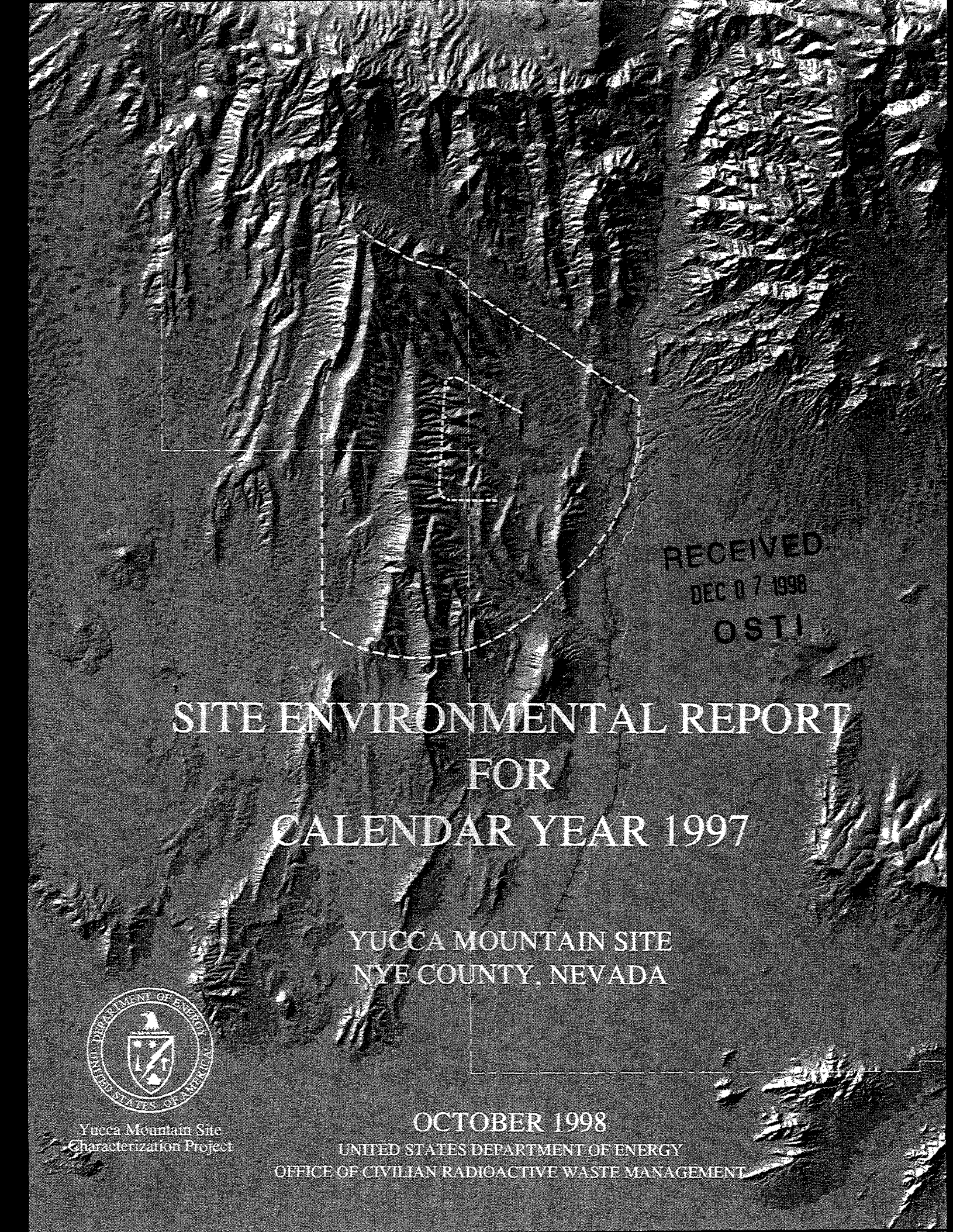

SITE ENVIRONMENTAL REPORT FOR CALENDAR YEAR 1997

YUCCA MOUNTAIN SITE
NYE COUNTY, NEVADA

Yucca Mountain Site Characterization Project

OCTOBER 1998

UNITED STATES DEPARTMENT OF ENERGY
OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT

DOE/YMP--99001417

SITE ENVIRONMENTAL REPORT

FOR

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U.S. Department of Energy
Yucca Mountain Site Characterization Office
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SITE ENVIRONMENTAL REPORT

PREFACE

The environmental program established by the Yucca Mountain Site Characterization Office (YMSCO) has been designed and implemented to protect, maintain, and restore environmental quality, minimize potential threats to the environment and the public, and comply with environmental policies and U.S. Department of Energy (DOE) Orders. In accordance with DOE Order 5400.1, *General Environmental Protection Program* (DOE, 1990a), DOE Order 231.1, *Safety and Health Reporting Requirements* (DOE, 1995a), and DOE-M 231.1, *Environment, Safety, and Health Reporting Manual* (DOE, 1995b), the status of the Yucca Mountain Site Characterization Project (YMP) environmental program has been summarized in this annual Site Environmental Report (SER) to characterize performance, document compliance with environmental requirements, and highlight significant programs and efforts during calendar year 1997.

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SITE ENVIRONMENTAL REPORT

1.0 EXECUTIVE SUMMARY

The Yucca Mountain Site Characterization Project (YMP) met a major milestone on April 25, 1997, when the tunnel boring machine (TBM) broke through the surface at the South Portal exit point, marking the completion of the 7.9-kilometer (km) (4.9-mile [mi]) tunnel known as the Exploratory Studies Facility (ESF) main loop. During excavation, several experiments designed to characterize the geological and hydrological properties of Yucca Mountain were initiated in seven test alcoves excavated off the main loop. In addition, plans were being made to excavate a Cross Drift, starting in the ESF main loop and proceeding west through the proposed repository block, to better define the characteristics of the rock where the actual repository may be constructed.

The YMP environmental program in 1997 reflected changes brought about by the shift of major site characterization activities from the surface, where most early activities had occurred, to the underground venue of the TBM. Because many components of the environmental program were essentially surface-based in nature and directly associated with land disturbance, the emphasis on subsurface studies translated into fewer environmental issues. By spring of the year, however, the level of activity at the surface began to increase with the emergence of the TBM from the mountain and the planned excavation of a Cross Drift (also known as the "Enhanced Characterization of the Repository Block" [ECRB]). The South Portal pad, to be the final resting place of the TBM, was completed, and various ECRB-related activities (e.g., new roads and boreholes) were initiated. Accordingly, the number of tasks required of the YMP environmental program was once again on the upswing.

The most fundamental function of the environmental program, since the earliest days of the YMP (or Project), has been the acquisition and subsequent renewal, when required, of permits necessary to conduct site characterization activities at the Yucca Mountain site. In 1997, three existing permits were extended by the State of Nevada, allowing the continued use of water

from three wells for dust control. In addition, two sources of significant volumes of treated or reusable surface water were approved for the first time to be applied for dust suppression. Modification of another existing permit altered the way in which the State will consider future Yucca Mountain Site Characterization Office (YMSCO) requests to use tracer-bearing waters in underground tests. Also modified was the Air Quality Operating Permit, at YMSCO request, to include, among other things, State approval to increase the throughput of one drillrig and decrease the operating hours of another. All known pollutant emissions are presently permitted by the State under the conditions of this single air quality permit.

To ensure that the conditions and requirements of all permits were being fulfilled and applicable regulations adhered to, the YMSCO conducted frequent, unannounced surveillance checks in the field. In 1997, surveillance personnel conducted 374 environmental field surveillances.

Hand-in-hand with the permitting process is the preactivity survey, designed to inventory and protect ecological and cultural resources in areas proposed for surface-disturbing activities. Specially trained personnel thoroughly examine the area in question in advance of the activity for the presence of important plant and animal species (e.g., the officially threatened desert tortoise, *Gopherus agassizii*) or items of archaeological significance (primarily Native American artifacts at Yucca Mountain). Occasionally, when activities are proposed to take place within the boundaries of the adjacent Nevada Test Site (NTS), the areas involved are first examined for radioactivity by YMP radiological personnel. During 1997, 12 archaeological and 7 biological preactivity surveys were conducted; no radiological surveys were required. Also carried out by biologists were seven clearance surveys for the purpose of clearing an area of tortoises, should any be present, immediately prior to the onset of an activity. No tortoises or tortoise sign (e.g., burrows or scat) were found during these clearance surveys in 1997.

Training personnel to be aware of their environmental responsibilities has always been an important component of the YMP environmental program. Any individual requiring unescorted

access to the site must first attend a training class which includes segments on biological and archaeological resources at the site and ways to avoid and/or protect them. Additionally, such individuals must demonstrate each year that they continue to understand their environmental obligations by either attending a refresher class or participating in computer-based refresher training. In 1997, 127 individuals attended the initial training class, while 446 employees took part in refresher training.

As in previous years, monitoring was a major component of the Yucca Mountain environmental program. The technical areas contributing monitoring data and information to this Site Environmental Report (SER) were radiological field studies, air quality, meteorology, cultural (archaeological and Native American) resources, water resources, and terrestrial ecosystems.

The radiological monitoring program for 1997 included the quantification of ambient gamma radiation, ambient radon, and radionuclides, both naturally occurring and man-made, in the Yucca Mountain environment. Ambient gamma radiation was determined using two monitoring techniques, while radon concentrations and gross alpha and gross beta radioactivities were measured using a single method for each. Environmental media sampled and monitored were air, water, and soil. In 1997, the YMP radiological monitoring program operated only near-field stations, i.e., monitoring units located within 16 km (10 mi) of the center of the Yucca Mountain radiological study area.

To further contribute to a determination of the existing levels of ambient radiation in the vicinity of the proposed repository site, groundwater samples, collected from eight wells and springs in the YMP study area, were analyzed for radioactivity. Analyses of radium (^{226}Ra and ^{228}Ra) and gross alpha radioactivity revealed that, at all eight locations, average combined radium concentrations and average alpha concentrations were below their respective maximum contaminant levels (MCL), established by the Environmental Protection Agency (EPA).

YMP activities generated no airborne radiological emissions in 1997. To date, concentrations of radon and other monitored radionuclides have not exceeded ambient levels measured at other locations outside the boundaries of the NTS.

As last year, the air quality program monitored particulate matter 10 micrometers (μm) or less in diameter (PM_{10}) at four locations. The data indicate an annual trend of higher concentrations of these particulates during the summer months, although individual, somewhat elevated concentrations were recorded periodically throughout the year. The highest concentration of PM_{10} in a 24-hour period was less than half the 24-hour ambient air quality standard of 150 micrograms per cubic meter ($\mu g/m^3$). Most values, in fact, were well below 20 $\mu g/m^3$. The highest average of all 24-hour periods for any monitoring site was less than one-fifth the annual ambient air quality standard of 50 $\mu g/m^3$.

The meteorology program continued to operate nine monitoring stations in the Yucca Mountain vicinity. The primary function of this program is to characterize local meteorological conditions and support future radiological transport calculations. The main station, Site 1, recorded meteorological data at the surface and at three levels on its 60-m tower. Many of the same parameters (e.g., wind speed and direction, temperature, solar radiation, barometric pressure, and precipitation) were also measured at the other eight sites, each equipped with a 10-m tower. Precipitation totals at the various stations for 1997 were nearly identical to the long-term averages for those locations. For example, the total at Site 1 was 12.75 centimeters (cm) or 5.02 inches (in) versus the 12-year average at that site of 12.64 cm (4.98 in). Typical differences were observed between sites, however, ranging from a total of 8.58 cm (3.38 in) at Site 9 to 15.47 cm (6.09 in) at Site 6. Annual average wind speed ranged from a low value of 2.8 m per second (m/s) or 6.2 mi per hour (mph) at Site 3 to a high of 4.9 m/s (11.0 mph) at Site 4. Also at Site 4, the highest 3-second wind speed gust of 30.7 m/s (68.7 mph) was recorded.

As a result of the 12 archaeological preactivity surveys mentioned previously, 3 new artifacts or historical sites were identified. Monitoring of 46 previously known historical properties indicated that all were in essentially the same condition as when discovered or last examined. In compliance with certain stipulations of the Programmatic Agreement between the U.S. Department of Energy (DOE) and the Advisory Council on Historic Preservation (ACHP), consultation and interactions with 17 Native American tribes and organizations continued in 1997. One tribal update meeting and two American Indian Writers subgroup meetings were sponsored by the YMSCO and held in Las Vegas, Nevada. A variety of national Native American meetings were attended by DOE personnel, and the DOE sponsored 20 speaking engagements and 31 educational forums during the year at which the YMP Native American program was explained to the public. Three displays (in Las Vegas, Beatty, and Pahrump, Nevada) that feature Indian history and culture in the Yucca Mountain area, as well as general scientific aspects of the Project, were visited by approximately 6,900 people in 1997.

Measurements of groundwater levels in 35 wells, and of groundwater discharge (in-flow) into 5 springs and 1 flowing well, in the Yucca Mountain region continued throughout 1997. Comparisons of provisional data from monitoring well JF-3 and two nearby production wells, J-12 and J-13, indicated that fluctuations in water levels during the year were 0.13 m (0.44 ft), 0.20 m (0.67 ft), and 0.12 m (0.39 ft), respectively.

Water samples were collected in May 1997 from eight selected well and spring sites near Yucca Mountain for purposes of assaying several water-quality parameters. Seven major categories, each consisting of many water property or chemistry parameters, were chosen for analysis and included the following: volatile and semi-volatile organic compounds, major and trace inorganic constituents, and radiochemical constituents. Results of these analyses will be used to characterize regional groundwater and contribute to the ongoing Yucca Mountain radiochemical monitoring program.

The terrestrial ecosystem program, which has generated a considerable body of data since its inception, has undergone substantial change over the past two years. Field data collection efforts for the desert tortoise component of the program were completed in 1995, and the information acquired has since been compiled for publication in topical reports, four being issued in 1997. (Though these studies have concluded, the presence of tortoises at Yucca Mountain will still be noted during preactivity surveys, and the animals will be removed from harm's way whenever necessary.) The trapping of small mammals, begun in 1989 as one of several methods of assaying the effects of site characterization, was completed in 1997, as were studies to monitor the indirect effects of site characterization activities on vegetation.

The continuing objective of the habitat reclamation program is to restore sites disturbed by YMP activities to an ecological state similar in form and productivity to their pre-disturbance condition. Reclamation efforts include seeding, mulching, or chemical stabilization of disturbed areas; revegetation and monitoring of revegetated areas; testing a variety of irrigation strategies and pre-planting treatments of seeds and soils; and exploring the dynamics of recovery processes in stored topsoil.

In 1997, two topsoil stockpiles, established as a result of site characterization activities, were restabilized by seeding and mulching, while two others received chemical soil stabilizer. Twenty-three additional sites were reclaimed by seeding with a mixture of native plant species, followed by mulching and stabilization. Soil erosion and the need for additional reclamation measures were monitored at 89 and 49 sites, respectively. Vegetative cover and plant density data were collected at 46 sites, and transplant survival was monitored at Trench A'2.

In addition, four reclamation studies begun in late 1996 continued in 1997. Three of these explore different irrigation regimens and seed treatments, while the fourth is designed to document the use of reclaimed areas by wildlife. With small mammals as the indicator species, initial results suggest that these areas are being used more frequently by wildlife over time as the vegetation becomes established.

To verify that these various programs and all YMP activities are performed in full compliance with the appropriate environmental requirements and regulations, the YMP environmental program includes an environmental assessment program. During 1997, 16 assessments were conducted, consisting of evaluations of 13 Project-wide environmental, safety, and health programs and three off-site contractors providing environmental support to the YMP. An additional function of the assessment group is the identification of new or revised regulatory requirements and notification of appropriate Project personnel whenever changes occur. In 1997, 151 notifications were electronically conveyed to YMP staff. The assessment team also reviewed 90 YMP plans, procedures, and special reports.

Continued emphasis was placed on waste minimization and adherence to hazardous waste regulations in 1997. Recycling efforts were once again successful, yielding, among other items, 244 tons of paper, approximately 117 tons of recyclable metal, and 5,220 gallons of used oil. Also collected and transported to a recycling facility were tires, lead-acid batteries, antifreeze coolants, and used cleaning solvents. Recycled for the first time in 1997 were fluorescent and high-intensity discharge lamps, many of which contained mercury.

Five shipments of hazardous waste were transported to EPA-permitted disposal facilities, in accordance with Resource Conservation and Recovery Act (RCRA) requirements. Because quantities of listed toxic chemicals used by the YMP during the course of the year were insufficient to activate the Emergency Planning and Community Right-to-Know Act (EPCRA) Section 313 reporting process, the YMSCO was not required to file an EPCRA Section 313 report with the EPA in 1997. Further, no listed toxic chemicals were released during the year. In compliance with Sections 302, 311 and 312 of EPCRA, reports are filed annually with the appropriate State and/or county agencies to document the storage by the YMP of substances in excess of their reporting thresholds. In 1997, six substances were included in this category: sulfuric acid, propane, diesel fuel, cement, and lubricating and waste oils. During the year, no chemicals classified by the State of Nevada as highly hazardous were stored in quantities that exceeded their reporting thresholds.

Two State-reportable petroleum releases occurred in 1997 as a result of YMP activities. Both were promptly reported, as required by law, and remedial action was performed at each release location. Approximately 31 tons of excavated, hydrocarbon-contaminated soil were sent during the year to an off-site, State-permitted treatment and recycling facility for bioremediation and ultimate use as landfill cover.

2.0 INTRODUCTION

2.1 DOCUMENT OVERVIEW

This document is the seventh annual Site Environmental Report (SER) submitted by the Yucca Mountain Site Characterization Office (YMSCO) to describe the environmental program implemented by the U.S. Department of Energy (DOE) at Yucca Mountain. As prescribed by the Nuclear Waste Policy Act (NWPA, 1982), this program ensures that site characterization activities are conducted in a manner that minimizes any significant adverse impacts to the environment and complies with all applicable laws and regulations. The most recent guidelines for the preparation of the SER (Memorandum from DOE, Office of Environmental Policy and Assistance, dated April 24, 1997) place major emphasis on liquid and gaseous emissions of radionuclides, pollutants or hazardous substances; human exposure to radionuclides; and trends observed by comparing data collected over a period of years. To date, the YMP has not been the source of any radioactive emissions or been responsible for any human exposure to radionuclides. Minuscule amounts of radioactivity detected at the site are derived from natural sources or from dust previously contaminated by nuclear tests conducted in the past at the NTS. Because data for only a few years exist for the site, identification of long-term trends is not yet possible.

Despite the lack of the aforementioned categories of information requested for the SER, the YMP has collected considerable material relevant to this report. An extensive environmental monitoring and mitigation program is currently in place and is described herein. Also, as requested by the SER guidelines, an account of YMP compliance with appropriate environmental legislation is provided.

2.2 SITE LOCATION

The area known as the "Yucca Mountain site" (or "the site" or "Project site") is situated on the southwestern boundary of the NTS and includes adjoining lands administered by the U.S. Air Force (USAF) and the Bureau of Land Management (BLM) (Figure 2-1). The USAF land comprises a small part of the Nellis Air Force Base Bombing and Gunnery Range (NAFR) and is used by the USAF for overflight purposes only. Access to both USAF and BLM land has been obtained by means of right-of-way reservations (ROWR) granted the DOE by each agency. The site is located in Nye County, Nevada, approximately 160 kilometers (km) or 100 miles (mi) northwest of the city of Las Vegas, Nevada (Figure 2-1).

2.3 SITE DESCRIPTION

Located in the southern Great Basin of the Basin and Range Province, the regional setting of the Yucca Mountain site may be generally characterized as consisting of linear mountain ranges separated by intervening valleys with ephemeral streams or rivers. Because little water is easily accessible, the region has been only sparsely populated. Historically, a few small communities have sprung up near mining operations but most are now abandoned or inhabited by relatively few permanent residents. The rocky desert soil, low in moisture and nutrient value, provides little opportunity for productive agriculture. In a few areas, however, groundwater is sufficiently shallow that irrigation of some crops has been possible.

Within this regional setting, the Project site encompasses ecological zones ranging from the Mojave Desert to the south (below 1,220 meters [m]; 4,000 feet [ft] elevation) through a transition zone (sometimes called the Transition Desert) which extends beyond the northern

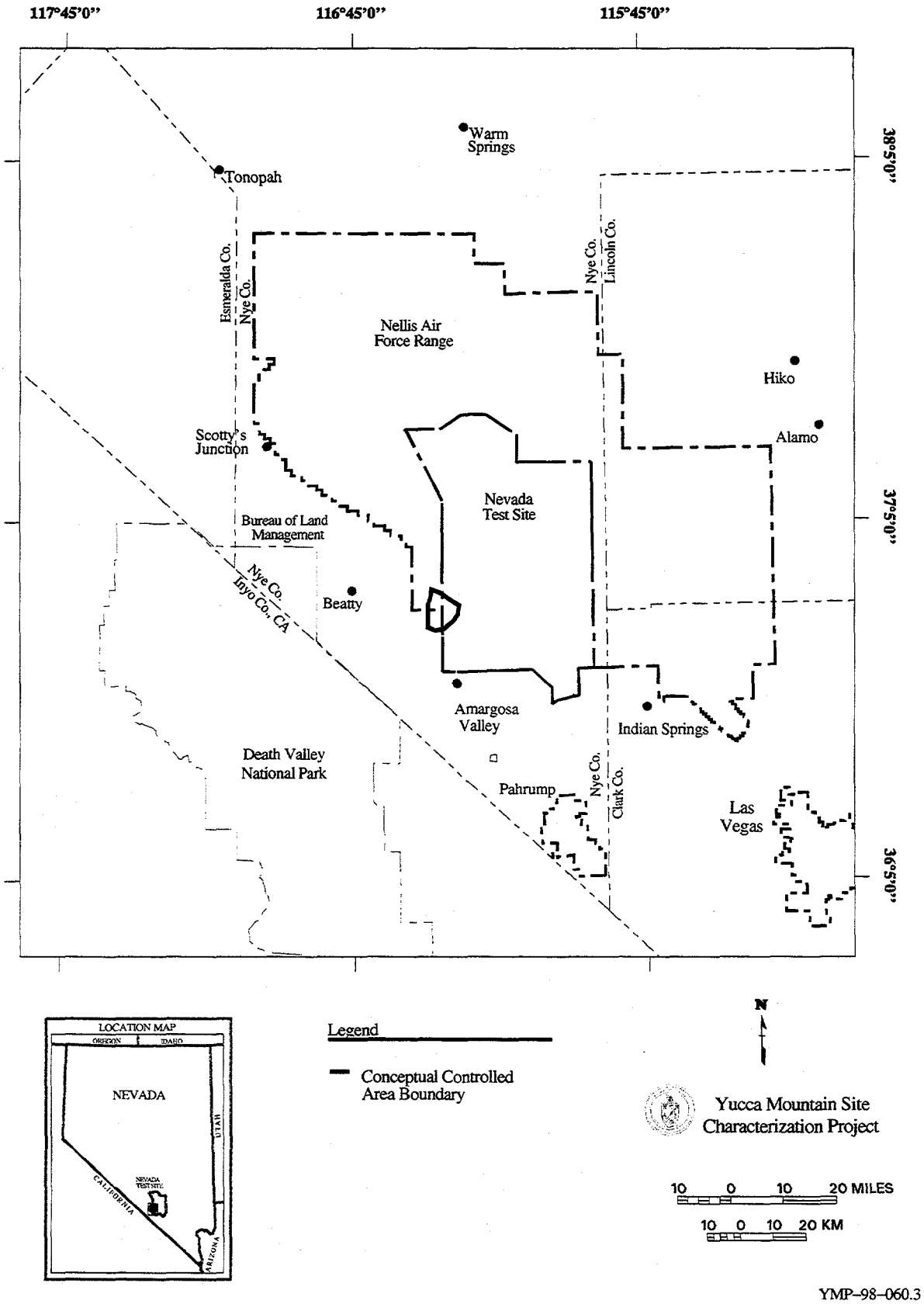


Figure 2-1. Location of the Yucca Mountain Site

boundary of the site to the cooler and wetter Great Basin Desert (above 1,525 m [5,000 ft]). The soils are generally rocky or sandy and dry, primarily supporting low bushes and shrubs. The major topographical feature of the site is Yucca Mountain itself, a long north to south-aligned volcanic ridge with an elevation of 1,494 m (4,900 ft). The mountain slopes steeply west to Crater Flat (elevation 1,189 m [3,900 ft]) and gradually eastward to Jackass Flats (elevation 1,097 m [3,600 ft]). Five sizable washes cross the site east of Yucca Mountain, the largest being Fortymile Wash which drains to the Amargosa Valley.

The regional setting and natural features of the Yucca Mountain site are described in more detail in the Environmental Assessment (EA) prepared for the site (DOE, 1986).

2.3.1 Climate and Meteorology

Typical of southwestern deserts, the climate of the Yucca Mountain region is characterized by intense solar radiation much of the year, limited amounts and infrequent occurrences of precipitation with large inter-annual variations, low relative humidity, and large diurnal temperature ranges. Local topography influences precipitation, temperature patterns, and wind direction and speed, as manifested by the diurnal mountain-valley, air-flow cycle. This cycle, which occurs in all seasons, produces winds predominantly from the north to northwest at night and from the south to southeast during the day. Synoptic-scale winds, produced by frontal storm passages in winter, spring, and fall, and the southerly monsoon of summer, can enhance, neutralize, or reverse the predominant diurnal cycle.

