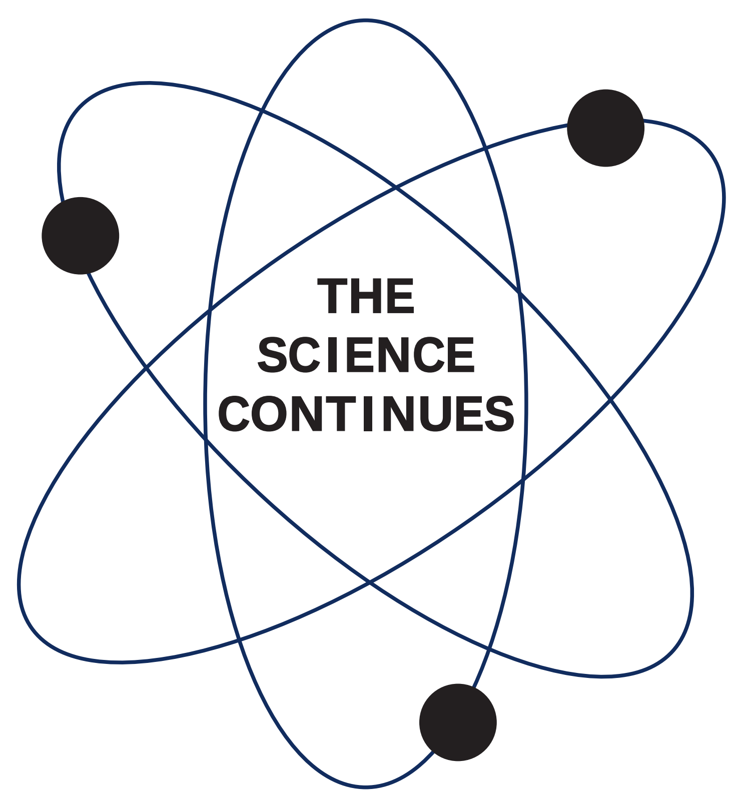
Welcome to the Groundwater Open House!

The Groundwater is Safe

Public water supply is safe from the impacts of historic underground nuclear testing. Current research shows contaminated groundwater will **not** reach public water supplies.

The Science Continues

Studies continue into the future to identify and track contaminated groundwater.



Long-term Monitoring

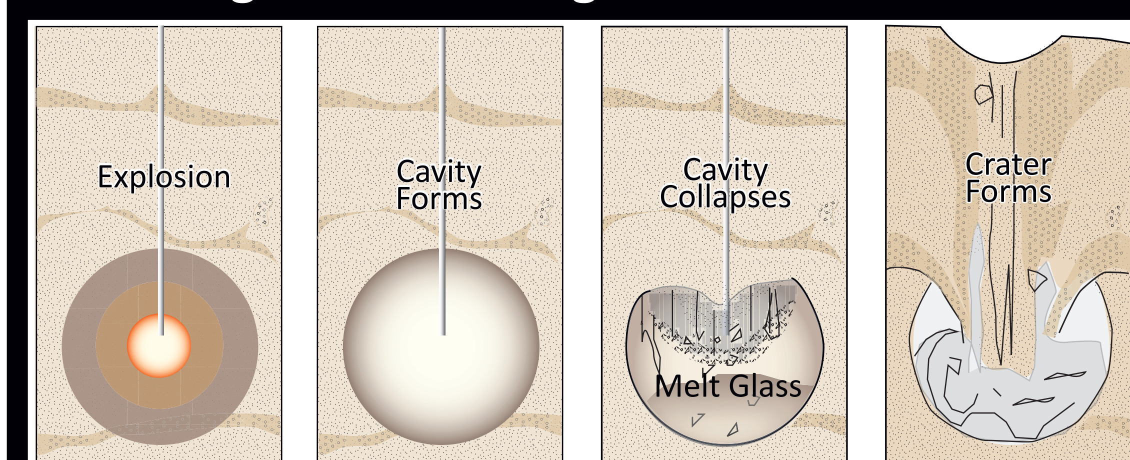
As part of a long-term monitoring program, ongoing scientific studies will continue into the future to identify where contaminated groundwater is located, in which direction it flows, and its rate of movement.

Log No. EMRP-2019-165

What Occurred

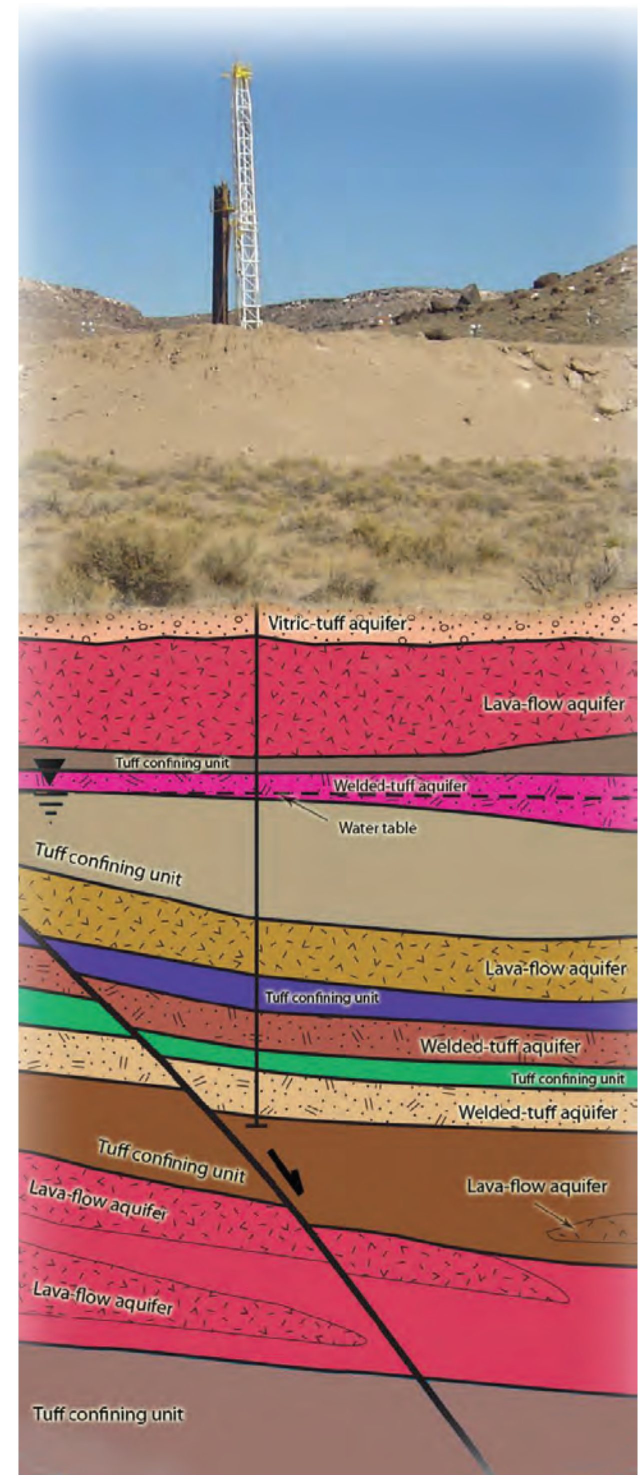
- 828 underground nuclear tests from 1951 to 1992
  - Up to 4,800 feet below the ground surface
  - One-third near, at, or below the water table
  - Some Nevada National Security Site (NNSS) groundwater contains radionuclides
  - The majority of radionuclides are tied up in the melt glass or adsorbed to the rocks surrounding the underground cavities

Stages of an Underground Nuclear Test



An underground nuclear explosion vaporizes the surrounding rock, resulting in a cavity. As the remaining rock cools, melt glass forms and settles to the bottom of the cavity. This may lead to a collapse of the cavity, which forms a depression on the surface, or a subsidence crater.

Important Factors



- Site characterization indicates the contaminants in groundwater are diluted or will decay to safe levels long before reaching public water sources
- No practical technology for vast-scale contaminant removal
- The NNSS has extremely complex underground hydrogeology
- Radionuclides are located deep underground
- Not all tests had equal potential to release radionuclides into groundwater

Log No. EMRP-2019-166

NNSS Groundwater Program Timeline

Evolution of the NNSS Groundwater Program

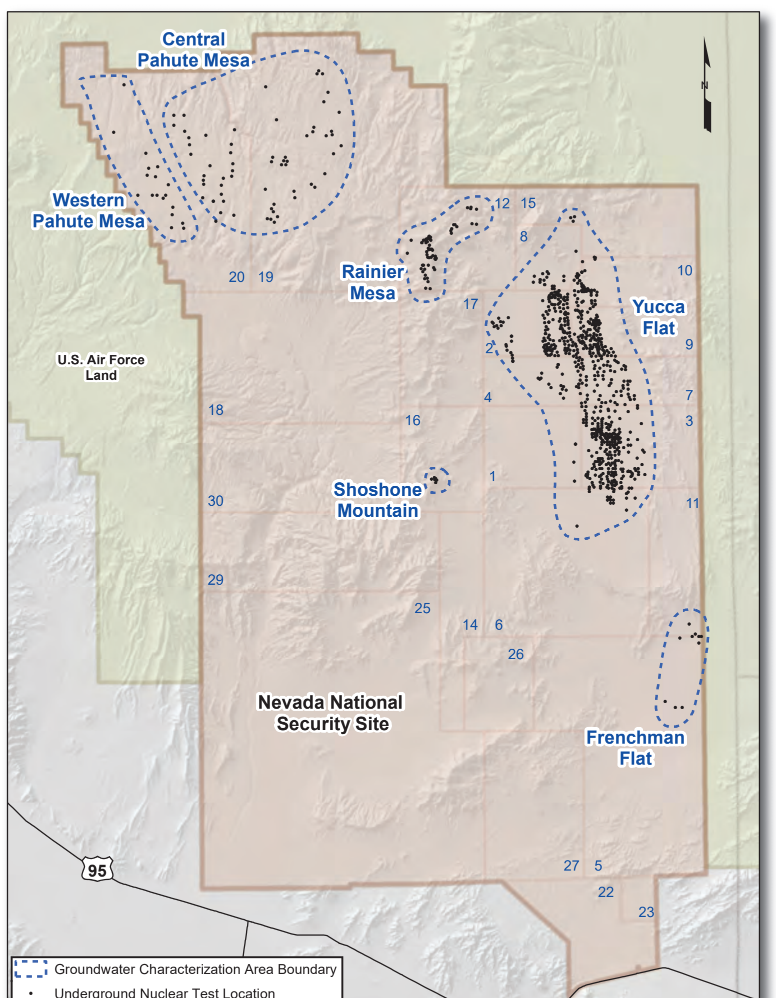
68 years of hydrogeologic data collection have contributed to a better understanding of the complex regional groundwater system

1951 First Underground Nuclear Test

1974 Radionuclide Migration Program Initiated

Pre-1989

- Scientific studies on radioactive releases in groundwater
- Significant data (geologic, geochemical, and hydrologic) collected
- Data still used today



1989 Environmental Management Program Created

1992 Final Underground Nuclear Test

1989-1993

- Installation of groundwater characterization wells
- Preliminary definition of contaminant concentration, distribution, and variability
- Defined groundwater pathways that may allow contaminant migration
- Developed a preliminary risk assessment to define the risks associated with contaminants
- Evaluated potential remedial methodologies and their ability to reduce defined risks

