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SITE ENVIRONMENTAL REPORT

FOR

CALENDAR YEAR 1994

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U.S. Department of Energy
Yucca Mountain Site Characterization Office
P.O. Box 98608
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PREFACE

The Yucca Mountain Site Characterization Office (YMSCO) has established an environmental program to ensure that facilities are operated in a manner that will 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. An Environmental Protection Implementation Plan (DOE, 1990a) has been prepared to describe the program in compliance with DOE Order 5400.1, General Environmental Protection Program (DOE, 1990b). The status of the Yucca Mountain Site Characterization Project (YMP) environmental program has been summarized in this annual Site Environmental Report to characterize performance, confirm compliance with environmental requirements, and highlight significant programs and efforts during calendar year 1994.

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1.0 EXECUTIVE SUMMARY

With the positioning of the tunnel-boring machine in the starter tunnel at Yucca Mountain in August of 1994, the main focus of site characterization began to shift from surface activities to subsurface scientific studies. The timeframe for the performance of long-anticipated experiments became clearer, and it was apparent that the properties of Yucca Mountain as a potential disposal site for high-level radioactive waste and spent nuclear fuel could soon be examined first-hand. Now, however, in addition to the environmental issues encountered and dealt with during the years dominated by surface-disturbing activities, the move underground presented other potential problems that would have to be addressed. More support facilities were necessary at the North Portal pad; increased personnel at the site meant more services required, more traffic, and greater opportunity for environmental disturbances; and additional areas would have to be developed for the storage of material brought to the surface. As a result, while the more newsworthy action might be taking place underground, activity at the surface also increased, and the responsibilities borne by the Yucca Mountain environmental program grew proportionately.

With significant progress being made at the surface and underground, the permitting process that made it all possible perhaps received less recognition than it once had. The time and effort expended in acquiring permits should not be overlooked, however, because official permission, be it Federal or State, is as essential as ever to the conduct of every activity at the site. In 1994, several permits were applied for, received or renewed. As examples, five air quality permits, each required for a different point source of emissions, were received. An application was submitted for another, to construct and operate a rock crushing plant in Borrow Pit #1. Another permit, required for the first time at Yucca Mountain in 1994, authorizes the storage of flammable materials. Permission had to be obtained from the State of Nevada whenever one of the dozens of boreholes in the vicinity was selected for tests involving the injection of a chemical tracer. Functioning much as a permit would, two major

Right-of-Way Reservations (ROWRs), granted by the Bureau of Land Management, authorize use by the DOE of the lands at Yucca Mountain. One of these critically needed ROWRs was renewed in 1994. Already in 1995, several other permit applications have been submitted to the appropriate Federal and State agencies.

Still an important component of the approval process for a proposed site characterization activity, the preactivity survey is one means of preventing or mitigating environmental damage. In 1994, 16 and 21 preactivity surveys were conducted by DOE contractor biologists and archaeologists, respectively. In addition, radiological personnel examined areas in which activities were proposed, if they were located within the boundaries of the adjacent Nevada Test Site (NTS). Because a single site characterization activity may affect more than one location, the corresponding preactivity survey may actually entail several individual surveys. In certain instances in which activities were postponed, resurveys were necessary before work could commence. Also, postactivity surveys were conducted upon completion of activities to ensure that the most appropriate reclamation techniques were considered for the restoration of disturbed areas.

Again in 1994, monitoring was a major component of the Yucca Mountain environmental program. The technical areas contributing monitoring data and information to this Site Environmental Report were radiological field studies, air quality, meteorology, cultural (archaeological and Native American) resources, water resources, and terrestrial ecosystems.

The radiological monitoring program for 1994 included the quantification of radioactive particulates, ambient gamma radiation, and ambient radon. Environmental media sampled for possible radioactivity were air and soil. Sampling stations were located as far as 84 kilometers (52 miles) from the Yucca Mountain site. Yucca Mountain Site Characterization Project (YMP) activities generated no airborne radiological emissions, although it is possible that particles contaminated with radioactivity from previous NTS activities may occasionally be resuspended by vehicular traffic, site activities, or wind. To

date, concentrations of radon and other monitored radionuclides have not exceeded acceptable environmental levels.

As last year, the air quality program monitored PM_{10} at four locations. The highest concentration of PM_{10} in a 24-hour period was approximately one-fourth the ambient air quality standard of 150 $\mu g/m^3$, while the average of all 24-hour periods 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 the atmospheric transport of airborne radionuclides and other materials. The meteorological staff also conducted nighttime cold air drainage studies for site characterization in 1994. The results of these studies revealed that nocturnal airflow from Yucca Mountain is rather stable near the surface, but is more complex above the near-surface layers.

As a result of the 21 archaeological preactivity surveys mentioned previously, 93 new historical sites were identified. Monitoring of 28 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 DOE and the Advisory Council on Historic Preservation, consultation and interactions with 17 Native American tribes and organizations continued in 1994. A tribal update meeting was held, a variety of national conferences were sponsored by and/or attended by DOE personnel, and the DOE sponsored 66 speaking engagements and 13 exhibits during the year at which the YMP Native American program was explained to the public.

Measurements of groundwater levels in 36 wells and of groundwater discharge (in-flow) into five springs in the Yucca Mountain region continued throughout 1994. 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 0.15 m (0.49 ft), 0.38 m (1.24 ft), and 0.19 m (0.61 ft), respectively. A draft water quality

monitoring plan, prepared in 1994, is currently undergoing DOE review. Sampling sites and sampling locations will be determined on the basis of geographic categories designated as site, subregional, and regional. This plan, when implemented, will generate data that will establish a comprehensive water quality baseline and allow the assessment of possible impacts on groundwater quality resulting from site characterization activities.

The terrestrial ecosystem program continued its extensive studies of biotic and abiotic factors at Yucca Mountain with the primary objectives of monitoring and mitigating the effects of site characterization on local flora and fauna (including the federally protected desert tortoise), and developing and testing strategies and techniques for reclaiming disturbed areas. Plant and animal reproduction was generally lower in 1994, relative to the three previous years, probably due to substantially less precipitation in the area throughout the year. Populations declined similarly on control plots and on plots adjacent to site characterization activities. Lack of rainfall also affected reclamation experiments, sometimes making it difficult to determine whether results were a reflection of variations in reclamation techniques or of water deprivation. Nevertheless, after testing different combinations of plant species, soil types and depths, soil amendments, seeding and mulching methods, and water harvesting methods, certain techniques emerged as better than others. Fill soil amended with polyacrylamide gel or organic matter appeared to offer a viable alternative to native topsoil when the latter is lacking or in short supply. Straw was the best mulch material, enhancing survivability of plants through the severe desert summer. Containerized plants transplanted to a reclamation site survived well and may provide a useful option in future reclamation efforts.

Conservation of the desert tortoise remains a major concern of the YMP. During the year, 112 previously unmarked tortoises were found, marked, and released; 58 of these were hatchlings. Radio transmitters were attached to 37 of the animals. Since 1989, a total of 486 tortoises have been captured and marked; 277 have been fitted with transmitters. In response to changes in the locations of several proposed site characterization activities since the inception of the desert tortoise program, the boundaries of one of the tortoise study areas (designated the "high impact" area) were redrawn in 1994. This modification resulted in the

reclassification of 17 tortoises, some of which were incorporated into another sampling population, while the remainder are no longer needed as study subjects and will have their transmitters removed as they emerge from hibernation in the spring of 1995. Tracking these various animals and documenting their responses to the YMP presence ultimately contributes to the protection of the desert tortoise and allows investigators to evaluate mitigation techniques and their effects on the animals.

Two of the newer components of the YMP environmental program are the audit program and the field surveillance program. The former functions to ensure that YMP activities are performed in full compliance with all environmental requirements. In this role, audit teams conducted three comprehensive audits and four special issue audits in 1994. Surveillance program personnel routinely conduct unannounced "spot checks" of YMP activities in the field to ensure that all environmental requirements and regulations are complied with on-site and that permit and ROWR conditions are met. Nearly 500 such surveillances were conducted in 1994.

Waste minimization and adherence to hazardous waste regulations were again emphasized in 1994. A new Waste Minimization and Pollution Prevention Awareness Plan was developed as a draft in December. Eight shipments of hazardous wastes were taken off-site to EPA-permitted disposal facilities, in accordance with RCRA requirements. To document that quantities of listed toxic chemicals used by the YMP during the course of the year were insufficient to activate the EPCRA 313 reporting process, the YMSCO filed a negative report with the EPA. A Section 311 report was filed with the State of Nevada, however, because the quantity of diesel fuel stored by the YMP exceeded the prescribed Reportable Quantity. Three new petroleum releases occurred during the year as a result of YMP activities. All were promptly reported to the State, as required by law, and remedial action was performed at each release location.

2.0 INTRODUCTION

2.1 SITE LOCATION

The area known as the "Yucca Mountain site" (or "the site" or "Project site") is situated on the southwestern boundary of the Nevada Test Site (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 U.S. Department of Energy (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).

2.2 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 settled. 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 1220 meters [m]; 4000 feet [ft] elevation) through a transition zone (sometimes called the Transition Desert) which extends beyond the northern boundary of the site to the cooler and wetter Great Basin Desert (above 1525 m

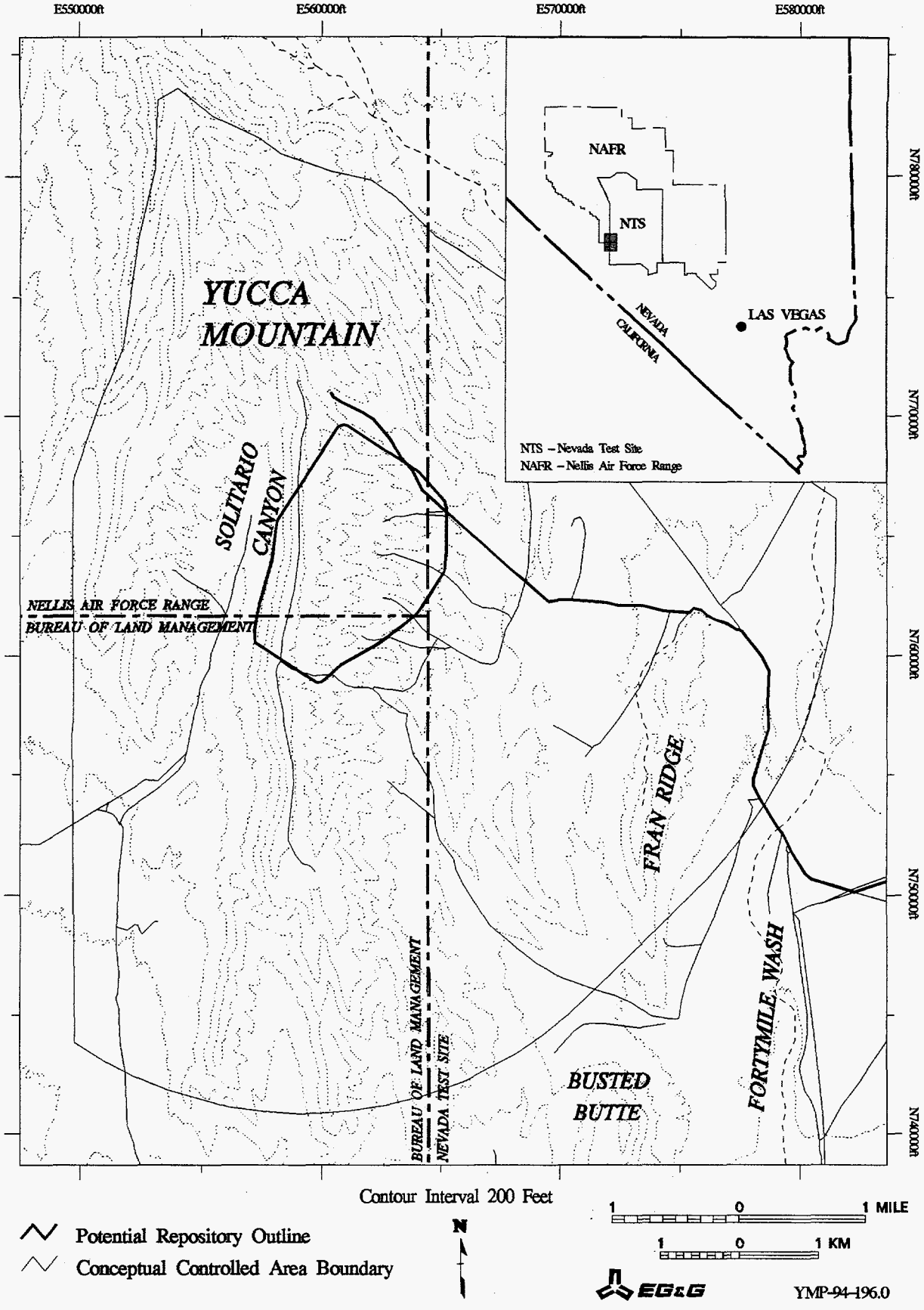

Figure 2-1. Location of the Yucca Mountain Site

[5000 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 1494 m (4900 ft). The mountain slopes steeply west to Crater Flat (elevation 1189 m [3900 ft]) and gradually eastward to Jackass Flats (elevation 1097 m [3600 ft]). Five sizable washes cross the site east of Yucca Mountain, the largest being Fortymile Canyon 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).

2.2.1 Climate and Meteorology

Typical of southwestern deserts, the climate of the Yucca Mountain region is characterized by considerable solar radiation, limited precipitation, low relative humidity, and large temperature ranges. While lower elevations consistently experience hot summers and mild winters, higher elevations are cooler with a greater chance of precipitation.

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 6.2.4). Preliminary data analysis verifies that most of the total annual precipitation falls in winter with several storms producing snow generally above 1065 m (3500 ft) elevation. Thunderstorms in July and August can contribute a large proportion of the annual rainfall over a relatively short period of time. From December 1985 through December 1994, average precipitation at the NTS-60 meteorological tower averaged 11.51 centimeters (cm) or 4.53 inches (in). The greatest daily amount of precipitation recorded at Yucca Mountain during this period was 6.17 cm (2.43 in) occurring at the Sever Wash meteorological station in December 1993. The driest years were 1988-90 and 1994, during which precipitation levels were below normal.

Average summer (July and August) temperatures have ranged from a low of 22° C (71.6° F) at the Yucca Mountain station to a high of 32° C (89.6° F) at the Fortymile Wash station. The extreme maximum temperature recorded since December 1985 was 42.6° C (108.7° F) in August 1994 at the Fortymile Wash site. Average winter (December and January) temperatures ranged from a low of 3° C (37.6° F) to a high of 10° C (50° F) at the Yucca Mountain and Fortymile Wash stations, respectively. The extreme minimum temperature recorded since December 1985 was -13.1° C (8.4° F) in December 1990, also recorded at the Fortymile Wash site.

The terrain at Yucca Mountain strongly influences wind direction and speed, as manifested by the diurnal mountain-valley air-flow cycle. This cycle, which occurs in all seasons, produces predominant northerly to northwesterly winds at night and southerly to southeasterly winds 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. Spring is the windiest season of the year, on average, with the winter experiencing lighter winds. Local winds can be very strong near thunderstorm activity in summer, however. Average monthly wind speeds for the period 1986-1994 were highest in April and May and generally weakest in the winter. The highest average monthly wind speed for the period occurred at Alice Hill (5.0 meters per second [m/s] or 11 miles per hour [mph]) and the lowest average monthly wind speed was in Coyote Wash (2.3 m/s or 5.1 mph). The extreme wind recorded was on Alice Hill (34.2 m/s or 75.8 mph) in June of 1993.

2.2.2 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 2000 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). 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.

2.2.3 Water Resources

Free-flowing surface water does not exist at or near the Project site. All 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 [1600 ft]), the other regional and very deep in the lower carbonate layer (probably in excess of 1250 m [4100 ft]) (DOE, 1986). The majority of the groundwater eventually discharges south and southwest of the site in Amargosa Valley and Death Valley.

2.2.4 Biological Resources

Because the Yucca Mountain site includes features of two botanical zones -- the Mojave Desert, and the transition zone that separates the Mojave from the Great Basin Desert to the north -- different plant communities or associations are recognizable. At lower elevations, *Larrea-Ambrosia* species (i.e., creosote bush/bursage) and *Coleogyne* (blackbrush) comprise the vegetation associations. A third association, *Larrea-Lycium-Grayia* (creosote bush/boxthorn/hopsage) characterizes middle elevations, and *Lycium-Grayia* dominates higher elevations. At still higher locations on the nearby NTS, *Artemisia* (sagebrush), pinyon pines, and junipers displace the aforementioned as the dominant species. Despite the number of species found at the site, plant life is considered generally sparse, typical of any desert region. This condition has been exacerbated in recent years by the adverse effects of a six-year drought in the southwestern United States. Above average rainfall during the winters of 1991-1992 and 1992-1993 has offered some recent relief, however.

As many as 46 mammalian species may occur in the vicinity of the site (Collins et al., 1982), although less than half are routinely seen or trapped during population studies. The most numerous are rodents (primarily kangaroo rats and two species of pocket mice), followed by jackrabbits and cottontails. Mammalian predators include the coyote and, much less frequently, bobcat, badger, and kit fox. None of the mammalian species present is considered threatened or endangered but all fur-bearing animals are protected by the State of Nevada.

Site-specific surveys in 1982 recorded 35 species of birds (O'Farrell and Collins, 1983). Of these, six were raptorial species. Only the red-tailed hawk was seen frequently. Ravens are common and are currently the subject of study because of their possible role as predators of young desert tortoises. No permanent or seasonal avian species are threatened or endangered, although the federally-listed (as endangered) Peregrine Falcon (*Falco peregrinus*) may migrate through the area on occasion.

Reptiles are represented at the site by eight species of lizards, four species of snakes, and one species of tortoise (O'Farrell and Collins, 1983). The latter, the desert tortoise (*Gopherus agassizii*), is listed as threatened by the U.S. Fish and Wildlife Service (USFWS) and is, therefore, the subject of an intensive study program at the site.

2.2.5 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 1500 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 at six sites, tin cans at 12 sites, and six temporary historic camps (DOE, 1990c). 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.

2.2.6 Demography

With the exclusion of Clark County to the southeast, the counties immediately surrounding the Yucca Mountain site are essentially rural and very low in population. Most residents are concentrated in a few small communities. County populations are as follows: Lincoln, 4,340 residents; Esmeralda, 1,390; Nye, 19,560 (BBER, 1994); and Inyo (California) with 18,788 (Inyo Co. Report, 1993). The exception is Clark County (971,680), which includes the cities of Las Vegas, North Las Vegas, Henderson, Boulder City, and Mesquite (BBER, 1994). 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. The largest community within this study area is Pahrump, situated on the southeast perimeter of the study circle, with an estimated permanent population of 10,396 (DOE, 1994a). The community of Amargosa Valley, 24 to 32 km (15 to 20 mi) south and primarily agricultural, has a population of 895. Beatty, approximately 32 km (20 mi) west has 1,945 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 people near the site occurs at Death Valley National Park, with an estimated population of 729 residents. The average number of visitors per day in 1994 was 2,760, with the peak daily average (4,020) occurring in April. As many as 30,000 may be present, however, for a brief period in November to celebrate "Death Valley Days."

2.2.7 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. 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) away, and the Bond Gold-Bullfrog Mine 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]) 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.

2.3 MISSION AND CURRENT ACTIVITIES

In response to requirements of the Nuclear Waste Policy Act (NWPA) of 1982, as amended in 1987, the DOE has initiated 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 were surface-based only, such as conducting ecological investigations and digging trenches and shallow boreholes. During 1993 and 1994, the emphasis shifted underground as preparations for the studies that would characterize the site geologically and hydrologically proceeded. The starter tunnel, excavated to serve as a

"launch chamber" for the tunnel-boring machine (TBM), was completed to a depth of 61 m (200 ft) in September 1993. By mid-1994, the TBM had been assembled on the North Portal pad of the Exploratory Studies Facility (ESF) and positioned in the starter tunnel for preliminary testing. By the end of December, the TBM had tunneled 91 m (300 ft) into Exile Hill. Concurrently, a number of exercises involving various kinds of drilling and coring were undertaken at locations other than the North Portal (Section 3.1.1).

This document is the fourth annual Site Environmental Report (SER) submitted by the Yucca Mountain Site Characterization Office (YMSCO). The guidelines for the preparation of the SER (Memorandum from DOE, Office of Environmental Policy and Assistance, dated April 6, 1995) 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 Yucca Mountain Site Characterization Project (YMP) has not been the source of any measurable emissions or been responsible for any human exposure to radionuclides. Minuscule amounts of radioactivity detected at the site are derived from dust previously contaminated by old NTS tests, the only potential source of radioactivity present at this time. Because multi-year data do not yet exist for the site, identification of definite trends is not possible.