Since late December 1985, meteorological data have been continually recorded at five sites on and around Yucca Mountain. Four additional stations were in operation by January 1993 (see Section 6.1.4). In 1997, 17 stations, previously operated by the U.S. Geological Survey (USGS) and equipped to measure precipitation only, were added to the environmental monitoring network. Typically, most of the total annual precipitation falls in winter with

occasional snowfall at higher elevations. Summer thunderstorms can also produce significant rainfall over a relatively short period of time. For the period December 1985 through December 1997, annual precipitation at the Site 1 (NTS-60) meteorological tower averaged 12.64 centimeters (cm) or 4.98 inches (in). Annual precipitation totals at this site for the same period ranged from 3.66 cm (1.44 in) in 1989 to 23.57 cm (9.28 in) in 1995 (Figure 2-2). The greatest daily amount of precipitation recorded at Yucca Mountain during this period was 6.17 cm (2.43 in) occurring at the Site 7 (Sever Wash) meteorological station in December 1993.

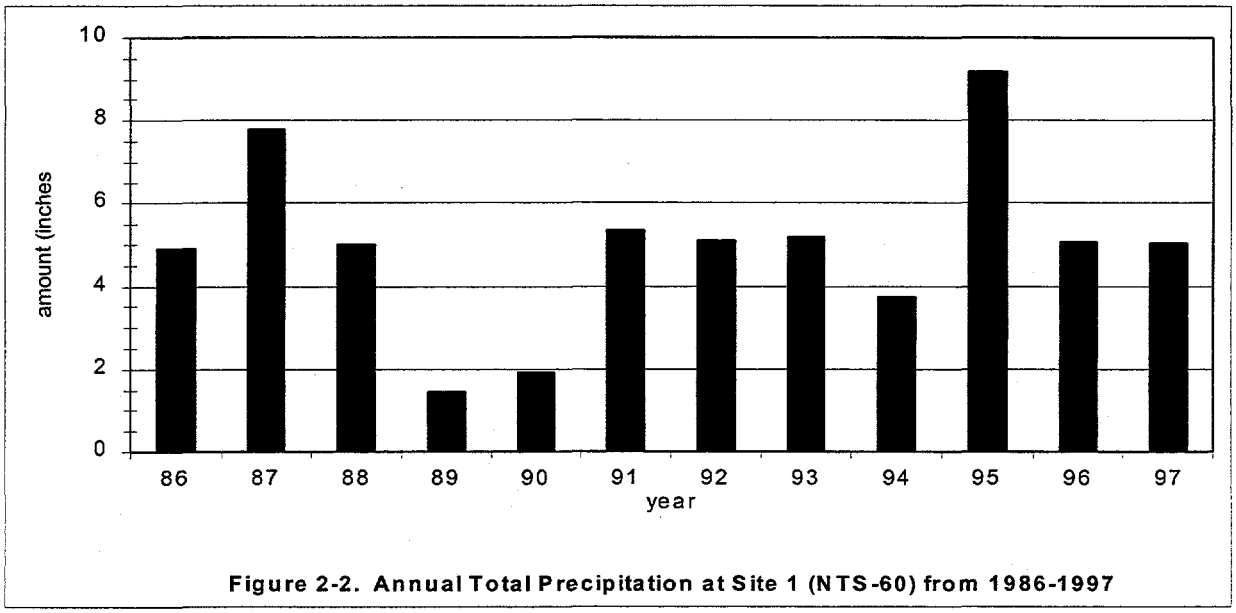


Figure 2-2. Annual Total Precipitation at Site 1 (NTS-60) from 1986-1997

2.3.2 Geology

Four major groups of rocks comprise the mountain ranges and basins in the region of the site (DOE, 1986). The first and oldest, Precambrian crystalline rock, is not exposed at Yucca Mountain but may occur beneath the site at great depths. The second, sedimentary rock including carbonates, is many thousands of feet thick and is overlaid in many places by the third group, volcanic tuffs and lava of Tertiary age. This third group, the result of eruptions preceding the collapse of large volcanic centers known as calderas, comprise at least the upper 2,000 m

(6,500 ft) of the total stratigraphic section at the site. The fourth group, Quaternary deposits, is represented at Yucca Mountain by alluvium derived from erosion of the nearby hills of sandstone and volcanic rock. Alluvial-fan deposits form aprons along the east and west flanks of the mountains.

In Crater Flat, west and southwest of Yucca Mountain, cinder cones of Quaternary age are conspicuous at the surface. It is estimated that the most recent major volcanic activity in the vicinity of the site occurred some 11 million years ago, forming the Timber Mountain caldera (between 16 and 24 km [10 and 15 mi] north) (DOE, 1986).

Current seismic activity in the vicinity of Yucca Mountain is monitored continuously by a network of 22 seismic stations funded by the YMSCO. Also part of the system are three microwave relay stations to assist in the transmission of data. On June 29, 1992, an earthquake of 5.6 Richter magnitude occurred 21 km (12.5 mi) south of Yucca Mountain beneath Little Skull Mountain at a depth of approximately 5 km (3 mi). More than 1,000 aftershocks were recorded immediately thereafter, the largest of which was magnitude 4.0. In August 1994, an aftershock of magnitude 3.0, too small to be felt at Yucca Mountain, was detected at Little Skull Mountain. An even smaller event (magnitude 2.1) occurred the same month in Crater Flat, 10 km (6.2 mi) from the ESF. Since 1994, seismic activity in the region has been restricted to weak aftershocks and low-magnitude background events.

2.3.3 Water Resources

Free-flowing surface water does not exist at or near the Project site. Drinking water is pumped from groundwater sources. Water tables are generally deep beneath the surface of the ranges and most valleys. Recharge results from precipitation falling at higher elevations to the north. After percolating from the surface through the unsaturated zone that overlies the water table, water flows generally south and southwest.

Beneath the Project site, water traverses two separate aquifers, one local and relatively shallow (at a depth of approximately 490 m [1,600 ft]), the other regional and very deep in the lower carbonate layer (probably in excess of 1,250 m [4,100 ft]) (DOE, 1986). The majority of the groundwater eventually discharges south and southwest of the site in Amargosa Valley and Death Valley.

2.3.4 Biological Resources

The major vegetation associations of the NTS and the surrounding region were described by Beatley (1976), whose classification was used to differentiate the four major vegetation associations in the immediate Yucca Mountain area. Plant species names follow the convention of Kartesz and Pankhurst (1994), and the common names of plants follow Kartesz (1988).

At the lowest elevations, below approximately 1,035 m (3,400 ft), the *Larrea-Ambrosia* (creosote bush, white bursage) vegetation association occurs on generally flat (slope = 0 to 2%), sandy, alluvial soils. *Larrea tridentata* and *Ambrosia dumosa* are the dominant perennial shrubs.

At middle elevations, between approximately 1,035 and 1,310 m (3,400 and 4,300 ft), the *Larrea-Lycium-Grayia* (creosote bush, desert thorn, hopsage) association occurs on the upper portions of bajadas (slope = 4 to 6%) and on rocky slopes. This association is typified by widely spaced creosote bush that forms a diffuse canopy, with *Ephedra nevadensis* (Nevada ephedra), *A. dumosa*, and *Krameria erecta* (littleleaf ratany) being subdominants in this association. *Lycium andersonii* (Anderson desert thorn) and *Grayia spinosa* (hopsage) are less common. This vegetation association is also characterized by an abundance of winter annuals such as *Bromus rubens* (red brome) and *Amsinckia tessellata* (common fiddleneck).

At middle elevations above approximately 1,100 m (3,600 ft), the *Coleogyne* (blackbrush) association occurs on the upper portions of bajadas with moderate slopes and few rocks (slope = 3 to 5%) and on flat ridge tops. This association is typically composed of nearly

monospecific stands of *Coleogyne ramosissima* interspersed with several species of *Chrysothamnus* (rabbitbrush) and *Ephedra*. At Yucca Mountain, this association often intergrades over long distances with the *Larrea-Ambrosia* and *Larrea-Lycium-Grayia* associations.

At higher elevations, above approximately 1,310 m (4,300 ft), the *Lycium-Grayia* (desert thorn, hopsage) association occurs on ridge tops (slope = 6 to 10%) and on the higher, steeper, and rockier slopes. *L. andersonii*, *G. spinosa*, *E. nevadensis*, *Eriogonum fasciculatum* (California buckwheat), and a variety of shrubs from higher and lower elevations share dominance in this association.

At still higher elevations or on some cooler, north-facing slopes and ridges, species of *Artemesia* (sagebrush) become dominant in small areas within the *Lycium-Grayia* association. On adjacent areas of the NTS, at elevations above 1,524 m (5,000 ft), a pinyon-juniper association is found which is dominated by one or both of two dwarf conifers, *Pinus monophylla* (pinyon pine) and *Juniperus osteosperma* (Utah juniper).

Based on NTS records, as many as 46 species of mammals may occur in the vicinity of Yucca Mountain (Collins et al., 1982); however, only 36 species have been recorded at the Yucca Mountain site. At middle and higher elevations, the most common rodents were Merriam's kangaroo rats (*Dipodomys merriami*) and long-tailed pocket mice (*Chaetodipus formosus*), while at lower elevations, Merriam's kangaroo rats and little pocket mice (*Perognathus longimembris*) were most common. Other species were recorded from live-trapping studies, scent-station surveys, bat surveys, spotlight surveys, roadkills, and anecdotal observations. None of the mammals observed are considered threatened or endangered. Two species of bats captured at Yucca Mountain, *Myotis volans* (long-legged myotis) and *Myotis thysanodes* (fringed myotis), were candidates for listing under the Endangered Species Act (ESA) until 1996. A third bat species (*Myotis ciliolabrum*, the small-footed myotis), also a former ESA candidate, may have been captured but is difficult to differentiate from *Myotis californicus* (California myotis).

Euderma maculatum (spotted bat), considered threatened by the State of Nevada and an ESA candidate until 1996, was neither seen nor detected at Yucca Mountain. The species was detected, however, about 30 mi (50 km) north of Yucca Mountain in higher-elevation regions of the NTS.

Site-specific surveys in 1982 recorded 35 species of birds (O'Farrell and Collins, 1983). A database of bird observations made by YMP biologists has been maintained since January 1993, and although observations were not systematically recorded, 116 species of birds have been observed at Yucca Mountain as of December 1997.

Twenty-seven (possibly 28) species of reptiles were observed during sampling operations conducted between 1991 and 1995 using a variety of techniques. Sampling was conducted throughout the Yucca Mountain site area, but most occurred within the three major low-elevation habitat types in and around Midway Valley. The most common lizards were the side-blotched lizard (*Uta stansburiana*) and western whiptail (*Cnemidophorus tigris*), while the most common snakes were the coachwhip (*Masticophis flagellum*) and longnose snake (*Rhinocheilus lecontei*). Two species of concern were found: the desert tortoise (*Gopherus agassizii*), listed as threatened under the Endangered Species Act (ESA; Section 3.1.6 of this report), and the western chuckwalla (*Sauromalus obesus*), a former candidate for ESA listing.

2.3.5 Cultural Resources

Archaeological resources found at the Yucca Mountain site indicate significant past use by small and highly mobile groups of aboriginal hunter-gatherers, followed by limited use by Euroamericans for purposes of travel and transportation, prospecting, surveying and, possibly, ranching. The region may have been inhabited by humans as long ago as 12,000 years. At that time, most activity appears to have centered on a pattern of sites along major ephemeral drainages. By 7,000 years Before Present (BP), a second settlement pattern was discernible, with

the establishment of temporary camps in the uplands of Yucca Mountain, some distance from linear water sources. A third shift in the pattern of aboriginal settlement occurred approximately 1,500 years ago, indicated by the presence of sites, often with grinding stones, on alluvial fans or in small rockshelters in the Yucca Mountain uplands. At that time, sites were no longer being established along major drainages, perhaps indicating that such waterways were by then lacking significant water. Sites were usually located, instead, near small seasonal water sources such as tinajas.

A fourth and most recent period of settlement adaptation, a Euroamerican presence, is indicated by the discovery of rock cairns, tin cans, and temporary historic camps (DOE, 1990b). At the time of the first recorded arrival of Euroamericans in 1849, the area was inhabited by the Paiute and Shoshone Indians.

Numerous archaeological surveys have been conducted in the Project area. As a result, over 900 historical properties, ranging from single pottery shards to campsites, milling stations, and quarries, have been identified.

2.3.6 Demography

With the exclusion of Clark County to the southeast, the counties immediately surrounding the Yucca Mountain site are essentially rural and sparsely populated. Most residents are concentrated in a few small communities. County populations as of July 1, 1997, are as follows: Lincoln, 4,435 residents; Esmeralda, 1,165; Nye, 27,168; and Inyo (California) with 18,300 (U.S. Bureau of the Census, 1998). The exception is Clark County (1,106,047 residents), which includes the cities of Las Vegas, North Las Vegas, Henderson, Boulder City, and Mesquite (U.S. Bureau of the Census, 1998). Population density is extremely low (approximately 0.5 person per square kilometer [km^2]) in these bordering counties (excluding Clark), relative to a 1992 estimate for the 48 contiguous states (33 persons per km^2).

A circular study area, 84 km (52 mi) in radius, is considered to be "the site" for radiological monitoring purposes. One community, Pahrump, is split by the southeast perimeter of the study circle. The estimated population, for the first quarter of 1997, of that portion of the town that lies within the study circle is 12,714, while the total population within the town boundary is 19,171 (DOE, 1997a). The community of Amargosa Valley, 24 to 32 km (15 to 20 mi) south and primarily agricultural, has a population of 1,270. Beatty, approximately 32 km (20 mi) west, has 1,846 residents. Las Vegas, already large and growing rapidly, lies 160 km (100 mi) to the southeast, well outside the study area boundary.

The only other concentration of population near the site occurs at Death Valley National Park, with an estimated population of 661 residents.

2.3.7 Land Use

The area within which the Project site is located is controlled by three Federal agencies: the DOE, the USAF, and the BLM. Consequently, access to much of the land is restricted. In addition, because of the lack of surface water and the generally harsh desert conditions that prevail in the area, few opportunities exist for agriculture or recreation on lands immediately adjacent to the site. An exception is a limited amount of off-road driving that occurs in the surrounding area. The nearest agriculture of note occurs in the Amargosa Valley, approximately 24 km (15 mi) south. The Pahrump Valley, 97 km (60 mi) south and east, also contains significant farming operations. The BLM issues a limited number of grazing leases for southern Nye County, though none have been issued for lands surrounding the site.

Several small mines exist in southern Nevada, most of them to the southwest near the Nevada-California border. Two major active mining operations near the site are the Stirling-Panama Mine at Bare Mountain, approximately 19 km (12 mi) to the west, and the Bullfrog Mine operated by Barrick, Incorporated, near the town of Beatty.

Areas south and southwest of the site are popular throughout the year for camping, boating, hiking, hunting, fishing, and nature study. Two that are particularly well-known are the Ash Meadows National Wildlife Refuge (32 km [20 mi] away) and Death Valley National Park (32 to 40 km [20 to 25 mi] to its northeastern boundary). The former is especially unique because of its seeps and springs (in excess of 30), providing habitat for four endemic, endangered fish species.

2.4 MISSION AND CURRENT ACTIVITIES

The NWPA of 1982, as amended in 1987, directs the DOE to conduct site characterization studies at Yucca Mountain to determine whether the site is suitable for the storage and isolation of high-level radioactive waste and spent nuclear fuel. Early studies undertaken in response to this mandate were surface-based only, as in conducting ecological investigations and digging trenches and shallow boreholes. In 1993, the emphasis began to shift underground as preparations proceeded for studies that would characterize the site geologically and hydrologically. Between mid-1994 and early 1997, the primary focus was on the TBM, as it excavated a tunnel 7.6 m (25 ft) in diameter along a U-shaped path within Yucca Mountain. As the TBM progressed, seven test alcoves were excavated off the main tunnel, and experiments commenced in some of these underground "laboratories" soon after the TBM had moved on. On April 25, 1997, the TBM emerged from the mountain, having completed the 7.9-km (4.9-mi) route extending from the North Portal tunnel entrance to the South Portal exit point.

As part of the ongoing effort to characterize Yucca Mountain, the effects of heat generation on the rock and the movement of water in the mountain are being studied. Electric heaters are being used to heat the rock, creating temperatures that might be produced by decaying materials in a future repository. Two of these tests are taking place in Alcove #5, the Thermal Test Facility, off the main ESF tunnel (Figure 2-3). One, the Single-Heater Test, was initiated in 1996, with completion of the heating phase in May 1997. The behavior of rock and moisture is

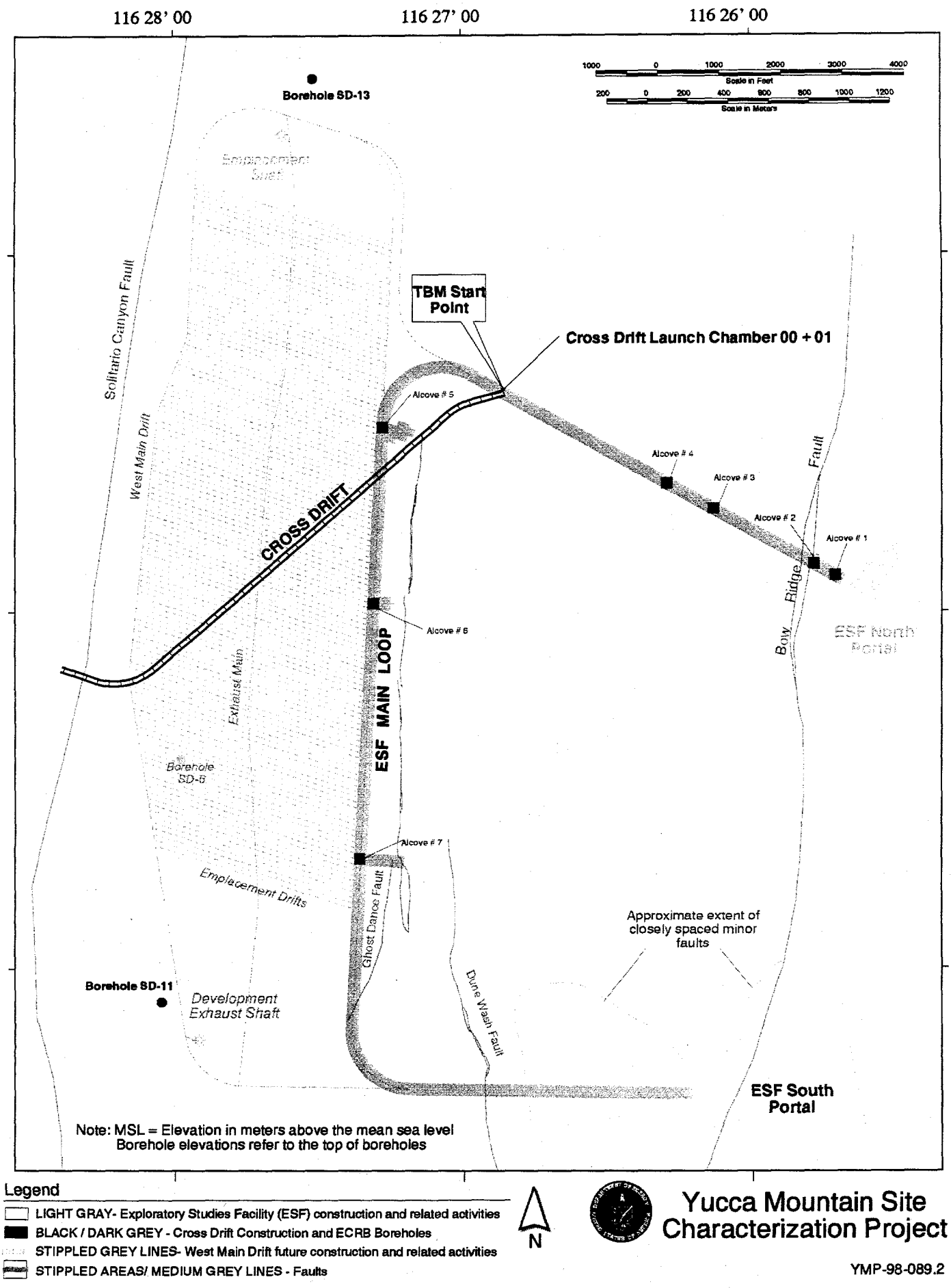


Figure 2-3. Relationship of the Cross Drift and Other ECRB Activities to the Existing ESF Main Tunnel in Yucca Mountain

presently being observed throughout a nine-month cooling period. The second test, the largest underground thermal test ever conducted to date, commenced in December 1997. Known as the Drift-Scale Test, this experiment requires heating the rock for four years, followed by a cool-down phase of another four years. Heat (perhaps exceeding 100° C [212° F], the boiling point of water) will be provided by 50 wing heaters and 9 canister heaters similar in size and shape to waste containers.

A third major heating experiment, the Large-Block Heater Test, is being conducted outside the ESF tunnel at nearby Fran Ridge (Figure 3-1, p. 3-22). Beginning March 1, 1997, heat was applied to a block of rock excavated from the mountain and measuring 3 m (10 ft) x 3 m x 4.5 m (15 ft). A temperature of 140° C (284 ° F) was maintained for one month, after which observations have been recorded as the rock cools.

Following the recommendation of the Nuclear Waste Technical Review Board, planning began in early 1997 for a new drift to be excavated in Yucca Mountain. Known formally as the "Enhanced Characterization of the Repository Block" (ECRB) and informally as the "east-west crossing" or "Cross Drift", this excavation will be significantly shorter and smaller in diameter than the just-completed main ESF tunnel. The Cross Drift will be created by a new TBM, 5 m (16.5 ft) in diameter, for a distance of 2,823 m (9,262 ft; 1.75 mi). Excavation will begin within the existing ESF tunnel and proceed in a southwesterly direction toward the west side of the repository block above the north-south leg of the ESF main tunnel and level of the proposed repository (Figure 2-3). This route will permit observation of rock conditions from a different orientation than that provided by the ESF tunnel and will allow excavation through the full range of emplacement-drift rock units. Three test alcoves will be excavated along the tunnel for purposes of testing hydrogeologic processes. On December 9, 1997, construction crews began excavation of a 26-m- (85-ft-) long assembly zone and "launch pad" in the main tunnel for the new TBM.

3.0 COMPLIANCE SUMMARY

This chapter briefly discusses environmental legislation that is applicable to DOE activities at Yucca Mountain, and summarizes YMP compliance actions and the results of those actions during 1997. A summary of permits and the status of each is presented at the end of the chapter in Tables 3-1, 3-2, and 3-3.

3.1 COMPLIANCE STATUS

3.1.1 Nuclear Waste Policy Act (NWPA)

Section 113(a) of the NWPA, as amended, stipulates that the Secretary of Energy shall carry out appropriate site characterization activities at the Yucca Mountain site. It further states that such activities shall be conducted in a manner that minimizes, to the maximum extent practicable, any significant adverse environmental impacts. For the third successive year, the primary effort to characterize the site took place underground, as the TBM completed the ESF tunnel through the mountain and exited in April at the South Portal.

As the TBM progressed through the mountain, experiments were initiated in seven alcoves, or underground laboratories, excavated off the main drift. Most of these research efforts were designed to reveal the ways in which fluids and gases (including water and water vapor) move within and between the rock types that comprise the mountain. Another experiment, known as the Drift-Scale Test, is investigating the effects of long-term heat on the rock and on the movement of water through the rock. For this test, electric heaters will heat more than 13,000 cubic yards of rock, and thermal, mechanical, hydrologic, and chemical processes will be studied over a total of eight years.

Two other major activities designed to characterize the site also commenced in 1997. One, another heating experiment, but conducted outside the ESF tunnel, is the Large-Block Heater Test (see Section 2.3). The second activity is a new tunnel to be excavated across and above the existing ESF tunnel (Figure 2-3, p. 2-13) to allow examination of the proposed repository block and to provide an opportunity to test the ability of current models to predict conditions in the rock.

As required by the NWPA, adverse impacts to the surface environment were prevented or minimized by implementing a variety of mitigative measures. For example, in preparation for the emergence in April 1997 of the TBM, as it completed the ESF tunnel, an area referred to as the South Portal was cleared, an access road was built, and a pad prepared on which the TBM will eventually be disassembled. Several steps were taken to minimize the amounts of dust emitted by these activities and to prevent erosion from the site. A large tank provided water under pressure for purposes of cleaning newly exposed rock surfaces and spraying the surrounding area to suppress dust emissions. Concrete sections, on which the TBM will rest, were constructed to include a concrete berm for the retention of liquids (spills or precipitation) and a built-in pump by which excess liquids may be transferred into 55-gallon (gal) drums for off-site disposal.

To mitigate potential soil contamination and runoff of fluids draining from heavy equipment parked at the ESF pad, a membrane liner, placed on the ground, was covered with fine sand. The sand (and liner, if necessary) can be removed periodically as needed, rather than, as in the past, having to clean up uncovered ground each time a release occurs. This liner, in conjunction with the continued application of spill prevention measures, significantly decreases the number of cleanup operations necessary during the year.

Three roadways were improved during the year, resulting in road surfaces essentially free of dust and requiring no water or oil applications for dust suppression: H Road, previously paved, was resurfaced from Fortymile Wash to the South Portal turnoff; and H Road to the South

Portal and H Road to the ESF pad were both treated using a "chip and seal" technique. An additional measure adopted in 1997 to reduce traffic-generated fugitive dust was the lowering of the speed limit on Busted Butte Road to 25 miles per hour (mph).

