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~~E. Campbell~~

EMSL-LV-0539-36

65150

OFFSITE ENVIRONMENTAL MONITORING REPORT FOR THE NEVADA TEST SITE AND OTHER TEST AREAS USED FOR UNDERGROUND NUCLEAR DETONATIONS

January through December 1979

#7

Nuclear Radiation Assessment Division
Environmental Monitoring Systems Laboratory
U.S. Environmental Protection Agency
Las Vegas, Nevada 89114

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January through December 1979

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, the 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 for nuclear testing. 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 in the offsite 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 inventories, 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 a comprehensive radiological monitoring report. Since 1971, the EPA has fulfilled the annual reporting requirements of this DOE directive.

CONTENTS

FIGURES

Number		Page

TABLES

ABBREVIATIONS AND SYMBOLS

μm	micrometer
μrem	microroentgen equivalent man
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
D.E.	Dose Equivalent
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
km	kilometer
kt	kiloton
LCL	lower confidence limit
LLL	Lawrence Livermore Laboratory
LTHMP	Long-Term Hydrological Monitoring Program
m	meter
MDC	minimum detectable concentration
mm	millimeter
MPa	megapascal
mrem/y	milliroentgen equivalent man per year
mrem/d	milliroentgen equivalent man 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	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	berylium
Cs	cesium
I	iodine
K	potassium
Kr	krypton
Pu	plutonium
Ra	radium
Ru	ruthenium
Sr	strontium
Te	tellurium
U	uranium
Xe	xenon
Zr	zirconium

ACKNOWLEDGMENT

The authors of this report gratefully acknowledge M. E. Kaye, M.D. and Dr. R. G. Patzer for providing the whole-body counting information.

PROGRAM SUMMARY -- 1979

No radioactivity from the nuclear tests conducted at the Nevada Test Site (NTS) in 1979 was measured offsite by the U.S. Environmental Protection Agency's Environmental Monitoring Systems Laboratory, which continued its Offsite Radiological Safety Program for the 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.

No measurable concentrations of manmade radionuclides attributable to the testing program were found in humans living in the environs of the NTS as determined by whole-body counts of individuals residing there.

The only radioactivity from non-NTS sites of past underground nuclear tests was due to tritium, which was measured 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 Concentration Guide, respectively. Further sampling is planned at the Project Dribble site.

A small amount of airborne radioactivity originating from nuclear tests carried out by the People's Republic of China was detected during 1979 at some stations scattered throughout the Air Surveillance Network.

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

Dose assessment calculations were not warranted this year because no radioactivity from the nuclear tests conducted at the NTS during 1979 was detected by the offsite monitoring networks.

INTRODUCTION

Under Memorandum of Understanding No. EY-76-A-08-0539 with the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency's (EPA) Environmental Monitoring Systems Laboratory--Las Vegas (EMSL-LV), continued its Offsite Radiological Safety Program for the Nevada Test Site (NTS) and for other sites designated by the DOE during calendar year 1979. This report, prepared in accordance with the DOE Manual, Chapter 0513 (ERDA 1974), 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 weapons 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 1979, 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 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.

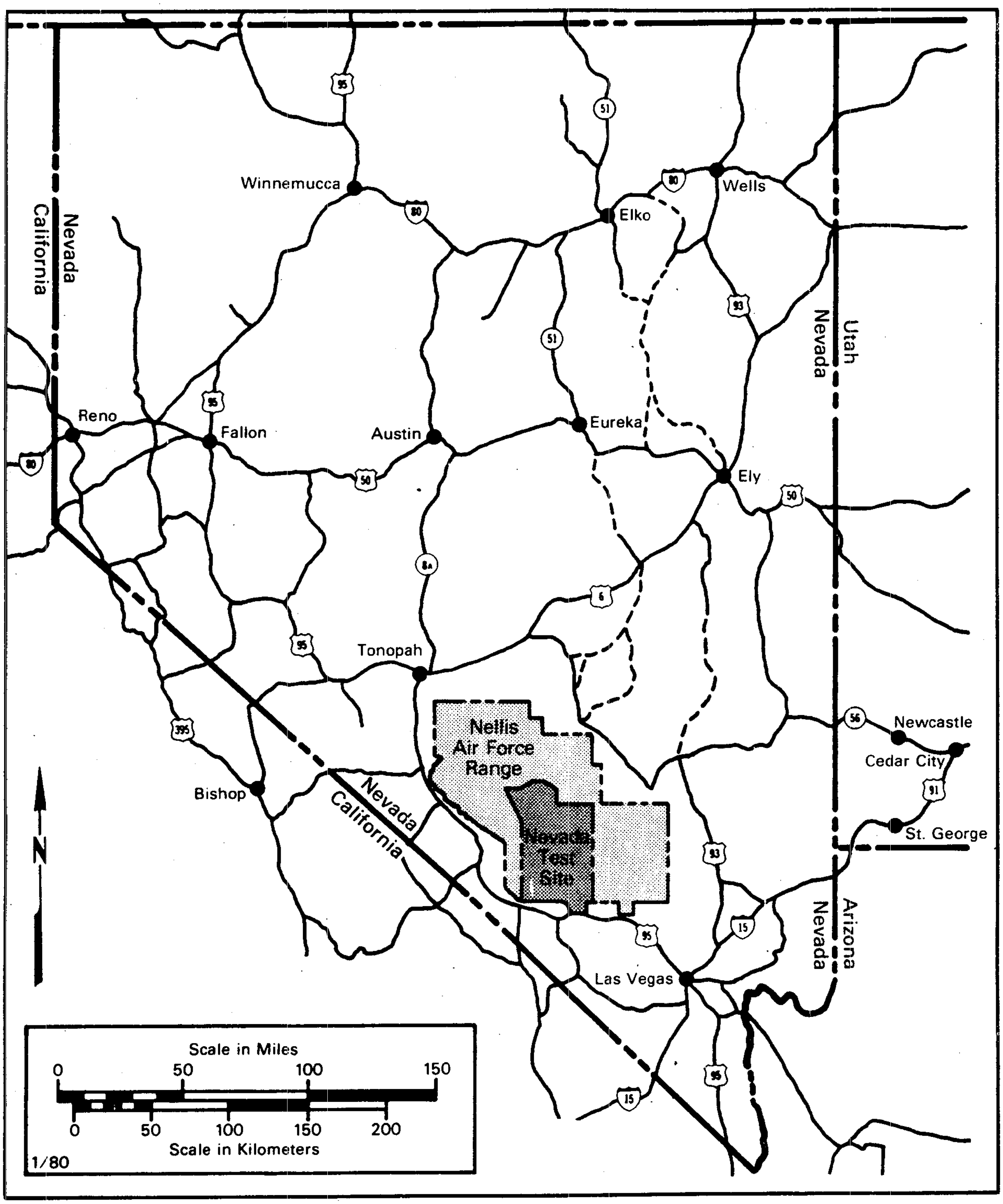

Figure 1. Location of the Nevada Test Site.

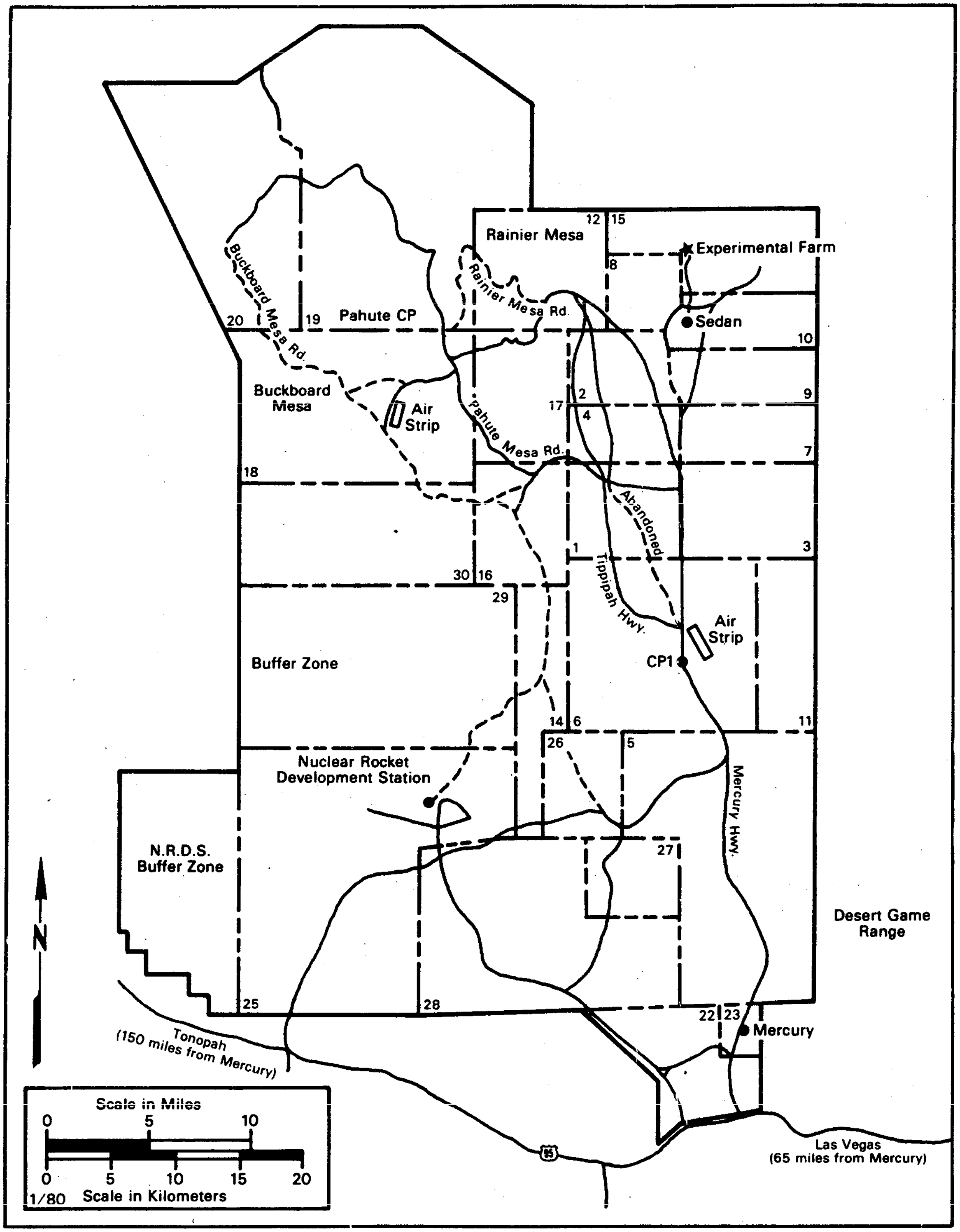

Figure 2. Nevada Test Site roads and facilities.

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 directions, 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 winder 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 characteristics 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 and published 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

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

Climate Type	Mean Temperature °C (°F) Winter	Summer	Annual Precipitation cm (inches) Total*	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.

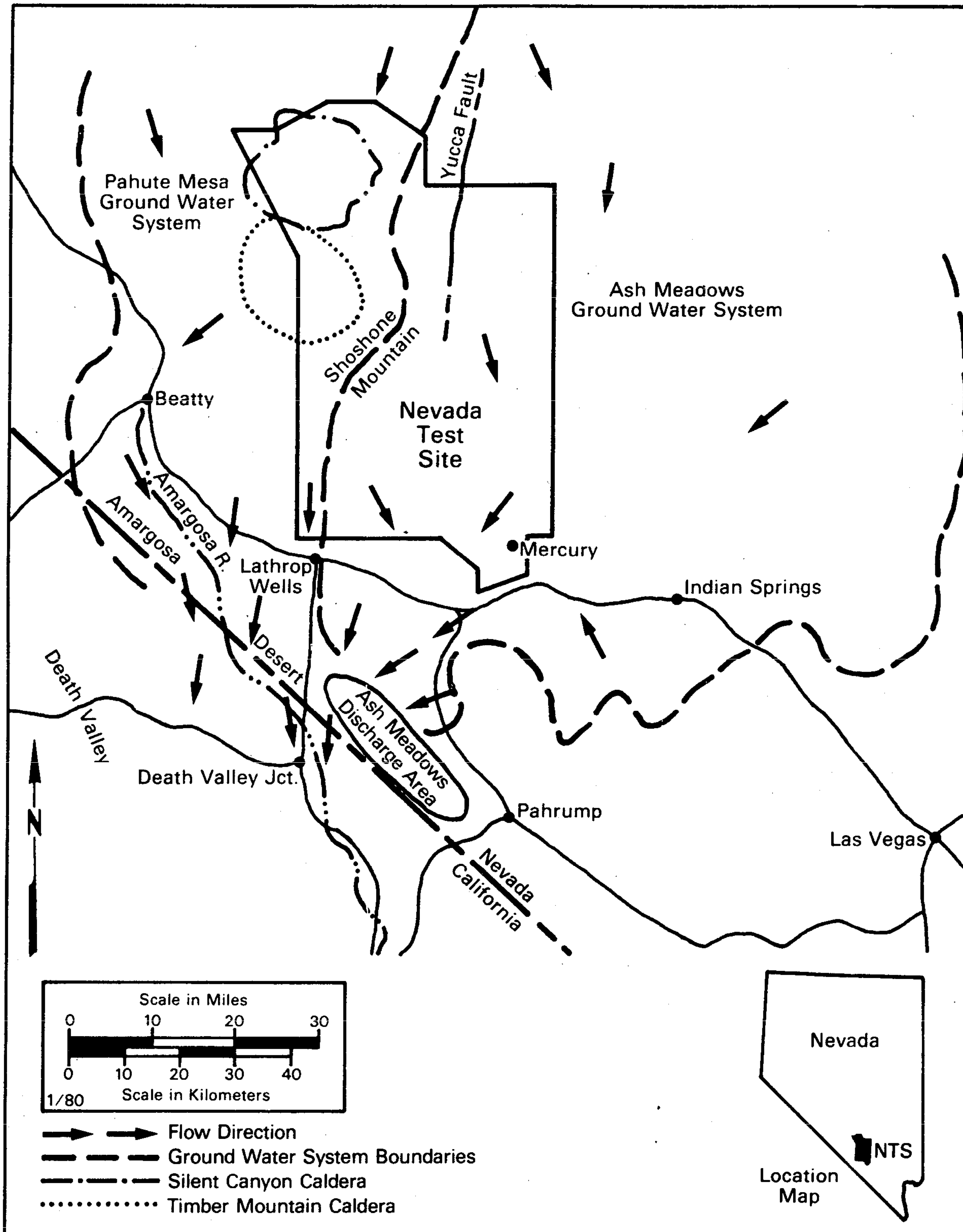

Figure 3. Groundwater flow systems around the Nevada Test Site.

south 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 southwest 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. For example, within a 300-km radius 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 34 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 (100 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.

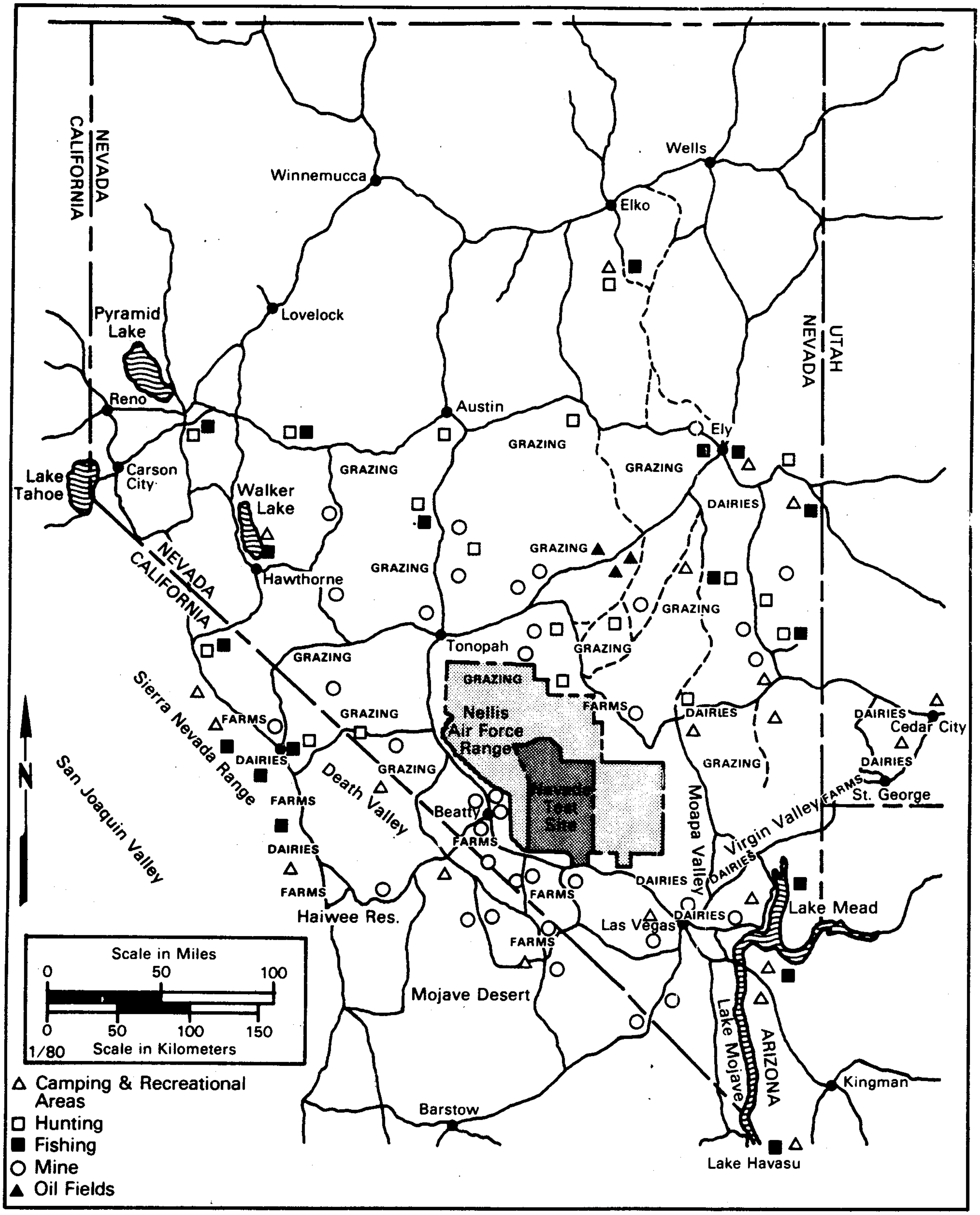

Figure 4. General land use in the Nevada Test Site environs.

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 southeast of the Site (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 250,000 cattle and 280,000 sheep (California 1979; Nevada Department of Agriculture 1978; Utah Department of Agriculture 1979) were pastured within this area during 1979. The distributions of the cattle and sheep by county are shown in Figures 7 and 8, respectively.

Population Distribution

Figure 9 shows the current population of counties surrounding the NTS based on projections by the States in which the counties were located. Excluding the Las Vegas area, the major population center (approximately 435,000 in 1979), the population density within this area is about 0.6 persons per square kilometer. For comparison, the 48 contiguous states (1970 census) had a population density of approximately 26 persons per square kilometer. The estimated average population density for Nevada in 1979 was 2.6 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 Control Point-1. The Amargosa Farm Area, which has a population of about 1,000, 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 600 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 of the NTS, with a population of about 25,000. The next largest populated area is the Ridgecrest-China Lake area, which has a population of about

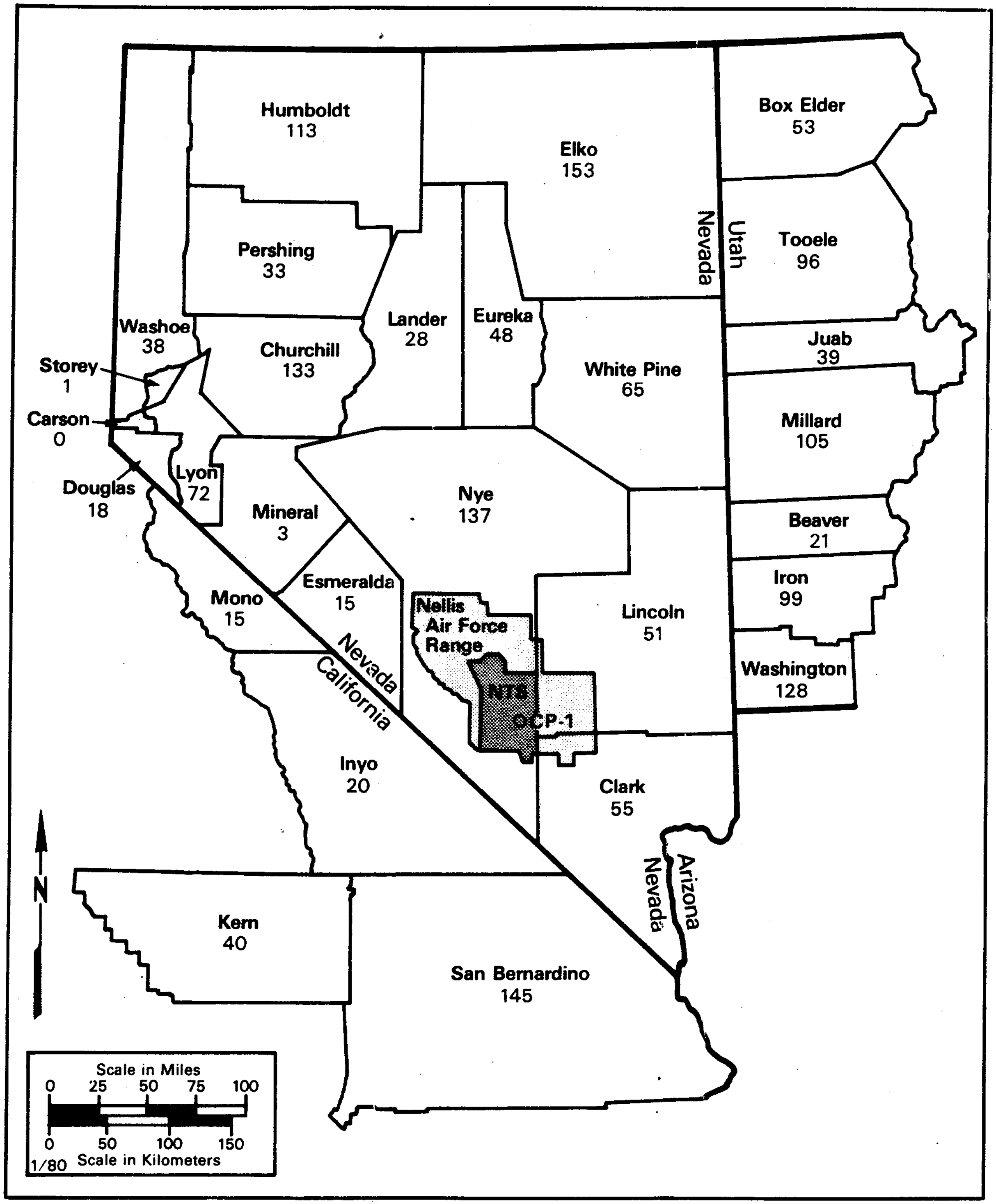

Figure 5. Distribution and number of family milk cows and goats, by county.

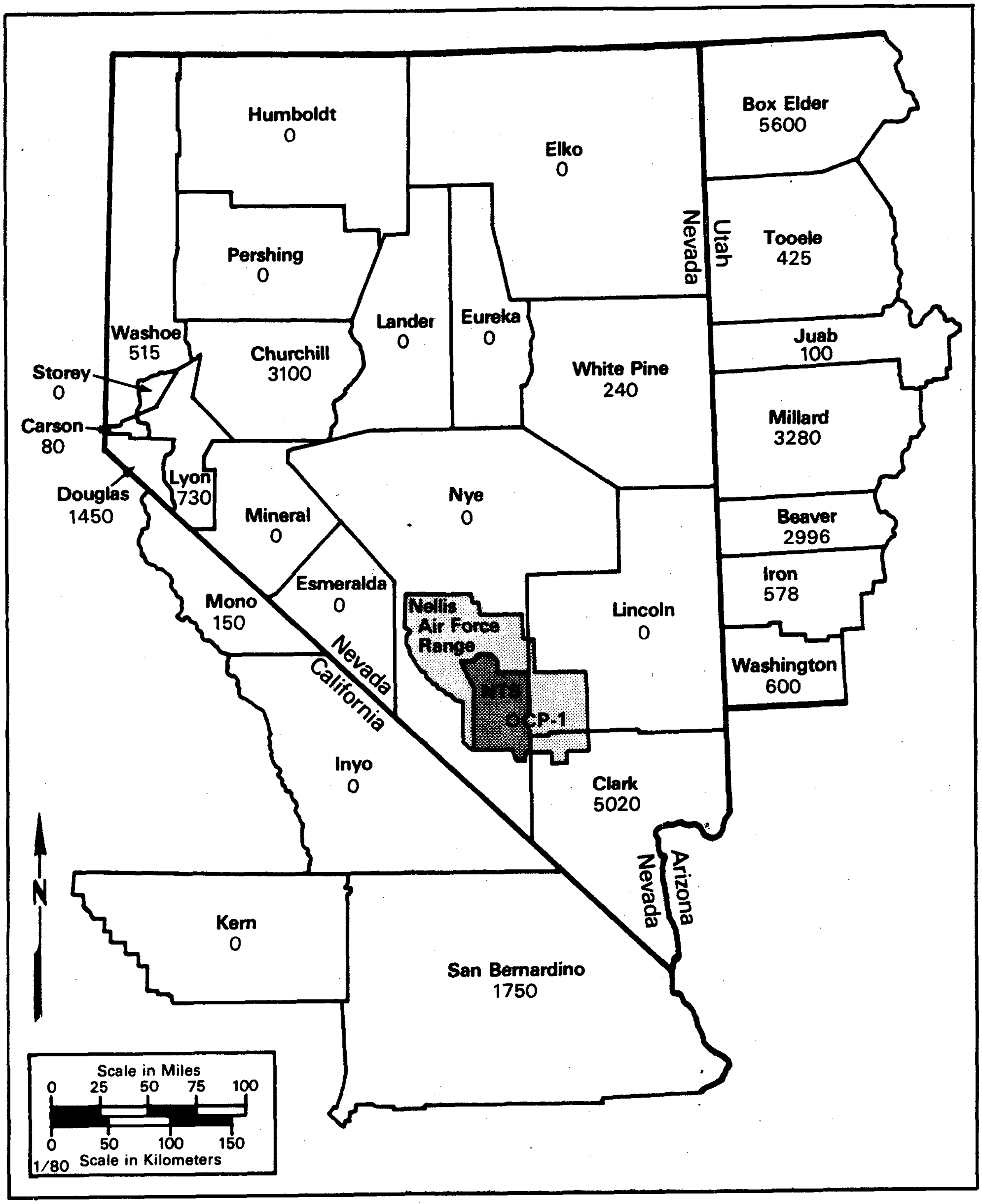

Figure 6. Distribution of dairy cows, by county.

