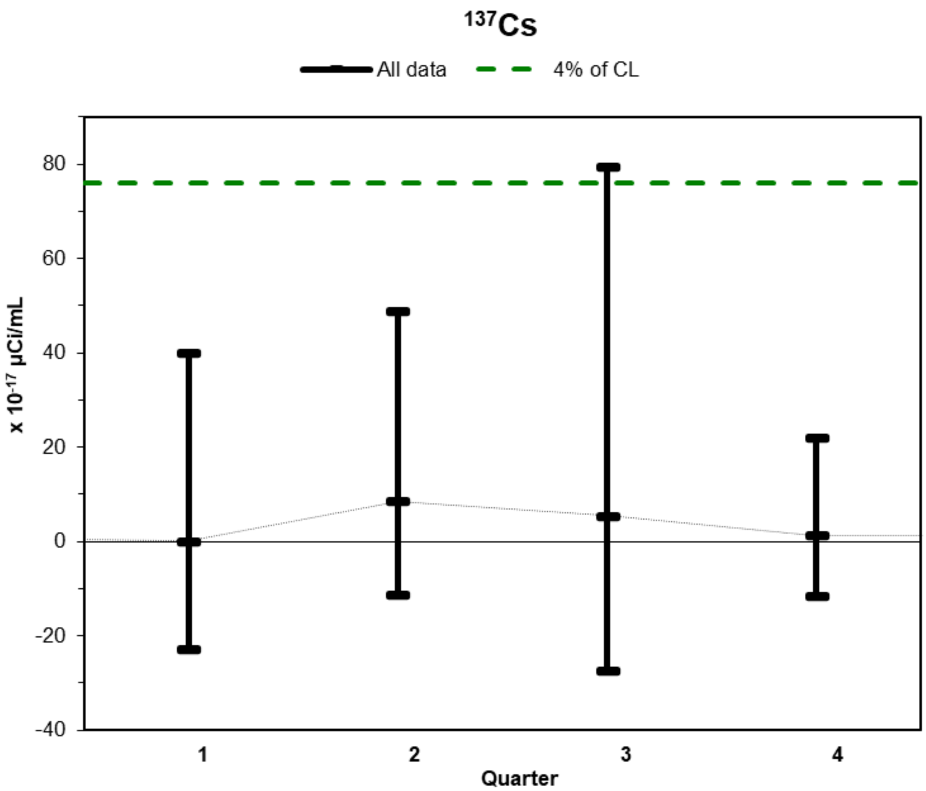

Figure 4-7. Concentrations of ^{137}Cs in air samples collected in 2024

4.1.4.5 Uranium Isotopes

Uranium analyses were performed in 2024 for samples collected near sites where exercises using uranium (predominately DU) have been conducted. Samples from the nine samplers identified in Section 4.1.2 were analyzed. Uranium is also a naturally occurring radionuclide, so tests were conducted to determine if man-made uranium materials are present. Ratios of the U isotopes ($^{233+234}U$ / ^{238}U and $^{235+236}U$ / ^{238}U) were compared among the samplers and compared with ratios found in blank filters. No evidence of DU or man-made uranium materials was observed in these comparisons.

4.1.4.6 Tritium

Tritium concentrations in air vary widely across the NNSS (Table 4-8). As in previous years, the sample location with the highest annual mean concentration is at the Schooner sampler (94.35×10^{-6} picocuries per milliliter [pCi/mL]); this is 6.3% of the CL. Figure 4-8 shows these data with Schooner results plotted at one-tenth of their actual values to allow the variation at other locations to be visible. Mean concentrations at other locations are less than 0.72% of the CL.

Tritium released to the environment quickly oxidizes into tritiated water. Tritium from past nuclear tests or buried waste diffuses into the surrounding soil and rubble until it moves to the surface and is emitted either through evaporation or plant transpiration. Because of this, higher ^{3}H concentrations in air are generally observed in the summer months. Increased ^{3}H emissions are likely due to the movement of relatively deep soil moisture (> 2 m) containing relatively high concentrations of ^{3}H to the surface when temperatures are the highest and when shallow (< 2 m) soil moisture is the lowest. During the summer months, rainfall can temporarily suppress these emissions by diluting ^{3}H in the atmosphere and in the shallow soil moisture. Figure 4-8 shows the relationship between ^{3}H and average daily temperature at Schooner Crater. Figure 4-9 shows the amount of precipitation occurring during monitoring periods at the Schooner sample location. In 2024, there was less late summer precipitation than in 2023; one can compare the patterns in ^{3}H in Figure 4-9 with those in the 2023 Nevada National Security Site Environmental Report. The points plotted in these figures show the average ^{3}H concentrations in air for 2-week periods. The average temperature and total precipitation are from the Schooner Crater meteorological station for those periods.

Figure 4-10 shows average (geometric mean) long-term trends for the annual mean ^{3}H levels at locations with at least 7-year histories, by area groups. Tritium levels have been decreasing through time. The overall average decline rate for samplers other than Schooner is around 13.1% per year. The decline rate for Schooner has been about 12.7% per year since 2002. These correspond to half-lives in the environment of approximately 4.9 and 6.7 years, respectively. The lowest two lines end up at 0.04 and 0.10 respectively in 2024. The line for Areas 6 through 12 is a bit higher than last year due to the addition of results from the Pu Valley AMS (air monitoring station) in Area 11. It met the 7-year criterion for the first time and its early values are somewhat higher than those of the other stations in this area group.

4.1.4.6.1 Tritium Monitoring at the North Las Vegas Facility

In 1995, a container of tritium-aluminum foils was opened in Building A-01 at the North Las Vegas Facility (NLVF) and emitted tritium into a basement area used as a fixed radiation source range (DOE 1996). Constant sampling of tritium in air began immediately and continued through 1998. Beginning in 1999, air sampling for tritium in the basement has been conducted intermittently. For Calendar Year (CY) 2024, the results of two atmospheric moisture samples were 110 picocuries per cubic meter (pCi/m^3) for the sample collected April 9–16, 2024, and 78 pCi/m^3 for the sample collected September 9–16, 2024. The average of these sample results (94 pCi/m^3) was multiplied by the room ventilation rate to estimate the total annual emission (0.94 microcuries per year). This is lower than values observed over the past 10 years.

Table 4-8. Concentrations of ^{3}H in air samples collected in 2024

			^{3}H Concentration (x 10^{-6} pCi/mL)			
Area	**Station**	**Number of Samples**	**Mean**	**Standard Deviation**	**Minimum**	**Maximum**
1	BJY	26	0.36	0.55	-0.48	2.26
3	Bilby Crater	26	0.20	0.44	-0.66	1.38
3	Kestrel Crater N	26	0.42	0.54	-0.29	1.78
3	U-3ax/bl S	26	0.56	0.62	-0.36	2.13
5	DoD	26	1.29	1.25	-0.14	4.28
5	RWMS 5 Lagoons	26	2.16	2.56	-0.73	10.62
6	Yucca*	26	0.29	0.51	-0.64	1.25
9	Bunker 9-300	24	0.48	0.51	-0.47	1.40
10	Gate 700 S*	26	0.28	0.40	-0.44	1.10
10	Sedan N	26	1.03	0.92	-0.36	2.95
11	Pu Valley AMS	26	1.06	0.85	-0.16	2.87
16	3545 Substation*	26	0.23	0.39	-0.56	0.95
18	Little Feller 2 N	26	0.13	0.41	-0.78	0.98
20	North Schooner	26	1.12	0.93	-0.32	4.01
20	Schooner*	26	35.29	35.80	1.42	94.35
23	Mercury Track*	26	0.31	0.52	-0.67	1.79
25	Gate 510*	26	0.20	0.47	-0.58	1.24
All Environmental Locations		**440**	**2.67**	**11.85**	**-0.78**	**94.35**

CL = 1500 × 10^{-6} pCi/mL

* Critical Receptor Station

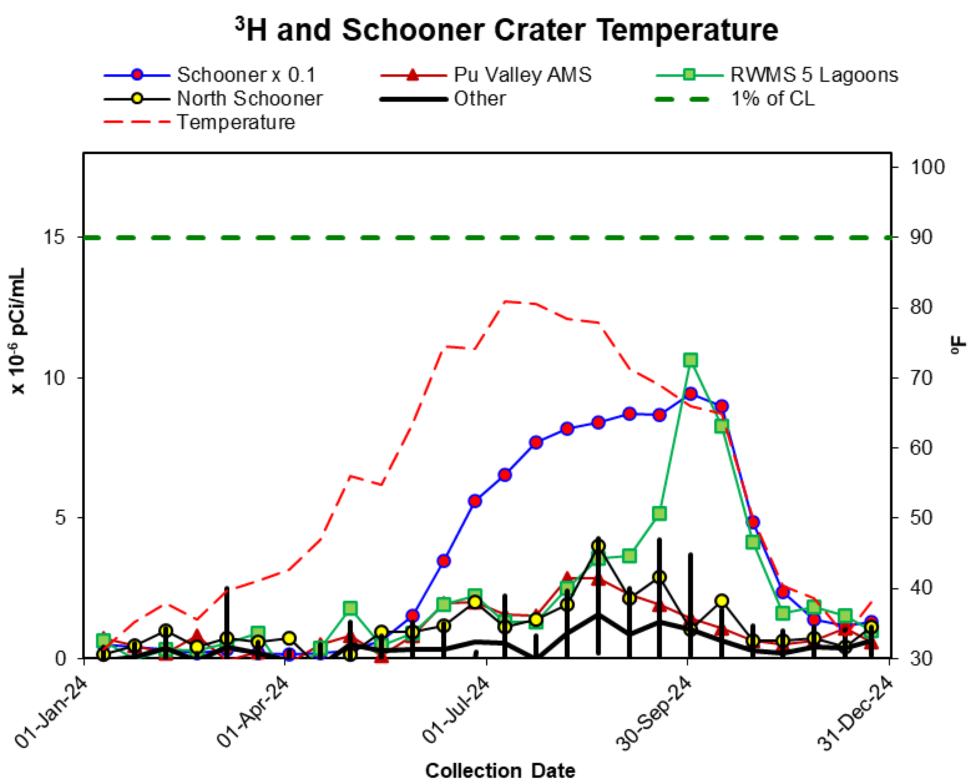

Figure 4-8. Concentrations of ^{3}H in air samples collected in 2024 with the average air temperature near the Schooner sampler during the collection period

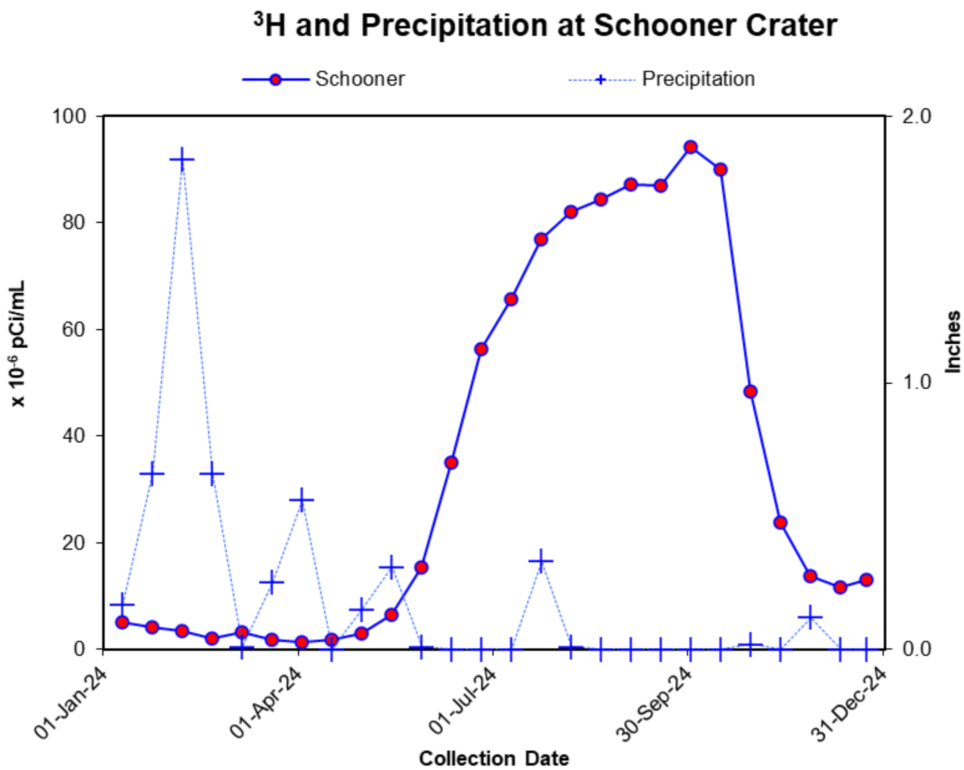

Figure 4-9. Concentrations of ^{3}H in air and amount of precipitation at Schooner during the sample collection period

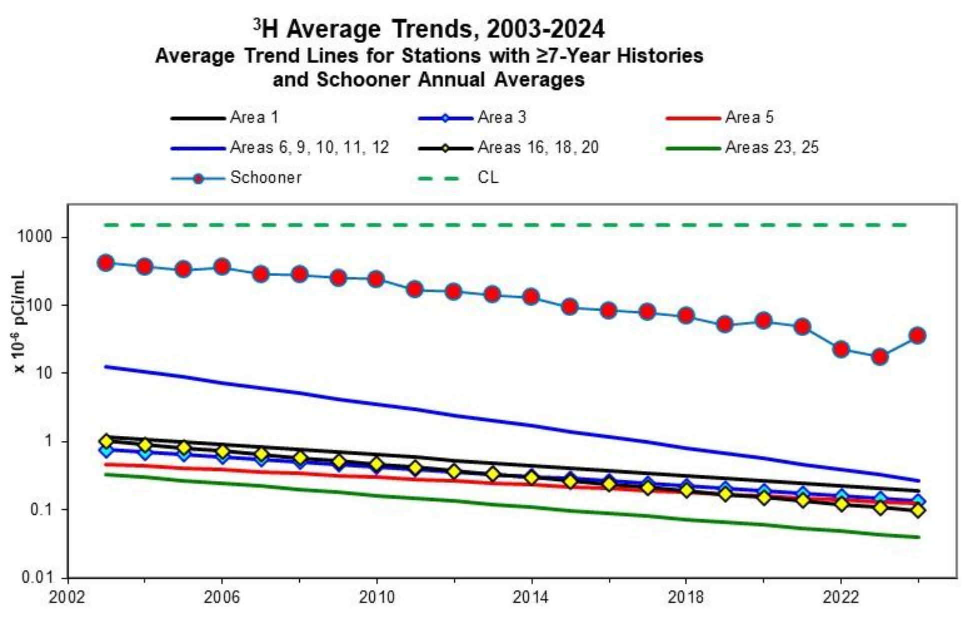

Figure 4-10. Average trend lines for annual mean ^{3}H air concentrations for Area groups, 2003-2024

4.1.5 Unplanned Releases

There were no unplanned releases of radionuclides during 2024. Five wildland fires were documented on the NNSS in 2024. Three were human-caused or project related, one was caused by lightning, and one was caused by an unknown source. The Ribbon Cliff Fire was the largest and burned approximately 3,228 hectares (7,977 acres) in Area 20. The remaining fires were all less than 0.5 hectares (1.2 acres) in size. None resulted in a detected release of radionuclides.

4.1.6 Estimate of Total NNSS Radiological Atmospheric Releases

Each year, existing operations that have the potential for airborne emissions of radioactive materials are reviewed. Quantities of radionuclides released during these operations and from legacy contamination sites are measured or calculated to obtain the total annual quantity of radiological atmospheric releases from the NNSS. The estimates and methods are described in detail in the NESHAP annual report for 2024 (Mission Support and Test Services, LLC [MSTS], 2025).

Total emissions during 2024, by radionuclide, are shown in Table 4-9. Radionuclide emissions by source are shown in Table 4-10. Their locations in relation to critical receptor air monitoring locations are shown in Figure 4-1.

In 2024, an estimated 398 curies (Ci) of radionuclides were released as air emissions. Of this amount, about 60% (240 Ci) was from the very short-lived (15.3 minute) metastable xenon-135 (Table 4-9 lists radionuclide name, half-life, and amount emitted). Short-lived radionuclides decay very quickly and are essentially not available to contribute dose to the public at the 31- to 62-kilometer (19- to 38-mile) distances over which they must travel. Of the total emission, noble gases make up about 74%, tritium makes up about 8.8%, and the radionuclides in the "Other" category (Table 4-9) make up about 17.4%.

Table 4-9. Total estimated NNSS radionuclide emissions for 2024

Radionuclide	Symbol	Half-life[(a)]	Total Quantity (Ci)
Primary Radionuclides			
Tritium	^{3}H	12.32 years (yr)	35
Plutonium-238	^{238}Pu	87.7 yr	0.038
Plutonium-239+240	$^{239+240}Pu$	24,110 yr	0.29
Americium-241	^{241}Am	432 yr	0.07
Noble Gases			
Argon-41	^{41}Ar	109.61 minutes (min)	0.19
metastable Krypton-85	^{85m}Kr	4.48 hours (h)	14
Xenon-133	^{133}Xe	5.24 days (d)	2.6
metastable Xenon-133	^{133m}Xe	2.19 d	0.18
Xenon-135	^{135}Xe	9.14 h	36
metastable Xenon-135	^{135m}Xe	15.29 min	240
Other			
Strontium-90	^{90}Sr	28.79 yr	0.046
Antimony-125	^{125}Sb	2.76 yr	0.00014
Tellurium-132	^{132}Te	3.2 d	3
Iodine-131	^{131}I	8.02 d	0.86
Iodine-133	^{133}I	20.8 h	16
Iodine-135	^{135}I	6.57 h	48
Cesium-137	^{137}Cs	30.17 yr	0.045
Barium-140	^{140}Ba	12.75 d	1
Lanthanum-140	^{140}La	1.68 d	0.000000077
Samarium-153	^{153}Sm	1.94 d	0.16
Europium-152	^{152}Eu	13.54 yr	0.0071
Europium-154	^{154}Eu	8.59 yr	0.000056
Depleted Uranium	DU	>159,200 yr	0.13

(a) Source: International Commission on Radiological Protection (2008).

Table 4-10. Radiological atmospheric releases from the NNSS for 2024

Emission Source[(a)]	Emission Control	Radionuclide	Quantity (Ci/y)
Historical Contamination Sites			
Grouped Area Sources– All NNSS Areas	None	^{3}H	21
		^{90}Sr	0.045
		^{137}Cs	0.044
		^{152}Eu	0.0071
		^{154}Eu	0.000056
		^{238}Pu	0.038
		$^{239+240}Pu$	0.29
		^{241}Am	0.07
E-Tunnel Ponds	None	^{3}H	3.3
Building A-01, basement ventilation, NLVF	None	^{3}H	0.00094
2024 Operations			
BEEF[(b)]	None	DU	0.055
Area 3 RWMS	Soil cover over waste	^{3}H	5.5
Area 5 RWMS	Soil cover over waste	^{3}H	3.9
Area 23 Mission Support Buildings[(c)]	None	^{3}H	0.00000048
DAF[(d)]	HEPA filter[(e)]	^{239}Pu	0.0017
NCERC[(f)]	HEPA filter	^{3}H	0.0000049
		^{41}Ar	0.19
		^{85m}Kr	14
		^{90}Sr	0.0011
		^{125}Sb	0.00014
		^{132}Te	3
		^{131}I	0.86
		^{133}I	16
		^{135}I	48
		^{133}Xe	2.6
		^{133m}Xe	0.18
		^{135}Xe	36
		^{135m}Xe	240
		^{137}Cs	0.0012
		^{140}Ba	1
		^{140}La	0.000000077
		^{153}Sm	0.16
		U	0.0000041
Tunnel Operations	None	DU	0.075
Well ER 20-5	None	^{3}H	0.0052
Well ER 20-7	None	^{3}H	0.56
Well ER 20-12	None	^{3}H	0.0076

(a) All locations are on the NNSS except for Building A-01.
(b) Big Explosives Experimental Facility.
(c) Activity in samples handled in Building 23-652 during 2023, which is higher than 2024 due to processing more biota samples.
(d) Device Assembly Facility.
(e) ***High-efficiency particulate air (HEPA) filter***.
(f) National Criticality Experimental Research Center.

4.1.7 Radiological Emissions Compliance

Dose from NNSS air emissions of radionuclides is described in detail in the NESHAP annual report for 2024 (MSTS 2025). The NNSS demonstrates compliance with dose limits using environmental measurements of radionuclide air concentrations near the NNSS borders and near the center of the NNSS. This critical receptor method [40 CFR 61.93(b)(5) and (g)] has been used to demonstrate compliance with the 40 CFR 61.92 dose standard since 2002. The six critical receptor locations are listed in Table 4-11 and displayed in Figure 4-2.

The following radionuclides from NNSS-related activities were detected at one or more of the ***critical receptor samplers***: ^{241}Am, ^{137}Cs, ^{3}H, ^{238}Pu, and $^{239+240}$Pu . All concentrations were well below their CLs. No man-made uranium isotopes were detected above levels found in blank filters (Section 4.1.4.5). The annual average concentration of each measured man-made radionuclide at each of the six critical receptor samplers is divided by its respective CL (Table 4-1) to obtain a "fraction of CL." If the average value is negative due to background measurements being higher than the low result, the negative value is set to zero to ensure the ratio to the CL is not negative. The sum of these fractions at each critical receptor sampler is far less than 1 (Table 4-11). The highest sum of fractions was 0.112 at the Yucca sampler (Table 4-11). This demonstrates that the NESHAP dose limit of 10 mrem/yr at these critical receptor locations was not exceeded.

Table 4-11. Sums of fractions of CLs for man-made radionuclides at critical receptor samplers in 2024

Radionuclides Included in Sum of Fractions	NNSS Area	Station	Sum of Fractions of CLs
^{241}Am, ^{238}Pu, $^{239+240}$Pu, ^{137}Cs, and ^{3}H	6	Yucca	0.112
	10	Gate 700 S	0.029
	16	3545 Substation	0.003
	20	Schooner	0.035
	23	Mercury Track	0.004
	25	Gate 510	0.003

As a secondary measure of NNSS compliance with air pathway dose limits, the radioactive air emissions from each NNSS sample location in Table 4-10 were modeled using the ***Clean Air Package, 1988***, model (CAP88-PC, Version 4.1; EPA 2019). Data for frequency distributions of wind speed, direction, and stability class from CY 2024 meteorological stations on the NNSS were provided by the National Oceanic and Atmospheric Administration, Air Resources Laboratory, Special Operations and Research Division. CAP88-PC predicted annual dose (mrem/yr) from each emission source to each receptor was calculated. The highest value (***maximally exposed individual***) is predicted to be 0.065 mrem/yr for a person residing on the Nevada Test and Training Range (Chapter 9 has a discussion of dose to the public from all pathways).

Nearly all radionuclides detected by environmental air samplers in 2024 appear to be from two sources: (1) legacy deposits of radioactivity on and in the soil from past nuclear tests, and (2) the upward flux of ^{3}H from the soil at sites of past nuclear tests and low-level radioactive waste burial. Long-term trends of $^{239+240}$Pu and ^{3}H in air continue to show a decline with time. Radionuclide concentrations in plants and animals on the NNSS and their potential impact are discussed in Chapter 8.

4.2 Nonradiological Air Quality Monitoring and Assessment

Air Quality Assessment Program Goals

Ensure NNSS operations comply with all requirements of the current air quality permit issued by the State of Nevada. Ensure emissions of criteria air pollutants (sulfur dioxide [SO_2], nitrogen oxides [NO_X], carbon monoxide [CO], volatile organic compounds [VOCs], and particulate matter) and emissions of hazardous air pollutants do not exceed limits established under National Ambient Air Quality Standards (NAAQS) and NESHAP, respectively. Ensure emissions of permitted NNSS equipment comply with the opacity criteria set by NAAQS and New Source Performance Standards (NSPS). Ensure NNSS operations comply with asbestos abatement reporting requirements under NESHAP. Document usage of ozone-depleting substances (ODS) to comply with Title VI of the CAA.

NNSS operations that are potential sources of air pollution include aggregate production, surface disturbance (e.g., construction), release of fugitive dust from driving on unpaved roads, use of fuel-burning equipment, open burning, venting from bulk fuel storage facilities, explosives detonations, and releases of various chemicals during testing. Air quality assessments are conducted to document compliance with the current State of Nevada air quality permit that regulates specific operations or facilities on the NNSS. The assessments mainly address nonradiological air pollutants. The State of Nevada has adopted the CAA standards, which include NESHAP, NAAQS, and NSPS. NESHAP compliance with radionuclide emissions monitoring and with public dose limits is presented in Section 4.1. Compliance with all other CAA air quality standards is addressed in this section. Data collection, opacity readings, recordkeeping, and reporting activities on the NNSS are conducted to meet the specific program goals.

4.2.1 Permitted NNSS Facilities

NNSA/NFO maintains a Class II Air Quality Operating Permit (AP9711-2557.02) for NNSS activities. State of Nevada Class II permits are issued for sources of air pollutants considered "minor," i.e., where annual emissions do not exceed 100 tons of any single ***criteria pollutant***, 10 tons of any single ***hazardous air pollutant (HAP)***, or 25 tons of any combination of all HAPs. The NNSS facilities regulated by permit AP9711-2557.02 include the following:

- Approximately 13 facilities/220 emission units in Areas 1, 2, 5, 6, 11, 12, 18, 19, 20, 23, 25, 26, 27, and 29
- Chemical releases at the Nonproliferation Test and Evaluation Complex (NPTEC) in Area 5 and at Port Gaston in Area 26
- Site-wide chemical releases (conducted throughout the NNSS)
- Experiments at BEEF in Area 4
- Explosives Management Unit (EMU) in Area 11
- Explosives activities sites at NPTEC in Area 5; High Explosives Simulation Test (HEST) in Area 14; Test Cell C, Calico Hills, and Army Research Laboratory (ARL) in Area 25; and Port Gaston in Area 26

4.2.2 Permit Maintenance Activities

An application to renew the NNSS air permit (AP9711-2557.02) was submitted to the Nevada Division of Environmental Protection (NDEP) in 2024 prior to the permit's expiration. Operations at the NNSS continued under a permit application "shield," as Nevada Administrative Code Chapter 445B, "Air Controls," allows for the continued operation of a stationary source until the permit is renewed or denied. The renewed permit was not issued in 2024.

A permit revision was submitted in February 2024 for the following but was not issued in 2024:

- Add 3 Explosive Facilities and 2 Alternate Explosive Facility Operating Scenarios
- Expand System 28, Emission Unit (EU) F0.001, BEEF northern operating boundary and increase the maximum allowable detonation of explosives to 60 tons of explosives per year
- Add 1 compressor

- Add 1 emergency generator
- Add 3 generators
- Remove 1 generator from System 104 Non-Grouped Generators
- Update several emission unit coordinates as part of map upgrade effort and higher resolution images that allowed for more accurate placement of EU
- Update System 88, EU F0.007, and System 95, F.010

An air permit renewal application was submitted in April 2024 for the following but was not issued in 2024:

- Change name of Sys 72, Explosives Ordnance Disposal Unit to Explosives Management Unit (EMU) to match Resource Conservation and Recovery Act permit
- Add 54 Insignificant Activity Radiant Heaters

4.2.3 Emissions of Criteria Air Pollutants and Hazardous Air Pollutants

The regulatory status of a source is determined by ***potential to emit (PTE)***, the maximum number of tons of criteria air pollutants and nonradiological HAPs it may emit in a 12-month period if the source were operated for the maximum number of hours and at the maximum production amounts specified in the source's air permit. The PTE is specified in an Air Emissions Inventory of all emission units. NDEP uses an online electronic reporting system, the State and Local Emissions Inventory System (SLEIS), for annual emissions reporting. Information reported electronically includes the actual annual operational information and the calculated emissions of the criteria air pollutants and HAPs for all permitted emission units used within the calendar year. The state uses the information to determine permit fees and to verify that emissions do not exceed the PTEs. Based on operational data and corresponding SLEIS calculations of emissions for CY 2024, PTEs for permitted facilities and equipment were not exceeded.

Unless specifically exempted, the open burning of any combustible refuse, waste, garbage, or oil is prohibited. Open burning for other purposes is allowed if approved in advance by the state issuance of an Open Burn Variance. For the NNSS, two Open Burn Variances are maintained and renewed annually. These variances are issued for fire extinguisher training and for support-vehicle live-fire training activities. In 2024, fire extinguisher training sessions and live-fire training sessions using wooden pallets were conducted at the NNSS. Quantities of criteria air pollutants produced by open burns are not required to be calculated or reported.

Table 4-12. Criteria air pollutants and HAPs released (in tons[a]) on the NNSS over the past 5 years

Pollutant	2020	2021	2022	2023	2024
Particulate Matter (PM10)[(b)]	0.20	1.67	2.81	1.87	1.94
Carbon Monoxide (CO)	0.10	1.74	1.79	4.61	11.93
Nitrogen Oxides (NO_X)	0.34	2.52	3.57	15.54	24.62
Sulfur Dioxide (SO_2)	0.02	0.56	0.47	1.27	7.40
Volatile Organic Compounds (VOCs)	4.26	5.52	5.37	5.79	9.87
Hazardous Air Pollutants (HAPs)[(c)]	0.01	7.0×10^{-5}	0.025	0.0066	0.09607

(a) For metric tons, multiply tons by 0.9072.
(b) Particulate matter equal to or less than 10 microns in diameter.
(c) The site-wide PTE for HAPs is 7 tons per individual HAP and 18 tons for all.

4.2.4 Performance Emission Testing and State Inspection

No performance emission testing was required or performed for any of the emission units in 2024. No NDEP air inspections were performed in 2024.

4.2.5 Opacity Readings

Visual opacity readings are conducted in accordance with permit and regulatory requirements. Personnel who take opacity readings are certified semiannually. In 2024, twelve NNSS employees were certified. No visible emission/opacity readings were conducted during CY 2024.

4.2.6 Chemical Releases and Detonations Reporting

The NNSS air permit regulates the release of chemicals at specific locations under three separate "systems": NPTEC in Area 5 (System 29), site-wide releases throughout the NNSS (System 81), and Port Gaston in Area 26 (System 95). The types and amounts of chemicals that may be released vary depending on the system. In 2024, no chemical releases took place at any chemical release-permitted facilities or locations on the NNSS.

Near-surface explosives detonations may take place at eight locations on the NNSS (BEEF in Area 4; EMU in Area 11; NPTEC in Area 5; Port Gaston in Area 26; HEST in Area 14; and Test Cell C, Calico Hills, and ARL in Area 25). BEEF is permitted to detonate large quantities of explosives (up to 41.5 tons per detonation with a limit of 50.0 tons per year). ARL, EODU, and NPTEC are permitted to detonate small quantities of explosives (up to 0.5 tons per detonation with a limit of 10.0 tons per year), while Port Gaston, HEST, Test Cell C, and Calico Hills are permitted to detonate explosives up to 1 ton per detonation with a limit of 10 tons per year. Permitted limits exist also for the amounts of criteria air pollutant and HAP emissions generated by the detonations. In 2024, explosives were detonated at BEEF and Calico Hills; no permit limits were exceeded. The annual Summary Report for activities at BEEF and Calico Hills was completed for activities conducted in 2024. This report was submitted to NDEP in February 2025, as required. No detonations took place at any of the other detonation-permitted explosives facilities.

4.2.7 Ozone-Depleting Substances Recordkeeping

At the NNSS, refrigerants containing ODS are used mainly in air conditioning units in vehicles, buildings, refrigerators, drinking water fountains, vending machines, and laboratory equipment. R-22, a Class II ODS, is being phased out through procurement of new systems using R-410-A, a non-ODS refrigerant, and through replacement of old R-22 equipment with new R-410-A equipment. As ODS-containing air conditioning systems fail in vehicles, they are replaced with non-ODS units. Halon 1211 and 1301, classified as ODS, have been used in the past in fire extinguishers and deluge systems, but all known occurrences of these halons have been removed from the NNSS. ODS recordkeeping requirements applicable to NNSS operations include maintaining evidence of technician certification and maintaining for 3 years records of recycling/recovery equipment approval, servicing records for appliances containing 22.7 kilograms (50 pounds) or more of refrigerant, and the amount and type of refrigerant sent off site for reclamation. In 2026, the threshold amount will drop to 15 pounds.

4.2.8 Asbestos Abatement

A Notification of Demolition and Renovation Form is submitted to the EPA at least 10 working days prior to the start of a demolition or renovation project if the quantities of asbestos-containing material (ACM) to be removed are estimated to equal or exceed 260 linear ft, 160 square ft, or 35 ft^3. Small asbestos abatement projects are conducted during the year with the removal of lesser quantities of ACM and a Notification of Demolition and Renovation Form is not required.

Thirty-six Notification of Demolition and Renovation Forms were submitted in 2024. Three notifications were annual notifications for routine steamline thermal system insulation and transit waterline repair operations that occur at the NNSS. Thirty-one notifications were for demolition of a facility. One notification was for a renovation activity at the NNSS. One emergency notification was submitted for an underground pipe that was damaged. ACM was buried in the Area 10 or Area 23 ***solid waste*** disposal site as per each project's work plan. Friable materials are segregated in a defined section of the landfill.

The recordkeeping requirements for asbestos abatement activities include maintaining air and bulk sampling data records, abatement plans, and operations and maintenance activity records for up to 75 years; and maintaining location-specific records of ACM for a minimum of 75 years. Compliance is verified through periodic internal management assessments. Asbestos abatement records continue to be maintained as required.

4.2.9 Fugitive Dust Control

The NNSS Class II Air Quality Operating Permit states that the best practical methods should be used to prevent particulate matter from becoming airborne prior to the construction, repair, demolition, or use of unpaved or untreated areas. At the NNSS, the main method of dust control is the use of water sprays. In 2024, field personnel observed operations throughout the NNSS for the occurrence of excessive fugitive dust, and water sprays were used to control dust at sites where grading, trenching, and digging activities occurred in Areas 1, 3, 5, 6, 12, 23, 25, and 27.

Off the NNSS, all NNSA/NFO surface-disturbing activities that cover 5 or more acres are regulated by stand-alone Class II Surface Area Disturbance (SAD) permits issued by the state. No SAD permits were issued in 2024.

4.2.10 Environmental Impact of Nonradiological Emissions

In 2024, NNSS activities produced a total of 59.65 tons of criteria air pollutants and 0.09607 tons of HAPs. These quantities had little, if any, impact on air quality on or around the NNSS. NNSS air pollutant emissions are low compared to the estimated daily releases from point sources in Clark County, Nevada. For example, the average emissions of NO_X in Clark County for 2023 were 3.23 tons per day (Ramboll US Consulting 2023), which calculates to 1,178.95 tons per year. By comparison, the estimated annual release from the NNSS in 2024 was 24.62 tons of NO_X, which is approximately 2% of Clark County's 2023 emissions of this criteria pollutant.

Impacts of the chemical release tests at the NNSS are minimized by controlling the amount and duration of each release. Biological monitoring at NPTEC is performed if there is a risk of significant exposure to downwind plants and animals from the planned tests. To date, chemical releases at NPTEC and other locations are such small quantities (when dispersed into the air) that downwind test-specific monitoring has not been warranted. No measurable impacts to downwind plants or animals have been observed.

4.3 References

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EPA, see U.S. Environmental Protection Agency.

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Chapter 5: Water Monitoring

Irene Farnham and Dona Murphy
Navarro Research and Engineering, Inc.

Peggy E. Elliott
U.S. Geological Survey

David M. Black, Elizabeth Burns, Theodore J. Redding, Nikolas J. Taranik, and Brian G. Verheyen
Mission Support and Test Services, LLC

This chapter presents the recent results of water monitoring conducted on and near the Nevada National Security Site (NNSS) by the U.S. Department of Energy (DOE), National Nuclear Security Administration Nevada Field Office (NNSA/NFO) and the Environmental Management (EM) Nevada Program. NNSA/NFO and the EM Nevada Program monitor groundwater to provide safe drinking water for NNSS workers and visitors, avoid NNSS groundwater contamination from current activities, and protect the public and environment from areas of known underground contamination that has resulted from historical nuclear testing. Water is monitored to comply with applicable state and federal water quality and water protection regulations, DOE directives, and the Federal Facility Agreement and Consent Order (FFACO), a legally binding agreement between the DOE, the U.S. Department of Defense, and the State of Nevada. Laws and regulations applicable to water monitoring are listed in Table 2-1.

The Community Environmental Monitoring Program (CEMP) and the Nye County Tritium Sampling and Monitoring Program (TSaMP) perform annual, independent radiological monitoring of water supply systems in communities surrounding the NNSS and encourage community involvement in these efforts. The TSaMP is funded through a grant from the EM Nevada Program and the CEMP is funded by NNSA/NFO. Sections 7.2 and 7.3 describe the CEMP and TSaMP monitoring activities in 2024.

5.1 Radiological Monitoring

Radiological Water Monitoring Objectives

Provide data to complete corrective actions prescribed under the FFACO to protect the public from groundwater contaminated by historical underground nuclear testing. Monitor water supply wells on the NNSS to demonstrate safety of the drinking water. Determine compliance with the dose limits to the general public via the water pathway as set by DOE Order DOE O 458.1, "Radiation Protection of the Public and the Environment" (see Chapter 9 for estimates of public dose). Monitor, operate, and maintain wells downgradient of the NNSS radioactive waste disposal unit in accordance with a Resource Conservation and Recovery Act (RCRA) permit to ensure wastes do not impact groundwater.

Radionuclides[1] have been detected in the groundwater in some areas of the NNSS and Nevada Test and Training Range (NTTR) that are a result of historical underground nuclear explosive tests (UGTs). Between 1951 and 1992, 828 UGTs were conducted, and approximately one-third were detonated near or in the ***saturated zone*** (NNSA/NFO 2015). These UGTs are assigned as underground test area (UGTA) corrective action sites, which are geographically grouped into corrective action units (CAUs). These CAUs are in various stages of corrective action and the status is presented in Chapter 11. A complete description of the hydrogeological environment in which UGTs were conducted is in *Attachment A: Site Description.*[2]

The approach for collecting and analyzing groundwater samples varies depending on the specific sampling objective and is described in multiple documents. While the EM Nevada Program sampling in support of UGTA CAU studies and closure requirements is described in a Sampling Plan (EM Nevada Program 2020d) and Closure Reports (NNSA/NFO 2016; NNSA/NFO 2019; EM Nevada Program 2020a,b,c; EM Nevada Program 2024a), NNSA/NFO sampling is described in various permits and other authorization documents. In 2024, monitoring requirements were transferred from Closure Reports to the FFACO NNSS Use-Restriction Management Plan (EM Nevada Program 2024b).

[1] The definition of word(s) in ***bold italics*** may be found by referencing the Glossary, Appendix B.
[2] *Attachment A: Site Description* is available on the NNSA/NFO web site at https://nnss.gov/publication-library/environmental-publications/.

5.1.1 NNSA/NFO and EM Nevada Program Groundwater Sampling Design

The radiological water sampling network consists of 72 sample locations (Figure 5-1), categorized into eight different well types (Table 5-1), with some locations monitored to meet multiple objectives. Risks associated with groundwater contaminated by UGTs remain low because of the slow groundwater movement, physical and chemical processes that slow radionuclide movement, immobility of some contaminants, radioactive decay, and long distances to publicly accessible groundwater supplies.

Table 5-1. Definitions and objectives for radiological water sample types

Sample Source Type	Purpose	Frequency
Characterization	Used for system characterization or model evaluation	2–3 years, as needed [a]
Source/Plume	Located within the plume of a UGT (i.e., confirmed presence of radionuclides from test)	4 years [a]
Early Detection	Located downgradient of, or near, a UGT and no radionuclides detected above 1,000 picocuries per liter (pCi/L)	5 years [a]
Distal	Downgradient of the Early Detection area	5 years [a]
Community	Located on Bureau of Land Management (BLM) or private land; used as a water supply source or is near one	5 years
Closure	Monitoring location supporting closure of an UGTA CAU	see EM Nevada Program 2024b
NNSS PWS	Permitted water supply well that is part of a state-designated non-community ***public water system (PWS)*** that provides drinking water to workers and visitors on the NNSS	Quarterly
Compliance	Sampled to comply with specific federal/state regulations or permits	As specified by permit

[a] The UGTA Sampling Plan (EM Nevada Program 2020d) provides sampling guidance, not requirements. Deviations from these frequencies may occur because sampling is focused on best meeting the objectives for the current CAU study.

5.1.1.1 Radionuclides of Interest

Most radionuclides produced by NNSS UGTs are relatively immobile in groundwater because they are bound within the melt glass produced during nuclear detonation, have physical processes that slow radionuclide movement, or have chemical properties that cause them to bind strongly to the aquifer rock materials. Analysis of ***tritium (^3H)*** is required for all sampling locations, because this radionuclide was produced in the highest abundance during nuclear testing and is one of the most mobile in groundwater. These characteristics make ^3H the radionuclide with the greatest potential for impacting groundwater quality. In addition, ^3H is the only radionuclide produced by NNSS UGTs known to have exceeded its U.S. Environmental Protection Agency (EPA) Safe Drinking Water Act (SDWA) ***maximum contaminant level (MCL)*** of 20,000 pCi/L in sampling locations away from the nuclear test location or outside of tunnels used for conducting UGTs. Though ^3H is one of the most mobile in groundwater, it decays rapidly (half-life of 12.3 years) and is not expected to be detectable when groundwater reaches publicly accessible wells.

Tritium (^3H) is a radioactive form of hydrogen with a half-life of 12.3 years. The Safe Drinking Water Act limit for ^3H in drinking water is 20,000 pCi/L. If an individual drank water with this amount of ^3H for an entire year, it would amount to approximately the same dose of radiation as a single commercial flight between Los Angeles and New York City.

pCi/L is a unit used to express the amount of radioactivity in one liter of a gas or a liquid. A picocurie is one-trillionth of a ***Curie***, and 1 pCi/L is the amount of radioactive material in 1 liter of a gas or liquid that will produce 0.037 disintegrations per second. In the case of ^3H, a disintegration is the emission of a beta particle.

Additional radionuclides from NNSS UGTs are analyzed in samples collected at Characterization and Source Plume locations (Table 5-2). These radionuclides, if present, are at insignificant levels (i.e., less than 0.1% of their MCL) unless ^3H is present at concentrations above its 20,000 pCi/L MCL. Therefore, these radionuclides are not required to be analyzed for Early Detection, Distal, and Community sampling locations. Trends in these data will be evaluated to determine whether any additional radionuclides should be monitored in Early Detection wells in the future. ***Gross alpha*** and ***gross beta*** are analyzed along with ^3H for the NNSS PWS and Compliance wells.

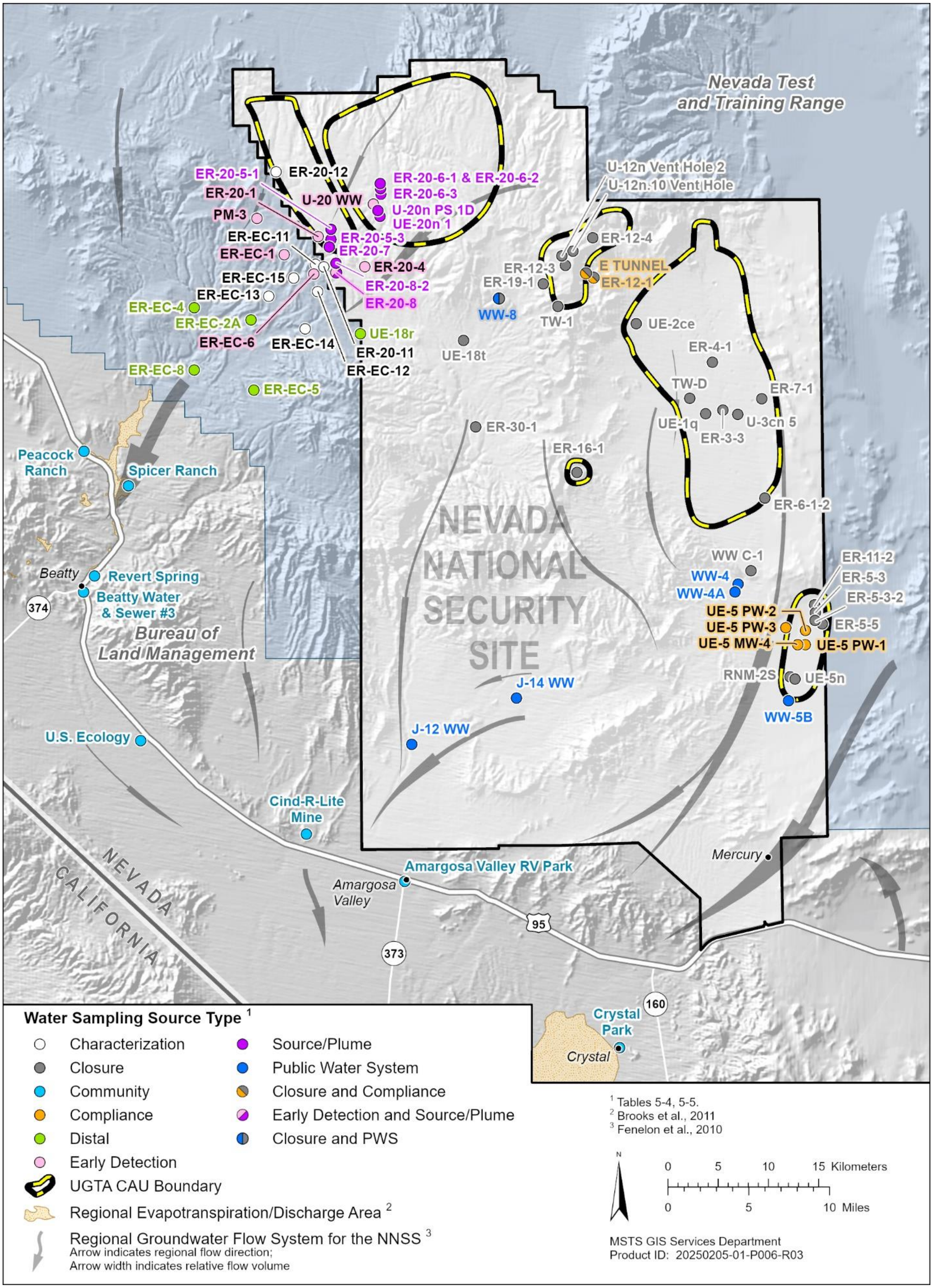

Figure 5-1. NNSA/NFO and EM Nevada Program water sampling network

Table 5-2. Radionuclides analyzed for each sample source type

Type	Radionuclide[1]
Characterization	Gross alpha, gross beta, ^{3}H, ^{14}C, ^{36}Cl, ^{90}Sr, ^{99}Tc, ^{129}I, U, Pu Gamma emitters (^{26}Al, ^{94}Nb, ^{137}Cs, ^{152}Eu, ^{154}Eu, ^{235}U, ^{241}Am, ^{243}Am)
Source Plume	^{3}H, ^{14}C, and ^{129}I (Pahute Mesa CAUs) and ^{3}H, ^{14}C, ^{36}Cl, ^{99}Tc, and ^{129}I (Frenchman Flat)
UGTA Closure, Early Detection, Distal, and Community	^{3}H (additional analyses are performed for select Closure wells as described in Section 5.1.3.1)
NNSS PWS and Compliance	Gross alpha, gross beta, and ^{3}H

[1]See Table 1-5 of Chapter 1 for a listing of full names and half-lives of radionuclide abbreviations listed.

5.1.1.2 Sample Collection Methods

Water sampling methods are based, in part, on the characteristics and configurations of sample locations. For example, wells with dedicated pumps may be sampled from the associated plumbing (e.g., spigots) at the wellhead, while wells without pumps may be sampled using a wireline bailer or a portable pumping system. Most wells in the sample network are single-zone completion wells, meaning that the wells were constructed to collect groundwater samples from a single depth interval. Some wells, however, are multiple-completion wells constructed to allow for collecting groundwater samples at different depth intervals that access multiple geologic formations.

Water samples are collected following the sampling methods described in standard operating procedures. Wells that are sampled using pumps are purged until the stability of certain water quality parameters (e.g., pH, temperature, and electrical conductivity) is achieved. Stabilization of these water quality parameters indicates that formation water is being sampled instead of stagnant water from within and surrounding the wellbore. Other wells are sampled using a depth-discrete bailer to obtain groundwater for certain sampling objectives (e.g., demonstrate early detection of ^{3}H at levels well below the 20,000 pCi/L MCL and to evaluate trends over time).

5.1.1.3 Detection Limits

Standard methods for radionuclide analysis are performed by commercial laboratories that are certified by the Nevada Division of Environmental Protection (NDEP) Bureau of Safe Drinking Water. The ***minimum detectable concentration (MDC)*** using standard methods is approximately 300 pCi/L, which is well below the EPA SDWA-required detection limit of 1,000 pCi/L and MCL of 20,000 pCi/L. For gross alpha and gross beta ***radioactivity***, the MDCs are 2 and 4 pCi/L, respectively, and satisfy their EPA SDWA-required detection limits of 3 and 4 pCi/L, respectively. Samples collected from some wells that are expected to have ^{3}H levels below 300 pCi/L (some Early Detection and Characterization wells) are enriched before ^{3}H analysis. The enrichment process (DOE 1997), referred to throughout this report as low-level ^{3}H analysis, concentrates ^{3}H in a sample to provide a lower MDC of approximately 2 to 40 pCi/L, depending on the laboratory performing the enrichment process.

Analysis routinely includes quality control samples such as duplicates, blanks, and spikes. Chapter 14 describes ***quality assurance*** and ***quality control*** procedures for groundwater samples and analyses.

- The standard ^{3}H analysis method can detect ^{3}H at levels of approximately 300 pCi/L.
- The low-level ^{3}H analysis method, which concentrates ^{3}H in a sample through an enrichment process, can detect ^{3}H at levels of 2–40 pCi/L.
- Groundwater samples collected at some Early Detection and Characterization wells are analyzed using the low-level ^{3}H analysis method.

5.1.2 Presentation of Water Sampling Data

NNSA/NFO and the EM Nevada Program classify each well in the sample network into one of four ^{3}H concentration levels (Table 5-3). The four categories are based on the percent of SDWA MCL (20,000 pCi/L) for ^{3}H concentrations measured in the most recent sampling event (Tables 5-4 and 5-5, and Figure 5-2). All sample locations exceeding the SDWA MCL are located on the NNSS.

Table 5-3. Tritium concentration categories

^{3}H Concentration in pCi/L	Percent of SDWA MCL
Less than 1,000	Less than 5[a]
Greater than 1,000 but less than 10,000	5–50
Greater than 10,000 but less than 20,000	50–100
Greater than 20,000	Greater than 100 (Exceeds SDWA MCL)

[a] Includes samples in which ^{3}H is undetectable.

Table 5-4 shows ^{3}H concentrations for the most recent sampling events at wells in the sampling network. For wells with the same classification that were sampled at multiple depths during a single sampling event, the depth with the highest concentration is listed. For example, three ***piezometers*** of Well ER-EC-11 are sampled as Characterization wells; Figure 5-2 and Table 5-4 only report the results of the shallowest piezometer for ER-EC-11 because the greatest concentration of ^{3}H is associated with this sample location. Data in Table 5-4 are grouped by CAU and then by sample location type. When ^{3}H was not detected, the value is reported as less than the sample's MDC (i.e., <1.5 or <270 when the sample's MDC is 1.5 or 270 pCi/L, respectively). Results from the analyses for radionuclides other than ^{3}H (Table 5-2) are not presented in this report but can be acquired upon request from NNSA/NFO. The ^{3}H, gross alpha, and gross beta levels for water samples in 2024 for the NNSS PWS and Compliance sampling locations are listed in Table 5-5.

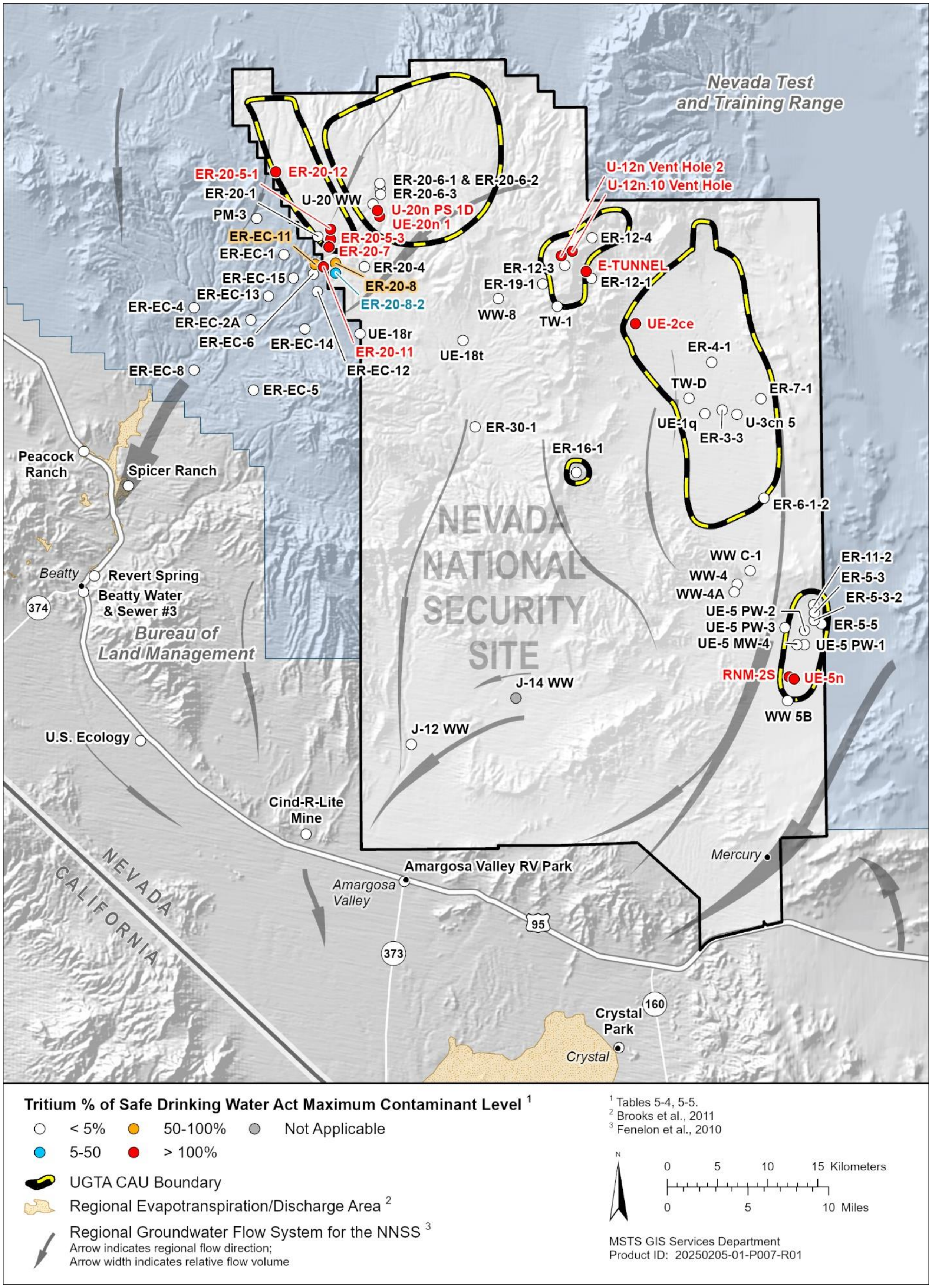

Figure 5-2. Tritium concentration categories at NNSA/NFO and EM Nevada Program sampling locations

Table 5-4. Tritium concentrations for the most recent sample at wells near and downgradient of historical underground nuclear test locations

Sample Location[a]	Land Management or NNSS Area	Sample Year	Maximum ^3H Concentration (pCi/L)[b]
Yellow highlight indicates ^3H levels above the SDWA MCL of 20,000 pCi/L			
Frenchman Flat			
Closure Wells			
ER-5-3	Area 5	2020	<2.5
ER-5-3-2[c]	Area 5	2020	<3.0
ER-5-5	Area 5	2020	<3.3
ER-11-2	Area 5	2020	<2.9
RNM-2S	Area 5	2020	65,100
UE-5n	Area 5	2020	116,000
Rainier Mesa/Shoshone Mountain			
Closure Wells			
E Tunnel[d]	Area 12	2024	211,000
ER-12-1[d]	Area 12	2024	<238
ER-12-3[e]	Area 12	2020	<300
ER-12-4	Area 12	2020	<300
ER-16-1	Area 16	2020	<142
ER-19-1[e]	Area 19	2020	<142
ER-30-1	Area 30	2020	<143
TW-1	Area 17	2020	<142
U-12n.10 Vent Hole	Area 12	2020	4,410,000
U-12n Vent Hole 2	Area 12	2020	666,000
UE-18t	Area 18	2020	<143
WW-8[f]	Area 18	2024	<290
Yucca Flat/Climax Mine			
Closure Wells			
ER-3-3	Area 3	2020	<310
ER-4-1	Area 4	2020	<310
ER-5-3-2[c]	Area 5	2020	<3.0
ER-6-1-2	Area 6	2020	<263
ER-7-1	Area 7	2020	<300
TW-D	Area 4	2020	<273
U-3cn 5	Area 3	2020	<280
UE-1q	Area 1	2020	<276
UE-2ce	Area 2	2020	89,900
WW C-1	Area 6	2024	J 14.2 [g]
Pahute Mesa (Central and Western)			
Characterization Wells			
ER-20-11	Area 20	2023	173,000
ER-20-12[e]	Area 20	2024	43,900
ER-EC-11[e]	NTTR	2023	14,800
ER-EC-12[e]	NTTR	2023	<2.7
ER-EC-13[e]	NTTR	2024	<2.8
ER-EC-14[e]	NTTR	2024	<2.8
ER-EC-15[e]	NTTR	2024	<2.7
Source/Plume Wells			
ER-20-5-1	Area 20	2019	20,000,000
ER-20-5-3	Area 20	2024	46,900
ER-20-6-1[h]	Area 20	2023	474
ER-20-6-2[h]	Area 20	2021	371
ER-20-6-3[h]	Area 20	2023	<260
ER-20-7	Area 20	2024	J 9,060,000 [g]
ER-20-8_p2	Area 20	2023	14,000
ER-20-8-2	Area 20	2023	7,880
U-20n PS 1D	Area 20	2019	13,100,000
UE-20n 1	Area 20	2019	32,600,000

Table 5-4. Tritium concentrations for the most recent sample at wells near and downgradient of historical underground nuclear test locations

Sample Location[(a)]	Land Management or NNSS Area	Sample Year	Maximum ^{3}H Concentration (pCi/L)[(b)]
Yellow highlight indicates ^{3}H levels above the SDWA MCL of 20,000 pCi/L			
Early Detection Wells			
ER-20-1	Area 20	2023	5.3
ER-20-4 [(i)]	Area 20	2024	< 162
ER-20-8_p1	Area 20	2023	J 205 [(g)]
ER-EC-1	NTTR	2016	<2.9
ER-EC-6	NTTR	2023	9.0
PM-3[(e)]	NTTR	2022	<228
U-20 WW	Area 20	2023	<2.8
Distal Wells			
ER-EC-2A	NTTR	2019	<310
ER-EC-4	NTTR	2018	<2.7
ER-EC-5	NTTR	2019	J <3.1[(g)]
ER-EC-8	NTTR	2016	<4.5
UE-18r	Area 18	2022	<265
Community Wells/Springs			
Amargosa Valley RV Park	BLM	2022	<298
Beatty Water & Sewer #3	Beatty	2017	<201
Cind-R-Lite Mine	BLM	2022	<206
Crystal Park	Private land	2020	<223
Peacock Ranch	Private land	2022	<208
Revert Spring	Private land	2024	<236
Spicer Ranch	Private land	2022	<203
U.S. Ecology	BLM	2022	<207

(a) Only the sample result, not the field duplicate, is reported.
(b) Concentrations presented as less than (<) a number indicate that ^{3}H levels are less than its sample-specific MDC shown. When the results of multiple samples are below the MDC, the largest MDC is reported.
(c) Closure well for Frenchman Flat and Yucca Flat/Climax Mine CAUs.
(d) ER-12-1 and E Tunnel are also Compliance locations (Table 5-5).
(e) Multiple depths are sampled at this location. The highest value is presented when multiple depths are sampled within the same year.
(f) WW-8 is also an NNSS PWS well (Table 5-5).
(g) J qualifier indicates that the reported result is considered estimated because a quality control measure was outside its acceptable limit (see Chapter 14).
(h) ER-20-6-1, ER-20-6-2, and ER-20-6-3 all access similar depths from the same hydrostratigraphic units downgradient of the Bullion detonation.
(i) ER-20-4 was recategorized from a Characterization well to an Early Detection well (EM Nevada Program 2025).

Table 5-5. Sample analysis results from NNSS PWS wells and Compliance wells/surface waters

Sample Location	NNSS Area	Sample Date	Concentration (pCi/L)[(a)]		
			^{3}H	α[(b)]	β[(b)]
NNSS PWS Wells					
J-12 WW	Area 25	2/13/24	<286	1.5	2.7
J-14 WW	Area 25	NA all 2024[(c)]	--	--	--
WW-4	Area 6	2/13/24	<281	6.2	3.4
		4/23/24	<286	5.9	4.9
		7/31/24	<254	3.9	2.7
		10/22/24	<188	7.4	4.7
		10/22/24 FD[(d)]	<190	6.4	5.8
WW-4A	Area 6	2/13/24	<284	7.3	3.7
		2/13/24 FD	<281	8.4	4.2
		4/23/24	<286	6.9	5.0
		7/31/24	<264	4.6	5.3
		10/22/24	<193	8.0	5.1
WW-5B	Area 5	2/13/24	<282	4.8	8.8
		4/23/24	<273	6.3	10.1
		4/23/24 FD	<289	7.7	9.0
		7/31/24	<264	3.0	7.5
		10/22/24	<204	5.3	8.2
WW-8	Area 18	2/13/24	<281	<1.0	2.3
		4/23/24	<290	<1.8	1.8
		7/31/24	<244	<1.5	2.0
		7/31/24 FD	<255	3.3	4.4
		10/22/24	<203	<1.9	3.2
Compliance Wells/Surface Waters					
UE-5 PW-1	Area 5	9/10/24	<233	NA	NA
UE-5 PW-2	Area 5	9/10/24	<232	NA	NA
UE-5 PW-3	Area 5	9/10/24	<222	NA	NA
UE-5 MW-4	Area 5	9/10/24	<230	NA	NA
ER-12-1[(e,f)]	Area 12	4/11/2024	<238	4.6	5.1
		4/11/2024 FD	<238	8.9	5.8
E Tunnel Wastewater Disposal System[(e)]	Area 12	10/9/2024	211,000	6.2	22.9
		10/9/2024 FD	NA	7.4	22.4

(a) Concentrations given as less than (<) a number indicate ^{3}H levels are less than its sample-specific MDC shown.
(b) α = gross alpha and β = gross beta.
(c) NA = not applicable, either because the well was not operational, or the analysis was not required.
(d) FD = field duplicate sample.
(e) α in Well ER-12-1 and E Tunnel Wastewater Disposal System is reported as adjusted gross α.
(f) Well ER-12-1 is monitored on a 24-month cycle, in accordance with the permit.

5.1.3 Discussion of 2024 Sample Results

The following sections discuss results for the eight sample source types that comprise the radiological water-sampling network (Table 5-1). As illustrated in Figure 5-1, Community wells or springs are either on private land or land managed by the BLM, and all other water-sampling network wells are on properties managed by the government. As reflected in Table 5-4 and discussed in the sections below, no UGT-related radionuclides have been detected in the Distal or Community wells. Consistent with the definition of Early Detection wells (^{3}H levels are less than 1,000 pCi/L), low concentrations of ^{3}H have been detected at a few locations. As reflected in Table 5-5, sampling results from NNSS PWS wells indicate that water sources used by NNSS personnel and visitors are not affected by past UGTs. In addition, all regulatory requirements associated with Compliance samples were satisfied.

5.1.3.1 Closure Wells

Characterization activities have been completed and advancement to the closure stage has been achieved for three UGTA CAUs: Frenchman Flat (CAU 98), Rainier Mesa/Shoshone Mountain (CAU 99), and Yucca Flat/Climax

Mine (CAU 97). Closure Reports and associated addenda (as applicable) that describe the required post-closure monitoring program have been developed and approved by NDEP (NNSA/NFO 2016; NNSA/NFO 2019; EM Nevada Program 2020a,b,c; EM Nevada Program 2024a). In 2024, post-closure requirements were transferred from the closure reports to the FFACO NNSS Use Restriction Management Plan (EM Nevada Program 2024b). Post-closure monitoring results for these CAUs are summarized below and are further discussed in Section 11.3.1.

Frenchman Flat Post-Closure Monitoring: The monitoring network for Frenchman Flat includes six sampling locations. Sampling for ^{3}H is required every 6 years. Additional radionuclides (^{14}C and ^{129}I) are analyzed at two locations (UE-5n and RNM-2S) impacted by a radionuclide migration experiment at the CAMBRIC UGT. Note that ER-5-3-2 is also a Closure well for the Yucca Flat / Climax Mine CAU. Sampling was last completed in 2020. Tritium was not detected in the Closure wells, except for those impacted by the radionuclide migration experiment (Table 5-4).

Rainier Mesa/Shoshone Mountain Post-Closure Monitoring: The monitoring network for Rainier Mesa / Shoshone Mountain includes 12 sampling locations; two locations, ER-12-3 and ER-19-1, are sampled at two separate depths. Sampling for ^{3}H is required every 6 years. Additional radionuclides (^{3}H, ^{14}C, ^{36}Cl, ^{90}Sr, ^{99}Tc, ^{129}I, and $^{238/239/240}$Pu) are analyzed at three locations where water samples are collected from tunnels where nuclear testing occurred (E Tunnel, U-12n.10 Vent Hole, and U-12n Vent Hole 2). E Tunnel, as well as ER-12-1, are also compliance locations and are discussed in Section 5.1.3.8. Tritium was not detected in the Closure wells, except for those accessing the tunnels (Table 5-4).

Yucca Flat/Climax Mine Post-Closure Monitoring: The monitoring network for Yucca Flat/Climax Mine includes 10 sampling locations, all of which are sampled for ^{3}H. Eight wells in Yucca Flat and one well in Frenchman Flat, ER-5-3-2, are sampled every 6 years and one well in Yucca Flat, WW C-1, is sampled annually for 6 years (2020–2025). Note that ER-5-3-2 is also a monitoring well for the Frenchman Flat CAU. These wells access the lower carbonate aquifer, which is a regional aquifer and the only groundwater pathway out of Yucca Flat (Navarro 2019). Except for UE-2ce and WW C-1, ^{3}H was not detected in the Closure well samples (Table 5-4). Well UE-2ce has been impacted by a radionuclide migration experiment at the NASH UGT. WW C-1 was sampled in 2024 and the ^{3}H concentration (14.2 pCi/L) is consistent with that reported in 2023 (15.5 pCi/L).

5.1.3.2 Characterization Wells

Characterization wells are either new wells or wells that require additional radionuclide data to establish a baseline and/or to ensure the current list of radionuclides is accurate for monitoring the CAU. A large suite of radionuclides is analyzed in samples collected from Characterization wells (Table 5-2). Once a baseline has been established, each Characterization well will be reclassified and sampled according to its new type (Source/Plume, Early Detection, or Distal). A total of seven Characterization wells, six accessing multiple (2–4) depths, are located within the Pahute Mesa CAUs (Figure 5-1). One well (ER-20-4) was reclassified as an Early Detection well and sampled in 2024. Results for the Characterization locations are presented in Table 5-4. When multiple depths are sampled in the same year, the largest result is reported. As shown in Table 5-4, the ^{3}H concentration in the Characterization wells ranges from below the 2.7 pCi/L MDC in well ER-EC-12 and ER-EC-15 located on the NTTR to 173,000 pCi/L in Well ER-20-11 located on the NNSS (Figure 5-1).

> ^{3}H was detected at 10,600 pCi/L in Well ER-EC-11, a Characterization well downgradient of the Pahute Mesa CAUs, in 2009. This was the first time that a radionuclide from NNSS UGTs had been detected in groundwater beyond NNSS boundaries. In 2017, ^{3}H was detected at 18,400 pCi/L. This concentration is below the EPA-established allowable drinking water limit of 20,000 pCi/L.
>
> In 2023, Well ER-EC-11 was pumped to ensure that samples would be representative of the groundwater in the accessed aquifer. The highest reported ^{3}H concentration was 14,800 pCi/L, which is nearly a 20 percent decrease since the last pumped sample collected in 2017.

While ^{3}H is not present in most wells on the NTTR, it has been detected at ER-EC-11 and ER-EC-6 (an Early Detection well). These, along with the other “ER-EC” wells, monitor a contaminant plume believed to originate from the TYBO and BENHAM UGTs, which were detonated in 1975 and 1968, respectively. ER-EC-11 is the first location where a radionuclide from NNSS UGTs had been detected in groundwater beyond NNSS boundaries.

