

2.0 INTRODUCTION

The Nevada Test Site (NTS), located in southern Nevada, was the primary location for testing of nuclear explosives in the continental U.S. from 1951 to 1992. Historically, nuclear testing has included the following: (1) atmospheric testing in the 1950s and early 1960s; (2) underground testing in drilled, vertical holes and horizontal tunnels; (3) earth-cratering experiments; and (4) open-air nuclear reactor and engine testing. No nuclear tests were conducted in 1996. Non-nuclear testing included controlled spills of hazardous material at the Hazardous Materials Spill Center (HSC). Low-level radioactive and mixed waste disposal and storage facilities for defense waste are also operated on the NTS.

The NTS environment is characterized by desert valley and Great Basin mountain terrain and topography, with a climate, flora, and fauna typical of the southern Great Basin deserts. Restricted access and extended wind transport times are notable features of the remote location of the NTS and adjacent U.S. Air Force lands. Also characteristic of this area are the great depths to slow-moving groundwater and little or no surface water. These features afford protection to the inhabitants of the adjacent areas from potential exposure to radioactivity or other contaminants resulting from operations on the NTS. Population density within 150 km of the NTS is only 0.5 persons/km² versus approximately 29 persons/km² in the 48 contiguous states. The predominant use of land surrounding the NTS is open range for livestock grazing with scattered mining and recreational areas.

In addition to the NTS operations, U.S. Department of Energy, Nevada Operations Office (DOE/NV) is accountable for six non-NTS Bechtel Nevada (BN) facilities in five different cities. The BN operations support the DOE/NV programs with activities ranging from aerial measurements and aircraft maintenance to electronics and heavy industrial fabrication. All of these operations are in metropolitan areas.

2.1 NTS OPERATIONS

NTS DESCRIPTION

The NTS has been operated by the DOE as the on-continent test site for nuclear weapons testing. It is located in Nye County, Nevada, with the southeast corner lying about 105 km (65 mi) northwest of the city of Las Vegas, Nevada, as shown in Figure 2.1. The NTS encompasses about 3,500 km² (1,350 mi²), an area larger than the state of Rhode Island. The dimensions of the NTS vary from 46 to 56 km (28 to 35 mi) in width (eastern to western border) and

from 64 to 88 km (40 to 55 mi) in length (northern to southern border). The NTS is surrounded on the east, north, and west sides by public exclusion areas, previously designated the Nellis Air Force Base (NAFB) Bombing and Gunnery Range and the Tonopah Test Range (TTR) (see Figure 2.1). These two areas presently comprise the Nellis Air Force Range Complex, which provides a buffer zone varying from 24 to 104 km (15 to 65 mi) between the NTS and public lands. The combination of the Nellis Air Force Range Complex and the NTS is one of the larger unpopulated land areas in the United States, comprising some 14,200 km² (5,470 mi²). Figure 2.2 shows the general layout of the NTS, including the location of major

