EPA-600/4-82-061
DOE/DP/00539-046
August 1982

OFFSITE ENVIRONMENTAL MONITORING REPORT
Radiation monitoring around United States nuclear test areas, calendar year 1981

compiled by

S. C. Black, R. F. Grossman, A. A. Mullen,
G. D. Potter and D. D. Smith
Environmental Monitoring Systems Laboratory
Las Vegas, Nevada 89114

and

J. L. Hopper
Reynolds Electrical & Engineering Company, Inc.
Las Vegas, Nevada 89102

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

ENVIRONMENTAL MONITORING SYSTEMS LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
LAS VEGAS, NEVADA 89114

DISCLAIMER

This report has been reviewed in accordance with the U.S. Environmental Protection Agency's peer and administrative review policies and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

PREFACE

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

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

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

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

In 1971, the AEC implemented a requirement, now referred to as the DOE Order 5484.1, that each contractor or agency involved in major nuclear activities provide a comprehensive annual radiological monitoring report. This is the tenth annual report in this series; it summarizes the activities of the EPA during CY 1981.

CONTENTS

CONTENTS (Continued)

FIGURES

TABLES

ABBREVIATIONS, SYMBOLS AND CONVERSIONS

a	annum (year)
ASN	Air Surveillance Network
CG	Concentration Guide
Ci	Curie
CP-1	Control Point One
CY	Calendar Year
d	day
DOE	U.S. Department of Energy
DOE/NV	Department of Energy, Nevada Operations Office
EMSL-LV	Environmental Monitoring Systems Laboratory, Las Vegas
EPA	U.S. Environmental Protection Agency
eV	electron volt
g	gram
GZ	Ground Zero
h	hour
HTO	Tritiated Water
L	liter
LTHMP	Long-Term Hydrological Monitoring Program
m	meter
MDC	Minimum Detectable Concentration
MSL	Mean Sea Level
MSN	Milk Surveillance Network
NGTSN	Noble Gas and Tritium Surveillance Network
NTS	Nevada Test Site
Pa	Pascal - unit of pressure
R	Roentgen
rad	unit of absorbed dose, 100 ergs/g
rem	the rad adjusted for biological effect
TLD	Thermoluminescent Dosimeter

PREFIXES

a	atto	$= 10^{-18}$
f	femto	$= 10^{-15}$
p	pico	$= 10^{-12}$
n	nano	$= 10^{-9}$
μ	micro	$= 10^{-6}$
m	milli	$= 10^{-3}$
k	kilo	$= 10^{3}$
M	Mega	$= 10^{6}$

CONVERSIONS

Multiply	By	To Obtain
Concentration Guides		
μCi/mL	10^{9}	pCi/L
μCi/mL	10^{12}	pCi/m^3
SI Units		
rad	10^{-2}	Gray (Gy = 1 Joule/kg)
rem	10^{-2}	Sievert (Sv)
pCi	0.037	Becquerel

SECTION 1

SUMMARY

PURPOSE

It is U.S. Environmental Protection Agency policy to protect the general public and the environment from pollution caused by human activities. This includes radioactive contamination of the biosphere and concomitant radiation exposure of the population. To this end and in concordance with U.S. Department of Energy policy of keeping radiation exposure of the general public as low as reasonably achievable, the EMSL-LV conducts an Offsite Radiological Safety Program centered on the DOE's Nevada Test Site. This program is conducted under an Interagency Agreement between EPA and DOE.

A principal activity of the Offsite Radiological Safety Program is routine environmental monitoring for radioactive materials in various media and for radiation in areas which may be affected by nuclear tests. It is conducted to document compliance with standards, to identify trends, and to provide information to the public. This report summarizes these activities for CY 1981.

Locations

Most of the radiological safety effort is applied in the areas around the Nevada Test Site in south-central Nevada. The principal activity at the NTS is testing of nuclear devices, though other related projects are also conducted. This portion of Nevada is sparsely settled, 0.5 person/km^2, and has a continental arid climate. The largest town in the near offsite area is Beatty, located about 65 km west of the NTS with a population of about 900.

Underground tests have been conducted in several other States for various purposes. At these sites in Alaska, Colorado, New Mexico and Mississippi, a long-term hydrological monitoring program (LTHMP) is conducted to detect any possible contamination of potable water and aquifers near these sites.

Pathways Monitoring

The pathways leading to human exposure to radionuclides, namely air, water and food, are monitored by networks of sampling stations. The networks are designed not only to detect radiation from DOE/NVO nuclear test areas but also to detect increases in population exposure from any source.

In 1981 the air sampling network (ASN) consisted of 27 continuously operating stations surrounding the NTS and 97 standby stations (operated 1 or

2 weeks each quarter) in States west of the Mississippi. Other than naturally occurring beryllium-7, the only activity detected was fission-product activity from a Chinese atmospheric nuclear test. A slight increase in plutonium-239 concentration, probably due to the same source, was also detected.

The noble gas and tritium sampling network (NGTSN) consisted of 10 stations offsite (off the NTS and exclusion areas) and 6 stations onsite in 1981. No NTS-related radioactivity was detected at any offsite station. Tritium concentration in air remained below MDC levels and krypton-85 concentration continued the upward trend which started in 1960, reflecting the world-wide increase in nuclear technology.

The long-term hydrological monitoring of wells and surface waters near sites of nuclear tests showed only background tritium and other radionuclide concentrations except for those wells which enter the test cavity or those that were previously spiked with radionuclides for hydrological tests.

The milk surveillance network (MSN) consisted of 27 sampling locations within 300 km of the NTS and about 140 standby locations in the Western U.S. The tritium concentration in milk was at background levels, and strontium-90 from world-wide fallout continued the slow downward trend observed in recent years.

Other foods analyzed have been mainly meat from domestic or game animals. The radionuclide most frequently found in the edible portion of these animals is cesium-137. Its concentration has also been declining in recent years. Meat from deer that reside on the NTS has not had markedly higher concentrations of radionuclides than meat from deer that reside in other areas of Nevada.

The NTS beef herd which had been maintained on the NTS and had been sampled semi-annually since 1957 was dispersed this year and the Experimental Dairy Farm activated in 1963 was placed in a standby status. These actions were taken because of the consistently unremarkable findings in the NTS animals and because of budgetary constraints. In the future, samples to be analyzed will be collected from ranches and farms in the near offsite areas.

External Exposure

External exposure is monitored by a network of TLD's at 80 locations surrounding the NTS and by TLD's worn by 46 offsite residents. In a few cases, small exposures of a few mrem above the average for the person or location were measured. Except for one case of occupational exposure, all such net exposures were very low and were not related to NTS activities. The range of exposures measured, varying with altitude and soil constituents, is similar to the range of such exposures found in other areas of the U.S.

Internal Exposure

Internal exposure is assessed by whole-body counting supplemented by phoswich detectors to measure lung burdens of radioactivity. In 1981, counts were made on 42 offsite residents and about 400 EPA and EG&G employees.

Natural potassium-40 was found as expected, but other than barely detectable cesium-137 in a few cases, no nuclear test related radioactivity was detected. In addition, physical examinations of the 42 offsite residents revealed only a normally healthy population consonant with the age and sex distribution of that population.

Community Monitoring Stations

During the fourth quarter of 1981, work commenced on installing 15 environmental radiation monitoring stations in the offsite area. Each station will be operated by a resident of the community, trained to collect samples and interpret some of the data. Each station will be part of the ASN, NGTSN and TLD networks and will also have a recording pressurized ion chamber and barograph. Complete samples and data from the stations will be analyzed by EMSL-LV and also interpreted and reported by the Desert Research Institute, University of Nevada.

Dose Assessment

Doses were calculated for an average adult living in Nevada based on the Kr-85, Sr-90, Cs-137 and Pu-239 detected by the monitoring networks. Using conservative assumptions, the estimated dose would have been less than 0.5 mrem per year, a small fraction of the variation of 10 mrem per year due to the natural radionuclide content of the body. Since no radioactivity originating on the NTS was detectable offsite, no dose assessment related to NTS activities could be made.

SECTION 2

INTRODUCTION

The EMSL-LV operates an Offsite Radiological Safety Program around the NTS and other sites as requested by the Department of Energy (DOE) under an Interagency Agreement between DOE and EPA. This report, prepared in accordance with the guidelines in DOE/E-0023 (DOE 1981), covers the program activities for calendar year 1981. It contains descriptions of pertinent features of the NTS and its environs, summaries of the EMSL-LV dosimetry and sampling methods, analytical procedures, and the analytical results from environmental measurements. Where applicable, dosimetry and sampling data are compared to appropriate guides for external and internal exposures of humans to ionizing radiation.

SECTION 3

DESCRIPTION OF THE NEVADA TEST SITE

Historically, the major programs conducted at the NTS have been nuclear weapons development, proof-testing and weapons safety and effects, 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, seismic studies (Vela Uniform), and studies of high-level waste storage. During 1981, nuclear weapons development, proof-testing and weapons safety, nuclear physics programs, and studies of high-level waste storage were continued at the NTS. 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. More detail and pertinent maps for the portions of this section are included in Appendix A. Only selected information is presented in this Section.

SITE LOCATION

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

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

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 precipitation to support the growth of common food crops without irrigation.

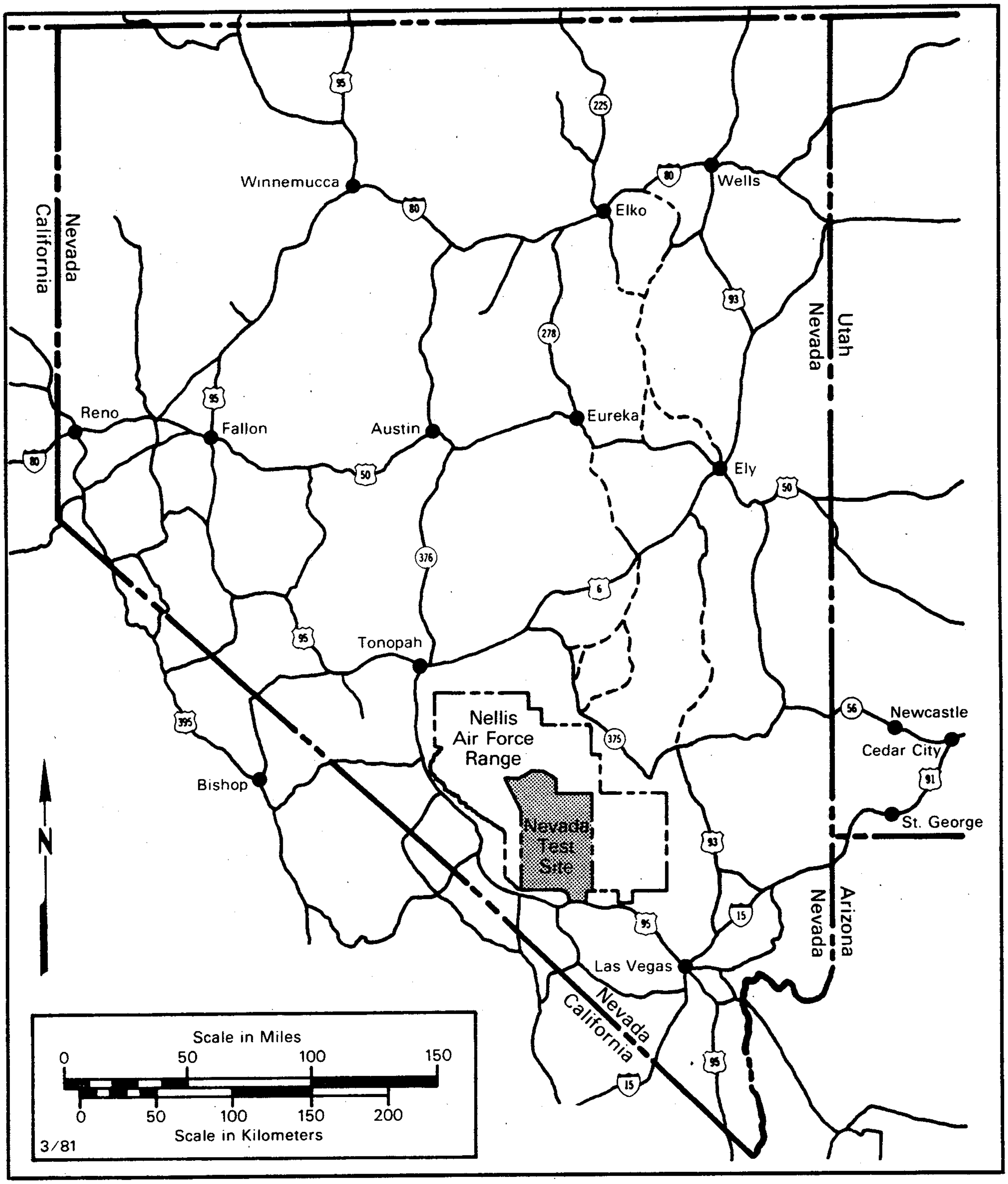


Figure 1. Location of the Nevada Test Site (NTS).