Multiple depths, ranging from 1,440 to 3,030 feet (ft), were bailed to collect samples from wells ER-EC-13, ER-EC-14, and ER-EC-15. No ^{3}H was detected in the samples (Table 5-4). The deepest interval (approximately 3,900 to 4,500 ft below ground surface) of Characterization Well ER-20-12 was sampled in 2024 (Table 5-4). ER-20-12 monitors a contaminant plume of ^{3}H believed to originate from the HANDLEY UGT. The ^{3}H concentrations for the 2024 sample, along with previous sample results, are presented in Figure 5-3. The ^{3}H concentration in ER-20-12 (43,900 pCi/L) increased by approximately 6 percent from that reported in 2017 (41,600 pCi/L). No other radionuclides were detected in the 2024 ER-20-12 sample.

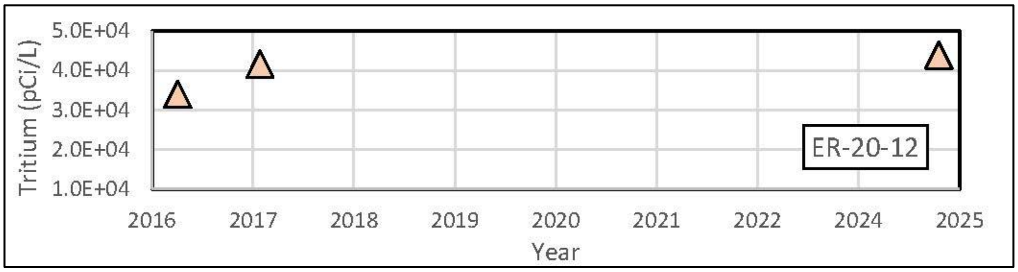

Figure 5-3. Tritium Concentrations for Characterization Well ER-20-12

5.1.3.3 Source/Plume Wells

Source/Plume wells are located within the plume from a UGT where ^{3}H is present at, or exceeds (or has exceeded) 1,000 pCi/L. Source/Plume wells are analyzed for ^{3}H and additional CAU-specific radionuclides (Table 5-2). Locations range from those accessing the nuclear test cavity (e.g., U-20n PS 1D) to those downgradient of a UGT (e.g., ER-20-8-2) where lower concentrations are observed (Table 5-4). Two Source/Plume wells were sampled in 2024 (Table 5-4). The ^{3}H concentrations for these samples as well as samples collected previously from these wells are presented in Figure 5-4. Figure 5-4 shows the ^{3}H concentrations decreasing in samples from both wells. These wells are located downgradient of the TYBO and BENHAM UGTs. Carbon-14 concentrations of 152 to 172 pCi/L were reported for the ER-20-7 samples. These concentrations are well below the 2,000 pCi/L dose-compliant concentration, which equates to a 4-mrem/year dose MCL (EPA 2002). Carbon-14 was not detected in the ER-20-5-3 samples, and no other radionuclides were detected in samples collected from ER-20-5-3 and ER-20-7.

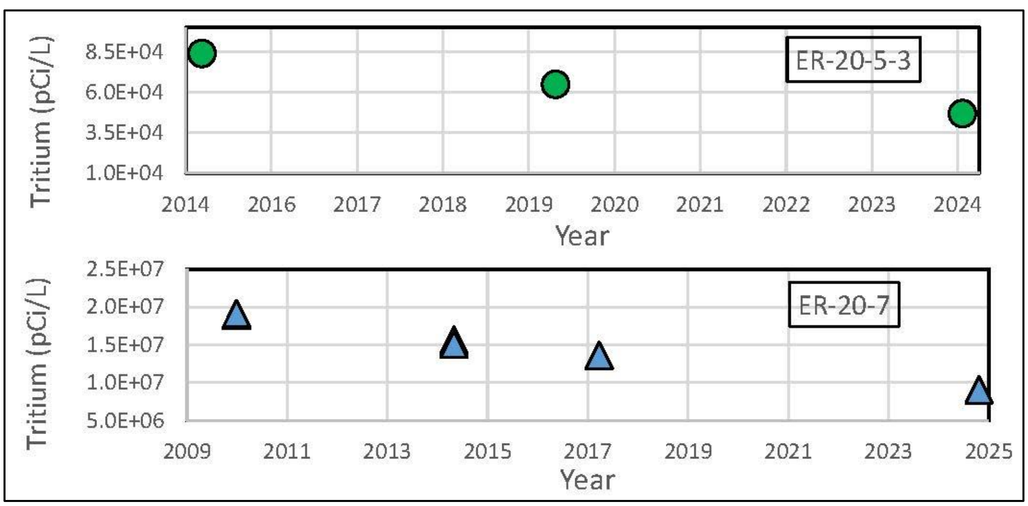

Figure 5-4. Tritium Concentrations for Source/Plume Wells ER-20-5-3 and ER-20-7

5.1.3.4 Early Detection Wells

Early Detection wells are the next wells downgradient of a UGT or Source/Plume well and are monitored to detect the presence of a plume well before concentrations reach levels near the 20,000-pCi/L SDWA MCL. Early Detection wells are recategorized as Source/Plume wells if ^{3}H levels reach 1,000 pCi/L. In the absence of ^{3}H, no other test-related radionuclides are present in historically sampled groundwater; therefore, Early Detection wells are monitored solely for ^{3}H. There are seven Early Detection wells, which are sampled once every 5 years (EM Nevada Program 2020d). The ER-EC-6 sampling in 2023 resulted in a low-level detection of 9 pCi/L. Sampling of Early Detection Well ER-EC-1 (last sampled in 2016) has been delayed because of poor road conditions that have caused it to be inaccessible for sampling. Sampling at this well will take place once the roads have been repaired. One Early Detection well was sampled and analyzed for ^{3}H in 2024. This well (ER-20-4) was previously a Characterization well and has now been recategorized as an Early Detection well. No ^{3}H was detected in the ER-20-4 samples (Table 5-4).

5.1.3.5 *Distal Wells*

Distal wells are sampled to demonstrate that ^{3}H is not present downgradient of UGTs at levels exceeding the SDWA-required minimum detection limit of 1,000 pCi/L. Distal well samples, collected at a 5-year frequency, are analyzed for ^{3}H using the standard EPA method. Sampling of Distal Well ER-EC-8 (last sampled in 2016) has been delayed because of poor road conditions that have caused it to be inaccessible for sampling. Sampling at this well will take place once the roads have been repaired. Five Distal wells are in the Pahute Mesa CAUs and none were sampled in 2024. Sampling in 2024 focused instead on wells (i.e., Source Plume and Characterization wells) that serve best to improve confidence in the Pahute Mesa groundwater flow and transport model results (see Chapter 11, Section 11.2.1).

5.1.3.6 *Community Wells/Springs*

The community sampling network includes eight locations that are off the NNSS and NTTR boundaries (Table 5-4). These wells and springs are used as private, business, or community water supply sources or are near such sources, and they are sampled for ^{3}H every 5 years, except the Beatty Water & Sewer #3 location, which has not been sampled since 2017. The Revert Spring was sampled in 2024, and ^{3}H was not detected. Samples are analyzed using a standard EPA method with the objective to demonstrate that ^{3}H is not present at levels exceeding the SDWA-required minimum detection limit of 1,000 pCi/L. As discussed in Section 5.1.3.4, analysis of groundwater samples from the Early Detection wells, located much farther upgradient of these community wells and springs, can detect the presence of ^{3}H at lower concentrations (i.e., 0.01% of its MCL). These sampling activities provide an additional mechanism for detecting a contaminant plume long before it would reach the more distant community water supplies.

5.1.3.7 *NNSS Public Water System Wells*

Results from the NNSS PWS water wells sampled quarterly in 2024 continue to indicate that historical underground nuclear testing has not impacted the NNSS water supply network. No ^{3}H measurements exceeded MDCs using the EPA standard analysis method (Table 5-5). Gross alpha and gross beta radioactivity were found at concentrations slightly greater than MDCs in most 2024 samples and are believed to represent the presence of naturally occurring radionuclides. However, no water supply samples had gross alpha measurements that exceeded the EPA MCL (15 pCi/L) or gross beta measurements that exceeded the EPA level of concern (50 pCi/L).

5.1.3.8 *Compliance Wells/Groundwater Discharges*

5.1.3.8.1 *RCRA Permitted Wells for the Area 5 Mixed Waste Disposal Unit*

Wells UE-5 PW-1, UE-5 PW-2, UE-5 PW-3, and UE-5 MW-4 are sampled annually for ^{3}H. They are monitored for ^{3}H and nonradiological parameters (Section 10.3.1) to verify the performance of the Area 5 Mixed Waste Disposal Unit (Cells 18 and 25), which is operated under a RCRA permit. In 2024, standard ^{3}H analyses were performed on water samples from these wells; ^{3}H was not detected in any sample (Table 5-5, Table 10-5), and MDCs were less than the permit-established investigation level of 2,000 pCi/L. Further groundwater analysis is required if an investigation level is exceeded. Results continue to indicate that Cell 18 and Cell 25 radioactive wastes have not contaminated local groundwater. Table 10-5 presents the 2024 sampling results for other additional indicators of groundwater contamination, and all 2024 sample analysis results for these four wells are presented by the NNSS Management and Operating Contractor, Mission Support and Test Services, LLC (MSTS), in MSTS (2025).

5.1.3.8.2 NDEP Permitted E Tunnel Wastewater Disposal System

NNSA/NFO manages and operates the NNSS Area 12 E Tunnel Wastewater Disposal System (ETDS) in accordance with the NDEP Bureau of Federal Facilities water pollution control permit (NEV96021). The permit governs the management of radionuclide-contaminated wastewater that discharges from the E Tunnel portal into a series of conveyance pipes and earthen holding/infiltration ponds.

The permit requires chemical and radiological constituents monitoring of the ETDS effluent and groundwater from Well ER-12-1. Tritium, adjusted gross alpha, and gross beta activities are measured in ETDS effluent annually. Tritium, adjusted gross alpha, gross beta activities, and several nonradiological parameters are required to be measured biennially at Well ER-12-1. Negotiations between NDEP, NNSA/NFO, and the EM Nevada Program resulted in sampling Well ER-12-1 in 2020, in advance of the permit-required 24-month interval. This was negotiated so that the UGTA 6-year sampling interval aligned with the permit's 24-month interval, and both requirements would be satisfied with one sampling event in 2020 and subsequent 6-year intervals. The permissible limit of ^{3}H in the ETDS effluent is 500,000 pCi/L. The permissible limits for ^{3}H, adjusted gross alpha, and gross beta in the groundwater from Well ER-12-1 are 20,000 pCi/L, 15 pCi/L, and 50 pCi/L, respectively.

Monitoring personnel sampled Well ER-12-1 on April 11, 2024, and the ETDS effluent on October 9, 2024 (Table 5.5). All radiological parameters were within their permissible and threshold limits. Nonradiological results and associated threshold limits are provided in Section 5.2.4.

5.1.3.8.3 UGTA Well Discharged Groundwater and Fluids

Groundwater and fluids discharged from UGTA wells are regulated through an agreement between DOE and NDEP called the Fluid Management Plan for the UGTA Project (Attachment 1 of NNSA/NFO 2009). The Fluid Management Plan is used in lieu of an NDEP-approved water pollution control permit for management of fluids produced during the drilling, construction, development, testing, experimentation, and/or sampling of wells by the UGTA Activity. The plan provides criteria by which fluids may be discharged on site and applies to groundwater purged (pumped) from the well during sampling. Groundwater ^{3}H concentrations are measured daily during sampling activities. Groundwater with ^{3}H greater than or equal to 400,000 pCi/L is discharged to lined sumps to evaporate. Groundwater with ^{3}H activity less than 400,000 pCi/L may be discharged to either lined/unlined sumps or infiltration areas. Fluid Management Plan samples are collected to analyze for metals, gross alpha, gross beta, and ^{3}H, unless previously demonstrated that these analyses have satisfied criteria established by the plan.

All requirements of the UGTA Fluid Management Plan were satisfied in 2024. The ^{3}H concentration was greater than 400,000 pCi/L in a single well (ER-20-7), which was pumped and discharged to a lined sump in 2024. Criteria for all Fluid Management Plan samples were within threshold levels established in the plan.

5.2 Nonradiological Drinking Water and Wastewater Monitoring

Nonradiological Water Monitoring Goals

Ensure that the operation of NNSS PWSs and private water systems provides high-quality drinking water to workers and visitors at the NNSS. Determine if NNSS PWSs are operated in accordance with the requirements in Nevada Administrative Code NAC 445A, "Water Controls," under permits issued by the state. Determine if the operation of septic systems that process domestic wastewater on the NNSS meets operational standards in accordance with the requirements of NAC 445A under permits issued by the state. Determine if the operation of industrial wastewater systems on the NNSS meets operational standards of federal and state regulations as prescribed under the GNEV93001 state permit.

Federal and state laws regulate the quality of drinking water and wastewater on the NNSS. The design, construction, operation, and maintenance of many of the drinking water and wastewater systems are regulated under state permits. NNSA/NFO ensures systems meet applicable water quality standards and permit requirements. The NNSS nonradiological water monitoring goals are met by analyzing water samples, performing assessments, and maintaining documentation. This section describes the results of 2024 activities. Results from radiological monitoring of drinking water on and off the NNSS and of wastewater on the NNSS are discussed in Section 5.1.3.

5.2.1 Drinking Water Monitoring

Six wells on the NNSS are permitted to supply the potable water needs of NNSS operations. These are grouped into three PWSs (Figure 5-5). The largest system (NNSS Areas 23 and 6) is classified under its permit as a non-transient non-community PWS and serves the main work areas of the NNSS. The other two systems (NNSS Area 12 and Area 25) are classified as transient non-community PWSs. The PWSs are designed, operated, and maintained in accordance with the requirements in NAC 445A under permits issued by the NDEP Bureau of Safe Drinking Water. PWS permits are renewed annually.

The three PWSs must meet National Primary Drinking Water Standards and Secondary Standards (set by the state) for water quality. They are sampled according to a 9-year monitoring cycle, which identifies the specific classes of contaminants to monitor at each drinking water source, and the sampling frequency (Table 5-6). At sample locations in buildings, the sampling point for coliform bacteria is a faucet within the building. Samples for chemical contaminants are collected at the points of entry to the PWS. Although not required by regulation or by any permit, NNSA/NFO collects samples inside service connections for coliform bacteria to further ensure safe drinking water.

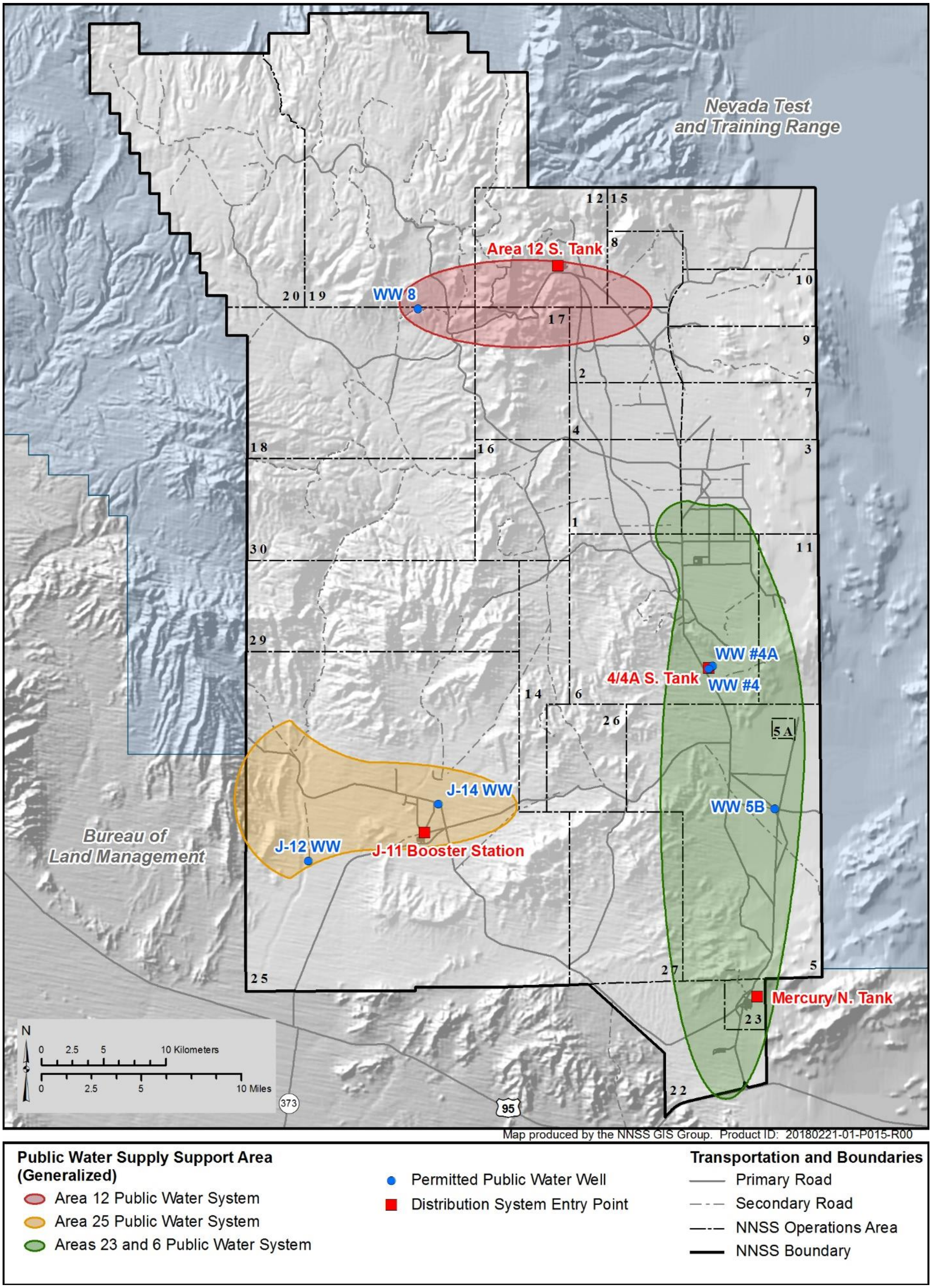

Figure 5-5. Water supply wells and drinking water systems on the NNSS

Table 5-6. Current sampling requirements for permitted NNSS PWSs and water-hauling trucks

System/ Truck	Contaminant or Contaminant Category	Sample Location	Sampling Cycle	Number of Samples	Year Sampled
NNSS Areas 23 and 6	**National Primary Standards**				
	Coliform	WDP-23/6[(a)]	monthly	2	2024
	Disinfectant residual	WDP-23/6	monthly	2	2024
	Asbestos	WDP-23/6	9 year	1	2016
	Disinfection by-products	WDP-23/6	1 year	1	2024
	Lead and copper	WDP-23/6	1 year	10	2024
	Arsenic	POE-23/6[(b)]	3 year	1	2023
	IOCs[(c)] - Phase 2 and 5[(d)]	POE-23/6	9 year	1	2016
	Nitrate	POE-23/6	1 year	1	2024
	Nitrite	POE-23/6	3 year	1	2024
	Nitrate + nitrite	POE-23/6	3 year	1	2023
	SOCs[(e)] - Phase 2 and 5	POE-23/6	6 year	1	2023
	VOCs[(f)] - Phase 2 and 5	POE-23/6	3 year	1	2022
	Secondary Standards				
	Secondary IOCs	POE-23/6	3 year	1	2022
Area 12	**National Primary Standards**				
	Coliform	WDP-12[(g)]	quarterly	1	2024
	Nitrate	POE-12[(h)]	1 year	1	2024
	Nitrite	POE-12	3 year	1	2023
	Nitrate + nitrite	POE-12	3 year	1	2023
	Secondary Standards				
	Secondary IOCs	POE-12	3 year	1	2023
Area 25	**National Primary Standards**				
	Coliform	WDP-25[(i)]	monthly	1	2024
	Nitrate	POE-25[(j)]	1 year	1	2024
	Nitrite	POE-25	3 year	1	2024
	Nitrate + nitrite	POE-25	3 year	1	2024
	Secondary Standards				
	Secondary IOCs	POE-25	3 year	1	2022
Water-hauling Trucks					
Trucks 84846 and 84847	Coliform Bacteria	Backflow preventer	weekly	1	2024

(a) WDP–23/6 = Water delivery points for the NNSS Main PWS: taps within Buildings 1-920A, 5-7, 6-CP-41, 6-644, 6-900, 23-117, 23-143, 23-180, 23-300, 23-531, 23-532, 23-535, 23-614, 23-650, and 23-652.
(b) POE–23/6 = Points of entry for the Area 23 and 6 PWS: Mercury N. Tank and 4/4A S. Tank (Figure 5-5).
(c) IOCs = Inorganic chemicals.
(d) Refers to sets of chemical contaminants in drinking water for which the EPA established MCLs through a series of rules known as the Chemical Phase Rules issued from1987 (Phase 1) through 1992 (Phase 5); https://www.epa.gov/dwreginfo/chemical-contaminant-rules.
(e) SOCs = Synthetic organic chemicals.
(f) VOCs = Volatile organic compounds.
(g) WDP-12 = Water delivery points for the Area 12 PWS: Building 12-909.
(h) POE-12 = Points of entry for the Area 12 PWS: Area 12 S. Tank (Figure 5-5).
(i) WDP-25 = Water delivery points for the Area 25 PWS: Buildings 25-3123 or 25-4222.
(j) POE-25 = Points of entry for the Area 25 PWS: J-11 Booster Station, and J-14 WW (Figure 5-5).

In addition to the monitoring required under the PWS permits, NNSA/NFO continues to evaluate the potential for per- and polyfluoroalkyl substances (PFAS) contamination in the drinking water supply, an emerging concern across the nation. While the NNSS is generally considered a low risk for PFAS contamination of the groundwater, the six permitted wells and PWS points of entry were monitored in 2020, with the samples analyzed by a Nevada certified laboratory. All results were non-detect at less than 1 nanogram per liter (part per trillion). Regulatory MCLs were finalized for PFAS compounds in April 2024; however, adoption of the MCLs is not expected until 2027. In May 2025, the EPA Administrator announced that the agency will keep the 4 nanograms per liter MCLs for perfluorooctanoic acid and perfluorooctane sulfonic acid, intends to rescind and reconsider the determinations for other PFAS compounds, and intends to extend the compliance deadlines. NNSA/NFO will continue to closely monitor the regulatory developments, and will take proactive measures to ensure drinking water quality and regulatory compliance. More information can be found at https://www.epa.gov/pfas.

For work locations at the NNSS not connected to a PWS, NNSA/NFO hauls potable water from the Area 23 and 6 PWS in two water tanker trucks. The trucks are certified annually by the NDEP Bureau of Safe Drinking Water, and the water they carry is subject to water quality standards for coliform bacteria (Table 5-6). Normal water delivery is to remote service connections and hand-washing stations at construction sites, which are activities not subject to permitting.

5.2.1.1 Results of Public Water System and Water-Hauling Truck Monitoring

Water samples are collected in accordance with accepted practices, analyses are conducted by state-certified laboratories, and analytical methods are approved as listed in NAC 445A and Title 40 ***Code of Federal Regulations (CFR)*** Part 141, "National Primary Drinking Water Standards." The 2024 monitoring results indicated all the PWSs complied with applicable National Primary Drinking Water Quality Standards. In addition, water samples from the water-hauling trucks were negative for coliform bacteria.

5.2.1.2 State Inspections

Approximately every 3 years, NDEP conducts a sanitary survey of the permitted PWSs that includes an inspection of wells, tanks, and other visible portions of each PWS. NDEP completed a survey in September of 2022: nine minor deficiencies were noted, corrected by MSTS, and accepted by the Bureau of Safe Drinking Water. Water-hauling trucks are inspected by NDEP annually in compliance with NAC 445A; water truck inspections were conducted in October 2024: both trucks were re-certified and no deficiencies were noted.

5.2.2 Wastewater Monitoring

5.2.2.1 Septic Tank Wastewater Monitoring

A total of 20 active and permitted domestic septic tanks systems are being used on the NNSS (Table 2-2, Figure 5-6). The septic systems are permitted to process/store up to 5,000 gallons of wastewater per day. They are inspected periodically for sediment loading and pumped as required. MSTS maintains a septic pumping contractor permit for three septic tank pump trucks (NY-017-06839), issued by the NDEP and the Nevada Division of Public and Behavioral Health, which was renewed in July 2024. State representatives conduct onsite inspections of septic pump trucks and contractor operations. NNSA/NFO performs management assessments and maintenance for domestic wastewater septic systems to document compliance with permit conditions. Management assessments are performed according to existing directives and procedures. The septic tanks operate in compliance with General Permit GNEVOSDS09 – L – (0271 – 0276). Table 5-7 provides septic tank information relating to Figure 5-6 and Table 2-2.

In February 2024, the state conducted inspections of NNSS septic pump trucks and all three trucks were found to be compliant with permit conditions.

Table 5-7. NNSS Septic Tanks

Permit GNEVOSDS09-L-	Discharger	Septic Tanks	Figure 5-6 Labels
0271	Area 1	U1a U1h	U1a & U1h
0272	Areas 5 and 6 South	NPTEC[(a)] RNCTEC[(a)] RWMC[(a)]	NPTEC RNCTEC RWMC
0273	Area 6 South	Area 6 Construction Tank 1 Area 6 Construction Tank 2 Area 6 Fire Station Yucca Lake Hangar	Area 6 Construction[(b)] Area 6 Fire Station Yucca Lake Hangar
0274	Areas 12 and 18	Area 12 Camp Area 12 Building 910 Area 18 Airfield	Area 12 Camp Area 12 Building 12-910 Area 18 Airstrip
0275	Areas 22 and 23	Area 22 Desert Rock Airport Area 22 Weather Station	Desert Rock Airport Weather Station

Table 5-7. NNSS Septic Tanks

Permit GNEVOSDS09-L-	Discharger	Septic Tanks	Figure 5-6 Labels
		Area 23 Building 1103	Area 23 Building 23-1103
		Area 23 Gate 100	Area 23 Gate 100
0276	Areas 25 and 27	Area 25 Central Support	Area 25 CSA(a)
		Area 25 Reactor Control Point	Area 25 RCP(a)
		Area 27 Baker	Area 27 Baker
		Area 27 JASPER	Area 27 JASPER(a)

(a) Figure 5-6 acronyms:
CSA = Central Support Area
JASPER = Joint Actinide Shock Physics Experimental Research
NPTEC = Nonproliferation Test and Evaluation Complex
RCP = Reactor Control Point
RNCTEC = Radiological/Nuclear Countermeasures Test and Evaluation Complex
RWMC = Radioactive Waste Management Complex (located in Area 5A)
(b) The Area 6 Construction label identifies the location of both Area 6 Construction Tank 1 and Tank 2.

5.2.2.2 *Wastewater Treatment Pond Monitoring*

All wastewater treatment ponds (Figure 5-6) operate in compliance with Groundwater Discharge Permit GNEV93001, issued by the NDEP Bureau of Federal Facilities.

Domestic sewage discharges on the NNSS were limited to three sewage lagoon systems in 2024: Area 6 Yucca Lake, Area 6 DAF [Device Assembly Facility], and Area 23 Mercury (Figure 5-6). The Yucca Lake system includes two primary lagoons and two secondary lagoons. The DAF system includes one primary and one secondary lagoon. Both the Yucca Lake and DAF lagoons are lined with compacted native soils and meet state requirements for transmissivity (10^{-7} centimeters per second).

The Area 23 Mercury system includes one primary lagoon and one secondary lagoon. The primary and secondary lagoons are lined with geosynthetic clay and high-density polyethylene. The lining of the ponds allows these systems to operate as fully contained, evaporative, non-discharging systems.

The U1a Complex system, which is permitted to receive discharge from the Principal Underground Laboratory for Subcritical Experimentation Complex, did not receive any domestic sewage discharge in 2024, and therefore is not presented on Figure 5-6. This system includes one primary and one secondary lagoon. The primary and secondary lagoons are lined with a Geosynthetic clay liner. This system includes a leak detection system using suction lysimeters and will be monitored quarterly.

The Area 25 Engine Test Stand (ETS) Drying Bed and Area 12 Camp Drying Bed (Figure 5-6, Area 25 ETS-1 and Area 12 Comp, respectively) have been designed as drying areas to receive septage, portable toilet waste, and other waste waters that contain propylene glycol solutions, oils, and greases. These drying beds are also used for disposal of septic tanks and liquids.

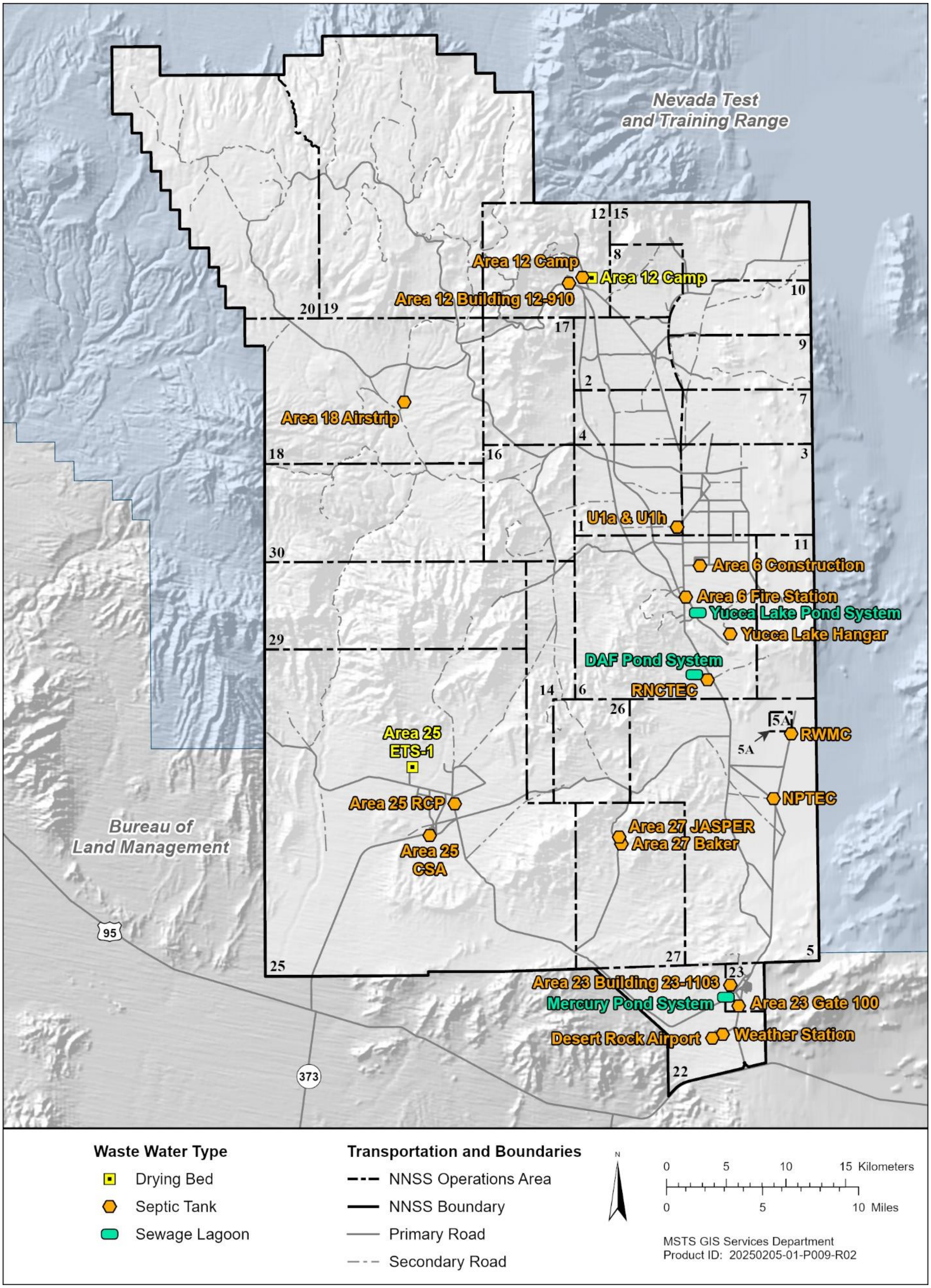

Figure 5-6. Active permitted sewage disposal systems on the NNSS

5.2.2.2.1 Quarterly and Annual Influent Monitoring

Sewage systems are monitored quarterly for influent quality. Composite samples from each system are collected over a period of 6 hours and analyzed by state-certified laboratories. Methods for sample collection and analyses are in accordance with NAC 445A and 40 CFR 141. Composite samples are analyzed for three parameters: ***5-day biochemical oxygen demand (BOD_5)***, total suspended solids, and pH. In 2024, sample analyses results for influent waters were within permitted limits (Table 5-8).

Toxicity monitoring of influent waters of the lagoons was not conducted in 2024. Permit GNEV93001 requires lagoons to be sampled and analyzed for the 29 contaminants listed in Table 4-10 of the Nevada Test Site Environmental Report 2008 (National Security Technologies, LLC [NSTec] 2009) only in the event of specific or accidental discharges of potential contaminants. No specific or accidental discharges occurred in 2024.

Table 5-8. Water quality and flow monitoring results for NNSS sewage lagoon influent waters

		Minimum and Maximum Values from Quarterly Samples		
Parameter	**Units**	**Area 6 Yucca Lake**	**Area 23 Mercury**	**Area 6 DAF**
BOD_5	mg/L	189 –270	199 – 293	31.8–139
Permit Limit		None	None	None
BOD_5 Mean Daily Load(a)	kg/d	0.10 –1.16	9.52–31.68	0.14–0.18
Permit Limit		34.43	124.31	15.29
Total Suspended Solids	mg/L	260 –404	210–310	64–254
Permit Limit		None	None	None
pH	S.U.(b)	8.03 –8.38	8.03–8.25	8.12–8.36
Permit Limit		6.0–9.0	6.0–9.0	6.0–9.0
Quarterly Average Flow Rate	GPD(c)	187 –1,350	10,774 –46,087	146–1,219
Permit Limit		10,850	73,407	7,640

(a) BOD_5 Mean Daily Load in kilograms per day (kg/d) = (milligrams per liter [mg/L] BOD × liters per day average flow × 3.785)/10^6.
(b) Standard units of pH.
(c) Gallons per day.

5.2.2.2.2 Sewage System Inspections

NNSA/NFO personnel inspect active systems bi-weekly; no notable observations were made in 2024. NDEP inspects both active and inactive NNSS lagoon systems annually; there were no findings of deficiency in 2024. Inspections evaluate all infrastructure (i.e., field maintenance programs, lagoons, sites, and access roads) for abnormal conditions, weeds, algae blooms, pond color, abnormal odors, dike erosion, burrowing animals, discharge, depth of staff gauge, crest level, excess insect population, maintenance/repairs, and general conditions.

5.2.2.3 E Tunnel Wastewater Disposal System Monitoring

NNSA/NFO manages and operates the ETDS in Area 12 under a separate water pollution control permit (NEV96021) issued by the NDEP Bureau of Federal Facilities, as described in Section 5.1.3.8.2. The permit regulates the management of radionuclide-contaminated wastewater that drains from the E Tunnel portal into a series of holding ponds. The permit requires ETDS discharge waters to be monitored every 12 months for radiological parameters (Adjusted Gross Alpha, Gross Beta, ^{3}H). It also requires nearby Well ER-12-1 to be sampled for the same radiological parameters and additional nonradiological parameters once every 24 months. ETDS discharge water is also monitored monthly for flow rate, pH, temperature, and specific conductance, and for the volume and structural integrity of the holding ponds. Monitoring data are reported to the NDEP Bureau of Federal Facilities in quarterly and annual reports.

Monitoring personnel sampled Well ER-12-1 on April 11, 2024, and the ETDS effluent on October 9, 2024. All nonradiological parameters were within the threshold limits. Nonradiological results and thresholds are provided in Table 5-9.

Table 5-9. Nonradiological results for E Tunnel Wastewater Disposal System discharge samples

	ETDS Discharge Water (Measured Monthly)		Well ER-12-1 Groundwater Sampled Every 24 Months (April 2024)	
Nonradiological Parameter	Threshold	Results	Threshold (mg/L)	Concentration (mg/L)[(a)]
Beryllium	NA[(b)]	NA	0.004	<0.001
Cadmium	NA	NA	0.005	<0.001
Chromium	NA	NA	0.10	<0.001
Lead	NA	NA	0.015	<0.0005
Mercury	NA	NA	0.002	<0.00007
Total Nitrate/Nitrite	NA	NA	10	<0.085
Flow Rate (liters/minute)	MR[(c)]	31.2[(d)]	NA	NA
pH (S.U.)	6.0–9.0	7.3[(d)]	6.0–9.0	7.4
Specific conductance (µS/cm)[(e)]	<1,500	365[(d)]	<1,500	1,025

(a) Concentrations given as less than (<) a number indicate the result is less than the laboratory's reporting limit.
(b) NA = Not applicable.
(c) Permit requires NNSA/NFO to monitor and report (MR); there are no threshold limits.
(d) Average of 12 monthly measures.
(e) µS/cm = microsiemens per centimeter.

5.3 Water-Level and Usage Monitoring

The U.S. Geological Survey (USGS) Nevada Water Science Center collects, compiles, stores, and reports hydrologic data used in determining the local and regional hydrogeological conditions in and around the NNSS. Hydrologic data are collected continuously, quarterly, semi-annually, or annually from wells on and off the NNSS. The USGS also has developed models for the Death Valley Regional Groundwater Flow System (Belcher and Sweetkind 2010, Belcher et al. 2017, Halford and Jackson 2020), and manages other NNSS hydrologic and geologic information databases (for example, https://waterdata.usgs.gov/nv/nwis and https://pubs.usgs.gov/ds/2007/297/).

In 2024, the USGS monitored water levels in 251 wells on and near the NNSS; these included 146 wells on the NNSS and 105 wells off the NNSS. Water levels are monitored to identify where water occurs in the subsurface, changes in the quantity of water in aquifers, the direction of groundwater movement, and groundwater velocity (derived from knowledge of groundwater movement and formation properties). Along with radiological groundwater data presented in Section 5.1, water-level data contribute to the development of UGTA CAU-specific models of groundwater flow and radionuclide transport (Section 11.2.1). A map showing the locations of monitored wells and all water-level data are available on the U.S. Geological Survey-U.S. Department of Energy Cooperative Studies in Nevada project website at https://nevada.usgs.gov/doe_nv/.

Groundwater withdrawal data are collected from water supply wells on the NNSS using flow meters and are reported monthly. The principal NNSS water supply wells monitored included J-12 WW, WW-4, WW-4A, WW-5B, WW-8 (Figure 5-1), and UE-16d WW. The USGS compiles the water-use data and reports annual withdrawals in millions of gallons. Withdrawal data from these wells for 2024 have been compiled and processed and are available from the Water Withdrawals page on the U.S. Geological Survey-U.S. Department of Energy Cooperative Studies in Nevada project website at https://nevada.usgs.gov/doe_nv/water_withdrawals.html. Total groundwater withdrawals from these wells in 2024 was about 168 million gallons (Figure 5-7).

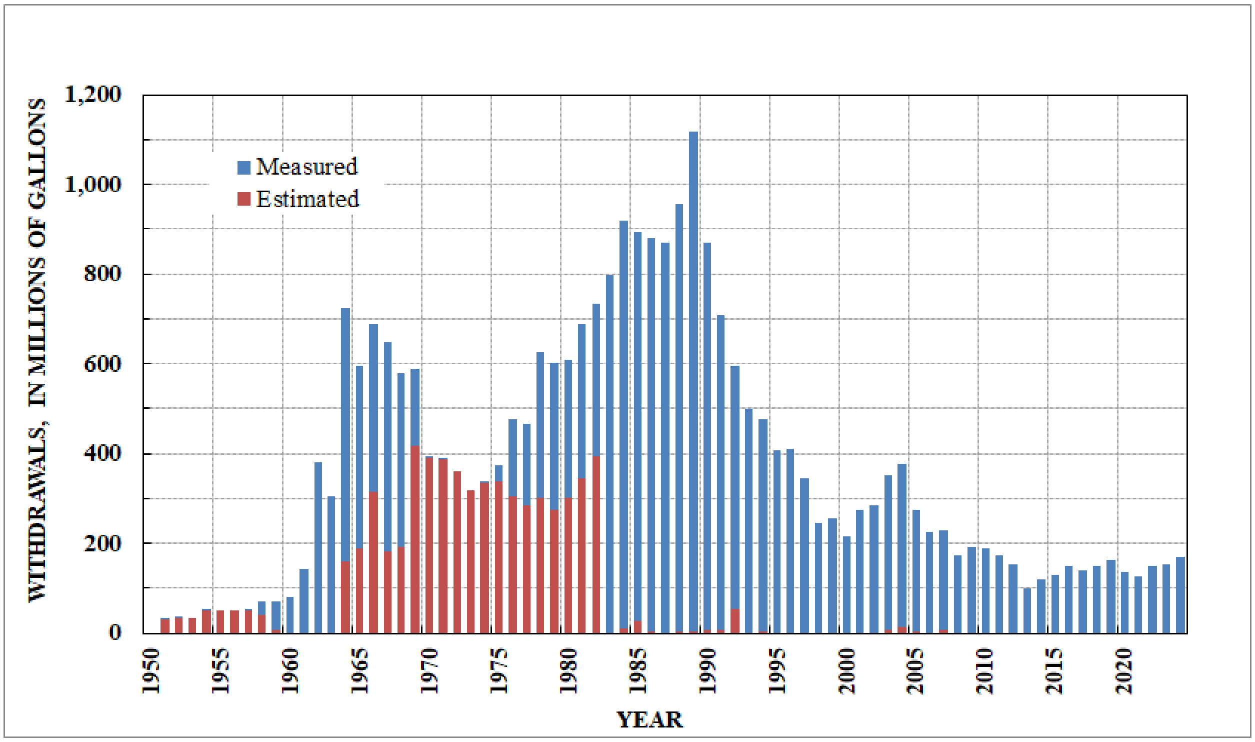

Figure 5-7. Annual withdrawals from the NNSS, 1951 to 2024

5.4 Water Monitoring Conclusions

Groundwater contaminated by historical UGTs does not impact the public or NNSS workers and visitors who consume water from wells located off or on the NNSS. Although the potential radiological impact to water resources from past activities on the NNSS is from migration of radionuclides in the groundwater downgradient from the UGTA CAUs, only testing within the Pahute Mesa CAUs has impacted groundwater off the NNSS boundary, while remaining on the NTTR. Furthermore, the detection of ^3H above its standard analysis method MDC of 300 pCi/L has only been observed in two wells on the NTTR (ER-EC-11 and PM-3). Thirteen wells (including ER-EC-11 and six other "ER-EC" wells located on the NTTR) monitor a contaminant plume of ^3H believed to originate from the TYBO and BENHAM UGTs. Similarly, two wells (including PM-3) monitor a contaminant plume of ^3H believed to originate from the HANDLEY UGT. Four other UGTA wells on the NTTR (i.e., "ER-EC" wells) have not shown the presence of man-made radionuclides downgradient of Pahute Mesa. Because of the slow migration of radionuclides in groundwater and the relatively rapid decay of ^3H, ^3H is not expected to be observed off the NTTR boundary at levels exceeding the SDWA MCL. In fact, ongoing scientific studies indicate that contaminated groundwater at levels exceeding the SDWA MCLs for all radionuclides is not expected to reach publicly accessible areas (see Chapter 11, Figures 11-4 and 11-6). Samples from community wells, including samples collected by CEMP and TSaMP (Sections 7.2 and 7.3), farther downgradient of Pahute Mesa, also contain no detectable man-made radionuclides.

NNSS wildlife can be exposed to ^3H in their drinking water or in their aquatic habitats whenever contaminated waters are retained for evaporation in state-approved ponds or sumps. Examples are the E Tunnel ponds and UGTA groundwater sumps used by wildlife as drinking water, and by plants, insects, and amphibians as aquatic habitats. The potential dose to NNSS biota from these water sources is routinely assessed and reported annually in this report (Section 9.2). Each year, results have demonstrated that the doses to biota are less than the limits established to protect plant and animal populations.

If present, nonradiological contamination of groundwater from NNSS operations would likely be co-located with the radiological contamination from historical UGTs within UGTA CAUs. It is expected to be minor, however, in comparison to the radiological contamination. For nuclear tests detonated above the water table, potential nonradiological contaminants are not likely to reach groundwater because of their negligible advective and dispersive transport rates through the thick ***vadose zone***. Water samples from UGTA investigation wells, which include highly contaminated wells, have not had elevated levels of nonradiological man-made contaminants.

Well drilling, waste burial, chemical storage, and wastewater management are the only current NNSS activities that have the potential to contaminate groundwater with nonradiological contaminants. This potential is very low, however, due to engineered and operational deterrents and natural environmental factors. Current drilling operations procedures include the containment of drilling muds and well effluents in sumps (Section 5.1.3.8.3). Well effluents are monitored for nonradiological contaminants (predominantly lead) to ensure lined sumps are used when necessary. The Area 3 and Area 5 Radioactive Waste Management Sites are monitored to ensure that contaminants do not reach groundwater (Chapter 10). In addition, the potential for mobilization of contaminants from all these sources to groundwater is negligible due to the arid climate, the great depth to groundwater (thickness of the vadose zone), and the proven behavior of liquid and vapor fluxes in the vadose zone (primarily upward liquid movement towards the ground surface due to evapotranspiration).

The EM Nevada Program is responsible for completing environmental corrective actions at sites where surface and shallow subsurface contamination historically occurred. Some of these sites also have nonradiological contaminants such as metals, petroleum hydrocarbons, hazardous organic and inorganic chemicals, and unexploded ordinance (Sections 11.2.2 and 11.3.2). The potential for mobilization of these contaminants to groundwater is negligible due to the same regional climatic, soil, and hydrogeological factors mentioned above.

Water level monitoring continues to be used to develop and refine CAU-specific models of groundwater flow and contaminant transport. Section 11.2.1 of this report describes the status of these models.

Current water usage, monitored annually, has dropped to levels that have not been seen since the early 1960s, due mainly to changes in site operations, and to some extent, recent conservation actions. Within the past several years, NNSA/NFO has taken actions to conserve groundwater by addressing DOE's water efficiency and water management goals, which include reducing both potable and non-potable water use (Chapter 3).

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Chapter 6: Direct Radiation Monitoring

Xianan Liu and Ronald W. Warren
Mission Support and Test Services, LLC

Charles B. Davis
EnviroStat

Direct Radiation Monitoring Program Goals

Assess the proportion of external dose from background radiation versus that from operations at the Nevada National Security Site (NNSS). Measure external radiation to assess the potential external dose to a member of the public from operations at the NNSS (Chapter 9 gives estimates for public dose). Measure external radiation to assess the potential external dose to a member of the public from operations at the Area 3 and 5 Radioactive Waste Management Sites (RWMSs). Monitor operational activities involving radioactive material, radiation-generating devices, and accidental releases of radioactive material to ensure exposure to members of the public is kept as low as reasonably achievable (ALARA). Measure external radiation to assess the potential external and absorbed radiation doses to NNSS plants and animals (Section 9.2 gives biota dose assessments). Determine the patterns of exposure rates through time at various soil contamination areas to characterize releases in the environment.

U.S. Department of Energy (DOE) Orders DOE O 458.1, "Radiation Protection of the Public and the Environment," and DOE O 435.1, "Radioactive Waste Management," present requirements to protect the public and environment from radiation ***exposure***;[1] see descriptions of these orders in Table 2-1. Energy absorbed from radioactive materials outside the body results in an external ***dose***. On the NNSS, external dose comes from direct ***ionizing radiation*** including natural ***radioactivity*** from cosmic and terrestrial sources as well as man-made radioactive sources. This chapter presents data obtained to assess external dose for 2024. Chapters 4, 5, and 8 present monitoring results for radioactivity from NNSS activities in air, water, and biota, respectively. Those results help scientists estimate potential internal radiation dose to the public via inhalation and ingestion. The total estimated dose, both internal and external, from NNSS activities is presented in Chapter 9.

Direct radiation monitoring is conducted to assess the external radiation environment, detect changes in that environment, respond to releases from DOE National Nuclear Security Administration Nevada Field Office (NNSA/NFO) activities, and measure ***gamma radiation*** levels near potential exposure sites. In addition, DOE O 458.1 provides that potential exposures to members of the public are to be ***ALARA***.

6.1 Measurement of Direct Radiation

Direct (or external) radiation exposure can occur when ***alpha particles***, ***beta particles***, or electromagnetic (gamma and X-ray) radiation interact with living tissue. Electromagnetic radiation can travel long distances through air and penetrate living tissue, causing ionization within the body tissues. For this reason, electromagnetic radiation is one of the greater concerns of direct radiation exposure. By contrast, alpha and beta particles do not travel far in air (a few centimeters [cm] for alpha, and about 10 meters [m] or 33 feet [ft] for beta particles). Alpha particles deposit only negligible energy to living tissue as they rarely penetrate the outer dead layer of skin and cannot penetrate thin plastic. Beta particles are generally absorbed in the layers of skin immediately below the outer layer.

Direct radiation exposure is usually reported in the unit milliroentgen (mR), which is a measure of exposure in terms of numbers of ionizations in air. The dose in human tissue resulting from an exposure from one of the most common ***radionuclides*** (cesium-137 [^{137}Cs]) is approximated by equating a 1-mR exposure with a dose of 1 millirem (mrem) (or 0.01 millisievert [mSv]).

6.2 Thermoluminescent Dosimetry Surveillance Network Design

A surveillance network of ***thermoluminescent dosimeter (TLD)*** sample locations (Figure 6-1) monitors NNSS areas that have elevated radiation levels from historical nuclear explosive testing, current and past radioactive

[1] The definition of word(s) in ***bold italics*** may be found by referencing the Glossary, Appendix B.

waste management activities, and/or current operations involving radioactive material or radiation-generating devices.

TLDs have the capability to measure exposure from all sources of ionizing radiation, but with normal use, the TLD will detect only electromagnetic radiation, high-energy beta particles, and in some special cases, neutrons. This is due to the penetrative abilities of the radiation. The TLD used for environmental sampling is the Panasonic UD-814AS, which has three calcium sulfate elements housed in an air-tight, water-tight, ultra-violet light-protected case. Measurements from the three calcium sulfate elements are averaged to assess penetrating gamma radiation.

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

Active environmental TLDs were set at 105 locations on the NNSS in 2024 (Figure 6-1), along with 6 control locations. They included the following:

- Background (B) – 10 locations where radiation effects from NNSS operations are negligible.
- Environmental 1 (E1) – 41 locations where there is no measurable radioactivity from past operations, but which are locations of interest due to the presence of people in the area and/or the potential for increased radiation exposure from a current operation.
- Environmental 2 (E2) – 35 locations where there is or has been measurable added radioactivity from past operations; these locations are of interest for monitoring direct radiation trends in the area. Some locations fitting this description are grouped with the Waste Operations category below.
- Waste Operations (WO) – 19 locations in and around the Area 3 and 5 RWMSs.
- Control (C) – Five locations in Building 652 and one in Building 650 (both in Area 23). Control TLDs are kept in stable environments. Those in Building 652 are shielded inside a lead cabinet, and those in Building 650 are shielded by just the building itself. These TLDs are used as a quality check on the TLDs and the analysis process.

This network of TLD locations, along with the analysis of their data, serve to continuously monitor operational activities throughout the NNSS for changes in external radiation measures over time and any accidental releases of radioactive material. TLD data are reviewed annually to identify any patterns of exposure rates through time at various soil contamination areas.

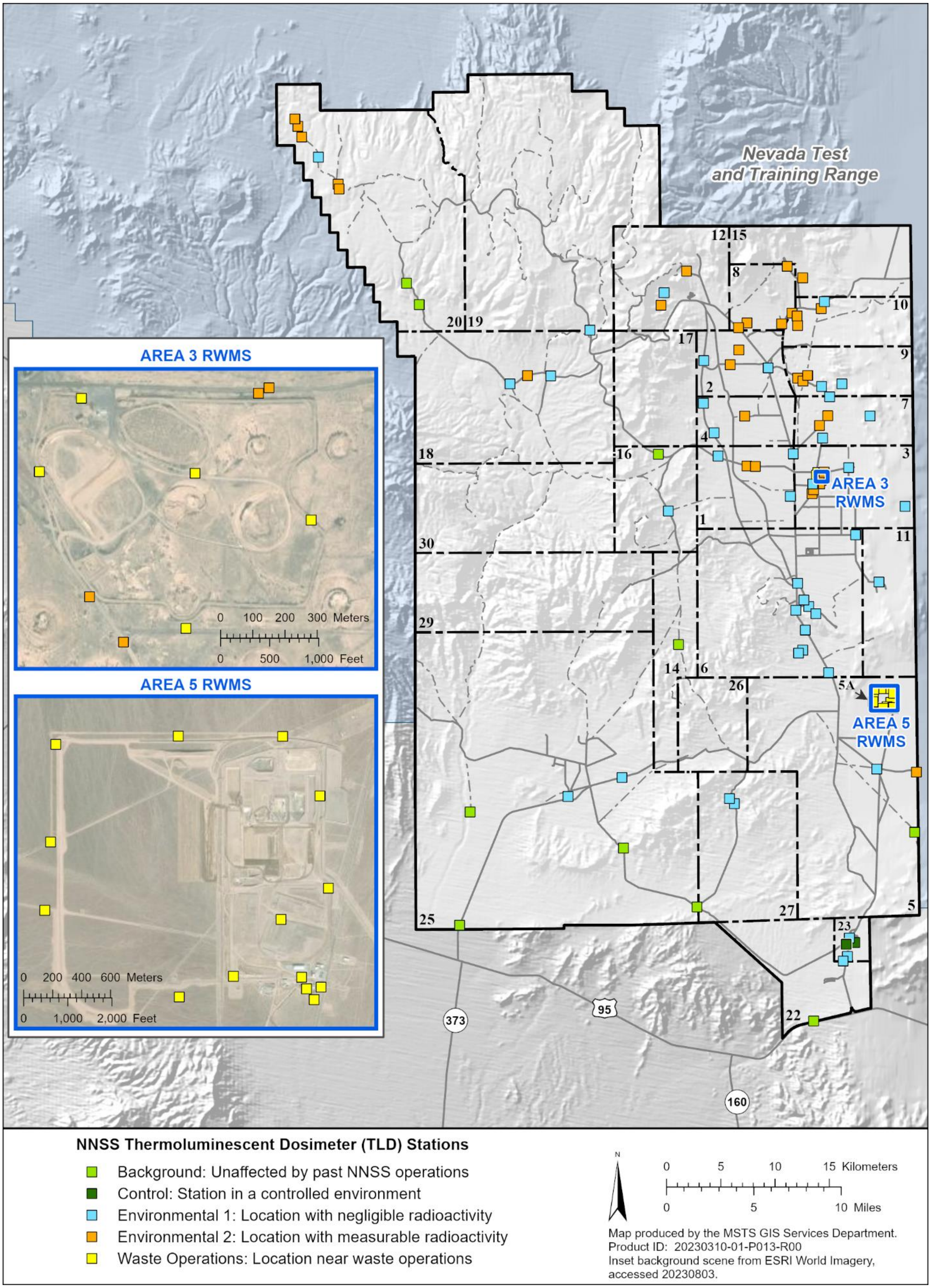

Figure 6-1. Locations of TLDs on the NNSS

6.2.1 Data Quality

Quality assurance (QA) procedures for direct radiation monitoring involve: (1) comparison of readings among the three TLD elements in individual TLDs, (2) comparison of data from the paired TLDs at each location to estimate the measurement and its precision, (3) comparison of current and past data measurements at each TLD location, and (4) review of data from the TLDs in the control locations. The TLDs in control locations allow the detection and estimation of any systematic variations that might be introduced by the measurement process itself.

Quality assurance and ***quality control (QC)*** protocols (including Data Quality Objectives) are maintained as essential elements of direct radiation monitoring. All procedures are updated based on the American National Standards Institute/Health Physics Society (ANSI/HPS 2019) QA/QC requirements, including the use of sample packages to thoroughly document each sampling event, rigorous management of databases, and completion of essential training (Chapter 14). The NNSS Radiological Control Department maintains certification through the DOE Laboratory Accreditation Program for ***dosimetry***.

Five steps comprise the monitoring process for each environmental TLD: the TLD is (1) annealed (i.e., heated and then cooled) to reset its original unexposed condition, then stored in a shielded location; (2) deployed to the field at the beginning of each quarter; (3) collected from the field at the end of each quarter; (4) again stored in a shielded location; and (5) read to measure exposure. To control for variations related to holding times, an estimate of the additional dose due to holding prior to deployment and following collection in the shielded location is subtracted from the measured quarterly dose before computing annual exposure estimates. This adjustment has been applied retroactively to data from 2003 on. This adjustment resulted in a decrease of estimated dose between 0.25% and 5.60%, averaging 1.74% for locations that were in the field in 2024.

6.2.2 Data Reporting

Direct radiation is recorded as exposure per unit time in milliroentgens per day (mR/d), calculated by dividing the measured exposure per quarter for each TLD by the number of days the TLD was exposed at its measurement location. These are multiplied by 365.25 to obtain annualized values. The estimated annual exposure is the average of the quarterly annualized values; this is the metric used to determine compliance with federal annual dose limits.

6.3 Results

Estimated annual exposures for all TLD locations are listed in Table 6-1. Summary statistics for the five location types are listed in Table 6-2. Data were successfully obtained from all but four of the TLDs during all quarters in 2024; six measurements were rejected due to inadequate inter-element agreement. Otherwise, agreement between the results provided by the paired TLDs was quite good, with an average relative percent difference between measurements of 3.8%. The quarter-to-quarter coefficient of variation (CV) (i.e., the relative standard deviation) ranged from 1.1% to 14.2% (mean = 5.7%) over all locations, excluding Gate 100 Truck Parking 1 (discussed in Section 6.3.2).

6.3.1 Background Exposure

In 2024, the average of the estimated annual exposures among the 10 background locations was 122 mR, ranging from 80 to 170 mR (Table 6-2). A 95% prediction interval (PI) for annual exposures based on the 2024 estimated annual exposures at the background locations (denoted "95% PI from Background Locations" in the plots, Figures 6-2, 6-3, and 6-4) is 45 to 199 mR. This interval predicts mean annual background exposures at locations where radiation effects from NNSS operations are negligible.

Exposure estimates at all locations include contributions from natural sources of radiation (i.e., cosmic, terrestrial), legacy sources (i.e., contaminated soils from NNSS historical nuclear testing), and current NNSS operational sources. It is important to note that all DOE dose limits to the public are for dose over and above background.

In order to study whether the NNSS TLD system is able to measure very small dose changes in the environment above the background radiation, statistical analysis of historical data from the 10 current background locations was performed and is summarized in Table 6-3. The baseline background dose at each location is determined using the most recent 10-year data, in accordance with the standard recommended in ANSI/HPS (2019). The estimated annual exposure was consistent over time at each background location from 2014 to 2023. The average annual exposures of the background locations varied from 80 mR to 163 mR (mean = 120 mR) in 2014 through 2023, and the year-to-year CVs ranged from 1.5% to 3.6% (mean = 2.6%). The relative differences between the 2024 mean exposures and their corresponding average annual exposures of the background locations are very small, ranging from -1.7% to 5.5%, averaging 1.5%. These results show that the TLDs are sensitive enough to measure radiation exposure over 10 percent of background, and no man-made radiation from NNSS operations was detected at background locations in 2024.

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

NNSS Area	Location	Number of Quarters	Estimated Annual Exposure (mR)[(a)] Mean[(b)]	Minimum[(b)]	Maximum[(b)]
		Background			
5	Old Indian Springs Road	4	80	74	85
14	Mid-Valley	4	148	137	157
16	Stake P-3	4	125	121	126
20	Stake A-112	4	170	168	172
20	Stake A-118	4	161	155	166
22	Army #1 Water Well	4	87	82	92
25	Gate 25-4-P	4	131	114	142
25	Gate 510	4	129	121	137
25	Jackass Flats & A-27 Roads	4	82	73	89
25	Skull Mtn Pass	4	109	95	117
		Control			
23	Building 650 Dosimetry	4	59	51	65
23	Lead Cabinet, 1	4	27	24	30
23	Lead Cabinet, 2	4	26	24	29
23	Lead Cabinet, 3	4	27	25	30
23	Lead Cabinet, 4	4	28	24	32
23	Lead Cabinet, 5	4	28	24	33
		Environmental 1[(c)]			
1	BJY	4	121	108	126
1	Sandbag Storage Hut	4	116	103	126
1	Stake C-2	4	116	106	123
2	Stake M-140	4	135	127	141
2	Stake TH-58	4	98	92	101
3	LANL Trailers	4	125	122	131
3	Stake OB-20	4	90	87	93
3	Well ER 3-1	4	122	107	131
4	Stake TH-41	4	115	107	123
4	Stake TH-48	4	122	116	125
5	Water Well 5b	4	114	101	122
6	CP-6	4	73	69	75
6	DAF East	4	99	87	105
6	DAF North	4	103	94	109
6	DAF South	4	136	124	146
6	DAF West	4	88	84	92
6	Decon Facility NW	4	131	125	137
6	Decon Facility SE	4	136	125	144
6	Stake OB-11.5	4	131	124	139
6	Yucca Compliance	4	95	90	100
6	Yucca Oil Storage	4	102	90	108
7	Reitmann Seep	4	134	127	138
7	Stake H-8	4	122	110	131
9	Papoose Lake Road	4	87	82	91
9	U-9cw South	4	107	103	109
9	V & G Road Junction	4	117	110	121
10	Gate 700 South	4	130	126	133
11	Stake A-21	4	132	120	143

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

NNSS Area	Location	Number of Quarters	Estimated Annual Exposure (mR)[a] Mean[b]	Minimum[b]	Maximum[b]
12	Upper N Pond	4	132	122	137
16	3545 Substation	4	142	134	149
18	Stake A-83	4	153	141	160
18	Stake F-11	4	150	144	154
19	Stake P-41	4	164	159	169
20	Stake J-41	4	147	143	149
23	Gate 100 Truck Parking 1	4	74	62	95
23	Gate 100 Truck Parking 2	4	56	49	60
23	Mercury Fitness Track	4	58	61	63
25	HENRE	4	125	115	134
25	NRDS Warehouse	4	125	110	135
27	Cafeteria	4	110	97	120
27	JASPER-1	4	116	105	122
		Environmental 2[c]			
1	Bunker 1-300	4	110	99	118
1	T1	4	183	194	197
2	Stake L-9	4	156	149	160
2	Stake N-8	4	311	287	332
3	Stake A-6.5	4	135	132	142
3	T3	4	236	225	246
3	T3 West	4	224	208	238
3	T3a	4	233	211	254
3	T3b	4	328	315	344
3	U-3co North	4	164	146	171
3	U-3co South	4	134	121	147
4	Stake A-9	4	324	306	345
5	Frenchman Lake	4	196	176	210
7	Bunker 7-300	4	169	160	174
7	T7	4	116	113	120
8	Baneberry 1	4	288	273	301
8	Road 8-02	4	118	112	123
8	Stake K-25	4	113	105	116
8	Stake M-152	4	157	153	163
9	B9a	4	124	122	126
9	Bunker 9-300	4	121	117	126
9	T9b	4	350	326	367
10	Circle & L Roads	4	118	109	125
10	Sedan East Visitor Box	4	132	127	135
10	Sedan West	4	199	191	211
10	T10	4	202	195	211
12	T-Tunnel #2 Pond	4	222	199	232
12	Upper Haines Lake	4	105	99	110
15	EPA Farm	4	114	112	120
18	Johnnie Boy North	4	152	149	155
20	Palanquin	4	202	197	206
20	Schooner-1	4	382	368	391
20	Schooner-2	4	201	184	209
20	Schooner-3	4	147	142	151
20	Stake J-31	4	163	159	165
		Waste Operations[c]			
3	RWMS Center	4	134	127	141
3	RWMS East	3	129	118	136
3	RWMS North	4	129	128	132
3	RWMS South	4	234	206	248
3	RWMS West	4	123	118	130
5	CAU-111	4	135	131	143
5	Lysimeter	4	148	146	151

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

NNSS Area	Location	Number of Quarters	Estimated Annual Exposure (mR)[a] Mean[b]	Minimum[b]	Maximum[b]
5	Pilot Well 3	4	136	129	146
5	Powerline Rd	4	138	128	145
5	RWMS East Gate	4	100	87	109
5	RWMS Expansion NE	4	150	144	156
5	RWMS NE Corner	4	128	113	135
5	RWMS-5 North	4	157	150	164
5	RWMS SW Corner	4	126	113	133
5	Vefa	4	157	147	161
5	Waterline Rd	4	143	128	157
5	WEF North	4	111	107	116
5	WEF South	4	123	112	134
5	WEF West	4	120	112	126

(a) To obtain the estimated daily exposure rates, divide the annual exposure estimates by 365.25.
(b) Mean, minimum, and maximum values from the adjusted quarterly estimates. Each quarterly estimate is the average of two TLD readings per location in all but six instances.
(c) Location types: Environmental 1 = Environmental locations with exposure rates near background, but monitored for potential for increased exposures due to NNSS operations; Environmental 2 = Environmental locations with measurable radioactivity from past operations, excluding those designated WO; Waste Operations = Locations in or near waste operations.

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

Location Type	Number of Locations	Estimated Annual Exposure (mR) Mean	Minimum	Maximum
Background (B)	10	122	80	170
Environmental 1 (E1)	41	116	56	164
Environmental 2 (E2)	35	189	105	382
Waste Operations (WO)	19	138	100	234
Control, Shielded (C)	5	27	26	28
Control, Unshielded (C)	1	59	59	59

Table 6-3. Summary statistics for recent exposure history of background TLD locations

Area	Location	Historical Average Annual Exposure (mR)[a]	CV(%)[b]	Estimated Exposure in 2024 (mR)	Difference(%)[c]
5	Old Indian Springs Road	80	1.5	80	0.8
14	Mid-Valley	146	3.1	148	0.9
16	Stake P-3	118	3.6	125	5.5
20	Stake A-112	163	3.0	170	4.2
20	Stake A-118	157	3.3	161	2.8
22	Army #1 Water Well	85	2.4	87	2.4
25	Gate 25-4-P	133	2.2	131	-1.7
25	Gate 510	129	2.5	129	0.1
25	Jackass Flats & A-27 Roads	82	2.7	82	-0.2
25	Skull Mtn Pass	109	2.2	109	0.1

(a) Average annual exposure was calculated from all available TLD data from 2014 to 2023.
(b) Coefficient of variation = the relative standard deviation.
(c) Relative difference between the 2024 exposure estimate and the average of 2014 to 2023 estimates.

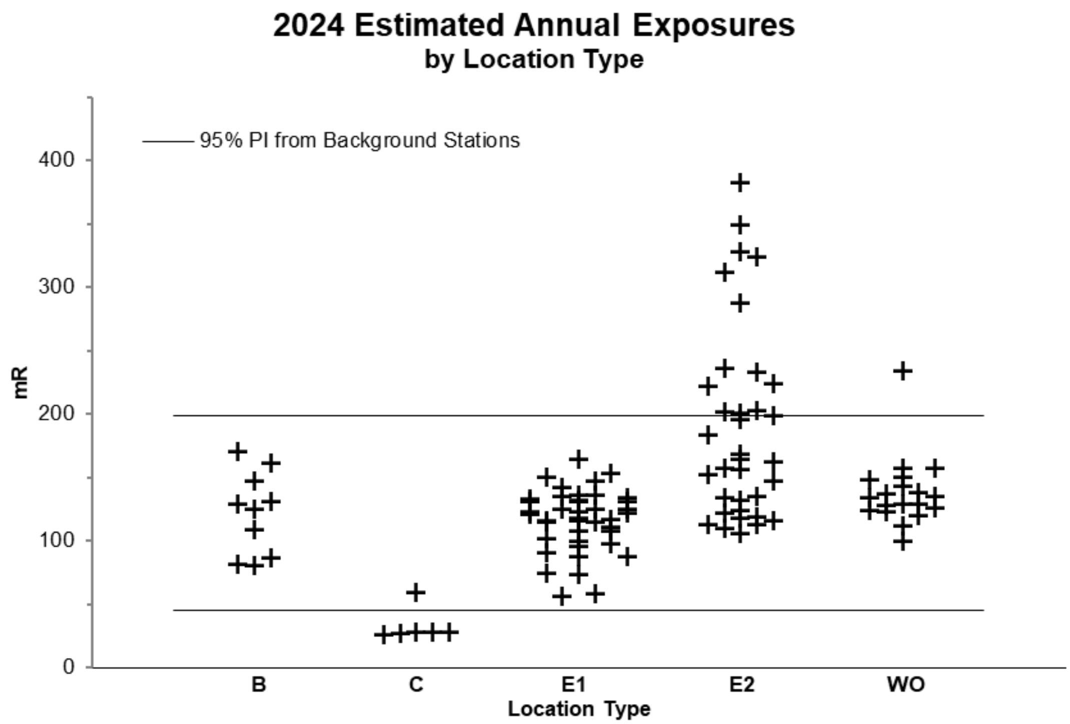

Figure 6-2. Estimated exposures on the NNSS by location type

6.3.2 Potential Exposure to the Public along the NNSS Boundary

Most of the NNSS is not accessible to the public; the public has limited access only at the southern portion of the NNSS, where Gate 100 is the primary entrance point to the NNSS. The outer parking areas are accessible to the public. Trucks hauling radioactive materials, primarily ***low-level waste (LLW)*** destined for disposal in the RWMSs, often park outside Gate 100 while waiting to enter the NNSS. Two TLD locations were established in October 2003 to monitor this truck parking area.

