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Radiation Monitoring Around United States Nuclear Test Areas, Calendar Year 1980

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OFFSITE ENVIRONMENTAL MONITORING REPORT
Radiation monitoring around United States nuclear test areas, calendar year 1980

by

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PREFACE

The U.S. Atomic Energy Commission (AEC) used the Nevada Test Site (NTS) from January 1951 through January 19, 1976, for conducting nuclear weapons tests, nuclear rocket-engine development, nuclear medicine studies, and other nuclear and non-nuclear experiments. Beginning January 19, 1976, these activities became the responsibility of the newly formed U.S. Energy Research and Development Administration (ERDA). On October 1, 1977 the ERDA was merged with other energy-related agencies to form the U.S. Department of Energy (DOE). Atmospheric nuclear tests were conducted periodically from January 27, 1951, through October 30, 1958, after which a testing moratorium was in effect until September 1, 1961. Since September 1, 1961, all nuclear detonations have been conducted underground with the expectation of containment, except for four slightly above-ground or shallow underground tests of Operation Dominic II in 1962 and five nuclear earth-cratering experiments conducted under the Plowshare program between 1962 and 1968.

Prior to 1954, an offsite surveillance program was performed by the Los Alamos Scientific Laboratory and the U.S. Army. From 1954 through 1970, the U.S. Public Health Service (PHS), and the U.S. Environmental Protection Agency (EPA) from 1970 to the present, provided an Offsite Radiological Safety Program under a memorandum of understanding. The PHS or EPA has also provided offsite surveillance for nuclear explosive tests at places other than the NTS.

Since 1954, the objective of this surveillance program has been to measure levels and trends of radioactivity, if present, in the environment surrounding testing areas to ascertain whether the testing is in compliance with existing radiation protection standards. Offsite levels of radiation and radioactivity are assessed by sampling milk, water, and air; deploying dosimeters; and sampling food crops, soil, etc., as required. To implement protective actions, provide immediate radiation monitoring, and obtain environmental samples rapidly after any release of radioactivity, personnel with mobile monitoring equipment are placed in areas downwind from the test site prior to each test. Since 1962, aircraft have also been deployed to rapidly monitor and sample releases of radioactivity during nuclear tests. Monitoring data obtained by the aircraft crew immediately after a test are used to position mobile radiation monitoring personnel on the ground. Data from airborne sampling are used to quantify the amounts, diffusion, and transport of the radionuclides released.

Prior to 1959 a report was published for each test series or test project. Beginning in 1959 for reactor tests, and in 1962 for weapons tests, surveillance data were published for each individual test that released radioactivity off site. From January 1964, through December 1970, semi-annual summaries of these reports for individual nuclear tests were also published.

In 1971, the AEC implemented a requirement, now referred to as the DOE Manual, Chapter 0513, that each contractor or agency involved in major nuclear activities provide annually a comprehensive radiological monitoring report. This is the tenth annual report in this series; it summarizes the activities of the EPA during CY 1980.

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ABBREVIATIONS AND SYMBOLS

μm	micrometer
μrem	microrem (rem = rad x correction factor)
μCi/g	microcurie per gram
μCi/ml	microcurie per milliliter
AEC	Atomic Energy Commission
ASN	Air Surveillance Network
C	temperature in Celsius
CG	Concentration Guide
Ci	Curie
cm	centimeter
CP-1	Control Point One
CY	Calendar Year
DOE	U.S. Department of Energy
DOE/NV	U.S. Department of Energy, Nevada Operations Office
EMSL/LV	Environmental Monitoring Systems Laboratory-Las Vegas
EPA	U.S. Environmental Protection Agency
ERDA	Energy Research and Development Administration
ERDA/NV	Energy Research and Development Administration, Nevada Operations Office
ft	feet
GZ	Ground Zero
h	hour
kg	kilogram
keV	kiloelectron volts
km	kilometer
kt	kiloton
LCL	lower confidence limit
LLL	Lawrence Livermore Laboratory
LTHMP	Long-Term Hydrological Monitoring Program
m	meter
MDC	minimum detectable concentration
MeV	megaelectron volts
MLON	Medical Liaison Officer Network
mm	millimeter
MPa	megapascal
mrem/y	millirem per year
mrem/d	millirem per day
mR	milliroentgen
mR/h	milliroentgen per hour
MSL	Mean Sea Level

μCi	microcurie
MSN	Milk Surveillance Network
nCi	nanocurie
NGTSN	Noble Gas and Tritium Surveillance Network
NTS	Nevada Test Site
PHS	U.S. Public Health Service
pCi	picocurie
SMSN	Standby Milk Surveillance Network
TLD	thermoluminescent dosimeter
UCL	Upper Confidence Limit
USGS	United States Geological Survey
WSN	Water Surveillance Network
y	year
^{3}H	tritium or hydrogen-3
HTO	tritiated water
Ba	barium
Be	beryllium
Cs	cesium
I	iodine
K	potassium
Kr	krypton
Pu	plutonium
Ra	radium
Ru	ruthenium
Sr	strontium
Te	tellurium
U	uranium
Xe	xenon
Zr	zirconium

PROGRAM SUMMARY -- 1980

The U.S. Environmental Protection Agency's (EPA) Environmental Monitoring Systems Laboratory in Las Vegas (EMSL-LV) continued its Offsite Radiological Safety Program for the Nevada Test Site (NTS) and other sites of past underground nuclear tests. For each test, the Laboratory provided airborne meteorological measurements, ground and airborne radiation monitoring teams, and special briefings to the Test Controller's Advisory Panel.

Test-related radioactivity from the NTS was detected offsite following the Riola Test conducted on September 25, 1980. This consisted of xenon-133 (3.4×10^{-11} μCi/ml) and xenon-135 (3.6×10^{-10} μCi/ml) in a compressed air sample collected at Lathrop Wells, Nevada. The estimated dose equivalent to the whole body of a hypothetical receptor at Lathrop Wells from exposure to the radioxenon was 0.011 mrem, which is 0.006 percent of the radiation protection guide for a suitable sample of the general population.

Whole-body counts of individuals residing in the environs of the NTS showed no manmade radionuclides attributable to the testing program.

The only radioactivity from non-NTS sites of past underground nuclear tests was due to tritium in water samples collected from the Project Dribble Site near Hattiesburg, Mississippi, and the Project Long Shot Site on Amchitka Island, Alaska. The maximum concentrations measured at these locations were 1 and 0.1 percent of the Concentration Guide for drinking water, respectively.

A small amount of airborne radioactivity originating from nuclear tests carried out by the People's Republic of China was detected during 1980 at some stations scattered throughout the Air Surveillance Network.

The Laboratory's Animal Investigation Program sampled tissues from wildlife and domestic animals on and around the NTS. Data from analysis of these tissues are published separately in an annual report.

INTRODUCTION

The EMSL-LV conducts the Offsite Radiological Safety Program for the NTS and other sites designated by the Department of Energy (DOE) under a memorandum of understanding between DOE and EPA. This report, prepared in accordance with the DOE Manual, chapter 0513 (ERDA 1974) covers the program activities for calendar year 1980. It contains descriptions of pertinent features of the NTS and its environs, summaries of the EMSL-LV dosimetry and sampling methods, analytical procedures, and the analytical results from environmental measurements. Where applicable, dosimetry and sampling data are compared to appropriate guides for external and internal exposures of humans to ionizing radiation.

DESCRIPTION OF THE NEVADA TEST SITE

Historically, the major programs conducted at the NTS have been nuclear development, proof-testing and weapons safety, testing peaceful uses of nuclear explosives (Plowshare Program), reactor engine development for nuclear rocket and ramjet applications (Projects Pluto and Rover), high-energy nuclear physics research, and seismic studies (Vela Uniform). During 1980, nuclear weapons development, proof-testing and weapons safety, and nuclear physics programs were continued. Project Pluto was discontinued in 1964; Project Rover was terminated in January 1973; Plowshare tests were terminated in 1970; Vela Uniform studies ceased in 1973. All nuclear weapons tests since 1962 have been conducted underground.

Site Location

The NTS is located in Nye County, Nevada, with its southeast corner about 90 km northwest of Las Vegas (Figures 1 and 2). It has an area of about 3,500 square km and varies from 40 to 56 km in width (east-west) and from 64 to 88 km in length (north-south). This area consists of large basins or flats about 900 to 1,200 m above mean sea level (MSL) surrounded by mountain ranges rising 1,800 to 2,300 m above MSL.

The NTS is surrounded on three sides by exclusion areas, collectively named the Nellis Air Force Range, which provide a buffer zone between the test areas and public lands. This buffer zone varies from 24 to 104 km between the test area and land that is open to the public. Depending upon wind speed and direction, from 1/2 to more than 6 hours will elapse before any release of airborne radioactivity could pass over public lands.

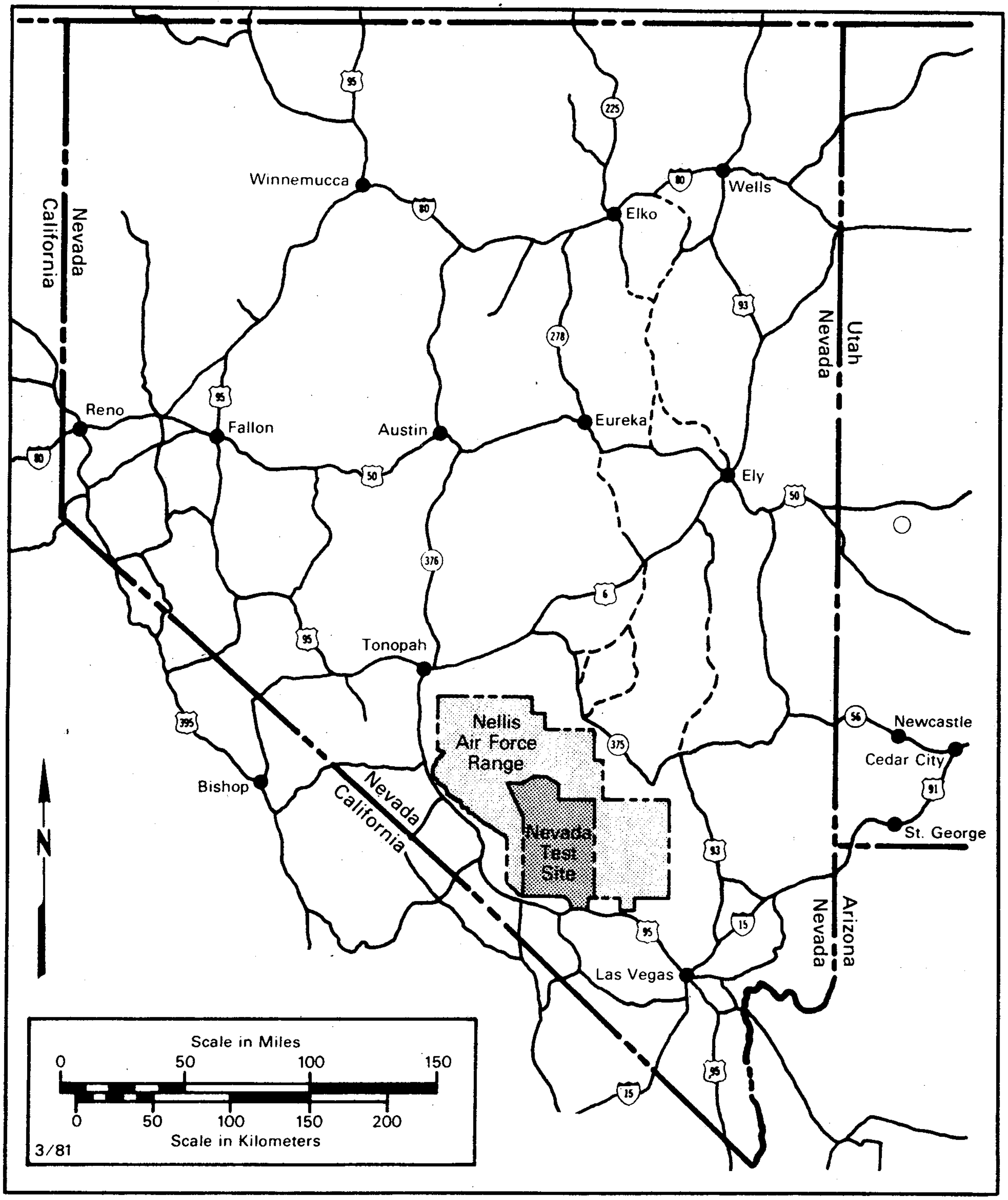

Figure 1. Location of the Nevada Test Site.

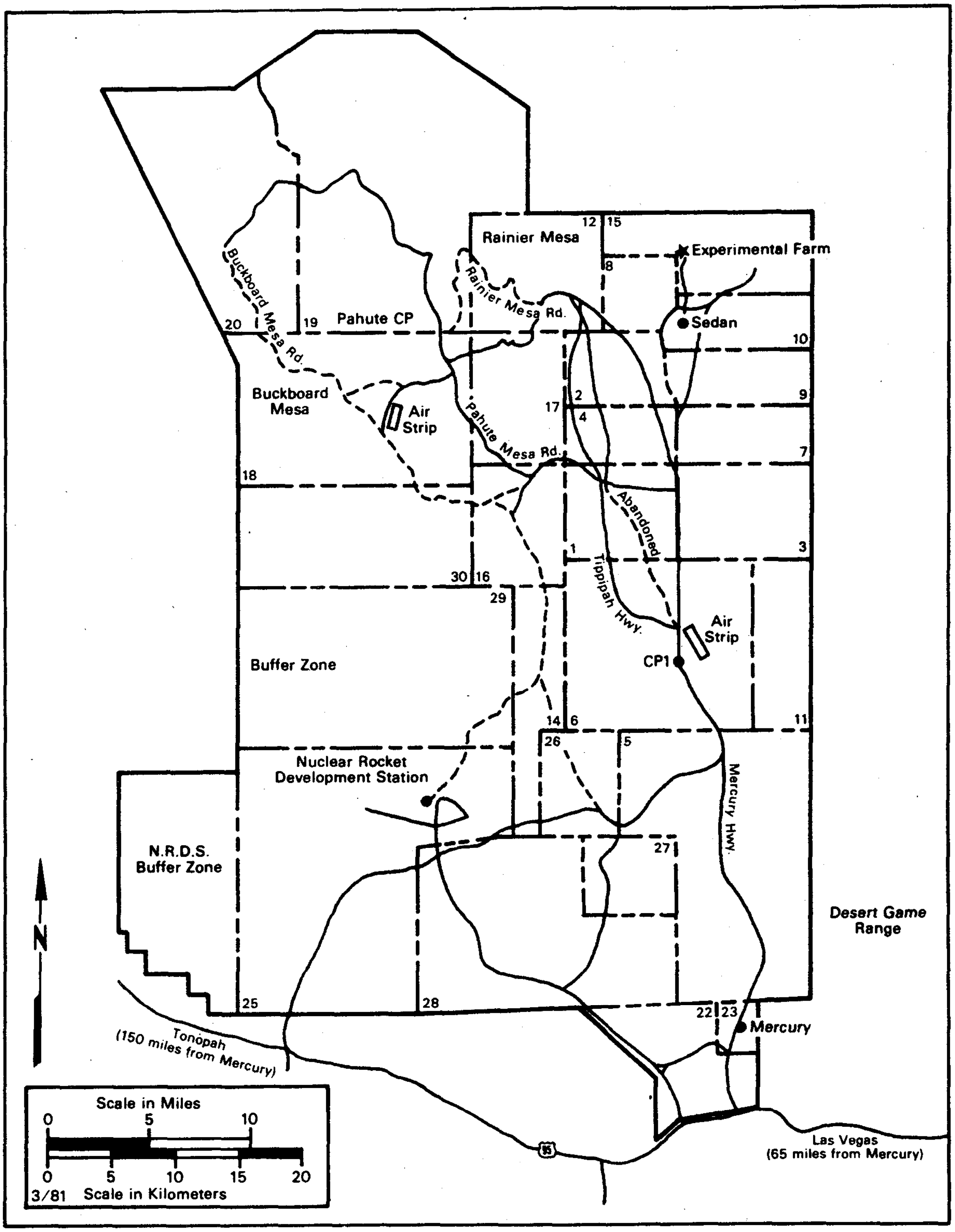

Figure 2. Nevada Test Site roads and facilities.

Climate

The climate of the NTS and surrounding area is variable, due to its variations in altitude and its rugged terrain. Generally, the climate is referred to as continental arid. Throughout the year, there is insufficient water to support the growth of common food crops without irrigation.

Climate may be classified by the types of vegetation indigenous to an area. According to Houghton et al. (1975), this method of classification of dry condition, developed by Doppen, is further subdivided on the basis of temperature and severity of drought. Table 1 (Houghton et al. 1975) summarizes the characteristics of climatic types for Nevada.

As Houghton et al. point out, 90 percent of Nevada's population lives in areas with less than 25 cm of rainfall per year or in areas that would be classified as mid-latitude steppe to low-latitude desert regions.

According to Quiring (1968), the NTS average annual precipitation ranges from about 10 cm at the lower elevations to around 25 cm on the higher elevations. During the winter months, the plateaus may be snow-covered for a period of several days or weeks. Snow is uncommon on the flats. Temperatures vary considerably with elevation, slope, and local air currents. The average daily high (low) temperatures at the lower altitudes are around 50°F(25°F) in January and 95°F(55°F) in July, with extremes of 110°F and -15°F. Corresponding temperatures on the plateaus are 35°F(25°F) in January and 80°F(65°F) in July with extremes of 100°F and -20°F. Temperature extremes as low as -30°F and higher than 115°F have been observed.

The wind direction, as measured on a 30-m tower at an observation station about 9 km NNW of Yucca Lake, is predominantly northerly except during the months of May through August when winds from the south-southwest predominate (Quiring 1968). Because of the prevalent mountain/valley winds in the basins, south to southwest winds predominate during daylight hours of most months. During the winter months southerly winds have only a slight edge over northerly winds for a few hours during the warmest part of the day. These wind patterns may be quite different at other locations on the NTS because of local terrain effects and differences in elevation.

Geology and Hydrology

Geological and hydrological studies of the NTS have been in progress by the U.S. Geological Survey and various other organizations since 1956. Because of this continuing effort, including subsurface studies of numerous boreholes, the surface and underground geological and hydrological character-aracteristics for much of the NTS are known in considerable detail. This is particularly true for those areas in which underground experiments are conducted. A comprehensive summary of the geology and hydrology of the NTS has been edited by Eckel (1968).

Two major hydrologic systems shown in Figure 3 exist on the NTS (ERDA 1977). Ground water in the northwestern part of the NTS or in the Pahute Mesa area has been reported to flow at a rate of 2 m to 180 m per year to the south

TABLE 1. CHARACTERISTICS OF CLIMATIC TYPES IN NEVADA (from Houghton et al. 1975)

Climate Type	Mean Temperature °C (°F) Winter	Mean Temperature °C (°F) Summer	Annual Precipitation cm (inches) Total*	Annual Precipitation Snowfall	Dominant Vegetation	Percent of Area
Alpine tundra	-18° to -9° (0° to 15°)	4° to 10° (40° to 50°)	38 to 114 (15 to 45)	Medium to heavy	Alpine meadows	--
Humid continental	-12° to -1° (10° to 30°)	10° to 21° (50° to 70°)	64 to 114 (25 to 45)	Heavy	Pine-fir forest	1
Subhumid continental	-12° to -1° (10° to 30°)	10° to 21° (50° to 70°)	30 to 64 (12 to 25)	Moderate	Pine or scrub woodland	15
Mid-latitude steppe	-7° to 4° (20° to 40°)	18° to 27° (65° to 80°)	15 to 38 (6 to 15)	Light to moderate	Sagebrush, grass, scrub	57
Mid-latitude desert	-7° to 4° (20° to 40°)	18° to 27° (65° to 80°)	8 to 20 (3 to 8)	Light	Greasewood, shadscale	20
Low-latitude desert	-4° to 10° (40° to 50°)	27° to 32° (80° to 90°)	5 to 25 (2 to 10)	Negligible	Creosote bush	7

*Limits of annual precipitation overlap because of variations in temperature which affect the water balance.

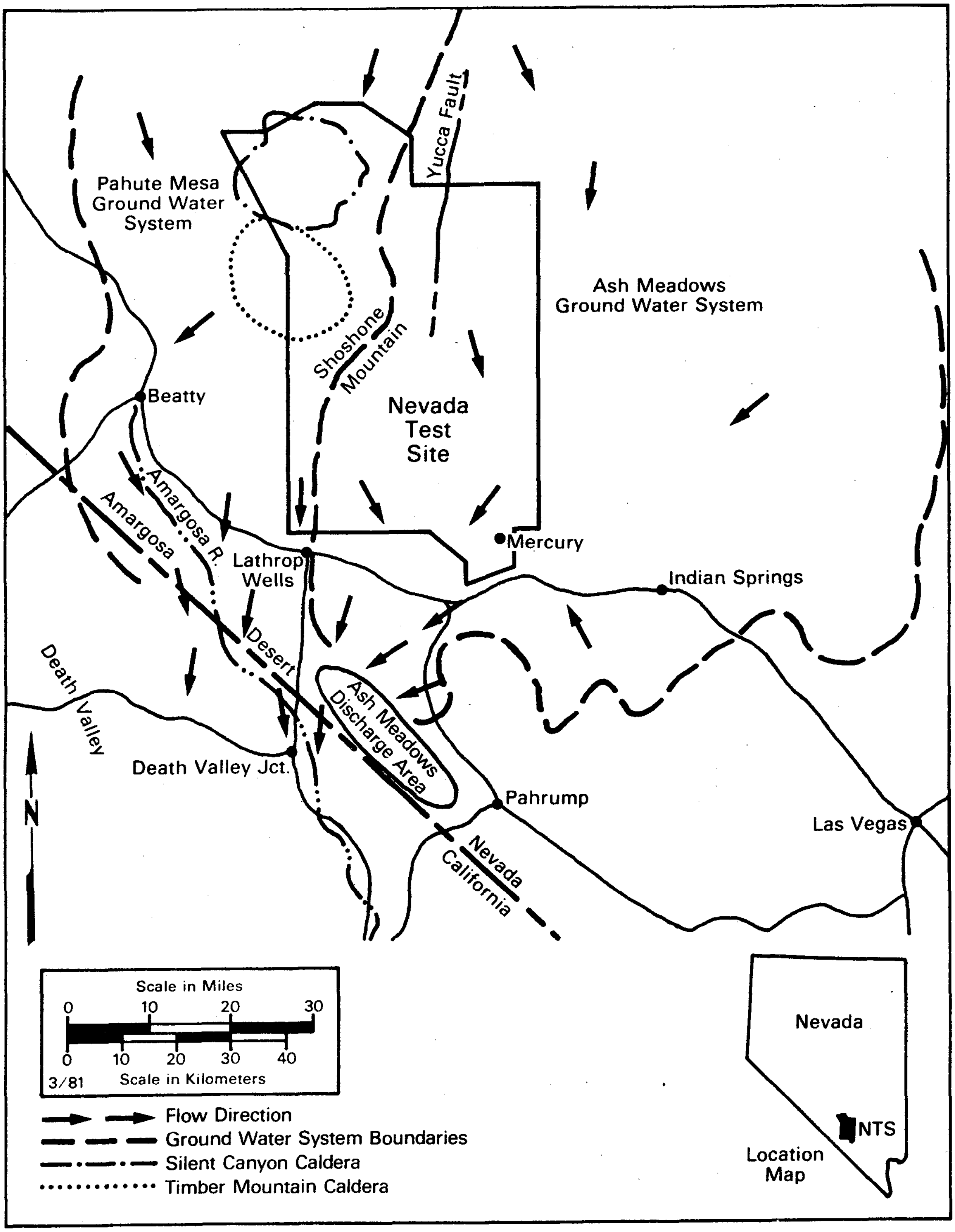

Figure 3. Groundwater flow systems around the Nevada Test Site.

and southwest toward the Ash Meadows Discharge Area in the Amargosa Desert. It is estimated that the ground water to the east of the NTS moves from north to south at a rate of not less than 2 m nor greater than 220 m per year. Carbon-14 analyses of this eastern ground water indicate that the lower velocity is nearer the true value. At Mercury Valley in the extreme southern part of the NTS, the eastern ground water flow shifts southwestward toward the Ash Meadows Discharge Area.

The water levels under the NTS vary from depths of about 100 m beneath the surface of valleys in the southeastern part of the site to more than 600 m beneath the surface of highlands to the north. Although much of the valley fill is saturated, downward movement of water is extremely slow. The primary aquifer in these formations is the Paleozoic carbonates that underlie the more recent tuffs and alluviums.

Land Use of NTS Environs

Figure 4 is a map of the off-NTS area showing a wide variety of land uses, such as farming, mining, grazing, camping, fishing, and hunting within a 300-km radius of the NTS. For example, west of the NTS, elevations range from 85 m below MSL in Death Valley to 4,420 m above MSL in the Sierra Nevada Range. Parts of two major agricultural valleys (the Owens and San Joaquin) are included. The areas south of the NTS are more uniform since the Mojave Desert ecosystem (mid-latitude desert) comprises most of this portion of Nevada, California, and Arizona. The areas east of the NTS are primarily mid-latitude steppe with some of the older river valleys, such as the Virgin River Valley and Moapa Valley, supporting irrigation for small-scale but intensive farming of a variety of crops. Grazing is also common in this area, particularly to the northeast. The area north of the NTS is also mid-latitude steppe, where the major agricultural activity is grazing of cattle and sheep. Minor agriculture, primarily the growing of alfalfa hay, is found in this portion of the State within 300 km of the NTS Control Point-1 (CP-1). Many of the residents grow or have access to locally grown fruits and vegetables.

Industry within the immediate off-NTS area includes approximately 40 active mines and mills, two oil fields at Trap Springs and Eagle Springs, and several industrial plants in Henderson, Nevada (Figure 4). The number of employees for these operations may vary from one person at several of the small mines to several hundred workers for the oil fields north of the NTS and the industrial plants in Henderson. Most of the individual mining operations involve less than 10 workers per mine; however, a few operations employ 100 to 250 workers.

The major body of water close to the NTS is Lake Mead (120 km southeast), a manmade lake supplied by water from the Colorado River. Lake Mead supplies about 60 percent of the water used for domestic, recreational, and industrial purposes in the Las Vegas Valley. Some Lake Mead water is used in Arizona, southern California, and Mexico. Smaller reservoirs and lakes located in the area are used primarily for irrigation and for watering livestock. In California, the Owens River and Haiwee Reservoir feed into the Los Angeles Aqueduct and constitute the major sources of water for the Los Angeles area.

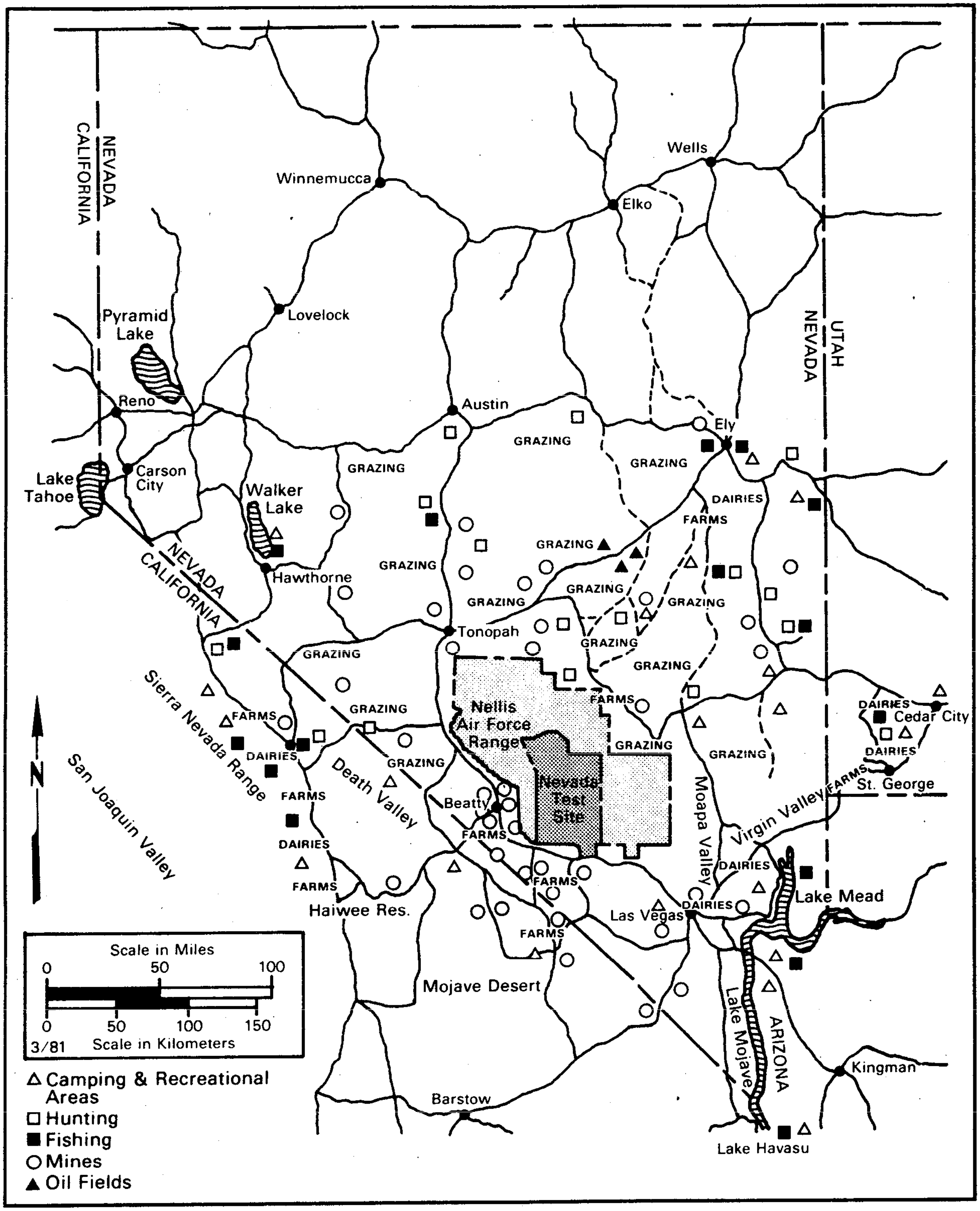

Figure 4. General land use within 300 km of the Nevada Test Site.

Many recreational areas, in all directions around the NTS (Figure 4) are used for such activities as hunting, fishing, and camping. In general, the camping and fishing sites to the northwest, north, and northeast of the NTS are utilized throughout the year except for the winter months. Camping and fishing locations to the southeast, south, and southwest are utilized throughout the year. The hunting season is from September through January.

Dairy farming is not extensive within 300 km of the NTS. A survey of milk cows during the summer of 1979 showed 8,200 dairy cows, 730 family milk cows and 258 family milk goats in the area. The family cows and goats are distributed in all directions around the NTS (Figure 5), whereas most dairy cows (Figure 6) are located to the southeast (Moapa River, Nevada; Virgin River Valley, Nevada; and Las Vegas, Nevada), northeast (Lund), and southwest (near Barstow, California).

Grazing is the most common land use within 300 km of the site. Approximately 280,000 cattle and 180,000 sheep are distributed within the area as shown in Figures 7 and 8, respectively. The estimates are based on information supplied by the California county agents during 1980, from 1979 agricultural statistics supplied by the Nevada Department of Agriculture and from 1978 census information supplied by the Utah Department of Agriculture.

Population Distribution

Figure 9 shows the current population of counties surrounding the NTS based on preliminary 1980 census figures. Excluding Clark County, the major population center (approximately 462,000 in 1980), the population density within a 150 km radius of the NTS is about 0.5 persons per square kilometer. For comparison, the 48 contiguous states (1980 census) had a population density of approximately 29 persons per square kilometer. The estimated average population density for Nevada in 1980 was 2.8 persons per square kilometer.