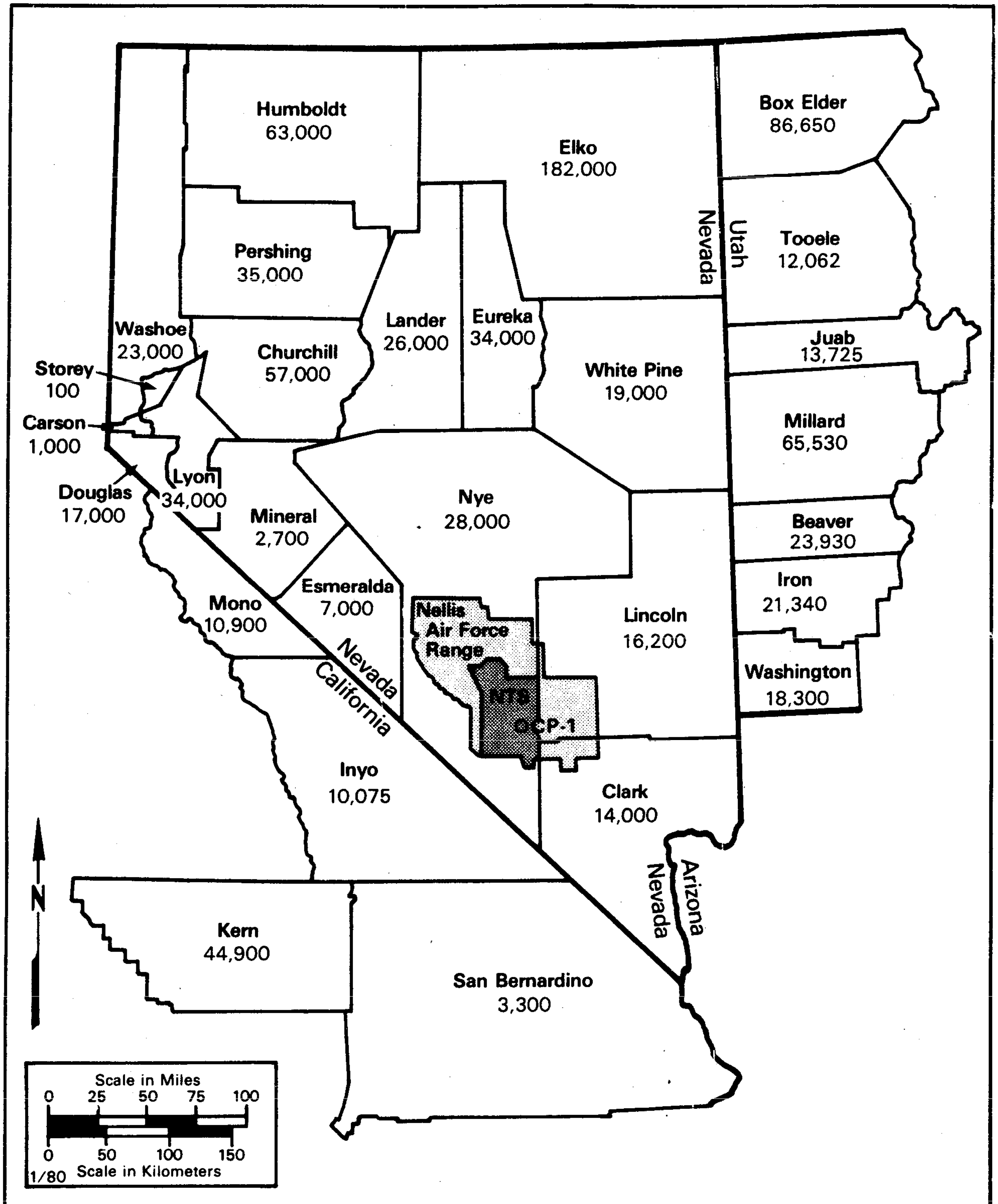

Figure 7. Distribution of beef cattle, by county.

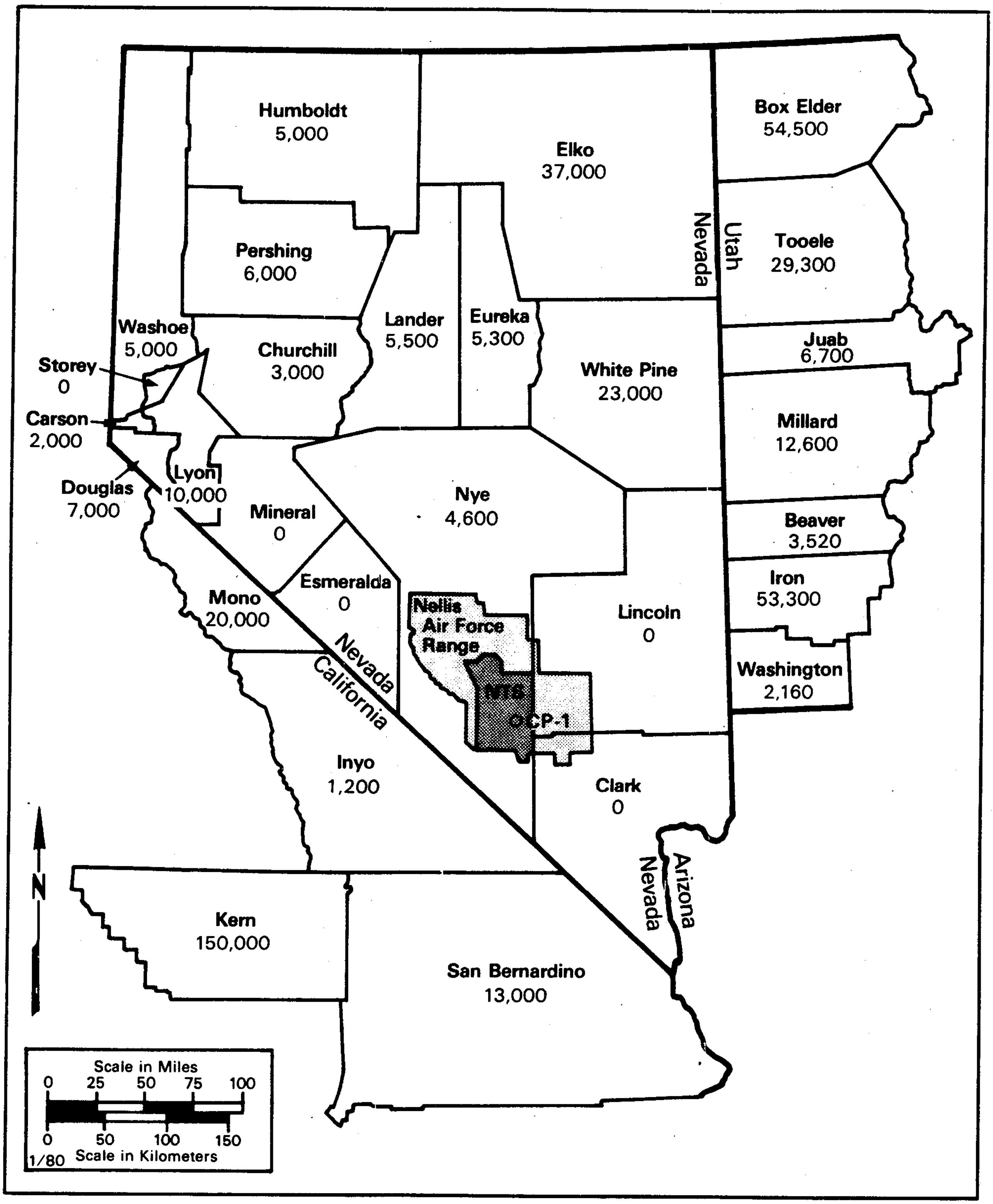

Figure 8. Distribution of sheep, by county.

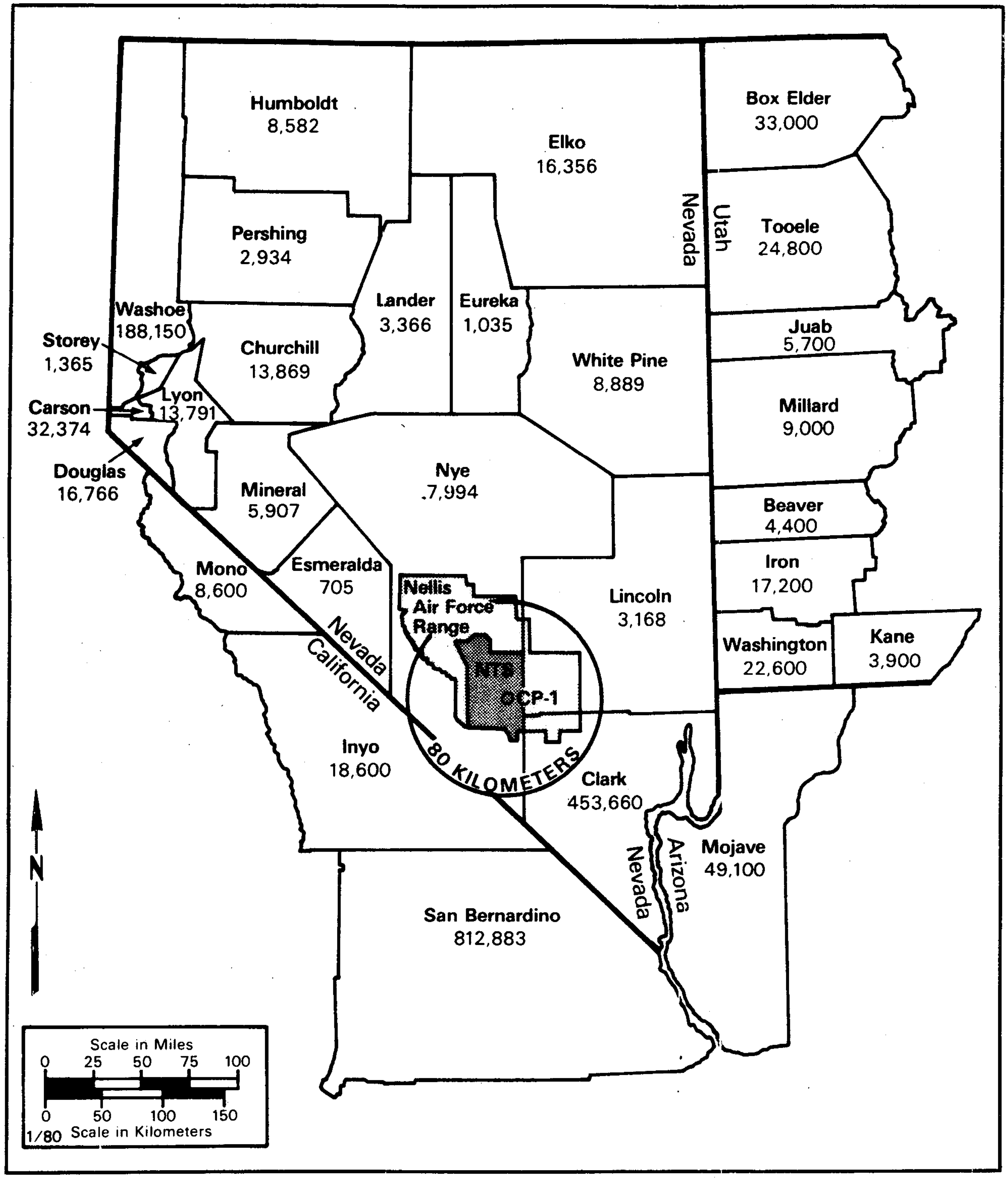

Figure 9. Population of Arizona, California, Nevada, and Utah counties near the Nevada Test Site.

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 town, Cedar City, with a population of 10,700, is located 280 km east northeast of the NTS. The next largest community is St. George, located 220 km east of the NTS, with a population of 9,100.

The extreme northwestern region of Arizona is mostly range land 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 8,000.

AIRBORNE RELEASES OF RADIOACTIVITY AT THE NTS DURING 1979

During 1979, all nuclear detonations were conducted underground, and all were contained. However, during re-entry drilling operations, occasional low-level releases of airborne radioactivity did occur. According to information provided by the Nevada Operations Office, DOE, the quantities of radionuclides released into the atmosphere during 1979 are shown in Table 2.

TABLE 2. TOTAL AIRBORNE RADIONUCLIDE RELEASES AT THE NTS DURING 1979

Radionuclide	Quantity Released (Ci)
Tritium	12.6
Krypton-85	ND
Iodine-131	ND
Xenon-133	ND
Xenon-133m	ND
Xenon-135	ND
Total	12.6

ND = no detectable release

There is also a continuous unknown 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 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 are shown in Table 3. No off-NTS nuclear tests were conducted during 1979.

TABLE 3. UNDERGROUND TESTS CONDUCTED OFF THE NEVADA TEST SITE

Name of Test, Operation or Project	Date	Location	Yield§ (kt)	Depth m (ft)	Purpose of the events§,#
Project/Gnome Coach*	12/10/61	48 km (30 mi) SE of Carlsbad, N. Mex.	3.1**	360 (1184)	Multi-purpose experiment.
Project Shoal†	10/26/63	45 km (28 mi) SE of Fallon, Nev.	12	366 (1200)	Nuclear Test detection research experiment.
Project Dribble† (Salmon Event)	10/22/64	34 km (21 mi) SW of Hattiesburg, Miss.	5.3	823 (2700)	Nuclear test detection research experiment.
OperaTion Long Shot†	10/29/65	Amchitka Island, Alaska	80	716 (2350)	DOD nuclear test detection experiment.
Project Dribble† (Sterling Event)	12/03/66	34 km (21 mi) SW of Hattiesburg, Miss.	0.38	823 (2700)	Nuclear test detection research experiment.
Project Gasbuggy*	12/10/67	88 km (55 mi) E of Farmington, N. Mex.	29	1292 (4240)	Joint Government-Industry gas stimulation experiment.
Faultless Event‡	01/19/68	Central Nevada Test Area 96 km (60 mi) E of Tonopah, Nev.	200-1000	914 (3000)	Calibration test.
Project Miracle Play (Diode Tube)‡	02/02/69	34 km (21 mi) SW of Hattiesburg, Miss.	Non-nuclear explosion	823 (2700)	Detonated in Salmon/Sterling cavity. Seismic studies.
Project Rulison*	09/10/69	19 km (12) SW of Rifle, Colo.	40	2568 (8425)	Gas Stimulation experiment.
Operation Milrow‡	10/02/69	Amchitka Island, Alaska	1000	1219 (4000)	Calibration test.

(continued)

TABLE 3. Continued

Name of Test, Operation or Project	Date	Location	Yield (kt)	Depth m (ft)	Purpose of the event
Project Miracle* Play (Humid Water)†	04/19/70	34 km (21 mi) SW of Hattiesburg, Miss.	Non-nuclear explosion	823 (2700)	Detonated in Salmon/Sterling cavity. Seismic studies.
Operation Cannikin‡	11/06/71	Amchitka Island, Alaska	<5000	1829 (6000)	Test of war-head for Spartan missile.
Project Rio Blanco*	05/17/73	48 km (30 mi) SW of Meeker, Colo.	3x30	1780 to 2040 (5840 to 6690)	Gas stimulation experiment.

*Plowshare Events
†Vela Uniform Events
‡Weapons Tests
§Information from "Revised Nuclear Test Statistics," dated September 20, 1974, and "Announced United States Nuclear Test Statistics," dated June 30, 1976, distributed by David G. Jackson, Director, Office of Public Affairs, Energy Research Administration, Nevada Operations Office, Las Vegas, Nevada.
#News release Al-62-50, ABC Albuquerque Operations Office, Albuquerque, New Mexico. December 1, 1961.
**"The Effects of Nuclear Weapons," Rev. Ed. 1964.

METHODS

SPECIAL TEST SUPPORT

Before each nuclear test, mobile monitoring personnel were positioned in the offsite areas most likely to be exposed 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. At the beginning of 1979, the ASN consisted of 49 continously operating sampling stations and 73 standby stations in 21 western States. By February 1, 1979, 24 of the active stations were changed to standby stations, and later in the year operation of the Diablo station was terminated. At the end of the year, the network had 25 active stations and 96 standby stations (Figures 10 and 11).

Samples of airborne particulates were collected at each active station on 4-in (10-cm) diameter glass-fiber or Microsorban filters at a flow rate of about 350 m^3per 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, used to collect gaseous radioiodine, were changed at the same time as the filters. The stations were operated by State and municipal health

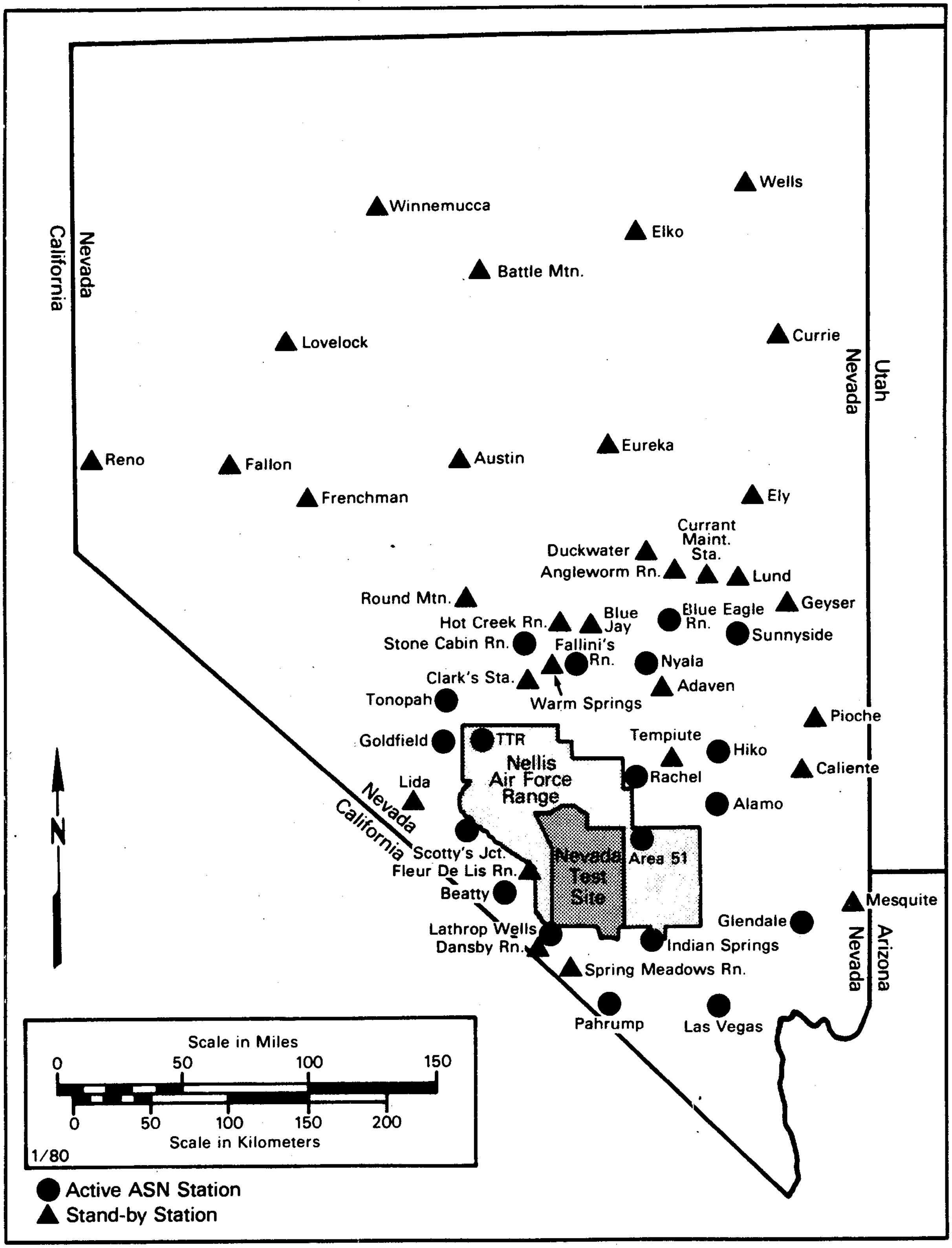

Figure 10. Air Surveillance Network stations within Nevada.

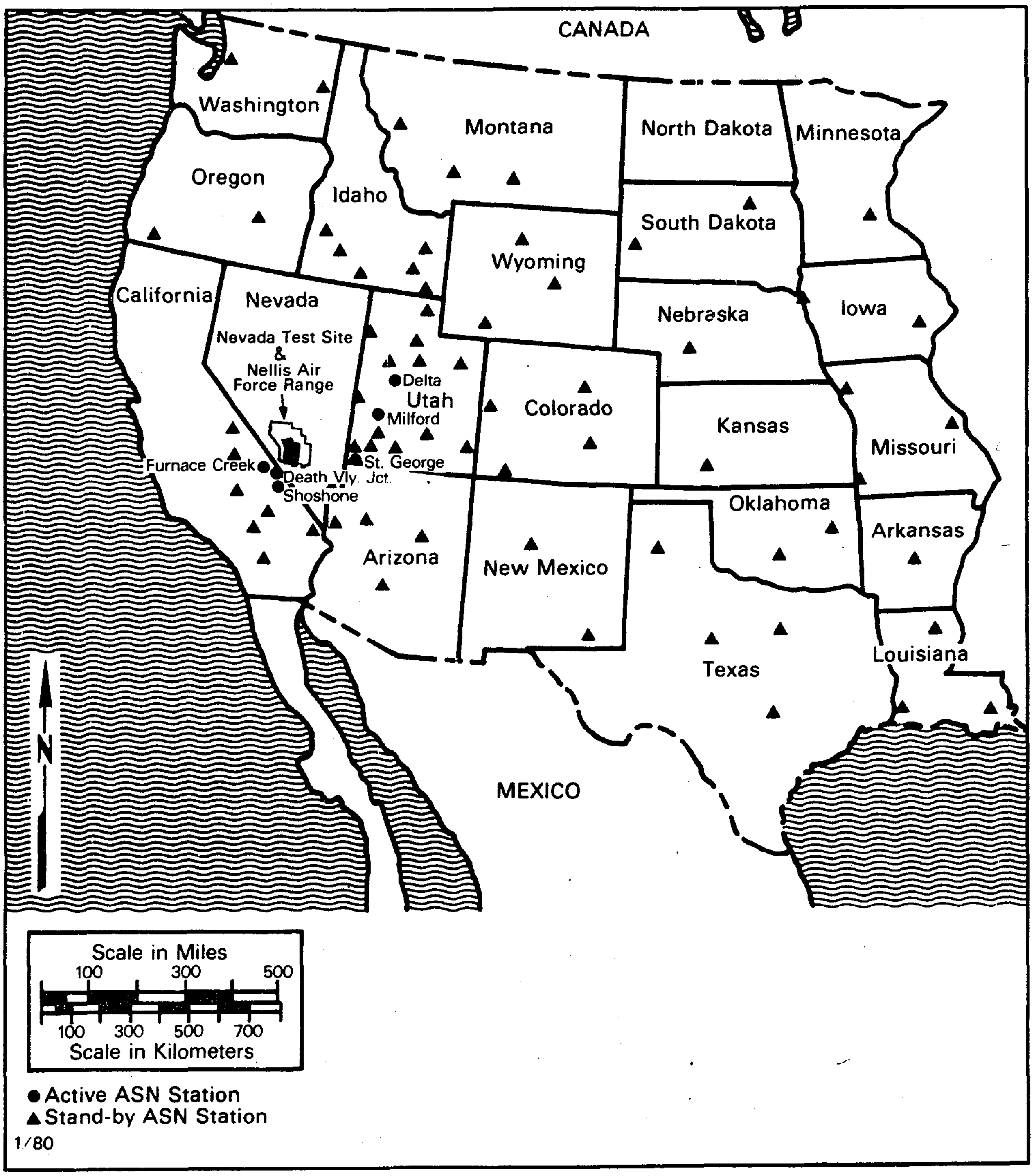

Figure 11. Air Surveillance Network stations in States other than Nevada.

department personnel or by local residents. All air filters and charcoal cartridges were mailed to the EMSL-LV for analysis. All 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. Gross beta analyses for samples from all stations were discontinued in 1979 in favor of high resolution gamma spectrometry, which resolves complex mixtures of gamma-emitting radionuclides and eliminates nonspecific background interferences. 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 0100 EST on December 14, 1978, 66 of the standby stations were activated with filters and charcoal cartridges from December 15, 1978, through January 5, 1979.

Noble Gas and Tritium Surveillance Network

The Noble Gas and Tritium Surveillance Network monitors the airborne levels of radiokrypton, radioxenon, and tritium. In May 1979, the sampling stations in Death Valley Junction and Las Vegas were removed from the Network, and new stations were added at Area 15 and Area 400 on the NTS and at Lathrop Wells in the offsite area to enhance the monitoring for effluents from experimental high-level waste study areas. Currently 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 for krypton-85 and radioxenon.

A molecular sieve column is used to collect tritiated 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. Tritiated water (HTO) absorbed on the molecular sieve column is recovered, and the concentration of tritium in water, expressed in μCi/ml of sampled air, is determined by liquid scintillation counting techniques. Analyses for tritium hydride and tritiated methane were discontinued in 1979.