The TLD at the north end of the parking area (Gate 100 Truck Parking 2) had an estimated annual exposure of 56 mR in 2024, with quarterly estimates of 60, 58, 57, and 49 mR, respectively. The TLD location about 64 m (210 ft) away, on the west side of the parking area (Gate 100 Truck Parking 1), has had elevated exposure levels at various times in its history, likely from waste shipments. Its average value for 2024 was 74 mR, with quarterly estimates of 62, 75, 65, and 95 mR, respectively. All results for both locations are within the range of background-based prediction limits.

While the public has limited access to the NNSS at Gate 100 along its southern border, others may have access to other boundaries of the NNSS. Most of the NNSS is bounded by the Nevada Test and Training Range (NTTR). Military or other personnel on the NTTR who are not classified as DOE radiological workers would also be subject to the DOE public dose limit of 100 millirem per year (mrem/yr [1 mSv/yr]). Nuclear tests on the NTTR (Double Tracks and Project 57) consisted of experiments (called safety experiments) where weapons were exploded with conventional explosives without going critical (i.e., starting a nuclear chain reaction). These areas, therefore, have primarily alpha-emitting radionuclides that do not contribute significantly to external dose. Historical nuclear testing activities also occurred on the Tonopah Test Range (TTR) (Clean Slate I, II, and III) in the northwest portion of the NTTR. Radiation exposure rates are measured on and around the TTR, and the results are reported by Sandia National Laboratories in the TTR annual environmental report posted at https://www.sandia.gov/news/publications/.

A radioactive material area boundary extends beyond the NNSS in the Frenchman Lake region of Area 5 along the southeast boundary of the NNSS. This region was a location of atmospheric weapons testing in the 1950s and is inaccessible to the public. A TLD location was established there in July 2003 to characterize direct radiation levels from this legacy contaminated-soil area and to assess the external dose to personnel not classified as radiation workers who may visit the area. The estimated annual exposure to a hypothetical person at the Frenchman Lake TLD location in 2024 was 196 mR. This has been declining over time, down from 420 mR in 2003. The estimated above-background dose in 2024 would be approximately 26 to 116 mrem, depending on which background value is subtracted. This may exceed the 100 mrem dose limit to a person residing full time, year-round, at this location, but there are no living quarters or full-time non-radiation workers in this vicinity. Workers specially trained and classified as radiation workers, although they do not work in the vicinity, have a higher allowable dose limit of 5,000 mrem/yr (50 mSv/yr), which would not be exceeded in the vicinity of the Frenchman Lake TLD location.

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

6.3.3 Exposures from NNSS Operational Activities

Forty-one TLDs are placed in locations where either workers and/or the public have the potential to receive radiation exposure from current operations (E1 locations). E1 locations have negligible radioactivity from past operations. The mean estimated annual exposure at these locations was 116 mR in 2024, a little lower than the mean estimated annual exposure at background locations (see Table 6-2). Overall, annual exposures were not different between B and E1 locations (Figure 6-2); the estimated annual exposures at all E1 locations are well within the 95% PI calculated from B locations.

6.3.4 Exposures from Radioactive Waste Management Sites

DOE Manual DOE M 435.1-1, "Radioactive Waste Management Manual," states that LLW disposal facilities shall be operated, maintained, and closed so that a reasonable expectation exists that the annual dose to members of the public shall not exceed 25 mrem from all exposure pathways combined. The RWMSs are located well within the NNSS boundaries, which are patrolled by security personnel; no member of the public can access these areas for significant periods of time. TLDs placed at the RWMSs show the potential dose from external radiation to a hypothetical person residing year-round at each RWMS.

Between 1952 and 1972, 60 nuclear explosive tests were conducted in Yucca Flat within 400 m (1,312 ft) of the current Area 3 RWMS boundary. Fourteen of these tests were atmospheric tests that left radionuclide-contaminated surface soil and, therefore, elevated radiation exposures across the area. Waste pits in the Area 3 RWMS are ***subsidence craters*** from seven subsurface tests, which have been filled with LLW and then covered with clean soil. As a result, exposures inside the Area 3 RWMS are low when compared with those at or outside the fence line.

Annual exposures measured inside the Area 3 RWMS and at three of four locations at the boundary were within the range of NNSS background exposures in 2024 (Figure 6-3). The boundary location A3 RWMS South has an estimated exposure above the range of NNSS background; it is 160 m (525 ft) from the site of two atmospheric nuclear explosive tests. The three E2 TLD locations outside the RWMS that are also above the range of NNSS background (Figure 6-3) are a similar distance from the same atmospheric tests, but on the other side, farther from the RWMS boundary. Based on these measurements, it does not appear that waste buried at the Area 3 RWMS would have contributed external exposure to a hypothetical person residing at its boundary during 2024.

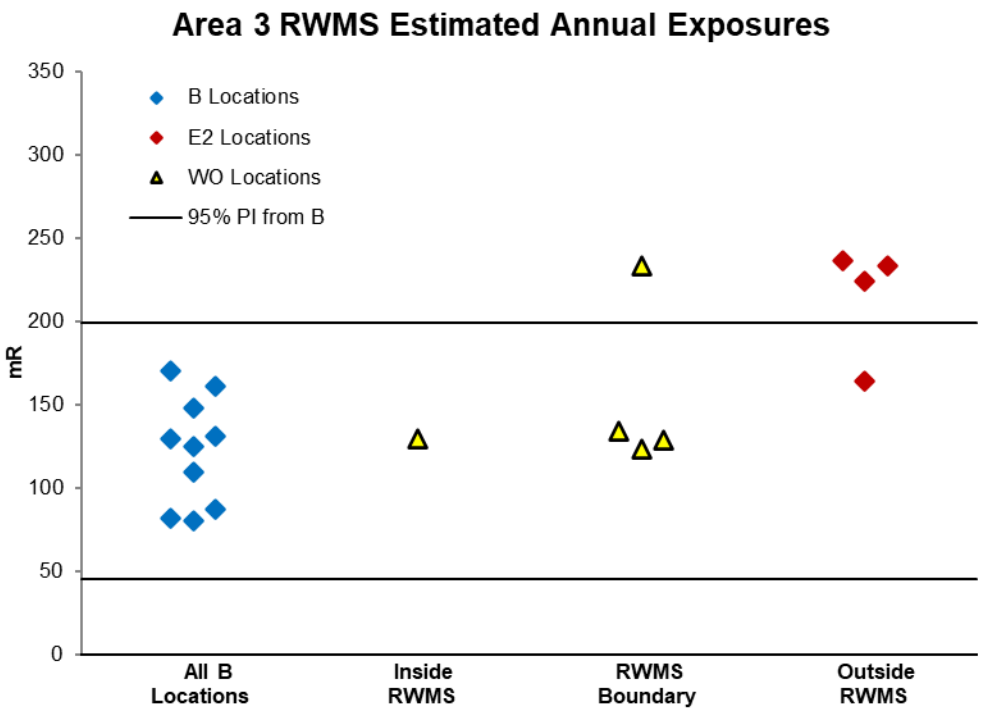

Figure 6-3. 2024 annual exposures in and around the Area 3 RWMS and at background locations

The Area 5 RWMS is located in the northern portion of Frenchman Flat. Between 1951 and 1971, 25 nuclear explosive tests were conducted within 6.3 kilometers (km) (3.9 miles [mi]) of the Area 5 RWMS. Fifteen of these were atmospheric tests and, of the remaining ten, nine released radioactivity to the surface, which contributes to exposures in the area. No nuclear explosive testing occurred within the boundaries of the Area 5 RWMS.

In 2024, estimated annual exposures at Area 5 RWMS TLD locations were within the range of exposures measured at NNSS ***background*** locations (Figure 6-4). The one location outside the Area 5 RWMS that has an estimated exposure above background levels (the Frenchman Lake TLD location) is within 0.5 km (0.3 mi) of six atmospheric tests conducted on the Frenchman Lake Playa.

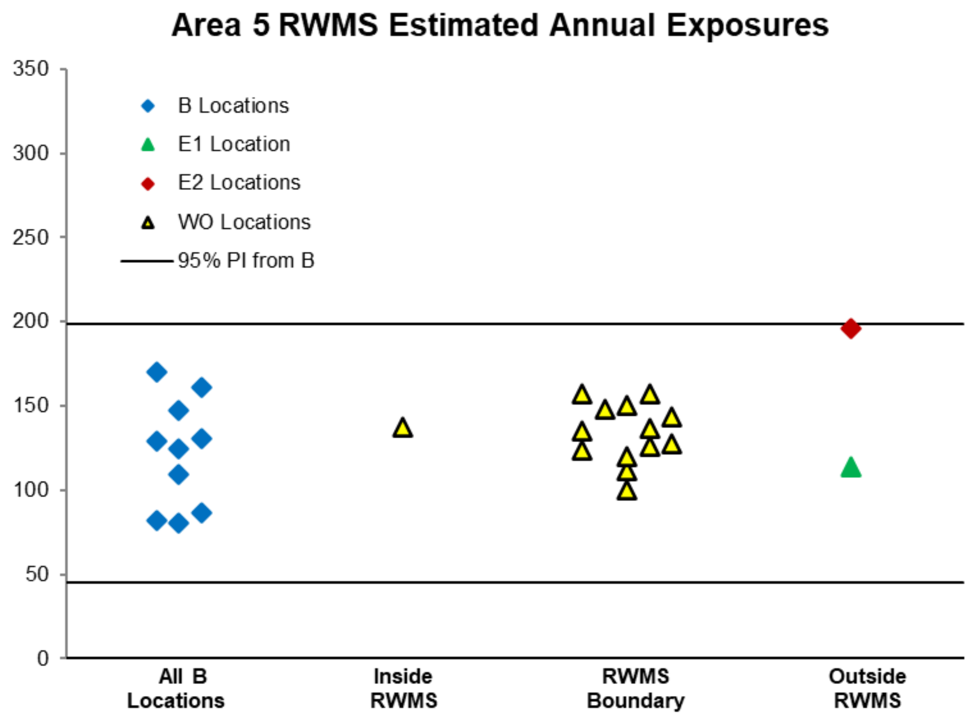

Figure 6-4. 2024 annual exposures around the Area 5 RWMS and at background locations

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

6.3.5 Exposures to NNSS Plants and Animals

The highest exposure rate measured at any TLD location in 2024 was 391 mR/yr (1.07 mR/d) at the Schooner-1 location during the third quarter (Table 6-1). Given such a large area source, there is very little difference between the exposure measured at a height of 1 m (3.3 ft) and that measured near the ground (e.g., 3 cm, or 1.2 in.) where small plants and animals reside. The daily exposure rate near the ground surface would be less than 2% of the total dose rate limit to terrestrial animals and less than 1% of the limit to terrestrial plants. Hence, doses to plants and animals from external radiation exposure at NNSS monitoring locations are much lower than the dose limits. Doses to biota from both internal and external radionuclides are presented in Section 9.2.

6.3.6 Exposure Patterns in the Environment over Time

Direct radiation monitoring is conducted to help characterize releases from NNSA/NFO activities. Continued monitoring of exposures at locations of past releases on the NNSS helps to accomplish this. Small quarter-to-quarter changes are normally seen in exposure rates from all locations. In 2024, the median CV for measurements between quarters was 5.1%. Gate 100 Truck Parking 1 showed the highest variation, with a CV of 20.5%. Except for some control locations, no other environmental location had a CV over 10%. In the past 10 years (2014-2023), the median CV has ranged from 2.8% to 5.1%; the quarter-to-quarter variability in 2024 is less than 10% relative uncertainty.

Long-term trends are displayed in Figure 6-5 by location type for locations that have been monitored for at least 10 years. The average annual ***decay*** rates by location group are 0.08% (B), -0.10% (C), 0.14% (E1), 1.60% (E2), and 0.47% (WO). Annual exposures decreased 3.17% per year on average at those locations with significant added man-made radiation (E2 and WO), where 2024 estimated exposures were higher than the 95% PI calculated from B locations. These average rates of decay are very similar to those measured from 2008 through 2023. The observed decreases are due to a combination of natural radioactive decay, dispersal, and dilution in the environment.

The locations with the six highest estimated annual exposures in 2024 are Schooner-1 (Area 20), T9b (Area 9), T3b (Area 3), Stake A-9 (Area 4), Stake N-8 (Area 2), and Baneberry 1 (Area 8). Their annual exposures have been decreasing at an estimated rate of 50% every 16, 27, 32, 16, 17, and 37 years, respectively.

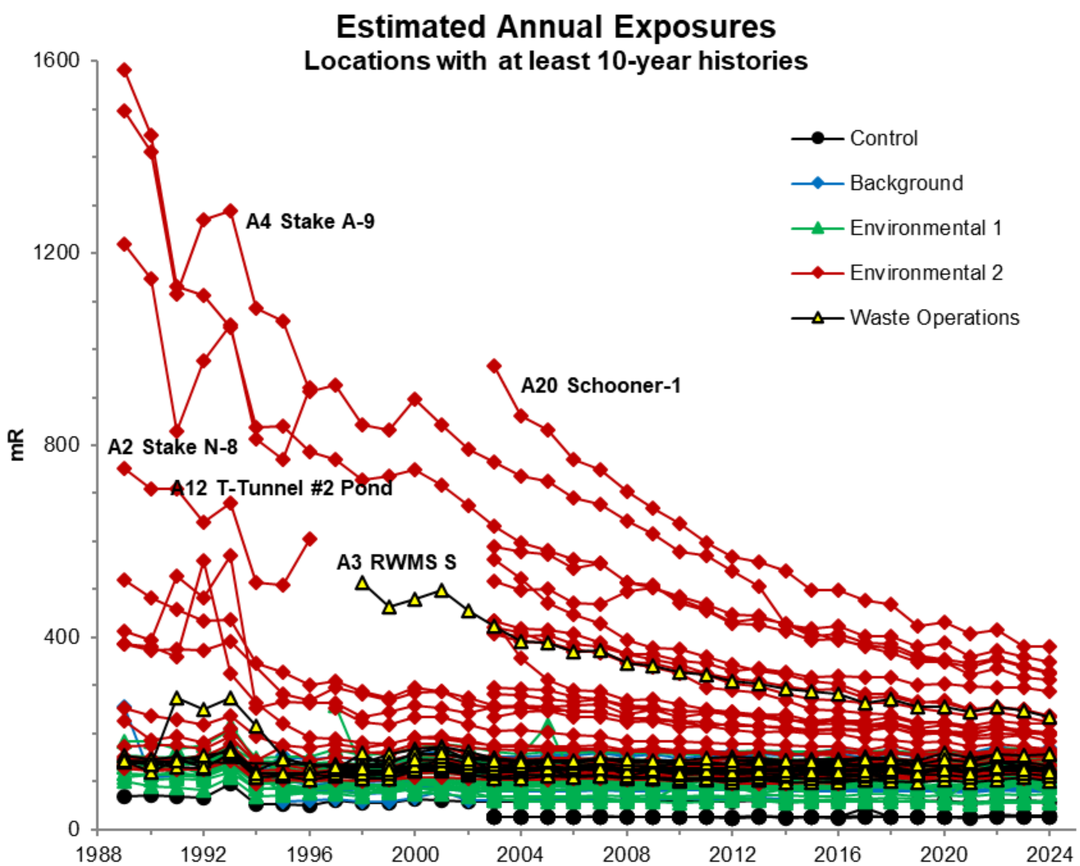

Figure 6-5. Trends in direct radiation exposure measured at TLD locations

6.4 Environmental Impact

Direct radiation exposure to the public from NNSS operations during 2024 was negligible. Radionuclides historically released to the environment on the NNSS have resulted in localized elevated exposures. The areas of elevated exposure are not open to the public, nor do personnel work in these areas full-time. Overall exposures at the RWMSs appear to be generally lower inside and at the boundary than those outside the RWMSs. This is due to the presence of radionuclides released from historical testing distributed throughout the area around the RWMSs compared with the clean soil used inside the RWMSs to cover the waste. The external dose to plants and animals at the location with the highest measured exposure was a small fraction of the dose limit to biota; hence, no detrimental effects to biota from external radiation exposure are expected at the NNSS.

6.5 References

American National Standards Institute/Health Physics Society, 2019. *Environmental Dosimetry – Criteria for System Design and Implementation*. N13.37-2014 (R2019), 2019.

ANSI/HPS, see American National Standards Institute / Health Physics Society.

Chapter 7: Community-Based Offsite Monitoring

John O. Goreham, Lynn H. Karr, Greg McCurdy, Beverly A. Parker, David Perez, and Charles E. Russell
Desert Research Institute

John M. Klenke
Nye County

Community Environmental Monitoring Program Goals

Provide independent monitoring at offsite locations and communicate environmental data relevant to past and continuing activities at the Nevada National Security Site (NNSS). Engage the public through hands-on monitoring of environmental conditions in their communities as they might relate to activities at the NNSS. Communicate environmental monitoring data to the public in a transparent and accessible manner. Provide an educated, trusted, local resource for public inquiries regarding past and present activities at the NNSS.

Two community-based radiological monitoring programs are conducted off the NNSS. They provide independent results for the presence of man-made ***radionuclides***[1] in air and groundwater samples from communities surrounding the NNSS.

The Community Environmental Monitoring Program (CEMP) was initiated in 1981 and is conducted by the Desert Research Institute (DRI) of the Nevada System of Higher Education. CEMP's mission is to provide data to the public regarding the presence of man-made radionuclides in air and groundwater off the NNSS that could be the result of current operations or past nuclear testing on the NNSS. Initially, the CEMP network functioned as a first line of offsite detection of potential radiation releases from underground nuclear tests at the NNSS. It currently exists as a non-regulatory public informational and outreach program. Monitored and collected data include, but are not necessarily limited to, ***background*** and airborne radiation data, meteorological data, and ***tritium*** (***^3H***) concentrations in downgradient community drinking water. Network air monitoring stations, located in Nevada, Utah, and California, are managed by local citizens, many of whom are middle and high school science teachers, whose routine tasks are to ensure equipment is operating normally and to collect air filters and route them to DRI for analysis. These Community Environmental Monitors (CEMs) are also available to discuss the monitoring results with the public and to speak to community and school groups. DRI's responsibilities include maintaining the physical monitoring network through quarterly visits by environmental radiation monitoring specialists, who also participate in training and interfacing with CEMs and interacting with local community members and organizations to provide information related to the monitoring data. DRI also provides public access to the monitoring data through maintenance of a project website at http://www.cemp.dri.edu/. A detailed informational background narrative about the CEMP can be found at http://www.cemp.dri.edu/cemp/moreinfo.html along with more detailed descriptions of the various types of sensors found at the stations and about outreach activities conducted by the CEMP. ***Quality control*** procedures for the CEMP are described in Chapter 15.

The Nye County Tritium Sampling and Monitoring Program (TSaMP) was initiated in 2015 when the U.S. Department of Energy (DOE), National Nuclear Security Administration Nevada Field Office (NNSA/NFO) and the Environmental Management (EM) Nevada Program issued a 5-year grant to Nye County to monitor ^3H in wells downgradient of the NNSS. The grant was extended through 2026 and supports the annual sampling of 10 core wells (i.e., the same wells year to year) and 10 additional wells (selected locations change from year to year). The program also supports Nye County's involvement in technical reviews of the Underground Test Area (UGTA) corrective action program (Chapter 11). Nye County coordinates with DRI, CEMs, and Nye County citizens to determine the sample well locations. Due to CEMP's success at involving and educating local communities, the grant directs that data administration and communication to the public of Nye County's program be conducted through the CEMP.

Sections 7.1 and 7.2 of this chapter present the 2024 CEMP air and water monitoring results. Section 7.3 presents the 2024 TSaMP monitoring results. Results from radiological monitoring of air, groundwater, direct radiation,

[1] The definition of word(s) in ***bold italics*** may be found by referencing the Glossary, Appendix B.

and biota conducted on the NNSS and the Nevada Test and Training Range (NTTR) by NNSA/NFO are presented in Chapters 4, 5, 6, and 8.

7.1 CEMP Air Monitoring

In 2024, DRI managed 24 CEMP stations, which comprise the Air Surveillance Network (ASN) (Figure 7-1). The ASN stations include various types of equipment to monitor airborne radiation and meteorological conditions. Descriptions of the various types of sensors at the stations can be found at http://www.cemp.dri.edu/cemp/moreinfo.html. The air monitoring equipment described in Section 7.1.1 is shown in Figure 7-2.

7.1.1 Air Monitoring Equipment

CEMP Low-Volume Air Sampler Network – In 2024, the CEMP ASN included 23 continuously operating low-volume particulate air samplers. Warm Springs Summit, Nevada, is the only ASN station with no low-volume air sampler. Duplicate continuously operating air samplers are co-located at two randomly selected stations for 3 months (one calendar quarter) before being moved to a new location. Glass-fiber filters from the low-volume particulate samplers are collected every 2 weeks by the CEMs and mailed to DRI. Each quarter, one complete set of filters are selected, prepared, and forwarded to an independent laboratory to be analyzed for ***gross alpha*** and ***beta radioactivity***, as well as gamma ***spectrometry***. Samples are held for a minimum of 7 days after collection to allow for the decay of naturally occurring ***radon progeny***. Filters not selected for laboratory analysis are archived at DRI.

At approximately 3:00 p.m. on Thursday, August 22, 2024, smoke was reported in a remote area of the NNSS. NNSS Fire and Rescue responded and confirmed that a wildland fire was burning in the northern section of the site.

The fire (dubbed the "Ribbon Fire") burned through two contaminated areas. Radiological exposure from the fire was determined to be well within acceptable bounds and no immediate threat to public health or safety was identified.

The fire was 100% contained on August 25, 2024. Approximately 7,970 acres burned. NNSA/NFO stated that no structures were damaged by the fire and no injuries were sustained by any NNSS personnel. Surveying conducted by Radiological Control Technicians of the two burned contaminated areas revealed no elevated levels of exposure.

At the beginning of every calendar year, the CEMP Quality Assurance Officer generates an air filter collection schedule for the entire forthcoming year based on a two-week collection schedule. This schedule is then disseminated to the CEMs responsible for installing and collecting the air filters at their stations. The collection dates for August were slated for the 11th and 25th. After discussion with NNSA/NFO regarding the Ribbon Fire, it was decided that both the August 11th and 25th "batches" would be submitted for radiological analysis (rather than one batch for the quarter) in the interest of capturing radiological results both preceding and during the fire.

CEMP Environmental Dosimetry Network – Environmental dosimeters are used at the stations to measure ambient ***gamma radiation*** from natural and man-made sources. Dosimeters are deployed at 23 of the 24 CEMP stations; a dosimeter is not deployed at Warm Springs Summit due to limited access during the winter months.

For ***quality assurance (QA)*** purposes, duplicate dosimeters are deployed at three randomly selected stations each quarter. An average daily ***exposure*** rate is calculated for each quarterly exposure period. The average of the quarterly daily values is multiplied by 365.25 days to obtain the total annual exposure for each station.

CEMP Pressurized Ion Chamber (PIC) Network – The PIC detector measures gamma radiation exposure rates and, because of its sensitivity, may detect low-level exposures that go undetected by other monitoring methods. PICs are in place at all 24 stations in the CEMP ASN. The primary function of the PIC network is to detect changes in ambient gamma radiation due to human activities. In the absence of such activities, ambient gamma radiation rates vary naturally among locations, reflecting differences in altitude (cosmic radiation), ***radioactivity*** in the soil (terrestrial radiation), and slight variations at a single location due to weather patterns. Because a full suite of meteorological data is recorded at each CEMP station (see next paragraph), variations in PIC readings caused by weather events such as precipitation or changes in barometric pressure are more readily identified.

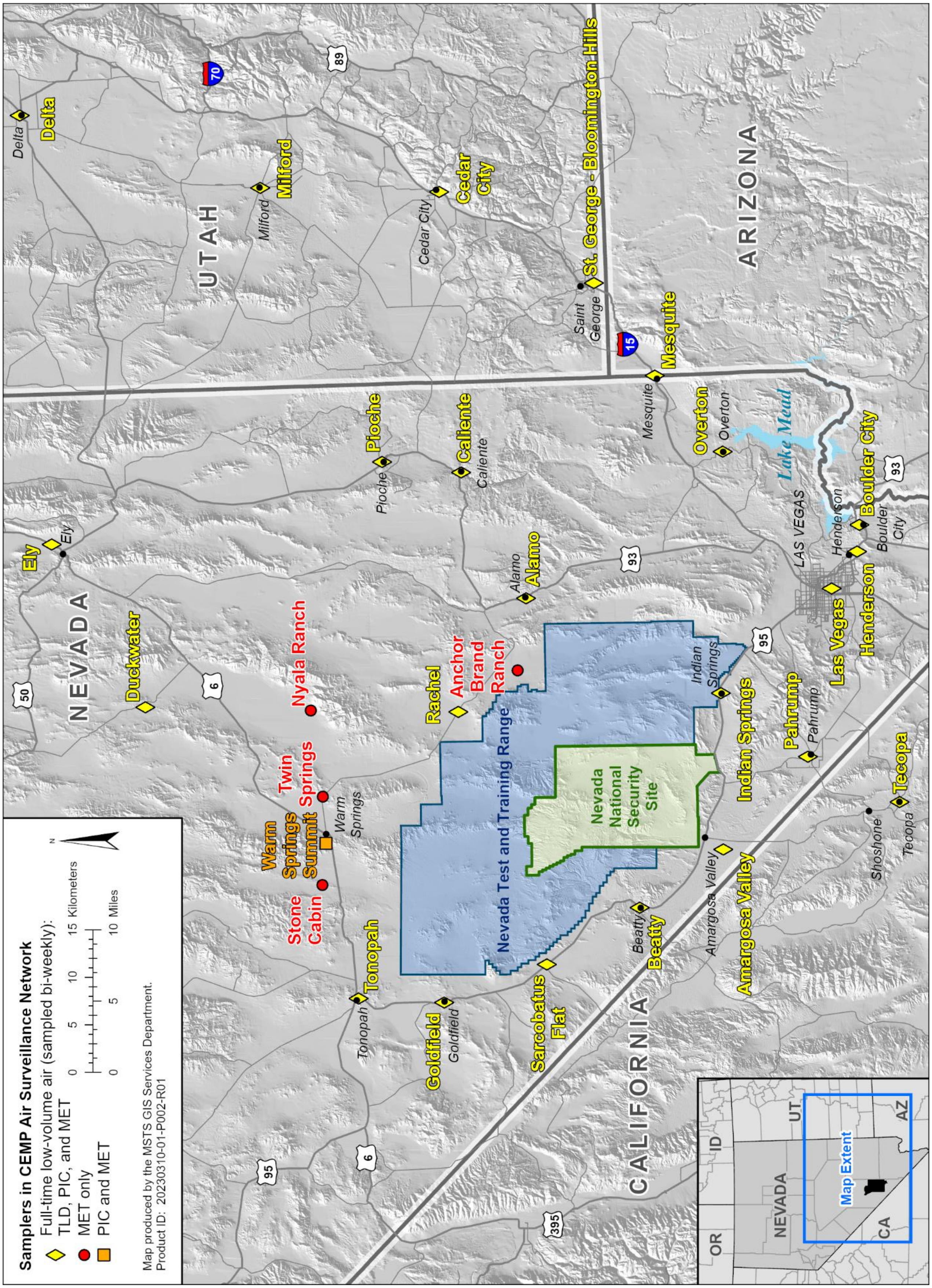

Figure 7-1. 2024 CEMP ASN

Variations are easily viewed by selecting a station location on the network map shown on the CEMP home page, http://www.cemp.dri.edu/, then selecting the desired variables.

CEMP Meteorological (MET) Network – Changing weather conditions can have an effect on measurable levels of background radiation; therefore, meteorological instrumentation is in place at each of the 24 CEMP stations and at the four ranch MET stations that do not monitor airborne radiation: Stone Cabin, Twin Springs, Nyala Ranch, and Anchor Brand Ranch.

The MET network includes sensors that measure air temperature, humidity, wind speed and direction, solar radiation, barometric pressure, precipitation, and soil temperature and moisture. All of these data can be observed real-time at the onsite station display and archived data are available by selecting a station location on the CEMP home page at http://www.cemp.dri.edu/.

7.1.2 Air Sampling Methods

Samples of airborne particulates from CEMP ASN stations were collected by drawing air through a 5-centimeter (2-inch) diameter glass-fiber filter at a constant flow rate of 49.5 liters (1.75 cubic feet [ft^3]) per minute at standard temperature and pressure. The actual flow rate and total volume were measured with an in-line air-flow calibrator. The filter is mounted in a holder that faces downward at a height of approximately 1.5 meters (m) (5 feet [ft]) above the ground. The total volume of air collected ranged from approximately 1,030 to 1,290 cubic meters (36,000 to 45,000 ft^3), depending on the elevation of the station and changes in air temperature and/or pressure.

Air sampling occurs full-time year-round at all stations, but only one sample per quarter from each station is selected for routine analysis, unless additional analyses are warranted (e.g., two sets of samples were analyzed during the third quarter due to the Ribbon Fire, as discussed above).

Figure 7-2. CEMP station in Tonopah, Nevada

7.1.3 Air Sampling Results

7.1.3.1 Gross Alpha and Gross Beta

Beginning in 2022, gross alpha, gross beta, and gamma spectrometry analyses of the air filters were performed by a new lab. The new lab is accredited by the DOE Consolidated Audit Program-Accreditation Program, meaning it has demonstrated successful completion of the American Association for Laboratory Accreditation evaluation process. This includes an assessment of the laboratory's compliance against the Department of Defense (DoD) / Department of Energy (DOE) Consolidated Quality Systems Manual (QSM) (currently version 6.0, December 2023). The QSM is based on Volume 1 of The NELAC Institute (TNI) Standards (September 2009), which incorporates International Organization for Standardization/International Electrotechnical Commission Standards ISO/IEC 17025:2005 and 17025:2017. More specifically, the new lab is accredited to perform U.S. Environmental Protection Agency (EPA) method 9310 for gross alpha and gross beta, and method (Health and Safety Laboratory) HASL-300 Ga-01-R for gamma spectrometry.

Analyses of gross alpha and gross beta in airborne particulate samples are used to screen for long-lived radionuclides in the air. Clean Air Act National Emission Standards for Hazardous Air Pollutants (NESHAP) concentration levels do not exist for gross alpha and gross beta in air, because these measurements include naturally occurring radionuclides in uncertain amounts. Instead, assessment of NESHAP compliance on the NNSS is determined through alpha and gamma spectrometry. The CEMP uses gross alpha and gross beta analyses because they are obtained relatively quickly and economically and are useful to identify increases that require further investigation through gamma spectrometry.

The mean annual gross alpha activity (shown in Table 7-1) for all CEMP sampling locations in 2024 (3.50×10^{-15} microcuries per milliliter [μCi/mL]) is an approximately 37% decrease from the value reported for 2023 (5.54×10^{-15} μCi/mL). The maximum gross alpha activity for all CEMP sampling locations in 2024 (7.22×10^{-15} μCi/mL) was obtained from the filter collected from the Boulder City station on October 20, 2024, and represents an approximately 47% decrease from the maximum gross alpha value reported for 2023 (13.65×10^{-15} μCi/mL).

Gross alpha results for all samples from both the August 11th and 25th collection dates (i.e., the samples collected preceding and during the Ribbon Fire) were consistent with previous results; none of the gross alpha results from the August 25th collection date were elevated with respect to previously analyzed samples.

Table 7-1. Gross alpha results for the CEMP offsite ASN in 2024

		Gross Alpha ($\times 10^{-15}$ μCi/mL)			
Station	**Number of Samples**	**Mean**	**Standard Deviation**	**Minimum**	**Maximum**
Alamo	5	3.78	1.31	2.26	6.03
Amargosa Valley	5	3.73	1.15	1.92	5.26
Beatty	5	3.44	1.17	2.03	5.33
Boulder City	5	4.08	1.69	2.39	7.22
Caliente	5	3.48	1.49	2.17	6.23
Cedar City	8	3.00	1.07	2.00	4.84
Delta	5	3.41	1.44	1.80	5.88
Duckwater	5	2.98	1.20	1.38	4.64
Ely	5	3.28	1.20	2.17	4.77
Goldfield	6	3.42	1.55	1.94	6.25
Henderson	5	3.99	2.11	1.47	7.10
Indian Springs	5	4.15	1.58	2.02	6.67
Las Vegas	5	3.36	0.60	2.53	4.34
Mesquite	6	3.49	1.20	2.05	5.68
Milford	6	3.27	1.22	1.92	5.38
Overton	5	3.57	1.04	2.30	5.30
Pahrump	5	3.73	1.27	2.27	5.40
Pioche	6	3.34	0.99	2.17	4.96
Rachel	8	3.33	1.21	1.58	5.18
Sarcobatus Flats	5	3.64	1.77	1.73	6.23
St. George, Bloomington Hills (BH)	7	3.55	1.54	2.19	7.03
Tecopa	5	3.83	1.12	2.72	5.69
Tonopah	6	3.09	1.29	1.92	5.61
All Stations	128	3.50	1.37	1.38	7.22

The mean annual gross beta activity across all sample locations (Table 7-2) was 1.20×10^{-14} μCi/mL. Gross beta activity was detected in all air samples and, overall, was similar to previous years' levels. Gross beta results for all samples from both the August 11th and 25th collection dates (i.e., the samples collected preceding and during the Ribbon Fire) were consistent with previous results; none of the gross beta results from the August 25th collection date were elevated with respect to previously analyzed samples.

Table 7-2. Gross beta results for the CEMP offsite ASN in 2024

Station	Number of Samples	Gross Beta (× 10^{-14} µCi/mL)			
		Mean	Standard Deviation	Minimum	Maximum
Alamo	5	1.21	0.38	0.70	1.73
Amargosa Valley	5	1.29	0.47	0.67	1.95
Beatty	5	1.14	0.42	0.69	1.75
Boulder City	5	1.42	0.44	0.82	2.07
Caliente	5	1.12	0.38	0.62	1.75
Cedar City	8	1.12	0.34	0.54	1.63
Delta	5	1.21	0.45	0.78	1.96
Duckwater	5	1.07	0.39	0.63	1.69
Ely	5	1.12	0.38	0.59	1.62
Goldfield	6	1.02	0.52	0.47	1.93
Henderson	5	1.32	0.35	0.94	1.88
Indian Springs	5	1.33	0.47	0.83	2.02
Las Vegas	5	1.25	0.41	0.66	1.86
Mesquite	6	1.12	0.37	0.80	1.82
Milford	6	1.25	0.40	0.85	2.04
Overton	5	1.18	0.35	0.86	1.83
Pahrump	5	1.23	0.38	0.72	1.76
Pioche	6	1.20	0.44	0.50	1.84
Rachel	8	1.18	0.41	0.68	1.82
Sarcobatus Flats	5	1.27	0.51	0.67	2.13
St. George (BH)	7	1.26	0.41	0.84	2.01
Tecopa	5	1.31	0.48	0.74	2.06
Tonopah	6	1.03	0.36	0.53	1.66
All Stations	128	1.20	0.43	0.47	2.13

7.1.3.2 Gamma Spectrometry

As with gross alpha and beta, gamma spectrometry analysis was performed on one set of samples from the low-volume air sampling network each quarter, with the exception of the third quarter in which two sets of samples were analyzed due to the Ribbon Fire, as described above. For a number of the samples, the results for naturally occurring beryllium-7 (^{7}Be) exceeded the minimum detectable activity (MDA). This radionuclide is produced by cosmic ray interaction with nitrogen in the atmosphere.

CEMP filters are analyzed for 17 gamma-emitting radionuclides including americium-241 (^{241}Am), cesium-134 (^{134}Cs), cesium-137 (^{137}Cs), cobalt-60 (^{60}Co), and uranium-235 (^{235}U). The results for these radionuclides were all below their respective MDAs for all 2024 samples (including all samples from both the August 11th and 25th collection dates).

7.1.4 Environmental Dosimetry Results

The environmental dosimeters are mounted in a Plexiglas® holder approximately 1m (3.3 ft) above the ground and are exchanged quarterly. From each station's quarterly exposure result (milliroentgens, mR) an estimated annual exposure is computed. The minimum and maximum estimated annual exposures for all stations in 2024 were 5 mR (0.05 millisieverts [mSv]) and 1,302 mR (11.42 mSv) at Pahrump, Nevada, and Tonopah, Nevada, respectively. The mean of all estimated annual exposures for all stations was 67 mR (0.59 mSv). Dosimeter results are not presented for the Warm Springs Summit station because access is limited in the winter, which does not allow for the required quarterly change of the dosimeter.

Table 7-3. Dosimeter monitoring results for the CEMP offsite ASN in 2024

Station	Number of Quarters	Estimated Annual Exposure (mR)[(a)]		
		Mean[(b)]	Minimum[(b)]	Maximum[(b)]
Alamo	4	59	39	71
Amargosa Valley	4	58	47	72
Beatty	4	111	98	123

Table 7-3. Dosimeter monitoring results for the CEMP offsite ASN in 2024

Station	Number of Quarters	Estimated Annual Exposure (mR)[(a)]		
		Mean[(b)]	Minimum[(b)]	Maximum[(b)]
Boulder City	4	69	45	100
Caliente	4	79	68	91
Cedar City	4	46	22	71
Delta	4	38	21	61
Duckwater	4	59	24	80
Ely	4	38	22	48
Goldfield	4	70	49	83
Henderson	4	82	55	109
Indian Springs	4	54	46	68
Las Vegas	4	78	62	95
Mesquite	4	54	44	72
Milford	4	97	74	113
Overton	4	38	21	57
Pahrump	4	23	5	35
Pioche	4	69	55	90
Rachel	4	91	64	105
Sarcobatus Flats	4	90	70	103
St. George (BH)	4	70	58	79
Tecopa	4	61	35	81
Tonopah	4	101	77	130

(a) To obtain daily exposure rates, divide annual exposure rates by 365.25.
(b) Mean, minimum, and maximum values are from quarterly estimates.

7.1.5 Pressurized Ion Chamber Results

The PIC data presented in this section are based on daily averages of gamma exposure rates from each station. Table 7-4 lists the maximum, minimum, and standard deviation of daily averages (in microroentgens per hour [µR/hr]) for periods in 2024 when data were available. It also shows the average gamma exposure rate for each station during the year (in µR/hr), as well as the total annual exposure (in milliroentgens per year [mR/yr]). The exposure rate ranged from 72.09 mR/yr (0.63 mSv/yr) in Pahrump, Nevada, to 159.08 mR/yr (1.40 mSv/yr) at Warm Springs Summit, Nevada. Background levels of environmental gamma exposure rates in the United States (from combined effects of terrestrial and cosmic sources) vary between 49 and 247 mR/yr (Committee on the Biological Effects of Ionizing Radiation III 1980). Averages for selected regions of the United States were compiled by the EPA and are shown in Table 7-5. The annual exposure levels observed at the CEMP stations in 2024 are well within these United States background levels and are consistent with previous years' exposure rates.

Table 7-4. PIC monitoring results for the CEMP offsite ASN in 2024

Station	Daily Average Gamma Exposure Rate (µR/hr)				Annual Exposure (mR/yr)
	Mean	Standard Deviation	Minimum	Maximum	
Alamo	12.58	0.36	11.40	14.10	110.20
Amargosa Valley	11.29	0.15	10.80	12.20	98.90
Beatty	16.23	0.35	15.70	17.60	142.17
Boulder City	15.04	1.08	13.90	17.80	131.75
Caliente	16.72	0.24	16.00	18.00	146.47
Cedar City	12.40	0.58	10.80	13.80	108.62
Delta	11.99	0.27	11.40	13.00	105.03
Duckwater	15.23	0.24	14.60	16.60	133.41
Ely	11.25	0.36	10.30	12.70	98.55
Goldfield	15.16	0.29	14.60	16.20	132.80
Henderson	14.84	0.75	13.70	16.40	130.00
Indian Springs	10.86	0.19	10.50	11.60	95.13

Table 7-4. PIC monitoring results for the CEMP offsite ASN in 2024

	Daily Average Gamma Exposure Rate (µR/hr)				
Station	Mean	Standard Deviation	Minimum	Maximum	Annual Exposure (mR/yr)
Las Vegas	11.44	0.17	11.10	12.50	100.21
Mesquite	11.44	0.32	11.00	12.60	100.21
Milford	17.86	0.51	16.90	19.40	156.45
Overton	10.75	0.22	10.30	11.70	94.17
Pahrump	8.23	0.16	7.90	8.80	72.09
Pioche	15.32	0.39	13.30	16.60	134.20
Rachel	15.26	0.28	14.60	16.60	133.68
Sarcobatus Flats	16.53	0.30	15.70	17.60	144.80
St. George (BH)	13.70	0.19	13.30	14.50	120.01
Tecopa	13.27	0.50	11.60	14.50	116.25
Tonopah	15.75	0.31	14.70	16.70	137.97
Warm Springs Summit	18.16	0.58	16.70	19.80	159.08

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

City	Annual Exposure (mR/yr)
Denver, CO	186
Fort Worth, TX	92
Las Vegas, NV	122
Los Angeles, CA	115
New Orleans, LA	92
Portland, OR	115
Richmond, VA	92
Rochester, NY	92
St. Louis, MO	115
Tampa, FL	92
Wheeling, WV	115

Source: https://www.epa.gov/radiation/calculate-your-radiation-dose. "Calculate Your Radiation Dose," (Access Date: 4/5/2023)

7.1.6 Environmental Impact

Results of analyses conducted on data obtained from the CEMP network of low-volume particulate air samplers, dosimeters, and PICs showed no measurable evidence at CEMP stations of offsite impacts from radionuclides from NNSA/NFO activities. All air filter results for man-made gamma-emitting radionuclides were below their respective minimum detectable activities. Dosimeter and PIC results remained consistent with previous years' background levels and are well within average background levels observed in other parts of the United States (Table 7-5).

Occasional elevated gamma readings (10%–50% above normal average background) detected by the PICs in 2024 were associated with precipitation events and/or low barometric pressure. Low barometric pressure can result in the release of naturally occurring radon and its progeny from the surrounding soil and rock. Precipitation events can result in the "rainout" of globally distributed radionuclides occurring as airborne particulates in the upper atmosphere. Figure 7-3, generated from the CEMP website, illustrates an example of this phenomenon.

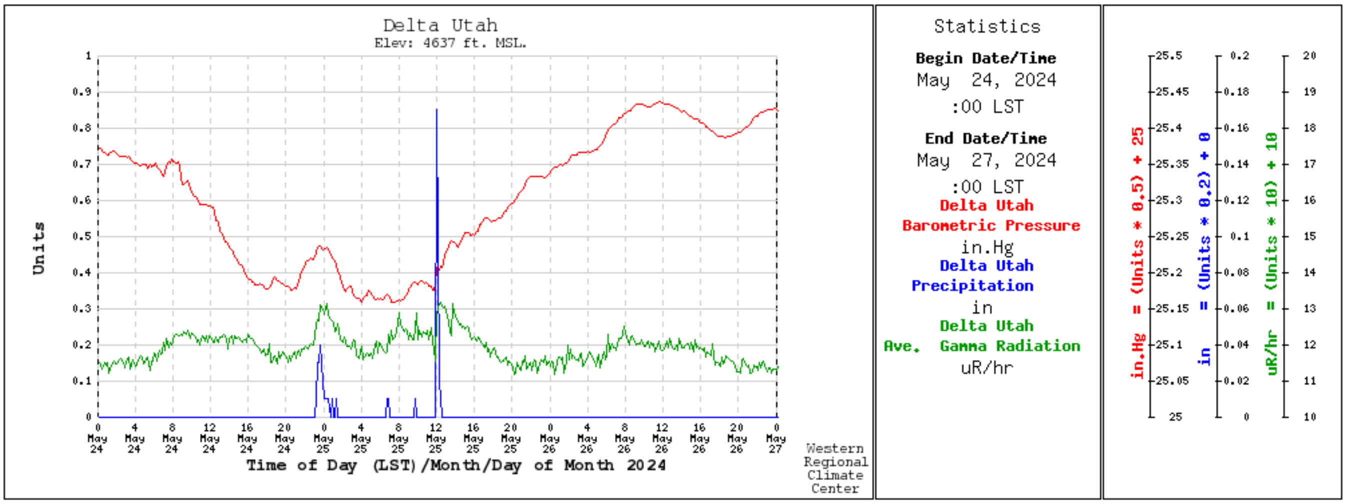

Figure 7-3. An example of the effect of meteorological phenomena on background gamma readings at the Delta, Utah, CEMP station for May 24 through 26, 2024

7.2 CEMP Groundwater Monitoring

CEMP groundwater monitoring is a non-regulatory program; its purpose is outreach and information to the public. Water samples are collected and analyzed for the presence of man-made radionuclides that could be the result of past nuclear testing on the NNSS. The CEMP monitors four groundwater wells downgradient of the NNSS (Figure 7-4). Water samples are collected by DRI personnel and analyzed for ^{3}H. Tritium is one of the most abundant radionuclides generated by an underground nuclear test, and because it is a constituent of the water molecule itself, it is also one of the most mobile. DRI provides public access to water monitoring data through CEMP's website at http://www.cemp.dri.edu/.

7.2.1 Sample Locations and Methods

In July and August 2024, DRI sampled four wells. Sample locations (Figure 7-4) were selected based upon input from participating CEMs in communities located downgradient of the NNSS. All wells were sampled at a water delivery point or at the wellhead. Each sample originated from submersible pumps that sampled the local groundwater system. Water was allowed to flow from each water delivery point for 5 to 15 minutes prior to obtaining a sample to purge stagnant water from the distribution lines. This process ensured the resultant sample was representative of local groundwater. Table 7-6 lists sample locations, date sampled, and sampling method.

Table 7-6. CEMP water monitoring locations sampled in 2024

Monitoring Location Description	Latitude(a)	Longitude(a)	Date Sampled	Sample Collection Method
Amargosa Valley school well	36°34.19'	−116°27.50'	7/17/2024	By hand from pump discharge
Beatty Water and Sanitation	36°50.00'	−116°49.44'	7/17/2024	By hand from well head
Sarcobatus Flats well	37°16.77'	−117°01.08'	7/17/2024	By hand at residential source
Tecopa well feeding municipal reverse osmosis unit	35°50.60'	−116°12.11'	8/13/2024	By hand from distribution line feeding Tecopa water kiosk

(a) Coordinate datum is WGS84 and was obtained using a GPS [global positioning system].

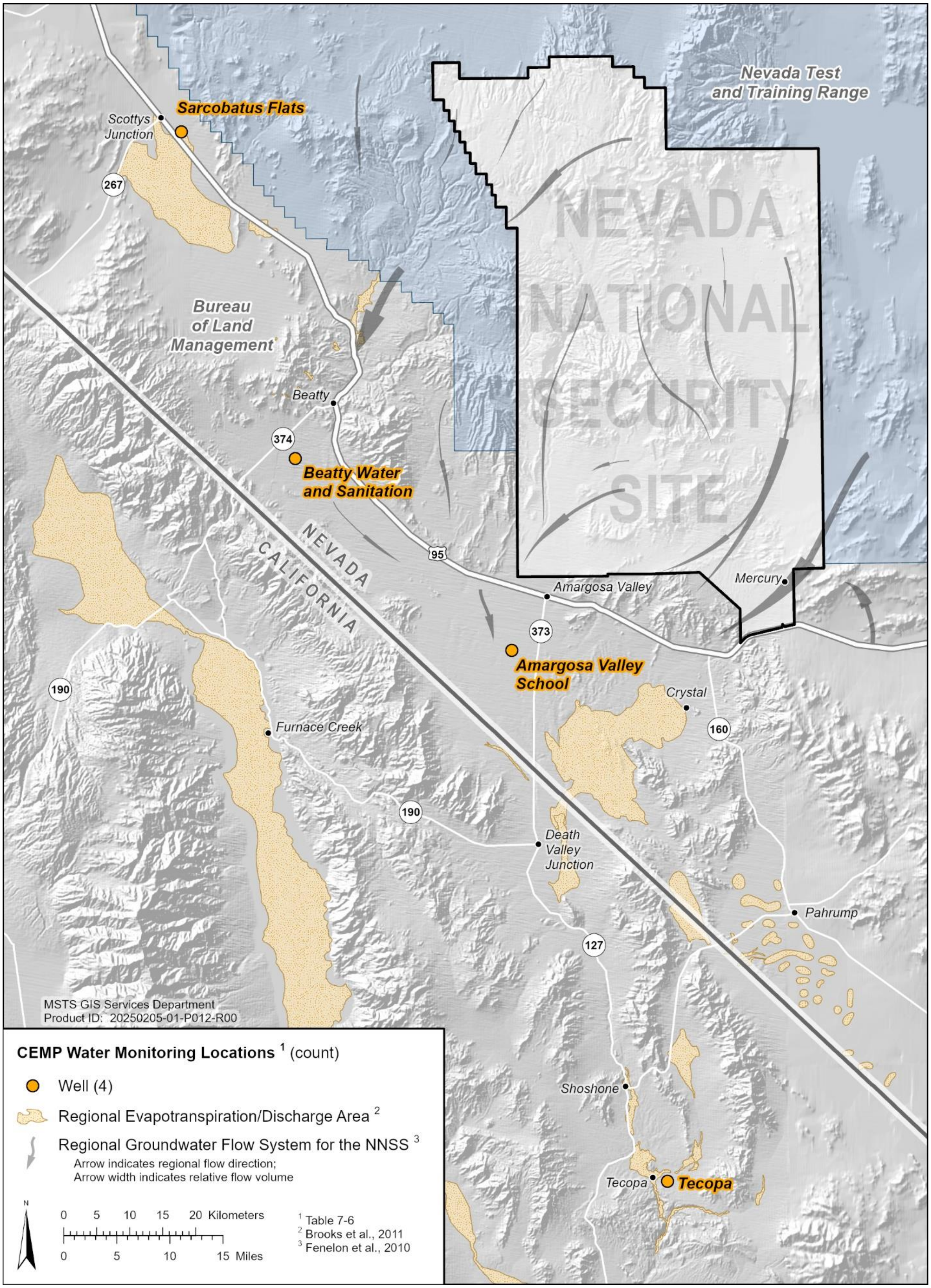

Figure 7-4. 2024 CEMP water monitoring locations

Samples were sent to American Radiation Services (ARS) Laboratory in Port Allen, Louisiana, who performed ^{3}H analysis using an EPA-approved method consisting of unenriched scintillation counting. The ***decision level (L_C)*** for this counting process was less than 126 picocuries per liter (pCi/L). The L_C is based on the variability of multiple measures of tritium-free samples, which establish laboratory background. If a sample exceeds the L_C, it is considered distinguishable from background. The ***Minimum Detectable Concentration (MDC)*** accounts for the variability associated with multiple measures of the background and the variability associated with multiple measures of a laboratory control sample containing trace quantities of ^{3}H. In 2024, the MDC for ^{3}H was approximately 255 pCi/L; this is a more rigorous threshold than the L_C, dictating that the sample be distinguishable from background at a confidence of 95%. The L_C and the MDC are approximately 0.6% and 1.3% of the EPA limit for ^{3}H in drinking water (respectively); the EPA limit is 20,000 pCi/L. QA and ***quality control*** procedures are described in Chapter 15.

7.2.2 Results of Groundwater Monitoring

Tritium analyses from ARS Analytical for the four groundwater samples yielded results that were all quantifiably below the MDC (≤255 pCi/L). Public access to monitoring data is available on the DRI CEMP website at http://www.cemp.dri.edu/.

7.3 Nye County Tritium Sampling and Monitoring Program

The Nye County 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. A 12-year grant from the EM Nevada Program supports the county's annual sampling of 20 locations downgradient of the NNSS: 10 core locations (i.e., the same locations year to year) and 10 additional locations (selected locations change from year to year). The grant also supports Nye County's involvement in technical reviews of the UGTA corrective action program (Chapter 11). To help determine sample locations, Nye County coordinates with DRI, who conducts the CEMP, with the CEMP's CEMs, and Nye County citizens. Nye County communicates their TSaMP activities and results to the public through poster presentations at annual DOE EM-funded Groundwater Open House meetings (Section 11.6), presentations at annual CEMP meetings, articles published in the Pahrump Valley Times, and this annually published report.

In 2024, in addition to the 10 core locations (9 wells and 1 springs), Nye County sampled 8 wells and 2 springs. (Table 7-7 and Figure 7-5). Selected locations for 2024 were in the same general areas as 2015–2023 and were chosen for their position within the projected groundwater flow path from the NNSS, proximity to downgradient communities, and recommendations provided by CEMs or Nye County citizens. Wells managed by Nye County and being sampled for ^{3}H under the TSaMP were initially drilled as part of the Nye County Early Warning Drill Program ("EWDP" labeled wells) or as Nye County Groundwater Evaluation Wells ("NC-GWE" labeled wells). Nye County also measures water levels in these wells on a quarterly basis through funding from the Nye County Water District's Water Level Measurement Program. Some locations selected for sampling under the TSaMP may include NNSA/NFO wells or locations that are also sampled under the NNSS Integrated Groundwater Sampling Plan (Section 5.1) or under the CEMP.

All wells without integrated pumps were sampled using either an air-powered submersible positive displacement pump or a 3-inch submersible electric pump. A minimum of three well volumes was pumped from each well prior to sampling in order to purge water from the pump tubing and well annulus and ensure samples are representative of local groundwater conditions. Community wells, which include domestic or municipal wells, were sampled from the dedicated pump discharge. Three private domestic wells were sampled in 2024, with the samples also being collected from the dedicated pump discharge. Sampling of private domestic wells was incorporated into the TSaMP program in 2018 to expand the spatial distribution of sampling sites and to provide a means to increase community involvement. Three springs were sampled in 2024, with samples being collected directly from the spring discharge.

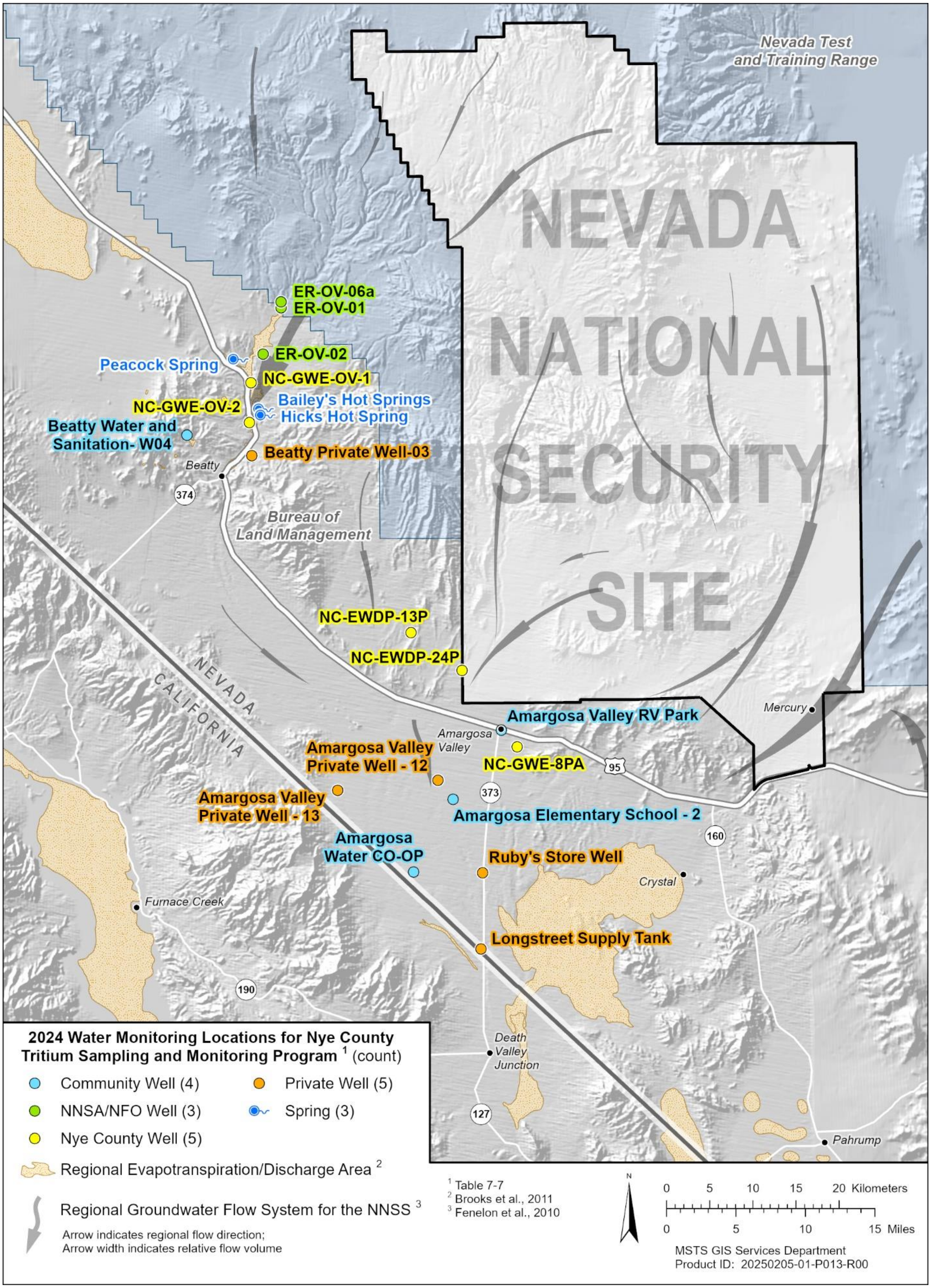

Figure 7-5. 2024 Nye County TSaMP water monitoring locations

Table 7-7. Nye County TSaMP water monitoring locations, results, and dates sampled

Sample Locations	Latitude[(a)]	Longitude[(a)]	Date Sampled	H^3 Activity MDC (pCi/L)
		Nye County Wells		
EWDP-13P*	36.74441	-116.51395	11/13/2024	<335
EWDP-24P*	36.70466	-116.44799	11/12/2024	<335
NC-GWE-8PA*	36.62442	-116.37708	11/14/2024	<335
NC-GWE-OV-1*	37.00618	-116.72076	11/20/2024	<335
NC-GWE-OV-2*	36.96455	-116.72298	11/19/2024	<335
		NNSA/NFO Wells		
ER-OV-01	37.08436	-116.68122	12/11/2024	<335
ER-OV-02	37.03606	-116.70492	12/9/2024	<335
ER-OV-06a	37.08436	-116.68128	12/12/2024	<335
		Community Wells		
Amargosa Elementary School-2*	36.57005	-116.46055	11/18/2024	<335
Amargosa Valley RV Park*	36.64205	-116.39751	11/18/2024	<335
Amargosa Water CO-OP	36.49432	-116.51217	12/4/2024	<335
Beatty Water and Sanitation-W04*	36.95155	-116.80433	12/4/2024	<335
		Private Wells		
Amargosa Valley Private Well-12	36.59	-116.48	12/2/2024	<335
Amargosa Valley Private Well-13	36.58	-116.61	12/5/2024	<335
Beatty Private Well-03	36.93	-116.72	12/16/2024	<335
Longstreet Supply Tank	36.41352	-116.42553	12/2/2024	<335
Ruby's Store Well* [(b)]	36.49307	-116.42283	12/5/2024	<335
		Springs		
Bailey's Hot Springs*	36.97472	-116.72250	12/19/2024	<335
Hicks Hot Spring	36.97247	-116.72020	11/21/2024	<335
Peacock Spring	37.03074	-116.75534	12/17/2024	<335

*Core locations are sampled each year.
(a) Coordinates are North American Datum 1983.
(b) Denotes a temporary well or spring substituted for a nearby "core" well not accessible in 2024.

All samples were analyzed for ^{3}H by Radiation Safety Engineering, Inc., in Chandler, Arizona, using an EPA-approved, unenriched scintillation counting method. The sample MDC for this method was 335 pCi/L, which is less than 2% of the EPA limit for ^{3}H in drinking water (20,000 pCi/L). Analytical methods included the use of quality control samples such as duplicates, blanks, and spikes. Nye County's quality assurance procedures for ^{3}H sampling are documented in Test Plan TPN-11.8 (2019), "Groundwater Sampling and Analysis for the Nye County Tritium Sampling and Monitoring Program," and Work Plan WP-11, "Groundwater Chemistry Sampling and Analysis" (2019), which are available on the Nye County website at http://www.co.nye.nv.us/index.aspx?NID=901.

All ^{3}H analysis results were below background, i.e., $\leq$ the MDC. Similar to the CEMP water sampling results (Section 7.2) and those of the community wells within NNSA/NFO's water sampling network (Section 5.1.3.6), Nye County's monitoring confirms that ^{3}H from past underground nuclear testing on the NNSS is not present in these wells.

The wells and water supply systems within the CEMP and Nye County monitored network downgradient of the NNSS continue to show no evidence of ^{3}H contamination from past underground nuclear testing on the NNSS. To date, the maximum concentration of ^{3}H observed off site is at ER-EC-11 on the NTTR. Tritium at ER-EC-11 was reported as 18,400 pCi/L in 2017 (NNSS Environmental Report 2017, Table 5-4 [Mission Support and Test Services, LLC, 2018]). Well ER-EC-11 is approximately 0.72 kilometers (km) (0.45 mile [mi]) west of the NNSS boundary (Figure 5-2). Additional sampling and analyses will continue as part of the Phase II investigation for the Central and Western Pahute Mesa, and groundwater characterization and modeling activities are ongoing to forecast the extent of offsite contamination over the next 1,000 years (Section 11.2.1). The nearest CEMP water monitoring locations downgradient of the NNSS are Amargosa Valley and Beatty, approximately 70 km (43 mi) and 40 km (25 mi), respectively, southwest of Well ER-EC-11.

7.4 References

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Chapter 8: Radiological Biota Monitoring

Ronald W. Warren
Mission Support and Test Services, LLC

Radiological Biota Monitoring Goals

Collect and analyze biota samples for radionuclides to estimate the potential dose to humans who may consume plants or game animals from the Nevada National Security Site (NNSS) (see Chapter 9 for the estimates of dose to humans). Collect and analyze biota samples for radionuclides to estimate the ***absorbed radiation dose***[1] *to NNSS biota (see Chapter 9 for the estimates of dose to NNSS plants and animals). Collect and analyze soil samples at the Area 3 and Area 5 Radioactive Waste Management Sites (RWMSs) to provide evidence that the burrowing activities of fossorial animals have or have not compromised the integrity of the soil-covered waste disposal units.*

Historical atmospheric nuclear explosive testing, releases from underground nuclear tests, and radioactive waste disposal sites provide potential sources of radiation contamination and ***exposure*** to NNSS plants and animals (biota). U.S. Department of Energy (DOE) Order DOE O 458.1, "Radiation Protection of the Public and the Environment," requires DOE sites to monitor ***radioactivity*** in the environment to ensure the public does not receive a radiological ***dose*** greater than 100 millirems per year from all pathways of exposure, including the ingestion of contaminated plants and animals. DOE O 458.1 also requires monitoring to ensure aquatic and terrestrial plant and animal populations are protected from excessive radiological dose.

The U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office land-use practices on the NNSS discourage the harvesting of plants or plant parts (e.g., pine nuts and wolfberries) for direct consumption by humans. Some edible plant material might be taken off site and consumed, but this is generally not allowed and, if it does occur, is very limited. Game animals on the NNSS might travel off the site and become available through hunting for consumption by the public, which makes the ingestion of game animals the primary potential biotic pathway for dose to the public.

Plants and game animals are sampled annually from contaminated NNSS sites to estimate doses to persons hypothetically consuming them, to measure the potential for ***radionuclide*** transfer through the food chain, and to determine if NNSS biota are exposed to radiation levels harmful to their own populations. Biota and soil samples from the RWMSs are also periodically collected to assess the integrity of waste disposal cells. This chapter describes the biota-monitoring program designed to meet public and environmental radiation protection regulations (Section 2.4) and presents the field sampling and analysis results from 2024. The estimated dose to humans potentially consuming NNSS plants and animals and the dose to biota from these radionuclides are presented in Chapter 9.

8.1 Species Selection

The goal for vegetation monitoring is to sample the plants most likely to have the highest contamination within the NNSS environment. They are generally found inside demarcated radiological areas near the locations of historical aboveground or near-surface nuclear tests. The species selected for sampling represent the most dominant life forms (e.g., trees, shrubs, herbs, or grasses) at these sites. Woody vegetation (i.e., shrubs versus forbs or grasses) is sampled because it is reported to have deeper penetrating roots and potentially higher concentrations of ***tritium*** (***^{3}H***) (Hunter and Kinnison 1998). Woody vegetation also is a major source of browse for game animals that might potentially migrate off site. Grasses and forbs are sampled when present because they are also a source of food for wildlife. Plant parts collected for analysis represent new growth over the past year. Pine nuts from singleleaf pinyon pine trees, which may be consumed by humans, are also sampled periodically.

[1] The definition of word(s) in ***bold italics*** may be found by referencing the Glossary, Appendix B.

When determining the potential dose to animals, the goal of sampling is to select species that are most exposed and most sensitive to the effects of radiation. In general, mammals and birds are more sensitive to radiation than fish, amphibians, reptiles, or invertebrates (DOE Standard DOE-STD-1153-2019, "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota"). The list of species used to assess the potential dose to animals in Table 8-1 reflects this graded approach and the fact that no native fish or amphibians are found on the NNSS.

The game animals monitored to assess the potential dose to the public meet three criteria: (1) they are a species consumed by humans; (2) they have a home range that overlaps a contaminated site and, as a result, have the potential for relatively high radionuclide body burdens from exposure to contaminated soil, air, water, or plants at the contaminated site; and, (3) they are sufficiently abundant at a site that an adequate tissue sample can be acquired for laboratory analysis. These criteria limit the candidate game animals to those listed in Table 8-1. Mule deer, pronghorn antelope (hereafter "pronghorn"), bighorn sheep, and predatory game animals such as mountain lions or bobcats are only collected as the opportunity arises, that is, if they are found dead on the NNSS (e.g., killed by a predator or accidentally hit by a vehicle). Tissues from species analogous to big game, such as feral horses or burros, may be collected opportunistically as well. If game animals are not sufficiently abundant at a particular site or at a particular time, non-game small mammals may be used as an ***analog*** (Table 8-1).

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

Table 8-1. NNSS animals that have been sampled for radionuclides

Small Mammals	Large Mammals	Birds	Reptiles
Game Animals Monitored for Dose Assessments			Desert tortoise (*Gopherus agassizii*)
Cottontail rabbit *(Sylvilagus audubonii)*	Mule deer *(Odocoileus hemionus)*	Mourning dove *(Zenaida macroura)*	
Jackrabbit *(Lepus californicus)*	Pronghorn *(Antilocapra americana)*	Chukar *(Alectoris chukar)*	
	Mountain lion *(Puma concolor)*	Gambel's quail *(Callipepla gambelii)*	
	Desert bighorn sheep *(Ovis canadensis nelsoni)*		
	Bobcat *(Lynx rufus)*		
Animals Monitored for Integrity of Radioactive Waste Containment or as Game Animal Analogs			
Kangaroo rats *(Dipodomys spp.)*			
Mice *(Peromyscus spp.)*			
Antelope ground squirrel *(Ammospermophilus leucurus)*			
Desert woodrat *(Neotoma lepida)*			

8.2 Site Selection

The monitoring program design focuses on sampling sites with the highest concentrations of radionuclides in natural media (e.g., soil and surface water) and relatively high densities of candidate animals. Five contaminated sites and their associated control sites have been identified and monitored over many years. Each year, biota from one or two of these sites is sampled, and each of the sites is sampled once every 5 years. They are E Tunnel Ponds, Palanquin/Schooner Craters, Sedan Crater, T2, and Plutonium (Pu) Valley (Figure 8-1), and each is associated with one type of legacy contamination area (see list below). The control site selected for each contaminated site has similar biological and physical features. Control sites are sampled to document the radionuclide levels representative of ***background***.