The offsite area within 80 km of the NTS (the area in which the dose commitment must be determined for the purpose of this report) is predominantly rural. Several small communities are located in the area, the largest being in the Pahrump Valley. This growing rural community, with an estimated population of about 3,600, is located about 72 km south-southwest of the NTS CP-1. The Amargosa Farm Area, which has a population of about 1,600, is located about 50 km southwest of CP-1. The largest town in the near-offsite area is Beatty, which has a population of about 900 and is located approximately 65 km to the west of CP-1.

The Mojave Desert of California, which includes Death Valley National Monument, lies along the southwestern border of Nevada. The National Park Service (1980) estimates that the population within the Monument boundaries ranges from a minimum of 900 permanent residents during the summer months to as many as 35,000 tourists and campers on any particular day during the major holiday periods in the winter months, and as many as 80,000 during "Death Valley Days" in the month of November. The largest town and contiguous populated area in the Mojave Desert is Barstow, located 265 km south-southwest

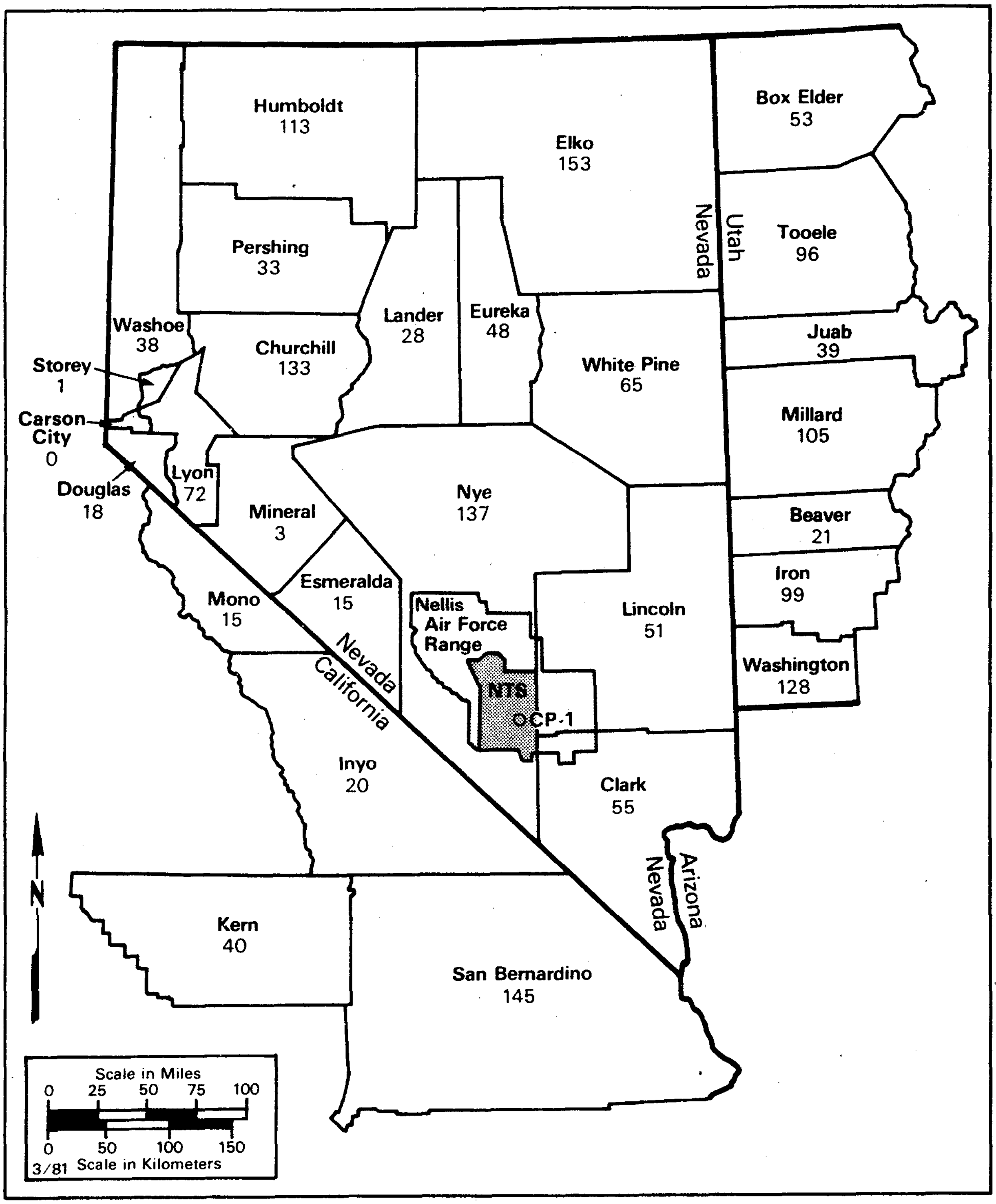

Figure 5. Distribution and number of family milk cows and goats, by county.

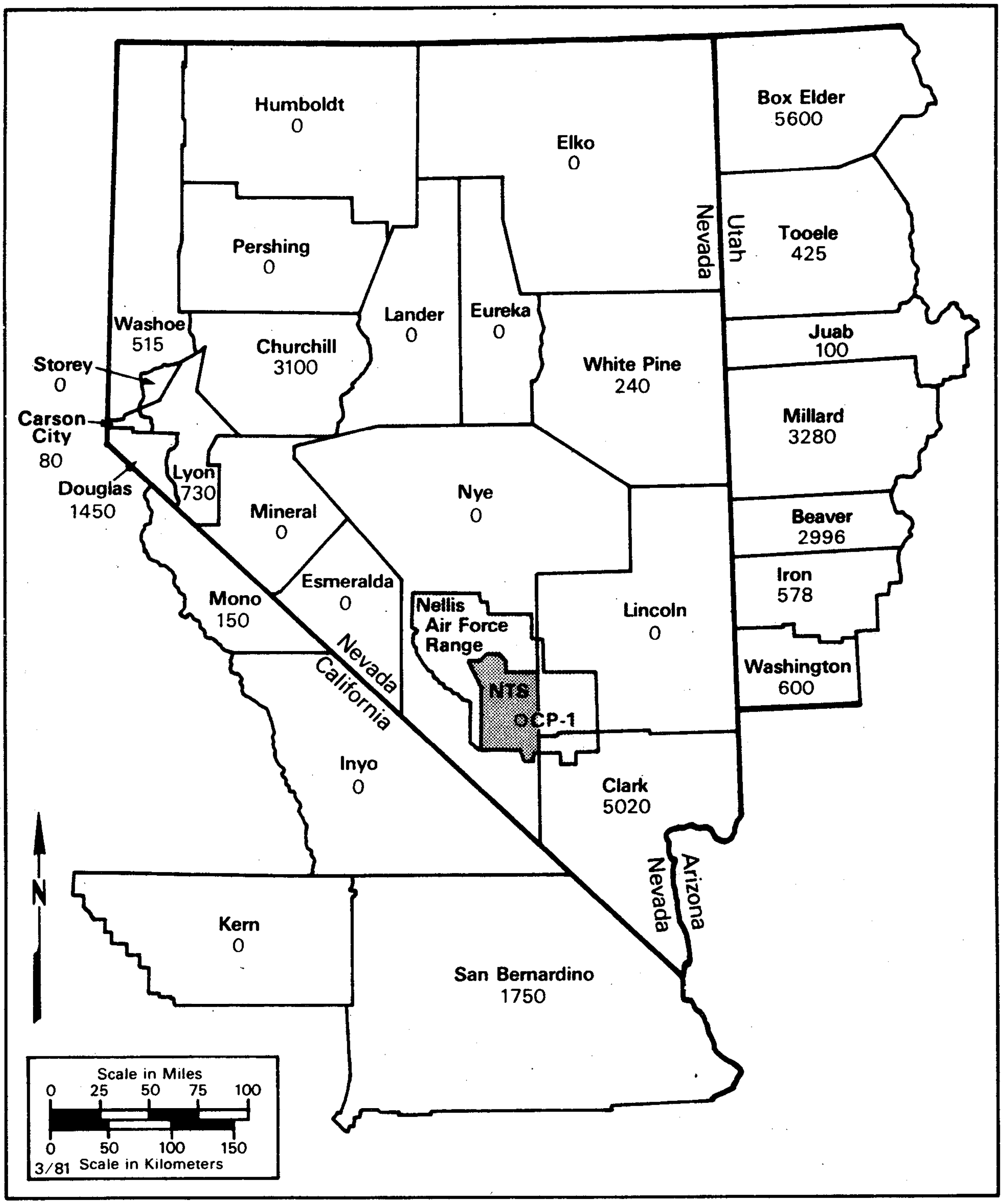

Figure 6. Distribution of dairy cows, by county.

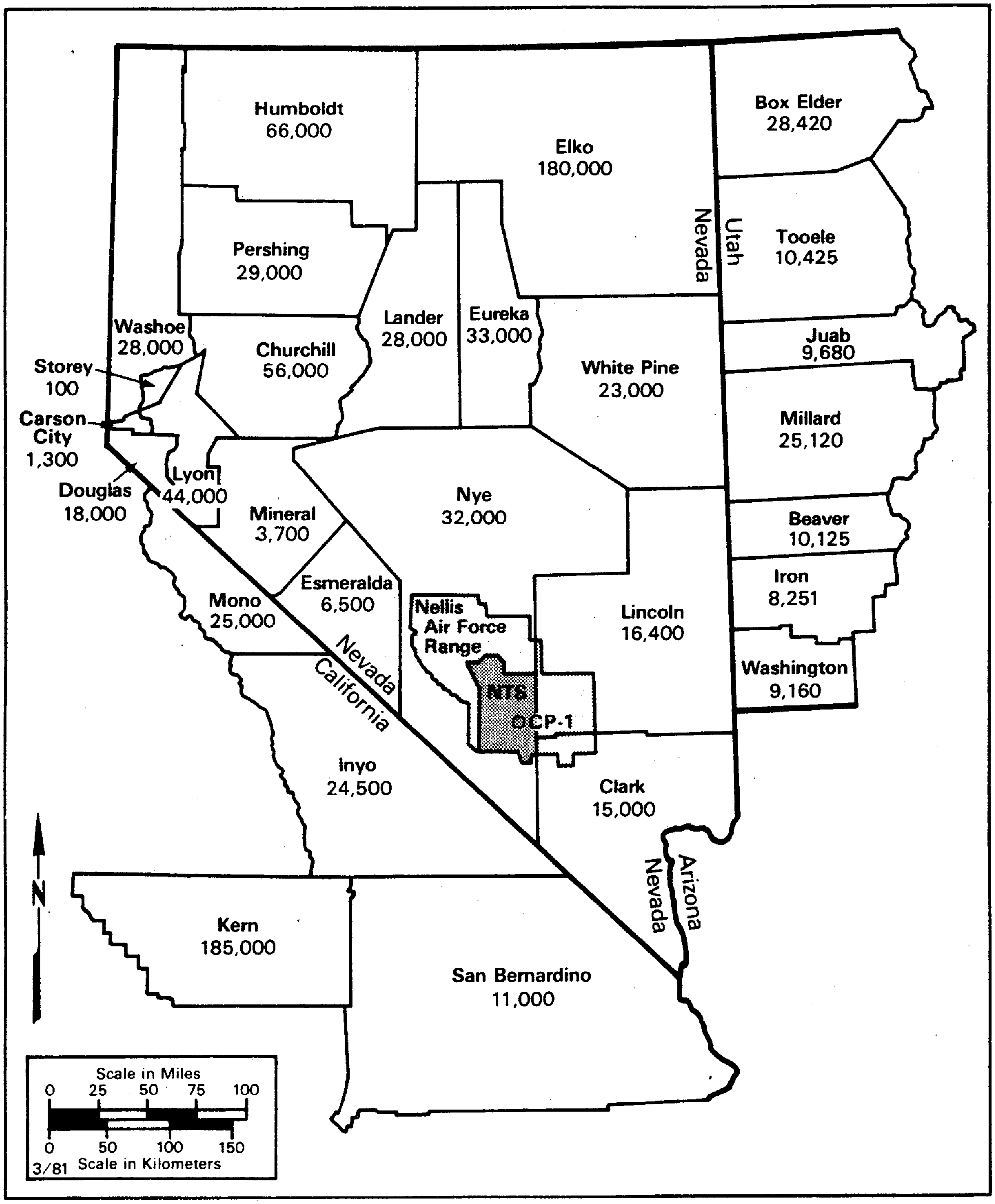

Figure 7. Distribution of beef cattle, by county.

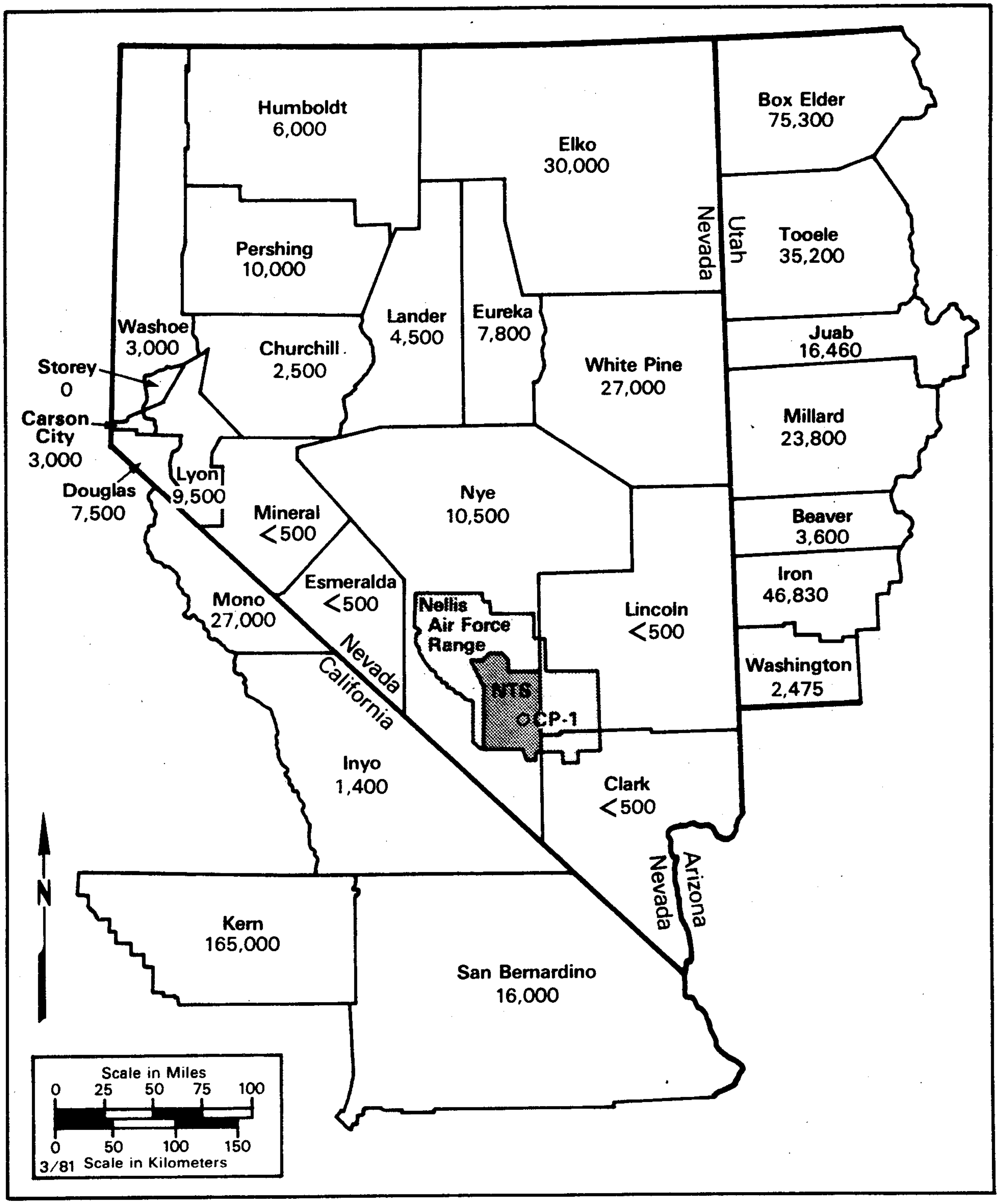

Figure 8. Distribution of sheep, by county.

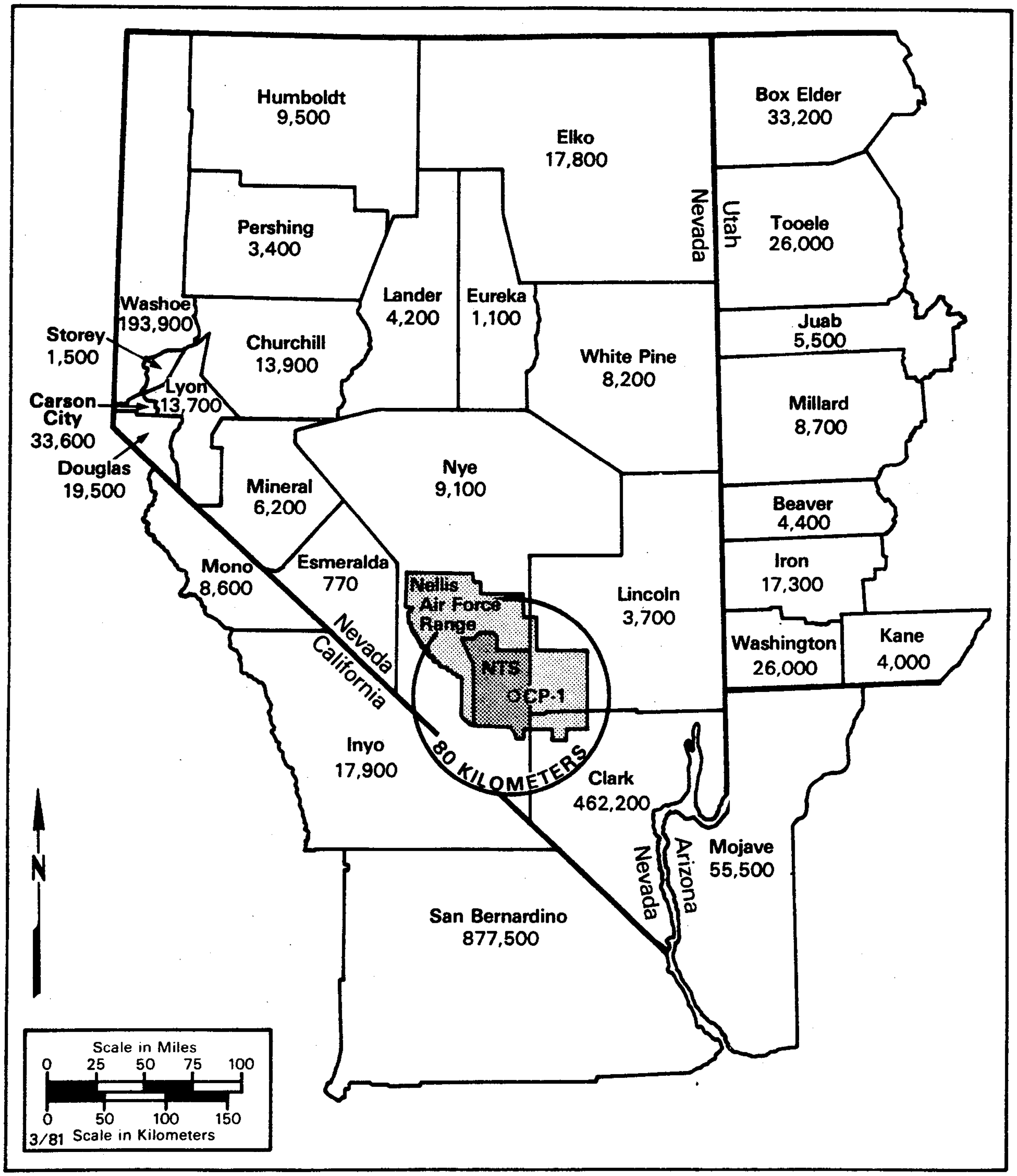

Figure 9. Population of Arizona, California, Nevada, and Utah counties near the Nevada Test Site (1980).

of the NTS, with a population of about 17,600. The next largest populated area is the Ridgecrest-China Lake area, which has a population of about 20,000 and is located about 190 km southwest of the NTS. The Owens Valley, where numerous small towns are located, lies about 50 km west of Death Valley. The largest town in Owens Valley is Bishop, located 225 km west-northwest of the NTS, with a population of about 5,300 including contiguous populated areas.

The extreme southwestern region of Utah is more developed than the adjacent part of Nevada. The largest community is St. George, located 220 km east of the NTS, with a population of 11,300. The next largest town, Cedar City, with a population of 10,900, is located 280 km east northeast of the NTS.

The extreme northwestern region of Arizona is mostly range land except for that portion in the Lake Mead Recreation Area. In addition, several small communities lie along the Colorado River. The largest town in the area is Kingman, located 280 km southeast of the NTS, with a population of about 9,200.

AIRBORNE RELEASES OF RADIOACTIVITY AT THE NTS DURING 1980

All nuclear detonations during 1980 were conducted underground. Occasional releases of low-level radioactivity occurred during reentry drilling and radioactive noble gases leaked to the atmosphere during the evening hours after the Riola test was conducted on September 25. Table 2 shows the total quantities of radionuclides released to the atmosphere, as reported by the DOE Nevada Operations Office.

TABLE 2. TOTAL AIRBORNE RADIONUCLIDE RELEASES AT THE NTS DURING 1980

Radionuclide	Half-Life (days)	Quantity Released (Ci)
Tritium	4,500	450
Krypton-85	3,916	87
Iodine-131	8.04	1.0
Xenon-133	5.29	1,262
Xenon-133m	2.33	1.69
Xenon-135	0.38	2,228.46
Xenon-135m	0.01	476
Total		4,506.15

There is also a continuous low-level release of tritium and krypton-85 on the NTS. Tritium is released primarily from the Sedan Crater and by the evaporation of water from ponds formed by drainage of water from, or ventilation of, the tunnel test areas in the Rainier Mesa. The seepage of krypton-85 and tritium to the surface from underground test areas is suspected. The short-lived iodines and xenons are released only during a venting or during a drillback operation.

OTHER TESTS

The name, date, location, yield, depth, and purpose of each underground nuclear test conducted off the NTS since 1961 have been discussed in previous reports (Nuclear Radiation Assessment Division, 1980). No off-NTS nuclear tests were conducted during 1980.

METHODS

SPECIAL TEST SUPPORT

Before each nuclear test, mobile monitoring personnel were positioned in the offsite areas most likely to be affected should a release of radioactive material occur. These monitors, equipped with radiation survey instruments, gamma exposure-rate recorders, thermoluminescent dosimeters (TLD's), portable air samplers, and supplies for collecting environmental samples, were prepared to conduct a monitoring program directed from the NTS Control Point (CP-1) via two-way radio communications.

In addition, for each event at the NTS, a U.S. Air Force aircraft, with two Reynolds Electrical and Engineering Company monitoring personnel equipped with portable radiation survey instruments, was airborne near surface ground zero to detect and track any radioactive effluent. One EMSL-LV cloud sampling and tracking aircraft was also airborne over NTS to obtain samples, assess total cloud volume, and provide long-range tracking in the event of a release of airborne radioactivity. A second EMSL-LV aircraft was airborne to gather meteorological data and to perform cloud tracking. Information from these aircraft was used in positioning the radiation monitors.

ROUTINE MONITORING AND SAMPLING

The Offsite Radiological Safety Program for the NTS consisted of continuously operated dosimetry and air sampling networks and scheduled collections of milk and water samples at locations surrounding the NTS.

Air Surveillance Network

The Air Surveillance Network (ASN) is operated to monitor environmental levels of radioactivity from NTS operations. During 1980, the ASN consisted of 25 continously operating sampling stations and 97 standby stations in 21 western States (Figures 10 and 11).

Samples of airborne particulates were collected at each active station on 4-in (10-cm) diameter glass-fiber or Microsorban polystyrene fiber filters at a flow rate of about 350 m^3 per day. Filters were changed after sampler operation periods of 2 or 3 days (700 to 1,100 m^3). Activated charcoal cartridges directly behind the filters collected gaseous radioiodine and were changed at the same time as the filters. The stations were operated by State and municipal health department personnel or by local residents. All air filters and charcoal cartridges were mailed to the EMSL-LV for analysis. All

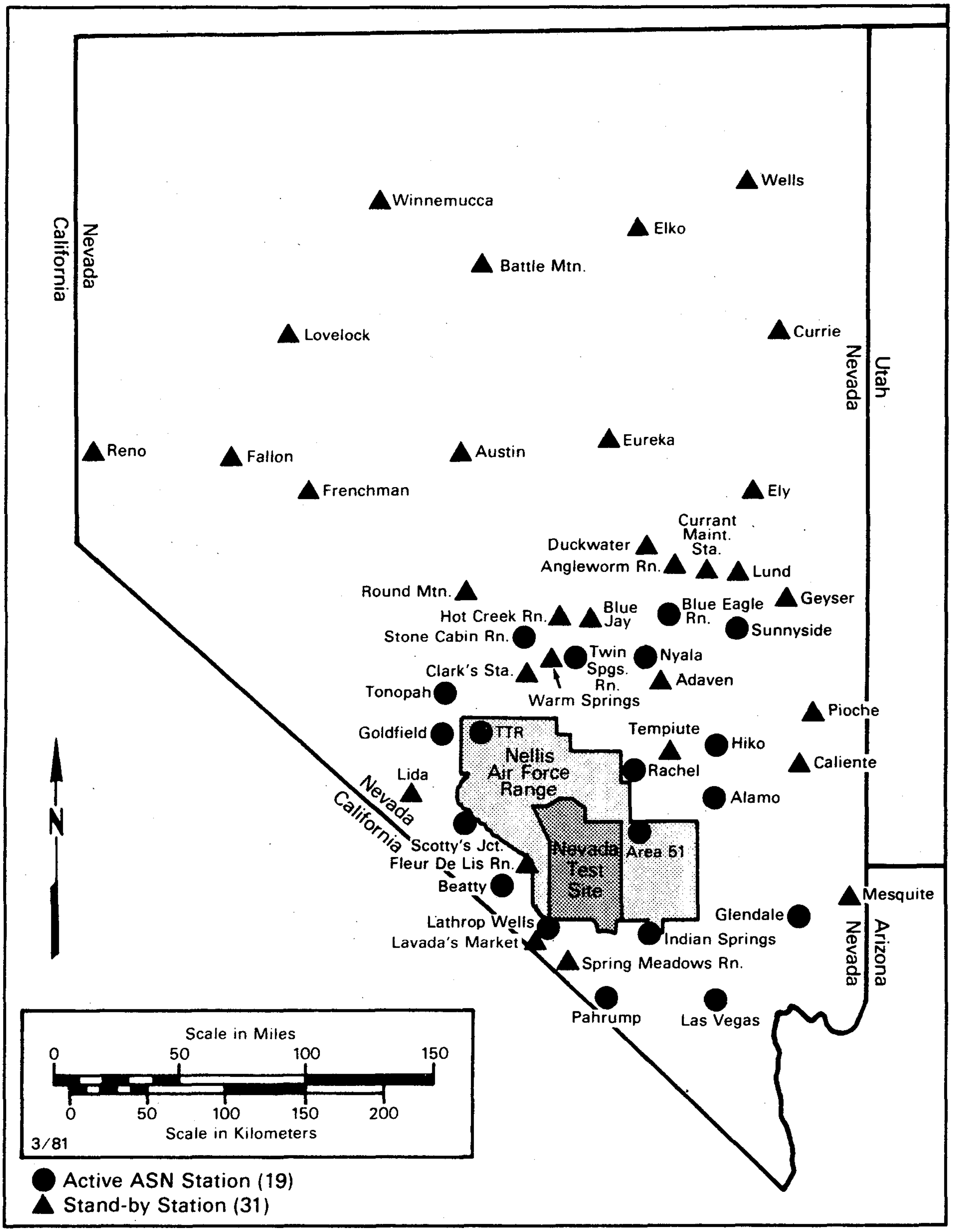

Figure 10. Air Surveillance Network stations within Nevada.

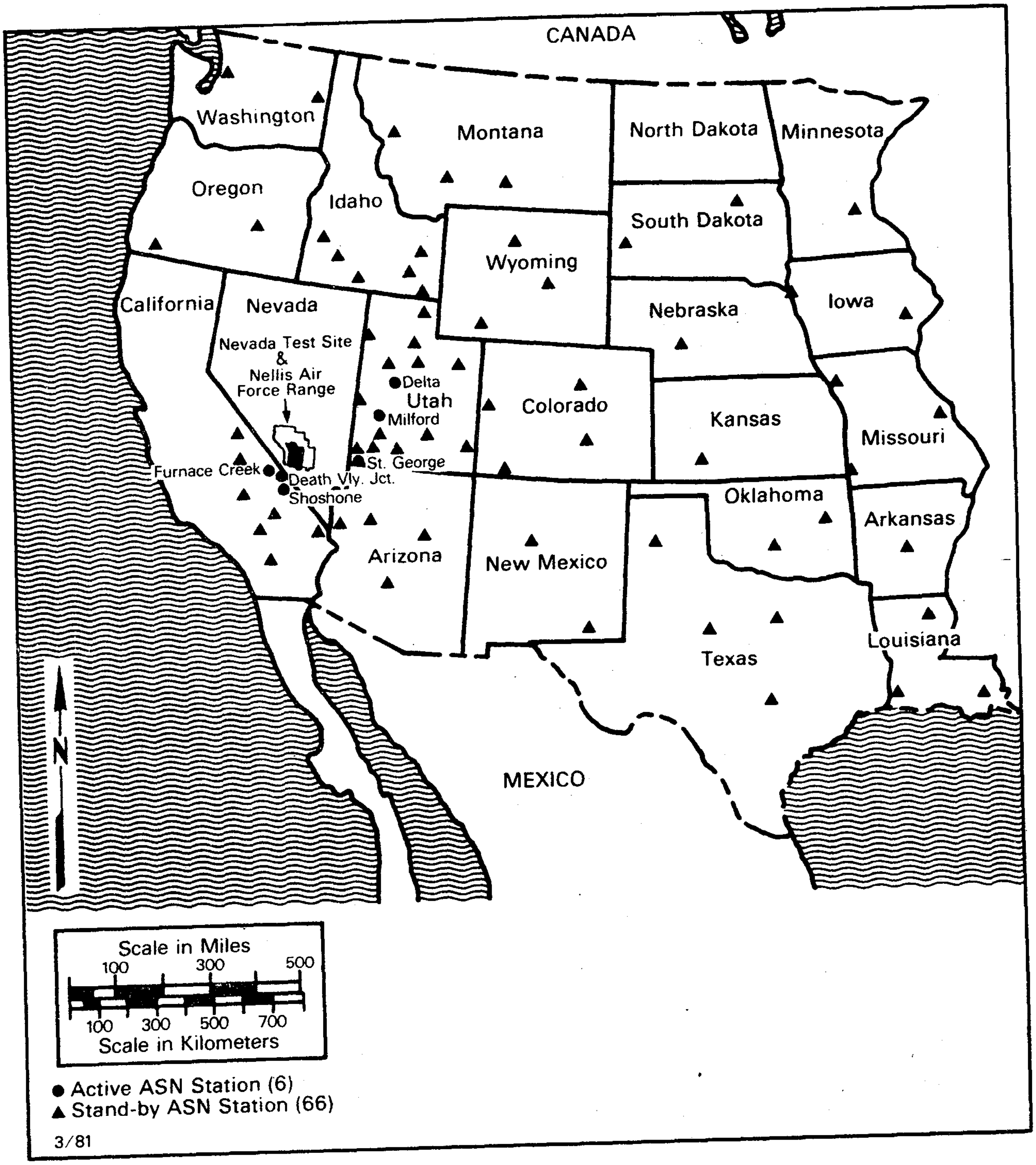

Figure 11. Air Surveillance Network stations in States other than Nevada.

standby stations were operated for 1-week periods each quarter for performance evaluation.

The filters and cartridges were analyzed by gamma spectrometry. If fresh fission products had been detected on the filters, radiochemical analysis would have been performed for strontium-89,90 and plutonium isotopes on selected filters. Appendix Table A-1 summarizes the analytical procedures and minimum detectable concentrations (MDC's) for each analysis. Quarterly composites from 11 ASN stations were analyzed for plutonium-238 and plutonium-239.