Despite the lack of the aforementioned categories of information, 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.

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 1994. 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. The DOE continued to prepare for, and to perform, site characterization activities in 1994. To accommodate additional facilities, access roads, utilities, and assembly of the TBM, the North Portal pad of the ESF was extended to 4 hectares (ha [10 acres]). By August, the TBM, approximately 140 m (460 ft) in length with its trailing components attached, had been assembled and was positioned in the starter tunnel. The initial test run of the TBM, begun in September, included flattening the surface of the tunnel rock face against which the machine was to bore, and drilling several meters into the mountain. By the end of December, the TBM was being operated around-the-clock (three shifts per day) and had tunneled 91 m (300 ft) into Exile Hill.

A number of other tests proceeded in 1994, as well. Coring to remove rock samples continued at dozens of sites, boreholes were drilled to study faults and to assess water infiltration, grout testing was conducted at borehole UZ-16, and a series of shotholes were drilled for seismic studies. Another major effort involved excavation of a block of rock

(3 x 3 x 5 m [10 x 10 x 16 ft]) at Fran Ridge to be used to test the effects of heat on rock characteristics. By December, the block had been mapped but was not yet instrumented. Finally, in the first alcove excavated within the ESF tunnel, pressure testing was initiated.

As required by the NWPA, adverse impacts to the surface environment were prevented or minimized by such mitigative practices as conducting preactivity surveys, applying water to roads for dust suppression, adding dust collection equipment to drillrigs, and emplacing excavated soil and rock in established containment areas. Ecosystem studies were continued and, as surface-disturbing activities were completed in certain areas, previously tested reclamation techniques were applied.

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 environmental impact statement (EIS), pursuant to Section 102(2)(C) of the NEPA, is required. The DOE must nevertheless 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 these requirements of NEPA. Further, should site characterization activities ultimately reveal that Yucca Mountain is suitable for a repository, the NEPA process (to include scoping meetings, preparation of an EIS, etc.) will play an important role in the Secretary of Energy's recommendation of the site to the President (Section 114, NWPA).

In December 1994, the DOE issued the three-volume Civilian Radioactive Waste Management Program Plan (DOE, 1994b,c,d) for managing and disposing of the Nation's spent nuclear fuel and high-level radioactive waste. The second volume, entitled "Yucca Mountain Site Characterization" (DOE, 1994c), includes a discussion of the DOE plan for

compliance with NEPA, to include the preparation and issuance of an EIS for the proposed repository. In anticipation of the need to prepare this EIS, the YMSCO planned and began drafting, in 1994, a Notice of Intent (NOI) and an annotated outline for the EIS. It is expected that the NOI will be published in the Federal Register by mid-year 1995.

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 and criteria gaseous pollutants 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 ha (20 acres) of land. The Operating Permit currently 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, and existing Permits to Construct are reissued, if renewed or revised, as Operating Permits. New or reissued air quality permits are subject to renewal five years after the date of issue.

Both the previous and present permits for surface disturbance stipulate that the DOE must sample ambient air for PM_{10} (i.e., inhalable particulate matter 10 micrometers 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 1994, particulate matter had been

monitored for 42 months, and 14 quarterly Ambient Air Monitoring Reports had been submitted to the State, as required by the permit. (At the present time, there is no requirement to report results of criteria gaseous pollutant monitoring to the State.) 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 6.2.3, Air Quality).

Fugitive dust is also addressed in the original Air Quality Permit to Construct and in the present Air Quality Operating Permit. The YMP is obliged to control fugitive dust by applying water or chemicals to disturbed areas and by paving or graveling roads and parking areas. This mitigative use of water was made possible when, in 1992, 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 establishing a backup for well J-13. Three temporary permits received in June 1993 supplemented these appropriations, allowing the use of discharge water from the C-well Complex for dust control, tunneling, testing or aquifer recharge (Section 3.1.15.1). (These latter three permits were renewed by the State of Nevada in March 1995 and are effective through 1998.)

Five Air Quality Registration Permits, each required for a different point source of emissions, were received in 1994 (Table 3-2). Action by the State of Nevada on another permit application, filed in May 1994, to construct and operate a rock crushing plant in Borrow Pit #1, is still pending (as of early 1995). One permit, approved in 1993, to operate a muck conveyor was cancelled in 1994 due to changes in the planned location of the facility. (With the final location now established, the application was refiled with the Nevada Division of Environmental Protection [NDEP] in February 1995).

An Annual Usage Report, summarizing 1994 information required by the various air quality permits (e.g., types of equipment, quantities of emissions, hours of operation, etc.) was submitted to the NDEP in February 1995.

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, as identified 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 of 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 notified the COE in 1992 of plans to excavate sand and gravel from Fortymile Wash 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. 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 May 1993, for stormwater discharge at Yucca Mountain.

In 1994, no new NPDES permits or General Discharge Permits were applied for by the YMSCO or granted by the NDEP. (Applications were filed, however, in March 1995 for permits to construct and operate the ESF mine wastewater evaporation pond and the sewage disposal system.)

3.1.5 Safe Drinking Water Act (SDWA)

The SDWA grants the Environmental Protection Agency (EPA) authority to regulate public drinking water supplies. The water supply planned for Yucca Mountain is considered a "public water supply", as defined by the SDWA, because it will probably 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 and operation of a water-delivery system at Yucca Mountain. Construction of this system is underway.

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 authorizes the DOE to inject water and various tracers, including gas (but excluding

ozone-depleting substances), into the three wells at the C-well site and into 50 other wells at Yucca Mountain. As required by the permit, an annual report was submitted to the State of Nevada in January 1994, with an updated status report filed each calendar quarter during the year.

3.1.6 Endangered Species Act (ESA)

The purpose 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 desert tortoise (*Gopherus agassizii*), listed as "threatened" by the USFWS, is the only species inhabiting the Yucca Mountain site that receives full protection under the ESA. In early 1990, the USFWS rendered its Biological Opinion regarding the status of the tortoise at the site, relative to proposed site characterization activities (McNatt, 1990). Various restrictions to which the YMP must adhere were also outlined. Most of these restrictions were already being observed by the YMP.

In 1994, programs designed to protect the tortoise were continued, though with some redefinition of study areas and reclassification of several resident tortoises to reflect changes in the locations of long-term, large-scale YMP activities since the studies were originally designed. Accordingly, the treatment classification (i.e., the sampling population to which an animal is assigned) of all radiomarked tortoises at Yucca Mountain was reevaluated (Section 6.2.1.2).

As in previous years, these efforts to protect the tortoise ranged from one-time or immediate-response tasks to long-term, labor-intensive studies. Examples of the former are posting speed zones on roadways at the site, emplacing road signs reminding drivers of the presence of the animals in the area, and removal by on-call biologists of tortoises found in existing construction sites, on roads, or at undisturbed sites for which land access has been approved. Long-term studies include tracking tortoises fitted with radio transmitters to detect

effects of YMP activities on reproduction and survival, monitoring the health of the tortoise population by evaluating growth patterns and blood profiles, and testing the feasibility of displacing or relocating the animals if they or their habitat cannot be avoided.

Two other ongoing activities represent compliance with the restrictions of the USFWS Biological Opinion (and, therefore, with the ESA). Before any site characterization activity is undertaken, a team of trained biologists inspects the area of proposed activity (i.e., conducts a preactivity survey designed to detect potential adverse impacts) for tortoises or evidence of their presence (burrow, scat, etc.). Secondly, all site workers must attend a General Employee Training (GET) session 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.

Details of the tortoise study programs, and results obtained thus far, are presented in Section 6.2.1.2, Desert Tortoise Program.

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 cultural 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; further, 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 of 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 participate. The DOE sends copies of all survey reports, data recovery plans, and annual reports to the SHPO for their review and comment. The SHPO did not request to inspect the YMP area in 1994.

A number of other actions to implement the PA were carried out in 1994. A total of 21 archaeological preactivity surveys were conducted in areas proposed for Project activities, resulting in the identification of 93 new historical properties. Nineteen short reports describing the results of these surveys were completed. Several activities were conducted to

answer research questions identified in the Research Design and Data Recovery Plan for archaeological resources (DOE, 1990c). Among these activities were obsidian hydration band measurements of assorted artifacts, thermoluminescence dating of ceramics from several archaeological sites, and studies to determine the relative nutritional importance of plants in the region to native inhabitants. In addition, a total of 28 known historical properties were revisited for purposes of periodically assessing their condition.

Analysis of artifacts collected in 1993 at two large archaeological sites, one near Alice Hill and one near Bare Mountain, continued in 1994. Reports describing the results of these analyses will be completed in the near future. Meanwhile, a draft report describing findings at the Bare Mountain site was submitted for BLM review in September 1994.

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. The Project supplemented educational displays located in Las Vegas, Pahrump, Beatty, and at the NTS, designed to inform YMP workers and the general public about the YMP archaeological program. The first three of these information centers were visited by a total of 17,665 people in 1994; an undetermined number visited the NTS display.

The YMSCO continued consultations and interactions with involved Native American tribes in 1994, as directed by the AIRFA and the PA. At mid-year, the Ely Shoshone tribe was added to the group, bringing the total number of participating tribes and organizations to 17. At a tribal update meeting, sponsored by YMSCO and held in Las Vegas in April, Official Tribal Contact Representatives (OTCRs) from each group, were apprised of current cultural resource protection initiatives and the present status of site characterization activities. The OTCRs, organized as the Consolidated Group of Tribes and Organizations, drafted recommendations that were later forwarded to the DOE, the National Congress of American

Indians (NCAI), and the Nevada Indian Environmental Coalition. YMP personnel conducted informal visits to two tribal groups during the year: the Colorado River Indian Tribes, headquartered in Parker, Arizona, and the Chemehuevi Tribe in Havasu Lake, California.

Throughout 1994, the YMSCO sponsored the attendance of, or presentations by, DOE and/or Native American representatives at meetings across the nation. In the order of their occurrence, some of these meetings were:

- Stakeholder's Meeting convened by the DOE to elicit input from stakeholders involved with, or concerned about, the YMP.

- High Level Nuclear Waste Conference in Las Vegas, Nevada, primarily to attend a workshop entitled "Nuclear Waste Issues in Indian Country." The workshop panel consisted of five Native Americans.

- Fiftieth Annual NCAI Mid-Year Conference in Buffalo, New York; attended by DOE representatives, government contractors, and Native Americans from several states, especially for sessions of the NCAI Nuclear Waste Policy Committee.

- Meeting at the Prairie Island Nuclear Power Plant in Red Wing, Minnesota, with members of tribes from Nevada, Arizona, and Minnesota (Prairie Island Sioux).

- Meeting of the High-Level Nuclear Waste Policy Committee in San Diego, California; attended by representatives of the DOE, the NRC, government contractors, and Native Americans from several states.

- Indian Points-of-Contact Meeting, sponsored by DOE Headquarters and held in Tulsa, Oklahoma, at which personnel from each DOE facility having a Native American program shared policy and program ideas.

- Fifty-first Annual NCAI Convention in Denver, Colorado; attended by DOE representatives, government contractors, and Native Americans from several states. The NCAI Nuclear Waste Policy Committee met for three days.

- Second Annual National Tribal Environmental Council (NTEC) Conference in Reno, Nevada. The NTEC serves as a forum for a discussion by tribal groups of environmental issues as they impact Indian reservations.

In addition to participating in these meetings, the DOE sponsored 66 speaking engagements and 13 exhibits during the year at which the YMP Native American program was explained to the public. The presenter was a local Southern Paiute Indian, who also serves as Director of the Las Vegas Indian Center in southern Nevada.

Tribal councils with a historical relationship to the Yucca Mountain area participated in a special celebration in July at the Yucca Mountain Science Center in Las Vegas. The event was entitled "Visions in Culture: Native Americans of Southern Nevada." Participants demonstrated traditional dress and dances of their tribes. Other demonstrations and activities involved beadwork, games, storytelling, and basketweaving.

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. In 1994, neither RQ releases nor Continuous Releases under Section 103 of CERCLA occurred.

In 1986, CERCLA was reauthorized and amended by enactment of the Superfund Amendments and Reauthoriztion 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 1994 because the quantities of listed toxic chemicals used by the YMP were insufficient to activate the reporting process. Nevertheless, to document this fact, a negative report was filed with the EPA.

To ensure that other sections of EPCRA are satisfied, a database consisting of an inventory of hazardous chemicals was developed during the year by the YMSCO. Because the quantity of diesel fuel stored by the YMP exceeded the prescribed RQ (i.e., 10,000 pounds), a Section 311 report was filed with the Nevada State Emergency Planning Commission. Also during this reporting period, a permit to store hazardous chemicals was obtained from the Nevada State Fire Marshal Division.

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 1994, eight shipments of hazardous waste were sent off-site to EPA-permitted TSD (treatment/storage/disposal) facilities. Wastes consisted of the following: rags contaminated with chlorinated solvents (1,1,1-trichloroethane), soil contaminated with antifreeze, rags contaminated with lead, mercury debris, spent nickel cadmium batteries, and expended smoke pots containing hexachloroethane.

3.1.10 Federal Land Policy and Management Act (FLPMA)

Federal projects requiring access to, and activity on, public lands required 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 offsite trench or surface water monitoring station. Again in 1994, 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.

Three free-use permits to excavate sand and gravel for use in constructing roads and drillpads have been issued by the BLM to the YMP since 1990. No applications for free-use permits were filed in 1994. Annual reports for the three existing permits were submitted to the BLM during 1994.

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 confirmed that no such land will be disturbed by site characterization activities. No further compliance measures were necessary in 1994.

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, 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 Federal Register (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 Federal Register (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 1994.

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" (Navarre, 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 apply, to a greater or lesser extent, to radiological matters during site characterization are the following (DOE, 1992b): 5400.1, General Environmental Protection Program; 5400.5, Radiation Protection of the Public and the Environment; 5480.1B, Environment, Safety and Health Program for Department of Energy Operations; 5480.4, Environmental Protection, Safety and Health Protection Standards; 5480.11, Radiation Protection for Occupational Workers; and 5484.1, Environmental Protection, Safety, and Health Protection Information Reporting Requirements.

The YMP radiological monitoring activities conducted in 1994 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 has been extended to 84 km (52 mi) to include the town of Pahrump. Monitoring of ambient radioactivities in 1994 utilized 22 continuous air samplers (CAS),

127 thermoluminescent dosimeters (TLD), 19 electret-passive environmental radon monitors (E-PERM), eight pressurized ion chambers (PIC), and two continuous radon monitors (CRM). CAS samples were obtained weekly from 11 near-field and 10 far-field locations. (Two CAS samplers were operational at NF87, one of the near-field locations.) By the end of the year, 75 near-field and 52 far-field TLD stations were in service and being monitored on a quarterly basis. PIC data were recorded continuously at six far-field and two near-field sites throughout the year. CRM readings were also recorded continuously at two locations. E-PERM readings were taken monthly at 18 near-field locations and at one far-field site (University of Nevada, Las Vegas campus). Results of analyses of these samples for radon and ambient radiation appear in Chapter 5.0 of this report, and indicate that concentrations of both were below minimum detectable values throughout 1994.

No airborne radiological emissions were associated with YMP activities in 1994. Monitoring was performed to determine the extent of resuspension of existing radioactive material by casual traffic and/or wind. Analyses of CAS samples indicated that concentrations of airborne radionuclides were well below established safe limits. These data are also presented in Chapter 5.0 of this report.

Because of the long history of nuclear rocket engine development and testing in the general vicinity of Yucca Mountain, all areas newly proposed for surface-disturbing activities within the NTS boundary were monitored (i.e., a preactivity survey was conducted) for the presence of radionuclides at the soil surface.

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. These wells will be 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, tunneling, testing, or discharge to a spreading basin for aquifer recharge. These additional permits did not change DOE's total allocation of 430 acre-ft per year, granted by the State in 1992. (In March 1995, these permits were renewed by the State Engineer.)

3.1.15.2 Hazardous Materials

The 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 Administrator 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 25 gallons or contaminates at least 3 cubic yards of soil.

The YMP is complying with these regulations in its response to oil and chemical spills at the site (Section 6.3). In all instances, reporting requirements are being met, and contaminated soils are being excavated for authorized off-site disposal.

One permit new to the Project in 1994 was the Hazardous Material Storage Permit, granted by the Nevada State Fire Marshal Division. Required at Yucca Mountain primarily for the storage of flammable construction materials, this permit must be renewed annually.

3.1.15.3 Miscellaneous

With the completion of facility designs in 1994, permit applications for the ESF mine wastewater evaporation pond and the sewage disposal system were filed with the NDEP. It is anticipated that both permits will be issued by mid-1995.

3.1.16 Environmental, Safety, and Health Audits

The primary objective of the YMP Environmental, Safety, and Health (ES&H) program is to ensure 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. One of the principal means by which the YMSCO achieves this objective is through ES&H audits of YMP organizations. The audit function was previously a responsibility of the Technical and Management Support Services (T&MSS) contractor. In 1994, audit scopes were expanded to incorporate safety and health with environmental protocols, a change made to accommodate YMSCO initiatives to consolidate YMP ES&H oversight activities. Accordingly, audits are now performed by the Environmental, Safety, and Health Compliance Department (ESHCD), a recently established unit within the CRWMS M&O organization.

The ESHCD conducts comprehensive and special-issue ES&H audits of YMP organizations and related support functions. A comprehensive audit assesses all aspects of an organization's ES&H activities and programs, while a special-issue audit focuses primarily on a specific concern or area of interest. Two comprehensive audits and four focused, special-issue audits were conducted in 1994.

Prior to reorganization of T&MSS under the CRWMS M&O, the YMSCO directed a comprehensive compliance audit of the T&MSS contractor. The audit team consisted of a YMSCO staff member as team leader, a DOE Headquarters representative, and highly qualified personnel from YMP and NTS contractor organizations (Section 4.3).

YMP organizations also assess regulatory compliance through self-appraisals of their respective ES&H protection programs, in accordance with Yucca Mountain Administrative Procedure (YAP)-30.8, *Environmental, Safety, and Health Appraisal*. All activities associated

with protection of the environment, protection of the public, and worker health and safety are included in these programs. Audits of quality-affecting environmental data collection programs are conducted by the Quality Assurance Technical Support Services (QATSS).

3.1.17 Environmental Surveillance Program

The environmental surveillance program is another means by which compliance with environmental requirements by YMP activities is measured. Surveillances are conducted by the CRWMS M&O Environmental Programs Department (EPD) to ensure 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 more than 550 environmental surveillances in 1994 (Section 4.4).

3.2 SUMMARY OF PERMITS AND COMPLIANCE ACTIONS

Because the YMP has consistently remained in full compliance with all applicable environmental legislation, it has not been necessary for the YMSCO to be a party to any compliance agreements. Tables 3-1, 3-2, and 3-3 present the status of YMP's compliance with Federal, Federal flowdown, and State environmental regulations.

3.3 PERMIT-ASSOCIATED LITIGATION AND ENFORCEMENT ACTIONS

No court action was undertaken in 1994 by either the DOE or the State of Nevada, nor was any enforcement action brought by the State.