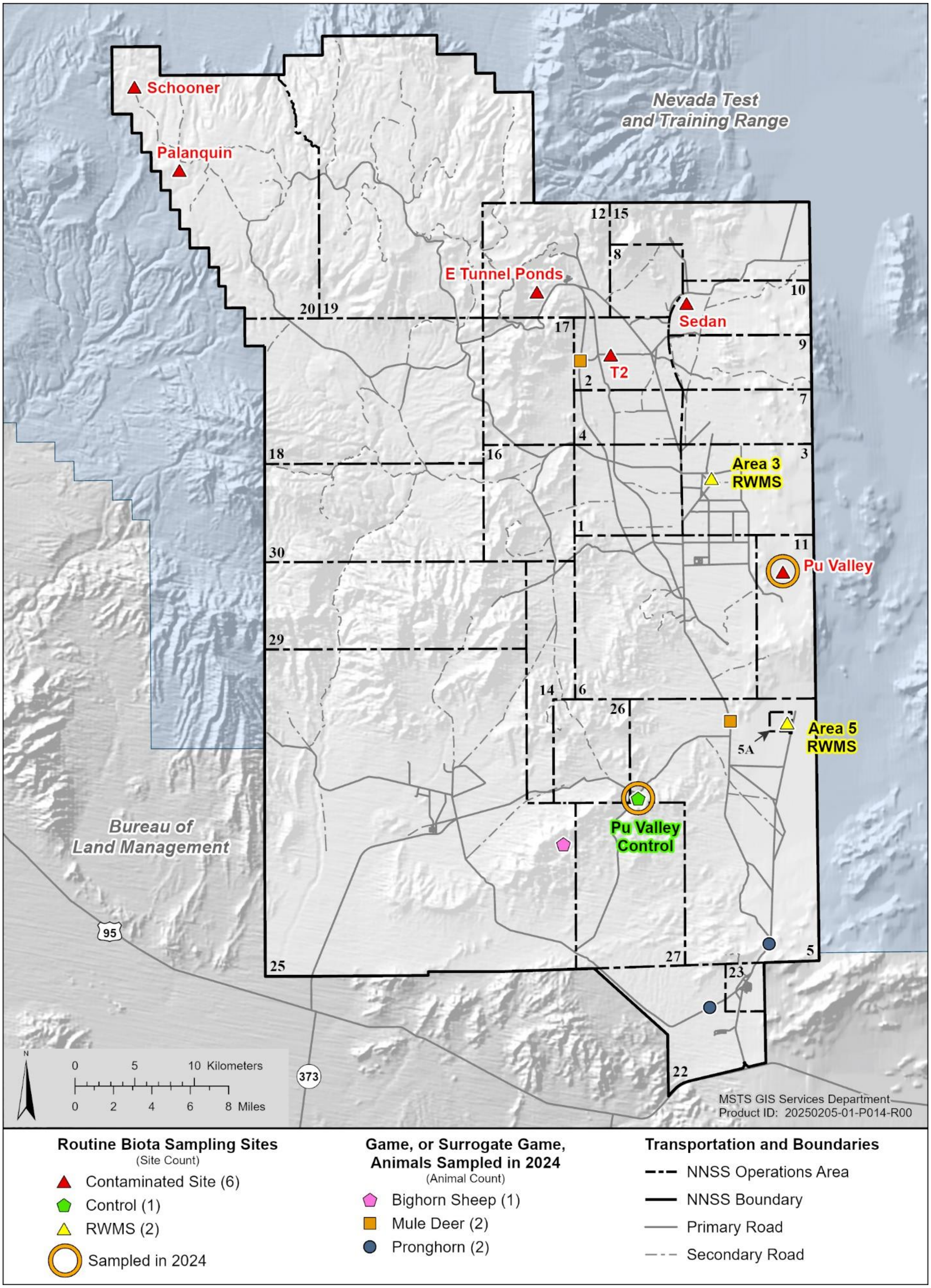

Figure 8-1. Radiological biota monitoring sites on the NNSS

- **Runoff areas or containment ponds associated with underground or tunnel test areas.** Contaminated water draining from test areas can form surface water sources that are important, given the limited availability of surface water on the NNSS. Therefore, they have a high potential for transferring radionuclides to plants and to wildlife seeking surface water. The associated monitoring site is E Tunnel Ponds below Rainier Mesa. This contaminated site, along with its control site, was last sampled in 2022.
- **Plowshare sites in alluvial fill at lower elevations with high surface contamination.** The historical ***Plowshare Program***, conducted throughout the NNSS, explored the potential use of nuclear explosives for peaceful purposes. Surface and shallow subsurface nuclear detonations at these alluvial, low elevation sites have distributed contaminants over a wide area, usually in the lowest precipitation areas of the NNSS. The associated monitoring site is Sedan Crater in Yucca Flat. It was last sampled in 2020.
- **Plowshare sites in bedrock or rocky fill at higher elevations with high surface contamination.** Surface and shallow subsurface nuclear detonations at these Plowshare Program sites distributed contaminants over a wide area, usually in the highest precipitation areas of the NNSS. Two monitored sites are in this category: Palanquin Crater and Schooner Crater. Both sites were last sampled in 2023.
- **Atmospheric test areas.** These sites have highly disturbed soils due to the removal of topsoil during historical cleanup efforts and due to the sterilization of soils from heat and radiation during testing. The same areas were often used for multiple nuclear tests. The associated monitoring site is T2 in Yucca Flat. It was last sampled in 2021.
- **Aboveground safety experiment sites.** These areas are typified by current radioactive soil contamination, primarily in the form of plutonium and uranium. The associated monitoring site is Pu Valley in Area 11. It was sampled in 2024.

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

- **Area 3 RWMS.** Waste disposal cells within the Area 3 RWMS were created within subsidence craters resulting from underground nuclear testing. Two closed cells containing bulk ***low-level radioactive waste*** are craters U-3ax and U-3bl, which were combined to form the U-3ax/bl disposal unit (Corrective Action Unit 110). U-3ax/bl is covered with a vegetated, native alluvium closure cover that is at least 2.4 meters (m) (8 feet [ft]) thick. It was last sampled in 2023.
- **Area 5 RWMS.** Waste disposal has occurred at the Area 5 RWMS since the early 1960s. There are 11 closed disposal cells containing bulk low-level radioactive waste. The cells are unlined pits and trenches that range in depth from 4.6 to 15 m (15 to 48 ft). Efforts are currently being made to establish native vegetation on the cover cap of the 92-Acre Area, which caps multiple waste cells. The cover cap is approximately 2.4 m (8 ft) thick. It was last sampled in 2023.

8.3 Sampling and Analysis

In 2024, Pu Valley was sampled as a representative aboveground safety experiment (Figure 8-1). Pu Valley, located in Area 11 on the eastern edge of the NNSS at an elevation of 1,250 m (4,100 ft), was the location of four safety experiments conducted from November 1, 1955, through January 18, 1956. These tests were designed to confirm that a nuclear explosion would not occur in cases of accidental detonation of the chemical explosive associated with the nuclear device. In one of these tests, there was a slight nuclear yield that resulted in the production of fission products (e.g., ^{137}Cs and ^{90}Sr), but the primary contaminant produced and dispersed in the area was plutonium. A control area for Pu Valley is located in Area 27 near Cane Spring about 24 kilometers (14.9 miles) to the southwest (Figure 8-1). Any of the candidate game species could be present in Pu Valley or at the control site.

In 2024, no biota or soil sampling was conducted at the Area 3 or Area 5 RWMSs. The last sampling of the RWMSs in 2023 did not suggest that burrowing animals had come into contact with buried waste (MSTS 2024).

8.3.1 Plants

On June 10, 2024, two composite plant samples were collected from both Pu Valley and its control locations (Figure 8-1 and Table 8-2). All samples consisted of about 150 to 500 grams (5.3 to 17.6 ounces) of fresh-weight plant material.

Plant leaves and stems were handpicked and stored in airtight Mylar bags. Rubber gloves were used by samplers and changed between each composite sample. Samples were labeled and stored in an ice chest. Within 4 hours of collection, the samples were delivered to the laboratory for processing. Water was separated from the samples by distillation and the dry plant material was homogenized. The water samples were submitted for analysis of tritium and dried plant tissues were submitted for analysis of americium-241 (^{241}Am), strontium-90 (^{90}Sr), plutonium-238 (^{238}Pu), $^{239+240}$Pu, and gamma emitting radionuclides (including cobalt-60 [^{60}Co], europium isotopes, and cesium-137 [^{137}Cs]).

Table 8-2. Plant samples

Location	Common Name	Scientific Name	Name Code	Sample Description
Area 11 Pu Valley	Indian ricegrass	*Achnatherum hymenoides*	ACHY	Composite from 8 bunches of grass
	Shadscale saltbush	*Atriplex confertifolia*	ATCO	Composite from 11 plants
Pu Valley Control (Area 27)	Indian ricegrass	*Achnatherum hymenoides*	ACHY	Composite from 4 bunches of grass
	4 four-wing saltbush	*Atriplex canescens*	ATCA	Composite from about 6 plants

Results of radiological analyses are shown in Table 8-3. Both samples from Pu Valley had elevated $^{239+240}$Pu and ^{241}Am. The grass (ACHY) from both Pu Valley and its control location had europium results greater than the ***Minimum Detectable Concentration (MDC)*** (^{152}Eu at Pu Valley and ^{154}Eu at the control location). These are activation products occasionally detected in biota samples throughout the NNSS, but have not been in past samples from Pu Valley, and are therefore not included in Figure 8-2. Concentrations of consistently detected radionuclides through time are relatively stable (Figure 8-2).

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

	Radionuclide Concentrations ± Uncertainty$^{(a)}$				
Sample	**^{152}Eu (pCi/g)**	**^{154}Eu (pCi/g)**	**^{238}Pu (pCi/g)**	**$^{239+240}$Pu (pCi/g)**	**^{241}Am (pCi/g)**
Area 11 Pu Valley					
ACHY	0.351 ± 0.260	0.616 ± 0.386	0.035 ± 0.016	3.080 ± 0.285	0.583 ± 0.083
ATCO	0.164 ± 0.314	0.113 ± 0.218	0.006 ± 0.007	0.099 ± 0.023	0.015 ± 0.010
Average	0.258	0.365	0.020	1.590	0.299
Average MDC$^{(b)}$	0.446	0.323	0.015	0.007	0.015
Pu Valley Control (Area 27)					
ACHY	0.593 ± 0.324	-0.063 ± 0.243	0.006 ± 0.007	0.005 ± 0.005	0.006 ± 0.007
ATCA	0.326 ± 0.539	0.213 ± 0.281	0.005 ± 0.007	0.007 ± 0.007	0.001 ± 0.005
Average	0.460	0.075	0.006	0.006	0.003
Average MDC$^{(b)}$	0.441	0.356	0.011	0.007	0.011

(a) Picocuries per gram wet weight of sample ± 2 standard deviations.
(b) Sample specific lab-reported MDC.

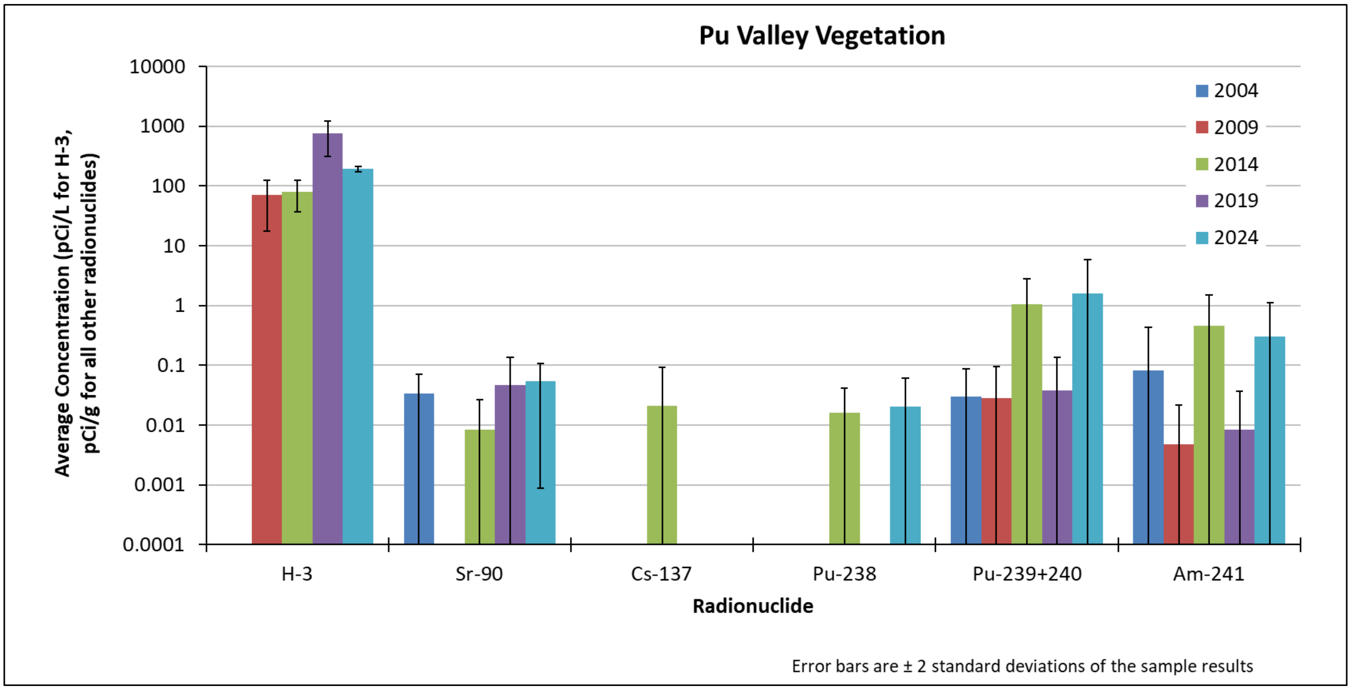

Figure 8-2. Radionuclide concentrations in vegetation sampled at Pu Valley through time

8.3.2 Animals

State and federal permits were secured to trap specific small mammals and birds in 2024 and to opportunistically sample large mammal mortalities on the NNSS. Small mammal trapping in Area 20 occurred June 19 through July 26, 2024. Three jackrabbits and nine smaller mammals were captured at Pu Valley, and two cottontail rabbits and 18 smaller mammals were captured at the Control site (Table 8-4). One bighorn sheep that died of natural causes, two mule deer, and two pronghorn killed by vehicles were also sampled opportunistically during 2024 (Table 8-4).

All samples were homogenized. Water was distilled from tissue samples for ^{3}H analysis. The tissue samples were submitted for ^{90}Sr, ^{238}Pu, $^{239+240}$Pu, ^{241}Am, and gamma spectrometry analysis.

Table 8-4. Animal samples

Routine Monitoring Samples			
Location	**Sample**	**Collection Date(s)**	**Sample Description**
Area 11 Pu Valley	Jackrabbit #1	7/23/2024	Whole body of black-tailed jackrabbit
	Jackrabbit #2	7/25/2024	Whole body of black-tailed jackrabbit
	Jackrabbit #3	7/26/2024	Whole body of black-tailed jackrabbit
	Small Mammal Composite	6/19/2024	Whole body composite of 9 small mammals: 5 kangaroo rats (*Dipodomys merriami*) 3 cactus mice (*Peromyscus eremicus*) 1 deer mouse (*Peromyscus maniculatus*)
Pu Valley Control (Area 27)	Cottontail Rabbit #1	7/23/2024	Whole body of cottontail rabbit
	Cottontail Rabbit #2	7/23/2024	Whole body of cottontail rabbit
	Cottontail Rabbit #3	7/26/2024	Whole body of cottontail rabbit
	Small Mammal Composite	6/11/2024	Whole body composite of 18 small mammals: 6 cactus mice (*Peromyscus eremicus*) 4 southern grasshopper mice (*Onychomys torridus*) 4 longtail pocket mice (*Perognathus formosus*) 3 kangaroo rats (*Dipodomys merriami*) 1 antelope ground squirrel (*Ammospermophilus leucurus*)

Opportunistic Samples			
Location	**Sample**	**Collection Date**	**Sample Description**
Area 25	Bighorn Sheep	3/27/2024	Muscle from a 6-year-old, global positioning system (GPS)-collared (ID 13059), male that died of natural causes.
Area 2	Mule Deer	9/9/2024	Muscle from adult female hit by a vehicle
Area 5	Mule Deer	4/15/2024	Muscle from an adult female hit by a vehicle
Area 5	Pronghorn	9/9/2024	Muscle from adult, GPS-collared (ID 705963), male hit by a vehicle
Area 22	Pronghorn	11/1/2024	Muscle from 2–3-year-old female hit by a vehicle

Radionuclide results are listed in Table 8-5. As with vegetation, ^{238}Pu, $^{239+240}$Pu, and ^{241}Am concentrations were elevated in samples from Pu Valley. This is expected as there are elevated levels of ^{238}Pu, $^{239+240}$Pu, and ^{241}Am in soils at Pu Valley resulting from past nuclear weapon safety tests that occurred there. The concentrations of radionuclides in animals from Pu Valley has not significantly changed over the past 20 years, except for ^{90}Sr, which was not detected in the 2024 samples (Figure 8-3). The mule deer sampled in Area 2 also had elevated tritium concentrations – likely from the nearby E Tunnel ponds, which contain higher levels of tritium. No manmade radionuclides were detected in the muscle from the pronghorn sampled in 2024.

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

	Radionuclide Concentrations ± Uncertainty[(a)]				
Sample	**^{3}H (pCi/L)[(b)]**	**^{137}Cs (pCi/g)[(c)]**	**^{238}Pu (pCi/g)[(c)]**	**$^{239+240}$Pu (pCi/g)[(c)]**	**^{241}Am (pCi/g)[(c)]**
Area 11 Pu Valley					
Jackrabbit #1	267 ± 200	-0.005 ± 0.019	0.0977 ± 0.0605	4.2120 ± 0.5130	0.8262 ± 0.1480
Jackrabbit #2	225 ± 198	-0.003 ± 0.016	0.0004 ± 0.0021	0.0093 ± 0.0057	0.0014 ± 0.0018
Jackrabbit #3	221 ± 196	0.031 ± 0.021	0.0002 ± 0.0023	0.0026 ± 0.0040	0.0002 ± 0.0017
Average	238	0.008	0.0328	1.4080	0.2759
Average MDC[(d)]	321	0.026	0.0266	0.0274	0.0130
Small Mammal Composite	385 ± 214	0.026 ± 0.032	0.0369 ± 0.0256	2.7601 ± 0.3018	0.4249 ± 0.0929
MDC	326	0.060	0.0239	0.0239	0.0425

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

Sample	Radionuclide Concentrations ± Uncertainty[(a)]				
	^{3}H (pCi/L)[(b)]	^{137}Cs (pCi/g)[(c)]	^{238}Pu (pCi/g)[(c)]	$^{239+240}$Pu (pCi/g)[(c)]	^{241}Am (pCi/g)[(c)]
Pu Valley Control (Area 27)					
Cottontail Rabbit #1	329 ± 206	0.018 ± 0.017	-0.0002 ± 0.0017	0.0004 ± 0.0023	-0.0002 ± 0.0015
Cottontail Rabbit #2	283 ± 202	0.006 ± 0.012	0.0011 ± 0.0026	0.0079 ± 0.0051	0.0005 ± 0.0020
Cottontail Rabbit #3	164 ± 187	0.006 ± 0.012	-0.0004 ± 0.0013	0.0007 ± 0.0025	0.0006 ± 0.0014
Average	259	0.010	0.0002	0.0030	0.0003
Average MDC[(d)]	318	0.025	0.0039	0.0043	0.0032
Small Mammal Composite	364 ± 210	0.011 ± 0.017	0.0012 ± 0.0026	0.0015 ± 0.0032	-0.0004 ± 0.0012
MDC	322	0.033	0.0043	0.0056	0.0031
Opportunistic Sampling					
Bighorn Sheep					
Area 25	240 ± 226	0.008 ± 0.016	0.0004 ± 0.0012	0.0025 ± 0.0016	-0.0002 ± 0.0015
MDC	369	0.036	0.0021	0.0015	0.0030
Mule Deer					
Area 2	40,600 ± 4,210	0.013 ± 0.039	0.0022 ± 0.0060	-0.0086 ± 0.0079	-0.0016 ± 0.0070
Area 5	1 ± 152	-0.025 ± 0.056	0.0032 ± 0.0072	0.0065 ± 0.0061	0.0000 ± 0.0044
Average	20,300	-0.006	0.0027	-0.0011	-0.0008
Average MDC[(d)]	308	0.087	0.0118	0.0136	0.0130
Pronghorn					
Area 5	152 ± 196	-0.023 ± 0.039	0.0025 ± 0.0060	-0.0025 ± 0.0085	0.0033 ± 0.0079
Area 22	118 ± 189	0.001 ± 0.011	0.0008 ± 0.0027	0.0008 ± 0.0019	-0.0003 ± 0.0019
Average	135	-0.011	0.0017	-0.0008	0.0015
Average MDC[(d)]	328	0.042	0.0072	0.0106	0.0083

(a) Uncertainty is ± 2 standard deviations.
(b) Picocuries per liter water from sample.
(c) Picocuries per gram wet weight of sample.
(d) Average sample-specific MDC.

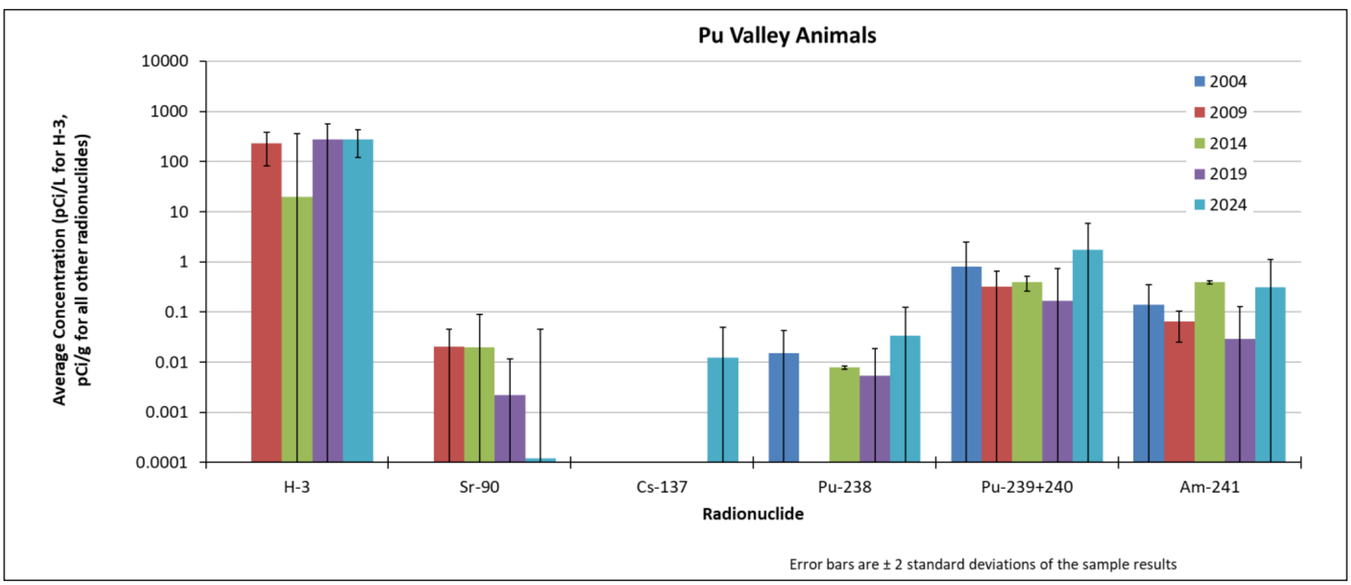

Figure 8-3. Radionuclide concentrations in animals sampled at Pu Valley through time

8.4 Data Assessment

Biota sampling results show that man-made radionuclide concentrations in Pu Valley are elevated and relatively stable through time. Though NNSS-related radionuclides are detected in some plants and animals, the levels pose negligible risk to humans and biota. Mobile game animals (mule deer and pronghorn) are shown to uptake radionuclides from NNSS sources, but the potential dose to a person hunting and consuming these animals is well below dose limits to members of the public (see Section 9.1.1.2). Also, radionuclide concentrations were below levels considered harmful to the health of the plants and animals; the dose resulting from observed concentrations was less than 30 percent of dose limits set to protect populations of plants and animals (see Section 9.2).

8.5 References

Hunter, R. B., and R. R. Kinnison, 1998. *Tritium in Vegetation on the Nevada Test Site, U.S. Department of Energy, December 1998, In: Nevada Test Site Routine Radiological Environmental Monitoring Plan*, Appendices. DOE/NV/11718--244. Bechtel Nevada, Las Vegas, NV.

Mission Support and Test Services, LLC, 2024. *Nevada National Security Site Environmental Report 2023*, DOE/NV/03624—2026, Las Vegas, NV, prepared for the U.S. Department of Energy, National Nuclear Security Administration, Nevada Field Office.

MSTS, see Mission Support and Test Services, LLC.

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Chapter 9: Radiological Dose Assessment

Ronald W. Warren and Phillip D. Worley
Mission Support and Test Services, LLC

Radiological Dose Assessment Goals

Determine if the maximum radiation dose to a member of the general public from airborne radionuclide emissions at the Nevada National Security Site (NNSS) complies with the Clean Air Act, National Emission Standards for Hazardous Air Pollutants (NESHAP) limit of 10 millirems per year (mrem/yr) (0.1 millisieverts per year [mSv/yr]). Determine if radiation levels from the Radioactive Waste Management Sites (RWMSs) comply with the 25 mrem/yr (0.25 mSv/yr) dose limit to members of the public as specified in U.S. Department of Energy (DOE) Manual DOE M 435.1-1, "Radioactive Waste Management Manual." Determine if the total radiation dose (total effective dose equivalent [TEDE]) to a member of the general public from all possible pathways (direct exposure, inhalation, ingestion of water and food) as a result of NNSS operations complies with the limit of 100 mrem/yr (1 mSv/yr) established by DOE Order DOE O 458.1, "Radiation Protection of the Public and the Environment." Determine if the radiation dose (in a unit of measure called a rad) to NNSS biota complies with the limits set by DOE Standard DOE-STD-1153-2019, "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota."

The U.S. Department of Energy requires DOE facilities to estimate the radiological ***dose***[1] to the general public, plants, and animals in the environment caused by past or present facility operations. These requirements are specified in DOE O 458.1 and in DOE O 435.1, "Radioactive Waste Management" (Table 2-1). To estimate these radiological doses, ***radionuclide*** concentration data gathered on the NNSS are used along with dose conversion factors published in DOE-STD-1196-2022, "***Derived Concentration Technical Standard***." The dose conversion factors account for different population fractions of age and sex to give representative dose coefficients for a reference person within the U.S. population. The 2024 data are presented in Chapters 4, 5, 6, and 8 of this report, and include the results for onsite monitoring of air, water (on site and off site), direct radiation, and biota, respectively. The independent offsite air and groundwater data presented in Chapter 7, "Community-Based Offsite Monitoring," provide extra assurance to the public that estimated doses do not underestimate potential offsite ***exposures*** to NNSS-related radiation. The specific goals for the dose assessment component of radiological monitoring are described below.

9.1 Dose to the Public

This section identifies the possible pathways by which the public could be exposed to radionuclides present in the environment due to past or current NNSS activities. It describes how field-monitoring data are used with other NNSS data sources (e.g., radionuclide inventory data) to provide input to the dose estimates and presents the estimated 2024 public dose attributable to U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office (NNSA/NFO) activities from each pathway and from all pathways combined. The public dose due to radioactive waste operations on the NNSS is also assessed, and a description of the program that controls the release of NNSS materials having residual ***radioactivity*** into the public domain is provided.

9.1.1 Dose from Possible Exposure Pathways

Air, groundwater, and biota are routinely sampled to document the amount of radioactivity in these media and to provide data to assess the potential radiation dose received by the general public.

[1] The definition of word(s) in ***bold italics*** may be found by referencing the Glossary, Appendix B.

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

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

The subsections below address the potential pathways and their contribution to the 2024 estimated public dose.

9.1.1.1 Dose from NNSS Air Emissions

Six air particulate and ***tritium (^3H)*** sampling stations located near the boundaries and the center of the NNSS were proposed and formally submitted to the U.S. Environmental Protection Agency (EPA) Region 9 as ***critical receptor samplers*** (EPA 2001), and have been used to demonstrate compliance with the NESHAP public dose limit of 10 mrem/yr (0.1 mSv/yr) from air emissions since 2002. The annual average concentration of an airborne radionuclide must be less than the NESHAP Concentration Level for Environmental Compliance (abbreviated as ***compliance level [CL]***) (Table 4-1). The CL for each radionuclide represents the annual average concentration of that radionuclide in air that would result in a TEDE of 10 mrem/yr. If multiple radionuclides are detected at a station, then compliance with NESHAP is demonstrated when the sum of the fractions (determined by dividing each radionuclide's concentration by its CL and then adding the fractions together) is less than 1.0.

The critical receptor sampling stations can be thought of as worst-case for an offsite receptor because these samplers are close to emissions sources (Figures 4-1, 4-2). Table 9-1 displays the distances between the critical receptor monitoring stations and points where members of the public potentially live, work, and/or go to school. The distance between the sampling location and the closest onsite emission location is also listed (Figure 4-1).

Table 9-1. Distance between critical receptor air monitoring stations and nearest points of interest

Critical Receptor Station	Distance[(a)] and Direction[(b)] to Nearest Offsite Locations and Onsite Emission Location			
	Residence	Business/Office	School	NNSS Emission Source
Area 6, Yucca	47 km SW Amargosa Valley	38 km SSE American Silica[(c)]	54 km SE Indian Springs	2.4 km SW Area 6, Grouped Area Sources
Area 10, Gate 700 S	49 km ENE Anchor Brand Ranch	56 km NNE Rachel	75 km SSE Indian Springs	2.6 km SW Area 10, Sedan Crater
Area 16, 3545 Substation	46 km SSW Amargosa Valley	46 km SSW Amargosa Valley	58 km SSW Amargosa Valley	1.6 km NW Area 16, Grouped Area Sources
Area 20, Schooner	36 km WSW Sarcobatus Flat	20 km WSW Tolicha Peak	56 km SSW Beatty	0.3 km ESE Area 20, Schooner Crater
Area 23, Mercury Track	24 km SW Crystal	6.0 km SE American Silica	31 km SSW Indian Springs	0.2 km ESE Area 23, Building 652
Area 25, Gate 510	4 km S Amargosa Valley	3.5 km S Amargosa Valley	15 km SW Amargosa Valley	21 km NNE Area 25, nearest portion of Grouped Area Sources

(a) Distance is shown in kilometers (km). For miles, multiply by 0.62.
(b) N=north, S=south, E=east, W=west in all direction combinations shown.
(c) The American Silica mine was not active in 2024, but is the closest business to the SE of the NNSS.

In 2024, the man-made radionuclides detected in samples from at least one air monitoring station included tritium (^3H), cesium-137 (^{137}Cs), americium-241 (^{241}Am), plutonium-238 (^{238}Pu), and plutonium-239+240 ($^{239+240}Pu$) (Section 4.1). The annual average concentrations of these radionuclides at critical receptor air monitoring stations were well below their CLs and the sum of fractions for each location were all less than 1.0 (Table 4-11). As in previous years, 2024 data from the six critical receptor stations show that the NESHAP public dose limit of 10 mrem/yr (0.1 mSv/yr) was not exceeded.

The radioactive air emissions from each 2024 NNSS source were modeled using the ***Clean Air Package, 1988***, model (CAP88, Version 4.1; EPA 2019). The highest value (0.065 mrem/yr [0.00065 mSv/yr]) is predicted to be a person residing on the Nevada Test and Training Range (NTTR) east of the NNSS. More detailed information regarding the estimation of the dose to the public from airborne radioactivity in 2024 from all activities conducted by NNSA/NFO on the NNSS and its Nevada support facilities is reported in Mission Support and Test Services, LLC (MSTS) (2025).

9.1.1.2 Dose from Ingestion of Game Animals from the NNSS

Three game species (mule deer, bighorn sheep, and mourning doves) have been shown to travel off the NNSS and be available to hunters (Giles and Cooper 1985; Hall and Perry 2019; National Security Technologies, LLC [NSTec] 2009). In fact, one mule deer captured on the NNSS and fitted with a radio-collar in 2019 was taken by a hunter near Kawich Peak in October 2020 (MSTS 2021). Because of this, big game animals are sampled opportunistically when natural mortalities or road-kills occur on the NNSS and small game animals are sampled annually near known radiologically contaminated areas to give conservative (worst-case) estimates of the level of radionuclides that hunters may consume if these animals are harvested off the NNSS. In 2024, the following animals were sampled (Figure 8-1 and Tables 8-4 and 8-5):

- Three jackrabbits from Plutonium (Pu) Valley, Area 11.
- Three cottontail rabbits from a control site, Area 27.
- One bighorn sheep that died of natural causes, Area 25.
- Two mule deer killed by vehicles, Area 2 and Area 5.
- Two pronghorn killed by vehicles, Area 5 and Area 22.

The potential ***committed effective dose equivalent (CEDE)*** to an individual consuming game animals was calculated for each animal sampled in 2024 unless no man-made radionuclides were detected in animals from a particular location. The following assumptions/parameters were used to estimate dose:

- Analysis results from all samples were included in calculating dose from consuming a particular species as long as the radionuclide was detected, i.e., the analysis result was above the ***minimum detectable concentration***, in at least one sample of that species at a particular location. The opportunistic samples are grouped as all being from the same location (NNSS) for this assessment.
- If the analytical result for a radionuclide concentration in the sample was a negative value (resulting from a ***background*** measurement higher than what was observed in the sample), then the concentration for that sample was set to zero.
- Though it is very unlikely, the ***maximally exposed individual (MEI)*** consumes one of each species of animal sampled from each location during the year, which had at least one detected man-made radionuclide:
  - One jackrabbit (513 grams [g]) from Pu Valley (Area 11)
  - One cottontail rabbit (167 g) from the Area 11 control site
  - One bighorn sheep (35.5 kilograms [kg])
  - One mule deer (35.5 kg)
- The moisture content of the muscle tissue samples of all species is 73%.
- Dose coefficients for per capita ingestion of milk as defined by DOE-STD-1196-2022 are used; they are for a hypothetical person representing an aggregate of individuals in the U.S. population and dose coefficients for milk are used instead of those for water ingestion because they are more restrictive (result in higher dose estimate).
- The entire committed dose is considered to be received during the calendar year.

Dose coefficients, listed in DOE-STD-1196-2022, were multiplied by the amount of radioactivity potentially ingested to obtain the potential dose (mrem CEDE) (Table 9-2). The average and maximum CEDEs for each monitored location and for each animal species are presented in Table 9-2. Based on the 2024 samples, an individual who consumes one animal of each sampled species from each location (where opportunistic large game samples were considered to be from one location, i.e., the entire NNSS) may receive an estimated dose of 1.25 mrem (0.0125 mSv) based on the averages. To put this dose in perspective, it is about the dose received from naturally occurring cosmic radiation during a 4-hour airplane flight at 39,000 feet. The animal sampled in 2024 with maximum concentrations was a jackrabbit from Pu Valley. The dose from consuming just this one animal would be about 2.5 mrem (0.025 mSv) (Table 9-3).

Table 9-2. CEDE from ingesting game animals on the NNSS

	Committed Effective Dose Equivalent (mrem)[(a)] (Dose only displayed for radionuclides that were detected in at least one sample of a species at that location)							
Location and Sample	**^{3}H (b)**	**^{137}Cs**	**^{238}Pu**	**$^{239+240}Pu$**	**^{241}Am**	**Total**	**Average**	**Max**
Area 11 Pu Valley								
Jackrabbit #1	0.0000	0.0000	0.0477	2.1666	0.2964	2.5107	1.0272	2.5107
Jackrabbit #2	0.0000	0.0000	0.0002	0.0048	0.0005	0.0055		
Jackrabbit #3	0.0000	0.0008	0.0001	0.0014	0.0001	0.0024		
Small Mammal Composite (rabbit analog)	0.0000	0.0000	0.0180	1.4197	0.1524	1.5902		
Area 11 Control								
Cottontail Rabbit #1	0.0000			0.0001		0.0001	0.0004	0.0013
Cottontail Rabbit #2	0.0000			0.0013		0.0013		
Cottontail Rabbit #3	0.0000			0.0001		0.0001		
Small Mammal Composite (rabbit analog)	0.0000			0.0000		0.0000		
	Opportunistic samples from natural mortality or accidental road kills							
Location and Sample	**^{3}H (b)**	**^{137}Cs**	**^{238}Pu**	**$^{239+240}Pu$**	**^{241}Am**	**Total**	**Average**	**Max**
Area 25 Bighorn				0.0880		0.0880	0.0880	0.0880
Area 2 Mule Deer	0.2727					0.2727	0.1364	0.2727
Area 5 Mule Deer	0.0000					0.0000		
Area 5 Pronghorn Area 22 Pronghorn	No manmade radionuclides detected in pronghorn							
CEDE from consuming 1 animal of each species = 1.25 mrem (using averages) and 2.87 mrem (using maximums)								

(a) Based on dose coefficients in Appendix A of DOE-STD-1196-2021 for a Reference Person. Dose only calculated for radionuclides that were detected in at least one sample from a species and location.
(b) Calculated from tritium concentration in water from tissue and water content of muscle tissue samples is 73%.

A person may consume animals from locations on the NNSS other than where samples were collected in 2024; therefore, Table 9-3 presents the maximum CEDE for humans consuming various species of wildlife from all animals sampled from 2001–2024. Table 9-3 gives a worst-case scenario based on radionuclide analyses of NNSS game animal samples over the past 24 years.

The highest CEDE from consuming just one animal (12.9 mrem or 0.129 mSv) would have been from the pronghorn sampled in 2018 from Area 9 (Table 9-3). This represented 12.9% of the annual dose limit for members of the public.

Table 9-3. Maximum CEDEs to a person hypothetically ingesting NNSS game animals sampled from 2001–2024

Game Animal	Sample Location	Year Sampled	Amount Consumed	CEDE for Consumption of One Animal (mrem)
Bighorn Sheep	Area 25 (captured study animal)	2015	all muscle	0.170
Bobcat	Area 25 (roadkill)	2012	all muscle	0.032
Burro	Area 5 (roadkill)	2020	all muscle	0.486
Chuckar	Area 12 (E Tunnel)	2001	breast muscle	0.006
Cottontail Rabbit	Area 12 (E Tunnel Ponds)	2022	whole body	0.037
Duck	No man-made radionuclides detected (2 duck samples)	2021 & 2022	whole body	0.000
Gambel's Quail	Area 2 (T2)	2002	all muscle	0.004
Jackrabbit	Area 11 (Pu Valley)	2024	all muscle	2.510
Mountain Lion	NTTR (natural mortality of study lion NNSS4)	2013	all muscle	0.095
Mourning Dove	Area 20 (Palanquin control but likely from sump of Well U-20n)	2003	breast muscle	0.032
Mule Deer	Area 19 (killed by a mountain lion)	2014	all muscle	3.228
Pronghorn	Area 9 (likely killed by coyotes)	2018	all muscle	12.869

9.1.1.3 Dose from Ingestion of Plants from the NNSS

Current NNSS land-use practices discourage the harvesting 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 harvested and consumed across the western United States. Pinyon pine trees grow throughout regions of higher elevation on the NNSS. The most recent year pine nuts were sampled was in 2013. These were 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 (NSTec 2014). No other edible plant materials have been collected for analysis on the NNSS in recent history, and no edible plants were sampled in 2024.

9.1.1.4 Dose from Drinking Contaminated Groundwater

The 2024 groundwater monitoring data indicate that groundwater from offsite private and community wells and springs has not been impacted by past NNSS nuclear testing operations (Sections 5.1.3.6, 7.2, and 7.3). 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 discussed in Chapter 11. Therefore, drinking water from underground aquifers containing radionuclides is not a possible pathway of exposure to the public residing off site.

9.1.1.5 Dose from Direct Radiation Exposure along NNSS Borders

The direct exposure pathway from ***gamma radiation*** to the public is monitored routinely (Chapter 6). In 2024, the only place where the public had the potential to be exposed to direct radiation from NNSS operations was at Gate 100, the primary entrance to the site on the southern NNSS border. Trucks hauling radioactive materials, primarily ***low-level waste (LLW)*** being shipped for disposal at the Area 5 RWMS, park outside Gate 100 while waiting for entry. Only during these times is there a potential for exposure to the public due to NNSS activities. However, no member of the public resides or remains full-time at the Gate 100 truck parking area. Therefore, dose from direct radiation is not included as a current pathway of exposure to the public residing off site.

9.1.2 Dose from Waste Operations

DOE M 435.1-1 states that LLW disposal facilities shall be operated, maintained, and closed so that a reasonable expectation exists that annual dose to members of the public shall not exceed 10 mrem through the air pathway and 25 mrem through all pathways for a 1,000-year compliance period after closure of the disposal units. Because of this long compliance period, a Performance Assessment and Composite Analysis is completed to estimate future doses and potential releases into the future (Section 10.3). Given that the RWMSs are located well within the NNSS boundaries and public access is limited (e.g., tours), members of the public have access only for brief periods. However, for purposes of documenting current potential impacts, the pathways for radionuclide movement from waste disposal facilities are monitored.

In 2024, external radiation from waste operations measured near the boundaries of the Area 3 and Area 5 RWMSs were within the range of exposures measured at NNSS ***background*** locations except for one location at the Area 3 RWMS southern boundary (Section 6.3.4). Area 3 and Area 5 RWMS operations would have contributed negligible external exposure to a hypothetical person residing near the boundaries of these sites and would have resulted in no dose to the offsite public.

The dose from the air pathway can be estimated from air monitoring results from stations near the RWMSs (Figure 4-2 and Table 10-5). Mean concentrations of radionuclides in air at the Area 3 and Area 5 environmental sampler locations were, at the most, only 22% of their CLs (Table 10-5).

There is no exposure, and therefore no dose, to the public from groundwater beneath waste disposal sites on the NNSS. Groundwater monitoring indicates that man-made radionuclides have not been detected in wells accessible to the offsite public or in private wells or springs (Sections 5.1.3.6, 7.2, and 7.3). Also, groundwater and ***vadose zone*** monitoring at the Area 3 and Area 5 RWMSs, conducted to verify the performance of waste disposal facilities, has not detected the migration of radiological wastes into groundwater (Sections 10.3.1 and 10.3.2). Based on these results, potential dose to members of the public from LLW disposal facilities on the NNSS from all pathways is negligible.

9.1.3 Total Offsite Dose to the Public from All Pathways

The DOE-established radiation dose limit to a member of the general public from all possible pathways as a result of NNSA/NFO facility operations is 100 mrem/yr (1 mSv/yr), excluding background radiation, while considering air transport, ingestion, and direct exposure pathways. For 2024, the only plausible pathways of public exposure to man-made radionuclides from current or past NNSS activities included the air transport pathway and the ingestion of game animals. The doses from these pathways are combined in Table 9-4 to present an estimate of the total 2024 dose to the MEI residing off site.

The MEI for the air pathway was considered to be a person residing on the NTTR east of the NNSS (Section 9.1.1.1). If the offsite MEI were assumed to also eat wildlife from the NNSS, additional dose would be received. Based on 2024 samples, the additional dose from consuming one animal may range up to 2.51 mrem (0.0251 mSv) (Table 9-2). When the 0.065 mrem (0.00065 mSv) dose from the air pathway is added, the TEDE to this hypothetical MEI from all exposure pathways combined due to NNSA/NFO activities would be 2.58 mrem/yr (0.0258 mSv/yr) (Table 9-4).

Table 9-4. Estimated radiological dose to hypothetical MEI of the general public from 2024 NNSS activities

Pathway	Dose to MEI (mrem/yr)	Dose to MEI (mSv/yr)	Percent of DOE 100 mrem/yr Limit
Air[(a)]	0.065	0.00065	0.07
Water[(b)]	0.00	0.00	0.00
Wildlife[(c)]	2.51	0.0251	2.51
Direct[(d)]	0.00	0.00	0.00
All Pathways	2.58	0.0258	2.58

(a) Based on highest offsite dose predicted from modeled 2024 air emissions (Section 9.1.1.1).
(b) Based on all offsite groundwater sampling conducted by NNSA/NFO to date (Section 5.1).
(c) Based on consuming one animal sampled in 2024, which would result in the highest dose (Table 9-3).
(d) Based on 2024 gamma radiation monitoring data at the NNSS entrance (Section 6.3.2).

The total dose of 2.58 mrem/yr to the hypothetical MEI is 2.58% of the DOE limit of 100 mrem/yr and about 0.72% of the total dose that the MEI receives from natural background radiation (360 mrem/yr [3.6 mSv/yr]) (Figure 9-1). Natural background radiation consists of cosmic radiation, terrestrial radiation, radiation from radionuclides within the composition of the human body (primarily potassium-40), and radiation from the inhalation of naturally occurring radon and its ***progeny***. The cosmic and terrestrial components of background radiation shown in Figure 9-1 were estimated from the annual mean radiation exposure rate measured with a pressurized ion chamber (PIC) at Indian Springs by the Community Environmental Monitoring Program (95.13 milliroentgens per year [mR/yr]; Table 7-4). The radiation exposure in air, measured by the PIC in units of mR/yr, is conservatively approximated to be equivalent to the unit of mrem/yr for tissue. The portion of the background dose from the internally deposited, naturally occurring radionuclides and from the inhalation of radon and its ***daughters*** were estimated at 31 mrem/yr (0.31 mSv/yr) and 229 mrem/yr (2.29 mSv/yr), respectively (Figure 9-1), using the approximations by the National Council on Radiation Protection and Measurements (2006).

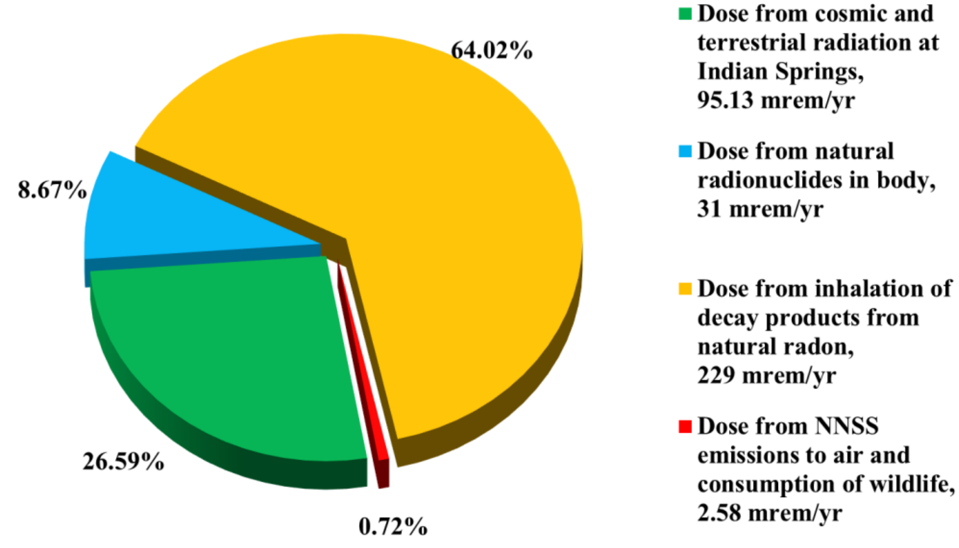

Figure 9-1. Comparison of radiation dose to the MEI from the NNSS and natural background (% of total) in 2024

9.1.4 Collective Population Dose

The ***collective population dose*** to residents within 80 km (50 miles [mi]) is the product of the predicted individual doses multiplied by the population potentially receiving those doses. The CAP88 modeled doses from 2024 air emissions for the estimated 557,100 people who lived within 80 km (50 mi) of NNSS emission sources resulted in a collective dose of 0.31 person-rem/yr. This 2024 calculation verifies the relatively low dose risk from the NNSS.

9.1.5 Release of Property Containing Residual Radioactive Material

In addition to discharges to the environment, the release of DOE property containing residual radioactive material is a potential contributor to the dose received by the public. The release of property off the NNSS is controlled. No vehicles, equipment, structures, or other materials can be released from the NNSS for unrestricted public use unless the amount of residual radioactivity on such items is less than the authorized limits. The default authorized limits for 2024 are specified in the *Nevada National Security Site Radiological Control Manual* (RadCon Manual) (Radiological Control Manager's Council 2022) and are consistent with the limits set by DOE O 458.1. These limits, excerpts from the RadCon Manual Table 4-2, are shown in Table 9-5. The RadCon Manual was revised effective October 2022, but the Table 4-2 release limits were not changed.

All NNSA/NFO contractors use a risk-based graded approach for release of material and equipment for unrestricted public use. Either items are surveyed prior to release to the public, or a process knowledge evaluation is conducted to verify that the material has not been exposed to radioactive material or beams of radiation capable of generating radioactive material. In some cases, both a radiological survey and a process knowledge evaluation are performed (e.g., a radiological survey is conducted on the outside of the item, and a process knowledge form is signed by the custodian to address inaccessible surfaces). Items are evaluated/surveyed prior to shipment to the NNSA/NFO property/excess warehouse. All contractors also complete material surveys prior to release and transport to the Area 23 landfill. The only exception is for items that could be internally contaminated; these items are submitted to Waste Generator Services for disposal using one of the facilities that can accept LLW. Excess items that can be free-released are either donated to interested state agencies, federal agencies, or universities; redeployed to other onsite users; or sold on an auction website. No released items had residual radioactivity in excess of the limits specified in Table 9-5.

Independent verification of radiological surveys and process knowledge evaluations is achieved through NNSA/NFO program oversight and through assessments. DOE O 458.1, which includes the process of releasing property to the public, has been incorporated into the site's Radiological Control Manager's Council Internal Assessment Schedule, and DOE O 458.1 assessments are scheduled to occur once every 3 years. An assessment was conducted in 2022, and NNSS property release activities were found to comply with DOE O 458.1.

Table 9-5. Allowable total residual surface contamination for property released off the NNSS

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

(a) Disintegrations per minute per 100 square centimeters (cm^2).
(b) Averaged over an area of not more than 1 square meter.
(c) Applicable to an area of not more than 100 cm^2.

9.2 Dose to Aquatic and Terrestrial Biota

DOE requires their facilities to evaluate the potential impacts of radiation exposure to biota in the vicinity of DOE activities. To assist in such an evaluation, DOE's Biota Dose Assessment Committee developed DOE-STD-1153-2019. This standard established the following radiological dose limits for plants and animals. Dose rates equal to or less than these are expected to have no direct, observable effect on plant or animal reproduction:

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

DOE-STD-1153-2019 also provides concentration values for radionuclides in soil, water, and sediment to use as a guide to determine if biota are potentially receiving radiation doses above the limits. These concentrations are called the Biota Concentration Guide (BCG) values. They are defined as the minimum concentration of a radionuclide that would cause dose limits to be exceeded using very conservative uptake and exposure assumptions.

NNSS biologists use the graded approach described in DOE-STD-1153-2019. The approach is a three-step process consisting of a data assembly step, a general screening step, and an analysis step. The analysis step consists of site-specific screening, site-specific analysis, and site-specific biota dose assessment. The following information is required by the graded approach:

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

A comprehensive biota dose assessment for the NNSS using the graded approach was reported in the *Nevada Test Site Environmental Report 2003* (Bechtel Nevada 2004). The assessment demonstrated that the potential radiological dose to biota on the NNSS was not likely to exceed dose limits. Data from monitoring air, water, and biota across the NNSS suggest no significant change to NNSS surface conditions; therefore, the biota dose evaluation conclusion remains the same for 2024.

9.2.1 Site-Specific Biota Dose Assessment

The site-specific biota dose assessment phase of the graded approach centers on the actual collection and analysis of biota. To obtain a predicted internal dose to biota sampled in 2024, the RESRAD-BIOTA, Version 1.8, computer model (DOE 2004) was used. Maximum concentrations of man-made radionuclides detected in plant and animal tissue (Tables 8-3 and 8-5) were entered into the model. External dose was based on the measured annual exposure rate using the maximum quarterly ***thermoluminescent dosimeter (TLD)*** measurement made close to each biota sampling site (Table 6-1), minus the average background exposure rate (Table 6-2). If the average background exposure rate was higher than the monitored location, then man-made external dose was set to zero.

The 2024 site-specific estimated dose rates to biota were all below the DOE limits for both plants and animals (Table 9-6). The highest dose rate (0.028 rad/d) was predicted for a jackrabbit in Pu Valley. This is 28.4% of the DOE dose limit and was dominated (99.9%) by ^{238}Pu, $^{239/240}$Pu, and ^{241}Am.

Table 9-6. Site-specific dose assessment for terrestrial plants and animals

Location [a]	Internal [b]	External [c] (TLD Location)	Total
Terrestrial Plants			
Area 11 Pu Valley	0.011308	0.00067 (T9B)	0.011979
Area 11 Control	0.000079	0.00007 (3545 Substation)	0.000153
		DOE Dose Limit:	**1.0**
Terrestrial Animals			
Area 11 Jackrabbit	0.027766	0.00067 (T9B)	0.028437
Area 11 Small Mammals	0.017378	0.00067 (T9B)	0.018049
Area 11 Control Cottontail Rabbit	0.000053	0.00007 (3545 Substation)	0.000127
Area 11 Control Small Mammals	0.000015	0.00007 (3545 Substation)	0.000089
Area 25 Bighorn Sheep	0.000013	0.00000 (Skull Mtn Pass)	0.000013
Area 2 Mule Deer	0.000009	0.00058 (Stake N-8)	0.000584
Area 5 and 22 Pronghorn	No manmade radionuclides detected	0.000115 (RWMS-5 North)	0.000115
		DOE Dose Limit:	**0.1**

(a) For information on plants and animals sampled, see Chapter 8.
(b) Based on maximum concentrations of each man-made radionuclide detected in plant or animal samples.
(c) Based on maximum TLD measured exposure rate(s) at or near the sample location minus the average background. See Chapter 6 for information on direct radiation measurements.

9.3 Dose Assessment Summary

Radionuclides in the environment as a result of past or present NNSS activities result in a potential dose to the public or biota much lower than the dose limits set to protect the public health and the environment. The estimated dose to the hypothetical MEI for 2024 was 2.58 mrem/yr (0.0258 mSv/yr), which is 2.58% of the dose limit set to protect human health. Doses to biota at the NNSS sites sampled in 2024 were less than 30% of dose limits set to protect plant and animal populations. Based on the low potential doses from NNSS radionuclides, impacts from those radionuclides are expected to be negligible.

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Chapter 10: Waste Management

David M. Black, Louis B. Gregory, Alissa J. Silvas, Karlita L. Simper, Brian G. Verheyen, and Ronald W. Warren
Mission Support and Test Services, LLC

George C. DeLullo, Dona F. Murphy
Navarro Research and Engineering, Inc.

Waste Management Goals
Ensure disposal systems meet performance objectives. Manage and safely dispose of all types of wastes. Ensure wastes received for disposal at the Nevada National Security Site (NNSS) meet NNSS acceptance criteria. Manage and monitor wastes and waste sites for the protection of the worker, the public, and the environment.

2024 Waste Management Accomplishments
Upgraded Real-Time Radiography (RTR) technology and equipment to enhance diagnostic capabilities.
Performed 184 waste-related evaluation activities to verify compliance with NNSS Waste Acceptance Criteria (NNSSWAC).

Several federal and state regulations govern the safe management, storage, and disposal of radioactive, hazardous, and solid wastes generated or received at the NNSS (Tables 2-1 and 2-3). This chapter describes waste management operations and compliance with applicable environmental/public safety regulations. The U.S. Department of Energy (DOE) Environmental Management (EM) Nevada Program, in coordination with the National Nuclear Security Administration Nevada Field Office (NNSA/NFO), is responsible for the Area 3 and Area 5 radioactive waste disposal facilities described in Section 10.1. NNSA/NFO is responsible for and operates all other waste disposal facilities on the NNSS (Figure 10-1).

This chapter describes several waste streams, including the following:

- ***low-level radioactive waste (LLW)***[1]
- ***mixed LLW (MLLW)***
- ***classified non-radioactive (CNR) waste***
- ***classified non-radioactive hazardous (CNRH) waste***
- ***hazardous waste (HW)***
- ***transuranic (TRU) waste***
- explosive ordnance wastes
- solid/sanitary waste

In addition, details are included for the process to evaluate, design, construct, maintain, and monitor closure covers for radioactive waste disposal units at the Area 3 and Area 5 Radioactive Waste Management Sites (RWMSs); and monitoring radiation ***doses*** from the Area 3 RWMS and the ***Area 5 Radioactive Waste Management Complex (RWMC)*** to the levels specified in DOE Manual DOE M 435.1-1, "Radioactive Waste Management Manual."

10.1 Radioactive Waste Management

The NNSS Radioactive Waste Management facilities include the Area 5 RWMC and the Area 3 RWMS. They operate as Category II non-reactor nuclear facilities. The Area 5 RWMC (Figure 10-2) is composed of the Area 5 RWMS, the Mixed Waste Storage Unit (MWSU), and the Mixed Waste Disposal Unit (MWDU). Co-located with the Area 5 RWMC is the Waste Examination Facility (WEF), which includes the TRU Pad, the Sprung Instant Structure (SIS), and the Visual Examination and Repackaging Building (VERB) depicted on Figure 10-2, as well as other operational units described in Section 10.1.2.

[1] The definition of word(s) in ***bold italics*** may be found by referencing the Glossary, Appendix B.

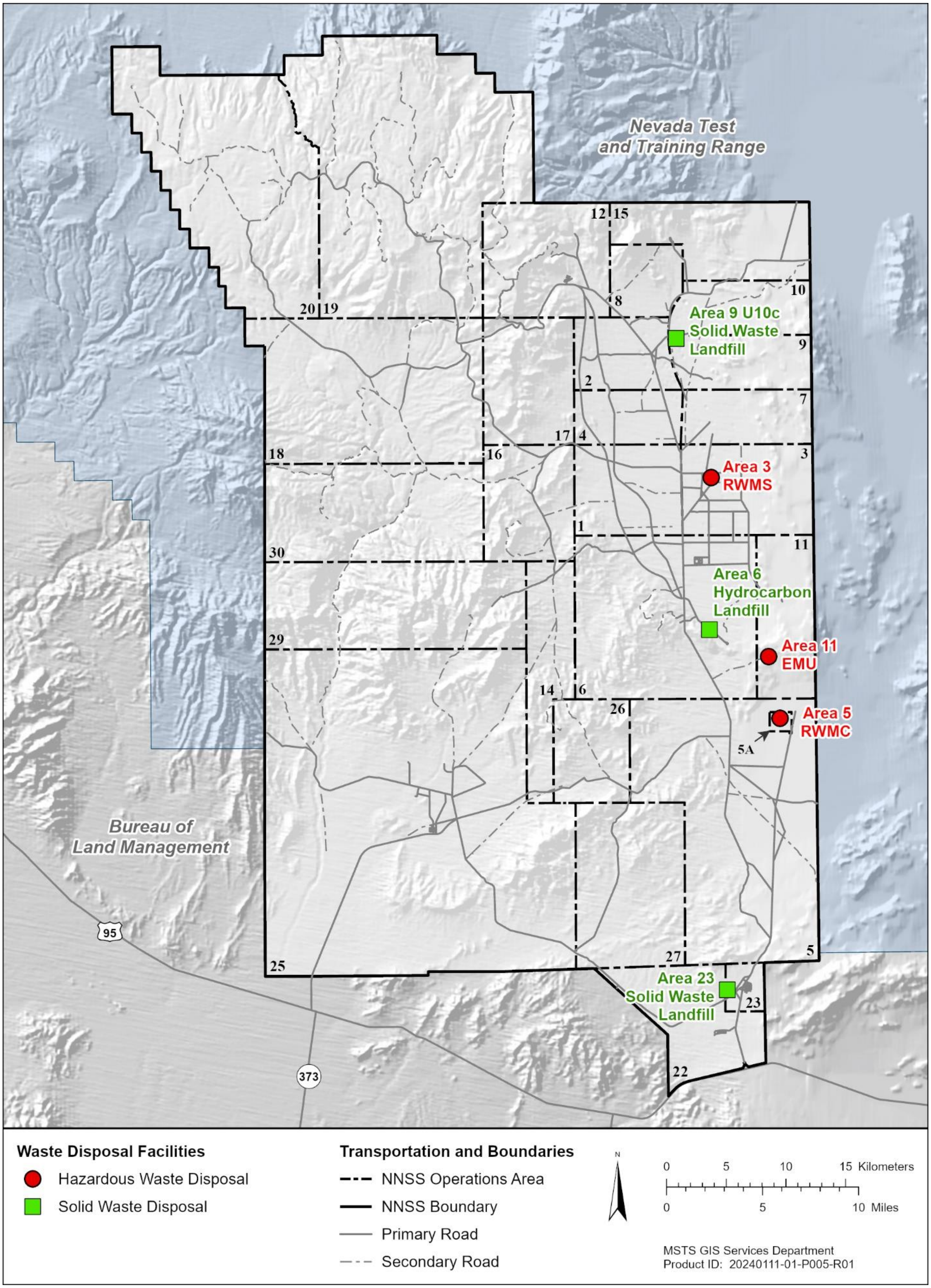

Figure 10-1. Waste disposal facilities on the NNSS

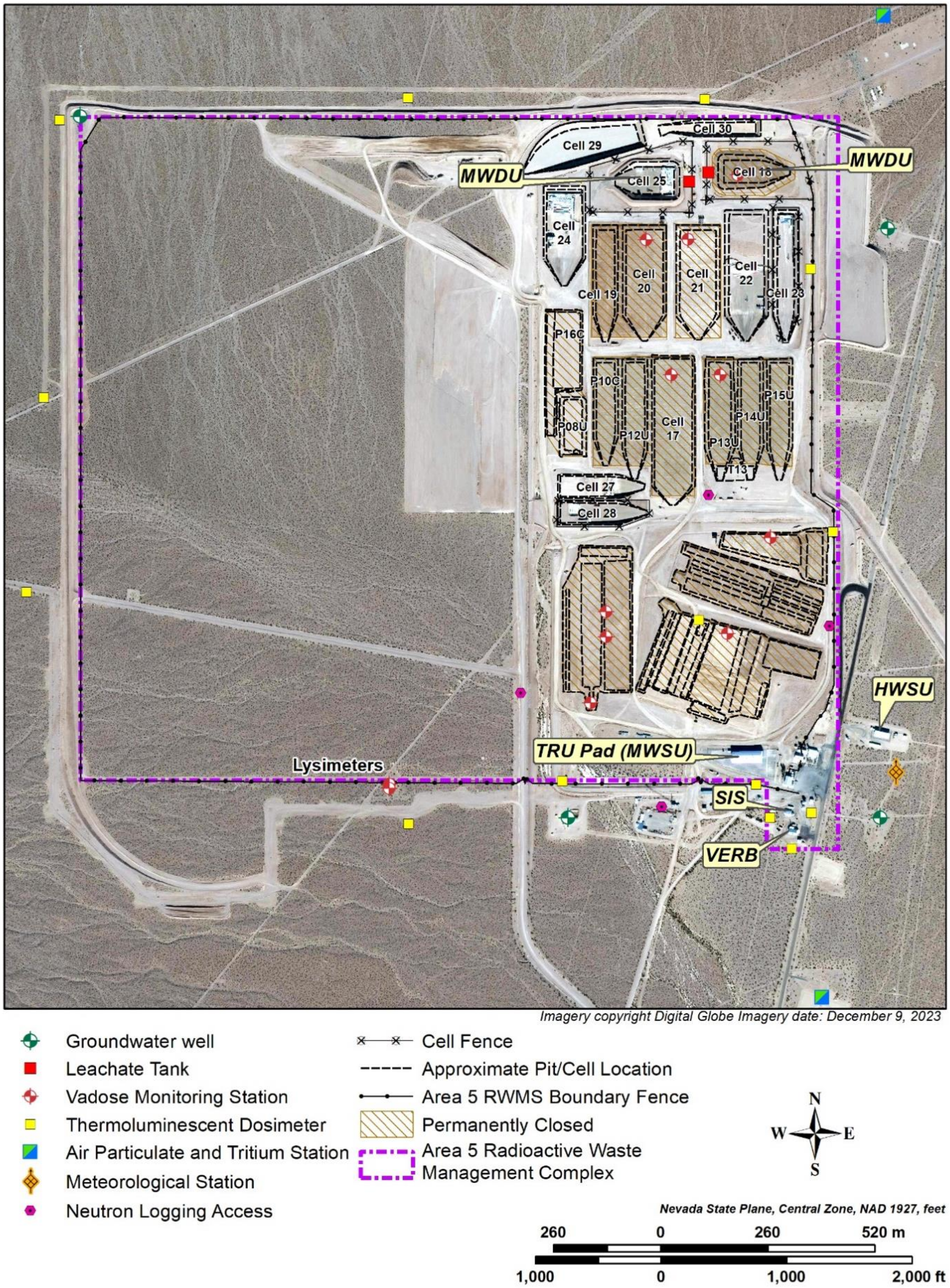

Figure 10-2. Area 5 RWMC facilities

The waste disposed at the Area 5 RWMS must be generated at a DOE facility or defense-affiliated site or have a clear connection with a DOE-sponsored program. The same criteria apply to waste disposed at the Area 3 RWMS, with the added requirement that the waste is generated within the State of Nevada, and then only after engaging in detailed discussions with the State of Nevada Division of Environmental Protection (NDEP). This section describes the facilities and associated activities. Section 10.2 provides an overview of activities conducted by the Radioactive Waste Acceptance Program (RWAP)[2] and NNSS Disposal Operations to evaluate and verify waste generators and waste streams in order to provide for the safe transportation, receipt, storage, disposal, and monitoring of classified, radioactive, and mixed wastes at the NNSS.

10.1.1 Area 5 Radioactive Waste Management Complex

The Area 5 RWMC is a DOE/NNSA-owned radioactive waste disposal facility. It encompasses approximately 740 acres (ac), including approximately 285 ac used for historical and active permanent disposal of LLW, MLLW, CNR, and CNRH. The Area 5 RWMC also includes 435 ac of land with infrastructure established for future radioactive waste disposal, and about 20 ac that support waste management and facility operations. Waste disposal at the Area 5 RWMS began in a 92-acre portion of the site starting in the early 1960s. The 92-Acre Area was permanently closed in 2011.

Nine cells received waste during 2024. They include eight LLW cells (Cells 22, 23, 24, 27, 28, 29, 30 and T13) and one MLLW cell (Cell 25). Cell 27 was filled to capacity and all waste was covered in 2024. In addition, federal and State of Nevada requirements regulate the disposal of ***polychlorinated biphenyls (PCBs)***, PCB remediation waste (equal to or greater than 50 parts per million), asbestos-containing LLW, and MLLW in specific disposal cells. Table 10-1 lists the disposal cells that were active in 2024. Area 5 RWMS disposal services are expected to continue until the remaining needs of the DOE complex are met.

Disposal Cell 25 is managed under a Resource Conservation and Recovery Act (RCRA) Part B Permit (NEV HW0101), which authorizes the disposal of up to 37,000 cubic meters (m^3) (1,306,643 cubic feet [ft^3]). The volume and weight of waste received at Cell 25 in 2024 are shown in Table 10-1. Cell 25 waste accumulation began on July 12, 2018; a cumulative total of 11,063 m^3 (390,701 ft^3) of MLLW/CNRH has been disposed through the end of 2024. Quarterly, the amount (in tons) of MLLW/CNRH disposed is reported to the state and a payment is made based on the tonnage.

In 2024, the Area 5 RWMC received shipments containing a total of 21,932 m^3 (774,522 ft^3) of radioactive waste for disposal (Table 10-1), which included both CNR and CNRH waste. The majority of waste disposed was received from offsite generators. The total number of waste shipments in Fiscal Year (FY) 2024 is reported annually (Mission Support and Test Services, LLC [MSTS], 2024c) and published on the NNSS website at https://nnss.gov/mission/environmental-programs/radioactive-waste-management/.

Table 10-1. Total waste volumes received and disposed at the Area 5 RWMS

Waste Type	Disposal Cell(s)	2024 Volume Received and Disposed in m^3 (ft^3)
LLW and CNR	Cells 22, 23, 24, 27, 28, 29, 30, T13	20,469 (722,856)
MLLW and CNRH	Cell 25	1,463 (51,666) [853 tons][(a)]
Total		**21,932 (774,522)**

(a) Fees paid to the state for HW generated at the NNSS and MLLW wastes received for disposal are based on weight.

RCRA Permit NEV HW0101 also requires post-closure monitoring of closed cells that were permitted to accept MLLW, including Cell 18 and Pit 3 (an interim status unit located in the 92-Acre Area of the Area 5 RWMC). Post-closure requirements include visual inspections of the closed units, subsidence surveys, vegetation surveys, vadose zone monitoring, leachate monitoring, and groundwater monitoring. All 2024 post-closure activities were conducted according to RCRA Permit NEV HW0101 and indicate the disposal units are performing as expected for the long-term isolation of buried waste. Post-closure activities required for RCRA Permit NEV HW0101 are presented in the annual report (MSTS 2025f).