In anticipation of airborne radioactivity from the atmospheric nuclear test by the People's Republic of China at 2130 PDT on October 15, 1980, 92 of the standby stations were activated from October 13, 1980, through November 7, 1980.

Noble Gas and Tritium Surveillance Network

The Noble Gas and Tritium Surveillance Network is used to measure the airborne levels of radiokrypton, radioxenon, and tritium. This network consists of six stations on and six stations off the NTS as shown in Figure 12 (the Area 51 station is considered an NTS station).

Two sampling systems are used in this Network: a compressor-type air sampler and a molecular sieve sampler. The compressor-type equipment continuously samples air over a 7-day period and stores it in two pressure tanks, which together hold approximately 1 cubic meter of air at about 220 psi (1.6 MPa). The tanks are exchanged weekly and returned to the EMSL-LV where their contents are analyzed. The separated krypton and xenon fractions are counted by liquid scintillation for krypton-85 and radioxenon.

A molecular sieve column is used to collect water from air. A prefilter is used to remove particles before air passes through the molecular sieve column. Approximately 5 cubic meters of air are passed through each sampler over a 7-day sampling period. Water absorbed on the molecular sieve column is recovered, and the concentration of tritium (HTO) in water, reported as μCi/ml of air and μCi/ml of water recovered, is determined by liquid scintillation counting techniques.

Thermoluminescent Dosimetry Network

The Thermoluminescent Dosimetry Network comprises 79 stations at both inhabited and uninhabited locations within a 300-km radius of the CP-1. Each station is equipped with three Harshaw Model 2271-G2 (TLD200) thermoluminescent dosimeters (TLD's) to measure gamma exposure doses resulting from environmental background as well as accidental releases of gamma-emitting radioactivity (Figure 13). Within the area covered by the Network, 24 offsite residents wore dosimeters during 1980. All TLD's were exchanged quarterly.

A station was added at Valley Crest, California, at the beginning of the first quarter, 1980. The station at Selbach Ranch was moved approximately 1 mile to Lavada's Market, to prevent further vandalism.

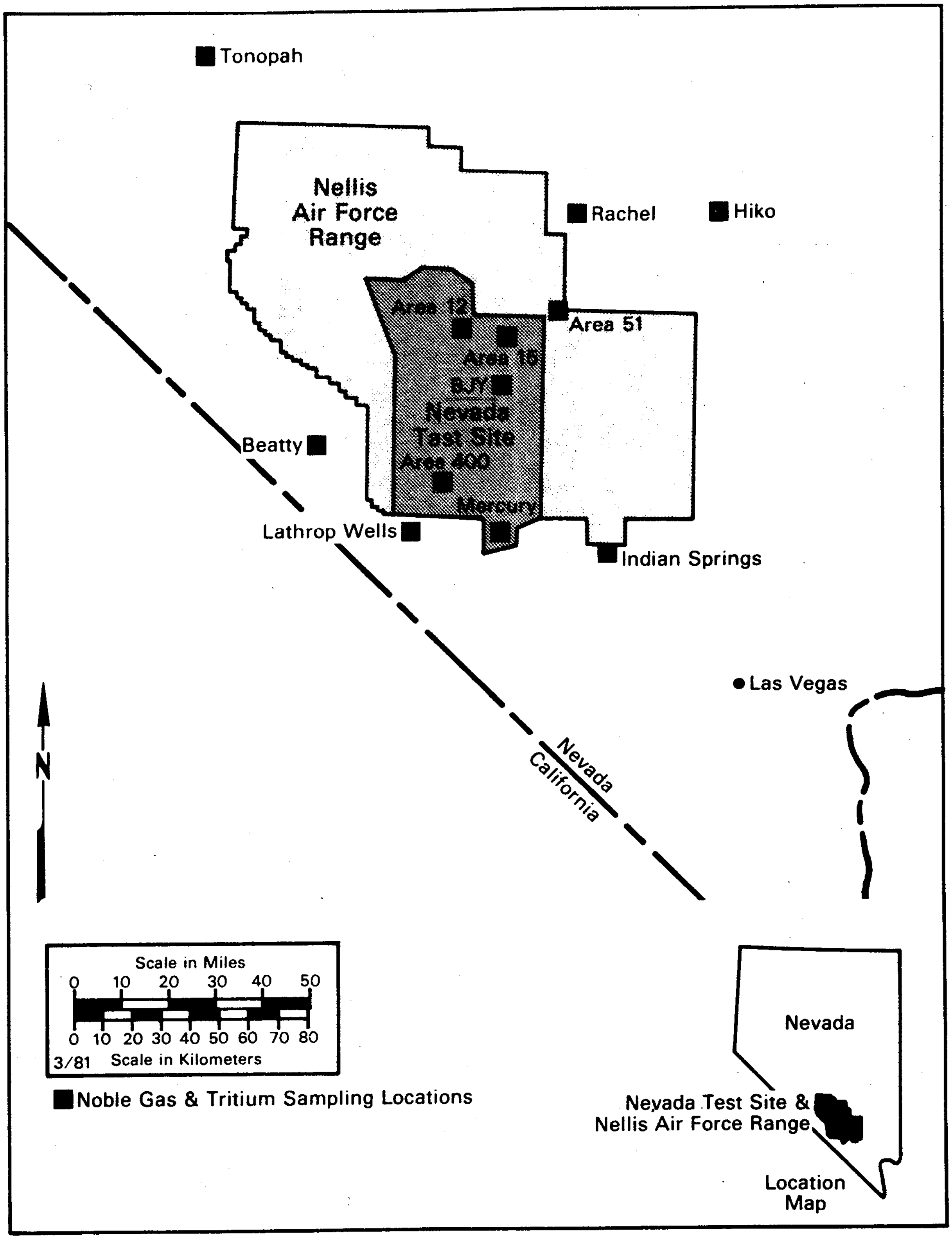

Figure 12. Noble Gas and Tritium Surveillance Network stations.

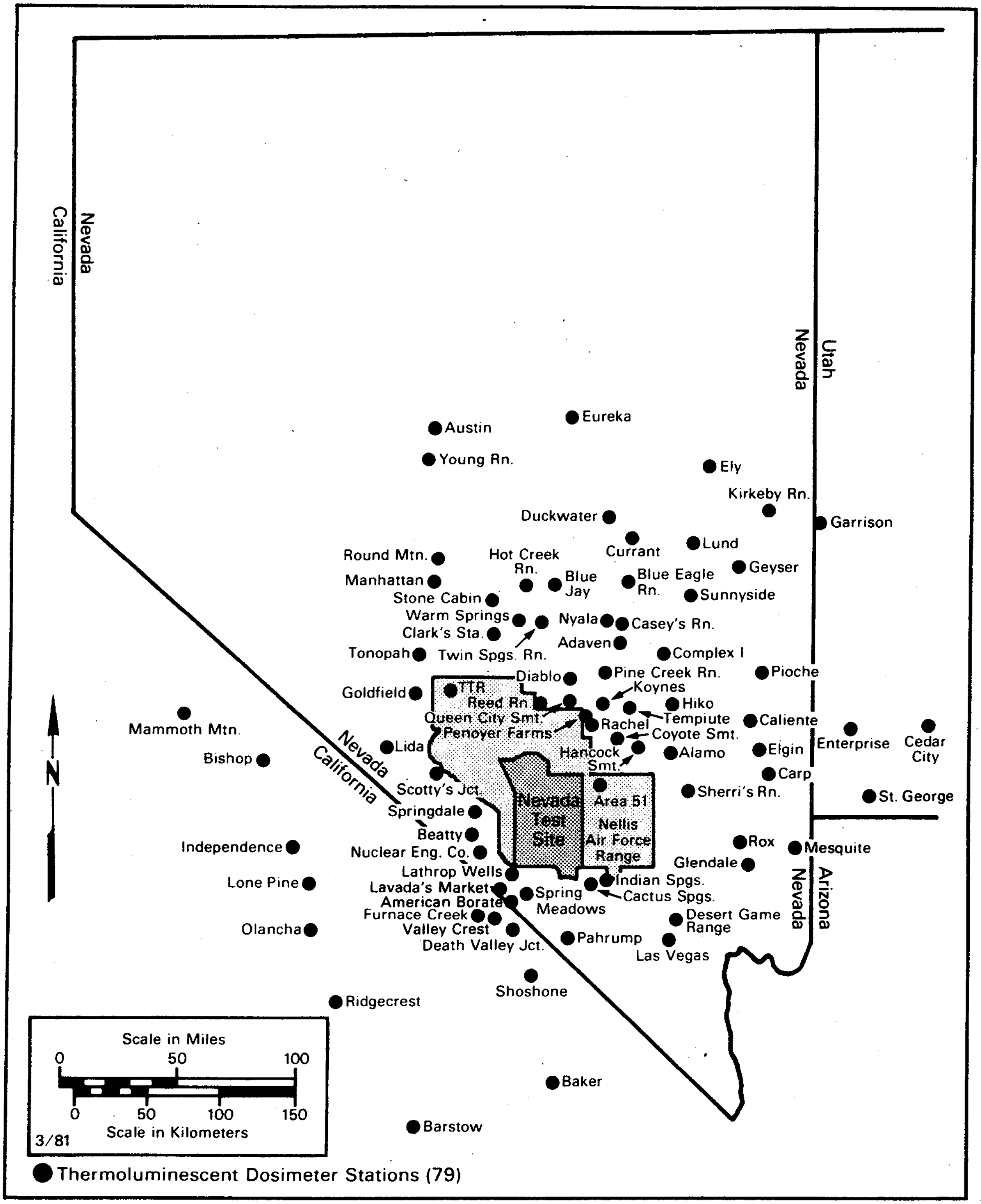

Figure 13. Thermoluminescent Dosimeter Network stations.

The Model 2271-G2 dosimeter consists of two small "chips" of dysprosium-activated calcium fluoride mounted in a window of Teflon plastic attached to a small aluminum card. An energy compensation shield of 1.2-mm thick cadmium metal is placed over the card containing the chips, and the shielded card is then sealed in an opaque plastic card holder. Three of these dosimeters are placed in a secured, rugged, plastic housing 1 meter above ground level at each station to standardize the exposure geometry. One dosimeter is issued to each of 24 offsite residents who are instructed in its proper wearing.

After appropriate corrections were made for background exposure accumulated during shipment between the laboratory and the monitoring location, the TLD readings for each station were averaged. The average value for each station was then compared to the values obtained during the previous year to determine whether the new value was within the range of previous background values for that station. The data from each of the personnel dosimeters were compared to the background value measured at the nearest station.

The smallest exposure above background radiation that can be determined from these TLD readings depends primarily on the magnitude of variations in the natural background exposure rate at the particular station. In the absence of other independent exposure rate measurements, one must compare the present exposure rate with valid prior measurements of natural background. Typically, the smallest net exposure detectable at the 99 percent significance level for a 90-day exposure period would be 5 to 15 mR above background. Depending on location, the background ranges from 15 to 35 mR. The term "background," as used in this context, refers to naturally occurring radioactivity plus a contribution from residual manmade fission products, such as world-wide fallout.

Milk Surveillance Networks

Milk is one of the most important pathways by which manmade radionuclides enter the diet of man. For this reason, milk produced near the NTS is monitored routinely. The six most common fission products found in milk are tritium, strontium-89 and -90, radioiodines, cesium-137, and barium-140. Concentrations of potassium-40, a naturally occurring radionuclide found in milk, are not reported.

The routine Milk Surveillance Network (MSN) and the Standby Milk Surveillance Network (SMSN) were continued during 1980 to monitor concentrations of radionuclides in milk. The MSN consisted of 21 sampling sites (Figure 14) at which EMSL-LV personnel collected 4 liters of raw milk each quarter from family cows, commercial producers, and pasteurization plants. In the event of a release of radioactivity from the NTS, the MSN would be expanded to permit extensive sampling in the affected area within a 480 km radius of CP-1 to assess the radionuclide concentrations in milk, the radiation doses that could result from the ingestion of milk, and the protective actions required. Milk from suppliers and producers beyond 480 km is normally collected by the SMSN operators however, EMSL-LV monitors are prepared to collect samples as far out as necessary to assure adequate and timely coverage.

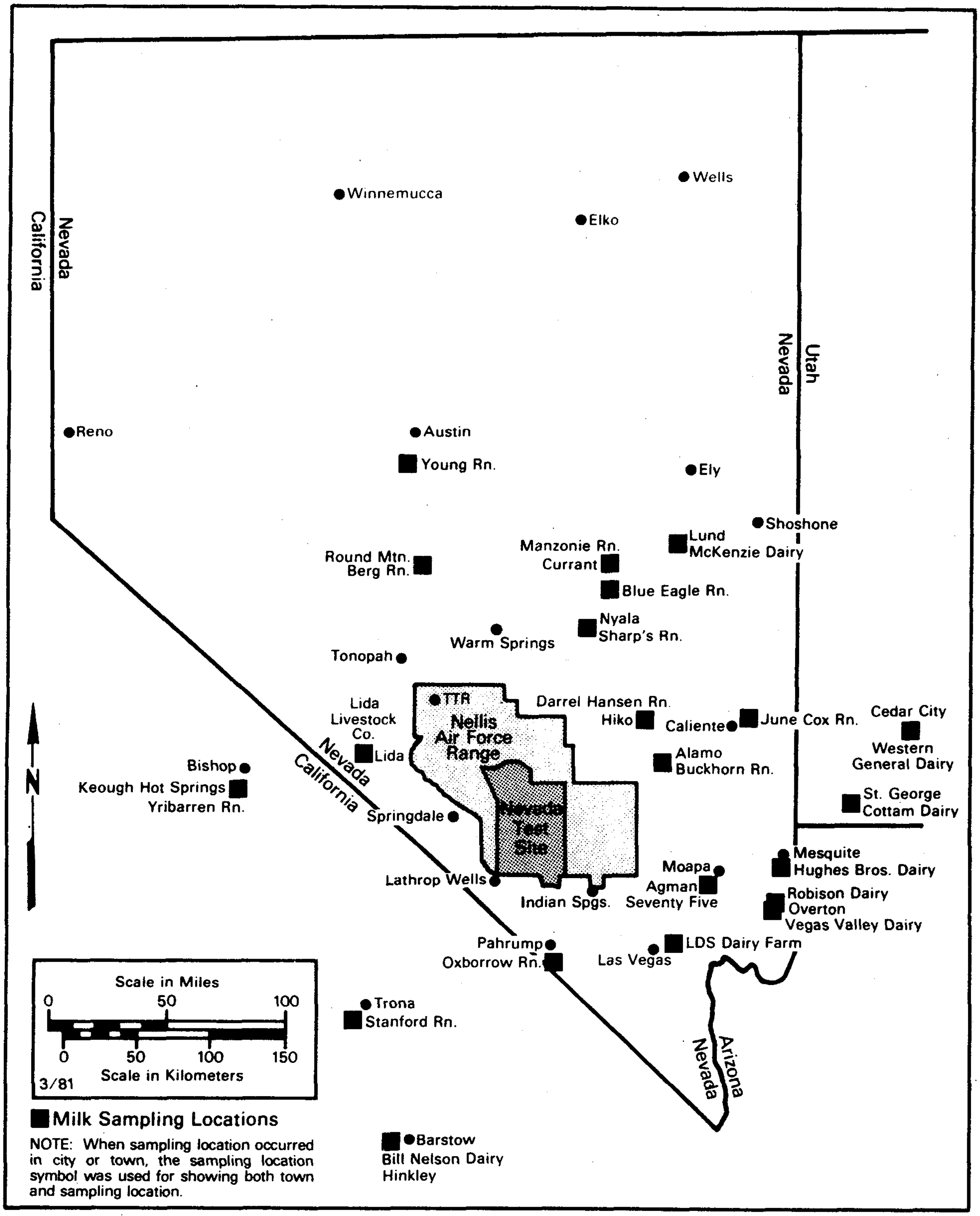

Figure 14. Milk Surveillance Network stations.

The SMSN consists of about 140 Grade A milk processing plants in all States west of the Mississippi River. Federal regional offices and State health departments can be requested to collect raw milk samples representing milk sheds supplying milk to processing plants. During 1980, there was no release of radioiodine from the NTS; therefore, this Network was activated only for performance testing.

All milk samples from the MSN were analyzed for gamma emitters and strontium-89 and -90. Six milk samples were also analyzed for tritium. Selected samples from the SMSN were analyzed for gamma emitters, strontium-89 and -90, and tritium. Appendix Table A-1 lists the analytical procedures and detection limits for these analyses.

Long-Term Hydrological Monitoring Program

The Long-Term Hydrological Monitoring Program (LTHMP) was continued during 1980. Wells, springs, and surface water sources near underground nuclear detonation test areas in Alaska, Nevada, Colorado, New Mexico, and Mississippi were sampled periodically to monitor for the migration of test-related radionuclides. A deep-well water sampler, capable of collecting 3-liter samples from depths to 1,800 m, was used to collect many of the samples from wells having no pumps.

Nevada Test Site

Figures 15 and 16 show the sampling locations on and around the NTS. Thirteen stations are sampled monthly while 20 stations, 8 of them on the NTS, are sampled semiannually. Eleven other offsite stations are sampled annually. Not all stations could be sampled with the desired frequency because of inclement weather or inoperative pumps. Two locations were not sampled: Well UE18r and Road D windmill.

Each sample was analyzed for gamma emitters and tritium. Raw water and filtered/acidified water were collected at each location. The raw water samples were analyzed for tritium. Portions of the filtered/acidified samples were analyzed for gamma emitters. Appendix Table C-1 summarizes the analytical techniques used. Suspended solids collected on each filter were also analyzed for gamma emitters.

Other Test Sites

Water samples were collected annually from the vicinity of all off-NTS sites of underground nuclear detonations. These sites included Project Faultless near Warm Springs, Nevada; Project Gnome near Carlsbad, New Mexico; Project Shoal near Fallon, Nevada; Project Dribble (Miracle Play) near Hattiesburg, Mississippi; Project Gasbuggy near Gobernador, New Mexico; Project Rulison near Grand Valley, Colorado; Project Rio Blanco in Rio Blanco County, Colorado; and Projects Long Shot/Milrow/Cannikin on Amchitka Island, Alaska. Figures 17 through 29 identify the sampling locations. All samples were analyzed in the same manner as those samples collected for the NTS. Due to the presence of tritium in concentrations above background in surface water samples and well water samples collected in the past on the Project

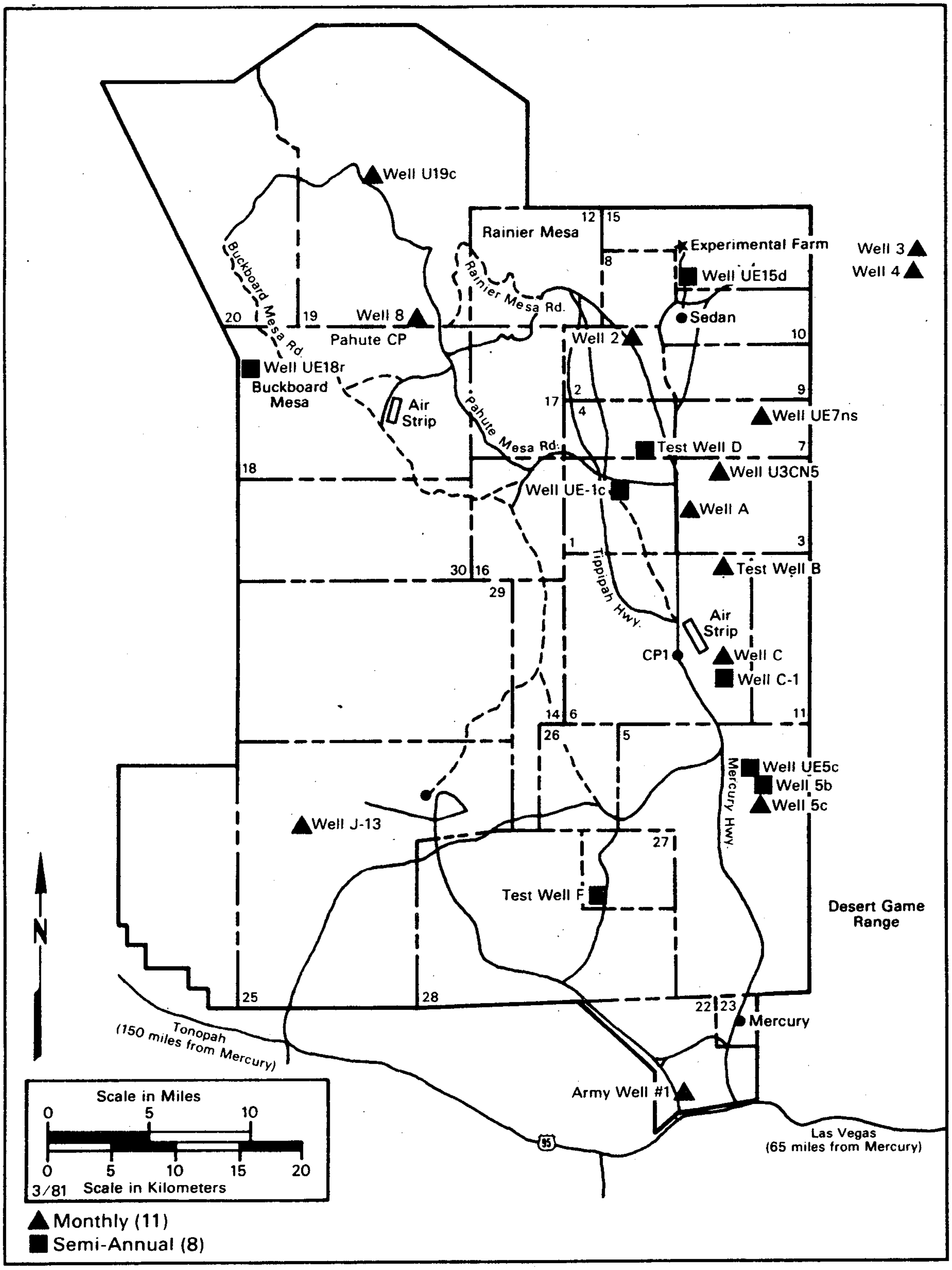

Figure 15. Long-Term Hydrological Monitoring Program sampling sites on the Nevada Test Site.

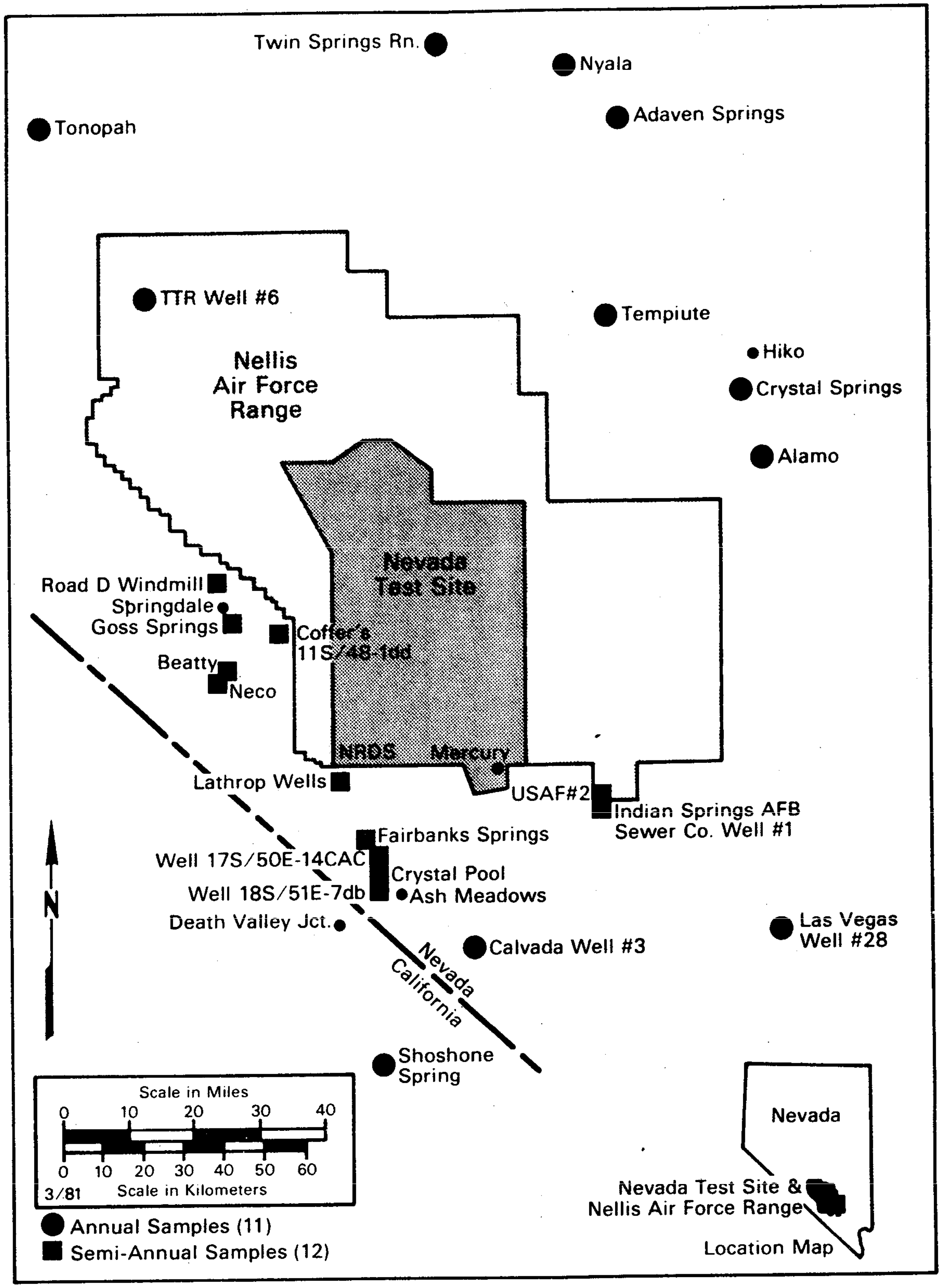

Figure 16. Long-Term Hydrological Monitoring Program sampling sites surrounding the Nevada Test Site.

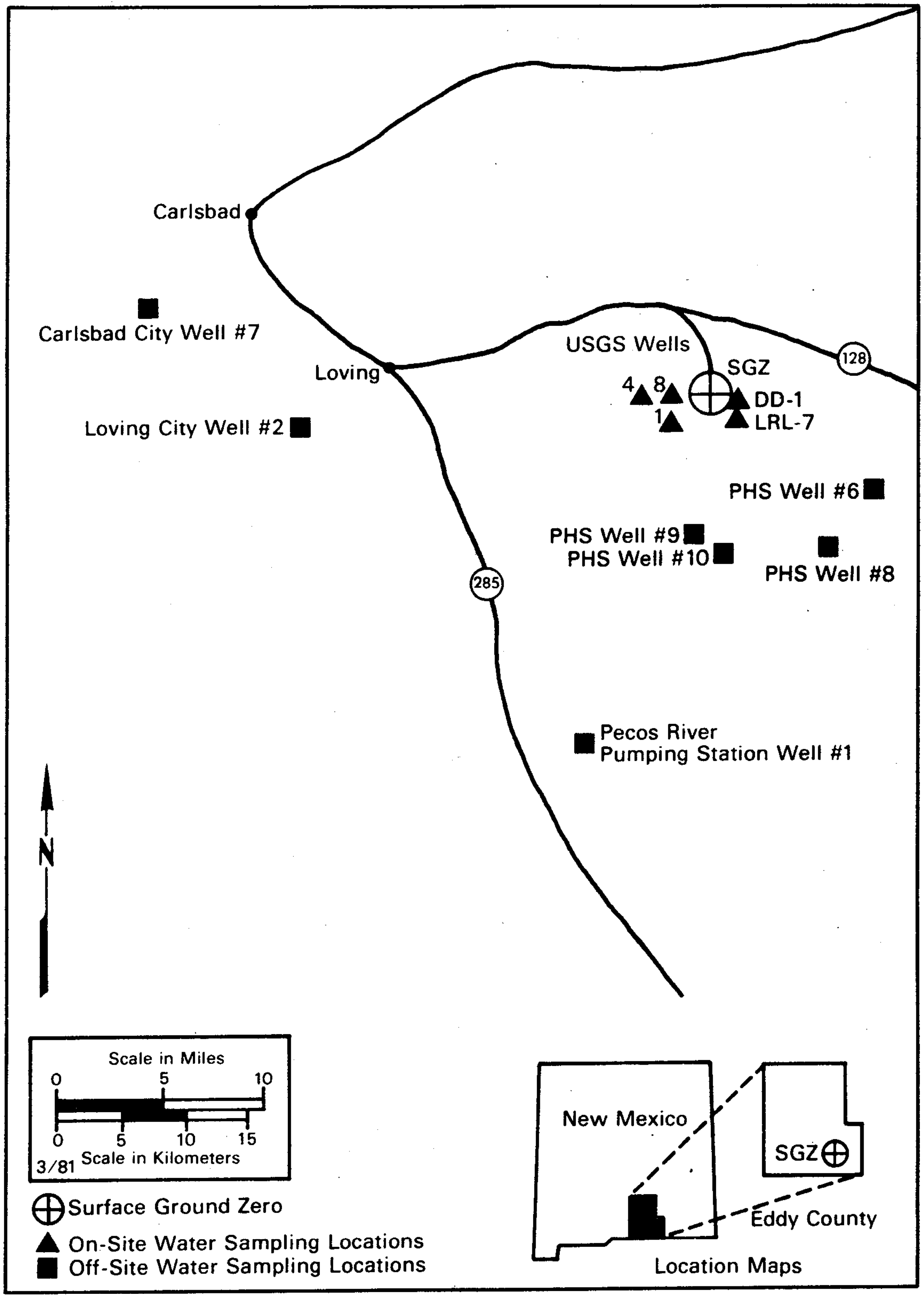

Figure 17. Long-Term Hydrological Monitoring Program sampling sites for Projects Gnome and Coach, Carlsbad, New Mexico.

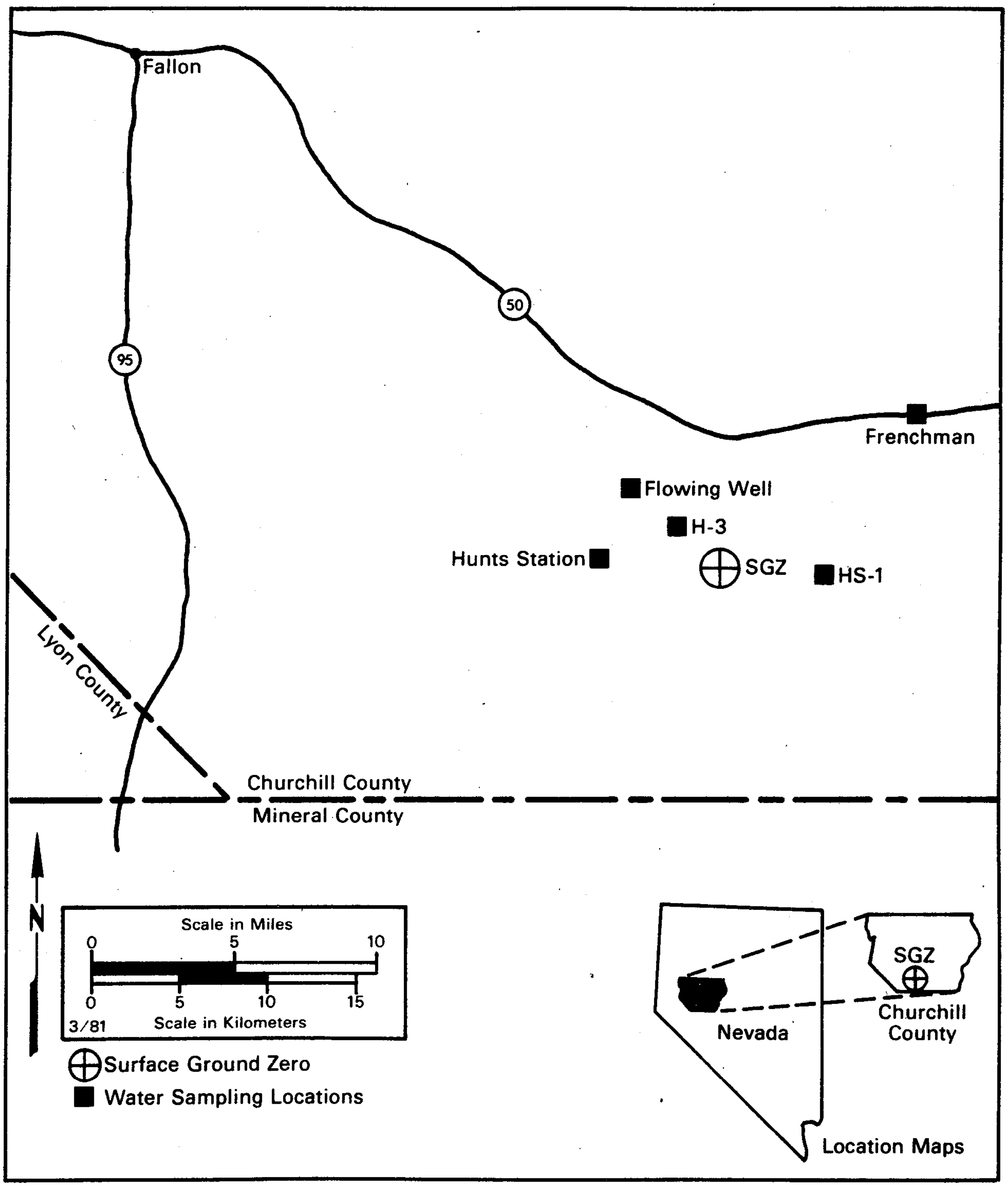

Figure 18. Long-Term Hydrological Monitoring Program sampling sites for Project Shoal, Fallon, Nevada.