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	7/15/89	10/26/90	- EXPIRES WHEN CONSTRUCTION ENDS
			- 40 MILE WASH PIT	1/28/92	5/20/92	- 1/6/01
			- BORROW PIT #1	8/28/92	1/8/93	- 1/6/01
	RIGHT-OF-WAY RESERVATIONS	BLM/USAF	NEEDED FOR ACCESS TO PUBLIC AND AIR FORCE LAND	11/23/87 10/23/87	1/6/88 10/10/89; RENEWED 6/30/94	- 1/6/01
ENDANGERED SPECIES ACT	ENDANGERED SPECIES ACT COMPLIANCE	USFWS	NEEDED IF ENDANGERED SPECIES POTENTIALLY AFFECTED (TORTOISE)	10/10/89	2/9/90	- BIOLOGICAL OPINION RECEIVED
			EACH ACTIVITY LOCATION MUST BE SURVEYED PRIOR TO DISTURBANCE	--	7/21/93	- EG&G ANIMAL HANDLING PERMITS RENEWED ANNUALLY
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.	--	10/1/91	- SBT ASSESSMENT AND STATEMENT OF FINDINGS ISSUED
			MUST BE PUBLISHED IN FEDERAL REGISTER	5/15/92	10/23/92	- ESF ASSESSMENT AND STATEMENT OF FINDINGS ISSUED
CLEAN WATER ACT	NATIONWIDE GENERAL PERMIT (SECTION 404)	COE	NEEDED BEFORE CONSTRUCTING IN A WATER COURSE	4/28/89	7/17/90 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	12/1/86	12/22/88	- PA COMPLETED. COMPLIANCE WITH PA SATISFIES REGULATORY REQUIREMENTS
FARMLAND PROTECTION POLICY ACT	PRIME FARMLAND CONSULTATION	SCS	NEEDED TO ENSURE NO IMPACT TO PRIME FARMLAND	2/11/88	3/1/88	- 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 LAND DISTURBANCE	NDEP	REQUIRED FOR DISTURBANCE >20 ACRES	--	6/12/91 8/23/94	- REPLACED BY AUG 94 PERMIT - TO BE RENEWED 8/23/99
	AIR QUALITY PERMITS TO CONSTRUCT AND OPERATING PERMITS	NDEP	NEEDED FOR EACH POINT SOURCE OF EMISSIONS.			
			- LM-300 DRILLRIG (ENGINES)	--	9/17/93	- REPLACES 1991 PERMIT
			- GRAVEL SCREEN	--	6/8/92	
			- PORTABLE AIR COMPRESSORS (4)		9/17/93	- REPLACES 1992 PERMIT
			- CONE GRAVEL SCREENING PLANT (40-MILE WASH)	--	10/28/93	- REPLACES 1992 PERMIT
			- KOLBERG GRAVEL SCREENING PLANT	--	10/28/92	- TO BE MODIFIED IN 1995
			- LM-300 DRILLRIG (DUST)	--	7/13/93	
			- FAILING DRILLRIG	--	7/13/93	
			- CME-850 DRILLRIG	--	7/29/93	
			- CME-550 DRILLRIG	--	9/29/93	
			- JOY-1 DRILLRIG	--	9/29/93	
			- STRATMASTER DRILLRIG	--	10/28/93	
			- ESF ROCK CONVEYOR	--	10/28/93	
			- CONCRETE BATCH PLANT	--	2/3/94	
			- RADIAL STACKER CONVEYOR	--	2/3/94	
			- ROCK CRUSHING PLANT	--	--	
			- WILSON DRILLRIG	5/94	6/6/94	
			- TOP HEAD DRILLRIG (2)	--	8/19/94	
			- CME 85 DRILLRIG	--	8/19/94	
				--		
SAFE DRINKING WATER ACT	UNDERGROUND INJECTION CONTROL PERMIT	NDEP	NEEDED BEFORE INJECTION TRACERS			
			- C-WELL COMPLEX	4/6/89	7/17/91	- PERMIT RECEIVED FOR C-WELLS
			- DRILLHOLES (53)	12/30/91	5/27/92	- PERMIT MODIFICATION APPROVED; EXPIRES 5/27/97
			- C-WELL PUMP TESTS	4/6/89	7/17/91	- EXPIRES 7/16/96
	DRINKING WATER SYSTEM PERMIT		NEEDED BEFORE CONSTRUCTION BEGINS ON THE SYSTEM	5/18/93	9/3/93	- NO EXPIRATION DATE
RESOURCE CONSERVATION AND RECOVERY ACT	RCRA EPA REGISTRATION AND ID NUMBER	NDEP	NEEDED BEFORE GENERATING REGULATED QUANTITIES OF HAZARDOUS WASTE	4/1/89	6/26/89	- ID NUMBER RECEIVED

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

REGULATION	PERMIT	AGENCY	APPLICABILITY	FILED	EXPECTED (E)/ ACTUAL	STATUS/EXPIRATION DATE
CLEAN WATER ACT	GENERAL DISCHARGE PERMIT	NDEP	NEEDED PRIOR TO DISCHARGING EFFLUENT			
			- BOREHOLES	--	5/20/92	
			- STORMWATER	9/8/92	5/14/93	- EXPIRES 5/14/98
			- MINE WASTEWATER EVAPORATION POND	3/3/95	7/31/95 (E)	
			- SEWAGE DISPOSAL	3/15/95	5/31/95 (E)	

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	7/12/88	3/2/92	3/2/02
			- ADDITIONAL REQUEST	4/2/92	8/18/92	4/9/02
			- WELL VH-1	3/20/92	5/18/92	4/9/02
			- C-WELL COMPLEX (3)	5/11/93	6/28/93	RENEWED 3/7/95
			- WELL JF-3	10/10/91	10/24/91	RENEWAL NOT REQUIRED
			- HOLE UZ-16	12/11/91	12/7/92	RENEWAL NOT REQUIRED
			- HOLE UZ-14	2/26/93	3/17/93	EXTENDED INDEFINITELY
			- HOLES USW-G2, SRG-5/SD-11, SD-12	--	--	EXTENDED INDEFINITELY
			- HOLES WT-1, WT-10, WT-12, WT-13, WT-17	--	12/27/93	WAIVERS RECEIVED
	WATER POLLUTION CONTROL PERMIT	NDEP	NEEDED FOR POND CONSTRUCTION	TBD	12/94 (E)	AWAITING STATE APPROVAL
	SANITARY SEWAGE DISPOSAL PERMIT	NDEP	NEEDED FOR SEWAGE SYSTEM CONSTRUCTION	6/21/93	--	AWAITING STATE APPROVAL
	LAND APPROVAL	NDEP	NEEDED FOR CLASS III LANDFILL CONSTRUCTION	TBD	TBD	AWAITING DESIGN. NEW LANDFILL MAY NOT BE NEEDED
	HAZARDOUS MATERIAL STORAGE PERMIT	NFMD	NEEDED FOR STORAGE OF FLAMMABLE MATERIALS	--	1/1/94	EXPIRES 12/31/94. 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
SCS	Soil 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

4.0 ENVIRONMENTAL PROGRAM INFORMATION

4.1 WASTE MINIMIZATION

Waste minimization is a fundamental concept in protecting the environment, and the YMSCO stresses the avoidance of waste generation. Personnel are encouraged and trained 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.

The overall YMP waste minimization program is designed to (1) obtain accurate and current information on waste stream generation and waste management costs, providing the basis for the implementation of specific waste minimization techniques and technologies; (2) create an organization comprised of YMP Participant representatives who will develop and administer the waste minimization program; (3) define targets of waste to be reduced; and (4) develop a method of tracking the performance and progress of the program. Efforts to achieve these goals are described in the Annual Report on Waste Generation and Waste Minimization Progress, required by DOE Order 5400.1 and submitted by the YMSCO to DOE Headquarters in October 1994.

The YMSCO updated its waste minimization and pollution program plan, issued as a draft in December 1994 and entitled "U.S. Department of Energy Yucca Mountain Site Characterization Office Waste Minimization and Pollution Prevention Awareness Plan". This new plan establishes more specific goals for the program in 1995 and 1996.

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

significant portion of the Project's GET program. Approximately 2,700 individuals have received GET training, which must be taken by all employees working in the field. In addition, the GET program requires participation in an annual refresher course.

For site employees who routinely enter the Project site and encounter radiological barriers, postings or radioactive materials, an additional class, entitled General Employee Radiological Safety Training (GERT), must be attended. Employee responsibilities for observing and obeying radiological postings and procedures are emphasized during this training session.

The YMP hazardous materials management program requires that each Project Participant provide 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 emergencies. A professional Training Department conducts the training programs.

4.3 ENVIRONMENTAL , SAFETY, AND HEALTH AUDIT PROGRAM

The environmental, safety, and health (ES&H) audit program is a YMSCO initiative that provides programmatic oversight of YMP activities in support of the broader goal of achieving full compliance with all requirements in the environmental area. The general objectives of the audit program are to (1) provide information that will assist the audited YMP organization in making informed decisions about any necessary modifications in its approach to the management of ES&H programs; (2) assure management that potential exposure to compliance problems is known and is being reduced to acceptable levels; (3) verify adequacy of ES&H management and organizational structure; (4) determine compliance with DOE Orders and YMP ES&H plans, policies, and procedures; (5) identify and assure corrective action of deficiencies; and (6) identify the noteworthy aspects of a YMP organization's ES&H program.

The Environmental, Safety, and Health Compliance Department (ESHCD) conducts ES&H audits of YMP organizations in accordance with requirements outlined in the *YMP Environmental Regulatory Compliance Plan* (DOE, 1992b) and in YAP-30.16, *Environmental Auditing and Surveillance of Yucca Mountain Site Characterization Project Activities.* During 1994, three comprehensive audits and four special issue audits were conducted to verify the ES&H performance of YMP organizations and supporting services. The three comprehensive audits were designed to assess the audited organization over a broad range of ES&H protocol areas. These audits were conducted by specially selected Audit Teams comprised of a Team Leader, Technical Coordinator, and environmental technical specialists. Audit Team size varied as a function of the number of protocols to be evaluated during the audit.

Eleven different audit protocols have been identified, of which eight to ten are normally evaluated during an audit depending on the extent of the organization's activities and the audit scope defined through pre-audit consultation and questionnaires. Protocols employed in the 1994 audits, and the regulatory requirement or policy guidance for each protocol, are listed in Table 4-1. A breakout of protocols used in each audit appears in Figure 4-1.

Special issue audits are of limited scope and duration, and are conducted to provide a "quick response" assessment of high priority ES&H compliance or management topics. They are usually performed by a single auditor with assistance from other technical specialists, as necessary, to ensure a thorough assessment of an audited function or issue. Such topics have generally included a specific regulatory requirement, new YMP activities or support functions, or common elements that bridge YMP organizational areas of responsibility. Special issue audits conducted during 1994 evaluated environmental permit stipulation compliance, environmental readiness for TBM activities, and off-site contractor support services.

A structured improvement action program and follow-up are critical to the success of the audit program. YMP requirements mandate that YMP Participants respond to audits through development and implementation of improvement actions. Audit closure occurs once

TABLE 4-1. Regulatory Requirement(s) and/or Policy Guidance for Yucca Mountain Site Characterization Project Environmental Audit Protocols

PROTOCOL	REQUIREMENT/POLICY GUIDANCE
Environmental Management	DOE/EH--0229, Environmental Management Performance Objectives and Criteria
Occurrence Reporting	YAP-30.1, Occurrence Reporting and Processing of Operations Information
Regulated Materials Management	YAP-30.10, Authorization for Use of Regulated Hazardous Substances and Materials YAP-30.15, Operating of Hazardous Waste Satellite Accumulation Areas
Hazard Communication	29 CFR 1910.1200; Hazardous Materials Management and Handling Plan (HMMHP)
Waste Assessment/Minimization	AP-6.27, Waste Assessment; HMMHP
Resolutions	AP-6.18, Resolutions of Environment, Safety and Health (ES&H) Concerns
Appraisals	YAP-30.8, ES&H Appraisal
Protection Program	AP-5.43, ES&H Protection Program for U.S. DOE Operations
Radioactive Materials	AP-6.7, Authorization for the Use of Radioactive Materials or Ionizing Radiation Producing Equipment
Permit Agreements	YMP Permit Stipulations
Environmental Training	GET/GERT and HMMHP

ENVIRONMENTAL AUDITS	AUDIT PROTOCOLS										
	POC	RAP	RMM	HAC	WAM	REC	ESA	EPP	RAD	PAC	ETR
FY94B	■	■	■	■	■				■	■	■
FY94C	■	■	■		■	■	■	■			■
FY94D	■	■	■	■	■	■	■		■		■

POC - Environmental Management Performance Objectives and Criteria
RAP - Reporting and Processing of Operations Information
RMM - Regulated Materials Management
HAC - Hazard Communication
WAM - Waste Minimization
REC - Resolutions of Environment, Safety and Health Concerns
ESA - Environment, Safety and Health Appraisal
EPP - Environment Safety and Health Protection Program for U.S. Department of Energy Operations
RAD - Use of Radioactive Materials
PAC - Permit Agreement Compliance
ETR - Environmental Training Program

Figure 4-1. Audit Protocols: YMP Environmental Audits FY94B, FY94C, and FY94D

completion of an organization's improvement action is verified by the ESHCD and approved by the YMSCO Assistant Manager for Environment, Safety, and Health (AMESH).

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 audit 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.

Nearly 500 surveillances were conducted by the EPD in 1994. A surveillance is closed once corrective actions for any noted discrepancies have been completed, verified by the EPD, and reviewed and approved by the AMESH.

5.0 ENVIRONMENTAL RADIOLOGICAL MONITORING

The responsibilities for monitoring environmental radiological conditions in the Yucca Mountain region for the YMP are shared by two groups. The Health Physics Environmental Radioactivity Division (HPERD) has developed the overall environmental radiological monitoring program and analyzes, evaluates, and reports data generated by the program. Implementation of the program is carried out by the Radiological Field Programs Division (RFPD), which installs and maintains field equipment and collects data recorded in the field. In addition, the RFPD conducts two types of radiological survey: those conducted prior to the commencement of a surface-disturbing activity (i.e., the preactivity survey), and those conducted periodically at site facilities and along roadways.

The 1994 monitoring program included the quantification of radioactive particulates, ambient gamma radiation, and ambient radon. A synopsis of the monitoring regime is given in Table 5-1. Environmental media sampled and monitored during the year were air (as a carrier of radioactive particles and gas) and soil. Small mammals and vegetation, collected in past years as potential contributors to radionuclide pathways, were not collected in 1994 due to budgetary constraints.

Radioactive particulates were collected by continuous air samplers (CAS) installed at 11 near-field and 10 far-field locations. (Near-field is defined as the area within 16 km [10 mi] of the proposed location of the Yucca Mountain surface facilities. Far-field is the area between 16 and 84 km [10 and 52 mi] of the proposed facilities.) One near-field location, NF87, consists of two CAS units, one (NF87A) operating on alternating current, the other (NF87D) on direct current (Figure 5-1). This design allows field personnel to determine whether differences exist in the effectiveness of the two techniques. Several changes were made during the year in the locations of far-field units. The CAS unit at FF83 was moved to FF12 on October 31, 1994. Because both sites are on the University of Nevada, Las Vegas

Table 5-1. Synopsis of the Radiological Environmental Field Monitoring Program.
Key: CAS = continuous air sampler; E-PERM = electret - passive environmental radon monitor; CRM = continuous radon monitor; TLD = thermoluminescent dosimeter; PIC = pressurized ionization chamber.

Sample Source/ Equipment	Number of Units	Frequency of Collection	Parameter Analyzed	Frequency of Analysis
Air/				
CAS	22	Weekly	Gross alpha and beta radioactivity	Weekly
		Weekly	Radionuclide concentrations	Quarterly
E-PERM	19	Monthly	Radon	Monthly
CRM	2	Continuous	Radon	Weekly
Soil	12	Annual	Radionuclide concentrations	Weekly
Ambient/				
TLD	127	Quarterly	Gamma	Quarterly
PIC	8	Continuous	Gamma	Weekly

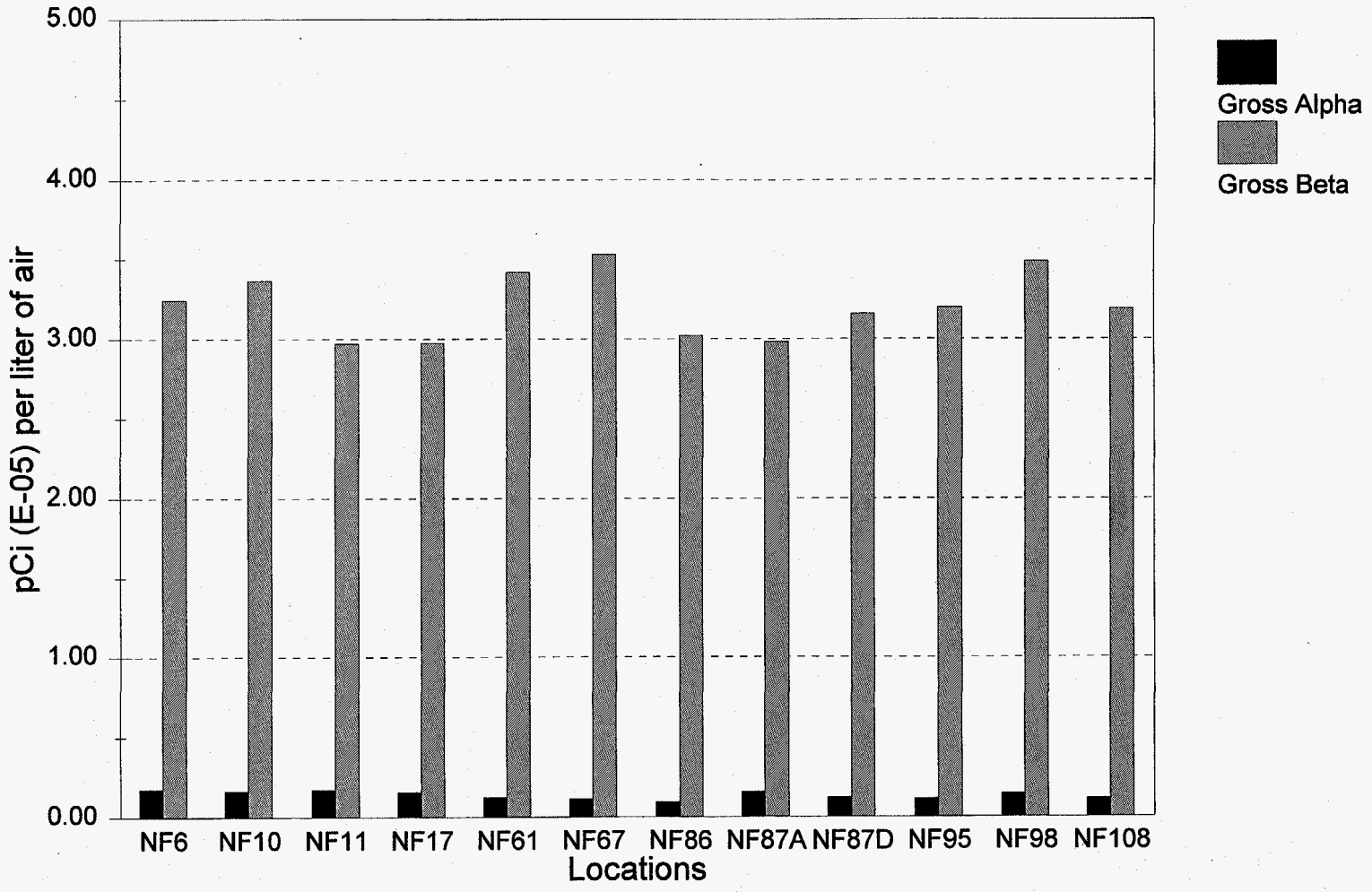

Fig. 5-1. Average Gross Alpha and Beta Radioactivity in 1994 at Near-field (NF) Locations as Detected by Continuous Air Samplers.

(UNLV) campus, this is regarded as a single CAS location. Three other sites (FF15, FF16, and FF28) were closed and another three (FF11, FF14, and FF22) were opened during the course of the year. At any one time during 1994, only ten far-field sites were operating, though a total of 13 locations were involved over the 12-month period (Figure 5-2).

To count particulates trapped on CAS filters, an alpha/beta counting system was used. The results of these analyses, expressed as the annual average of gross alpha and beta radioactivity per station, are shown in Figures 5-1 and 5-2. Following each 13-week period of sampling, the filters were composited and sent to a vendor for analysis of specific radionuclides. The results of these analyses are not yet available.

Two methods were used to monitor ambient gamma radiation. Of these, thermoluminescent dosimeters (TLDs) were used most extensively (75 near-field and 52 far-field locations). At the end of each calendar quarter, TLDs were retrieved and sent to a vendor for processing. The average quarterly TLD data for all near-field or far-field stations combined appear in Figure 5-3. Exposure levels were not significantly different from quarter to quarter in either category of TLD stations.

The second method used to determine ambient gamma radiation involved pressurized ionization chambers (PIC)s at two near-field and six far-field locations. These instruments operate continuously, recording the exposure rate integrated over intervals of fifteen seconds. The average monthly exposure rates for each of the eight PIC sites are shown in Figure 5-4. Though data from nine sites are presented in Figure 5-4, sites FF83 and FF12 are considered one site, as explained previously.