As in past years, preactivity surveys were conducted in 1997, water was routinely applied to gravel roads for dust suppression, and dust collection equipment was in place on drillrigs. Certain ecosystem studies were continued and, as surface-disturbing activities were completed in several areas, previously tested reclamation techniques were applied.

While the NWPA clearly states in Section 113 that no environmental impact statement (EIS) is required to conduct site characterization studies, such a document is called for in Section 114 of the Act in the event that studies reveal that Yucca Mountain is suitable for development as a repository. In compliance with this requirement, the YMSCO initiated the EIS process in 1995. Following a hiatus in EIS activity for most of 1996, necessitated by budgetary considerations, the process was renewed in Fiscal Year (FY) 1997 and continued throughout Calendar Year (CY) 1997 (see Section 3.1.2).

3.1.2 National Environmental Policy Act (NEPA)

Section 113 of the NWPA, entitled "Site Characterization," states that each activity carried out for purposes of evaluating the suitability of the Yucca Mountain site for development as a repository shall be considered a "preliminary decision-making activity." As such, no EIS, pursuant to Section 102(2)(C) of the NEPA, was required prior to initiating site characterization. Throughout characterization, however, the DOE has been obliged to adhere to those sections of NEPA that pertain to overall protection of the environment and to the systematic interdisciplinary assessment of impacts of federal actions on the environment. The environmental program being carried out by the DOE (and described in sections 4.0, 5.0, and 6.0 of this document) is designed to satisfy those requirements of NEPA. Ultimately, should site

characterization activities reveal that Yucca Mountain is suitable for a repository, the NEPA process (including the preparation of a Repository EIS) will play an important role in the Secretary of Energy's recommendation of the site to the President (Section 114, NWPA).

In anticipation of the need for a Yucca Mountain Repository EIS, the YMSCO published a Notice of Intent (NOI) in the Federal Register (FR) on August 7, 1995, stating its intention to prepare an EIS and to solicit public comments on the scope of the document. Fifteen scoping meetings were held, concluding in December 1995, with approximately 1,000 public comment documents submitted during the scoping period. Budgetary restrictions resulted in the deferral of further EIS activities for most of FY 1996, but on October 1, 1996, EIS functions resumed. The DOE reviewed all public scoping comments and issued a public comment summary document in May 1997. This document summarizes comments and issues identified during the scoping process and describes the DOE's approach to addressing those issues in the EIS.

Other NEPA activities pursued during 1997 included the gathering and review of data for the EIS, development of approaches to EIS impact assessment, completion of initial draft text for certain EIS chapters, and coordination between affected DOE field sites and DOE Headquarters. All of these activities were directed toward the scheduled issuance of a draft of the required Repository EIS in July 1999.

3.1.3 Clean Air Act (CAA)

The CAA is one of the statutes applicable to Yucca Mountain site characterization activities whose implementation and enforcement have been delegated to the State of Nevada by the Federal government. In part to comply with provisions of the CAA, the YMSCO established an extensive monitoring network to record meteorological conditions and to sample airborne particulate matter in the vicinity of the site. In addition, it was anticipated that the data to be acquired by such a monitoring network might be needed for future environmental analyses.

3.1.3.1 Air Quality Permits

An Air Quality Operating Permit is required for site characterization activities that are projected to disturb more than 8.1 hectares (ha [20 acres]) of land. The Operating Permit formerly held by the YMP for land disturbance was originally granted by the State of Nevada in 1991 as an Air Quality Permit to Construct. Effective July 1, 1994, the State changed its permitting process such that all new air quality permits are issued as Operating Permits. Another change, specific to the Yucca Mountain permit, occurred in mid-1995, when a number of existing permits for point sources of emissions and the surface disturbance permit were consolidated by the State into a single Air Quality Operating Permit (No. AP9611-0573, see Table 3-2, p. 3-29). New or reissued air quality permits are subject to renewal five years after the date of issue.

In May of 1996, the State of Nevada removed the restriction from the Air Quality Operating Permit that established a maximum area of land that can be disturbed by YMP site characterization activities. Until then, the upper limit was 188.25 ha (465 acres) of land disturbed. Despite removal of this restriction, the YMSCO intends to continue to track and record the area disturbed each year. In 1997, approximately 6.1 ha (15.1 acres) were disturbed by YMP activities, bringing the total since June 21, 1991, to approximately 121.2 ha (299 acres) of land disturbed.

Both the previous and present permit conditions for surface disturbance stipulate that the DOE must sample ambient air for PM_{10} (i.e., inhalable particulate matter 10 micrometers [μm] or less in diameter) and monitor air temperature and wind during construction and for at least one year after construction is completed. Sampling for PM_{10} is conducted every sixth day for 24 consecutive hours at four locations. As of the end of 1997, particulate matter had been monitored for 92 months, and quarterly Ambient Air Monitoring Reports had been submitted to

the State, as required by the permits. During this period, the highest reported PM_{10} values were well below the ambient air quality standards, both for any single 24-hour period and for the average of all 24-hour periods (see Section 6.1.3, Air Quality).

Effective September 17, 1997, revised National Ambient Air Quality Standards (NAAQS) for particulate matter and ozone were implemented. The new NAAQS for particulate matter includes $PM_{2.5}$ (i.e., particles in the respirable range with diameters of 2.5 μm or less) (40 Code of Federal Regulations [CFR] 50.7). These $PM_{2.5}$ regulations respond, for the most part, to health concerns in urban areas because the source of this pollutant is primarily combustion rather than fugitive dust, and the first priority of this legislation is the monitoring of densely populated areas. As a result, the application of $PM_{2.5}$ regulations to areas as remote as Yucca Mountain and the Amargosa Valley will probably not be necessary anytime soon.

The new NAAQS for ozone applies to a daily maximum 8-hour average, as stated in 40 CFR 50.8. It is anticipated that the YMP will not be required to monitor ozone. Therefore, work at Yucca Mountain should not be affected by the ozone standard.

Fugitive dust is also addressed in the original Air Quality Permit to Construct and in the Air Quality Operating Permit modified in 1995. The YMP is obliged to control fugitive dust by applying water or chemical stabilizers to disturbed areas, and by paving or graveling roads and parking areas. This mitigative use of water has been possible since 1992, when the Nevada State Engineer granted permission to the YMP to use NTS well J-13 water, primarily for dust suppression, subject to the conditions of the permit application and his approval. Since then, additional water appropriations-related permits have been issued, increasing groundwater appropriations and allowing flexibility in the choice of groundwater sources. Three temporary permits, received in June 1993 and extended in 1995, supplemented these appropriations, allowing the use of discharge water from the C-well Complex for dust control, testing, or aquifer recharge (Section 3.1.15.1). In 1996, a Proof of Completion of Work was filed with the State for one of these wells, while one-year permit extensions were requested and received for the other

two. Again in 1997, one-year permit extensions were granted for these latter two wells. Another permit, allowing use of water from well VH-1 for some of the same purposes, including dust control, was extended in May 1996 and again in April 1997.

Two other sources of water were approved for dust suppression in July 1997, when the Nevada Department of Environmental Protection (NDEP) granted YMSCO requests to use (1) tracer-bearing water at the South Portal, as previously approved and used for dust control in the ESF tunnel; and (2) rainwater that has been collected and passed through an oil-water separator to remove oil contaminants (Section 4.1). Samples from both sources are to be tested at regular intervals before use to ensure that acceptable levels of total petroleum hydrocarbons (TPH) are not exceeded.

On December 22, 1997, the State revised Air Quality Operating Permit No. AP9611-0573 to reflect changes in the operation of two drillrigs, the LM-300 and the Stratmaster. In both instances, the changes had been requested by the YMSCO. For the Stratmaster, an increase in throughput from 0.5 to 2.4 tons per hour was approved, making it consistent with other drillrigs, while for the LM-300, annual hours of operation were reduced from 2,000 to 1,000 per calendar year. Decreasing the hours of operation of the LM-300 contributes toward maintaining emissions at levels below the upper limits stipulated by the Class II Air Quality Operating Permit.

Seventeen emission sources are presently authorized by the modified Air Quality Operating Permit, as listed in Table 3-2 (p. 3-29). In summary, all known pollutant emissions are presently permitted by the State under the conditions of this single air quality permit. An Annual Usage Report, summarizing 1997 information required by the air quality permit (e.g., types of equipment, quantities of emissions, hours of operation, etc.), was submitted to the NDEP in February 1998.

3.1.3.2 Ozone-depleting Substances

In response to legislation restricting the use of ozone-depleting substances, the YMSCO, in 1992, withdrew its request for permission to inject chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) into boreholes for the purposes of studying infiltration and groundwater flow (Section 3.1.5). Ozone-depleting substances that are prohibited under Title VI of the 1990 amendments to the CAA are not approved for use in any manner for Project activities.

3.1.4 Clean Water Act (CWA)

Many provisions of the CWA are not applicable to characterization of the Yucca Mountain site. Exceptions are requirements for a Section 404 permit from the U.S. Army Corps of Engineers (COE) and for National Pollutant Discharge Elimination System (NPDES) permits granted by the State of Nevada. With regard to the former, the COE determined in November 1989 that rerouting washes for site characterization would require Section 404 permitting. In July of 1990, a Nationwide General Permit was issued by the COE, requiring a simple notification process when work entailing dredging, filling or modification of washes at the site was planned. In compliance with this permit, the DOE has notified the COE, whenever appropriate, of plans to excavate sand and gravel for the construction of roads, drill pads, and ESF pads.

Prior to discharging effluents at Yucca Mountain, an approval to discharge, granted by the NDEP, is necessary for each type of discharge anticipated. The form of approval depends upon the effluent and circumstances involved. One possibility is an NPDES permit, as issued in May 1993 for stormwater discharge. Alternatively, the discharge may be included under the existing Underground Injection Control (UIC) Permit (Section 3.1.5), as with C-well pump test discharges, providing the State has been notified in advance. A third possibility for a potential

discharge is inclusion under NDEP's statewide General Discharge Permit, as done in July 1995 for sewage disposal (i.e., approval to construct a septic tank/leach field facility).

3.1.5 Safe Drinking Water Act (SDWA)

The SDWA grants the EPA authority to regulate public drinking water supplies. The water supply for Yucca Mountain is considered a "public water supply," as defined by the SDWA, because it will service 15 or more connections or 25 people for more than 60 days per year. In 1978, the EPA approved Nevada's program for enforcing the drinking water standards established by the EPA. In response to an application filed by the YMSCO in May 1993, the Nevada Division of Health, in September 1993, issued a permit for construction of a water-delivery system at Yucca Mountain. Construction of this system was completed in early 1996, with approval to operate the system granted by the State in April of that year. Since then, drinking water for the site has been provided by wells J-12 and J-13.

Another component of the SDWA that is applicable to the YMP is the UIC Program, established to prevent contamination of underground sources of drinking water as a result of improper design, construction, and operation of injection wells. The State of Nevada also has EPA-granted authority to administer this program. Before tracers can be injected into drillholes or used in infiltration studies, a permit must be obtained from the State. In May of 1992, a permit was received allowing modification of the existing permit, granted in 1991, to conduct tests at the C-well Complex. The modified permit authorized the DOE to inject water and various tracers, including gas (but excluding ozone-depleting substances), into the 3 wells at the C-well site and into 50 other wells at Yucca Mountain.

In January 1996, the State finalized actions initiated earlier to modify the UIC permit (No. UNEV 89031). Included in the changes were an additional 50 boreholes for tracer injection and use of the following tracers: noble gases, sodium bromide, sodium iodide, potassium

bromide, potassium iodide, sodium tungstate dihydrate, sodium molybdate dihydrate, sodium fluoride, fluorescein, potassium fluoride, magnesium iodide, and magnesium fluoride. Further, the modified permit consolidated other existing individual Project permits to include the following surface discharges: fire suppression pond (formerly the mine evaporation pond), concrete batch plant, infiltration basin, and water for dust suppression.

One significant modification of the UIC permit was made by the State in 1997. Instead of approving the use of a general or "blanket" concentration applicable to all tracers, the NDEP declared in January that future requests by the YMSCO to use tracers, often each at a different concentration, would be considered on a case-by-case basis.

As required by the UIC permit, an annual report was submitted to the State of Nevada in January 1997, with an updated status report filed each calendar quarter during the year.

3.1.6 Endangered Species Act (ESA)

A policy of the ESA is to ensure that no Federal agency authorizes, funds, or carries out an action that jeopardizes the continued existence of an endangered or threatened species, or results in the destruction or adverse modification of the species' critical habitat. To date, the Mojave population of the desert tortoise (*Gopherus agassizii*), listed as threatened under the ESA, is the only species at Yucca Mountain that receives full protection under the ESA.

In 1990, the U.S. Fish and Wildlife Service (USFWS) rendered its Biological Opinion regarding the impacts of site characterization activities on desert tortoises (USFWS, 1990). Early in 1997, the DOE reinitiated consultation with the USFWS to clarify how many tortoises could be moved out of construction areas at Yucca Mountain. In July 1997, the USFWS issued a new Biological Opinion for site characterization activities (USFWS, 1997), which outlines the

activities required of the YMP to protect desert tortoises. Most of these requirements were already being observed by the YMP.

Three ongoing activities represent compliance with the restrictions of the USFWS Biological Opinion (and, therefore, with the ESA). First, before any site characterization activity is undertaken, a team of trained biologists inspects the area of proposed activity for tortoises or evidence of their presence (e.g., burrows, scat). Potential adverse impacts on tortoises are identified, and recommendations are made to minimize activity impacts on these animals and their habitat. Second, trained biologists inspect the proposed activity area immediately prior to ground-clearing activities and survey in front of vehicles driven off-road to minimize the chance of harming tortoises. Tortoises found during these surveys that are in danger of being injured or killed are moved to nearby safe areas. Results of these surveys in 1997 are summarized in Section 6.1.1.4, Monitoring and Mitigation Program, of this report. Finally, all new workers who require unescorted access to the YMP site must attend a General Employee Training (GET) session (Section 4.2) at which a film and viewgraphs accompany an in-class discussion that stresses the responsibility of YMP workers to protect the Yucca Mountain environment. One module of the presentation is devoted exclusively to biological resources, with considerable emphasis placed on protecting the desert tortoise. Each year thereafter, these workers must either repeat the GET class or participate in GET refresher training (now available on computer) that demonstrates a continued understanding of their environmental obligations. The GET training program was reviewed and updated in 1997 to meet requirements of the new Biological Opinion.

In compliance with the 1990 Biological Opinion, data collected from previous field studies of tortoises at Yucca Mountain were analyzed, and the results are being summarized in several technical reports. Details of these reports are presented in Section 6.1.1.2, Desert Tortoise Program. The 1997 Biological Opinion requires no further field studies of desert tortoises.

3.1.7 National Historic Preservation Act (NHPA) and Associated Cultural Resource Legislation Affecting Archaeology and Native Americans

The NHPA is the principal authority to which the YMP must respond with regard to the protection of historic properties. Also included in the general category of cultural resource protection are the following: (1) Archaeological Resources Protection Act (ARPA); (2) Antiquities Act (AA); (3) American Indian Religious Freedom Act (AIRFA); and (4) the Native American Graves Protection and Repatriation Act (NAGPRA). The latter two laws also address cultural values and beliefs of the American Indian, and protect and preserve Native American religious rights and practices. The goal of all of these laws is to ensure that historic properties and cultural values are considered when Federal activities are to be undertaken, and that every effort is expended to identify and mitigate any adverse effects on significant historic properties and matters of concern to Native Americans. The YMP area contains many historic sites and artifacts which require protection under these statutes. In addition, the rights of several Indian tribes and groups in the region, having traditional ties to the Yucca Mountain area, are protected by these laws.

Compliance with these acts is performed in accordance with a Programmatic Agreement for the Protection of Historical Properties, executed between the DOE and the Advisory Council on Historic Preservation (ACHP) in December 1988. Implementation of the Programmatic Agreement (PA) satisfies the YMP's commitments and responsibilities under most of these various acts (the exception being NAGPRA). Stipulations of the PA include commitments by the DOE to (1) afford the Nevada State Historic Preservation Officer (SHPO) the opportunity to participate in monitoring compliance with the PA; (2) develop and implement a comprehensive research design for recovering, documenting, and interpreting data from historical properties in the region; (3) implement data recovery programs at affected historical properties; (4) train and inform workers of their responsibilities with respect to archaeological resources; (5) engage in consultations with identified Native American tribes and organizations regarding religious and cultural concerns about historical properties; and (6) provide the SHPO and the ACHP with

regular reports concerning implementation of the PA. The YMSCO has developed a program to comply with all stipulations of the PA.

Stipulation 1 of the PA requires that the SHPO be given the opportunity to participate in monitoring compliance with the PA. Although the SHPO is not signatory to the PA, the DOE has invited that agency to participate. To date, the SHPO has chosen not to do so. The DOE sends copies of all survey reports, data recovery plans, and annual reports to the SHPO for review and comment. The SHPO did not request to inspect the YMP area in 1997.

3.1.7.1 Research and Data Recovery

A number of other actions to implement the PA were carried out in 1997. A total of 12 archaeological preactivity surveys were conducted in areas proposed for Project activities, resulting in the identification of three new archaeological sites. While no short reports describing the results of survey projects were completed in 1997, eight short reports are nearing completion or are in review for submission in 1998 to the ACHP and the Nevada SHPO.

Several activities were conducted to answer research questions identified in the Research Design and Data Recovery Plan for archaeological resources (DOE, 1990b). Studies included the continued development of a chronology of surface archaeological sites using obsidian hydration, caloric cost-benefit analyses of native plants of economic importance, dating of perishable artifacts found in the vicinity of Yucca Mountain, natural processes of artifact movement on ground surfaces, and functional analyses of various artifact classes collected as part of Project activities. A total of 46 known historical properties were revisited for purposes of periodically assessing their condition. All were in essentially the same condition as when discovered or last examined. Where not already in existence, study plots were established at several of these locations to assess the extent of artifact movement or loss through subsequent years.

Because no data recovery projects were proposed for 1997, mitigative data recovery plans were not developed. No artifacts were collected for the Project during 1997. However, the analysis and reporting of mitigative data recovery projects conducted during previous years was continued. Results of data recovery at two sites, 26Ny1011 and 26Ny8187, large lithic scatters located east and west of Yucca Mountain, respectively, are presently being combined for future publication in a technical report entitled *Topics in Yucca Mountain Archaeology* No. 2.

Finally, a summary of all artifacts collected and processed during 1996 was submitted to the YMSCO in 1997. This listing supplements the master artifact inventory, issued in 1992 and updated each year since. All inventories are submitted to the U. S. Department of the Interior, in compliance with reporting requirements of the NAGPRA. Artifacts are maintained by the Desert Research Institute (DRI) in a Las Vegas, Nevada, storage facility, in accordance with provisions of 36 CFR 79 and with Stipulation 3E of the PA.

3.1.7.2 Educational Initiatives

A program-wide worker education module stressing protection of archaeological and historic resources has been developed by the YMP as part of the comprehensive GET program (Sections 3.1.6 and 4.2). All employees scheduled to work unescorted in the field must attend this course and pass an examination proving their understanding of their environmental responsibilities. Yearly refresher training, now available by computer, is required thereafter. In 1997, 127 individuals attended initial GET training; another 446 fulfilled the requirements of annual GET refresher training.

The Project supplemented several educational displays to inform YMP workers and the general public about the YMP archaeological program and the kinds of historical properties present in the YMP region that are being protected. Items displayed include maps of southern Nevada depicting areas historically occupied by various Indian tribes, biographical sketches of

local Native American individuals, projectiles and written explanations of their manufacture, examples of basket weaving and animal traps, traditional stories relating to certain plants and animals, and descriptions of plants as sources of food, clothing, medicine, and as religious objects.

Three such displays are located in the Yucca Mountain Science Centers in Las Vegas, Beatty, and Pahrump, visited by approximately 6,900 people in 1997. Another display is located permanently in the Field Operations Center in Area 25 of the NTS for use during public tours of the Yucca Mountain site. A total of 3,481 people took part in 196 public tours in 1997. Finally, a portable display and slide show depicting archaeological and historical resources, and explaining the archaeological program, has been developed for other presentations by DOE personnel and support contractors.

Results of archaeological studies conducted at Yucca Mountain were presented at several professional meetings, including the annual meeting of the Society for American Archaeology. Results were subsequently submitted to professional journals for publication.

3.1.7.3 Native American Interactions

The YMSCO continued consultations and interactions with involved Native American tribes in 1997, as directed by the AIRFA and the PA. Currently, the YMP Native American interaction program involves 17 tribes and organizations, and is comprised of Western Shoshone, Southern Paiute, and Owens Valley Paiute and Shoshone groups located in a four-state area (Nevada, California, Utah, and Arizona). A tribal update meeting, sponsored by the YMSCO, was held in Las Vegas, Nevada, in September. Official Tribal Contact Representatives (OTCR) from each group were apprised of current cultural resources protection initiatives and the present status of site characterization activities and the Repository EIS. The OTCRs, organized as the

Consolidated Group of Tribes and Organizations (CGTO), drafted recommendations that were later forwarded to the DOE.

In February and June, representatives from three tribal groups having cultural ties to the Yucca Mountain region (Western Shoshone, Southern Paiute, and Owens Valley Paiute and Shoshone) examined artifact collections from Yucca Mountain, currently housed at the DRI in Las Vegas, Nevada. These visits were sponsored by the YMSCO in response to a request by the CGTO to determine whether items subject to NAGPRA requirements existed in the collections. Following the June visit, the representatives drafted a report requesting that knowledgeable tribal elders be allowed to examine items in the collection to determine their potential significance in relation to NAGPRA specifications. The YMSCO will sponsor visits by tribal elders to examine these artifacts in FY 1999.

In June and December, the American Indian Writers subgroup met to draft a document outlining Native American views and perspectives on the Yucca Mountain area. The CGTO designated appropriate Western Shoshone, Southern Paiute, and Owens Valley Paiute and Shoshone representatives to take part in this effort. These meetings were also sponsored by the YMSCO, as recommended by the CGTO. The draft document will be finalized in 1998 and is intended to be used as a reference by those writing the Repository EIS.

No data recovery projects were conducted during 1997. Consequently, the Native American Monitor Program, in which Native Americans accompany DRI staff in the field to ensure that Native American sensitivities are fully considered during artifact collection, was not utilized during the year.

Throughout 1997, the YMSCO sponsored the attendance of, or presentations by, DOE and/or Native American representatives at meetings with groups across the nation, including the National Congress of American Indians (NCAI). In addition, the DOE sponsored 20 speaking engagements and 31 educational forums at which the YMP Native American program was

explained to the public. Mr. Richard Arnold, a Southern Paiute who serves as Director of the Las Vegas Indian Center in Las Vegas, supported the DOE in these presentations.

3.1.8 Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)

CERCLA requires that the National Response Center, administered by the U.S. Coast Guard, be contacted in the event of a release of a reportable quantity (RQ) of a hazardous material to the environment. No RQ releases under Section 103 of CERCLA occurred at Yucca Mountain in 1997, nor were there any Continuous Releases under Section 103 of CERCLA.

In 1986, CERCLA was reauthorized and amended by enactment of the Superfund Amendments and Reauthorization Act (SARA). Title III of SARA is known as the Emergency Planning and Community Right-to-Know Act (EPCRA), and is designed to ensure that the general public has access to information about chemicals present in their communities. The YMP is required by Executive Order 12856 (EO, 1993) to comply with the reporting requirements of EPCRA and the Pollution Prevention Act (PPA) of 1990. The reportable chemicals differ for each section of EPCRA and include Hazardous Substances (HS), Extremely Hazardous Substances (EHS), hazardous chemicals for which Material Safety Data Sheets (MSDS) are necessary, and toxic chemicals listed under EPCRA Section 313. The YMSCO was not required to file an EPCRA 313 Report in 1997 because the quantities of listed toxic chemicals used by the YMP were insufficient to activate the reporting process. Further, none of these chemicals were released during the year.

The inventory of chemicals stored by the YMP in 1997 is reflected in certain other EPCRA reports to be submitted in March 1998. A Section 302 report must be filed when the quantity of an EHS, stored or used, exceeds the threshold planning quantity (TPQ) of 1000 pounds (lb). In 1997, the YMP had approximately 6,601 lb of the EHS, sulfuric acid, in use,

most of it as an electrolyte in manufactured lead-acid batteries. The required Section 302 report was submitted to the Nevada State Emergency Response Commission and the Nye County Local Emergency Planning Committee in February 1998. (Similarly, a Section 302 report was submitted in March 1997 for chemicals stored by the YMP in 1996.) To further satisfy the reporting requirements of Section 302 and to fulfill those of Sections 311 and 312 of the EPCRA, the Nevada Combined Agency Hazardous Substances Information Facility Report is prepared annually by YMSCO and submitted to the Office of the State Fire Marshal. This report serves as one component of the application to renew the annual Nevada Hazardous Material Storage Permit. In addition to the aforementioned sulfuric acid, the YMSCO will list, in its permit renewal request for CY 1998, several hazardous chemicals that were stored in 1997 in quantities that exceeded their prescribed reporting threshold of 10,000 lb: propane, diesel fuel #2, cement, and lubricating and waste oils. During the year, no chemicals classified by the State of Nevada as highly hazardous were stored in quantities that exceeded their reporting thresholds.

3.1.9 Resource Conservation and Recovery Act (RCRA)

The management of hazardous wastes is regulated by the RCRA. The generation and management of YMP hazardous wastes is regulated under the Project-specific EPA Identification Number (ID) NV7890090023, granted by the EPA to the YMP. The intent of the Project is to minimize amounts of hazardous waste generated and accumulated on site to ensure that RCRA regulatory thresholds are not exceeded. All hazardous wastes are packaged, transported and disposed of off site in accordance with Federal and State requirements.