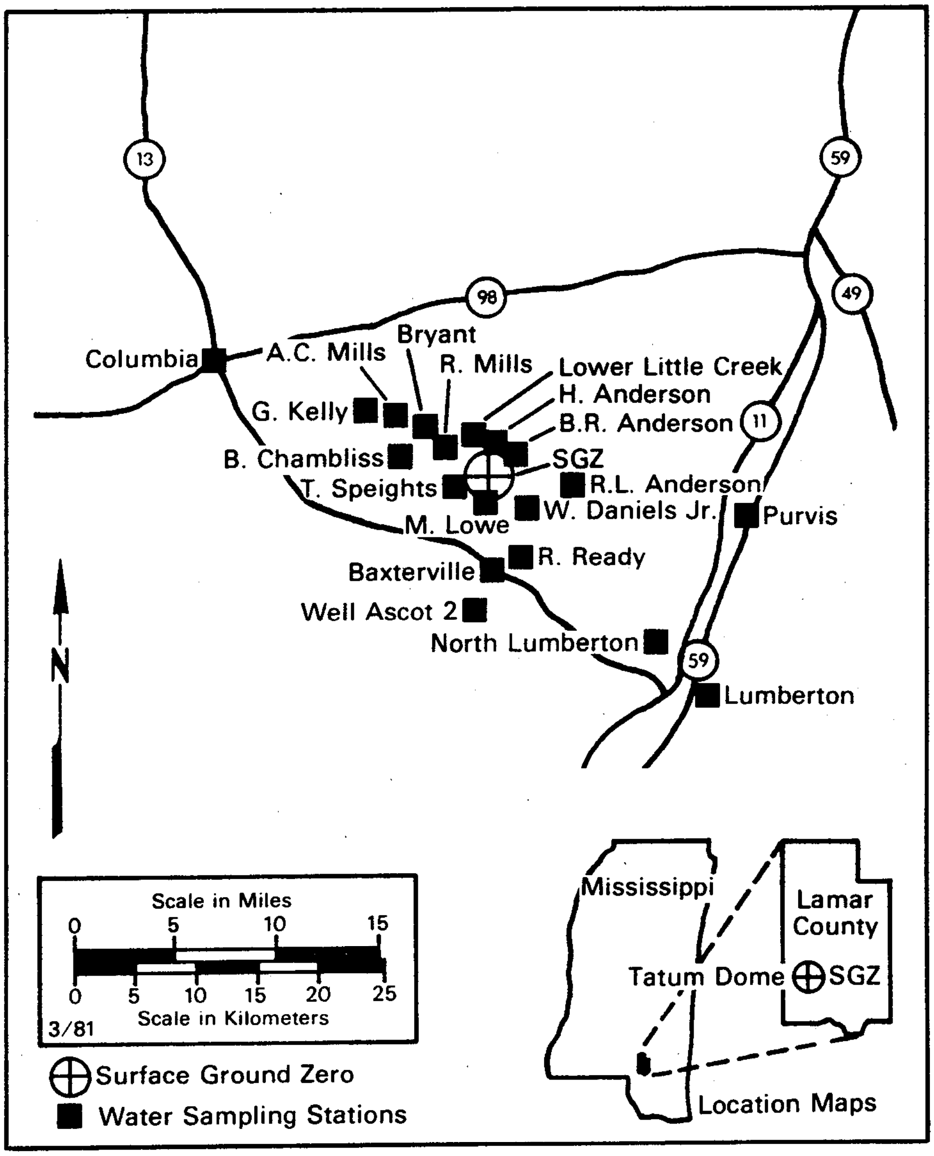

Figure 19. Long-Term Hydrological Monitoring Program sampling sites for Projects Dribble and Miracle Play, vicinity of Tatum Salt Dome, Mississippi.

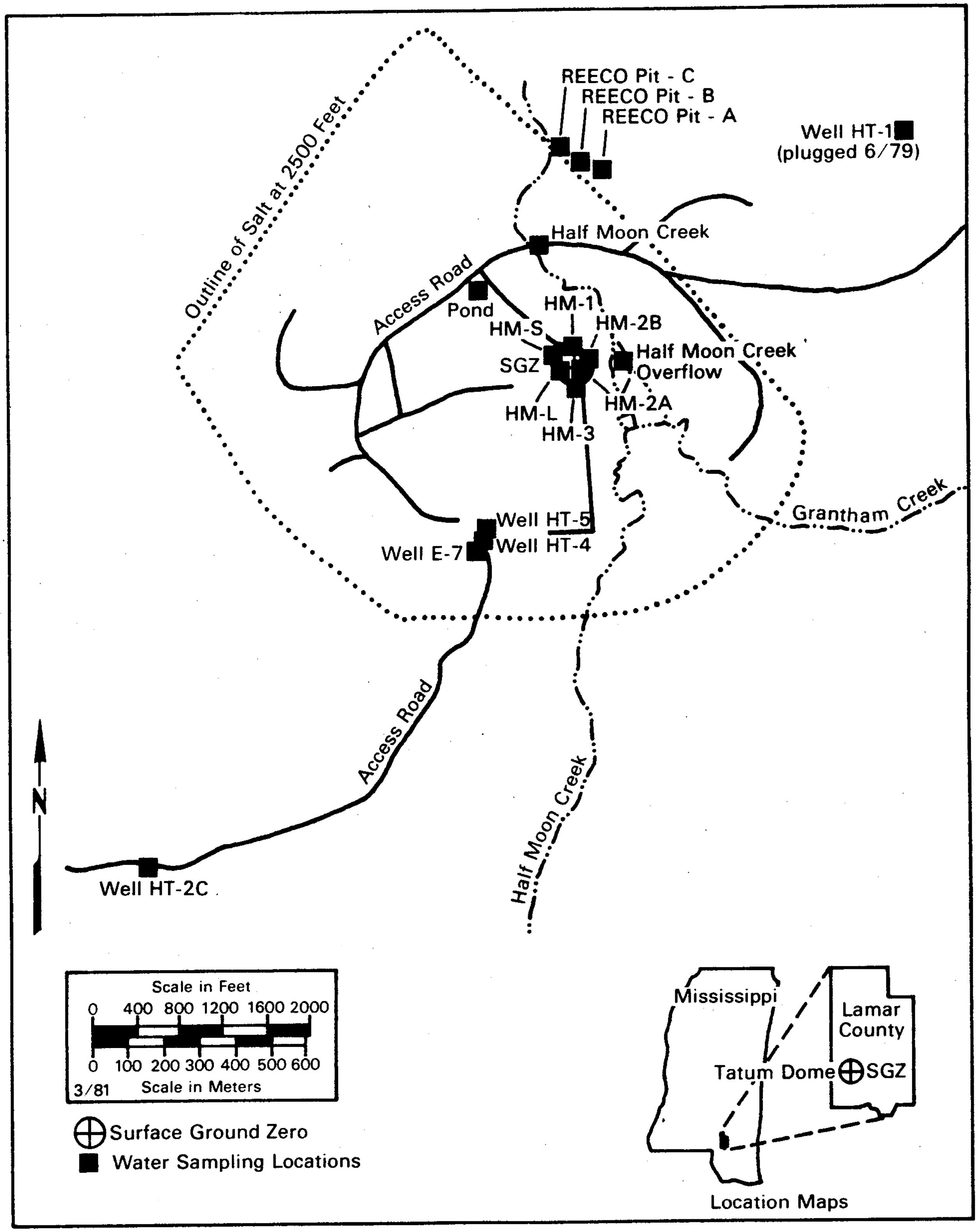

Figure 20. Long-Term Hydrological Monitoring Program sampling sites for Projects Dribble and Miracle Play, Tatum Salt Dome, Mississippi.

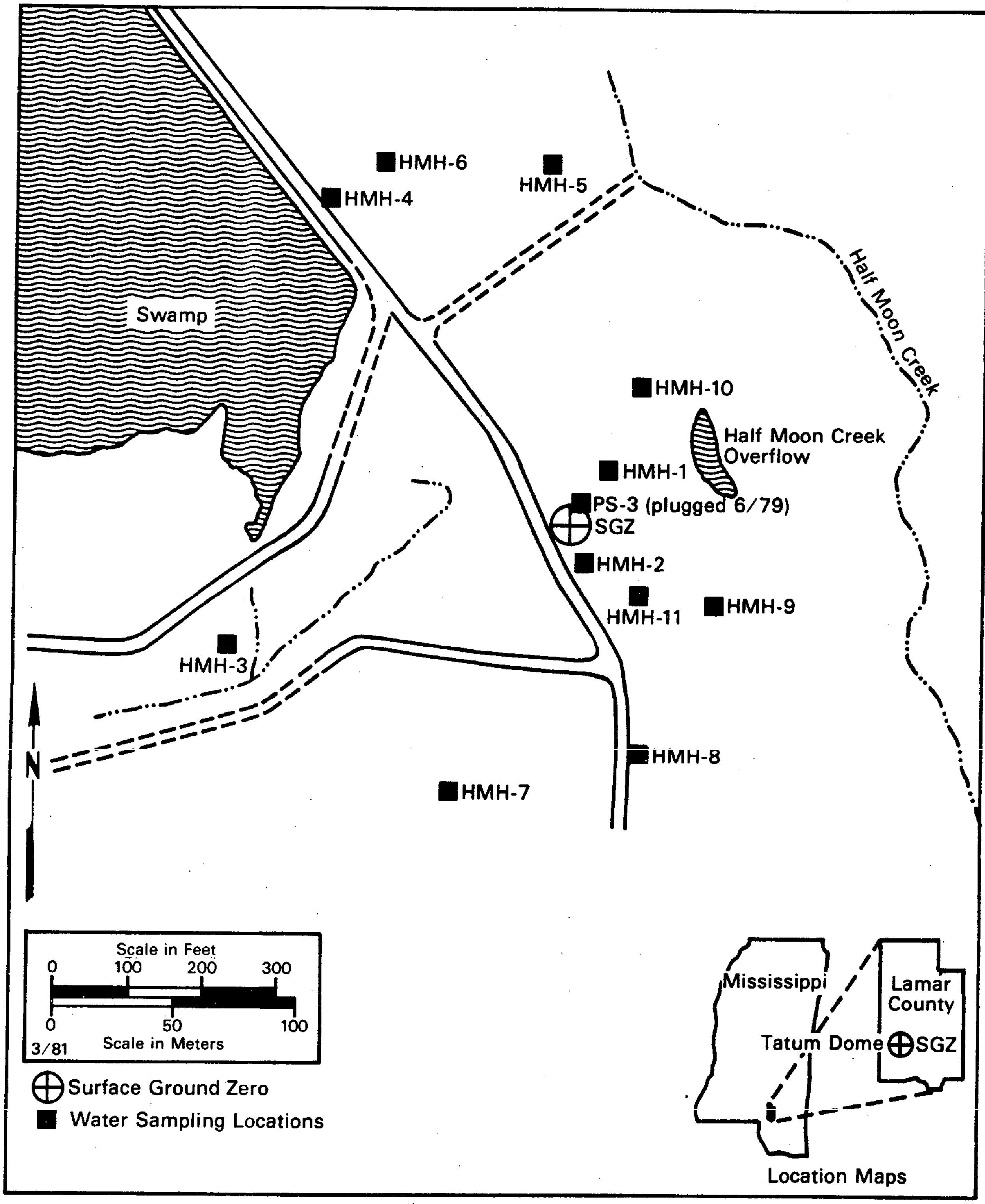

Figure 21. Long-Term Hydrological Monitoring Program sampling sites for Projects Dribble and Miracle Play, Tatum Dome, Mississippi.

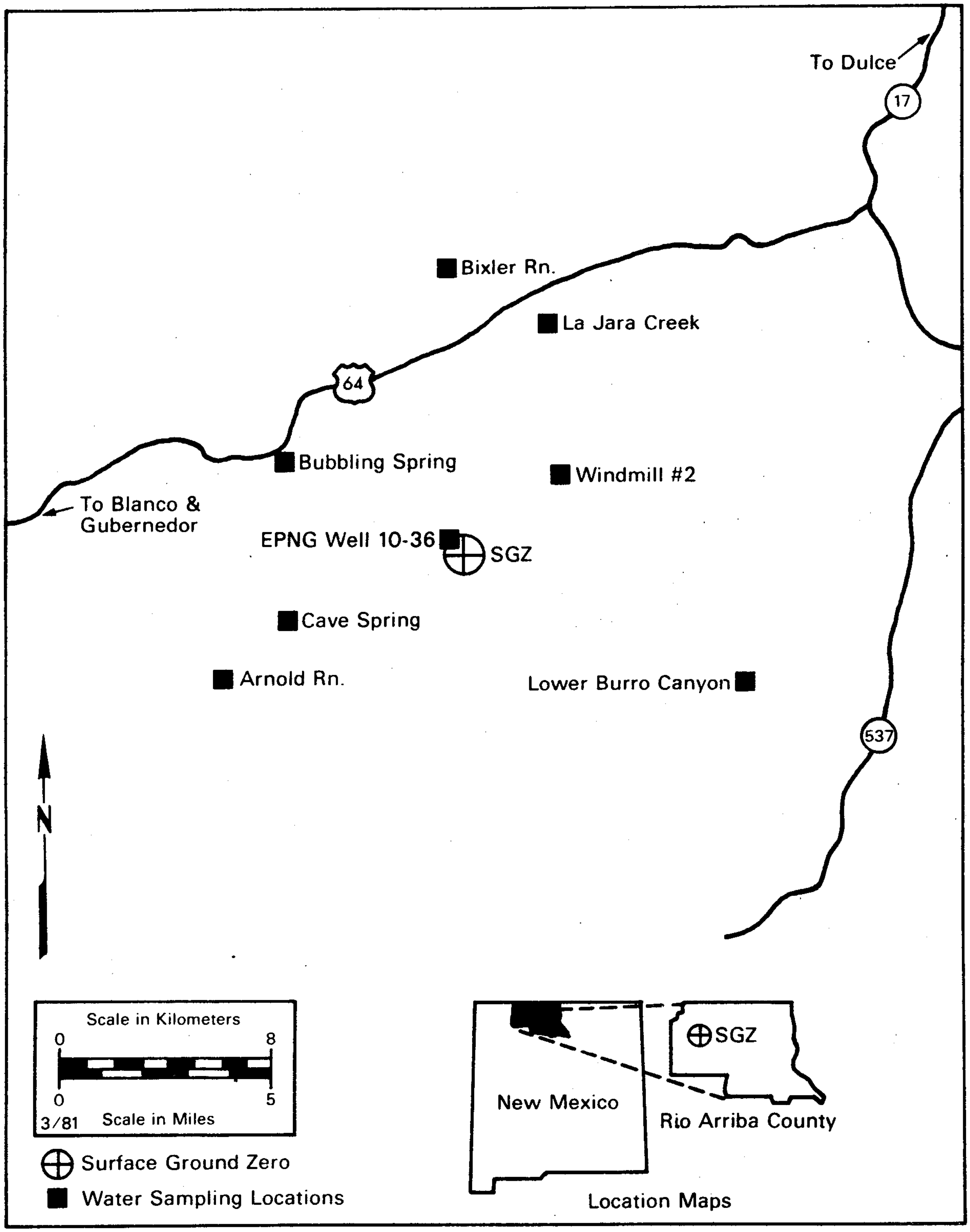

Figure 22. Long-Term Hydrological Monitoring Program sampling sites for Project Gasbuggy, Rio Arriba County, New Mexico.

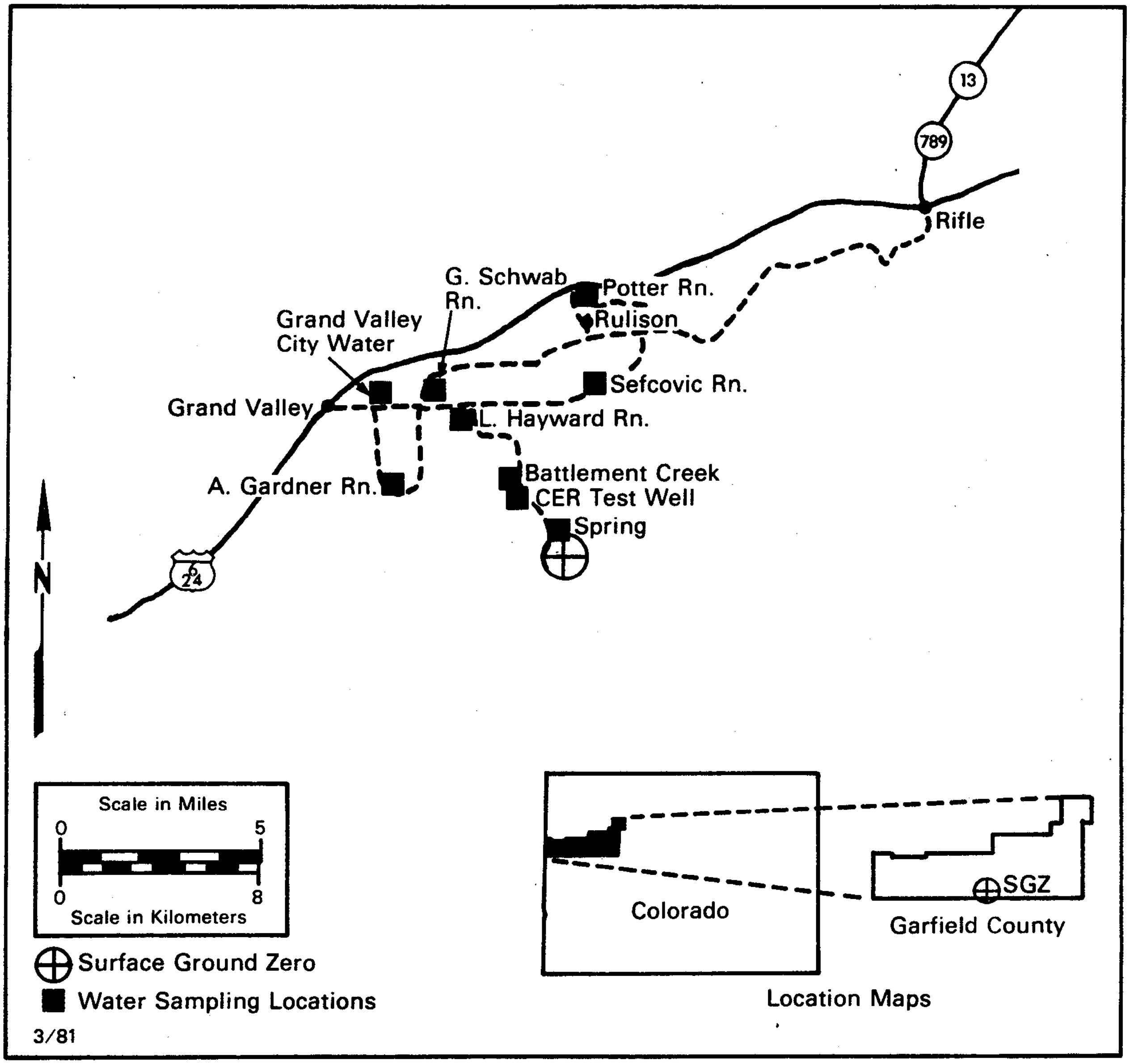

Figure 23. Long-Term Hydrological Monitoring Program sampling sites for Project Rulison, Rulison, Colorado.

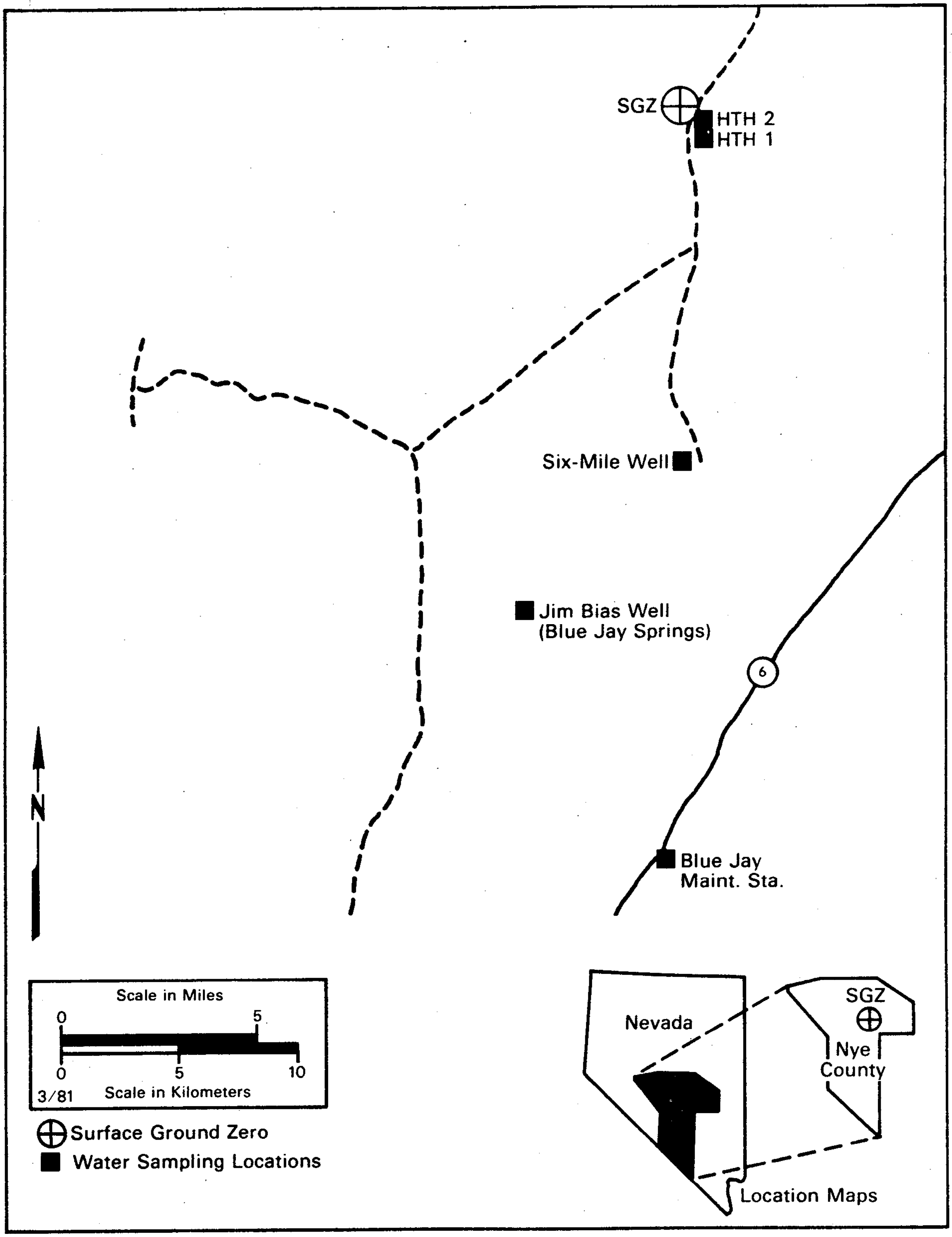

Figure 24. Long-Term Hydrological Monitoring Program sampling sites for Faultless Event, Central Nevada Test Area.

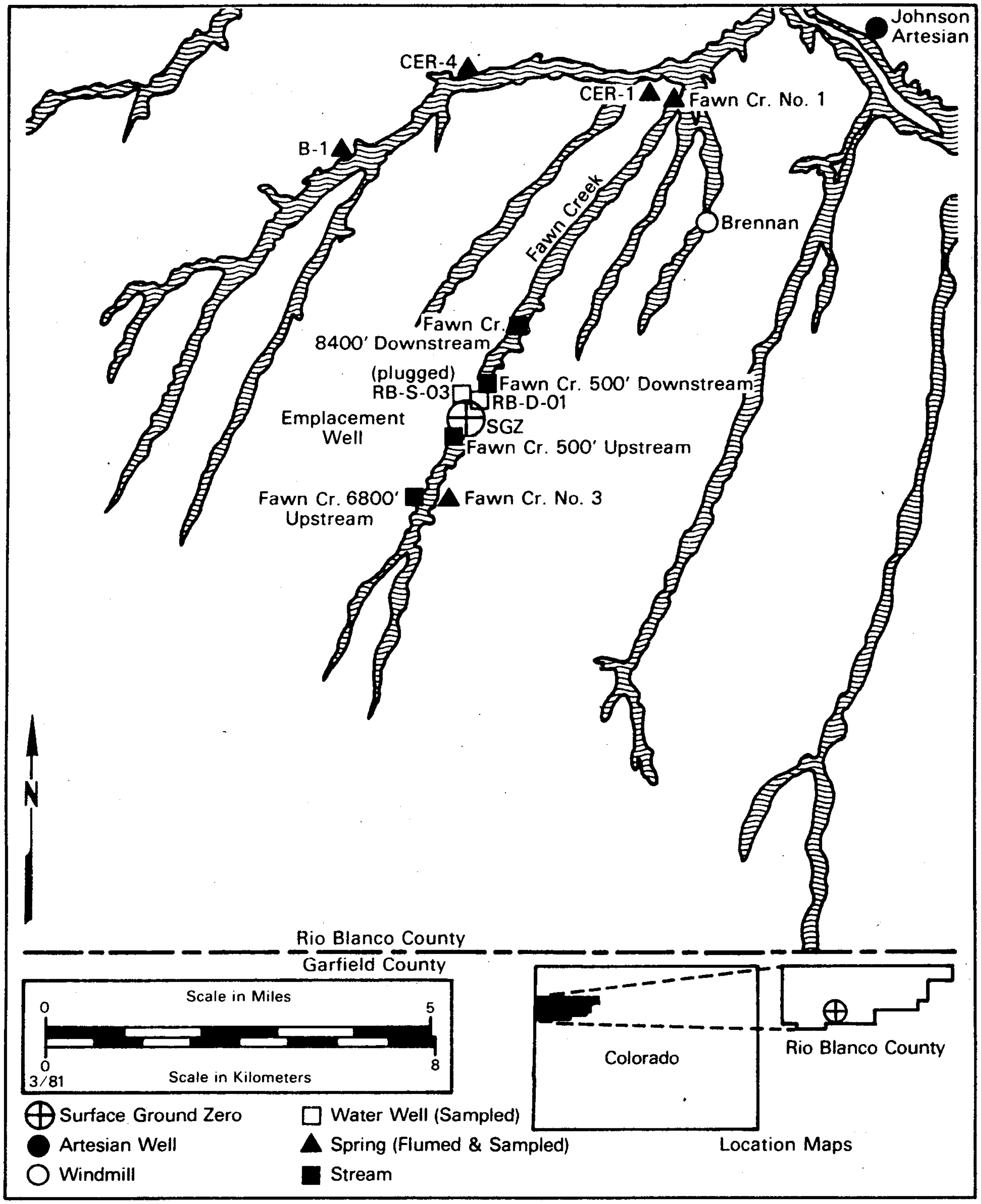

Figure 25. Long-Term Hydrological Monitoring Program sampling sites for Project Rio Blanco, Rio Blanco County, Colorado.

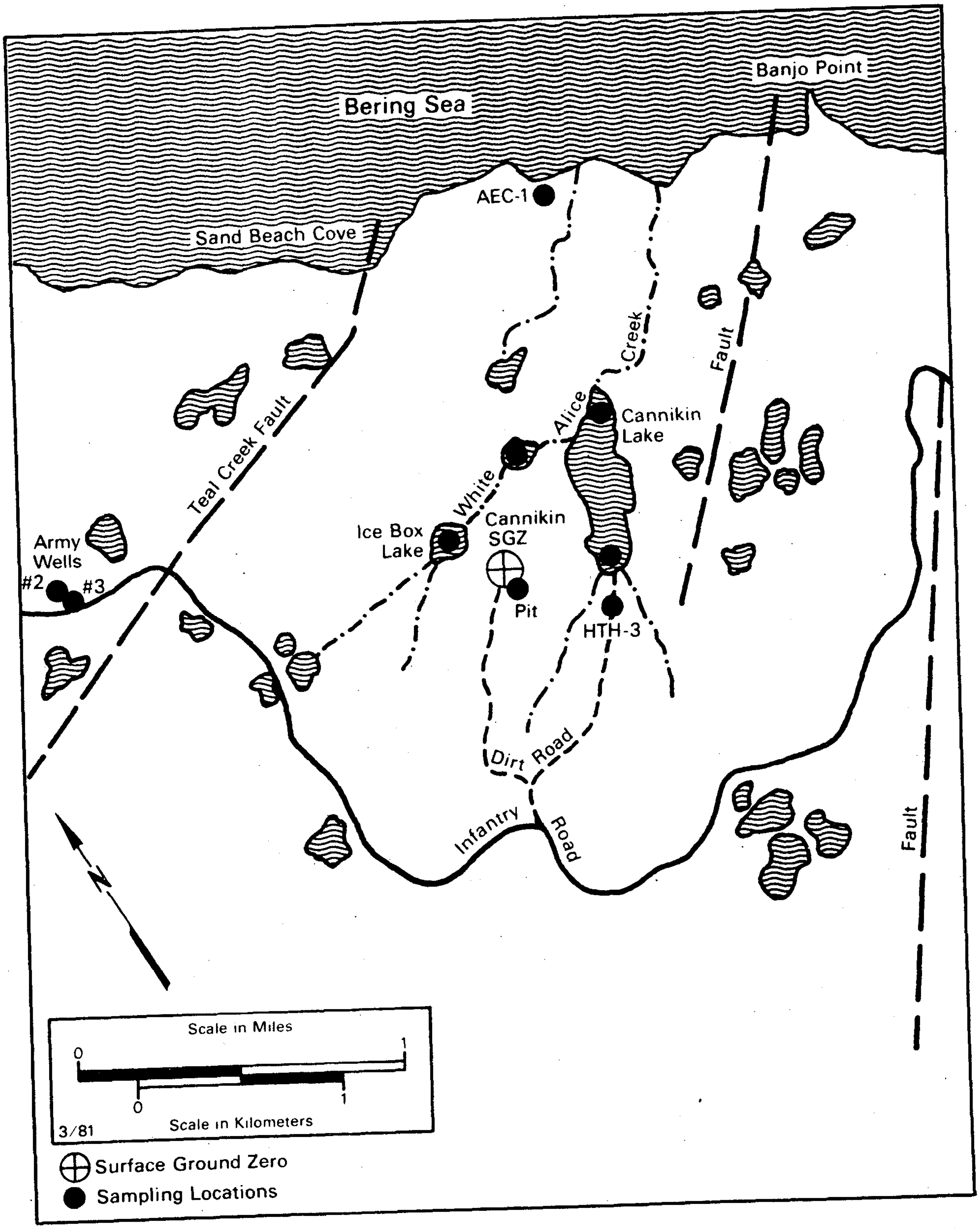

Figure 26. Long-Term Hydrological Monitoring Program sampling sites for Project Cannikin, Amchitka Island, Alaska.