Figure 5-4 reveals that ambient gamma radiation was consistently higher at near-field than at most far-field locations. The same phenomenon was observed in 1992 and 1993. This difference is probably attributable to variations in geology between near-field sites and the widely dispersed far-field sites. The higher exposure rates detected at FF12, as compared

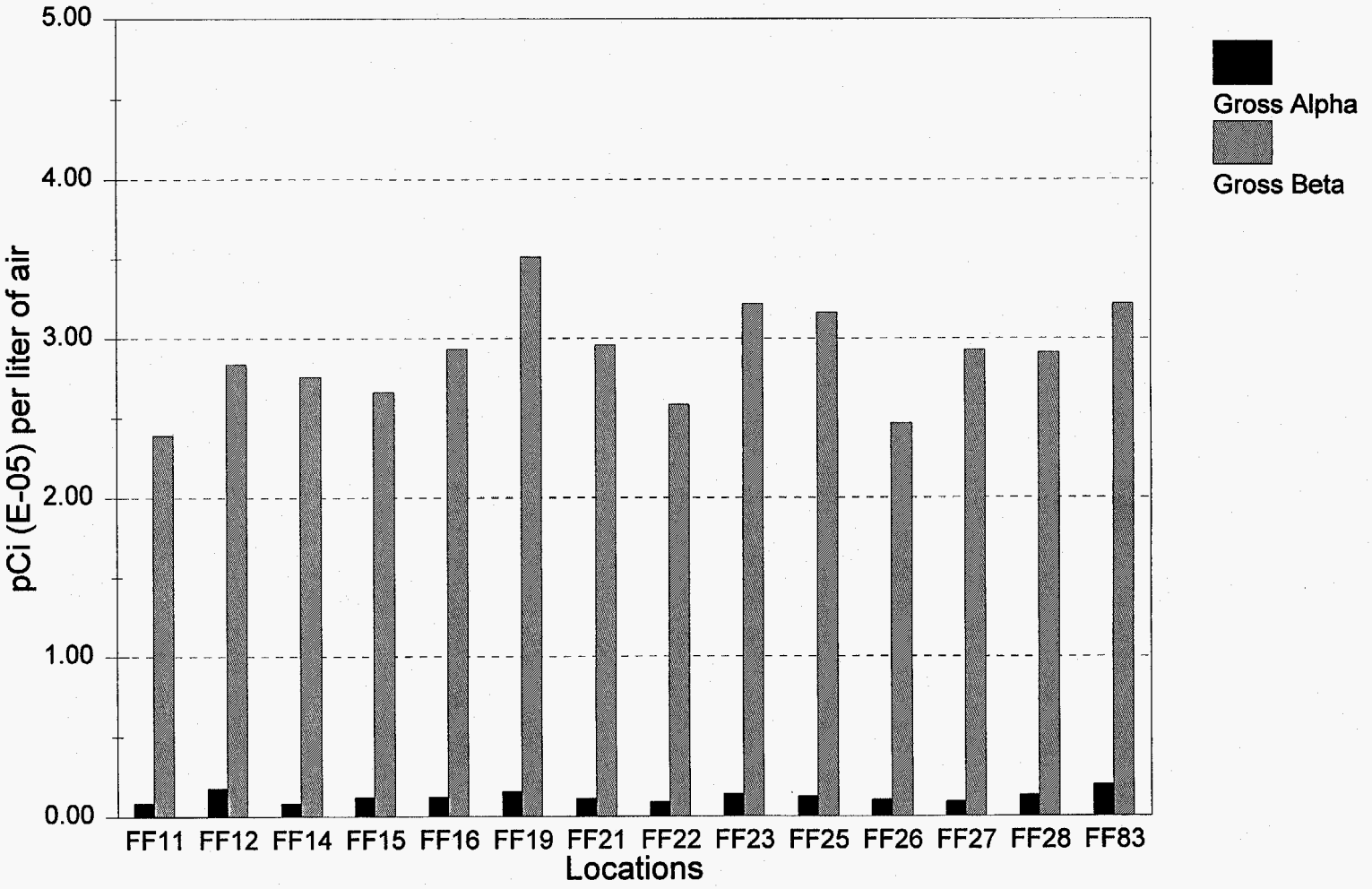

Fig. 5-2. Average Gross Alpha and Beta Radioactivity in 1994 at Far-field (FF) Locations as Detected by Continuous Air Samplers.

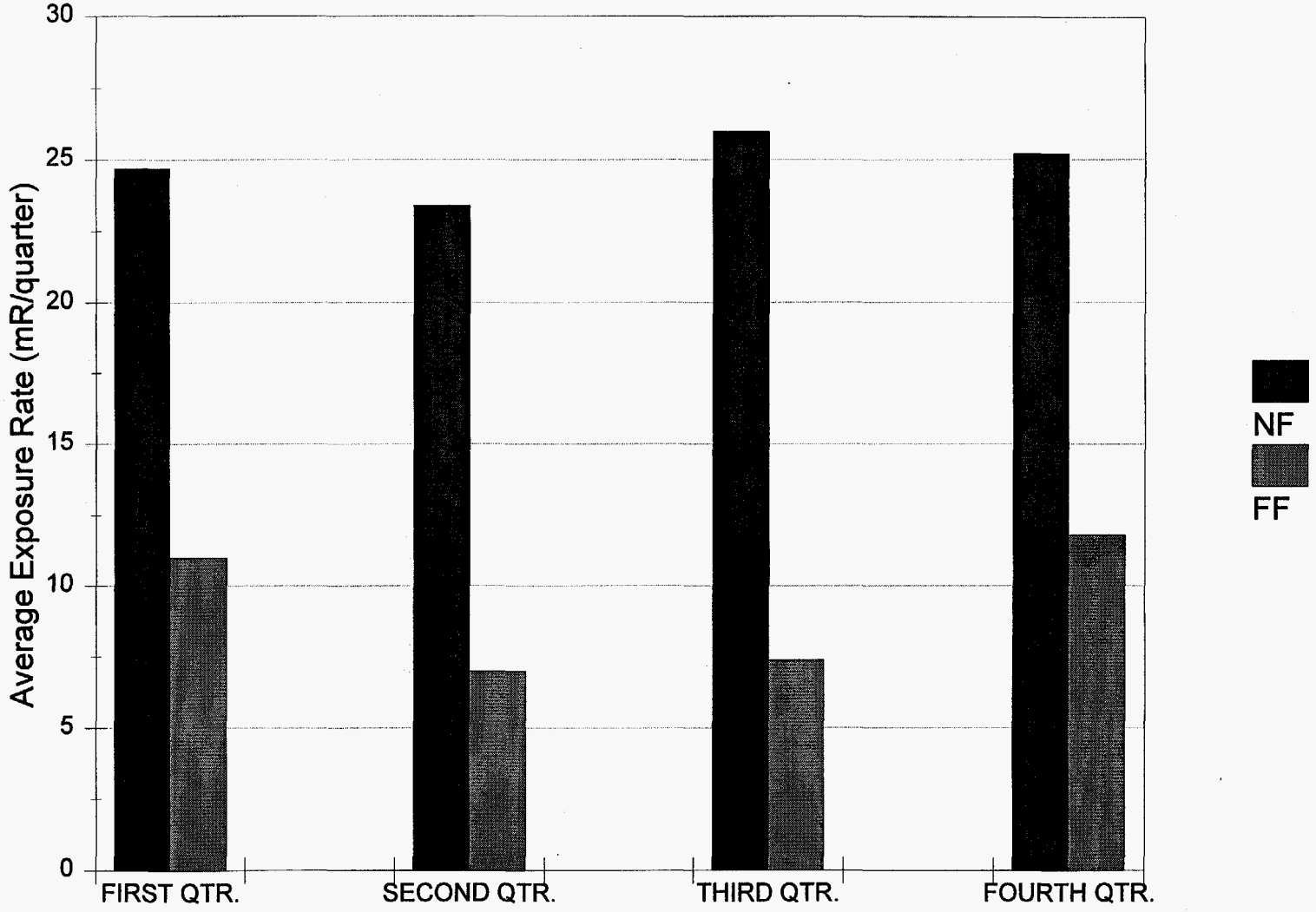

Fig. 5-3. Ambient Gamma Radiation in 1994 Expressed as Average of Readings from Near-field (NF) or Far-field (FF) TLD Stations per Calendar Quarter.

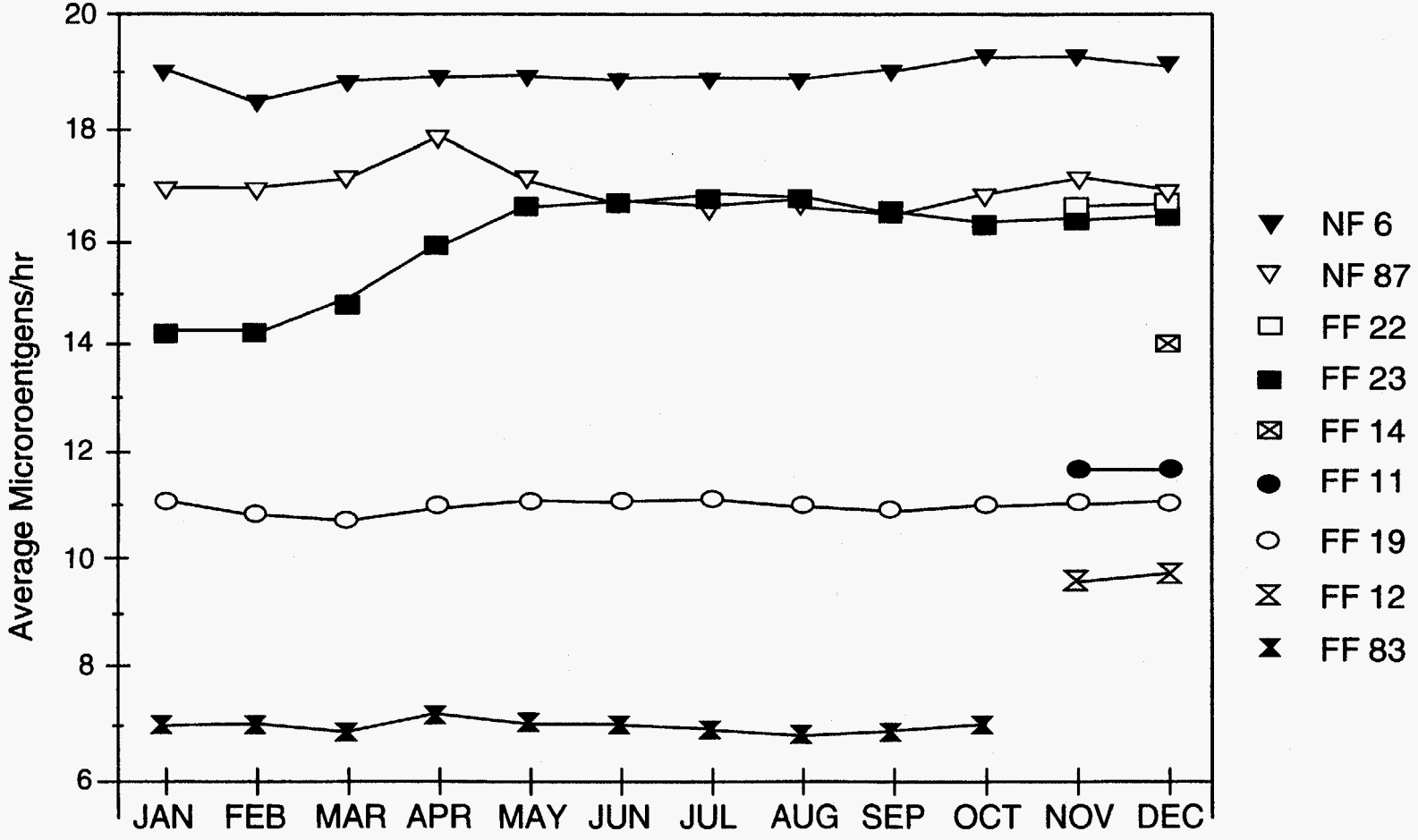

Fig. 5-4. Ambient Gamma Radiation Detected by PIC Units at Near-field (NF) and Far-field (FF) Sites in 1994.

PIC93.CDR.1213/4-20-95

to FF83, can be attributed to the fact that the equipment at FF12 is now mounted above a concrete slab rather than above soil.

Ambient radon was also monitored using two different techniques. The technique that provided data from the most sites (19) was an integrating system of electret-passive environmental radon monitors (E-PERMs). Radon concentrations at each of the 19 E-PERM sites in 1994, averaged on an approximately monthly basis, are listed in Table 5-2. Figure 5-5 depicts the average monthly radon concentrations at all 18 near-field locations combined, while concentrations at far-field site 83/12 (UNLV campus) appear in Figure 5-6. The latter site was graphed separately because it is more than 140 km (85 mi) from the near-field sites.

Radon concentrations at near-field sites during the last three months of 1994 appear to be consistently lower than those recorded earlier in the year (Figure 5-5). This difference is due to a change made in October in the method used to calculate the background gamma exposure rate, an integral part of the algorithm for deriving radon concentrations from E-PERM data. A similar decline was not seen at the far-field site (Figure 5-6) because the method of calculating results for that location had not yet changed as of the end of the year.

The second technique used for measuring ambient radon employed continuous radon monitors (CRMs), only two of which were in operation during 1994 (Figure 5-7). Both were installed at near-field locations.

The different types of data analyzed to date suggest the existence of cyclic seasonal patterns. Only with the accumulation and analysis of additional data over time will it be possible to identify trends and establish the significance of any patterns that may be emerging. Some of the data presented in this report have yet to be validated.

Table 5-2. Environmental Radon Concentrations (average picocuries per liter) at 19 E-PERM Stations between January and December 1994.

	INCLUSIVE DATES (and number of days interval)											
Location	1/5-2/2 (27)	2/2-3/3 (29)	3/3-4/7 (35)	4/7-5/4 (27)	5/4-6/3 (30)	6/3-7/1 (28)	7/1-8/4 (34)	8/4-9/7 (33)	9/7-10/6 (29)	10/6-11/2 (27)	11/2- 2/6 (34)	12/6/94-01/5/95 (30)
NF06	0.76	0.64	0.70	0.66	0.66	0.67	0.53	0.52	0.76	0.08	Neg.	0.16
NF38	0.82	0.67	1.03	0.64	0.57	0.70	0.83	0.63	0.94	0.41	0.22	0.45
NF60	0.82	0.68	0.64	0.61	0.78	0.73	0.64	0.57	0.67	0.17	0.10	0.16
NF61	0.70	0.64	0.57	0.64	0.97	0.72	0.60	0.49	0.53	0.13	0.08	0.25
NF62	0.80	0.64	0.69	0.57	0.72	0.76	0.51	0.66	0.62	0.14	0.13	0.10
NF63	0.65	0.64	0.54	0.61	0.62	0.53	0.64	0.64	0.56	0.12	Neg.	0.14
NF64	0.63	0.50	0.48	0.49	0.39	0.41	0.57	0.47	0.57	0.17	0.20	0.01
NF65	0.53	0.59	0.64	0.47	0.64	0.45	0.58	0.53	0.60	0.09	0.02	0.42
NF67	0.64	0.55	0.68	0.51	0.78	0.86	0.60	0.31	0.63	0.19	Neg.	0.03
NF87	0.57	0.42	0.47	0.50	0.34	0.60	0.42	0.34	0.48	0.06	0.11	0.16
NF88	0.72	0.63	0.66	0.65	0.71	0.72	0.65	0.59	0.66	0.25	0.07	0.06
NF95	0.67	0.75	0.63	0.73	0.60	0.51	0.59	0.64	0.70	0.20	Neg.	Neg.
NF98	0.70	0.58	0.96	0.76	0.54	0.71	0.61	0.52	0.68	0.03	0.08	0.16
NF99	0.66	0.47	0.57	0.68	0.70	0.50	0.61	0.47	0.53	0.03	Neg.	Neg.
NF100	0.60	0.57	0.45	0.79	0.55	0.41	0.41	0.51	0.45	0.09	0.09	0.07
NF101	0.65	0.51	0.80	0.72	0.55	0.57	0.68	0.48	0.63	0.10	0.18	0.04
NF102	0.66	0.70	0.66	0.80	0.60	0.70	0.57	0.75	0.69	Neg.*	Neg.	Neg.
NF108	0.64	0.56	0.62	0.52	0.46	0.43	0.58	0.51	0.64	0.13	0.03	0.03
FF83/12**	0.23	0.26	0.11	0.12	0.08	0.12	0.30	0.36	0.26	0.38	0.38	0.47

* Neg. - negative, i.e., less than the minimum dectectable value.

** Monitoring equipment was moved on October 31, 1994, from the original site (FF83) to an existing EPA site (FF12), both on the University of Nevada, Las Vegas campus.

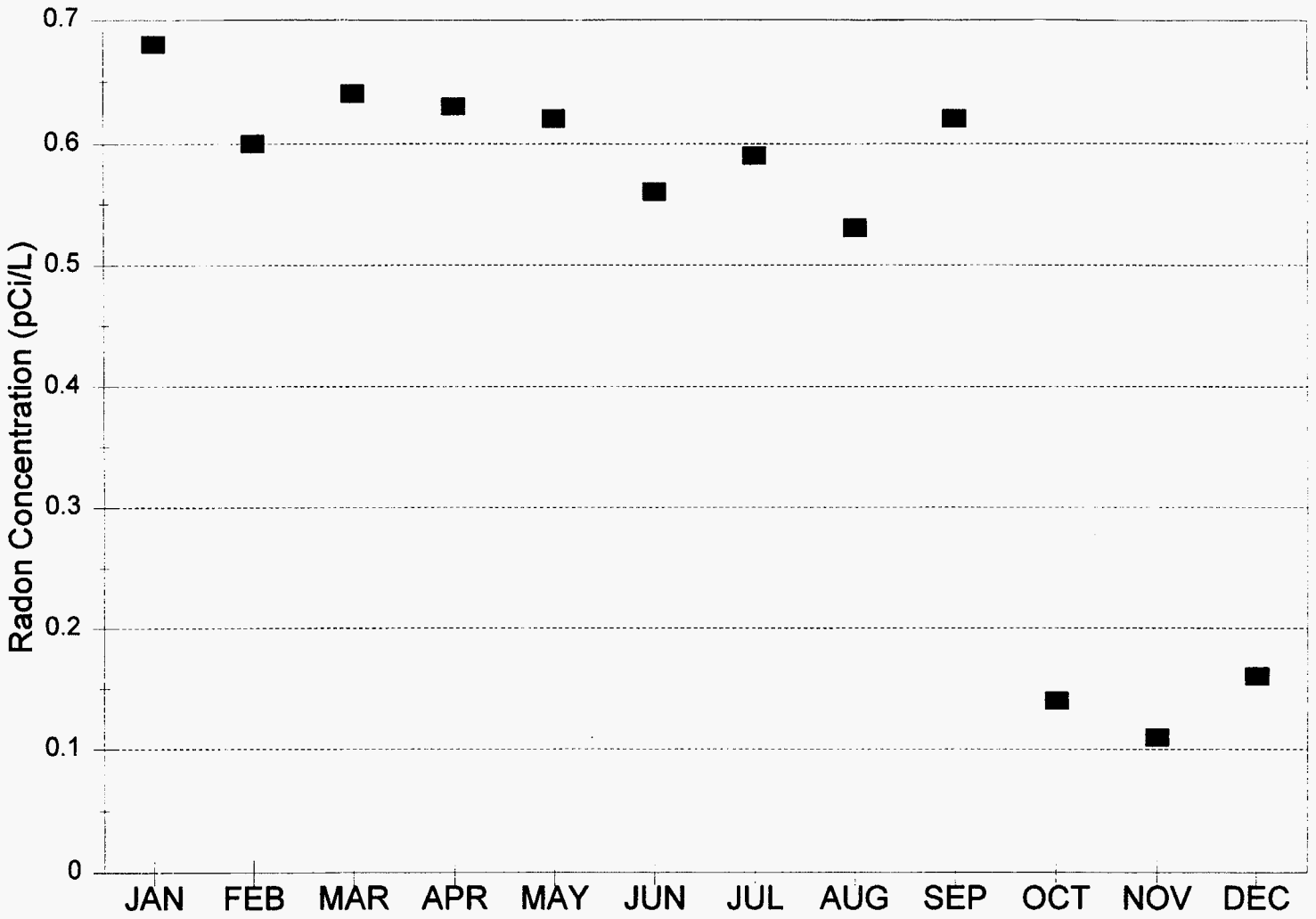

Fig. 5-5. Average Environmental Radon Concentrations at Near-field (NF) E-PERM Locations in 1994.