During 1997, five shipments of hazardous waste, totaling 414 kg (910 lb), were transported to EPA-permitted treatment, storage and disposal (TSD) facilities. Wastes consisted of the following: non-empty/non-working aerosol cans, isoparafinnic hydrocarbons, flammable liquids, lead-contaminated oil and debris, and various other hazardous wastes, both liquid and solid.

3.1.10 Federal Land Policy and Management Act (FLPMA)

Federal projects requiring access to, and activity on, public lands require compliance with the FLPMA. Because Yucca Mountain is partially on BLM-administered public land and USAF-administered BLM land, YMP site characterization activities must comply with BLM requirements for access and use. Access to these areas for purposes of site characterization was granted in two major ROWRs issued in January 1988 and October 1989. The latter ROWR was renewed by the BLM in June 1994.

Many smaller ROWRs are granted each year for site characterization activities that may range in size from a single radiological dosimeter mounted on a post to an off-site trench or surface water monitoring station. Again in 1997, several ROWRs for activities in this size class (usually requiring less than 0.124 ha [0.05 acre]) were issued by the BLM. The DOE complied with all environmental actions stipulated in the ROWRs.

Since 1990, the BLM has issued three free-use permits to excavate sand and gravel for use in constructing roads and drillpads. No applications for free-use permits were filed in 1997. Annual reports for the three existing permits were submitted to the BLM during 1997.

3.1.11 Farmland Protection Policy Act (FPPA)

The FPPA requires that the DOE determine whether the potential exists for site characterization to affect land designated as either prime or unique, or farmlands of State or local importance. In 1988, the Soil Conservation Service (since renamed the Natural Resource Conservation Service) confirmed that no such land will be disturbed by site characterization activities. No further compliance measures were necessary in 1997.

NOTE: Two major federal environmental statutes not discussed in this Compliance Summary are the Toxic Substances Control Act (TSCA) and the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). Neither is applicable to current Yucca Mountain site characterization activities.

3.1.12 Executive Order (EO) 11988, Floodplain Management

The DOE's implementation of EO 11988 extends to the normally dry washes of the Yucca Mountain site. If proposed activities within the 100-year floodplain are anticipated, a notice of the proposed action must be published in the Federal Register (FR), and alternatives to the proposed locations must be evaluated in a floodplain assessment. On February 9, 1989, a Notice of Floodplain/Wetlands Involvement was published for the YMP in the FR (54 FR 6318) followed, in August 1991, by issuance of a floodplain assessment of surface-based investigations (DOE, 1991). On October 1, 1991, a Floodplain Statement of Findings appeared in the FR (56 FR 49765). A companion assessment, examining the potential effects of ESF activities and cumulative impacts of ESF and surface-based activities combined, was issued in October 1992 (DOE, 1992a). No further action was required in 1997.

3.1.13 Executive Order (EO) 11990, Protection of Wetlands

Wetlands are not discussed in this SER because none exist at or near Yucca Mountain. The USFWS has declared that ". . . site characterization activities should not affect any wetlands on or near the Yucca Mountain site" (USFWS, 1988).

3.1.14 DOE Orders

The DOE, the EPA, and the Nuclear Regulatory Commission (NRC) have each established rules, regulations, and orders that pertain to radiological effects on health, safety, and the environment. The orders and regulations that most apply to site characterization are those emanating from the DOE. Regulations issued by the EPA and the NRC apply, for the most part, to repository construction, operation, closure, and decommissioning. Collectively, however, these regulations represent a continuum of rules and standards that begin with the DOE Orders, and mandate that the DOE initiate and continue radiological monitoring activities at Yucca Mountain throughout the duration of the YMP.

DOE Orders that currently apply, to a greater or lesser extent, to radiological matters during site characterization are the following: 5400.1, General Environmental Protection Program; 231.1, Safety and Health Reporting Requirements; 5400.5, Radiation Protection of the Public and the Environment; 5480.4, Environmental Protection, Safety and Health Protection Standards; 5484.1, Environmental Protection, Safety, and Health Protection Information Reporting Requirements; and 440.1A, Worker Protection Management for DOE Federal and Contractor Employees.

The YMP radiological monitoring activities conducted in 1997 focused on ambient radiation and air as a carrier of radioactive particles and gas. While a circular radiological study area 80 km (50 mi) in radius is required by DOE and NRC guidelines, the study area at Yucca Mountain was extended to 84 km (52 mi) to include the town of Pahrump. The study circle consists of a near-field area within a 16-km (10-mi) radius of Yucca Mountain and a far-field area between the 16- and 84-km (10- to 52-mi) boundaries. The locations of YMP radiological monitoring sites in the near-field area are represented in Figure 3-1. No radiological monitoring sites have been operated in the far-field area since the beginning of FY 1996 (October 1, 1995).

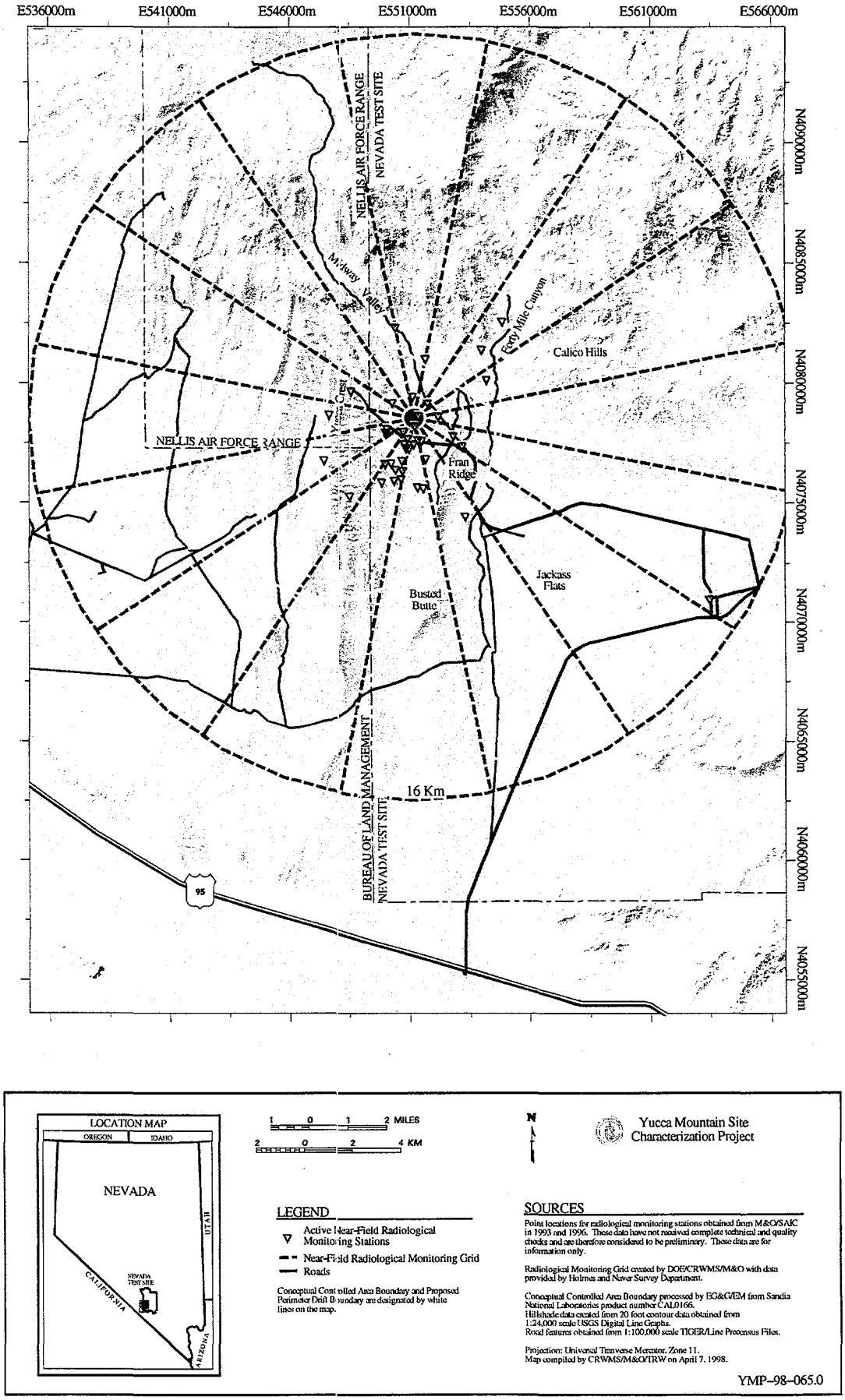


Figure 3-1. Near-field Radiological Monitoring Sites

The monitoring regimen during 1997 was as follows: 40 thermoluminescent dosimeters (TLD, typically two units per station) monitored quarterly; two pressurized ionization chambers (PIC) recording data continuously at two sites; one continuous radon monitor (CRM) operating near Site 1, the NTS-60 air quality/meteorology monitoring site; and samples obtained weekly from continuous air samplers (CAS) at five locations. A synopsis of the monitoring regimen for the year is given in Table 5-1 (p. 5-2).

To further establish levels of ambient radiation near Yucca Mountain, groundwater samples from eight wells or springs in the YMP study area were analyzed for radioactivity. Monitoring was also performed to determine the extent of resuspension of existing radioactive material by casual traffic and/or wind. As a precaution for workers in the field, all areas proposed for surface-disturbing activities within the NTS boundary are to be investigated in advance of the activity for the presence of radionuclides. In 1997, no such radiological preactivity surveys were necessary.

3.1.15 Nevada Law

3.1.15.1 Water

On June 28, 1993, the Nevada State Engineer issued Temporary Water Appropriation Permits for three boreholes that comprise the C-well Complex. Since then, these wells have been used to conduct aquifer characteristics studies as part of the YMP site characterization program. The permits allow the discharge from the three wells to be put to beneficial use to include dust control, testing, or transfer to a spreading basin for aquifer recharge (Section 3.1.3.1). In March 1995, these permits were renewed by the State Engineer.

In 1996, permits for two of the wells were extended for another year. An extension of the third permit was not needed, and a Proof of Completion of Work at that well was filed with

the State. Permits for the remaining two wells were renewed again in 1997. Another permit, allowing use of water from well VH-1 for some of the same purposes including dust control, was extended in May 1996 and again in April 1997.

Three new appropriation permits were received from the State in 1997 allowing the use of water from well J-12 for discharge or the performance of pump tests at boreholes SD-6, WT-3, and WT-17. These permits, like those previously described, expire after one year unless extended by the State.

On July 22, 1997, the YMSCO filed a water appropriation request with the Office of the Nevada State Engineer to use 430 acre-feet annually to meet YMP responsibilities under the NWPA, as amended. Existing YMP water rights will soon expire. The YMSCO did not request more water than is currently permitted, and water would be withdrawn from the same wells at Yucca Mountain as are used now. The administrative review and approval process is expected to be lengthy.

3.1.15.2 Hazardous Materials

Nevada Administrative Code (NAC) 445A.345-.348 requires notification of the State in instances of releases involving specified quantities of pollutants. The Division of Emergency Management must be notified as soon as possible in the event of a hazardous material/waste release, and the NDEP is to be notified as soon as possible after the release, but no later than the end of the first working day after the release. Although petroleum products are not considered hazardous by the State of Nevada, a report is required by the State for any release onto a land surface of a petroleum product that exceeds 95 liters or 25 gal, or that contaminates at least

2.3 cubic meters (m^3) or 3 cubic yards (yd^3) of soil at a concentration greater than 100 micrograms per kilogram ($\mu g/kg$).

The YMP is complying with these regulations in its response to oil and chemical spills at the site (Section 6.2). In all instances, reporting requirements are being met, and contaminated soils are being excavated for authorized off-site treatment and recycling of treated soils.

The Hazardous Material Storage Permit was renewed in 1997 by the Nevada State Fire Marshal Division. This permit, required at Yucca Mountain primarily for the storage of flammable construction materials, must be renewed annually.

3.1.16 Environmental, Safety, and Health Assessments

The primary objective of the YMP Environmental, Safety, and Health (ES&H) assessment program is to verify that all Project-related activities are managed and performed in compliance with Federal, State, and local regulations, DOE Orders and management objectives, YMP plans and procedures, and permit stipulations. Specifically, Titles 10 (Energy), 29 (Labor), 40 (Protection of Environment), and 49 (Transportation) of the CFR, and DOE Orders on Occupational Safety and Health and Environmental Protection contain requirements for audits, assessments, and inspections of various ES&H program elements.

One of the principal means by which the YMSCO and the Civilian Radioactive Waste Management System Management and Operating Contractor (CRWMS M&O) pursue the objective of full regulatory compliance is through their respective ES&H assessments of Project activities. Project assessments are performed for the Assistant Manager for Environmental, Safety, and Health (AMESH) by the CRWMS M&O Environmental, Safety, and Health Compliance Department (ESHCD). The CRWMS M&O ESHCD also performs internal M&O

assessments. Assessments of activities that have been graded "quality-affecting" are conducted by the Quality Assurance Technical Support Services (QATSS).

ES&H assessments evaluate Project organizations, programs, activities, and related support functions. Assessments can evaluate a broad range of environmental, safety, and health topics or examine a particular program element, potential noncompliance condition, or specific area of concern that is time-sensitive or requires immediate attention. Sixteen assessments were completed in 1997.

The ES&H assessment function also includes ongoing regulatory review and analysis of FRs, CFRs, DOE Orders, and other resources to keep Project personnel abreast of contemporary ES&H information and/or new or changing ES&H regulatory requirements applicable to YMP activities. Information from these reviews is posted on the Project-wide ES&H Notifications database. Project documents and reports are also reviewed for ES&H compliance requirements. During 1997, results of 151 regulatory reviews or analyses were posted on the ES&H Notifications database, and 90 Project documents were reviewed for ES&H compliance. New ES&H regulatory requirements identified during these reviews that are applicable to YMP activities may be included in subsequent assessments.

3.1.17 Environmental Surveillance Program

The environmental surveillance program is another means by which compliance with environmental requirements during the performance of YMP activities is measured. Surveillances are conducted by the CRWMS M&O Environmental Programs Department (EPD) to confirm that YMP activities are being planned, managed, and operated in a manner that will protect and maintain environmental quality, minimize potential threats to the environment, and comply with applicable Project programmatic requirements. The EPD conducted 374 environmental surveillances in 1997 (Section 4.4).

3.2 SUMMARY OF PERMITS AND COMPLIANCE ACTIONS

Tables 3-1, 3-2, and 3-3 list the permits currently required to conduct site characterization activities at Yucca Mountain. In addition, the current status of each permit and its applicability to a specific YMP activity are presented. Because the YMP was in full compliance with all environmental legislation and permit conditions in 1997, the YMSCO was not a party to any compliance actions during the year.

3.3 PERMIT-ASSOCIATED LITIGATION

No court action was undertaken in 1997 by either the DOE or the State of Nevada.

TABLE 3-1. PERMITTING APPLICABLE TO SITE CHARACTERIZATION ACTIVITIES (FEDERAL)

REGULATION	PERMIT	AGENCY	APPLICABILITY	FILED	EXPECTED(E)/ ACTUAL	STATUS/EXPIRATION DATE
Federal Land Policy & Management Act	Free Use Permit	BLM	Needed for excavation of sand and gravel from public lands. Includes NTS land, additional gravel needed for construction of roads, drill pads, ESF pads.			
			- Drillhole Wash Pit	07/15/89	10/26/90	- Expires when construction ends
			- Fortymile Wash Pit	01/28/92	05/20/92	- Expires 01/06/01
			- Borrow Pit #1	08/28/92	01/08/93	- Expires 01/06/01
	Right-of-Way Reservations	BLM BLM/USAF	Needed for access to public and Air Force land	11/23/87 10/23/87	01/06/88 10/10/89; renewed 7/1/94	- Expires 01/06/01 - Expires 01/06/01
Endangered Species Act	Endangered Species Act Compliance	USFWS	Needed if endangered species is potentially affected (e.g., desert tortoise). Each activity location must be surveyed prior to disturbance.	10/10/89 --	07/23/97 08/20/97	- New Biological Opinion issued - Amendment to State animal handling permits issued
Executive Order 11988 (10 CFR 1022)	Floodplain Assessment and Federal Register Notice	DOE/EH	Needed before construction in a floodplain (100-Yr). EH-1 reviews/approves assessment. Must be published in Federal Register.	-- 05/15/92	10/01/91 10/23/92	- SBT Assessment and Statement of Findings issued - ESF Assessment and Statement of Findings issued
Clean Water Act	Nationwide General Permit (Section 404)	COE	Needed before constructing in a water course	04/28/89	07/17/90 10/15/92	- No expiration date - Notified COE of start of ESF
National Historic Preservation Act Archaeological Resources Protection Act American Indian Religious Freedom Act	Programmatic Agreement	ACHP	Cultural properties must be protected. Each activity location must be surveyed prior to disturbance.	12/01/86	12/22/88	- PA completed - Compliance with PA satisfies regulatory requirements
Farmland Protection Policy Act	Prime Farmland Consultation	NRCS	Needed to ensure no impact to prime farmland	02/11/88	03/01/88	- Consultation completed

TABLE 3-2. PERMITTING APPLICABLE TO SITE CHARACTERIZATION ACTIVITIES (FEDERAL FLOWDOWN)

REGULATION	PERMIT	AGENCY	APPLICABILITY	FILED	EXPECTED (E)/ ACTUAL	STATUS/EXPIRATION DATE
Clean Air Act	Air Quality Operating Permit	NDEP	Required for disturbance of >20 acres and for point sources of emissions: (System #1) Borrow Screen (2) Kolberg Screening Plant & Conveyors (3) LM-300 Drillrig (4) Failing Drillrig (5) CME 850 Drillrig (6) Cummins Engine, 600 HP (7) Air Compressors (8) CME 550 Drillrig (9) Joy 1 Drillrig (10) Stratmaster Drillrig (11-13) Concrete Batch Plant (14) Radial Stack Conveyor (15) Wilson Drillrig (16) ESF Conveyor System (17) Diesel Engines for 500 KW Generator	N/A (See note under Status)	Revised 11/25/95, 11/25/96, and 12/22/97	- Permit No. 9999-0076 (for surface disturbance) superseded by permit below - Each of these point sources was originally assigned its own permit. In 1995, the State of Nevada included all under Permit No. AP9611-0573, with an expiration date of April 26, 2000. Effective December 22, 1997, NDEP modified this permit with regard to Systems #6 and 10 (see Section 3.1.3, this report).
Safe Drinking Water Act	Underground Injection Control Permit	NDEP	- C-Well Complex and Drillholes (103) - C-Well Pump Tests - Tracers - Fire Suppression Pond	05/18/95 07/19/95	01/30/96 01/30/96 01/30/97 01/30/96	- Original UIC Permit No. UNEV 89031 modified slightly in 1997
	Public Water System Permit	NDEP	Needed before construction begins on the system	05/18/93	04/25/96 06/11/96	- State verbal approval to operate - Permit received; renewed by 9/30/97
Resource Conservation and Recovery Act	RCRA EPA Registration and ID Number	NDEP	Needed before generating regulated quantities of hazardous waste	04/01/89	06/26/89	- ID Number received
Clean Water Act	General Discharge Permit; NPDES	NDEP	Needed prior to discharging effluent - Stormwater - Septic Tank/Leach Field	 09/08/92 03/15/95	 05/14/93 07/12/95	 - Expires 05/14/98 - Permit expires 05/12/98

TABLE 3-3. PERMITTING APPLICABLE TO SITE CHARACTERIZATION ACTIVITIES (STATE)

REGULATION	PERMIT	AGENCY	APPLICABILITY	FILED	EXPECTED (E)/ ACTUAL	STATUS/EXPIRATION DATE
Nevada Law	Groundwater Appropriation	NSE	Needed for use of water			
			- Well J-13	07/12/88	03/02/92	Expires 03/02/02
			- Additional request	04/02/92	08/18/92	Expires 04/09/02
			- Well VH-1	03/20/92	05/18/92	Expires 04/09/02
			- Well VH-1 Extension	--	04/15/97	Expires 04/09/98
			- C-well Complex (3 wells)	05/11/93	06/28/93	One-year extensions in 1995, 1996 and, for 2 wells, in 1997.
			- Well JF-3	10/10/91	10/24/91	Renewal not required
			- Hole UZ-16	12/11/91	12/07/92	Renewal not required
			- Hole UZ-14	02/26/93	03/17/93	Extended indefinitely
			- Holes USW-G2, SRG-5/SD-11, SD-12	--	--	Extended indefinitely
			- Holes WT-1, WT-10, WT-12, WT-13, WT-17, WT-24	--	12/27/93	Waivers received
			- SD-6, WT-3, WT-17	08/28/97	11/07/97	Temporary permits; expire 12/15/98
	Hazardous Material Storage Permit	NFMD	Needed for storage of flammable materials	--	02/29/97	Expires 12/31/97. Renewed annually.

LEGEND

NDEP	Nevada Division of Environmental Protection
NFMD	Nevada Fire Marshal Division
NSE	Nevada State Engineer
BLM	Bureau of Land Management
USFWS	U.S. Fish and Wildlife Service
COE	Corps of Engineers
USAF	U.S. Air Force
ACHP	Advisory Council on Historic Preservation
NRCS	Natural Resource Conservation Service
DOE/EH	Department of Energy/Office of Environment, Safety, and Health
EPA	Environmental Protection Agency
SBT	Surface-based Testing
ESF	Exploratory Studies Facility
NPDES	National Pollutant Discharge Elimination System
PA	Programmatic Agreement
RCRA	Resource Conservation and Recovery Act

4.0 ENVIRONMENTAL PROGRAM INFORMATION

4.1 WASTE MINIMIZATION

Waste minimization is a fundamental concept in protecting the environment. Personnel are encouraged to reduce the amount of waste generated by employing waste minimization and pollution prevention in their day-to-day operations. Recycling is also encouraged and routinely practiced whenever the generation of waste cannot be avoided. Disposal is considered a last resort only.

A principle component of the YMP waste minimization program is the Request for Authorization (RFA) to use regulated materials. This review and approval process was developed to control the purchase, storage, and use by the YMP of products having the potential to adversely affect the environment. By tracking the identity, quantity, and storage locations of such chemicals, the program also provides information necessary to meet reporting requirements of EPCRA (refer to CERCLA, Section 3.1.8).

The RFA program functions by requiring those planning an activity that involves the use or purchase of a chemical to submit an RFA. The EPD reviews the request and any associated Material Safety Data Sheets, then consults chemical databases to determine whether the chemical poses an environmental problem. In 1997, the EPD reviewed 150 RFAs. Should the EPD find reason for concern, alternative chemicals are discussed with the requestor. If a suitable substitute is available, the original RFA is withdrawn or rejected, a new one is prepared, and the alternative chemical may be approved. If no substitute is available, the EPD may deny authorization or, more likely, will develop criteria with the requestor regarding the quantity, use, and storage of the original chemical that will minimize potential environmental impacts. Also involved in the process is the CRWMS M&O Safety and Health Department, which reviews the RFA and recommends engineering controls and personal protection equipment appropriate for the activity.

Another component of the YMP waste minimization program is the *Waste Minimization and Pollution Prevention Awareness Plan*, issued in 1995 (DOE, 1995c) and updated in 1997. This plan calls for formation of a Waste Minimization Committee comprised of representatives of the CRWMS M&O contractors and other YMP teaming organizations. In administering the waste minimization program, the committee meets quarterly, reviews operations, conducts Pollution Prevention Opportunity Assessments, identifies potential waste reduction activities, and tracks overall performance of the program.

The waste minimization plan also requires the preparation of an annual Waste Management Report to serve as an internal management tool. This report summarizes waste management activities for the year, to include materials recovered, materials recycled, and items disposed of, both at the YMP site and at support facilities in Las Vegas. The first annual report, describing activities and results during CY 1996, was submitted to the YMSCO in July 1997.

Considerable quantities of materials were gathered for recycling or reuse by the YMP in 1997, including the following: paper (244 tons), used notebook binders (1,482 binders, donated to local school districts), copy machine and printer toner cartridges (622), cardboard (5.12 tons), and aluminum cans (940 lb). In addition, approximately 117 tons of ferrous and non-ferrous metals were contributed to the NTS metals recycling program.

Several other items recycled by the YMP were, for the most part, collected following the performance of mechanical maintenance. Among these were 8.12 tons of lead-acid batteries and 64 heavy equipment tires. Used oils, following tests to ensure that chlorinated solvents were not present, were sent off site for recycling (5,220 gal). Approximately 400 gal of this total consisted of oil recovered by processing oily water (construction waste water and rain runoff) through an oil-water separator, operational since 1996. The remaining aqueous portion (20,000 gal) is being used for dust suppression with the approval of the State of Nevada. In addition, water recovered as a result of mining activities (312,000 gal) was filtered and used for the same purpose.

Antifreeze coolants (300 gal) were also recycled, as were 110 gal of used cleaning solvent. The solvent used by the YMP was selected because it contains no RCRA constituents and characteristics.

Recycled for the first time in 1997 were fluorescent and high-intensity discharge lamps (436), many of which contained mercury. At the recycling facility, the mercury is recovered from the phosphor powder and mercury-containing gases, while the remaining glass and metal parts are recycled separately.