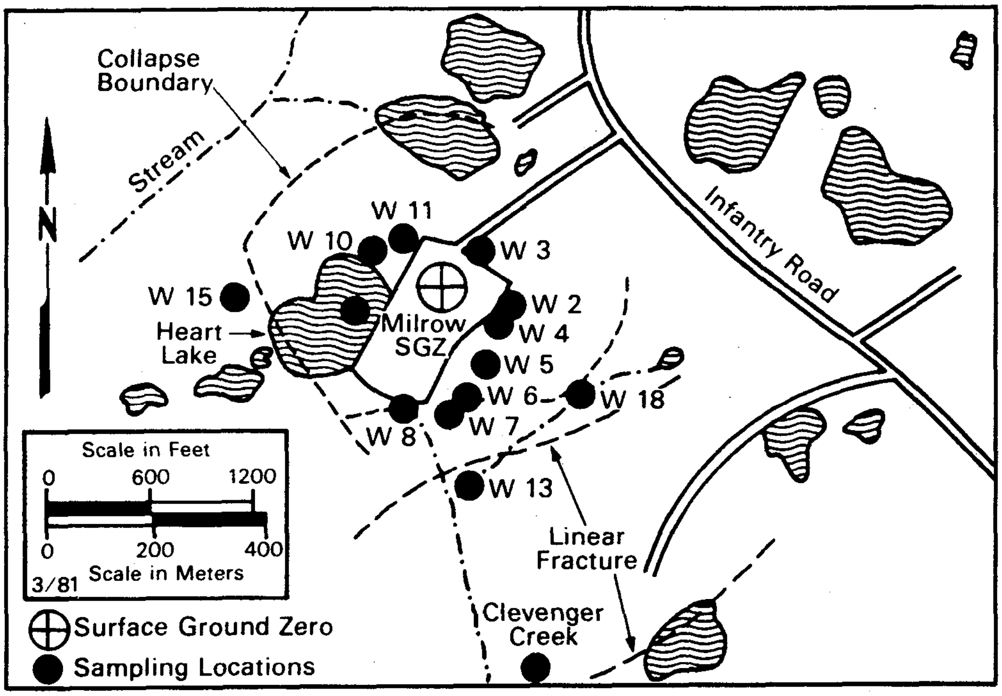

Figure 27. Long-Term Hydrological Monitoring Program sampling sites for Project Milrow, Amchitka Island, Alaska.

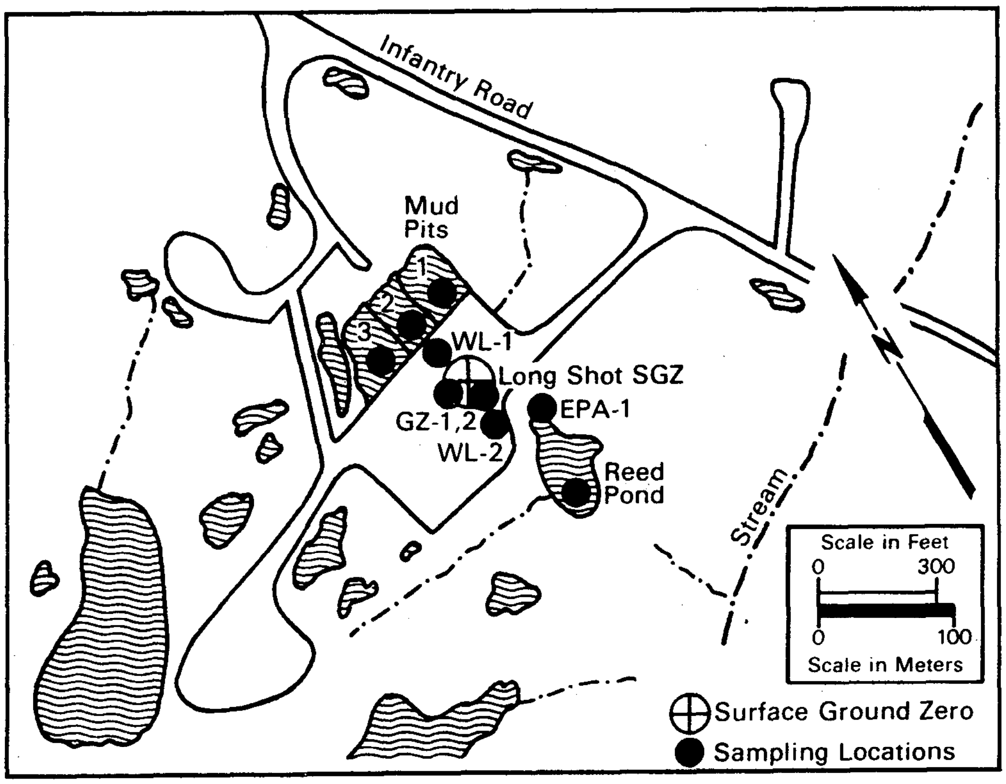

Figure 28. Long-Term Hydrological Monitoring Program sampling sites for Project Longshot, Amchitka Island, Alaska.

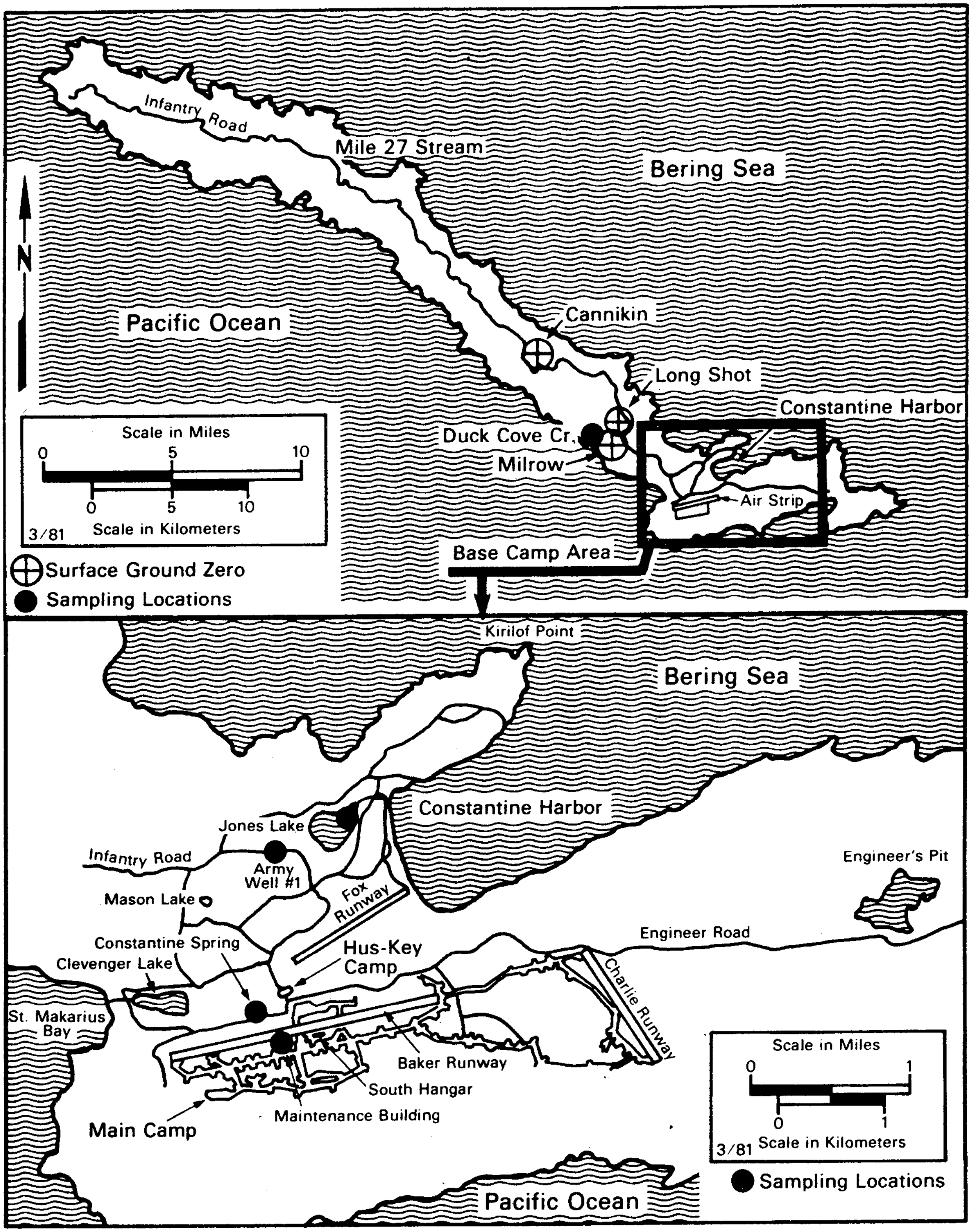

Figure 29. Background sampling sites for the Long-Term Hydrological Monitoring Program on Amchitka Island, Alaska. (Base camp area is shown in larger scale in the lower portion of the figure.)

Dribble site, nine more sampling locations within 100 feet of surface ground zero and five wells used by residents of the area were added to the routine sampling schedule for this project. The analytical results of special water samples collected for this project between July 18, 1979, and September 5, 1979, but not reported in last year's environmental report are reported separately (Fenske, P. R. and T. M. Humphrey, Jr., 1980).

Animal Investigation Program

The basic responsibility of the Animal Investigation Program (AIP) is to monitor the radionuclide burdens in, and damage to, domestic animals and wildlife on and around the NTS. These analyses have not been completed, but will be reported in the annual AIP report for 1980.

AIP personnel sampled mule deer, rabbits, a horse, desert bighorn sheep, and cattle. Some of these animals were found dead as road kills or from natural causes; others were collected by hunting or were sacrificed for sampling. Figure 30 shows where the animals were collected.

Animals were necropsied whenever possible. Samples of adrenals, eyes, heart, kidneys, liver, lungs, muscle, spleen, thyroid, gonads, and gross lesions were collected for histopathological evaluation if post mortem change had not occurred. Tissues from large animals collected for radioanalysis included liver, lung, tracheobronchial lymph node, muscle, thyroid, blood, kidney, fetus, and bone samples from the femur or hock. Rumen or stomach contents were also taken for radioanalysis. In small animals, bone from the entire skeleton, muscle, skin, entire gastrointestinal tract, and composited internal organs (liver, lungs, kidneys, and spleen), were collected for radioanalysis.

Soft tissues and rumen contents were analyzed for gamma emitters. Tissue water from blood was analyzed for tritium. If blood was not available a soft tissue was substituted. Bone was analyzed for strontium-89 and -90 and plutonium-238 and -239.

A sizeable mule deer herd described by Smith et al. (1978) resides in the mountainous regions of the NTS during the summer. If they move to unrestricted lands, these deer may be hunted by members of the public. A study designed to determine migration patterns of the herd by tracking individual deer wearing collars containing miniature radio transmitters was begun in 1975 and continued through 1980.

During the summer and fall of 1980, 13 mule deer were captured either by the chemical restraint of free-ranging animals (Smith et al. 1978) or by trapping (Giles 1979). These deer were outfitted with radiotransmitter collars, ear tags, and reflective markers suspended from the collar. These 13 newly installed transmitters brought to 20 the total number of working transmitters in the field (7 from previous years). Laboratory personnel monitored the movements of the deer weekly with hand-held receivers and directional antenna. Nineteen other deer were captured but were unsuitable for collaring and were released after visible markers had been attached.

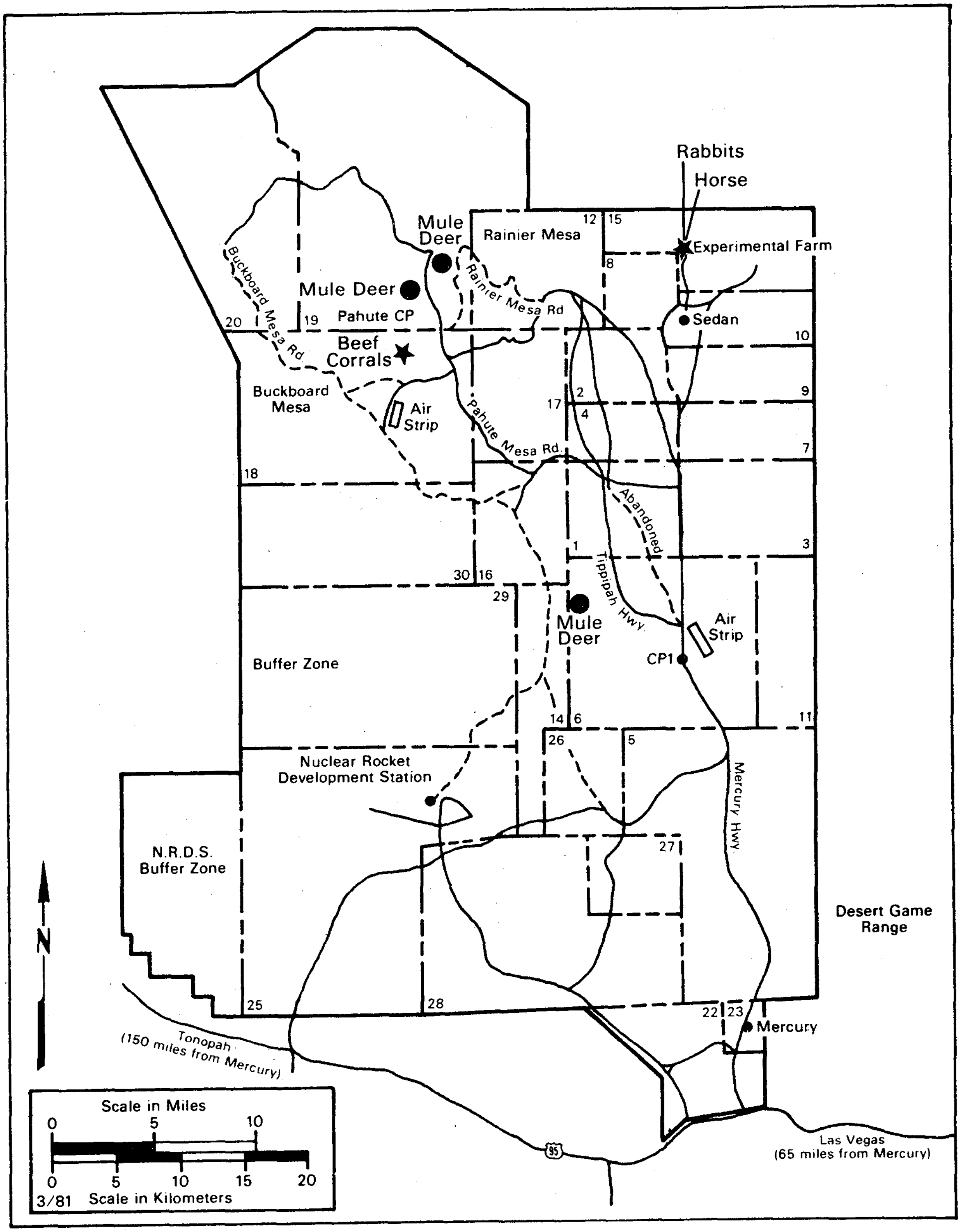

Figure 30. Wildlife collection sites on the Nevada Test Site.

Offsite Human Surveillance Program

A whole-body counting facility has been maintained at the EMSL-LV since 1966 and is equipped to determine the identity and quantity of gamma-emitting radioactive materials which may have been inhaled or ingested. A single thallium-activated sodium iodide crystal, 28x10 centimeters, is used to measure gamma radiation in the energy range from 0.1 to 2.5 MeV. Two phoswich detectors (a thin thallium-activated sodium iodide crystal coupled to a thick thallium-activated cesium iodide crystal) are placed on the chest to measure low-energy radiation - for example, 17 keV x-rays from plutonium-239. The most likely mode of intake for most alpha-emitting radionuclides is inhalation, and the most important of these also emit low-energy x-rays which can be detected in the lungs by the phoswich detectors.

The Offsite Human Surveillance Program was initiated in December 1970 to determine levels of radioactive nuclides in a population consisting of families residing in communities and ranches surrounding the Nevada Test Site. Analysis is performed in the spring and fall. This program started with 34 families (142 individuals). In 1980, 16 of these families (45 individuals) were still active in the program. The geographical locations of the 16 families are shown in Figure 31. A whole-body count of each person is made at the EMSL-LV to determine the body burden of gamma-emitting radionuclides. A urine sample is collected for analysis and a short medical history, complete blood count, thyroid profile and physical examination are obtained on each participant. Results of the whole-body count are available before the families leave the facility and are discussed with the subjects. The results of the blood and urine tests are sent to the families along with a letter of explanation from the examining physician.

In addition to these offsite families, counts are performed routinely on EPA and EG&G employees as part of the health monitoring programs. Selected individuals from the general population of Las Vegas and other cities are also counted to obtain background data. During 1980, a total of 1,656 spectra were obtained from persons visiting the facility.

MEDICAL LIAISON OFFICER NETWORK

The Medical Liaison Officer Network (MLON) is a nationwide volunteer group of physicians, coordinated through the EMSL-LV, which is available to investigate claims of radiation injury purported to be the result of the DOE nuclear testing activities. The history and investigative procedures of MLON were discussed by Holder (1972).

QUALITY ASSURANCE

A quality assurance program is carried out on sampling and radioanalytical procedures to assure that data from these procedures will be valid. This program includes instrumental quality control procedures, the analysis of replicate samples to measure precision, and the analysis of cross-check samples obtained from an independent laboratory to measure accuracy.

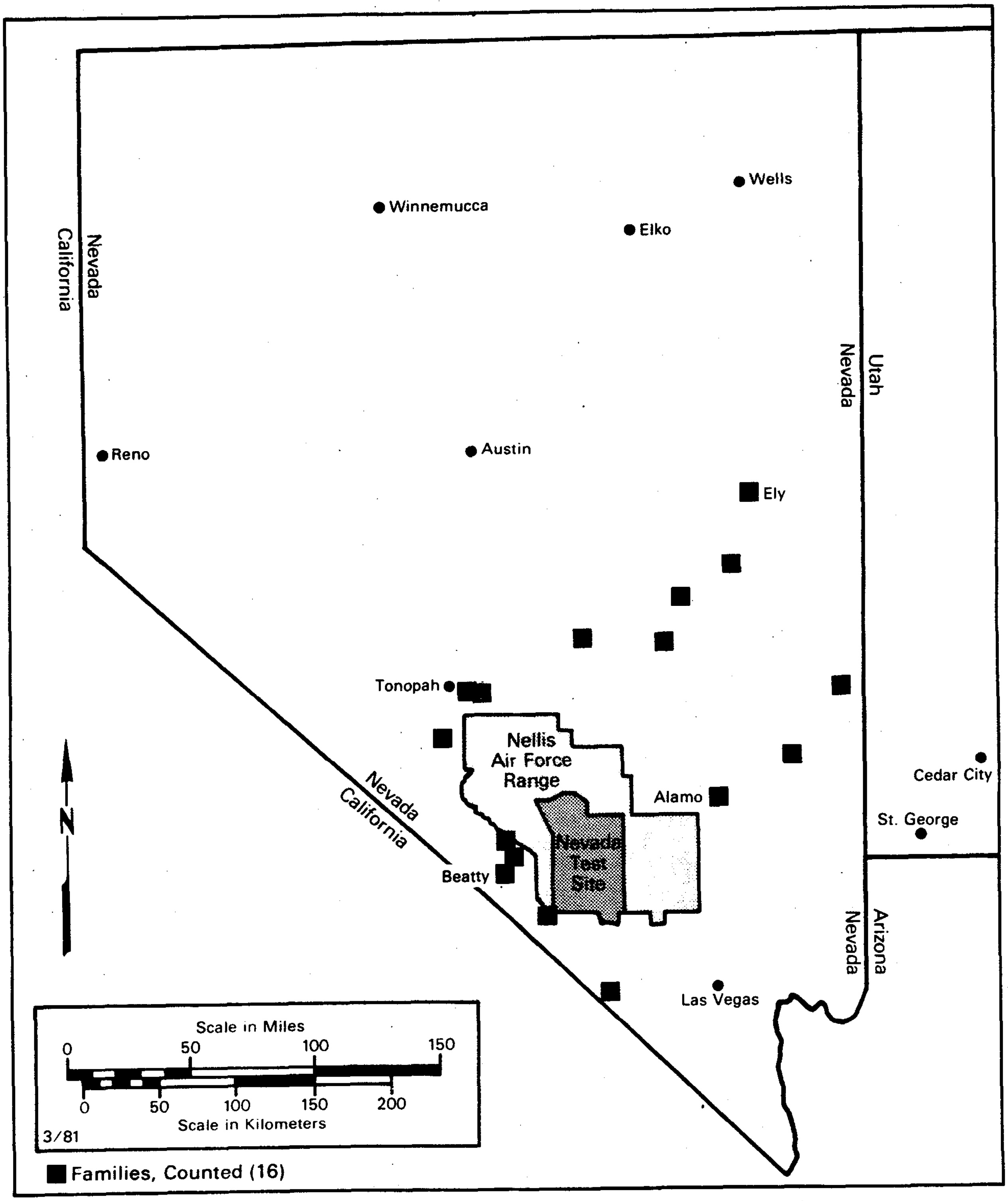

Figure 31. Location of families participating in the Offsite Human Surveillance Program, 1980.

Radioanalytical counting systems and TLD systems are calibrated using radionuclide standards that are traceable to the National Bureau of Standards (NBS). These standards are obtained from the Quality Assurance Division at EMSL-LV or from NBS. Each standard source used for TLD calibrations is periodically checked for accuracy in accordance with procedures traceable to NBS.

To determine accuracy of the data obtained from the TLD systems, dosimeters are periodically submitted to the University of Texas School of Public Health for intercomparisons of environmental dosimeters. Dosimeters were submitted to the Fifth International Intercomparison in August 1980. Results will be published in 1981. All TLD measurements are performed in conformance with standards proposed by the American National Standards Institute (ANSI 1975).

Instrument quality control charts are used to assure that instrument background measurements and the response of laboratory instruments to a reference standard are within required limits.

Precision of the results, as influenced by sampling and analytical errors, is estimated through a program of replicate analysis and duplicate sampling. Approximately 20 percent of all samples are used to determine sampling and analytical error. About 10 percent of the samples are collected in duplicate and analyzed to obtain an estimate of the combined sampling and analytical error (Appendix A). An additional 10 percent of the samples are split in the laboratory to obtain an estimate of the analytical error. For the TLD Network, six replicate exposures are made (two chips on each of the three TLD's) at each station. Estimates of the total error in precision are made from the variances of these replicates (Appendix Table A-3).

Accuracy determinations are made by the analysis of intercomparison samples provided by the Quality Assurance Division, EMSL-LV (EPA 1981). These intercomparison samples consist of simulated environmental samples containing known amounts of one or more radionuclides. The intercomparison samples are analyzed, and the results sent to the Quality Assurance Division for statistical analysis and comparison with the known value and analytical values obtained by other participating laboratories. These intercomparisons are performed bimonthly, quarterly, or semiannually, depending upon the type of sample. The results of the analyses of these cross-check samples for 1980 are summarized in Appendix Table A-4.

RESULTS AND DISCUSSION

The only test-related radioactivity from the Nevada Test Site detected offsite was released following the Riola test conducted at 8:26.5 a.m. PDT on September 25, 1980.

The only radioactivity observed from non-NTS sites of past underground nuclear tests was from small amounts of tritium found in water samples from the Project Dribble site in Mississippi and the Project Long Shot site in Alaska. These waters are not used for human consumption and do not constitute a health hazard.

The results from the Radiological Safety Program are discussed in the following sections, and specific data are presented in the Appendix tables.

RIOLA TEST

Immediately following this event, no radioactivity was detected onsite or offsite by ground and aerial monitoring teams; therefore, the teams were released 2 hours after the test. During the evening, airborne radioactivity began seeping from the test and continued into the next day. When EPA personnel were notified about the release by the Department of Energy at about 7:30 a.m. the following day (September 26, 1980), an estimate of where the effluent traveled was obtained from the National Oceanic and Atmospheric Administration, Las Vegas. Radiation monitors were then deployed to monitor the highways surrounding the NTS and to activate standby air samplers at Tempiute north of NTS, at Dansby's store southwest of NTS, and at the Fleur de Lis Ranch west of NTS. Gamma-rate recorders were also placed at Lathrop Wells, Area 51, and Dansby's store. No radiation was detected by survey instruments used by the monitors or by the gamma-rate recorders.

One of two aircraft used for aerial monitoring left Las Vegas at 9:45 a.m. on September 26 and flew 500 feet over the terrain at the NTS and along Highway 16 leading to Pahrump, Nevada. The aircraft detected no radiation above background levels, and returned to Las Vegas at 12:15 p.m. the same day. The second aircraft departed Las Vegas at 10:15 a.m. for the NTS, where a survey was made for airborne radioactivity at an elevation of 500 feet over the terrain. No radioactivity was detected with sensitive gamma-radiation instrumentation except directly over the shot area. A compressed air sample, a sample of particulates collected by electrostatic precipitation, a sample of airborne particulates collected by filtration, and a sample of gases adsorbed on activated charcoal were collected between 11:23 a.m. and 12:10 p.m. directly over the Riola test location. This aircraft returned to Las Vegas to be refitted with clean sampling media and then travelled over Highway 95 between the Mercury turn-off and eight miles east of the turn-off to the

Nuclear Engineering Company where a second set of samples was collected between 2:21 p.m. and 2:50 p.m.

Only gaseous radioactivity, krypton-85, xenon-133, and xenon-135 was measured in the compressed air sample collected over the Riola test area; no particulate radioactivity or any other radioactivity was detected in the aerial samples collected offsite.

AIR SURVEILLANCE NETWORK

During 1980, no airborne radioactivity related to the Riola test or any other underground nuclear test at the NTS was detected on any sample from this Network. However, naturally occurring beryllium-7 and the fission or activation products zirconium-95, niobium-95, molybdenum-99, ruthenium-103, iodine-131, tellurium-132, barium-140, lanthanum-140, cerium-141, uranium-237, and neptunium-239 from nuclear tests conducted by the People's Republic of China were detected on air filters. Appendix Tables B-1 and B-2 summarize data from these samples. The most recent Chinese test detected was conducted on October 15, 1980, at 9:30 p.m. PDT.

Appendix Table B-3 shows the average concentration of plutonium-238 and -239 in air at selected stations of the ASN. These filter samples were composited monthly for three Nevada stations and quarterly for four standby air stations. The three Nevada stations represent air samples collected near the NTS (Figure 10), while the other seven stations represent remote locations (Figure 11).

All observed plutonium was attributed to world-wide fallout. The plutonium concentrations shown for 1980 are generally within the same range as those measurements for the northern hemisphere reported for 1977 and 1978 by Toonkel (1980) except for one high concentration of plutonium-239 observed at Rachel, Nevada, (1.3×10^{-16} μCi/ml) during the month of July 1980, one high value observed at St. Joseph, Missouri, (1.9×10^{-16} μCi/ml) during the month of January, and one high value at Austin, Texas, (6.2×10^{-16} μCi/ml) during the month of January. The cause of the high variability observed in these samples is suspected to be from relatively low concentrations of large particles having a high specific radioactivity. If one assumed that all the plutonium-239 radioactivity in the Austin, Texas, sample collected from 2,220 m^3 of air was concentrated in one spherically shaped particle of plutonium oxide, the diameter of that particle would be 1.6 μm, which is a reasonable size for atmospheric fallout. All values were less than 1 percent of the Concentration Guide (Appendix C) for exposure to the general public.

NOBLE GAS AND TRITIUM SURVEILLANCE NETWORK

The only radioactivity from NTS tests that was detected offsite by the Noble Gas and Tritium Surveillance Network was xenon-133 and xenon-135 in one compressed air sample collected during the period from 11:50 a.m., September 24, through 2:00 p.m., September 26, at Lathrop Wells, Nevada. The radioactivity concentrations in this sample were 3.4×10^{-11} μCi/ml and 3.6 x

10^{-10} µCi/ml, respectively. If these concentrations had persisted at this location throughout the year, they would have been less than 0.4 percent of the CG (Appendix C).

The concentrations of krypton-85 for the stations in the Network ranged from 1.4×10^{-11} µCi/ml to 3.3×10^{-11} µCi/ml (Appendix Table B-4). As shown in Figure 32, a plot of the logarithm of the concentrations for the Network stations against probits (the number of standard deviations from the mean) is a straight line suggesting that the data is lognormally distributed. To aid the reader, the geometric mean of 2.10×10^{-11} µCi/ml and the geometric standard deviation of 1.15 was evaluated and shown on the figure. As the expected geometric standard deviation of the krypton-85 measurements attributed to sampling, analytical, and counting errors was determined to be 1.08 from the duplicate sampling program (Appendix A), the variation in the krypton-85 concentrations throughout the Network appears to be caused primarily by the errors in its measurement and collection.

The annual average concentrations of krypton-85, xenon-133, xenon-135, and tritium at each station were calculated over the time period sampled using all values, including those less than the MDC. All concentrations listed in Appendix Table B-4 are reported as µCi/ml of air. Because of variations in absolute humidity, the tritium concentration in air (µCi/ml air) varies by factors of 15 to 20 while the concentrations in atmospheric moisture (µCi/ml water) vary by factors of up to about 7. Therefore, the tritium concentration

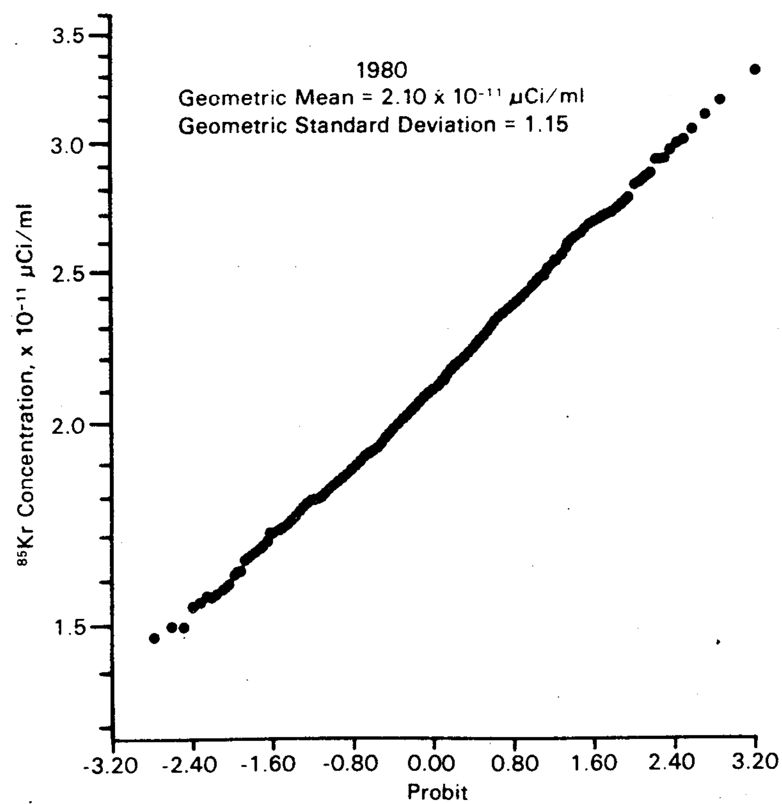

Figure 32. Distribution of Network concentrations of krypton-85.

in µCi per ml of water recovered is also given in Appendix Table B-4 as a more reliable indicator of variations in tritium concentrations.