Figure 2.1 NTS Location in Nevada

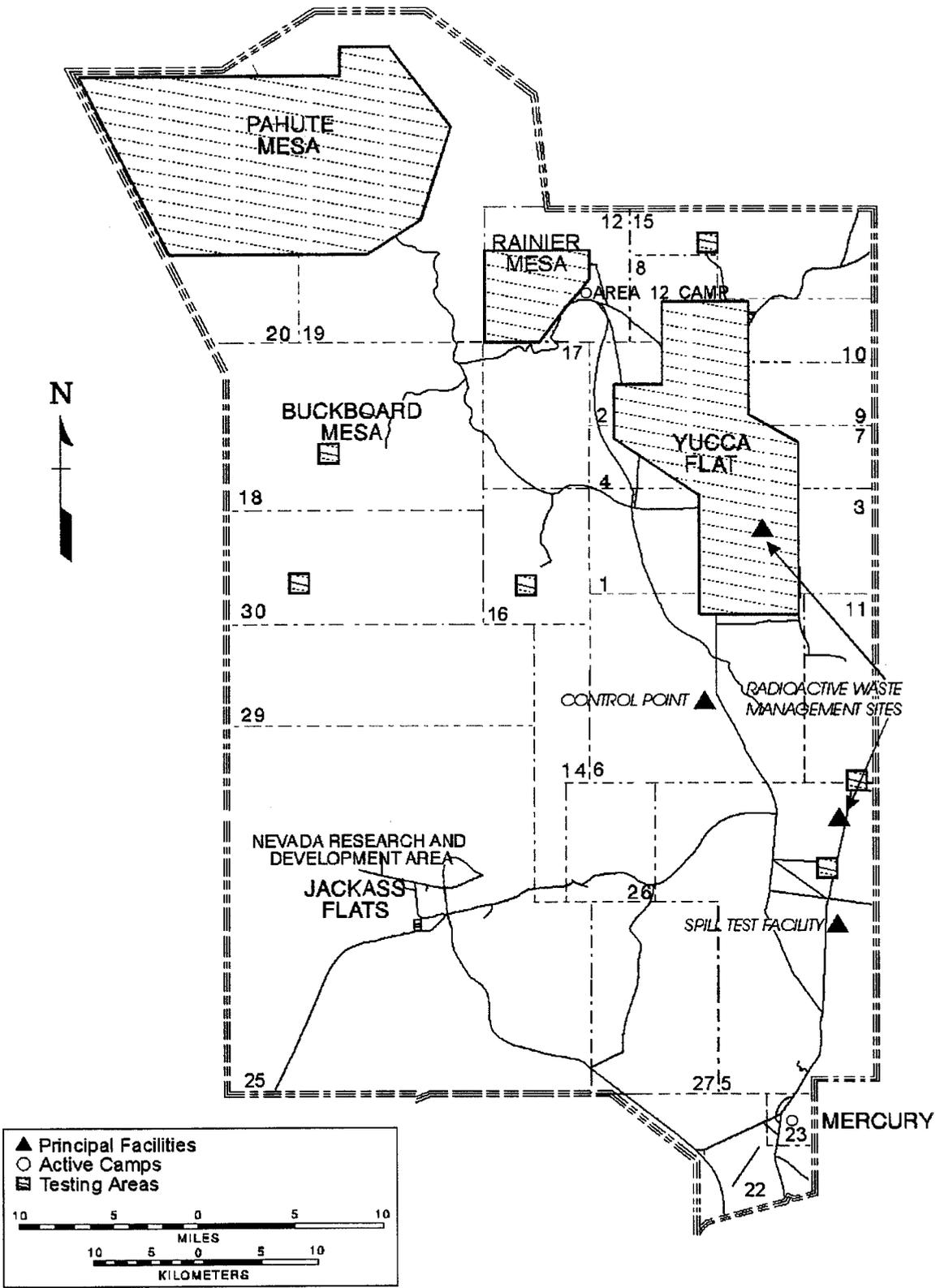


Figure 2.2 NTS Area Numbers, Principal Facilities, and Testing Areas

facilities and area numbers referred to in this report. The areas outlined in green in Figure 2.2 indicate the principal geographical areas used recently for underground nuclear testing. Mercury, Nevada, at the southern end of the NTS, is the main base camp for worker housing and administrative operations for the NTS. Area 12 Base Camp, at the northern end of the NTS, was another major worker housing and operations support facility.

MISSION AND NATURE OF OPERATIONS

The NTS has been the primary location for testing the nation's nuclear explosive devices since January 1951. Tests conducted through the 1950s were predominantly atmospheric tests. These tests involved a nuclear explosive device detonated while on the ground surface, on a steel tower, suspended from tethered balloons, or dropped from an aircraft. Several of the tests were non-nuclear, i.e., "safety" tests, involving destruction of a nuclear device with non-nuclear explosives. Safety tests resulted in dispersion of plutonium in the test vicinity. One of these test areas lies just north of the NTS boundary and four others involving transport-storage safety at the north end of the Nellis Air Force Range Complex (see Figure 2.3). All nuclear tests are listed in DOE/NV Report NVO-209 (DOE 1994a).

Underground nuclear tests were first conducted in 1957. Testing was discontinued during a moratorium that began in November 1958, but was resumed in September 1961 after tests by the Union of Soviet Socialist Republics (USSR) began. Four small atmospheric (surface) tests were conducted in 1961 and 1962. Two additional safety test series were conducted in the mid-1960s, one on the Nellis Air Force Range Complex and one on the TTR. Since 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. Five earth-cratering (shallow-burial) tests were conducted over the period of 1962 through

1968 as part of the Plowshare Program, which explored peaceful uses of nuclear explosives. The first and largest test (SEDAN) was detonated at the northern end of Yucca Flat. There have been no U.S. nuclear explosive tests since September 1992.

Other nuclear testing over the history of the NTS has included the Bare Reactor Experiment - Nevada series in the 1960s. These tests were performed with a 14-MeV neutron generator mounted on a 465-m (1,530-ft) steel tower, used to conduct neutron and gamma-ray interaction studies on various materials. From 1959 through 1973, a series of open-air nuclear reactor, nuclear engine, and nuclear furnace tests were conducted in Area 25. Also, a series of tests with a nuclear ramjet engine was conducted in Area 26.

Limited non-nuclear testing has also occurred at the NTS, including spills of hazardous materials at the HSC in Area 5. The tests conducted at the HSC, from the latter half of the 1980s to date, involved controlled spilling of liquid materials to study both spill control and mitigation measures and the resultant dispersion and transport of airborne clouds. These tests are cooperative studies involving private industry, the U.S. Department of Transportation, and the DOE. At the Explosive Ordnance Disposal in Area 11, explosive materials are destroyed, generally by detonation, with the amounts destroyed being limited in order to maintain downwind air concentrations within state limits.

Waste storage and disposal facilities for defense low-level radioactive waste (LLW) and mixed waste are located in Areas 3 and 5. At the Area 5 Radioactive Waste Management Site (RWMS-5), LLW from DOE-affiliated onsite and offsite generators are disposed of using standard shallow land disposal techniques. A greater confinement disposal technique was once used for disposal of wastes that had high specific activity, high mobility, or were not acceptable for normal disposal. This method of disposal is no longer used.

Figure 2.3 Location of Safety Tests on the NTS and the Nellis Air Force Range Complex

Transuranic (TRU) wastes are retrievably stored in surface containers at the RWMS-5 pending shipment to the Waste Isolation Pilot Plant (WIPP) facility in New Mexico. Nonradioactive hazardous wastes are accumulated at a special accumulation site before shipment to a licensed offsite disposal facility. At the Area 3 RWMS, bulk LLW (such as debris from atmospheric nuclear test locations) and LLW in large non-standard packages are emplaced and buried in selected surface subsidence craters (formed as a result of prior underground nuclear tests).

1996 ACTIVITIES

NUCLEAR TESTS

No nuclear explosives tests were conducted during 1996 due to the moratorium announced in late 1992. However, continuous environmental surveillance for radioactivity and radiation was conducted both onsite and offsite because of the large number of potential effluent sources that exist on the NTS as a result of the prior nuclear tests. The surveillance program and results are described in Chapters 4 and 5.

NTS-RELATED ACTIVITIES

LLW and mixed waste handling and disposal, TRU waste storage and monitoring prior to shipment to the WIPP in New Mexico, and remedial actions related to sites contaminated by tests of nuclear devices are some of the activities that occurred in 1996.