1996 *Federal Facility Agreement and Consent Order* (FFACO)

2009 First Groundwater Open House

2016 Frenchman Flat Transition to Long-term Monitoring

2019 Yucca Flat and Rainier Mesa Long-term Monitoring Negotiations Begin

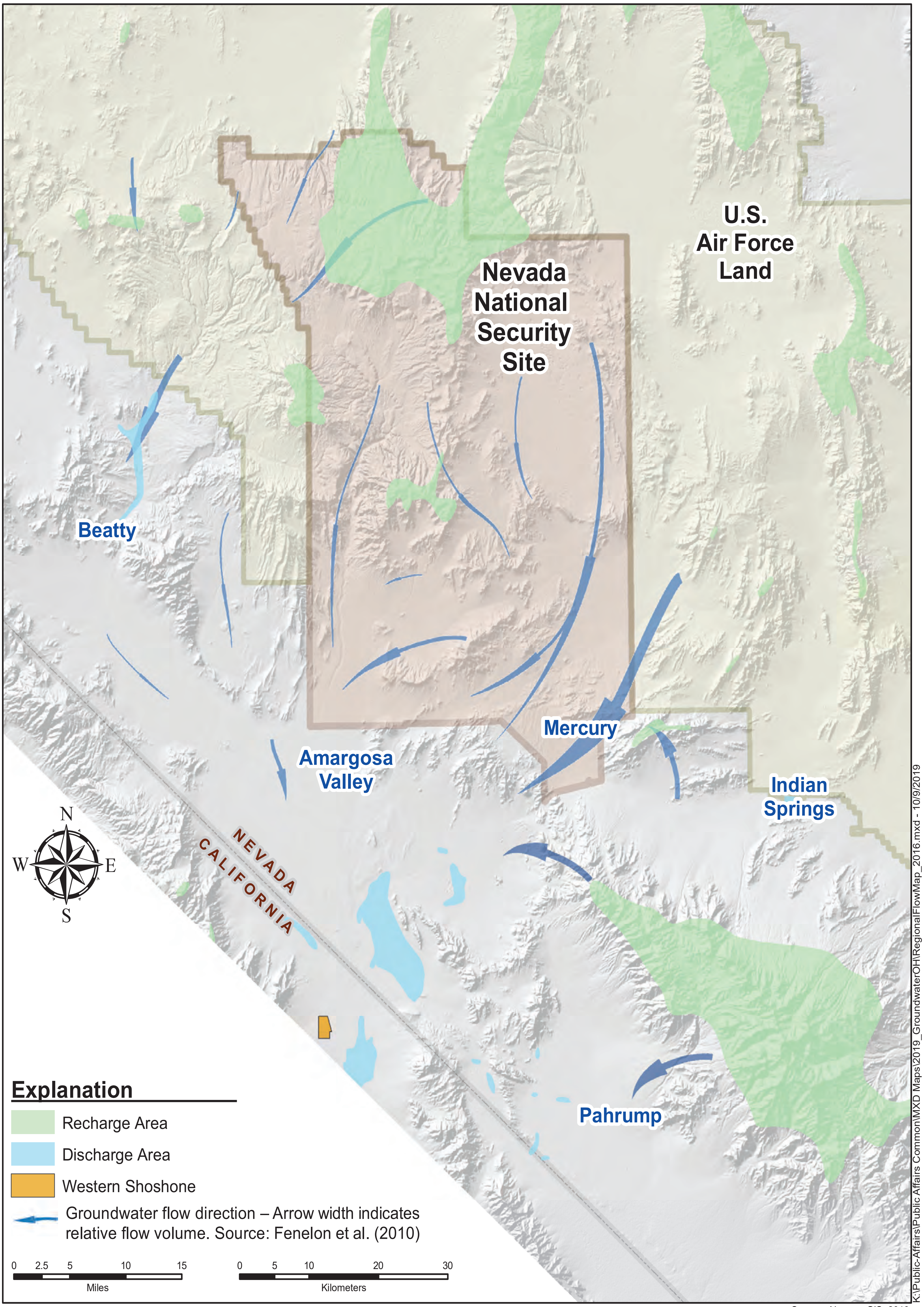
1993-Present

- Drilling and sampling of characterization and monitoring wells
- Data interpretation
- Computer modeling
- Identifying contaminant extent and estimating potential risks
- Implementing a monitoring program to ensure continued protection of human health and the environment

Log No. EMRP-2019-167

Regional Groundwater Flow

Groundwater Flows from Recharge to Discharge



Source: Navarro GIS, 2019

Log No. EMRP-2019-168

Radiation Basics

Radiation Exposure and You

- Average person receives approximately 320 mrem* of radiation per year
- Medical procedures (such as dental or chest x-rays) expose the average person to another 298 mrem (not illustrated below)
- Total exposure to radiation from all sources, for the average person, is about 620 mrem/year
- Health effects (primarily cancer) have been demonstrated in humans at doses exceeding 5,000-10,000 mrem delivered at high dose rates; below this dose, estimation of adverse health effects is speculative

The Average Annual Dose of Radiation

Radon - 230 mrem

- Gas produced by natural breakdown of uranium in soil, rock, and water
- Migrates through porous areas like the ground and the foundation of your house

The Human Body - 31 mrem

- Large portion of our radiation exposure comes from within our own bodies and the bodies of others near us
- Potassium-40 and other radioactive isotopes found in the air, water, and soil are incorporated into the food we eat, then into body tissue
- Carbon-14, the same isotope used for carbon-dating in archaeology, is naturally-occurring in our bodies

Cosmic - 30 mrem

- High-energy gamma radiation that originates in outer space and filters through the Earth's atmosphere in the form of rays such as sunlight
- Cosmic radiation increases with altitude

Terrestrial - 19 mrem

- Soil, rock, and clay are examples of material deposits in the Earth that contain naturally radioactive materials like uranium and thorium
- Naturally radioactive materials are also present in construction materials

Consumer Products - 12 mrem

- Small amounts emitted from such household items as smoke detectors and televisions

Tritium - 4 mrem

- Drinking two (2) liters of water each day for a year that contains 20,000 picocuries of tritium per liter (allowable limit under the *Safe Drinking Water Act*)
- Equivalent to drinking 193 gallons (3½ 55-gallon drums) of water

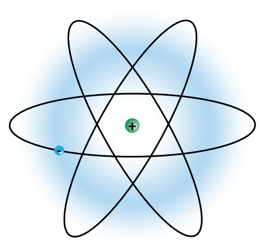
*mrem (millirem) is one one-thousandth of a rem, which measures biological impact, or "dose" of radiation

Log No. EMRP-2019-169

Understanding Tritium in Water

- Radioactive form of hydrogen with a half-life* of 12.3 years
- Decays to levels acceptable under the *Safe Drinking Water Act* standards within 200 years from the 1992 Test Ban
- Naturally occurs in surface waters, such as Lake Mead, at 10 to 30 pCi/L
- Regulatory safety standard for drinking water is 20,000 pCi/L

A person who drinks more than 730 liters of water per year containing 20,000 picocuries of tritium per liter would receive about the same dose of radiation one would get during a typical commercial flight between Los Angeles and New York City.



Hydrogen Atom

One proton
No neutrons
One electron

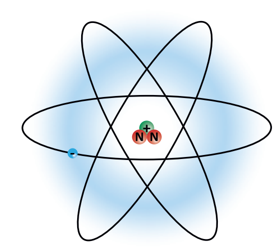
Why Analyze for Tritium?

Comprises more than 95% of the radionuclide inventory

Moves easily in groundwater

Many longer-lived radionuclides, such as plutonium, are slow-moving or immobile

Unless increased levels of tritium are observed, other longer-lived radionuclides will not be present



Tritium Atom

One proton
Two neutrons
One electron

*Half-life refers to the amount of time it takes for a radioactive substance to lose half of its radioactivity.

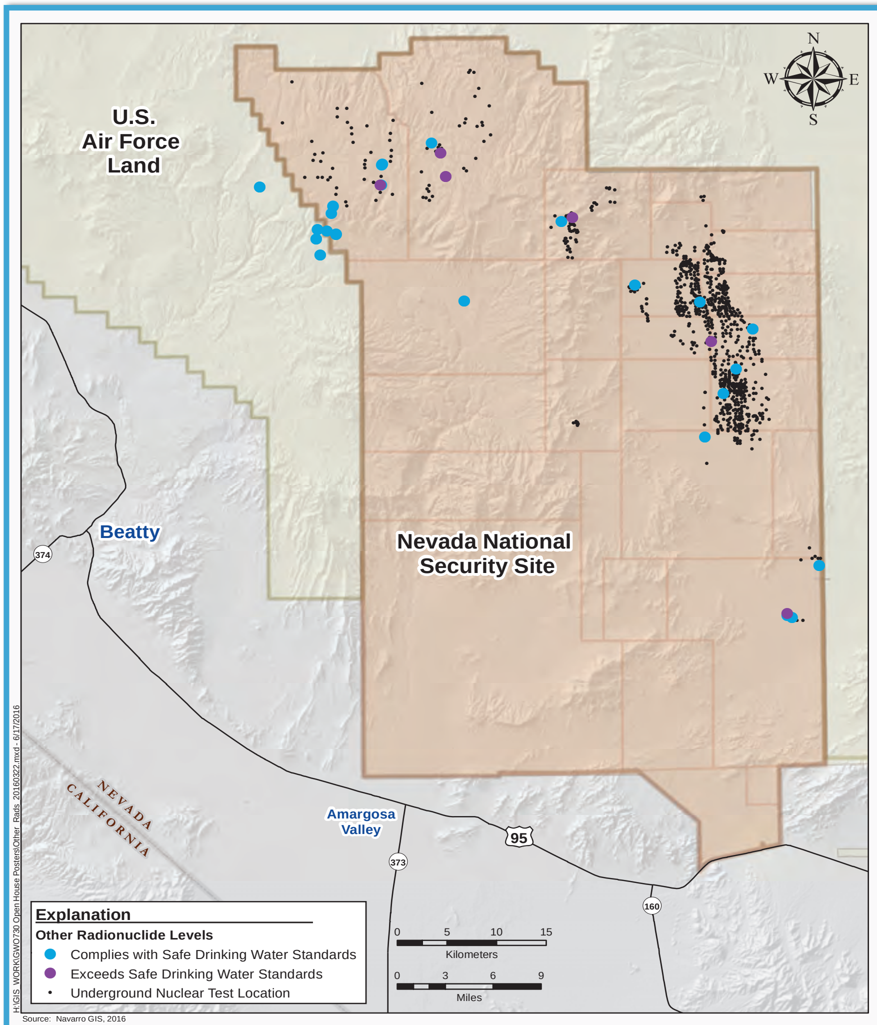
Log No. EMRP-2019-170

Sampling Results for Other Radionuclides

- No radionuclides from underground nuclear testing have been detected on publicly-accessible land

- Radionuclides other than tritium that were produced by historic underground nuclear testing have been detected at extremely low levels (less than 0.05% of safety standards) in water samples collected on U.S. Air Force land

- Radionuclides other than tritium have been found in excess of safe drinking water standards only in wells close to a nuclear test cavity on the NNSS