The average concentration of krypton-85 for the year at all stations was the same (2.1×10^{-11} µCi/ml), except for the concentrations at BJY (2.3×10^{-11} µCi/ml) and Lathrop Wells (2.2×10^{-11} µCi/ml). However, only the concentration average at BJY is significantly greater than the Network average at the 95 percent significance level. The average concentration at this station has been the highest in the Network more often than at any other station, probably because of its central location on the NTS where seepage of the radioactive noble gases from past underground nuclear detonations is suspected.

As shown in Table 3 and Figure 33, the average concentrations of krypton-85 for the Network has gradually increased since sampling began in 1972. This increase, observed at all stations, probably reflects the worldwide increase in ambient concentrations resulting from the proliferation of nuclear technology.

TABLE 3. ANNUAL AVERAGE KRYPTON-85 CONCENTRATIONS IN AIR, 1972-1980

	^{85}Kr Concentrations ($\times 10^{-11}$ µCi/ml)								
Sampling Locations	1972	1973	1974	1975	1976	1977	1978	1979	1980
Beatty, Nev.	1.6	1.6	1.7	1.9	2.0	2.0	2.0	1.9	2.1
Diablo & Rachel, Nev.‡	1.6	1.6	1.7	1.8	1.9	1.9	2.0	1.9	2.1
Hiko, Nev.	1.6	1.6	1.7	1.7	1.7	1.9	2.0	1.9	2.1
Indian Springs, Nev.	-	-	-	2.0	2.0	2.0	2.0	1.9	2.1
NTS, Mercury, Nev.	1.6	1.6	1.8	1.8	1.9	2.0	2.0	1.9	2.1
NTS, Area 51, Nev.	1.6	1.6	1.7	1.8	2.0	1.9	2.0	1.9	2.1
NTS, BJY, Nev.	1.7	1.8	1.9	1.9	2.0	2.1	2.2	2.1	2.3
NTS, Area 12, Nev.	1.6	1.6	1.8	1.8	2.0	1.9	2.0	1.9	2.1
Tonopah, Nev.	1.6	1.6	1.8	1.7	1.9	1.9	2.0	1.8	2.1
Las Vegas, Nev.*	1.6	1.6	1.7	1.8	1.8	2.0	2.0	-	-
Death Valley Jct., Calif.*	1.6	1.5	1.8	1.7	2.0	2.0	2.0	1.9	-
NTS, Area 15, Nev.†	-	-	-	-	-	-	-	1.9	2.1
NTS, Area 400, Nev.†	-	-	-	-	-	-	-	1.8	2.1
Lathrop Wells, Nev.†	-	-	-	-	-	-	-	1.9	2.2
Network Average	1.6	1.6	1.8	1.8	1.9	2.0	2.0	1.9	2.1

*Removed 1979
†New stations 1979
‡Station at Diablo was moved to Rachel in March 1979.

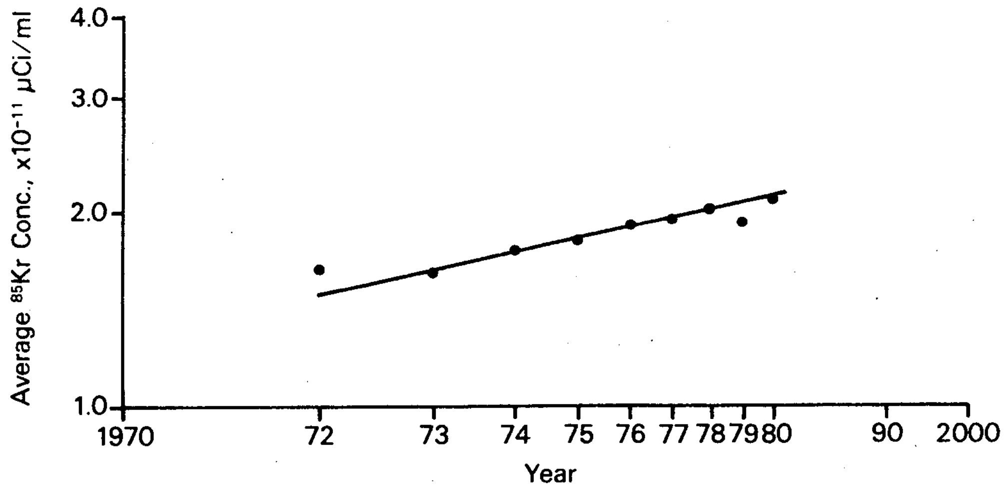

Figure 33. Trend in annual concentrations of krypton-85.

As in the past, tritium concentrations in atmospheric moisture samples collected at all off-NTS stations and at the NTS stations at Mercury and Area 51 were generally below the minimum detectable concentration (MDC) of about 4×10^{-7} µCi/ml water, except for occasional detectable concentrations. All detectable concentrations observed at off-NTS stations were considered to be representative of the environmental background. A few of the values above the MDC at Area 51 and Mercury appeared to be slightly above the environmental background which fluctuated up to 3×10^{-6} µCi/ml. The NTS stations at Area 51, BJY, and the Area 12 had tritium concentrations consistently above background; the concentration average for these stations were factors of 1.7 to 17 times the average for all off-NTS stations.

THERMOLUMINESCENT DOSIMETRY NETWORK

Appendix Table B-5 lists the maximum, minimum, and average dose equivalent rate (mrem/day) and the annual adjusted dose equivalent rate (average in mrem/day times the number of days in the year) measured at each station in the Network during 1980. No allowance was made for the small additional exposure due to the neutron component of the cosmic ray spectrum. No station exhibited an exposure in excess of background.

Appendix Table B-6 lists the personnel number, associated background station, the maximum, minimum, and average dose equivalent rate (mrem/d) and dose equivalent (mrem) measured for each offsite resident monitored during 1980. No resident dosimeter exhibited an exposure in excess of background. The average dose equivalent rates of the offsite residents were generally lower than their background stations due to the shielding provided by their bodies and by their homes or places of work.

Table 4 shows that the average annual dose rate for the Dosimetry Network is consistent with the Network average established in 1975. Annual doses decreased from 1971 to 1975 with a leveling trend since 1975, except for a high bias in the 1977 results attributed to mechanical readout problems. The trend shown by the Network average is indicative of the trend exhibited by individual stations.

TABLE 4. DOSIMETRY NETWORK SUMMARY FOR THE YEARS 1971-1980

	Environmental Radiation Dose Rate (mrem/y)		
Year	Maximum	Minimum	Average
1971	250	102	160
1972	200	84	144
1973	180	80	123
1974	160	62	114
1975	140	51	94
1976	140	51	94
1977	170	60	101
1978	150	50	95
1979	140	49	92
1980	140	51	90

MILK SURVEILLANCE NETWORK

The analytical results from the 1980 milk samples are summarized in Appendix Table B-7, where the maximum, minimum, and average concentrations of tritium, strontium-89, and strontium-90 in the samples collected during 1980 are shown for each sampling location. No milk samples from the Standby Milk Surveillance Network were analyzed this year for comparison. However, comparisons in the past have shown no significant difference, and this year's results are similar to those of previous years, as shown by Table 5 which lists the Network average concentrations of tritium and strontium-90 for the years 1975 through 1980.

TABLE 5. NETWORK ANNUAL AVERAGE CONCENTRATIONS OF TRITIUM AND STRONTIUM-90 IN MILK, 1975-1980

	Average Concentrations x 10^{-9} μCi/ml	
Year	^{3}H	^{90}Sr
1975	<400	<3
1976	<400	<2
1977	<400	<2
1978	<400	1.2
1979	<400	<3
1980	<400	<2

LONG-TERM HYDROLOGICAL MONITORING PROGRAM

Table 6 lists the locations at which water samples were found to contain manmade radioactivity. Radioactivity in samples collected at these locations has been reported previously, except for the HM wells, which were added to the program this year. The data for all samples analyzed are compiled in Appendix Tables B-8 through B-12 together with the percent of the relevant CG listed in Appendix C.

None of the radionuclide concentrations found at the locations listed in Table 6 are expected to result in radiation exposures to residents in the areas where the samples were collected. Well C, Test Well B, and Well UE7ns are located on the NTS and are not used for drinking water. USGS Wells 4 and 8, which were contaminated with the reported radionuclides during tracer studies years ago, are on private land at the Project Gnome site and are closed and locked to prevent their use. The HM wells and the HMH holes at the Project Dribble site are about 1 mile from the nearest residence and are not sources of drinking water for humans. The shallow wells at the Project Long Shot site are in an isolated location and are not sources of drinking water.

No gamma-emitting radionuclides were detected in any sample by gamma spectrometry analysis, except for USGS Well 8, which was contaminated with cesium-137 during a radioactive tracer study many years ago. The minimum detectable concentration is about 6 x 10^{-9} μCi/ml.

ANIMAL INVESTIGATION PROGRAM

No animal damage claims were made during 1980. Annual reports which summarize analytical results from biological samples collected for the Animal Investigation Program are published separately.

TABLE 6. WATER SAMPLING LOCATIONS WHERE SAMPLES WERE FOUND TO CONTAIN MANMADE RADIOACTIVITY

Sampling Location	Type of Radioactivity	Concentration (x 10^{-9} μCi/ml)	% of Conc. Guide
NTS, Well C	^{3}H	<20 - 47	<0.01
NTS, Test Well B	^{3}H	110 - 180	<0.01
NTS, Well UE7ns	^{3}H	1,400 - 3,200	0.1
Project Gnome, USGS Well 4	^{3}H	400,000*	10
	^{90}Sr	7,600*	2,500
USGS Well 8	^{3}H	440,000*	10
	^{137}Cs	72*	0.7
	^{90}Sr	5,600*	1,900
Project Dribble, Wells HMH-1 through 11	^{3}H	<400 - 34,000	1
Project Dribble Well HM-S	^{3}H	36,000	1
Project Dribble Well HM-1	^{3}H	2,000	0.07
Project Dribble Well HM-L	^{3}H	2,600	0.09
Project Dribble Well HM-2A	^{3}H	1,300	0.04
Project Dribble Well HM-2B	^{3}H	1,300	0.04
Project Dribble Well HM-3	^{3}H	860	<0.01
Project Long Shot, Well WL-2	^{3}H	370	<0.01
Project Long Shot, Well GZ, No. 1	^{3}H	4,700	0.2

(continued)

TABLE 6. (Continued)

Sampling Location	Type of Radioactivity	Concentration (x 10^{-9} μCi/ml)	% of Conc. Guide
Project Long Shot, Well GZ, No. 2	^3H	400	0.01
Project Long Shot, Mud Pit, No. 1	^3H	830	0.03
Project Long Shot, Mud Pit, No. 2	^3H	1,100	0.03
Project Long Shot, Mud Pit, No. 3	^3H	2,000	0.07

*These radionuclide concentrations are the result of tracer studies conducted in the 1960's and not the result of underground tests conducted at the project Gnome site.

NTS Mule Deer Migration patterns for the winter of 1979-1980 differed from the patterns observed during the last few winters. Tracking of the deer equipped with radiotransmitter collars revealed that when they left Areas 19 and 20, they dispersed over a wider area of the NTS and the Nellis Air Force Range (NAFR), and several migrated to the north. One male deer traveled west from the NTS onto the NAFR in the vicinity of Black Mountain, which is approximately 40 km north northeast of Beatty, Nevada. Two does wintered in the NAFR just west of the Area 20 boundary. One doe and one buck wintered north of Area 19 on the NAFR in the southern portion of the Belted Range.

A doe captured on December 4, 1979, at the Echo Peak trap site was observed in June and August 1980 by survey crews working on the MX site selection in the Barley Creek area of Nye County. These sightings reported by the Nevada Department of Wildlife, took place over 160 km from the capture point. The remainder of the deer tagged in Area 19 went south to the Timber Mountain, 40-Mile Canyon, and Beatty Wash areas.

The winter of 1980-1981 was very mild and little migration was noted. As of December 31, 1980, all radio-equipped deer remained within a few kilometers of their original capture location.

OFFSITE HUMAN SURVEILLANCE PROGRAM

During 1980, a total of 652 whole-body and 1,004 phoswich spectra were obtained from offsite residents and employees of EPA and EG&G. Seventy-seven of these whole-body spectra were from family members participating in the

Offsite Human Surveillance Program. Small amounts of cesium-137 were found in about half of the family members counted. The maximum, minimum and average concentrations of cesium-137 found in the offsite residents were 3×10^{-8}, $<5 \times 10^{-9}$ and 1×10^{-8} µCi/g of body weight, respectively. These values are similar to 1978 and 1979 results (averages of 1.3×10^{-8} and 1.4×10^{-8} µCi/g, respectively).

Body burdens of cesium-137 in the offsite population are similar to those in other U.S. residents from California to New York (Patzer, 1981). All spectra were representative of normal background for people and showed only natural potassium-40 in addition to the cesium-137 levels representative of world-wide fallout. No plutonium was detected in any of the phoswich spectra.

The concentration of tritium in urine samples during 1980 ranged from $<3 \times 10^{-7}$ to 1.6×10^{-6} µCi/ml with an average of 5×10^{-7} µCi/ml. These are generally within the range of background concentrations normally observed in surface waters or atmospheric moisture as reported in Table B-4 for offsite stations. However, the tritium distribution between the spring (May-July) and fall (October-December) samples was uneven. During the spring period, only four of 32 samples had detectable ($>3 \times 10^{-7}$ µCi/ml) levels of tritium present. In the fall, only the four samples collected prior to October 20 had less than detectable levels and the 27 samples collected after October 20 all had detectable tritium concentrations. The values in these samples ranged from 4.4×10^{-7} to 1.6×10^{-6} µCi/ml) with an average of 7.5×10^{-7} µCi/ml. Six additional samples collected in December have not yet been analyzed. This general pattern for tritium in urine concentrations has also been noted in urine samples from EMSL-LV employees. The reason for these seasonal increases has not been identified.

As in the past, medical examination of the offsite families revealed a generally healthy population. No abnormal results were observed in the hematological examinations and thyroid profiles which could be attributed to past or present NTS testing operations.

MEDICAL LIAISON OFFICER NETWORK (MLON)

The MLON made 15 investigations of persons with claims of alleged radiation injury, responded to 12 inquiries and completed six evaluations of radiation injury claims. The MLON Conference was held at the Environmental Monitoring Systems Laboratory, Las Vegas, Nevada, on September 8-10, 1980. The purpose of the meeting was to update current information on the biological effects of radiation, its diagnosis and treatment.

DOSE ASSESSMENT

The only radioactivity detected in an offsite populated area was xenon-133 (1.7×10^{-9} µCi·h/ml) and xenon-135 (1.8×10^{-8} µCi·h/ml) in a compressed air sample collected at Lathrop Wells, Nevada, during the period September 24 to 26 following the Riola test.

The estimated dose equivalent to the whole body of a hypothetical receptor at Lathrop Wells from the exposure to the radioxenon would be

$$\frac{(1.97 \times 10^{-8}\ \mu\text{Ci}\cdot\text{h/ml})\ (500\ \text{mrem/year})}{(10^{-7}\ \mu\text{Ci/ml})\ (8{,}760\ \text{hours/year})\ (1\ \text{mrem}/1{,}000\ \mu\text{rem})} = 11\ \mu\text{rem}$$

This dose equivalent is 0.006 percent of the radiation protection standard (170 mrem per year) for a suitable sample of the general population.

Based upon a population of 65 at Lathrop Wells the estimated population dose for the area is 0.00072 person-rem. As this area is within 80 km of the center of the NTS, the 80 km population dose would be the same. This dose is small compared to the 6.2 person-rem that residents of Lathrop Wells received from natural background radiation during this report period.

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APPENDIX A. SAMPLING AND ANALYSIS PROCEDURES AND QUALITY ASSURANCE

ANALYTICAL PROCEDURES

The procedures for analyzing samples collected for offsite surveillance, described by Johns et al. in "Radiochemical Analytical Procedures for Analyses of Environmental Samples" (EMSL-LV-0539-17, published by the EMSL-LV in 1979) are summarized in Table A-1.

TABLE A-1. SUMMARY OF ANALYTICAL PROCEDURES

Type of Analysis*	Analytical Equipment	Counting Period (min)	Analytical Procedures	Sample Size	Approximate Detection Limit**
NaI(Tl) Gamma Spectrometry‡	NaI detector calibrated at 10 keV per channel (0.05-2.0 MeV range).	10 min. for air charcoal cartridges	Radionuclide concentrations quantified from gamma spectral data by computer using a least squares technique.	700-1200 m^3 for air cc samples.	4×10^{-14} µCi/ml.
IG & Ge (Li) Gamma Spectrometry‡	IG or Ge(Li) detector calibrated at 0.5 keV/channel (0.4 to 2 MeV range) individual detector efficiencies ranging from ~15% to 35%.	Individual air filters, 30 min; air filter composites, ~1200 min. 100 min for milk, water, suspended solids.	Radionuclide concentration quantified from gamma spectral data by on-line computer program. Radionuclides in air filter composite samples are identified only.	700-1200 m^3 for air filters; 4 liters for milk and water.	For routine milk and water generally, $\sim1\times10^{-8}$ µCi/ml for most common fallout radionuclides in a simple spectrum. Filters for Long-Term Hydro. suspended solids, 6.0×10^{-9} µCi/ml.
$^{89-90}Sr$	Low-background thin-window, gas-flow proportional counter with a 5.7-cm diameter window (80 µg/cm^2)	50	Separation of strontium by wet chemical method. After an ingrowth period, yttrium is separated and ^{90}Sr activity is calculated from the activity of the ^{90}Y daughter. ^{89}Sr activity is obtained by decay curve analysis.	1.0 liter for milk or water. 0.1-1 kg for tissue.	$^{89}Sr = 5\times10^{-9}$ µCi/ml $^{90}Sr = 2\times10^{-9}$ µCi/ml.

(continued)

TABLE A-1. (Continued)

Type of Analysis*	Analytical Equipment	Counting Period (min)	Analytical Procedures	Sample Size	Approximate Detection Limit**
^{3}H	Automatic liquid scintillation counter with output printer.	200	Sample prepared by distillation and counted with liquid scintillation counter.	5 ml for water	4×10^{-7} µCi/ml
^{3}H Enrichment (Long-Term Hydrological Samples)	Automatic scintillation counter with output printer.	200	Sample concentrated by electrolysis followed by distillation.	250 ml for water	1×10^{-8} µCi/ml
$^{238,239}Pu$ $^{234,235,238}U$	Alpha spectrometer with 450 mm^2, 300-µm depletion depth, silicon surface barrier detectors operated in vacuum chambers.	1000-1400	Water sample or acid-digested tissue samples separated by ion exchange, electroplated on stainless steel planchet and counted by alpha spectrometer.	1.0 liter for water; 0.1-1 kg for tissue; 5,000-10,000 m^3 for air.	^{238}Pu = 8×10^{-11} µCi/ml ^{239}Pu, ^{234}U, ^{235}U, ^{238}U = 4×10^{-11} µCi/ml for water; for tissue samples, 0.04 pCi per total sample for all isotopes; 5 = 10×10^{-6} pCi/m^3 for filters and all isotopes.
^{85}Kr, ^{133}Xe, ^{135}Xe	Automatic liquid scintillation counter with output printer.	200	Physical separation by gas chromatography; dissolved in toluene "cocktail" for counting.	0.4-1.0 m^3 for air	^{85}Kr = 4×10^{-12} µCi/ml ^{133}Xe, ^{135}Xe = 4×10^{-12} µCi/ml

*Johns, F. B., P. B. Hahn, D. J. Thome, and E. W. Bretthauer. Radiochemical Analytical Procedures for Analyses of Environmental Samples, EMSL-LV-0539-17, U.S. Environmental Protection Agency, EMSL-LV, Las Vegas. 1979.

**The detection limit for all samples received after January 1, 1978 is defined as 3.29 sigma where sigma equals the counting error of the sample and Type I error = Type II error = 5 percent. (Corley, J. P., D. H. Denham, D. E. Micheles, A. R. Olsen and D. A. Waite, "A Guide for Environmental Radiological Surveillance at ERDA Installations," ERDA 77-24 pp. 3.19-3.22, March, 1977, Energy Research and Development Administration, Division of Safety, Standards and Compliance, Washington, D.C.)

‡Gamma spectrometry performed by thallium activated sodium iodide (NaI(Tl)), intrinsic germanium (IG), or lithium-drifted germanium diode (Ge(Li)) detectors.

REPLICATE SAMPLING PROGRAM

The replicate sampling program was initiated for the purpose of routinely assessing the errors due to sampling, analysis, and counting of samples obtained from the surveillance networks maintained by the EMSL-LV.

The program involves the collection and analysis of replicate samples from the ASN, the NGTSN, the LTHMP, and the SMSN. Due to difficulties anticipated in obtaining sufficient quantities of milk for duplicate samples from the Milk Surveillance Network, duplicate samples are normally collected during the annual activation of the SMSN.

At least 30 duplicate samples from each network are normally collected and analyzed over the report period. Since three TLD cards consisting of two TLD chips each are used at each station of the Dosimetry Network, no additional samples were necessary. Table A-2 summarizes the sampling information for each surveillance network.

TABLE A-2. SAMPLES AND ANALYSES FOR REPLICATE SAMPLING PROGRAM*

Surveillance Network	Number of Sampling Locations	Samples Collected Per Year	Sets of Replicate Samples Collected	Number of Replicates Per Set	Sample Analysis
ASN (1978)	121	8,300	533	2	Gross beta, γ Spectrometry
NGTSN (1978)	11	572	52	2	^{85}Kr, ^{3}H, HTO, H_2O
Dosimetry (1980)	78	308	308	4-6	Effective dose from gamma
SMSN (1978)	150	150	~30	2	^{40}K
LTHMP (1978)	134	254	~35	2	^{3}H

*Only the Dosimetry Network had a sufficient number of replicate results during 1980. The duplicate sampling results reported for all other networks are for 1978.

Since the sampling distributions of each sample type appeared to be log normal from a review of cumulative frequency plots of the results, the variance of each set of replicate sample results was estimated from the logarithms of the results in each set.

The variance, s^2, of each set of replicate TLD results (n=6) was estimated from the logarithms of the results by the standard expression,

$$s^2 = \sum_{i=1}^{n} (x_i - \bar{x})^2 / (n - 1).$$

Since duplicate samples were collected for all other sample types, the variances, s^2, for these types were calculated from $s^2 = (0.886R)^2$, where R is the absolute difference between the logarithms of the duplicate sample results. For small sample sizes, this estimate of the variance is statistically efficient* and certainly more convenient to calculate than the standard expression.

The principle that the variances of random samples collected from a normal population follow a chi-square distribution (χ^2) was then used to estimate the expected population variance for <u>each type of sample analysis</u>. The expression used is as follows:**

$$\tilde{s}^2 = \sum_{i=1}^{n} (n_i - 1)s_i^2 \Big/ \sum_{i=1}^{n} (n_i - 1)$$

where $n_i - 1$ = the degrees of freedom for n samples collected for the ith replicate sample

s_i^2 = the expected log-variance (variance of logarithm values) of the ith replicate sample

$\tilde{s}^2$ = the best estimate of sample log variance derived from the variance estimates of all replicate samples (the expected value of s^2 is σ^2).

The 99% upper confidence limit for the total error (sampling + analytical + counting errors) of the geometric mean (antilog of mean of log values) of any group of samples collected from a given network was then determined as the antilog $(2.57\tilde{s})$.

Table A-3 lists the expected geometric standard deviation (antilog $\sqrt{\tilde{s}^2}$) and its 99% upper confidence limit (UCL) for most analyses.

INTERCOMPARISON STUDIES

Data from the analysis of intercomparison samples are statistically analyzed and compared to known values and values obtained from other participating laboratories. A summary of the statistical analysis is given in Table A-4, which compares the mean and standard deviation of three replicate analyses with the known value and lists the values of two other statistical parameters used for evaluating the results. The mean range plus standard error of range is a measure of the precision of the analysis, and the

*Snedecor, G. W., and W. G. Cochran. Statistical Methods. The Iowa State University Press, Ames, Iowa. 6th Ed. 1967. pp. 39-47.

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TABLE A-3. UPPER CONFIDENCE LIMITS OF SAMPLING AND ANALYTICAL/COUNTING ERRORS*

Surveillance Network	Analysis	Sets of Replicate Samples Evaluated	Expected Geometric Std. Dev. $\tilde{s}$	99% UCL of Total Error (Geometric mean times appropriate value below)
ASN	Gross β	533	2.03	6.2
	^{7}Be	86	1.46	2.6
	^{131}I	23	1.48	2.8
	^{132}Te	13	1.53	3.0
	^{140}Ba	28	1.50	2.8
	^{144}Ce	21	1.52	2.9
NGTSN	^{85}Kr	44	1.088	1.2
	^{3}H	51	1.42	2.4
	HTO	20	2.29	8.4
Dosimetry	γ (TLD)	308	1.046	1.12
SMSN	^{40}K	32	1.086	1.2
LTHMP	^{3}H (conv.)	36	1.12	1.3
	^{3}H (enrich.)	50	1.34	2.1

*Only the Dosimetry Network had a sufficient number of replicate results during 1980. The duplicate sampling results reported for all other networks are for 1978.

normalized deviation is a measure of the accuracy of the analysis when compared to the grand average of the results of all intercomparison participants or to the known concentration. The determination of these parameters is explained in detail separately.* If the values of these two parameters (in multiples of standard normal deviate, unitless) lie between control limits of -3 and +3, the precision or accuracy of the analysis is within normal statistical variation. However, if the parameters exceed these limits, one must suspect that there is some other cause other than normal statistical variations that contributed to the difference between the measured values and the known value. As shown by this table, the cesium-137 analysis for air filters exceeded the control limit for the comparison to the grand average and was close to exceeding it for the comparison to the known value. Further evaluation of these comparisons revealed that incorrect preparation of the intercomparison sample was the cause of the difference and not the method of analysis. When this was corrected, subsequent evaluations showed that the normalized deviations were within the control limits.

*"Environmental Monitoring Series - Environmental Radioactivity Laboratory Intercomparison Studies Program 1980-1981". National Technical Information Service, Springfield, Virginia, 22161. February 1981.

TABLE A-4. 1980 QUALITY ASSURANCE INTERCOMPARISONS

Analysis	Month	Mean of Replicate Analyses ± Std. Dev. (x 10^{-9} µCi/ml)	Mean Range Plus Standard Error of Range	Known Value (x 10^{-9} µCi/ml)	Normalized Deviation from: Grand Avg. Conc.	Normalized Deviation from: Known Conc.
^{3}H in water	Feb	1,827 ± 204	0.29	1,750	0.2	0.4
	Apr	Lost	--	3,400	--	--
	Jun	2,471 ± 58	0.19	2,500	0.3	-0.1
	Aug	1,320 ± 191	0.59	1,210	0.5	0.6
	Oct	2,952 ± 126	0.39	3,200	-0.9	-1.2
	Dec	2,220 ± 92	0.31	2,240	-0.2	-0.1
^{60}Co in water	Feb	12 ± 2	0.47	11	0.1	0.3
	Jun	7 ± 1	0.24	5	0.3	0.7
	Oct	16 ± 0	0	16	0	0
^{134}Cs in water	Feb	11 ± 3	0.59	10	0.1	0.2
	Jun	12 ± 0	0	11	0.4	0.3
	Oct	15 ± 0	0	20	-1.3	-1.7
^{137}Cs in water	Feb	30 ± 5	1.12	30	-0.4	0.0
	Jun	17 ± 1	0.12	17	-0.1	0.1
	Oct	16 ± 0	0	12	1.3	1.5
^{131}I in milk	Jan	<10	--	0	--	--
	Apr	30 ± 3	0.26	33	-0.5	-0.9
	Jul	<10	--	0	--	--
^{137}Cs in milk	Jan	36 ± 3	0.59	40	-1.5	-1.3
	Apr	27 ± 1	0.24	28	-0.7	-0.3
	Jul	34 ± 2	0.15	35	-0.7	-0.3
^{140}Ba in milk	Jan	<20	--	0	--	--
	Apr	<10	--	0	--	--
	Jul	<10	--	0	--	--
^{137}Cs in air filters (pCi/filter)	Mar	12 ± 4	0.83	20	-3.8	-2.8
	Jun	15 ± 0	0	12	0.3	1.0
	Sep	16 ± 0	0	10	1.4	2.0

APPENDIX B. DATA SUMMARY FOR MONITORING NETWORKS

TABLE B-1. 1980 SUMMARY OF ANALYTICAL RESULTS FOR AIR SURVEILLANCE NETWORK ACTIVE STATIONS*

Sampling Location*	No. Days Detected	Type of Radio-activity	Radioactivity Conc. ($\times 10^{-12}$ µCi/ml) C_{max}	C_{min}	C_{avg}
Death Valley Jct., CA	107.9	^{7}Be	3.2	0.19	0.10
	19.0	^{95}Nb	0.12	0.031	0.0033
	3.0	^{95}Zr	0.036	0.036	<0.001
	15.0	^{103}Ru	0.075	0.031	0.0019
	8.0	^{141}Ce	0.060	0.028	<0.001
Furnace Creek, CA	109.0	^{7}Be	0.58	0.12	0.084
	18.5	^{95}Nb	0.093	0.043	0.0034
	3.0	^{95}Zr	0.088	0.088	<0.001
	26.7	^{103}Ru	0.049	0.016	0.0026
	7.7	^{141}Ce	0.049	0.025	<0.001
Shoshone, CA	105.7	^{7}Be	2.3	0.14	0.090
	23.0	^{95}Nb	0.14	0.023	0.0043
	4.0	^{95}Zr	0.14	0.081	0.0012
	25.0	^{103}Ru	0.11	<0.013	0.0030
	10.0	^{141}Ce	0.063	0.027	0.0012
Alamo, NV	81.1	^{7}Be	2.9	0.026	0.10
	9.3	^{95}Nb	0.047	0.034	0.0011
	12.8	^{103}Ru	0.064	0.028	0.0014
	3.0	^{141}Ce	0.031	0.031	<0.001
	0.9	^{237}U	0.78	0.78	0.0020
Area 51, NTS, NV[1]	64.5	^{7}Be	4.0	0.25	0.13
	2.9	^{95}Nb	0.055	0.055	<0.001
	3.0	^{99}Mo	0.027	0.027	<0.001
	5.9	^{103}Ru	0.065	0.026	0.0011
	3.0	^{140}La	0.083	0.083	0.0010
	3.0	^{237}U	0.35	0.35	0.0044
	3.0	^{239}Np	0.15	0.15	0.0019

(continued)

TABLE B-1. (Continued)

Sampling Location*	No. Days Detected	Type of Radio-activity	Radioactivity Conc. ($\times 10^{-12}$ µCi/ml) C_{max}	C_{min}	C_{avg}
Beatty, NV	117.1	^{7}Be	4.1	0.14	0.14
	20.0	^{95}Nb	0.15	0.034	0.0038
	2.0	^{95}Zr	0.099	0.099	<0.001
	27.0	^{103}Ru	0.10	0.028	0.0037
	1.0	^{131}I	0.24	0.24	<0.001
	14.0	^{141}Ce	0.11	0.026	0.0018
Blue Eagle Ranch, NV	95.4	^{7}Be	4.3	0.21	0.16
	21.1	^{95}Nb	0.12	0.055	0.0055
	6.0	^{95}Zr	0.079	0.074	0.0014
	23.0	^{103}Ru	0.094	0.034	0.0039
	3.0	^{141}Ce	0.061	0.061	<0.001
Twin Springs Ranch, NV	26.8	^{7}Be	0.43	0.21	0.069
Glendale, NV	80.1	^{7}Be	1.1	0.14	0.089
	10.1	^{95}Nb	0.085	0.048	0.0019
	18.2	^{103}Ru	0.055	0.024	0.0025
	6.0	^{141}Ce	0.036	0.036	<0.001
Goldfield, NV	60.9	^{7}Be	4.5	0.22	0.091
	16.1	^{95}Nb	0.13	0.42	0.0037
	3.1	^{95}Zr	0.086	0.86	<0.001
	1.0	^{99}Mo	0.22	0.22	<0.001
	10.2	^{103}Ru	0.079	0.025	0.0015
	1.0	^{131}I	0.16	0.16	<0.001
	4.0	^{132}Te	0.18	0.061	0.0010
	1.0	^{140}Ba	0.12	0.12	<0.001
	1.0	^{140}La	0.30	0.30	<0.001
	4.1	^{141}Ce	0.081	0.036	<0.001
	4.0	^{237}U	0.74	0.22	0.0041
	1.0	^{239}Np	0.82	0.82	0.0024
Hiko, NV	82.9	^{7}Be	3.3	0.11	0.10
	15.0	^{95}Nb	0.057	0.020	0.0017
	7.0	^{103}Ru	0.065	0.050	0.0011