4.2 TRAINING

Worker environmental awareness and pollution prevention are major components of the YMP environmental compliance effort. A formal YMP environmental training program, which includes waste minimization and pollution prevention awareness, comprises a portion of the Project's GET program. In 1997, 127 individuals attended GET, with a cumulative total of 3,818 trained since the beginning of the Project. All new employees whose work requires them to have unescorted access to the YMP site must take this course. In addition, the GET program requires participation in annual refresher training attended in 1997 by 446 Project employees. Of these, 415 took advantage of computer-based training offered for the second year as an option to class attendance.

Employees who enter the Project site and routinely work with radiological materials are required to attend a radiological training program. This program is based on a graded approach to the hazards likely to be encountered by the employees. Three classes comprise the program: General Employee Radiation Training (GERT), Radiation Worker I (RW I) Training, and Radiation Control Technician (RCT) Training.

The YMP hazardous materials management program provides special training for those whose work involves facility waste minimization, handling and disposal of hazardous materials, and actions and reporting required in the event of hazardous material spills or occurrences. These programs, approved by the M&O Training and Development Department, may be taught by representatives of other departments. One such course, entitled "Hazardous Waste for the Generator" is offered at least once every two years by the EPD.

In 1997, the EPD developed and implemented environmental compliance training for YMP managers and supervisors. The main objective of this course is to train managerial personnel to be fully aware of their responsibilities in maintaining environmental compliance and protecting the environment at Yucca Mountain. Trainees are instructed to minimize significant adverse environmental impacts, comply with environmental regulations, and mitigate impacts through prevention, corrective action, reclamation, or other measures. In addition, the managers and supervisors are reminded of the environmental ramifications of their decisions. This training, or an associated refresher course, will be offered once each year by the EPD.

4.3 ENVIRONMENTAL, SAFETY, AND HEALTH ASSESSMENT PROGRAM

The ES&H assessment program provides programmatic oversight of YMP activities in support of the broader goal of achieving full compliance and excellence in the ES&H area. This is accomplished through evaluation of YMP ES&H activities and programs for compliance with Federal, state, and local regulations, DOE Orders, permit stipulations, and YMP and CRWMS M&O plans/policies/procedures. As a result, the assessment process, to include verification and closure of improvement actions, continues to enhance the effectiveness and implementation of ES&H roles and responsibilities among the CRWMS M&O contractors, subcontractors, and the U.S. Geological Survey (USGS).

At YMSCO AMESH request, the CRWMS M&O Environmental, Safety, and Health Compliance Department (ESHCD) conducts ES&H assessments of the YMP/M&O organizations, programs, and activities, in accordance with requirements outlined in the ERCP (DOE, 1996), the Environmental Management Plan (DOE, 1997b), and the CRWMS M&O Safety and Health Plan (CRWMS M&O, 1996a). During 1997, 16 assessments were conducted by the CRWMS ESHCD, which included evaluations of 13 Project-wide ES&H programs and three off-site contractors providing environmental services support to the YMP.

Assessment topics have generally included a specific regulatory requirement, new YMP activities or support functions, or common elements that bridge YMP organizational areas of responsibility. Assessments conducted during 1997 evaluated implementation of safety and health requirements relative to heavy equipment use, machine guarding, Type B accident investigations, the Occurrence Reporting and Processing System, the CRWMS M&O Safety and Health Plan, facility access/egress, gas cylinder marking, and maintenance of Occupational Safety and Health Act records. Assessment of environmental programs included used oil management, hazardous waste accumulation, EPCRA reporting, and the radiation protection program. Implementation of the YMP Emergency Management Plan was also assessed. Assessments of off-site support contractors included Safety-Kleen (solvent services), Evergreen Environmental (used oil recycling services), and Rollins Treatment, Storage, and Disposal Facility (hazardous waste transport and disposal). Table 4-1 summarizes the results of these assessments.

A structured improvement action program and follow-up are critical to the success of the assessment program and to providing assurance and confirmation to Project management of continuous improvement in ES&H performance. YMP requirements mandate that responsible affected organization managers respond to assessments through development and implementation of improvement actions. Assessments are closed when completion of improvement actions is verified by the Assessment Team Leader and approved by the AMESH

for YMSCO-requested assessments or by the CRWMS M&O Environmental, Safety, and Regional Programs Manager for internal CRWMS M&O assessments.

TABLE 4-1. SUMMARY OF 1997 ASSESSMENT RESULTS

ASSESSMENT	RESULTS
97-2	Verified heavy equipment use met environmental/radiological requirements.
97-3	Improved tracking documentation and guidance for managing used oil.
97-4	Verified compliance of waste treatment, storage and disposal contractor.
97-5	Verified compliance of solvent services contractor.
97-6	Verified completion of Type B accident investigation actions.
97-7	Improved administration of hazardous waste management processes.
97-8	Revised/improved procedures for overall occurrence reporting processes.
97-9	Initiated procedures to fully implement safety and health plan requirements.
97-11	Verified facility compliance with federal access/egress regulations.
97-13	Improved data collection processes for compiling annual EPCRA reports.
97-14	Verified compliance of used oil recycling contractor.
97-15	Improved identification/understanding of emergency management roles.
97-16	Verified correct marking of compressed gas cylinders.
97-17	Corrected OSHA reporting discrepancies.
98-2	Verified YMP compliance with federal machine guarding requirements.
98-3	Improved refresher training and noncompliance reporting and tracking.

Note: Assessment 97-1 was replaced by a trend analysis report; 97-12 was canceled to be performed as a CY 1998 assessment; and 98-1 was delayed until CY 1998. The report for assessment 97-10 will be issued in CY 1998.

Three functions integral to the ES&H oversight process are (1) identifying new or revised regulatory requirements issued by governing agencies; (2) notifying appropriate Project personnel of these requirements and their potential impact on YMP activities; and (3) verifying that applicable requirements are properly implemented in Project ES&H programs and activities. The ESHCD performs these functions for the AMESH by reviewing FRs, DOE Orders, professional publications, and Internet sites for proposed or newly issued federal agency rulings, DOE policies, or other pertinent ES&H information. Results of these regulatory reviews are posted electronically on a Project-wide ES&H Notifications database. During 1997, 151 notifications were provided to Project personnel on ES&H topics that included issues and rulings relating to the CAA, CWA, RCRA, NEPA, ESA, CERCLA, and Occupational Safety programs. ESHCD also reviewed 90 YMP plans, procedures, and special reports for ES&H compliance.

4.4 ENVIRONMENTAL SURVEILLANCE PROGRAM

The environmental surveillance program constitutes a significant oversight effort by the DOE to achieve full environmental compliance through routine, unannounced "spot checks" of normal YMP activities. Environmental Programs Department (EPD) surveillances may cover any or all of the items investigated during an assessment and include, but are not limited to, the following: (1) environmental requirements specified in DOE/YMP documents (e.g., DOE Orders, YMP plans and procedures) written for or about an activity; (2) environmental permit conditions applicable to an activity; (3) applicable land access and/or ROWR conditions; and (4) Federal and State environmental regulations.

In 1997, 374 environmental surveillances were conducted by the EPD. A surveillance is closed once corrective actions for any noted discrepancies have been completed, verified by the EPD, and reviewed and approved by the YMSCO AMESH.

5.0 ENVIRONMENTAL RADIOLOGICAL PROGRAM

Again in 1997, the responsibility for monitoring environmental radiological conditions in the Yucca Mountain region was borne by the Radiological Control Division (RCD) of the CRWMS M&O Radiological/Environmental Field Programs Department. In addition to supervising the overall environmental radiological monitoring program, the RCD analyzed, evaluated, and reported the data generated by the program. Implementation of the program was also carried out by RCD personnel, who installed and maintained field equipment, collected data recorded in the field, and performed validation procedures on the data accumulated. In addition, the RCD retained responsibility for conducting two types of radiological surveys: those administered prior to the commencement of a surface-disturbing activity (i.e., the preactivity survey), and those executed periodically at site facilities and along roadways.

The 1997 monitoring program included the quantification of ambient gamma radiation, ambient radon, and radionuclides (both naturally occurring and man-made) in the Yucca Mountain environment. Environmental media sampled and monitored during the year were air (as a carrier of radioactive particles and gas), water, and soil. A synopsis of the monitoring regime during the year is given in Table 5-1.

The environmental radiological monitoring study area is defined as a circular grid with a radius of 84 km (52 mi) centered on the northeastern side of Exile Hill at the Yucca Mountain site. For monitoring purposes, the study area is divided into two sections, designated near-field and far-field. Near-field sites are located in the proximity of actual or expected areas of activity or disturbance that lie within 16 km (10 mi) of the circle's center (Section 3.1.14 and Figure 3-1, p. 3-22). The portion of the grid extending beyond 16 km (10 mi) from the site is referred to as the far-field area. No radiological monitoring sites have been operated by the YMP outside of the near-field area since September 1995.

Table 5-1. Synopsis of the Environmental Radiological Field Monitoring Program in 1997. Key: CAS = Continuous Air Sampler; CRM = Continuous Radon Monitor; TLD = Thermoluminescent Dosimeter; PIC = Pressurized Ionization Chamber.

Sample Source/ Equipment	Number of Monitoring/ Sampling Locations	Frequency of Collection	Parameter Analyzed	Frequency of Analysis
Air/				
CAS	5	Weekly	Gross alpha and beta radioactivity	Weekly
		Weekly	Radionuclide concentrations	Quarterly
CRM	1	Continuous	Radon	Weekly
Ambient/				
TLD	40	Quarterly	Gamma	Quarterly
PIC	2	Continuous	Gamma	Weekly

Two methods were used to monitor ambient gamma radiation during the year. Of these, thermoluminescent dosimeters (TLD) were used most extensively (40 near-field locations). At the end of each calendar quarter, TLDs were retrieved and sent to a vendor for processing. The exposure rate for each TLD was calculated and reported by the vendor. These data were then reviewed and validated by the RCD, in accordance with approved procedures. The overall average quarterly TLD data for all near-field and far-field stations operated since 1991 appear in Figure 5-1. Ambient gamma radiation was consistently higher at near-field than at far-field locations, a phenomenon that may be attributable to variations in geology between near-field and far-field sites. Exposure levels were not significantly different from quarter to quarter in either category of TLD stations.

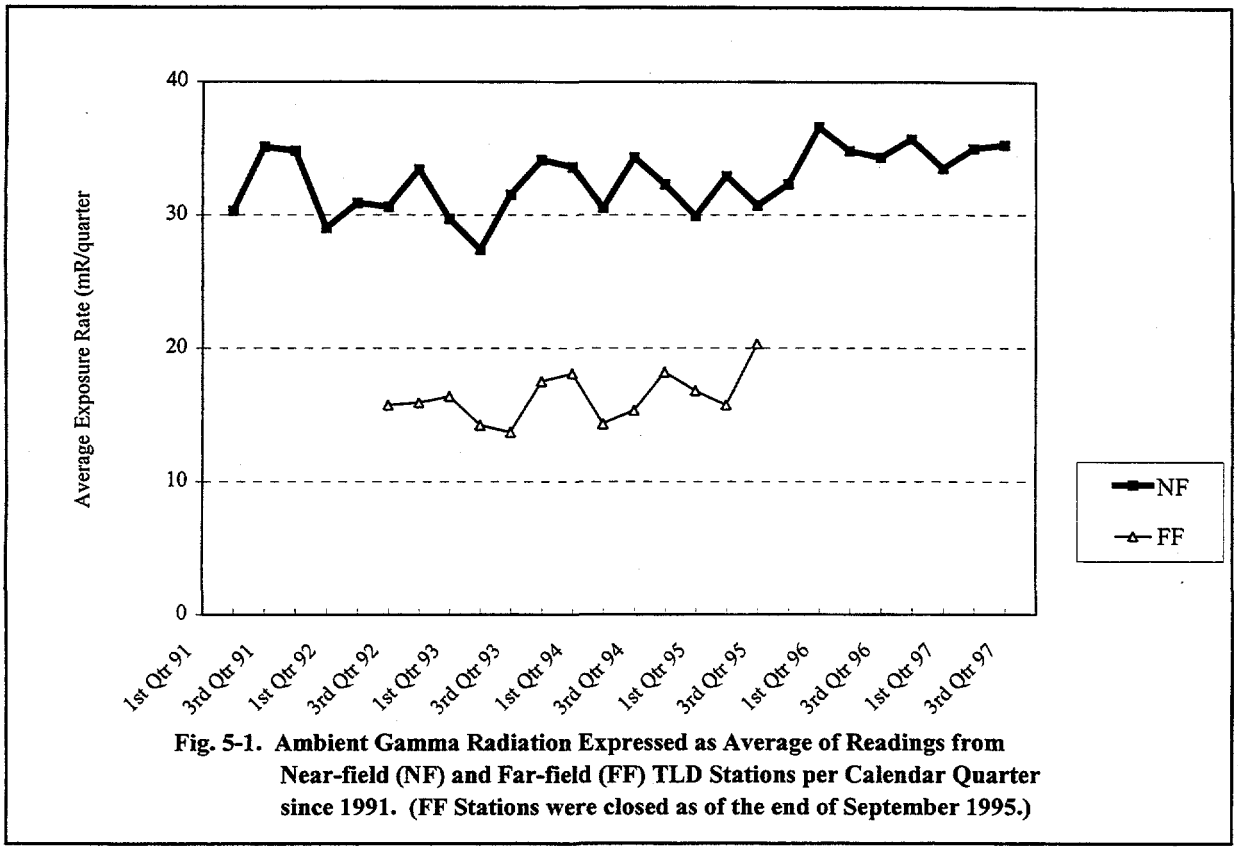


Fig. 5-1. Ambient Gamma Radiation Expressed as Average of Readings from Near-field (NF) and Far-field (FF) TLD Stations per Calendar Quarter since 1991. (FF Stations were closed as of the end of September 1995.)

The second method used to determine ambient gamma radiation involved pressurized ionization chambers (PIC) at two near-field locations. These instruments operate continuously, recording the dose rate integrated over intervals of fifteen seconds. The average monthly dose rates calculated for the two PIC sites since July of 1992 are shown in Figure 5-2.

A single continuous radon monitor (CRM) at near-field location NF87 was used to measure ambient radon. A CRM at site NF06 was removed in November 1996. For comparative purposes, the data collected at both NF87 and NF06 since January 1995 are presented in Figure 5-3.

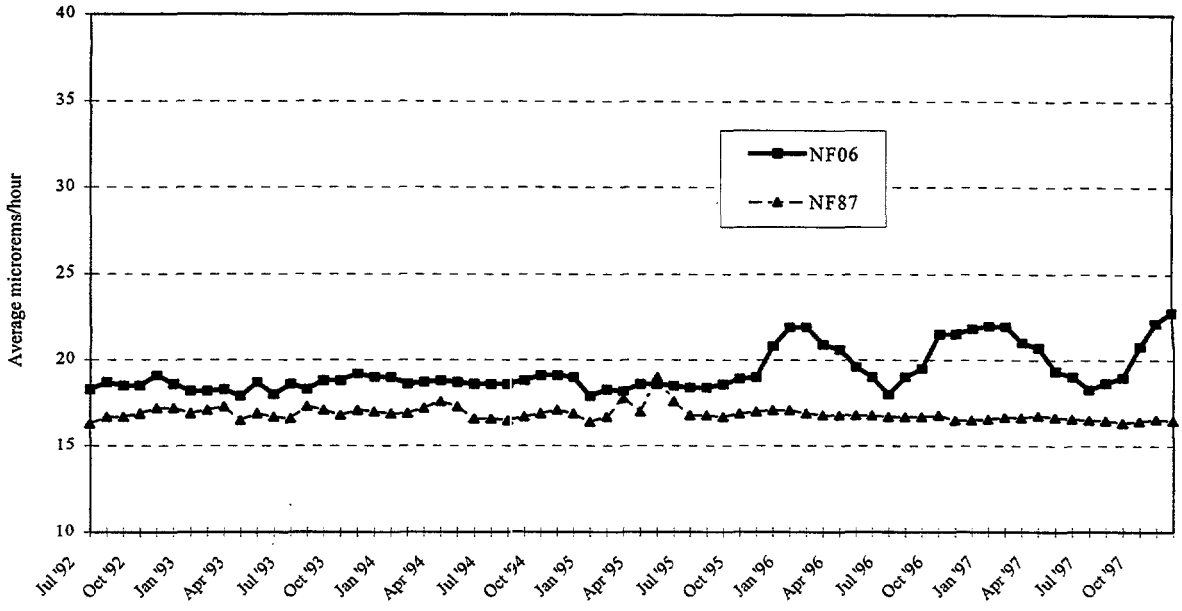


Fig. 5-2. Ambient Gamma Radiation Detected by PIC Units at the two Near-Field Sites, NF06 andNF87, since mid-1992

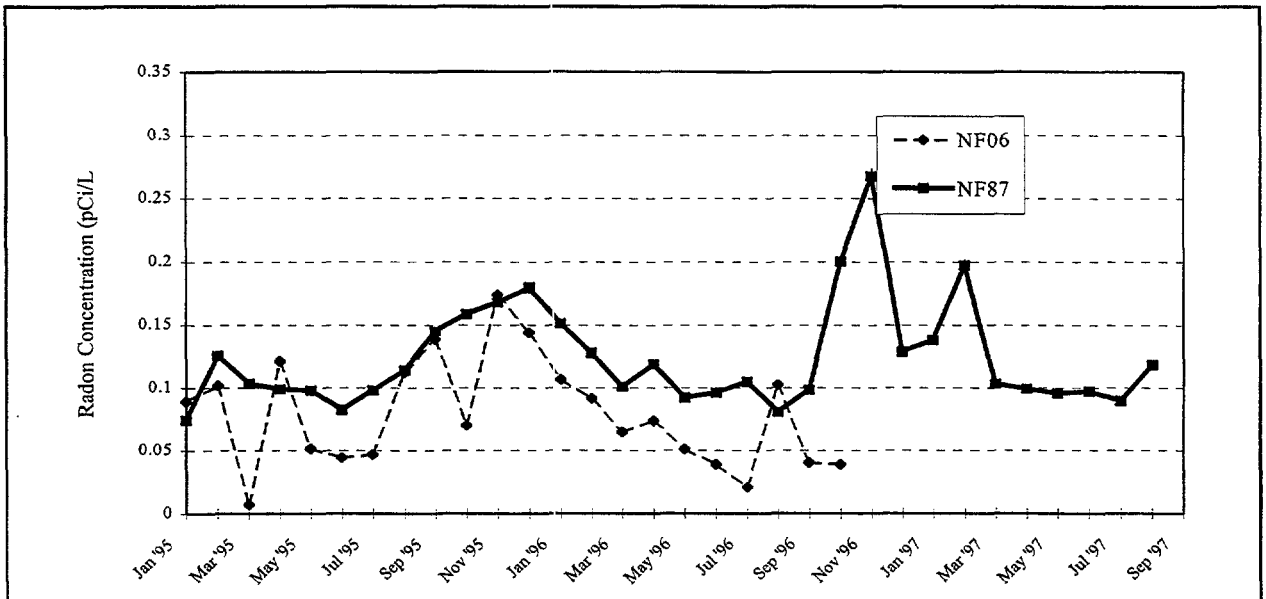


Fig. 5-3. Monthly Average Radon Concentrations Measured by Continuous Radon Monitors (Pylon) at Near-Field (NF) Locations since 1995. (NF06 was closed as of November 1996.)

Radioactive particulates were collected by continuous air samplers (CAS) installed at five near-field locations (NF06, NF67, NF86, NF95, NF108). To measure gross radioactivity on CAS filters, an alpha/beta counting system was used. At the end of the year, filters (collected weekly and stored on site) from each CAS were composited and sent to a vendor for analysis of specific radionuclides. The results of these analyses, expressed as the annual average of gross alpha radioactivity and gross beta radioactivity per station at five near-field locations since 1993, are shown in Figures 5-4 and 5-5, respectively. The figures reveal that the ratio of gross beta radioactivity to gross alpha radioactivity was greater than 10:1, typical of the natural environment.

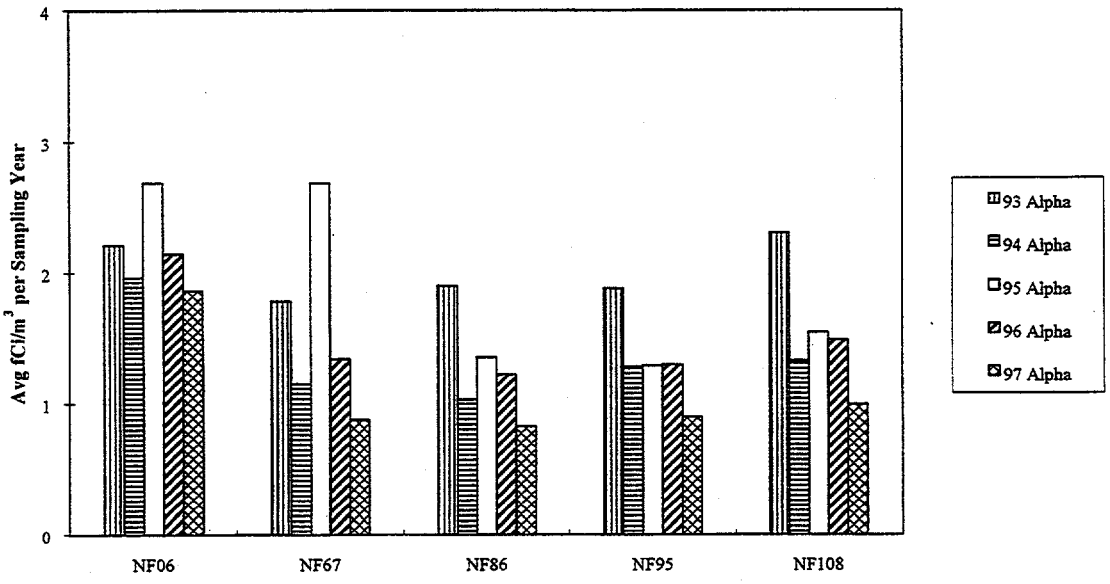


Fig. 5-4. Average Annual Gross Alpha Radioactivity at five Near-field (NF) Locations as Detected by Continuous Air Samplers since 1993.

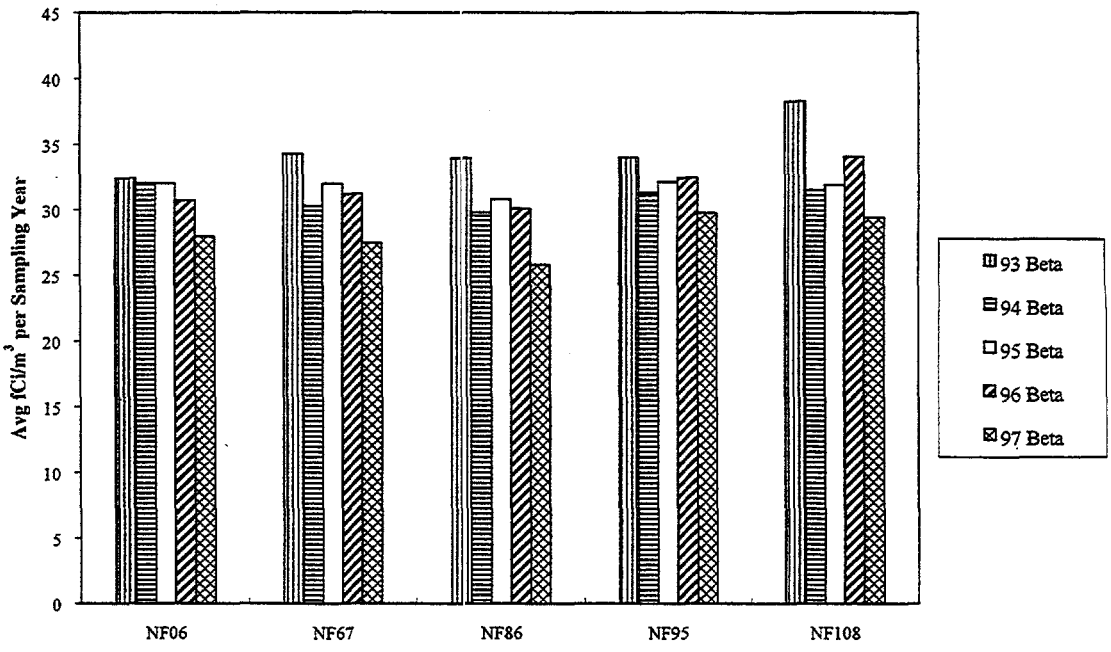


Fig. 5-5. Average Annual Gross Beta Radioactivity at five Near-field (NF) Locations as Detected by Continuous Air Samplers since 1993.

Another component of the radiological monitoring program designed to establish existing levels of ambient radiation near the Yucca Mountain site involved testing local groundwater for radioactivity. Water samples, collected from eight wells or springs in the YMP study area, were analyzed for radium (^{226}Ra and ^{228}Ra), gross alpha radioactivity, and man-made beta and gamma radioactivities. National Primary Drinking Water Regulations (40 CFR 141) were selected to serve as evaluation guidelines for radioactivities in groundwater because specific standards were not available. Tables 5-2 and 5-3 compare the results of these radiochemical analyses with maximum contaminant levels (MCL) established in 40 CFR 141 for combined ^{226}Ra and ^{228}Ra and gross alpha (excluding radon and uranium).

Average combined ^{226}Ra and ^{228}Ra concentrations are shown in Table 5-2. These concentrations represent the average of the four quarterly measurements from FY 1997 (not CY 1997) at each location. In all cases, combined radium concentrations were less than 20% of the MCL listed in 40 CFR 141.15.