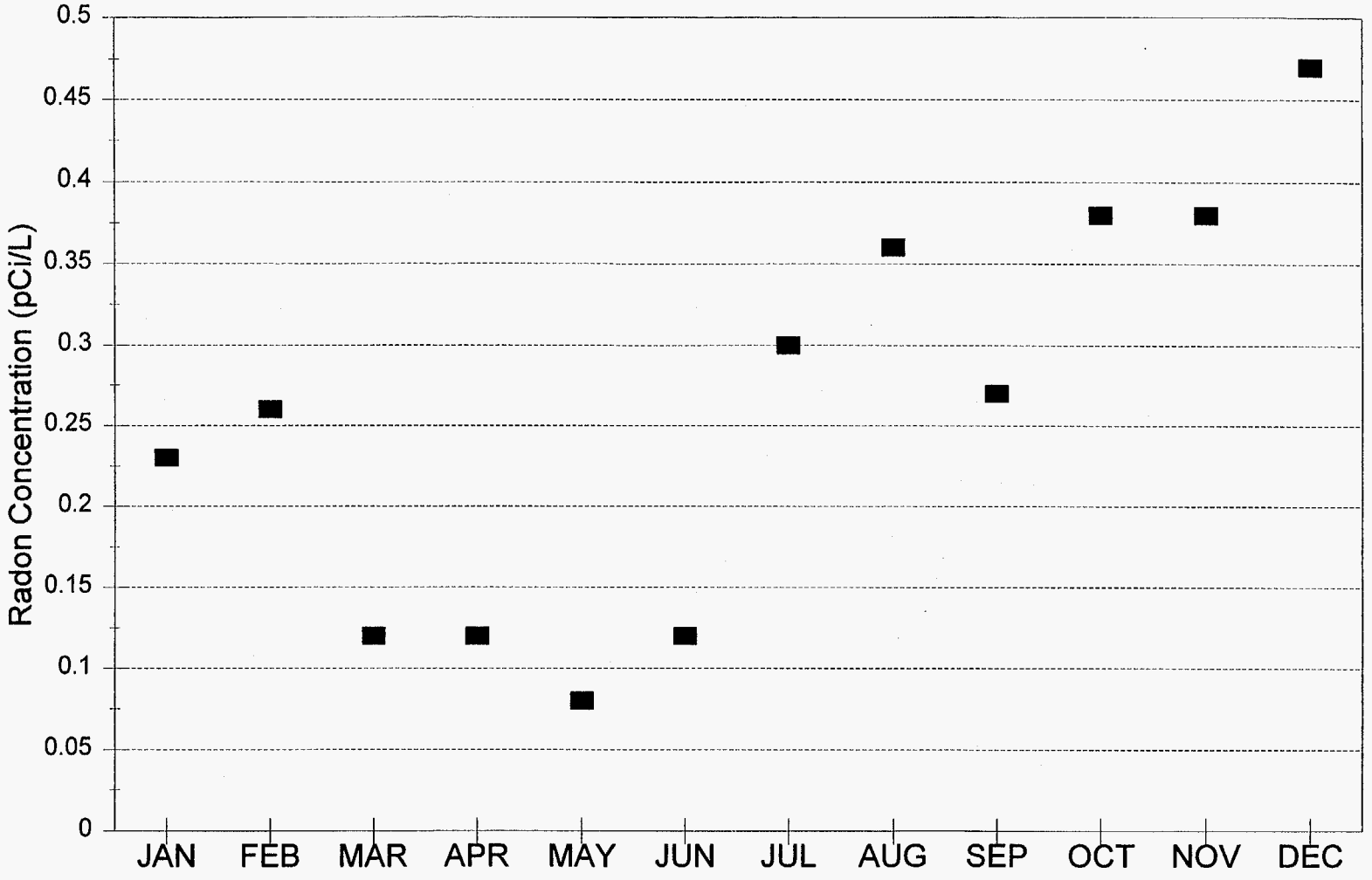

Fig. 5-6. Environmental Radon Concentrations at Far-field (FF) E-PERM Location 83/12 in 1994.

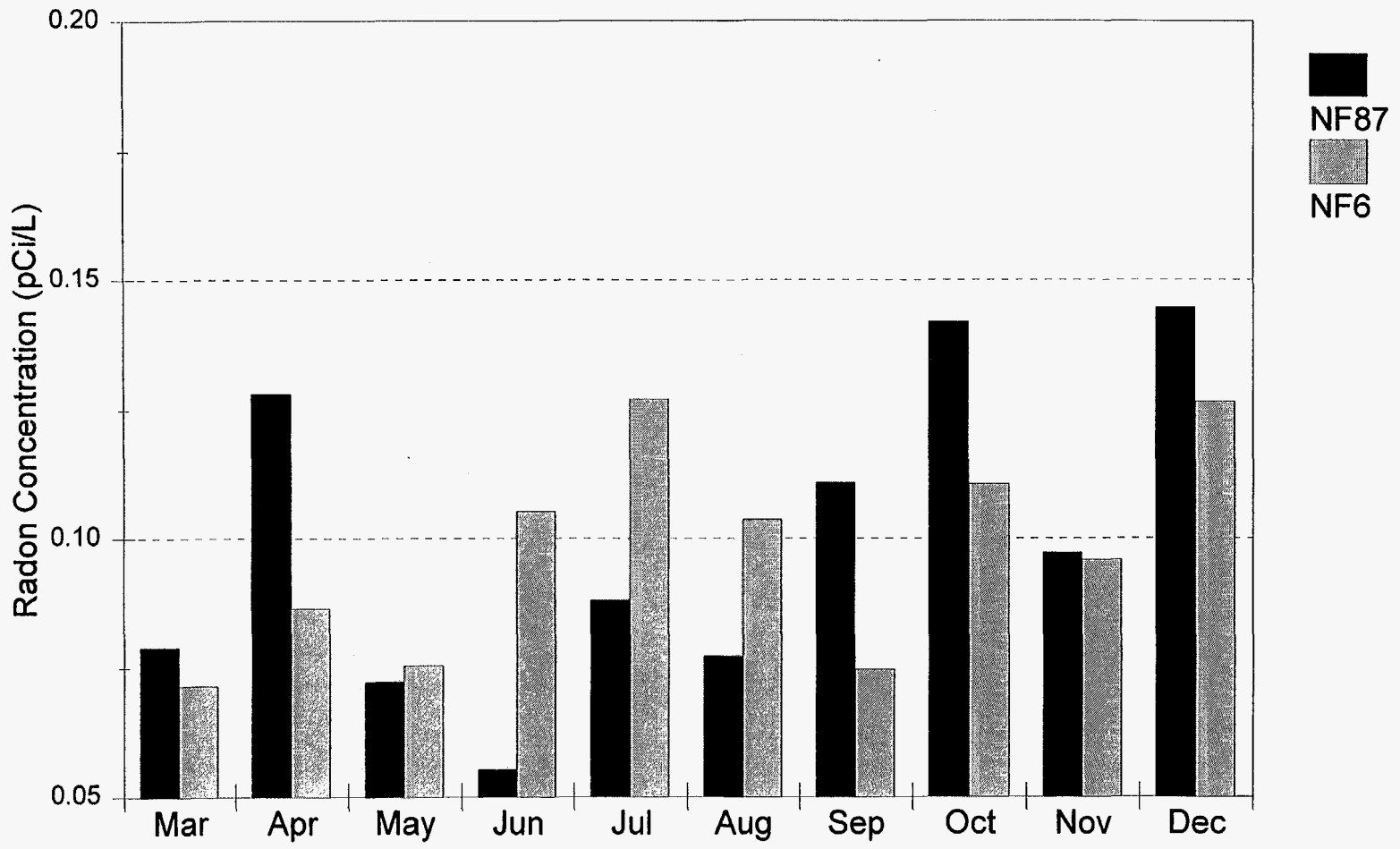

Fig. 5-7. Monthly Average Radon Concentrations in 1994 Measured by Continuous Radon Monitor (Pylon) at Near-field Locations.

6.0 ENVIRONMENTAL NON-RADIOLOGICAL PROGRAM

Most of the activities occurring in this category during 1994 involved preactivity surveys (also see Sections 1.0, 3.1.6, 3.1.7 and 3.1.14) and various types of monitoring. The non-radiological disciplines studied were Terrestrial Ecosystem, Cultural (i.e., Archaeological) Resources, Air Quality, Meteorology, Water Resources, and Soils. Details of the design of these investigations appear in the appropriate Environmental Field Activity Plan (EFAP) for five of the disciplines (DOE, 1990d; 1992c-e; 1995a) and in a study plan for Meteorology (DOE, 1993).

6.1 NPDES DATA

No NPDES permits were received or applied for in 1994. (An application was filed in March 1995 for permits for the ESF wastewater evaporation pond and a sewage disposal system.)

6.2 MONITORING PROGRAM SUMMARY

6.2.1 Terrestrial Ecosystem

This section describes the activities performed within the Terrestrial Ecosystem Program during 1994. Five areas of concern were monitored: Site Characterization Effects, Desert Tortoises, Habitat Reclamation, Monitoring and Mitigation, and Biological Sample Collection.

6.2.1.1 Site Characterization Effects

The studies in the Site Characterization Effects Program were designed to monitor particular components of the terrestrial ecosystem as a means of assessing the effects of site characterization activities on the ecosystem. The program included studies of vegetation, small mammals, reptiles, climatic factors, and assorted disturbances.

In response to analyses of data derived from the previous six years of monitoring, as well as to suggestions from the Nuclear Waste Technical Review Board, the Site Characterization Effects Program was redesigned in 1994 for implementation in 1995. The number of Ecological Study Plots (ESPs) will be reduced from the current 48 to 18, to consist of 8 existing ESPs and 10 new ones. All ESPs will be located in the *Larrea-Lycium-Grayia* vegetation association (Section 2.2.4) near the ESF, in which most of the major disturbances during site characterization will occur. Six of the new plots will serve as far-field controls, located further from disturbances than the existing control plots (which will continue to be monitored).

Climatic Factors

Data collected at each of the 48 ESPs will be used to identify the influence of temperature and precipitation on biotic resources and reclamation efforts. Monitoring occurred weekly from March through May, and monthly thereafter. Data recorded were maximum and minimum air temperatures, precipitation, and soil moisture and temperature.

Only precipitation data have been summarized to date. Precipitation in 1994 was substantially less than in the previous three years. The average for all four vegetation associations in 1991 was 147 millimeters (mm) or 5.9 inches (in), 208 mm (8.3 in) in 1992, and 271 mm (10.8 in) in 1993. In 1994, the average across the four vegetation associations

ranged from 67 to 111 mm (2.7 to 4.4 in). Variation in precipitation between ESPs, even within the same vegetation association, was still greater, ranging from 54 to 119 mm (2.2 to 4.8 in).

Vegetation

Vegetative cover was measured on the existing 48 ESPs, each 200 x 200 m (660 x 660 ft) in area. Cover in 1994, averaged over all ESPs, deceased to 19% from a value of 27% in 1993. Presumably, this reduction may be explained by the relatively dry winter of 1993 and spring of 1994. When plants were categorized as shrubs (including cacti), annuals, or perennial forbs and grasses, it was apparent that the decrease in vegetative cover in 1994 was due to the poor growth of annuals. Again, this effect may be the result of lower precipitation amounts during the year. Shrubs and perennials were not adversely affected.

Plant production was measured by clipping and weighing current annual growth in a total of 72 1-m x 1-m (3-ft x 3-ft) quadrats on 18 ESPs. Perennial shrubs, more difficult to collect than grass forbs and less responsive to subtle environmental conditions, were not collected. Sampling was limited to annuals and perennial forbs and grasses. No summary of production data is yet available.

The density of perennial plants does not fluctuate greatly from year to year, so density was not measured in 1994.

Efforts commenced in 1994 to map the vegetation communities at Yucca Mountain. Such a map will (1) allow ecological inferences to be made from sampled areas (e.g., ESPs and tortoise locations) to unsampled areas with similar vegetation; (2) provide a baseline for gauging future vegetation changes; (3) make it possible to document, in conjunction with a geographic information system database, the amount and location of vegetation disturbed by site characterization activities; and (4) contribute to reclamation decisions. As of December, a

vegetation classification scheme had been standardized and approximately half the target area mapped onto acetate overlays.

Small Mammals

Small mammals are useful indicator species for monitoring changes to desert ecosystems because their home ranges are relatively small, their generation time is short, and they are sufficiently abundant to permit statistical comparisons. The objective of this study is to monitor potential effects of site characterization activities on the small mammal community by estimating the demographic attributes of the most abundant small mammal species through time.

Each sample plot consists of a grid of 144 trap-stations (two live-traps/station). The plots are established according to vegetation association, with one treatment and one control ESP in each of the four associations for a total of eight plots. All eight plots were trapped in 1994 (4-day trap sessions in each of April, June, July, August and September).

Ten small mammal species were captured. The long-tailed pocket mouse (*Chaetodipus formosus*) and Merriam's kangaroo rat (*Dipodomys merriami*) were the species most frequently caught. The species composition of the small mammal community was similar at all plots with the exception of one control plot. Isolated by Fortymile Wash from the other vegetation associations, this site may not be as accessible to animals migrating from other habitats.

In general, populations of small mammals declined in 1994, possibly due to the effects of decreased precipitation during the year on annual forbs and grasses. Long-tailed pocket mice continue to decrease in two vegetation associations, while Merriam's kangaroo rats declined for the first time since 1990 in all associations. Four less common species, the

desert woodrat (*Neotoma lepida*), canyon mouse (*Peromyscus crinitus*), little pocket mouse (*Perognathus longimembris*), and chisel-toothed kangaroo rat (*Dipodomys microps*), also declined in abundance in 1994.

Analyses of numbers of these species captured since trapping began in 1989 suggest that population trends on control and treatment ESPs have been parallel. Although the magnitude of response may vary in some vegetation associations, changes appear to be largely proportional.

Reptiles

Reptiles compose a significant portion of the vertebrate species in desert ecosystems. Many lizard species are habitat-specific (Mayhew, 1968), making them good indicator species of change in habitat structure. The objectives of this study are to estimate species composition of the reptile community and monitor changes in abundance in relation to site characterization activities.

To estimate species composition, three plots were sampled using pitfall and funnel traps with drift fences. During a one-week trapping period in May 1994, eleven species of reptiles were caught. Most common were the side-blotched lizard (*Uta stansburiana*) and western whiptail (*Cnemidophorus tigris*). Overall, the number of side-blotched lizards decreased, relative to 1993, and two lizard species and three snake species captured in 1993 were not found in 1994.

To estimate and compare survival and abundance of a common species relative to disturbance by YMP activities, side-blotched lizards were captured using nooses on nine 1-ha (2.5-acre) plots in March, May and October. All plots were located in the *Larrea-Lycium-Grayia* vegetation association. Three plots were adjacent to existing or proposed construction sites, three were next to roads, and three were more than 200 m (660 ft) from any disturbance. Captured lizards were marked, measured, weighed and released.

The number of side-blotched lizards captured in each of the three treatment locations has declined since March 1993. Since it has been reported that a relationship exists between the production of winter annuals and clutch frequency of the side-blotched lizard (Turner et al., 1973), it is possible that the lower precipitation recorded in 1994 has indirectly influenced the abundance of this reptile. Populations declined similarly on control plots and plots adjacent to site characterization activities suggesting a response to area-wide environmental conditions rather than to YMP activities.

The chuckwalla (*Sauromalus obesus*), a candidate for federal protection under the Endangered Species Act, was observed on eighteen occasions in 1994. Most observations occurred in rocky habitat near the crest of Yucca Mountain, on Fran Ridge, or on the road to Castle Point.

Disturbance Studies

Studies continued in 1994 to quantify ways in which disturbances resulting from site characterization activities might indirectly affect biotic resources. The availability of such information may enable researchers to predict the effects of similar activities in the future on plant and animal communities. Two types of disturbance were evaluated: vehicle and construction equipment traffic, and dust deposition.

Motor vehicle activity in the Yucca Mountain vicinity was measured using 19 portable traffic counters. Traffic volume was expressed as average (mean) number of vehicle passes per day. The highest volume (mean of 127 passes per day) occurred at a location that recorded traffic servicing drilling operations near UZ-16 in Split Wash. Two other areas of high volume were the road to the top of Yucca Mountain (mean of 57 passes per day at one location) and the road in Drill Hole Wash (mean = 51). Little traffic occurred in Crater Flat and at the north and south ends of Yucca Mountain. Overall, traffic volume throughout the area remained much as it was in 1993.

To compare the amount of fugitive dust deposited at varying distances from YMP disturbances, dust samplers (filter papers in open Petri dishes) were placed at each of the 12 ESPs located within the *Larrea-Lycium-Grayea* vegetation association. Dust samplers were collected and replaced monthly.

Analysis of deposited dust revealed that dust deposition was significantly greater near disturbances, decreasing with distance from the disturbance. In all instances, however, the amount of dust deposited was small. Mean values, expressed as the total yearly accumulation of dust per square meter, were 11.53 grams on ESPs near disturbances and 6.89 grams on control ESPs.

6.2.1.2 Desert Tortoise Program

The goals of the desert tortoise program are to develop a better understanding of the biology and status of the desert tortoise population at Yucca Mountain, assess impacts of site characterization activities on the population, develop and implement mitigation techniques to minimize adverse impacts to the animals, and ensure compliance with Federal and State regulations. Ten studies conducted in 1993 were continued in 1994; no new studies were added.

The first five studies described were designed to evaluate impacts of YMP activities by measuring and comparing parameters as they relate to three sample populations of desert tortoises, each representing a different level of impact or exposure to stress. These different levels are (1) exposure to long-term, large-scale disturbances (designated the "high impact" population of animals); (2) exposure to small, widely scattered disturbances (the "area-wide" population); and (3) exposure to no disturbances (the control population). Because the locations of several proposed activities have changed with time, the boundaries of those areas designated "high impact" were redrawn in 1994, and the corresponding treatment classification (i.e., the sample population to which an animal is assigned) of all radiomarked tortoises at Yucca Mountain was reevaluated. Specifically, high impact areas are now defined as those

areas that have been or will be disturbed by the North Portal facilities, South Portal, borrow pit, muck storage area, topsoil storage area, and General Support Facility (GSF) test pits, including a 200-m (660-ft) buffer zone around each site. Tortoises were assigned to the high impact population if more than 25% of their known locations during their active season (March through November) were within one of these areas. The classification of 17 adult tortoises changed, 14 of which were placed in the "area-wide" sampling population. Because this group already contains a number of radiomarked adults, transmitters will be removed from 10 tortoises as they emerge from hibernation in the spring of 1995.

While conducting work on these and other studies during 1994, 112 previously unmarked desert tortoises, including 58 hatchlings, were captured and marked. Radio transmitters were attached to 20 hatchlings and 17 older tortoises that were not previously radiomarked. Between 1989 and 1994, 486 tortoises have been captured and marked; 145 of these were hatchlings captured at nests. Transmitters have been attached to 277 tortoises. One hundred thirty-four of these radiomarked tortoises were still being monitored at the end of 1994. The remainder had died of natural causes (n = 46), were missing (n = 54), had lost their transmitters (n = 16), or their transmitters had been intentionally removed by biologists (n = 27). Figure 6-1 shows the last known location of all tortoises found more than one time on or near Yucca Mountain from 1989 through 1994.

Reproduction Study

The objectives of this study are to evaluate the effects of YMP activities on the reproductive success of the desert tortoise and to learn site-specific attributes of its reproduction at Yucca Mountain that may contribute to improvement of mitigation techniques and to preservation of the species at the YMP site.

Annual egg production of tortoises was compared among the three treatment populations. Nine adult females from the high-impact population, twelve from the area-wide population, and seven from the control group, were x-rayed every two weeks from early May

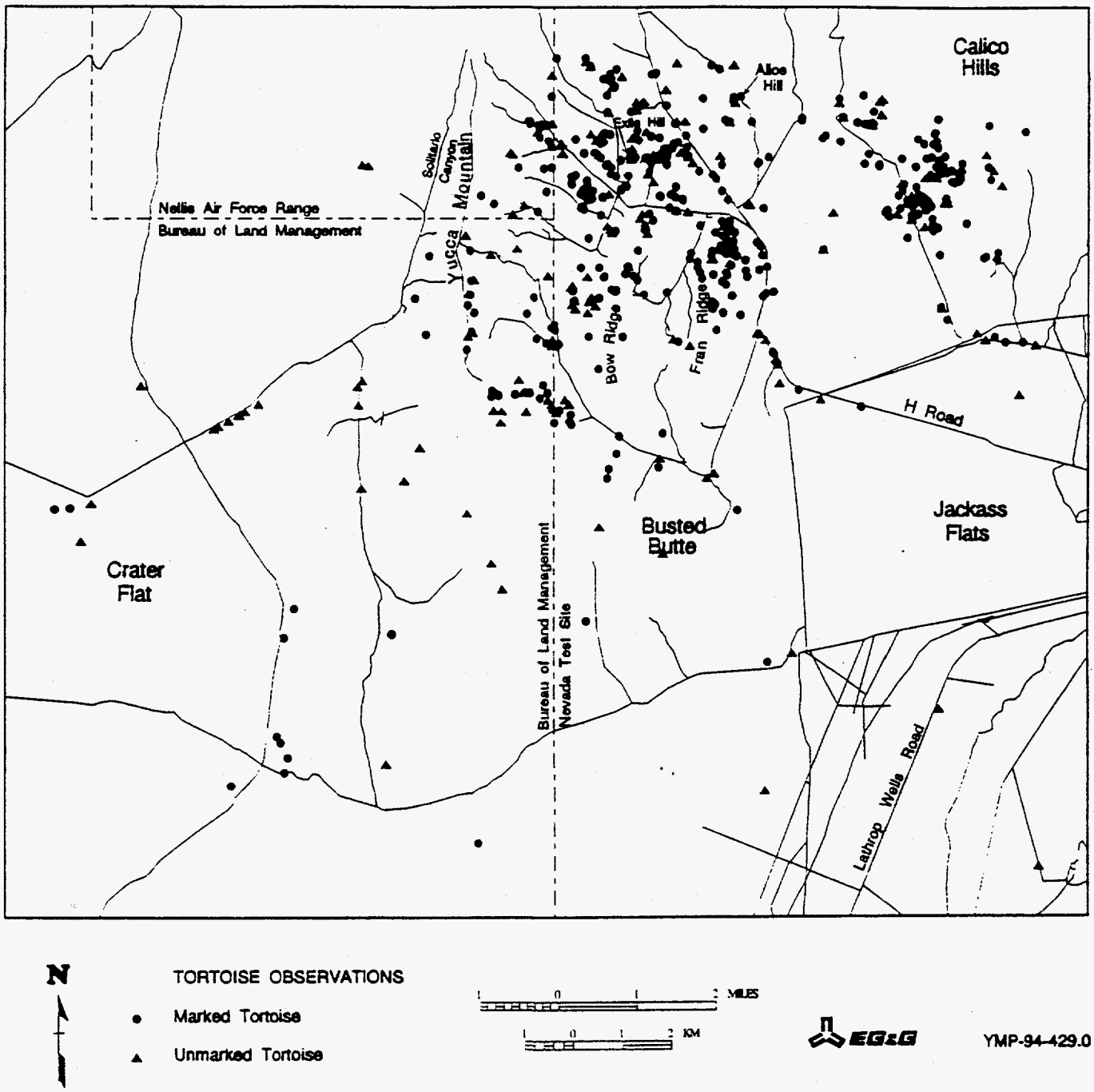

Figure 6-1. Most Recent Locations of all Tortoises Found More than Once at Yucca Mountain and in the Adjacent Control Area Between 1989 and 1994.

through early July. The average number of eggs produced per female was 8.0. No difference in egg production was observed between groups.