As Houghton et al. (1975) 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.

The wind direction, as measured on a 30-m tower at an observation station about 9 km NNW of Yucca Lake near CP-1, is predominantly northerly except during May through August when winds from the south-southwest predominate (Quiring 1968). Because of the prevalent mountain/valley winds in the basins, south to southwest winds predominate during daylight hours of most months. During the winter months southerly winds have only a slight edge over northerly winds for a few hours during the warmest part of the day. These wind patterns are often 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 (see Figure A-1). This is particularly true for those areas in which underground experiments are conducted. A comprehensive summary of the geology and hydrology of the NTS edited by Eckel was published in 1968.

The aquifers underlying the NTS vary in depths from about 200 m beneath the surface of valleys in the southeastern part of the site to more than 500 m beneath the surface of highlands to the north. Although much of the valley fill is saturated, downward movement of water is retarded by various tuffs and is extremely slow. The primary aquifer in these formations consists of Paleozoic carbonates that underlie the more recent tuffs and alluviums.

LAND USE OF NTS ENVIRONS

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

The major body of water close to the NTS is Lake Mead (120 km southeast, Figure A-2), 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.

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 (Figures A-4 and A-5). The family cows and goats are distributed in all directions around the NTS, whereas most dairy cows are located to the southeast (Moapa River, Nevada; Virgin River Valley, Nevada; and Las Vegas, Nevada), northeast (Lund), and southwest (near Barstow, California).

Grazing is the most common land use within 300 km of the site. Approximately 280,000 cattle and 180,000 sheep are distributed within the area as shown in Appendix Figures A-6 and A-7, respectively. The estimates are based on information supplied by the California county agents during 1980, from 1979 agricultural statistics supplied by the Nevada Department of Agriculture and from 1978 census information supplied by the Utah Department of Agriculture.

Population Distribution

Excluding Clark County, the major population center (approximately 462,000 in 1980), the population density within a 150 km radius of CP-1 on the NTS is about 0.5 persons per square kilometer. For comparison, the 48 contiguous states (1980 census) had a population density of approximately 29 persons per square kilometer. The estimated average population density for Nevada in 1980 was 2.8 persons per square kilometer.

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

AIRBORNE RELEASES OF RADIOACTIVITY AT THE NTS DURING 1981

All nuclear detonations during 1981 were conducted underground and were contained, although occasional releases of low-level radioactivity occur during re-entry drilling. Table 1 shows the total quantities of radionuclides released to the atmosphere, as reported by the DOE Nevada Operations Office (1982).

TABLE 1. TOTAL AIRBORNE RADIONUCLIDE EMMISIONS AT THE NTS DURING 1981

Radionuclide	Half-Life (days)	Quantity Released (Ci)
Tritium	4,500	534
Iodine-131	8.04	0.05
Xenon-133	5.29	2,700
Xenon-133m	2.33	29
Xenon-135	0.38	142

SECTION 4

QUALITY ASSURANCE

GOALS

The goals of the EMSL-LV quality assurance program are to assure the collection and analysis of environmental samples with the highest degree of accuracy and precision obtainable with state-of-the-art instrumentation and to achieve the best possible completeness and comparability given the extent and type of networks from which samples are collected. To meet these goals, it is necessary to devote strict attention to both the sample collection and sample analysis procedures.

SAMPLE COLLECTION

The collection of samples is governed by a detailed set of Standard Operating Procedures (SOP's). These SOP's prescribe the frequency and method of collection, the type of collection media, sample containment and transport, sample preservation, sample identification and labeling, and operating parameters for the instrumentation. Sample control is an important segment of these activities as it enables tracking from collection to analysis for each sample and governs the selection of duplicate samples for analysis and the samples chosen for replicate analysis.

These procedures provide assurance that sample collection, labeling and handling are standardized to minimize sample variability due to inconsistency among samples.

SAMPLE ANALYSIS

All of the networks operated by the EMSL-LV have individual Quality Assurance Project Plans that assure the results of analysis will be of high accuracy and precision and will be comparable to results obtained elsewhere with equivalent procedures. The QA Plan is summarized in the following sections.

External QA

External QA provides the data from which the accuracy and precision of analysis can be determined. Accuracy is assessed from the results obtained on Intercomparison Study samples and on samples "spiked" with known amounts of radionuclides. The Offsite Radiological Safety Program participates in

Intercomparison Study Programs that include environmental sample analysis, TLD dosimetry, and whole-body counting. Also, samples unknown to the analyst are spiked by adding known amounts of radionuclides and entered into the normal chain of analysis.

Data for precision are collected from duplicate and replicate analyses. At least 10 percent of all samples are collected in duplicate. When analyzed, the data indicate the precision of both sample collection and analysis. Replicate counting of at least 10 percent of all samples yield data from which the precision of counting can be determined.

If the accuracy and precision data are of sufficient quality, then comparability, i.e., comparison of the data with those of other analytical laboratories, can be assessed with confidence. The results of external QA procedures are shown in Appendix C.

Internal QA

Internal QA consists of those procedures used by the analyst to assure proper sample preparation and analysis. The principal procedures used are the following:

- Instrument background counts
- Blank reagent analyses
- Instrument calibration with known nuclides
- Internal standards analysis
- Performance check-source analysis
- Maintenance of control charts for background and check-source data
- Scheduled instrument maintenance

These procedures ensure that the instrumentation is not contaminated, that calibration is correct, and that standards carried through the total analytical procedure are accurately analyzed.

VALIDATION

After the results are produced, supervisory personnel examine the data to determine whether or not the analysis is valid. This includes checking all procedures from sample receipt to analytical result with particular attention to the internal QA data and comparison of the results with previous data from similar samples at the same location.

Any variant result or failure to follow internal QA procedures during sample analysis will trigger an internal audit of the analytical procedures and/or a re-analysis of the sample or its duplicate.

Examples of the operation of these procedures are mentioned on page 22, where a failure to follow the sampling SOP was detected; on page 50, where TLD readout problems were discovered; and on page 56, where duplicate sample analysis corrected a problem noted from comparison of data.

SECTION 5

RADIOLOGICAL SAFETY ACTIVITIES

The radiological safety activities of the EMSL-LV are divided into two major areas; special test support and routine environmental surveillance. Both of these activities are designed to detect any increase in environmental radiation which might cause exposure to individuals or population groups so that protective actions may be taken, to the extent feasible. These activities are described in the following portions of this report.

SPECIAL TEST SUPPORT

Before each nuclear test, mobile monitoring personnel are positioned in the offsite areas most likely to be affected should a release of radioactive material occur. They ascertain the locations of residents, work crews and animal herds and obtain information relative to controllability of residents in small population centers. These monitors, equipped with radiation survey instruments, gamma exposure-rate recorders, thermoluminescent dosimeters (TLD's), portable air samplers, and supplies for collecting environmental samples, are prepared to conduct a monitoring program as directed from the NTS Control Point (CP-1) via two-way radio communications.

For those tests which might cause ground motion detectable offsite, EPA monitors were stationed at locations where hazardous situations might ensue. At these locations, e.g., mines and specific buildings, occupants are evacuated, or warned against entry, until after the test is conducted.

Professional EPA personnel serve as members of the Test Manager's Advisory Committee to provide advice on possible public and environmental impact of each test and possible protective actions in case accidental releases of radioactivity should occur.

An EMSL-LV cloud sampling and tracking aircraft is flown over the 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 is flown to gather meteorological data and to perform cloud tracking. Information from these aircraft can be used in positioning the radiation monitors.

During CY 1981 none of the tests conducted at the NTS released radioactivity that was detected offsite.

PATHWAYS MONITORING

The offsite radiation monitoring program includes pathways monitoring consisting of air, water and milk surveillance networks surrounding the NTS and a limited animal sampling project. These are explained in detail below.

Air Surveillance Network

Network Design--

The ASN monitors an important route of human exposure to radionuclides: inhalation of airborne materials. Not only the concentration but also the source must be determined if appropriate corrective actions are to be taken. Thus the ASN is designed to circumscribe the NTS with a 200 km circle, is limited only by the availability of electric power and a resident for operation, and has a slight concentration of sampling stations in the prevailing downwind direction as shown in Figure 2. This continuously operating network is reinforced by a standby network which covers the contiguous States west of the Mississippi River, Figure 3.

Methods--

During 1981 the ASN consisted of 27 continuously operating sampling stations and 97 standby stations. Each sampler was equipped to collect both particulate and gaseous radionuclides.

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

Results--

Throughout the network, concentrations of beryllium-7, zirconium-95, niobium-95, ruthenium-103, ruthenium-106, cerium-141, and cerium-144 were detected. The principal means of beryllium-7 production is from spallation of oxygen-16 and nitrogen-14 in the atmosphere by cosmic rays. The remainder of the radionuclides detected were fission products attributed to atmospheric nuclear tests conducted by the People's Republic of China. The most recent Chinese test detected was conducted on October 15, 1980, at 9:30 p.m. PDT. Appendix Tables E-1 and E-2 summarize the data from the ASN samples. All time-weighted averages (Avg/a in the tables) are less than 1 percent of the Concentration Guide (Appendix D), for exposure to the general public.

During 1981, no airborne radioactivity related to nuclear testing at the NTS was detected on any sample from the ASN.