(continued)

TABLE B-1. (Continued)

Sampling Location*	No. Days Detected	Type of Radio-activity	Radioactivity Conc. (x 10^{-12} μCi/ml)		
			C_{max}	C_{min}	C_{avg}
Indian Springs, NV	68.0	^{7}Be	3.5	0.13	0.099
	7.0	^{95}Nb	0.089	0.028	0.0011
	2.0	^{95}Zr	0.055	0.055	<0.001
	3.0	^{103}Ru	0.030	0.030	<0.001
Las Vegas, NV	142.5	^{7}Be	2.8	0.20	0.18
	16.9	^{95}Nb	0.34	0.033	0.0045
	2.0	^{95}Zr	0.22	0.22	0.0013
	11.0	^{103}Ru	0.12	0.031	0.0020
	10.0	^{141}Ce	0.13	0.030	0.0018
Lathrop Wells, NV	89.8	^{7}Be	2.3	0.16	0.094
	16.0	^{95}Nb	0.18	0.043	0.0040
	5.0	^{95}Zr	0.11	0.024	<0.001
	17.8	^{103}Ru	0.11	0.023	0.0027
	1.1	^{132}Te	0.13	0.13	<0.001
	3.8	^{141}Ce	0.12	0.055	0.0010
	1.1	^{237}U	0.36	0.36	0.0012
Nyala, NV	102.0	^{7}Be	4.7	0.15	0.14
	26.0	^{95}Nb	0.17	0.046	0.0070
	4.0	^{95}Zr	0.14	0.099	0.0014
	3.0	^{99}Mo	0.077	0.077	<0.001
	16.0	^{103}Ru	0.15	0.038	0.0030
	3.0	^{131}I	0.054	0.054	<0.001
	3.0	^{140}La	0.56	0.56	0.0048
	7.0	^{141}Ce	0.077	0.048	0.0012
	3.0	^{237}U	0.52	0.52	0.0045
Pahrump, NV	118.3	^{7}Be	5.7	0.15	0.19
	9.0	^{95}Nb	0.13	0.030	0.0015
	2.0	^{95}Zr	0.048	0.048	<0.001
	11.0	^{103}Ru	0.070	0.026	0.0013
	1.0	^{132}Te	0.055	0.055	<0.001
	4.0	^{141}Ce	0.039	0.037	<0.001
	1.0	^{237}U	0.25	0.25	<0.001

(continued)

TABLE B-1. (Continued)

Sampling Location*	No. Days Detected	Type of Radio-activity	Radioactivity Conc. (x 10^{-12} μCi/ml) C_{max}	C_{min}	C_{avg}
Robinson Trailer Park, Rachel, NV	65.9	^{7}Be	4.8	0.22	0.11
	14.2	^{95}Nb	0.11	0.055	0.0038
	5.0	^{95}Zr	0.075	0.073	0.0012
	1.1	^{99}Mo	0.17	0.17	0.00060
	15.2	^{103}Ru	0.12	0.038	0.0030
	1.1	^{131}I	0.11	0.11	0.00040
	1.1	^{132}Te	0.21	0.21	0.00075
	1.1	^{140}La	0.69	0.69	0.0025
	12.8	^{141}Ce	0.050	0.025	0.0016
	1.1	^{237}U	1.1	1.1	0.0039
Scotty's Junction, NV	94.7	^{7}Be	2.8	0.11	0.11
	15.8	^{95}Nb	0.13	0.023	0.0028
	1.0	^{99}Mo	0.080	0.080	<0.001
	15.0	^{103}Ru	0.11	0.036	0.0024
	1.1	^{131}I	0.16	0.16	<0.001
	1.0	^{132}Te	0.17	0.17	<0.001
	1.1	^{140}La	0.50	0.50	0.0016
	6.1	^{141}Ce	0.089	0.056	0.0011
	2.1	^{237}U	0.54	0.28	0.0025
Stone Cabin Ranch, NV	119.6	^{7}Be	3.7	0.22	0.16
	11.7	^{95}Nb	0.22	0.079	0.0044
	2.9	^{99}Mo	0.14	0.14	0.0012
	16.7	^{103}Ru	0.15	0.040	0.0042
	2.9	^{131}I	0.079	0.079	<0.001
	2.9	^{140}Ba	0.14	0.14	0.0012
	2.9	^{140}La	0.99	0.99	0.0085
	4.9	^{141}Ce	0.12	0.089	0.0015
	5.0	^{237}U	0.84	0.18	0.0083
	2.9	^{239}Np	0.33	0.33	0.0028
Sunnyside, NV	101.0	^{7}Be	6.0	0.042	0.13
	9.8	^{95}Nb	0.58	0.063	0.0048
	4.1	^{95}Zr	0.54	0.22	0.0043
	13.7	^{103}Ru	0.14	0.046	0.0031
	1.5	^{131}I	0.14	0.14	<0.001
	1.5	^{132}Te	0.12	0.12	<0.001
	1.5	^{140}La	0.52	0.52	0.0022
	7.0	^{141}Ce	0.093	0.040	0.0014
	1.5	^{237}U	1.5	1.5	0.0063

(continued)

TABLE B-1. (Continued)

Sampling Location*	No. Days Detected	Type of Radio-activity	Radioactivity Conc. ($\times 10^{-12}$ μCi/ml)		
			C_{max}	C_{min}	C_{avg}
Tonopah, NV	103.6	^{7}Be	0.86	0.20	0.12
	16.9	^{95}Nb	0.14	0.027	0.0035
	3.0	^{95}Zr	0.058	0.058	<0.001
	1.0	^{99}Mo	0.25	0.25	<0.001
	20.9	^{103}Ru	0.16	0.036	0.0040
	1.0	^{131}I	0.15	0.15	<0.001
	1.0	^{132}Te	0.17	0.17	<0.001
	1.0	^{140}La	0.067	0.067	<0.001
	9.0	^{141}Ce	0.13	0.032	0.0017
	1.0	^{237}U	0.19	0.19	<0.001
	1.0	^{239}Np	0.74	0.74	0.0022
Tonopah Test Range, NV	97.7	^{7}Be	2.8	0.18	0.13
	15.8	^{95}Nb	0.090	0.043	0.0031
	3.2	^{99}Mo	0.066	0.066	<0.001
	16.9	^{103}Ru	0.50	0.047	0.010
	3.2	^{131}I	0.046	0.046	<0.001
	3.2	^{132}Te	0.062	0.062	<0.001
	3.2	^{140}Ba	0.12	0.12	0.0012
	3.2	^{140}La	0.38	0.38	0.0040
	7.5	^{141}Ce	0.055	0.041	0.0012
	4.8	^{237}U	0.85	0.77	0.013
Delta, UT	83.0	^{7}Be	5.5	0.16	0.13
	14.1	^{95}Nb	0.25	0.038	0.0048
	6.1	^{95}Zr	0.27	0.10	0.0036
	14.1	^{103}Ru	0.55	0.032	0.0069
	8.1	^{141}Ce	0.054	0.031	0.0011
Milford, UT	25.3	^{7}Be	0.40	0.15	0.10
	5.0	^{95}Nb	0.048	0.036	0.0029
	12.0	^{103}Ru	0.053	0.032	0.0066
	2.0	^{141}Ce	0.052	0.052	0.0014
St. George, UT	86.7	^{7}Be	3.3	0.11	0.096
	15.1	^{95}Nb	0.20	0.049	0.0033
	3.0	^{95}Zr	0.053	0.053	<0.001
	12.0	^{103}Ru	0.098	0.030	0.0018
	2.0	^{141}Ce	0.048	0.048	<0.001

[1]Also known as Groom Lake.

*Samples from stations not reported here contained radioactivity less than the MDC of about 4×10^{-14} μCi/ml. The maximum and minimum concentrations reported are only for those few samples in which radionuclides were actually detected. The average includes all samples collected; therefore the average concentration is usually much smaller than the minimum concentration.

TABLE B-2. 1980 SUMMARY OF ANALYTICAL RESULTS FOR AIR SURVEILLANCE NETWORK STANDBY STATIONS*

Sampling Location*	No. Days Detected	Type of Radio-activity	Radioactivity Conc. ($\times 10^{-12}$ $\mu Ci/ml$) C_{max}	C_{min}	C_{avg}
Little Rock, AR	2.9	^{7}Be	0.16	0.16	0.025
Bishop, CA	4.0	^{99}Mo	0.31	0.056	0.027
	4.0	^{103}Ru	0.14	0.030	0.013
	3.0	^{131}I	0.038	0.038	0.0066
	4.0	^{132}Te	0.25	0.080	0.028
	1.0	^{140}Ba	0.31	0.31	0.017
	4.0	^{140}La	0.79	0.19	0.075
	1.0	^{141}Ce	0.15	0.15	0.0082
	4.0	^{237}U	0.89	0.51	0.14
	1.0	^{239}Np	2.1	2.1	0.12
Indio, CA	1.0	^{99}Mo	0.14	0.14	0.0077
	1.0	^{103}Ru	0.098	0.098	0.0054
	1.0	^{140}La	0.98	0.98	0.054
	1.0	^{141}Ce	0.12	0.12	0.0064
	1.0	^{237}U	0.74	0.74	0.041
Pocatello, ID	2.9	^{7}Be	0.23	0.23	0.041
Austin, NV	0.7	^{99}Mo	0.82	0.82	0.16
	0.7	^{131}I	0.43	0.43	0.085
	0.7	^{132}Te	0.88	0.88	0.18
	0.7	^{140}Ba	0.67	0.67	0.13
	0.7	^{140}La	6.0	6.0	1.2
	0.7	^{141}Ce	0.42	0.42	0.085
	0.7	^{237}U	4.6	4.6	0.91
Battle Mountain, NV	1.0	^{99}Mo	0.23	0.23	0.013
	1.0	^{103}Ru	0.088	0.088	0.0049
	1.0	^{131}I	0.10	0.10	0.0057
	1.0	^{132}Te	0.24	0.24	0.013
	1.0	^{140}La	1.2	1.2	0.068
	1.0	^{141}Ce	0.093	0.093	0.0052
	1.0	^{237}U	2.3	2.3	0.13
Blue Jay, NV	3.1	^{103}Ru	0.056	0.056	0.011

(continued)

TABLE B-2. (Continued)

Sampling Location*	No. Days Detected	Type of Radio-activity	Radioactivity Conc. ($\times 10^{-12}$ μCi/ml) C_{max}	C_{min}	C_{avg}
Caliente, NV	1.2	^{99}Mo	0.14	0.14	0.0089
	1.2	^{103}Ru	0.075	0.075	0.0049
	1.2	^{132}Te	0.21	0.21	0.014
	1.2	^{140}La	0.93	0.93	0.060
	1.2	^{237}U	0.98	0.98	0.064
Currant Maint. Sta., NV	1.2	^{99}Mo	0.13	0.13	0.0085
	2.2	^{131}I	0.22	0.11	0.019
	1.2	^{132}Te	0.14	0.14	0.0094
	1.0	^{140}Ba	0.25	0.25	0.013
	1.0	^{140}La	1.4	1.4	0.071
	2.2	^{237}U	2.3	0.44	0.15
	1.0	^{239}Np	1.1	1.1	0.059
Currie, NV	2.4	^{7}Be	0.30	0.30	0.040
	2.2	^{103}Ru	0.11	0.079	0.012
	1.1	^{131}I	0.15	0.15	0.0087
	1.1	^{140}La	0.92	0.92	0.055
	1.1	^{237}U	1.8	1.8	0.11
Duckwater, NV	3.3	^{7}Be	0.23	0.23	0.049
Elko, NV	2.0	^{7}Be	0.42	0.30	0.042
	3.2	^{132}Te	0.044	0.044	0.0084
	3.2	^{237}U	0.23	0.23	0.042
Ely, NV	1.0	^{99}Mo	0.43	0.43	0.026
	1.0	^{103}Ru	0.25	0.25	0.015
	1.0	^{131}I	0.30	0.30	0.018
	1.0	^{132}Te	0.25	0.25	0.015
	1.0	^{140}La	2.6	2.6	0.16
	1.0	^{141}Ce	0.25	0.25	0.015
	1.0	^{237}U	2.9	2.9	0.17
	1.0	^{239}Np	2.5	2.5	0.15
Fallon, NV	1.0	^{99}Mo	0.17	0.17	0.0094
	1.0	^{103}Ru	0.11	0.11	0.0058
	1.0	^{132}Te	0.14	0.14	0.0076
	1.0	^{140}Ba	0.18	0.18	0.0097
	1.0	^{140}La	0.67	0.67	0.037
	1.0	^{237}U	1.0	1.0	0.057
	1.0	^{239}Np	0.64	0.64	0.036

(continued)

TABLE B-2. (Continued)

Sampling Location*	No. Days Detected	Type of Radio-activity	Radioactivity Conc. ($\times 10^{-12}$ µCi/ml) C_{max}	C_{min}	C_{avg}
Frenchman Sta., NV	1.0	^{131}I	0.053	0.053	0.0038
	1.0	^{132}Te	0.28	0.28	0.020
	1.0	^{140}La	0.86	0.86	0.062
	1.0	^{237}U	0.63	0.63	0.045
Geyser Ranch, NV	4.1	^{99}Mo	0.058	0.058	0.058
	4.1	^{103}Ru	0.073	0.073	0.073
	4.1	^{131}I	0.062	0.062	0.062
	4.1	^{132}Te	0.085	0.085	0.085
	4.1	^{140}Ba	0.17	0.17	0.17
	4.1	^{140}La	0.72	0.72	0.72
	4.1	^{141}Ce	0.046	0.046	0.046
	4.1	^{237}U	0.14	0.14	0.14
	4.1	^{239}Np	0.21	0.21	0.21
Lovelock, NV	2.0	^{7}Be	0.47	0.47	0.046
	1.1	^{103}Ru	0.16	0.16	0.0089
	1.1	^{131}I	0.15	0.15	0.0087
	1.1	^{140}La	1.4	1.4	0.076
	1.1	^{237}U	1.5	1.5	0.086
Lund, NV	3.0	^{7}Be	0.36	0.36	0.059
	1.0	^{99}Mo	0.24	0.24	0.013
	1.0	^{131}I	0.11	0.11	0.0062
	2.0	^{132}Te	0.32	0.29	0.035
	1.0	^{140}La	0.53	0.53	0.029
	1.0	^{141}Ce	0.11	0.11	0.0061
	2.0	^{237}U	0.74	0.73	0.083
Mesquite, NV	0.5	^{7}Be	1.1	1.1	0.054
Reno, NV	3.0	^{7}Be	0.37	0.37	0.053
	3.0	^{140}La	0.45	0.45	0.065
	3.0	^{141}Ce	0.043	0.043	0.0062
Round Mountain, NV	1.9	^{99}Mo	0.31	0.20	0.022
	3.9	^{103}Ru	0.18	0.033	0.012
	1.0	^{131}I	0.12	0.12	0.0056
	1.0	^{132}Te	0.26	0.26	0.012
	1.9	^{140}La	2.2	0.40	0.11
	3.9	^{141}Ce	0.25	0.032	0.015
	1.9	^{237}U	1.8	0.70	0.11
	0.9	^{239}Np	1.4	1.4	0.057

(continued)

TABLE B-2. (Continued)

Sampling Location*	No. Days Detected	Type of Radio-activity	Radioactivity Conc. ($x 10^{-12}$ μCi/ml) C_{max}	C_{min}	C_{avg}
Wells, NV	2.0	^{7}Be	0.36	0.36	0.040
	1.0	^{131}I	0.14	0.14	0.0079
	1.0	^{132}Te	0.26	0.26	0.014
	1.0	^{140}La	1.6	1.6	0.087
	1.0	^{237}U	1.3	1.3	0.070
Albuquerque, NM	1.1	^{99}Mo	0.16	0.16	0.0092
	1.1	^{237}U	0.42	0.42	0.025
Norman, OK	3.0	^{7}Be	0.17	0.17	0.032
Austin, TX	4.1	^{7}Be	0.20	0.20	0.085
Capitol Reef, UT	1.0	^{7}Be	0.74	0.74	0.043
Cedar City, UT	1.1	^{99}Mo	0.096	0.096	0.0064
	1.1	^{131}I	0.095	0.095	0.0064
	1.1	^{132}Te	0.32	0.32	0.021
	1.1	^{237}U	0.33	0.33	0.022
Dugway, UT	1.0	^{132}Te	0.32	0.32	0.018
	1.0	^{237}U	0.61	0.61	0.034
Logan, UT	1.2	^{99}Mo	0.13	0.13	0.0094
	1.2	^{131}I	0.10	0.10	0.0070
	1.2	^{132}Te	0.055	0.055	0.0038
	1.2	^{140}La	0.53	0.53	0.0038
	1.2	^{141}Ce	0.12	0.12	0.0082
	1.2	^{237}U	0.77	0.77	0.054
	1.2	^{239}Np	0.86	0.86	0.061
Parowan, UT	2.0	^{237}U	0.34	0.34	0.040
Provo, UT	1.4	^{237}U	1.1	1.1	0.074
Salt Lake City, UT	1.0	^{99}Mo	0.15	0.15	0.011
	1.0	^{103}Ru	0.078	0.078	0.0058
	1.0	^{132}Te	0.19	0.19	0.014
	1.0	^{140}La	0.70	0.70	0.052
	1.0	^{141}Ce	0.11	0.11	0.0085
	1.0	^{237}U	0.94	0.94	0.070

(continued)

TABLE B-2. (Continued)

Sampling Location*	No. Days Detected	Type of Radio-activity	Radioactivity Conc. ($\times 10^{-12}$ µCi/ml) C_{max}	C_{min}	C_{avg}
Wendover, UT	2.0	^{7}Be	0.33	0.33	0.035
Casper, WY	1.0	^{237}U	0.53	0.53	0.033
Rock Springs, WY	1.0	^{237}U	0.61	0.61	0.036

*Samples from stations not reported here contained radioactivity less than the MDC of about 4×10^{-14} µCi/ml. The maximum and minimum concentrations reported are only for those few samples in which radionuclides were actually detected. The average includes all samples collected; therefore the average concentration is usually much smaller than the minimum concentration.

TABLE B-3. 1980 SUMMARY OF PLUTONIUM-239 CONCENTRATIONS AT SELECTED AIR SURVEILLANCE NETWORK STATIONS

Sampling Location	No. Days Sampled	^{238}Pu Conc. (x 10^{-18} µCi/ml)			^{239}Pu Conc. (x 10^{-18} µCi/ml)		
		C_{max}	C_{min}	C_{avg}	C_{max}	C_{min}	C_{avg}
Barstow, CA	33.4	<10	<5	<5	28	<20	<20
St. Joseph, MO	39.3	<20	<6	<6	190	<7	16
Las Vegas, NV	313.1	<6	<3	<3	25	<4	12
Lathrop Wells, NV	300.5	<6	<3	<3	20	<4	10
Rachel,* NV	293.4	<30	<3	<3	130	<4	30
Albuquerque, NM	50.7	<30	<13	<13	<30	<20	<20
Medford, OR	51.7	<20	<7	<7	<20	<20	<20
Aberdeen, SD	15.4	<6	<5	<5	<10	<10	<10
Austin, TX	35.7	36	<5	<5	620	<20	<20
Provo, UT	55.1	<30	<6	8.1	34	<20	18
Spokane, WA	39.4	<20	<3	<3	20	<9	9.9

*Station replaced Diablo, Nev.

TABLE B-4. 1980 SUMMARY OF ANALYTICAL RESULTS FOR THE NOBLE GAS AND TRITIUM SURVEILLANCE NETWORK

Sampling Location	No. Days Detected	Radio-nuclide	Radioactivity Conc. ($\times 10^{-12}$ µCi/ml) C_{max}	C_{min}	C_{avg}	% of Conc. Guide†
Beatty, NV	346.4	^{85}Kr	26	16	21	0.02
	346.5	^{133}Xe	<54	<3	<3	<0.01
	321.5	^{3}H in atm. m.*	1.9	<0.4	<0.4	--
	321.5	^{3}H as HTO in air	12	<0.9	1.6	<0.01
Hiko, NV	334.4	^{85}Kr	27	15	21	0.02
	348.9	^{133}Xe	<20	<3	<3	<0.01
	200.0	^{3}H in atm. m.*	1.6	<0.4	<0.4	--
	200.0	^{3}H as HTO in air	8.6	<0.5	0.53	<0.01
Indian Springs, NV	346.5	^{85}Kr	29	15	21	0.02
	356.6	^{133}Xe	<30	<3	<3	<0.01
	328.8	^{3}H in atm. m.*	2.6	<0.4	<0.4	--
	328.8	^{3}H as HTO in air	20	<0.5	1.5	<0.01
Lathrop Wells, NV	342.4	^{85}Kr	27	15	22	0.02
	342.5	^{133}Xe	34	<3	<3	<0.01
	2.1	^{135}Xe	360	360	2.1	<0.01
	318.6	^{3}H in atm. m.*	2.5	<0.4	0.46	--
	318.6	^{3}H as HTO in air	17	<2	2.5	<0.01
Rachel, NV	340.4	^{85}Kr	28	15	21	0.02
	327.1	^{133}Xe	<50	<3	<3	<0.01
	347.9	^{3}H in atm. m.*	2.0	<0.4	<0.4	--
	347.9	^{3}H as HTO in air	11	<1	1.6	<0.01
Tonopah, NV	355.5	^{85}Kr	28	16	21	0.02
	348.5	^{133}Xe	<40	<3	<3	<0.01
	329.0	^{3}H in atm. m.*	1.7	<0.4	<0.4	--
	329.0	^{3}H as HTO in air	16	<2	<2	<0.01
Area 15, NTS,‡ NV	364.5	^{85}Kr	29	16	21	<0.01
	357.5	^{133}Xe	<40	<4	<4	<0.01
	3.0	^{135}Xe	64	64	0.53	<0.01
	322.7	^{3}H in atm. m.*	24	1.6	6.0	--
	322.7	^{3}H as HTO in air	57	6.9	26	<0.01

(continued)

TABLE B-4. (Continued)

Sampling Location	No. Days Detected	Radio-nuclide	Radioactivity Conc. (x 10^{-12} μCi/ml) C_{max}	C_{min}	C_{avg}	% of Conc. Guide†
Area 51, NTS,‡ NV	349.4	^{85}Kr	27	16	21	<0.01
	364.3	^{133}Xe	<30	<2	<2	<0.01
	3.0	^{135}Xe	12	12	0.099	<0.01
	322.6	^{3}H in atm. m.*	8.9	<0.4	0.67	--
	322.6	^{3}H as HTO in air	33	<0.4	2.8	<0.01
Area 400, NTS, NV	367.5	^{85}Kr	33	17	21	<0.01
	367.4	^{133}Xe	<50	<3	<3	<0.01
	213.9	^{3}H in atm. m.*	1.9	<0.4	<0.4	--
	213.9	^{3}H as HTO in air	7.3	<0.30	1.1	<0.01
BJY, NTS, NV	363.6	^{85}Kr	32	14	23	<0.01
	348.6	^{133}Xe	2,100	<3	32	<0.01
	3.0	^{135}Xe	39,000	39,000	320	<0.01
	361.7	^{3}H in atm. m.*	8.0	<0.4	2.5	--
	361.7	^{3}H as HTO in air	32	0.68	9.6	<0.01
Mercury, NTS, NV	350.6	^{85}Kr	30	15	21	<0.01
	335.6	^{133}Xe	<40	<3	<3	<0.01
	313.6	^{3}H in atm. m.*	3.9	<0.3	0.34	--
	313.6	^{3}H as HTO in air	22	<0.5	1.6	<0.01
Area 12, NTS, NV	364.5	^{85}Kr	26	15	21	<0.01
	357.4	^{133}Xe	96	<3	<3	<0.01
	3.0	^{135}Xe	280	280	2.3	<0.01
	328.6	^{3}H in atm. m.*	36	0.51	6.9	--
	328.6	^{3}H as HTO in air	84	<2	23	<0.01

*Concentrations of tritium in atmospheric moisture (atm. m.) are expressed as 10^{-6} μCi per ml of water collected.

†Concentration Guides used for NTS stations are those applicable to radiation workers. Those used for off-NTS stations are for exposure to a suitable sample of the population in an uncontrolled area. See Appendix C for Concentration Guides.

‡Also known as Groom Lake.

TABLE B-5. 1980 SUMMARY OF RADIATION DOSES FOR THE DOSIMETRY NETWORK

Station Location	Measurement Period	Dose Equivalent Rate (mrem/d) Max.	Min.	Avg.	Annual Adjusted Dose Equivalent (mrem/y)
Adaven, NV	01/30/80 - 01/13/81	0.38	0.35	0.36	130
Alamo, NV	01/08/80 - 01/14/81	0.23	0.22	0.22	81
Area 51-NTS, NV	01/14/80 - 01/06/81	0.19	0.17	0.18	66
Austin, NV	01/29/80 - 01/07/81	0.29	0.26	0.28	100
Baker, CA	01/14/80 - 01/20/81	0.25	0.22	0.23	84
Barstow, CA	01/14/80 - 01/20/81	0.31	0.30	0.30	110
Beatty, NV	01/08/80 - 01/07/81	0.27	0.25	0.26	95
Bishop, CA[1]	01/15/80 - 01/21/81	0.27	0.26	0.26	95
Blue Eagle Ranch, NV	01/29/80 - 01/13/81	0.17	0.16	0.16	59
Blue Jay, NV	01/16/80 - 01/08/81	0.34	0.32	0.33	120
Cactus Springs, NV	01/07/80 - 01/06/81	0.17	0.16	0.16	59
Caliente, NV	01/09/80 - 01/13/81	0.32	0.30	0.31	110
Carp, NV	01/10/80 - 01/16/81	0.30	0.28	0.29	110
Casey's Ranch, NV	01/16/80 - 01/07/81	0.22	0.19	0.21	77
Cedar City, UT	01/16/80 - 01/07/81	0.21	0.19	0.20	73
Clark Station, NV	01/15/80 - 01/08/81	0.33	0.32	0.32	120
Complex 1, NV	01/30/80 - 01/13/31	0.28	0.27	0.28	100
Coyote Summit, NV	01/15/80 - 01/06/81	0.38	0.34	0.35	130
Currant, NV	01/29/80 - 01/13/81	0.28	0.26	0.27	99
Death Valley Jct., CA	01/17/80 - 01/22/81	0.22	0.20	0.21	77
Desert Game Range, NV	01/07/80 - 01/06/81	0.16	0.14	0.15	55
Diablo Maint. Sta., NV	01/15/80 - 01/07/81	0.43	0.34	0.37	140
Duckwater, NV	01/29/80 - 01/13/81	0.28	0.26	0.27	99
Elgin, NV	01/10/80 - 01/16/81	0.36	0.33	0.34	120
Ely, NV	01/29/80 - 01/08/81	0.20	0.20	0.20	73
Enterprise, UT	01/16/80 - 01/07/81	0.27	0.25	0.26	95
Eureka, NV	01/30/80 - 01/07/81	0.31	0.25	0.28	100
Furnace Creek, CA	01/17/80 - 01/22/81	0.18	0.17	0.18	65

(continued)

TABLE B-5. (Continued)

Station Location	Measurement Period	Dose Equivalent Rate (mrem/d) Max.	Min.	Avg.	Annual Adjusted Dose Equivalent (mrem/y)
Garrison, UT	01/28/80 - 01/08/81	0.18	0.17	0.18	66
Geyser Maint. Sta., NV	01/28/80 - 01/08/81	0.28	0.27	0.27	99
Glendale, UT	01/15/80 - 01/06/81	0.16	0.16	0.16	59
Goldfield, NV	01/28/80 - 01/06/81	0.26	0.25	0.25	92
Hancock Summit, NV	01/15/80 - 01/06/81	0.40	0.37	0.39	140
Hiko, NV	01/08/80 - 01/14/81	0.22	0.20	0.21	77
Hot Creek Ranch, NV	01/16/80 - 01/08/81	0.30	0.25	0.27	99
Independence, CA	01/15/80 - 01/21/81	0.27	0.26	0.27	99
Indian Springs, NV	01/07/80 - 01/06/81	0.17	0.16	0.16	59
Kirkeby Ranch, NV	01/28/80 - 01/08/81	0.21	0.19	0.20	73
Koynes, NV	01/17/80 - 01/07/81	0.32	0.26	0.27	99
Las Vegas (Airport), NV	01/15/80 - 01/07/81	0.15	0.13	0.14	51
Las Vegas (Placak), NV	01/15/80 - 01/07/81	0.14	0.14	0.14	51
Las Vegas (USDI), NV	01/15/80 - 01/07/81	0.17	0.16	0.17	62
Lathrop Wells, NV	01/08/80 - 01/06/81	0.26	0.25	0.26	95
Linda's Market, NV[2]	01/08/80 - 01/07/81	0.25	0.23	0.24	88
Lida, NV	01/28/80 - 01/06/81	0.28	0.26	0.27	99
Lone Pine, CA	01/15/80 - 01/21/81	0.28	0.26	0.27	99
Lund, NV	01/29/80 - 01/09/81	0.23	0.22	0.23	84
Mammoth Mtn., CA[3]	11/06/79 - 01/21/81	0.28	0.26	0.27	99
Manhattan, NV	01/29/80 - 01/07/81	0.36	0.29	0.33	120
Mesquite, NV	01/15/80 - 01/06/81	0.18	0.16	0.18	66
Nevada Farms, NV	01/15/80 - 01/06/81	0.34	0.32	0.33	120
Nuclear Eng. Co., NV	01/08/80 - 01/07/81	0.34	0.30	0.32	120
Nyala, NV	01/16/80 - 01/07/81	0.23	0.21	0.23	84
Olancha, CA[4]	01/15/80 - 01/21/81	0.25	0.25	0.25	92
Pahrump, NV	01/09/80 - 01/08/81	0.17	0.16	0.17	62
Pine Creek Ranch, NV[5]	01/30/80 - 01/13/81	0.36	0.32	0.34	120

(continued)

TABLE B-5. (Continued)

Station Location	Measurement Period	Dose Equivalent Rate (mrem/d) Max.	Min.	Avg.	Annual Adjusted Dose Equivalent (mrem/y)
Pioche, NV	01/09/80 - 01/13/81	0.24	0.22	0.23	84
Queen City Summit, NV	01/15/80 - 01/06/81	0.37	0.34	0.36	130
Rachel, NV	01/15/80 - 01/06/81	0.31	0.27	0.29	110
Reed Ranch, NV[6]	01/15/80 - 09/30/80	0.38	0.31	0.34	120
Ridgecrest, CA	01/15/80 - 01/20/81	0.24	0.22	0.23	84
Round Mountain, NV	01/28/80 - 01/07/81	0.31	0.29	0.30	110
Rox, NV	01/15/80 - 01/06/81	0.27	0.25	0.26	95
Scotty's Junction, NV	01/28/80 - 01/06/81	0.26	0.24	0.26	95
Sherri's Bar, NV	01/08/80 - 01/13/81	0.21	0.19	0.20	73
Shoshone, CA	01/17/80 - 01/22/81	0.30	0.28	0.29	110
Springdale, NV	01/08/80 - 01/08/81	0.32	0.28	0.30	110
Spring Meadows, NV	01/07/80 - 01/06/81	0.17	0.16	0.17	62
St. George, UT	01/17/80 - 01/07/81	0.17	0.17	0.17	62
Stone Cabin Ranch, NV	01/17/80 - 01/08/81	0.32	0.28	0.30	110
Sunnyside, NV	01/30/80 - 01/09/81	0.18	0.16	0.17	62
Tempiute, NV	01/17/80 - 01/07/81	0.33	0.31	0.32	120
Tenneco, NV	01/07/80 - 01/06/81	0.26	0.24	0.25	92
Tonopah, NV	01/28/80 - 01/06/81	0.31	0.28	0.30	110
Tonopah Test Range, NV	01/29/80 - 01/07/81	0.27	0.26	0.26	95
Twin Springs Ranch, NV	01/16/80 - 01/08/81	0.31	0.27	0.30	110
Valley Crest, CA	01/17/80 - 01/22/81	0.16	0.15	0.16	59
Warm Springs, NV	01/15/80 - 01/07/81	0.33	0.30	0.31	110
Young's Ranch, NV	01/29/80 - 01/07/81	0.25	0.24	0.25	92

[1]Dosimeters not collected First Quarter 1980.
[2]Dosimeters stolen First and Second Quarter 1980, station moved from Selbach Ranch to Linda's Market, Nevada Fourth Quarter 1980.
[3]Station snowed in Second Quarter 1980.
[4]Dosimeters stolen First and Second Quarter 1980.
[5]Station vandalized Second Quarter 1980.
[6]Dosimeters stolen Fourth Quarter 1980.