Thermoluminescent Dosimetry Network

The Thermoluminescent Dosimetry Network comprises 78 stations at both inhabited and uninhabited locations within a 300-km radius of the CP-1. Each

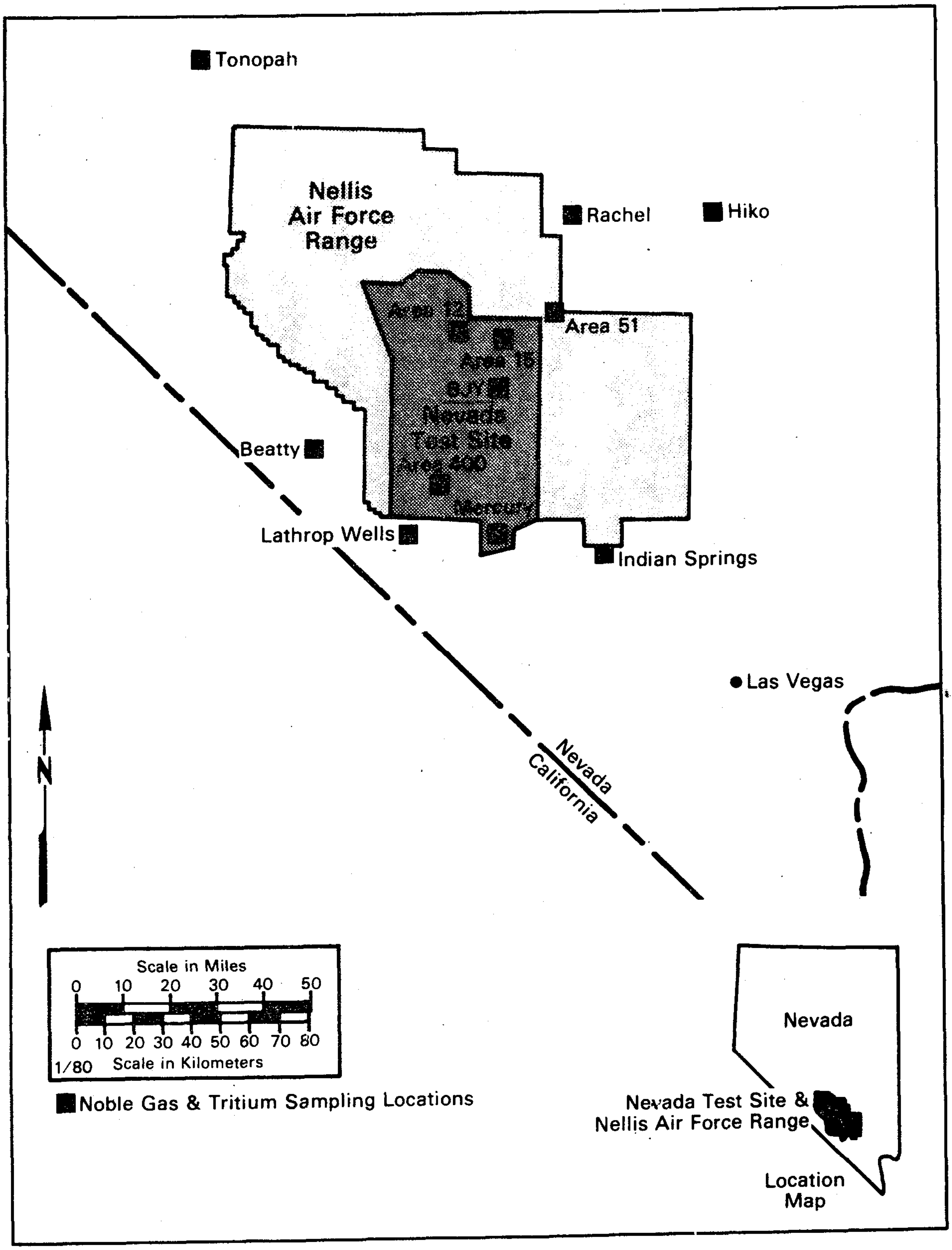

Figure 12. Noble Gas and Tritium Surveillance Network stations.

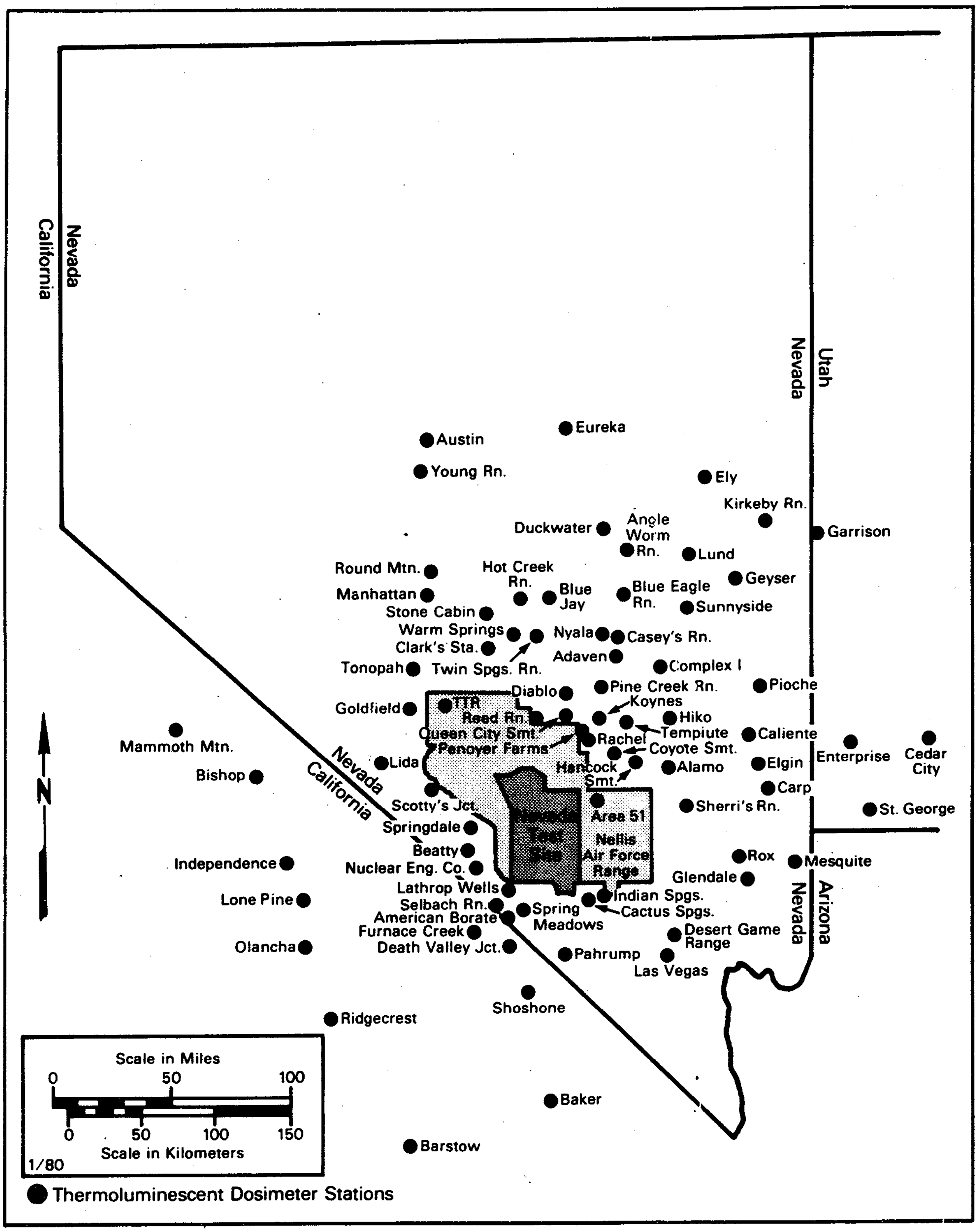

Figure 13. Thermoluminescent Dosimeter Network stations.

station is equipped with three Harshaw Model 2271-G2 (TLD200) thermoluminescent dosimeters (TLD's) to measure environmental background levels as well as accidental releases of gamma-emitting radioactivity (Figure 13). Within the area covered by the Network, each of 24 offsite residents wore a dosimeter during 1979. All TLD's were exchanged quarterly.

The only major change in the Network during 1979 was the removal of gamma rate recorders from Network stations beginning February 1, 1979. The dosimeters at Pine Creek Ranch station were not exchanged until the third quarter due to weather conditions and the erection of a padlocked fence. At the beginning of the third quarter, this station was moved outside the fence several hundred feet from its original location. Dosimeters stolen from several stations were replaced the following quarter.

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 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 confidence 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 observed in milk are tritium, strontium-89,90, 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 1979 to monitor concentrations of radionuclides in milk. The MSN consisted of 24 sampling sites (Figure 14) at which EMSL-LV personnel collected 4 liters of raw milk each quarter from family cows, commercial producers, and pasturization plants. In the event of a release of radioactivity from the NTS, extensive sampling would be conducted 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 suppliers and producers beyond 480 km are normally sampled by the SMSN; however, EMSL-LV monitors are prepared to collect samples as far out as necessary to assure adequate and timely coverage.

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 1979, there was no release of radioactivity 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-89,90. Six milk samples were also analyzed for tritium. Selected samples from the SMSN were analyzed for gamma emitters, strontium-89,90, 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 1979. 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 around the NTS. Eleven 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 at all: Well UE18r and Road D windmill.

Each sample was analyzed for gamma emitters and tritium. Gross alpha and beta radioactivity measurements were made on all samples collected prior to October 1, 1979, at which time these analyses were discontinued in favor of high resolution gamma spectrometry. For each sampled location, samples of raw water and filtered/acidified water were collected. 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

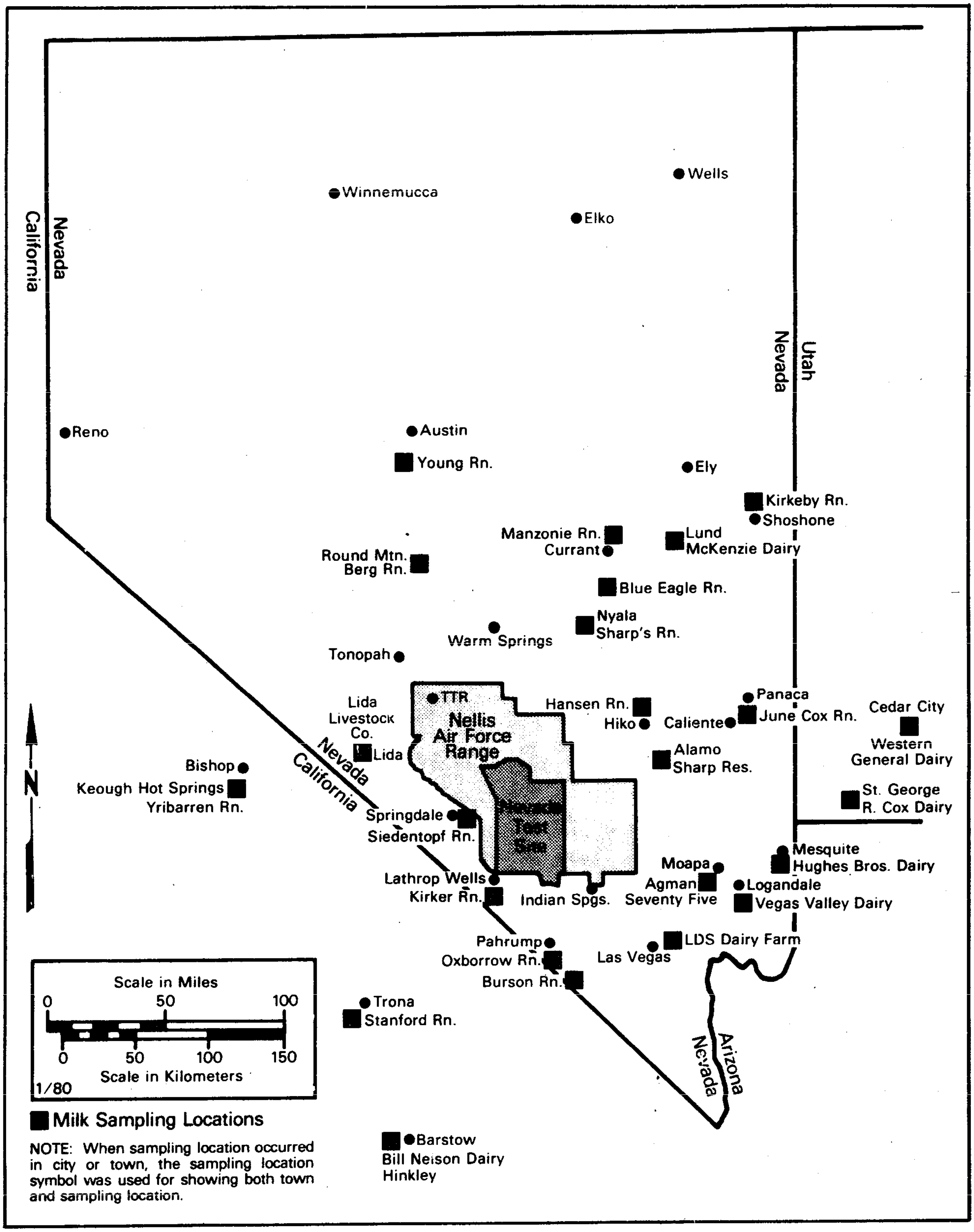

Figure 14. Milk Surveillance Network stations.

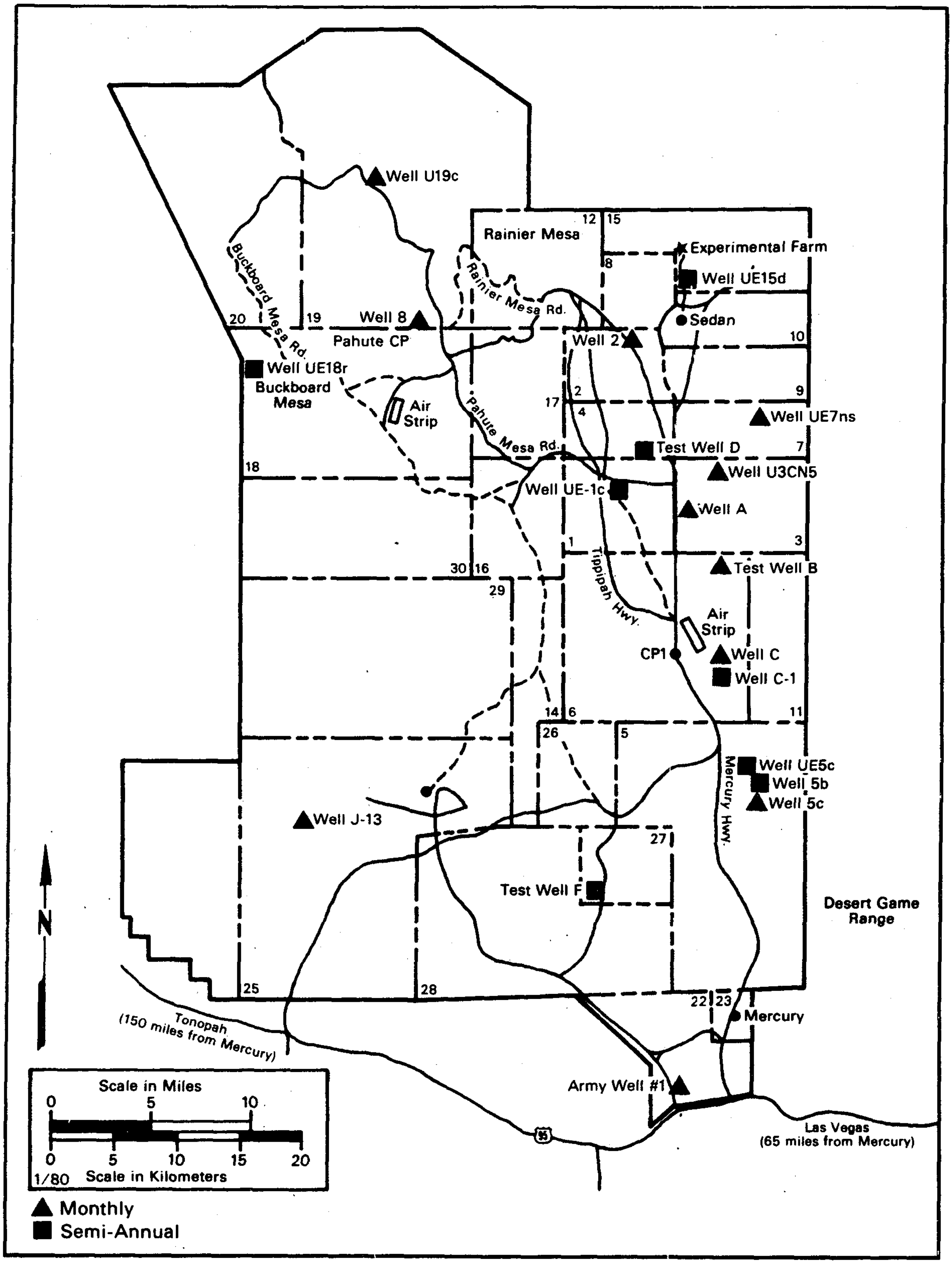

Figure 15. Onsite Long-Term Hydrological Monitoring Program sampling sites on the Nevada Test Site.

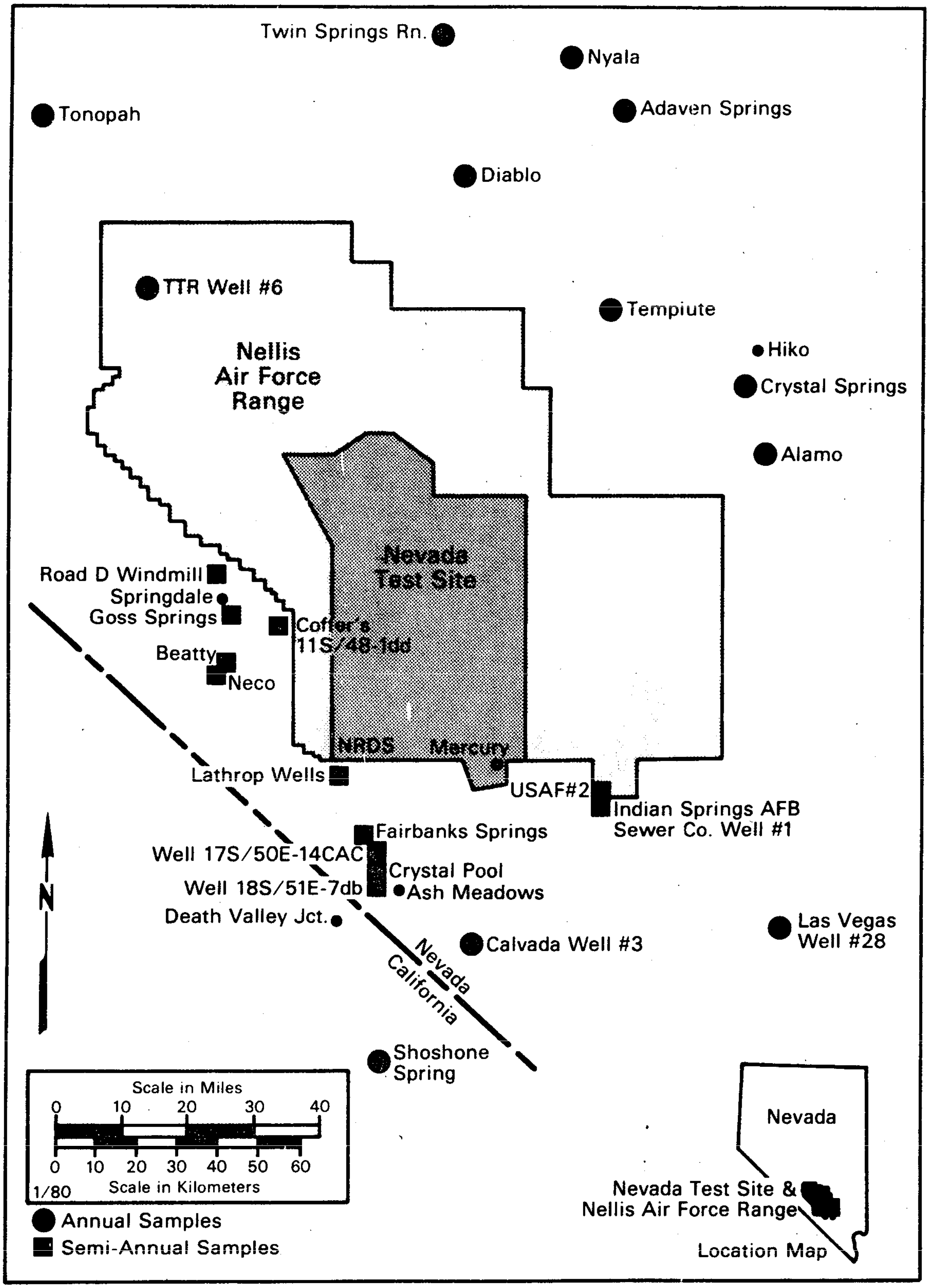

Figure 16. Offsite Long-Term Hydrological Monitoring Program sampling sites surrounding the Nevada Test Site.

techniques used. Suspended solids collected on each filter were also analyzed for gamma emitters.

Other Test Sites

Annual water samples were collected from all off-NTS sites of underground nuclear detonations except for the Project Faultless site near Warm Springs, Nevada, where sampling will be resumed in 1980. These sites included 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, and Table 3 (p. 17-18) lists additional information on the location of each site and tests performed at these locations.

Because tritium was observed to exceed background levels in water samples taken from the Half Moon Creek overflow, twelve wells were drilled in April 1978 to monitor these tritium concentrations quarterly (DOE 1978). Quarterly collection of water samples from these wells continued until March 1979 when a new drilling program (DOE 1979) was planned by the DOE/NV. The EMSL-LV was assigned responsibility for radiological safety, field analysis for tritium, providing contract monitoring, quality assurance services, and laboratory analyses for the program between July 18, 1979 and September 5, 1979 by the DOE/NV.

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 1979.

Animals sampled were deer, eagles, rabbits, chuckars, a horse, a coyote, a bobcat, desert bighorn sheep, and cattle. Some of these animals were found dead as road kills or from natural causes; others were collected and sacrificed for sampling. Figure 30 shows where the animals were collected.

Animals were necropsied whenever possible. Samples of the 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, tracheobrochial lymph node, muscle, thyroid, blood, kidney, fetus, and bone samples from the 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, included 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-89,90 and plutonium-238,239.

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 through tracking individual deer outfitted with collars containing miniature radio transmitters was begun in 1975 and continued through 1979.

During the summer and fall of 1979, 11 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 11 newly installed transmitters brought to 25 the total number of working transmitters in the field (14 from previous years). Laboratory personnel monitored the movements of the deer weekly with hand-held receivers and directional antenna. Thirteen other deer were captured but were unsuitable for collaring and were released after visible markers had been attached.

Offsite Human Surveillannce Program

During 1979, the Offsite Human Surveillance Program continued to determine levels of radionuclides in families residing around the NTS. Whole-body counts and physical examinations are performed semiannually to determine levels of radioactivity in the body and to document any physical changes that might be attributed to the effects of chronic exposure to radiation.

Currently, 56 individuals from 19 families participate in the program. The geographical locations of the participating families are shown in Figure 31. These families travel to the EMSL-LV, where a whole-body count of each person is performed to determine the body burden of gamma-emitting radionuclides. A short medical history, complete blood count, urinalysis and a thyroid profile are obtained for each individual, and each receives a physical examination.

The results of each whole-body count are provided to the families immediately after counting is completed. Results from the blood analyses, urinalysis and physical examinations are sent to the families at a later date.

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.

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. The most recent such determination was performed in October 1979.

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 Fourth International Intercomparison of Environmental Dosimeters in January 1979 (Table 4).

TABLE 4. SUMMARY RESULTS OF THE FOURTH INTERNATIONAL INTERCOMPARISON OF ENVIRONMENTAL DOSIMETERS

Quantity	Mean	Standard Deviation	Remarks
Summary of "low" laboratory results (mR):			
EMSL-LV dosimeters	11.1	0.8	EMSL-LV results 8% lower than the mean for all participants and 9% lower than the calculated exposure.
All dosimeters (121)	12.0	3.8	
Calculated exposure	12.2	1.2	
Summary of "high" laboratory results (mR):			
EMSL-LV dosimeters	43.1	3.2	EMSL-LV results 2% lower than the mean for all participants and 6% lower than the calculated exposure.
All dosimeters (122)	43.9	6.6	
Calculated exposure	45.8	4.6	
Summary of field results (mR):			
EMSL-LV dosimeters	14.3	1.1	EMSL-LV results 11% lower than the mean for all participants and 1% higher than the measured exposure.
All dosimeters (120)	16.0	4.5	
Measured exposure	14.1	0.7	

A study to determine the response of the TLD's over a range of energies performed in 1974 was repeated in 1979. TLD's exposed by the NBS were read out at the EMSL-LV in the usual manner. The results for this intercomparison, shown in Figure 32, indicate little or no change in energy dependence from one year to the other. All TLD measurements are 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 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 (from the six chips) 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 1979). 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 1979 are summarized in the (Appendix Table A-4).