[2] Information on the RWAP can be found at https://nnss.gov/mission/environmental-programs/radioactive-waste-management/.

10.1.2 Waste Examination Facility

Operational units of the WEF include the TRU Pad, TRU Pad Cover Building (TPCB), TRU Loading Operations Area, WEF Yard, WEF Drum Holding Pad, SIS, and the VERB. Historically, the WEF was used for the staging, characterization, repackaging, and offsite shipment of legacy TRU wastes that were disposed at the Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico.

Revision 7 of the RCRA permit was issued by NDEP on April 4, 2023, for the continuing safe storage of MLLW at the TRU Pad and TPCB. The TPCB is also authorized for the storage of TRU/Mixed TRU (MTRU) waste generated on site at the NNSS. The TPCB stores the TRU/MTRU waste until it is characterized for disposal at WIPP. In 2024, the TRU waste remaining in storage at the TPCB consisted of legacy transuranic waste from Lawrence Livermore National Laboratory and 43 standard waste boxes from the Joint Actinide Shock Physics Experimental Research facility.

10.1.3 Area 5 Hazardous Waste Storage Unit (HWSU)

The HWSU is located outside the Area 5 RWMC (Figure 10-2). It is a fenced area used for storage of NNSS-generated nonradioactive hazardous waste and PCB waste. These wastes may be stored for up to 1 year before shipment to an offsite disposal facility. The HWSU consists of a 30.3 meter (m) (100 foot [ft]) long by 9.1 m (30 ft) wide concrete pad with 6-inch curbs to contain spills and prevent run-on and/or run-off during precipitation events. A canopy roof protects waste containers from exposure to environmental conditions. A 90-day hazardous waste accumulation area, inactive during 2024, is located east of the HWSU.

10.1.4 Area 3 Radioactive Waste Management Site

Disposal operations at the Area 3 RWMS began in the late 1960s. The Area 3 RWMS consists of seven ***subsidence craters*** configured into five disposal cells (Figure 10-3):

- Two undeveloped cells: U-3az and U-3bg
- Two inactive cells: U-3ah/at and U-3bh
- One closed cell: U-3ax/bl (Corrective Action Unit 110)

Each subsidence crater was created by an underground nuclear explosives test. Until 2006, the site was used for disposal of bulk LLW, such as soils or debris, and waste in large cargo containers. In 2018 and 2019, the Area 3 RWMS was re-opened for disposal of bulk LLW in the U-3ah/at cell, which was generated by environmental corrective actions conducted at the Clean Slate III site on the Tonopah Test Range, located just north of the NNSS. At this time, only DOE waste generated within the State of Nevada may be disposed at the Area 3 RWMS. No waste was disposed at the Area 3 RWMS in 2024.

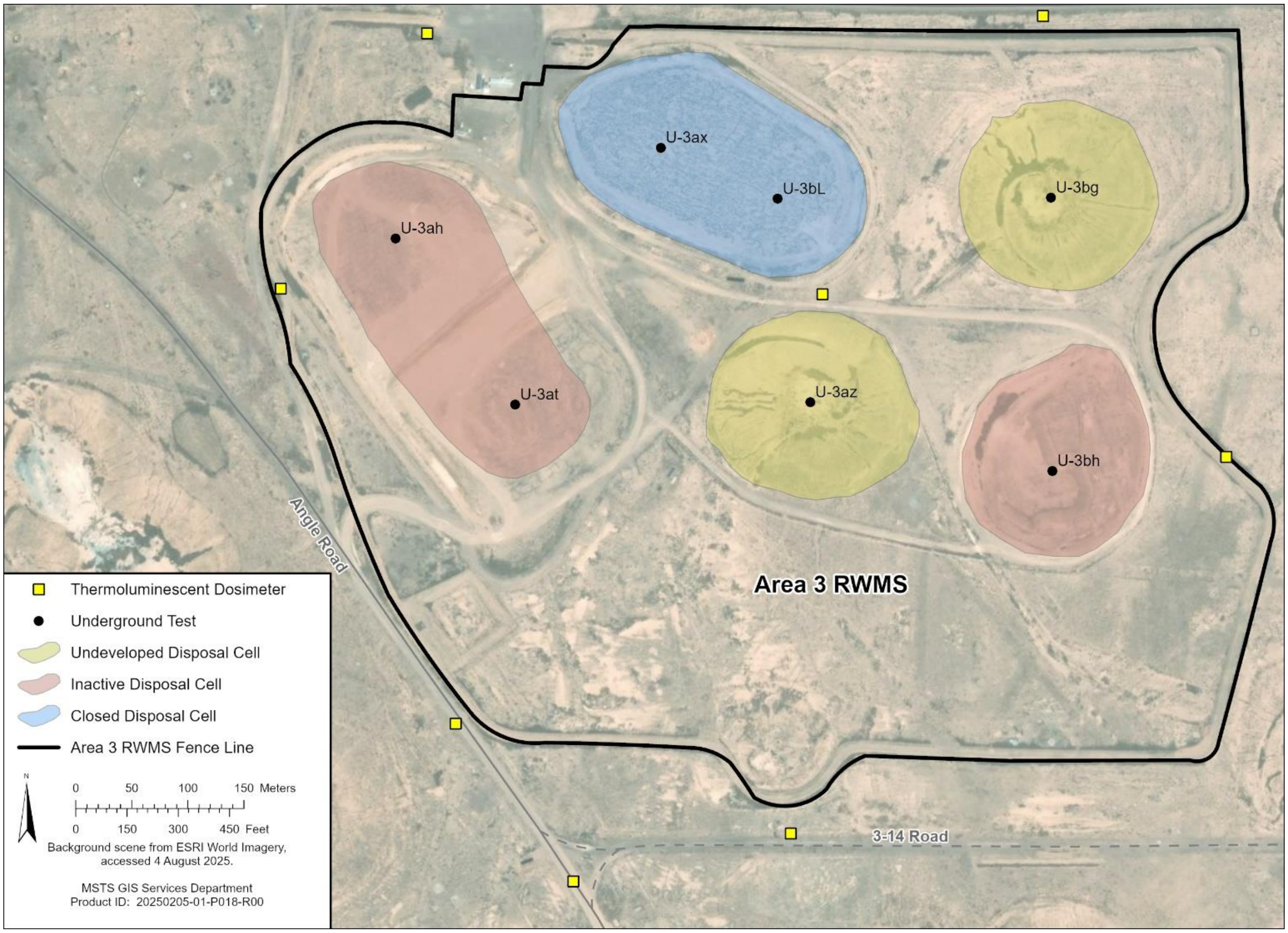

Figure 10-3. Area 3 RWMS disposal cells

10.2 Waste Characterization

Generators of CNR waste, CNRH waste, LLW, and MLLW proposed for disposal at the NNSS must demonstrate eligibility for waste to be disposed, submit detailed profiles of waste characteristics, demonstrate programs that assure compliance with the NNSSWAC, and obtain EM Nevada Program approval of their waste certification program and individual waste profiles.

Characteristics of the waste are determined through sampling and analysis, non-destructive analysis, and process knowledge of how the waste was generated. Following the characterization of a waste stream, the waste generator develops a waste profile. The waste profile delineates the pedigree of the waste, including but not limited to a description of the waste generating process, physical and chemical characteristics, radioactive ***isotope*** activity and quantity, and packaging information. The waste profile is reviewed by the NNSS Waste Acceptance Review Panel, a group of subject matter experts, and upon resolution of comments, is recommended for approval to the EM Nevada Program. Generally, once a waste profile is approved, the generator packages and ships the approved waste streams to the Area 5 RWMC in accordance with U.S. Department of Transportation requirements. Some waste streams may require that additional actions, such as a visual verification or treatment at an offsite facility, be completed prior to shipment for disposal at the Area 5 RWMC.

Examples of waste profiles include:

- Amalgamated Mercury
- Contaminated Asbestos Waste
- Contaminated Demolition Debris
- Lead Solids
- Miscellaneous Debris/Solids
- Miscellaneous Radioactive Trash

- Contaminated PCB Waste
- Contaminated Soil
- ***Depleted Uranium*** Waste
- Non-radioactive Classified Waste
- Radioactive Hazardous Classified Waste
- Sealed Sources

10.2.1 RWAP Activities

Three main elements provide the foundation for safe and compliant waste disposal at the NNSS:

- Programmatic Certification: Evaluation and approval of generator programs that address quality requirements, waste traceability, waste characterization (chemical and radiological), and packaging and transportation, to provide assurance that the program meets NNSS requirements. This is accomplished through surveillances and audits predominantly performed on site.
- Profile Approval: Review and approval of extensive documentation to verify that described waste complies with NNSSWAC requirements prior to shipment. This is accomplished through initial and, for MLLW, annual recertification of profiles submitted by generators.
- Container Certification: Each container is certified prior to shipment by the generator site certification personnel. Additional verification by RWAP may include visual and chemical LLW/MLLW verifications at generator sites to validate container certifications or RTR performed at the NNSS to evaluate container contents for consistency with the approved waste profile.

Table 10-2 reflects the evaluation activities conducted by RWAP in 2024. The volume of waste disposed at the NNSS slightly increased in Calendar Year (CY) 2024 as compared to CY 2023. RWAP performed 184 waste-related evaluations activities, as noted in Table 10-2. These evaluations verify ongoing adherence to approved waste certification programs to provide confidence in protection of the DOE workforce, the public, and the environment. A comprehensive report of RWAP activities in FY 2024 was provided to NDEP in January 2025.

Table 10-2. Calendar Year 2024 summary of RWAP evaluation activities

Period Involved (Quarter [QTR])	Onsite Profile or Special Topics Discussions (a)	LLW & MLLW(b) Verifications	Onsite/Hybrid Surveillances	Tabletop Surveillances	Audits(c)	RTR(d)	Split Sampling/ Chemical Screening	Profile Approvals/ Recertifications
Jan-Mar 2024 (2nd QTR FY 2024)	1	8 MLLW (14)	4	----	1(1)	2 (5)	----	10/15
Apr-Jun 2024 (3rd QTR FY 2024)	----	1 MLLW (1)	5	----	1	6 (17)	1/1	11/12
Jul-Sep 2024 (4th QTR FY 2024)	2	2 MLLW (3)	3	----	2	0 (0)	----	7/11
Oct-Dec 2024 (1st QTR FY 2025)	----	9 MLLW (14)	3	----	2	0 (0)	----	4/5

(a) In conjunction with the Waste Acceptance Review Panel, RWAP now conducts generator onsite profile discussions or special topics/situations (usually with NDEP attending) instead of focusing on regular “deep dive” profile verifications.
(b) LLW & MLLW verification numbers include in parentheses the number of waste packages visually inspected (see 10.2.2).
(c) Comprehensive evaluation performed at a waste generator’s facility to verify compliance of the five foundational elements comprising the waste certification program: 1) radiological constituent characterization; 2) chemical constituent characterization; 3) quality assurance; 4) waste packaging and transportation; and 5) waste traceability. NOTE: In first quarter 2024, an audit was changed to an assist visit which resulted in one audit and one assist visit conducted for the quarter.
(d) RTR numbers reflect the number of generator waste streams and (containers) verified consistent with approved profiles and free from prohibited items. NOTE: Due to equipment renovation, RTR was not available for several months during CY 2024.

10.2.2 Mixed Waste and Classified Non-Radioactive Hazardous Waste Verification

Waste verification is an inspection process that affirms the waste in a specific container is consistent with the waste stream data supplied by approved waste generators before MLLW or CNRH is accepted for disposal at the NNSS. Verification may involve visual inspection, RTR, and/or chemical screening on a designated percentage of MLLW or CNRH. The objectives of waste verification include verifying that regulatory treatment objectives are met, confirming that waste containers do not contain free liquids, and validating that waste containers are at least 90% full, per RCRA and State of Nevada requirements. Waste is verified either upon receipt at the NNSS or while still at a generator facility or a designated treatment facility. The primary method of verification is visual inspection at the site of generation.

In 2024, offsite visual inspections were completed on 32 MLLW packages from 14 separate waste streams. One waste stream required split sampling and one required chemical screening. No onsite RTR of MLLW or CNRH was conducted at the NNSS Area 5 RWMC. MLLW subjected to verification was compliant upon receipt at the NNSS.

10.2.3 Waste Receipt and Disposal Operations

Upon arrival at the NNSS, waste shipment validation activities occur prior to acceptance and permanent disposal. The key tasks performed upon receipt of a waste shipment include:

- Reviewing shipment documentation to verify consistency with the information submitted during the profile approval process.
- Obtaining transportation routing information from waste shipment drivers.
- Performing radiological surveys of all trucks, trailers, and containers entering the disposal facility.
- Verifying security seals are in place and packages are intact and appropriately labeled.
- Inspecting the contents of selected waste packages using onsite RTR x-ray technology to verify consistency with the approved waste profile.

Once a shipment has successfully been accepted under the receipt process, trucks are allowed access and directed to the appropriate disposal cell. During off-loading, radiological surveys are conducted on each waste package, container bar codes are scanned for entry into a tracking system, and the waste is placed in its permanent disposal position. Waste cells are organized in a 20-ft by 20-ft grid system, using letters and numbers to designate the location of waste packages. This tracking system helps waste personnel monitor the accumulation of radionuclide levels and maintain a record of specific waste packages once they are buried.

Reports containing waste transportation and disposal volume information are publicly available on the NNSS website at https://nnss.gov/mission/environmental-programs/radioactive-waste-management/.

10.3 Annual Performance Assessments and Composite Analyses

As required by DOE Order DOE O 435.1, "Radioactive Waste Management," NNSA/NFO must conduct a ***Performance Assessment (PA)*** and ***Composite Analysis (CA)*** of each of its radioactive waste disposal facilities. A PA is a systematic analysis of the potential risks posed to the public and environment by a waste disposal facility for LLW disposed after 1988. A CA is an assessment of the risks posed by all wastes disposed in an LLW disposal facility and by all other sources of residual contamination that may interact with the disposal site. Current PAs and CAs are maintained for the Area 3 and Area 5 RWMSs (Table 10-3). DOE O 435.1 further requires an annual review of the PAs and CAs to be submitted to DOE EM each March. The annual reviews include tracking through closure all unresolved issues identified by EM's PA/CA assessments. The unresolved issues are also tracked in a Maintenance Plan (MSTS 2019).

As required by DOE O 435.1, in 2024, the EM Nevada Program and NNSA/NFO performed the annual review of the Area 3 and Area 5 RWMS Disposal Authorization Statements including the PAs, CAs, Supplemental Analyses, Radioactive Waste Management Basis, and Waste Acceptance Criteria. Operational factors (e.g., waste forms and containers, facility design), closure plans, monitoring results, and research and development activities in or near the facilities were also reviewed. Both the FY 2023 summary report, dated February 2024 (MSTS 2024a), and the FY 2024 summary report, dated February 2025 (MSTS 2025e), present data and conclusions that verify the adequacy of both the Area 3 and Area 5 PAs and CAs. Table 10-3 lists the necessary documents required and maintained for RWMS disposal operations.

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

Disposal Authorization Statement
- Disposal Authorization Statement for Area 3 RWMS, October 1999
- Disposal Authorization Statement for Area 5 RWMS, December 2000

Performance Assessment
- Performance Assessment/Composite Analysis for Area 3 RWMS, Revision 2.1, DOE/NV--491-Rev 2.1, December 2001
- Addendum 2 to Performance Assessment for Area 5 RWMS, DOE/NV/11718--176-ADD2, January 2006
- Fiscal Year 2024 Annual Summary Report for the Area 3 and Area 5 Radioactive Waste Management Sites at the Nevada National Security Site, DOE/NV/03624--2111, February 2025

Composite Analysis
- Addendum 1, Composite Analysis for Area 5 RWMS, DOE/NV--594-ADD1, November 2001
- Performance Assessment/Composite Analysis for Area 3 RWMS, Revision 2.1, DOE/NV--491-Rev 2.1, December 2001

NNSS Waste Acceptance Criteria
- NNSS Waste Acceptance Criteria, DOE/NV--325-24-00, Issued February 2024

Integrated Closure and Monitoring Plan
- Closure Plan for the Area 3 RWMS at the NNSS, DOE/NV/25946--289, September 2007
- Closure Plan for the Area 5 RWMS at the NNSS, DOE/NV/25946--553, September 2008

Documented Safety Analysis
- Nevada National Security Site Area 3 and 5 Radioactive Waste Facilities (RWF) Documented Safety Analysis, DSA-2151.100, Revision 8, December 2021
- Safety Evaluation Report (SER) for the Nevada National Security Site (NNSS) Areas 3 and 5 Radioactive Waste Facilities (RWF) Documented Safety Analysis (DSA), Revision 8, the Low-Level Waste (LLW) Activities Technical Safety Requirements (TSR), Revision 10, and the Transuranic (TRU) Waste Activities TSR, Revision 13, Revision 0, August 2022
- Nevada National Security Site Area 3 and 5 Radioactive Waste Management Sites Low-Level Waste (LLW) Activities, Technical Safety Requirements, TSR-2156.03, Revision 10, December 2021
- Nevada National Security Site Area 5 Radioactive Waste Management Complex (RWMC) TRU Waste Activities, Technical Safety Requirements, TSR-2156.02, Revision 13, December 2021

10.3.1 Groundwater Protection Assessment

As detailed in Chapter 5, NNSA/NFO and the EM Nevada Program monitor groundwater to provide safe drinking water for NNSS workers and visitors, avoid NNSS groundwater contamination from current activities, and protect the public and environment from areas of known underground contamination that has resulted from historical nuclear testing.

The depth to groundwater in wells in the vicinity of and generally downgradient from each waste disposal site are provided in Table 10-4.

Table 10-4. Waste Management Sites Approximate Depth to Groundwater

Waste Site	Well	Feet Below Ground Surface
Area 3 RWMS	Water Well A[(a)]	1,598
Area 5 RWMS[(b)]	UE5PW-1	772
	UE5PW-2	840
	UE5PW-3	889
	UE5MW-4	766
Area 6	Water Well C-1[(a)]	1,539
Area 9	ER-2-1 main (shallow)[(a)]	1,726
Area 23	SM-23-1[(a)]	1,163

(a) USGS 2025
(b) MSTS 2025f

Hazardous waste disposal in Cells 18 and 25 complies with RCRA standards and DOE O 435.1 requirements. Title 40 ***Code of Federal Regulations (CFR)*** Part 264, Subpart F (40 CFR 264.92), requires groundwater monitoring to verify that the design and construction of active hazardous waste cells are adequate to protect groundwater from contamination by buried waste. Specifically, groundwater monitoring at the Area 5 RWMS is conducted in accordance with 40 CFR 264.97, "General Ground-Water Monitoring Requirements," and

40 CFR 264.98, "Detection Monitoring Program." Groundwater samples are analyzed for indicators of contamination (pH, specific conductance, total organic carbon, total organic halides, and ***tritium***), volatile organic compounds, semi-volatile organic compounds, pesticides, herbicides, and toxicity characteristic metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver). Limits for each parameter were established by the NDEP-issued RCRA Permit NEV HW0101. Groundwater samples are collected and analyzed annually at wells UE5 PW-1, UE5 PW-2, UE5 PW-3, and UE5MW-4. All samples collected in 2024 had concentration levels below their Groundwater Protection Standards (Table 10-5). Static water levels are also monitored. All sample analysis results are presented in the annual report (MSTS 2025f). The tritium results were all below their sample-specific ***minimum detectable concentration (MDC)*** of between 88 and 112 picocuries per liter (pCi/L). Table 5-5 presents the sample-specific tritium MDCs (i.e., the less than values) for each water sample collected from these wells in 2024. No groundwater contamination is indicated by the 2024 results.

Table 10-5. Area 5 groundwater monitoring results

Parameter	Groundwater Protection Standard	2024 Sample Levels[(a)]
pH	<6.0 or >9.0 S.U.[(b)]	7.94 to 8.16 S.U.
Specific conductance	10.0 mmhos/cm [(c)]	0.363 to 0.386 mmhos/cm
Total organic carbon[(d)]	5.0 mg/L[(e)]	<1 to 1.5 mg/L
Total organic halides[(d)]	0.1 mg/L	<0.1 mg/L
Tritium (^{3}H)	20,000 pCi/L[(f)]	ND[(g)]
Arsenic (As)	0.05 mg/L	ND to < 0.03 mg/L
Barium (Ba)	1.0 mg/L	<0.005 to 0.015 mg/L
Cadmium (Cd)	0.01 mg/L	ND
Chromium (Cr)	0.05 mg/L	<0.01
Lead (Pb)	0.05 mg/L	ND to <0.02
Mercury (Hg)	0.002 mg/L	ND
Selenium (Se)	0.01 mg/L	ND to <0.03
Silver (Ag)	0.05 mg/L	ND
o-cresol	200.0 mg/L	ND
m- and p-cresol	200.0 mg/L	ND
1,4-dichlorobenzene	7.5 mg/L	ND to <0.001
2,4-dinitrotoluene	0.13 mg/L	ND
Hexachlorobenzene	0.13 mg/L	ND
Hexachlorobutadiene	0.5 mg/L	ND
Hexachloroethane	3.0 mg/L	ND
Nitrobenzene	2.0 mg/L	ND
Pentachlorophenol	100.0 mg/L	ND
Pyridine	5.0 mg/L	ND
2,4,5-trichlorophenol	400.0 mg/L	ND
2,4,6-trichlorophenol	2.0 mg/L	ND
Benzene	0.5 mg/L	<0.001
Carbon tetrachloride	0.5 mg/L	<0.001
Chlorobenzene	100.0 mg/L	<0.001
Chloroform	6.00 mg/L	<0.001
1,2-dichloroethane	0.5 mg/L	<0.001
1,1-dichloroethylene	0.7 mg/L	<0.001
Methylethylketone	200.0 mg/L	ND
Tetrachloroethylene	0.7 mg/L	<0.001
Trichloroethylene	0.5 mg/L	<0.001
Vinyl chloride	0.2 mg/L	<0.001
Chlordane	0.03 mg/L	ND
Endrin	0.02 mg/L	ND
Heptachlor	0.008 mg/L	ND
Lindane	0.4 mg/L	ND
Methoxychlor	10.0 mg/L	ND

Table 10-5. Area 5 groundwater monitoring results

Parameter	Groundwater Protection Standard	2024 Sample Levels(a)
Toxaphene	0.5 mg/L	ND
2,4,5-TP (Silvex)	1.0 mg/L	ND
2,4-D	10.0 mg/L	ND

(a) Levels shown are the lowest and highest values.
(b) S.U. = standard unit(s) (for measuring pH).
(c) mmhos/cm = millimhos per centimeter.
(d) Sampled biennially.
(e) mg/L = milligrams per liter.
(f) pCi/L = picocuries per liter.
(g) ND = not detected; levels were below the MDC or Method Detection Limit.

10.3.2 Vadose Zone Assessment

Monitoring of the ***vadose zone*** (***unsaturated zone*** above the ***water table***) is conducted at the Area 3 and Area 5 RWMSs to demonstrate (1) the PA assumptions are valid regarding the hydrologic conceptual models used, including soil water content, and upward and downward flux rates; and (2) there is negligible infiltration and percolation of precipitation into zones of buried waste. Vadose zone monitoring (VZM) offers many advantages over groundwater monitoring, including detecting potential problems long before groundwater resources would be impacted, allowing corrective actions to be made early, and being less expensive than groundwater monitoring. The components of the VZM program include the Drainage Lysimeter Facility northwest of U-3ax/bl within the Area 3 RWMS, the Area 5 Weighing Lysimeter Facility on the southern border of the Area 5 RWMC, a meteorology tower at both RWMSs, and nine stations that measure water content and water potential at varying depths in the waste covers. Data from these components are used to monitor the natural water balance at the RWMSs. All VZM continued to demonstrate negligible infiltration of precipitation into zones of buried waste at the RWMSs, and the effectiveness of performance criteria to prevent contamination of groundwater and the environment. Descriptions of the VZM components and the results of monitoring in 2024 are provided in an annual report (MSTS 2025f).

10.4 Assessment of Radiological Dose to the Public

DOE M 435.1-1 states that LLW disposal facilities shall be operated, maintained, and closed so that a reasonable expectation exists that the annual dose to members of the public shall not exceed 10 millirem (mrem) through the air pathway and 25 mrem through all pathways for a 1,000-year compliance period after closure of the disposal units. Because of this long compliance period, a PA and a CA (Section 10.3) are completed to estimate potential releases in the future and the subsequent related dose. Given that the RWMSs are well within the NNSS boundaries, no members of the public can currently access the areas for long periods of time. However, to document compliance with DOE M 435.1-1, the possible pathways for ***radionuclide*** movement from waste disposal facilities are monitored. Long-term compliance with the DOE M 435.1-1 dose limits is evaluated by performance assessment modeling. As discussed below, waste operations would contribute negligible ***exposure*** to a hypothetical person residing near the boundaries of the RWMSs and would contribute no dose to the offsite public (Chapter 9).

10.4.1 Dose from Air and Direct Radiation

Air samplers operate continuously to collect air particulates and atmospheric moisture near each RWMS. These samples are analyzed for radionuclides, and results are used to assess potential dose. Details of the air sampling and a summary of the analysis results are given in Chapter 4. In 2024, three environmental sampling stations operated in/near the Area 3 RWMS (U-3ax/bl S, Bilby Crater, and Kestrel Crater N), and two air monitoring stations operated near the Area 5 RWMS (DoD and RWMS 5 Lagoons). The fraction of the dose limit was measured for the air pathway based on the highest annual mean concentration for each measured radionuclide from these five stations. This results in the most conservatively high air concentration to compare with compliance limits.

The highest annual mean concentration of each measured radionuclide among the five stations, and the station at which the highest concentration occurred, are shown in Table 10-6. The highest mean concentration of any radionuclide was $2,160 \times 10^{-15}$ microcuries per milliliter (µCi/mL) for tritium at RWMS 5 Lagoons. All five of the highest mean concentrations were far below their established National Emission Standards for Hazardous Air Pollutants (NESHAP) Concentration Levels (CLs) for Environmental Compliance (Table 10-6, fourth column). The highest mean concentration of each measured radionuclide is divided by its respective CL to obtain a “fraction of CL” (Table 10-6, right-most column). The fractions are then summed, and if the sum is less than 1, it demonstrates that the NESHAP dose limit of 10 millirem/year (mrem/yr) was not exceeded at a location having all those radionuclides at those average concentrations. Summing the fractions of CLs gives 0.22, which is only 22% of the limit in this conservatively high scenario.

Table 10-6. Highest annual mean concentrations of radionuclides detected at Area 3 and Area 5 RWMS

Radionuclide	RWMS Sampler	2024 Highest Annual Mean Concentration	NESHAP CL[(a)] ($\times 10^{-15}$ µCi/mL)	Fraction of CL
^{3}H	RWMS 5 Lagoons	2,160	1,500,000	0.0014
^{137}Cs	Kestrel Crater N	0.13	19	0.0067
^{238}Pu	U-3ax/bl S	0.0058	2.1	0.0028
^{239}Pu	Kestrel Crater N	0.350 ($^{239+240}Pu$)	2	0.1750
^{241}Am	Kestrel Crater N	0.058	1.9	0.0303
			Sum of Fractions:	**0.2162**

(a) CL values represent an annual average concentration that would result in a ***total effective dose equivalent*** of 10 mrem/yr, the federal dose limit to the public from all radioactive air emissions (from Table 2, Appendix E of 40 CFR 61, “National Emission Standards for Hazardous Air Pollutants,” 1999).

Thermoluminescent dosimeters (TLDs) are used to measure ***ionizing radiation*** exposure at nine locations in and around the Area 3 RWMS and 14 locations in and around the Area 5 RWMS. The TLDs have three calcium sulfate elements used to measure the total exposure rate from penetrating ***gamma radiation***, including ***background*** radiation. Penetrating gamma radiation makes up the deep dose, which is compared to the 25 mrem/yr limit when background exposure is subtracted. Details of the direct radiation monitoring are provided in Chapter 6. The external radiation measured near the boundaries of the Area 3 and Area 5 RWMSs could not be distinguished from background levels during 2024 (Section 6.3.4). Area 3 and Area 5 RWMS operations would have contributed negligible external exposure to a hypothetical person residing near the boundaries of these sites, and no dose to the offsite public.

10.4.2 Dose from Groundwater

Groundwater and vadose zone monitoring at the RWMSs is conducted to verify the performance of waste disposal facilities. Such monitoring has not detected the migration of radiological wastes into groundwater (Sections 10.3.1 and 10.3.2). Also, the results of monitoring offsite public and private wells and springs indicate that man-made radionuclides have not been detected in any public or private water supplies (Table 5-4, and Sections 7.2 and 7.3). Based on these results, potential doses to members of the public from radioactive waste disposal facilities on the NNSS from groundwater, and from all pathways combined, are negligible.

10.5 Hazardous Waste Management

HW regulated under RCRA is generated at the NNSS from a broad range of activities, including onsite laboratories, site and vehicle maintenance, communications operations, and environmental corrective actions at historically contaminated sites. The RCRA Part B Permit regulates operation of the Area 5 MWDU, consisting of a Subtitle C landfill (Cells 18 [closed] and 25) and two leachate collection tanks, the Area 5 HWSU, the Area 11 Explosives Management Unit (EMU) facilities, and the MWSU at the TRU Pad/TPCB.

All HW, whether generated at the NNSS or offsite, is ultimately shipped to an offsite approved disposal facility:

- HW generated off the NNSS (e.g., environmental corrective action sites on the Tonopah Test Range, or the North Las Vegas Facility) is initially stored in Satellite Accumulation Areas (SAAs) and 90-day Hazardous Waste Accumulation Areas (HWAAs) and is then shipped directly to the approved disposal facility.
- HW generated on the NNSS is initially stored in SAAs and HWAAs and is then shipped to the HWSU (Figure 10-2) for temporary storage prior to shipping off site or shipped directly to the offsite disposal facility if the HW is of a type or volume that exceeds the HWSU operational limits.

The Area 11 EMU is permitted to treat explosive ordnance wastes by open detonation of not more than 45.4 kilograms (100 pounds) of approved waste at a time, not to exceed one detonation event per hour. Conventional explosive wastes are generated at the NNSS from explosive operations at construction and experiment sites, the NNSS firing range, the resident national laboratories, and other activities.

10.5.1 Hazardous Waste Activities

The RCRA Part B Permit requires preparation of an Annual Summary/Waste Minimization Report of all HW volumes managed at the NNSS. The CY 2024 report was submitted to the State of Nevada in February 2025 (MSTS 2025d). It includes the amount of wastes received in CY 2024 at the Area 5 MWDU, MWSU, HWSU, and Area 11 EMU.

The NNSS is a large-quantity generator of hazardous waste and is required to submit a biennial report. This report is submitted via an online application and prepared for odd-numbered years only. Accordingly, a biennial report for CY 2023 was submitted on February 25, 2024.

Table 10-7 lists the quantities of HW generated either on or off site that were managed (received, stored, shipped, or disposed) at the various NNSS waste units during CY 2024. It includes the tons of MLLW received and disposed on site in MWDU Cell 25; the tons of MLLW received at the MWSU; the tons of MLLW shipped off site from the MWSU for disposal; the tons of HW with and without PCBs received, stored, and shipped off site from the HWSU; and the tons of HW stored and then shipped off site from one or more HWAAs. Quarterly 2024 HW volume reports were submitted on schedule to NDEP.

Table 10-7. Hazardous waste managed at the NNSS

Waste Unit	2024 Amount (tons)		
	Received[(a)]	Shipped	Disposed
MWDU	802.10	0	802.10
MWSU	0.0	0.0	--
HWSU	13.99	9.71	--
HWSU – PCB Waste	14.25	14.25	--
HWAA	NA[(b)]	0	--
EMU	0.0	0	0

(a) Fees paid to the state for HW generated at the NNSS and MLLW wastes received for disposal are based on weight (tons).
(b) Not applicable; amounts of HW received at HWAAs are not tracked. Only the length of time they are stored and the amounts shipped off from all HWAAs combined are tracked.

Each year NDEP performs a Compliance Evaluation Inspection (CEI) of the RCRA permitted HW units at the NNSS. On November 12, 13, and 14, 2024, NDEP conducted its CEI of the waste units listed in Table 10-7, and selected SAAs and Universal Waste Collection Centers. The November 2024 CEI documented that NNSA/NFO was compliant with the NNSS RCRA Part B Permit.

In June 2024, NDEP confirmed that DOE satisfied all obligations under the June 2021 Settlement Agreement[3] to resolve regulatory actions resulting from the July 2019 waste issue. The thirty-four corrective actions implemented by DOE under the Settlement Agreement contribute to enhancing the rigor of waste management activities for the protection of the DOE workforce, the public, and the environment.

10.6 Solid and Sanitary Waste Management

Three Solid Waste Disposal Sites (SWDSs) for ***solid waste*** disposal were operated at the NNSS in 2024. The SWDSs are regulated and permitted by the State of Nevada (see Table 2-3 for list of permits). No liquids, HW, or radioactive waste are accepted in these SWDSs. These are:

- Area 6 SWDS – permitted for industrial waste such as construction and demolition debris.
- Area 9 SWDS – designated for industrial waste such as construction and demolition debris and asbestos waste under certain circumstances.

[3] The Settlement Agreement and Administrative Order can be found at https://ndep.nv.gov/uploads/land-doe-aip-docs/NDEPDOEJune22SASignedF.pdf

- Area 23 SWDS – accepts municipal-type wastes such as office waste. Regulated asbestos-containing material is also permitted in a special section. The permit allows disposal of no more than an average of 20 tons/day at this site.

These SWDSs are designed, constructed, operated, maintained, and monitored in adherence to the requirements of state permits. NDEP visually inspects the SWDSs annually for compliance; NDEP inspected the SWDSs in October 2024, which resulted in no findings. The amount of waste disposed in each SWDS is shown in Table 10-7. Biannual reports for the Area 23 SWDS were submitted in July 2024 and January 2025 to NDEP (MSTS 2024b and MSTS 2025a, respectively). Annual reports for the Area 6 and Area 9 SWDSs were submitted in January 2025 (MSTS 2025b and MSTS 2025c, respectively).

The VZM schedule for the Area 6 SWDS and the Area 9 SWDS was amended by NDEP to biennial events beginning with 2017 and 2018. VZM is performed biennially or after a 24-hour rain event in lieu of groundwater monitoring to demonstrate that contaminants from the SWDSs are not leaching into the groundwater. The monitoring reports for 2023 through 2024 were submitted to NDEP in June 2025 (MSTS 2025g, 2025h). VZM has not detected any soil moisture migration.

Table 10-8. Quantity of solid wastes disposed in NNSS SWDSs

2024 Waste Disposed in SWDSs in Metric Tons (Tons)		
Area 6	**Area 9**	**Area 23**
7.38	5795.47	261.11
8.13	6388.08	287.83

10.7 References

Mission Support and Test Services, LLC, 2019. *Maintenance Plan for the Performance Assessments and Composite Analyses for the Area 3 and Area 5 Radioactive Waste Management Sites at the Nevada National Security Site, Revision 3.0*. DOE/NV/03624--0423, Las Vegas, Nevada, March 2019.

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———, 2024b. *Area 23 Semi-Annual Solid Waste Disposal Site (SWDS) Report for the Nevada National Security Site (NNSS) – January 1, 2024, through June 30, 2024.* Las Vegas, Nevada, July 2024.

———, 2024c. *Fourth Quarter / Annual Transportation Report Fiscal Year 2024, Waste Shipments to and from the Nevada National Security Site, Radioactive Waste Management Complex*. DOE/NV/03624--2060, Las Vegas, Nevada, October 2024.

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———, 2025b. *Area 6 Annual Solid Waste Disposal Site (SWDS) Report for the Nevada National Security Site (NNSS), January 1, 2024 through December 31, 2024*. Las Vegas, Nevada, January 2025.

———, 2025c. *Area 9 Annual Solid Waste Disposal Site (SWDS) Report for the Nevada National Security Site (NNSS), January 1, 2024 through December 31, 2024*. Las Vegas, Nevada, January 2025.

———, 2025d. *Annual Summary/Waste Minimization Report, Calendar Year 2024.* Las Vegas, Nevada, February 2025.

———, 2025e. *Fiscal Year 2024 Annual Summary Report for the Area 3 and Area 5 Radioactive Waste Management Sites at the Nevada National Security Site, Nye County, Nevada*. DOE/NV/03624--2111, Las Vegas, Nevada, February 2025.

———, 2025f. *Environmental Monitoring and Post-Closure Report for Permitted Sites on the Nevada National Security Site, Calendar Year 2024*. DOE/NV/03624--2177, Las Vegas, NV, May 2025.

———, 2025g. *Neutron Monitoring Report for the Area 6 Class III Solid Waste Disposal Site, Nevada National Security Site, Nevada, for the Period December 2022 – December 2024*. Las Vegas, Nevada, June 2025.

———, 2025h. *Neutron Monitoring Report for the Area 9 Class III Solid Waste Disposal Site, Nevada National Security Site, Nevada, for the Period December 2022 – December 2024*. Las Vegas, Nevada, June 2025.

MSTS, see Mission Support and Test Services, LLC.

USGS, see U.S. Geological Survey

U.S. Geological Survey, 2025. USGS water data for the Nation: U.S. Geological Survey National Water Information System database, accessed June 13, 2025, at https://doi.org/10.5066/F7P55KJN.

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Chapter 11: Environmental Corrective Actions

Irene M. Farnham, Kevin Knapp, Patrick K. Matthews, Dona F. Murphy, and Glenn Puit

Navarro Research and Engineering, Inc

Reed J. Poderis and Alissa J. Silvas

Mission Support and Test Services, LLC

Environmental Corrective Action Objectives for All Sites

Characterize sites contaminated by activities related to nuclear testing and perform corrective actions in accordance with Federal Facility Agreement and Consent Order (FFACO)-approved planning documents. Conduct post-closure monitoring (PCM) of sites to ensure corrective actions continue to be protective of human health and the environment.

2024 Environmental Management (EM) Nevada Program Accomplishments

Safely demolished ancillary structures at Engine Maintenance, Assembly, and Disassembly (EMAD) and Test Cell C

Collected extensive model evaluation data for Pahute Mesa groundwater Corrective Action Units (CAUs)

Published FFACO Nevada National Security Site (NNSS) Use Restriction Management Plan

Achieved regulatory closure of 11 Industrial Sites associated with historic nuclear testing and remediation

Performed FFACO post-closure inspections at 113 sites and published the annual inspection report

Completed 32 post-closure inspections of 12 FFACO sites that are hazardous waste disposal sites listed in the NNSS Resource Conservation and Recovery Act (RCRA) permit

Completed monitoring for closed Underground Test Area (UGTA) CAUs and published the annual letter report

The U.S. Department of Energy (DOE) EM Nevada Program is responsible for evaluating and implementing corrective actions and performing required PCM of FFACO[1] sites located on the NNSS and the adjacent Nevada Test and Training Range (NTTR). These corrective action sites (CASs) are grouped into larger CAUs according to location, physical and geological characteristics, and/or contaminants. Environmental corrective action strategies are developed and completed based on the nature and extent of contamination, the risks posed by contamination, and projected future land use. Since 1989, the EM Nevada Program has obtained regulatory approval to close 99% of the more than 2,100 surface and near-surface CASs and 91% of the 878 deep subsurface CASs, with required PCM implemented for approximately one-third of all closed CASs.

CASs are broadly organized into four categories based on the source of contamination: UGTA, Industrial Sites, Soils, and Nevada Offsites. UGTA deep subsurface sites are directly related to groundwater impacted by past underground nuclear testing. Industrial Sites are facilities and land that may have become contaminated due to activities conducted in support of nuclear research, development, and testing. These include an extensive complex of research/development/testing facilities, disposal wells, inactive tanks, contaminated waste sites, inactive ponds, muckpiles, spill sites, drains and sumps, and ordnance sites. Industrial Sites include CASs on the NNSS owned by DOE and the Defense Threat Reduction Agency. Soils CASs include areas where nuclear tests have resulted in surface and/or

Key Terminology

- ***Corrective actions*** include removing contamination or leaving it in place with use restrictions and monitoring requirements that are based on contaminant amounts compared to action levels.
- ***Action levels*** are standards established, in coordination with the regulator, for each site based on expected land use and risk-based evaluation criteria.

[1] The FFACO fact sheet is available via https://nnss.gov/wp-content/uploads/2023/04/DOENV_964.pdf, and the Agreement can be viewed via https://nnss.gov/wp-content/uploads/FFACO_Document.pdf.

shallow subsurface contamination from radioactive materials and potentially contaminated by oils, solvents, heavy metals, and contaminated instruments and test structures used during testing activities. Nevada Offsites are associated with historical testing activities at the Project Shoal Area and the Central Nevada Test Area, located in northern and central Nevada, respectively. Long-term monitoring for those sites is the responsibility of the DOE Office of Legacy Management (LM) along with closed FFACO Soils and Industrial Sites on the NTTR/Tonopah Test Range (TTR) where environmental corrective actions were completed by the EM Nevada Program.

The ***closure process*** for FFACO CASs involves completion of needed remediation, implementation of required PCM, and regulatory review and approval of closure reports. ***Post-Closure activities*** (e.g., PCM and evaluations) are performed to ensure approved corrective actions are protective of human health and the environment.

In May 1996, DOE, the U.S. Department of Defense, and the State of Nevada entered into the FFACO to address the environmental remediation of CASs. LM became a signatory to the FFACO in June 2006 after assuming responsibility for the Nevada Offsites. Appendix VI of the FFACO (1996, as amended), describes the strategy to plan, implement, and complete environmental corrective actions (i.e., to "close" the CASs). The State of Nevada Division of Environmental Protection (NDEP) provides regulatory oversight and approval throughout the FFACO closure process, and the public is kept informed of progress through the Nevada Site Specific Advisory Board (NSSAB)[2], news articles, intergovernmental stakeholder meetings, and other educational/outreach initiatives. The NSSAB is a federally chartered group of volunteer members representing Nevada stakeholders who review and provide the EM Nevada Program informed recommendations and comments that are strongly considered throughout the corrective action process.

This chapter provides an update on EM Nevada Program corrective action progress and summarizes corrective action and post-closure activities at UGTA, Industrial Sites, and Soils CASs in Calendar Year (CY) 2024 and summarizes the NSSAB's CY 2024 activities and recommendations. Post-closure activities at Nevada Offsites and FFACO Soils and Industrial Sites on the NTTR/TTR performed in 2024 are presented in LM's Annual Site Environmental Report.

11.1 Corrective Actions Progress

Figure 11-1 depicts the progress made since 1996 to complete environmental corrective actions at sites managed under the FFACO (1996, as amended). A total of 2,954 of the 3,044 CASs managed under the FFACO were closed as of December 31, 2024; this includes CASs that are currently under EM Nevada Program or LM stewardship. During CY 2024, 11 CASs in CAU 578 achieved regulatory closure with use restrictions and PCM implemented at six of the sites. Of the remaining 90 CASs yet to be closed under the FFACO (all of which are the responsibility of EM Nevada Program), 82 (91%) are UGTA CASs in CAUs 101/102 (Pahute Mesa) and the remainder are Industrial Sites CASs at CAUs 114 (EMAD) and 572 (Test Cell C).

The EM Nevada Program satisfied numerous regulatory commitments in 2024, including the following reports [3] that reflect significant mission progress:

- Addendum to UGTA Closure Report for CAU 98: Frenchman Flat (EM Nevada Program 2024b)
- Closure Report for CAU 578: Miscellaneous Inactive Sites (EM Nevada Program 2024c)
- CY 2023 Non-RCRA CAU Post-Closure Inspection Report (EM Nevada Program 2024f)
- CY 2023 UGTA Annual Sampling Letter Report (CAUs 101/102) (EM Nevada Program 2024d)
- CY 2023 PCM Letter Report for Closed UGTA CAUs (EM Nevada Program 2024c)
- CY 2023 Environmental Monitoring and Post-Closure Report for Permitted Sites on the NNSS (MSTS 2024)
- FFACO, November 2024 Appendices Update (FFACO 1996, as amended)

[2] Information on NSSAB activities can be accessed at https://nnss.gov/NSSAB/.
[3] Most are available through the DOE Office of Scientific and Technical Information at https://www.osti.gov/.

- Final Corrective Action Decision Document/Corrective Action Plan (CADD/CAP) for CAUs 101 and 102: Central and Western Pahute Mesa (EM Nevada Program 2024a)
- Pahute Mesa Well Installation Presentation #4

The PCM/inspection reports present the results used to verify compliance and corrective action effectiveness for the sites closed under the FFACO process. The UGTA annual sampling letter report presents sampling results for Pahute Mesa CAUs 101 and 102, which are the remaining UGTA CAUs progressing toward regulatory closure that is planned for completion in 2030.

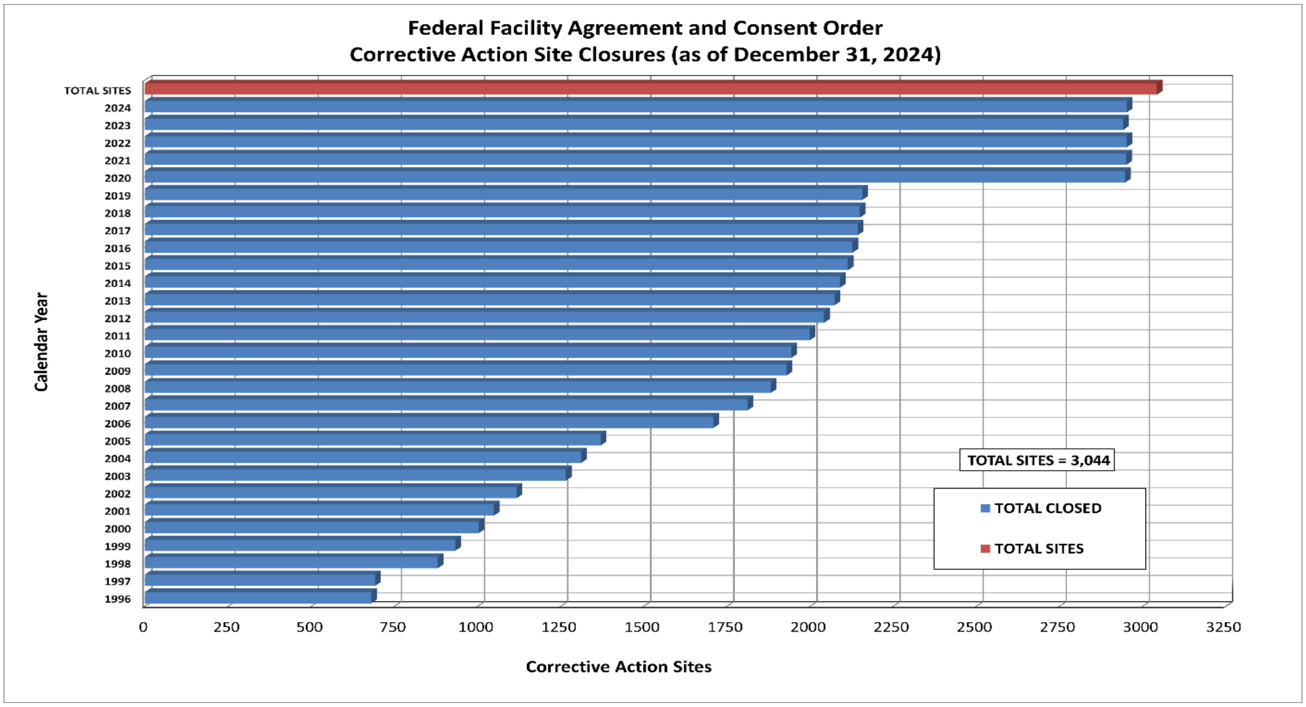

Figure 11-1. Annual cumulative totals of FFACO CAS closures

11.2 Corrective Action Sites – Active Investigations

The location and status (open or closed) of UGTA, Industrial Sites, and Soils CASs as of December 31, 2024, are shown in Figure 11-2. Figure 11-2 does not depict the closed FFACO CASs (Industrial Sites and Soils) on the NTTR/TTR that were transferred to LM in 2020. Investigations and, as appropriate, corrective actions were performed for 82 UGTA CASs in two CAUs and eight Industrial Sites CASs in two CAUs during 2024.

11.2.1 Underground Test Area Sites

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.

The corrective action is implemented in four stages: (1) *planning*; (2) *investigation* (characterization and modeling); (3) *model evaluation*; and (4) *closure*. NDEP approval of each stage is required before advancing to the next stage. Characterization and modeling studies are evaluated throughout the *investigation stage* by a committee of scientists (preemptive review committee) specializing in the fields of geology, hydrology, chemistry, and nuclear testing.

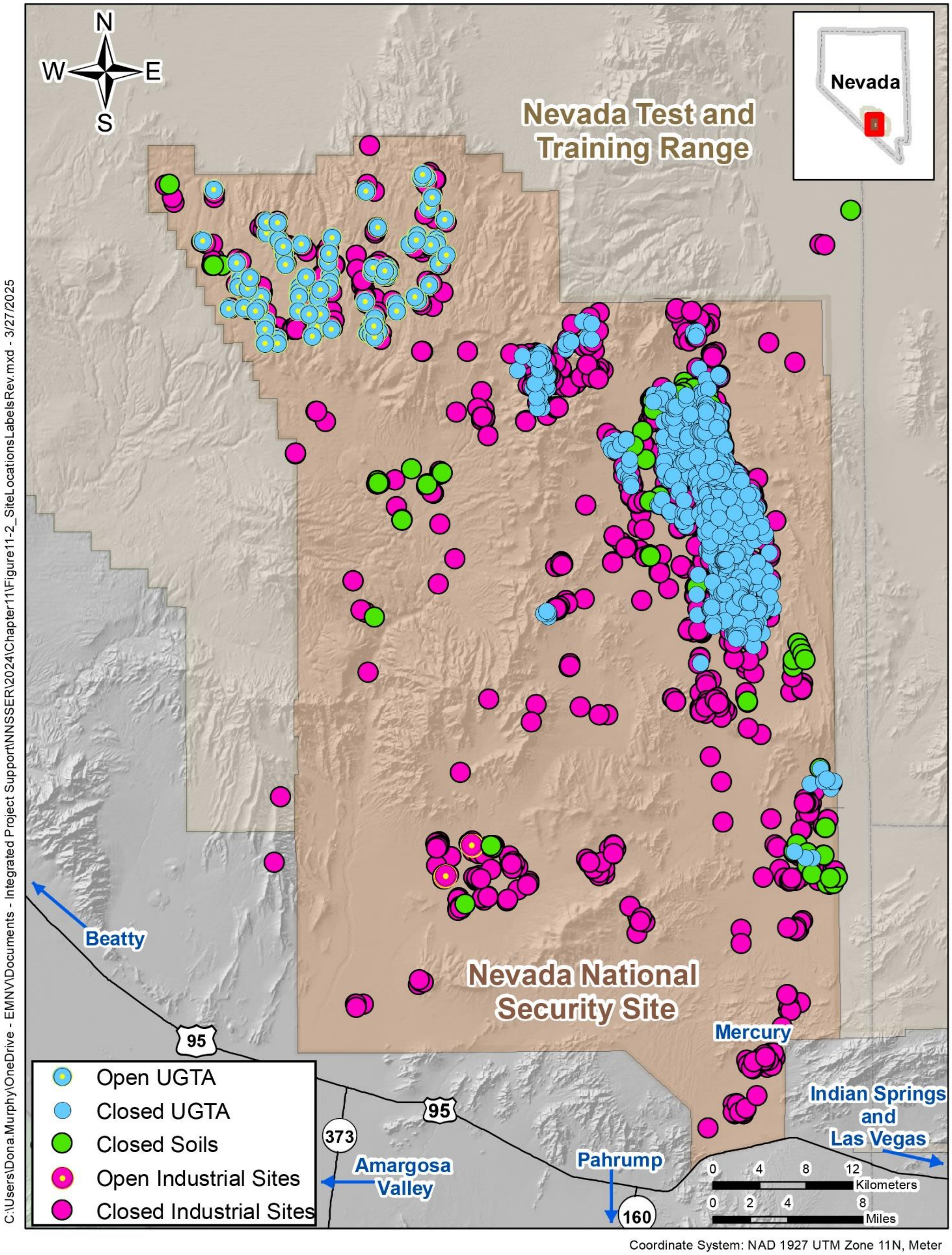

Figure 11-2. Map of FFACO UGTA, Industrial Sites, and Soils CASs managed by the EM Nevada Program as of December 31, 2024

CAU-specific preemptive review committees provide internal technical review of ongoing studies to ensure work is comprehensive, accurate, consistent with the state-of-the-art modeling and data analysis methods, and consistent with CAU goals (EM Nevada Program 2019). In addition, an external peer review is included in the *investigation stage*.

Environmental Corrective Action Objectives for UGTA Sites

- *Collect data (e.g., new wells, groundwater samples, groundwater levels, geologic, hydrologic testing, field and laboratory studies) to characterize the hydrogeological setting and nature and extent of contamination.*
- *Develop CAU-specific models of groundwater flow and contaminant transport.*
- *Identify **contaminant boundaries**[4] within which contaminants are forecasted to potentially (95th percentile) exceed the Safe Drinking Water Act limits at any time within a 1,000-year compliance period.*
- *Negotiate and implement regulatory boundary objectives and **regulatory boundaries** to protect the public and environment from the effects of radioactive contaminant migration.*
- *Negotiate and implement **use-restriction boundaries** to restrict access to contaminated groundwater.*
- *Develop and implement a long-term closure monitoring network to verify consistency with the contaminant boundaries, compliance to the regulatory boundary, and protection of human health and the environment.*

Key FFACO UGTA Terminology

Computer models are developed using extensive data collected for more than 70 years on subsurface geologic and groundwater conditions to determine:

- ***Contaminant boundary*** – perimeter and subsurface area where the probability exists (95%) for groundwater to exceed Safe Drinking Water Act radiological standards for up to 1,000 years after the underground nuclear testing era.
- ***Regulatory boundary*** – established far upgradient of populated areas to provide an extra layer of protection, this line (or boundary) is downgradient of the contaminant boundary area where a plan must be submitted to the state detailing how users down gradient will be protected if test-related radionuclides are observed above radiological standards in groundwater at or beyond this boundary.
- ***Use-Restriction boundary*** – areas encompassing the contaminant boundary where the probability of encountering contaminated groundwater over the next 1,000 years is higher and thus require controls that restrict access.

The locations of UGTA CAUs are shown in Figure 11-3.

Central and Western Pahute Mesa CAUs (101 and 102), comprising a total of 82 CASs, are the only two UGTA CAUs remaining to be closed. The CASs are nuclear test cavities produced from underground nuclear detonations. These roughly spherical cavities with original diameters greater than 200 meters (m) in some cases, are in complex geologic units at depths ranging from 226 to 1,450 m below ground surface (Carle et al. 2021). Most of these detonations were within 100 m of the ***water table***, or deeper, indicating potential interaction with the groundwater system (Figure 11-3) (DOE/NV 1997).

As required by the UGTA Strategy, three-dimensional groundwater flow and contaminant transport models were developed to represent the complex geologic structure underlying Pahute Mesa, as well as the complex contaminant transport processes associated with ***radionuclide*** movement through the fractured rock. Four models were constructed and calibrated, including a "base case" and three alternative models to address different geologic and recharge conditions (EM Nevada Program 2022b). Similar contaminant boundary forecasts resulted from each model. The 1,000-year contaminant boundary for the base-case model, shown in Figure 11-4, extends a few kilometers beyond the NNSS boundary but is more than 12 kilometers upgradient of the closest public receptor in Oasis Valley. These results indicate that radionuclides from underground nuclear testing on Pahute Mesa pose little to no risk to the health of groundwater users in Oasis Valley.

During 2024, model evaluation activities were conducted for the Pahute Mesa CAUs, to include implementing remote data acquisition, performing Controlled-Source Audio-frequency Magnetotelluric geophysical surveys, and planning for drilling three wells in 2025. These activities provide additional data that will be used to evaluate

[4] The definition of word(s) in ***bold italics*** may be found by referencing the Glossary, Appendix B.

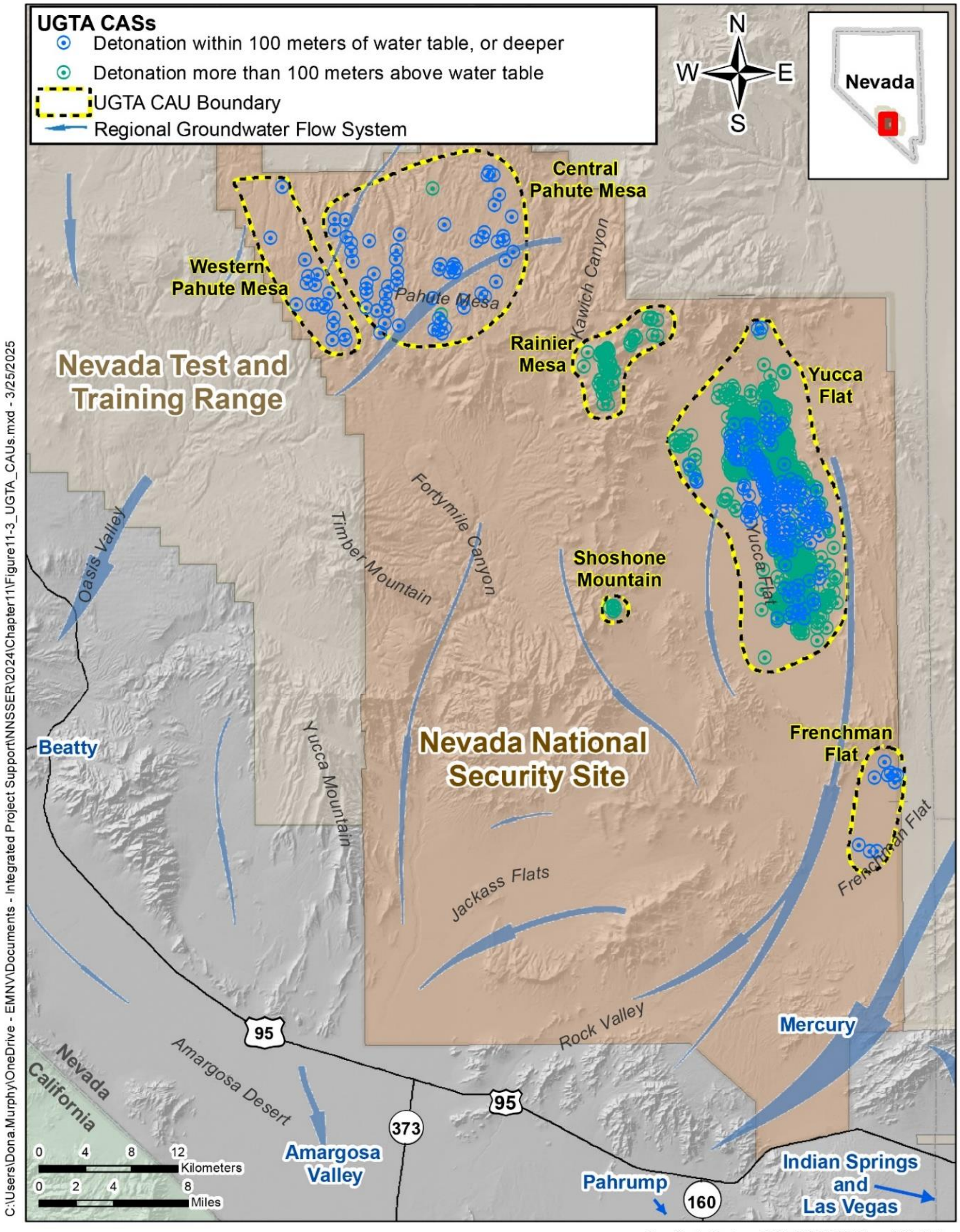

Figure 11-3. UGTA CASs in relation to Regional Groundwater Flow System[5]

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[5]Arrow direction indicates regional flow direction and arrow width indicates relative flow volume (Fenelon et al. 2010)

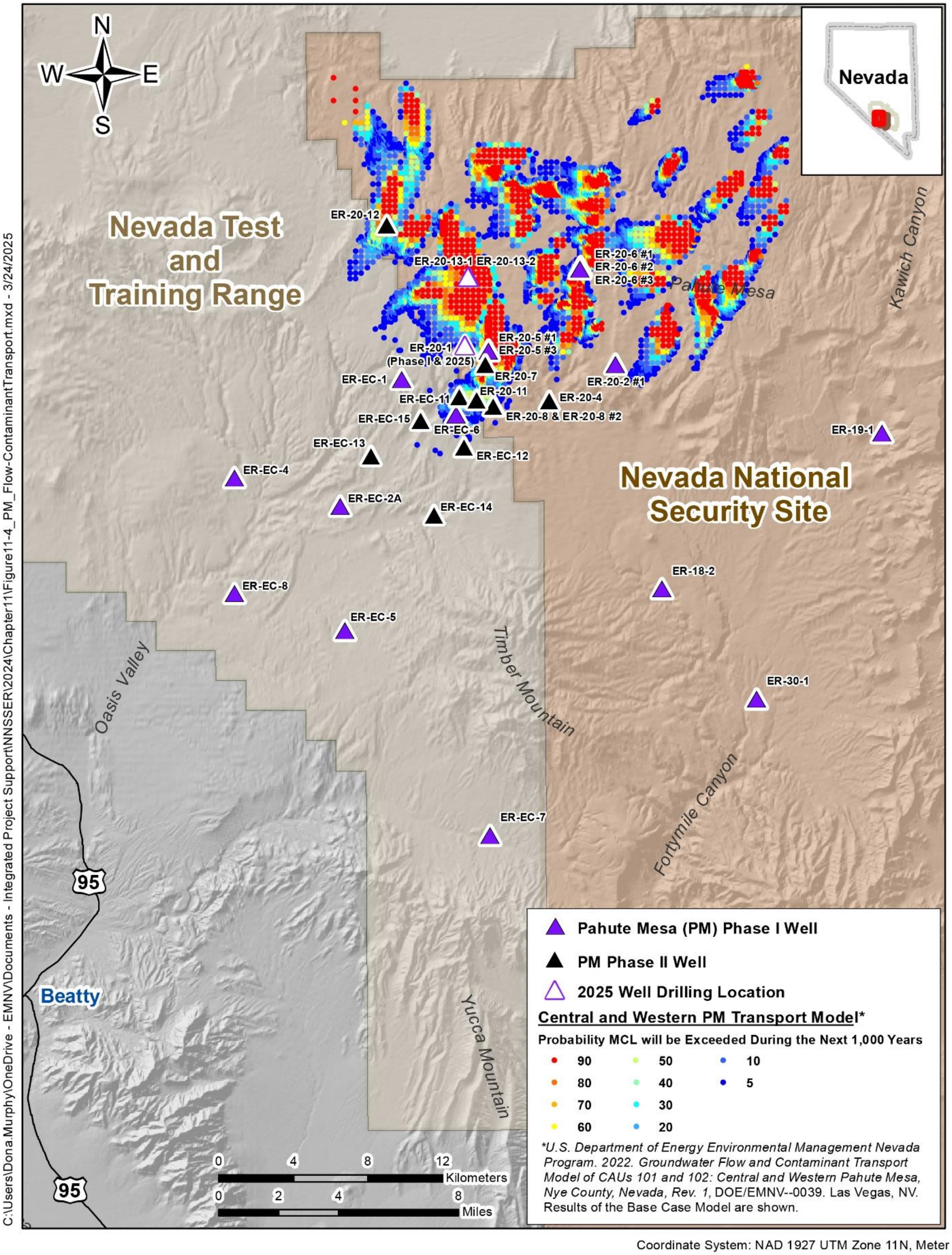

Figure 11-4. Contaminant boundary forecasted by the Pahute Mesa Base-Case Groundwater Flow and Contaminant Transport Model

and update computer models. Once the updated models are accepted by NDEP, the final ***closure stage*** will commence. Advancement to the model evaluation stage was approved by NDEP following an extensive peer review of the groundwater flow and contaminant transport model and model results (Navarro 2023a,b). Activities planned for model evaluation are identified in the CADD/CAP for CAUs 101 and 102: Central and Western Pahute Mesa (EM Nevada Program 2024a) and are focused on improving confidence in the model results for use in developing a monitoring network and establishing use restrictions that ensure downgradient groundwater users remain protected.

A *Risk Evaluation of Radionuclides in Groundwater* for the Pahute Mesa CAUs (Navarro 2024) presents the potential impacts to the health of hypothetical downgradient groundwater users from exposure to radiological contaminants in groundwater of the Pahute Mesa CAUs. The results of this evaluation provide additional confidence that public groundwater users downgradient of the NNSS in Oasis Valley will not be adversely impacted by the radionuclides within the 1,000-year time frame defined in the FFACO.

During 2024, groundwater samples were collected from 12 locations within 8 wells in the Pahute Mesa CAUs. Samples were collected from multiple depths at three wells. The sample analysis results are presented in Chapter 5. The sampling results, including samples with no radionuclides present, will continue to be used to ensure that the groundwater flow and contaminant transport model results are consistent with known levels of contamination within the Pahute Mesa CAUs. In addition, transducer (water level) and barometer pressure data are now remotely transmitted from seven wells within the Pahute Mesa CAUs.

11.2.2 Industrial Sites

Environmental corrective actions at eight Industrial Sites CASs occurred in 2024. The activities focused on advancing demolition of the EMAD (CAU 114) and Test Cell C (CAU 572) complexes (Figure 11-5). The EMAD water tower, an electrical substation, and two stacks were demolished. In addition, the four liquid hydrogen dewars at Test Cell C were prepared for demolition and the water tower was demolished. Both facilities were part of a larger complex of facilities constructed to support the historical Nuclear Rocket Development Station that was jointly administered by the Atomic Energy Commission (predecessor to DOE) and the National Aeronautics and Space Administration's Space Nuclear Propulsion Office between 1958 and 1971[6].

Test Cell C Ancillary Buildings and Structures (CAU 572) once consisted of a 6,800-square-foot (ft^2) single-story masonry building with multiple rooms (e.g., cryogenic bench lab, pump and electric shops, control room); a large steel-framed building containing three large electric motors; a 750-ft^2 single-story concrete-framed pump house; a 1,700-ft^2 light steel-framed building used for cryogenic experiments and storage; and 10 large ancillary structures (i.e., dewars for storing liquid hydrogen, cooling towers, storage tanks, and piping). The EMAD facility (CAU 114) encompasses a 100,000-ft^2, 80-foot (ft) tall, four-story building with 6-ft thick concrete walls and the largest "hot cell" in the world; a steel-framed building that was used for railcar maintenance and treatability tests on plutonium-contaminated soil; a 32 ft-long, 107-ton manned control car; and a 60-foot long, 70-ton engine installation vehicle.

FFACO closure of both facilities is being performed through the Streamlined Approach for Environmental Restoration (SAFER) process (EM Nevada Program 2021c,d). The goal of the SAFER process is to reduce risks to site workers, the public, and environment by removing hazardous constituents where feasible; demolish structures; and properly dispose waste.

[6] https://nnss.gov/wp-content/uploads/2023/04/DOENV_707.pdf.