Compliance with state and federal environmental laws and regulations was another principal activity during 1996. Specifically included were actions related to: (1) National Environmental Policy Act documentation preparation, such as the Sitewide Environmental Impact Statement; (2) Clean Air Act compliance for asbestos renovation projects, radionuclide emissions, and state air quality permits; (3) Clean Water Act compliance involving state wastewater permits; (4) Safe Drinking Water Act

compliance involving monitoring of drinking water distribution systems; (5) Resource Conservation and Recovery Act management of hazardous wastes; (6) Comprehensive Environmental Response, Compensation, and Liability Act reporting; and (7) Toxic Substances Control Act management of polychlorinated biphenyls. Also included were preactivity surveys to detect and document archaeological and historic sites on the NTS. Compliance with the Endangered Species Act involved conducting pre-operation surveys to document the status of state of Nevada and federally listed endangered or threatened plant and animal species.

HAZARDOUS MATERIALS SPILL CENTER

DOE/NV's HSC is a research and demonstration facility available on a user-fee basis to private and public sector test and training sponsors concerned with the safety aspects of hazardous chemicals. The site is located in Area 5 of the NTS and is maintained by BN. The HSC is the basic research tool for studying the dynamics of accidental releases of various hazardous materials. Discharges from the HSC tanks occur at a controlled rate and consist of a measured volume of hazardous test fluid released on a surface especially prepared to meet the test requirements. The facility has the capability for releasing large volumes of cryogenic and non-cryogenic liquids. Spill rates for the cryogenic system range up to 98-m³/min (26,000-gpm) capability to release the entire contents of two tanks in two minutes. The non-cryogenic system can release materials at rates up to 19 m³/min (5,000 gpm). Test sponsors can vary intake air humidity, temperature, release rate, and release volume in an 8-ft x 16-ft x 96-ft wind tunnel. There are two spill pads available for use in contained open air releases of volumes up to 3.8 m³ (1,000 gal). An area has been added to provide the capability for determining the efficacy of protective suiting materials when exposed to high concentrations of toxic and hazardous gaseous materials.

An array of diagnostic sensors may be placed up to 16 km downwind of the spill point to obtain cloud-dispersion data. Deployment of the array is test-dependent and is not used for all experiments. The array can consist of up to 20 meteorological and 41 sensor stations to gather wind data and gaseous concentration data from a variety of sensors at various levels above ground. The array and associated data-acquisition system are linked to the HSC control point by means of telemetry. The operation and performance of the HSC are controlled and monitored from the Command Control and Data Acquisition System building located one mile from the test fluid spill area.

TOPOGRAPHY AND TERRAIN

The topography of the NTS is typical of the Great Basin Section of the Basin and Range physiographic province of Nevada, Arizona, and Utah. North-south-trending mountain ranges are separated by broad, flat-floored, and gently-sloped valleys. The topography is depicted in Figure 2.4. Elevations range from about 910 m (3,000 ft) above mean sea level (MSL) in the south and east, rising to 2,230 m (7,300 ft) in the mesa areas toward the northern and western boundaries. The slopes on the upland surfaces are steep and dissected, whereas the slopes on the lower surfaces are gentle and alluviated with rock debris from the adjacent highlands.

The principal effect upon the terrain from nuclear testing has been the creation of numerous dish-shaped surface subsidence craters, particularly in Yucca Flat. Most underground nuclear tests conducted in vertical shafts produced surface subsidence craters that occurred when the overburden above a nuclear cavity collapsed and formed a rubble "chimney" to the surface. A few craters have been formed as a result of tests conducted on or near the surface by shallow depth-of-burial cratering experiments, or following some tunnel events.

There are no continuously flowing streams on the NTS. Surface drainages for Yucca and Frenchman Flats closed-basin systems

are onto the dry lake beds (playas) in each valley. The remaining areas of the NTS drain via arroyos and dry stream beds that carry water only during unusually intense or persistent storms. Rainfall or snow melt typically infiltrates quickly into the moisture-deficient soil or runs off in normally dry channels, where it evaporates and seeps into permeable sands and gravels. During extreme conditions, flash floods may occur.

GEOLOGY

The basic lithologic structure of the NTS is depicted in Figure 2.5. Investigations of the geology of the NTS, including detailed studies of numerous drill holes and tunnels, have been in progress by the U.S. Geological Survey and other organizations since 1951. Because of the large number of drilled holes, see Figure 2.6, the NTS is probably one of the better geologically characterized large areas within the United States.

In general, the geology consists of three major rock units. These are: (1) complexly folded and faulted sedimentary rocks of Paleozoic age overlain at many places by; (2) volcanic tuffs and lavas of Tertiary age, which (in the valleys) are covered by; (3) alluvium of late Tertiary and Quaternary age. The sedimentary rocks of Paleozoic age are many thousands of feet thick and are comprised mainly of carbonate rocks (dolomite and limestone) in the upper and lower parts, separated by a middle section of clastic rocks (shale and quartzite). The volcanic rocks in the valleys are down-dropped and tilted along steeply dipping normal faults of late Tertiary age. The alluvium is rarely faulted and is derived from erosion of Tertiary and Paleozoic rocks. Compared to the Paleozoic rocks, the Tertiary rocks are relatively undeformed, and dips are generally gentle. The volcanic rocks of the Tertiary age are predominantly tuffs, which erupted from various volcanic centers and lavas, mostly of rhyolitic composition. The aggregate thickness of the volcanic rocks is many thousands of feet, but in most places the total thickness of the section is far less because of erosion or