- Many of the radionuclides produced by nuclear tests are relatively immobile
  - 29 radionuclides are trapped in the melt glass formed by the detonation of the underground nuclear device
  - Tritium, carbon, iodine, chlorine, and technetium are mobile in most subsurface environments
  - Cesium and strontium are mobile in some subsurface environments
  - Plutonium is adsorbed on small particles and transported a limited distance

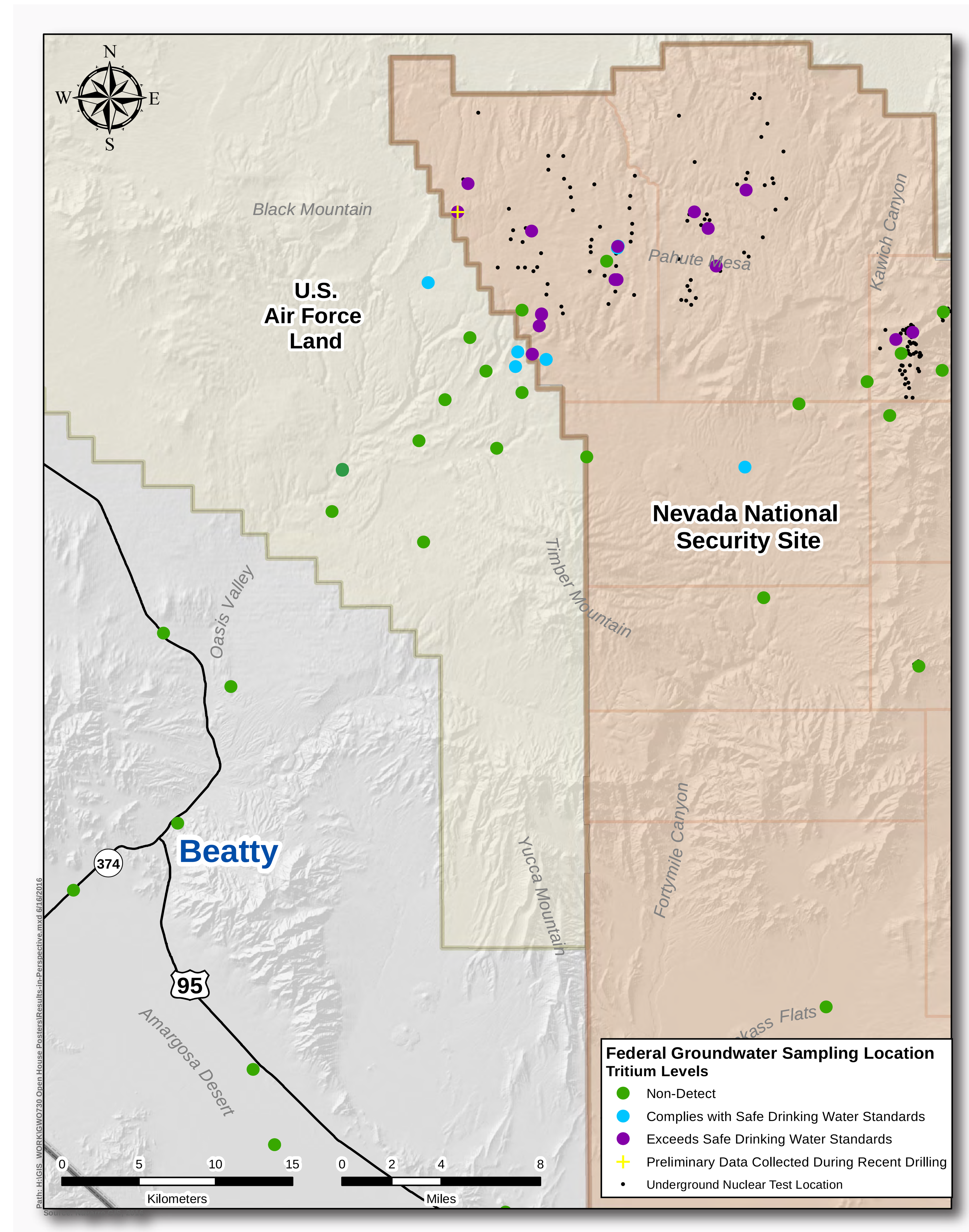
Log No. EMRP-2019-171

Putting Results in Perspective

EM NV

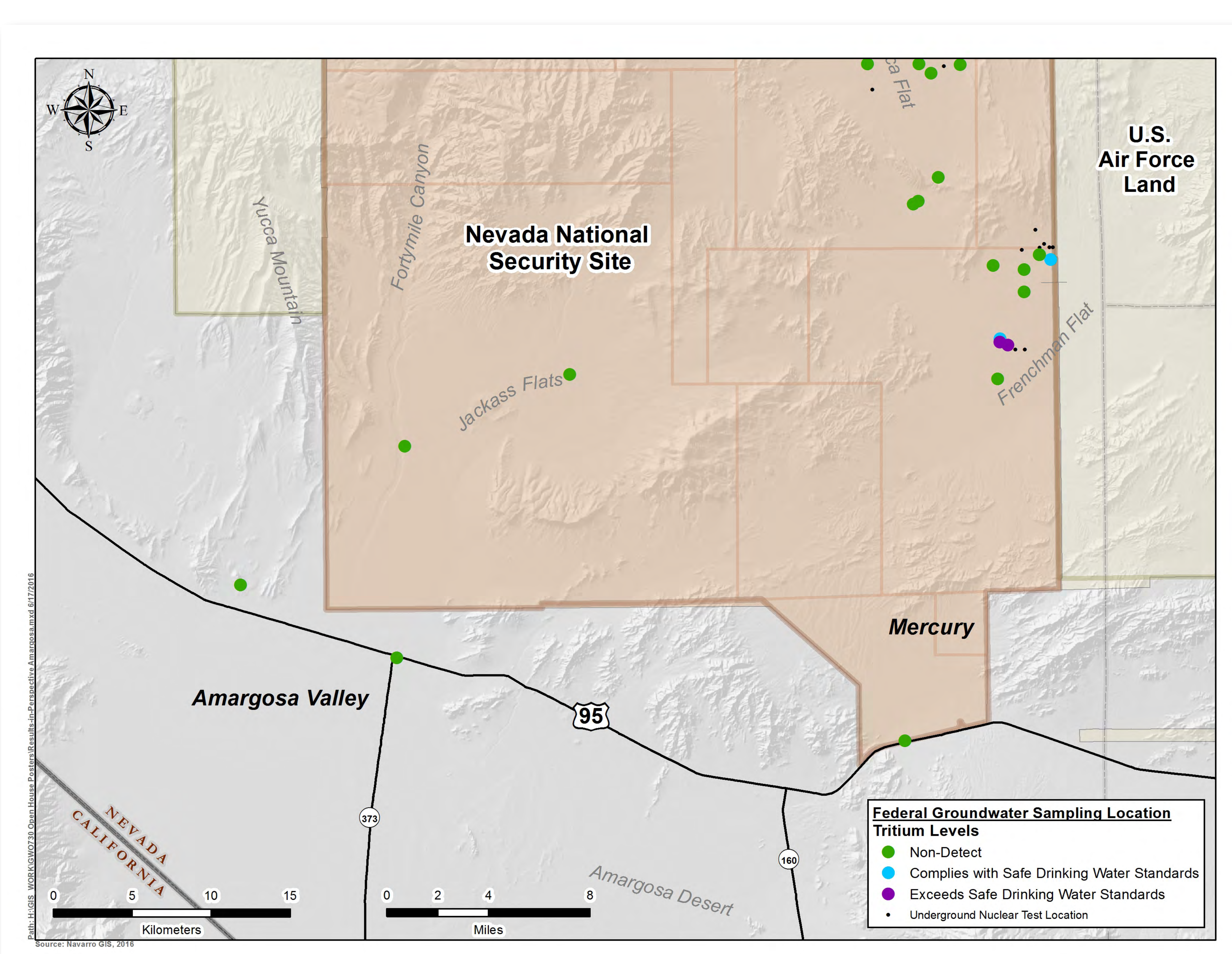
Pahute Mesa

- Based on conservative, scientific calculations and sampling results, tritium will decay to safe levels before it reaches the closest public land boundary
  - Concentration of tritium will remain nearly zero at the closest public land boundary
  - No other radionuclides are observed above safety standards beyond the NNSS boundary



Frenchman Flat

- Contaminated groundwater is not expected to leave the Frenchman Flat basin
  - Modeling indicates that radionuclides in groundwater will travel less than one (1) mile in 1,000 years



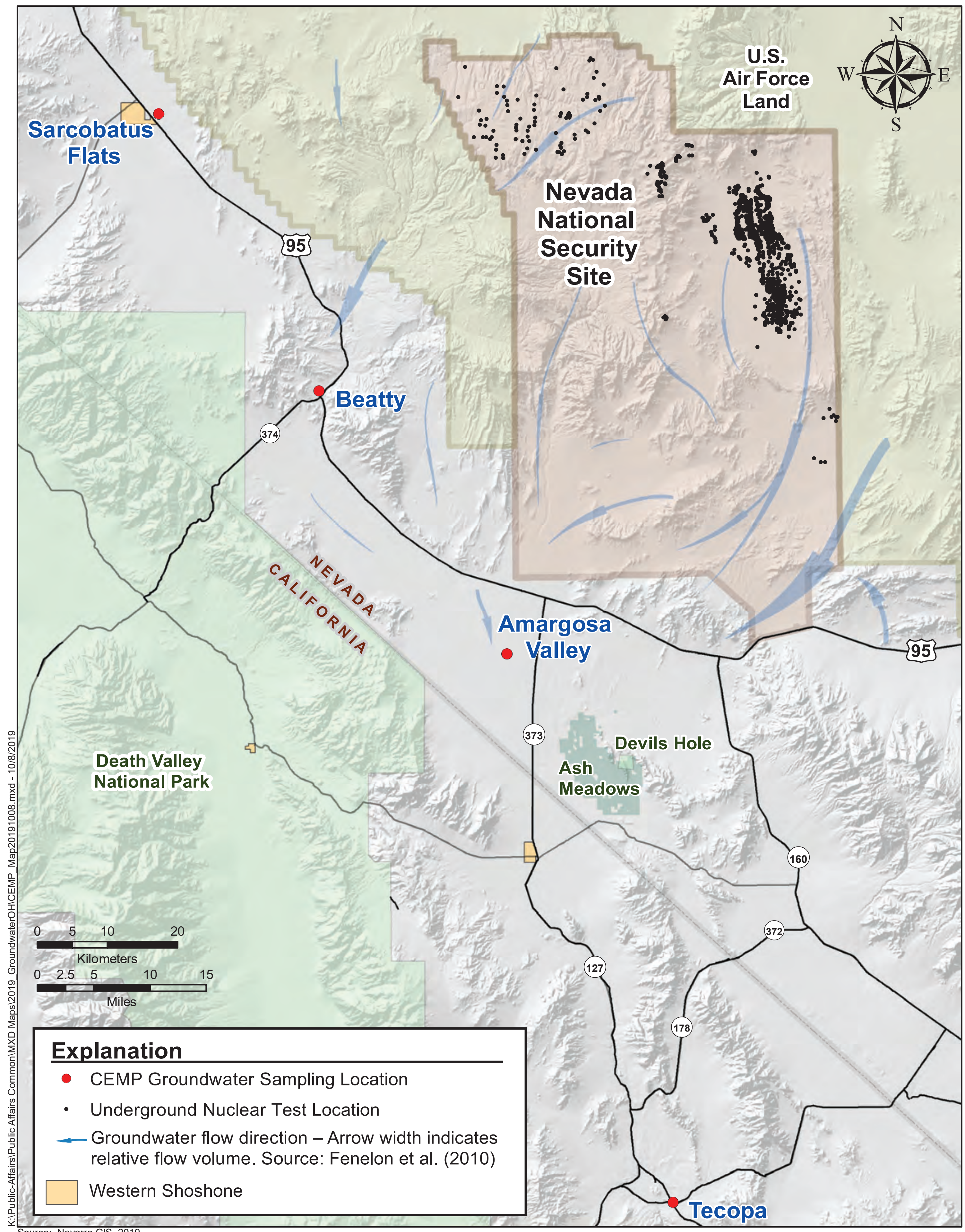
Protecting the Public

- No public access to contaminated groundwater
  - Large area of federally-controlled land provides buffer zone
- Evolving and conservative computer models provide forecasts to continually inform sampling strategies
- Ongoing monitoring serves as a means for early detection and confirmation/validation of modeling forecasts