A plot of the logarithm of the individual concentrations for all stations during the year versus probits indicates that the air data are approximately lognormally distributed. The distributions for the individual nuclides that were detected indicated that there was a single source, assumed to be

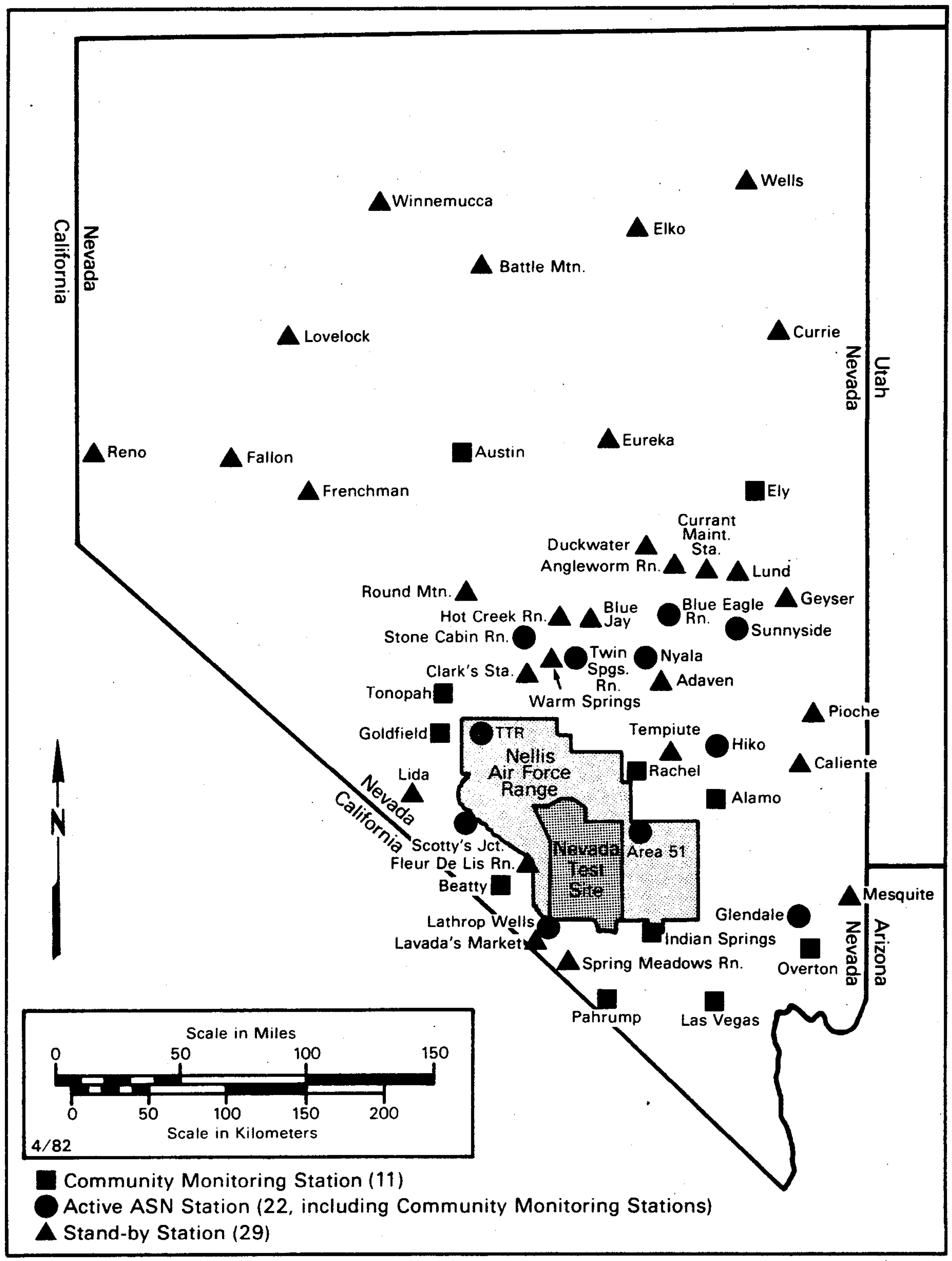


Figure 2. Air Surveillance Network stations within Nevada.

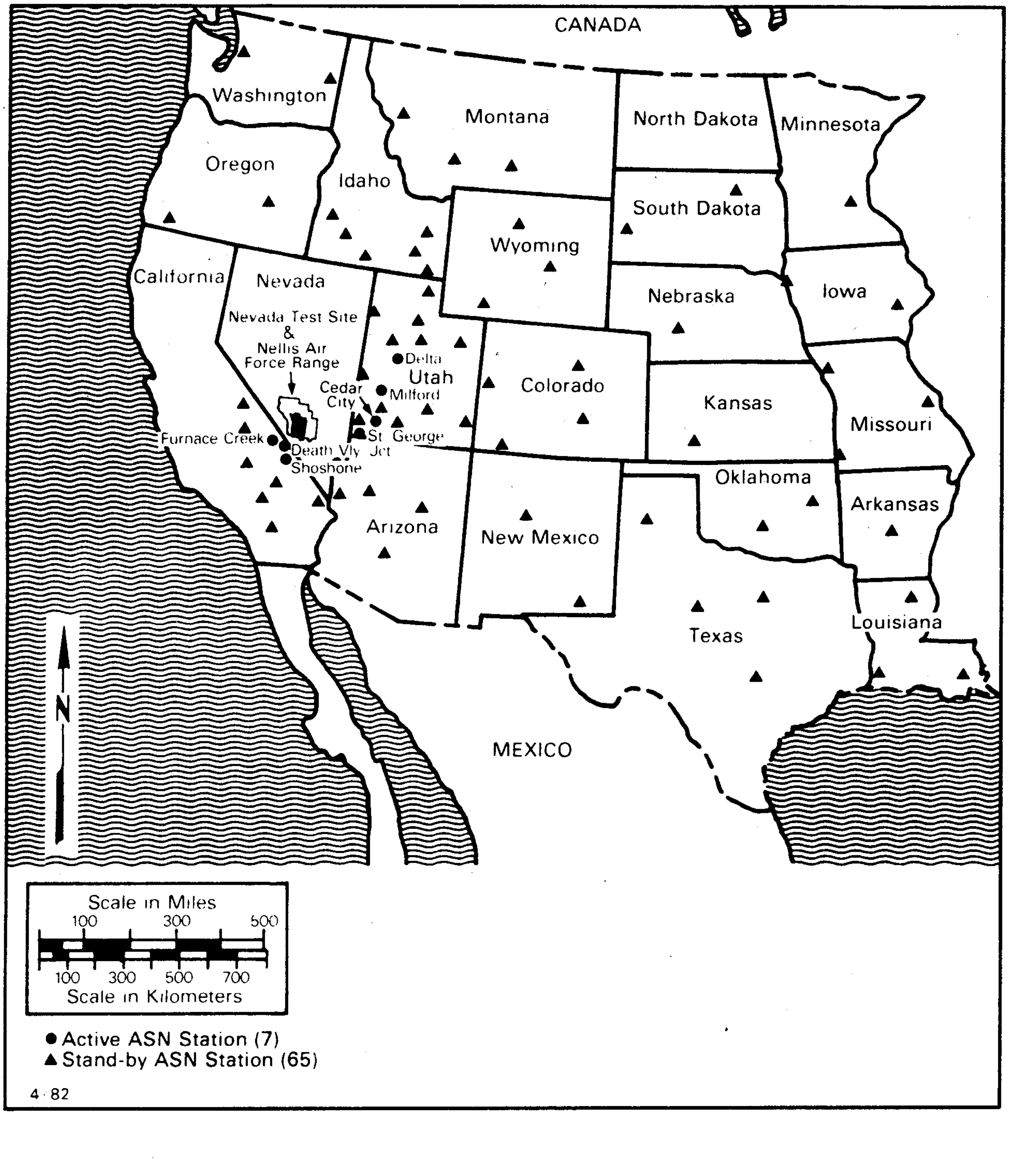


Figure 3. Air Surveillance Network stations in States other than Nevada.

atmospheric fallout because all stations were affected. The geometric mean concentrations and standard deviations for all of the measurements of each radionuclide measured throughout the whole Network, including standby stations, are shown in Table 2.

Two special studies are performed on the samples from the ASN: a gross beta analysis of the prefilters from 5 stations, and plutonium-238 and plutonium-239 analysis of composited prefilters from 11 stations.

The gross beta analysis is used to detect trends in atmospheric radioactivity more quickly than is possible with gamma spectrometry. For this study, three stations in Utah, north and east of the NTS, and two stations south and west of the NTS are used. The three filters per week from each station are analyzed for gross beta activity after a 7-day delay to decrease the contribution from radon daughter activity.

The gross beta study began in the first week of July 1980. The data suggest little significant difference among stations and show the normal trend of decreased activity to be expected after the rainout which occurs each spring. The maximum concentration measured was 0.17 pCi/m^3, the minimum was 0.012 pCi/m^3, and the arithmetic average was 0.047 pCi/m^3. A summary of the data is shown in Appendix Table E-4.

The plutonium study uses the prefilters from eight standby ASN stations, distant from the NTS, and from three ASN stations near the NTS. The filters from each standby station (operated 1 or 2 weeks per quarter) are composited quarterly, and those from the ASN stations are composited monthly. The composites are analyzed radiochemically as indicated in Appendix B.

TABLE 2. ASN GEOMETRIC MEAN CONCENTRATIONS

Material Detected	Geometric Mean Concentration (pCi/m^3)	Geometric Standard Deviation
Gross beta	0.039	2.3
Beryllium-7	0.32	1.4
Niobium-95	0.14	2.0
Zirconium-95	0.12	1.6
Ruthenium-103	0.059	1.6
Ruthenium-106	0.16	1.4
Cerium-141	0.049	1.4
Cerium-144	0.18	1.5

A plot of the quarterly average plutonium-239 data for the eight distant from and the three near to NTS stations, Figure 4, indicates that the concentration in air peaked for all stations in the 2nd Quarter of 1981 and that there was no significant difference between the two groups of stations. The plutonium concentration in air, though, was higher in 1981 than in 1980. The 1981 average annual concentration was 35 aCi/m^3 versus 16 aCi/m^3 in 1980. However, the plutonium-238 concentrations did not change very much; 2.3 aCi/m^3 in 1981 versus 1.8 in 1980. Considering the Pu-239 concentrations and the similarity of results from near and distant NTS stations, the probable source of the increased concentration of plutonium was the 0.2 to 1 megaton atmospheric nuclear test conducted by the People's Republic of China on October 15, 1980. A summary of the data is in Appendix Table E-5.

Noble Gas and Tritium Surveillance Network

Network Design--

There are several sources of the radionuclides monitored by this network. Noble gases are emitted from nuclear power plants, propulsion reactors, reprocessing facilities and nuclear explosions. Tritium is emitted from the same sources and is also produced naturally. The monitoring network will be affected by all these sources, but must be able to detect NTS emissions. For this purpose the samplers are located close to the NTS and particularly in drainage-wind channels leading from the test areas. In 1981 this network included ten stations around the NTS as well as six stations onsite as shown in Figure 5.

Methodology--

The noble gas samples are collected by compressing air into tanks. 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. Analysis starts by condensing the samples at liquid nitrogen temperature and using fractional distillation to separate the gases. The separate fractions of radioxenon and radiokrypton are dissolved in scintillation cocktails and counted in a liquid scintillation counter (see Appendix B).

For tritium sampling, a molecular sieve column is used to collect water from air. A prefilter is used to remove particles before air passes through the molecular sieve column. Up to 10 cubic meters of air are passed through each column over a 7-day sampling period. Water absorbed on the molecular sieve column is recovered, and the concentration of tritium in the water (HTO) is determined by liquid scintillation counting techniques (see Appendix B).