Table 5-2. Average Combined ^{226}Ra and ^{228}Ra Activities in FY 1997 Groundwater Samples

Location	Combined ^{226}Ra and ^{228}Ra Activity (pCi/L)
C-3 Well	0.58 ± 0.36
J-13 Well	0.45 ± 0.36
J-12 Well	0.18 ± 0.31
Gilgans South Well	0.19 ± 0.31
Cherry Patch Well	0.22 ± 0.33
NDOT Well	0.32 ± 0.33
Fairbanks Spring	0.80 ± 0.36
Crystal Pool Spring	0.93 ± 0.20
40 CFR 141.15 MCL	**5**

Note: All uncertainties are reported at the two sigma level.

While both ^{226}Ra and ^{228}Ra are naturally occurring, the contribution of the ^{226}Ra to the combined radium activity was generally higher than that of the ^{228}Ra. Average ^{226}Ra concentrations in the water samples ranged from below the detection limit to 0.93 picoCuries per liter (pCi/L). The ^{228}Ra results ranged from below the detection limit to 1.12 pCi/L.

Average gross alpha concentrations are shown in Table 5-3. In all cases, the average concentrations were below the MCL listed in 40 CFR 141.15(b). The only location at which the measured concentration was more than half of the associated MCL was the gross alpha concentration (excluding radon and uranium) at Cherry Patch Well.

Table 5-3. Average Gross Alpha Activities in FY 1997 Groundwater Samples

Location	Average Gross Alpha Activity (pCi/L)	Maximum (PCi/L)	Minimum (pCi/L)
C-3 Well	1.34 ± 1.05	4.57 ± 2.71	-2.67* ± 1.68
J-13 Well	-0.11* ± 0.83	0.98* ± 1.80	-1.06* ± 1.54
J-12 Well	-1.42* ± 3.95	0.13* ± 1.50	-4.52* ± 15.6
Gilgans South Well	0.09* ± 0.88	1.40* ± 2.00	-1.05* ± 1.30
Cherry Patch Well	9.19 ± 4.35	12.0 ± 8.08	7.79 ± 10.36
NDOT Well	-0.54* ± 1.20	1.26* ± 2.56	-2.61* ± 2.14
Fairbanks Spring	-0.27* ± 1.49	1.48* ± 3.56	-2.38* ± 2.64
Crystal Pool Spring	-0.66* ± 1.51	0.49* ± 3.48	-1.56* ± 2.92
40 CFR 141.15 MCL	**15**		

* Below detection limit

Note: Gross alpha activity excludes radon and uranium contributions. All uncertainties are reported at the two sigma level. The average MDA for gross alpha (prior to correcting for radon and uranium) was 5 pCi/L.

No man-made beta- or gamma-emitting radionuclides were positively identified in the water samples (Table 5-4).

Table 5-4. Average Concentrations of Man-made Beta- or Gamma-emitting Radionuclides in Groundwater Samples in FY 1997.

Location	Average Concentration (pCi/L)					
	3H	14C	36Cl	59Ni	89Sr	90Sr
C-3 Well	-22 ± 62	4.9 ± 5.8	0.26 ± 2.6	-7.4 ± 23	0.60 ± 1.3	0.47 ± 0.50
J-13 Well	-64 ± 61	1.7 ± 5.8	-0.44 ± 2.5	-14 ± 25	0.59 ± 1.4	0.55 ± 0.74
J-12 Well	-46 ± 62	4.1 ± 5.9	-0.60 ± 2.5	6.8 ± 29	0.94 ± 1.3	0.42 ± 0.51
Gilgans South Well	-32 ± 64	3.5 ± 5.9	0.31 ± 2.5	7.2 ± 23	0.93 ± 1.2	0.18 ± 0.43
Cherry Patch Well	11 ± 64	-1.2 ± 7.2	0.31 ± 3.2	16 ± 26	-0.17 ± 1.4	0.09 ± 0.49
NDOT Well	-43 ± 63	-1.9 ± 5.8	-0.09 ± 2.6	-19 ± 23	0.43 ± 1.6	0.61 ± 0.51
Fairbanks Spring	-93 ± 61	-1.4 ± 5.8	0.42 ± 2.6	-11 ± 25	0.81 ± 1.6	0.70 ± 0.75
Crystal Pool Spring	-92 ± 62	-5.2 ± 5.8	-0.28 ± 2.6	-5.8 ± 21	1.3 ± 1.7	0.45 ± 0.56
Average Annual Concentration Limit (pCi/L); Critical Organ	20,000 Total Body	2,000 Fat	700 Total Body	300 Bone	80 Bone	8 Bone

6.0 ENVIRONMENTAL NON-RADIOLOGICAL PROGRAM

Most of the activities occurring in this category during 1997 involved preactivity surveys (also see Sections 1.0, 3.1.6, 3.1.7.1, 3.1.14 and 6.1.1.4), various types of monitoring, and the continued development of the extensive habitat reclamation program. The non-radiological disciplines studied were Terrestrial Ecosystem, Cultural (i.e., Archaeological) Resources, Air Quality, Meteorology, and Water Resources. Details of the design of these investigations appear in the appropriate Environmental Field Activity Plan (EFAP) for four of the disciplines (DOE,1992b-d; 1995d) and in a study plan for Meteorology (DOE, 1993).

6.1 MONITORING PROGRAM SUMMARY

6.1.1 Terrestrial Ecosystem

This section describes the activities performed within the Terrestrial Ecosystem Program during 1997. Five areas of concern were monitored: Site Characterization Effects, Desert Tortoises, Habitat Reclamation, Monitoring and Mitigation, and Biological Sample Collection.

6.1.1.1 Site Characterization Effects

The studies in the Site Characterization Effects Program (SCEP) were designed to monitor selected components of the terrestrial ecosystem as a means of assessing the effects of site characterization activities on the ecosystem. As redesigned in 1995, the present program monitors impacts on vegetation and certain animals near large construction projects in Midway Valley (e.g., the ESF, South Portal, proposed General Services Facility [GSF], and the muck and topsoil storage areas) and compares results with those obtained from two sets of control plots, each set located a different distance from ongoing site characterization activities.

In 1997, the final year of monitoring for the SCEP, field studies were conducted on a total of 19 Ecological Study Plots (ESP), each 200 x 200 m (660 x 660 ft) in area, to collect information on climatic factors, vegetation, and small mammals. All ESPs were located in the *Larrea-Lycium-Grayia* vegetation association (Section 2.3.4), the habitat type in which most of the major disturbances during site characterization are occurring. Seven ESPs were designated as treatment plots, located near areas of intense activity, while 12 other plots served as controls (Figure 6-1). Six of the latter, in the immediate vicinity of Yucca Mountain but at least 450 m (492 yd) from the nearest dirt road, were considered near-field controls; the remaining six were far-field controls, located near Little Skull Mountain more than 10 km (6 mi) from disturbances at Yucca Mountain.

Climatic Factors

Data collected will be used to detect variations in precipitation and temperature among the ESPs. Monitoring was conducted monthly. Data recorded were maximum, minimum, and ambient air temperatures, precipitation, and soil moisture and temperature.

The average precipitation across ESPs in 1997 was 15.4 cm (6.1 in). As in past years, considerable difference existed between locations. Treatment and near-field control plots averaged 17.3 and 15.5 cm (6.8 and 6.1 in), respectively, whereas the far-field control plots averaged only 13.3 cm (5.23 in) of precipitation. A statistical examination of yearly trends in precipitation revealed that approximately 90% of the total variation was caused by differences among years; 3% of the variation was caused by differences among the three locations; 3% of the variation was caused by differences among ESPs within each location; and 4% of the variation was unexplained. Thus, differences among the three locations were small compared to yearly fluctuation. Average maximum and minimum temperatures for all months and all ESPs were 32.7° and 1.7°C (90.9° and 35° F), respectively. Far-field control ESPs registered the highest, 47°C (116.6° F) , and treatment ESPs the lowest, -11.5°C (11.3° F), temperatures for 1997.

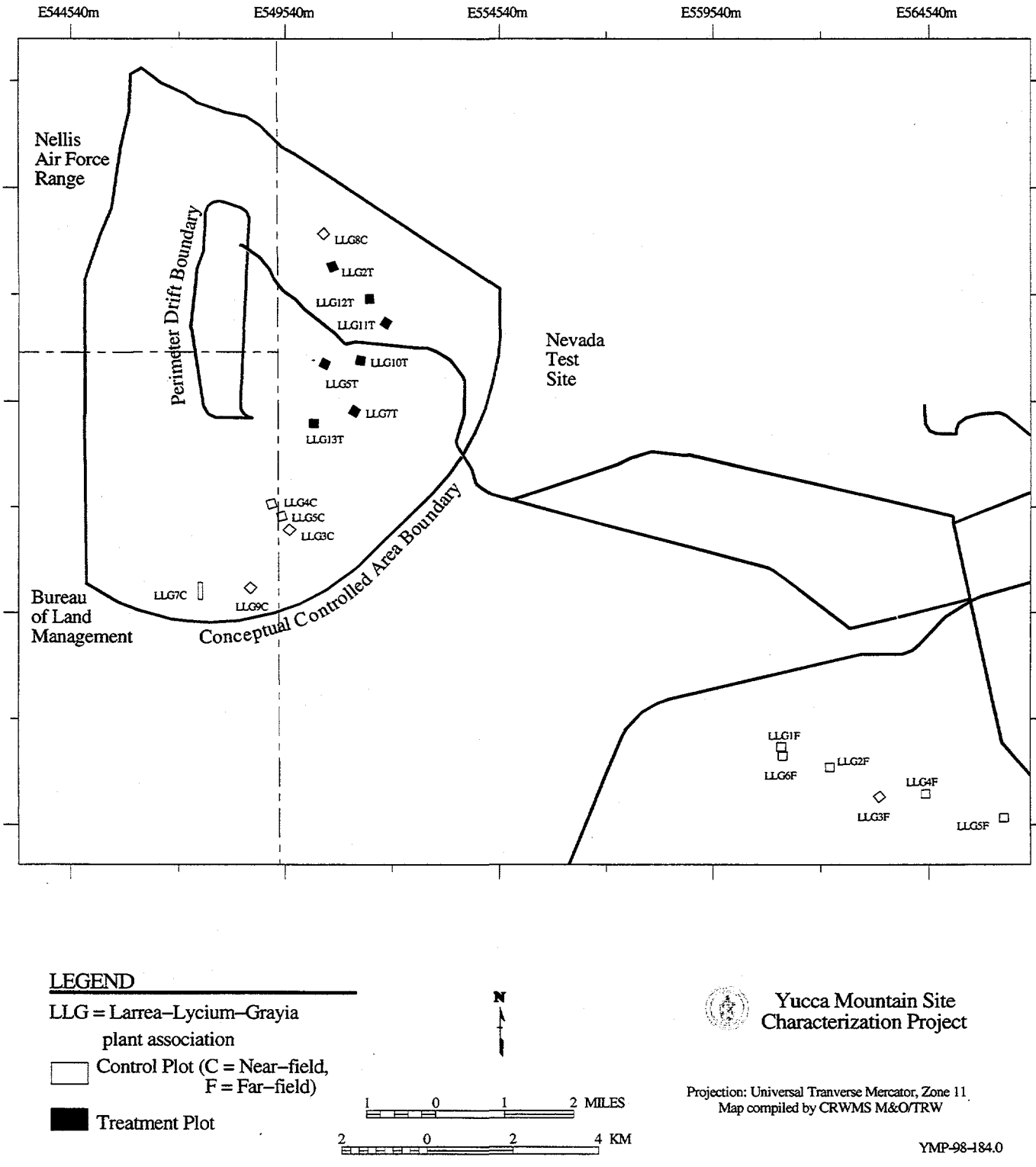


Figure 6-1. Ecological Study Plots

Vegetation

Vegetative cover was measured on all 19 ESPs in April and May 1997. Production was measured on the four ESPs on which small mammal populations are also being monitored: LLG8C, LLG6FFC, LLG5T, and LLG11T. The average cover among ESPs was 29.2%, and the average number of plant species on each ESP was 17.5.

Vegetation Mapping

During 1997, vegetation across 173 square kilometers (km^2) of the Yucca Mountain formation was classified and mapped. The vegetation map was designed to serve several purposes, including land management, resource inventory, and environmental assessment. Mapping was based on four steps: (1) Ecological Landform Units were identified and mapped, based on topography, aerial photographs, satellite images, and soil and geology maps (An Ecological Landform Unit is an 8- to100-ha [20- to 247-acre] landscape feature that contains relatively homogeneous vegetation.); (2) Vegetation from 295 Ecological Landform Units was sampled; (3) Field samples were quantitatively classified; and (4) A map displaying the distribution of vegetation associations was compiled.

Descriptions of the vegetation associations were also compiled. Vegetation was classified into two formations, representing the Mojave and Great Basin Deserts, and further divided into five alliances and nine associations. No sensitive species or plant communities were observed. Transitions among associations were gradual, and most perennial species were found in several vegetation associations. Future plans call for mapping additional areas surrounding ESPs at Little Skull Mountain, and creating a Geographic Information System (GIS) overlay of floristic composition that enables Project participants to interactively access detailed information about each vegetation association and landform.

Small Mammals

Small mammals are useful indicators of changes in desert ecosystems because their home ranges are relatively small, their generation time is short, and they are sufficiently abundant to permit statistical comparisons. Ecologically, small mammals are important because they are common inhabitants of the desert; they consume large quantities of seeds and foliage, thereby influencing plant community dynamics; and they represent a major source of prey for carnivores. The objective of the small mammal studies was to monitor potential effects of site characterization activities on the small mammal community at Yucca Mountain by estimating changes in demographic attributes of the most abundant small mammal species. Small mammal trapping, begun in 1989, was completed in 1997.

During 1997, trapping plots were sampled for small mammals on four consecutive nights in April, June, August, and September. Each sampling location consisted of a grid of 144 trap-stations (two live-traps per station). All four plots were located in the *Larrea-Lycium-Grayia* vegetation community: two were treatment plots located adjacent to disturbed areas at Yucca Mountain; the other two were undisturbed control sites.

A report entitled *Abundance and Species Composition of Rodent Populations at Yucca Mountain, Nevada,* was issued in March 1997 (CRWMS M&O, 1997a). This report documents the abundance and distribution of desert rodents in the Mojave-Great Basin Desert transition at Yucca Mountain. Eleven species of rodents were captured during six years of live trapping on eight ESPs, and four additional rodent species were captured at other sites. Merriam's kangaroo rats (*Dipodomys merriami*) were found in relatively high abundance in all plots. Long-tailed pocket mice (*Chaetodipus formosus*) were common and widely distributed except in the sandy valley bottoms, where little pocket mice (*Perognathus longimembris*) were most abundant. Desert woodrats (*Neotoma lepida*) and canyon mice (*Peromyscus crinitus*) were relatively common at high elevations during some years, though the former species was not present in sufficient numbers to allow subsequent statistical analyses of impacts.

Additionally, the information acquired from these studies of small mammals will be further examined for evidence of indirect impacts due to site characterization activities. Continuing evaluations will include a comparison of the number of animals on control plots with those on treatment plots before and after November 1992, the date of grading the ESF for the North Portal. Preliminary analysis indicates that animal abundance has fluctuated over the years, with the numbers generally fluctuating in synchrony on all plots. Differences in population sizes on the control and treatment plots have generally been small.

6.1.1.2 Desert Tortoise Program

The only resident animal species at Yucca Mountain that is protected under the ESA is the desert tortoise. The Mojave population of this species was listed by the USFWS as endangered in 1989 and reclassified as threatened in 1990. Desert tortoises are also classified as threatened by the State of Nevada. The YMSCO initiated a desert tortoise monitoring program in 1989, the goals of which were to assess and monitor the potential effects of site characterization activities on desert tortoises, develop and evaluate mitigation methods for minimizing those effects, and develop a better understanding of the status and ecology of the desert tortoise population at Yucca Mountain. To meet those goals, and to ensure compliance with conditions of the Biological Opinion issued in 1990 by the USFWS (following formal ESA Section 7 consultations), 308 tortoises were radiomarked and monitored between 1989 and September of 1995 at Yucca Mountain and in a nearby unimpacted control area. Field data collection efforts for this program were completed in September 1995, and final reports are being written to document compliance with the 1990 Biological Opinion.

A report entitled *The Distribution and Relative Abundance of Desert Tortoises at Yucca Mountain*, issued in 1997, summarized the findings of previous transect surveys conducted in the Yucca Mountain area during the 1980s and presented additional information on the distribution and abundance of tortoises collected during the period 1989 to 1995 (CRWMS M&O, 1997b).

Surveys conducted in the 1980s indicated that the relative abundance of tortoises was low (4 to 20 animals/km^2). Two areas in which intensive research on radiomarked tortoises was conducted from 1989 to 1995 were identified, and the number of tortoises within those areas was tallied to determine the minimum population size. The minimum density of tortoises found in these two areas was 10 and 12 tortoises/km^2, respectively, similar to results of earlier surveys.

To better define the time of year during which desert tortoises at Yucca Mountain hibernate, dates on which radiomarked tortoises entered and exited hibernacula (hibernation burrows) during the winters of 1991-92 through 1994-95 were determined. Radiomarked tortoises were also monitored during the winter to determine whether they became active during their period of hibernation. Data collected indicate that, for management purposes, the period of winter inactivity for tortoises at Yucca Mountain is November 15 through February 15. A report summarizing this information and entitled *Hibernation Behavior of Desert Tortoises at Yucca Mountain, Nevada*, was issued in 1997 (CRWMS M&O, 1997c).

Another report, entitled *Patterns of Burrow Use by Desert Tortoises at Yucca Mountain, Nevada*, quantified the seasonal use of cover and the number and types of burrows used by adult tortoises (CRWMS M&O, 1997d). Patterns of burrow use were influenced by season, year and sex of the animals. As expected, the annual pattern of burrow use was closely related to temperature. Tortoises were located in burrows more than in other types of cover during the hottest and coldest months, and were most often found in above-ground pallets and away from cover during months with more moderate temperatures. On average, tortoises at Yucca Mountain used approximately 12 burrows per year. This report was issued in April 1997.

One factor thought to contribute to desert tortoise population declines is increased predation on hatchling tortoises by common ravens (*Corvus corax*). A term and condition of the Incidental Take Provision of the original Biological Opinion (USFWS, 1990), issued by the USFWS to the DOE, was that the abundance of ravens in the vicinity of Yucca Mountain be monitored. A report issued in 1997 entitled *The Effects of Site Characterization Activities on the*

Abundance of Ravens (Corvus corax) *in the Yucca Mountain Area* summarizes the final results of raven surveys conducted from 1991 to 1995 (CRWMS M&O, 1997e). While raven numbers increased on both the Yucca Mountain and control survey routes, the magnitude of differences between the two routes (Yucca Mountain versus control) did not change, suggesting that the increases in bird numbers were not related to man-induced disturbances at Yucca Mountain.

Other documents summarizing desert tortoise studies conducted from 1989 through 1995 are presently being written and reviewed. Included are reports on the indirect impacts of site characterization activities on the tortoise, the efficacy of relocating tortoises from construction sites, movement patterns of tortoises, the prevalence of upper respiratory tract disease in tortoises in the Yucca Mountain vicinity, and the movements of, and uses of cover by, hatchling tortoises.

6.1.1.3 Habitat Reclamation Program

The objective of the Habitat Reclamation Program is to restore sites disturbed by YMP activities to an ecological state similar in form and productivity to their pre-disturbance condition. The program consists of reclamation inventories, reclamation implementation (interim and final reclamation activities), reclamation monitoring (interim, final, and animal use), reclamation trials, and topsoil stockpile studies.

Reclamation Inventories

A Reclamation Inventory is performed before the initiation of an activity at a site from which topsoil is to be salvaged and stabilized during storage. The Reclamation Stipulation Report resulting from the inventory includes recommendations for salvaging, storing, and managing the topsoil to prevent wind and water erosion, and for maintaining soil viability. Two reclamation inventories were conducted in 1997, one for the SD-6 drill pad, and the other for the Busted Butte drift pad and access road. Vegetative cover, soil depth, soil texture, and soil

erodability were recorded for the Reclamation Stipulation Reports. Soil samples were collected at the Busted Butte drift pad and access road site and will be sent to a commercial soil laboratory for analysis of physical and chemical properties. By the end of the year, construction activities for the SD-6 site had been completed. Construction activities for the Busted Butte drift pad and access road will continue into 1998.

Reclamation Implementation

Interim reclamation refers to efforts that may include seeding, mulching, or chemical stabilization of a disturbed area before the completion of all activities at the site. The objectives of interim reclamation are to prevent erosion and maintain a viable soil until activities are completed and the site is released by the YMSCO for final reclamation. Included in final reclamation are decommissioning, recontouring, and revegetation of the site.

In 1997, two topsoil stockpiles, established as a result of site characterization activities, were restabilized by seeding and mulching. Restabilization was necessary because initial revegetation of the sites produced plant densities lower than desired. Two other stockpiles required additional applications of chemical soil stabilizer.

Reclamation was initiated at twenty-three sites in 1997: 17 soil pits in Yucca Wash and Fortymile Wash, 2 trenches in northern Midway Valley, 2 trenches in Drill Hole Wash, 1 pit on the southern tip of Fran Ridge, and 1 pit in Midway Valley. Following site preparation, the 23 sites were seeded in November or December with a mixture of native plant species. The sites were then mulched with straw and stabilized with a crimper, netting, or chemical tackifier.

Reclamation Monitoring

In 1997, both interim and final reclamation sites were monitored to assess soil stability and the success of revegetation efforts. Stockpiled topsoil at 89 interim sites was checked for

soil erosion. Twenty-three stockpiles were monitored for the last time, because sites associated with these stockpiles were released for final reclamation (see previous section). Soil from these stockpiles was used to recontour the site and prepare the site for final reclamation.

Final reclamation monitoring was conducted at 49 sites during 1997 to determine whether additional reclamation measures were necessary. Vegetative cover data were collected on 46 sites, including 9 study areas, 26 GSF pits, and 11 miscellaneous disturbances. Plant density data were collected at four study sites, and transplant survival was monitored at Trench A'2.

Reclamation Success Standards

To determine whether reclamation has been successful at Yucca Mountain, success standards are needed. During 1997, work progressed on the development of such standards. In addition, a monitoring program is being developed to gather data needed for these reclamation success determinations.

Reclamation Trials

Data collected from reclamation feasibility studies conducted during the period 1991 to 1995 have been analyzed, and many have been reported in *Reclamation Feasibility Studies at Yucca Mountain, Nevada: 1991-1995* (CRWMS M&O, 1996b). In summary, these studies have shown that revegetation by direct seeding of native, adapted species can be successful in the Mojave Desert during years of average and above-average precipitation. Conditions were conducive for plant establishment during 1992-93 and again in 1995. The direct seeding studies were conducted and monitored during these wet periods, possibly a factor in the success of the studies. The continuing goal of the reclamation program at Yucca Mountain will be to repeat these successes, using alternate strategies, in years with below-average rainfall. Based on the results of these feasibility studies, recommendations were made for implementing reclamation measures at Yucca Mountain and for evaluating additional reclamation techniques. Work to

revise the *Reclamation Implementation Plan* (DOE, 1995e) to reflect these recommendations was begun in 1997.

Three studies were implemented during late fall and winter 1996 and continued during 1997. The objective of one study, at the ESF Topsoil Stockpile, was to determine whether the period of the year during which most reclamation is accomplished at Yucca Mountain (October to December) could be extended into late winter and early spring by using irrigation. Eight 10- x 10-m (33- x 33-ft) plots were ripped, seeded with 15 native shrub, forb, and grass species, and mulched with wheat straw during December 1996. The revegetation treatments were applied to eight more plots during February, March, and May 1997. One-half of the plots were irrigated for approximately one month following revegetation treatment application. The other plots were treated as controls and were not irrigated. Seedling density sampling of seeded species and annuals was conducted during the spring and summer of 1997 to determine seedling emergence. Sampling to determine survival occurred during fall 1997. Preliminary results indicate that the period of seeding can be successfully extended into the late winter and spring with irrigation.

A second study was designed to determine if seeds of native plant species will germinate with irrigation 16 to 18 months after they are sown. To meet this objective, a site at the sewer line corridor, seeded in fall 1995, was divided into plots and irrigated for approximately one month. Density data were then collected in spring 1997. Data from irrigated and non-irrigated plots will be compared, and these, in turn, will be compared with baseline plant density data collected at the study site during the fall of 1996. If plant densities from irrigated plots are statistically greater than baseline densities, consideration should be given to utilizing irrigation to remediate disturbed sites with limited plant densities and viable seedbanks. Further, if plant densities from non-irrigated plots are greater than baseline densities, it is possible that nothing should be done with these disturbed sites, allowing natural precipitation to initiate germination and subsequently increase plant densities. Data from this study will be analyzed during 1998.

The objective of the third study was to determine effects of dormancy-breaking treatments and irrigation on the emergence of creosotebush (*L. tridentata*) and Anderson desert thorn (*L. andersonii*). The design of this study was to maximize the germinability of creosotebush and Anderson desert thorn seeds with dormancy-breaking treatments, and then provide optimal soil water and temperature conditions for germination and seedling emergence. These conditions were provided by irrigating only after soil temperatures were above 23° to 26° C (73° to 79° F) in late summer.

A site on the ESF Topsoil Stockpile was prepared for this study in December 1996, and plots were identified in January 1997. Creosotebush seeds were treated with 24-hour water leaching, while seeds of Anderson desert thorn were treated with 30-day stratification (moist/cold treatment). The plots were seeded and mulched with wheat straw in January and August 1997. Two sowing dates were necessary because a question existed as to whether the effects of dormancy-breaking in late fall or winter would still be manifest in August when germination was expected to occur. Therefore, seeds of both species were treated to break dormancy in December and January prior to the January seeding date, and again in July and August prior to the August seeding date. Seedling density sampling occurred in September 1997. Sampling to determine survival will occur during the spring of 1998.