Log No. EMRP-2019-172

CEMP Groundwater Sampling

The Community Environmental Monitoring Program (CEMP) focuses on groundwater monitoring down gradient of the NNSS



Source: Navarro GIS, 2019

- CEMP provides off-site radiological monitoring in communities surrounding the NNSS
  - Radionuclides from underground testing have never been detected in water supplies serving CEMP communities
- U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office provides funding for DRI to administer the program
- CEMP provides a hands-on role for public stakeholders
- Water sampling results available at **www.cemp.dri.edu** and posted on bulletin boards at local CEMP stations (red dots on map)

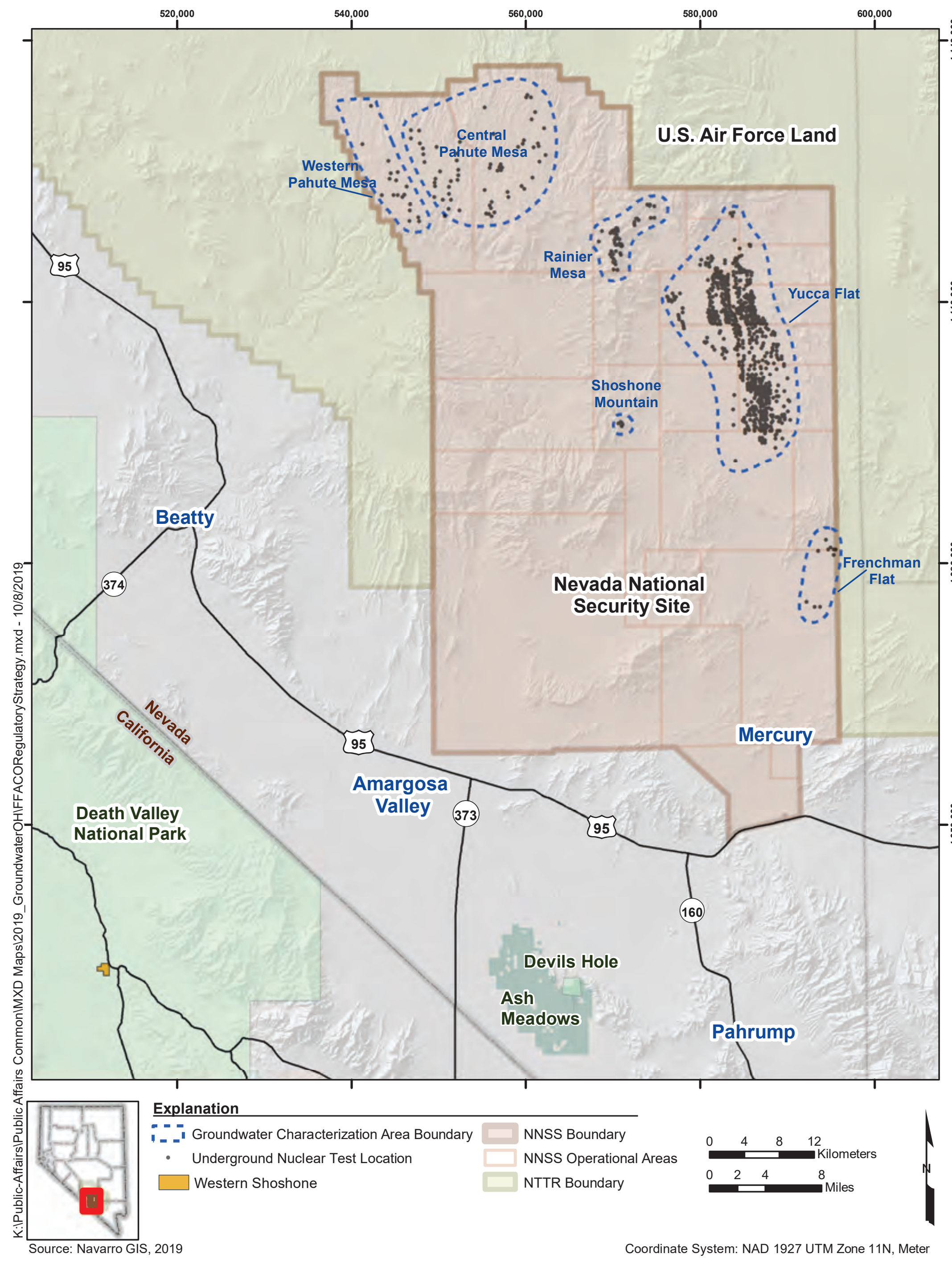
DRI Desert Research Institute

Log No. EMRP-2019-173

Regulatory Strategy

Federal Facility Agreement and Consent Order

Under a binding legal agreement, the State of Nevada Division of Environmental Protection must review and approve advancement to each stage of NNSS groundwater corrective action activities



Investigation Stage

- Gather new data to enhance models developed for each underground nuclear test area
- Review geology, hydrology, sampling, groundwater and transport models, and modeling approach

Decision/Action Stage

- Develop a model evaluation plan to challenge and refine model forecasts
- Use model evaluation plan to identify locations for new wells or data collection activities
- Use data collected to defend that each area is acceptable for closure

Closure Stage

- Negotiate use restrictions and regulatory boundaries
- Establish institutional controls and requirements
- Develop long-term closure monitoring program

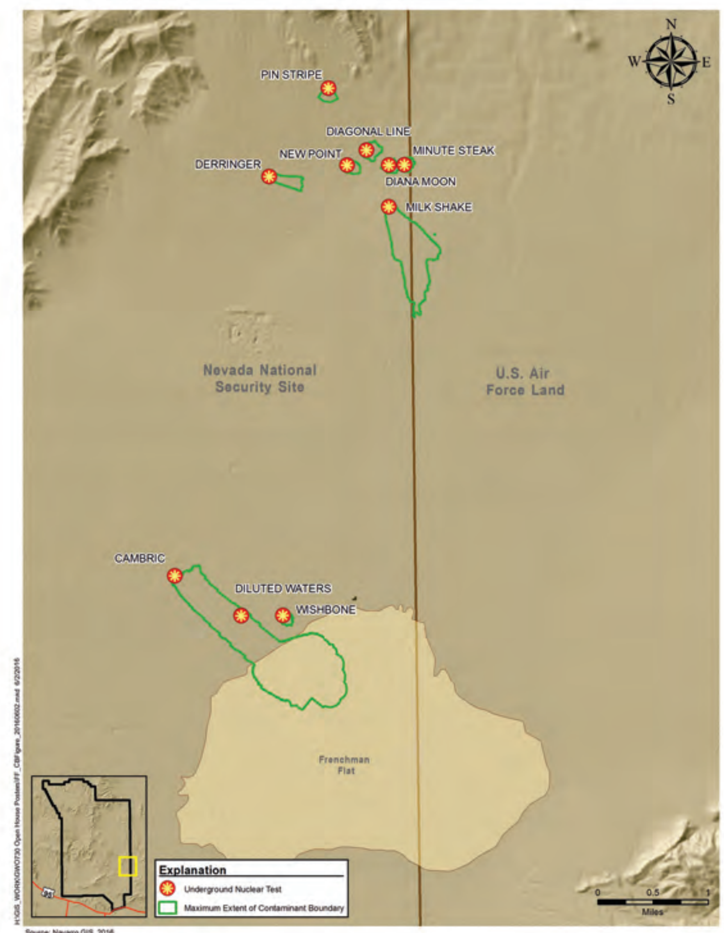
Log No. EMRP-2019-174

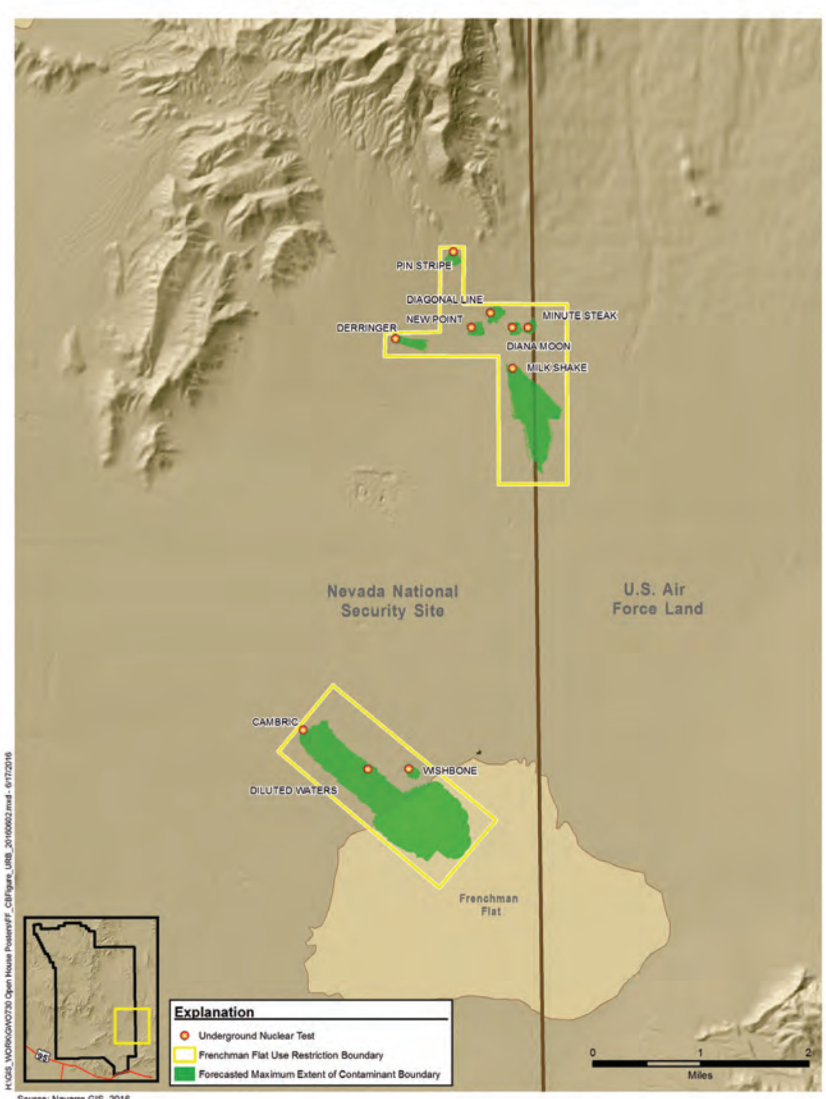
Boundaries

What is a Contaminant Boundary?