Results--

All results are shown in Appendix Table E-3 as the maximum, minimum and average concentration for each station. These data indicate that no radioactivity from NTS tests was detected offsite by the Noble Gas and Tritium Surveillance Network during 1981. However, radioactive xenon-133 was detected four times onsite at the BJY station. Those samples containing xenon-133 are listed in Table 3 with their associated krypton-85 results. All of these concentrations were less than 0.02 percent of the concentration guide for occupational exposures from xenon-133, (Appendix D).

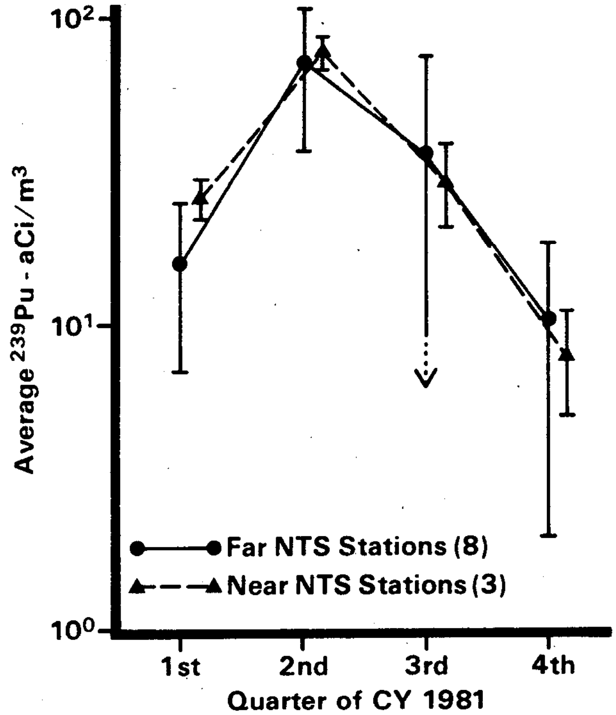


Figure 4. Average plutonium concentration in air at stations near to and distant from the NTS.

As shown in Figure 6, the concentrations of krypton-85 within the whole network appeared to have a bimodal distribution with three values not fitting the distribution. The samples from which these three values were measured were the first 3 samples listed in Table 3.

As these three values do not fit the distribution for the whole network and two of them also contained xenon-133, they are attributed to nuclear testing operations at the NTS. The bimodal distribution suggests that two sources of krypton-85 with different averages were sampled. The distribution with the lower modal concentration near 22 pCi/m^3 is possibly from worldwide ambient concentrations resulting from nuclear power generation and nuclear fuel processing. The source of the other distribution is not known, but is not attributed to nuclear testing at NTS due to the fact that the same bimodal distribution was observed at all network stations both onsite and offsite. The weighted average concentration of krypton-85 at all offsite stations that operated throughout the year was 24 pCi/m^3. During 1980 the concentrations of krypton-85 were lognormally distributed with an average concentration of 21 pCi/m^3.

The onsite BJY station continued to have the highest average concentration of krypton-85 with 26 pCi/m^3 (Table E-3). 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.

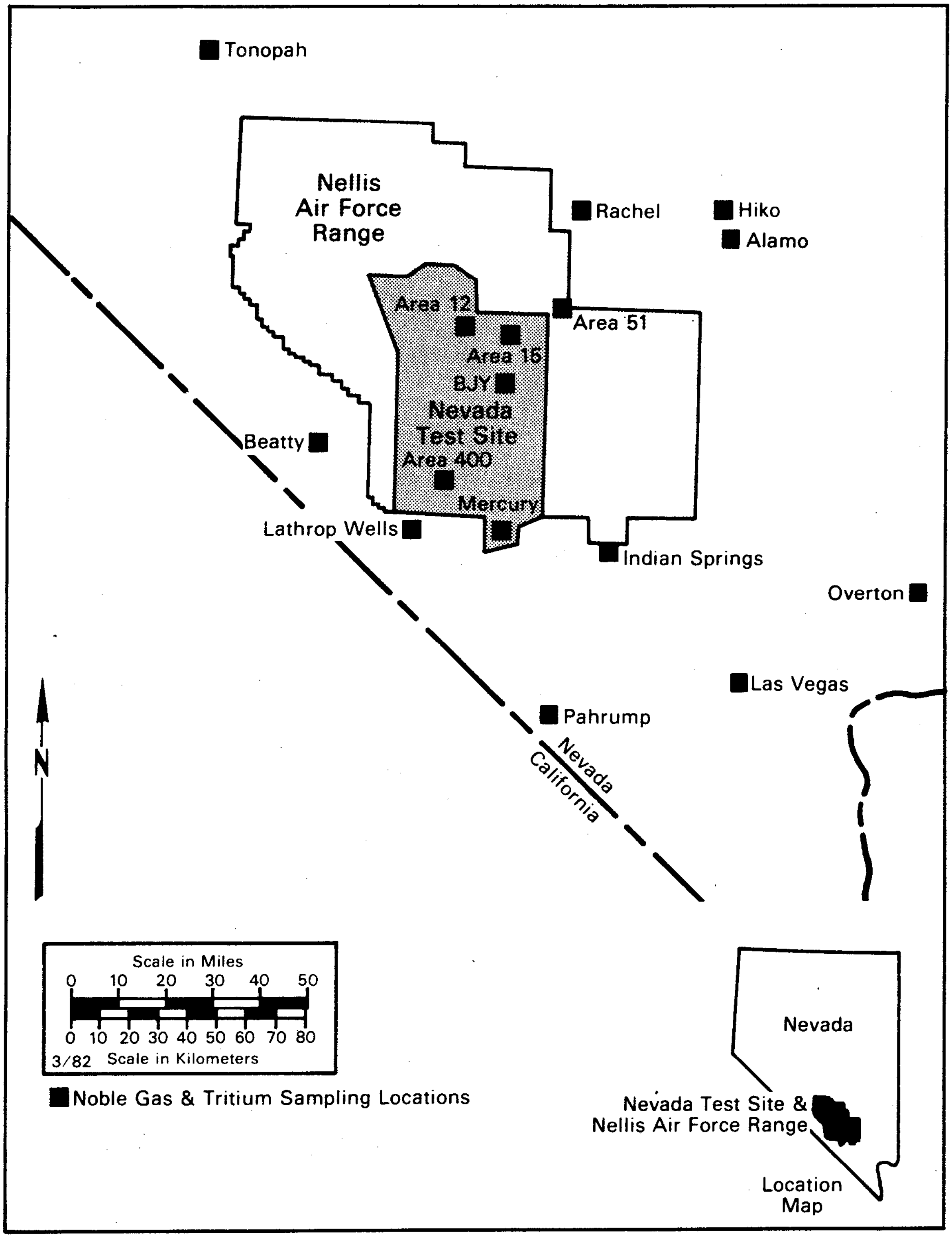


Figure 5. Noble Gas and Tritium Surveillance Network sampling locations.

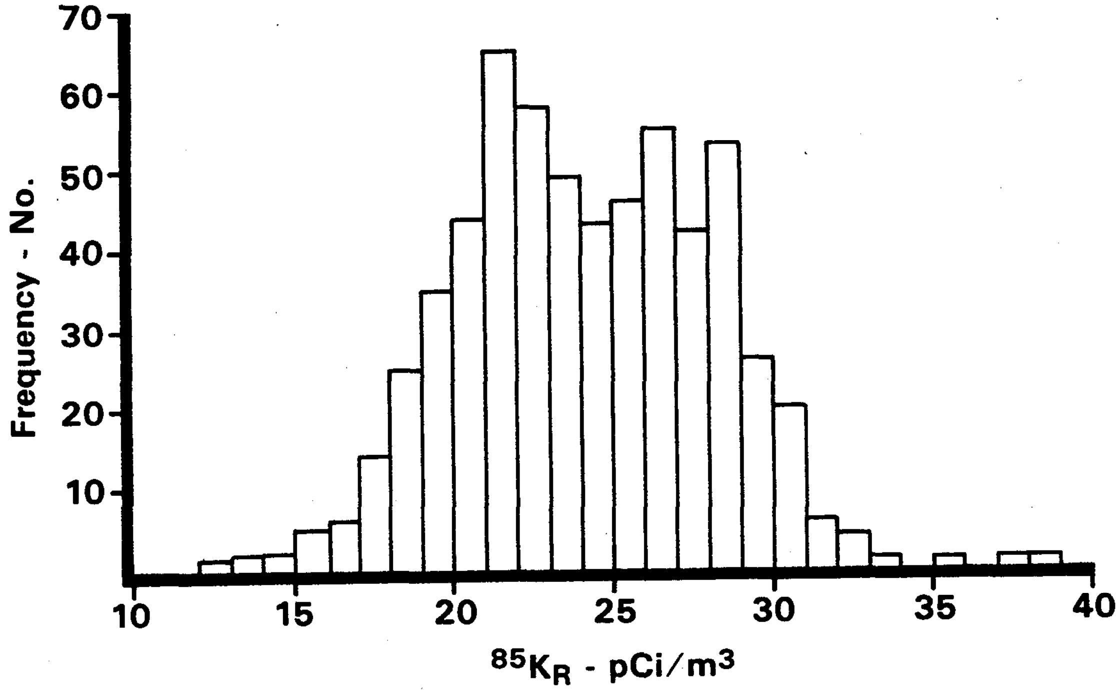


Figure 6. Frequency distribution of krypton-85 concentration in air, 1981 data.

TABLE 3. BJY COMPRESSED AIR SAMPLES CONTAINING HIGH CONCENTRATIONS

Collection Period		Concentration - pCi/m^3	
Date and Time ON	Date and Time OFF	Xe-133	Kr-85
02/18 1200	02/24 1025	<20	37 ± 3
08/24 1500	08/31 1500	1,500 ± 22	35 ± 3
09/08 1342	09/12 0815	26 ± 9	39 ± 6
09/12 0815	09/14 1500	310 ± 25	(Lost)
11/17 1335	11/23 1505	340 ± 10	25 ± 4

As shown in Table 4 and Figure 7, the average concentration of krypton-85 for the whole network has gradually increased since sampling began in 1972. This increase, observed at all stations, reflects the worldwide increase in ambient concentrations resulting from the increased use of nuclear technology. The rate of increase of ambient krypton-85 concentration seems to have accelerated in 1981. This is consistent with projections (Bernhardt, et al., 1973) of rapidly increasing concentrations. However, the measured network average in 1981 is only about 25 percent of the projected value of 99 pCi/m . Since nuclear fuel reprocessing is the primary source of krypton-85, the decision of the United States to defer fuel reprocessing may be one reason why krypton-85 levels have not increased as fast as predicted.

Using published data for krypton-85 concentration in air (NCRP 1975) and the data from our network (Table 4), the change over time was plotted as shown in Figure 7. Linear correlation analysis indicates that the krypton concentration/time relation is $pCi/m^3 = 5.8 + 0.8\ t$ where t is number of years after 1960.

As in the past, tritium concentrations in atmospheric moisture samples from the off-NTS stations were generally below the minimum detectable concentration (MDC) of about 400 pCi/L water (Appendix Table E-3). The tritium concentrations observed at off-NTS stations were considered to be representative of environmental background. Several stations on the test site had tritium concentrations consistently above background; the concentration averages for Area 15, BJY, and Area 12 were approximately 10 times the average for the offsite stations but were still less than 0.01 percent of the appropriate CG.