To improve the mitigation technique of searching for and relocating tortoise nests, threads were attached to gravid females and their movements tracked. Of 27 nests found, 22 were associated with burrows; the remainder were shielded by shrubs. Nests associated with burrows were not always inside the burrow (a range of 37 cm [14 in] outside the burrow to 49 cm [19 in] within the entrance).

To establish the time period during which one can expect to find nests, egg dates and incubation periods were determined. First clutches of eggs were laid between May 14 and June 12; second clutches from June 10 to 29. No tortoise laid more than two clutches. In 16 nests, the interval between egg-laying and emergence of the first hatchling ranged from 75 to 97 days (mean = 86 days).

X-rays of tortoises of different sizes revealed that the smallest egg-bearing female was 210 mm (8.4 in) in mid-carapace (shell) length. Tortoise size and the number of eggs produced (fecundity) were positively correlated.

Survival Study

To evaluate the effects of YMP activities on tortoise survival, three stages in the animal's life history were measured: egg (further divided into nest survival and egg viability), hatchling, and adult. Nests found during the Reproduction Study were checked once each week for signs of predation. Of 27 nests located (ten in the high-impact population, eight in the area-wide population, and nine in the control group), seven were destroyed by predators. Nest survival did not differ between populations.

Nests that were not destroyed contained 99 eggs: 44 in the high-impact population, 23 in the area-wide population, and 32 in the control population. Seventy-five eggs produced viable young. Egg viability did not differ among treatment groups.

Twenty hatchlings were fitted with radio transmitters. By the end of the year, four had died, one had lost its transmitter, and fifteen were believed to be alive in their hibernacula (winter burrows).

Of the 14 hatchlings from the 1993 cohort that were still being monitored that autumn, only eight were found alive in spring 1994. Two had died in their hibernacula and the other four were missing. By the end of 1994, only five of the eight survivors were being located. One remaining hatchling from the 1992 cohort died in 1994, probably from predation.

Improvements in tracking hatchlings were made in 1994 through the use of transmitters with greater reliability and power. As a result, no hatchlings were lost due to transmitter failure or movements out-of-range.

None of the 81 adult tortoises from the three treatment groups that were monitored in 1994 was known to have died. As of the end of the year, 75 were in their hibernacula. The remaining six were either missing or their transmitters had been removed. Two juvenile radiomarked tortoises died during 1994, one representing the second incidental take since site characterization began (see Roadway Monitoring Study, this Section).

Movements and Habitat Use Study

The objectives of this study are to evaluate the effects of YMP activities on the movements, habitat use, and behavior of desert tortoises; monitor the reaction of individual tortoises to disturbances within or near their home range; and study selected aspects of behavior and habitat use by tortoises to better conserve the species at Yucca Mountain.

Tortoises monitored for this study were located at least once every other week during hibernation and twice per week the rest of the year. The following parameters were measured in 1994: number of burrows used, number of new burrows used, percent of time active (i.e., walking, digging, feeding, etc.), length of hibernation, home range size, and shift in home range.

Several methods were tested for quantifying the movements of tortoises at Yucca Mountain, e.g., the maximum area used by tortoises during one year, and the areas tortoises used most frequently during a year (i.e., core area). The 100% minimum convex polygon method and the cluster method were chosen as most satisfactory for analyzing data from Yucca Mountain. Analytical comparisons between the three treatment groups will be completed in 1995.

To determine the period of the year during which tortoises near YMP construction activities should be monitored, the timing of hibernation was analyzed. From 1991 to 1993, the average date on which tortoises entered their hibernacula was October 23 (range of August 18 to December 7). Ninety-six percent of the animals were in hibernation before November 15. The average date by which the animals exited their hibernacula was March 24 (range of February 27 to May 4). Only 2% exited before March 1. Females both enter and exit hibernacula a few days earlier than males. Based on this information, monitoring tortoises at construction sites was not scheduled between November 15 and March 1.

Health Monitoring Study

To evaluate the effects of YMP activities on the health of the Yucca Mountain desert tortoise population, four sets of parameters -- growth, blood profiles, condition index, and exposure to upper respiratory tract disease (URTD) -- were monitored. Only data for the latter two parameters were compared for the three impact groups of animals. Methods for comparing growth and blood profiles are presently being developed.

The condition index, a parameter that relates mass to height, width, and length, primarily reflects the state of hydration of the tortoise. If YMP activities prevent tortoises from drinking or indirectly cause a decrease in the availability of water in plants, the effect might be detectable in the animals by means of the condition index. The index for the high-impact sample of tortoises (mean = 0.52) was slightly, but significantly (by ANOVA), higher than the values calculated for the area-wide and control groups (means of 0.50 and 0.48, respectively). It is possible, therefore, that more water was available to tortoises in the high-impact areas than to animals in the other treatment groups.

Using an Enzyme-Linked Immunosorbent Assay (Schumacher et al., 1993), blood collected from tortoises in June and September was assayed for the presence of antibodies to *Mycoplasma agassizii*, the probable etiologic agent of URTD. The proportion of tortoises within each test group that possessed antibodies was approximately the same. In June, antibodies were detected in 3 of 19 high-impact animals, 4 of 21 area-wide animals, and in 3 of 17 controls. In September, the ratios were, respectively, 5 of 25, 9 of 38, and 7 of 21. Two tortoises observed in 1994 demonstrated symptoms of URTD (e.g., wet nasal openings, cloudy eyes, and wheezing), bringing to five the number of animals at Yucca Mountain displaying symptoms since 1989. Blood was collected from four of these five tortoises. Tested for antibodies to *M. agassizii* in 1994, three sera were positive, one negative. Repeat tests of 40 samples yielded the same results.

Food Habits Study

Site characterization may alter plant communities by denuding plant cover and/or causing an increase in exotic plant species. Such changes may adversely affect the diet of the desert tortoise at Yucca Mountain. To determine the local tortoise diet, the relative nutritional and quantitative importance of various dietary components, and large-scale effects of YMP activities on the species' diet, tortoises were observed feeding, and scat samples from the

three sample groups were analyzed. During 89 feeding episodes in 1994, 18 plant species were observed being eaten. As in 1993, low trefoil (*Lotus humistratus*) and red brome (*Bromus rubens*) were the species most frequently consumed.

One hundred fifty fresh tortoise scats were collected during 1994, several from each of the three sample groups. Samples were biased toward females because scats were found while females were being tracked to their nests. In addition, females being transported for x-ray to determine egg burden often defecated. All scats were sent for microhistological laboratory analysis of plant species composition. Meanwhile, results were received during the year from the analysis of scats collected in 1992 and 1993. During 1992, desert globemallow (*Sphaeralcea ambigua*), trefoil (*Lotus* spp.) - lupine (*Lupinus* spp.), red brome, Arabian schismus (*Schismus arabicus*), and seed were present most often in samples (i.e., highest frequency of occurrence) and comprised most of the material in the samples (highest percent of composition). In 1993, desert globemallow, trefoil-lupine, borage (*Boraginacea* spp.), and grass components were present most often and in greatest bulk.

Impact Mitigation Study

For this study, areas in which the more extensive site characterization activities will occur are searched. All tortoises found are radiomarked and located approximately two to eight times per month for several months before activities are scheduled to begin. Information collected on the movements and behavior of these tortoises is used during the preactivity survey process to develop mitigation plans for protecting these animals.

Four study sites have been established since 1990. The first, in Midway Valley east of Exile Hill, was expanded in 1991 to include tortoises that might be impacted by the North Portal Facility. This site was redrawn in 1994 to include the proposed location of the GSF test pits and the new location for muck storage. At the same time, part of the original area was eliminated from the study because planned trenches will be smaller than anticipated. The second site, in Drill Hole Wash, was selected for purposes of monitoring tortoises that might

be impacted by activities (such as the subdock) that take place in the area originally proposed for the now-defunct ESF. The third site, at the southwest end of Midway Valley, includes tortoises in the proximity of the South Portal Facility and topsoil/muck storage areas. The fourth site is located at the borrow pit on the northeast side of Fran Ridge.

Changes in the area comprising the first study site (eastern Midway Valley) resulted in the elimination of eight tortoises as study subjects, leaving 12 to be monitored as of the end of 1994. Because activities in Drill Hole Wash, the second study site, have been scaled back, the resident tortoises will no longer be monitored for this Impact Mitigation Study. Some of the nine tortoises monitored there in 1994 may, however, be incorporated into other studies in 1995. Twelve tortoises were monitored at the third site (southwest Midway Valley) in 1994 and, at the end of the year, 17 were being monitored at the Fran Ridge site.

Displacement and Relocation Study

The Displacement and Relocation Study was designed to develop, implement, and test methods for moving potentially threatened tortoises from areas to be disturbed, and for minimizing impacts to both relocated and resident tortoises. Displacement is defined as moving tortoises within, or as close as possible to, their existing home ranges. Relocation is defined as moving an animal away from Yucca Mountain to a distant location such as Jackass Flats or Rock Valley. It was decided in 1993 that if more than 25% of a tortoise's home range was to be destroyed by a YMP activity, the animal would be displaced within its home range first or, as a second option, as close as possible to its home range. Tortoises will be relocated only if they persist in returning to construction sites or other unsafe areas after being displaced.

During 1994, eight desert tortoises were displaced, and none were relocated from construction sites at Yucca Mountain. All, with the exception of three hatchlings in a nest, were radiomarked before being moved. After being displaced, these animals were located at

least twice per day during land clearing and grading operations, and at least twice per week after land clearing had been completed.

One tortoise, moved in April 1994 to a point south of the borrow pit fence, had been removed twice in 1993. Another had to be removed twice in 1994 after returning to the water tank pad on Exile Hill. This latter individual, and another removed from the access road to the pad, eventually took up residence at the south end of Exile Hill, out of harm's way. Two other tortoises, found in the path of a road being cleared for seismic studies in Crater Flats, were moved 100 to 200 m (330 to 660 ft) and placed under shrubs. The three hatchlings were found in a nest in Midway Valley and were moved to an artificial nest 800 m (2624 ft) to the northwest. Each suffered deformities in its plastron and carapace. Should any of the three emerge from hibernation in 1995, it will be radiomarked and monitored.

Roadway Monitoring Study

The objectives of the Roadway Monitoring Study are to monitor sightings and mortalities of tortoises along roads and, if necessary, to develop, test and implement methods for reducing the potential for mortalities along roadways.

All personnel working at Yucca Mountain were required to report sightings of desert tortoises to the YMP Field Operations Center. Forty-four observations of tortoises on or along roads in the Yucca Mountain area were reported during the year, with an additional five on other roads used by YMP personnel. Most of the sightings occurred on the Lathrop Wells Road southwest of the Field Operations Center, on the SD-9 access road, and along the "H" Road extension leading from Jackass Flats to Midway Valley. Information derived from these reports is reviewed annually to identify mitigation measures needed to reduce mortalities.

Under the Incidental Take Provision issued by the USFWS as part of its Biological Opinion (McNatt, 1990) regarding the status of the desert tortoise at Yucca Mountain, the YMP is authorized to "take" as many as 15 tortoises during the period of site characterization.

("Incidental Take" is defined as any harassment, harm, pursuit, collection, wounding or killing of a tortoise attributed to YMP-associated human activity.) During 1994, one tortoise, a hatchling crushed by a vehicle on the unpaved access road to SD-9, represented the second incidental take of a tortoise at Yucca Mountain.

Raven Monitoring Study

A Raven Monitoring Study has been conducted each year since 1991 in compliance with requirements of the USFWS Biological Opinion (McNatt, 1990). Site characterization activities may cause an increase in raven (*Corvus corax*) abundance by creating new nest or roost sites (e.g., buildings, power lines) and food sources (garbage and road-killed animals). Since ravens are known to prey on small tortoises (Campbell, 1983; Esque and Duncan, 1985), an increase in ravens may adversely affect the tortoise population at Yucca Mountain.

This study was modified in 1994 because few ravens have been seen during past surveys (mean = 3.5 ravens per survey) and, to date, there is no evidence that ravens are impacting the tortoise population at Yucca Mountain. The number of survey days each month was reduced from five to three. Further, it was suggested that surveys be suspended altogether, with their reinstatement in the future should raven abundance appear to increase. It was decided to continue the survey for at least one more year because the planned increase in the construction of facilities at Yucca Mountain in 1995 may attract more ravens to the site.

Road surveys, 40 km (24 mi) in distance, were conducted simultaneously along a test route (YMP area) and a control route (Bare Mountain) every other month, ending in October 1994. Ravens were counted for one minute at stops spaced 0.8 km (0.5 mi) apart. Ninety-one ravens were counted along the YMP route, with 70 along the control route. Of these, 25 ravens along the test route and 5 along the control route were observed using man-made facilities or disturbances as perches, feeding sites, etc. Reclamation sites, flag poles at survey sites, and utility poles were the most frequently used objects or areas

associated with humans. Analysis by ANOVA revealed no statistical difference between the three survey years (October 1991 through October 1994) in the number of ravens observed. It appears that the YMP presence has not caused an increase in raven abundance at the site.

Ground Motion Effects Study

YMP activities such as blasting and seismic reflection studies will cause ground motion that may collapse tortoise burrows or alter tortoise behavior. To evaluate the effects of ground motion on tortoises and their burrows, and to obtain information needed to develop mitigation plans for future activities that cause ground motion, this study was initiated in 1993.

All radiomarked tortoises near activities causing ground motion were monitored during or immediately after these activities were conducted. Burrows were measured before, one week after, and six months after the ground motion event. Control burrows were also measured for comparison. The behavior of tortoises near, and distant from, the event was also compared.

In 1994, six months after the Windy Wash Seismic Study had been conducted (in 1993), 12 burrows were remeasured. Two burrows, one less than 50 m (164 ft) from the disturbance, and one beyond that distance, had collapsed. Meanwhile, measurements of 36 burrows located within 100 m (328 ft) of the sites of another study (Seismic Reflection Study) revealed no changes in the dimensions of the burrows one week after the activity occurred. These burrows will be remeasured in 1995. Since it is not uncommon to find naturally collapsed burrows similar to the two at Windy Wash, there are presently no results indicating that seismic activities have adversely affected tortoise burrows.

6.2.1.3 Habitat Reclamation Program

The objective of the Habitat Reclamation Program is to restore sites disturbed by YMP activities to a 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, reclamation trials, topsoil stockpile studies, and disturbed habitat studies.

Reclamation Inventories

A Reclamation Inventory is performed before the initiation of an activity at a site that is subsequently to be reclaimed. The resulting Reclamation Stipulation Report includes recommendations for salvaging, storing, and managing topsoil to prevent wind and water erosion, and for maintaining soil viability. In 1994, 18 reclamation inventories were conducted; a total of 34 separate sites were involved. Vegetative cover, soil depth, soil texture, and soil erodability were recorded for the Reclamation Stipulation Report.

Soil samples were collected at 29 of the sites and sent for analysis of physical and chemical properties to a commercial soil laboratory. Samples were not required from the remaining five sites because of their small area or their proximity to previously sampled sites.

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 objective of interim reclamation is to prevent erosion and to maintain a viable soil until activities are completed and the site is released for final reclamation.

In 1994, 50 topsoil stockpiles resulting from site characterization activities were stabilized (48 of them existed prior to 1994). Twenty-three stockpiles were treated with only

the chemical soil stabilizer, Soil Master WR™. Twenty-one received seed only. Six received Soil Master WR™ first, then were seeded later.

Four sites were released for final reclamation in 1994: Trench NRT-1, Borehole UZN #85, the C-well discharge line, and the Large Rocks collection site. Following site preparation, these sites were seeded in December 1994 with a mixture of native plant species, then mulched with straw and stabilized with a chemical tackifier. Seedling density and plant cover will be monitored yearly.

Reclamation Monitoring

In 1994, both interim reclamation sites and final reclamation sites were monitored. Of the former, 48 were topsoil stockpiles and 13 were neutron boreholes. All 61 sites had been revegetated in either 1992 or 1993. Thirty-one of the 48 topsoil stockpiles required additional erosion control in 1994, with 22 being re-treated with Soil Master WR™ and nine being reseeded and mulched.

The final reclamation sites monitored were Well JF-3 and Trench A'2, both released for final reclamation in 1992, and 35 GSF test pit sites, released in 1993. At JF-3, a study was initiated in 1993 to determine the effects of polyacrylamide gel (as a soil amendment) and mulch type (straw versus gravel) on the emergence and establishment of perennial plants. Seedling density measured in April 1994 was compared with similar data from May and September 1993. Results to date suggest that polyacrylamide gel, with its water-holding capacity, may be beneficial to emerging seedlings. Gel may not, however, reduce seedling mortality or improve the recruitment of seedlings the second spring season. Straw mulch appeared superior to gravel mulch in enabling plants to survive the rigors of a desert summer and in the recruitment of new seedlings, but did not necessarily enhance the emergence of seedlings. Indian ricegrass (*Oryzopsis hymenoides*) and Nevada ephedra (*Ephedra nevadensis*) were the species that fared best in most revegetation situations.

Due to low seedling densities at Trench A'2 since the onset of experiments in 1992, containerized plants were transplanted onto the site in March 1994. To determine whether polyacrylamide gel would enhance survivability, 10 grams (0.35 ounce) of gel were added to half of the transplant holes. Transplants, consisting of seven species, were watered one week and four weeks after planting. Percent survival was monitored in July. Survival rates were high for all species, and the presence of gel seemingly made little difference (85% survival with gel, 88% survival without). Continued monitoring may reveal that transplants are a useful option for reclaiming disturbed lands in the YMP area.

The remaining final reclamation sites to be monitored in 1994 were 35 GSF test pits (each approximately 9 m^2 [97 ft^2] in area) and the disturbed surface surrounding each pit. Seeding occurred in November 1993 and seedling emergence was noted in the spring and fall of 1994. Though seedlings were present in spring, few survived the summer. Erosion was not a problem, but higher than normal temperatures or browsing by lagomorphs (jackrabbits and cottontails) may have been responsible for the loss of plants. A decision whether to reseed the sites will be made in 1995.

Reclamation Trials

Reclamation field trials are being conducted to evaluate site-specific reclamation techniques. Results of these experiments will be used to modify and improve methods of stabilizing and revegetating salvaged topsoil once a site characterization activity has been completed. In 1991, five previously disturbed sites were selected as locations for reclamation trials. All four major vegetative associations (Section 2.2.4) are represented among these sites, which were disturbed to establish drill pads, borrow pits, scraped areas, road beds, and staging areas.

Field studies commenced at two of the sites in 1992 and were extended to two others in 1993. In 1994, studies were initiated at the fifth trial site and at two additional demonstration plots. The factors being examined are seeding methods, seeding rate, and

mulching; the influence of soil quality, soil depth, and soil amendments on seedling emergence, seedling density, and long-term (more than 5 years) survival; and the enhancement of seed germination and seedling establishment through the use of water harvesting techniques (e.g., land imprinting and pitting).