Groundwater within this boundary may exceed the safety standards at some time within 1,000 years

- *Safe Drinking Water Act* for tritium is 20,000 pCi/L
- Boundary is developed based on modeling studies of groundwater flow and radionuclide transport





What is a Use-Restriction Boundary?

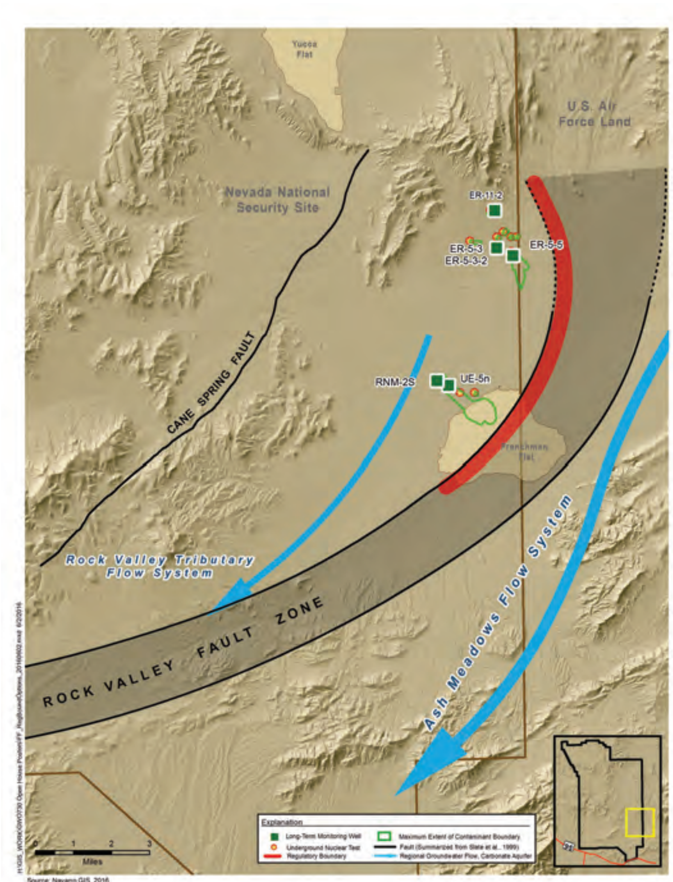
Boundaries defining the areas that require institutional controls to restrict access to potentially contaminated groundwater

- Based on contaminant boundaries
- Use restrictions are associated with the deep subsurface
- Ensures workers and the public are protected from exposure to contaminated groundwater

What is a Regulatory Boundary?

Boundaries that provide protection for the public and the environment from the effects of radionuclide contamination

- 1,000-year contaminant boundaries are well within the regulatory boundary
- If radionuclides reach this boundary, a plan must be submitted to the State to ensure water resources down gradient are protected



Log No. EMRP-2019-175

Pahute Mesa

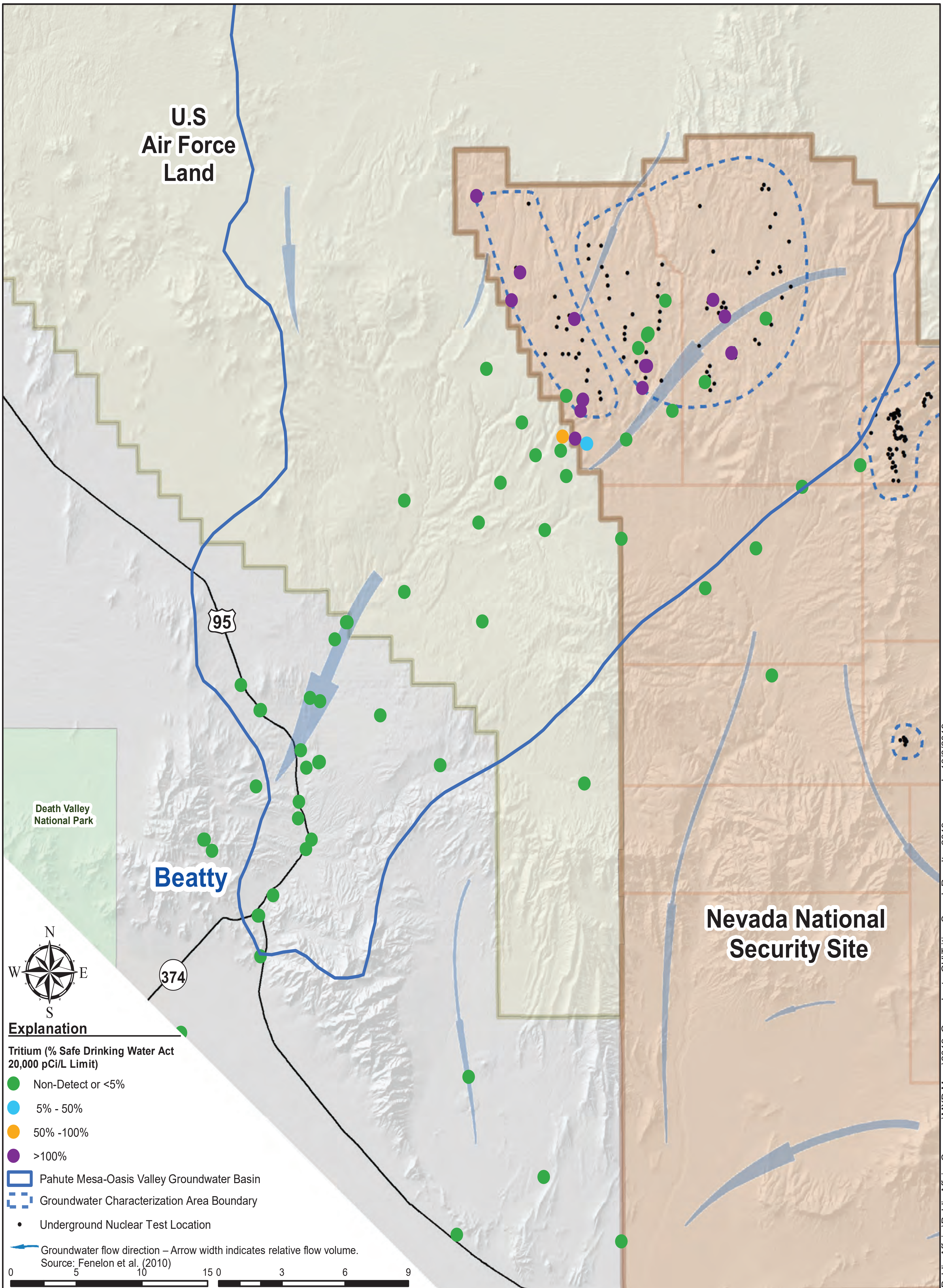
- 82 underground nuclear tests
  - 36 tests in Area 19 and 46 tests in Area 20
  - ~60% of the radionuclide inventory of the NNSS
  - All tests conducted in volcanic units
  - Location of the largest tests conducted on the NNSS
  - Three (3) plumes of radionuclides from underground nuclear tests have been observed
  - Leading edge of two (2) plumes have been detected on U.S. Air Force-controlled land

Pahute Mesa Timeline

- 1998 - 2008
  - State approved Phase I investigation plan
  - Drilled and tested nine (9) new wells
  - Model developed based on investigations performed since the early 1950s
  - Internal peer reviews recommended additional investigations
- 2009 - 2019
  - State approved Phase II investigation plan
  - Drilled and tested 11 new wells
  - Data updated based on new hydrogeologic, geochemical, and geophysical data
  - Water sample data used to develop a new pragmatic approach

Pahute Mesa

Tritium Results



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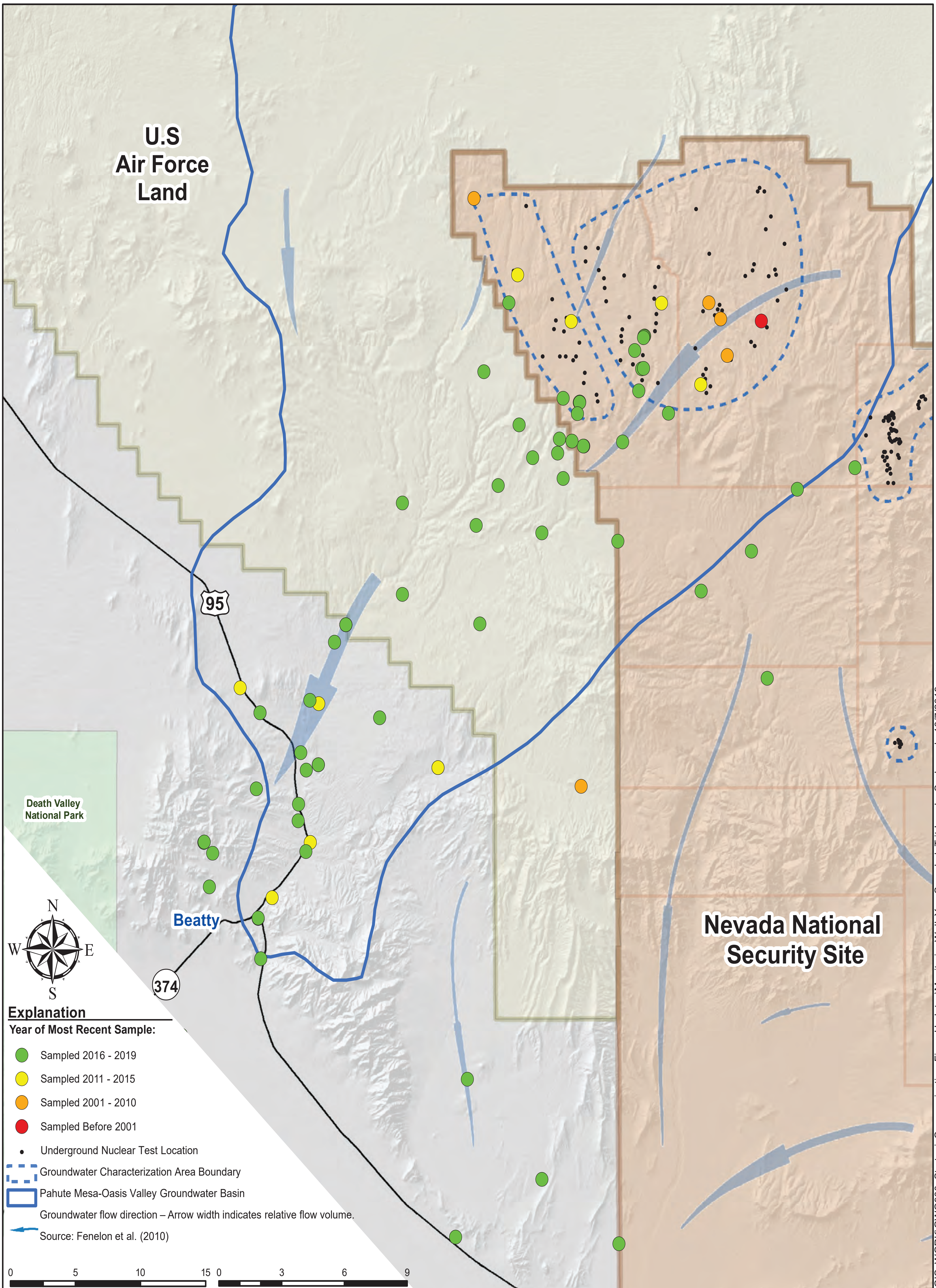
Source: Navarro GIS, 2019