The distribution of all the measurements of tritium in atmospheric moisture for the whole network consisted of possibly two lognormal distributions with different means and standard deviations. All the tritium concentrations above background were measured in samples collected at the onsite stations. The geometric mean of the tritium concentrations for all offsite stations was evaluated as 170 pCi/L of moisture, which is below the minimum detectable concentration of about 400 pCi/L. The geometric standard deviation for the mean was determined to be 1.72.

Long-term Hydrological Monitoring Program

Network Design--

A major pathway for transport of radionuclides to individuals is potable water. This program monitors possible radioactive contamination of potable water sources. The design is for a system to monitor the aquifers underlying, and surface waters on or near, sites where nuclear explosions have occurred. For aquifers, monitoring is limited by the availability of wells that tap those sources. For the sites considered herein, a suitable number of wells is present so that sufficient monitoring data are obtained.

The monitored locations for the NTS and nearby offsite areas are shown in Figures 8 and 9. For Projects Cannikin, Longshot and Milrow in Alaska; for Projects Rio Blanco and Rulison in Colorado; for Projects Dribble and Miracle Play in Mississippi; for Projects Faultless and Shoal in Nevada; and for Projects Gasbuggy and Gnome in New Mexico, the sampling locations are shown in Figures E-1 through E-12 in Appendix E.

TABLE 4. ANNUAL AVERAGE KRYPTON-85 CONCENTRATIONS IN AIR, 1972-1981

Sampling Locations	^{85}Kr Concentrations (pCi/m^3)									
	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Alamo, Nev†	--	--	--	--	--	--	--	--	--	27
Beatty, Nev.	16	16	17	19	20	20	20	19	21	24
Diablo and Rachel, Nev.‡	16	16	17	18	19	19	20	19	21	24
Hiko, Nev.	16	16	17	17	17	19	20	19	21	24
Indian Springs, Nev.	--	--	--	20	20	20	20	19	21	24
NTS, Mercury, Nev.	16	16	18	18	19	20	20	19	21	23
NTS, Area 51, Nev.	16	16	17	18	20	19	20	19	21	24
NTS, BJY, Nev.	17	18	19	19	20	21	22	21	23	26
NTS, Area 12, Nev.	16	16	18	18	20	19	20	19	21	24
Tonopah, Nev.	16	16	18	17	19	19	20	18	21	25
Las Vegas, Nev.	16	16	17	18	18	20	20	--	--	24
Death Valley Jct., Calif.*	16	15	18	17	20	20	20	19	--	--
NTS, Area 15, Nev.	--	--	--	--	--	--	--	19	21	25
NTS, Area 400, Nev.	--	--	--	--	--	--	--	18	21	23
Lathrop Wells, Nev.	--	--	--	--	--	--	--	19	22	24
Pahrump, Nev.†	--	--	--	--	--	--	--	--	--	23
Overton, Nev.†	--	--	--	--	--	--	--	--	--	26
Network Average	16	16	18	18	19	20	20	19	21	24

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

Methods--

At each sampling location, four samples are collected. Two samples are collected in 500-mL glass bottles; one is used for tritium analysis and the other stored for use as a duplicate sample or to replace the original sample if it is lost in analysis. Two 3.5-L samples are filtered through 10 cm diameter membrane filters into cubitainers and acidified with HNO_3. One sample and the filter are gamma-scanned, the other sample is stored for duplicate analysis or for re-analysis as required.

Tritium and gamma spectrometric analyses are described in Appendix B. If the tritium concentration detected by the conventional analysis is less than 700 pCi/L, then the sample is reanalyzed using the enrichment method.

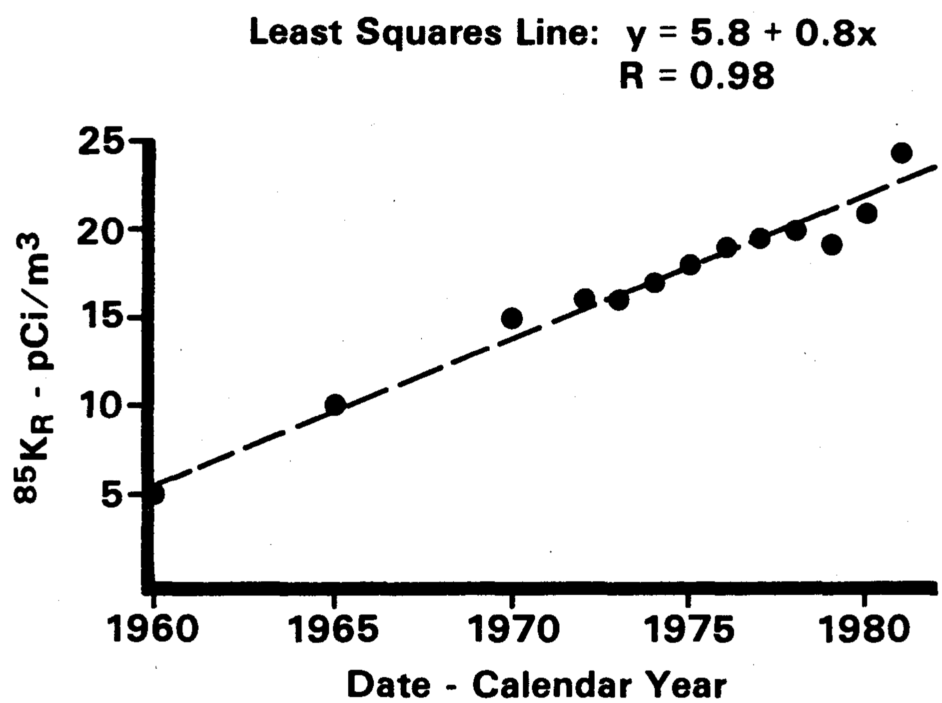


Figure 7. Trend in annual average krypton-85 concentration.

Results--

Table 5 lists the locations at which water samples were found to contain man-made radioactivity. Radioactivity in samples collected at these locations has been reported in previous years, except for Wells LRL-7 and DD-1, which were added to the program this year. The data for all samples analyzed are compiled in Appendix Tables E-6 through E-9 together with the percent of the relevant CG listed in Appendix D.

None of the radionuclide concentrations found at the locations listed in Table 5 are expected to result in radiation exposures to residents in the areas where the samples were collected. Well UE7NS is located on the NTS and is not used for drinking water.

USGS Wells 4 and 8, which were contaminated with the reported nuclides during tracer studies years ago, are on private land at the Project Gnome site in New Mexico and are closed and locked to prevent their use. Well DD-1 enters the Gnome cavity, to which Well LRL-7 is connected by a shaft for the disposal of contaminated soil and salt. As a result, both of these wells were expected to produce contaminated water.

The Project Dribble wells in Mississippi are about 1 mile from the nearest residence and are not sources of drinking water.

The shallow wells at the Project Long Shot site on Amchitka Island in Alaska are in an isolated location and are not sources of drinking water.

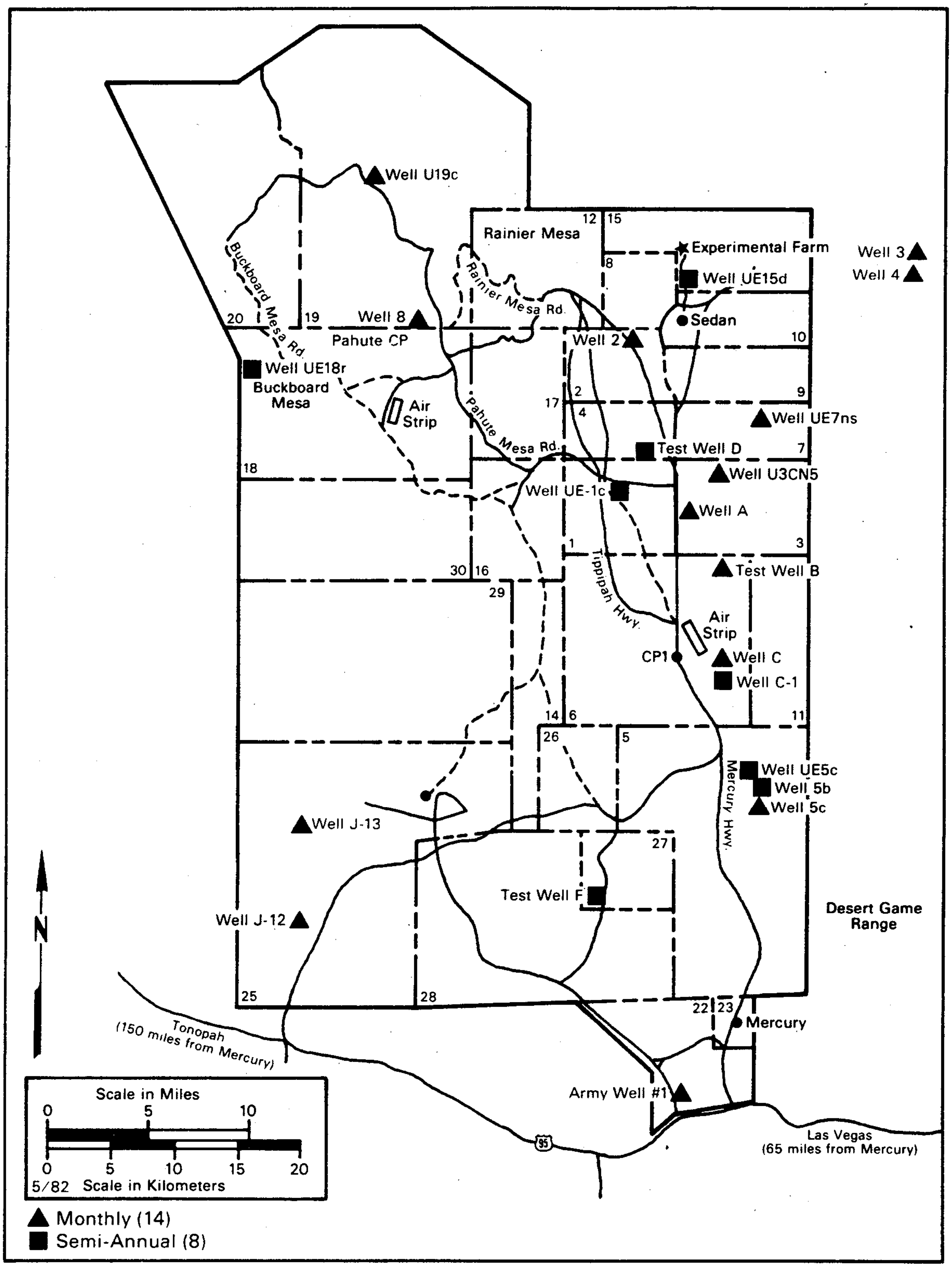


Figure 8. LTHMP sampling locations on the NTS.