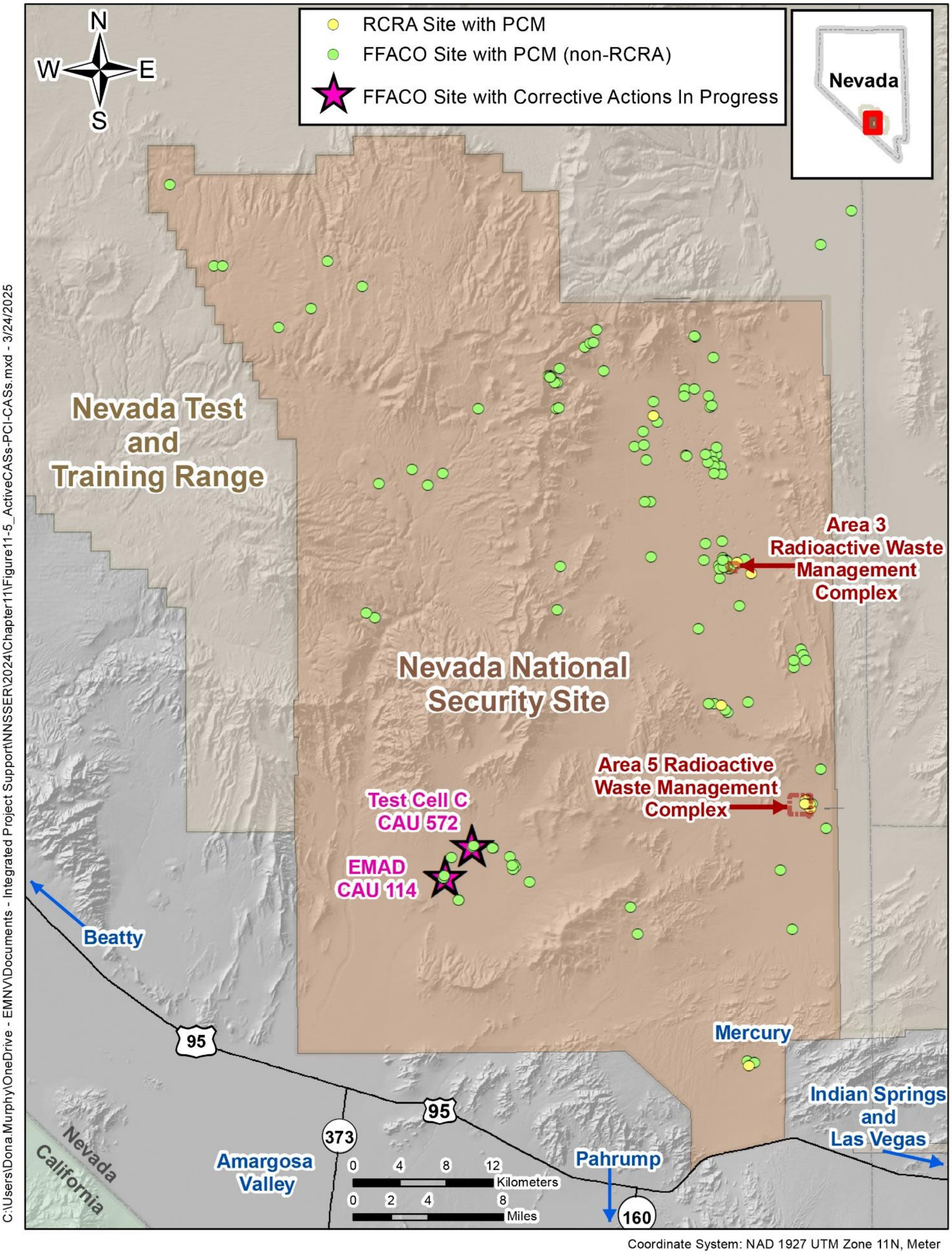

Figure 11-5. FFACO Industrial Sites and Soils CASs undergoing corrective actions and PCM during 2024

11.3 Corrective Action Sites – Post-Closure Activities

11.3.1 Underground Test Area Sites

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 and agreed upon by DOE and NDEP. The boundaries for each CAU are presented in Figure 11-6. 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 CAU's regulatory boundary objectives. ***CAU regulatory boundary objectives*** are statements of specific objectives for each CAU to protect the public and environment from exposure to groundwater contaminated by underground testing of nuclear weapons on the NNSS.

Closure reports for these CAUs were developed at the beginning of the *closure stage* to document these boundaries and describe the monitoring well network and land-use restrictions. Three types of monitoring are performed during closure: water quality, water level, and institutional control. The monitoring objective is to determine whether use restriction boundaries remain protective of human health and the environment. Additionally, water-quality and water-level monitoring are used to evaluate consistency with the groundwater flow and contaminant transport conceptual and numerical model. Such consistency is important because the models are the primary basis for use-restriction boundaries.

In 2024, a letter report was submitted to NDEP that summarized PCM activities completed for the closed UGTA CAUs (97, 98, and 99) in 2023 (EM Nevada Program 2024c). Institutional control monitoring confirmed that use restrictions are recorded in land management systems maintained by the DOE National Nuclear Security Administration Nevada Field Office (NNSA/NFO) and the U.S. Air Force (for the Frenchman Flat CAU) and that no activities were identified that could potentially affect the contaminant boundaries of the closed UGTA CAUs. A survey of groundwater resources in basins surrounding the CAUs similarly identified no current or pending development that would indicate the need to increase monitoring activities or otherwise cause concern for the closure decision. Use restrictions continue to prevent ***exposure*** to the public and workers from contaminants of concern by preventing access to potentially contaminated groundwater.

11.3.1.1 Frenchman Flat Corrective Action Unit 98

The closure report for the Frenchman Flat CAU (comprising 10 CASs) was approved by NDEP in 2016 (NNSA/NFO 2016) and describes the monitoring program for the first 5 years post-closure (2016 through 2020). An evaluation of the 5-year monitoring data was published in 2022 (EM Nevada Program 2022a). This evaluation showed the 5-year radionuclide concentrations in groundwater samples and water-level monitoring data to be consistent with the current understanding of the groundwater flow as well as the forecasted contaminant boundaries for this CAU (Figure 11-6). Monitoring requirements based on these evaluation results were documented in an addendum to the closure report, which was approved by NDEP in 2024 (EM Nevada Program 2024b). The monitoring network includes 17 locations, of which 6 are sampled for radionuclides and measured for water levels, and 11 for measured water levels only. Sampling for ***tritium*** is required every 6 years at all locations and for additional radionuclides at two locations. Water-level measurements are required annually.

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 potential groundwater migration pathway. The negotiated regulatory boundary is established at the interface of the alluvial/volcanic aquifer and the Rock Valley fault (Figure 11-6). All monitoring results indicate that the regulatory boundary objective has been met (EM Nevada Program 2022a).

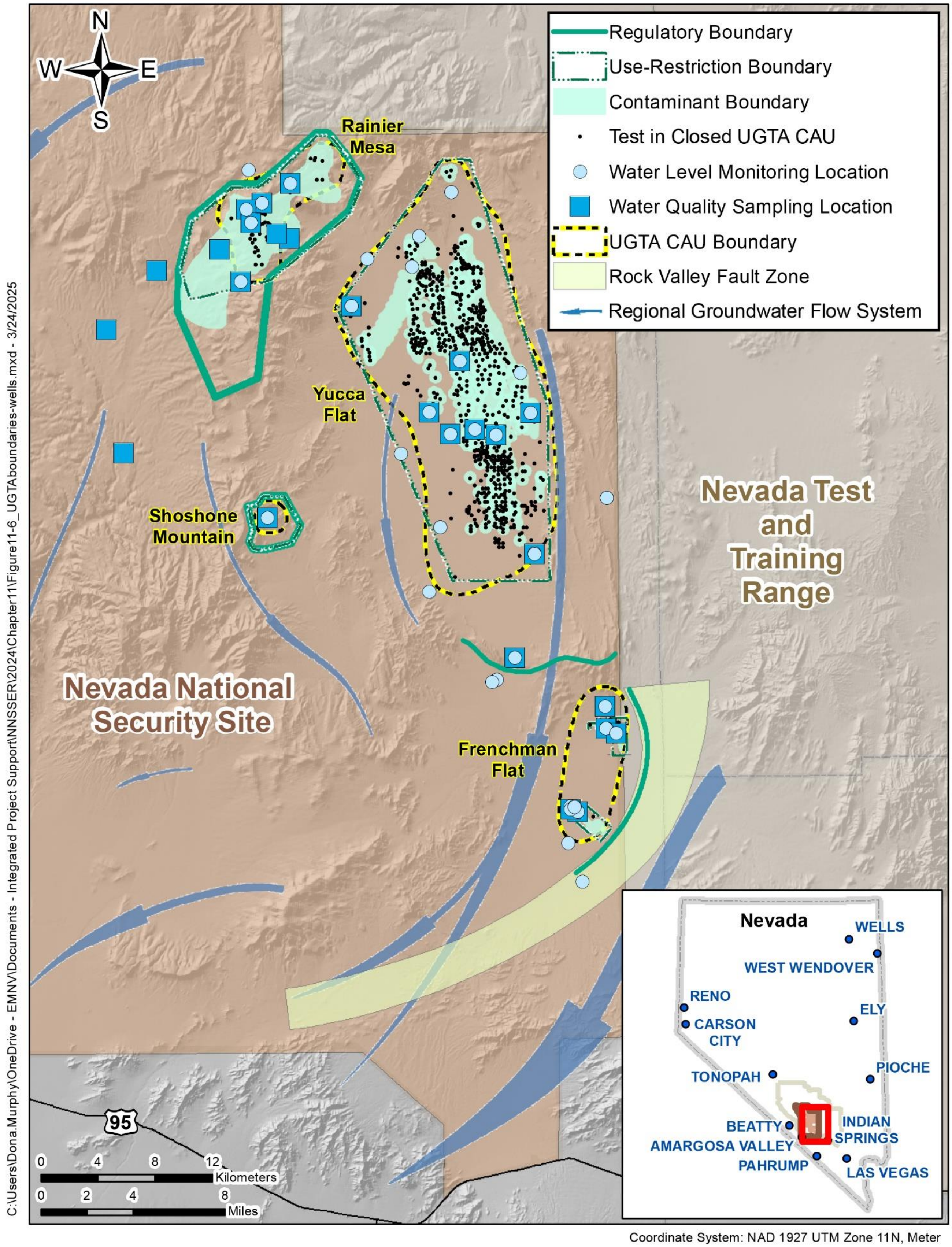

Figure 11-6. Boundaries and monitoring wells for closed UGTA CAUs

11.3.1.2 Rainier Mesa/Shoshone Mountain Corrective Action Unit 99

The closure report for the Rainier Mesa/Shoshone Mountain CAU (comprising 66 CASs) was approved by NDEP in 2020 (EM Nevada Program 2020b). The regulatory boundary objective for Rainier Mesa is to protect receptors of groundwater from radionuclide contamination within the three downgradient groundwater basins that receive recharge from Rainier Mesa (Pahute Mesa-Oasis Valley, Ash Meadows, and Alkali Flat-Furnace Creek). The regulatory boundary objective for Shoshone Mountain is to verify that radionuclide contamination does not reach the lower carbonate aquifer (LCA) (i.e., the regional aquifer) below Shoshone Mountain.

The monitoring network includes 16 locations, of which seven are sampled for radionuclides and measured for water levels, seven for sampling only, and two for water levels only. Sampling for tritium is required every 6 years at all locations and for additional radionuclides at three locations that access the tunnels where testing took place. Water-level measurements are required annually. Sampling results, presented in Chapter 5, are consistent with the current understanding of the groundwater flow as well as the forecasted contaminant boundaries for this CAU (Figure 11-6). All monitoring results indicate that the regulatory boundary objective has been met (EM Nevada Program 2021a).

11.3.1.3 Yucca Flat/Climax Mine Corrective Action Unit 97

The closure report for the Yucca Flat/Climax Mine CAU (comprising 720 CASs) was approved by NDEP in 2020 (EM Nevada Program 2020a). 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 LCA beneath Frenchman Flat or downgradient receptors. The regulatory boundary aligns with the southern extent of the Yucca Flat hydrographic basin (Basin 159; Nevada Division of Water Resources 2024) and supports the regulatory boundary objective.

The PCM network for this CAU includes 26 locations, nine of which are sampled for radionuclides (i.e., tritium) and water levels, one for sampling only, and 16 for water levels only. Eight wells in Yucca Flat and one well in Frenchman Flat are sampled every 6 years, and one well in Yucca Flat will be sampled annually for 6 years (2020 through 2025). These wells access the LCA, which is a regional aquifer and the only pathway out of Yucca Flat (Navarro 2019). Water-level measurements are made annually. Sampling results, presented in Chapter 5, are consistent with the current understanding of the groundwater flow as well as the forecasted contaminant boundaries for this CAU (Figure 11-6). All monitoring results indicate that the regulatory boundary objective has been met (EM Nevada Program 2021b).

11.3.2 Industrial Sites and Soils

As of December 31, 2024, environmental corrective actions are complete at 2,115 Industrial Sites and Soils CASs on the NNSS, NTTR, and TTR. Characterization and closure of these CASs were completed by the EM Nevada Program in accordance with the FFACO (1996, as amended). Long-term stewardship responsibility for 70 of these completed CASs located on the NTTR and TTR were transferred to LM in 2020. 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

Key FFACO Closure Terminology

- ***Clean closure*** is the removal of pollutants, hazardous wastes, and solid wastes above action levels in accordance with regulator-approved corrective action plans.
- ***Closure in place*** is the stabilization or isolation of pollutants, hazardous wastes, and solid wastes, with or without partial treatment, removal activities, and/or PCM, in accordance with corrective action plans.
- ***No further action*** denotes that no contamination exists above action levels as confirmed through investigation.

without partial treatment, removal activities, and/or PCM – in accordance with corrective action plans approved under the FFACO. Radioactive materials removed from sites were either disposed as ***low-level waste (LLW)*** or ***mixed low-level waste*** at the Area 5 Radioactive Waste Management Complex (RWMC) (Section 10.1). Solid waste (e.g., demolition debris) containing asbestos is disposed at the Area 9 U10c Solid Waste Landfill. Hazardous materials removed from CASs are either recycled or declared waste and shipped to approved offsite treatment and disposal facilities. PCM requirements are established as needed to provide for the long-term protection of the public and the environment.

During 2024, 133 CASs within 70 FFACO Soils and Industrial Sites CAUs on the NNSS had post-closure inspection requirements and 12 CASs (in seven CAUs) had post-closure inspections required by the RCRA Part B Permit (NDEP 2023). Inspection frequencies (such as annually, every 5 years, or following a rain event) for non-RCRA CAUs are identified in the Use Restriction for each CAS and requirements for RCRA CAUs are detailed in the RCRA Part B Permit. In 2024, the EM Nevada Program conducted post-closure inspections at 113 non-RCRA CASs managed under the FFACO. In addition, a total of 44 inspections were performed at CASs within the seven CAUs identified in the RCRA Part B Permit. In 2024, annual inspection reports for FFACO (EM Nevada Program 2024f) and RCRA Permit (MSTS 2024) post-closure sites on the NNSS were prepared and submitted to NDEP.

11.3.3 Environmental Management Nevada Program Public Outreach

In 2024, the EM Nevada Program conducted numerous public outreach activities in partnership with its Environmental Program Services contractor, Navarro Research and Engineering, Inc. This includes a variety of community outreach events designed to educate and inform the public of ongoing environmental restoration work at the NNSS. Events included hosting an educational groundwater booth for a Star Wars-themed “May the Science Be With You” at the Atomic Museum, a Science Saturday presentation to local students interested in groundwater, and a similar educational demonstration in Pahrump, Nevada, for Earth Day.

A major highlight for 2024 was the awarding of Navarro Education Grants. The grant program, in its fourth year, was created to support educational activities related to science, technology, engineering, and math (STEM) learning in communities near the NNSS. Navarro received dozens of applications in 2024 and, of the seven grants selected, five were fully funded for the requested amounts. In total, Navarro awarded nearly $24,000 in CY 2024 for the advancement of STEM learning throughout Nevada. This brings the total investment since the inception of this grant to more than $61,000.

The EM Nevada Program also successfully hosted four Low-Level Waste Stakeholders Forum meetings, five Intergovernmental Liaison meetings, and five NSSAB public meetings. The NSSAB provided informed recommendations in 2024 on topics including the annual review and prioritization of EM Nevada Program activities; input on specific topics to be included in the final Site Transition Plan and how it should be communicated; ways to enhance public outreach and media communications; and enhancements and improvements to LLW facility evaluations, real-time radiography operations at the Area 5 RWMC, and LLW visual verifications. Also in 2024, NSSAB leadership collaborated with the chairs and vice-chairs from the other seven site-specific advisory boards (SSABs) during the EM SSAB National Chairs Spring Meeting hosted by the Portsmouth, Ohio, site and the Fall Meeting hosted by the Oak Ridge, TN, site. These meetings provide an opportunity for the eight local boards to share lessons learned and develop recommendations on cross-cutting issues affecting the EM Program. NSSAB meeting agendas, handouts, minutes, and recommendations are posted on the NNSS website[7].

Throughout 2024, the EM Nevada Program also facilitated multiple tours of the NNSS. EM Nevada Program scientists made numerous presentations, both virtually and in person, as part of the ongoing effort to share the details of the EM Nevada Program mission to stakeholders throughout the region.

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Chapter 12: Historic Preservation and Cultural Resources Management

Laura O'Neill, Jeffrey Wedding, Tatianna Menocal, and Richard Arnold
Desert Research Institute

Cultural Resources Management Program Goals

Ensure compliance with all regulations pertaining to cultural resources. Identify, evaluate, and manage cultural resources. Evaluate the potential effects of proposed projects on cultural resources and, when necessary, mitigate adverse effects. Curate archaeological collections in accordance with Title 36 Code of Federal Regulations (CFR) Part 79, "Curation of Federally Owned or Administered Archeological Collections." Consult with American Indians regarding places and items of importance to 16 Tribal nations and organizations culturally affiliated with Nevada National Security Site (NNSS) lands.

The NNSS contains a wide range of cultural resources, including prehistoric and historic archaeological sites, buildings, districts, and structures that are part of the historic built environment, and places of religious and cultural importance to American Indians. Attachment A, Section A.5, summarizes the known human occupation and uses of the NNSS from the earliest known prehistoric societies in North America, circa 13,000 years ago, through the millennia to the Cold War era and nuclear testing period from 1951 to 1992.

U.S. Department of Energy (DOE) Policy DOE P 141.1, "Management of Cultural Resources," requires that the DOE National Nuclear Security Administration Nevada Field Office (NNSA/NFO) integrate cultural resources management into their missions and activities. To that end, NNSA/NFO maintains the Cultural Resources Management Program (CRMP) at the NNSS. Desert Research Institute (DRI) implements the mandates of this program to aid in conserving and preserving cultural resources that may be affected by proposed NNSA/NFO activities. NNSA/NFO must also comply with applicable federal and state regulations to protect and manage cultural resources eligible for listing in the National Register of Historic Places (NRHP). These NRHP-eligible resources are technically known as *historic properties*.

To meet federal and state requirements and achieve CRMP goals, the NNSA/NFO program includes the following major components: (1) NNSS project reviews for cultural resource compliance; (2) archival research, archaeological inventories, built-environment surveys, and evaluations of NRHP eligibility; (3) the curation of archaeological collections and program records; and (4) the American Indian Consultation Program (AICP). Guidance for CRMP work is provided in the NNSS Cultural Resources Management Plan (NNSA/NFO 2025). DRI historic preservation personnel, architectural historians, and archaeologists who meet the professional qualification standards set by the Secretary of the Interior (SOI) carry out these activities.

The methods used to identify cultural resources vary according to the type of resource under consideration. Archaeological sites are typically identified through an intensive pedestrian surface inventory, which is sometimes supplemented by small-scale subsurface testing to assess the presence of intact subsurface cultural deposits at potentially significant archaeological sites. Historic architectural buildings, structures, and objects are identified during architectural surveys using maps and aerial imagery, historical archives, and information from individuals who may have direct knowledge of the functions and historical events associated with particular buildings or structures. Direct communication and consultation are also utilized to identify and characterize resources important to American Indians, such as sacred sites or traditional-use areas.

12.1 Compliance with Section 106 of the NHPA

Cultural resource inventories and surveys are conducted to meet the requirements of the National Historic Preservation Act (NHPA). The two sections of the NHPA that pertain to cultural resource inventories and surveys are Section 106 and 110. Section 106 requires that federal agencies take into account the effects of their undertakings on historic properties. To comply with Section 106, surveys and inventories are completed before initiation of proposed undertakings that have the potential to affect historic properties. If historic properties are identified in the Area of Potential Effect (APE) for an undertaking, then the federal agency must analyze the effects of the undertaking on the historic properties. If the effects are adverse, then the agency must take steps to resolve them through mitigation.

12.1.1 Preliminary Cultural Resources Project Reviews

As part of Section 106 compliance and prior to initiating proposed projects, NNSA/NFO completes preliminary project reviews to identify potential cultural resource concerns. The reviews include researching cultural resource records to identify previous cultural resource studies and previously identified historic properties near or within the project area. Under some circumstances, the review also includes a pre-activity inventory of a project area. The research and inventory help determine whether further evaluation is required and the potential of a proposed project to affect historic properties. In some cases, the preliminary project review results in preparing full technical studies and consulting with the Nevada State Historic Preservation Officer (SHPO). Examples include the projects in Tables 12-1 and 12-2. In other cases, the preliminary project review finds that full technical studies and SHPO consultation are not necessary. In 2024, NNSA/NFO's subject matter experts who meet the professional qualification standards set by the SOI reviewed 62 proposed projects. Of these projects, five required pre-activity pedestrian inventories.

NNSA/NFO has two programmatic agreements (PAs) with the SHPO and Advisory Council on Historic Preservation (ACHP) to streamline its Section 106 efforts on the NNSS: one for the modernization of the town of Mercury (Mercury PA) and one for the rest of the NNSS (NNSS PA). The Mercury PA was executed in December 2018 and has a 20-year term. The NNSS PA was executed in April 2024 and has a 10-year term.

12.1.2 Projects under the NNSS Programmatic Agreement

The execution of the NNSS PA in 2024 marked a significant milestone in NNSA/NFO's CRMP history. It represents the conclusion of several years of negotiations with the SHPO and ACHP and provides streamlined Section 106 compliance procedures for routine undertakings and common NNSS property types. In 2024, NNSA/NFO completed six cultural resource inventories and architectural surveys in four areas of the NNSS under the NNSS PA (Table 12-1). The projects encompassed a total of 73.28 acres. Eighteen cultural resources were identified. Of these, ten were identified as eligible for the NRHP and included Cold War-era buildings, structures, and historic districts. Eight of the identified cultural resources were isolated archaeological artifacts, which are not NRHP-eligible.

In accordance with the NHPA and NNSS PA, NNSA/NFO consults with the SHPO regarding the adequacy of identification efforts, eligibility determinations, and findings of effect. NNSA/NFO completed consultation for four of the six projects in 2024 and initiated consultation on two. Summaries for projects for which consultation was completed or initiated in 2024 follow Table 12-1.

NNSA/NFO also initiated work on an additional five Section 106 projects in 2024, totaling 208 acres of cultural resources inventory, and will initiate consultation on them in 2025. These projects will be summarized in the 2025 NNSS Environmental Report (NNSSER).

Table 12-1. Section 106 compliance projects under the NNSS PA in 2024

Project	NNSS Area(s)	Size (acres)	Cultural Resources	NRHP Eligible	Reference
Mitigation for the Demolition of Building 01-103	1	0.25	1	1	Stueve 2024
Mitigation for the Demolition of Building 01-202681	1	0.25	1	1	Stueve 2024a
Identification, Evaluation, and Finding of Effect for Rock Valley Direct Comparison Project, Supplemental	27	9.95	2	0	Stueve 2024b
Identification and Evaluation for the Demolition of Four Cap and Magazine Storage Buildings	12	0.55	4	0	Brannan, Stueve, and O'Neill 2024
Identification, Evaluation, and Finding of Effect for Additional Proposed Demolition at U12g Tunnel, Supplemental†	12	1.78	5	3	Brannan, Menocal, and Wedding 2024
Finding of Adverse Effect for the Demolition of Five Resources in Area 25†	25	60.5	5	5	Stueve and O'Neill 2024
Total	---	73.28	18	10	

†Consultation with the SHPO began in 2024 and will be finalized in 2025.

Mitigation for the Demolition of Building 01-103. NNSA/NFO proposes to demolish Building 01-103, the Drill Bit Repair Building, a contributing element to the Area 1 Subdock Historic District and eligible for the NRHP. NNSA/NFO consulted with the SHPO on the proposed demolition in 2023, and the SHPO concurred with NNSA/NFO's finding of adverse effect. In 2024, NNSA/NFO completed the standard mitigation in the NNSS PA for contributing elements in historic districts to mitigate the adverse effects of the undertaking (Stueve 2024). NNSA/NFO submitted the mitigation to the SHPO and the SHPO concurred with its adequacy.

Mitigation for the Demolition of Building 01-202681. NNSA/NFO proposes to demolish Building 01-202681, a small, galvanized metal portable building in the Main Storage Yard, a contributing element to the Area 1 Subdock Historic District and eligible for the NRHP. NNSA/NFO consulted with the SHPO on the proposed demolition in 2023, and the SHPO concurred with NNSA/NFO's finding of adverse effect. In 2024, NNSA/NFO completed the standard mitigation in the NNSS PA for contributing elements in historic districts to mitigate the adverse effects of the undertaking (Stueve 2024a). NNSA/NFO submitted the mitigation to the SHPO and the SHPO concurred with its adequacy.

Identification, Evaluation, and Finding of Effect for Rock Valley Direct Comparison Project, Supplemental. NNSA/NFO expanded the APE for the Rock Valley Direct Comparison Project in 2024, resulting in an additional pedestrian inventory and supplemental survey report (Stueve 2024b). The inventory identified two cultural resources that were considered categorically not eligible for the NRHP per Appendix B of the NNSS PA.

Identification and Evaluation for the Demolition of Four Cap and Magazine Storage Buildings. NNSA/NFO proposes to demolish four cap and magazine storage buildings (Figure 12-1) and their accessory resources in Area 12. NNSA/NFO prepared an identification and evaluation report for the proposed undertaking and determined that none of the buildings are historic properties eligible for listing in the NRHP and made a finding of no historic properties affected (Brannan, Stueve, and O'Neill 2024). The SHPO concurred with NNSA/NFO's determinations and findings.

Identification, Evaluation, and Finding of Effect for Additional Proposed Demolition at U12g Tunnel, Supplemental. The U12g Tunnel Historic District is eligible for listing in the NRHP under the SOI's Significance Criteria A and C for its role as an underground testing environment for the development of nuclear weapons during the Cold War and its distinctive character as a horizontal tunnel complex. NNSA/NFO originally initiated consultation on demolition at the U12g Tunnel portal in 2023. In 2024, NNSA/NFO expanded the scope of work for proposed demolition. Two additional buildings (12-B100933 and 12-B100944) and three storage areas (Storage Areas 1, 2, and 3) were evaluated and included in an updated district recording and finding of adverse effect (Brannan, Menocal, and Wedding 2024). NNSA/NFO determined that only three of the five resources were

NRHP-eligible. NNSA/NFO intends to use the standard mitigation in the NNSS PA for historic districts to mitigate the adverse effects of the undertaking. As of the end of 2024, NNSA/NFO was awaiting a response from the SHPO on its updated documentation, findings, and intended mitigation.

Finding of Adverse Effect for the Demolition of Five Resources in Area 25. NNSA/NFO proposes to demolish five resources in the Nuclear Rocket Development Station (NRDS) Historic District (Buildings 25-3124, 25-3153 [Figure 12-2], 25-4314, and 25-4838, and the remaining foundation of Building 25-3113/3113A). The district is eligible for listing in the NRHP under SOI Significance Criteria A, B, C, and D, primarily for its role in the U.S. Space Program and advancing nuclear rocket propulsion for space travel. The resources proposed for demolition have all been previously evaluated as contributing elements to the district. NNSA/NFO determined that all five resources were NRHP-eligible. As a result, NNSA/NFO prepared a finding of adverse effect report and submitted it to the SHPO for concurrence (Stueve and O'Neill 2024). NNSA/NFO intends to use the standard mitigation in the NNSS PA for historic districts to mitigate the adverse effects of the undertaking. As of the end of 2024, NNSA/NFO was awaiting a response from the SHPO on its updated documentation, findings, and intended mitigation.

Figure 12-1. Magazine Powder House
(Source: DRI)

Figure 12-2. Building 25-3153, NRDS Fire Station (Source: DRI)

12.1.3 Projects under the Mercury Programmatic Agreement

The Mercury PA was executed in 2018 to mitigate the effects of the Mercury Modernization program on historic properties. As part of the stipulations in the Mercury PA, the town of Mercury was evaluated for the NRHP in 2018 and determined to be eligible as a historic district for its direct association with Cold War-era nuclear testing (Mercury Historic District, MHD). In 2024, two projects were reviewed against the provisions of the Mercury PA. Pursuant to the Mercury PA, NNSA/NFO completed a finding of adverse effect report and mitigation for the demolition of three primary resources and 24 accessory resources that are contributing elements to the MHD; and an NRHP evaluation report, finding of effect report, and mitigation for a proposed solar project in the MHD (Table 12-2). Project summaries follow Table 12-2.

Table 12-2. Resources evaluated for individual NRHP eligibility and mitigated pursuant to the Mercury PA in 2024

Project	NNSS Area(s)	Cultural Resources	NRHP Eligible	Reference
Evaluation, Finding of Effect, and Mitigation for Mercury Solar Photovoltaic Array and Battery Energy Storage System	23	1	1	Haynes 2024; 2024a; 2024b
Finding of Effect and Mitigation for Demolition of Three Primary Resources and Twenty-Four Accessory Resources	23	27	27	Wedding and Stueve 2024; 2024a
Total	---	28	28	

Mercury Solar Photovoltaic Array and Battery Energy Storage System. NNSA/NFO plans to install a solar photovoltaic array and battery storage system in Mercury. An inventory of the 45.5-acre project area was completed and two historic properties were identified: the MHD and the Mercury Airfield, which is a contributing element to the district and eligible for the NRHP. In particular, the APE for the undertaking includes two accessory resources to the airfield. An identification and evaluation report was prepared and NNSA/NFO submitted the report to the SHPO (Haynes 2024). The SHPO concurred with NNSA/NFO's determinations. NNSA/NFO then prepared a finding of adverse effect report and mitigation pursuant to the stipulations in the Mercury PA (Haynes 2024a and 2024b). The documents were submitted to the SHPO for review and comment and the SHPO concurred with their findings and adequacy.

Demolition of Three Primary Resources and Twenty-Four Accessory Resources within the Mercury Historic District. NNSA/NFO proposes the demolition of three primary resources and 24 accessory resources in Mercury. The resources are primarily concrete foundations that have previously been recorded as either primary resources or accessory resources within the MHD. They represent the former locations of environmental support program buildings, including a greenhouse, warehouses, offices, dormitories, and two of unknown purpose. Other resources include a newly documented buried storage tank and sidewalks. All 27 resources are NRHP-eligible. In accordance with the Mercury PA, NNSA/NFO then prepared a finding of adverse effect report and mitigation pursuant to the stipulations in the Mercury PA (Wedding and Stueve 2024 and 2024a). The documents were submitted to the SHPO for review and comment and the SHPO concurred with their findings and adequacy.

12.1.4 Other Section 106 Projects

NNSA/NFO completed one Section 106 project in 2024 prior to the April execution of the NNSS PA: mitigation for the Signals Exploration Testbed (SET) Project. NNSA/NFO determined in 2023 that the SET Project would have an adverse effect on the Pluto Test Bunker Historic District and executed a Memorandum of Agreement (MOA) with the SHPO to resolve the adverse effects that same year. In 2024, NNSA/NFO finished the mitigation stipulated in the MOA, which included a full recording of the historic district and its contributing elements (Brannan and Menocal 2023; Brannan et al. 2023). The mitigation was submitted to the SHPO for review and comment and the SHPO concurred with its adequacy in fulfillment of the MOA.

12.2 Compliance with Section 110 of the NHPA

To comply with Section 110 of the NHPA, NNSA/NFO completes surveys, inventories, research, and evaluations in support of its historic properties stewardship responsibilities. In 2024, NNSA/NFO completed two Section 110 projects including resources in four areas of the NNSS (Table 12-3). The efforts resulted in determinations of NRHP eligibility for seven resources, including five prehistoric sites, one multi-component prehistoric and historic site, and one Cold War-era structure.

NNSA/NFO consults with the SHPO regarding the adequacy of its Section 110 efforts. NNSA/NFO initiated consultation in 2024 on both of the projects in Table 12-3. NNSA/NFO also completed work on an additional two Section 110 projects and will initiate consultation on them in 2025. Summaries for projects for which consultation was initiated in 2024 follow Table 12-3. Projects for which consultation will be initiated in 2025 will be summarized in the 2025 NNSSER.

Table 12-3. Seciton 110 compliance projects in 2024

Project	NNSS Area(s)	Cultural Resources	NRHP Eligible	Reference
Fiscal Year (FY) 2024 Annual Historic Properties Monitoring	18, 29, 30	6	6	Stueve and Menocal 2024
Huron King Test Chamber NRHP Evaluation	3	1	1	Haynes et al. 2023, Revised 2024
Total	---	7	7	

FY 2024 Annual Historic Properties Monitoring. NNSA/NFO selected six properties to revisit and update in 2024 as part of its annual monitoring program. The six properties were selected based on interest from AICP tribes, the length of time that had passed since a property was last monitored, and findings from recent Section 106 surveys. NNSA/NFO determined that all six properties retained integrity and were eligible for listing in the NRHP (Stueve and Menocal 2024). NNSA/NFO updated the site form for each property and submitted its determinations to the SHPO. As of the end of 2024, NNSA/NFO was awaiting the SHPO's response. Figure 12-3 shows an example of one of the monitored prehistoric sites.

Huron King Test Chamber NRHP Evaluation. This aboveground test chamber was associated with the Huron King underground nuclear test conducted on June 24, 1980. The test chamber was specially designed to hold a defense communications satellite and was connected to a nuclear device placed 1,050 feet below the ground (Figure 12-4). Upon detonation, the satellite was exposed to an electromagnetic pulse and nuclear radiation and then evaluated for effects. In 2024, NNSA/NFO finalized an NRHP evaluation of the test chamber and determined that it is eligible for listing under SOI Significance Criteria A and C for its association with nuclear testing on the NNSS and its unique design elements. NNSA/NFO also determined that the test chamber met Criteria Consideration G by possessing exceptional significance despite being less than 50 years old (Haynes et al. 2023, Revised 2024). NNSA/NFO submitted its determinations to the SHPO and, as of the end of 2024, was awaiting the SHPO's response.

Figure 12-3. Rockshelter site 26NY204, part of the FY 2024 Annual Report for Cultural Resource Monitoring (Source: DRI)

Figure 12-4. The Huron King Test Chamber (Source: DRI)

12.3 Curation

The NHPA requires that federal agencies maintain archaeological collections and associated records according to professional standards. The specific requirements are provided in 36 CFR Part 79. The NNSS Archaeological Collection currently contains approximately 467,000 artifacts and is curated by DRI on NNSA/NFO's behalf in accordance with 36 CFR Part 79. The artifacts were collected between the late 1960s and early 2000s, after which the NNSA/NFO instituted a "No Collection" policy following consultation with the 16 tribes in NSA/NFO's AICP.

Curation requirements include:

- Maintaining an inventory catalog of the items in the NNSS collection.
- Packaging the NNSS collection in materials that meet archival standards (e.g., acid-free boxes).
- Maintaining the NNSS collection and records in a secure facility with environmental controls.
- Following established procedures for the NNSS collection and curation facility.
- Complying with the Native American Graves Protection and Repatriation Act (NAGPRA).

As part of routine curatorial maintenance, DRI staff conducts random spot-check inventories to assess the condition of the artifacts in the collections room. This year, DRI curatorial staff conducted a spot-check inventory of the Worman Collection. This collection consists of multiple boxes containing lithic, ceramic, and perishable artifacts recovered by Frederick Worman between 1965 and 1969 during surface collections and archaeological excavations on the NNSS. DRI staff identified artifacts that were misattributed to incorrect site trinomials and other artifacts that needed to be repackaged and have their records reviewed. DRI staff began reviewing the transfer records, artifact logs, and other documents to determine the artifacts' correct provenience and ensure records are accurate, as well as updating box and bag inventory forms for the entirety of the Worman Collection in 2024. Work on this collection will carry over into 2025.

To support education and public outreach priorities, DRI, in consultation with NNSA/NFO, provided three tours of the curation facility. The tours were for Nevada State Senators Carrie Buck and Melanie Scheible and Nevada State Assemblyperson Erica Mosca.

NNSA/NFO loans three of its collections to the Atomic Museum in Las Vegas: the Historic Artifact Collection, the Ethnographic Display Item Collection, and the McGuffin Collection. NNSA/NFO pursued renewal of the associated loan agreements in 2024 and anticipates the agreements will be fully executed in 2025.

In the curation facility, all security and environmental controls functioned satisfactorily throughout the year, and regular housekeeping practices were maintained. A custodian, supervised by curatorial staff, entered the facility regularly to sweep, dust, and repair lights. In the collections room, temperature and humidity levels remained within normal parameters with temperatures not rising above 68 degrees Fahrenheit and humidity levels never exceeding 38 percent.

Curatorial staff continued to expand a photograph archive related to CRMP projects in 2024. Currently, the archive contains over 89,000 photographic files produced from both digital and film photographs. The files are accompanied by the original photograph/image log when possible and are organized by the CRMP project numbering system utilized to track projects.

The implementing regulations for NAGPRA were revised in 2024 (43 CFR Part 10). NNSA/NFO began analyzing its artifact collection to ensure it remains in compliance with the act accordingly. Curatorial staff focused efforts in 2024 on artifacts collected from the NNSS after 2000 and collections formally accepted and accessioned into the NNSA/NFO collection from other DOE sites in Nevada. NNSA/NFO completed NAGPRA consultation for all artifacts collected from the NNSS prior to 2000 in 1999. Work to maintain compliance with NAGPRA per the revised regulations will continue in 2025.

12.4 Cultural Resources Annual Reporting

The following annual reports related to cultural resource activities were completed in 2024 as part of NNSA/NFO's CRMP (Table 12-4). The reports summarize annual activities accomplishments under the NNSS PA, Mercury PA, curation program, and cultural resources GIS database program.

Table 12-4. FY 2024 annual cultural resource reports

Project	Description of Contents	Reference
Mercury Annual Progress Report*	Annual report regarding the progress of the implementation of the MHD PA during FY 2024	Brannan 2024
NNSS Sitewide Annual Progress Report*	Annual report regarding the progress of the implementation of the NNSS Sitewide PA during FY 2024	Stueve et al. 2024
Curation Compliance Annual Report†	Annual report for curation tasks completed in support of the NNSS artifact collection and records in the NNSA/NFO records facility managed by DRI during FY 2024.	Menocal and Stueve 2024
Geographic Information System (GIS) Database Annual Report†	Annual report for the updates and revisions to the CRMP GIS Database during FY 2024.	Collins 2024

*Submitted by NNSA/NFO to the SHPO.
†Submitted by DRI to NNSA/NFO only.

12.5 American Indian Consultation Program

NNSA/NFO established the AICP in 1991 to formalize its consultations with 16 Southern Paiute/Chemehuevi, Western Shoshone, and Owens Valley Paiute-Shoshone tribal nations and organizations with cultural and historical ties to the NNSS. The history of this program, and a list of the 16 culturally affiliated tribes, can be found in "American Indians and the Nevada Test Site: A Model of Research and Consultation" (Stoffle et al. 2001). The program operates in accordance with DOE Order DOE O 144.1A, "Department of Energy (DOE) Requirements for Consultation and Engagement with Federally Recognized Indian Tribes and Alaska Native Claims Settlement Act Corporations Pursuant to DOE Policy 144.1," issued in 2024, and the Presidential Memorandum on Strengthening Nation to Nation Relationships dated January 26, 2021, which provides a foundation for engaging tribal leadership and their designated representatives in activities that occur on the NNSS.

The goals of the AICP are to:

- Provide a government-to-government forum for tribal members to interface directly with NNSA/NFO management on activities associated with NNSA/NFO undertakings.
- Afford tribal members with opportunities to actively participate in and help guide decisions that involve culturally significant places, resources, and locations on the NNSS.
- Involve tribal members in the management, curation, display, and protection of American Indian artifacts originating from the NNSS.
- Enable tribal representatives to engage in religious and traditional activities within the boundaries of the NNSS.
- Provide opportunities for AICP subgroups to participate in the review of program documents and participate in NNSS field visits and teleconferences between annual meetings.
- Include tribal members' views in the development of tribal text in the agency's National Environmental Policy Act documents.
- Develop approaches for expanding tribal involvement in NNSA/NFO activities on the NNSS.

One key element of the AICP is supporting the NNSA/NFO Annual Tribal Update Meeting (TUM), which brings together the 16 culturally affiliated tribes, NNSA/NFO managers, DOE Environmental Management Nevada (EM Nevada) managers, and both NNSA/NFO and EM Nevada contractors to discuss NNSS activities. NNSA/NFO held the 2024 Annual TUM on April 2–4, 2024, at DRI's campus in Las Vegas. The first day of the meeting included project updates by NNSA, NNSA/NFO, Nevada Division of Environmental Protection (NDEP), U.S. Department of Justice (DOJ), Sandia National Laboratories (SNL), Mission Support and Test Services, LLC (MSTS), DRI, and tribal representatives.

Topics presented by NNSA and NNSA/NFO focused on tribal affairs, the role of the AICP liaison, and the DOE Carbon Free Energy Initiative on the NNSS. EM Nevada and NDEP presented on Federal Facility Agreement and Consent Order requirements on the NNSS, followed by an additional EM Nevada presentation about Underground Test Area groundwater monitoring. MSTS presented on biological monitoring on the NNSS. The DOJ provided information on the Radiation Exposure Compensation Act Program. SNL then shared information on the cultural resources program at the Tonopah Test Range. Lastly, DRI presented information on the history of NNSS Area 23; NHPA Section 106 compliance activities, including the NNSS PA; and a review of the previous year's AICP activities. The first meeting day concluded with tribal representatives participating in panel discussions describing recent Tribal Planning Committee (TPC) field visits to Tippipah Cave and Buckboard Mesa petroglyphs, as well as Topopah Spring and the Bighorn Sheep Rockshelter.

On the second day, tribal representatives traveled to the NNSS for a tour of the Radioactive Waste Management Complex in Area 5, additional presentations on nuclear waste management at the NNSS, and a visit to the Cane Springs Wash archaeological site.

The meeting concluded on the third day with a Tribal Executive Session where tribal representatives deliberated on the information presented during the meeting to formulate tribal recommendations for presentation to

NNSA/NFO before adjourning the meeting. A summary report with presentation information, tribal recommendations, and NNSA/NFO responses to the recommendations was produced and distributed to tribal representatives who attended the meeting (Arnold and Menocal 2024).

In addition to the 2024 TUM, NNSA/NFO held quarterly meetings with the TPC, which consisted of six individuals representing Southern Paiute/Chemehuevi, Western Shoshone, and Owens Valley Paiute-Shoshone ethnic groups. The TPC interacts with NNSA/NFO throughout the year, receives project briefings, and discusses tribal topics of mutual interest for future tribal meetings. Quarterly meetings were held on February 22, April 30, August 13, and November 7, 2024. A summary report was prepared following each meeting (Arnold and Menocal 2024c–f).

In 2024, the TPC participated in two NNSS site visits. In the spring, the TPC visited Gold Meadows and the Kawich Cabin and prehistoric archaeological site in Area 12. In the fall, the TPC alongside three additional tribal representatives visited Bighorn Sheep Rockshelter, a small shelter with red pictographs, followed by Topopah Spring (Figure 12-5), in Area 29. After both field visits, the TPC met for a debriefing session to share and document tribal perspectives which were incorporated into a summary report (Arnold and Menocal 2024a, 2025).

A summary report of all AICP activities completed in 2024 was also prepared for NNSA/NFO's administrative file. Table 12-5 lists all summary reports prepared for AICP activities over the course of the year.

Table 12-5. AICP reports in 2024

Project	Reference
AICP FY 2024 Tribal Update Meeting Summary	Arnold and Menocal 2024
TPC FY 2024 Spring Site Visit (Gold Meadows and the Kawich Cabin and Prehistoric Site)	Arnold and Menocal 2024a
AICP Annual Report FY 2024*	Arnold and Menocal 2024b
TPC FY 2024 First Quarterly Meeting Report	Arnold and Menocal 2024c
TPC FY 2024 Second Quarterly Meeting Report	Arnold and Menocal 2024d
TPC FY 2024 Third Quarterly Meeting Report	Arnold and Menocal 2024e
TPC FY 2024 Fourth Quarterly Meeting Report	Arnold and Menocal 2024f
TPC FY 2024 Fall Site Visit (Bighorn Sheep Rockshelter and Topopah Spring)	Arnold and Menocal 2025

*Submitted by DRI to NNSA/NFO only. All other reports are distributed to tribal representatives.

Figure 12-5. Tribal Planning Committee and additional invited tribal representatives at Topopah Spring (Source: DRI)

12.6 References

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Chapter 13: Ecological Monitoring

Fernando K. Diaz, Derek B. Hall, and Jeanette A. Hannon
Mission Support and Test Services, LLC

Ecological Monitoring and Compliance Program Goals

Ensure compliance with all state and federal regulations and stakeholder commitments pertaining to Nevada National Security Site (NNSS) flora, fauna, wetlands, and sensitive vegetation and wildlife habitats. Ecosystem monitoring to identify impacts of climate and other environmental changes on the NNSS. Provide ecological information that can be used to evaluate the potential impacts of proposed projects and programs on NNSS ecosystems and important plant and animal species. Provide fuels assessments to examine fire risk, implement a revegetation program to revegetate disturbed lands, and monitor program success.

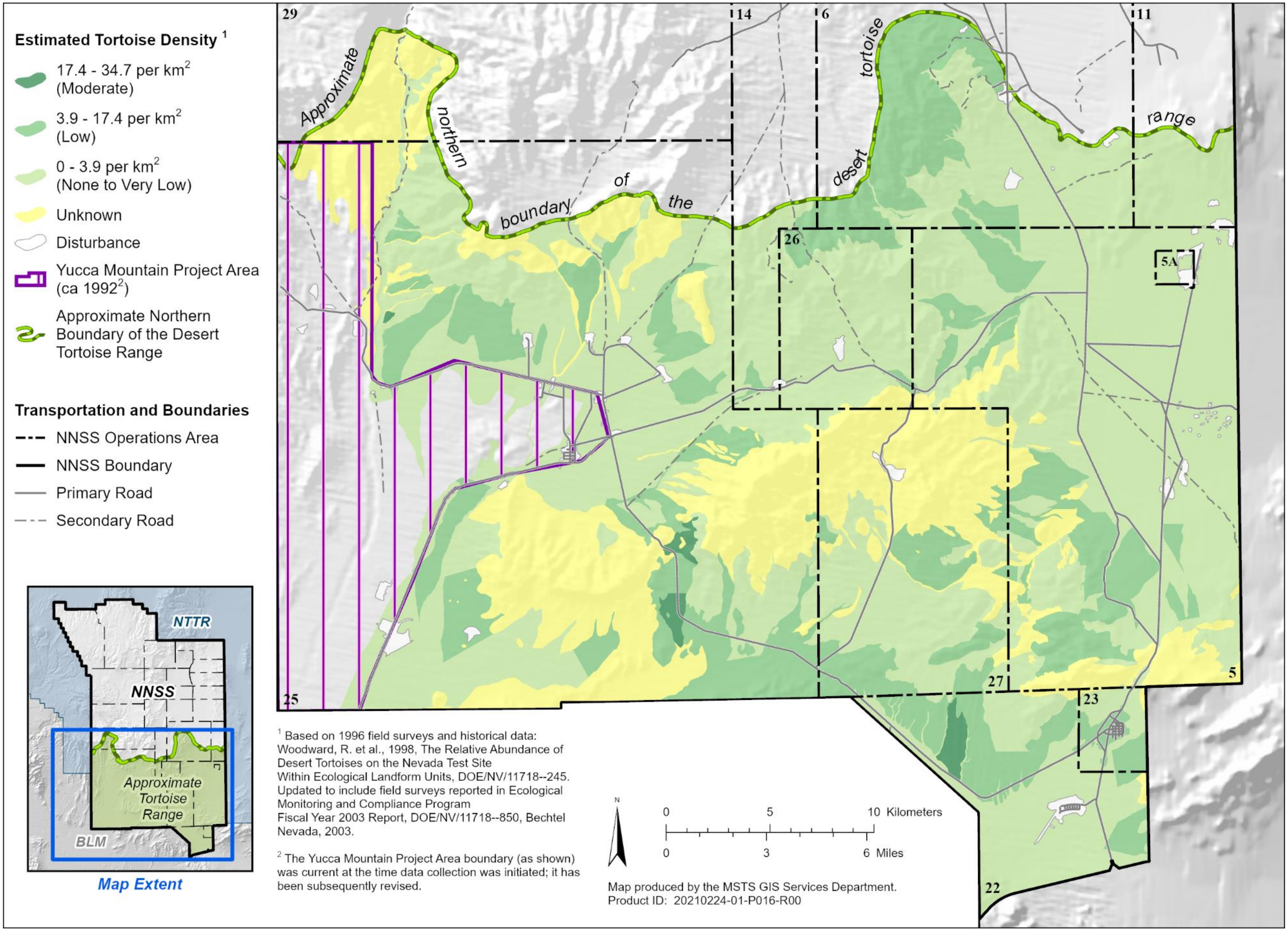
The Ecological Monitoring and Compliance (EMAC) Program provides ecological monitoring and biological compliance support for activities and programs conducted at the NNSS. Major program activities include (a) biological surveys at proposed activity sites, (b) desert tortoise permit compliance, (c) ecosystem monitoring, (d) sensitive and protected/regulated plant species monitoring, (e) sensitive and protected/regulated animal species monitoring, and (f) habitat restoration implementation and monitoring. Brief descriptions of these programs and associated 2024 accomplishments are provided in this chapter. Detailed information may be found in the most recent annual EMAC report (Hall et al. 2025). EMAC annual reports are available at https://nnss.gov/publication-library/environmental-publications/. The reader is also directed to *Attachment A: Site Description*, also available at https://nnss.gov/publication-library/environmental-publications/, where the ecology of the NNSS is described.

13.1 Desert Tortoise Compliance Program

The Mojave Desert tortoise (*Gopherus agassizii*), hereinafter *tortoise*, which inhabits the southern one-third (544 square miles) of the NNSS (Figure 13-1), is listed as threatened under the federal Endangered Species Act (ESA). Activities conducted in tortoise habitat on the NNSS must comply with the terms and conditions of a Programmatic Biological Opinion, hereinafter Opinion, issued to the U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office (NNSA/NFO) by the U.S. Fish and Wildlife Service (FWS). On February 27, 2019, NNSA/NFO provided FWS with a Biological Assessment of anticipated activities on the NNSS from 2019 through 2029 and entered into a formal consultation with FWS to obtain an updated Opinion. NNSA/NFO received the new Opinion on August 27, 2019 (FWS 2019). The Opinion is effectively a permit to conduct activities in tortoise habitat in a specific manner. It authorizes the ***incidental take***[1] of tortoises that may occur during the activities, which, without the Opinion, would be illegal and subject to civil or criminal penalties.

The Opinion states that proposed NNSS activities are not likely to jeopardize the continued existence of the Mojave population. It sets limits for the acres (ac) of tortoise habitat that can be disturbed; the number of accidentally injured and killed tortoises; and the number of captured, displaced, and relocated tortoises (Table 13-1). It also establishes mitigation requirements for habitat loss. The focus of the Desert Tortoise Compliance Program is to implement the Opinion's terms and conditions, document compliance actions, and assist NNSA/NFO in continued FWS consultations.

[1] The definition of word(s) in ***bold italics*** may be found by referencing the Glossary, Appendix B.



[1] Based on 1996 field surveys and historical data: Woodward, R. et al., 1998, The Relative Abundance of Desert Tortoises on the Nevada Test Site Within Ecological Landform Units, DOE/NV/11718--245. Updated to include field surveys reported in Ecological Monitoring and Compliance Program Fiscal Year 2003 Report, DOE/NV/11718--850, Bechtel Nevada, 2003.

[2] The Yucca Mountain Project Area boundary (as shown) was current at the time data collection was initiated; it has been subsequently revised.

Map produced by the MSTS GIS Services Department.
Product ID: 20210224-01-P016-R00

Figure 13-1. Tortoise distribution and abundance

13.1.1 Desert Tortoise Surveys and Compliance

Eighteen projects occurring within the range of the tortoise were reviewed by biologists in 2024 and 12 projects in progress were carried over from previous years. Of the projects reviewed, nine required biological surveys, and nine were determined to have no effects to the tortoise. These determinations were based on the amount of anticipated habitat disturbance, habitat quality, and location of projects (e.g., within developed versus undisturbed areas). Some projects had multiple locations, and therefore a total of 19 biological surveys were conducted to protect tortoises. No tortoises were observed or reported injured or killed due to project activities. A total of 55.2 ac of tortoise habitat was disturbed in 2024.

Limits for the acres of tortoise habitat that can be disturbed; the number of accidentally injured and killed tortoises; and the number of captured, displaced, and relocated tortoises became effective on August 27, 2019 (Table 13-1). The threshold limit for moving tortoises safely off of NNSS roads was set at 350 for the 10-year term of the Opinion and includes only large tortoises (>180 millimeters [mm] in length). Small tortoises (≤180 mm in length) that are encountered will be reported to FWS but are not counted toward the threshold due to their low detectability.

There were 40 reported tortoise roadside observations on the NNSS during 2024. There was no reported roadkill. Two small and 38 large tortoises were observed on roads. Of the 38 large tortoises, 3 did not need to be handled and 4 were moved off the road twice in one day. Thirty-one large tortoises were determined to be incidental take. The small tortoises did not count towards incidental take but were detected and reported to FWS.

In January 2025, NNSA/NFO submitted an annual report to the FWS Southern Nevada Field Office; the report summarizes tortoise compliance activities on the NNSS from January 1 through December 31, 2024.

Table 13-1. Cumulative totals through 2024 and permit limits for tortoise habitat disturbance and take of large tortoises (>180 mm)

Program	Actual Number of Acres Impacted (Limit Allowed)	No. of Tortoises Incidentally Taken (Maximum Allowed)	
		Non-injury or Non-mortality [(a)]	Detected Injury or Mortality [(b)]
Continued Use of Existing Roads	NA	222 (350) [(c)]	4 (15) [(d)]
Defense	0.7 (500)	0 (10)	0 (2)
Waste Management	52.6 (250)	0 (10)	0 (2)
Environmental Restoration	0.0 (250)	0 (10)	0 (2)
Nondefense Research and Development	36.5 (1,000)	0 (20)	0 (4)
Work-for-Others	0.0 (500)	0 (20)	0 (2)
Infrastructure	126.3 (500)	2 (20)	0 (4)[(e)]
Totals by Permit Term	**216.1 (3,000)**	**224 (440)**	**4 (31)**
Totals for 2024	**55.2**	**31**	**0**

(a) All tortoises observed in harm's way may be moved to a safe location as outlined in the Opinion.
(b) The numbers in parentheses in this column represent triggers that if exceeded require reinitiation of the Opinion.
(c) No more than 35 non-injury/non-mortality tortoises in a given year and no more than 350 during the term of the Opinion. Going over this limit would require concurrence from FWS.
(d) No more than 4 tortoises killed in a given year and no more than 15 killed during the term of the Opinion.
(e) No more than 2 tortoises killed in a given year and no more than 4 killed during the term of the Opinion.

13.1.2 Desert Tortoise Conservation Projects

Biologists continue to conduct research and increase tortoise conservation awareness through several activities and FWS conservation recommendations.

As a recommendation from FWS, biologists implemented a study in 2019 of tortoise exposure to radiological sources or fallout from nuclear testing by opportunistically testing tortoise carcasses for radionuclides. Tortoise carcasses that are found on the NNSS, mainly roadkill, are sent to a lab to test for radionuclides. A total of 18 tortoises collected from various mortalities from June 2019 through May 2023 were processed in 2023. Samples were submitted for spectrometry analysis to measure tritium, strontium-90, isotopic plutonium, americium-241, isotopic uranium, and gamma sources. Radionuclide results are published in Chapter 8 of the 2023 NNSS Environmental Report (https://nnss.gov/publication-library/environmental-publications/). Bone and shell from the tortoises, particularly the tortoise hit and killed by a vehicle in Area 12 in 2023, had the highest concentrations of strontium-90. This may not be unusual as strontium is an analog of calcium, so it accumulates in bone. Uranium detected in the tortoise samples could not be distinguished from natural uranium based on isotopic ratios. Radionuclide concentrations were below levels considered harmful to the health of animals.

The direct and indirect effects roads have on tortoises have been implicated in population declines. Work continued on studying impacts of roads through an opportunistic mark-recapture study that allows tracking of road crossing events for individual tortoises. The study was approved by FWS and allows Authorized Desert Tortoise Biologists to attach identification numbers to tortoises when they are found and moved safely off roads. The objectives of the study are to (1) determine if tortoises moved safely off roads are repeat offenders, (2) identify trends in repeat offenders crossing roads, and (3) assist with collection of tortoise density data. Four tortoises were marked with unique numbers this year.

As in previous years, biologists continued placing temporary warning signs on either side of the road where multiple tortoise observations occur. These are locations that particular tortoises are observed daily, foraging along the road edges or crossing the road. Signs are left out for several weeks or until observations stop. All nets radio announcements are made when weather conditions are anticipated to increase tortoise activity. Biologists also post articles on the company's webpage on tortoise emergence from hibernation and roadkill events.

NNSS biologists continued a study that involves monitoring the survival of 60 juvenile tortoises translocated to the NNSS in September 2012. Prior to their release, the tortoises were in the care of the San Diego Zoo Institute for Conservation Research at the Desert Tortoise Conservation Center located near Las Vegas, Nevada. NNSS biologists use radiotelemetry to track the location of study tortoises, record habitat characteristics and use, and collect other ecological data.

Of the 60 juvenile tortoises released in 2012, 10 tortoises remain alive and continue to be monitored. No tortoises were found dead during 2024. Monitoring of the remaining animals includes location tracking and annual health assessments. Due to above-average precipitation, a pattern of increased foraging and activity was evident, with tortoises growing an average of 6.0 mm in length (range = -3–10 mm) between spring and fall. This study will continue for the next several years and will provide valuable data for future juvenile desert tortoise translocations.

13.2 Biological Surveys at Proposed Project Sites

Biological surveys are performed at proposed project sites where project activities may have impacts to plants, animals, associated habitat, and other biological resources (e.g., the demolition of structures that may contain bird nests). The goal is to minimize the adverse effects to important biological resources (Section 13.3). Important biological resources include such things as cover sites, nest/burrow sites, roost sites, wetlands, or water sources that are vital to important species.

> **Important Habitat Categories**
>
> Pristine Habitat: having few human-made disturbances
>
> Unique Habitat: containing uncommon biological resources such as a natural wetland
>
> Sensitive Habitat: containing vegetation associations that recover very slowly from direct disturbance or are susceptible to erosion
>
> Diverse Habitat: having high plant species richness

In 2024, biologists surveyed a total of 279.5 ac for 21 proposed projects on the NNSS. Although projects target previously disturbed areas (e.g., road shoulders, utility corridors), a total of 66.7 ac of undisturbed lands were disturbed by projects in 2024. The total area of disturbed important habitats has been tracked since 1999; totals to date are 27.2 ac (Pristine), 64.0 ac (Unique), 1,065.7 ac (Sensitive), and 216.3 ac (Diverse).

Some of the sensitive and protected/regulated species and important biological resources found during the surveys included tortoise burrows, an inactive owl nest, an inactive red-tailed hawk nest, relocation of five horned lizards (*Phrynosoma platyrhinos*), chukar (*Alectoris chukar*), an invasive plant (Sahara mustard [*Brassica tournefortii*]), Monarch butterfly (*Danaus plexippus*) habitat (milkweed [*Asclepias erosa*]), and yucca plants (Joshua tree [*Yucca brevifolia*] and Mojave yucca [*Yucca schidigera*]). Biologists communicated to ground crews and provided written reports of survey findings and mitigation recommendations. Important biological resources within project sites were flagged, avoided, or removed.

13.3 Sensitive and Protected/Regulated Species and Ecosystem Monitoring

NNSA/NFO strives to protect and conserve sensitive and protected/regulated plant and animal species found on the NNSS, and to minimize cumulative impacts to those species as a result of NNSA/NFO activities. Important species known to occur on the NNSS include one mollusk, two insects, two reptiles, 242 birds, 31 mammals, 20 sensitive plants, and 23 plants protected from unauthorized collection (Table A-6 of *Attachment A: Site Description*). These species are classified as important due to their sensitive, protected, and/or regulatory status with state or federal agencies, and they are evaluated for inclusion in long-term monitoring activities on the NNSS. NNSA/NFO has produced numerous documents reporting the occurrence, distribution, and susceptibility to threats for predominately sensitive species on the NNSS (Wills and Ostler 2001).

Field monitoring activities in 2024 related to important NNSS plants and animals and to ecosystem monitoring are listed in Table 13-2. A description of the methods and a more detailed presentation of the results of these activities are reported in Hall et al. 2025.

Table 13-2. Activities conducted in 2024 for important species and ecosystem monitoring on the NNSS

<u>Sensitive Plants (Table A-6 of *Attachment A: Site Description*)</u>

The list of sensitive and protected/regulated plants on the NNSS is reviewed annually to ensure the appropriate species are included in the NNSS sensitive plant monitoring program. No updates to the NNSS sensitive plant monitoring program were needed. Currently there are 19 vascular plants and one non vascular plant considered sensitive that warrant inclusion in the NNSS sensitive plant monitoring program.

White-margined beard tongue (*Penstemon albomarginatus*), a sensitive plant that grows on adjacent lands to the NNSS, is currently under a 12-month review by FWS for protection under the ESA. Long-term monitoring was conducted for white bearpoppy (*Arctomecon merriamii*), opportunistic encounters were documented for sanicle biscuitroot (*Cymopterus ripleyi* var. *saniculoides*), and post-fire monitoring was conducted for Beatley's milkvetch (*Astragalus beatleyae*).

More detailed information can be found in Hall et al. 2025.

<u>Reptiles</u>

No trapping or roadkill surveys were conducted in 2024. Opportunistic observations were documented.

<u>Migratory Birds (protected under the Migratory Bird Treaty Act)</u>

A total of 22 dead birds were documented on the NNSS in 2024. One common raven (*Corvus corax*) was electrocuted. Five birds were hit by vehicles including one sharp-shinned hawk (*Accipiter striatus*), one immature red-tailed hawk (*Buteo jamaicensis*), one barn owl (*Tyto alba*), one common poorwill (*Phalaenoptilus nuttallii*), and one northern mockingbird (*Mimus polyglottos*). Four birds (two red-tailed hawks, one great-horned owl [*Bubo virginianus*], and one northern mockingbird) died of entrapment. One European starling (*Sturnus vulgaris*) may have collided with a building and died, but is included in the unknown category. Including the starling, 12 birds were found dead due to unknown causes; 2 red-tailed hawks, a sharp-shinned hawk, a mourning dove (*Zenaida macroura*), a lesser goldfinch (*Spinus psaltria*), a Say's phoebe (*Sayornia saya*), 2 common ravens, a Virginia rail (*Rallus limicola*),

Table 13-2. Activities conducted in 2024 for important species and ecosystem monitoring on the NNSS

1 northern mockingbird, and an ash-throated flycatcher (*Myiarchus cinerascens*). Some of these mortalities occurred during record-breaking heat and may have been caused by heat exposure.

Currently, there are two federal permits and one state permit pertaining to birds on the NNSS. Federal permit MB008695-2 allows for the taking of up to 10 mourning doves each year for radiological analysis and the salvage of dead migratory birds (except species listed under the ESA). All permit conditions were met and an annual report summarizing 2024 activities was submitted to FWS. No mourning doves were taken, and no bird specimens were salvaged for educational purposes. Federal permit MB60930C-1 is a "Special Purpose Utility Permit – Electric," and was issued November 6, 2018. This permit enables NNSS biologists to remove active nests at project sites in emergency situations and possess and transport carcasses of golden eagles (*Aquila chrysaetos*) and other bird species. On May 1, a sparrow nest containing five eggs was removed from a conveyor belt and placed in an old nest in a Joshua tree. The nest was checked the next day and it had been predated with no intact eggs remaining. FWS was notified. On May 16, a house finch (*Haemorhous mexicanus*) nest containing five young was moved from an energized breaker panel to a new box. FWS was notified. Subsequent checks determined the nest was safe and the young fledged. All permit conditions were met and an annual report summarizing 2024 activities was submitted to FWS. This included entering all bird injuries and mortalities into the Injury and Mortality Reporting system, a FWS electronic database. Nevada Department of Wildlife (NDOW) Scientific Collection Permit 261454 allows for the salvage and possession of migratory birds and the sacrificing of mourning doves, chukar, and Gambel's quail. All permit conditions pertaining to birds were met and an annual report summarizing 2024 activities was submitted to NDOW.

Several mortality reduction measures were taken. Two great-tailed grackles (*Quiscalus mexicanus*), two house finches, a juvenile brown-headed cowbird (*Molothrus ater*), and a cactus wren (*Campylorhynchus brunneicapillus*) were extracted from glue traps and released, and a grounded pied-billed grebe (*Podilymbus podiceps*) was rescued and moved to water so it could take off. A total of 113 hectares (ha) of habitat was surveyed at 22 project sites for active bird nests before disturbance. Finally, several dead rabbits and snakes were removed from roads to reduce the potential for vehicle mortalities of scavenging birds.

In coordination with NDOW, three new bird survey routes were established on the NNSS following the United States Geological Survey Breeding Bird Survey protocol (Hudson et al. 2017); one in the Mojave Desert ecoregion (South Route), one in the transition ecoregion (Yucca Flat), and one in the Great Basin Desert ecoregion (North Route). Surveys were done in late May through June, and a total of 566 birds and 33 different species were detected across all routes. The North Route had the highest species richness (25 species), the South Route had the lowest species richness (11 species), and the Yucca Flat Route had the most bird detections (282) and intermediate species richness (17 species). Black-throated sparrow (*Amphispiza bilineata*) was the most common species detected (33% of all birds counted). Notably, a flock of 12 Pinyon Jays (*Gymnorhinus cyanocephalus*) was observed on the North Route.

Two long-term winter raptor survey routes were sampled in January and February; 28 raptor sightings (20 red-tailed hawk, 6 American kestrel [*Falco sparverius*], and 2 northern harrier [*Circus cyaneus*]) were recorded. Surprisingly, no golden eagles were documented. Data were shared with NDOW for their statewide monitoring effort.

Feral Horses (*Equus caballus*) (protected under the Wild and Free-Roaming Horses and Burros Act)

Horse monitoring during 2024 entailed focused surveys for the first time since 2014, in addition to opportunistic observations. A total of 36 horses (33 adults and 3 foals) were identified during focused surveys. Gold Meadows Spring and Camp 17 Pond were used to conduct focused surveys during the hot, dry summer when horses are known to stay close to these water sources. Horses were photographed and observed using binoculars to identify individuals. These were meticulously compared to old photos to identify known horses from prior surveys, and identify new ones never identified between 2014–2024. An opportunistic sighting of 34 horses (31 adults, 2 foals, and 1 juvenile) were observed near Camp 17 Pond on May 31, 2024. A total of 321 and 345 photos of horses were recorded using motion-activated cameras at Gold Meadows Spring and Camp 17 Pond, respectively.

Mule Deer (*Odocoileus hemionus*) (managed as a game mammal by NDOW)

Mule deer surveys were conducted on Pahute and Rainier mesas. The average number of deer counted was 11.7 deer/night, about 2.6 times higher than in 2023. The observed buck/doe ratio was 206 bucks/100 does, and the observed fawn/doe ratio was 31 fawns/100 does.

Desert Bighorn Sheep (*Ovis canadensis nelsoni*) (managed as a game mammal by NDOW)

Desert bighorn sheep were detected at five water sources using motion-activated cameras, including 700 images of at least 15 individuals (6 marked ewes [686314, 686316, 686319, NT30, NT31, NT32], 4 unmarked ewes, 3 lambs, 1 mature ram, 1 young ram) at Cottonwood Spring (#4); 326 images of at least 13 individuals (3 marked ewes [686314, 6866319, NT3?], 3 unmarked mature ewes, 1 yearling ewe, 2 lambs, 3 mature rams, 1 young ram) at Twin Spring (#16); 59 images of at least 13 individuals (3 marked ewes [686314, 686319, NT3?], 5 unmarked ewes, 3 lambs, 1 mature ram, 1 young ram) at Fortymile Canyon Tanks (#9); 2 images of unknown sex at South Pah Canyon Tanks (#11); and 1 image of a lamb at Delirium Canyon Tanks (#5). Combining these observations, at least 19 sheep (6 marked ewes, 5 unmarked ewes, 1 yearling ewe, 3 lambs, 3 mature rams, 1 young ram) were documented on the NNSS during 2024.