Figure 2.4 Topography of the NTS



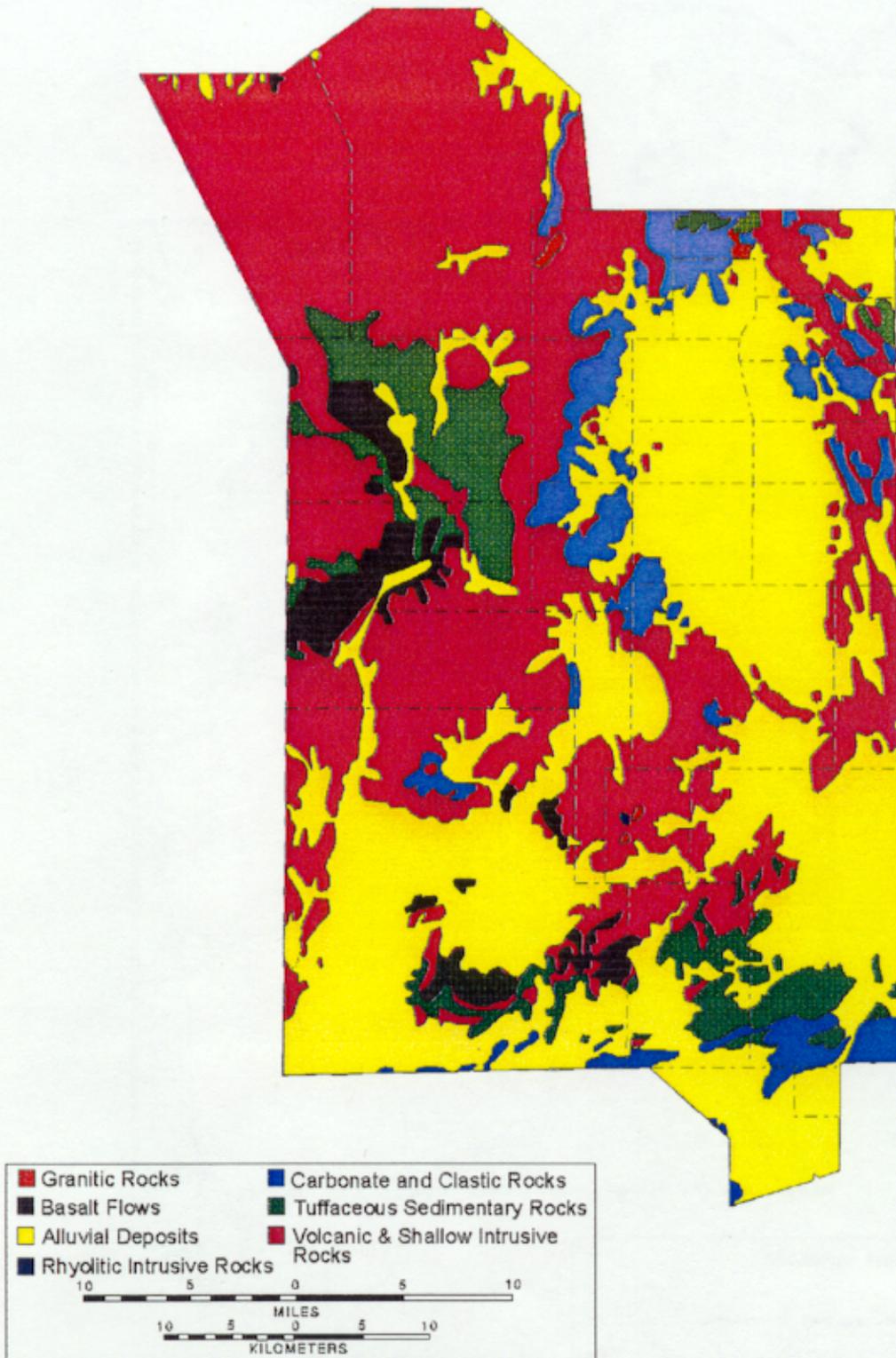


Figure 2.5 Basic Lithologic Structure of the NTS



Figure 2.6 Drill Hole Locations on the NTS



nondeposition. These materials erupted before the collapse of large volcanic centers known as *calderas*. Alluvial materials fill the intermountain valleys and cover the adjacent slopes. These sediments attain thicknesses of 600 to 900 m (2000 to 3000 ft) in the central portions of the valleys. The alluvium in Yucca Flat is vertically offset along the prominent north-south-trending Yucca fault.

HYDROGEOLOGY

The deep aquifers, slow groundwater movement, and exceedingly slow downward movement of water in the overlying unsaturated zone serve as significant barriers to transport of radioactivity from unsaturated zone sources via groundwater, greatly limiting the potential for transport of radioactivity to offsite areas. Some historic nuclear tests were conducted below the groundwater table; others were at varying depths above the groundwater table. Nuclear tests below the groundwater table have a greater potential for offsite migration. However, the great distance to offsite water supply wells or springs makes it unlikely that contaminants will be transported in significant quantities.

Depths to groundwater beneath the NTS vary from about 157 m (515 ft) beneath the Frenchman Flat playa (Winograd and Thordarson 1975) in the southern part of the NTS to more than 700 m (2,300 ft) beneath part of Pahute Mesa. In the eastern portions, the water table occurs generally in the alluvium and volcanic rocks above the regional carbonate aquifer, and in the western portions it occurs predominantly in volcanic rocks. The flow in the shallower parts of the groundwater body is generally toward the major valleys (Yucca and Frenchman), where it may deflect downward to join the regional drainage to the southwest in the carbonate aquifer.

The hydrogeology of the underground nuclear testing areas on the NTS (Figure 2.7) has been summarized by the Desert Research Institute, University of Nevada System (Russell 1990). Yucca Flat is situated within the Ash Meadows

groundwater subbasin. Groundwater occurs within the valley-fill, volcanic, and carbonate aquifers and in the volcanic and clastic aquitards. The depth to water generally ranges from 160 m (525 ft) to about 580 m (1,900 ft) below the ground surface. The tuff aquitard forms the principal Cenozoic hydrostratigraphic unit beneath the water table in the eastern two-thirds of the valley and is unconfined over most of its extent. The valley-fill aquifer is saturated in the central part of the valley and is unconfined (Winograd and Thordarson 1975).