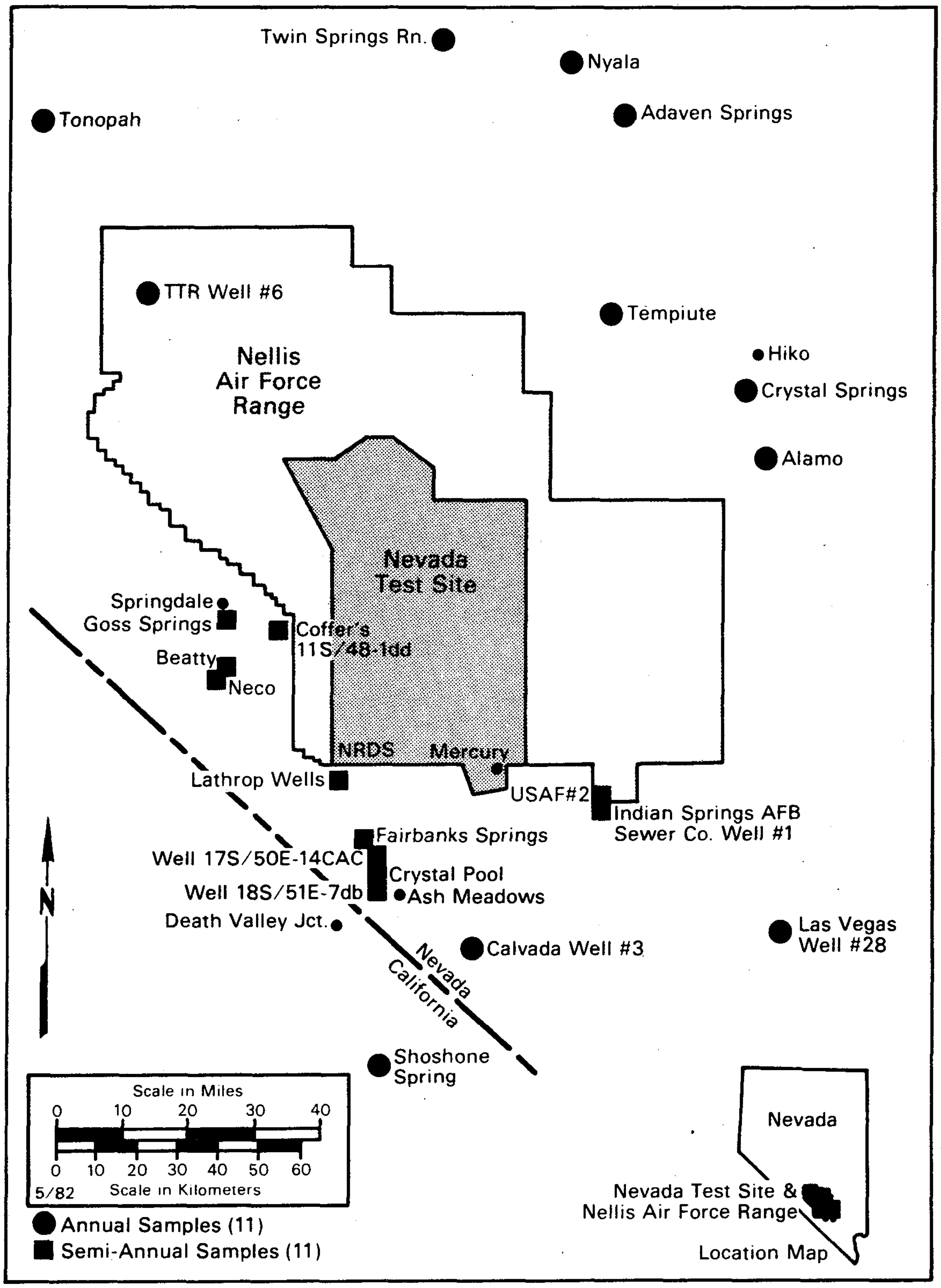


Figure 9. LTHMP sampling locations near the NTS.

TABLE 5. WATER SAMPLING LOCATIONS WHERE SAMPLES CONTAINED MAN-MADE RADIOACTIVITY

Sampling Location	Type of Radioactivity	Concentration (pCi/L)	% of Conc. Guide
NTS (Nev.)			
Well UE7NS	^{3}H	1,000-1,700	0.06
PROJECT GNOME (N. Mex.)			
USGS Well 4	^{3}H	400,000	13
	^{90}Sr	8,300	3,000
	^{137}Cs	27	0.2
USGS Well 8	^{3}H	340,000	11
	^{90}Sr	3,400	1,000
	^{137}Cs	67	0.3
Well LRL-7	^{3}H	39,000	1
	^{90}Sr	870	300
	^{137}Cs	350	2
Well DD-1	^{3}H	18 x 10	6,000
	^{90}Sr	310,000	100,000
	^{137}Cs	900,000	5,000
PROJECT DRIBBLE (Miss.)			
Half Moon Creek Overflow	^{3}H	830	0.03
Well HMH-1 through 11	^{3}H	29-12,000	0.04
Well HM-S	^{3}H	28,000	0.9
Well HM-L	^{3}H	2,700	0.09
REECo Pit Drainage-B	^{3}H	2,500	0.08
PROJECT LONG SHOT (Alaska)			
Well WL-2	^{3}H	290	<0.01
Well GZ, No. 1	^{3}H	4,200	0.01
Well GZ, No. 2	^{3}H	240	<0.01
Mud Pit No. 1	^{3}H	530	0.02
Mud Pit No. 2	^{3}H	850	0.03
Mud Pit No. 3	^{3}H	1,400	0.05

No gamma-emitting radionuclides were detected in any sample by gamma spectrometry analysis, except for USGS Well 8, Well LRL-7, and Well DD-1, at the Project Gnome Site which were contaminated with Cs-137 many years ago. The minimum detectable concentration for Cs-137 is about 10 pCi/L. (The Cs-137 in the sample from USGS Well 4 is attributed to contamination of the sampling gear, it has never been detected in samples collected in the past.)

Milk Surveillance Network

Network Design--

An important pathway for transport of radionuclides to humans is the air-forage-cow-milk chain. This pathway is monitored by EMSL-LV through analysis of milk. The design of the network is based on collections from areas likely to be affected by accidental releases from the NTS as well as from areas unlikely to be so affected. Additional considerations are: 1) a complete ring of stations to cover any eventuality, 2) stations at major milksheds as well as family cows, and 3) availability of milk cows.

Methods--

The network consists of two major portions, locations within 300 km of the NTS from which samples are collected quarterly (Figure 10) and locations in all major milksheds west of the Mississippi River from which samples are collected annually. One exception to the latter portion of the network is Texas; the State Health Department performs the surveillance of the milksheds in that State.

The quarterly raw milk samples are collected by EPA monitors in 4-liter plastic containers (cubitainers) and preserved with formaldehyde. The annual milk samples are also collected in cubitainers and preserved with formaldehyde. They are collected by contacting State Food and Drug Administration Representatives, after notification of the Regional EPA offices by telephone, and mailed to EMSL-LV for analysis.

All the milk samples are analyzed first for gamma-emitting nuclides by high-resolution gamma spectrometry and then for strontium-89 and strontium-90 by the methods outlined in Appendix B. A few samples are selected for tritium analysis. Occasionally a milk sample will turn sour thus preventing the strontium analysis, but the other analyses can generally be performed.

Results--

The analytical results from the 1981 milk samples are summarized in Appendix Table E-10 where the maximum, minimum, and average concentrations of tritium, strontium-89 and strontium-90 are shown for each sampling location. As shown in Table 6 below, the average concentrations of tritium and strontium-90 for the whole network are similar to the network averages for previous years. However, from the results of intercomparison samples used for quality assurance, the strontium results for 1981 are considered to be low by about 15 to 30 percent.

Other than naturally-occurring potassium-40, radionuclides were not detected by gamma spectrometry in any samples except one collected at the Droubay Dairy in St. George, Utah (replaced the Cottam Dairy), which contained

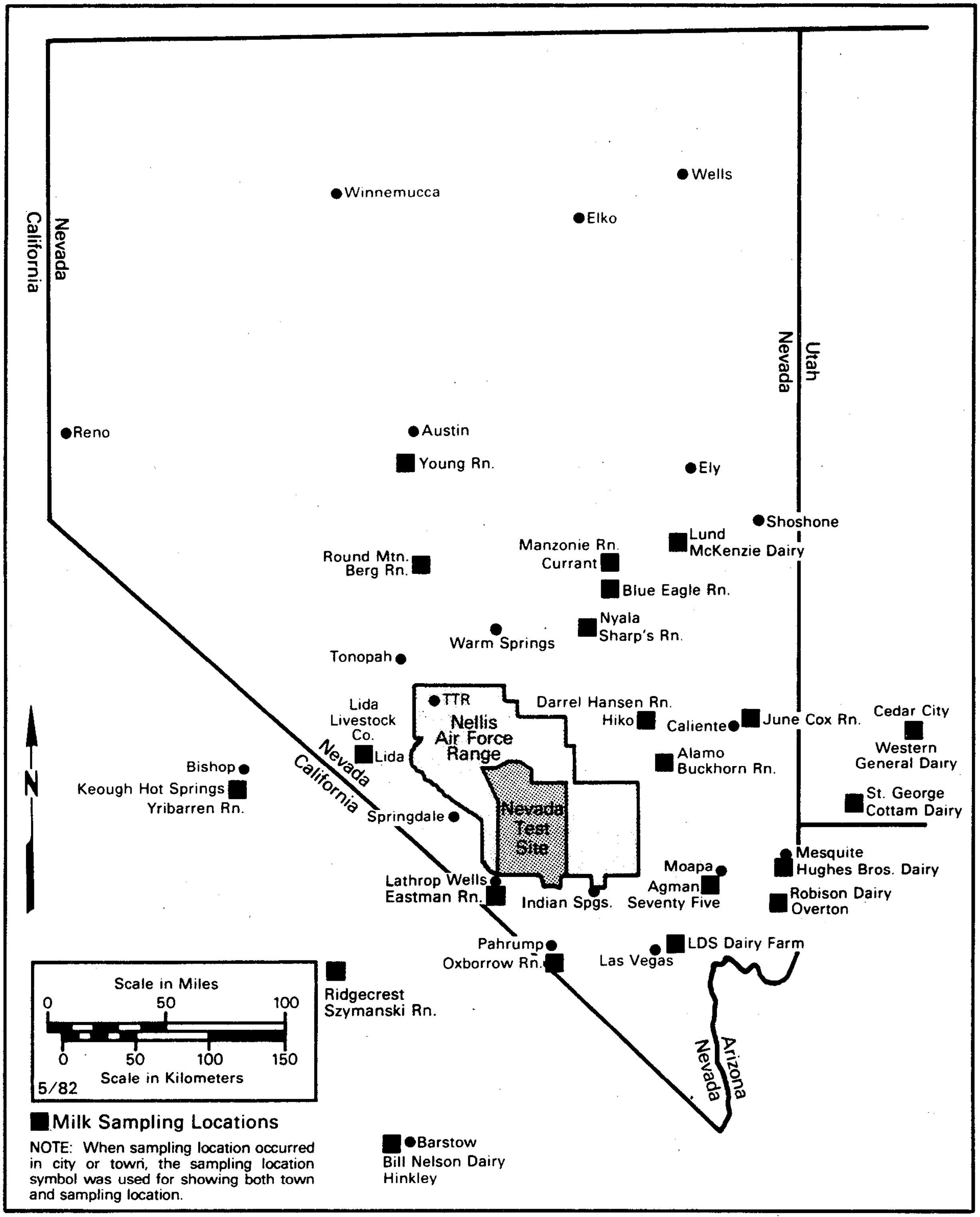


Figure 10. Milk sampling locations within 300 km of the NTS.