Log No. EMRP-2019-176

Pahute Mesa
Wells Sampled



Source: Navarro GIS, 2019

Log No. EMRP-2019-176

Pragmatic Approach

- Use the measured contaminant data to the fullest extent possible
- Models must match measured data (water levels, tritium, aquifer parameters)
- This reduces uncertainty
- Focus on monitoring contaminants that are moving off the site toward Oasis Valley
- Utilize models to help determine if new monitoring wells should be drilled, and if so, where to drill
- Goal is to develop a robust monitoring well network that is protective of human health and the environment

What We Know

- Groundwater flow is southwest from Pahute Mesa to Oasis Valley in volcanic aquifers
- Groundwater flow is slow
- At the present rate of movement, tritium at concentrations in excess of safe drinking water limits IS NOT expected to travel beyond federally-controlled land surrounding the NNSS
- Tritium is the only radionuclide moving in concentrations exceeding drinking water standards and decays to safe levels in 200 years
- All radionuclides are expected to comply with drinking water standards in Oasis Valley

Log No. EMRP-2019-176

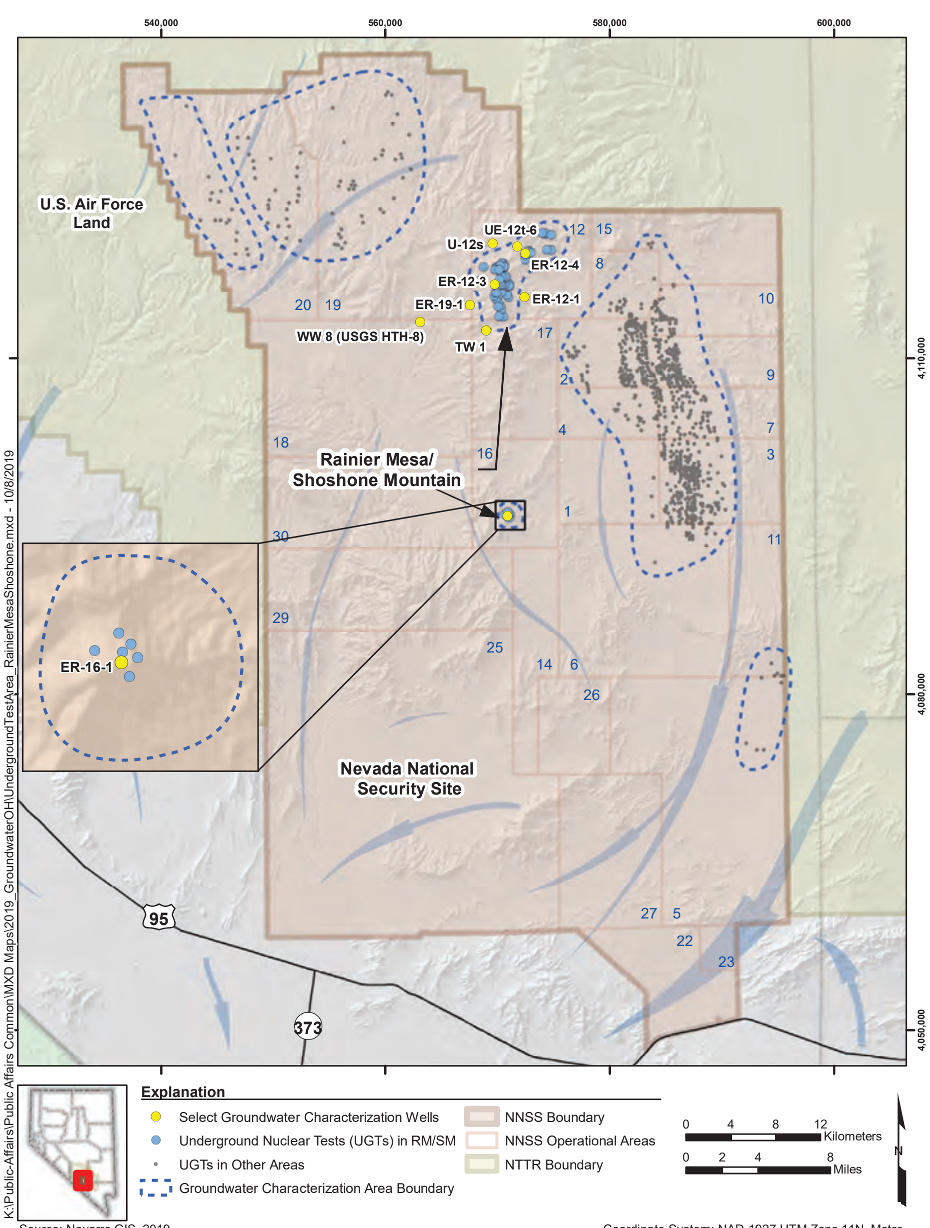
Future

- Complete Phase II modeling to forecast contaminant migration for 1,000 years
- Request State approval of the models
- Conduct an external peer review of the model
- Develop Model Evaluation Plan
- Conduct model evaluation; collect new data; and update models as necessary
- Request State approval to move to closure

Rainier Mesa/ Shoshone Mountain

History

- Located in the remote northern and central part of NNSS
- 61 tests at Rainier Mesa (RM) and six (6) tests at Shoshone Mountain (SM)
  - Conducted from 1957-1992
  - Two (2) tests in vertical shafts on RM, all others in tunnels
- At RM, majority of tests located at or above regional water table; several tests in a thick zone of perched water
- At SM, all tests located substantially above the water table
- A small fraction (~8%) of the total 828 tests conducted at the NNSS
- Represents a small fraction (0.72%) of the radionuclide inventory at the NNSS



Timeline

1999–2012

- State approved Phase I investigation plan
- Six (6) wells drilled and tested
- Developed preliminary complex 3-D models, which suggested that radionuclide transport would not cross NNSS boundaries in 1,000 years

2013–2018

- State approved Alternate Modeling Strategy
- Developed Flow and Transport Model and Report (FTMR)
- Conducted external peer review of FTMR
- State accepted comment resolution and revised FTMR with addendum

2018–2019

- Identified use-restriction boundaries, regulatory boundary objectives, and regulatory boundaries
- Identified long-term monitoring network
- Submitted closure report to state for review

What We Know

- RM is located at a higher elevation and receives more precipitation than the rest of the NNSS
- Groundwater moves downward through thick zones of rocks before reaching the water table
- At RM, groundwater also flows in perched zones via thin layers of higher conductivity rocks
- At SM, radionuclides will not migrate in groundwater because the tests were conducted almost 3,000 ft above the water table
- Sampling results indicate radionuclides do not exceed *Safe Drinking Water Act* (SDWA) standards, except in test cavities, sealed tunnels, and one set of discharge ponds
- Contaminated groundwater expected to remain near the testing areas and is not expected to cross the NNSS boundary within 1,000 years
- The main contaminant of concern is tritium, which will decay below SDWA standards within 200 years

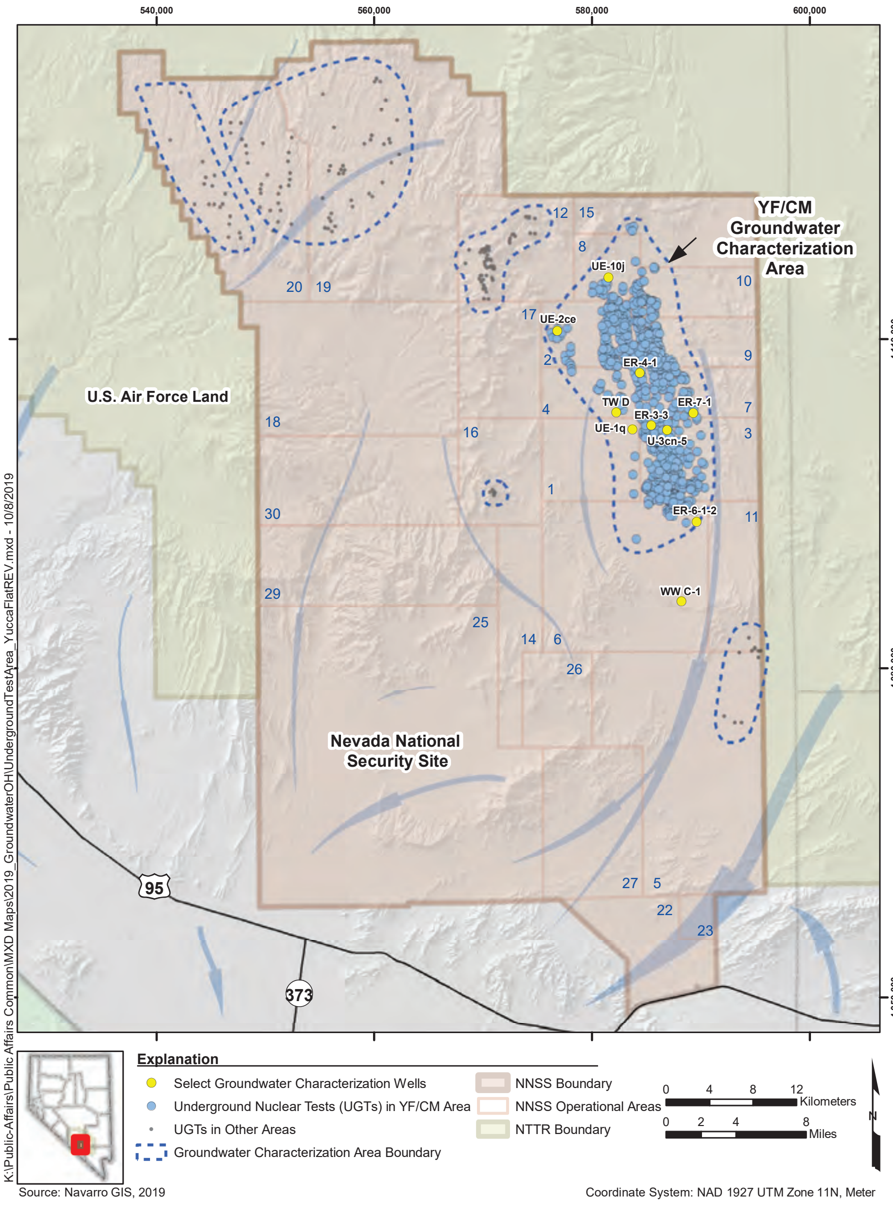
Log No. EMRP-2019-177

Yucca Flat/Climax Mine

EM NV

History

- Located in the northeastern part of the NNSS
- 656 tests in Yucca Flat (YF) and three (3) in Climax Mine (CM)
  - Conducted between 1951 and 1992
  - Represents about 39% of the radionuclide inventory
- In YF, all detonations conducted in vertical shafts
  - About 31% of the radionuclide inventory is more than 100 meters above the water table



Timeline

1999–2013

- State approved investigation plan
- 10 wells drilled and tested
- Developed flow and transport model
- Conducted external peer review of the flow and transport model report

2013–2018

- Drilled and tested three (3) wells
- State accepted resolution of external peer review comments
- State approved decision document and action plan
- Negotiated Regulatory Boundary Objective
- Model evaluation completed