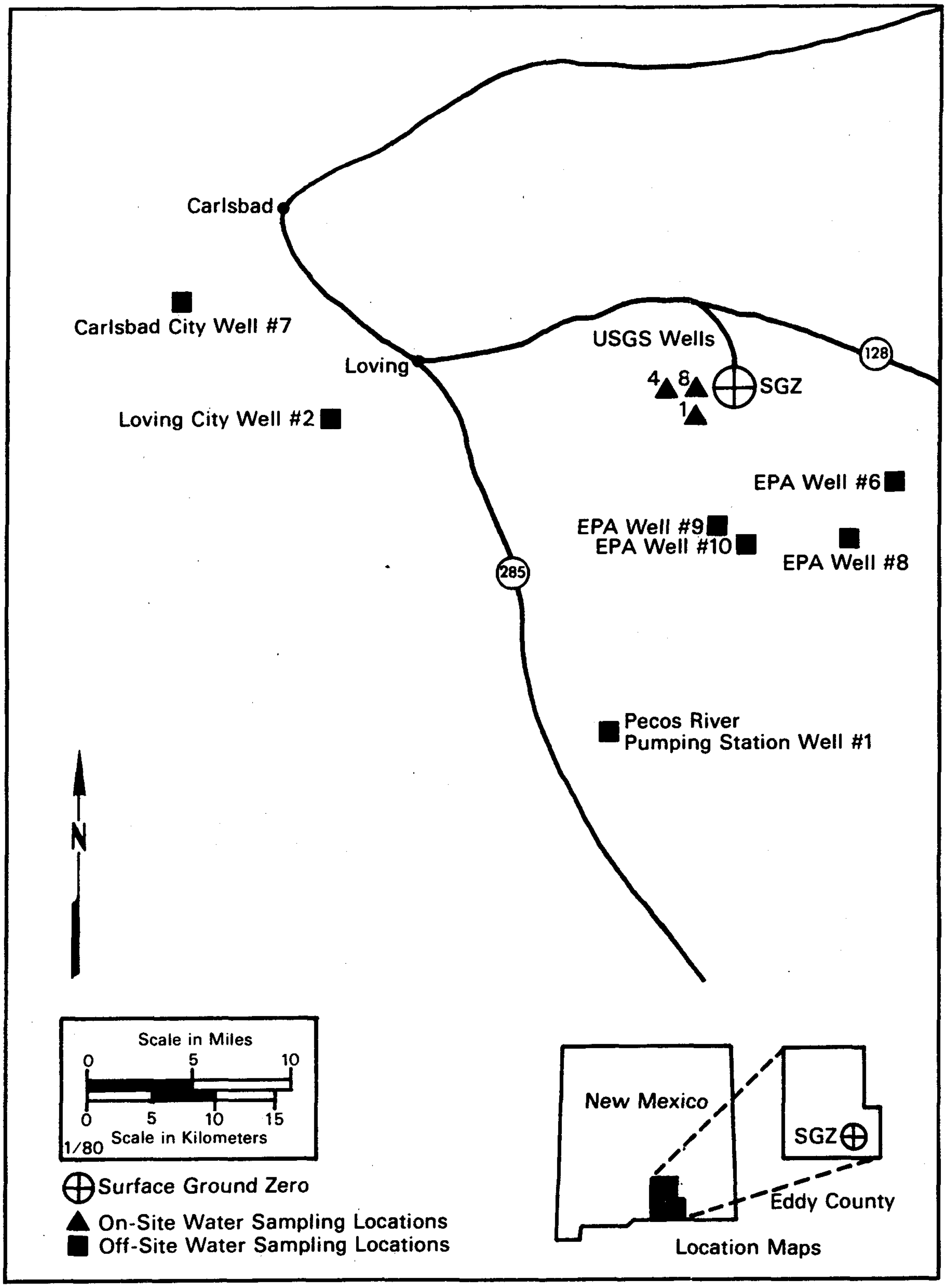

Figure 17. Long-Term Hydrological Monitoring Program sampling sites for Projects Gnome and Coach, Carlsbad, New Mexico.

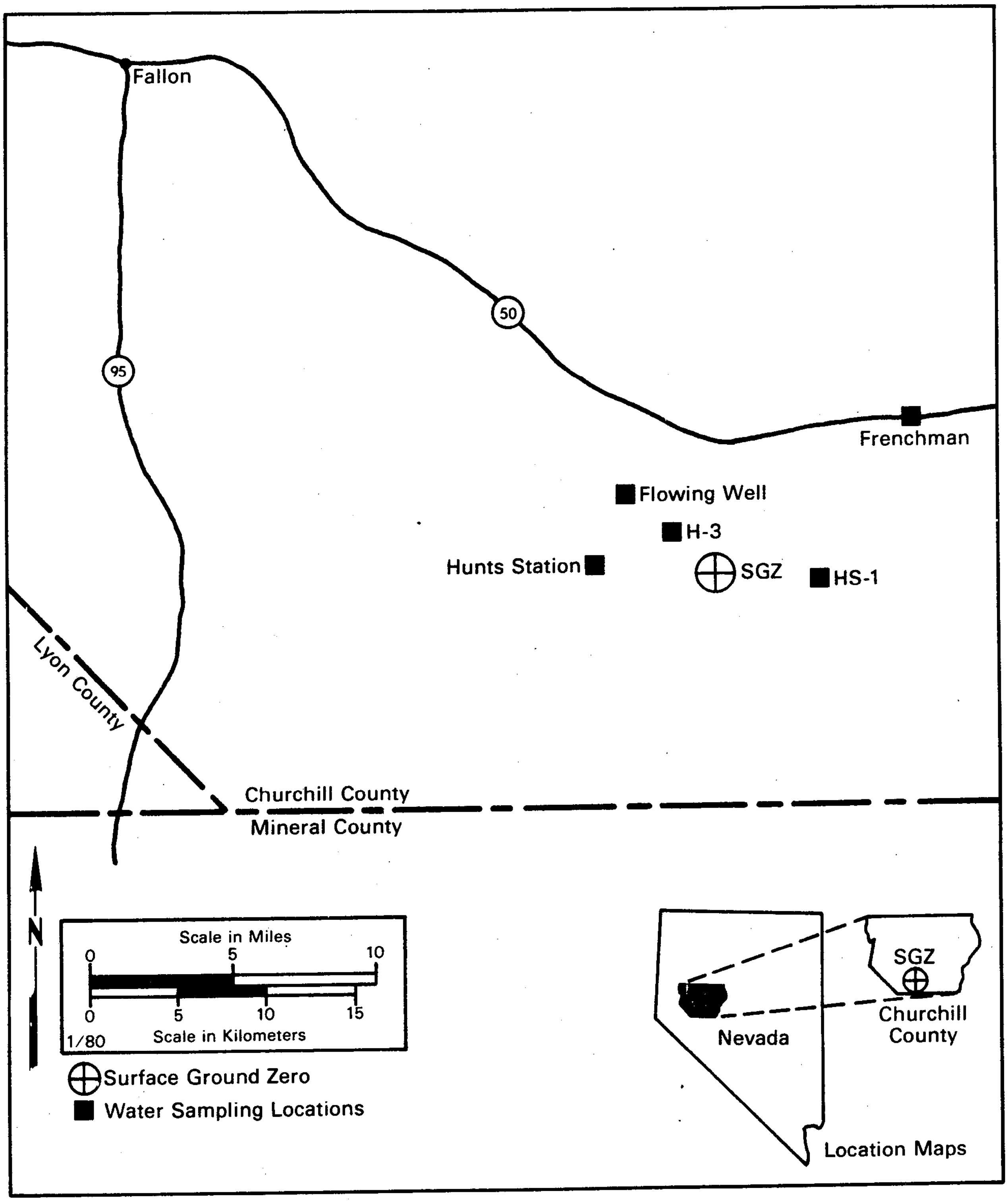

Figure 18. Long-Term Hydrological Monitoring Program sampling sites for Project Shoal, Fallon, Nevada.

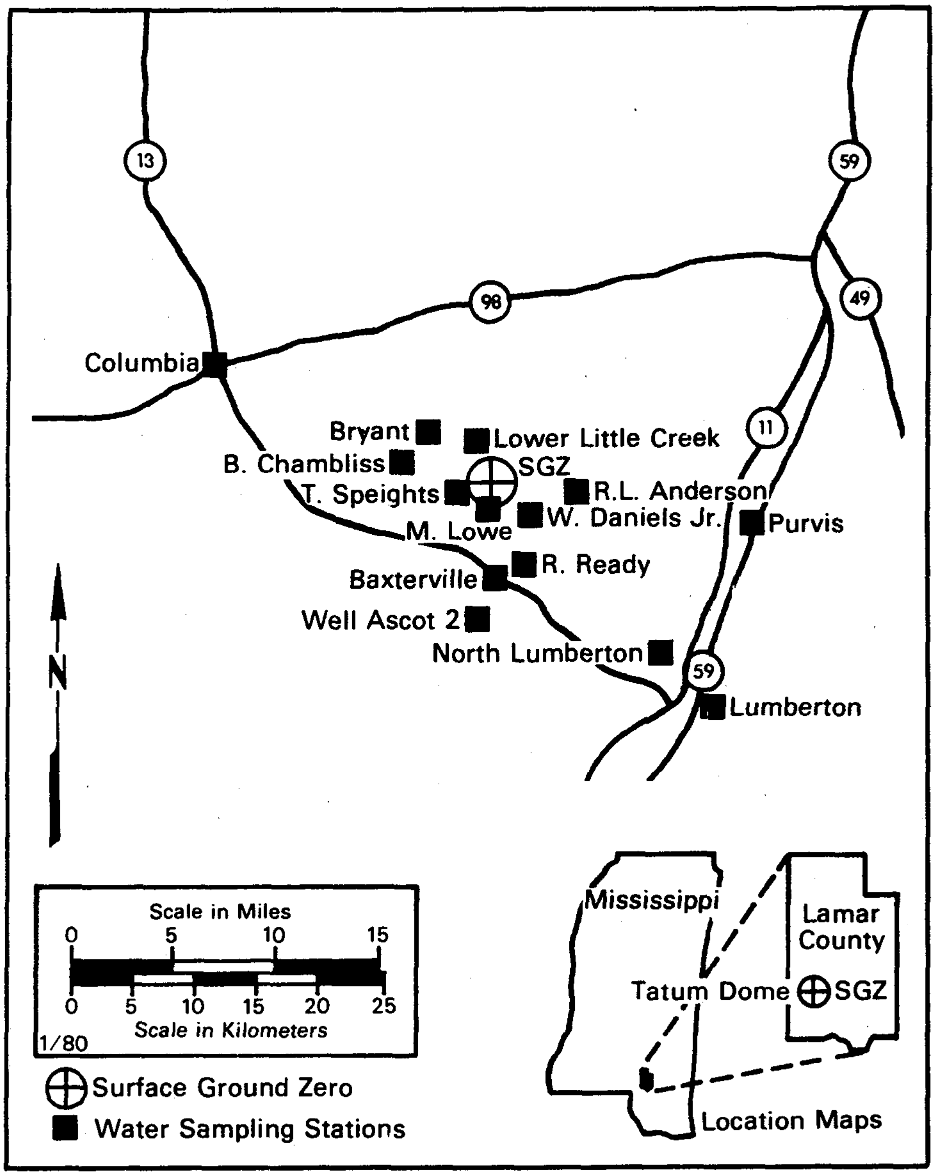

Figure 19. Long-Term Hydrological Monitoring Program sampling sites for Projects Dribble and Miracle Play, vicinity of Tatum Salt Dome, Mississippi.

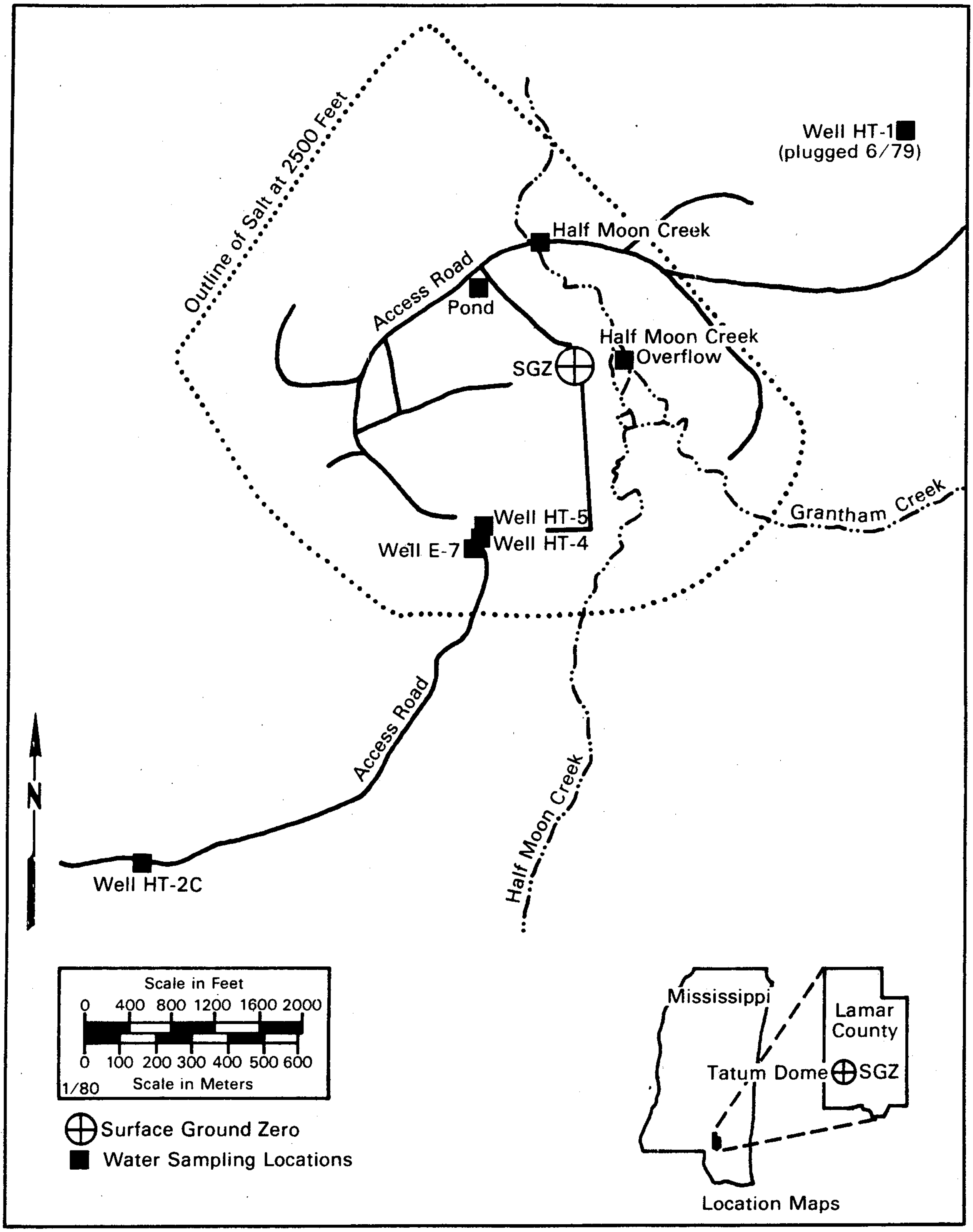

Figure 20. Long-Term Hydrological Monitoring Program sampling sites for Projects Dribble and Miracle Play, Tatum Salt Dome, Mississippi.

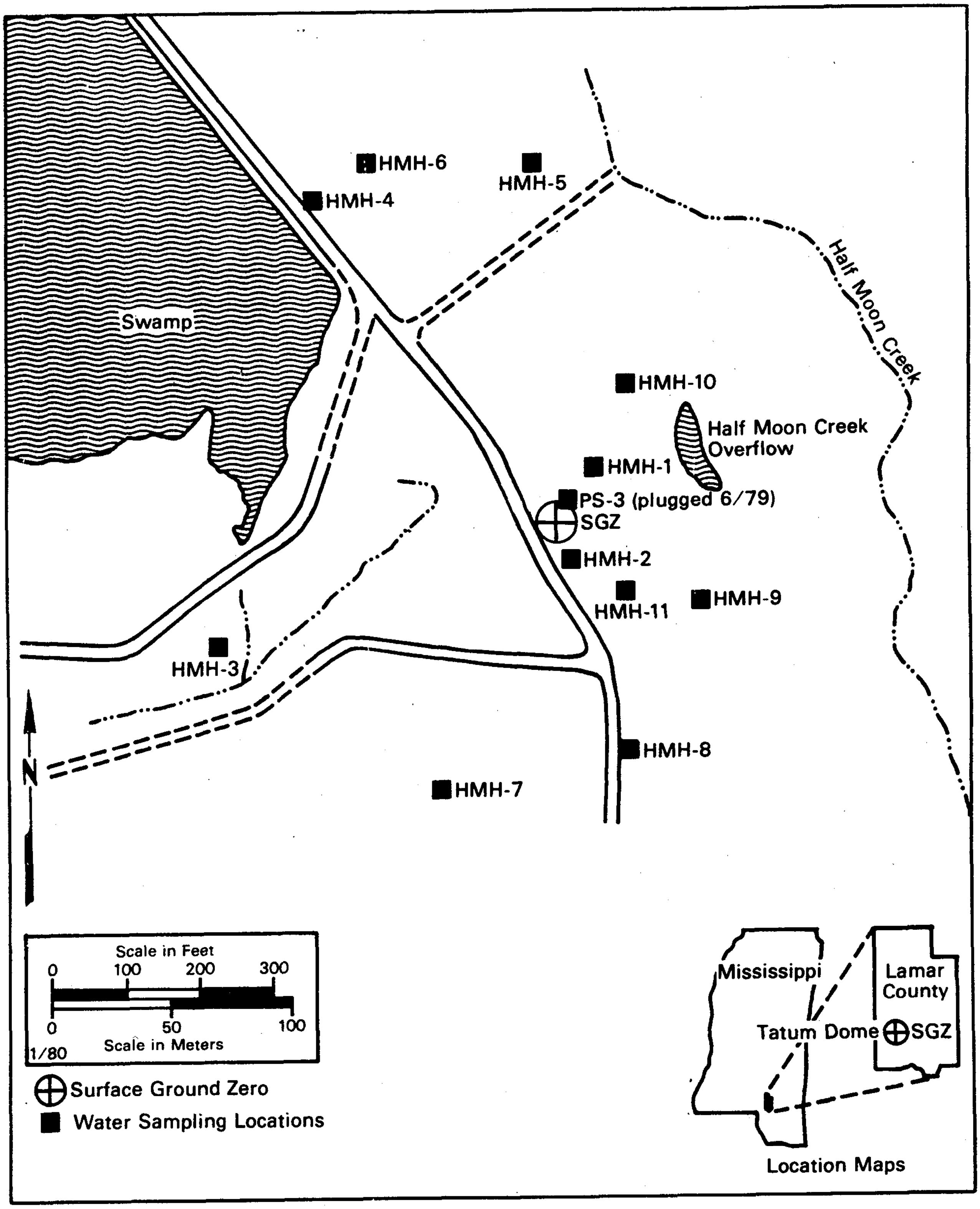

Figure 21. Long-Term Hydrological Monitoring Program sampling sites for Projects Dribble and Miracle Play, Tatum Dome, Mississippi.

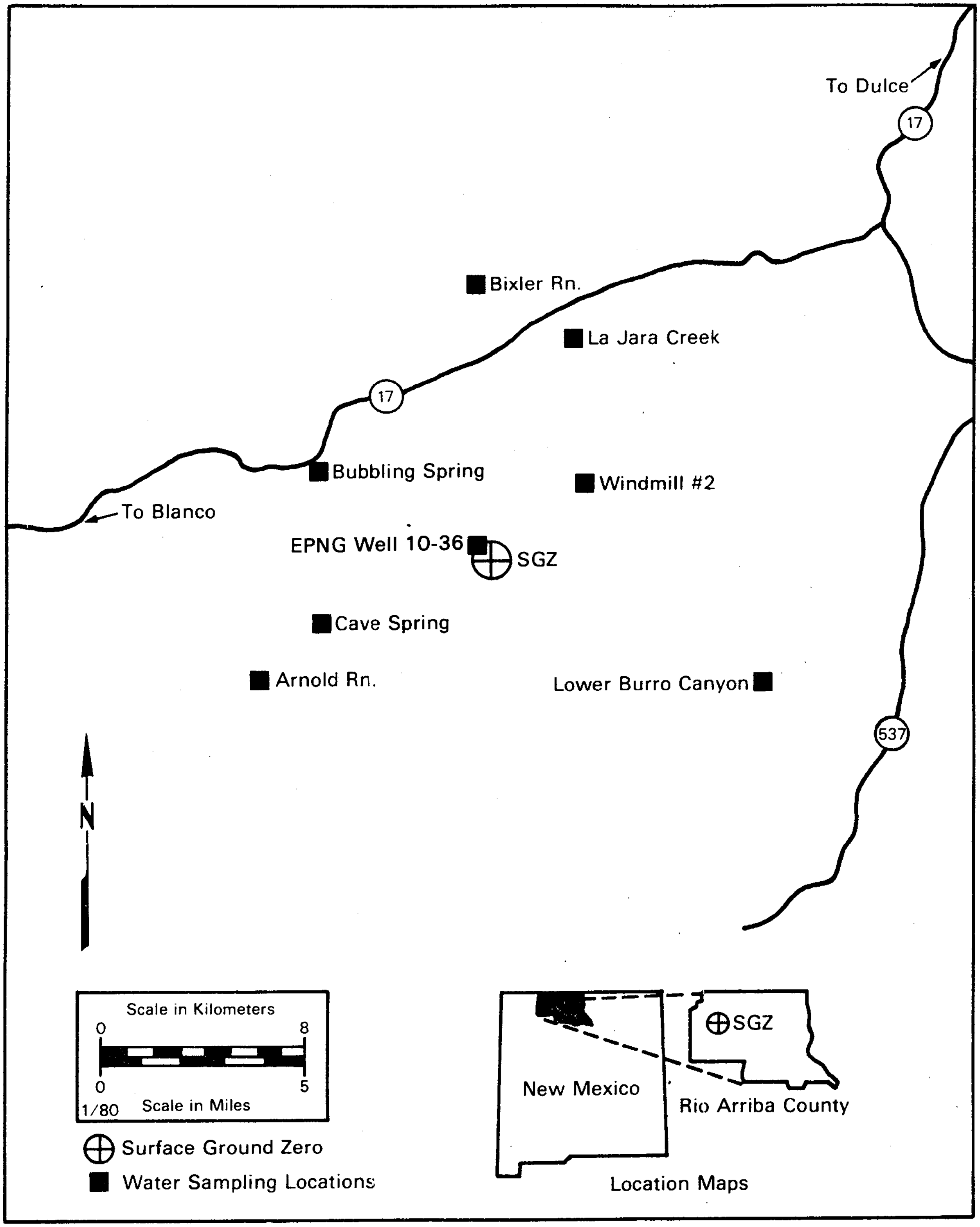

Figure 22. Long-Term Hydrological Monitoring Program sampling sites for Project Gasbuggy, Rio Arriba County, New Mexico.

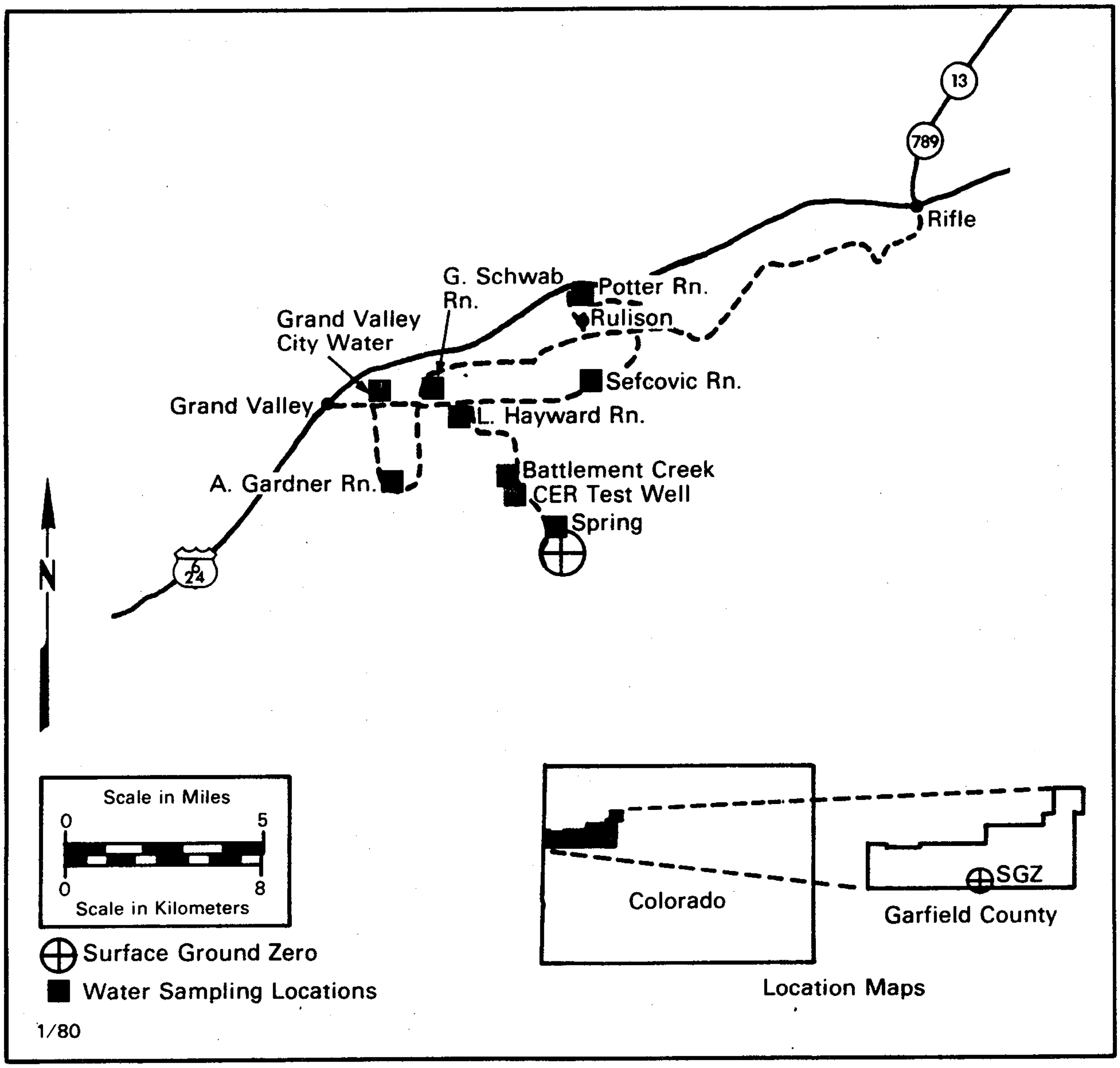

Figure 23. Long-Term Hydrological Monitoring Program sampling sites for Project Rulison, Rulison, Colorado.