Some underflow, past all of the subbasin discharge areas, probably reaches springs in Death Valley. Recharge for all of the subbasins most likely occurs by precipitation at higher elevations and infiltration along stream courses and in playas. Regional groundwater flow is from the upland recharge areas in the north and east towards discharge areas at Ash Meadows and Death Valley, southwest of the NTS. Due to the large topographic changes across the area and the importance of fractures to groundwater flow, local flow directions can be radically different from the regional trend. Groundwater is the only local source of drinking water in the NTS area. Drinking and industrial water supply wells for the NTS produce from the lower and upper carbonate, the volcanic and the valley-fill aquifers. Although a few springs emerge from perched groundwater lenses at the NTS, discharge rates are low, and spring water is not currently used for DOE activities. South of the NTS, private and public supply wells are completed in a valley-fill aquifer. Frenchman Flat is also within the Ash Meadows subbasin. Regional groundwater flow in this valley occurs within the major Cenozoic and Paleozoic hydrostratigraphic units at depths ranging from 157 to 360 m (515 to 1,180 ft) below the ground surface. Perched water is found as shallow as 20 m (66 ft) within the tuff and lava flow aquitards in the southwestern part of the valley. In general, the depth to water is at least 157 m (515 ft) beneath Frenchman playa and increases to nearly 360 m (1,180 ft) near the margins of the valley (Winograd and Thordarson 1975).



Figure 2.7 Groundwater Hydrologic Units of the NTS and Vicinity



The water table beneath Frenchman Flat is considerably shallower (and stratigraphically higher) than beneath Yucca Flat. Consequently, the areal extent of saturation in the valley-fill and volcanic aquifers is correspondingly greater.

Winograd and Thordarson (1975) hypothesized that groundwater within the Cenozoic units of Yucca and Frenchman Flats probably cannot leave these basins without passing through the underlying and surrounding lower carbonate aquifer. In addition, lateral gradients within the saturated volcanic units exist and may indicate groundwater flow toward the central areas of Yucca and Frenchman Flats prior to vertical drainage.

The only hydrostratigraphic units encountered at Pahute Mesa are the volcanic aquifers and aquitards. Pahute Mesa is thought to be a part of both the Oasis Valley and Alkali Flat/Furnace Creek Ranch subbasins. The location of the inter-basin boundary is uncertain. Groundwater is thought to move towards the south and southwest, through Oasis Valley, Crater Flat, and western Jackass Flats (Blankennagel and Weir 1973). Points of discharge are thought to include the springs in Oasis Valley, Alkali Flat, and Furnace Creek. The amount of recharge to Pahute Mesa and the amount of underflow which moves to the various points of discharge are not accurately known. Vertical gradients within Pahute Mesa suggest that flow may be downward in the eastern portion of the mesa but upward in the western part.

The hydrostratigraphic units beneath Rainier Mesa consist of the welded and bedded tuff aquifer, zeolitized tuff aquitard, the lower carbonate aquifer, and the tuffaceous and lower clastic aquitards. The volcanic aquifer and aquitards support a semiperched groundwater lens. Nuclear testing at Rainier Mesa was conducted within the tuff aquitard. Work by Thordarson (1965) indicates that the perched groundwater is moving downward into the underlying regional aquifer. Depending on the location of the subbasin boundary, Rainier Mesa groundwater may be part of either the Ash

Meadows or the Alkali Flat/Furnace Creek Ranch subbasin. The regional flow from the mesa may be directed either towards Yucca Flat or, because of the intervening upper clastic aquitard, towards the Alkali Flat discharge area in the south. The nature of the regional flow system beneath Rainier Mesa requires further investigation.

CLIMATE AND METEOROLOGY

Precipitation levels on the NTS are low, runoff is intermittent, and the majority of the active testing areas onsite drain into closed basins on the NTS. Topography contributes to temporal and spatial variability of precipitation. For example, on the NTS the mesas receive an average annual precipitation of 9 in. (23 cm), which includes wintertime snow accumulations. The lower elevations receive approximately 6 in (15 cm) of precipitation annually, with occasional snow accumulations lasting only a matter of days (Quiring 1968).

Elevation also influences temperatures on the NTS. At an elevation of 2,000 m (6,560 ft) above MSL in Area 20 on Pahute Mesa, the average daily maximum temperatures range from 40 to 80 ° F, and minimum temperatures from 21 to 57° F (4 to 27° C and -6 to 14° C, respectively). In Area 6 (Yucca Flat, 1,200 m [3,940 ft MSL]), the average daily maximum temperatures range from 51 to 96° F and the minimum temperatures from 28 to 62° F (11 to 36° C and -2 to 17° C, respectively).

Wind direction and speed are important aspects of the environment at the NTS. The movements of large-scale pressure systems control the seasonal changes in the wind direction frequencies. Predominating winds are southerly from the south during summer and northerly during winter. The general downward slope in the terrain from north to south results in an intermediate scenario that is reflected in the characteristic diurnal wind reversal from southerly winds during the day to northerly winds at night. This north to south reversal is strongest in the summer and, on occasion, becomes intense enough to override the wind regime

associated with large-scale pressure systems. This scenario is very sensitive to the orientation of the mountain slopes and valleys. At higher elevations such as Area 20, the average annual wind speed is 17 km/h (10 mi/h) but is only 11 km/h (7 mi/h) in the valleys, such as Yucca Flat. The prevailing wind direction during winter months is from the north-northeast and north-northwest, but it reverses in the summer months. The 1992 10-m wind roses for the NTS are shown in Figure 2.8.