TABLE B-6. 1980 SUMMARY OF RADIATION DOSES FOR OFFSITE RESIDENTS

Resident No.	Background Station Location	Period of Measurement		Dose Equivalent Rate (mrem/d)			Net Exposure (mrem)
		Issue	Collect	Max.	Min.	Avg.	
1	Tonopah, NV	01/28/80	01/06/81	0.24	0.21	0.23	0.0
2	Caliente, NV[1]	01/09/80	01/13/81	0.31	0.25	0.27	0.0
3	Blue Jay, NV	01/16/80	01/08/81	0.28	0.23	0.25	0.0
4	Glendale, NV[2]	01/15/80	01/06/81	0.19	0.17	0.18	0.0
5	Lathrop Wells, NV	01/09/80	01/07/81	0.25	0.22	0.24	0.0
6	Indian Springs, NV	01/07/80	01/06/81	0.16	0.13	0.14	0.0
7	Goldfield, NV	01/28/80	01/06/81	0.21	0.19	0.20	0.0
8	Twin Springs Ranch, NV[3]	01/16/80	01/08/81	0.26	0.19	0.24	0.0
9	Blue Eagle Ranch, NV[4]	01/29/80	01/13/81	0.19	0.16	0.18	0.0
10	Complex 1, NV	01/30/80	01/13/81	0.28	0.25	0.27	0.0
11	Complex 1, NV	01/30/80	01/13/81	0.30	0.26	0.28	0.0
12	Desert Game Range, NV[5]	01/15/80	01/07/81	0.13	0.12	0.13	0.0
13	Koyne's Ranch, NV[6]	01/17/80	01/07/81	0.21	0.17	0.19	0.0
14	Hancock Summit, NV	01/08/80	01/14/81	0.23	0.19	0.22	0.0
15	Hancock Summit, NV	01/08/80	01/14/81	0.25	0.23	0.24	0.0
16	Tempiute, NV	01/17/80	06/24/80	0.26	0.21	0.24	0.0
17	Nyala, NV	01/16/80	01/07/81	0.21	0.18	0.20	0.0
18	Nyala, NV	01/16/80	01/07/81	0.22	0.17	0.19	0.0
19	Goldfield, NV	01/28/80	01/06/81	0.21	0.18	0.20	0.0
20	Desert Game Range, NV	01/15/80	07/08/80	0.16	0.16	0.16	0.0
21	Beatty, NV[7]	01/08/80	01/07/81	0.25	0.23	0.24	0.0
22	Alamo, NV	01/08/80	01/14/81	0.21	0.17	0.19	0.0
23	Alamo, NV	01/08/80	01/16/81	0.22	0.19	0.21	0.0
24	Desert Game Range, NV	10/23/79	01/07/81	0.18	0.11	0.15	0.0
25	Desert Game Range, NV[8]	01/15/80	01/07/81	0.21	0.17	0.19	0.0

[1] Dosimeter lost third quarter 1980.
[2] Dosimeter damaged second quarter 1980.
[3] Dosimeter lost third quarter 1980.
[4] Dosmieter lost third quarter 1980.
[5] Dosimeter lost second quarter 1980.
[6] Dosimeter damaged second quarter 1980.
[7] Dosimeter lost third quarter 1980.
[8] Dosimeter lost third quarter 1980.

TABLE B-7. 1980 SUMMARY OF ANALYTICAL RESULTS FOR THE MILK SURVEILLANCE NETWORK

Sampling Location	Sample Type*	No. of Samples	Radio-nuclide	Radioactivity Conc. ($x\ 10^{-9}\ \mu Ci/ml$) C_{max}	C_{min}	C_{avg}
Hinkley, CA, Bill Nelson Dairy	12	4	^{89}Sr	<5	<2	<2
		4	^{90}Sr	<5	1.5	<2
Keough Hot Spgs., CA Yribarren Ranch	13	3	^{89}Sr	<4	<1	<1
		3	^{90}Sr	<3	0.85	1.2
Trona, CA, Stanford Ranch	13	1	^{89}Sr	<2	<2	<2
		1	^{90}Sr	<1	<1	<1
Alamo, NV, Buckhorn Ranch	13	3	^{89}Sr	<5	<2	<2
		3	^{90}Sr	<5	<2	1.9
Austin, NV, Young's Ranch	13	3	^{3}H	480	<420	460
		4	^{89}Sr	<3	<1	<1
		4	^{90}Sr	2.5	1.6	2.0
Caliente, NV, June Cox Ranch	13	4	^{89}Sr	<3	<1	<1
		4	^{90}Sr	<5	<1	0.94
Currant, NV, Blue Eagle Ranch	13	3	^{89}Sr	<3	<1	<1
		3	^{90}Sr	1.6	0.98	1.3
Currant, NV, Manzonie Ranch	13	2	^{89}Sr	<3	<2	<2
		2	^{90}Sr	2.1	1.6	1.9
Hiko, NV, Darrel Hansen Ranch	13	2	^{3}H	610	<400	<400
		2	^{89}Sr	<3	<1	<1
		2	^{90}Sr	<2	1.1	1.3
Las Vegas, NV, LDS Dairy Farm	12	4	^{3}H	920	<400	<400
		4	^{89}Sr	<3	<1	<1
		4	^{90}Sr	<5	0.76	0.8
Lida, NV, Lida Livestock Co.	13	4	^{89}Sr	<30	<1	<1
		4	^{90}Sr	<6	<2	2.2
Logandale, NV, Vegas Valley Dairy	12	4	^{89}Sr	<4	<1	<1
		4	^{90}Sr	<3	<1	0.83

(continued)

TABLE B-7. (Continued)

Sampling Location	Sample Type*	No. of Samples	Radio-nuclide	Radioactivity Conc. (x 10^{-9} μCi/ml)		
				C_{max}	C_{min}	C_{avg}
Lund, NV, McKenzie Dairy	12	4	^{3}H	1,100	<300	<300
		4	^{89}Sr	<4	<1	<1
		4	^{90}Sr	<3	<1	0.83
Mesquite, NV, Hughes Bros. Dairy	12	4	^{3}H	<500	<400	<400
		4	^{89}Sr	<2	<1	<1
		4	^{90}Sr	<20	0.96	<1
Moapa, NV, Agman Seventy-Five, Inc.	12	4	^{89}Sr	<7	<1	1.2
		4	^{90}Sr	<7	<1	<1
Nyala, NV, Sharp's Ranch	13	4	^{3}H	<500	<400	<400
		4	^{89}Sr	<50	<1	<1
		4	^{90}Sr	<8	0.73	3.0
Overton, NV, Robison Dairy	12	4	^{89}Sr	<20	<1	2.3
		4	^{90}Sr	<20	<1	1.3
Pahrump, NV, Oxborrow Ranch	13	1	^{89}Sr	<3	<3	<3
		1	^{90}Sr	2.9	2.9	2.9
Round Mountain, NV, Berg Ranch	13	2	^{89}Sr	<1	<1	<1
		2	^{90}Sr	2.1	1.8	2.0
Cedar City, UT, Western General Dairy	12	4	^{89}Sr	<4	<1	<1
		4	^{90}Sr	<6	<1	<1
St. George, UT, Cottom Dairy	12	4	^{89}Sr	<4	<1	<1
		4	^{90}Sr	<6	0.76	<1

*12 = raw milk from Grade A producer(s); 13 = raw milk from family cow(s); 14 = other than Grade A producer (raw)

TABLE B-8. 1980 SUMMARY OF TRITIUM RESULTS FOR THE NTS MONTHLY LONG-TERM HYDROLOGICAL MONITORING PROGRAM

Sampling Location	No. Samples*	Tritium Conc. ($\times 10^{-9}$ µCi/ml) C_{max}	C_{min}	C_{avg}	% of Conc. Guide†
Well 8	12	45	<7	<7	<0.01
Well U3CN-5	12	15	<9	<9	<0.01
Well A	12	<20	<9	<9	<0.01
Well C	12	58	<20	33	<0.01
Well 5c	11	33	<9	<9	<0.01
Army Well No. 1	9	32	<9	<9	<0.01
Well 2	12	38	<9	<9	<0.01
Test Well B	10	200	110	140	<0.01
Well J-13	11	36	<9	<9	<0.01
Well J-12	1	<20	<20	<20	<0.01
Well UE7ns	2	3,200	1,700	2,400	0.08
Well U19c	11	56	<9	<9	<0.01
Well 3	8	16	<9	<9	<0.01
Well 4 Alternate	8	28	<9	<9	<0.01

* Samples could not be collected every month due to weather conditions or inoperative pumps.

† Concentration Guides for drinking water at NTS locations are the same as those for off-NTS locations. See Appendix B for Concentration Guides.

TABLE B-9. 1980 TRITIUM RESULTS FOR THE NTS SEMI-ANNUAL LONG-TERM HYDROLOGICAL MONITORING PROGRAM

Sampling Location	Date	Sample Type	Tritium Conc. (x 10^{-9} μCi/ml)	% of Conc. Guide*
NTS, Well UE15d	2/04	Well	<9	<0.01
	7/10	Well	10	<0.01
NTS, Test Well D	2/06	Well	13	<0.01
	7/16	Well	<10	<0.01
NTS, Well UElc	2/11	Well	<54	<0.01
	7/18	Well	<10	<0.01
NTS, Well C-1	2/06	Well	130	<0.01
	7/09	Well	<10	<0.01
NTS, Well UE5C	2/05	Well	14	<0.01
	7/11	Well	<10	<0.01
NTS, Well 5b	2/05	Well	<9	<0.01
	7/10	Well	<10	<0.01
NTS, Test Well F**	2/12	Well	34	<0.01
Ash Meadows, NV, Crystal Pool	2/13	Spring	10	<0.01
	7/15	Spring	<10	<0.01
Ash Meadows, NV, Well 18S/51E-7DB	2/13	Well	70	<0.01
	7/15	Well	18	<0.01
Ash Meadows, NV, Well 17S/50E-14CAC**	7/15	Well	<10	<0.01
Ash Meadows, NV, Fairbanks Springs	2/13	Spring	<9	<0.01
	7/16	Spring	<10	<0.01
Beatty, NV, City Supply, 12S/47E-7DBD	2/14	Well	<10	<0.01
	7/17	Well	<10	<0.01
Beatty, NV, Nuclear Engineering Co.	2/14	Well	<10	<0.01
	7/17	Well	<10	<0.01

(continued)

TABLE B-9. (Continued)

Sampling Location	Date	Sample Type	Tritium Conc. (x 10^{-9} μCi/ml)	% of Conc. Guide*
Beatty, NV, Coffers Well, 11S/48/1DD	2/13	Well	12	<0.01
	7/17	Well	<10	<0.01
Indian Springs, NV, USAF No. 2	2/14	Well	<10	<0.01
	7/15	Well	<10	<0.01
Indian Springs, NV, Sewer Co. Inc., Well No. 1	2/14	Well	<10	<0.01
	7/15	Well	<10	<0.01
Lathrop Wells, NV, City Supply	2/12	Well	<9	<0.01
	7/16	Well	<10	<0.01
Springdale, NV, Goss Springs	2/12	Spring	<9	<0.01
	7/17	Spring	59	<0.01

*Concentration Guides for drinking water at NTS locations are the same as those for off-NTS locations. See Appendix C.
**During 1980, samples were collected only once.

TABLE B-10. 1980 TRITIUM RESULTS FOR THE NTS ANNUAL LONG-TERM HYDROLOGICAL MONITORING PROGRAM

Sampling Location	Date	Sample Type	Tritium Conc. (x 10^{-9} μCi/ml)	% of Conc. Guide*
Shoshone, CA Shoshone Spring	8/05	Spring	<20	<0.01
Hiko, NV Crystal Springs	8/08	Spring	<20	<0.01
Alamo, NV City Supply	8/08	Well	<20	<0.01
Warm Springs, NV Twin Springs Ranch	8/06	Spring	<20	<0.01
Nyala, NV Sharp Ranch	8/06	Well	<20	<0.01
Adaven, NV Adaven Spring	8/06	Spring	86	<0.01
Pahrump, NV Calvada Well 3	8/08	Well	<20	<0.01
Tonopah, NV City Supply	8/06	Well	<20	<0.01
Clark Station, NV Tonopah Test Range Well 6	8/06	Well	<20	<0.01
Las Vegas, NV Water District Well No. 28	8/12	Well	<20	<0.01
Tempiute, NV Union Carbide Well	8/08	Well	<20	<0.01

*See Appendix B for Concentration Guides.

TABLE B-11. 1980 TRITIUM RESULTS FOR THE OFF-NTS LONG-TERM HYDROLOGICAL MONITORING PROGRAM (ANNUAL SAMPLES)

Sampling Location	Date	Sample Type	Tritium Conc. (x 10^{-9} μCi/ml)	% of Conc. Guide*
PROJECT GNOME -- NEW MEXICO				
Malaga, USGS Well No. 1	6/13	Well	16	<0.01
Malaga, USGS Well No. 4	4/07	Well	400,000**	11**
Malaga, USGS Well No. 8	4/07	Well	440,000***	15***
Malaga, PHS Well No. 6	4/09	Well	69	<0.01
Malaga, PHS Well No. 8	4/09	Well	<10	<0.01
Malaga, PHS Well No. 9	4/09	Well	<10	<0.01
Malaga, PHS Well No. 10	4/09	Well	11	<0.01
Malaga, Pecos River Pumping Stations Well No. 1	4/08	Well	<10	<0.01
Loving, City Well No. 2	4/08	Well	<10	<0.01
Carlsbad, City Well No. 7	4/09	Well	16	<0.01
PROJECT SHOAL -- NEVADA				
Frenchman, Frenchman Station	4/29	Well	<10	<0.01

(continued)

TABLE B-11. (Continued)

Sampling Location	Date	Sample Type	Tritium Conc. (x 10^{-9} μCi/ml)	% of Conc. Guide*
Frenchman, Well HS-1	4/29	Well	<10	<0.01
Frenchman, Well H-3	(Pump inoperative)			
Frenchman, Flowing Well	4/29	Well	22	<0.01
Frenchman, Hunts Station	4/29	Well	<10	<0.01
Frenchman, Spring Windmill	4/03	Well	<10	<0.01
PROJECT DRIBBLE -- MISSISSIPPI				
Baxterville, City Supply	3/28	Well	51	<0.01
Baxterville, Lower Little Creek	3/28	Creek	32	<0.01
Baxterville, Well HT-1	(No longer sampled. Plugged 7/79)			
Baxterville, Well HT-2c	3/31	Well	20	<0.01
Baxterville, Well HT-4	3/22	Well	43	<0.01
Baxterville, Well HT-5	3/23	Well	31	<0.01
Baxterville, Well E-7	3/31	Well	33	<0.01

(continued)

TABLE B-11. (Continued)

Sampling Location	Date	Sample Type	Tritium Conc. (x 10^{-9} μCi/ml)	% of Conc. Guide*
Baxterville, Well Ascot No. 2	3/31	Well	43	<0.01
Baxterville, Half Moon Creek	3/31	Creek	34	<0.01
Baxterville, Half Moon Creek Overflow	3/29	Creek	61	<0.01
Baxterville, T. Speights residence	(Pump inoperative)			
Baxterville, R. L. Anderson residence	4/01	Well	71	<0.01
Baxterville, L. J. Bryant residence (creek)	(Discontinued)			
Baxterville, Well HM-S	3/26	Well	36,000	1
Baxterville, Well HM-1	3/26	Well	2,000	0.07
Baxterville, Well HM-L	3/26	Well	2,600	0.09
Baxterville, Well HM-2A	3/26	Well	1,300	0.04
Baxterville, Well HM-2B	3/25	Well	1,300	0.04
Baxterville, Well HM-3	3/26	Well	860	0.03

(continued)

TABLE B-11. (Continued)

Sampling Location	Date	Sample Type	Tritium Conc. (x 10^{-9} μCi/ml)	% of Conc. Guide*
Baxterville, B. R. Anderson residence	3/24	Well	35	<0.01
Baxterville, R. Mills residence	3/31	Well	65	<0.01
Baxterville, A. C. Mills residence	4/01	Well	47	<0.01
Baxterville, G. Kelly residence	4/01	Well	27	<0.01
Baxterville, H. Anderson residence	4/02	Well	69	<0.01
Baxterville, REECo Pit Drainage-A	4/03	Pond	43	<0.01
Baxterville, REECo Pit Drainage-B	4/03	Pond	280	<0.01
Baxterville, REECo Pit Drainage-C	4/03	Pond	210	<0.01
Baxterville, B. Chambliss residence	4/02	Well	<10	<0.01
Baxterville, Mark Lowe residence	3/27	Well	18	<0.01

(continued)

TABLE B-11. (Continued)

Sampling Location	Date	Sample Type	Tritium Conc. (x 10^{-9} μCi/ml)	% of Conc. Guide*
Baxterville, R. Ready residence	3/27	Well	61	<0.01
Baxterville, W. Daniels residence	3/27	Well	24	<0.01
Lumberton, City Supply Well No. 2	3/29	Well	<10	<0.01
Purvis, City Supply	3/28	Well	15	<0.01
Columbia, City Supply	3/28	Well	<20	<0.01
Lumberton, North Lumberton City Supply	3/29	Well	<10	<0.01
Baxterville, Pond W of GZ	3/29	Pond	30	<0.01
PROJECT GASBUGGY -- NEW MEXICO				
Gobernador, Arnold Ranch	5/09	Spring	63	<0.01
Gobernador, Lower Burro Canyon	5/11	Well	94	<0.01
Gobernador, Fred Bixler Ranch	5/09	Well	30	<0.01
Gobernador, Cave Springs	5/11	Spring	<10	<0.01

(continued)

TABLE B-11. (Continued)

Sampling Location	Date	Sample Type	Tritium Conc. (x 10^{-9} µCi/ml)	% of Conc. Guide*
Gobernador, Windmill No. 2	5/09	Well	26	<0.02
Gobernador, Bubbling Springs	5/08	Spring	86	<0.01
Gobernador, La Jara Creek	5/09	Creek	120	<0.01
Gobernador, EPNG Well 10-36	5/10	Well	<10	<0.01
PROJECT RULISON -- COLORADO				
Rulison, Lee L. Hayward Ranch	5/13	Well	330	0.01
Rulison, Glen Schwab Ranch	5/13	Well	360	0.01
Grand Valley, Albert Gardner Ranch	5/13	Well	300	0.01
Grand Valley, City Water Supply	5/13	Spring	31	<0.01
Grand Valley Spring 300 Yds. NW of GZ	5/16	Spring	210	<0.01
Rulison, Felix Sefcovic Ranch	5/13	Spring	310	0.01
Grand Valley, Battlement Creek	5/16	Creek	140	<0.01
Grand Valley, CER Well	5/16	Well	240	<0.01

(continued)

TABLE B-11. (Continued)

Sampling Location	Date	Sample Type	Tritium Conc. (x 10^{-9} μCi/ml)	% of Conc. Guide*
Rulison, Potter Ranch	5/16	Spring	230	<0.01
PROJECT FAULTLESS -- NEVADA				
Blue Jay, Maintenance Sta.	6/19	Well	<20	<0.01
Blue Jay, Sixmile Well	6/18	Well	24	<0.01
Blue Jay, Well HTH-1	6/18	Well	<20	<0.01
Blue Jay, Well HTH-2	6/18	Well	<20	<0.01
Blue Jay, Bias Well	6/19	Well	15	<0.01
PROJECT RIO BLANCO -- COLORADO				
Rio Blanco, Fawn Creek 6,800 ft upstream from SGZ	5/14	Creek	110	<0.01
Rio Blanco, Fawn Creek 500 ft upstream from SGZ	5/14	Creek	140	<0.01
Rio Blanco Fawn Creek 500 ft downstream from SGZ	5/14	Well	110	<0.01
Rio Blanco, Fawn Creek 8,400 ft downstream from SGZ	5/15	Creek	92	<0.01

(continued)

TABLE B-11. (Continued)

Sampling Location	Date	Sample Type	Tritium Conc. (x 10^{-9} µCi/ml)	% of Conc. Guide*
Rio Blanco, Fawn Creek No. 1	5/15	Spring	42	<0.01
Rio Blanco, Fawn Creek No. 3	5/14	Spring	110	<0.01
Rio Blanco, CER No. 1 Black Sulphur	5/15	Spring	140	<0.01
Rio Blanco, CER No. 4 Black Sulphur	5/15	Spring	93	<0.01
Rio Blanco, B-1 Equity Camp	5/15	Spring	100	<0.01
Rio Blanco, Brennan Windmill	5/15	Well	32	<0.01
Rio Blanco, Johnson Artesian Well	5/15	Well	11	<0.01
Rio Blanco, Well RB-D-01	5/14	Well	<10	<0.01
PROJECT CANNIKIN -- AMCHITKA, ALASKA				
South End of Cannikin Lake	9/19	Lake	43	<0.01
North End of Cannikin Lake	9/19	Lake	31	<0.01
Well HTH-3	9/19	Well	44	<0.01
Ice Box Lake	9/19	Lake	50	<0.01
White Alice Creek	9/19	Creel	60	<0.01

(continued)

TABLE B-11. (Continued)

Sampling Location	Date	Sample Type	Tritium Conc. (x 10^{-9} μCi/ml)	% of Conc. Guide*
Pit South of Cannikin GZ	9/19	Pond	27	<0.01
PROJECT MILROW -- AMCHITKA, ALASKA				
Heart Lake	9/20	Lake	27	<0.01
Well W-5	9/20	Well	51	<0.01
Well W-6	9/20	Well	63	<0.01
Well W-8	9/20	Well	53	<0.01
Well W-15	9/20	Well	43	<0.01
Well W-10	9/20	Well	67	<0.01
Well W-11	9/20	Well	110	<0.01
Well W-3	9/20	Well	54	<0.01
Well W-2	9/20	Well	44	<0.01
Clevenger Creek	9/20	Creek	45	<0.01
Well W-4	(Well dried up)			
Well W-7	9/20	Well	47	<0.01
Well W-13	9/20	Well	70	<0.01
Well W-18	9/20	Well	140	<0.01
PROJECT LONG SHOT -- AMCHITKA, ALASKA				
Well WL-2	9/21	Well	380	<0.01
EPA Well-1	9/21	Well	460	0.01
Reed Pond	9/21	Pond	44	<0.01

(continued)

TABLE B-11. (Continued)

Sampling Location	Date	Sample Type	Tritium Conc. (x 10^{-9} µCi/ml)	% of Conc. Guide*
Well GZ No. 1	9/21	Well	4700	0.2
Well GZ No. 2	9/21	Well	400	0.01
Well WL-1	9/21	Well	40	<0.01
Mud Pit No. 1	9/21	Pond	830	0.03
Mud Pit No. 2	9/21	Pond	1100	0.03
Mud Pit No. 3	9/21	Pond	2000	0.07
BACKGROUND SAMPLES -- AMCHITKA, ALASKA				
Constantine Spring	9/20	Spring	70	<0.01
Army Well No. 1	9/20	Well	68	<0.01
Jones Lake	9/20	Lake	42	<0.01
Army Well No. 2	9/19	Well	30	<0.01
Army Well No. 3	9/19	Well	89	<0.01
Well AEC 1	9/19	Well	89	<0.01
Duck Cove Creek	9/20	Creek	48	<0.01

*Concentration Guides (CG) for drinking water at onsite locations are the same as those for offsite locations. See Appendix C for Concentration Guides.

**The sample from Malaga, USGS Well No. 4 also contained 7.6 x 10^{-6} µCi of strontium-90 per ml of water, which is 2,500 percent of its Concentration Guide.

***The sample from the Malaga, USGS Well No. 8 also contained 7.2 x 10^{-8} µCi of cesium-137 per ml of water and 5.6 x 10^{-6} µCi of strontium-90 per ml of water. The cesium-137 concentration is 0.7 percent of its Concentration Guide, and the strontium-90 concentration is 1,900 percent of its Concentration Guide.

TABLE B-12. TRITIUM RESULTS FOR SPECIAL SAMPLES: LONG-TERM HYDROLOGICAL MONITORING PROGRAM - PROJECT DRIBBLE*

Sampling Location	Date	^{3}H Concentration ($\times 10^{-9}$ μCi/ml)	% of Conc. Guide
HMH-1	3/27	14,000	0.4
HMH-2	3/27	34,000	1
HMH-3	3/27	530	0.02
HMH-4	3/27	570	0.02
HMH-5	3/27	6,900	0.2
HMH-6	3/27	1,500	0.05
HMH-7	3/27	1,400	0.05
HMH-8	3/27	400	0.01
HMH-9	3/27	960	0.03
HMH-10	3/27	<400	<0.01
HMH-11	3/27	1,500	0.03
PS-3	Plugged	Not sampled	

*Each sample was also analyzed by gamma spectrometry. No gamma-emitting radionuclides were detected above the MDC of $\sim 1 \times 10^{-8}$ μCi/ml.

APPENDIX C. RADIATION PROTECTION STANDARDS FOR EXTERNAL AND INTERNAL EXPOSURE

DOE ANNUAL DOSE COMMITMENT

The annual dose commitment tabulated below is from "Standards for Radiation Protection" in DOE manual, Chapter 0524.

Type of Exposure	Dose limit to Individuals in Uncontrolled Area at Points of Maximum Probable Exposure (rem)	Dose Limit to Suitable Sample of the Exposed Polulation in an Uncontrolled Area (rem)
Whole body, gonads, or bone marrow	0.5	0.17
Other organs	1.5	0.5

EPA DRINKING WATER REGULATIONS FOR RADIONUCLIDES

The EPA drinking water regulations for radionuclides are set forth in Title 40 of the code of Federal Regulations, Chapter 1, Part 141. They were published in the Federal Register, Vol. 41, No. 133, on July 9, 1976.

For purposes of the regulation listed below, "community water system" is defined as a public water system that serves a population of which 70 percent or greater are residents. A public water system is a system for the provision to the public of piped water for human consumption, and has at least 15 service connections or regularly serves an average of 25 individuals daily at least 3 months out of the year.

The regulation is stated in terms of annual dose equivalent and average annual concentration assumed to produce that dose equivalent.

Maximum Contaminant Levels for Beta Particles and Photon Radioactivity from Manmade Radionuclides in Community Water Systems

The average annual concentration of beta particle and photon radioactivity from manmade radionuclides in drinking water shall not produce an annual dose equivalent to the total body or any internal organ greater than 4 millirem per year.

Except for the tritium and strontium-90, the concentration of manmade radionuclides causing 4 mrem total body or organ dose equivalents shall be calculated on the basis of a 2-liter per day drinking water intake using the 168 hour data listed in "Maximum Permissible Body Burdens and Maximum Permissible Concentration of Radionuclides in Air or Water for Occupational Exposure," NBS Handbook 69 as amended August 1963, U.S. Department of Commerce. If two or more radionuclides are present, the sum of their annual dose equivalent to the total body or to any organ shall not exceed 4 millirem per year.

Average Annual Concentration Assumed to Produce A Total Body or Organ Dose of 4 mrem/year

Radionuclide	Critical Organ	pCi per liter
Tritium	Total body	20,000
Strontium-90	Bone marrow	8

DOE CONCENTRATION GUIDES

This table of concentration guides (CG's) is from the DOE Manual, Chapter 0524, "Standards for Radiation Protection." All values are annual average concentrations.

Network or Program	Sampling Medium	Radio-nuclide	CG (μCi/ml)	Basis of Exposure
Air Surveillance Network	air	^{7}Be	1.1×10^{-8}	Suitable sample of the exposed population in uncontrolled area.
		^{95}Zr	3.3×10^{-10}	
		^{95}Nb	1.0×10^{-9}	
		^{99}Mo	2.3×10^{-9}	
		^{103}Ru	1.0×10^{-9}	
		^{131}I	3.3×10^{-11}	
		^{132}Te	1.3×10^{-9}	
		^{137}Cs	1.7×10^{-10}	
		^{140}Ba	3.3×10^{-10}	
		^{140}La	1.3×10^{-9}	

(continued)

Network or Program	Sampling Medium	Radio-nuclide	CG ($\mu Ci/ml$)	Basis of Exposure
Air Surveillance Network (continued)	air	^{141}Ce	1.7×10^{-9}	
		^{144}Ce	6.7×10^{-10}	
		^{239}Pu	3.3×10^{-13}	
Noble Gas and Tritium Surveillance Network, On-NTS	air	^{85}Kr	1.0×10^{-5}	Individual in controlled area.
		^{3}H	5.0×10^{-6}	
		^{133}Xe	1.0×10^{-5}	
		^{135}Xe	1.0×10^{-5}	
Noble Gas and Tritium Surveillance Network, On-NTS	air	^{85}Kr	1.0×10^{-7}	Suitable sample of the exposed population in uncontrolled area.
		^{3}H	6.7×10^{-8}	
		^{133}Xe	1.0×10^{-7}	
		^{135}Xe	1.0×10^{-7}	
Long-Term Hydrological Program	water	^{3}H	3.0×10^{-3}	Individual in a controlled or an uncontrolled area.
		^{89}Sr	3.0×10^{-6}	
		^{90}Sr	3.0×10^{-7}	
		^{137}Cs	2.0×10^{-5}	
		^{226}Ra	3.0×10^{-8}	
		^{234}U	3.0×10^{-5}	
		^{235}U	3.0×10^{-5}	
		^{238}U	4.0×10^{-5}	
		^{238}Pu	5.0×10^{-6}	
		^{239}Pu	5.0×10^{-6}	

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

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Prepared for the U.S. Department of Energy under Memorandum of Understanding DE-AI08-76DP00539

16. ABSTRACT The U.S. Environmental Protection Agency's Environmental Monitoring Systems Laboratory in Las Vegas continued its Offsite Radiological Safety Program for the Nevada Test Site (NTS) and other sites of past underground nuclear tests. For each test, the Laboratory provided airborne meteorological measurements, ground and airborne radiation monitoring teams, and special briefings to the Test Controller's Advisory Panel. Radioactivity from the NTS was detected in a compressed air sample collected at Lathrop Wells, Nevada, following the Riola Test conducted on September 25, 1980. This consisted of xenon-133 (3.4×10^{-11} μCi/ml) and xenon-135 (3.6×10^{-10} μCi/ml). The estimated dose equivalent to the whole body of a hypothetical receptor at Lathrop Wells was 0.011 mrem, which is 0.006 percent of the radiation protection guide for a suitable sample of the general population. Whole-body counts of individuals residing in the environs of the NTS showed no manmade radionuclides attributable to the testing program. The only radioactivity from non-NTS sites of past underground nuclear tests was due to tritium in water samples collected from the Project Dribble Site near Hattiesburg, Mississippi, and the Project Long Shot Site on Amchitka Island, Alaska. The maximum concentrations measured at these locations were 10 and 0.1 percent of the Concentraton Guide for drinking water, respectively. A small amount of airborne radioactivity originating from nuclear tests carried out by the People's Republic of China was detected during 1980 at some stations scattered throughout the Air Surveillance Network.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group

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