Generally, emergence of creosotebush and Anderson desert thorn seedlings was similar for both planting dates, indicating that seeds of both species sown in January retained viability throughout the spring and summer of 1997. Irrigation quadrupled the number of Anderson desert thorn seedlings, but did not generally increase densities of creosotebush seedlings. This was apparently due to September rainfall being sufficient to maximize the emergence of creosotebush but not Anderson desert thorn. Water leaching doubled the densities of creosotebush, while stratification appeared not to increase the emergence of Anderson desert thorn.

Topsoil Stockpile Studies

A study was undertaken at Yucca Mountain in 1993 to determine the effects of stockpiling on topsoil. Results of studies elsewhere indicate that prolonged stockpiling disrupts nutrient cycles, reduces organic matter, increases bulk density, and disturbs soil microbial populations.

The study was conducted at a stockpile created from topsoil removed during the excavation of Borrow Pit #1. After stockpile completion, four revegetation treatments were applied, each consisting of a seed mix having a different proportion of shallow-rooted, deep-rooted, and legume species. These mixes were selected in an attempt to create stands of vegetation having different root profiles. Soil sampling began in May 1993. Samples were collected from five depths in each revegetation treatment plot, with samples also being collected in adjacent undisturbed topsoil to assess baseline conditions. Sampling occurred approximately every month until December 1993 to determine short-term effects of stockpiling. From December 1993 to September 1995, samples were collected every six months to determine longer term effects. For each sampling period, stockpile status was assessed by measuring active and total bacterial biomass, active and total fungal biomass, vesicular-arbuscular mycorrhizae spores, soil physical properties, and soil chemical properties.

Data collected during the study were analyzed to determine the effectiveness of the revegetation treatments and the short- and long-term effects of topsoil stockpiling. The results of the analyses indicated that no revegetation treatment resulted in consistently higher levels of soil attributes. This response was considered due to the lack of proportional differences between the species seeded on the stockpile. Another interesting result was that bacteria and fungal components were not affected by depth of the stockpile; however, the stockpiled soil contained significantly different bacteria and fungal components when compared to undisturbed soil during the first year of the study. During the second year, performance of the stockpiled topsoil was similar to that of the undisturbed soil. Samples were again collected from the stockpile in

September 1997 to determine if these trends continued over the long term. These data will be analyzed during 1998.

Wildlife Use of Reclaimed Sites

A study implemented in 1995 was continued in 1997 at Reclamation Trial Site 1 and the NRT-1 Final Reclamation Site. The objective of this study is to document the level of use of reclaimed areas by wildlife, using small mammals as indicator species. Numbers of individuals and species composition of the small mammal community using these reclaimed areas are to be compared with the same parameters on adjacent undisturbed (control) areas. Animals were trapped in May and September at these sites. Initial results indicate that small mammal use of reclaimed areas has increased over time.

6.1.1.4 Monitoring and Mitigation Program

Important species are those listed by the USFWS or the State of Nevada as threatened, endangered, or of commercial and recreational value. One of the primary goals of the terrestrial ecosystem monitoring and mitigation program is to preserve important plant and animal species and their associated habitats that may be impacted by site characterization activities. A mitigation tool used by the YMP is the field survey to detect the presence of important plant and animal species prior to the initiation of land-disturbing activities. As a result of these preactivity surveys, additional mitigation measures such as clearance surveys or relocation of important resources may be recommended. The survey process was modified with issuance by the USFWS in July 1997 of the new Biological Opinion (USFWS, 1997) to include terms, conditions, and site-specific recommendations designed to further minimize the possibility of harming tortoises and to reduce impacts on biological resources.

Seven preactivity survey requests resulted in surveys of eight separate sites during the year. Approximately 8.2 ha (20.3 acres) were surveyed, all within the range of the desert tortoise. No tortoises or sign indicating the presence of tortoises were found during any of the surveys.

All sites at which surface-disturbing activities occurred during the tortoise activity period (February 16 through November 15) were surveyed to clear the area of tortoises, usually on the day of, or the day before, the activity. Activities scheduled outside of the tortoise activity period were clearance-surveyed less than one week prior to the activity. Seven clearance surveys were conducted for eight activities at eight sites. Approximately 7.4 ha (18.4 acres) were surveyed. No tortoises or tortoise sign were found during the clearance surveys.

In compliance with conditions of the 1997 Biological Opinion (USFWS, 1997), the YMSCO continued to track and record acreage disturbed during the year, approximately 6.1 ha (15.1 acres). Total acreage disturbed since June 21, 1991, is approximately 121.2 ha (299 acres).

6.1.1.5 Biological Sample Collection

The objectives of this program were to collect plant and animal specimens for the determination of radionuclide concentrations in their tissues, and to monitor populations of the animal species being collected for this purpose. No samples were collected in 1997.

As part of this program, the relative abundance of lagomorphs and predators was monitored from 1990 through 1995. A report summarizing this effort, entitled *Lagomorph Population Trends at Yucca Mountain, Nevada: 1990-1995*, was officially released in 1997 (CRWMS M&O, 1997f). During 1992, 1993, and 1994, lagomorphs were numerous, but during 1990, 1991, and 1995, abundance was low and harvest of the animals would have been difficult and expensive. The number of jackrabbits (*Lepus californicus*) seen per km of road fluctuated

from a low of 0.01 in 1991 to a high of 1.5 in 1994, before declining to fewer than 0.4 in 1995. Jackrabbit populations on the east and west sides of Yucca Mountain generally fluctuated synchronously. Although populations fluctuated greatly, correlations between precipitation and abundance of animals were high. It was concluded that historic precipitation records could be used to predict periods of high animal abundance and, therefore, the most efficient times to harvest lagomorphs.

Also for this program, the movements and abundance of Gambel's quail (*Callipepla gambellii*) were monitored at Yucca Mountain during 1992 and 1993 to determine whether numbers of quail were sufficient to withstand their being collected and to identify areas from which quail should be collected. Quail were found throughout the Yucca Mountain area concentrated near sources of water, and 93 quail were captured during 3 trap sessions. Based on 39 radiomarked quail, some individuals moved more than 3 km (1.9 mi), while two moved in excess of 6.5 km (4 mi).

6.1.2 Archaeological Resources

Areas of proposed land disturbance were examined in advance to identify and evaluate historical properties and to ensure avoidance or mitigation of potential adverse effects to those properties by YMP-related activities. A total of 12 archaeological preactivity surveys of areas proposed for Project activities were made during the past year (Section 3.1.7.1). Surveys of YMP areas resulted in the identification and recording of three new historical properties.

The M&O archaeological support contractor has implemented an archaeological site monitoring program, designed to periodically assess the condition of known historical properties in the main Project area around Yucca Mountain. During 1997, a total of 46 historical properties were revisited for purposes of site monitoring. The results of these visits indicated that historical properties were largely in the same condition as when discovered or last examined.

6.1.3 Air Quality

In accordance with the requirements of the two air quality permits issued by the State of Nevada since 1991 (Section 3.1.3.1), the YMP monitors and reports particulate matter equal to, or less than, 10 micrometers in nominal aerodynamic diameter (PM_{10}). Sampling is conducted every sixth day for 24 consecutive hours at four locations: Site 1 (NTS-60), Site 5 (Fortymile Wash), Site 6 (WT-6), and Site 9 (Gate 510) (Figure 6-2). To assess the precision of measured concentrations, in compliance with regulatory quality assurance requirements, two collocated PM_{10} samplers are operational at Site 1.

As of the end of 1997, 92 months of particulate matter data had been processed to meet the requirements of the air quality permits. Figure 6-3 presents 1997 monitoring results plotted chronologically, revealing an annual trend of higher concentrations of PM_{10} during the summer months and the occurrence of individual episodes of higher values throughout the year. During 1997, the highest reported value for a 24-hour period was 59 $\mu g/m^3$, well below the 24-hour ambient air quality standard of 150 $\mu g/m^3$. Occurring on August 8, 1997, this value coincided with the presence in the area of range fires which may have contributed particulate matter to the total. Most values during the year did not exceed 15 $\mu g/m^3$. The highest annual average for any of the four sites, derived by averaging all 24-hour values for the year from each site separately, was 9 $\mu g/m^3$, less than one-fifth the annual ambient air quality standard of 50 $\mu g/m^3$.

6.1.4 Meteorology

For the fifth successive year, nine sites were operated in the meteorological network (Figure 6-2). The first five sites (NTS-60, Yucca Mountain, Coyote Wash, Alice Hill and Fortymile Wash) have operated since December 1985. In addition to increasing the number of sites, the measurement program has expanded in keeping with changing regulatory guidance on

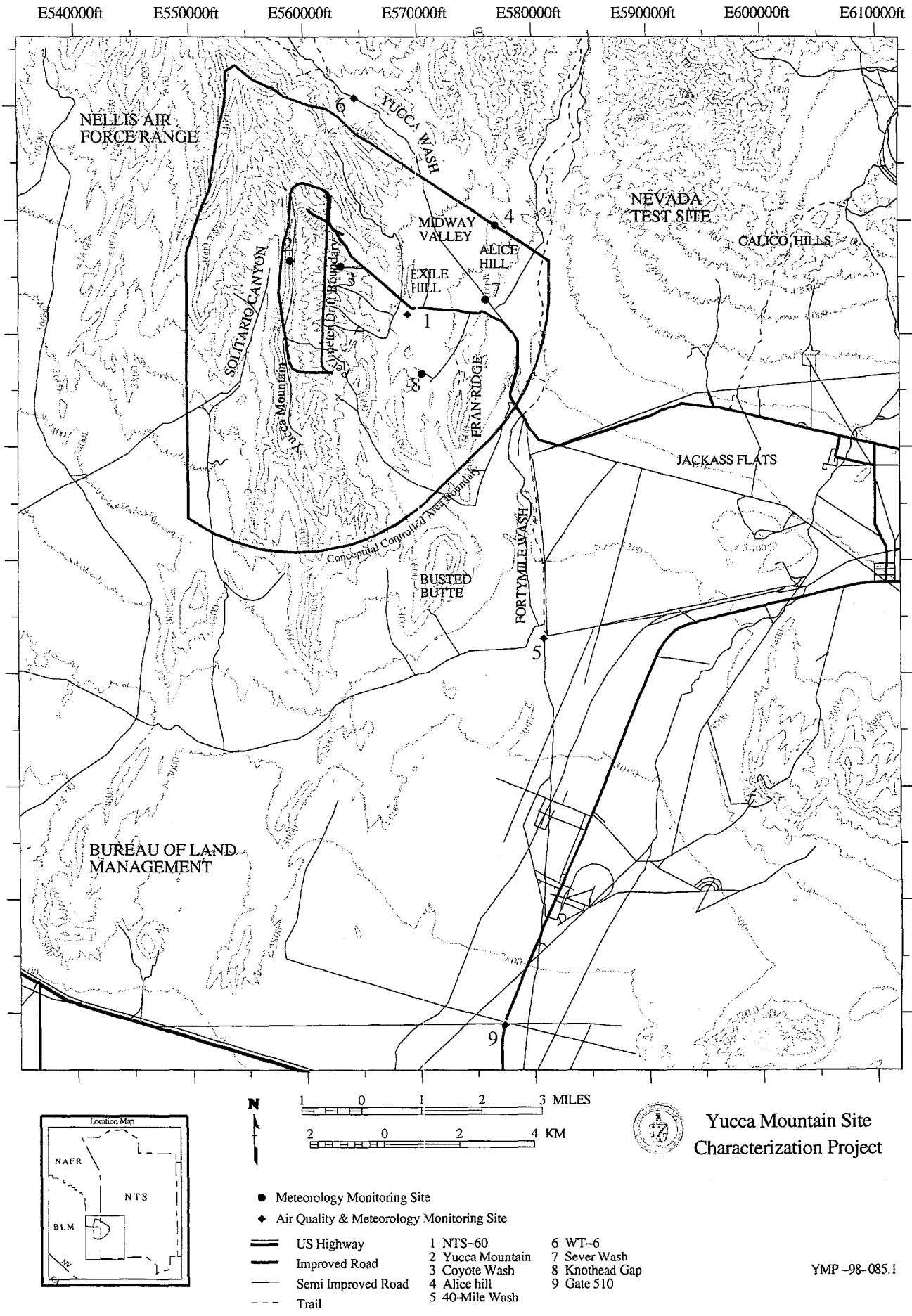


Figure 6-2. Air Quality and Meteorology Monitoring Sites

supplying meteorological data as input to atmospheric dispersion models. The equipment and operational methods used comply with U.S. EPA Prevention of Significant Deterioration (PSD) monitoring guidance.

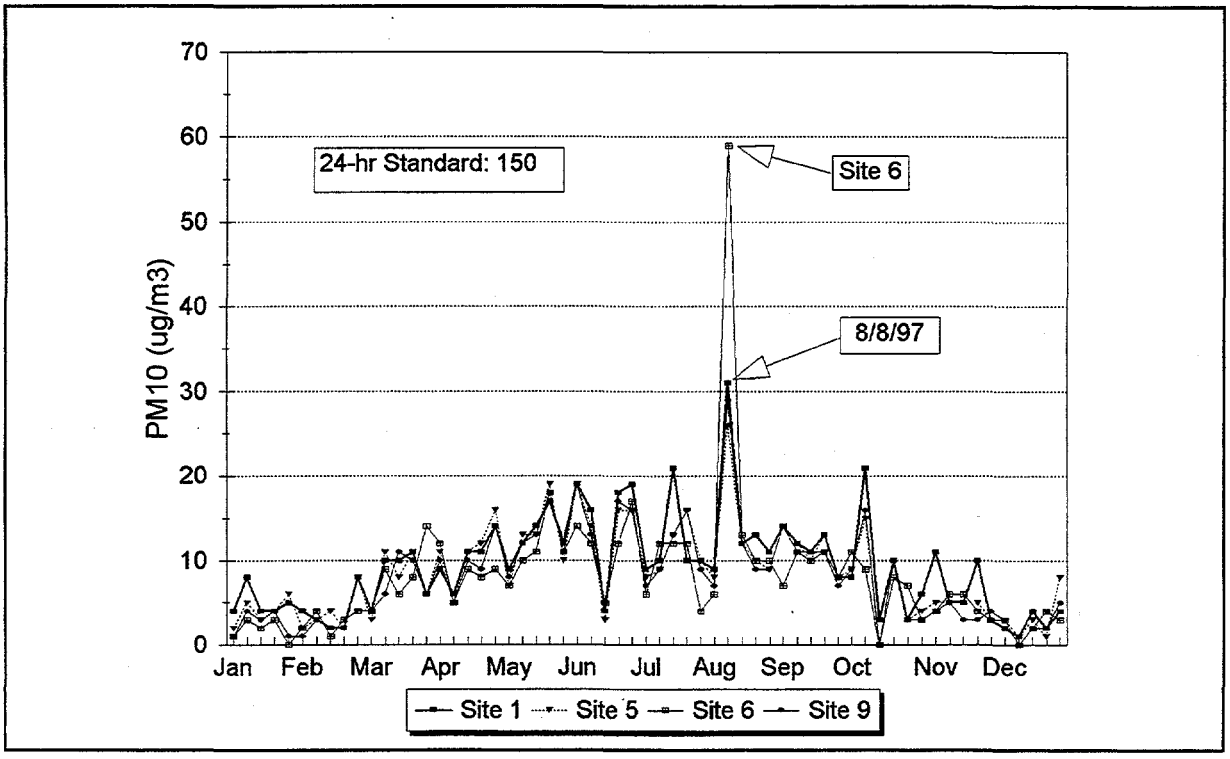


Figure 6-3. Inhalable Particulate Matter (PM_{10}) Measured in 1997 at the four Yucca Mountain Air Quality Monitoring Sites: 1 (NTS-60), 5 (Fortymile Wash), 6 (WT-6), and 9 (Gate 510).

Wind measurements at all nine sites are recorded 10 m (33 ft) above ground level (AGL); Site 1 (NTS-60) also takes wind measurements at 60 m (197 ft) AGL. Since September 1993, in compliance with changing regulatory guidance, temperature and atmospheric humidity measurements have been recorded at 2 m (6.6 ft) AGL. (Prior to that date, these measurements were taken at 10 m AGL.) Various indicators of atmospheric stability are reported from all sites.

For example, the hourly standard deviation of wind direction (known as sigma-theta and sigma-A) has been measured since the beginning of the program. Barometric pressure and precipitation measurements provide additional meteorological information needed in climate and airflow studies.

The primary use of the data from all sites is to characterize local meteorological conditions and support radiological transport calculations. Depending upon the location of these sites, the acquired data will serve additional purposes. For example, data from Site 1 can be used to assess possible impacts associated with site characterization and/or repository operations. Data from Sites 5 (Fortymile Wash) and 9 (Gate 510) will indicate airflow pathways between the Midway Valley site characterization area and the Amargosa Valley area to the south. Site 7 (Sever Wash) is important for monitoring both up-valley daytime winds and nighttime drainage flows through Midway Valley. Site 8 (Knothead Gap) will monitor winds in the south end of Midway Valley.

Results from the meteorological monitoring program are reported in annual summary reports. Average wind speeds during 1997 continued to be high enough to be conducive to good atmospheric dispersion, since higher wind speed provides greater dilution of airborne emissions. The lowest annual average wind speed at any site was 2.8 m per second (m/s) or 6.2 mph at the protected canyon location at Site 3 (Coyote Wash). The highest annual average speed was 4.9 m/s (11.0 mph) at the exposed hilltop location at Site 4 (Alice Hill), in the northeast portion of Midway Valley. The highest 3-second wind speed gust, 30.7 m/s (68.7 mph) was also recorded at Site 4.

Preliminary analyses indicate that precipitation totals for 1997 were very close to the average for the local area. The total at Site 1, the tall tower site near the North Portal of the ESF, was 12.75 cm (5.02 in), nearly identical to the 12.64 cm (4.98 in) 12-year average for this site. The relationships of precipitation totals between the individual sites was similar to previous years. Totals ranged from 8.58 cm (3.38 in) at Site 9 near the Amargosa Valley community on

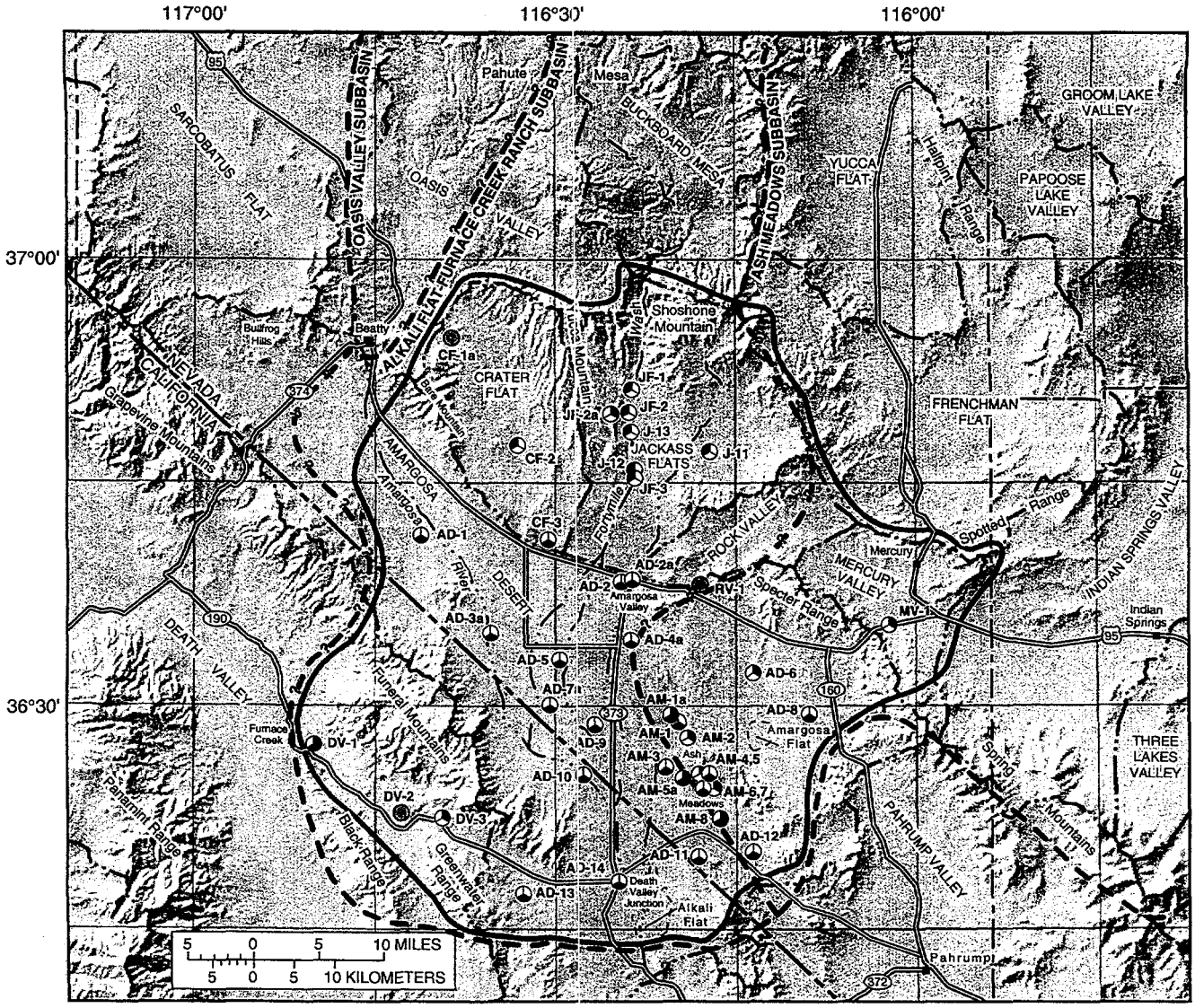
State Highway 95 to 15.47 cm (6.09 in) at Site 6 (WT-6) in upper Yucca Wash, immediately north of the Yucca Mountain ridge.

6.1.5 Water Resources

The Yucca Mountain Water Resources Program consists of monitoring both water quantity and water quality. Studies are being conducted for purposes of documenting any potential effects of site characterization activities on regional water resources and satisfying water-related regulatory and program requirements. The study area for the Water Resources Program encompasses the majority of the site characterization study area and additional sensitive areas to the south of Yucca Mountain (Figure 6-4). Included are the Ash Meadows spring-discharge area and Devils Hole, which together harbor a number of endemic plant and animal species.

6.1.5.1 Water Quantity Monitoring

Because surface water is present in the Yucca Mountain region only during infrequent brief storms, the monitoring of water quantity is restricted to inventorying groundwater resources. Assessing the status of these resources essentially involves three types of monitoring. The first is that of measuring levels of groundwater in 35 wells over time (Figure 6-4). These data are being used to characterize historical and current water resources in the region, and to indicate changes in the quantity of groundwater stored or transmitted within aquifers through time. The same objective is served by the second type of monitoring, i.e., measuring groundwater discharge (or in-flow) into five springs and one well. In particular, these discharge measurements provide data that indicate the status of certain critical water supplies in the environmentally sensitive Ash Meadows and Death Valley areas. The third type of monitoring provides an estimate of regional groundwater withdrawals or water use, both current and historical, by means of an ongoing review of information collected by public or private entities.



Base from U.S. Geological Survey digital elevation data, 1:250,000, 1987, and digital data, 1:100,000, 1981-89; Universal Transverse Mercator projection, Zone 11. Shaded-relief base from 1:250,000-scale Digital Elevation Model; sun illumination from northwest at 30 degrees above horizon

EXPLANATION

- **Study-area boundary**
- **Ground-water subbasin boundary**—From Laczniak and others (1996, pl. 1). Queried where location uncertain
- **Hydrographic-area boundary**

AD-6 **Carbonate rock**
CF-2 **Volcanic rock**
AD-1 **Valley fill**
DV-2 **Undifferentiated sedimentary rock**
DV-1 **Combined carbonate rock and valley fill**

Figure 6-4. Groundwater Level and Discharge Monitoring Sites in the YMP Water Resources Study Area

Routine data collection commenced in February 1992. Initially, measurements were made monthly at wells and quarterly at springs. The frequency of data collections has been revised, however, as evaluations of water-level and spring-discharge data are completed. In 1997, wells and springs were measured quarterly, monthly, or hourly, as testing demands dictated.

Monitoring well JF-3, routinely monitored since May 1992, is located and designed to detect impacts that might be caused by pumping at the well complex consisting of wells J-12 and J-13. Provisional data provided by the USGS indicate that fluctuations in water levels in these three wells (JF-3, J-12 and J-13) during 1997 ranged from 0.12 to 0.20 m (0.39 to 0.67 ft) (USGS, 1997a-d). The ranges in water levels (expressed as meters and feet below land surface) and fluctuations in each well were as follows:

JF-3: 216.46 to 216.59 m (710.15 to 710.59 ft); difference (Δ) of 0.13 m (0.44 ft).

J-12: 225.55 to 225.75 m (739.98 to 740.65 ft); Δ of 0.20 m (0.67 ft).

J-13: 282.88 to 283.00 m (928.07 to 928.46 ft); Δ of 0.12 m (0.39 ft).

In accordance with stipulations of the water monitoring program developed by the DOE and its contractors in 1991 and approved by the National Park Service (NPS), reports listing groundwater-level and springflow data are prepared and submitted by the DOE to the NPS and the State of Nevada each quarter of the year.