2018–2019

- State approved Model Evaluation Report
- State approved advancement to Closure Report stage
- Use-restriction and regulatory boundaries under discussions
- Long-term monitoring network being developed

What We Know

- YF is a valley bounded by highland areas on all sides
- Depth to water table ranges from ~500 feet to ~1,900 feet
- Outflow from the basin is across the southern boundary
- Regional aquifer within deep carbonate rocks provides the only potential flow paths outside of the basin
- Little to no contamination observed in the regional carbonate aquifer and is expected to stay within the YF basin
- Main contaminant of concern is tritium, which will decay below *Safe Drinking Water Act* standards within 200 years

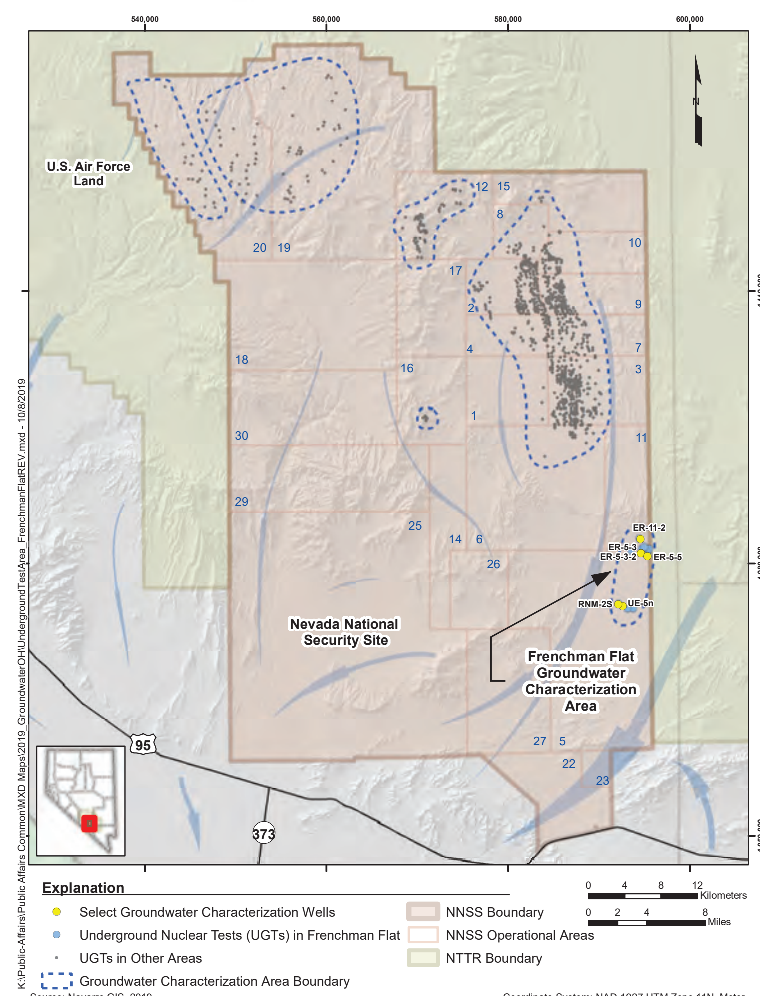
Log No. EMRP-2019-178

Frenchman Flat

First Groundwater Characterization Area to Transition to Long-Term Monitoring

History

- Ten (10) underground nuclear tests
  - Conducted between 1965 and 1971
  - Nine (9) in alluvium and one (1) in a volcanic unit
  - Nine (9) detonated above but near the water table, each less than 20 kilotons
  - One (1) test (less than one (1) kiloton) detonated below the water table
  - Represents a small fraction (0.1%) of the radionuclide inventory



Timeline

1999–2000

- State approved Phase I investigation plan
- Models developed based on investigations performed since the early 1950s
- Internal and external peer reviews recommended additional investigations

2001–2010

- State approved Phase II investigation plan
- Five (5) wells drilled and tested
- Models updated based on new data
- Results published in more than 30 peer-reviewed reports
- External peer review team recommended progressing to model evaluation

2011–2016 (Model Evaluation)

- Negotiated Regulatory Boundary Objective
- Two (2) wells drilled and tested; surface-magnetic surveys developed
- Model evaluation completed
- State approved Model Evaluation Report
- State approved advancement to Closure Report stage

2017–2019 (Long-Term Monitoring)

- Negotiated Use-Restriction and Regulatory boundaries
- Sample six (6) wells every year
- Measure water levels in 16 wells four (4) times per year

Transitioning Frenchman Flat through the regulatory process provided an invaluable experience for establishing the necessary balance of modeling, monitoring, and institutional control that is protective of public health and the environment

- Regulatory process refined to best support strategy of modeling, monitoring, and restricted access
- Peer review processes (external and internal committees of experts) established to provide confidence that the strategy is protective of the public and environment
- State-of-the-art methodologies developed and applied by a highly technical team of experts from numerous scientific organizations

Log No. EMRP-2019-179

Groundwater Demonstration

- The general principles of groundwater flow and transport can be demonstrated visually in a geologic display similar to an "ant farm"
- The display provides a sense of how groundwater behaves in nature
- Groundwater demonstrations can be requested for schools and community events by e-mailing emnv@emcbc.doe.gov

Groundwater is water that has infiltrated from surface sources (rain/snow) and accumulated in the subsurface

- Groundwater moves through pore spaces and fractures in various types of geologic layers
  - Geologic layers range from near-surface soils, such as sands and gravels, to deeper rock units such as limestones and volcanic rocks

- Groundwater moves within geologic layers at different rates and directions based on the geology, hydraulic properties (i.e., ability of water to flow through rock), and elevation of the water table

Log No. EMRP-2019-180

Expanding Our Understanding of Groundwater

The U.S. Department of Energy continues to gather information that expands scientific knowledge of location, type, quantity, direction of movement, and rate of radionuclide movement in groundwater

Identifying Information

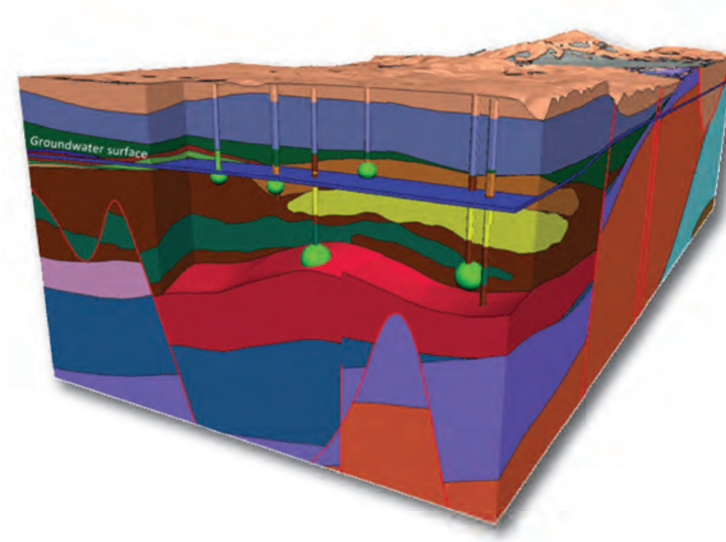
- Geology
- Hydrology
- Groundwater chemistry
- Radionuclide concentrations

Gathering Information

- Well drilling and construction
- Aquifer testing and water-level monitoring
- Water sample collection

Analyzing Information

- Computer simulations (modeling) of hydrogeology and groundwater flow and contaminant transport



Computer model of NNSS subsurface

USGS
science for a changing world

The U.S. Geological Survey

National Water Information System

NWIS

• *What is it and how do I use it?*

NWIS is a publicly-available, national database that contains surface-water, groundwater, water-quality, and water-use data collected from over 1.9 million sites. These hydrologic data can be accessed through the interactive web interface, NWISWeb, using navigation features to search, find, retrieve, and compare data.

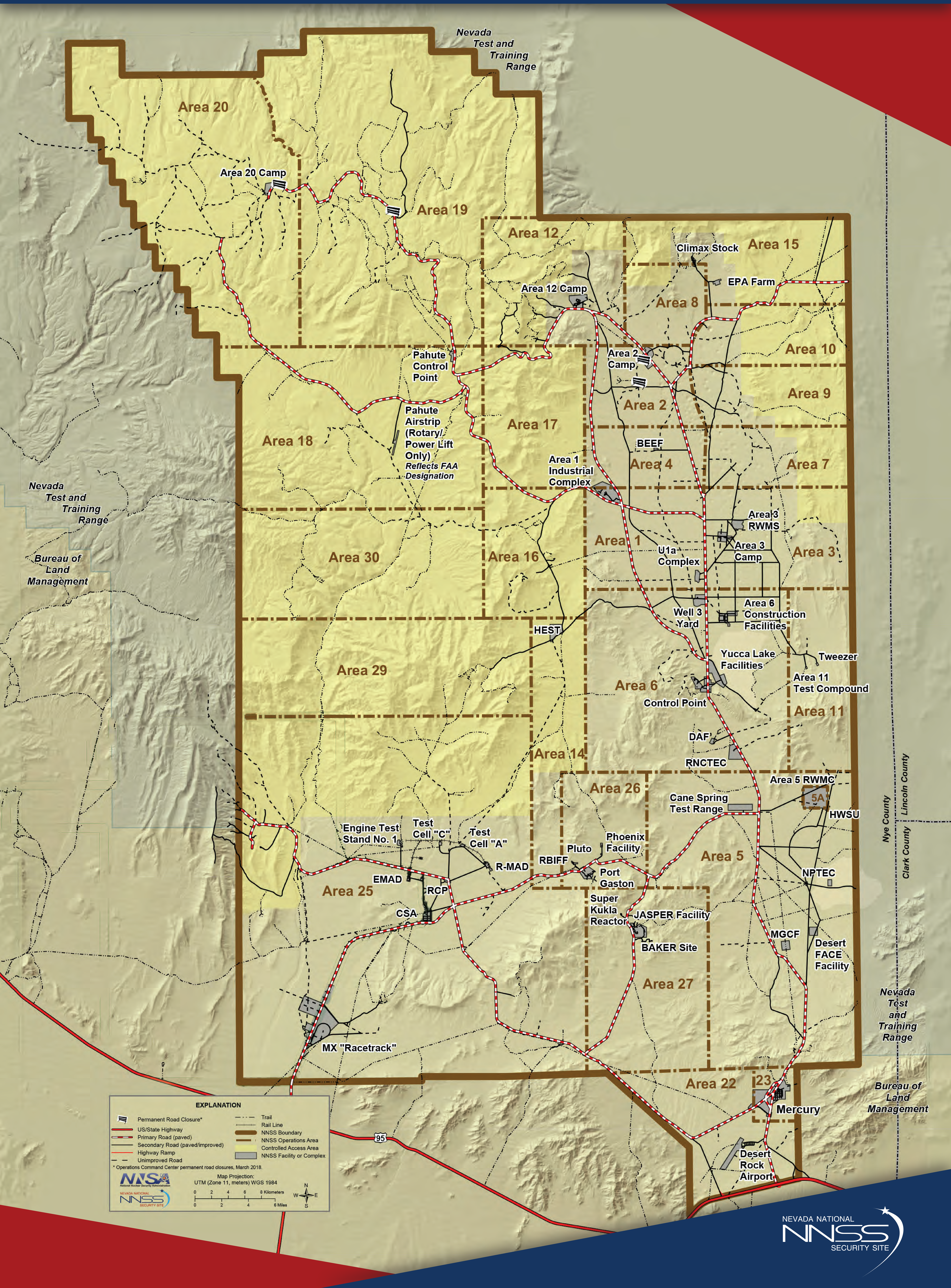
http://waterdata.usgs.gov

• *Where else can I find hydrologic data?*

Hydrologic data specific to the Nevada National Security Site (NNSS) also can be accessed through the U.S. Geological Survey/U.S. Department of Energy Cooperative Studies in Nevada website, which provides project specific data collected in support of various U.S. Department of Energy programs.

http://nevada.usgs.gov/doe_nv

Points of Interest on the NNSS



Nevada National Security Site

Site Overview

The Nevada National Security Site is a large, geographically diverse outdoor laboratory used to safely and securely conduct national security programs and other research and development efforts.