FLORA AND FAUNA

The vegetation on most of the NTS includes various associations of desert shrubs typical of the Mojave or Great Basin Deserts or the zone of transition between these two. Extensive floral collection has yielded 711 taxa of vascular plants within or near the boundaries of the NTS (O'Farrell and Emery 1976). Associations of creosote bush, *Larrea tridentata*, which are characteristic of the Mojave Desert, dominate the vegetation mosaic on the bajadas of the southern NTS. Between 1,220 and 1,520 m (4,000 and 5,000 ft) in elevation in Yucca Flat, transitional associations are dominated by *Grayia spinosa-Lycium andersonii* (hopsage/desert thorn) associations, while the upper alluvial fans support *Coleogyne* types. Above 1,520 m (5,000 ft), the vegetation mosaic is dominated by sagebrush associations of *Artemisia tridentata* and *Artemisia arbuscula* subspecies *nova*. Above 1,830 m (6,000 ft), piñon pine and juniper mix with the sagebrush associations where there is suitable moisture for these trees. No plant species located on the NTS is currently on the federal endangered species list; however, the state of Nevada has placed *Astragalus beatleyae* on its critically endangered species list.

Most mammals on the NTS are small and secretive (often nocturnal in habitat), hence not often seen by casual observers. Rodents are the most important group of mammals on the NTS, based on distribution and relative abundance. Larger mammals

include feral horses, mule deer, mountain lions, bobcats, coyote, kit foxes, and rabbits, among others. Among others Reptiles include: the desert tortoise, over 12 lizards, and 17 snakes; 4 of which are venomous. Bird species are mostly migrants or seasonal residents. Most nonrodent mammals have been placed in the "protected" classification by the state of Nevada. On August 4, 1989, the Mojave population of the desert tortoise, *Gopherus agassizii*, was placed on the endangered species list by the U.S. Fish and Wildlife Service. This population was relisted as threatened on April 2, 1990. The reasons for listing this population included deterioration, loss of habitat, and collection for pets. Other purposes included elevated levels of predation, loss from disease, and the inadequacy of existing regulatory mechanisms to protect tortoises and their habitat. The habitat of the desert tortoises on the NTS is found in the southern third of the NTS outside the recent areas of nuclear explosive test activities.

CULTURAL RESOURCES

Human habitation of the NTS area began at least as early as 10,000 years ago. Various indigenous cultures occupied the region in prehistoric times. The survey of less than 5 percent of the NTS area has located more than 2,000 archaeological sites which contain the only information available concerning the prehistoric inhabitants. The site types identified include rock quarries, tool-manufacturing areas, plant-processing locations, hunting locales, rock art, temporary camps, and permanent villages. The prehistoric people's lifestyle was sustained by a hunting and gathering economy which utilized all parts of the NTS. While major springs provided perennial water, the prehistoric people developed strategies to take advantage of intermittent fresh water sources in the arid region. In the nineteenth century, at the time of initial contact, the area was occupied by Paiute and Shoshone Indians.

Figure 2.8 1992 Wind Rose Patterns for the NTS (Courtesy of Air Resource Laboratory, Special Operations & Research Division)

Prior to 1940, the historic occupation consisted of ranchers, miners, and Native Americans. Several natural springs were able to sustain livestock, ranchers, and miners. Stone cabins, corrals, and fencing stand today as testaments to these early settlers. The mining activities included two large mines: one at Wahmonie, the other at Climax Mine. Prospector claim markers are found in these and other parts of the NTS. Native Americans coexisted with the settlers and miners, utilizing the natural resources of the region and, in some cases, working for the new arrivals. They also maintained a connection with the land, especially areas important to them for religious and historical reasons. These locations, referred to as traditional cultural properties, continue to be significant to the Paiute and Shoshone Indians.

Between 1940 and 1950, the area now known as the NTS was under the jurisdiction of NAFB and was part of the Nellis Bombing and Gunnery Range. Very few locations associated with this time period have been identified. In 1950, the NTS was selected as the continental nuclear testing ground. Surveys have located and recorded many structures associated with nuclear testing. These structures are significant because of the importance of the nuclear testing program in the history of the United States, as well as its effects on the rest of the world.

DEMOGRAPHY

The population of the area surrounding the NTS has been estimated based on the 1990 Bureau of Census estimates (Department of Commerce 1990). Excluding Clark County, the major population center (over 1,000,000 in 1996), the population density within a 150-km (90-mi) radius of the NTS is about 0.5 persons/km². In comparison, the 48 adjoining states (1990 census) had a population density near 29 persons/km². The offsite area within 80 km (50 mi) of the NTS Control Point (CP) is predominantly rural. CP-1 (a building at the Control Point) historically has been the point from which

distances from the NTS were determined. Several small communities are located in the area, the largest being in the Pahrump Valley. This growing rural community, with an estimated population of 20,000, is about 50 mi (80 km) south of CP-1. The Amargosa Farm area, which has a population of about 1,200, is approximately 50 km (30 mi) southwest of CP-1. The largest town in the near offsite area is Beatty, which has a population of about 1,500 and is approximately 65 km (40 mi) to the west of CP-1.

The Mojave Desert of California, which includes Death Valley National Monument, lies along the southwestern border of Nevada. The National Park Service estimated that the population within the boundaries ranges from 200 permanent residents during the summer months to as many as 5,000 tourists and campers on any particular day during holiday periods in the winter months. As many as 30,000 are in the area during "Death Valley Days" in the month of November. The largest nearby population in this desert is in the Ridgecrest-China Lake area about 190 km (118 mi) southwest of the NTS, containing about 28,000 people. The next largest is in the Barstow area located 265 km (165 mi) south-southwest of the NTS with a population of 24,000. The Owens Valley, where numerous small towns are located, lies 50 km (31 mi) west of Death Valley. The largest town in the Owens Valley is Bishop, located 225 km (140 mi) west-northwest of the NTS, with a population of 3,500.