TABLE 6. NETWORK ANNUAL AVERAGE CONCENTRATIONS OF TRITIUM AND STRONTIUM-90 IN MILK, 1975 - 1981

	Average Concentrations - pCi/L	
Year	^{3}H	^{90}Sr
1975	<400	<3
1976	<400	<2
1977	<400	<2
1978	<400	1.2
1979	<400	<3
1980	<400	<2
1981	<400	1.9

cesium-137 at a concentration and two-sigma counting error of 9.1 ± 5.4 pCi/L. This radionuclide is attributed to past atmospheric fallout and has a concentration that is comparable to what has been observed previously.

The logarithms of the tritium and strontium-90 concentrations for the whole milk network were plotted versus probits. The tendency of the data to fit one straight line indicates that the data are lognormally distributed and represent a single source, which appears to be atmospheric fallout. These results are consistent with the results obtained for the Pasteurized Milk Network shown in Figure 11. This network is operated by the Eastern Environmental Radiation Laboratory in Montgomery, Alabama.

Biomonitoring Program

Objective--

This program began about 1957 and most recently was known as the Animal Investigation Program (AIP). The program had two major objectives; to measure the tissue concentration of radionuclides in beef cattle maintained life-long in an area used for above-ground nuclear tests and to measure radionuclides in the tissues of game animals (deer, bighorn sheep) which might become a source of exposure to humans.

Methods--

The beef herd of about 70 cattle had been maintained in Area 18, NTS, since the early 1960's. Each spring and fall the herd was collected and 3 to 6 animals sacrificed, including both yearling and aged animals. The samples collected from each animal included: liver, lung, tracheobronchial lymph node, muscle, thyroid, kidney, (fetus, if present) and rumen contents for gamma spectrometric analysis; blood (or tissue water) for tritium analysis;

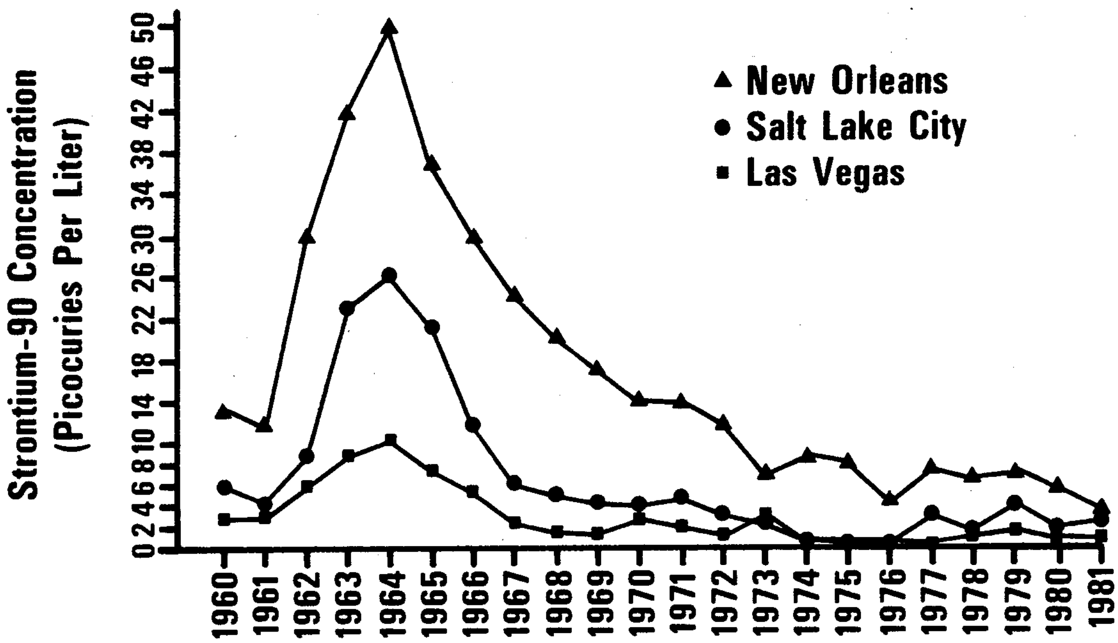


Figure 11. Strontium-90 concentration in Pasteurized Milk Network samples.

and femur or hock bone for strontium and plutonium analyses. Other animals found dead on the NTS, such as deer or sheep, were necropsied, examined for suspicious lesions, and samples taken for histopathological examination in addition to the samples taken for radionuclide analyses.

A sizeable mule deer herd resides in the mountainous regions of the NTS during the summer. If they move to unrestricted lands, these deer may be hunted by members of the public. A study designed to determine migration patterns of the herd by tracking individual deer wearing collars containing miniature radio transmitters was begun in 1975 and continued through 1981. During the summer and fall of 1981, 25 mule deer were captured either by the chemical restraint of free-ranging animals or by trapping (Giles 1979). Fourteen of these deer were fitted with radiotransmitter collars, ear tags, and reflective markers suspended from the collar. These 14 newly installed transmitters brought to 24 the total number of working transmitters in the field. Laboratory personnel monitored the movements of the deer weekly with hand-held receivers and directional antenna. The other 11 deer captured were unsuitable for collaring and were released after visible markers had been attached.

Bighorn sheep are not collected or monitored by EMSL-LV personnel, but samples for radionuclide analyses are obtained through the cooperation of licensed hunters or from animals killed in accidents.

Results--

Complete analyses of all samples collected this calendar year are not available for this report. These will be published in an AIP report when available (Smith et al. 1982). From previous reports, the trend in strontium-90 concentration in bone was derived and is shown in Figure 12 (Smith and Andrews 1981). A United Nations report includes a table on strontium-90 in human vertebra (New York residents), covering the years of 1962 through 1975 (UNSCEAR 1977), which shows a peak in 1965 followed by a decline similar to that shown by the data in Figure 12. The 1975 average for the human samples was about 3 pCi/g ash compared to the maximum of about 4 pCi/g ash in the NTS cattle. This suggests that most of the Sr in NTS cattle bones originated from world-wide fallout.

The deer migration pattern observed during the winter of 1981-1982 was similar to that observed in 1980-1981. During December and January, most of the deer captured on Pahute Mesa moved south to Timber Mountain or 40-Mile Canyon in Areas 29 and 30. However, two bucks moved off the NTS to the west, in the vicinity of Black Mountain north of Beatty.

By mid-December of 1981, six of the nine radio-equipped deer captured on Rainier Mesa moved to Shoshone Mountain in Areas 16, 29 and 14. The remaining three bucks, along with several unmarked deer of both sexes, stayed in Area 12 in the vicinity of N Tunnel and Captain Jack Spring all winter long.

EXTERNAL EXPOSURE MONITORING

Thermoluminescent Dosimetry Network

External radiation exposure of people is due primarily to medical sources and to natural sources such as cosmic radiation and naturally-occurring radiactivity in soil. Radioactivity from fallout generated by the early atmospheric nuclear testing causes approximately 0.6 percent of a person's total exposure. Until 1965, film badges were used to document external exposure, but TLD's gradually replaced film as the measurement instrument because of their greater sensitivity and precision. From 1970 to 1974 the EMSL-LV used the TLD-12 dosimeter but changed to the TLD-200 in 1975.

Network Design--

The TLD network is designed to measure environmental radiation exposure at a location rather than to an individual because of the many uncertainties associated with personal monitoring. Several individuals, some residing within and some residing without estimated fallout zones from past nuclear tests at the NTS, have been monitored so that any correlations that may exist between personal and environmental monitoring could be obtained. The network consists of 80 monitored locations encircling the NTS with some concentration in the area of the estimated fallout zones (Figure 13). This arrangement permits an estimate of average background exposure; yet any increase due to NTS activities can be detected.

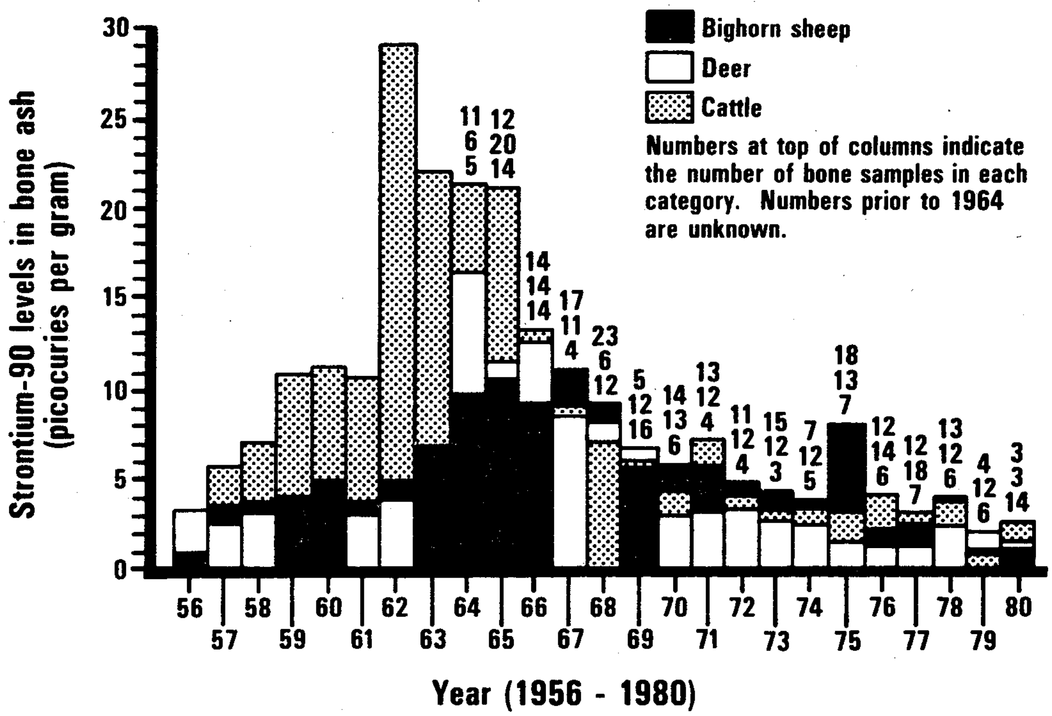


Figure 12. Strontium-90 concentration trends in animal bone.

Methods--

In 1981 the TLD Network consisted of 80 stations at both inhabited and uninhabited locations within a 300-km radius of the CP-1. Each station is equipped with three Harshaw Model 2271-G2 (TLD-200) thermoluminescent dosimeters (TLD's) to measure gamma exposure doses resulting from environmental background as well as accidental releases of gamma-emitting radioactivity. Within the area covered by the Network, 43 offsite residents wore dosimeters during 1981. All TLD's were exchanged quarterly.

In CY81, a station was added at the University of Nevada in Las Vegas, and 13 stations were moved from their original locations to the Community Monitoring Station in the same area.

The Model 2271-G2 (TLD-200) 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 43 offsite residents who are instructed in its proper wearing.