BIG	SECURE	REMOTE
1,360 square miles	Access to the site is controlled	Surrounded by federally-owned land


Stockpile Stewardship


Global Security


National Incident Response


Strategic Partnerships

Economic Impact

$900 million
Annual Nevada Enterprise spend

$6 million
State and local taxes

$190 million
Awarded annually to small businesses

4,600
Well-paying jobs

1,150
Highly skilled technical positions

1,050
Highly skilled professional positions

900
Skilled craft and laborer positions

1,500
Subcontract jobs in Southern Nevada

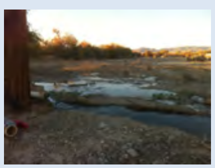
200
Users visit NNSS daily

NEVADA NATIONAL NNSS SECURITY SITE









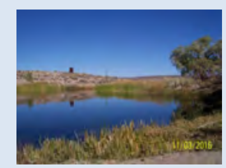

Nye County Tritium Sampling and Monitoring Program

Nye County Nuclear Waste Repository Project Office










Introduction

Since 2015, the Nye County Nuclear Waste Repository Project Office (NWRPO) has conducted the Nye County Tritium Sampling and Monitoring Program (TSaMP), a program funded by a grant from United States Department of Energy (DOE). The TSaMP works in conjunction with the Community Environmental Monitoring Program (CEMP), conducted by Desert Research Institute, to select and sample 10 groundwater "core wells" located generally hydrologically downgradient of the Nevada National Security Site (NNSS) and in the vicinity of the communities of Beatty, Lathrop Wells, and Amargosa Valley (Figure 1). Additionally, the program selects and samples an additional 10 unique wells or springs annually based on input from the public through outreach, availability and logistic needs. Water samples from groundwater wells and springs are analyzed for tritium (H^3) by a commercial laboratory under Nye County Chain of Custody. The NWRPO maintains quality control by applying the Nye County NWRPO Quality Assurance Program to all phases of the work. Figure 2 shows the locations of the core wells and annual additional locations for tritium sampling.

The TSaMP core wells include five previously installed Nye County monitoring wells (GWE-OV-1, GWE-OV-2, GWE-8PA, EWDP-13P, and EWDP-24P) and five community wells (Amargosa Elementary School, Amargosa Valley RV Park, a Beatty Water and Sanitation supply well, Northwest Academy, and Baileys Hot Springs). These core wells are sampled and analyzed annually along with the additional 10 locations selected, for a total of 20 samples per year, subsequent to 2015.

Figure 1: Map showing the general area (blue oval) of the Nye County Tritium Sampling And Monitoring Program (TSaMP). The TSaMP focus is on areas downgradient (south) and off of the NNSS. Triangles are locations of CEMP stations in communities surrounding and downwind of the Nevada National Security Site (NNSS). Map is from the CEMP Website at: (www.cemp.dri.edu).

2015 through 2018 Annual Sampling

Water samples were collected annually between October and December, from each core well and each of the 10 additional locations each year, subsequent to 2015 (number of samples=70). The Nye County monitoring wells did not have dedicated pumps and were sampled using a portable positive displacement Bennett pump after purging at least 3 well volumes from each well. This process ensured that the resultant samples were representative of local groundwater conditions. The 5 community wells were sampled from the dedicated pump discharge. These wells were purged prior to sampling to ensure that representative water samples were obtained. Standard water quality parameters (pH, temperature, electrical conductivity) were also measured at all locations sampled. The 10 annual additional samples use similar methods for purging, sampling and analysis.

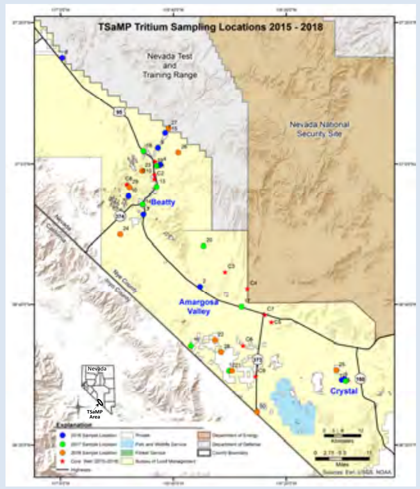


Figure 2: Map showing the location of the 10 TSaMP core wells and the location of each annual 10 additional locations.

Nye County TSaMP Locations and Results 2015 - 2018								
Locations					Results			
Location Number	Sample Number	Location	Latitude NAD83	Longitude NAD83	Tritium Activity (pCi/L) (2015)	Tritium Activity (pCi/L) (2016)	Tritium Activity (pCi/L) (2017)	Tritium Activity (pCi/L) (2018)
C1	GWS0328	NC-GWE-OV-1	37.0061820	-116.7207580	<313	<288	<291	<282
C2	GWS0329	NC-GWE-OV-2	36.9845540	-116.7229820	<313	<288	<291	<282
C3	GWS0330	EWDP-13P	36.7444070	-116.5139540	<313	<288	<291	<289
C4	GWS0331	EWDP-24P	36.7046597	-116.4479878	<313	<288	<291	<289
C5	GWS0332	NC-GWE-8PA	36.6244220	-116.3770836	<278	<288	<291	<289
C6	GWS0333	Amargosa Elementary School	36.5696120	-116.4609460	<278	<288	<291	<289
C7	GWS0334	Amargosa Valley RV Park	36.6417350	-116.3974740	<278	<288	<291	<289
C8	GWS0335	Beatty Water and Sanitation (W04)	36.9514580	116.8050020	<278	<288	<291	<289
C9	GWS0336	Northwest Academy	36.4961660	116.4235630	<278	<288	<291	<289
C10	GWS0337	Baileys Hot Springs*	36.9747200	-116.7225000	<278	<288	<291	<289
1	GWS0344	NC-GWE-33PA	36.660738	-116.4958630		<288		
2	GWS0345	EWDP-10X-Shallow	36.7093128	-116.5883342		<288		
3	GWS0353	Amargosa Narrows South Well 1	36.8802180	-116.7556910		<288		
4	GWS0354	ER-OV-03-A3	36.9988330	-116.7053380		<288		
5	GWS0357	Crystal Park Well	36.4904530	-116.1617900		<288		
6	GWS0358	Crystal Fire Department	36.4878479	-116.1698509		<288		
7	GWS0359	Private Spring Oasis Valley (Colson)	37.0739000	-116.6912030		<288		
8	GWS0362	Sarcobatus Flat Well	37.2507560	-116.9954100		<288		
9	GWS0364	Fleur-de-Lis Spring	37.0382810	-116.7124720		<288		
10	GWS0367	Beatty Water and Sanitation (W06)	36.9242060	-116.7997050		<288		
11	GWS0378	Amargosa Desert 8	36.4849730	-116.1576250			<291	
12	GWS0379	Amargosa Estates Water Co. Well 2	36.5096260	-116.5024110			<291	
13	GWS0380	Beatty RV Park	36.9457100	-116.7164270			<291	
14	GWS0381	Beatty Water and Sanitation Well No. 3	36.9049110	-116.7578260			<291	
15	GWS0382	ER OV 01	37.0843870	-116.6811730			<291	
16	GWS0383	HWWT Gravel Pit	36.5690610	-116.6149670			<291	
17	GWS0384	NC-GWE-2P	36.6611350	-116.4657460			<291	
18	GWS0385	Peacock Spring	37.0307600	-116.7556920			<291	
19	GWS0386	Spicer Ranch (Goss) Spring	36.9954800	-116.7159330			<291	
20	GWS0387	USW VH-2	36.8058790	-116.5778190			<291	
21	GWS0405	Amargosa Estates Water Co. Well 1	36.5097440	-116.4940950				<282
22	GWS0406	Amargosa Valley Private Well-01	36.581	-116.544				<282
23	GWS0407	Bryan Spring	36.9841820	-116.7591000				<289
24	GWS0408	Beatty Water and Sanitation Well EW4	36.8333700	-116.8239330				<289
25	GWS0409	Crystal Private Well-01	36.511	-116.186				<289
26	GWS0410	ER-OV-03b	37.0274450	-116.6522820				<289
27	GWS0411	ER-OV-06a	37.0843870	-116.6811730				<289
28	GWS0412	Amargosa Valley Private Well-02-wellhead	36.554	-116.526				<289
29	GWS0413	Lower Indian Spring	36.9448140	-116.7967720				<289
30	GWS0414	Nye Co. Station #2	36.4115380	-116.4201070				<289
Note: Quality assurance samples, blanks and duplicates, are not included on this spreadsheet.								

Table 1: Locations of TSaMP Map showing the location of the 10 TSaMP core wells and the location of each annual 10 additional locations.

Public Outreach

Under the DOE grant, Nye County TSaMP is responsible for providing public outreach and providing sampling methodology, data, and quality check results to the DOE. To achieve these goals, the TSaMP program has been featured in articles in the Pahrump Valley Times (12/18/2015, 4/29/16, 3/15/17, 4/18/18, 09/06/2019), and has provided the sampling results to DOE annually for inclusion in the Nevada National Security Site Environmental Report. TSaMP personnel conducted a tour in 2015 for the Nevada Site Specific Advisory Board and Community Environmental Monitors. The TSaMP QA program was surveilled in November 2018 by DOE, which resulted in improvements in communication protocols and updates to QA documentation. Nye County TSaMP personnel have attended and presented at community board meetings to solicit input on TSaMP sample locations from the public. TSaMP has also presented posters at public outreach events such as DOE's annual Groundwater Open House events.

2015 through 2018 Results

Annually, all 10 core well samples and all of the 10 additional samples had tritium activities below the detection limits (non-detect) of 278 to 313 picocuries per liter (<278 pCi/ L to <313 pCi/L) tritium (Table 1).

Tritium Primer

Samples were analyzed using a standard tritium analysis method (unenriched) by Radiation Safety Engineering, Inc. in Chandler Arizona. Tritium is a radioactive form of hydrogen with a half-life of 12.3 years. Tritium is analyzed in water because it is one of the most abundant radionuclides generated by an underground nuclear test. Because it is a constituent of the water molecule itself, it is one of the most mobile radionuclides. (NNSS Environmental Report 2014, http://www.nv.energy.gov/library/publications/aser.aspx). The Safe Drinking Water Act (SDWA) standard or maximum contaminant level (MCL) for tritium in drinking water is 20,000 pCi/L. A picocurie (pCi) is a unit of measure to quantify radiation and, is used to quantify the amount of tritium that is in the water. 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 produced 0.037 disintegrations per second.