To explore the influence of soil quality and soil depth on seedling emergence and plant establishment, two soils (one a subsoil or "poor soil," the other a mix of subsoil and topsoil or "good soil") were spread over plots at one reclamation trial site in four depths (5, 15, 25, and 35 cm [2, 6, 10, and 14 in]). Plant densities in May 1994 (i.e., one year after seeding with 14 species) indicated that greater numbers of seedlings were produced in poor soils, especially at a depth of 15 cm (6 in), than in good soils. At greater depths, results in the two soil types were comparable.

In another study at the same site, two soil types (topsoil/subsoil mix, and fill material) at two depths (5 and 20 cm [2 and 8 in]) were supplemented with amendment combinations consisting of organic matter (chopped alfalfa), polyacrylamide gel, and gel plus organic matter. A seed mix containing species found in the adjacent plant community was broadcast onto these plots. Average seedling density was determined in June and September 1994. Results indicate that fill material (i.e., subsoil), regardless of soil amendment, supported eight to ten times more plants than did native topsoil, regardless of its amendment. Seedling density was generally higher in 5-cm depth plots than in 20-cm plots, but survival from June to September was greatest in the 20-cm fill plots. It appears that amended fill soil may be a viable alternative to native topsoil for plant establishment at sites lacking topsoil.

In a related study, the effect of topsoil depth and mixing on plant establishment was explored. Topsoil (5, 10, 15, and 20 cm [2, 4, 6, and 8 in]) was either mixed into subsoil or layered on top with no mixing. As in previous tests, the 5-cm depth soil yielded the highest plant numbers, with mixing into the existing subsoil being the most beneficial technique.

In previous seeding studies at Yucca Mountain, only 30 to 60% of seedlings present in spring survived the summer months. A study was initiated in December 1994 to establish the optimal seeding rate and seeding method for increasing the number of seedlings that survive the summer. On a disturbed plot 80- x 50-m (262- x 164-ft) in area, three rates of seeding (21, 42, and 84 kg of pure live seed [PLS]/ha or 46, 92, and 185 pounds [lb] of PLS/2.5 acres) and three seeding methods (drill seed, broadcast seed, and drill seed/broadcast seed) were tested. After the plots were seeded, the entire site was mulched with straw, and M-Binder was added to hold the mulch in place.

A comparison of fenced and unfenced plots was initiated in 1994 to determine whether two-year-old plants can withstand browsing by lagomorphs and whether fencing will improve plant cover on previously revegetated areas. Plant density and cover will be measured in 1995 and compared with earlier data that indicated that excluding lagomorphs by fencing increased vegetative cover.

Techniques such as land imprinting and pitting modify the soil surface, allowing precipitation to accumulate. A study combining these methods with soil ripping, topsoil application, seeding, and mulching suggested that such water harvesting techniques offered no advantages, at least in the short term. In fact, seedling emergence was hindered when imprinting was used, perhaps due to soil compaction. The test plot employing planting and mulching followed by topsoil ripping (with no imprinting) yielded four times as many seedlings as the plots using imprinting.

Three experiments to explore irrigation strategies were implemented in 1994. One, established to evaluate the effects on seedling emergence and plant establishment of seeding date, irrigation at time of seeding, and amount and timing of irrigation events after seeding, failed because no seedlings grew. The quality of the irrigation water appeared to be satisfactory but it is possible that the application of large quantities of water in a relatively short time period compacted the soil and prevented seedling emergence.

The other two irrigation experiments are designed to yield results in 1995. The first, implemented at a topsoil stockpile adjacent to the concrete batch plant, will determine which of three broadcast-seeding rates (10, 21, or 42 PLS kg/ha or 22, 46, or 92 lb/2.5 acres) will ensure adequate plant establishment when irrigation is used. The second, established at the ESF topsoil stockpile site, will examine the effects of irrigating before the growing season, during germination, and after germination, on plants (a mix of 15 species) seeded and mulched two different ways.

Because some cut slopes at Yucca Mountain are too steep to access with conventional reclamation equipment, alternative reclamation methods are being evaluated. In December 1994, a study was initiated that will compare two seeding methods that may be suitable for slopes (hand broadcast and hydroseeding) and two methods of stabilizing straw mulch on a slope (plastic netting or chemical binding agent). Seed mixes consist of species comprising the surrounding vegetation association. Seedling densities will be monitored in 1995.

Topsoil Stockpile Studies

Studies were undertaken at two sites at Yucca Mountain in 1993 to determine the effects on topsoil of stockpiling. Results of studies elsewhere indicate that prolonged stockpiling disrupts nutrient cycles, reduces organic matter, increases bulk density, and disturbs soil microbial populations. It is possible that topsoil that is to be stored for more than six months at Yucca Mountain should be revegetated to maintain microbial viability.

One topsoil stockpile was created from soil removed prior to excavation of Borrow Pit #1; the other consists of topsoil removed in the construction of the NRG-6 drill pad. Soil samples have been collected for analysis from five depths in the first stockpile, and from four depths in the second. In both cases, soil was also collected from undisturbed areas adjacent to each pile to provide baseline information. Sampling frequencies have differed for the two stockpiles: eight sampling events within 420 days of completion of the Borrow Pit #1 pile, and three sampling events within 560 days of completion of the NRG-6 pile. Parameters

being analyzed in these samples are total and active bacteria, total and active fungi, nematodes, mycorrhizal spores, CO_2 respiration, and physical/chemical properties.

To evaluate the effect of plant species on the above parameters, the Borrow Pit #1 stockpile (1.9 ha [4.7 acres] and 2 m [6.6 ft] deep) was seeded with four combinations of plant species. Simultaneously, one-half of the NRG-6 pile was seeded with a mix of grass and shrubs while the other half was seeded with shrubs only.

Results to date have focused on bacterial biomass. The bacterial population (measured as active bacterial biomass per mg of dry soil) in the Borrow Pit pile was low at 40 days at all depths but rose substantially between 60 and 90 days, dropping again until approximately day 200. Numbers of bacteria increased somewhat between 200 and 400 days. With the exception of one sampling period (between 60 and 90 days), active bacterial biomass at all depths in the stockpile was lower than in undisturbed soil (control). Bacterial biomass, greatest in the top meter (3 ft) of the pile, generally decreased as depth of the stockpile increased.

Bacterial responses in the NRG-6 stockpile were slightly different from those in the Borrow Pit pile. The top portion of the pile (0 to 20 cm [0 to 8 in]) registered the lowest active bacterial biomass, relative to all other depths, at each sampling event. Reasons for this difference will be explored. At 400 and 560 days, the active bacterial biomass at all depths in the pile was significantly less than that in the undisturbed soil.

Disturbed Habitat Study

This study was designed to inventory past disturbances, identify dominant plant species on disturbed sites as candidates for use in revegetation efforts, and describe plant succession at Yucca Mountain. Fifty-seven disturbed sites greater than 0.012 ha (0.03 acre) in area were identified. The study commenced in 1991 and, in 1994, results of the research were reported (Angerer et al., in press).

Vegetation on disturbed sites, after an average of ten years, was quite different from that found on undisturbed areas. Dominant species across all disturbed sites were white bursage (*Ambrosia dumosa*), needleleaf rabbitbrush (*Chrysothamnus teretifolius*), burrobush (*Hymenoclea salsola*), snakeweed (*Gutierrezia sarothrae*), shadscale (*Atriplex concertifolia*), fourwing saltbush (*A. canescens*), and wirelettuce (*Stephanomeria pauciflora*). With the exception of white bursage, these species are usually minor components of the vegetation found in undisturbed areas. Significant environmental variables influencing plant succession were elevation, soil compaction, soil potassium, and amounts of sand and gravel in soil.

Estimates of the recovery rates for secondary succession at the disturbed sites were calculated. Using a linear function (i.e., assuming optimal conditions), the recovery rate for perennial plant cover, regardless of the species involved, was 20 years. Using a logarithmic function (representing the most probable conditions), the estimated time for recovery was approximately 800 years.

6.2.1.4 Monitoring and Mitigation Program

Important species are those listed by the USFWS or the State of Nevada as threatened or endangered, or those 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 initiation of land-disturbing activities. As a result of these preactivity surveys, additional mitigation measures such as resurveys or continuous monitoring may be recommended. Subsequently, upon completion of a land-disturbing activity and before a site is declared ready for reclamation, a postactivity survey is usually conducted.

Because a proposed YMP activity may disturb more than one site, several surveys may be required for each survey request. Sixteen preactivity survey requests required surveys of

27 separate sites during the year. Approximately 252 ha (622 acres), including 2.8 ha (7 acres) along 1.4 km (0.8 mi) of road were surveyed. Thirty-five percent of the total area surveyed was for the ESF. Seven tortoises were found. Cacti, protected by the State of Nevada, were observed at three sites.

As a result of these surveys, 19 recommendations were made for purposes of minimizing the possibility of harming tortoises. These included 16 recommendations to conduct resurveys for tortoises immediately prior to construction, three to monitor radiomarked tortoises during construction, and one to move tortoises prior to construction. An additional recommendation was made to place netting over the proposed ESF mine wastewater pond to prevent birds and other wildlife from using the water in any way. No recommendations were made to move or modify proposed activities to avoid ESPs.

Resurveys were conducted for 16 activities at 42 separate sites one to ten days prior to the commencement of ground-clearing operations. Mitigative actions included collapsing 16 unoccupied burrows, displacing three tortoises from construction areas (see Displacement and Relocation Study, this Section), and monitoring radiomarked tortoises at the sites affected by four activities. No tortoises entered construction areas once activities had begun.

Postactivity surveys were conducted for five activities that were completed in 1994. The actual area disturbed by two of these five activities was slightly greater than had been anticipated (0.2 ha [0.5 acre] more in one case, 1 ha [2.5 acre] more in the other).

6.2.1.5 Biological Sample Collection

The objectives of this program are to collect plant and animal specimens for the determination of radionuclide concentrations in tissues, and to monitor populations of the animal species being collected (or that may be collected in the future) for this purpose. This program was not funded in 1994. Nevertheless, though no specimens were collected, monitoring of lagomorphs and predators continued.

Lagomorphs

Because lagomorphs are primarily active at night, spotlight counts were chosen to monitor population abundance. Such surveys can also provide supplemental data regarding the abundance of predators. A control route (31 km [18.6 mi] in Crater Flat) and a Yucca Mountain route (40 km [24 mi]) were each driven on three successive nights in July and August 1994. The number of observed lagomorphs decreased in 1994, relative to 1993. Average numbers of lagomorphs counted per 10 km (6 mi) traveled at Yucca Mountain and Crater Flat, respectively, were 14.3 and 6.9. By contrast, the average numbers a year earlier were 18.3 and 17.1, respectively. This decline was probably the result of decreased precipitation during 1994 and the corresponding reduction in forb and grass production. Most observations (92%) were of black-tailed jackrabbits (*Lepus californicus*); the remaining 8% were desert cottontails (*Sylvilagus audubonii*).

Kit foxes (*Vulpes velox macrotis*) and coyotes (*Canis latrans*) were observed at least once during each survey. One bobcat (*Lynx rufus*) was seen during the August survey in Crater Flats.

6.2.2 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 21 archaeological preactivity surveys of areas proposed for Project activities were made during the past year (Section 3.1.7). Surveys of YMP areas resulted in the identification and recording of 93 new historical properties.

DOE archaeological support contractors have 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 1994, a total of 28

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.

6.2.3 Air Quality

In accordance with the requirements of the air quality permit issued by the State of Nevada in 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: NTS-60, 40-Mile Wash, WT-6, and Gate 510 (Figure 6-2). To assess the precision of measured concentrations, two collocated PM_{10} samplers are operational at the NTS-60 site.

As of the end of 1994, 42 months of particulate matter data had been processed to meet the requirements of the air quality permit. Figure 6-3 summarizes the 1994 data for the sites. During this period, the highest reported value for a 24-hour period was 42 micrograms (μg)/m^3, well below the 24-hour ambient air quality standard of 150 μg/m^3. The average of all 24 hour periods was 9 μg/m^3, also below the annual ambient air quality standard of 50 μg/m^3.

6.2.4 Meteorology

The meteorological program was initiated by the YMP in December 1985 as an environmental monitoring network. This network originally consisted of five monitoring sites: NTS-60, Yucca Mountain, Coyote Wash, Alice Hill, and 40-Mile Wash (Figure 6-2). The program was subsequently modified to provide additional information for site characterization activities. Three sites were added to the network in 1992: WT-6, Sever Wash, and Knothead Gap. The G-510 site was added in 1993.

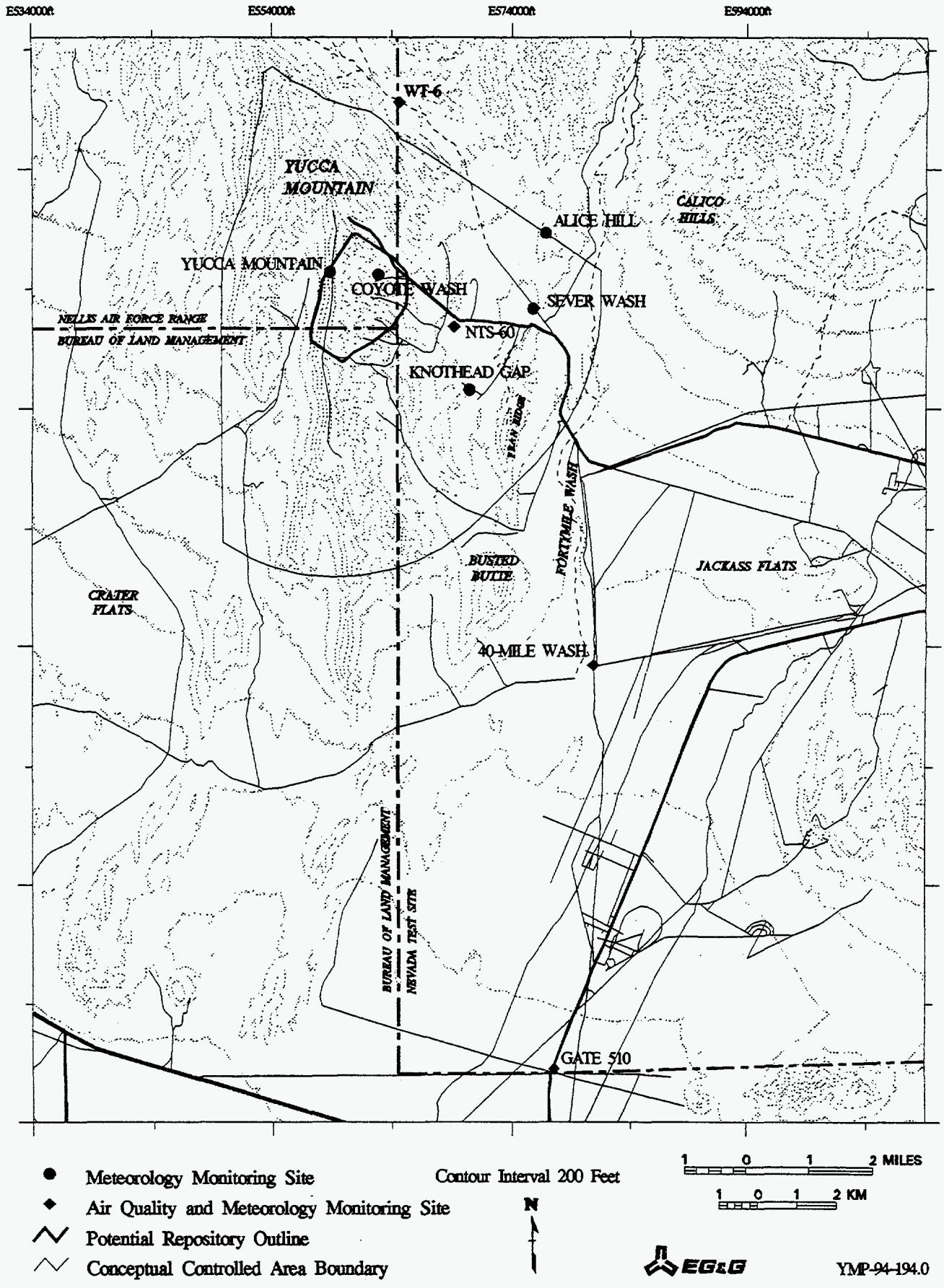

Figure 6-2. Meteorological and Ambient Monitoring Sites

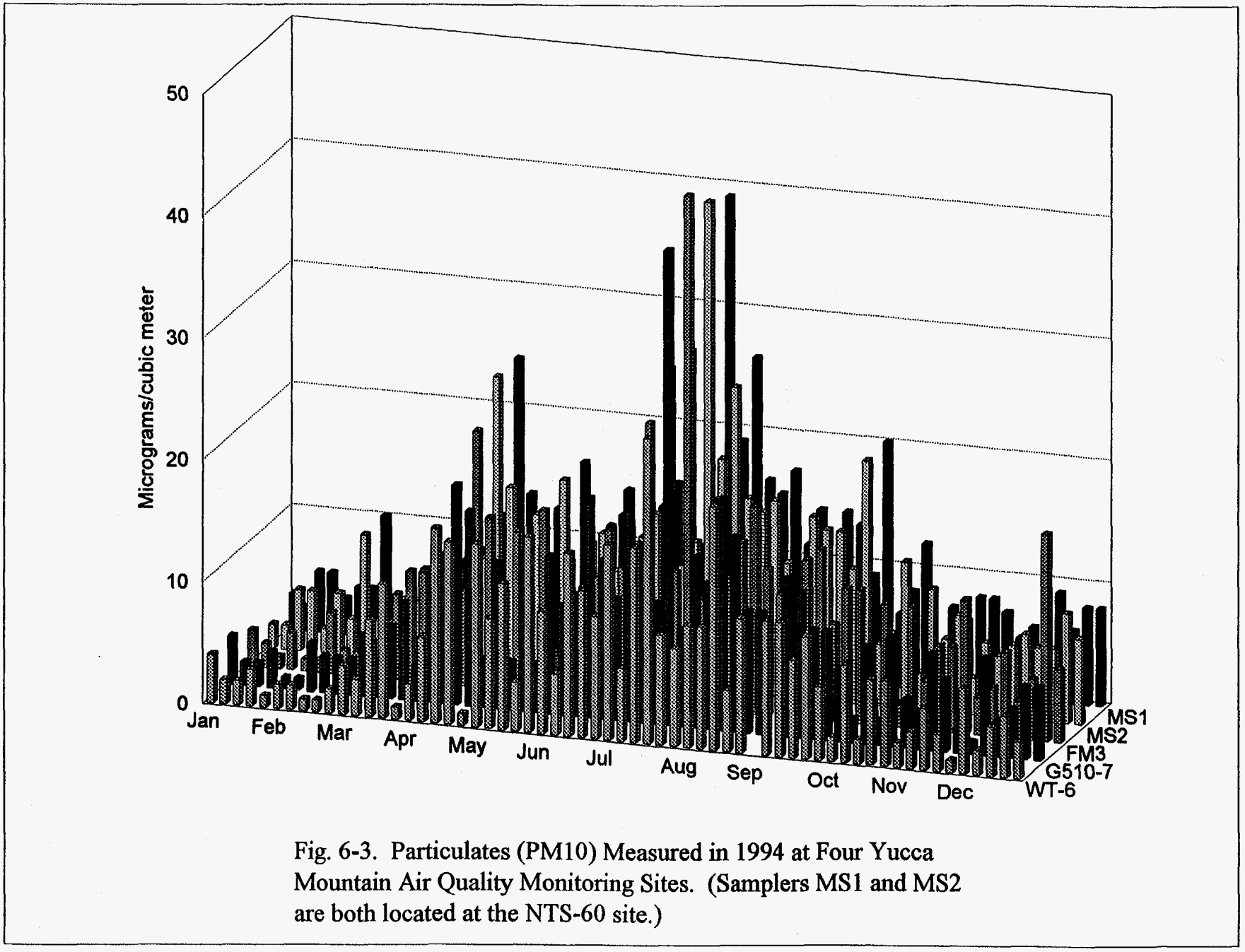

Fig. 6-3. Particulates (PM10) Measured in 1994 at Four Yucca Mountain Air Quality Monitoring Sites. (Samplers MS1 and MS2 are both located at the NTS-60 site.)

The meteorological monitoring equipment and operation methods used comply with EPA Prevention of Significant Deterioration (PSD) regulations and guidelines. The NTS-60 site, with its 60-m (197-ft) tower, is instrumented to measure and report several parameters at four tower levels (Table 6-1).