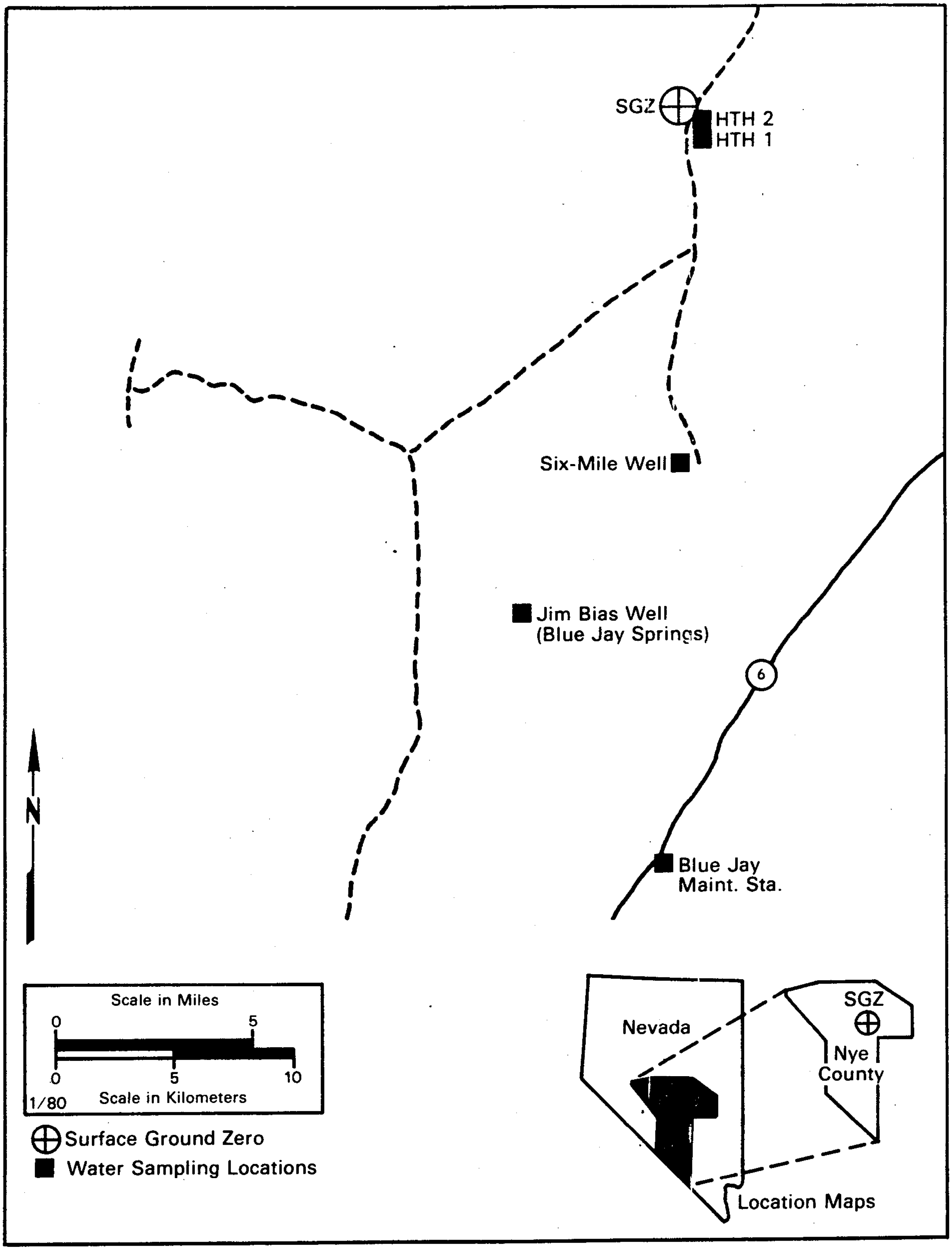

Figure 24. Long-Term Hydrological Monitoring Program sampling sites for Faultless Event, Central Nevada Test Area. (No samples were collected during 1979; collection will resume in 1980.)

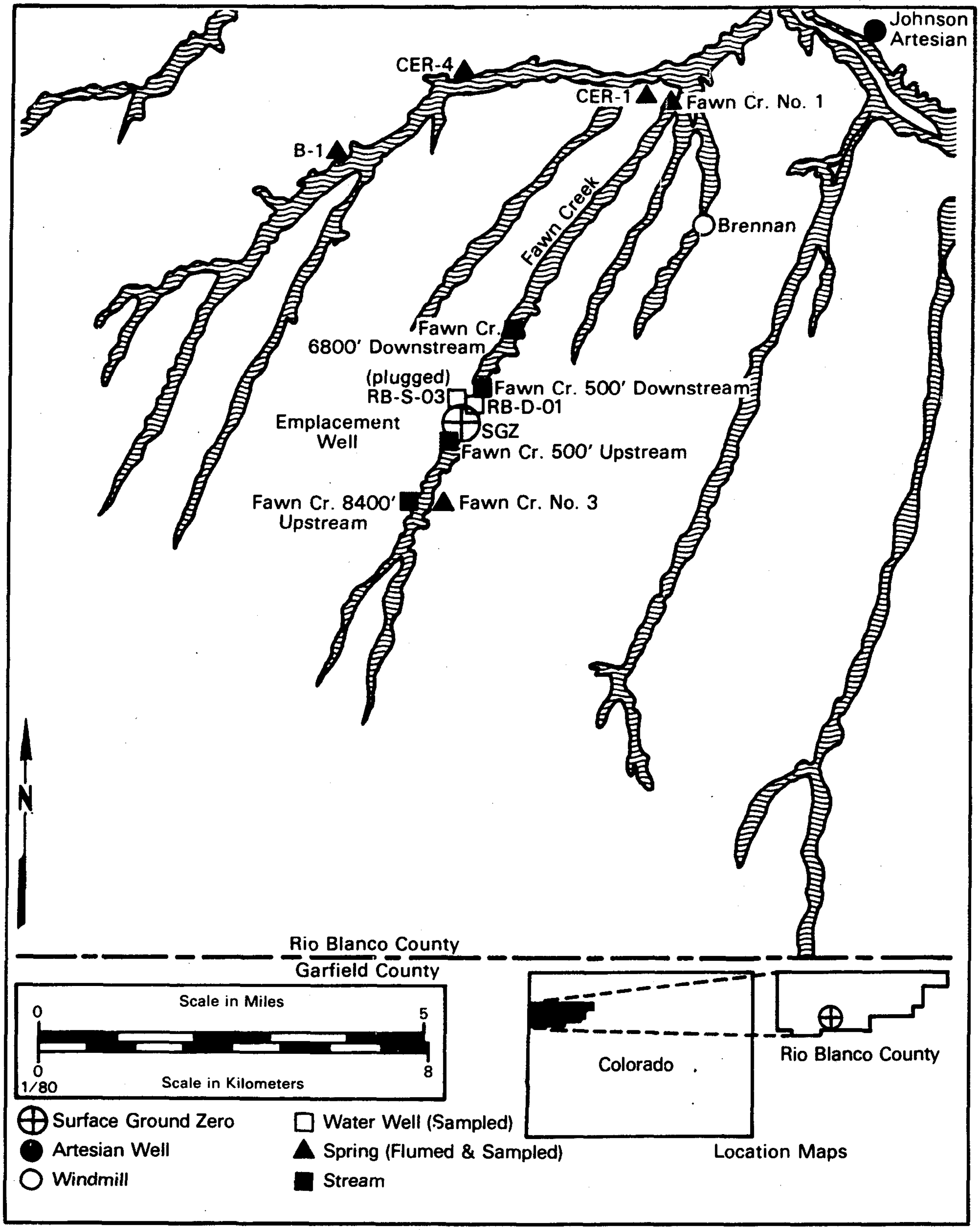

Figure 25. Long-Term Hydrological Monitoring Program sampling sites for Project Rio Blanco, Rio Blanco County, Colorado.

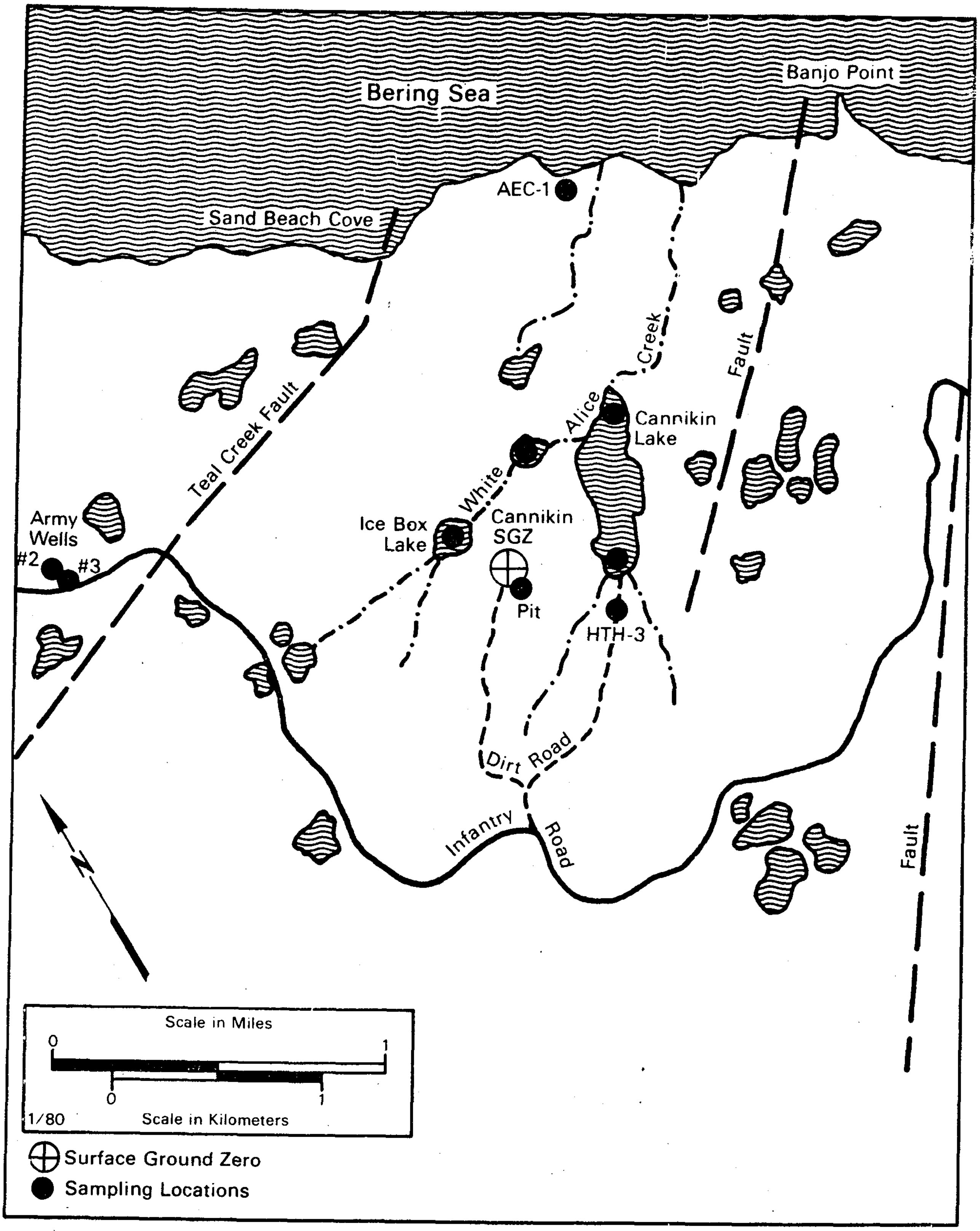

Figure 26. Long-Term Hydrological Monitoring Program sampling sites for Project Cannikin, Amchitka Island, Alaska.

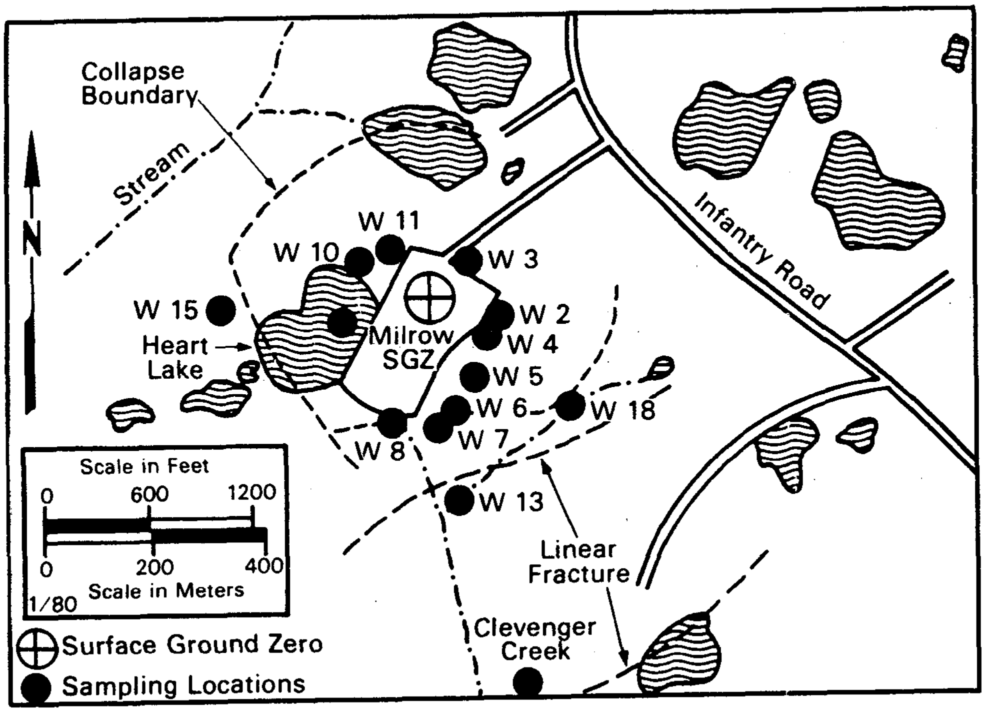

Figure 27. Long-Term Hydrological Monitoring Program sampling sites for Project Milrow, Amchitka Island, Alaska.

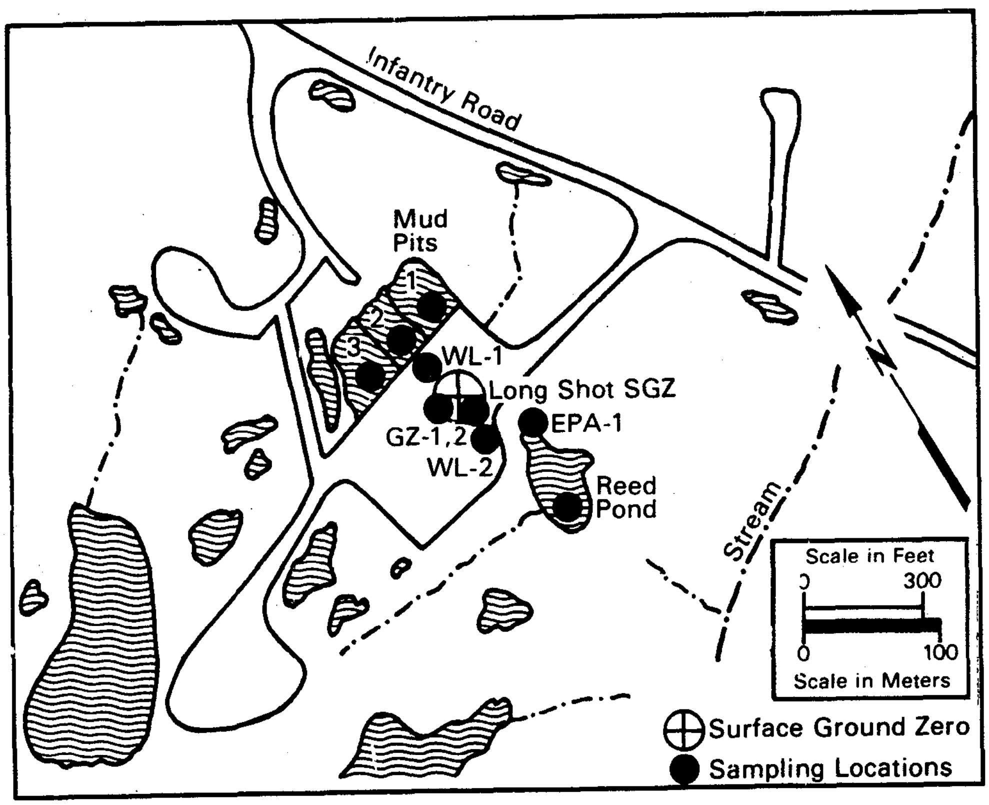

Figure 28. Long-Term Hydrological Monitoring Program sampling sites for Project Longshot, Amchitka Island, Alaska.

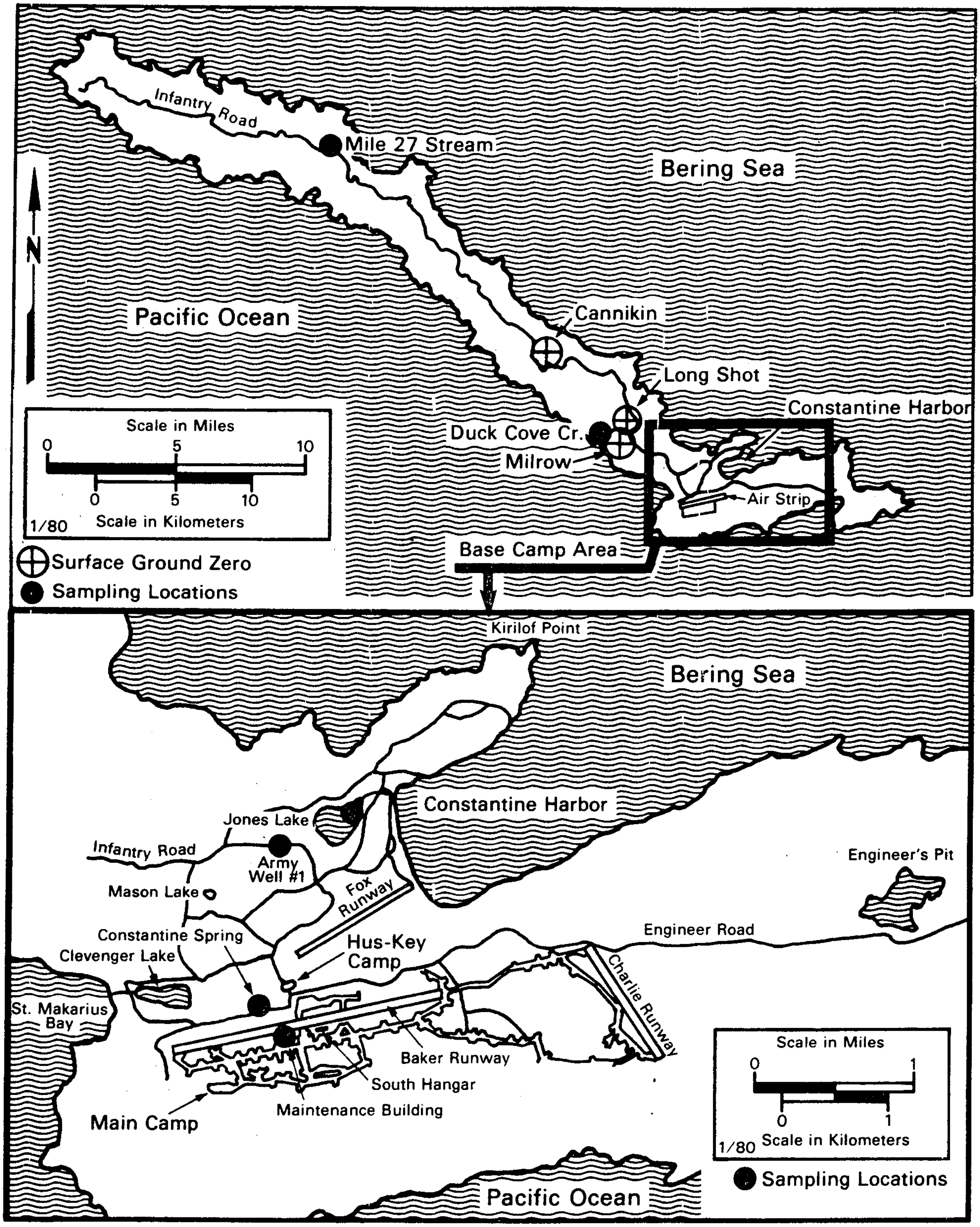

Figure 29. Background sampling sites for the Long-Term Hydrological Monitoring Program on Amchitka Island, Alaska. (Base camp area is shown in larger scale in the lower portion of the figure.)

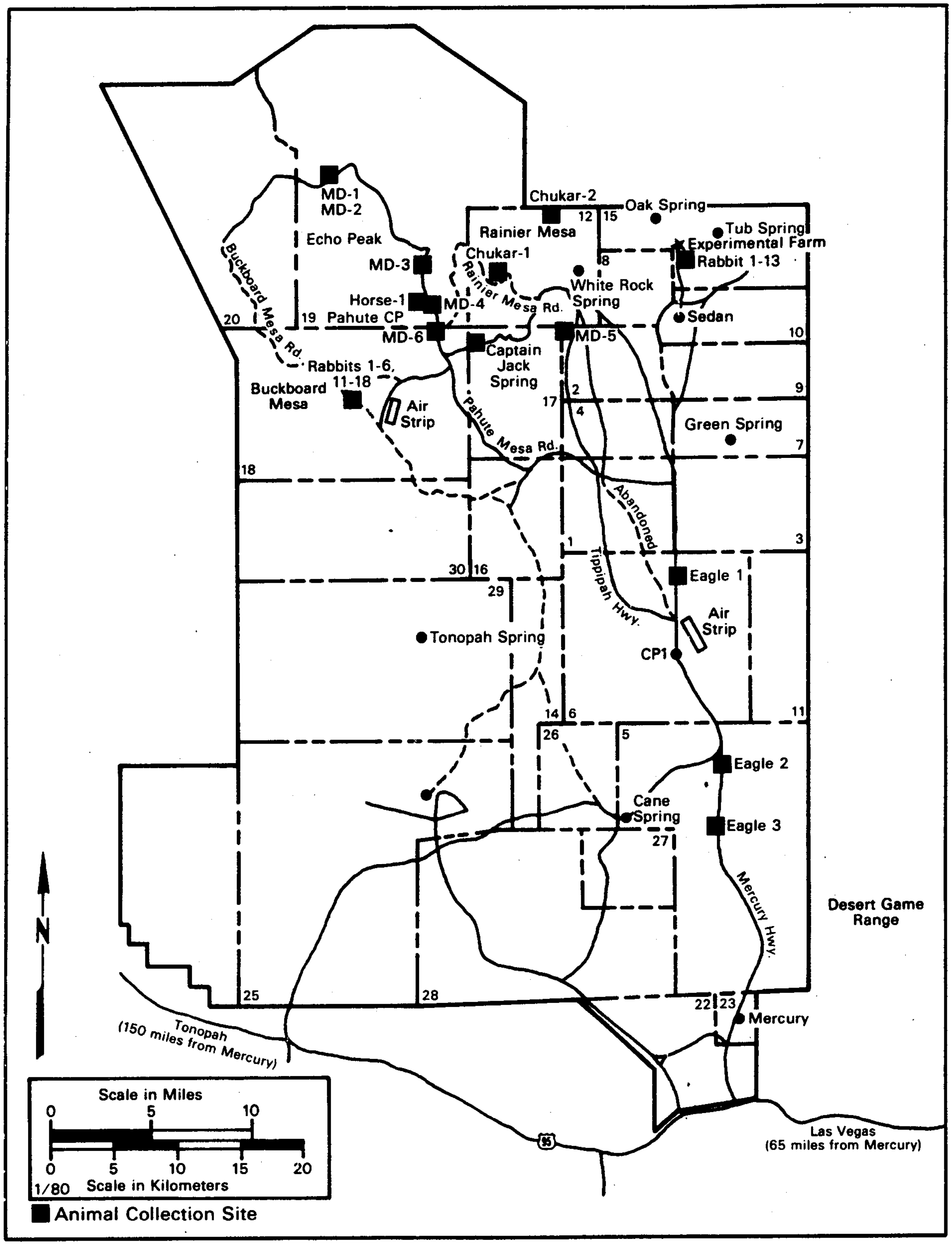

Figure 30. Wildlife collection sites on the Nevada Test Site.

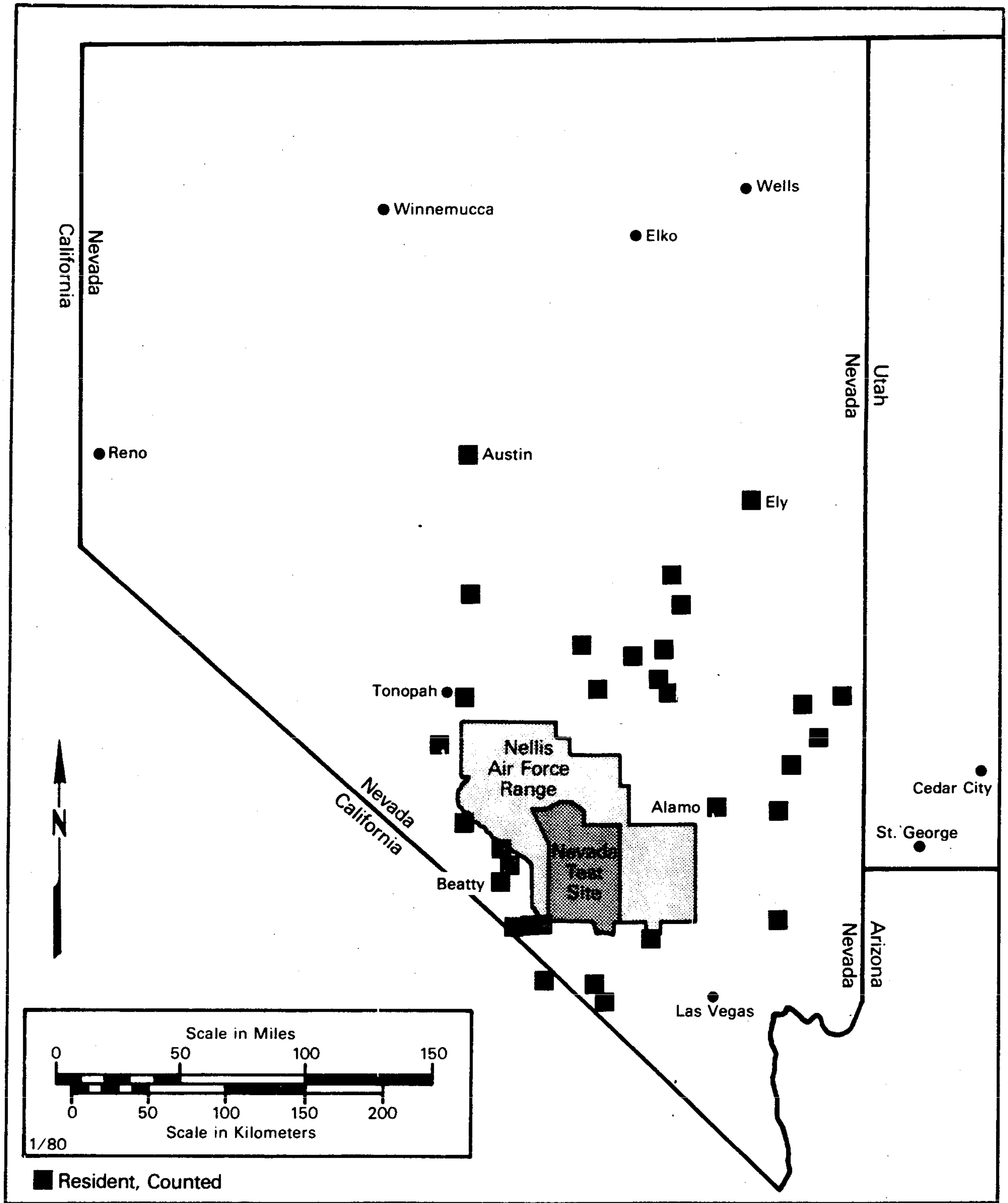

Figure 31. Location of residents participating in the Offsite Human Surveillance Program.