A report prepared by the USGS, entitled *Selected Ground-Water Data for Yucca Mountain Region, Southern Nevada and Eastern California, through December 1995,* was issued in 1997 (USGS, 1997e). Data and text are presented that describe groundwater levels at 36 sites, groundwater discharges at 6 sites, and groundwater withdrawals in Crater Flat, Jackass Flats, Mercury Valley, and the Amargosa Desert.

6.1.5.2 Water Quality Monitoring

Water samples were collected in May 1997 by the USGS from eight selected well and spring sites near Yucca Mountain (Table 6-1) for purposes of assaying a number of water-quality parameters in regional groundwater.

Table 6-1. Sites in the Yucca Mountain Water Resources Study Area Monitored in 1997 for Water Quality Properties and Constituents.

Site Name	Site Number (See Figure 6-4)
J-13 WW	J-13
J-12 WW	J-12
NDOT Well	AD-2a
Cherry Patch Well	AD-8
UE-25c #3	---
Fairbanks Spring	AM-1a
Gilgans South Well	---
Crystal Pool	AM-5a

Categories of water-quality parameters analyzed, and examples of parameters within each category were:

- Selected properties (e.g., pH, temperature, color, turbidity, dissolved oxygen, and hardness) and major inorganic constituents.

- Dissolved trace constituents (e.g., boron, cadmium, copper, iron, lead, mercury, selenium, and zinc).

- Dissolved nitrogen and phosphorus species (e.g., ammonia, nitrite, nitrite plus nitrate, phosphorus, and phosphorus ortho).

- Radiochemical constituents (e.g., gross alpha radioactivity, gross beta, tritium, ^{226}Ra, uranium, ^{228}Ra, and ^{222}Rn).

- Organochlorine and organonitrogen compounds (e.g., DDT, DDE, aldrin, dieldrin, chlordane, total PCB, mirex, diphenamide).

- Volatile organic compounds (e.g., chloroform, toluene, trichloroethane, several benzene species, xylene, and naphthalene).

- Semi-volatile organic compounds (e.g., several phenols, benzo(a)pyrene, ether, diethylphthalate, and phenanthrene).

Results of these analyses will be used to characterize the groundwater in the Yucca Mountain region and to supplement the ongoing Yucca Mountain radiochemical monitoring program.

6.2 ENVIRONMENTAL OCCURRENCES

Although petroleum products are not considered hazardous by the State of Nevada, a report is required by the State for any release onto a land surface of a petroleum product that exceeds 95 liters (25 gal) or that contaminates more than 2.3 m^3 or 3 yd^3 of soil at a concentration greater than 100 μg/kg. In 1997, two petroleum releases exceeded the State reporting threshold: one consisted of diesel fuel, the other was hydraulic oil. Both spills were the result of equipment failure. A malfunctioning fuel delivery sensor caused the diesel spill, while a ruptured hose on a "Watermaster" caused the release of hydraulic fluid.

Remedial action, performed at each of the release locations, entailed excavating the site, then analyzing soil samples from the excavation using EPA Analytical Method 8015 (modified for diesel/gasoline/oil) to determine TPH concentrations. Cleanup was considered complete when soil removed from the excavation exhibited a TPH level below the 100 μg/kg threshold.

In 1997, two shipments of excavated hydrocarbon-contaminated soil, amounting to 31.2 tons, were sent to a State-permitted bioremediation facility. Included were all hydrocarbon-contaminated soils resulting from State-reportable releases, as well as those not requiring a report to the State. (The latter non-reportable "housekeeping" releases consisted of soils having hydrocarbon concentrations less than the State-established threshold). Once the concentration of contaminants in the soil had been lowered by microbial action to less than 100 μg of TPH/kg of soil, the cleaned soils were used as landfill cover at a Clark County, Nevada, sanitary landfill operated by the firm responsible for bioremediation.

7.0 GROUNDWATER PROTECTION

At the present time, the YMP groundwater protection program consists of the monitoring activities presented in Section 6.1.5 of this SER. Background data are being collected on groundwater quality and quantity. The YMP has not caused any groundwater pollution or contamination and is in compliance with all applicable Federal and State regulations (Sections 3.1.4, 3.1.5, 3.1.15.1, and 3.2).

8.0 QUALITY ASSURANCE

8.1 OVERVIEW

The quality and validity of monitoring data in this report have been ensured through implementation of a conventional Quality Assurance (QA) program. This QA program pertains to all aspects of monitoring, sampling, analysis, and subsequent data reduction and reporting operations in order to produce scientifically valid, traceable, and defensible data.

QA criteria are incorporated from conventional industry-wide standards and practices to meet applicable EPA and CFR requirements. Additional conventional QA programs may include, as appropriate, applicable portions of basic and supplementary requirements of ANSI/ASME Nuclear Quality Assurance (NQA) -1-1989 (ASME, 1989), as invoked through the DOE Office of Civilian Radioactive Waste Management (OCRWM) Quality Assurance Requirements and Description (QARD) document.

QA program requirements are further imposed on subcontractors and vendors who are subjected to QA qualification requirements through a rigorous qualification process. These QA qualification requirements prescribe that stringent controls be invoked and implemented to ensure that equipment, devices, instruments and services, which directly affect the quality of data, are procured and supplied from qualified vendors. QA requirements also prescribe that processes and activities be performed in accordance with approved procedures.

QA controls, which ensure that data quality requirements are implemented, include the following practices:

- Personnel training is performed and documented prior to work initiation.

- Work instructions and procedures are developed and technically reviewed before approval for use.

- A verbatim compliance policy for work performance, in accordance with approved procedures, is mandated for all work.

- Standards traceable to the National Institute of Standards and Technology (NIST) are used for conducting calibrations and performance checks of measuring and test equipment (M&TE).

- M&TE and operational equipment (OE), used for monitoring, sampling, analysis, and analysis and counting, are regularly calibrated at prescribed intervals.

- Operational status and accuracies of M&TE and OE are independently checked on a continual basis by trained personnel.

- Discrepancies and nonconforming conditions, which may potentially affect data quality, are documented and evaluated in accordance with a structured and approved corrective action process.

- Technical data are reviewed prior to data reduction/analysis and reporting.

- Computer software programs, used for data reduction/analysis, are evaluated.

- Monitoring, sampling, analysis, and subsequent data reduction operations and related activities are periodically evaluated to verify effective implementation.

8.2 SAMPLE CONTROL

All environmental samples are controlled in accordance with approved work instructions and procedures. These controlled documents specify approved methods and processes for sample collection, sample handling, chain-of-custody control, and analysis and data reporting.

Technicians are trained to ensure that samples are properly labeled, stored, and protected against loss or contamination. Samples are uniquely identified by markings either on the sample or its packaging. Sample transactions are documented on either a "Chain-of-Custody" form for external transfers or a "Sample Transfer" form, if transferred internally. Transfer recipients are required to verify that proper conditions and identification of samples are provided and maintained before accepting sample custody.

8.3 SAMPLE ANALYSIS

Analyses of samples are conducted in accordance with approved protocols, based on standard and approved methods. Personnel performing analyses and measurements are specifically trained for these work assignments prior to initiating work activities.

As prescribed by a scope of work, analysis programs selectively use sample blanks, spikes, and replicates to better determine accuracy and precision of methods and to eliminate bias. Subcontractors who measure or analyze samples are required to establish an equivalent QA control system. Results of measurements and analyses are reviewed and approved by technically qualified personnel.

8.4 INSTRUMENT CONTROL

Instruments used to measure, monitor, test, or sample environmental conditions are procured, calibrated, controlled, and maintained in accordance with approved procedures. M&TE, OE, and calibration standards, used to ensure instrumentation accuracy, are traceable to the National Institute of Standards and Technology. Equipment calibration frequencies and maintenance practices are prescribed in approved work instructions and procedures that are based upon manufacturers' recommendations. Provisions are made for frequency adjustments commensurate with reliability experience.

All calibrated equipment is subjected to periodic performance checks to verify adherence to EPA and YMP operation specifications. Calibrated equipment is routinely checked by trained field technicians, and appropriate maintenance adjustments are made to optimize data collection equipment performance. M&TE and OE out-of-tolerance conditions are documented, and resolution is determined by either recalibration, rework, or replacement. Data affected by out-of-tolerance conditions are reported and identified as "indeterminate" until resolution of the condition has been evaluated and data can be validated.

8.5 DATA MANAGEMENT

To preserve data integrity, monitoring and sampling data are recorded and handled in accordance with approved work instructions and procedures. The efficiency of data reduction software is verified through formal acceptance tests prior to official use.

During data reduction activities or compilation for summary reports, raw data are validated and qualified to identify inconsistencies and anomalies. Data validation and qualification are performed by technical processor personnel who, using their professional judgment, compare the data to expected or predetermined ranges and historical data results.

Discrepancies identified during data validation and qualification are evaluated. Decisions to include or eliminate suspect or nonverifiable data are determined during technical overviews by technically qualified personnel.

9.0 REFERENCES

AA (Antiquities Act), 1979. "Antiquities Act of 1906," as amended. U.S. Code, Title 16, Sec. 431-433.

AIRFA (American Indian Religious Freedom Act), 1978. "American Indian Religious Freedom Act of 1978." U.S. Code, Title 42, Sec. 1996.

ARPA (Archaeological Resources Protection Act), 1979. "Archaeological Resources Protection Act." U.S. Code, Title 16, Sec. 470aa-47011.

ASME (American Society of Mechanical Engineers), NQA-1-1989. "Quality Assurance Program Requirements for Nuclear Facilities." September 15, 1989.

Beatley, J. C., 1976. Vascular Plants of the Nevada Test Site and central-south Nevada. ERDA. National Technical Information Service. TID-26881. Springfield, VA.

BLM (U.S. Bureau of Land Management), 1988. Right-of-Way Reservation N-47748, January 6, 1988.

BLM (U.S. Bureau of Land Management), 1989. Right-of-Way Reservation N-48602, October 10, 1989.

CAA (Clean Air Act), 1977. "Clean Air Act," as amended. U.S. Code, Title 42, Sec. 7401.

CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act), 1980. "Comprehensive Environmental Response, Compensation, and Liability Act," as amended by "The Superfund Amendments and Reauthorization Act of 1986." U.S. Code, Title 42, Sec. 9601.

Collins, E., T. P. O'Farrell, and W. A. Rhoads, 1982. "Biologic Overview for the Nevada Nuclear Waste Storage Investigations, Nevada Test Site, Nye County, Nevada," EGG 1183-2460. EG&G, Inc., Goleta, Calif.

CRWMS M&O, 1996a. "M&O Safety and Health Plan," B00000000-01717-4600-00016, rev. 02. TRW Environmental Safety Systems, Inc., Las Vegas, NV.

CRWMS M&O, 1996b. "Reclamation Feasibility Studies at Yucca Mountain, Nevada: 1991-1995," B00000000-01717-5700-00003, rev. 00. TRW Environmental Safety Systems, Inc., Las Vegas, NV.

CRWMS M&O, 1997a. "Abundance and Species Composition of Rodent Populations at Yucca Mountain, Nevada," B00000000-01717-5705-00034, rev. 00. TRW Environmental Safety Systems, Inc., Las Vegas, NV.

CRWMS M&O, 1997b. "The Distribution and Relative Abundance of Desert Tortoises at Yucca Mountain," B00000000-01717-5705-00033. TRW Environmental Safety Systems, Inc., Las Vegas, NV.

CRWMS M&O, 1997c. "Hibernation Behavior of Desert Tortoises at Yucca Mountain, Nevada," B00000000-01717-5705-00031, rev. 00. TRW Environmental Safety Systems, Inc., Las Vegas, NV.

CRWMS M&O, 1997d. "Patterns of Burrow Use by Desert Tortoises at Yucca Mountain, Nevada," B00000000-01717-5705-00041, rev. 00. TRW Environmental Safety Systems, Inc., Las Vegas, NV.

CRWMS M&O, 1997e. "The Effects of Site Characterization Activities on the Abundance of Ravens (*Corvus corax*) in the Yucca Mountain Area," B00000000-01717-5705-00040, rev. 00. TRW Environmental Safety Systems, Inc., Las Vegas, NV.

CRWMS M&O, 1997f. "Lagomorph Population Trends at Yucca Mountain, Nevada: 1990-1995," B00000000-01717-5705-00053, rev. 00. TRW Environmental Safety Systems, Inc., Las Vegas, NV.

CWA (Clean Water Act), 1972. "Federal Water Pollution Control Act of 1972," as amended by the "Clean Water Act of 1977," and the "Water Quality Act of 1987." U.S. Code, Title 33, Sec. 1251.

DOE (U.S. Department of Energy), 1986. "Environmental Assessment, Yucca Mountain Site, Nevada Research and Development Area, Nevada," DOE/RW-0073. Office of Civilian Radioactive Waste Management, Washington, D.C.

DOE (U.S. Department of Energy), 1990a. "General Environmental Protection Program," DOE Order 5400.1. U.S. Department of Energy, Washington, D.C.

DOE (U.S. Department of Energy), 1990b. "Research Design and Data Recovery Plan for Yucca Mountain Project." Yucca Mountain Project Office, Las Vegas, NV.

DOE (U.S. Department of Energy), 1991. "Floodplain Assessment of Surface-Based Investigations at the Yucca Mountain Site, Nye County, Nevada," YMP/91-11. Yucca Mountain Site Characterization Project Office, Las Vegas, NV.

DOE (U.S. Department of Energy), 1992a. "Floodplain Assessment of Site Characterization Activities at the Yucca Mountain Site, Nye County, Nevada," YMP/92-30. Yucca Mountain Site Characterization Project Office, Las Vegas, NV.

DOE (U.S. Department of Energy), 1992b. "Environmental Field Activity Plan for Terrestrial Ecosystems," YMP/91-41. Yucca Mountain Site Characterization Project Office, Las Vegas, NV.

DOE (U.S. Department of Energy, 1992c. "Environmental Field Activity Plan for Archaeological Resources," YMP/92-15. Yucca Mountain Site Characterization Project Office, Las Vegas, NV.

DOE (U.S. Department of Energy), 1992d. "Environmental Field Activity Plan for Air Quality," YMP/91-42. Yucca Mountain Site Characterization Project Office, Las Vegas, NV.

DOE (U.S. Department of Energy), 1993. "Meteorological Data Collection at the Yucca Mountain Site," YMP-021-R2. Yucca Mountain Site Characterization Project Office, Las Vegas, NV.

DOE (U.S. Department of Energy), 1995a. "Safety and Health Reporting Requirements," DOE Order 231.1. U.S. Department of Energy, Washington, D.C.

DOE (U.S. Department of Energy), 1995b. "Environment, Safety, and Health Reporting Manual," DOE M 231.1-1. U.S. Department of Energy, Washington, D.C.

DOE (U.S. Department of Energy), 1995c. "Waste Minimization and Pollution Prevention Awareness Plan," YMP/95-01. Yucca Mountain Site Characterization Project, Las Vegas, NV.

DOE (U.S. Department of Energy), 1995d. "Environmental Field Activity Plan for Water Resources: Water Quantity Component," YMP/90-50, rev. 1. Office of Civilian Radioactive Waste Management, Las Vegas, NV.

DOE (U.S. Department of Energy), 1995e. "Reclamation Implementation Plan," YMP/91-14, rev. 1. Yucca Mountain Site Characterization Project, Las Vegas, NV.

DOE (U.S. Department of Energy), 1996. "Environmental Regulatory Compliance Plan," YMP/92-2. Yucca Mountain Site Characterization Office, Las Vegas, NV.

DOE (U.S. Department of Energy), 1997a. "Yucca Mountain Site Characterization Project Summary of Socioeconomic Data Analyses Conducted in Support of the Radiological Monitoring Program, April 1996 to April 1997." TRW Environmental Safety Systems, Inc., Las Vegas, NV.

DOE (U.S. Department of Energy), 1997b. "Environmental Management Plan," YMP/93-04, rev. 2. Yucca Mountain Site Characterization Office, Las Vegas, NV.

EO (Executive Order) 11988, Office of the President, 1977a. "Floodplain Management." 42 Federal Register 101, Washington, D.C.

EO (Executive Order) 11990, Office of the President, 1977b. "Protection of Wetlands." 42 Federal Register 101, Washington, D.C.

EO (Executive Order) 12856, Office of the President, 1993. "Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements." Washington, D.C.

ESA (Endangered Species Act), 1973. "Endangered Species Act of 1973." U.S. Code, Title 16, Sec. 1531.

FLPMA (Federal Land Policy and Management Act), 1976. "Federal Land Policy and Management Act of 1976." U.S. Code, Title 43, Sec. 1701.

FPPA (Farmland Protection Policy Act), 1981. "Farmland Protection Policy Act of 1981." U.S. Code, Title 7, Sec. 4201.

Kartesz, J. T., 1988. "A Flora of Nevada." Ph. D. dissertation, University of Nevada, Reno, NV.

Kartesz, J. T., and R. J. Pankhurst, 1994. "A Synonymized Checklist of the Vascular Flora of the United States, Canada and Greenland," 2 volumes, 2nd edition. Timber Press, Portland, OR.

NAC (Nevada Administrative Code), Chapter 445, Sec. A.345-.348, "Water Pollution Control." State of Nevada.

NAGPRA (Native American Graves Protection and Repatriation Act), 1990. Public Law 101-106, U.S. Code, Title 25, Sec. 3001-3013.

NEPA (National Environmental Policy Act), 1969. "National Environmental Policy Act of 1969." U.S. Code, Title 42, Sec. 4321.

NHPA (National Historic Preservation Act), 1966. "National Historic Preservation Act of 1966." U.S. Code, Title 16, Sec. 470.

NWPA (Nuclear Waste Policy Act), 1982. "Nuclear Waste Policy Act of 1982," as amended by the "Nuclear Waste Policy Amendments Act (NWPAA) of 1987." Public Law 97-425, U.S. Code, Title 42, Sec. 10101.

O'Farrell, T. P., and E. Collins, 1983. "1982 Biotic Survey of Yucca Mountain, Nevada Test Site, Nye County, Nevada," EGG-10282-2004. EG&G, Inc., Goleta, CA.

PA (Programmatic Agreement), 1988. "Programmatic Agreement Between the United States Department of Energy and the Advisory Council on Historic Preservation for the Nuclear Waste Deep Geologic Repository Program, Yucca Mountain, NV."

PPA (Pollution Prevention Act), 1990. "Pollution Prevention Act of 1990." Public Law 101-508; 104 Stat. 1388, U.S. Code, Title 42, Sec. 13010 et seq.

RCRA (Resource Conservation and Recovery Act), 1976. "Resource Conservation and Recovery Act of 1976." U.S. Code, Title 42, Sec. 6901.

SDWA (Safe Drinking Water Act), 1974. "Safe Drinking Water Act of 1974." U.S. Code, Title 42, Sec. 300(f)-(j)-10.

U.S. Bureau of the Census, 1998. "Estimates of the Population of Counties (alphabetical list) for July 1, 1997, and Population Change: April 1, 1990 to July 1, 1997." Website: http://www.census.gov/population/estimates/county/co-97-1/97C1_32.txt. U.S. Bureau of the Census, Washington, D.C.

USFWS (U.S. Fish and Wildlife Service), 1988. Letter from R. J. Navarre, USFWS, to C. P. Gertz, U.S. Department of Energy. Consultation regarding wetlands and threatened and endangered species at Yucca Mountain. February 23, 1988.

USFWS (U.S. Fish and Wildlife Service), 1990. Letter from R. M. McNatt, USFWS, to C. P. Gertz, U.S. Department of Energy. Consultation and Biological Opinion on the potential for adverse impacts on the desert tortoise from site characterization activities. February 9, 1990.

USFWS (U.S. Fish and Wildlife Service), 1997. Letter from C.C. Buchanan, USFWS, to W. Dixon, YMSCO, U.S. Department of Energy. Final Biological Opinion for Reinitiation of Formal Consultation for Yucca Mountain Site Characterization Studies, July 23, 1997.

USGS (U.S. Geological Survey), 1997a. Provisional Data on Ground-Water Levels and Springflows in the Yucca Mountain Region for the Period January-March 1997.

USGS (U.S. Geological Survey), 1997b. Provisional Data on Ground-Water Levels and Springflows in the Yucca Mountain Region for the Period April-June 1997.

USGS (U.S. Geological Survey), 1997c. Provisional Data on Ground-Water Levels and Springflows in the Yucca Mountain Region for the Period July-September 1997.

USGS (U.S. Geological Survey), 1997d. Provisional Data on Ground-Water Levels and Springflows in the Yucca Mountain Region for the Period October-December 1997.

USGS (U.S. Geological Survey), 1997e. "Selected Ground-Water Data for Yucca Mountain Region, Southern Nevada and Eastern California, through December 1995," Open-File Report 96-553. U.S. Geological Survey, Denver, CO.

36 CFR 79. Title 36 of the Code of Federal Regulations, Part 79, "Curation of Federally-Owned and Administered Archaeological Collections," U.S. Government Printing Office, Washington, D.C.

40 CFR 50. Title 40 of the Code of Federal Regulations, Part 50, "National Primary and Secondary Ambient Air Quality Standards," U.S. Government Printing Office, Washington, D.C.

40 CFR141. Title 40 of the Code of Federal Regulations, Part 141, "National Primary Drinking Water Regulations," U.S. Government Printing Office, Washington, D.C.

LIST OF ACRONYMS

AA	Antiquities Act
ACHP	Advisory Council on Historic Preservation
AGL	Above Ground Level
AIRFA	American Indian Religious Freedom Act
AMESH	Assistant Manager for Environment, Safety, and Health
ARPA	Archaeological Resources Protection Act
BDL	Below Detection Limit
BLM	Bureau of Land Management
BP	Before present
CAS	Continuous air samplers
CAA	Clean Air Act
CERLA	Comprehensive Environmental Response, Compensation and Liability Act
CFC	Chlorofluorocarbon
CFR	Code of Federal Regulations
CGTO	Consolidated Group of Tribes and Organizations
COE	Corps of Engineers
CRM	Continuous radon monitor
CRWMS M&O	Civilian Radioactive Waste Management System Management and Operating Contractor
CWA	Clean Water Act
CY	Calendar Year
DDE	1, 1-dichloro-2, 2-bis (p-chlorophenyl) ethylene; metabolite of DDT
DDT	Dichlorodiphenyltrichloroethane
DOE	U.S. Department of Energy
EA	Environmental Assessment
ECRB	Enhanced Characterization of the Repository Block
EFAP	Environmental Field Activity Plan

EHS	Extremely Hazardous Substances
EIS	Environmental Impact Statement
EO	Executive Order
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
EPD	Environmental Programs Department
ERCP	Environmental Regulatory Compliance Plan
ESA	Endangered Species Act
ES&H	Environmental, Safety, and Health
ESF	Exploratory Studies Facility
ESHCD	Environmental, Safety, and Health Compliance Department
ESP	Ecological Study Plot
FF	Far-field
FIFRA	Federal Insecticide, Fungicide and Rodenticide Act
FLPMA	Federal Land Policy and Management Act
FPPA	Farmland Protection Policy Act
FR	Federal Register
FY	Fiscal Year
GERT	General Radiological Safety Training
GET	General Employee Training
GIS	Geographic Information System
GSF	Ground Surface Facility
HCFC	Hydrochlorofluorocarbon
HS	Hazardous Substances
M&TE	Measuring and Test Equipment
MCL	Maximum Contaminant Level
MDA	Minimum Detectable Activity
MSDS	Material Safety Data Sheet
NAAQS	National Ambient Air Quality Standards

NAC	Nevada Administrative Code
NAFR	Nellis Air Force Base Bombing and Gunnery Range
NAGPRA	Native American Graves Protection and Repatriation Act
NCAI	National Congress of American Indians
NDEP	Nevada Division of Environmental Protection
NEPA	National Environmental Policy Act
NF	Near-field
NHPA	National Historic Preservation Act
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NQA	Nuclear Quality Assurance
NRC	Nuclear Regulatory Commission
NTS	Nevada Test Site
NWPA	Nuclear Waste Policy Act
OCRWM	Office of Civilian Radioactive Waste Management
OE	Operational Equipment
OTCR	Official Tribal Contact Representative
PA	Programmatic Agreement
PCB	Polychlorinated Biphenyl
PIC	Pressurized ionization chamber
$PM_{2.5}$	Particulate Matter 2.5 micrometers or less in diameter
PM_{10}	Particulate Matter 10 micrometers or less in diameter
PPA	Pollution Prevention Act
PSD	Prevention of Significant Deterioration
QA	Quality Assurance
QARD	Quality Assurance Requirements and Description
QATSS	Quality Assurance Technical Support Services
RCD	Radiological Control Division

RCRA	Resource Conservation and Recovery Act
RCT	Radiation Control Technician
RFA	Request for Authorization
ROWR	Right-of-Way Reservation
RQ	Reportable Quantity
SARA	Superfund Amendments and Reauthorization Act
SCEP	Site Characterization Effects Program
SDWA	Safe Drinking Water Act
SER	Site Environmental Report
SHPO	State Historic Preservation Office
TBM	Tunnel-boring machine
TLD	Thermoluminescent dosimeter
TPH	Total Petroleum Hydrocarbons
TPQ	Threshold Planning Quantity
TSCA	Toxic Substances Control Act
TSD	Treatment, Storage, and Disposal
UIC	Underground Injection Control
USAF	U.S. Air Force
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
YMP	Yucca Mountain Site Characterization Project
YMSCO	Yucca Mountain Site Characterization Office