The extreme southwestern region of Utah is more developed than the adjacent portion of Nevada. The largest community is St. George, located 220 km (137 mi) east of the NTS, with a population of 29,000. The next largest town, Cedar City, with a population of 14,000, is located 280 km (174 mi) east-northeast of the NTS.

The extreme 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, 165 km (103 mi) south-southeast of the NTS, with a population estimate of 22,000, and Kingman, located 280 km (174 mi) southeast of the NTS, with a population of about 13,000.

SURROUNDING LAND USE

Figure 2.9 is a map of the offsite area showing a wide variety of land uses such as farming, mining, grazing, camping, fishing, and hunting within a 300-km (180-mi) radius of the CP-1. West of the NTS, elevations range from 85 m (280 ft) below MSL in Death Valley to 4,400 m (14,500 ft) above MSL in the Sierras, including parts of the Owens and San Joaquin agricultural valleys. The areas south of the NTS are more uniform, since the Mojave Desert ecosystem (mid-latitude desert) comprises most of this portion of Nevada, California, and Arizona. The areas east of the NTS are primarily mid-latitude steppe with some of the older river valleys, such as the Virgin River and Moapa Valleys, supporting irrigation for small-scale but intensive farming of a variety of crops. Grazing is also common in this area, particularly towards the northeast. The area north of the NTS is also mid-latitude steppe where the major agricultural activity is grazing of cattle and sheep, and a minor agricultural activity is growing of alfalfa hay. Many of the residents cultivate home gardens.

Recreational areas lie in all directions around the NTS and are used for such activities as hunting, fishing, and camping. In general the camping and fishing sites to the north of the NTS are not utilized in the winter months. Camping and fishing locations to the south are utilized throughout the year. The peak hunting season is from September through January.

2.2 NON-NTS FACILITIES

BN had several offsite operations in support of activities at the NTS under a contract with

the DOE/NV. Those that were operational in support of NTS activities are described in the following sections. Each of these facilities is located in a metropolitan area.

City, county, and state regulations govern emissions, waste disposal, and sewage. No independent BN systems exist for sewage disposal or for supplying drinking water, and hazardous waste is moved off the facility sites for disposal. Radiation sources are sealed, and no radiological emissions are expected during normal facility operations.

AMADOR VALLEY OPERATIONS (AVO)

The AVO facility in Pleasanton, California, occupies a 5,520-m² (59,445-ft²) two-story combination office/laboratory building. AVO is located near the Lawrence Livermore National Laboratory (LLNL) in Livermore, California, to simplify logistics and communications associated with BN support of LLNL programs. Although most of the work has been in support of NTS underground weapons testing, AVO also supports LLNL with optical alignment systems and a variety of mechanical and electrical engineering activities associated with energy research and development programs. Areas of environmental interest include two small chemical cleaning operations.

SPECIAL TECHNOLOGIES LABORATORY (STL)

STL is located in Santa Barbara, California. The current facilities occupy approximately 4,608 m² (49,600 ft²) and consist of combination office/lab areas used primarily for engineering and electronic research. The research is conducted to develop a suite of sensor systems for testing and field deployment in support of DOE Headquarters and DOE/NV. Areas of environmental interest include a small printed circuit board operation, minor solvent cleaning operations, neutron activation, and pulsed X-ray system experiments.