Table 13-2. Activities conducted in 2024 for important species and ecosystem monitoring on the NNSS

Sensitive Bats (see Table A-11 of *Attachment A: Site Description*)
Bat monitoring in 2024 included documenting roost sites or locations of bats found around buildings or in other areas and continued acoustic sampling at North American Bat Monitoring Program (NABat) priority grid cells. NNSS biologists responded to 15 reports of bats at NNSS facilities. NABat is a multi-national, multi-agency coordinated bat monitoring program across North America made up of an extensive community of partners who use standardized protocols to gather data that allows for assessing population status and trends, informing responses to stressors, and sustaining viable populations. Four priority grid cells are located on the NNSS, all of which were sampled during 2024. Acoustic bat detectors were set up at two locations within each grid cell and collected ultrasonic echolocation calls from bats for a minimum of four consecutive nights. Results from data collected from 2021 through 2023 documented a total of 13 bat species, all of which were known to occur except the little brown bat (*Myotis lucifugus*), which has not been detected before on the NNSS. Surprisingly, silver-haired bat (*Lasionycteris noctivagans*), western red bat (*Lasiurus frantzii*), and Brazilian free-tailed bat (*Tadarida brasiliensis*) were not detected, but are known to occur from previous sampling efforts. The canyon bat (*Parastrellus hesperus*) and California myotis (*Myotis californicus*) were the most prevalent being detected in all grid cells across all years. Data collected during 2024 are still being processed and analyzed.
Mountain Lions (*Puma concolor*) (managed as a game mammal by NDOW)
A collaborative effort with United States Geological Survey (USGS) scientist Dr. Kathy Longshore continued in 2024 to investigate mountain lion distribution and abundance on the NNSS using remote, motion-activated cameras. Cameras collected a total of 393 images of mountain lions at 11 of 17 camera sites. A minimum of four mountain lions (one adult male, one adult female, one subadult male, one subadult female) inhabited the NNSS in 2024 based on photographic data.
Natural and Man-made Water Sources
Ten natural water sources, one well pond, two wildlife water troughs, and one well sump that periodically retains tritium-contaminated groundwater discharged from monitoring wells (Chapter 5, Section 5.1.3) were monitored with motion activated cameras to document wildlife use. Tritium-contaminated well sumps are monitored to identify which species are being exposed and which may provide an exposure pathway to offsite hunters who may consume them. At least nine bird species, including golden eagle, mourning dove, two raptor species, and waterfowl were photographed at the monitored well sump.

13.3.1 Mule Deer and Pronghorn Antelope Distribution

Mule deer and pronghorn antelope are mobile game animals that inhabit the NNSS. Both are generally considered to be migratory with distinct winter and summer ranges. Mule deer typically prefer the forested, mountainous habitats in the northern and western portions of the NNSS, while pronghorn typically prefer the open valleys in the southern and eastern portions of the NNSS. Mule deer are much more abundant than pronghorn on the NNSS. Mule deer movements on the NNSS were studied more than 30 years ago (Giles and Cooper 1985) using radio-collars that lacked the accuracy of current GPS [Global Positioning System] technology. They identified summer and winter ranges and a couple of long-distance movements of mule deer into areas where hunting is allowed on public land. Mule deer in their study were not necessarily those known to be using radioactively contaminated locations. Pronghorn are relatively new residents to the NNSS (first observed in 1991) and their use of the NNSS has never been studied. Tsukamoto et al. (2003) report the distribution of pronghorn in Nevada as of 2002 with the nearest population to the NNSS being just north in Emigrant Valley. The NNSS represents an expansion of pronghorn range in Nevada.

A research study funded by NNSA/NFO and the Environmental Management (EM) Nevada Program was initiated on the NNSS in November 2019 to better understand the potential radiological dose to the offsite public via the hunter pathway. This was a collaborative effort involving USGS, NDOW, the Nevada Test and Training Range (NTTR), NNSS Management and Operating Contractor biologists, and several volunteers. Native Range Capture Services captured the animals. Study objectives include: 1) determine the distribution, abundance, and range of movements of mule deer and pronghorn, 2) estimate the potential for hunters to harvest animals that use the NNSS, 3) evaluate the animals' use of contaminated areas, 4) obtain information on the potential radiological dose to someone consuming animals from the NNSS, 5) determine the potential radiological dose to animals on the NNSS, 6) document survival and causes of mortality, 7) refine habitat use patterns for both mule deer and pronghorn using resource selection functions and correlate that with phenological changes in the vegetation, and 8) assess the overall health, disease status, and genetics of NNSS mule deer and pronghorn.

In November 2019, a total of 23 mule deer (16 does, 7 bucks) and 20 pronghorn (14 does, 6 bucks) were captured. All 23 mule deer were radio-collared and ear-tagged. Eighteen pronghorn (12 does, 6 bucks) were radio-collared and ear-tagged, one doe was ear-tagged only, and one yearling doe with pneumonia died at the staging area. Two pronghorn does died within a few days of capture and were scavenged by coyotes.

Radio-collars were programmed to drop off the tracked animals in November 2022, which they did successfully. At the end of the radio-tracking period, five pronghorn (three does, two bucks) were still alive, including the ear-tagged-only doe. Seven mule deer, all does, were still alive. A final report is being written that will address the study objectives described above.

For more detailed information on capture method, health assessments, and distribution, refer to the annual EMAC reports (Hall and Perry 2020, 2021, 2022, 2023, 2024).

13.4 Habitat Restoration Program

NNSS biologists conduct revegetation activities at disturbances on and off the NNSS in support of NNSA/NFO and EM Nevada activities and continue to evaluate those efforts. The objectives of revegetation include: 1) establish a perennial vegetation community on waste cover caps to prevent water from infiltrating into buried waste through evapotranspiration, 2) establish a perennial vegetation community in disturbed areas (e.g., burned areas) to outcompete invasive annual grasses, reduce the risk of wildland fires, restore ecosystem function, and create wildlife habitat, 3) support the intent of United States Executive Order 13112, "Invasive Species," to prevent the introduction and spread of non-native species and restore native species to disturbed sites, and 4) demonstrate that revegetation may qualify as mitigation for the loss of desert tortoise habitat under the current Opinion.

Activities conducted in 2024 included: 1) qualitative vegetation assessment at the U-3ax/bl closure cover (Corrective Action Unit [CAU] 110) (Area 3 Radioactive Waste Management Site) and West Cover and North South Cover at the "92-Acre Area" (CAU 111) (Area 5 Radioactive Waste Management Complex [RWMC]), 2) revegetating and monitoring seeding success at South Cover (CAU 111), 3) monitoring revegetation success at CAU 577 Cell 21 and North Cover (CAU111) and planting transplants at CAU 577 Cell 21, 4) monitoring revegetation success at CAU 577 Cells 19/20 (Area 5 RWMC), 5) assessing revegetation success at CAU 577 East and West Cover Caps (Area 5 RWMC), 6) assessing revegetation success and planting transplants on Cell 18 (Area 5 RWMC), 7) monitoring results from a research study to evaluate the effectiveness of different herbicide treatments to control cheatgrass after the Cherrywood Fire, 8) aerially applying herbicide over large, previously burned areas to create firebreaks in cheatgrass dominated areas and monitoring results, and 9) monitoring seeding success in revegetated area in the Area 16 Burn. Noteworthy highlights and results from select activities are discussed below. For more detailed information, refer to the annual EMAC report (Hall et al. 2025).

13.4.1 CAU 110, U-3ax/bl, Closure Cover

The installation of an evapotranspiration cover on CAU 110, U-3ax/bl closure site, located in Area 3 of the NNSS, was completed in the fall of 2000. Once the evapotranspiration cover was in place, action was taken to establish a cover of native vegetation. Revegetation activities were completed in December 2000. The plant community on the closure cover has been monitored annually since the spring of 2001, including quantitative measurements of plant density and cover from 2001 to 2013 and every 5 years since, to document the vigor of the plant community that has established on the cover and to identify any remedial actions that may be necessary to ensure that it persists. Precipitation in the vicinity of CAU 110, U3-ax/bl was about 1.6 times the long-term average for the period December 2023 to April 2024. This created ideal conditions for plant growth.

A qualitative assessment of the vegetation on CAU 110, U3-ax/bl closure cover was made on June 26, 2024. A meandering transect covering the entire cap was walked. The vigor of perennial plant species was assessed based on current year's growth, whether plants were flowering, and if any showed signs of stress, e.g., dead stems or leaves. Shadscale (*Atriplex confertifolia*) continues to be the most abundant shrub species on the closure cover (Figure 13-2). Numerous dead shadscale plants were noted but many were still alive and did not look stressed. Nevada jointfir, the second most common perennial species, appeared to be thriving with no signs of stress. No perennial plant seedlings were seen. No perennial grasses have been found on the closure cover for several years and none were found again this year. Some annual plants from this year were documented but not in high densities. Saltlover (*Halogeton glomeratus*), Russian thistle (*Salsola tragus*) and flatcrown buckwheat

(*Eriogonum deflexum*) plants were found in the unseeded portion on the periphery of the cover cap, highlighting the importance of seeding to establish a perennial vegetation community

Figure 13-2. Overview of plant community that has established on the CAU 110 cover cap over the last 24 years

13.4.2 Area 5 RWMC Revegetation

Overall, revegetation on the cover caps at Area 5 RWMC appears to be successful with plant density exceeding 60% of that found in the reference area. At most sites, perennial plant density exceeds that found in the reference area by more than double (Figure 13-3). Sites will continue to be monitored over the next several years to evaluate revegetation success.

Figure 13-3. Revegetated CAU 577 East Cover cap, seeded in February 2021 (Photo by D.B. Hall, April 17, 2024)

13.4.3 Cheatgrass Control Research Trial

The Cherrywood wildland fire burned more than 20,000 ac in the western portion of the NNSS in May 2021. This was the third wildland fire in this area since 2011. One of the major contributing factors to this increased fire frequency is the abundance of cheatgrass, an invasive annual grass. Cheatgrass is problematic for many reasons. It is able to germinate and grow at colder soil temperatures than many native species; as such, by the time the native species germinate and start growing, the cheatgrass has used up most of the available soil moisture, which results in native seedlings struggling to survive. Cheatgrass also has a high germination rate even with little precipitation, grows quickly, and is able to produce a lot of biomass in a short amount of time. Because it is an annual, it dries out early in the season when the soil moisture dries out, resulting in an abundant, highly flammable fine fuel that is easily ignited and carries fire readily. It thrives in areas of disturbance, especially previously burned areas. The cheatgrass biomass is problematic not just for the year in which it germinates but also because the residual biomass can persist for multiple years. The best way to control cheatgrass in the long term is to establish a perennial vegetative community that will outcompete cheatgrass. For short-term control, herbicides such as imazapic (e.g., Panoramic) (1-year control) or indaziflam (e.g., Rejuvra) (multi-year control) work best. The optimal strategy is to use a combination of herbicide treatments followed by seeding.

NNSS biologists implemented a multi-year research trial in the fall of 2021 to evaluate the effectiveness of different herbicide and seeding treatments to control cheatgrass and establish a perennial vegetative community within the Cherrywood Fire burned area (see the 2022 Nevada National Security Site Environmental Report for study details). Sampling results during May 2022 showed significantly lower cheatgrass densities and percent cover in the herbicide-treated plots and a positive perennial plant response to the reduced cheatgrass. Results from May 2024 sampling revealed that Rejuvra is the best multi-year treatment for controlling cheatgrass (Figure 13-4). Monitoring will continue over the next few years to assess the longevity of Rejuvra on cheatgrass control.

Figure 13-4. Plot treated with Rejuvra (top) compared to a non-treated control plot (bottom, cheatgrass circled) (Photo by D.B. Hall, May 20, 2024)

13.4.4 Operation Rejuvenation Aerial Herbicide Project

Thousands of acres on the NNSS have been converted to annual grasslands dominated by cheatgrass and red brome, primarily from wildland fires. These areas are at high risk of burning again due to the abundant, flammable fine fuel the annual grasses create, especially during years of normal or above-normal precipitation. Fire suppression activities are expensive and somewhat limited in these areas for many reasons, including inaccessibility (e.g., rugged terrain, remoteness), presence of unexploded ordnance, and radiological concerns. Prevention is the best way to minimize the spread and negative impacts of wildland fire. A useful technique is to strategically create wide firebreaks in these annual grasslands to prevent fire spread if a fire is ignited. Usually, firebreaks are made with heavy equipment (e.g., road grader, bulldozer), but this is cost-prohibitive and impractical in many rugged areas. Aerial application of herbicides to create firebreaks on a large scale was investigated as an alternate technique.

A collaborative effort (Operation Rejuvenation) between NNSS and Nellis Air Force Base biologists was planned and implemented to treat large areas with the pre-emergent herbicide, Rejuvra, to create firebreaks in annual grasslands on the NNSS and NTTR. Based on results from the Cheatgrass Control Research Trial, NNSS biologists believed that this was a technique worth evaluating. The Ohio Air Reserve Unit is a U.S. Air Force program that has unique capabilities utilizing a C-130 transport plane and high-capacity spray system to carry out missions world-wide (such as spraying to control mosquitoes after hurricanes, spraying for invasive plant species, and other military missions). To keep their crew trained and equipment functional, they need to conduct training missions. NNSS was able to utilize this asset and only had to pay for the herbicide and the crew's per diem, which resulted in a significant cost savings.

In November 2023, several 200-foot-wide firebreaks covering approximately 1,884 ac were strategically created in Mid Valley and the Timber Mountain/Buckboard Mesa area by applying Rejuvra herbicide using the C-130 asset. Research plots were established to determine the efficacy of the treatment. Control plots were covered with plastic sheeting during spraying operations to prevent herbicide from hitting the ground while treated plots were left uncovered. Spray dye was used to verify the spray pattern and coverage. Paired treated and control plots were established in Mid Valley, near Buggy crater, and on the North Timber Mountain spur road. These plots were sampled in May 2024 and will continue to be sampled over the next few years to evaluate the long-term effectiveness of this technique on controlling cheatgrass. Initial results from the monitoring were mixed. Cheatgrass density and cover were lower in the Rejuvra treated plots than the control plots at Buggy Crater (Figure 13-5). Cheatgrass density was lower in the Rejuvra plots than the control plots at Mid Valley but cover was about the same in both (fewer but larger plants). Cheatgrass density and cover were similar in the Rejuvra and control plots at North Timber Mountain. It was quite windy the day of application in this area with undulating topography, which caused the plane to be flown at a higher altitude than usual. These factors combined to create a dispersed spray pattern that may have reduced the efficacy of Rejuvra. Another explanation may be that due to good fall rains, cheatgrass may have already germinated and was growing before the Rejuvra was applied and since Rejuvra is strictly a pre-emergent, consequently it had no impact on the already germinated plants.

In November 2024, several additional 200-foot-wide firebreaks covering approximately 1,690 ac were created in Mid Valley, Area 16 Fire burn, Orange Blossom Road, and the Ribbon Cliff Wildland Fire burn (Figure 13-6) with the C-130 (Figure 13-7). As a result of the 2023 lessons learned, imazapic herbicide was included (all areas but recent Ribbon Cliff Wildland Fire burn) since it is both a short-term (one year) pre-emergent and post-emergent. The amount of water used was increased from seven to nine gallons per acre for better distribution, and fuelbreaks were placed in lower-relief topography. Like 2023, paired treated and control plots were established in Mid Valley, Orange Blossom Road, and Ribbon Cliff Fire burns to evaluate the efficacy of this technique on controlling cheatgrass. These plots will be monitored for plant density and cover by species over the next several years to evaluate the effort's efficacy to control cheatgrass and impacts to other species.

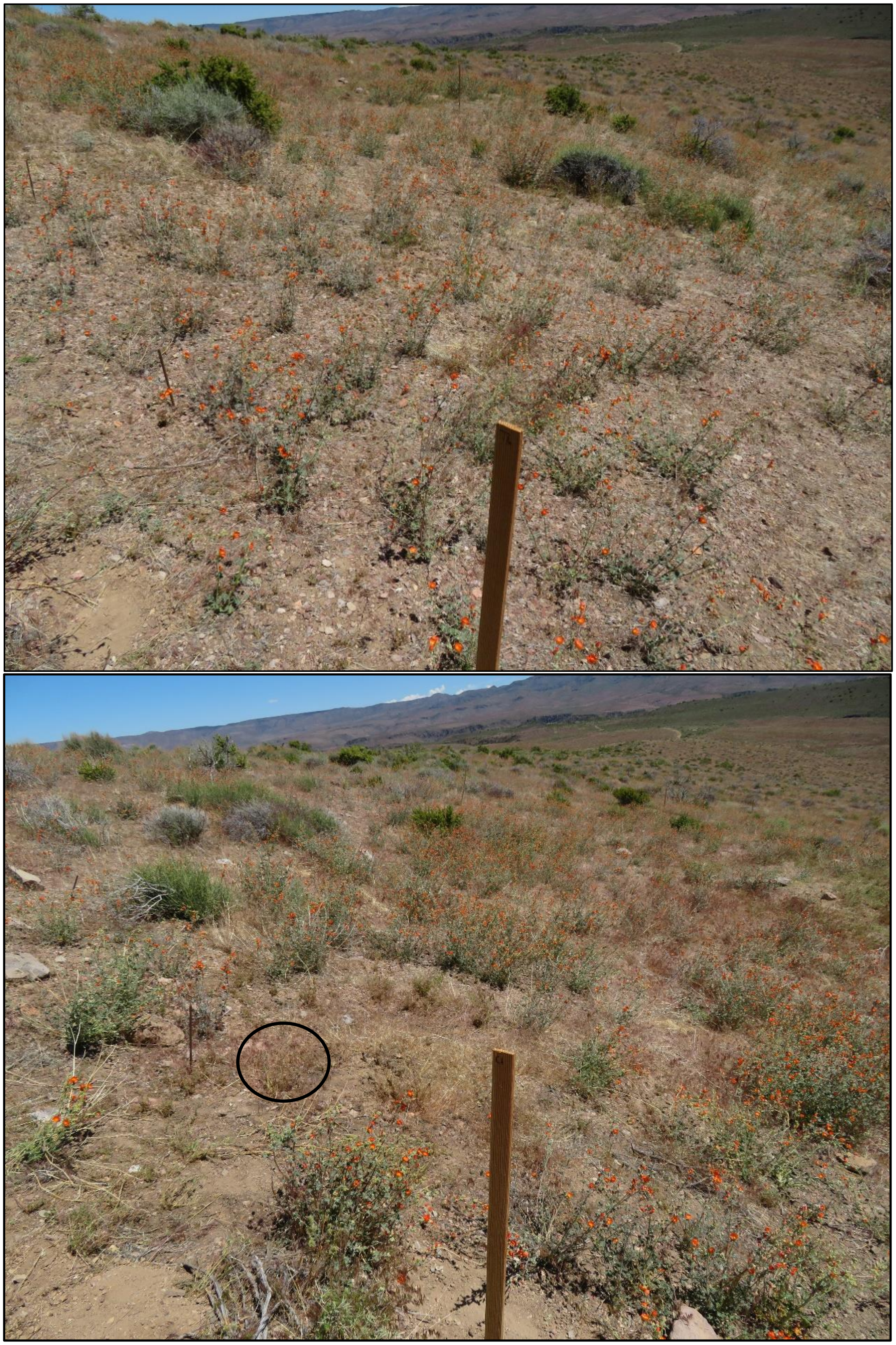


Figure 13-5. Reduced cheatgrass density and cover in Rejuvra treated plot (upper) compared to a control plot (lower, cheatgrass circled) (Photo by D.B. Hall, May 15, 2024)

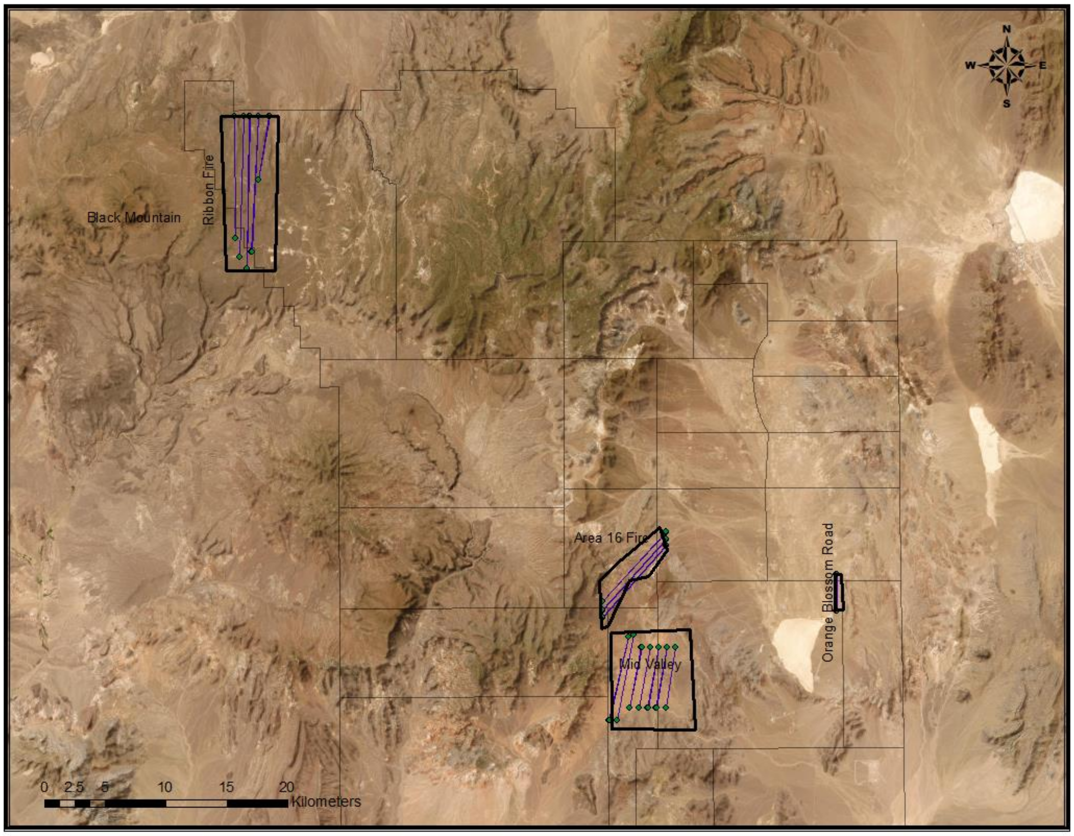


Figure 13-6. Map of firebreaks (purple lines, green dots are starting and ending points) on the NNSS created by aerially applying herbicide, November 2024

Figure 13-7. Aerial application of Rejuvra using the C-130 in the Ribbon Cliff Wildland burn area, November 2024 (Photo by D.B. Hall, November 9, 2024)

13.4.5 Area 16 Burn Seeding Project

In July 2020, the Area 16 Fire burned approximately 3,131 ac in predominantly blackbrush habitat between Tippipah Highway and Mid Valley Road. To establish a native perennial vegetation community to outcompete cheatgrass and reduce the risk of a wildland fire destroying power infrastructure, approximately 11 ac were seeded adjacent to an active powerline in December 2023. Revegetating the entire burned area was too expensive, and therefore seeding locations were strategically selected to protect important infrastructure and habitat. The locations were prepared by dragging a heavy chain harrow across the area to be seeded using a utility task vehicle (UTV). This technique loosens the surface, which facilitates seed coverage and promotes germination. Following harrowing, seed was broadcast on the surface using a drill seeder pulled behind the UTV. A light chain harrow dragged behind the seeder covered the seed. The seedmix was composed of nine shrub, three perennial grass, and three perennial forb species, seeded at a rate of 20 pounds of pure live seed per acre. The seeded area and a nonseeded control area were monitored in 2024 to evaluate success. An average of around 5.0 seeded seedlings per square meter were found, with most of them being Perennial Flax (*Linum perenne*) at 3.3 seedlings per square meter.

13.4.6 Sahara mustard (Brassica tournefortii)

Sahara mustard (*Brassica tournefortii*, synonyms: African or Asian mustard, wild turnip) is an invasive, annual weed that invades disturbed areas (e.g., roadsides, areas disturbed by heavy equipment, naturally disturbed areas) quickly with a single plant capable of propagating thousands of seeds (McDonald 2023). Sahara mustard has a quick life cycle, does not need a lot of soil moisture, and can flower as early as February in the Mojave Desert (U.S. Department of Agriculture Forest Service 2017). The plant grows taller than native annuals and outcompetes native plants for light, water, and resources (McDonald 2023). The plants are robust and form dense stands where they invade. Sahara mustard contains toxic oxalates and is not a good food plant (Abella and Berry 2016, Jacobson et al. 2009). Plants have spread throughout the Mojave Desert into tortoise habitat.

Sahara mustard has been known to occur in Area 25 on the NNSS since 2008, along the road shoulders and decommissioned buildings near Lathrop Wells Road. Up until recently, it was thought the population had not spread. The plant recently was observed at three different locations in Area 25. The invaded area is approximately 77 ac and all locations were previously disturbed by heavy equipment.

Due to the invasion of Sahara mustard into different locations in tortoise habitat in Area 25, biologists began an eradication program in 2024. In early spring, biologists hand-removed plants to prevent the spread of seeds. Most plants had immature seed pods, while others were flowering. Thirty-two large trash bags of plants were removed from March 27 through April 2 (Figure 13-8). An herbicide treatment plan has been developed for late January–early February 2025. Herbicide treatments will cover previously disturbed areas, while hand-removal of plants will continue in disturbed and undisturbed invaded areas. Eradication of Sahara mustard takes “consistent and repeated efforts” and “can be achieved after 3 to 4 years of consistent and timely control efforts” (McDonald 2023).

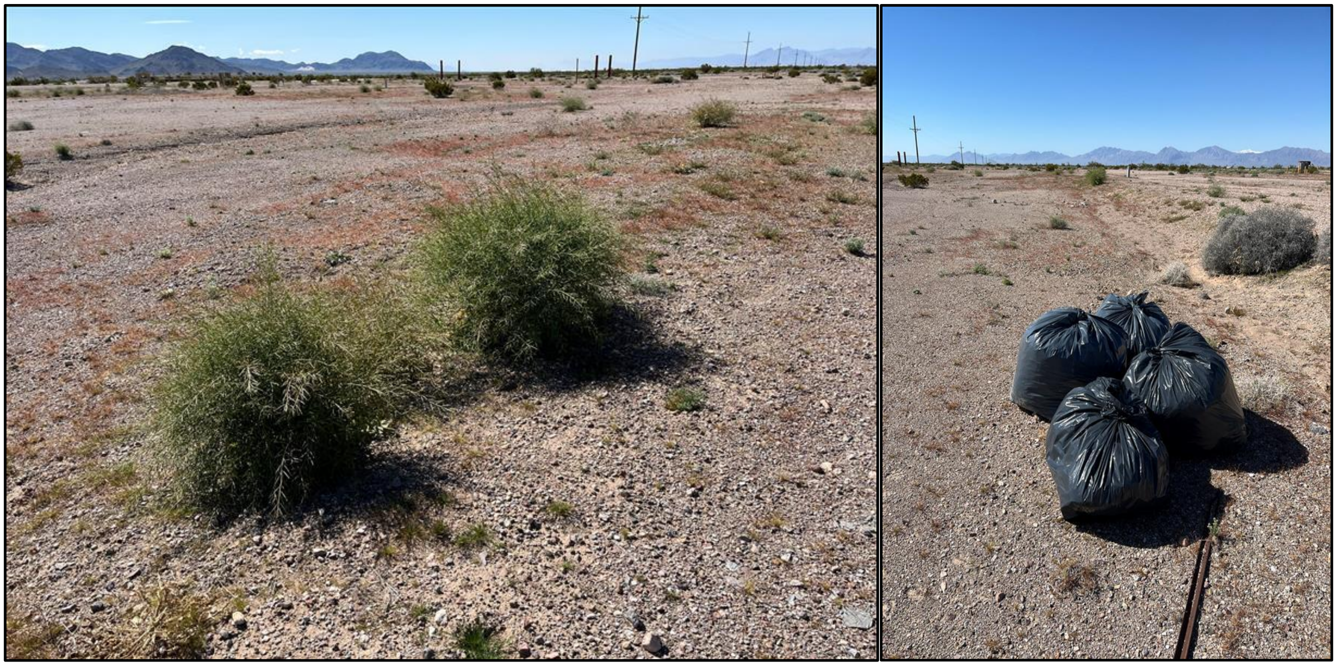


Figure 13-8. Sahara mustard plants with seed pods at MX Racetrack in Area 25 (left) and some of the 32 trash bags removed by hand (right) (Photo by J.A. Perry, March 28, 2024)

13.5 Wildland Fire Hazard Assessment

An NNSS Wildland Fire Management Plan requires the protection of site resources from wildland and operational fires. An annual vegetation survey to determine wildland fire hazards is conducted on the NNSS each spring. Survey findings are submitted to the NNSS Fire Marshal and summarized in the annual EMAC report (Hall et al. 2025). Between April 24 and May 31, 2024, NNSS biologists visited 104 sampling stations to assess a fuel index that can range from 0 to 10 (lowest to highest risk of wildfires). The mean combined fuels index (which includes both fine [non-woody] and woody fuels) for all sampling stations was 5.0, which represented above-average fuel loads. Due to the above-average precipitation received during winter/spring 2023–2024, production of annual and perennial forbs and grasses was high.

Five wildland fires were documented on the NNSS in 2024. Three were human-caused or project related, one was caused by lightning, and one was caused by an unknown source. The Ribbon Cliff Wildland Fire was the largest and burned approximately 3,228 ha in primarily sagebrush habitat in Area 20. The remaining fires were all <0.5 ha in size.

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Chapter 14: Quality Assurance Program

Elizabeth Burns, Xianan Liu, and Theodore J. Redding
Mission Support and Test Services, LLC

Irene Farnham
Navarro Research and Engineering, Inc.

Charles B. Davis
EnviroStat

Required Criteria of a Quality Program
• Quality assurance program • Personnel training and qualification • Quality improvement process • Documents and records • Established work processes • Established standards for design and verification • Established procurement requirements • Inspection and acceptance testing • Management assessment • Independent assessment

The environmental monitoring work conducted for the U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office (NNSA/NFO) and the Environmental Management (EM) Nevada Program is performed in accordance with the Quality Assurance Program (QAP) established by the current Management and Operating (M&O) Contractor, Mission Support and Test Services, LLC (MSTS), or with the Underground Test Area (UGTA) QAP implemented by Navarro Research and Engineering, Inc. (Navarro). The QAPs describe the methods used to ensure quality is integrated into monitoring work, and to comply with Title 10 ***Code of Federal Regulations***[1] Part 830, Subpart A, "Quality Assurance Requirements," and with U.S. Department of Energy (DOE) Order DOE O 414.1D, "Quality Assurance." The 10 criteria of a quality program specified by these regulations are shown in the box above. The QAPs require a graded approach to quality for determining the level of rigor that effectively provides assurance of performance and conformance to requirements.

A Data Quality Objective (DQO) process is cited by most organizations as the planning approach used to ensure that environmental data collection activities produce the appropriate data needed for decision-making. Sampling and Analysis Plans are developed prior to performing an activity to ensure complete understanding of the data-use objectives. Personnel are trained and qualified in accordance with company- and task-specific requirements. Access to sampling locations is coordinated with organizations conducting work at or having authority over those locations in order to avoid conflicts in activities and to communicate hazards to better ensure successful execution of the work and protection of the safety and health of sampling personnel. Sample collection activities adhere to organization instructions and/or procedures designed to ensure that samples are representative and data are reliable and defensible. Sample shipments on site and to offsite laboratories are conducted in accordance with U.S. Department of Transportation and International Air Transport Association regulations, as applicable. ***Quality control (QC)*** in the analytical laboratories is maintained through adherence to standard operating procedures based on methodologies developed by nationally recognized organizations such as DOE, the Environmental Protection Agency (EPA), and ASTM International. Key quality-affecting procedural areas cover sample collection, preparation, instrument calibration, instrument performance checking, testing for precision and accuracy, obtaining a measurement, and laboratory data review. Data users perform reviews as required by the project-specific objectives before the data are used to support decision-making.

The key elements of the environmental monitoring process workflow are listed below. Each element is designed to ensure that applicable ***quality assurance (QA)*** requirements are implemented. A discussion of these elements follows.

- A **Sampling and Analysis Plan** (SAP) is developed consistent with a DQO process to ensure clear goals and objectives are established for the environmental activity. The SAP is implemented in accordance with EPA, DOE, and other requirements addressing environmental, safety, and health objectives.
- **Environmental Sampling** is performed in accordance with the SAP, procedures, and site work controls to ensure defensibility of the resulting data products as well as protection of the worker and the environment.

[1] The definition of word(s) in ***bold italics*** may be found by referencing the Glossary, Appendix B.

- **Laboratory Analyses** are performed to ensure the resultant data meet DOE, MSTS (the current M&O Contractor), and UGTA regulation-defined requirements.
- **Data Review** ensures the SAP DQOs have been met and determines whether the data are suitable for their intended purpose.
- **Assessments** ensure monitoring operations are conducted according to procedure and analytical data quality requirements are met in order to identify nonconforming items, investigate causal factors, implement corrective actions, and monitor for corrective action effectiveness.

14.1 Sampling and Analysis Plan

Sampling is specifically mandated to demonstrate compliance with a variety of requirements, including federal and state regulations and DOE orders and standards. Developing the SAP using the DQO approach ensures those requirements are considered in the planning stage. The following statistical concepts and controls are vital in designing and evaluating the system design and implementation.

14.1.1 Precision

Precision is the consistency of measurement values quantified by measures of dispersion such as the sample standard deviation. Precision must be defined in context, e.g., for a certain analyte, matrix, method, perhaps concentration, lab, or group of labs (EPA 2017).

In practice, precision is determined by comparing the results obtained from performing analyses on split or duplicate samples taken at the same time from the same location or locations very close to one another, maintaining sampling and analytical conditions as nearly identical as possible.

14.1.2 Accuracy

Accuracy refers to the degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components that are due to sampling and analytical operations. Accuracy is a data quality indicator (EPA 2017) and is monitored by performing measurements and evaluating results of control samples containing known quantities of the ***analytes*** of interest.

14.1.3 Representativeness

Representativeness is the degree to which measured analytical concentrations represent concentrations in the medium being sampled (Stanley and Verner 1985).

At each point in the sampling and analysis process, samples of the medium of interest are obtained. The challenge is to ensure each sample maintains the character of the larger population being sampled. From a field sample collection standpoint, representativeness is managed through sampling plan design and execution. Sampling locations are/have been determined historically by consensus and/or agreement with authorities, in many cases, or are determined based on the properties of the operation being monitored (such as environmental remediation).

Representativeness related to laboratory operations addresses the ability to appropriately subsample and characterize for analytes of interest. For example, to ensure representative characterization of a heterogeneous matrix (soil, sludge, solids, etc.), the sampling and/or analysis process should evaluate whether homogenization or segregation should be employed prior to sampling or analysis. Water samples are generally considered homogeneous unless observation suggests otherwise. Each air monitoring station's continuous operation at a fixed location results in representatively sampling the ambient atmosphere. Field sample duplicate analyses are additional controls allowing evaluation of representativeness and heterogeneity; these are employed for air monitoring and direct radiation monitoring measurements. Generally, monitoring measurements are compared with historical measurements at the same location.

14.1.4 Comparability

Comparability refers to "the confidence with which one data set can be compared to another" (Stanley and Verner 1985). Comparability from an overall monitoring perspective is ensured by consistent execution of the sampling design for sample collection and handling, laboratory analyses, and data review and through adherence to established procedures and standardized methodologies. Ongoing data evaluation compares data collected at the same locations from sampling events conducted over multiple years and produced by numerous laboratories to detect any anomalies that might occur.

14.1.5 Completeness

Completeness refers to "the amount of valid data obtained compared to the planned amount" (EPA 2016). Field operations completeness is a measure of the number of samples collected that are valid for further processing (e.g., field measurements, laboratory analyses) versus the number of samples planned. Field measurements completeness compares the number of valid measurements obtained with those planned. Laboratory analyses completeness is a measure of the number of valid measurements compared to the total number of measurements planned. Data use completeness is a measure of the number of results determined to be valid for their intended use compared to the number of results planned.

14.2 Environmental Sampling

Environmental samples are collected in support of various environmental programs. Each program executes field-sampling activities in accordance with the SAP to ensure usability and defensibility of the resulting data. The key elements supporting the quality and defensibility of the sampling process and products include the following:

- Training and qualification
- Procedures and methods
- Field documentation
- Inspection and acceptance testing

14.2.1 Training and Qualification

The environmental programs ensure that personnel are properly trained and qualified prior to doing the work. In addition to procedure-specific and task-specific qualifications for performing work, training addresses environment, safety, and health aspects for protection of workers, the public, and the environment. Recurrent training is also conducted as appropriate to maintain proficiency.

14.2.2 Procedures and Methods

Sampling is conducted in accordance with established procedures to ensure consistent execution and continuous comparability of the environmental data. Descriptions of the analytical methods to be used are also consulted to ensure that, as methods are revised, sample collection is performed appropriately and viable samples are obtained.

14.2.3 Field Documentation

Field documentation is generated for each sample collection activity. This may include chain-of-custody documentation, sampling procedures, analytical methods, equipment and data logs, maps, Safety Data Sheets, and other materials needed to support the safe and successful execution and defense of the sampling effort. Chain-of-custody practices are employed from point of generation through disposal (cradle-to-grave); these are critical to the defensibility of the decisions made as a result of the sampling and analysis. Sampling data and documentation are stored and archived so they are readily retrievable for use later. In many cases, the data are managed in electronic data management systems. Routine assessments or surveillances are performed to ensure that sampling activities are performed in accordance with applicable requirements. If deficiencies are noted, then causal factors are determined, corrective actions are implemented, and follow-up assessments are performed to ensure effective resolution. Field data log notes are reviewed as a first step in data evaluation. This data management approach ensures the quality and defensibility of the decisions made using analytical environmental data.

14.2.4 Inspection and Acceptance Testing

Sample collection data are reviewed for appropriateness, accuracy, and fit with historical measurements. In the case of groundwater sampling, water quality parameters are monitored during purging. Stabilization of these parameters generally indicates that the water is representative of the ***aquifer***, at which time sample collection may begin. After a sampling activity is complete, data are reviewed to ensure the samples were collected in accordance with the SAP. Samples are further inspected to ensure that their integrity has not been compromised, either physically (leaks, tears, breakage, custody seals) or administratively (labeled incorrectly), and that they are valid for supporting the intended analyses. If concerns are raised at any point during collection, the data user, in consideration of data usability, is consulted for direction on proceeding with or canceling the subsequent analyses.

14.3 Laboratory Analyses

Samples are transported to a laboratory for analysis. Several DOE contractor organizations maintain measurement capabilities that may be used to support planning or decision-making activities. However, unless specifically authorized by NNSA/NFO, the EM Nevada Program, or the regulator, data used for demonstrating regulatory compliance are generated by a DOE- and contractor-qualified laboratory whose services have been obtained through subcontracts. Ensuring the quality of procured laboratory services is accomplished through focus on three specific areas: (1) procurement, (2) initial and continuing assessment, and (3) data evaluation.

14.3.1 Procurement

Laboratory services are procured through subcontracts in accordance with the Competition in Contracting Act, the Federal Acquisition Regulations, the DOE Acquisition Regulations, contractor terms and conditions for subcontracting, and other relevant policies and procedures. The analytical services technical basis is codified in the Department of Defense (DoD) Department of Energy (DOE) Consolidated Quality Systems Manual (QSM) for Environmental Laboratories (DOE 2019). The QSM is based on Volume 1 of The NELAC [National Environmental Laboratory Accreditation Conference] Institute Standards (September 2009), which incorporates International Organization for Standards/International Electrotechnical Commission Standard ISO/IEC 17025:2005, "General requirements for the competence of testing and calibration laboratories," and ISO/IEC 17025:2017. Subcontracted laboratories are assessed for compliance with the QSM and are audited by the DoD Environmental Laboratory Accreditation Program Accreditation Bodies and the DOE Consolidated Audit Program - Accreditation Program (DOECAP-AP) Accreditation Bodies. A QSM revision was completed in October 2021, and went into effect for DOECAP-AP audits beginning October 28, 2021.

A request for proposal (RFP) is posted to the government website, laboratory responses are evaluated, and subcontracts awarded. The RFP cites the QSM as the base technical requirement, requires or advises participation in the DOECAP-AP, and addresses site-specific conditions. Multiple laboratories may receive a subcontract through one RFP.

The laboratories are primarily those providing a wide range of analytical services to DOE. Other services can be subcontracted by the laboratory (i.e., lower-tier subcontractor) or contracted directly from a vendor. In either case, requirements are established for the specific services provided.

The subcontract places numerous requirements on the laboratory, including the following:

- Maintaining the following documents:
  - A Quality Assurance Plan and/or Manual describing the laboratory's policies and approach to the implementation of QA requirements
  - An Environment, Safety, and Health Plan

  - A Waste Management Plan
  - Procedures pertinent to subcontract scope
- The ability to generate data deliverables, both hard copy reports and electronic files
- Responding to all data quality questions in a timely manner
- Mandatory participation in proficiency testing programs
- Maintaining specific licenses, accreditations, and certifications
- Conducting internal audits of laboratory operations as well as audits of vendors
- Allowing external audits by DOECAP-AP, EM Nevada Program, and NNSA/NFO contractors and providing copies of other audits considered to be comparable and applicable

14.3.2 Initial and Continuing Assessment

An initial assessment is made during the RFP process, including a pre-award audit. If an acceptable audit has not been performed within the past year, MSTS or Navarro will consider performing an audit (or participating in a DOECAP-AP audit) of those laboratories awarded the contract. Neither contractor will initiate work with a laboratory without authorized approval from those personnel responsible for ensuring vendor acceptability.

A continuing assessment consists of the ongoing monitoring of a laboratory's performance against contract terms and conditions, of which the technical specifications are a part. Tasks supporting continuing assessment are listed below:

- Conducting regular audits or participating in evaluation of DOECAP-AP audit products
- Monitoring for continued successful participation in proficiency testing programs such as:
  - National Institute of Standards and Technology Radiochemistry Intercomparison Program
  - Studies that support certification by the State of Nevada or appropriate regulatory authority for analyses performed in support of routine monitoring
- Routine ongoing monitoring of the laboratory's adherence to the quality requirements

14.3.3 Data Evaluation

Data products are routinely evaluated for compliance with contract terms and specifications. This primarily involves review of the laboratory data against the specified analytical method to determine the laboratory's ability to adhere to the QA/QC requirements, as well as an evaluation of the data against the DQOs. This activity is discussed in further detail in Section 14.4. Any discrepancies are documented and resolved with the laboratory, and ongoing assessment tracks the recurrence and efficacy of corrective actions.

14.4 Data Review

A systematic approach to thoroughly evaluating the data products generated from an environmental monitoring effort is essential for understanding and sustaining the quality of data collected under the program. This allows the programs to determine whether the DQOs established in the planning phase were achieved and whether the monitoring design performed as intended or requires review.

Because decisions are based on environmental data, and the effectiveness of operations is measured at least in part by environmental data, reliable, accurate, and defensible records are essential. Detailed records that must be kept include temporal, spatial, numerical, geotechnical, chemical, and radiological data as well as all sampling, analytical, and data review procedures used. Failure to maintain these records in a secure but accessible form may result in exposure to legal challenges and the inability to respond to demands or requests from regulators and other interested organizations.

An electronic data management system is a key tool used by many programs for achieving standardization and integrity in managing environmental data. The primary objective is to store and manage in an easily and efficiently retrievable form unclassified environmental data that are directly or indirectly tied to monitoring events. This may include information on monitoring system construction (groundwater wells, ambient air monitoring), and analytical, geotechnical, and field parameters at the Nevada National Security Site. Database integrity and security are enforced through the assignment of varying database access privileges commensurate with an employee's database responsibilities.

14.4.1 Data Verification

Data verification generally involves a subcontract compliance and completeness review to ensure that all laboratory data and sample documentation are present and complete. Additional critical sampling and analysis process information is also reviewed at this stage, which may include, but is not limited to, sample preservation and temperature, defensible chain-of-custody documentation and integrity, and analytical hold-time compliance. Data verification also ensures that electronic data products correctly represent the sampling and/or analyses performed, and includes evaluation of QC sample results.

14.4.2 Data Validation

Data validation supplements verification and is a more thorough process of analytical data review to better determine if the data meet the analytical and project requirements. Data validation ensures that the reported results correctly represent the sampling and analyses performed, determines the validity of the reported results, and assigns data qualifiers (or "flags"), if required.

14.4.3 Data Quality Assessment (DQA)

DQA is a scientific and statistical evaluation to determine if the data obtained from environmental operations are of the right type, quality, and quantity to support their intended use. The DQA includes reviewing data for accuracy, representativeness, and fit with historical measurements to ensure that the data will support their intended uses.

14.5 Assessments

The overall effectiveness of the environmental program is determined through routine surveillance and assessments of work execution as well as review of program requirements. Deficiencies are identified, causal factors are investigated, corrective actions are developed and implemented, and follow-on monitoring is performed to ensure effective resolution. The assessments discussed below are broken down into general programmatic and focused measurement data areas.

14.5.1 Programmatic

Assessments and audits under this category include evaluations of work planning, execution, and performance activities. Personnel independent of the work activity perform the assessments to evaluate compliance with established requirements and report on deficiencies identified. Organizations responsible for the activity are required to develop and implement corrective actions, with the concurrence of the deficiency originator or recognized subject matter expert. NNSA/NFO and DOE EM Nevada Program contractors maintain companywide issues tracking systems to manage assessments, findings, and corrective actions.

14.5.2 Measurement Data

This type of assessment includes routine evaluation of data generated from analyses of QC and other samples. QC sample data are used to monitor the analytical control on a given batch of samples and are indicators over time of potential biases in laboratory performance. Discussions of the 2024 results for field duplicates, laboratory control samples, blank analyses, matrix spikes, and proficiency testing programs are provided, and summary tables are included below.

14.5.2.1 Field Duplicates

Samples obtained at nearly the same locations and times as initial samples are termed field duplicates. These are used to evaluate the overall precision of the measurement process, including small-scale heterogeneity in the matrix (air, water, or direct radiation) being sampled as well as analytical and sample preparation variation. The absolute relative percent difference (RPD) compares the absolute difference of initial and field duplicate measurements with the average of the two measurements (Table 14-1, footnote c); it is computed only from pairs for which both values are above their respective ***minimum detectable concentrations (MDCs)*** (or MDC + 2σ uncertainty for UGTA water samples). The relative error ratio (RER) compares the absolute difference of initial and field duplicate measurements to the laboratory's reported analytical uncertainty (Table 14-1, footnote d).

The average absolute RPD and average RER values for all 2024 radiological air and water duplicate pairs are shown in Table 14-1. They are similar to those seen in prior years. The higher average absolute RPDs (those greater than ~30) are typically associated with two types of phenomena. RPDs for ***actinides*** in air, in particular, and consequently for ***gross alpha*** in air, can be elevated when one sampler of a pair intercepts a particle with high americium (Am) or plutonium (Pu), while the other sampler in the pair had a typical ***background*** value. Also, higher average absolute RPDs can be associated with relatively few pairs having both values above their MDCs, as low-level measurements are typically relatively "noisier" than higher-level measurements.

Table 14-1. Summary of field duplicate samples

Analyte	Matrix	Number of Duplicate Pairs[(a)]	Number of Pairs > MDC[(b)]	Average Absolute RPD[(c)]	Average Absolute RER[(d)]
Environmental Monitoring Samples					
Gross Alpha	Air	52	30	20.1	0.66
Gross Beta	Air	52	52	6.0	1.20
Tritium	Air	52	14	26.0	0.97
^{241}Am	Air	8	0	—	0.90
^{238}Pu	Air	8	0	—	0.38
$^{239+240}$Pu	Air	8	3	25.0	0.46
$^{233+234}$U	Air	4	4	18.5	1.14
$^{235+236}$U	Air	4	0	—	0.87
^{238}U	Air	4	4	9.2	0.67
^{7}Be[(e)]	Air	8	8	6.1	0.76
^{137}Cs	Air	8	0	—	1.22
^{40}K[(e)]	Air	8	8	39.1	1.32
Gross Alpha	Water	6	5	19.8	1.27
Gross Beta	Water	6	6	23.1	1.31
Tritium (standard)	Water	6	0	—	0.49
TLD	Ambient Radiation	437	NA	1.7	0.16
UGTA Samples					
Tritium (standard)	Water	1	1	1.2	0.09
Tritium (low-level)	Water	2	1	14.2	0.39

(a) Represents the number of field duplicates reported for evaluating precision.

(b) Represents the number of field duplicate–field sample pairs with both values above their MDCs or MDC + 2σ (UGTA). If either the field sample or duplicate was below the MDC (+ 2σ), the RPD was not determined. This does not apply to ***thermoluminescent dosimeter (TLD)*** measurements; because TLDs virtually always detect ambient background radiation, MDCs are not computed.

(c) Represents the average absolute RPD calculated as follows:

$$Absolute\ RPD = \frac{|S - D|}{(D + S)/2} \ X \ 100$$

Where: S = Sample result
D = Duplicate result

(d) Represents the absolute RER, determined by the following equation, which is used to determine whether a sample result and the associated field duplicate result differ significantly when compared to their respective 1 sigma uncertainties (i.e., measurement standard deviation). The RER is calculated for all sample and field duplicate pairs reported, without regard to the MDC.

$$Absolute\ RER = \frac{|S - D|}{\sqrt{(SD_S)^2 + (SD_D)^2}}$$

Where: S = Sample result
D = Duplicate result
SD_S Standard deviation of the sample result as reported
SD_D = Standard deviation of the duplicate result as reported

(e) ^{7}Be and ^{40}K are naturally occurring analytes included for quality assessment of the gamma ***spectrometry*** analyses.

14.5.2.2 Laboratory Control Samples (LCSs)

An LCS is prepared from a sample matrix verified to be free from the analytes of interest, and then spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes. The LCS is generally used to establish intra-laboratory or analyst-specific precision and bias or to assess the performance of all or a portion of the measurement system (DOE 2019).

The results are calculated as a percentage of the true value (i.e., percent recovery), and must fall within established control limits to be considered acceptable. If the LCS recovery falls outside control limits, evaluation for potential sample data bias is necessary. The numbers of the 2024 LCSs analyzed and within control limits are summarized in Table 14-2. There were no systemic issues identified in 2024 by the LCS recovery data, and no failures that invalidated the associated sample data.

Table 14-2. Summary of laboratory control samples

Analyte	Matrix	Number of LCS Results Reported	Number Within Control Limits	Control Limits (%)
Environmental Monitoring Samples				
Tritium	Air	93	93	75–125
^{60}Co	Air	6	6	75–125
^{137}Cs	Air	6	6	75–125
$^{239+240}$Pu	Air	10	10	75–125
^{241}Am	Air	28	26	75–125
Gross alpha	Water	11	11	75–125
Gross beta	Water	11	11	75–125
Tritium (standard)	Water	14	14	75–125
^{60}Co	Water	0	0	75–125
^{90}Sr	Water	0	0	75–125
^{137}Cs	Water	0	0	75–125
$^{239+240}$Pu	Water	0	0	75–125
^{241}Am	Water	0	0	75–125
Tritium	Soil	0	0	75–125
^{60}Co	Soil	5	5	75–125
^{90}Sr	Soil	5	5	75–125
^{137}Cs	Soil	5	5	75–125
$^{239+240}$Pu	Soil	7	7	75–125
^{241}Am	Soil	12	12	75–125
^{60}Co	Vegetation	1	1	75–125
^{90}Sr	Vegetation	1	1	75–125
^{137}Cs	Vegetation	1	1	75–125
$^{239+240}$Pu	Vegetation	1	1	75–125
^{241}Am	Vegetation	2	2	75–125
Metals	Water	90	90	80–120
Volatiles	Water	169	167	70–130
Semi volatiles	Water	189	188	Laboratory specific
Miscellaneous	Water	37	37	80–120
Metals	Soil	16	16	80–120
Volatiles	Soil	0	0	70–130

Table 14-2. Summary of laboratory control samples

Analyte	Matrix	Number of LCS Results Reported	Number Within Control Limits	Control Limits (%)
Semi volatiles	Soil	23	23	Laboratory specific
Miscellaneous	Soil	3	3	80–120
UGTA Samples				
Tritium (standard)	Water	4	4	80–120
Tritium (low-level)	Water	2	2	75–125

14.5.2.3 Blank Analysis

In general, a blank is a sample that has not been exposed to the targeted environment and is analyzed in order to monitor "no exposure" analyte levels and contamination that might be introduced during sampling, transport, storage, and/or analysis. The blank is subjected to the usual analytical and measurement process to establish a baseline or background value, and is sometimes used to adjust or correct routine analytical results (DOE 2019). Blanks are processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures. The following list identifies the blanks routinely used during environmental monitoring activities.

- A trip blank is a sample of analyte-free media taken from the laboratory to the sampling site and returned to the laboratory unopened. A trip blank is used to document contamination attributable to shipping and field handling procedures. This type of blank is useful in documenting contamination of volatile organics samples.
- An equipment blank is a sample of analyte-free media that has been used to rinse common sampling equipment to check effectiveness of decontamination procedures.
- A field blank is prepared in the field by filling a clean container with purified water (appropriate for the target analytes) and appropriate preservative, if any, for the specific sampling activity being undertaken. The field blank is used to indicate the presence of contamination due to sample collection and handling.
- A method blank is a sample of a matrix similar to the associated sample batch in which no target analytes or interferences are present at concentrations that would impact the sample analyses results. Method blank data are summarized in Table 14-3.

There were no systemic blank data issues and no failures identified in 2024 that required invalidating the associated sample data.

Table 14-3. Summary of laboratory method blank samples

Analyte	Matrix	Number of Blank Results Reported	Number of Results < MDC
Environmental Monitoring Samples			
Tritium	Air	72	71
^{7}Be	Air	6	6
^{60}Co	Air	2	2
^{137}Cs	Air	6	6
^{238}Pu	Air	5	5
$^{239+240}$Pu	Air	5	5
^{241}Am	Air	11	11
Gross alpha	Water	11	11
Gross beta	Water	11	11
Tritium (standard)	Water	13	13
^{60}Co	Water	0	0
^{90}Sr	Water	0	0
^{137}Cs	Water	0	0
^{238}Pu	Water	0	0
$^{239+240}$Pu	Water	0	0
^{241}Am	Water	0	0
Tritium	Soil	0	0
^{60}Co	Soil	1	1
^{90}Sr	Soil	5	5

Table 14-3. Summary of laboratory method blank samples

Analyte	Matrix	Number of Blank Results Reported	Number of Results < MDC
^{137}Cs	Soil	5	5
^{238}Pu	Soil	6	6
$^{239+240}$Pu	Soil	6	5
^{241}Am	Soil	7	7
^{60}Co	Vegetation	1	1
^{90}Sr	Vegetation	1	1
^{137}Cs	Vegetation	1	1
^{238}Pu	Vegetation	1	1
$^{239+240}$Pu	Vegetation	1	1
^{241}Am	Vegetation	2	2
Metals	Water	98	84
Volatiles	Water	181	181
Semi volatiles	Water	234	229
Miscellaneous	Water	277	269
Metals	Soil	32	28
Volatiles	Soil	0	0
Semi volatiles	Soil	24	21
Miscellaneous	Soil	1	1
UGTA Samples			
Tritium (standard)	Water	4	4
Tritium (low-level)	Water	2	2

14.5.2.4 Matrix Spike Analysis

A matrix spike is a sample spiked with a known concentration of analyte. This spiked sample is subjected to the same sample preparation and analysis as the original environmental sample. The matrix spike is used to indicate if the matrix (e.g., soil, water with sediment) interferes with the analytical results. Matrix spike analyses were conducted for samples in 2024, and there were no issues identified by the analysis data, except for one UGTA standard tritium sample (Table 14-4). The standard tritium results for the UGTA samples associated with the poor matrix spike recovery was identified as estimated (see Chapter 5, Table 5-4).

Table 14-4. Summary of matrix spike samples

Analyte	Matrix	Number of Matrix Spikes Reported	Number Within Control Limits	Control Limits[(a)] (%)
Environmental Monitoring Samples				
Tritium	Air	11	11	60–140
Gross alpha	Water	16	10	60–140
Gross beta	Water	16	16	60–140
Tritium	Water	12	11	60–140
UGTA Samples				
Tritium (standard)	Water	4	3	60–140
Tritium (low-level)	Water	2	2	60–140

(a) These control limits apply when the sample results are < 4x the amount of spike added.

14.5.2.5 Proficiency Testing Program Participation

All contracted laboratories are required to participate in proficiency testing programs. Laboratory performance supports decisions on work distribution and may also be a basis for state certifications. Table 14-5 presents the 2024 results for the laboratory performance in the March and August studies of the Mixed Analyte Performance Evaluation Program (MAPEP) (http://www.id.energy.gov/resl/mapep/mapepreports.html) administered by the Radiological and Environmental Sciences Laboratory operated by the DOE Idaho Operations Office.

Table 14-5. Summary of Mixed Analyte Performance Evaluation Program reports

Analyte	Matrix	Number of Results Reported	Number within Control Limits[(a)]
Environmental Monitoring Samples			
^{60}Co	Filter	2	2
^{137}Cs	Filter	2	2
^{238}Pu	Filter	2	2
$^{239+240}$Pu	Filter	2	2
^{241}Am	Filter	2	2
Tritium (standard)	Water	2	2
^{60}Co	Water	2	2
^{90}Sr	Water	2	1
^{137}Cs	Water	2	2
^{238}Pu	Water	2	2
$^{239+240}$Pu	Water	2	2
^{241}Am	Water	2	2
^{60}Co	Vegetation	2	2
^{90}Sr	Vegetation	2	2
^{137}Cs	Vegetation	2	2
^{238}Pu	Vegetation	2	2
$^{239+240}$Pu	Vegetation	2	2
^{60}Co	Soil	2	2
^{90}Sr	Soil	2	2
^{137}Cs	Soil	2	2
^{238}Pu	Soil	2	2
$^{239+240}$Pu	Soil	2	2
^{241}Am	Soil	2	2
Metals	Water	38	36
Metals	Soil	40	38
Gross Alpha	Water	2	2
Gross Beta	Water	2	2

(a) Based upon MAPEP criteria.

Table 14-6 shows the summary of inter-laboratory comparison sample results for the MSTS External Dosimetry Program (EDP). DOE Standard DOE-STD-1095-2018, “Department of Energy Laboratory Accreditation for External Dosimetry,” establishes the methodology for determining acceptable performance testing of dosimeter systems. It also establishes the technical basis for performance testing and the testing categories and performance criteria, which are outlined in American National Standards Institute/Health Physics Society (ANSI/HPS) Standard N13.11-2009, “American National Standard for Dosimetry–Personnel Dosimetry Performance–Criteria for Testing,” and in ANSI/HPS N13.32-2008, “An American National Standard, Performance Testing of Extremity Dosimeters.” The MSTS EDP participated in a blind testing program through the Battelle Pacific Northwest National Laboratory program and the Radiological and Environmental Sciences Laboratory during the course of the year.

Table 14-6. Summary of inter-laboratory comparison TLD samples (UD-802 dosimeters)

Analysis	Matrix	Number of Results Reported	Number within Control Limits[(a)]
Gamma Radiation	TLD	24 batches of 5 TLDs	24 batches of 5 TLDs

(a) Based upon ANSI/HPS N13.11-2009 criteria.

ANSI/HPS N13.37-2014, “Environmental Dosimetry – Criteria for System Design and Implementation,” contains guidance on conducting “blind spike” quality assurance testing. This process was last followed in 2024 by having 24 Panasonic UD-814AS environmental TLDs exposed to a known radiation level (150 milliroentgens) and placing them with routine monitoring TLDs for analysis. A performance quotient for each ***dosimeter*** was calculated as follows: P = (reported exposure – true value) / true value. According to the standard, the absolute value of the mean performance quotient should not exceed 0.15. The value for the 2024-tested environmental TLDs was 0.015, demonstrating good agreement between the results and the controlled exposure using the blind spike.

14.6 References

DOE, see U.S. Department of Energy.

EPA, see U.S. Environmental Protection Agency.

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Chapter 15: Quality Assurance Program for the Community Environmental Monitoring Program

John Goreham
Desert Research Institute

The Community Environmental Monitoring Program (CEMP) Quality Assurance Management and Assessment Plan (QAMAP) (Desert Research Institute [DRI] 2009) is followed for the collection and analysis of radiological air and water data presented in Chapter 7 of this report. The CEMP QAMAP ensures compliance with U.S. Department of Energy (DOE) Order DOE O 414.1D, "Quality Assurance," which implements a quality management system, ensuring the generation and use of quality data. This QAMAP addresses the following items previously defined in Chapter 14:

- Data Quality Objectives (DQOs)
- Sampling plan development to satisfy the DQOs
- Environmental health and safety
- Sampling plan execution
- Sample analyses
- Data review
- Continuous improvement

15.1 Data Quality Objectives

The DQO process is a strategic planning approach used to plan data collection activities. It provides a systematic process for defining the criteria that a data collection design should satisfy. These criteria include when and where samples should be collected, how many samples to collect, and the tolerable level of decision errors for the study. DQOs are unique to the specific data collection or monitoring activity and follow similar guidelines for onsite activities where applicable (Chapter 14).

15.2 Measurement Quality Objectives (MQOs)

The MQOs are basically equivalent to DQOs for analytical processes. The MQOs provide direction to the analytical laboratory concerning performance objectives or requirements for specific method performance characteristics. Default MQOs are established in the subcontract with the laboratory but may be altered in order to satisfy changes in the DQOs. The MQOs for the CEMP project are described in terms of precision, accuracy, representativeness, comparability, and completeness requirements. These terms are defined and discussed in Section 14.1 for onsite activities.

15.3 Sampling Quality Assurance Program

Quality Assurance (QA)[1] in CEMP field operations includes sampling assessment, surveillance, and oversight of the following supporting elements:

- The sampling plan, DQOs, and field data sheets accompanying the sample package
- Database support for field and laboratory results, including systems for long-term storage and retrieval
- A training program to ensure that qualified personnel are available to perform required tasks

Sample packages include the following:

- Station manager checklist confirming all observable information pertinent to sample collection
- An Air Surveillance Network Sample Data Form documenting air sampler parameters, collection dates and times, and total sample volumes collected
- Chain-of-custody forms

This managed approach ensures that the sampling is traceable and enhances the value of the final data. The sample package also ensures that the Community Environmental Monitor station manager (Chapter 7 describes Community Environmental Monitors) followed proper procedures for sample collection. The CEMP Project

[1] The definition of word(s) in ***bold italics*** may be found by referencing the Glossary, Appendix B.

Manager or QA Officer routinely performs assessments of the station managers and field monitors to ensure that standard operating procedures and sampling protocols are followed properly.

Data obtained in the course of executing field operations are entered in the documentation accompanying the sample package during sample collection and in the CEMP database along with analytical results upon their receipt and evaluation.

Completed sample packages are kept as hard copy in file archives at DRI. Analytical reports are kept as hard copy in file archives as well as in electronic form by calendar year. Analytical reports and databases are protected and maintained in accordance with DRI's Computer Protection Program.

15.4 Laboratory QA Oversight

The CEMP QA Officer ensures that DOE O 414.1D requirements are met with respect to laboratory services through review of the vendor laboratory policies formalized in a Laboratory Quality Assurance Plan (LQAP). The CEMP is assured of obtaining quality data from laboratory services through a multifaceted approach involving specific procurement protocols, the conduct of quality assessments, and requirements for selected laboratories to have an acceptable QA program. These elements are discussed below.

15.4.1 Procurement

Laboratory services are procured through subcontracts. The subcontract establishes the technical specifications required of the laboratory and provides the basis for determining compliance with those requirements and evaluating overall performance. The subcontract is awarded on a "best value" basis as determined by pre-award audits. The prospective vendor is required to provide a review package to the CEMP QA Officer that includes the following:

- All procedures pertinent to subcontract scope
- Environment, Safety, and Health Plan
- LQAP
- Example deliverables (hard copy and/or electronic)
- Proficiency testing (PT) results from the previous year from recognized PT programs
- Résumés of laboratory personnel
- All procedures pertinent to subcontract scope
- Facility design/description
- Accreditations and certifications
- Licenses
- Pricing
- Audits performed by an acceptable DOE program covering comparable scope
- Past performance surveys

The CEMP QA Officer evaluates the review package in terms of technical capability. Vendor selection is based solely on these capabilities and not biased by pricing.

15.4.2 Initial and Continuing Assessment

An initial assessment of a laboratory is managed through the procurement process above, including a pre-award audit. Pre-award audits are conducted by the CEMP (usually by the CEMP QA Officer). The CEMP does not initiate work with a laboratory without approval from the CEMP Program Manager.

A continuing assessment of a selected laboratory involves ongoing monitoring of a laboratory's performance against the contract terms and conditions, of which technical specifications are a part. The following tasks support continuing assessment:

- Tracking schedule compliance
- Monitoring the laboratory's adherence to the LQAP
- Reviewing analytical data deliverables
- Conducting regular audits
- Monitoring for continued successful participation in approved PT programs

15.4.3 Laboratory QA Program

The laboratory policy and approach to implement DOE O 414.1D is verified in an LQAP prepared by the laboratory. The required elements of a CEMP LQAP are similar to those required by Mission Support and Test Services, LLC, for onsite monitoring (Section 14.3).

15.5 Data Review

Essential components of process-based QA are data checks, verification, validation, and data quality assessment to evaluate data quality and usability.

Data Checks – Data checks are conducted to ensure accuracy and consistency of field data collection operations prior to and upon data entry into CEMP databases and data management systems.

Data Verification – Data verification is defined as a subcontract compliance and completeness review to ensure that all laboratory data and sample documentation are present and complete. Sample preservation, chain-of-custody, and other field sampling documentation is reviewed during the verification process. Data verification ensures that the reported results entered in CEMP databases correctly represent the sampling and/or analyses performed and includes evaluation of ***quality control (QC)*** sample results.

Data Validation – Data validation is the process of reviewing a body of analytical data to determine if it meets the data quality criteria defined in operating instructions. Data validation ensures that the reported results correctly represent the sampling and/or analyses performed, determines the validity of reported results, and assigns data qualifiers (or “flags”), if required. The process of data validation consists of the following:

- Evaluating the quality of data to ensure all project requirements are met
- Determining the impact on data quality of those requirements if they are not met
- Verifying compliance with QA requirements
- Checking QC values against defined limits
- Applying qualifiers to analytical results in CEMP databases to define the limitations in the use of the reviewed data

Operating instructions, procedures, applicable project-specific work plans, field sampling plans, QA plans, analytical method references, and laboratory statements of work may all be used in the process of data validation. Documentation of data validation includes checklists, qualifier assignments, and summary forms.

Data Quality Assessment (DQA) – DQA is the scientific evaluation of data to determine if the data obtained from environmental data operations are of the right type, quality, and quantity to support their intended use. DQA review is a systematic review against pre-established criteria to verify that the data are valid for their intended use.

15.6 QA Program Assessments

The overall effectiveness of the QA Program is determined through management and independent assessments as defined in the CEMP QAMAP. These assessments evaluate the plan execution workflow (sampling plan development and execution, chain-of-custody, sample receiving, shipping, subcontract laboratory analytical activities, and data review) as well as program requirements as they pertain to the organization.

15.7 Sample QA Results

QA assessments were performed by the CEMP, including the laboratories responsible for sample analyses. These assessments ensure that sample collection procedures, analytical techniques, and data provided by the subcontracted laboratories comply with CEMP requirements. Data were provided by Pace Analytical National Center for Testing & Innovation (Pace National), Landauer, Inc. (optically stimulated luminescence dosimeters), and the American Radiation Services Laboratory (ARS) in Port Allen, Louisiana (***tritium*** [^3H] data). A brief discussion of the 2024 results for field duplicates, laboratory control samples, blank analyses, and inter-laboratory comparison studies is provided along with summary tables within this section. The 2024 CEMP radiological air and water monitoring data are presented in Chapter 7.

15.7.1 Field Duplicates (Precision)

A field duplicate is a sample collected, handled, and analyzed by the same procedures as the primary sample. The relative percent difference (RPD) between the field duplicate result and the corresponding field sample result is a measure of the variability in the process caused by the sampling uncertainty (matrix heterogeneity, collection variables, etc.) and measurement uncertainty (field and laboratory) used to arrive at a final result. The average absolute RPD, expressed as a percentage, was determined for the Calendar Year 2024 samples and is listed in Table 15-1. An RPD of zero indicates a perfect duplication of results of the duplicate pair, whereas an RPD greater than 100% generally indicates that a duplicate pair falls beyond QA requirements and is not considered valid for use in data interpretation. These samples are further evaluated to determine the reason for QA failure and if any corrective actions are required. Overall, the RPD values for all analyses indicate very good results.

Table 15-1. Summary of 2024 field duplicate samples for CEMP monitoring

Analysis	Matrix	Number of Samples Reported[(a)]	Number of Samples Reported above MDA[(b)]	Average Absolute RPD of those above MDA (%)[(c)]
Gross Alpha	Air	10	10	17.4
Gross Beta	Air	10	10	7.1
Gamma – Beryllium-7	Air	10	9	16.2
^{3}H	Water	1	0	NA[(d)]
Dosimeters	Ambient Radiation	12	NA[(d)]	29.5

(a) Represents the number of field duplicates reported for the purpose of monitoring precision. If an associated field sample was not processed, the field duplicate was not included in this table.
(b) Represents the number of field duplicate–field sample result sets reported above the minimum detectable activity (MDA) (MDA is not applicable for dosimeters). If either the field sample or its duplicate was reported below the MDA, the precision was not determined.
(c) Reflects the average absolute RPD calculated for those field duplicates reported above the MDA.
(d) Not applicable.