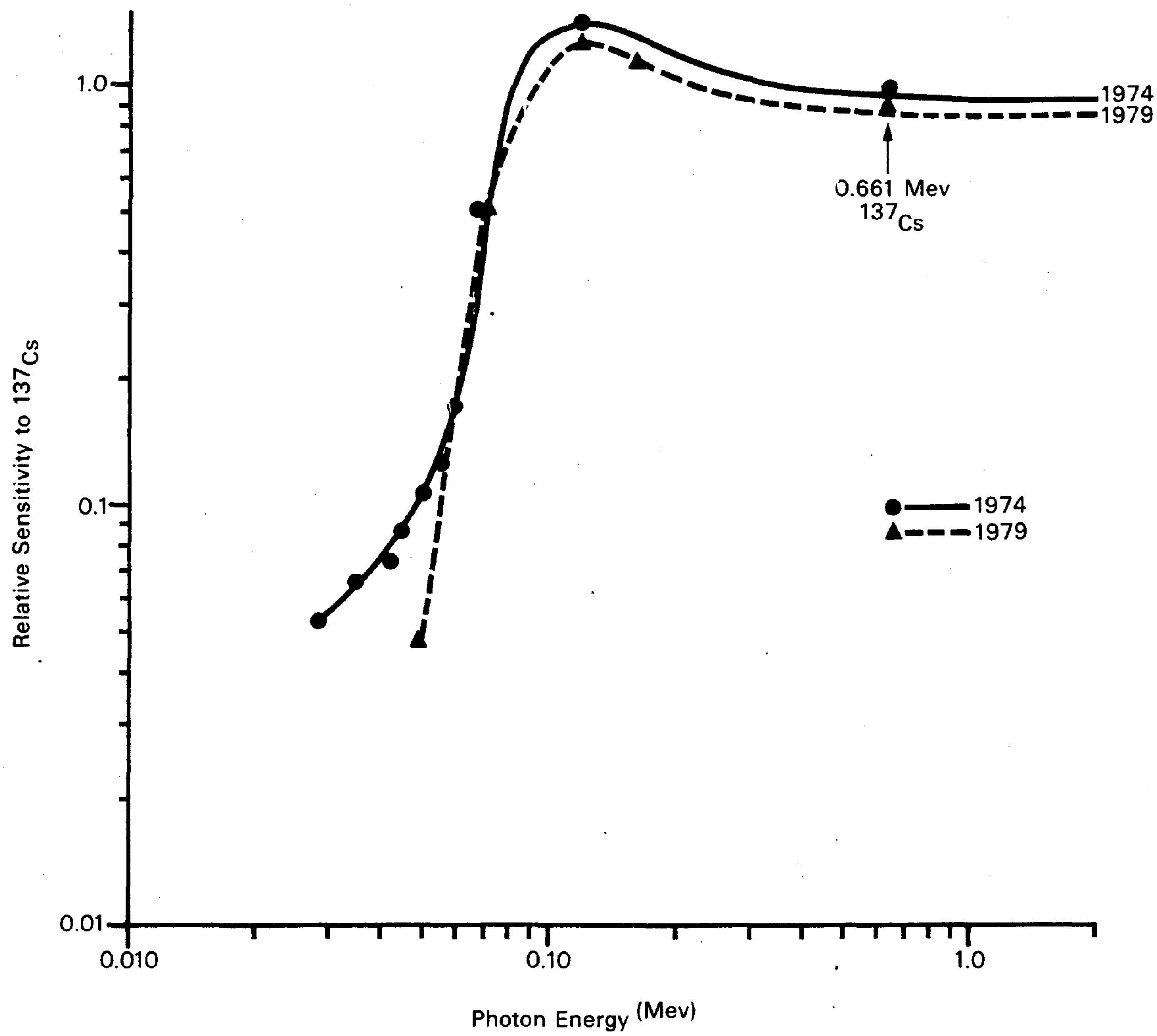

Figure 32. Energy response of thermoluminescent dosimeters.

RESULTS AND DISCUSSION

No test-related radioactivity from the nuclear testing programs conducted at the NTS during 1979 was measured offsite in air, milk, or water. 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. The concentrations of tritium in these samples were no greater than 10 percent of the Concentration Guide. These waters are not used for human consumption and would not constitute a health hazard. Results from the offsite Radiological Safety Program are discussed below and specific data are presented in the Appendix tables.

AIR SURVEILLANCE NETWORK

During 1979, no airborne radioactivity related to the underground testing program at the NTS was detected on any sample from the Network. However, naturally occurring beryllium-7 and the fission products zirconium-95, cesium-137, barium-140, and cerium-144 from past 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.

Appendix Table B-3 shows the average concentration of plutonium-239 in airborne particulates collected at selected stations of the Air Surveillance Network. The particulate samples were collected on filters and composited quarterly prior to analysis. The four Nevada stations represent air samples collected near the NTS (Figure 10), while the other three stations represent remote locations (Figure 11).

All observed concentrations of plutonium-239 were attributed to worldwide fallout. The plutonium concentrations shown for 1978 and 1979 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 observed at Rachel, Nevada, (1.1×10^{-16} μCi/ml) during the second quarter of 1979 and one high value observed at Diablo, Nevada, (1.0×10^{-16} μCi/ml) during the fourth quarter of 1978. However, both of these values are less than 0.04 percent of the Concentration Guide (Appendix C) for exposure to the general public and are within a factor of two of the highest concentrations observed by Toonkel in the United States. Differences of a factor of two have been observed for air samples in the Duplicate Sampling Program (Appendix Table A-3).

NOBLE GAS AND TRITIUM SURVEILLANCE NETWORK

Maximum concentrations of krypton-85 for the stations in the Noble Gas and Tritium Surveillance Network ranged from 1.1×10^{-11} µCi/ml to 3.3×10^{-11} µCi/ml (Appendix Table B-3). As shown in Figure 33, the maximum concentrations for the Network stations combined follow a lognormal distribution with a geometric mean of 1.88×10^{-11} µCi/ml and a geometric deviation of 1.16. As the expected geometric standard deviation of the krypton-85 measurements attributed to sampling, analytical, and counting errors was determined to be 1.1 from the duplicate sampling program (Appendix A), the variation in the krypton-85 concentrations throughout the Network appears to be caused primarily by the measurement errors.

The annual average concentrations at each station were calculated over the time period sampled using all values, including those less than the MDC. All concentrations of krypton-85, xenon-133, and tritium listed in Appendix Table B-3 are expressed in µCi/ml of air. Since the tritium concentration in air varies by factors of 15 to 20 while the concentrations in µCi/ml of atmospheric moisture vary by factors of up to about 7, the tritium concentration in µCi per ml of atmospheric moisture is also given in Appendix Table B-3 as a more reliable indicator.

The average concentration of krypton-85 for the year at all stations was the same (1.9×10^{-11} µCi/ml), except for the concentration at BJY (2.2×10^{-11} µCi/ml), which was significantly different from the Network average at the 95 percent confidence 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 5 and Figure 34, the average concentration 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.

Xenon-133 was detected only on the NTS. If the highest concentration measured had persisted throughout the year, the occupational exposure would have been less than 0.01 percent of the CG (Appendix C).

As in the past, tritium as HTO in atmospheric moisture samples was generally at background concentrations; i.e., below the MDC of approximately 3×10^{-7} µCi/ml at all off-NTS stations and at the on-NTS stations at Mercury, Area 400, and Area 51. Occasional increased concentrations were observed at Area 400 and Area 51. The on-NTS stations at Area 15, BJY, and Area 12 had concentrations consistently above background; the concentration averages for these stations were factors of 5 to 65 times the average for all off-NTS stations.

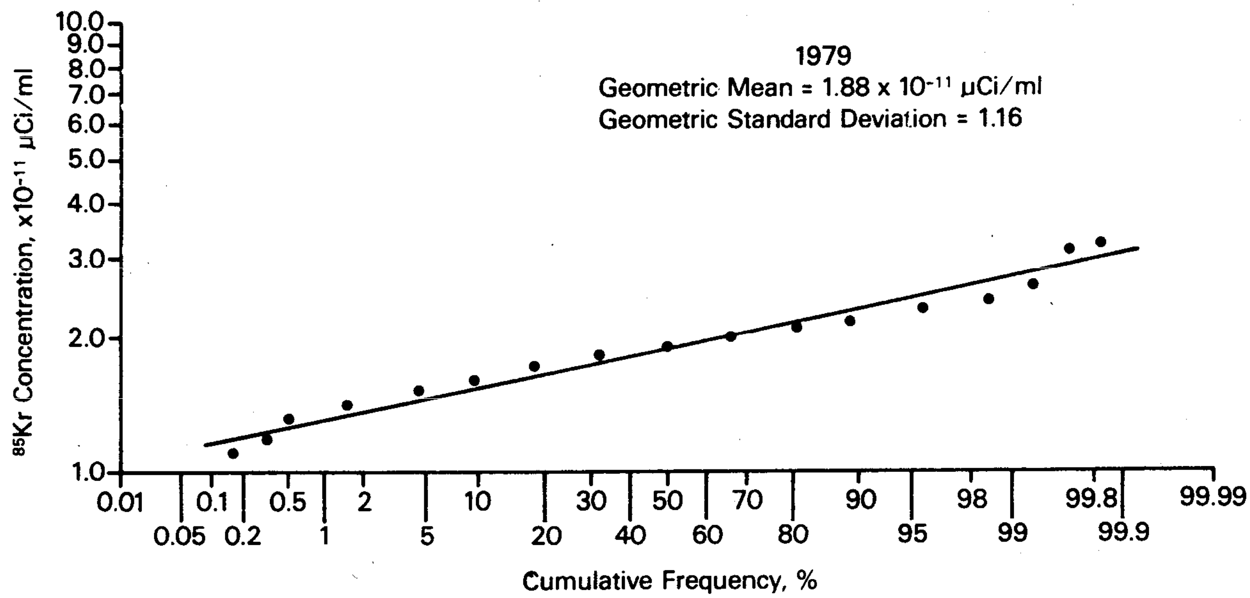

Figure 33. Distribution of Network concentrations of krypton-85.

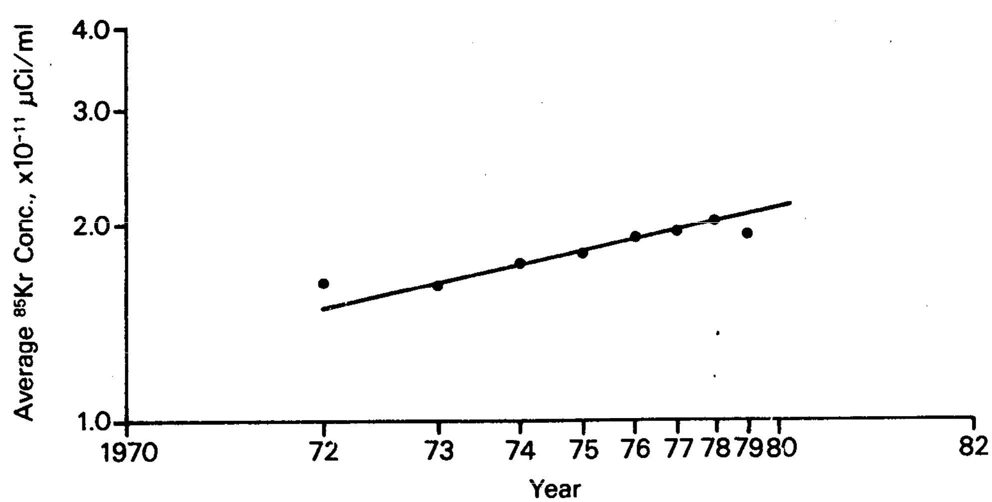

Figure 34. Trend in annual concentrations of krypton-85.

TABLE 5. ANNUAL AVERAGE KRYPTON-85 CONCENTRATIONS IN AIR, 1972-1979

Sampling Locations	^{85}Kr Concentrations ($x10^{-11}$ µCi/ml)							
	1972	1973	1974	1975	1976	1977	1978	1979
Beatty, Nev.	1.6	1.6	1.7	1.9	2.0	2.0	2.0	1.9
Diablo & Rachel, Nev.‡	1.6	1.6	1.7	1.8	1.9	1.9	2.0	1.9
Hiko, Nev.	1.6	1.6	1.7	1.7	1.7	1.9	2.0	1.9
Indian Springs, Nev.	-	-	-	2.0	2.0	2.0	2.0	1.9
NTS, Mercury, Nev.	1.6	1.6	1.8	1.8	1.9	2.0	1.0	1.9
NTS, Area 51, Nev.	1.6	1.6	1.7	1.8	2.0	1.9	2.0	1.9
NTS, BJY, Nev.	1.7	1.8	1.9	1.9	2.0	2.1	2.2	2.2
NTS, Area 12, Nev.	1.6	1.6	1.8	1.8	2.0	1.9	2.0	1.9
Tonopah, Nev.	1.6	1.6	1.8	1.7	1.9	1.9	2.0	1.8
Las Vegas, Nev.*	1.6	1.6	1.7	1.8	1.8	2.0	2.0	-
Death Valley, Calif.*	1.6	1.5	1.8	1.7	2.0	2.0	2.0	1.9
NTS, Area 15, Nev.†	-	-	-	-	-	-	-	1.9
NTS, Area 400, Nev.†	-	-	-	-	-	-	-	1.8
Lathrop Wells, Nev.†	-	-	-	-	-	-	-	1.9
Network Average	1.6	1.6	1.8	1.8	1.9	2.0	2.0	1.9

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

THERMOLUMINESCENT DOSIMETRY NETWORK

During 1979 none of the stations in the Network received an exposure above background; however, a net exposure was recorded for three consecutive quarters on dosimeters worn by one offsite resident. We investigated and found that the resident had placed the TLD next to a radium-dial alarm clock rather than wearing it as instructed. The net exposure was attributed to the proximity of the TLD to the clock.

Appendix Table B-5 lists the maximum, minimum, and average dose equivalent rate (mrem/day) measured at each station in the Network during 1979. 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.

Table 6 shows that the average annual dose rate for the Dosimetry Network is consistent with the Network average established in 1975. The general trend is decreasing from 1971 to 1975 and is leveling off 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 6. DOSIMETRY NETWORK SUMMARY FOR THE YEARS 1971-1979

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

MILK SURVEILLANCE NETWORK

The analytical results for the 1979 MSN samples are summarized in Appendix Table B-6, where the maximum, minimum, and average concentrations of tritium, strontium-89, and strontium-90, in samples collected during 1979 are shown for each sampling location. The average radionuclide concentrations for the MSN and the SMSN listed in Table 7 are comparable.

TABLE 7. SUMMARY OF RADIONUCLIDE CONCENTRATIONS FOR MILK SURVEILLANCE NETWORK AND STANDBY MILK SURVEILLANCE NETWORK

Network	Radionuclide	No. of Samples	Concentrations ($\times 10^{-9}$ μCi/ml)		
			C_{max}	C_{min}	C_{avg}
MSN	^{3}H	6	1,400	<400	<400
	^{89}Sr	21	<50	<2	<10
	^{90}Sr	21	9	<1	<3
SMSN	^{3}H	11	<400	<400	<400
	^{89}Sr	11	<40	<20	<20
	^{90}Sr	11	3.6	<1	<2

LONG-TERM HYDROLOGICAL MONITORING PROGRAM

Table 8 lists the locations at which water samples were found to contain man-made radioactivity. Radioactivity in samples collected at these locations have been reported previously, except for Well UE7ns, which was added to this program in 1979. The data for all samples analyzed are compiled in Appendix Tables B-7 through B-11 and compared to the CG's in Appendix C.

None of the radionuclide concentrations found at the locations listed in Table 8 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 on private land at the Project Gnome site are closed and locked to prevent their use. The Half-Moon Creek overflow 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, although the Half-Moon Creek overflow is used by cattle grazing in the area. The shallow wells at the Project Long Shot site are in an isolated location and are not sources of drinking water.

To make certain that the subsurface tritium contamination near the Project Dribble site has not entered an aquifer used by offsite residents, further drilling and water sampling is planned by representatives of the State of Mississippi, the U.S. Department of Energy, and the EPA.

We observed no increase in either gross alpha or gross beta radioactivity in samples analyzed for this activity. The concentrations ranged from $<2 \times 10^{-9}$ to $<1 \times 10^{-7}$ μCi gross alpha per milliliter and from $<3 \times 10^{-9}$ to $<8 \times 10^{-8}$ μCi gross beta per milliliter.

ANIMAL INVESTIGATION PROGRAM

No animal damage claims were made during 1979. Annual reports for the Animal Investigation Program are published separately.

OFFSITE HUMAN SURVEILLANCE PROGRAM

During 1979 a total of 465 whole body and 556 phoswich counts were performed on people. Cesium-137 was detected by the NaI(Tl) whole body counter in 79 out of 92 whole body measurements. The maximum, minimum, and average body burdens for this radionuclide were 3.0×10^{-8}, $<0.5 \times 10^{-9}$, and 1.4×10^{-8} μCi/g body weight, respectively, which were similar to last year's concentrations (maximum of 3.4×10^{-8} μCi/g; minimum of $<5.0 \times 10^{-9}$; and average of 1.3×10^{-8} μCi/g body weight).

No abnormal hematological findings or thyroid profiles were observed that could be attributed to past or present NTS testing operations.

TABLE 8. WATER SAMPLING LOCATIONS WHERE SAMPLES WERE FOUND TO CONTAIN MANMADE RADIOACTIVITY

Sampling Location	Type of Radioactivity	Concentration ($x10^{-9}$ μCi/ml)	% of Conc. Guide
NTS, Well C	^{3}H	34-170*	<0.01
NTS, Test Well B	^{3}H	140-180*	<0.01
NTS, Well UE7ns	^{3}H	13-3,700*	<0.2
Project Gnome, USGS Well 4	Gross β	23,000	--
	^{3}H	580,000	20
	^{90}Sr	14,000	5,000
Project Gnome, USGS Well 8	Gross β	14,000	--
	^{3}H	510,000	20
	^{90}Sr	13,000	4,000
	^{137}Cs	30	0.2
Project Dribble, Wells HMH-1 through 11	^{3}H	360-320,000*	0.01-10
Project Dribble, Well PS-3	^{3}H	110	<0.01
Project Dribble, Half-Moon Creek overflow	^{3}H	530-1,700	0.2-0.06
Project Long Shot, Well WL-2	^{3}H	390	0.01
Project Long Shot, EPA, Well 1	^{3}H	300	0.01
Project Long Shot, Well GZ, No. 1	^{3}H	4,100	0.1
Project Long Shot, Well GZ, No. 2	^{3}H	580	0.02
Project Long Shot, Mud Pit, No. 1	^{3}H	1,200	0.04
Project Long Shot, Mud Pit, No. 2	^{3}H	1,200	0.04
Project Long Shot, Mud Pit, No. 3	^{3}H	1,700	0.06

*Concentration range

The concentrations of tritium in urine samples from people (average of 7.6×10^{-7} μCi/ml with a range of <3.0×10^{-7} to 5.3×10^{-6} μCi/ml) were within the range of background concentrations normally observed in surface waters or in atmospheric moisture. The single high level (5.3×10^{-6} μCi/ml) could have resulted from a tritiated luminous dial watch worn by the subject.

DOSE ASSESSMENT

Dose assessment calculations are not included in this report because detectable levels of radioactivity from the 1979 nuclear testing program at the NTS were not observed offsite by any of the monitoring networks. Residual radioactivity was observed in waters from off-NTS wells known to be contaminated during past nuclear tests at the Project Dribble Site near Hattiesburg, Mississippi, and at the Project Long Shot Site on Amchitka Island, Alaska. However, the waters from these contaminated wells are not used for drinking purposes.

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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, pubslished 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 (liter)	Approximate Detection Limit**
NaI(Tl) Spectrometry	Gamma spectrometer with 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.	For air cc $4x10^{-14}$ µCi/ml.
IG & Ge (Li) gamma Spectrometry	Gamma spectrometer with 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, Long-Term Hydro, suspended solids.	Radionuclide concentration quantified from gamma spectral data by on-line computer program. Radionuclides in air filter composite samples are identified only.	Same as above.	For routine milk and water generally, ~$1x10^{-8}$ µCi/ml for most common fallout radionuclides in a simple spectrum. Filters, for Long-Term Hydro. suspended solids, 6.0x 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	Chemical separation by ion exchange. Separated sample counted successively; activity calculated by simultaneous equations.	1.0	^{89}Sr = $5x10^{-9}$ µCi/ml ^{90}Sr = $2x10^{-9}$ µCi/ml.
^{3}H	Automatic liquid scintillation counter with output printer.	200	Sample prepared by distillation.	0.005	$4x10^{-7}$ µCi/ml

(continued)

TABLE A-1. Continued

Type of Analysis*	Analytical Equipment	Counting Period (min)	Analytical Procedures	Sample Size (liter)	Approximate Detection Limit**
^{3}H Enrichment (Long-Term Hydrological Samples)	Automatic scintillation counter with output printer.	200	Sample concentrated by electrolysis followed by distillation.	0.25	$1x10^{-8}$ 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	Sample is acid digested, separated by ion exchange, electroplated on stainless steel planchet and counted by alpha spectrometer.	1.0	^{238}Pu = $8x10^{-11}$ μCi/ml ^{239}Pu, ^{234}U, ^{235}U, ^{238}U = $4x10^{-11}$ μCi/ml
^{226}Ra	Single channel analyzer coupled to P.M. tube detector.	30	Precipitated with Ba, converted to chloride. Stored for 30 days for ^{222}Rn ^{226}Ra to equilibrate. Radon gas pumped into scintillation cell for alpha scintillation counting.	1.5	$2x10^{-10}$ μCi/ml
Gross alpha Gross beta in liquid samples	Low-background thin-window, gas-flow proportional counter with a 5.7-cm-diameter window (80 μg/cm^2).	50	Sample evaporated; residue weighed and counted; corrected for self-attenuation.	0.2	α = $6x10^{-9}$ μCi/ml β = $4x10^{-9}$ μCi/ml
Gross beta on air filters	Low-level end window, gas flow proportional counter with a 12.7-cm-diameter window (100 mg/cm^2).	20	Filters counted at 7 and 14 days after collection; two counts can be used to extrapolate concentration to mid-collection time assuming $T^{-1.2}$ decay or using experimentally derived decay.	10-cm diameter glass fiber filter; sample collected from 500-1200m^3.	$4x10^{15}$μCi/ml
^{85}Kr, ^{133}Xe CH_3T	Automatic liquid scintillation counter with output printer.	200	Physical separation by gas chromatography; dissolved in toluene "cocktail" for counting.	400-1000	^{85}Kr = $4x10^{-12}$ μCi/ml ^{133}Xe = $4x10^{-12}$ μCi/ml CH_3T = $4x10^{-12}$ 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.)

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 around the Nevada Test Site and other sites designated by the Nevada Operations Office, Department of Energy.

The program involved the collection and analysis of replicate samples from the Air Surveillance Network (ASN), the Noble Gas and Tritium Surveillance Network (NGTSN), the Dosimetry Network and the Standby Milk Surveillance Network (SMSN). Due to difficulties anticipated in obtaining sufficient quantities of milk for duplicate samples from the Milk Surveillance Network, duplicate samples were collected during the annual activation of the SMSN.

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	121	8,300	533	2	Gross β γ Spectrometry
NGTSN	11	572	52	2	^{85}Kr, ^{3}H, HTO, HT,H_2O
Dosimetry	78	212	212	4-6	External
SMSN	150	150	~30	2	^{40}K
LTHMP	134	254	~35	2	Gross α, Gross β, ^{3}H

*Only the Dosimetry Network had a sufficient number of replicate samples during 1979. The duplicate sampling results reported for all other networks are for 1978.

At least 30 duplicate samples from each network were collected and analyzed over the report period. Since three thermoluminescent (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.

Since the sampling distributions of each sample type appeared to be log normal from the 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

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

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 confidence interval of the expected population geometric variance for <u>each type of sample analysis</u>. The expressions used are as follows:(2)

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

$$\text{Lower Confidence Limit (LCL)} = \sum_{i=1}^{n} (n_i - 1)(\tilde{s}^2) / \chi^2\, 0.995,\ \sum_{i=1}^{n} (n_i - 1)$$

$$\text{Upper Confidence Limit (UCL)} = \sum_{i=1}^{n} (n_i - 1)(\tilde{s}^2) / \chi^2\, 0.005,\ \sum_{i=1}^{n} (n_i - 1)$$

$$\text{LCL} \leq \sigma^2 \leq \text{UCL}$$

where σ^2 = the true value of the population geometric variance

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

s_i^2 = the expected geometric variance of the ith replicate sample

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

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

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

The following table lists the expected geometric standard deviation and its 99% upper confidence limit (UCL) for most analyses.