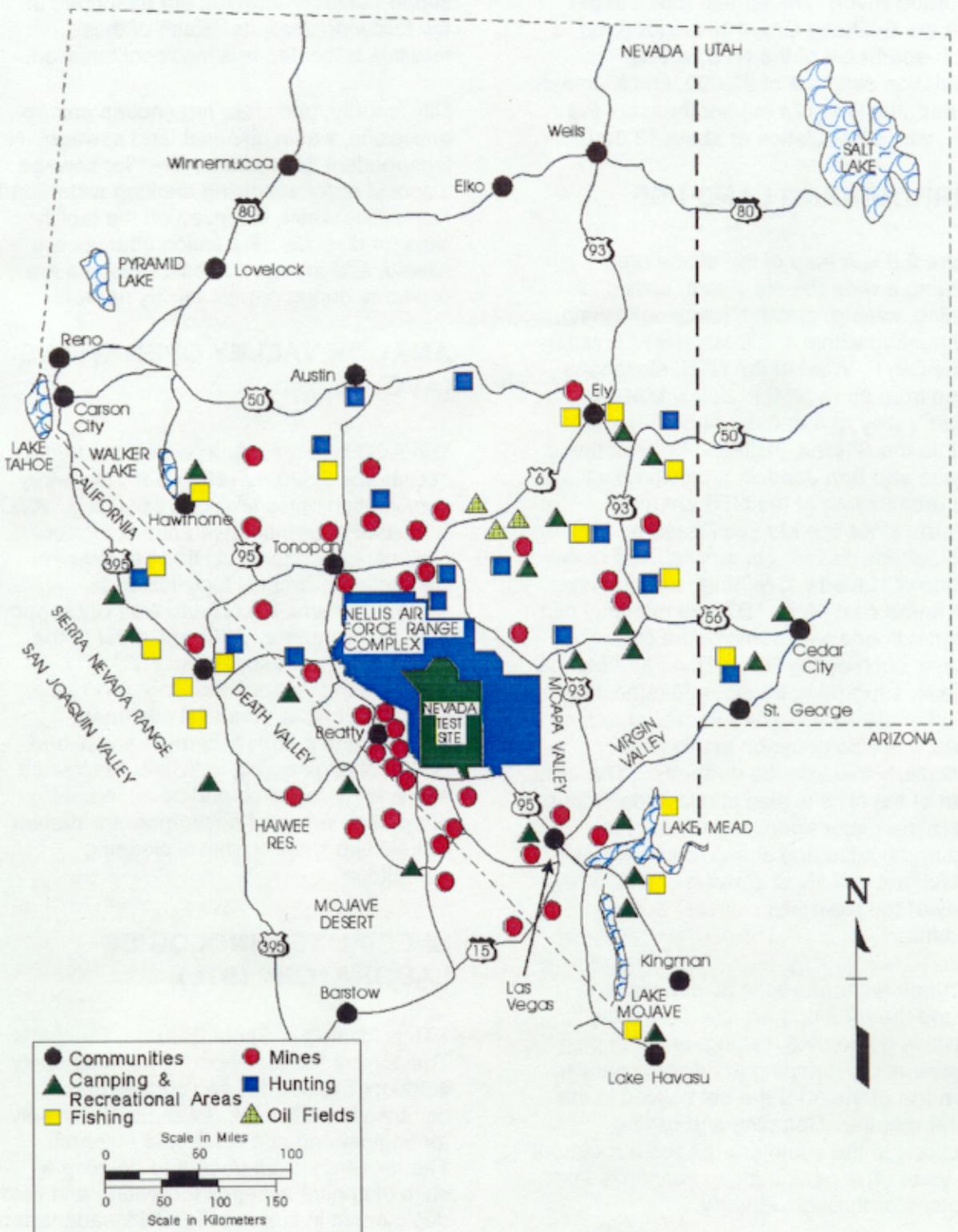


Figure 2.9 Land Use Around the NTS

LAS VEGAS AREA OPERATIONS (LVAO)

The LVAO includes the North Las Vegas Facility (NLVF) and the Remote Sensing Laboratory (RSL) on the NAFB in North Las Vegas, Nevada. These facilities provide technical support for the DOE/NV activities.

The NLVF includes multiple structures totaling about 53,820 m² (585,000 ft²). At the facility there are numerous areas of environmental interest, including metal finishing operations, a radiation source range, an X-ray laboratory, solvent and chemical cleaning operations, small amounts of pesticide and herbicide application, photo laboratories, and hazardous waste generation and accumulation.

The RSL is an 11,000-m² (118,000-ft²) facility located on a 14-ha (35-acre) site within the confines of the NAFB. The facility includes space for aircraft maintenance and operations, mechanical and electronics assembly, computer operations, photo processing, a light laboratory, warehousing, and emergency operations. Areas of environmental interest are photo processing, aircraft maintenance, and operations.

LOS ALAMOS OPERATIONS (LAO)

The LAO resides in a facility of approximately 4,645 m² (50,000 ft²). It is a two-story combination engineering laboratory office complex located near the Los Alamos National Laboratory (LANL) facility to provide local support for LANL's programs. The work performed includes direct support to the LANL Science-Based Stockpile Stewardship program, the DOE Research and Development Program, and miscellaneous DOE cash-order work. LAO's primary activities are twofold: the design, fabrication, and fielding of data acquisition systems used in underground and above ground testing diagnostics; and the analysis

of data from prior experiments. Areas of environmental interest include small solvent cleaning, metal machining operations, and a small photo laboratory.

WASHINGTON AERIAL MEASUREMENTS OPERATIONS (WAMO)

The WAMO, located at Andrews Air Force Base, consists of five buildings: a 186-m² (2,000-ft²) Butler building used as office space; a 1,110-m² (12,000-ft²) hangar, combination electronics laboratory, aircraft maintenance, and office complex; a 37-m² (400-ft²) equipment service and storage building; and 186 m² (2,000 ft²) in each of two other joint tenant buildings. WAMO operations provide an effective east coast emergency response capability and an eastern aerial survey capacity to the DOE/NV. Areas of environmental interest include minor solvent cleaning operations, used fuels, and oils.

2.3 NON-NTS UNDERGROUND TEST SITES

In past years, nuclear explosive tests were conducted for a variety of purposes at eight different non-NTS sites in the U.S. The events and their locations appear in Table 2.1 (AEC 1964, 1965, 1966, 1970, 1972, 1973a, 1973b)(DOE 1978, 1984, 1986)(PHS 1966). Those that were not sampled in 1996 are indicated. Activities at these locations generally are limited to annual sampling of surface and groundwater at over 200 wells, springs, etc., at locations near the sites where tests were conducted. However, a Remedial Investigation/Feasibility Study has begun at the Mississippi test location which will include significant new characterization activities. Sampling near three test sites on Amchitka Island, Alaska, occurs only periodically. Sampling results for these sites appear in Chapter 9 of this report.

Table 2.1 Non-NTS Nuclear Underground Test Sites

<u>Event Name</u>	<u>Location</u>	<u>Purpose</u>	<u>Date of Test</u>
GNOME	Carlsbad, New Mexico	Multi-purpose in salt	12/10/61
SHOAL	Fallon, Nevada	Test detection research	10/26/63
SALMON (Dribble)	Hattiesburg, Mississippi	Test detection research	10/22/64
LONG SHOT ^(a)	Amchitka Island, Alaska	Test detection research	10/29/65
STERLING (Dribble)	Hattiesburg, Mississippi	Test detection research	12/03/66
GASBUGGY	Farmington, New Mexico	Gas stimulation experiment	12/10/67
FAULTLESS	Central Nevada, Nevada	Seismic calibration	01/19/68
RULISON	Grand Valley, Colorado	Gas stimulation experiment	09/10/69
MILROW ^(a)	Amchitka Island, Alaska	Seismic calibration	10/02/69
CANNIKIN ^(a)	Amchitka Island, Alaska	Spartan missile warhead test	11/06/71
RIO BLANCO	Rifle, Colorado	Gas stimulation experiment	05/17/73

(a) Not sampled in 1996.