Table 6-1. Parameters Measured and Type of Data Reported at the 60-meter Meteorological Tower at Yucca Mountain (NTS-60 Site)

Level	Parameter	Report (Hourly Values)
60-meter	Wind Speed Wind Direction (WD) Temperature	Wind Speed Wind Direction Temperature Difference (60m-10m) Std. Dev. of WD (sigma-theta)
10-meter	Wind Speed Wind Direction Temperature Vertical Wind Speed (VWS)	Wind Speed Wind Direction, and Std. Dev. of WD (sigma-theta) Temperature Difference (10m-2m) Std. Dev. of VWS (sigma-w)
2-meter	Temperature Dew-Point Temperature Solar Radiation	Temperature Dew-Point Temperature Solar Radiation
Surface	Barometric Pressure Precipitation	Barometric Pressure Precipitation

Each of the other sites is equipped with a 10-m (33-ft) tower instrumented to measure and report the same parameters listed in Table 6-1 for the 10-m, 2-m (6.6-ft), and surface levels, with one exception: relative humidity is measured and reported instead of dew-point temperature.

The primary use of the data from all sites is to characterize atmospheric transport of airborne radionuclides and other materials. Depending upon the location of these sites, the acquired data will serve additional purposes. For example, data from the NTS-60 site can be used to assess possible impacts associated with site characterization and/or repository operations. Data from the 40-Mile Wash and G-510 sites will indicate airflow pathways between the Midway Valley site characterization area and the Amargosa Valley area to the south. The Sever Wash site is important for monitoring both up-valley daytime winds and nighttime drainage flows through Midway Valley. The Knothead Gap site will monitor winds in the south end of Midway Valley.

The meteorological program also performed special nighttime cold air drainage studies for site characterization, in conjunction with two National Oceanic and Atmospheric Administration groups (DOE, 1995b). Nocturnal airflow from Yucca Mountain toward the west and south through Crater Flat, and toward the east and south through Jackass Flats toward Amargosa Valley, was investigated. Results revealed that air layers near the surface in downvalley airflow patterns were stable. Airflow above the near-surface layers was complex, however, with stable layers at times flowing in directions different from the simple downvalley pattern. Additional studies of these flows are planned.

6.2.5 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.

6.2.5.1 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 36 wells over time (Figure 6-5). 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, that of measuring groundwater discharge (or in-flow) into five springs. 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.

Routine data collection commenced in February 1992. Initially, measurements were made monthly at wells and quarterly at springs. The frequency of data collections is being revised, however, as evaluations of water-level and spring-discharge data are completed. In a few instances in 1994, wells were measured quarterly and springs monitored monthly. As testing demands have dictated, some wells have even been monitored as often as hourly.

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 U.S. Geological Survey (USGS) indicate that

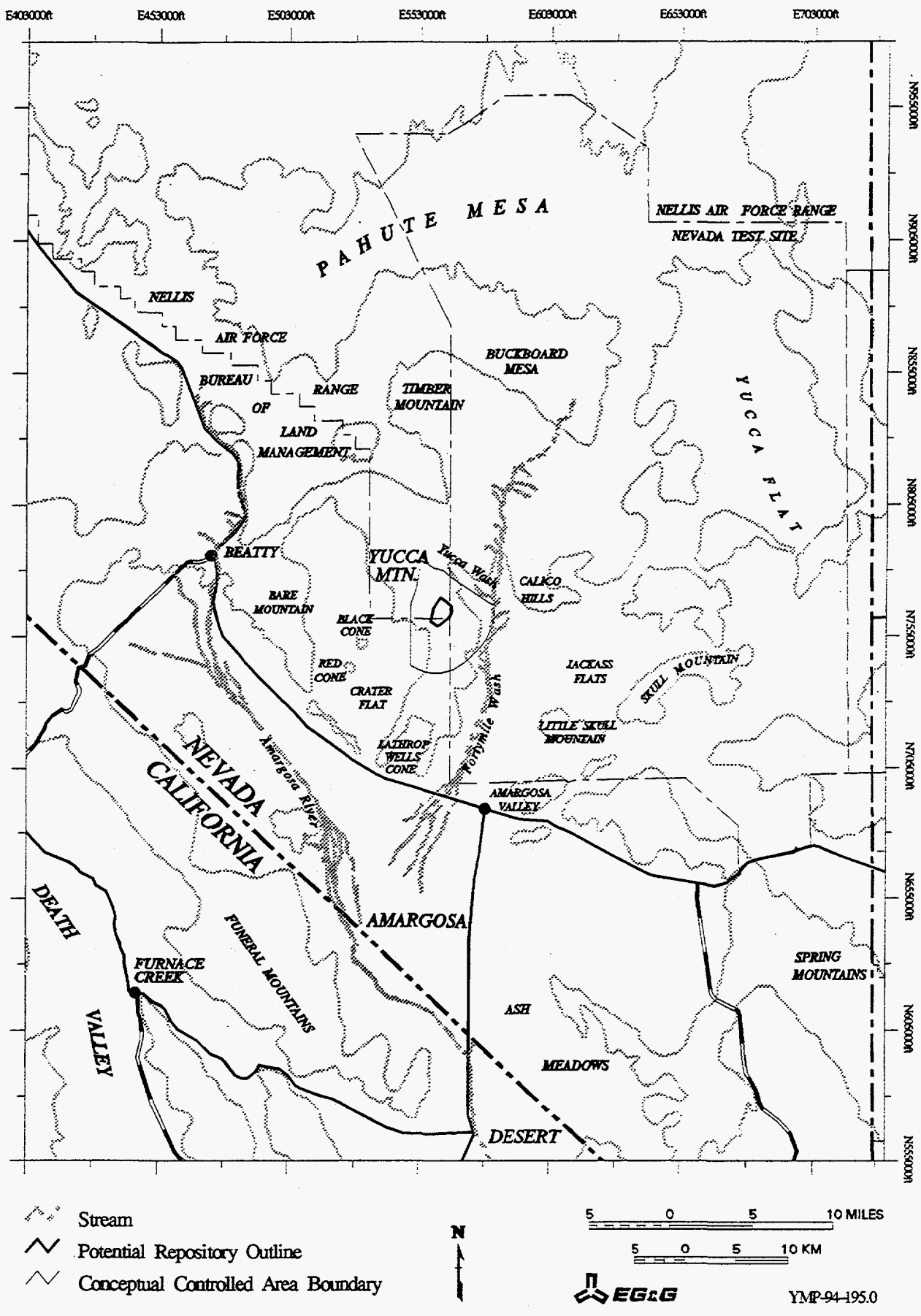

Figure 6-4. Study Area for the Yucca Mountain Project Water Resources Program

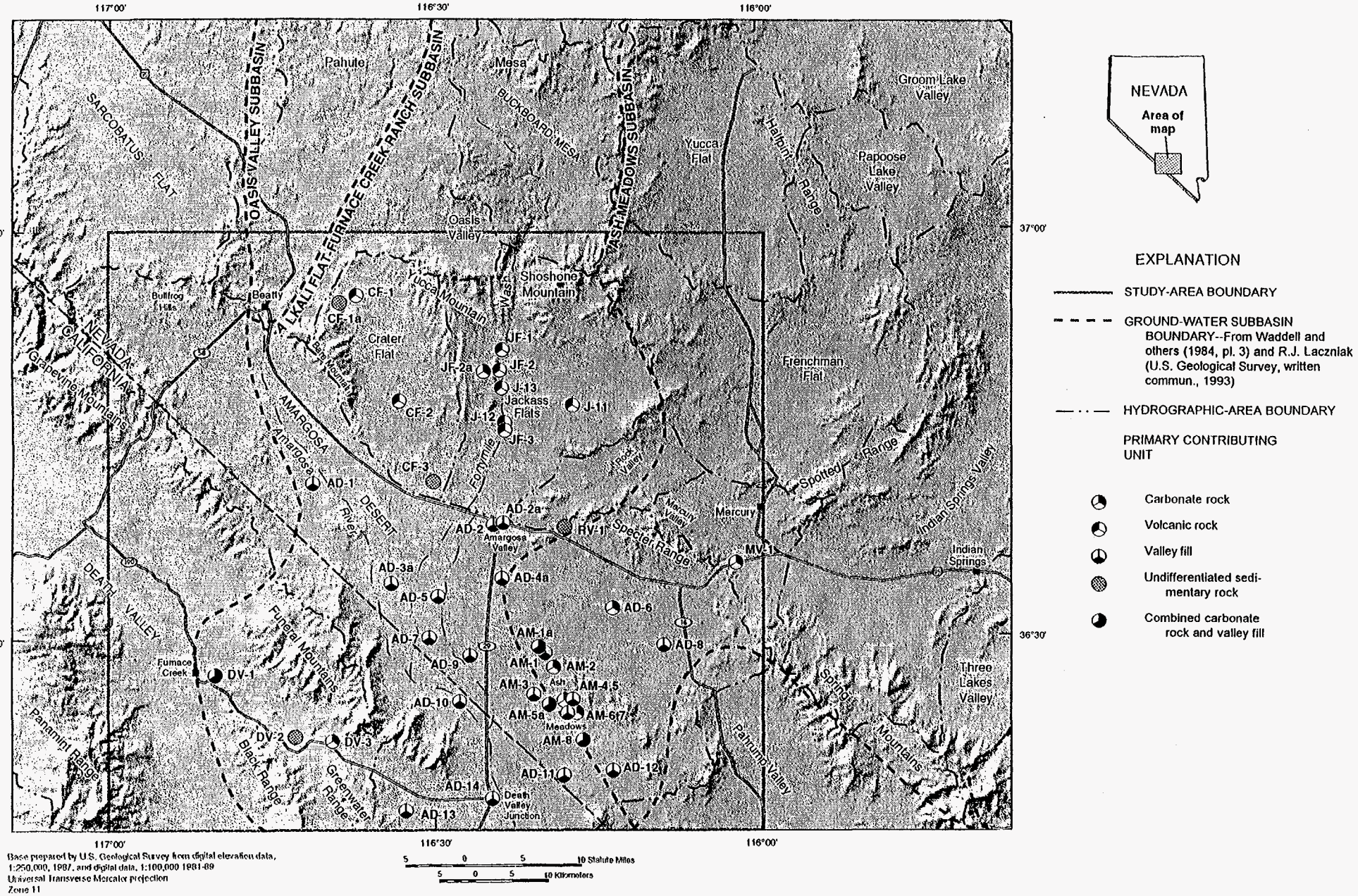

Figure 6-5. Groundwater Level and Discharge Monitoring Sites in the Yucca Mountain Region, Southern Nevada, and Eastern California

fluctuations in water levels in these three wells (JF-3, J-12 and J-13) during 1994 ranged from 0.15 to 0.38 m (0.49 to 1.24 ft) (USGS, 1994a,b,c,d). The ranges in water levels (expressed as meters and feet below land surface) and fluctuations in each well were as follows:

JF-3: 216.40 to 216.55 m (709.96 to 710.45 ft); difference (Δ) of 0.15 m (0.49 ft).

J-12: 225.35 to 225.73 m (739.33 to 740.57 ft); Δ of 0.38 m (1.24 ft).

J-13: 282.81 to 283.00 m (927.86 to 928.47 ft); Δ of 0.19 m (0.61 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.

6.2.5.2 Water Quality Monitoring

A draft water quality monitoring plan, prepared by the USGS, has been reviewed by the YMSCO. This plan describes a program designed to (1) provide a comprehensive water quality baseline to support the preparation of an environmental impact statement for a potential repository; (2) assess possible impacts on groundwater quality of site characterization activities; and (3) comply with Federal and State laws and regulations and applicable DOE Orders.

It is recognized that it may be necessary to modify and refine this program as the processes and features that control groundwater flow beneath Yucca Mountain are better understood. Based upon present knowledge, the water quality sampling program will be divided geographically into three components: site, subregional, and regional. Though the identification of sampling locations is still tentative, it is anticipated that the initial selection of candidate sites will include several existing boreholes. The site component of the program

will be concerned with determining existing baseline water quality parameters within the conceptual controlled area at the Yucca Mountain site. Initially, sampling at the site monitoring locations will be conducted at least quarterly. The subregional component will consist of sampling locations out to approximately 25 km (15 mi) from the site, to be sampled on a semi-annual to annual basis. For the first year, however, more frequent sampling may occur for purposes of establishing baseline conditions. The regional component will involve sampling at least annually at locations used in previous regional studies. Included will be areas of known groundwater discharge from regional aquifer systems, specifically, the springs at Ash Meadows and in Death Valley National Park.

Initial sampling at all locations will be comprehensive and will include analyses for major inorganic constituents, trace elements, radiochemicals, gross alpha-particle and gross beta-particle radioactivity, nitrogen compounds, extractable acid and base/neutral organic compounds, purgeable organic compounds, selected herbicides and pesticides, microorganisms, and turbidity. Although organic compounds are not expected to be present in the groundwater at Yucca Mountain, it is necessary to establish baseline concentrations in order to detect such compounds should they be introduced as a result of site characterization activities. Baseline radiochemical data are needed for both naturally occurring and anthropogenic radionuclides to detect the possible presence of radiochemicals in groundwater at Yucca Mountain and in the Yucca Mountain region resulting from nuclear weapons testing at the NTS. Analyses for herbicides and pesticides may be limited to those compounds commonly applied for agricultural purposes in southern Nevada.

Once baseline water quality conditions have been established, this comprehensive list of constituents may be reduced on a location-by-location basis for subsequent monitoring and analysis.

6.2.6 Soils

Although an EFAP for Soils has been issued (DOE, 1990d), work has been delayed by budgetary uncertainties. The soils study effort, once underway, will provide information mainly for the reclamation and terrestrial ecosystem monitoring programs. A few preliminary studies have been initiated, however, for purposes of characterizing soil properties for reclamation trial programs.

6.3 ENVIRONMENTAL OCCURRENCES

During 1994, three new reportable petroleum releases occurred at Yucca Mountain as a result of YMP activities. The releases, of approximately 76 to 95 liters (20 to 25 gallons) each, occurred at the NRG-7 drill site, Borrow Pit #1, and a location in Area 6 of the NTS. All of the releases were reported to the NDEP within 24 hours of evaluation of the release, as required by law. Additionally, remedial action was performed at each of the release locations. This included characterizing the release using EPA Analytical Method 8015 (modified) to determine Total Petroleum Hydrocarbon (TPH) concentration, and initiating excavation of the impacted soils. The excavated soils removed from NRG-7 and the location in Area 6 have been disposed of at an off-site commercial bioremediation facility permitted by the State of Nevada. Excavated soils from the Borrow Pit #1 release are currently stored in metal drums awaiting final disposal.

7.0 GROUNDWATER PROTECTION

At the present time, the YMP groundwater protection program consists of the monitoring activities presented in Section 6.2.5 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 formal Quality Assurance (QA) programs. These QA programs cover all aspects of monitoring, sampling, analysis, and subsequent data reduction operations in order to produce scientifically valid, traceable, and defensible data.

The QA program implements basic and supplementary requirements of consensus standard ANSI/ASME NQA-1-1989, as invoked through the Office of Civilian Radioactive Waste Management (OCRWM) Quality Assurance Requirements and Description (QARD) document.

Applicable quality control requirements are also imposed on subcontractors and vendors through a qualification process. Quality controls ensure that equipment, devices and services, which directly affect the quality of data, are procured only from qualified suppliers.

Effective implementation of the quality programs have been confirmed and are regularly monitored through independent audits and surveillances.

Controls to ensure data quality are executed though the following practices:

- Documented training and qualification of personnel prior to work initiation.
- Reviews of procedures before approval for use.
- A verbatim compliance policy for work performance, in accordance with approved procedures.

- Use of standards traceable to the National Institute of Standards and Technology (NIST) for instrumentation calibrations and performance checks.

- Regular calibration of instruments used for monitoring, sampling, analysis, and analysis and counting.

- Mandatory documentation of nonconforming conditions potentially affecting data quality, with a structured corrective action process.

- Technical data review prior to data reduction/analysis and reporting.

- Verification assessments of computer software used for data reduction/analysis and before reporting.

- Independent equipment performance audits, and audit/surveillance activities of program compliance.

8.2 SAMPLE CONTROL

All environmental samples were controlled in accordance with approved procedures. The procedures specify methods of sample collection, handling, chain-of-custody control, and analysis and reporting. Samples were uniquely identified by markings either on the sample or its packaging. Technicians were personally responsible for protecting samples against loss or contamination. Sample transactions were documented on either a "Chain-of-Custody" form for external transfers or a "Sample Transfer" form, if transferred internally. Transfer recipients verified the proper condition and identity of samples before accepting custody.

8.3 SAMPLE ANALYSIS

Analyses of samples were conducted in accordance with approved protocols based on standard methods. Personnel performing analyses and measurements were specifically trained for their work assignments.

Where feasible, analysis programs selectively used blanks, spikes, and replicate analyses to better determine accuracy and precision of methods and to eliminate bias. Subcontractors who measured or analyzed samples were required to establish an equivalent control system. Results of measurements and analyses were reviewed and approved by technically qualified personnel prior to use in reports.

8.4 INSTRUMENT CONTROL

Instruments used to monitor, test, sample or measure environmental conditions were procured, controlled, maintained and calibrated in accordance with approved procedures. Measuring and Test Equipment (M&TE) and calibration standards used to ensure instrumentation accuracy are traceable to NIST. Calibration frequencies were established and maintained based on recommendations of the manufacturers; however, provisions are made for frequency adjustment commensurate with reliability experience.

Monitoring equipment was subjected to independent performance checks to determine adherence to EPA and YMP operation specifications. Equipment was routinely checked by trained field technicians, and appropriate maintenance and adjustments were made to optimize data collection performance of the instruments. Out-of-tolerance conditions were documented and resolved by either recalibration, rework or replacement. Data affected by nonconforming hardware operations were reported, identified and flagged as "indeterminate" until resolution of the condition.

8.5 DATA MANAGEMENT

Recorded monitoring and sampling data were handled in accordance with approved procedures designed to maintain standards for data integrity established before data collection activities are performed. The efficiency of data reduction software was verified through formal acceptance tests prior to official use.

During data reduction activities or compilation for summary reports, raw data were again scrutinized to identify inconsistencies and anomalies. This "validation" process by the technical processor compared data to expected ranges and past readings. Discrepancies were evaluated and decisions to include or eliminate the suspect data were jointly reached during technical overviews.

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LIST OF ACRONYMS

AA	Antiquities Act
ACHP	Advisory Council on Historic Preservation
AIRFA	American Indian Religious Freedom Act
AMESH	Assistant Manager for Environment, Safety, and Health
ANOVA	Analysis of Variance
ARPA	Archaeological Resources Protection Act
BBER	Bureau of Business and Economic Research
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
COE	Corps of Engineers
CRM	Continuous radon monitor
CRWMS M&O	Civilian Radioactive Waste Management System Management and Operating Contractor
CWA	Clean Water Act
DOE	Department of Energy
E-PERM	Electret-passive environmental radon monitor
EA	Environmental Assessment
EFAP	Environmental Field Activity Plan
EHS	Extremely Hazardous Substances
EIS	Environmental Impact Statement
EO	Executive Order
EPA	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
ESHCD	Environmental, Safety, and Health Compliance Department
ESF	Exploratory Studies Facility
ESP	Ecological Study Plot
FF	Far-field
FLPMA	Federal Land Policy and Management Act
FPPA	Farmland Protection Policy Act
GERT	General Radiological Safety Training
GET	General Employee Training
GSF	Ground Surface Facility
HCFC	Hydrochlorofluorocarbon
HPERD	Health Physics Environmental Radioactivity Division
HS	Hazardous Substances
M&TE	Measuring and Test Equipment
MSDS	Material Safety Data Sheet
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
NIST	National Institute of Standards and Technology
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRC	Nuclear Regulatory Commission

NTEC	National Tribal Environmental Council
NTS	Nevada Test Site
NWPA	Nuclear Waste Policy Act
OCRWM	Office of Civilian Radioactive Waste Management
OTCR	Official Tribal Contact Representative
PA	Programmatic Agreement
PIC	Pressurized ionization chamber
PLS	Pure live seed
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
RCRA	Resource Conservation and Recovery Act
RFPD	Radiological Field Programs Division
ROWR	Right-of-Way Reservation
RQ	Reportable Quantity
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SER	Site Environmental Report
SHPO	State Historic Preservation Office
T&MSS	Technical and Management Support Services
TBM	Tunnel-boring machine
TLD	Thermoluminescent dosimeter
TPH	Total Petroleum Hydrocarbons
UIC	Underground Injection Control
UNLV	University of Nevada, Las Vegas
URTD	Upper Respiratory Tract Disease
USAF	U.S. Air Force

USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
YAP	Yucca Mountain Administrative Procedure
YMP	Yucca Mountain Site Characterization Project
YMSCO	Yucca Mountain Site Characterization Office