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

Surveillance Network	Analysis	Sets of Replicate Samples Evaluated	Expected Geometric Stnd. Dev. $\tilde{s}$	99% UCL of Total Error
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
	HT	21	2.84	15
Dosimetry	γ (TLD)	212	1.061	1.2
SMSN	^{40}K	32	1.086	1.2
LTHMP	Gross α	38	1.55	3.1
	Gross β	27	1.29	1.9
	^{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 samples during 1979. The duplicate sampling results reported for all other networks are for 1978.

INTERCOMPARISON STUDIES

Data from analysis of intercomparison samples are statistically analyzed and compared with known values and values obtained from other participating laboratories. A summary of the statistical analysis is given in Table A-4. The 1979 analyses were within acceptable limits except for the strontium-90 analyses of milk. However, none of the analytical results differed from the known values by more than 25 percent.

TABLE A-4. 1979 QUALITY ASSURANCE INTERCOMPARISONS

Analysis	Month	Mean of Replicate Analyses ±σ ($x10^{-9}$ μCi/ml)	Mean Range Plus Standard Error of Range	Known Value ($x10^{-9}$ μCi/ml)	Normalized Deviation from: Grand Avg.	Normalized Deviation from: Conc.
Gross α in water	Jan	10 ± 2	0.35	6	1.1	1.5
	Mar	5 ± 1	0.12	10	-1.5	-1.6
Gross β in water	Jan	15 ± 3	0.71	16	-0.4	-0.2
	Mar	8 ± 1	0.24	16	-2.7	-2.7
^{3}H in water	Jan	1,167 ± 1.5	0.36	1,250	-0.7	-0.6
	Apr	2,233 ± 58	0.17	2,270	-0.3	-0.2
	Sep	13,130 ± 318	0.91	13,200	0.2	-0.3
^{90}Sr in water	Jan	7 ± 1	0.39	6	1.0	0.8
^{89}Sr in water	Jan	15 ± 3	0.24	14	0.5	0.2
U in water	Feb	34 ± 3	0.74	35	0.1	-0.3
^{60}Co in water	Oct	6 ± 2	0.35	6	-0.2	0.1
^{134}Cs in water	Oct	8 ± 1	0.24	7	0.1	0.2
^{137}Cs in water	Oct	11 ± 0	0.0	11	-0.3	-0.0
^{131}I in milk	Jan	111 ± 9	2.92	105	1.7	2.1
^{137}Cs in milk	Jan	51 ± 1	0.24	49	-0.2	0.6
^{140}Ba in milk	Jan	<4	--	0	--	--
^{90}Sr in milk	Jan	8 ± 2	2.10	19	-10.4	-12.7
^{89}Sr in milk	Jan	29 ± 2	0.47	33	-0.1	-1.3
^{40}K in milk	Jan	1,548 ± 104	1.76	1,560	1.1	-0.3
^{137}Cs in air filters (pCi/filter)	Jan	9 ± 1	0.24	6	0.4	1.0
	Mar	32 ± 2	0.35	21	2.9	3.7
^{131}I in water	Apr	41 ± 8	3.60	40	0.0	0.4

APPENDIX B. DATA SUMMARY FOR MONITORING NETWORKS

TABLE B-1. 1979 SUMMARY OF ANALYTICAL RESULTS FOR AIR SURVEILLANCE NETWORK ACTIVE STATIONS*

Sampling Location	No. Days Detected	Type of Radio-activity	Radioactivity Conc. ($\times10^{-12}$ µCi/ml) C_{max}	C_{min}	C_{avg}
Baker, Calif.	8.3	^{7}Be	0.29	0.12	0.11
Bishop, Calif.	7.0	^{7}Be	0.43	0.31	0.21
Death Valley Jct., Calif.	132.9	^{7}Be	1.9	0.13	0.12
	5.0	^{137}Cs	0.014	0.0087	<0.001
Furnace Creek, Calif.	139.4	^{7}Be	1.03	0.084	0.11
Needles, Calif.	3.2	^{7}Be	0.14	0.14	0.14
Ridgecrest, Calif.	5.0	^{7}Be	0.29	0.26	0.23
Shoshone, Calif.	136.1	^{7}Be	1.16	0.098	0.12
Alamo, Nev.	89.8	^{7}Be	3.4	0.094	0.10
Beatty, Nev.	120.7	^{7}Be	1.3	0.081	0.12
	3.0	^{137}Cs	0.013	0.013	<0.001
Blue Eagle Ranch, Nev.	113.9	^{7}Be	1.3	0.11	0.14
	3.0	^{95}Zr	0.025	0.025	<0.001
	5.0	^{137}Cs	0.022	0.020	<0.001
Blue Jay, Nev.	2.0	^{7}Be	0.22	0.22	0.045
Caliente, Nev.	3.0	^{7}Be	0.13	0.13	0.067
Angleworm Ranch, Nev.	3.8	^{7}Be	0.48	0.48	0.19

(continued)

TABLE B-1. Continued

Sampling Location	No. Days Detected	Type of Radio-activity	Radioactivity Conc. ($x10^{-12}$ μCi/ml) C_{max}	C_{min}	C_{avg}
Diablo, Nev.	4.1	^{7}Be	0.16	0.16	0.062
Duckwater, Nev.	3.0	^{7}Be	0.30	0.30	0.11
Eureka, Nev.	6.0	^{7}Be	0.46	0.27	0.36
Fallini's Ranch, Nev.	131.5	^{7}Be	1.3	0.13	0.12
	2.0	^{137}Cs	0.019	0.019	<0.001
Glendale, Nev.	94.5	^{7}Be	1.2	0.12	0.11
	3.0	^{137}Cs	0.016	0.016	<0.001
Goldfield, Nev.	82.1	^{7}Be	1.1	0.15	0.090
	6.0	^{137}Cs	0.042	0.017	<0.001
Area 51, NTS, Nev.†	96.8	^{7}Be	0.84	0.10	0.13
	2.0	^{137}Cs	0.037	0.037	<0.001
Hiko, Nev.	96.7	^{7}Be	1.1	0.0066	0.094
Indian Springs, Nev.	58.9	^{7}Be	1.0	0.078	0.069
Las Vegas, Nev.	116.5	^{7}Be	1.5	0.088	<0.2
Lathrop Wells, Nev.	91.0	^{7}Be	1.2	0.092	0.14
	3.2	^{137}Cs	0.0084	0.0084	<0.001
Lida, Nev.	2.0	^{7}Be	0.27	0.27	0.11
Lund, Nev.	2.0	^{7}Be	0.34	0.34	0.14
Mesquite, Nev.	6.0	^{7}Be	0.16	0.15	0.061
Nyala, Nev.	51.0	^{7}Be	1.4	0.076	0.047
	2.0	^{95}Zr	0.0095	0.0095	<0.001
Pahrump, Nev.	112.8	^{7}Be	1.2	0.062	0.097
Pioche, Nev.	5.0	^{7}Be	0.37	0.19	0.14

(continued)

TABLE B-1. Continued

Sampling Location	No. Days Detected	Type of Radio-activity	Radioactivity Conc. ($x10^{-12}$ μCi/ml) C_{max}	C_{min}	C_{avg}
Scotty's Junction, Nev.	128.4	^{7}Be	2.0	0.10	0.13
	3.0	^{137}Cs	0.017	0.017	<0.001
Stone Cabin Ranch, Nev.	78.1	^{7}Be	0.98	0.20	0.12
	5.0	^{137}Ce	0.12	0.067	0.0018
Sunnyside, Nev.	132.2	^{7}Be	1.6	0.11	0.17
	2.3	^{137}Cs	0.016	0.016	<0.001
Robison Trailer Park Rachel, Nev.	74.7	^{7}Be	2.8	0.13	0.15
Tonopah, Nev.	116.3	^{7}Be	1.9	0.16	0.16
Tonopah Test Range, Nev.	110.0	^{7}Be	1.6	0.14	0.14
	3.0	^{137}Cs	0.014	0.14	<0.001
	3.0	^{144}Ce	0.064	0.064	<0.001
Delta, Utah	52.7	^{7}Be	3.4	0.17	0.13
	2.0	^{137}Cs	0.031	0.031	<0.001
Garrison, Utah	2.0	^{7}Be	0.38	0.38	0.051
St. George, Utah	72.1	^{7}Be	1.0	0.12	0.074
	7.2	^{137}Cs	0.085	0.032	0.0011
	2.1	^{140}Ba	0.055	0.055	<0.001

* Those stations not reported here had samples indicating radioactivity concentrations less than the MDC, which is approximately 4 x 10^{-14} μCi/ml.

† Also known as Groom Lake.

TABLE B-2. 1979 SUMMARY OF ANALYTICAL RESULTS FOR AIR SURVEILLANCE NETWORK STANDBY STATIONS*

Sampling Location	No. Days Detected	Type of Radio-activity	Radioactivity Conc. ($x10^{-12}$ μCi/ml) C_{max}	C_{min}	C_{avg}
Winslow, Ariz.	2.0	^{140}Ba	0.046	0.046	0.023
Indio, Calif.	2.0	^{7}Be	0.23	0.23	0.23
Grand Junction, Colo.	6.1 2.0	^{7}Be ^{95}Zr	0.28 0.012	0.22 0.012	0.11 0.0017
Idaho Falls, Idaho	2.1	^{7}Be	0.42	0.42	0.42
Mountain Home, Idaho	2.0	^{7}Be	0.31	0.31	0.15
Twin Falls, Idaho	2.0	^{7}Be	0.20	0.20	0.057
Sioux City, Iowa	3.0	^{7}Be	0.26	0.26	0.26
Monroe, La.	3.0	^{7}Be	0.17	0.17	0.17
Joplin, Mo.	2.9	^{7}Be	0.22	0.22	0.16
St. Joseph, Mo.	3.0	^{7}Be	0.22	0.22	
Frenchman Sta., Nev.	1.9	^{7}Be	0.34	0.34	0.16
Capitol Reef, Utah	2.0	^{140}Ba	0.042	0.042	0.021
Logan, Utah	1.9	^{140}Ba	0.051	0.051	0.051
Provo, Utah	1.9	^{7}Be	0.30	0.30	0.15
Seattle, Wash.	1.0	^{140}Ba	0.060	0.060	0.060

* Samples from stations not reported here contained less radioactivity than the MDC of approximately 4 x 10^{-14} μCi/ml.

TABLE B-3. AIR CONCENTRATIONS OF ^{239}PU AT SELECTED AIR SURVEILLANCE NETWORK STATIONS, 1978-1979

Sampling Location	Year	Sampling Period On Date	On Time	Off Date	Off Time	Dates Sampler Off	^{239}Pu Concentration ($\times 10^{-18}$ μCi/ml)
Rachel, Nevada	1978	0401	1235	0703	1830	5/12-15, 16-24	19
		0703	1835	1002	1920	--	56
		1002	1920	0102	1530	10/13-16;11/4-8	13
	1979	0102	1530	0402	1400	2/5-7. 16-19	37
		0404	1600	0702	0800	4/25-27; 5/8-9	110
		0704	0800	1001	1500	7/25-26, 28-29; 8/17-21	31
		1001	1500	1230	1330	11/28-12/14	62
Las Vegas, Nevada	1978	1002	0803	0102	0755	--	9.7
	1979	0102	0758	0402	0828	--	18
		0402	0829	0702	0817	--	<9
		0702	0820	1001	0800	--	32
		1001	0805	0102	0845	12/7-12, 21-26	7.5
Lathrop Wells, Nevada	1979	2010	2075	0402	1211	--	<5
		0402	1211	0702	1420	5/11-15; 6/25-28	<7
		0702	1425	1003	0820	7/23-8/9; 9/26-27	21
Diablo, Nevada	1978	1002	1700	0102	1700	12/10-14	100
	1979	0102	1700	0223	1330	1/5-23; 2/17-20	13
Barstow, Calif.	1978	1120	0700	1219	1215	--	10
	1979	0112	0700	0201	0700	7/6-9	
		0629	0700	0713	0700		16
Provo, Utah	1978	1020	0805	1101	0900	--	24
		1215	0900	0101	1500	--	27
	1979	0702	0900	0713	0853	--	
		1001	0900	1008	0915		38
Aberdeen, South Dak.	1978	1020	0800	1103	0800	--	
		1215	1130	0101	1100		12
	1979	0629	0800	0713	0800	--	
		1001	0800	1008	0800		16

TABLE B-4. 1979 SUMMARY OF ANALYTICAL RESULTS FOR THE NOBLE GAS AND TRITIUM SURVEILLANCE NETWORK

Sampling Location	No. Days Samples	Radionuclide	Radioactivity Conc. ($x10^{-12}$ µCi/ml)**			% of Conc. Guide*
			C_{max}	C_{min}	C_{avg}	
Beatty, Nev.	348.3	^{85}Kr	24	14	19	0.02
	348.4	^{133}Xe	<20	<3	<3	<0.01
	364.5	^{3}H in atm. m.	0.98	<0.4	<0.4	--
	364.5	^{3}H as HTO in air	5.7	<0.3	<1	<0.01
Death Valley Jct., Calif.	138.7	^{85}Kr	23	15	19	0.02
	138.7	^{133}Xe	<6	<3	<3	<0.01
	131.8	^{3}H in atm. m.	0.9	<0.4	<0.4	--
	131.8	^{3}H as HTO in air	<4	<2	<2	<0.01
Diablo, Nev.†	75.9	^{85}Kr	26	18	21	0.02
	75.9	^{133}Xe	<3	<2	<2	<0.01
	68.9	^{3}H in atm. m.	0.82	<0.5	<0.5	--
	68.9	^{3}H as HTO in air	6.1	<0.9	<2	<0.01
Hiko, Nev.	327.5	^{85}Kr	30	14	19	<0.2
	334.5	^{133}Xe	<7	<3	<3	<0.01
	357.6	^{3}H in atm. m.	1.2	<0.3	<0.3	--
	357.6	^{3}H as HTO in air	12	<0.7	<2	<0.01
Indian Springs, Nev.	333.5	^{85}Kr	23	16	19	0.02
	362.4	^{133}Xe	<20	<3	<3	<0.01
	355.5	^{3}H in atm. m.	0.96	<0.4	<0.4	--
	355.5	^{3}H as HTO in air	7.5	<1	<1	<0.01
Lathrop Wells, Nev.	217.6	^{85}Kr	23	13	19	0.02
	225.8	^{133}Xe	<20	<3	<3	<0.01
	203.6	^{3}H in atm. m.	0.97	<0.4	<0.4	--
	203.6	^{3}H as HTO in air	4.4	<2	<2	<0.01
Rachel, Nev.	280.6	^{85}Kr	21	14	18	0.02
	283.7	^{133}Xe	<7	<3	<3	<0.01
	275.7	^{3}H in atm. m.	1.1	<0.3	<0.3	--
	275.7	^{3}H as HTO in air	<6	<0.8	<0.8	<0.01
Tonopah, Nev.	359.4	^{85}Kr	23	14	18	<0.02
	364.5	^{133}Xe	<10	<3	<3	<0.01
	335.7	^{3}H in atm. m.	1.0	<0.3	<0.3	--
	335.7	^{3}H as HTO in air	6.2	<0.5	<0.8	<0.01

(continued)

TABLE B-4. Continued

Sampling Location	No. Days Samples	Radio-nuclide	Radioactivity Conc. ($x10^{-12}$ μCi/ml)** C_{max}	C_{min}	C_{avg}	% of Conc. Guide*
Area 15, NTS, Nev.‡§	210.8	^{85}Kr	24	14	19	<0.01
	217.7	^{133}Xe	<40	<3	<3	<0.01
	155.7	^{3}H in atm. m.	22	<0.5	<0.6	--
	155.7	^{3}H as HTO in air	62	<2	<17	<0.01
Area 51, NTS, Nev.‡§	347.6	^{85}Kr	31	12	19	<0.01
	340.8	^{133}Xe	17	<2	<2	<0.01
	348.6	^{3}H in atm. m.	20	<0.4	<0.8	--
	348.6	^{3}H as HTO in air	19	<0.4	<2	<0.01
Area 400, NTS, Nev.§	201.6	^{85}Kr	23	11	18	<0.01
	218.4	^{133}Xe	<14	<3	<3	<0.01
	176.5	^{3}H in atm. m.	2.4	<0.4	<0.5	--
	176.5	^{3}H as HTO in air	7.7	2.0	<3	<0.01
BJY, NTS, Nev.	336.8	^{85}Kr	33	15	21	<0.01
	337.8	^{133}Xe	24	<2	<2	<0.01
	307.5	^{3}H in atm. m.	5	<0.4	<2	--
	307.5	^{3}H as HTO in air	27	1.5	<7	<0.01
Mercury, NTS, Nev.	347.6	^{85}Kr	25	13	19	<0.01
	362.6	^{133}Xe	<9	<0.4	<0.4	<0.01
	312.7	^{3}H in atm. m.	1.1	<0.4	<0.4	--
	312.7	^{3}H as HTO in air	6.5	0.77	<2	<0.01
Area 12, NTS, Nev.	323.8	^{85}Kr	23	14	19	<0.01
	332.7	^{133}Xe	<14	<3	<3	<0.01
	329.6	^{3}H in atm. m.	43	<0.4	<8	--
	329.6	^{3}H as HTO in air	92	<0.9	<26	<0.01

*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 B for Concentration Guides.

†Sampler was moved to Rachel, Nevada.

‡Also known as Groom Lake.

§New station added to the Network.

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

TABLE B-5. 1979 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, Nev.	01/10/79 - 01/30/80	0.39	0.31	0.35	130
Alamo, Nev.*	01/08/79 - 01/08/80	0.27	0.22	0.24	88
Area 51-NTS, Nev.	01/08/79 - 01/14/80	0.19	0.16	0.19	68
Austin, Nev.	01/09/79 - 01/29/80	0.36	0.28	0.31	110
Baker, Calif.	01/08/79 - 01/14/80	0.24	0.21	0.22	81
Barstow, Calif.	01/08/79 - 01/14/80	0.31	0.29	0.30	110
Beatty, Nev.	01/03/79 - 01/08/80	0.27	0.23	0.25	91
Bishop, Calif.†	01/10/79 - 01/15/80	0.29	0.25	0.27	98
Blue Eagle Ranch, Nev.	01/09/79 - 01/29/80	0.18	0.16	0.17	63
Blue Jay, Nev.	01/11/79 - 01/16/80	0.35	0.33	0.34	120
Cactus Springs, Nev.	01/02/79 - 01/07/80	0.18	0.15	0.17	63
Caliente, Nev.	01/09/79 - 01/09/80	0.32	0.27	0.30	110
Carp, Nev.	01/09/79 - 01/10/80	0.30	0.28	0.29	100
Casey's Ranch, Nev.	01/10/79 - 01/16/80	0.20	0.17	0.19	69
Cedar City, Utah	01/16/79 - 01/16/80	0.22	0.19	0.21	76
Clark Station, Nev.	01/11/79 - 01/15/80	0.32	0.28	0.30	110
Complex I, Nev.	01/10/79 - 01/30/80	0.29	0.27	0.28	100
Coyote Summit, Nev.	01/12/79 - 01/15/80	0.35	0.32	0.33	120
Currant, Nev.	01/09/79 - 01/29/80	0.29	0.26	0.28	100
Death Valley Jct., Calif.	01/11/79 - 01/17/80	0.21	0.20	0.21	78
Desert Game Range, Nev.	01/02/79 - 01/07/80	0.17	0.13	0.15	55
Diablo Maint. Sta., Nev.	01/11/79 - 01/15/80	0.37	0.34	0.36	130
Duckwater, Nev.	01/09/79 - 01/29/80	0.29	0.25	0.27	99
Elgin, Nev.	01/09/79 - 01/10/80	0.35	0.34	0.34	120
Ely, Nev.	01/09/79 - 01/29/80	0.22	0.20	0.21	77
Enterprise, Utah	01/16/79 - 01/16/80	0.29	0.25	0.27	99
Eureka, Nev.	01/10/79 - 01/30/80	0.30	0.25	0.29	104
Furnace Creek, Calif.	01/11/79 - 01/17/80	0.18	0.17	0.18	65
Garrison, Utah	01/08/79 - 01/28/80	0.21	0.18	0.19	71
Geyser Maint. Sta., Nev.	01/08/79 - 01/28/80	0.31	0.28	0.29	100
Glendale, Utah	01/15/79 - 01/15/80	0.17	0.14	0.16	59
Goldfield, Nev.	01/08/79 - 01/28/80	0.26	0.24	0.25	92
Hancock Summit, Nev.	01/12/79 - 01/15/80	0.40	0.37	0.38	140
Hiko, Nev.	01/08/79 - 01/08/80	0.22	0.20	0.21	76
Hot Creek Ranch, Nev.	01/11/79 - 01/16/80	0.27	0.24	0.25	92
Independence, Calif.	01/09/79 - 01/15/80	0.27	0.23	0.26	95
Indian Springs, Nev.	01/02/79 - 01/07/80	0.17	0.15	0.16	60
Kirkeby Ranch, Nev.	01/08/79 - 01/28/80	0.21	0.18	0.20	75
Koynes, Nev.	01/12/79 - 01/17/80	0.26	0.24	0.25	92
Las Vegas (Airport), Nev.	01/19/79 - 01/15/80	0.14	0.13	0.14	49
Las Vegas (Placak), Nev.	01/19/79 - 01/15/80	0.14	0.14	0.14	50
Las Vegas (USDI), Nev.	01/19/79 - 01/15/80	0.17	0.16	0.17	62
Lathrop Wells, Nev.‡	01/03/79 - 01/08/80	0.27	0.16	0.24	87

(continued)

TABLE B-5. Continued

Station Location	Measurement Period	Dose Equivalent Rate (mrem/d)			Annual Adjusted Dose Equivalent (mrem/y)
		Max.	Min.	Avg.	
Lida, Nev.	01/08/79 - 01/28/80	0.28	0.26	0.28	100
Lone Pine, Calif.	01/09/79 - 01/15/80	0.27	0.24	0.25	93
Lund, Nev.	01/10/79 - 01/29/80	0.24	0.23	0.24	87
Mammoth Mtn., Calif.§	01/10/79 - 11/06/79	0.37	0.22	0.30	110
Manhattan, Nev.	01/09/79 - 01/29/80	0.37	0.32	0.35	130
Mesquite, Nev.	01/15/79 - 01/15/80	0.19	0.16	0.18	65
Nevada Farms, Nev.	01/12/79 - 01/15/80	0.36	0.31	0.33	120
Nuclear Eng. Co., Nev.	01/03/79 - 01/08/80	0.33	0.29	0.32	120
Nyala, Nev.	01/10/79 - 01/16/80	0.23	0.21	0.21	78
Olancha, Calif.	01/09/79 - 01/15/80	0.26	0.25	0.26	93
Pahrump, Nev.#	01/02/79 - 01/09/80	0.19	0.16	0.16	60
Pine Creek Ranch, Nev.	07/20/79 - 01/30/80	0.35	0.32	0.33	120
Pioche, Nev.	01/10/79 - 01/09/80	0.24	0.22	0.23	84
Queen City Summit, Nev.**	01/12/79 - 01/15/80	0.38	0.36	0.37	130
Reed Ranch, Nev.	01/11/79 - 01/15/80	0.32	0.30	0.31	110
Ridgecrest, Calif.	01/09/79 - 01/15/80	0.22	0.17	0.21	77
Robison's Tr. Park, Nev.	01/12/79 - 01/15/80	0.33	0.30	0.32	120
Round Mountain, Nev.	01/09/79 - 01/28/80	0.31	0.27	0.29	110
Rox, Nev.††	05/09/79 - 01/15/80	0.26	0.25	0.26	95
Scotty's Junction, Nev.	01/08/79 - 01/28/80	0.26	0.25	0.26	93
Selbach Ranch, Nev.	01/03/79 - 01/08/80	0.33	0.29	0.30	110
Sherri's Bar, Nev.	01/08/79 - 01/08/80	0.23	0.19	0.21	76
Shoshone, Calif.	01/11/79 - 01/17/80	0.30	0.25	0.28	100
Springdale, Nev.	01/03/79 - 01/08/80	0.32	0.31	0.32	110
Spring Meadows, Nev.	01/02/79 - 01/07/80	0.19	0.14	0.17	61
St. George, Utah	01/16/79 - 01/17/80	0.18	0.16	0.18	64
Stone Cabin Ranch, Nev.	01/11/79 - 01/17/80	0.32	0.29	0.30	110
Sunnyside, Nev.	01/10/79 - 01/30/80	0.18	0.16	0.18	66
Tempiute, Nev.	01/12/79 - 01/17/80	0.34	0.31	0.32	120
Tenneco, Nev.	01/02/79 - 01/07/80	0.28	0.26	0.27	99
Tonopah, Nev.	01/08/79 - 01/28/80	0.30	0.28	0.30	110
Tonopah Test Range, Nev.	01/09/79 - 01/29/80	0.27	0.25	0.27	98
Twin Springs Ranch, Nev.	01/11/79 - 01/16/80	0.30	0.27	0.28	100
Warm Springs, Nev.	01/11/79 - 01/15/80	0.30	0.25	0.29	110
Young's Ranch, Nev.	01/09/79 - 01/29/80	0.25	0.13	0.24	89

*Stolen second quarter 1979, replaced third quarter 1979.
†Dosimeters and container stolen third quarter 1979, replaced fourth quarter 1979.
‡Station moved fourth quarter 1979.
§Fourth quarter exchange not possible due to weather conditions.
#Station moved second quarter 1979.
**Station monitored only third and fourth quarter 1979.
††Dosimeters and container stolen first quarter 1979, replaced second quarter 1979.