The absolute RPD calculation is as follows:

$$Absolute\ RPD = \frac{|FD - FS|}{(FD + FS)/2} \ X \ 100\%$$

Where: FD = Field duplicate result
FS = Field sample result

15.7.2 Laboratory Control Samples (Accuracy)

Laboratory control samples (LCSs) are performed by the subcontract laboratory to evaluate analytical accuracy, which is the degree of agreement of a measured value with the true or expected value. Samples of known activity are analyzed using the same methods as employed for the project samples. The results are determined as the measured value divided by the true value, expressed as a percentage. To be considered valid, the results must fall within established control limits (or percentage ranges) for further analyses to be performed. The LCS results obtained for 2024 are satisfactory and are summarized in Table 15-2.

Table 15-2. Summary of 2024 laboratory control samples for CEMP monitoring

Analysis	Matrix	Number of LCS Results Reported	Number Within Control Limits	Control Limits
Gross Alpha	Air	9	9	29.7–125%
Gross Beta	Air	9	9	69.0–135%
Gamma (^{137}Cs, ^{60}Co, ^{241}Am)	Air	18	18	80.0–120%
^{3}H	Water	4	4	75–125%

15.7.3 Blank Analysis

Laboratory blank analyses are essentially the opposite of LCSs. These samples do not contain any of the analyte of interest. Results of these analyses are expected to be below the MDA of a specific procedure. Blank analysis and control samples are used to evaluate overall laboratory procedures, including sample preparation and instrument performance. The laboratory blank sample results obtained for 2024 are summarized in Table 15-3. Overall, the laboratory blank results were satisfactory for the air and water sample matrices.

Table 15-3. Summary of 2024 laboratory blank samples for CEMP monitoring

Analysis	Matrix	Number of Blank Results Reported	Number within Control Limits[(a)]
Gross Alpha	Air	9	9
Gross Beta	Air	9	9
Gamma	Air	9	9
^{3}H	Water	2	2

(a) Control limit is less than the MDA.

15.7.4 Accreditation of Subcontracted Laboratories and Inter-laboratory Comparison Studies

Inter-laboratory comparison studies are conducted by the subcontracted laboratories to evaluate their performance relative to other laboratories providing the same service. These types of samples are commonly known as “blind” samples, in which the expected values are known only to the program conducting the study. The analyses are evaluated and, if found satisfactory, the laboratory is certified that its procedures produce reliable results.

ARS, the subcontracted laboratory utilized by the CEMP for the analysis of tritium samples, participated in both 2024 Mixed Analyte Performance Evaluation Program (MAPEP) studies and demonstrated acceptable performance for the measurement of tritium in water. MAPEP is administered by the Radiological and Environmental Sciences Laboratory, a government-owned and -operated laboratory, managed by the DOE Idaho Operations Office.

Although Pace National did not participate in the two 2024 MAPEP studies for radiological air filters and gross alpha/beta air filters, it is noteworthy that Pace National is accredited by the DOE Consolidated Audit Program-Accreditation Program, meaning it has demonstrated successful completion of the American Association for Laboratory Accreditation evaluation process (Certificate Number: 1461.01, valid to November 30, 2025). This includes an assessment of the laboratory’s compliance against the Department of Defense/Department of Energy Consolidated Quality Systems Manual (accredited to version 5.4, January 2021). The Quality Systems Manual is based on Volume 1 of The NELAC Institute Standards (September 2009), which incorporates International Organization for Standardization/International Electrotechnical Commission Standards ISO/IEC 17025:2005 and ISO/IEC 17025:2017, “General requirements for the competence of testing and calibration laboratories.” More specifically, Pace National is accredited to perform U.S. Environmental Protection Agency method 9310 for gross alpha and gross beta, and DOE method (Health and Safety Laboratory) HASL-300 Ga-01-R for gamma spectrometry.

Landauer, Inc. InLight dosimeters are utilized at the CEMP monitoring stations. InLight products are accredited by the National Voluntary Laboratory Accreditation Program (NVLAP, Lab Code 100518-0) and the Department of Energy Laboratory Accreditation Program (DOELAP). In addition, InLight dosimeters have passed 50+ independent performance tests by NVLAP and DOELAP, and Landauer is International Organization for Standardization (ISO 17025) certified through NVLAP. Landauer’s Calibration Laboratory is accredited by the American Association for Laboratory Accreditation.

15.8 References

Desert Research Institute, 2009. *DOE NNSA/NSO Community Environmental Monitoring Program Quality Assurance Management and Assessment Plan*, July 2009. Las Vegas, NV.

Appendix A

Las Vegas Area Support Facilities

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Appendix A: Las Vegas Area Support Facilities

Kyle A. Jones, Jennifer M. Larotonda, Xianan Liu, Erika Lomeli-Uribe, Karlita L. Simper, Amanda M. Rasmussen, and Brian G. Verheyen
Mission Support and Test Services, LLC

The U.S. Department of Energy (DOE), National Nuclear Security Administration Nevada Field Office (NNSA/NFO) manages two facilities in Clark County, Nevada, that support NNSA/NFO missions on and off the Nevada National Security Site (NNSS). These are the North Las Vegas Facility (NLVF) and the Remote Sensing Laboratory–Nellis (RSL-Nellis) (Figure A-1). This appendix describes environmental monitoring and compliance activities in 2024 at these facilities.

A.1 North Las Vegas Facility

The NLVF is a controlled-access complex composed of 31 buildings that house much of the NNSS project management, diagnostic development and testing, design, engineering, and procurement personnel. The 32-hectare (80-acre) facility is located along Losee Road, a short distance west of Interstate Highway 15 (Figure A-1). The facility is buffered on the north, south, and east by general industrial zoning. The western border separates the property from fully developed, single-family residential-zoned property. Environmental compliance and monitoring activities associated with this facility in 2024 included the maintenance of one air quality operating permit; one wastewater permit; one National Pollutant Discharge Elimination System (NPDES) permit; one Spill Prevention, Control, and Countermeasure (SPCC) Plan; and one hazardous materials permit (Table 2-2 lists NNSA/NFO permits). NNSA/NFO also monitors ***tritium (^3H)***[1] in air and ambient gamma emissions to comply with federal radiation protection regulations.

A.1.1 Air Quality and Protection

Sources of air pollutants at the NLVF are regulated by the Source 657 Minor Source Permit issued by the Clark County Division of Air Quality (DAQ) for the emission of ***criteria pollutants***. These pollutants include particulate matter (PM), nitrogen oxide (NO_X), carbon monoxide (CO), sulfur dioxide (SO_2), and volatile organic compounds (VOCs). Because the NLVF is considered a true minor source, there is no requirement to report ***hazardous air pollutants***. The regulated sources of emissions at the NLVF include diesel generators, a fire pump, cooling towers, and boilers. The DAQ requires an annual emissions inventory of criteria air pollutants; the 2024 inventory reported the estimated quantities (Table A-1) on March 25, 2024.

Table A-1. Summary of air emissions for the NLVF in 2024

	Criteria Pollutant (tons/year)[(a)]					
Parameter	**PM10[(b)]**	**PM2.5[(c)]**	**NO_x**	**CO**	**SO_2**	**VOC**
PTE[(d)]	1.24	1.24	19.58	4.75	0.09	0.96
Actual[(e)]	0.08	0.08	0.56	0.29	0.01	0.05
Total Emissions = 1.49 Actual, 27.82 PTE						

(a) 1 ton equals 0.91 metric tons.
(b) Particulate matter equal to or less than 10 microns in diameter.
(c) Particulate matter equal to or less than 2.5 microns in diameter.
(d) ***Potential to emit (PTE)*** is the quantity of criteria air pollutants that facilities/pieces of equipment would emit annually if they were operated for the maximum number of hours at the maximum production rate specified in the air permit.
(e) Emissions based on calculations using actual hours of operation for each piece of equipment.

Clark County air regulations specify that the opacity from any emission unit may not exceed the Clean Air Act National Ambient Air Quality Standards (NAAQS) opacity limit of 20% for more than 6 consecutive minutes. The NLVF air permit requires that a visible emissions check be performed from each diesel-fired generator and fire pump when operated for testing and maintenance.

[1] The definition of word(s) in ***bold italics*** may be found by referencing the Glossary, Appendix B.

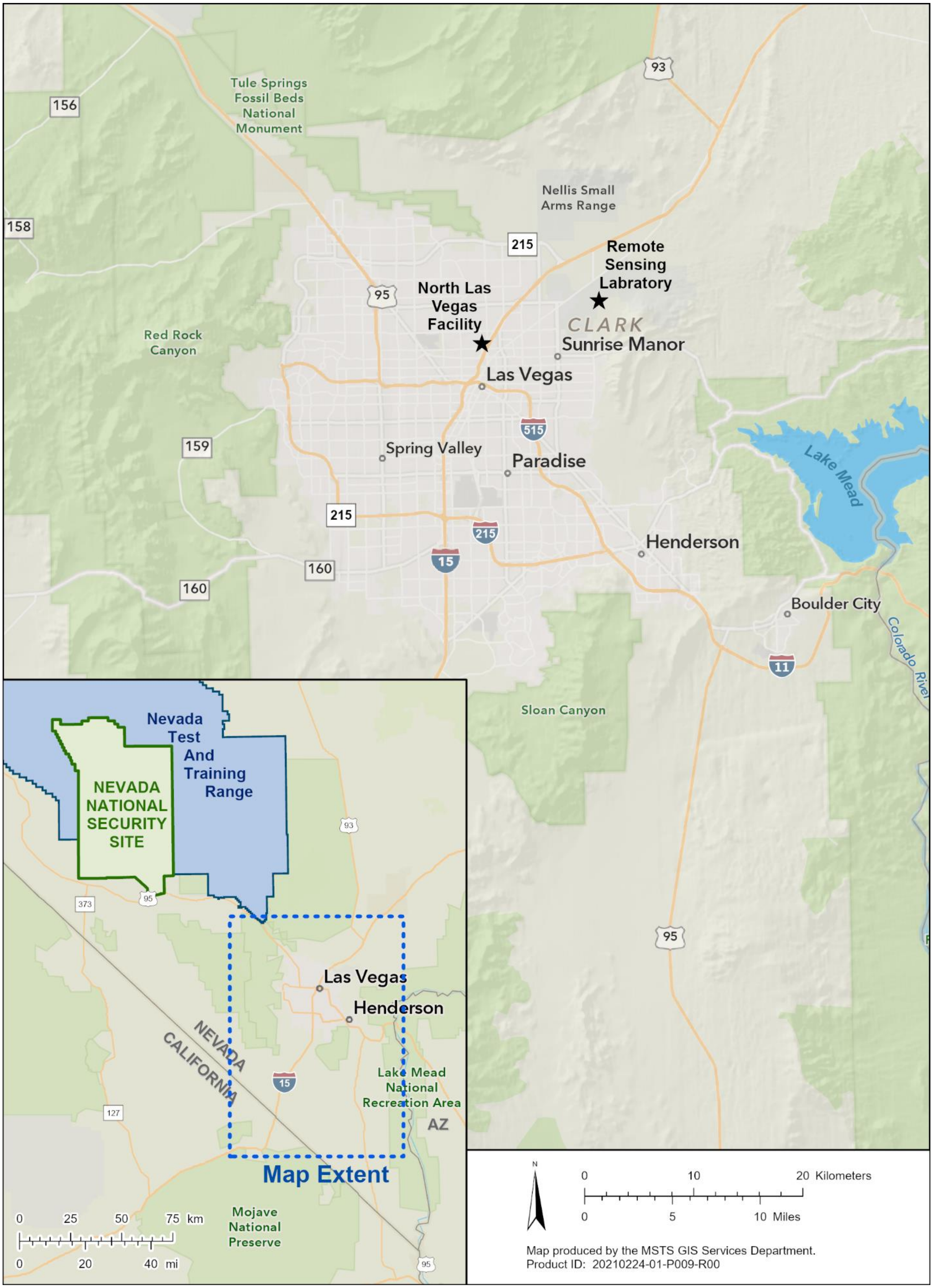

Figure A-1. Location of NNSS offsite facilities in Las Vegas and North Las Vegas

If emissions that appear to exceed the opacity limits are observed, then immediate corrective action would be taken. If practical, U.S. Environmental Protection Agency (EPA) Method 9 opacity readings would be recorded by a certified visible-emissions evaluator. In 2024, three NLVF Maintenance Engineers were recertified.

If visible emissions appear to exceed the limit, corrective actions must be taken to minimize emissions. In 2024, observations were taken for diesel-fired generators; all emissions were below the NAAQS opacity limit of 20%.

At NLVF, a verbal notification to the City of North Las Vegas (CNLV) Fire Department is required before each fire extinguisher training session. In 2024, hot work live fire extinguisher training sessions were conducted at the NLVF. Quantities of criteria air pollutants produced by the open burns during training are not required to be calculated or reported.

A.1.2 Water Quality and Protection

Water used at the NLVF is supplied by the CNLV and meets or exceeds federal drinking water standards. Water quality permits issued to NNSA/NFO include a Class II Wastewater Control Permit (036555-02) from the CNLV for NLVF sewer discharges and an NPDES DeMinimis (NVG201000) permit from the Nevada Division of Environmental Protection (NDEP) for dewatering operations to control rising groundwater levels at the facility. Discharges of sewage and industrial wastewater from the NLVF must meet permit limits set by the CNLV. These limits support the permit limits for the Publicly Owned Treatment Works operated by the CNLV. The Class II Permit specifies substances prohibited from being discharged at NLVF and requires that CNLV be notified of changes in discharge flow rates, spills, or other abnormal events. In 2024, no changes, spills, or abnormal events occurred.

A.1.2.1 Storm Water No Exposure Waiver ISW-40565

This waiver was approved on July 16, 2015, and provides a conditional exemption from the NPDES Storm Water Program and the State of Nevada Stormwater General Permit. The conditions specify that storm water discharges from the NLVF will not be exposed to industrial activities or materials. In 2024, no storm water exposures to such activities or materials occurred.

A.1.2.2 National Pollutant Discharge Elimination System DeMinimis General Permit

An NPDES DeMinimis general permit covers the dewatering operation at the NLVF (Section A.1.2.3). Dewatering wells (NLVF-13s, -15, -16, -17) and the A-01 Basement Sump Well pump groundwater into a 37,854-liter (L) (10,000-gallon [gal]) storage tank (Figure A-2). The water is then discharged from the storage tank into the Las Vegas Wash via direct discharge (Outfall 002) into the CNLV storm drainage system. Chemical analyses are performed annually on water samples collected from the storage tank. The total quantities of groundwater produced and discharged and the results of chemical analyses are reported annually to NDEP's Bureau of Water Pollution Control.

In 2024, the five dewatering wells at the NLVF produced an average of about 131,481 gal (497,710 L) per month that were directed into the storage tank. Annual water sampling for the presence of 23 analytes (permit NVG201000, Section A.10.3.4) was performed on October 10, 24, and November 7, 2024. All analyte concentrations were below permit limits, and discharge rates (i.e., daily maximum flows) did not exceed the NPDES DeMinimis general permit limits (Table A-2).

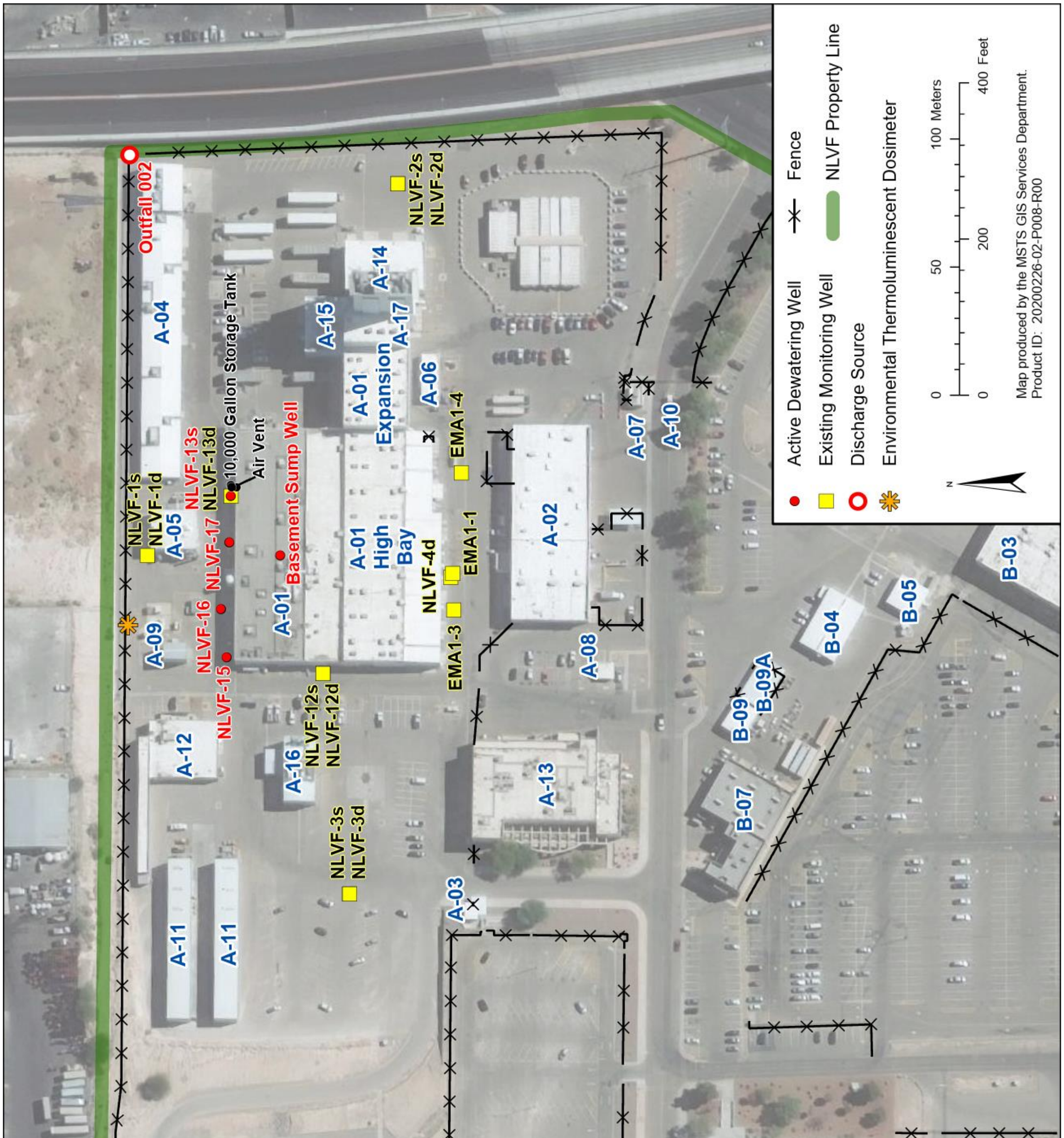

Figure A-2. Location of dewatering and monitoring wells around Building A-1

Table A-2. NLVF NPDES permit 2024 monitoring requirements and analysis results of storage tank water samples

	Monitoring Requirements		Permit Discharge Limits	Sample Results			
Parameter	**Sample Frequency**	**Sample Type**	**Daily Maximum**	**1st Quarter**	**2nd Quarter**	**3rd Quarter**	**4th Quarter**
Daily Maximum Flow (MGD)[(a)]	Continuous	Flow Meter	0.36	0.004	0.004	0.004	0.004
Total Petroleum Hydrocarbons[(b)] (mg/L)	Annually[(c)]	Discrete	1	NS[(d)]	NS	NS	ND[(e)]
Total Suspended Solids (mg/L)	Annually	Discrete	M&R[(f)]	NS	NS	NS	109
Total Dissolved Solids (mg/L)	Annually	Discrete	M&R	NS	NS	NS	1,320
Total Inorganic Nitrogen as N (mg/L)	Annually	Discrete	10	NS	NS	NS	2.6
pH (Standard Units)	Annually	Discrete	6.5–9.0	NS	NS	NS	7.14
Total Residual Chlorine (mg/L)	Annually[(g)]	Discrete	0.10	NS	NS	NS	0.06
Methyl tert-Butyl Ether (µg/L)[(h)]	Annually	Discrete	20.0	NS	NS	NS	ND
Total Phosphorus (mg/L)	Annually	Discrete	M&R	NS	NS	NS	ND
Trichloroethylene (µg/L)	Annually	Discrete	5.0	NS	NS	NS	ND
Tetrachloroethylene (µg/L)	Annually	Discrete	5.0	NS	NS	NS	0.51[(i)]
Benzene (µg/L)	Annually	Discrete	5.0	NS	NS	NS	ND
Ethylbenzene (µg/L)	Annually	Discrete	100.0	NS	NS	NS	ND
Toluene (µg/L)	Annually	Discrete	100.0	NS	NS	NS	ND
Xylene (µg/L)	Annually	Discrete	200.0	NS	NS	NS	ND
Barium (mg/L)	Annually	Discrete	2.0	NS	NS	NS	0.084
Fluoride (mg/L)	Annually	Discrete	M&R	NS	NS	NS	0.363
Iron (mg/L)	Annually	Discrete	1.0	NS	NS	NS	<0.1
Sulfate (mg/L)	Annually	Discrete	M&R	NS	NS	NS	209
Molybdenum (mg/L)	Annually	Discrete	6.16	NS	NS	NS	3.3
Turbidity (NTU)[(j)]	Annually	Discrete	M&R	NS	NS	NS	1.10
Fecal Coliform (MPN/100 ml)[(k)]	Annually	Discrete	M&R	NS	NS	NS	ND
Escherichia Coli (MPN/100 ml)	Annually	Discrete	M&R	NS	NS	NS	ND
Dissolved Oxygen (mg/L)	Annually	Discrete	M&R	NS	NS	NS	5.96

(a) MGD = million gallons per day.
(b) This parameter includes three analytes, in milligrams per liter (mg/L): diesel range organics, gasoline range organics, and oil range organics.
(c) Sampled in the 4th quarter of the calendar year.
(d) NS = not required to be sampled that quarter.
(e) ND = not detected; values were less than the laboratory detection limits.
(f) M&R = Monitor and report.
(g) The permit includes a "Two/Discharge" sampling frequency, but since this is continually discharging, the annual monitoring meets the requirement.
(h) µg/L = micrograms per liter.
(i) The value is estimated, since it is above the Method Detection Limit of 0.56 µg/L and below the Reporting Limit of 1.0 µg/L.
(j) NTU = nephelometric turbidity unit.
(k) MPN/100 ml = most probable number per 100 milliliters.

A.1.2.3 Groundwater Control and Dewatering Operation

In 2024, the groundwater control and dewatering project at the NLVF continued efforts to reduce the intrusion of groundwater below Building A-01. The project has transitioned from initial groundwater investigations and characterization to a long-term/permanent dewatering operation project. A review of the rising groundwater situation, and past efforts to understand and remediate this, is presented in previous reports (Bechtel Nevada 2003, 2004; National Security Technologies, LLC, 2006). Monitoring for this operation includes periodic measurements of water level at 24 of the 27 NLVF monitoring wells (not all wells are presented on Figure A-2), continuous water level measurements at the A-01 Basement Sump Well, measurement of water level at the A-01 elevator shaft, measurement of the total volume of discharged groundwater, and conducting groundwater characterization in accordance with the NPDES DeMinimis general permit. Groundwater data are assessed as new data become available. This information is used to help characterize groundwater conditions and evaluate the dewatering operation.

When the A-01 Basement Sump Well pump is active, the water level directly beneath Building A-01 averages 12.5 inches (in.) (31.8 centimeters [cm]) below the basement floor, as measured in a monitoring tube installed in a nearby elevator shaft. This average water level is based on daily measurements taken in 2024 and reflects a drop of about 21.0 in. (53.3 cm) in the local ***water table*** beneath Building A-01 since full-scale dewatering operations began in 2006. The general trend for the NLVF site-wide monitoring network shows an average rise in the water level of 4.2 feet (1.3 meters) since 2003. Dewatering efforts must continue to counter this rising groundwater trend.

A.1.2.4 Oil Pollution Prevention

The NLVF has an SPCC Plan that was prepared in accordance with the Clean Water Act to minimize the potential discharge of petroleum products, animal fats and vegetable oils, and other non-petroleum oils and greases into waters of the U.S. (i.e., the Las Vegas Wash). The EPA requires SPCC Plans for non-transportation–related facilities having the potential to pollute waters of the U.S. and having an aggregate aboveground oil storage capacity of more than 4,997 L (1,320 gal). Oil storage facilities at the NLVF include 11 aboveground tanks, 18 transformers, 12 pieces of oil-filled machining equipment (e.g., lathes, elevators), and numerous 55-gal drums that are used to store new and used oils. These facilities/pieces of equipment are located within approved spill and storm water runoff containment structures. The SPCC specifies procedures for removing storm water from containment structures and identifies discharge countermeasures, disposal methods for recovered materials, and discharge reporting requirements.

In 2024, quarterly inspections of tanks, transformers, oil-filled equipment, and drums were conducted in March, May, September, and December. Throughout 2024, all NLVF employees who handle oil received their required annual spill prevention and management training. No spills occurred in 2024 that met regulatory agency reporting criteria.

A.1.3 Radiation Protection

A.1.3.1 National Emission Standards for Hazardous Air Pollutants

In compliance with the National Emission Standards for Hazardous Air Pollutants (NESHAP) of the Clean Air Act, the ***radionuclide*** air emissions from the NLVF and the resultant radiological ***dose*** to the public surrounding the facility were assessed. NESHAP establishes a dose limit for the general public to be no greater than 10 millirems per year (mrem/yr) from all radioactive air emissions (Mission Support and Test Services, LLC [MSTS], 2025). The basement of Building A-01 was contaminated with ^{3}H in 1995 when a container of ^{3}H foils was opened, emitting about 1 curie of ^{3}H (U.S. Department of Energy, Nevada Operations Office 1996). Complete cleanup of the ^{3}H was unsuccessful due to the ^{3}H being absorbed into the building materials. This has resulted in a continuous but decreasing release of ^{3}H into the basement air space, which is ventilated to the outdoors. Since 1995, a dose assessment has been performed every year for this building.

In 2024, ^{3}H emissions continued emanating from building materials in the building's basement. This ^{3}H emission was estimated by taking two air samples from the basement (on April 9–16 and September 9–16, 2024) in order to compute average ^{3}H emissions. A calculated annual total of 0.94 millicuries were released from the basement air that was vented to the outside. Based on this emission rate, the 2024 calculated radiation dose to the nearest member of the general public from the NLVF was very low: 0.0000047 mrem/yr (MSTS 2025). The nearest public place is 100 meters (328 feet) northwest of Building A-01. This annual public dose is well below the regulatory limit of 10 mrem/yr.

A.1.3.2 U.S. Department of Energy Order 458.1

DOE Order DOE O 458.1, "Radiation Protection of the Public and the Environment," specifies that the radiological dose to a member of the public from radiation from all pathways must not exceed 100 mrem/yr as a result of DOE activities. This dose limit does not include the dose contribution from natural ***background*** radiation. The Atlas A-1 Source Range Laboratory and the Building C-3 High Intensity Source Building are two NLVF facilities that use radioactive sources or where radiation-producing operations are conducted that have the potential to expose the general population or non-project personnel to direct radiation. Direct radiation monitoring is conducted using ***thermoluminescent dosimeters (TLDs)*** to monitor external ***gamma radiation exposure*** near the boundaries of these facilities. The methods of TLD use and data analyses are described in Chapter 6 of this report.

In 2024, radiation exposure was measured at two locations along perimeter fences for Buildings A-01 and C-3 and at one control location along the west fence of Building C-1 (Figure A-2). Annual exposure rates estimated from measurements at those locations are summarized in Table A-3. The radiation exposure in air measured by the TLDs is in the unit of milliroentgens per year (mR/yr), which is considered equivalent to the unit of mrem/yr for tissue. These exposures are similar to the average natural background radiation of 69.5 mrem/yr (excluding radon) in Las Vegas (https://cemp.dri.edu/cemp/Radiation.html). The NLVF TLD results indicate that facility activities do not contribute a radiological dose to the surrounding public that can be distinguished from the dose due to background radiation.

Table A-3. Results of 2024 direct radiation exposure monitoring at the NLVF

Location	Number of Samples	Gamma Exposure (mR/yr)			
		Mean	Median	Minimum	Maximum
West Fence of Building C-1 (Control)	4	99	98	95	104
North Fence of Building A-01	4	67	67	61	75
North Fence of Building C-3	4	68	67	67	73

A.1.4 Hazardous Waste Management

Hazardous wastes (HWs) generated at the NLVF include such items as non-empty aerosol cans, lead-contaminated debris, and spent machine cutting fluid. HWs are accumulated temporarily in satellite accumulation areas until they are direct-shipped to approved disposal facilities. The NLVF is a Very Small Quantity Generator and does not store HW; therefore, no HW permit is required by the State of Nevada. However, the Southern Nevada Health District (SNHD) issues the facility an annual permit for restricted waste management. The SNHD normally conducts an annual audit to validate proper handling and storage of restricted wastes; SNHD conducted an audit in 2024, and no issues were identified.

A.1.5 Hazardous Materials Control and Management

The 2024 NLVF chemical inventory was submitted to the state in the Nevada Combined Agency (NCA) Report on February 26, 2025. The inventory data were submitted in accordance with the requirements of the Hazardous Materials Permit 95585. For a description of the content, purpose, and federal regulatory driver behind the NCA Report, see Section 2.4.4.1, "Emergency Planning and Community Right-to-Know Act." No accidental or unplanned release of an extremely hazardous substance (EHS) occurred at the NLVF. Also, the quantities of toxic chemicals kept at the NLVF that are used annually did not exceed the specified reporting thresholds (Chapter 2, Table 2-6 concerning Toxic Chemical Release Inventory, Form R).

A.2 Remote Sensing Laboratory–Nellis

RSL-Nellis is approximately 13.7 kilometers (km) (8.5 miles [mi]) northeast of the Las Vegas city center and approximately 11.3 km (7 mi) northeast of the NLVF. It occupies six facilities on approximately 14 secured hectares (35 acres) at Nellis Air Force Base. A Memorandum of Agreement between the U.S. Air Force (USAF) and NNSA/NFO acknowledges that the land belongs to the USAF and is leased to NNSA/NFO, while the RSL facilities are owned by NNSA/NFO. RSL-Nellis provides emergency response resources for weapons-of-mass-destruction incidents. The laboratory also designs and conducts field tests of counterterrorism/intelligence technologies, and has the capability to assess environmental and facility conditions using complex radiation measurements and multi-spectral imaging technologies.

Environmental compliance and monitoring activities at RSL-Nellis in 2024 included maintenance of an air quality permit, an underground storage tank (UST) permit for one active UST, and a hazardous materials permit (Table 2-2 lists NNSA/NFO permits). Sealed radiation sources are used for calibration at RSL-Nellis, but the public has no access to any area that may have elevated gamma radiation emitted by the sources. Therefore, no environmental TLD monitoring is conducted. However, dosimetry monitoring is performed to ensure worker protection.

A.2.1 Air Quality and Protection

Sources of air pollutants at RSL-Nellis are regulated by the Source 348 Synthetic Minor Source Permit issued by the Clark County DAQ for the emission of criteria pollutants. Regulated sources of air pollutant emissions at RSL-Nellis include an aluminum sander, an abrasive blaster, spray paint booth, generators, a fire pump, and boilers. The 2024 emissions inventory of criteria air pollutants was submitted to the DAQ on March 25, 2025, and is shown in Table A-4.

Clark County air regulations specify that the opacity from any emission unit may not exceed the NAAQS opacity limit of 20% for more than 6 consecutive minutes. The RSL-Nellis air permit requires that a visible emissions check be performed from each diesel-fired generator and fire pump when operated for testing and maintenance. If emissions appear to exceed the opacity limit, then immediate corrective action would be taken. If practical, EPA Method 9 opacity readings would be recorded by a certified visible-emissions evaluator. In 2024, no RSL Maintenance Engineers were certified.

Table A-4. Summary of air emissions for RSL-Nellis in 2024

	Criteria Pollutant (tons/year)[(a)]					
Parameter	**PM10[(b)]**	**PM2.5[(c)]**	**NO_x**	**CO**	**SO_2**	**VOC**
PTE[(d)]	0.52	0.52	4.26	1.74	0.05	0.40
Actual[(e)]	0.05	0.05	0.30	0.21	0.00	0.03
Total Emissions = 0.64 Actual, 7.49 PTE						

(a) 1 ton equals 0.91 metric tons.

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

(c) Particulate matter equal to or less than 2.5 microns in diameter.

(d) PTE is the quantity of criteria pollutants that facilities/pieces of equipment would emit annually if they were operated for the maximum number of hours at the maximum production rate specified in the air permit.

(e) Emissions based on calculations using actual hours of operation for each piece of equipment.

A.2.2 Water Quality and Protection

Water used at RSL-Nellis is supplied by the Southern Nevada Water Authority and meets or exceeds federal drinking water standards. The Clark County Water Reclamation District (CCWRD) determined that a discharge permit is not necessary for RSL-Nellis since no industrial wastewaters are discharged. Instead, an annual submission of a Zero Discharge Form verifying that no industrial wastewater was discharged to the sanitary sewer system is required. A Zero Discharge Certification for 2024 was submitted to CCWRD on January 23, 2025. There were no regulatory inspections of RSL-Nellis by the CCWRD and no findings or corrective actions were identified by internal assessments.

A.2.2.1 Oil Pollution Prevention

An SPCC Plan is in place for RSL-Nellis. Similar to the NLVF (Section A.1.2.4), the SPCC Plan is required because the facility has an aggregate aboveground oil storage capacity of more than 4,997 L (1,320 gal), and spills could potentially enter the Las Vegas Wash. Oil storage facilities at RSL-Nellis include five aboveground tanks, four transformers, and two pieces of oil-filled equipment (i.e., elevators). These facilities and pieces of equipment are within approved spill and storm water runoff containment structures. The SPCC specifies procedures for removing storm water from containment structures and identifies discharge countermeasures, disposal methods for recovered materials, and discharge reporting requirements.

In 2024, quarterly inspections of tanks, transformers, and oil-filled equipment were conducted in March, June, September, and December. All RSL-Nellis employees who handle oil received their required annual spill prevention and management training. No spills occurred in 2024 that met regulatory agency reporting criteria.

A.2.3 Underground Storage Tank Management

The SNHD has oversight authority of USTs in Clark County. On January 1, 2024, the UST program at RSL-Nellis consisted of one fully regulated active tank for diesel fuel, three fully regulated temporarily closed tanks (one for unleaded gasoline, one for diesel fuel, and one for used oil), and four excluded tanks. The fully regulated USTs are operated under the RSL-Nellis UST Permit PR0064276 issued by SNHD. The fully regulated, active, and temporarily closed tanks are typically inspected annually by SNHD. SNHD was unable to complete an annual inspection in 2024, but completed an inspection on January 8, 2025. SNHD did not identify any findings.

A.2.4 Hazardous Materials Control and Management

The chemical inventory at RSL-Nellis was submitted to the state in the NCA Report on February 26, 2025, in accordance with the requirements of the Hazardous Materials Permit 95579 (Section 2.4.4.1 describes the content, purpose, and federal regulatory driver behind the NCA Report). No accidental or unplanned release of an EHS occurred at RSL-Nellis in 2024. Also, no annual usage quantities of toxic chemicals kept at RSL-Nellis exceeded specified thresholds (Chapter 2, Table 2-5 concerning Toxic Chemical Release Inventory, Form R).

A.3 References

Bechtel Nevada, 2003. *Summary Report for the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office FY02/FY03 Groundwater Control Study at the North Las Vegas Facility*. Las Vegas, NV.

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Mission Support and Test Services, LLC, 2025. *National Emission Standards for Hazardous Air Pollutants - Radionuclide Emissions Calendar Year 2024.* DOE/NV--1609, prepared for U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office, Las Vegas, NV.

MSTS, see Mission Support and Test Services, LLC.

National Security Technologies, LLC, 2006. *Groundwater Control at Building A-01, North Las Vegas Facility Enhanced Dewatering Initiative*. Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office, 1996. *National Emission Standards for Hazardous Air Pollutants Submittal – 1995*. DOE/NV/11718--032, Las Vegas, NV. OSTI ID: 436417

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Appendix B: Glossary of Terms

A **Absorbed dose:** the amount of energy absorbed by an object or person per unit mass. It reflects the amount of energy that ionizing radiation sources deposit in materials through which they pass, and is measured in units of radiation-absorbed dose (rad). The related international system unit is the gray (Gy), where 1 Gy is equivalent to 100 rad.

Actinide: any of the series of 15 metallic elements from actinium (atomic number 89) to lawrencium (atomic number 103) in the periodic table. They are all radioactive, the heavier members being extremely unstable and not of natural occurrence. The actinides mentioned in this document include uranium, plutonium, and americium.

Action levels: standards established by, or in coordination with the regulator, based on expected land use and risk-based evaluation criteria.

Alpha particle: a positively charged particle emitted from the nucleus of an atom having mass and charge equal to those of a helium nucleus (two protons and two neutrons), usually emitted by transuranic elements (elements with atomic numbers greater than 92 [the atomic number of uranium], all of which are unstable and decay radioactively into other elements).

Alpha radioactivity: ionizing radiation consisting of alpha particles, emitted by some substances undergoing radioactive decay.

Aquifer: a saturated layer of rock or soil below the ground surface that can supply usable quantities of groundwater to wells and springs and be a source of water for domestic, agricultural, and industrial uses.

Area 5 Radioactive Waste Management Complex (RWMC): the complex in Area 5 of the Nevada National Security Site at which low-level waste (LLW) and mixed low-level waste (MLLW) may be received, examined, packaged, stored, or disposed. Limited quantities of onsite-generated transuranic waste (TRU) are also stored temporarily at the RWMC. The RWMC is composed of the Area 5 Radioactive Waste Management Site (RWMS), the Mixed Waste Storage Unit (MWSU), the Mixed Waste Disposal Unit (MWDU) and supporting administrative buildings, parking areas, and utilities. Co-located with the Area 5 RWMC is the Waste Examination Facility (WEF) which includes the TRU Pad, the Sprung Instant Structure (SIS), and the Visual Examination and Repackaging Building (VERB), as well as other operational units described in Chapter 10.

As low as reasonably achievable (ALARA): an approach to radiation safety that strives to manage and control doses to the work force and general public.

Atom: the smallest particle of an element capable of entering into a chemical reaction.

B **Background:** as used in this report, background is the term for the amounts of chemical constituents or radioactivity in the environment that are not caused by Nevada National Security Site operations. In the broader context outside this report, background radiation refers to radiation arising from natural sources always present in the environment, including solar and cosmic radiation from outer space and naturally radioactive elements in the atmosphere, the ground, building materials, and the human body.

Becquerel (Bq): the International System of Units unit of activity of a radionuclide, equal to the activity of a radionuclide having one spontaneous nuclear transition per second.

Beta particle: a negatively charged particle emitted from the nucleus of an atom, having charge, mass, and other properties of an electron, emitted from fission products such as cesium-137.

Beta radioactivity: ionizing radiation consisting of beta particles emitted in the radioactive decay of an atomic nucleus.

Biochemical oxygen demand (BOD): a measure of the amount of dissolved oxygen that microorganisms need to break down organic matter in water; used as an indicator of water quality.

Bureau of Land Management (BLM) herd management areas (HMA): the BLM manages wild horses and burros in 177 herd management areas across 10 western states. Each HMA is unique in its terrain features, local climate and natural resources, just as each herd is unique in its history, genetic heritage, coloring and size distribution (source: https://www.blm.gov/programs/wild-horse-and-burro/herd-management/herd-management-areas).

C **CAU regulatory boundary objectives:** statements of specific objectives for each CAU to protect the public and environment from exposure to groundwater contaminated by underground testing of nuclear weapons on the NNSS.

Classified Non-Radioactive (CNR) waste: waste to which access has been limited for national security reasons and cannot be declassified, and which does not need to be managed for its radioactive content.

Classified Non-Radioactive Hazardous (CNRH) waste: waste to which access has been limited for national security reasons and cannot be declassified, does not need to be managed for its radioactive content, and contains a hazardous component subject to the Resource Conservation and Recovery Act (RCRA), as amended.

Clean Air Package, 1988, (CAP88-PC): a computer model with a set of computer programs, databases and associated utility programs for estimating dose and risk from radionuclideemissions to air. CAP88 is a regulatory compliance tool under the National Emissions Standard for Hazardous Air Pollutants (NESHAP) (source: https://www.epa.gov/radiation/cap-88-pc).

Clean closure: the removal of pollutants, hazardous wastes, and solid wastes above action levels in accordance with regulator-approved corrective action plans.

Closure in place: the stabilization or isolation of pollutants, hazardous wastes, and solid wastes, with or without partial treatment, removal activities, and/or post-closure monitoring. Closures-in-place of legacy contamination sites on and off the Nevada National Security Site, which are managed by the U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office, are attained in accordance with approved corrective action plans outlined in the 1996 Federal Facility Agreement and Consent Order (as amended) between the U.S. Department of Energy, the U.S. Department of Defense, and the State of Nevada.

Closure process: the completion of needed remediation, implementation of required post-closure monitoring, and regulatory review and approval of closure reports.

Closure stage: phase of the FFACO corrective action strategy for UGTA when contaminant, regulatory, and use restriction boundaries are identified and agreed upon by DOE and NDEP. In addition, during this phase, monitoring requirements and land-use restrictions are established and implemented.

Code of Federal Regulations (CFR): a codification of all regulations promulgated by federal government agencies.

Collective population dose: the sum of the total effective dose equivalents of all individuals within a defined population. The unit of collective population dose is person-rem or person-sievert. Collective population dose may also be referred to as "collective effective dose equivalent" or simply "population dose."

Committed effective dose equivalent (CEDE): the sum of the committed dose equivalents to various tissues in the body, each multiplied by an appropriate weighting factor representing the relative vulnerability of different parts of the body to radiation. Committed effective dose equivalent is expressed in units of rem or sievert.

Community water system: as defined in Nevada Revised Statute 445A.808, a public water system that has at least 15 service connections used by year-round residents of the area served by the system; or regularly serves at least 25 year-round residents of the area served by the system.

Composite analysis (CA): an analysis of the risks posed by all wastes disposed in a low-level radioactive waste disposal facility and by all other sources of residual contamination that may interact with the disposal site. CAs, along with performance assessments (PAs), are conducted for the Area 3 and Area 5 Radioactive Waste Management Sites on the Nevada National Security Site to assess and predict their long-term performance.

Concentration Level (CL): the Clean Air Act National Emission Standards for Hazardous Air Pollutants Concentration Level for Environmental Compliance. The CL value represents the annual average concentration that would result in a dose of 10 millirem per year, which is the federal dose limit to the public from all radioactive air emissions.

Confining unit: a geologic unit of relatively low permeability that impedes the vertical movement of groundwater.

Contaminant Boundary: a type of boundary developed for an Underground Test Area (UGTA) corrective action unit (CAU). It is a forecast perimeter and a lower hydrostratigraphic unit boundary that delineates the potential extent of radionuclide-contaminated groundwater from underground testing for 1,000 years. Contaminated groundwater is defined as water exceeding the radiological standards of the Safe Drinking Water Act (SDWA). The forecasted contamination is a volume, which is projected upward to the ground surface to define a two-dimensional contaminant boundary perimeter. Simulation modeling of the transport of radiological contaminants in groundwater is usually used to forecast the locations of the contaminant boundaries within the next 1,000 years. CAU-specific contaminant boundaries are approved by the Nevada Division of Environmental Protection.

Continuous release: defined by the U.S Environmental Protection Agency as a release that occurs without interruption or abatement, or that is routine, anticipated, intermittent, and incidental to normal operation or treatment process.

Corrective actions: include removing contamination or leaving it in place with use restrictions and monitoring requirements that are based on contaminant amounts compared to action levels.

Criteria pollutants: those air pollutants designated by the U.S. Environmental Protection Agency as potentially harmful and for which National Ambient Air Quality Standards under the Clean Air Act have been established to protect the public health and welfare. These pollutants include sulfur dioxide (SO_2), nitrogen oxides (NO_X), carbon monoxide (CO), ozone, lead, and particulate matter equal to or less than 10 microns in diameter (PM10). The State of Nevada, through an air quality permit, establishes emission limits on the Nevada National Security Site for SO_2, NO_X, CO, PM10, and volatile organic compounds (VOCs). Ozone is not regulated by the permit as an emission, as it is formed in part from NO_X and VOCs. Lead is considered a hazardous air pollutant (HAP) as well as a criteria pollutant, and lead emissions on the Nevada National Security Site are reported as part of the total HAP emissions. Lead emissions above a specified threshold are also reported under Section 313 of the Emergency Planning and Community Right-to-Know Act.

Critical Level (L_C) (also known as decision level): the counts of radioactivity (or concentration level of a radionuclide) in a sample that must be exceeded before there is a specified level of confidence (typically 95 or 99 percent) that the sample contains radioactive material above the background.

Critical receptor samplers: a type of radiological air monitoring station on the NNSS that samples air particulates and water vapor for the purpose of assessing dose to the public from airborne radionuclides originating from past or current NNSS activities and documenting if the assessed dose exceeds the DOE public dose limit of 10 millirems per year from inhalation. The U.S. Environmental Protection Agency has approved a sampling network of six such stations on the NNSS. The critical receptor is assumed to be an individual who resides at the station location. Air sample analysis results for each station identify whether this hypothetical individual would be exposed to airborne radionuclides that would exceed the DOE public dose limit. It is assumed that if air sampling results at these six locations on the NNSS indicate doses below the public limit, then the public who reside off the NNSS at greater distances from the NNSS sources of airborne radionuclides, then the offsite public dose is even less.

Curie (Ci): a unit of measurement of radioactivity, defined as the amount of radioactive material in which the decay rate is 3.7×10^{10} (37 billion) disintegrations per second; one Ci is approximately equal to the decay rate of one gram of pure radium.

D **Daughter nuclide (also known as isotope or product):** a nuclide formed by the radioactive decay of another nuclide, which is called the parent.

Decay (see Radioactive decay).

Decision level (also known as critical level): the counts of radioactivity (or concentration level of a radionuclide) in a sample that must be exceeded before there is a specified level of confidence (typically 95 or 99 percent) that the sample contains radioactive material above the background.

Depleted uranium (DU): uranium having a lower proportion of the isotope ^{235}U than is found in naturally occurring uranium. The masses of the three uranium isotopes with atomic weights 238, 235, and 234 occur in depleted uranium in the weight-percentages 99.8, 0.2, and 5×10^{-4}, respectively.

Derived Concentration Standard (DCS): concentration of a given radionuclide in either water or air that results in a member of the public receiving 100 millirem (1 millisievert) effective dose following continuous exposure for one year via each of the following pathways: ingestion of water, submersion in air, and inhalation. They replace the Derived Concentration Guides previously published by the U.S. Department of Energy (DOE) in 1993 in DOE Order DOE O 5400.5. Since 1993, the radiation protection framework on which DCSs are based has evolved with more sophisticated biokinetic and dosimetric information provided by the International Commission on Radiological Protection (ICRP), thus enabling consideration of age and gender. DOE-STD-1196-2011 establishes DCS values that reflect the current state of knowledge and practice in radiation protection. These DCSs are based on age-specific effective dose coefficients, revised gender specific physiological parameters for the Reference Man (ICRP 2002), and the latest information on the energies and intensities of radiation emitted by radionuclides (ICRP 2008).

Designated pollutant: any pollutant regulated by the Clean Air Act's New Source Performance Standards that is not a criteria pollutant. Examples of these are acid mist, fluorides, hydrogen sulfide in acid gas, and total reduced sulfur.

Diffuse source: an area source from which radioactive air emissions are continuously distributed over a given area or emanate from a number of points randomly distributed over the area (generally, all sources other than point sources). Diffuse sources are not actively ventilated or exhausted. Diffuse sources include: emissions from large areas of contaminated soil, resuspension of dust deposited on open fields, ponds and uncontrolled releases from openings in a structure.

Dose: the energy imparted to matter by ionizing radiation; the unit of absorbed dose is the rad, equal to 0.01 joules per kilogram for irradiated material in any medium.

Dosimeter: a portable detection device for measuring the total accumulated exposure to ionizing radiation.

Dosimetry: the theory and application of the principles and techniques of measuring and recording radiation doses.

E **Effective dose equivalent (EDE):** an estimate of the total risk of potential effects from radiation exposure; it is the summation of the products of the dose equivalent and weighting factor for each tissue. The weighting factor is the decimal fraction of the risk arising from irradiation of a selected tissue to the total risk when the whole body is irradiated uniformly to the same dose equivalent. These factors permit dose equivalents from non-uniform exposure of the body to be expressed in terms of an EDE that is numerically equal to the dose from a uniform exposure of the whole body that entails the same risk as the internal exposure. The EDE includes the committed effective dose equivalent from internal deposition of radionuclides and the EDE caused by penetrating radiation from sources external to the body, and is expressed in units of rem or sievert.

Exposure: the absorption of ionizing radiation or ingestion of a radioisotope. Acute exposure is a large exposure received over a short period. Chronic exposure is exposure received over a long period, such as during a lifetime.

F **Federal citation:** a reference to a federal law identified by its Public Law (Pub. L) or United States Code (USC) abbreviation, or a reference to the implementing regulation of a federal law identified by its Code of Federal Regulations (CFR) abbreviation. CFR citations are used in this report unless none have been written, in which case, USC citations are used. If a public law has yet to be incorporated into the USC, then its public law (Pub. L) citation is used.

When a bill is signed by the President and becomes a new public law, it is assigned a law number, legal statutory citation, and prepared for publication as a slip law. Citations for public laws include the abbreviation, Pub. L., the Congress number, and the number of the law. At the end of each session of Congress, the slip laws are compiled into bound volumes called the Statutes at Large, which present a chronological arrangement of the laws in the order that they have been enacted.

Every 6 years, public laws are incorporated into the USC, which is a codification of all general and permanent laws of the United States. They are assigned a USC number which reflects their relationship to similar laws or laws that govern similar programs. A supplement to the USC is published during each interim year until the next comprehensive volume is published. The USC is arranged by subject matter, and it shows the present status of laws with amendments already incorporated in the text that have been amended on one or more occasions.

Implementing regulations for federal laws are written by the government agencies responsible for the subject matter of the laws and explain in detail how the laws are to be carried out. For example, the United States Environmental Protection Agency writes the regulations concerning water pollution control which are found in Title 40 of the CFR, while the U. S. Fish and Wildlife Service writes the regulations concerning endangered species protection found in Title 50 of the CFR.

G **Gamma radiation:** high-energy, short-wavelength, ionizing, electromagnetic radiation emitted from the nucleus of an atom, frequently accompanying the emission of alpha or beta particles. It consists of photons in the highest observed range of photon energy. Gamma radiation (or gamma rays) easily pass through the human body but can be almost completely blocked by about 40 inches of concrete, 40 feet of water, or a few inches of lead.

Gray (Gy): the International System of Units unit of measure for absorbed dose; the quantity of energy imparted by ionizing radiation to a unit mass of matter, such as tissue. One gray equals 100 rads, or 1 joule per kilogram.

Gross alpha: the measure of radioactivity caused by all radionuclides present in a sample that emit alpha particles. Gross alpha measurements reflect alpha activity from all sources, including those that occur naturally. Gross measurements are used as a method to screen samples for relative levels of radioactivity.

Gross beta: the measure of radioactivity caused by all radionuclides present in a sample that emit beta particles. Gross beta measurements reflect beta activity from all sources, including those that occur naturally. Gross measurements are used as a method to screen samples for relative levels of radioactivity.

H **Half-life:** the time required for one-half of the radioactive atoms in a given amount of material to decay; for example, after one half-life, half of the atoms will have decayed; after two half-lives, three-fourths; after three half-lives, seven-eighths; and so on, exponentially.

Hazardous air pollutant (HAP): a toxic air pollutant that is known or suspected to cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental effects. The U.S. Environmental Protection Agency has set emission standards for 22 of the 187 designated HAPs. Examples of toxic air pollutants include benzene, which is found in gasoline; perchloroethylene, which is emitted from some dry cleaning facilities; and methylene chloride, which is used as a solvent and paint stripper by a number of industries. Examples of other listed HAPs include dioxin, asbestos, toluene, and metals such as cadmium, mercury, chromium, and lead compounds.

Hazardous waste (HW): hazardous wastes exhibit any of the following characteristics: ignitability, corrosivity, reactivity, or Extraction Procedure toxicity (yielding excessive levels of toxic constituents in a leaching test), but other wastes that do not necessarily exhibit these characteristics have been determined to be hazardous by the U.S. Environmental Protection Agency (EPA). Although the legal definition of hazardous waste is complex, according to the EPA, the term generally refers to any waste that, if managed improperly, could pose a threat to human health and the environment.

High-efficiency particulate air (HEPA) filter: a disposable, extended-media, dry-type filter used to capture particulates in an air stream; HEPA collection efficiencies are at least 99.97 percent for 0.3-micrometer diameter particles.

I **Incidental take:** an unintentional, but not unexpected, taking that results from activities that are otherwise lawful.

International System of Units (SI): an international system of physical units that includes meter (length), kilogram (mass), kelvin (temperature), becquerel (radioactivity), gray (radioactive dose), and sievert (dose equivalent). The abbreviation, SI, comes from the French term Système International d'Unités.

Ionizing radiation: a form of radiation, which includes alpha particles, beta particles, gamma rays, x-rays, neutrons, high-speed electrons, high-speed protons, and other particles capable of producing ions. Compared to non-ionizing radiation, such as radio- or microwaves, or visible, infrared, or ultraviolet light, ionizing radiation is considerably more energetic. When ionizing radiation passes through material such as air, water, or living tissue, it deposits enough energy to produce ions by breaking molecular bonds and displace (or remove) electrons from atoms or molecules. This electron displacement may lead to changes in living cells. Given this ability, ionizing radiation has a number of beneficial uses, including treating cancer or sterilizing medical equipment. However, ionizing radiation is potentially harmful if not used correctly, and high doses may result in severe skin or tissue damage.

Isotope (also known as daughter nuclide or product): each of two or more forms of the same element that contain equal numbers of protons but different numbers of neutrons in their nuclei, and hence differ in relative atomic mass but not in chemical properties; in particular, a radioactive form of an element. For example, carbon-12 (^{12}C), the most common form of carbon, has six protons and six neutrons, whereas carbon-14 (^{14}C), the radioactive isotope of carbon, has six protons and eight neutrons.

L **L_C:** see Critical Level (L_C).

Low-level radioactive waste (LLW): defined by U.S. Department of Energy Manual DOE M 435.1-1, "Radioactive Waste Management Manual," as radioactive waste that is not high-level radioactive waste, spent nuclear fuel, transuranic waste, byproduct material (as defined in section 11e.(2) of the Atomic Energy Act of 1954, as amended), or naturally occurring radioactive material.

M **Maximally exposed individual (MEI):** a hypothetical member of the public at a fixed location who, over an entire year, receives the maximum effective dose equivalent (summed over all pathways) from a given source of radionuclide release. Generally, the MEI is different for each source at a site.

Maximum contaminant level (MCL): the highest level of a contaminant in drinking water that is allowed by U.S. Environmental Protection Agency regulation.

Minimum detectable concentration (MDC): also known as the lower limit of detection, the smallest amount of radioactive material in a sample that can be quantitatively distinguished from background radiation in the sample with 95 percent confidence.

Mixed low-level waste (MLLW): waste containing both radioactive and hazardous components. It is defined by U.S. Department of Energy Manual DOE M 435.1-1, "Radioactive Waste Management Manual," as low-level waste determined to contain both source, special nuclear, or byproduct material subject to the Atomic Energy Act of 1954, as amended, and a hazardous component subject to the Resource Conservation and Recovery Act (RCRA), as amended.

N **No further action:** denotes that no contamination exists above action levels as confirmed through investigation

Non-community water system: as defined in Nevada Revised Statute 445A.828, it is a public water system that is not a community water system.

O **Ozone Depleting Substances (ODS):** substances regulated by the EPA in the U.S. as Class I or Class II controlled substances. Class I substances have a higher ozone depletion potential (0.2 or higher) and have been completely phased out in the U.S. With a few exceptions, this means no one can produce or import Class I substances. Class I ODS include halons, chlorofluorocarbons (CFCs), methyl chloroform, carbon tetrachloride, and methyl bromide. Class II substances have an ozone depletion potential less than 0.2 and are all hydrochlorofluorocarbons (HCFCs). HCFCs were developed as transitional substitutes for many Class I substances. New production and import of most HCFCs will be phased out by 2020. The most common HCFC in use today is HCFC-22 or R-22, a refrigerant still used in existing air conditioners and refrigeration equipment.

P **Performance assessment (PA):** a systematic analysis of the potential risks posed by a waste disposal facility to the public and to the environment from disposed low-level radioactive waste. PAs are conducted, along with composite analyses (CAs), for the Area 3 and Area 5 Radioactive Waste Management Sites on the Nevada National Security Site to assess and predict their long-term performance.

Piezometer: an instrument for measuring the pressure of a liquid or gas, or something related to pressure (such as the compressibility of liquid). Piezometers are often placed in boreholes to monitor the pressure or depth of groundwater.

Plowshare Program: the program established by the United States Atomic Energy Commission (AEC), now the Department of Energy (DOE), as a research and development activity to explore the technical and economic feasibility of using nuclear explosives for industrial applications. The reasoning was that the relatively inexpensive energy available from nuclear explosions could prove useful for a wide variety of peaceful purposes. The Plowshare Program began in 1958 and continued through 1975. Between December 1961 and May 1973, the U.S. conducted 27 Plowshare nuclear explosive tests comprising 35 individual detonations. (source: https://www.osti.gov/opennet/reports/plowshar.pdf)

Point source: a single well-defined point (origin) of an airborne release, such as a stack or vent or other functionally equivalent structure. Point sources are actively ventilated or exhausted. Point source monitoring is monitoring emissions from a stack or vent.

Polychlorinated biphenyls (PCBs): a chemical belonging to the broad family of man-made organic chemicals known as chlorinated hydrocarbons. PCBs were domestically manufactured from 1929 until their manufacture was banned by the U.S. Congress in 1979. They have a range of toxicity and vary in consistency from thin, light-colored liquids to yellow or black waxy solids. Due to their non-flammability, chemical stability, high boiling point, and electrical insulating properties, PCBs were used in hundreds of industrial and commercial applications including electrical, heat transfer, and hydraulic equipment; as plasticizers in paints, plastics, and rubber products; in pigments, dyes, and carbonless copy paper; and many other industrial applications. PCBs can persist in the environment and accumulate in the food chain. PCBs' are classified as persistent organic pollutants. Their production was banned by the Stockholm Convention on Persistent Organic Pollutants in 2001. The International Research Agency on Cancer (IRAC) rendered PCBs as definite carcinogens in humans. According to the U.S. Environmental Protection Agency, PCBs cause cancer in animals and are probable human carcinogens.

Polychlorinated biphenyl (PCB) bulk waste: building material (i.e., substrate) "coated or serviced" with PCB bulk product waste (e.g., caulk, paint, mastics, sealants) at the time of disposal are managed as a PCB bulk product waste, even if the PCBs have migrated from the overlying bulk product waste into the substrate (source: https://www.epa.gov/pcbs/polychlorinated-biphenyl-pcb-guidance-reinterpretation).

Post-Closure activities: activities (e.g., post-closure monitoring and evaluations) performed to ensure approved corrective actions are protective of human health and the environment.

Potential to emit (PTE): the quantity of a criteria air pollutant that each facility/piece of equipment would emit annually if it were operated for the maximum number of hours at the maximum production rate specified under its applicable air permit.

Private water system: a water system that is not a public water system, as defined in Nevada Revised Statute 445A.235, and is not regulated under State of Nevada permits.

Product (also known as daughter nuclide or isotope): each of two or more forms of the same element that contain equal numbers of protons but different numbers of neutrons in their nuclei, and hence differ in relative atomic mass but not in chemical properties; in particular, a radioactive form of an element. For example, carbon-12 (^{12}C), the most common form of carbon, has six protons and six neutrons, whereas carbon-14 (^{14}C), the radioactive isotope of carbon, has six protons and eight neutrons.

Progeny (see Radon progeny).

Public water system (PWS): as defined in Nevada Revised Statute 445A.235, it is a system, regardless of ownership, that provides the public with water for human consumption through pipes or other constructed conveyances, if the system has 15 or more service connections, as defined in NRS 445A.843, or regularly serves 25 or more persons. The three PWSs on the NNSS are permitted by the State of Nevada as non-community water systems.

Q **Quality assurance (QA):** a system of activities whose purpose is to provide the assurance that standards of quality are attained with a stated level of confidence.

Quality control (QC): procedures used to verify that prescribed standards of performance are attained.

R **Rad:** one of the two units used to measure the amount of radiation absorbed by an object or person, known as the "absorbed dose," which reflects the amount of energy that radioactive sources deposit in materials through which they pass. The radiation-absorbed dose (rad) is the amount of energy (from any type of ionizing radiation) deposited in any medium (e.g., water, tissue, air). An absorbed dose of 1 rad means that 1 gram of material absorbed 100 ergs of energy (a small but measurable amount) as a result of exposure to radiation. The related international system unit is the gray (Gy), where 1 Gy is equivalent to 100 rad.

Radioactive decay: the spontaneous transformation of one radionuclide into a different nuclide (which may or may not be radioactive), or de-excitation to a lower energy state of the nucleus by emission of nuclear radiation, primarily alpha or beta particles, or gamma rays (photons).

Radioactivity: the spontaneous emission of nuclear radiation, generally alpha or beta particles, or gamma rays, from the nucleus of an unstable isotope.

Radioisotope: same as radionuclide.

Radionuclide: may also be called a radioactive nuclide, radioisotope, or radioactive isotope. It is an atom that has excess nuclear energy, making it unstable. This excess energy can either create and emit from the nucleus new radiation (gamma radiation) or a new particle (alpha particle or beta particle), or transfer this excess energy to one of its electrons, causing it to be ejected (conversion electron). During this process, the radionuclide is said to undergo radioactive decay.

Radon progeny: When radon in air decays, it forms a number of short-lived radioactive decay products (radon progeny), which include polonium-218, lead-214, bismuth-214 and polonium-214. All are radioactive isotopes of heavy metal elements and all have half-lives that are much less than that of radon.

Regulatory Boundary: a type of boundary developed for an Underground Test Area (UGTA) corrective action unit (CAU). It is established by negotiation between the U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office (NNSA/NFO) and the Nevada Division of Environmental Protection (NDEP) during the CAU closure process based upon negotiated CAU-specific objectives to provide protection for the public and the environment from the effects of migration of radioactive contaminants. If radionuclides above the agreed-upon levels reach this boundary, NNSA/NFO is required to submit a plan for NDEP approval that will identify how the CAU-specific regulatory boundary objectives will be met.

Rem: one of the two standard units used to measure the dose equivalent (or effective dose), which combines the amount of energy (from any type of ionizing radiation that is deposited in human tissue), along with the medical effects of the given type of radiation. For beta and gamma radiation, the dose equivalent is the same as the absorbed dose. By contrast, the dose equivalent is larger than the absorbed dose for alpha and neutron radiation, because these types of radiation are more damaging to the human body. Thus, the dose equivalent (in rems) is equal to the absorbed dose (in rads) multiplied by the quality factor of the type of radiation [see Title 10, Section 20.1004, of the *Code of Federal Regulations* (10 CFR 20.1004), "Units of Radiation Dose"]. The related international system unit is the sievert (Sv), where 100 rem is equivalent to 1 Sv.

Roentgen (R): a unit of measurement used to express radiation exposure in terms of the amount of ionization produced in a volume of air. It is the amount of gamma or x-rays required to produce ions resulting in a charge of 0.000258 coulombs/kilogram of air under standard conditions. Named after Wilhelm Roentgen, the German scientist who discovered x-rays in 1895.

S **Saturated zone:** a zone below the earth's surface below which all pore spaces between rocks or soil are completely filled with water.

Section 106: Section 106 of the National Historic Preservation Act requires federal agencies to take into account the effects of their undertakings on historic properties and afford the Council a reasonable opportunity to comment on such undertakings (source: https://www.achp.gov/protecting-historic-properties).

Sievert (Sv): the International System of Units unit of radiation dose equivalent and effective dose equivalent, that is the product of the absorbed dose (gray), quality factor, distribution factor, and other necessary modifying factors; 1 Sv equals 100 rem.

Solid waste: most simply, waste generated by routine operations that is not regulated as hazardous or radioactive by state or federal agencies.

Source term: the amount of a specific pollutant emitted or discharged to a particular medium, such as the air or water, from a particular source.

Spectrometry: the measurement of energy emitted from natural or man-made radioactive elements.

Subcritical experiment: an experiment using high explosives and nuclear weapon materials (including special nuclear materials like plutonium) to gain data used to maintain the nuclear stockpile without conducting nuclear explosions banned by the Comprehensive Nuclear Test Ban Treaty.

Subsidence crater: a hole or depression left on the surface of an area which has had an underground (usually nuclear) explosion.

T **Take:** as per the Endangered Species Act (ESA), 'take' means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct of a listed species under the ESA.

Thermoluminescent dosimeter (TLD): a device used to measure external beta or gamma radiation levels, and which contains a material that, after exposure to beta or gamma radiation, emits light when processed and heated.

Total effective dose equivalent (TEDE): The sum of the external exposures and the committed effective dose equivalent (CEDE) for internal exposures.

Transuranic (TRU) waste: material contaminated with alpha-emitting transuranium nuclides, which have an atomic number greater than 92 (e.g., ^{239}Pu), half-lives longer than 20 years, and are present in concentrations greater than 100 nanocuries per gram of waste. Mixed TRU waste also contains hazardous waste.

Tritium (^{3}H): a radioactive form of hydrogen that is produced naturally in the upper atmosphere when cosmic rays strike nitrogen molecules in the air. Although tritium can be a gas, its most common form is in water, because, like non-radioactive hydrogen, tritium reacts with oxygen to form water. Tritium replaces one of the stable hydrogens in the water molecule, H_2O, and is called tritiated water (HTO). Like H_2O, tritiated water is colorless and odorless. Naturally-occurring tritium is found in very small or trace amounts in the environment as HTO, which easily disperses in the atmosphere, water bodies, soil, and rock. Tritium is also produced during nuclear weapons explosions, as a by-product in nuclear reactors producing electricity, and in special production reactors, where the isotope lithium-6 is bombarded to produce tritium. In the mid-1950s and early 1960s, tritium was widely dispersed during the above-ground testing of nuclear weapons. The quantity of tritium in the atmosphere from weapons testing peaked in 1963 and has been decreasing ever since. Tritium is a contaminant of groundwater in select areas of the NNSS as a result of historical underground nuclear testing and is the contaminant of concern being monitored in NNSS groundwater samples. Tritium decays at a half-life of 12.3 years by emitting a low-energy beta particle. In 1976, EPA established a dose-based drinking water standard of 4 mrem per year and set a maximum contaminant level for drinking water of 20,000 picocuries per liter (pCi/L) for tritium, the level assumed to yield a dose of 4 mrem per year. One year of drinking water with this amount of contamination would produce approximately the same dose of radiation you would get during a single commercial flight between Los Angeles and New York City.

U **Uncertainty:** the parameter associated with a sample measurement that characterizes the range of the measurement that could reasonably be attributed to the sample. Used in this report, the uncertainty value is established at ± 2 standard deviations.

United States Code (USC): a codification of all general and permanent laws of the United States. Laws in the USC are grouped into various Titles, Chapters, and Sections by topic. For example, the citation 16 USC 1531-1544 is for Title 16 (Conservation), Sections 1531-1544 (in Chapter 35) which comprise the law called the Endangered Species Act.

Unsaturated zone: that portion of the subsurface in which the pores are only partially filled with water and the direction of water flow is vertical; also referred to as the vadose zone.

Use-Restriction (UR) Boundary: a type of boundary developed for an Underground Test Area (UGTA) corrective action unit (CAU). It delineates an area expected to require institutional controls to restrict access to potentially contaminated groundwater. A UR boundary is established by negotiation between the U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office (NNSA/NFO) and the Nevada Division of Environmental Protection. It is based primarily on ***contaminant boundary*** (see Glossary definition) forecasts. A UR boundary is established to protect site workers from inadvertently contacting, or site activities from affecting, the flow paths of contaminated groundwater. NNSA/NFO, and any future land manager, must maintain all official CAU-specific UR boundary records.

V **Vadose zone:** the partially saturated or unsaturated region above the water table that does not yield water to wells; also referred to as the unsaturated zone.

W **Water table:** the underground boundary between saturated and unsaturated soils or rock. It is the point beneath the surface of the ground at which natural groundwater is found. It is the upper surface of a saturation zone where the body of groundwater (i.e., aquifer) is not confined by an overlying impermeable formation. In the situation where an aquifer does have an overlying confining formation, the aquifer has no water table.

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For more information, contact:

U.S. Department of Energy
National Nuclear Security Administration
Nevada Field Office
Office of Public Affairs
P.O. Box 98518
Las Vegas, Nevada 89193-8518

Phone: (702) 295-3521
E-mail: PAO@nv.doe.gov

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