TABLE B-6. 1979 SUMMARY OF ANALYTICAL RESULTS FOR THE MILK SURVEILLANCE NETWORK

Sampling Location	Sample Type*	No. of Samples	Radio-nuclide	Radioactivity Conc. ($x10^{-9}$ µCi/ml)		
				C_{max}	C_{min}	C_{avg}
Hinkley, Calif., Bill Nelson Dairy	12	3	^{89}Sr	<30	<2	<10
		4	^{90}Sr	2.2	<0.8	<2
Keough Hot Spgs., Calif. Yribarren Ranch	13	3	^{89}Sr	<20	<3	<8
		4	^{90}Sr	2.7	<1	<2
Trona, Calif., Stanford Ranch	13	3	^{89}Sr	<20	<2	<8
		3	^{90}Sr	5.2	1.2	<3
Austin, Nev., Young's Ranch	14	4	^{3}H	700	<400	<400
		2	^{89}Sr	<20	<3	<9
		4	^{90}Sr	4.3	<1	<3
Caliente, Nev., June Cox Ranch	13	2	^{89}Sr	<3	<2	<2
		3	^{90}Sr	5.2	1.2	<3
Currant, Nev., Blue Eagle Ranch	13	3	^{89}Sr	<30	3.8	<10
		4	^{90}Sr	9.0	<2	<4
Hiko, Nev., Darrel Hansen Ranch	13	2	^{3}H	<400	<400	<400
		2	^{89}Sr	<30	<2	<20
		2	^{90}Sr	1.4	<2	<2
Las Vegas, Nev., LDS Dairy Farm	12	4	^{3}H	<500	<400	<400
		3	^{89}Sr	<30	<2	<20
		4	^{90}Sr	1.9	<1	<2
Lathrop Wells, Nev., Kirker Ranch	13	3	^{89}Sr	<2	<20	<9
		3	^{90}Sr	2.6	<2	<2

(continued)

TABLE B-6. Continued

Sampling Location	Sample Type*	No. of Samples	Radio-nuclide	Radioactivity Conc. ($x10^{-9}$ μCi/ml) C_{max}	C_{min}	C_{avg}
Lida, Nev., Lida Livestock Co.	13	1	^{89}Sr	<20	<20	<20
		1	^{90}Sr	2.0	2.0	2.0
Logandale, Nev., Vegas Valley Dairy	12	1	^{89}Sr	<2	<2	<2
		1	^{90}Sr	<2	<2	<2
Lund, Nev., McKenzie Dairy	12	4	^{3}H	1400	<400	<400
		3	^{89}Sr	<20	<2	<7
		4	^{90}Sr	3.9	0.94	<2
Mesquite, Nev., Hugh Bros. Dairy	12	4	^{3}H	770	<400	400
		3	^{89}Sr	<30	<2	<8
		4	^{90}Sr	3.5	0.83	<2
Moapa, Nev., Agman Seventy-Five, Inc.	12	3	^{89}Sr	<20	2.3	<9
		4	^{90}Sr	1.6	0.76	<0.76
Nyala, Nev., Sharp's Ranch	13	4	^{3}H	930	<400	<400
		3	^{89}Sr	<30	<2	<2
		4	^{90}Sr	5.6	<0.72	<3
Overton, Nev., Robison Dairy	12	2	^{89}Sr	<50	<3	<30
		3	^{90}Sr	3.7	<2	<3
Pahrump, Nev., Oxborrow Ranch	13	0	^{89}Sr	--	--	--
		1	^{90}Sr	2.0	2.0	2.0
Round Mountain, Nev., Berg Ranch	13	3	^{89}Sr	<20	<2	<9
		3	^{90}Sr	6.6	1.4	3.2

(continued)

TABLE B-6. Continued

Sampling Location	Sample Type*	No. of Samples	Radio-nuclide	Radioactivity Conc. ($x10^{-9}$ μCi/ml) C_{max}	C_{min}	C_{avg}
Shoshone, Nev., Kirkeby Ranch	13	1	^{89}Sr	3.5	3.5	3.5
		1	^{90}Sr	3.0	3.0	3.0
Springdale, Nev., Boiling Pot Ranch	13	1	^{89}Sr	<8	<8	<8
		1	^{90}Sr	2.5	2.5	2.5
Cedar City, Utah, Western General Dairy	12	3	^{89}Sr	<20	<2	<9
		4	^{90}Sr	1.9	<0.8	<2
St. George, Utah, Cottom Dairy	12	2	^{89}Sr	<20	<3	<10
		3	^{90}Sr	3.6	1.2	<2

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

TABLE B-7. 1979 SUMMARY OF ANALYTICAL RESULTS FOR THE NTS MONTHLY LONG-TERM HYDROLOGICAL MONITORING PROGRAM

Sampling Location	No. Samples*	Type of Radio-activity	Radioactivity Conc. ($x10^{-9}$ μCi/ml) C_{max}	C_{min}	C_{avg}	% of Conc. Guide
Well 8	7	Gross α	<3	<2	<2	--
	7	Gross β	<6	<4	<4	--
	8	^3H	23	<10	<10	<0.01
Well U3CN-5	7	Gross α	11	2.7	<4	--
	7	Gross β	1.2	<6	<6	--
	8	^3H	16	<10	<10	<0.01
Well A	7	Gross α	<30	<3	<3	--
	7	Gross β	11	<6	<6	--
	8	^3H	31	<9	<9	<0.01
Well C	7	Gross α	13	<6	<6	--
	7	Gross β	15	<2	<20	--
	8	^3H	170	34	73	<0.01
Well 5c	7	Gross α	8.1	<4	<4	--
	7	Gross β	9.8	<6	<6	--
	8	^3H	23	<10	<10	<0.01
Army Well No. 1	7	Gross α	3.1	<2	<2	--
	7	Gross β	<6	3.8	<4	--
	8	^3H	18	<10	<10	<0.01
Well 2	7	Gross α	<4	<3	<3	--
	7	Gross β	8.0	<6	<6	--
	8	^3H	48	<10	<10	<0.01
Test Well B	3	Gross α	<3	<3	<3	--
	3	Gross β	<6	<6	<6	--
	4	^3H	180	140	160	0.01
Well J-13	7	Gross α	<4	<3	<3	--
	7	Gross β	<6	3.9	<4	--
	7	^3H	35	<10	<10	<0.01
Well UE7ns	7	Gross α	6.5	<2	<2	--
	6	Gross β	5.9	<3	<3	--
	8	^3H	3,700	13	1,500	0.05
Well U19c	6	Gross α	<5	<3	<3	--
	6	Gross β	6.3	4.5	4.5	--
	8	^3H	35	<10	<10	<0.01

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

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

TABLE B-8. 1979 ANALYTICAL RESULTS FOR THE NTS SEMI-ANNUAL* LONG-TERM HYDROLOGICAL MONITORING PROGRAM

Sampling Location	Date	Sample Type†	Type of Radio-activity	Radioactivity Conc. ($x10^{-9}$ μCi/ml)	% of Conc. Guide‡
NTS, Well UE15d	01/17	23	Gross α	4.4	--
			Gross β	8.6	--
			^{3}H	NA	--
NTS, Test Well D,	01/19	23	Gross α	<4	--
			Gross β	<6	--
			^{3}H	NA	<0.01
NTS, Well UE1c,	02/23	23	Gross α	3.1	--
			Gross β	<6	--
			^{3}H	<10	<0.01
NTS, Well C-1	02/22	23	Gross α	<6	--
			Gross β	<20	--
			^{3}H	14	<0.01
NTS, Well UE5C	01/16	23	Gross α	<3	--
			Gross β	<6	--
			^{3}H	<20	<0.01
NTS, Well 5b	01/16	23	Gross α	<3	--
			Gross β	<6	--
			^{3}H	<20	<0.01
NTS, Test Well F,	01/16	23	Gross α	3.8	--
			Gross β	<6	--
			^{3}H	<20	<0.01
Ash Meadows, Nev., Crystal Pool	03/05	27	Gross α	<4	--
			Gross β	<6	--
			^{3}H	<10	<0.01
Ash Meadows, Nev., Well 18S/51E-7DB	03/05	23	Gross α	<4	--
			Gross β	7.1	--
			^{3}H	<10	<0.01
Ash Meadows, Nev., Well 17S/50E-14CAC	03/05	23	Gross α	4.8	--
			Gross β	8.8	--
			^{3}H	<10	<0.01

(continued)

TABLE B-8. Continued

Sampling Location	Date	Sample Type†	Type of Radio-activity	Radioactivity Conc. ($x10^{-9}$ µCi/ml)	% of Conc. Guide‡
Ash Meadows, Nev., Fairbanks Springs	03/05	27	Gross α	<4	--
			Gross β	<6	--
			^3H	<10	<0.01
Beatty, Nev., City Supply, 12S/47E-7DBD	03/06	23	Gross α	<6	--
			Gross β	<20	--
			^3H	<10	<0.01
Beatty, Nev., Nuclear Engineering Co.	03/07	23	Gross α		--
			Gross β	<20	--
			^3H	<10	<0.01
Beatty, Nev., Coffers Well, 11S/48/1DD	03/06	23	Gross α	4.5	--
			Gross β	<6	--
			^3H	<10	<0.01
Indian Springs, Nev., USAF No. 2	02/22	23	Gross α	<6	--
			Gross β	<20	--
			^3H	<20	<0.01
Indian Springs, Nev., Sewer Co. Inc., Well No. 1	02/20	23	Gross α	<3	--
			Gross β	<6	--
			^3H	11	<0.01
Lathrop Wells, Nev., City Supply	03/07	23	Gross α	2.7	--
			Gross β	<6	--
			^3H	<10	<0.01
Springdale, Nev., Goss Springs	03/06	27	Gross α	<10	--
			Gross β	<20	--
			^3H	<10	<0.01

*During 1979 samples were collected only once.
†23 = Well; 27 = Spring
‡Concentration Guides for drinking water at on-NTS locations are the same as those for off-NTS locations. See Appendix B.

TABLE B-9. 1979 ANALYTICAL RESULTS FOR THE NTS ANNUAL LONG-TERM HYDROLOGICAL MONITORING PROGRAM

Sampling Location	Date	Sample Type*	Type of Radio-activity	Radioactivity Conc. ($x10^{-9}$ μCi/ml)	% of Conc. Guide†
Shoshone, Calif. Shoshone Spring	11/16	27	^3H	800	0.03
Hiko, Nev. Crystal Springs	11/14	27	^3H	460	0.02
Alamo, Nev. City Supply	11/14	23	^3H	360	0.01
Warm Springs, Nev. Twin Springs Ranch	11/14	27	^3H	460	0.02
Nyala, Nev. Sharp Ranch	11/15	23	^3H	580	0.02
Adaven, Nev. Adaven Spring	11/15	27	^3H	1800	0.06
Pahrump, Nev. Calvada Well 3	11/16	23	^3H	510	0.02
Tonopah, Nev. City Supply	11/15	23	^3H	<10	<0.01
Clark Station, Nev. Tonopah Test Range Well 6	11/15	23	^3H	16	<0.01
Las Vegas, Nev. Water District Well No. 28	11/09	23	^3H	0.83	<0.01
Tempiute, Nev. Union Carbide Well	11/14	23	^3H	510	0.02

*23 = Well; 27 = Spring
†See Appendix B for Concentration Guides.

TABLE B-10. 1979 ANALYTICAL RESULTS FOR THE OFF-NTS LONG-TERM HYDROLOGICAL MONITORING PROGRAM (ANNUAL SAMPLES)

Sampling Location	Date	Depth (m)*	Sample Type†	Type of Radio-activity	Radioactivity Conc. ($x10^{-9}$ μCi/ml)	% of Conc. Guide‡
PROJECT GNOME -- NEW MEXICO						
Malaga, USGS Well No. 1	3/22	162	23	Gross α	<50§	--
				Gross β	<60§	--
				^{3}H	<10	<0.01
Malaga, USGS Well No. 4	3/22	148	23	Gross α	<200§	--
				Gross β	23,000	--
				^{3}H	580,000	19
				^{90}Sr	14,000	50
Malaga, USGS Well No. 8	3/24	144	23	Gross α	<60§	--
				Gross β	14,000	--
				^{3}H	510,000	17
				^{90}Sr	13,000	40
				^{137}Cs	30	0.2
Malaga, PHS Well No. 6	3/24	25	23	Gross α	<3	--
				Gross β	<6	--
				^{3}H	100	<0.01
Malaga, PHS Well No. 8	3/24	157	23	Gross α	<40§	--
				Gross β	7.5	--
				^{3}H	17	<0.01
Malaga, PHS Well No. 9	3/24	59	23	Gross α	<3	--
				Gross β	<6	--
				^{3}H	<10	<0.01
Malaga, PHS Well No. 10	3/24	137	23	Gross α	<300§	--
				Gross β	<30	--
				^{3}H	16	<0.01
Malaga, Pecos River Pumping Stations	3/23	236	23	Gross α	<20	--
				Gross W	<30	--
				^{3}H	<10	<0.01
Loving, City Well No. 2	3/23	69	23	Gross α	<3	--
				Gross β	<6	--
				^{3}H	<10	<0.01

(continued)

TABLE B-10. Continued

Sampling Location	Date	Depth (m)*	Sample Type†	Type of Radio-activity	Radioactivity Conc. ($x10^{-9}$ µCi/ml)	% of Conc. Guide‡
Carlsbad, City Well No. 7	3/23	249	23	Gross α	<4	--
				Gross β	<20	--
				^3H	<11	<0.01
PROJECT SHOAL -- NEVADA						
Frenchman, Frenchman Station	6/13	not known	23	Gross α	20	--
				Gross β	16	--
				^3H	21	<0.01
Frenchman, Well HS-1	6/13	213	23	Gross α	<3	--
				Gross β	0.1	--
				^3H	<9	<0.01
Frenchman, Well H-3	6/13	146	23	Gross α	51	--
				Gross β	19	--
				^3H	<10	<0.01
Frenchman, Flowing Well	6/13	not known	23	Gross α	<100	--
				Gross β	<80	--
				^3H	<10	<0.01
Frenchman, Hunts Station	6/13	96	23	Gross α	17	--
				Gross β	14	--
				^3H	<10	<0.01
PROJECT DRIBBLE -- MISSISSIPPI						
Baxterville, City Supply	3/13	95	23	Gross α	<2	--
				Gross β	<6	--
				^3H	<20	<0.01
Baxterville, Lower Little Creek	3/13	sfc.	22	Gross α	<2	--
				Gross β	<6	--
				^3H	68	<0.01

(continued)

TABLE B-10. Continued

Sampling Location	Date	Depth (m)*	Sample Type†	Type of Radio-activity	Radioactivity Conc. ($\times 10^{-9}$ µCi/ml)	% of Conc. Guide‡
Baxterville, Well HT-1	3/15	407	23	Gross α	<7	--
				Gross β	<30	--
				^{3}H	15	<0.01
Baxterville, Well HT-2c	3/15	116	23	Gross α	<2	--
				Gross β	<6	--
				^{3}H	30	<0.01
Baxterville, Well HT-4	3/14	131	23	Gross α	<3	--
				Gross β	<6	--
				^{3}H	<10	<0.01
Baxterville, Well HT-5	3/14	197	23	Gross α	<2	--
				Gross β	<6	--
				^{3}H	29	<0.01
Baxterville, Well E-7	3/14	302	23	Gross α	<4	--
				Gross β	<20	--
				^{3}H	78	<0.01
Baxterville, Well Ascot No. 2	3/16	640	23	Gross α	<200	--
				Gross β	<30	--
				^{3}H	<20	<0.01
Baxterville, Half Moon Creek	3/15	sfc.	22	Gross α	<2	--
				Gross β	<6	--
				^{3}H	49	<0.01
Baxterville, Half Moon Creek Overflow	3/15	sfc.	22	Gross α	<2	--
				Gross β	<6	--
				^{3}H	530	<0.02
Baxterville, T. Speights residence	3/12	13	23	Gross α	<2	--
				Gross β	(6	--
				^{3}H	<10	<0.01
Baxterville, R. L. Anderson residence	3/13	29	23	Gross α	< 2	--
				Gross β	< 6	--
				^{3}H	<10	<0.01
Baxterville, L. J. Bryant residence (creek)	3/13	sfc.	23	^{3}H	51	<0.01

(continued)

TABLE B-10. Continued

Sampling Location	Date	Depth (m)*	Sample Type†	Type of Radio-activity	Radioactivity Conc. ($x10^{-9}$ μCi/ml)	% of Conc. Guide‡
Baxterville, B. Chambliss residence	3/13	not known	23	^3H	10	<0.01
Baxterville, Mark Lowe residence	3/14	30	23	Gross α	<2	--
				Gross β	<6	--
				^3H	<10	<0.01
Baxterville, R. Ready residence	3/14	26	23	Gross α	<2	--
				Gross β	<6	--
				^3H	53	<0.01
Baxterville, W. Daniels residence	3/12	28	23	Gross α	<2	--
				Gross β	<6	--
				^3H	<10	<0.01
Lumberton, City Supply Well No. 2	3/13	262	23	Gross α	<2	--
				Gross β	<6	--
				^3H	<20	<0.01
Purvis, City Supply	3/12	295	23	Gross α	<2	--
				Gross β	<6	--
				^3H	37	<0.01
Columbia, City Supply	3/13	41	23	Gross α	<2	--
				Gross β	<6	--
				^3H	<10	<0.01
Lumberton, North Lumberton City Supply	3/13	258	23	Gross α	<1	--
				Gross β	<3	--
				^3H	<10	<0.01
Baxterville, Pond W of GZ	3/15	sfc.	21	Gross α	<2	--
				Gross β	<6	--
				^3H	24	<0.01
PROJECT GASBUGGY -- NEW MEXICO						
Gobernador, Arnold Ranch	9/30	sfc.	27	^3H	<10	<0.01

(continued)

TABLE B-10. Continued

Sampling Location	Date	Depth (m)*	Sample Type†	Type of Radio-activity	Radioactivity Conc. (x10⁻⁹ μCi/ml)	% of Conc. Guide‡
Gobernador, Lower Burro Canyon	9/30	70	23	^3H	<20	<0.01
Gobernador, Fred Bixler Ranch	9/30	53	23	^3H	<19	<0.01
Gobernador, Cave Springs	9/30	sfc.	27	^3H	<10	<0.01
Gobernador, Windmill No. 2	9/30	not known	23	^3H	<20	<0.01
Gobernador, Bubbling Springs	9/30	sfc.	27	^3H	85	<0.01
Gobernador, La Jara Creek	9/30	sfc.	22	^3H	72	<0.01
Gobernador, EPNG Well 10-36	9/29	1,181	23	^3H	<20	<0.01
PROJECT RULISON -- COLORADO						
Rulison, Lee L. Hayward Ranch	10/4	not known	23	^3H	390	0.01
Rulison, Glen Schwab Ranch	10/4	not known	23	^3H	440	0.01
Grand Valley, Albert Gardner Ranch	10/4	not known	23	^3H	310	0.01
Grand Valley, City Water Supply	10/4	sfc.	27	^3H	40	<0.01
Grand Valley Spring 300 Yds. NW of GZ	10/4	sfc.	27	^3H	180	<0.01

(continued)

TABLE B-10. Continued

Sampling Location	Date	Depth (m)*	Sample Type†	Type of Radio-activity	Radioactivity Conc. ($x10^{-9}$ μCi/ml)	% of Conc. Guide‡
Rulison, Felix Sefcovic Ranch	10/4	not known	23	^3H	300	0.01
Grand Valley, Battlement Creek	10/4	sfc.	22	^3H	240	<0.01
Grand Valley, CER Well	10/4	14	23	^3H	230	<0.01
Rulison, Potter Ranch	10/4	sfc.	27	^3H	280	<0.01
PROJECT RIO BLANCO -- COLORADO						
Rio Blanco, Fawn Creek 6,800 ft Upstream	10/2	sfc.	22	^3H	53	<0.01
Rio Blanco, Fawn Creek 500 ft Upstream	10/2	sfc.	22	^3H	48	<0.01
Rio Blanco, Fawn Creek 500 ft Downstream	10/2	sfc.	22	^3H	60	<0.01
Rio Blanco, Fawn Creek 8,400 ft Downstream	10/2	sfc.	22	^3H	55	<0.01
Rio Blanco, Fawn Creek No. 1	10/2	sfc.	27	^3H	46	<0.01
Rio Blanco, Fawn Creek No. 3	10/2	sfc.	27	^3H	62	<0.01
Rio Blanco, CER No. 1 Black Sulphur	10/2	sfc.	27	^3H	110	<0.01

(continued)

TABLE B-10. Continued

Sampling Location	Date	Depth (m)*	Sample Type†	Type of Radio-activity	Radioactivity Conc. ($x10^{-9}$ μCi/ml)	% of Conc. Guide‡
Rio Blanco, CER No. 4 Black Sulphur	10/2	sfc.	27	^3H	100	<0.01
Rio Blanco, B-1 Equity Camp	10/2	sfc.	27	^3H	110	<0.01
Rio Blanco, Brennan Windmill	10/2	not known	23	^3H	<20	<0.01
Rio Blanco, Johnson Artesian Well	10/2	not known	23	^3H	<20	<0.01
Rio Blanco, Well RB-D-01	10/3	476	23	^3H	23	<0.01
PROJECT CANNIKIN -- AMCHITKA, ALASKA						
South End of Cannikin Lake	9/27	sfc.	21	^3H	86	<0.01
North End of Cannikin Lake	9/27	sfc.	21	^3H	60	<0.01
Well HTH-3	9/27	42	23	^3H	77	<0.01
Ice Box Lake	9/27	sfc.	21	^3H	18	<0.01
White Alice Creek	9/27	sfc.	22	^3H	68	<0.01
Pit South of Cannikin GZ	9/27	sfc.	21	^3H	47	<0.01
PROJECT MILROW -- AMCHITKA, ALASKA						
Heart Lake	9/28	sfc.	21	^3H	41	<0.01

(continued)

TABLE B-10. Continued

Sampling Location	Date	Depth (m)*	Sample Type†	Type of Radio-activity	Radioactivity Conc. (x10^{-9} μCi/ml)	% of Conc. Guide‡
Well W-5	9/28	0.83	23	^{3}H	68	<0.01
Well W-6	9/28	0.94	23	^{3}H	55	<0.01
Well W-8	9/28	1.6	23	^{3}H	54	<0.01
Well W-15	9/28	1.0	23	^{3}H	55	<0.01
Well W-10	9/28	2.0	23	^{3}H	58	<0.01
Well W-11	9/28	1.5	23	^{3}H	120	<0.01
Well W-3	9/28	1.1	23	^{3}H	91	<0.01
Well W-2	9/28	0.3	23	^{3}H	LOST	
Clevenger Creek	9/28	sfc.	22	^{3}H	55	<0.01
Well W-4	9/28	0.46	23	^{3}H	48	<0.01
Well W-7	9/28	0.31	23	^{3}H	55	<0.01
Well W-13	9/28	0.74	23	^{3}H	69	<0.01
Well W-18	9/28	0.20	23	^{3}H	37	<0.01
PROJECT LONG SHOT -- AMCHITKA, ALASKA						
Well WL-2	9/29	3.0	23	^{3}H	390	<0.01
EPA Well-1	9/29	6.6	23	^{3}H	300	<0.01
Reed Pond	9/29	sfc.	21	^{3}H	53	<0.01
Well GZ No. 1	9/29	27.4	23	^{3}H	4,100	0.1
Well GZ No. 2	9/29	12.2	23	^{3}H	580	0.02

(continued)

TABLE B-10. Continued

Sampling Location	Date	Depth (m)*	Sample Type†	Type of Radio-activity	Radioactivity Conc. ($x10^{-9}$ μCi/ml)	% of Conc. Guide‡
Well WL-1	9/29	0.8	23	^{3}H	39	<0.01
Mud Pit No. 1	9/29	sfc.	21	^{3}H	1,200	0.04
Mud Pit No. 2	9/29	sfc.	21	^{3}H	1,200	0.04
Mud Pit No. 3	9/29	sfc.	21	^{3}H	1,700	0.06
BACKGROUND SAMPLES -- AMCHITKA, ALASKA						
Constantine Spring	9/29	sfc.	27	^{3}H	99	<0.01
Army Well No. 1	9/29	26	23	^{3}H	88	<0.01
Jones Lake	9/29	sfc.	21	^{3}H	49	<0.01
Army Well No. 2	10/1	16.0	23	^{3}H	30	<0.01
Army Well No. 3	10/1	92.0	23	^{3}H	120	<0.01
Well AEC 1	10/1	6.6	23	^{3}H	91	<0.01
Duck Cove Creek	9/29	sfc.	22	^{3}H	65	<0.01

* sfc. = surface

† 21 = Pond, lake, reservoir, stock tank, or stock pond; 22 = Stream, river, or creek; 23 = Well; 26 = Rain; 27 = Spring.

‡ Concentration Guides (CG) for drinking water at onsite locations are the same as those for offsite locations. See Appendix B for Concentration Guides. As gross alpha and gross beta radioactivity concentrations were used only for identifying gross radioactivity concentration increases, and as more complete radionuclide analyses were made in the past, calculating the percent of the concentration guide was not considered appropriate.

§ High MDC due to high concentration of dissolved solids.

TABLE B-11. SPECIAL ANALYTICAL RESULTS FOR THE LONG-TERM HYDROLOGICAL MONITORING PROGRAM - PROJECT DRIBBLE*

Sampling Location	Date	Depth (m)	H Concentration ($\times 10^{-9}$ µCi/ml)	% of Conc. Guide
HMH-1	01/09	3.8	320,000	10
	08/03		10,000	0.3
HMH-2	01/09	3.6	180,000	6.0
	08/03		4,600	0.2
HMH-3	01/09	3.0	80	<0.01
	08/03		800	0.03
HMH-4	01/09	1.9	<400	<0.01
	08/03		550	0.02
HMH-5	01/09	2.6	9,900	0.3
	08/03		8,800	0.3
HMH-6	01/09	1.6	390	0.01
	08/03		1,100	0.04
HMH-7	01/09	2.0	770	0.02
	08/03		1,200	0.04
HMH-8	01/09	3.6	58	<0.01
	08/03		360	0.01
HMH-9	01/09	1.7	97	<0.01
	08/03		<400	0.01
HMH-10	01/09	2.6	49	<0.01
	08/03		700	0.02
HMH-11	01/09	2.6	24,000	0.08
	08/03		9,200	0.03
PS-3	01/09	35	110	<0.01

*Each sample was also analyzed by gamma spectrometry. No gamma-emitting radionuclides were detected above the MDC of ~1 x 10^{-3} µCi/ml.
†sfc. = surface

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 Critical Individuals in Uncontrolled Area at Points of Maximium Probable Exposure (rem)	Dose Limit to Suitable Sample of the Exposed Population 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, if such system 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 Man-Made 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."

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}	
		^{131}I	3.3×10^{-11}	
		^{132}Te	1.3×10^{-9}	
		^{137}Cs	1.7×10^{-10}	
		^{140}Ba	3.3×10^{-10}	
		^{144}Ce	6.7×10^{-10}	
		^{239}Pu	3.3×10^{-13}	

(continued)

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

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