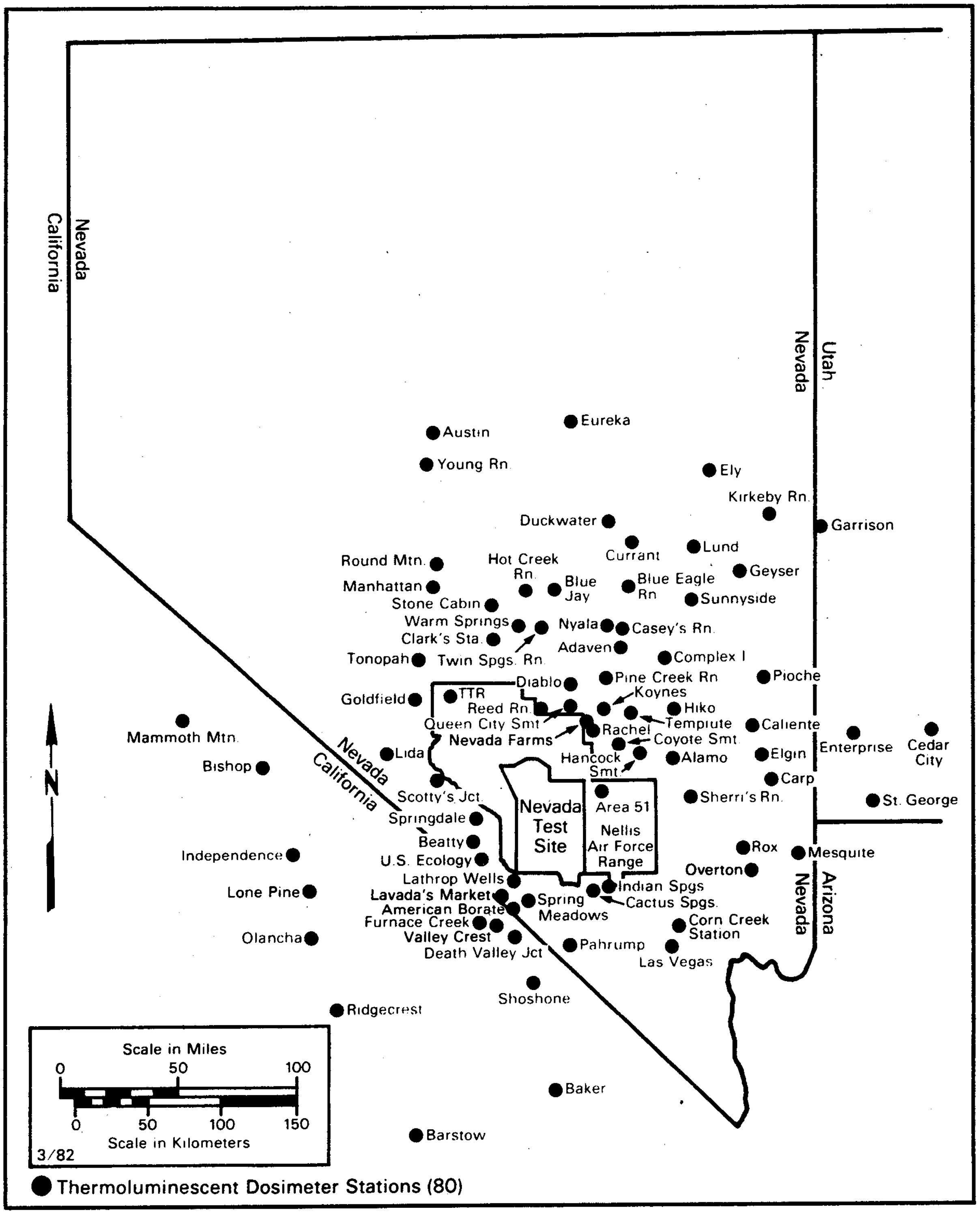


Figure 13. Locations monitored with TLD's.

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

The smallest exposure above background radiation that can be determined from these TLD readings depends primarily on the magnitude of variations in the natural background exposure rate at the particular station. In the absence of other independent exposure rate measurements, the present exposure rate is compared 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 1 to 5 mR above background. Depending on location, the background ranges from 15 to 35 mR per quarter. The term "background," as used in this context, refers to naturally-occurring radioactivity plus a contribution from residual manmade fission products, such as worldwide fallout.

Results--

Appendix Table E-11 lists the maximum, minimum, and average dose equivalent rate (mrem/day) and the annual adjusted dose equivalent rate (average in mrem/day times the number of days in the year) measured at each station in the Network during 1981. No allowance was made for the small additional exposure due to the neutron component of the cosmic ray spectrum. Four stations exhibited exposure in excess of background. They were the Complex I station during First Quarter 1981, the Bishop and Mammoth Mountain stations Third Quarter 1981, and the Area 51-NTS station during Fourth Quarter 1981. Each exposure was investigated and the possible cause of exposure noted in the Quarterly Interim Report. None of the net exposures were attributed to NTS activities.

Appendix Table E-12 lists the personnel number; associated background station; the maximum, minimum, and average dose equivalent rate (mrem/d); and the annual dose equivalent (mrem) measured for each offsite resident monitored during 1981. Six resident dosimeters exhibited exposures in excess of background. These exposures are attributed to higher background levels in the residence than at the station location or to occupational exposure (resident No. 49). The average dose equivalent rates of the offsite residents were generally lower than their background stations due to the shielding provided by their bodies and by their homes or places of work.

Table 7 shows that the average annual dose rate for the Dosimetry Network is consistent with the Network average established in 1975. Annual doses decreased from 1971 to 1975 with a leveling trend since 1975, except for a high bias in the 1977 results attributed to mechanical readout problems. The trend shown by the Network average is indicative of the trend exhibited by individual stations.

Because of the great range in the results, 40 to 142 mrem, an average for the whole area monitored may be inappropriate for estimating individual exposure. This would be particularly true if the exposure of a particular resident were desired. Since environmental radiation exposure can vary markedly with both altitude and the natural radioactivity in the soil, and since the altitude of the TLD station location is relatively easy to obtain, the measured dose rates were plotted as a function of altitude. As most of Nevada lies between 2,000 and 6,000 feet above mean sea level, this range was used and was split into two sections for plotting purposes. The results, shown in Figure 14, indicate that the average exposure at altitudes between 4,000 and 6,000 feet is about 20 mrem/a higher than that at altitudes between 2,000 and 4,000 feet, although both curves follow the same trend as the overall averages listed in Table 7. Thus, if an individual does not live near a monitored location, an estimate of exposure could be based on the altitude of his residence and rather than on the average for the whole area monitored.

INTERNAL EXPOSURE MONITORING

Internal exposure is caused by ingested or inhaled radionuclides that remain in the body either temporarily or for longer times because of storage in tissues. At EMSL-LV two methods are used to detect such body-burdens: whole-body counting and urinalysis.

The whole-body counting facility has been maintained at EMSL-LV since 1966 and is equipped to determine the identity and quantity of gamma-emitting

TABLE 7. DOSIMETRY NETWORK SUMMARY FOR THE YEARS 1971 - 1981

	Environmental Radiation Dose Rate (mrem/y)		
Year	Maximum	Minimum	Average
1971	250	102	160
1972	200	84	144
1973	180	80	123
1974	160	62	114
1975	140	51	94
1976	140	51	94
1977	170	60	101
1978	150	50	95
1979	140	49	92
1980	140	51	90
1981	142	40	90

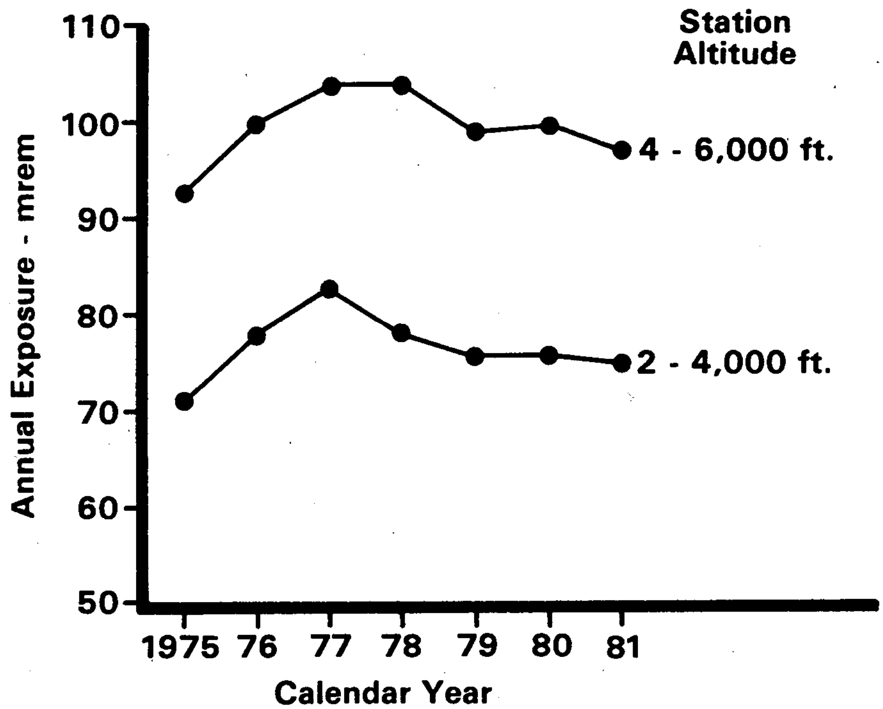


Figure 14. Average annual TLD exposure as a function of station altitude.

radioactive materials which may have been inhaled or ingested into the body. A single thallium-activated sodium iodide crystal, 28 x 10 centimeters, is used to measure gamma radiation having energies ranging from 0.1 to 2.5 MeV. Two phoswich detectors are available and can be placed on the chest to measure low-energy radiation - for example, 17 KeV x-rays from plutonium-239. The most likely mode of intake for most alpha-emitting radionuclides is inhalation, and the most important of these also emit low-energy X rays which can be detected in the lungs by the phoswich detectors.

Network Design

This activity consists of two portions, an Offsite Human Surveillance Program and a Radiological Safety Program. The design for the Offsite Human Surveillance Program is to measure radionuclide body-burdens in a representative number of families who reside in areas that were subjected to fallout during the early years of nuclear weapons tests. A few families who reside in areas not affected by such fallout were also selected for comparative study. The principal constraint to the program is the cooperation received from the people in the area of study.

The Radiological Safety portion requires all employees who may be exposed to radioactive materials in the course of their work to undergo a periodic whole-body count.

Methods

The Offsite Human Surveillance Program was initiated in December 1970 to determine levels of radioactive nuclides in some of the families residing in communities and ranches surrounding the Nevada Test Site. Biannual counting is performed in the spring and fall. This program started with 34 families (142 individuals). In 1981, 16 of these families, 42 individuals, were still active in the program. The geographical locations of the families which have participated are shown in Figure 15.

These persons travel to the Environmental Monitoring Systems Laboratory where a whole-body count of each person is made to determine the body burden of gamma-emitting radionuclides. A urine sample is collected for analysis and a short medical history, complete blood count, thyroid profile and physical examinations are obtained on each participant. Results of the whole-body count are available before the families leave the facility and are discussed with the subjects. The results of the blood and urine tests are sent to the families, along with a letter of explanation from the examining physician.

In 1981, 15 new families were added to the surveillance program. These people are in charge of the community monitoring stations described on page 35. As with the first group of families, each person will receive a whole-body count, medical history, complete blood count, thyroid profile, etc. This group will participate annually.

In addition to these offsite families, counts are performed routinely on EPA and EG&G employees as part of the health monitoring programs. Selected individuals from the general population of Las Vegas and other cities are also counted to obtain comparative data.

Results

During 1981, a total of 568 whole-body and 479 phoswich spectra were obtained from individuals, of which 89 were from persons participating in the Offsite Human Surveillance Program. Also, about 1,800 spectra for calibrations and background were generated. Cesium-137 is generally the only fission product detected and small amounts were found in one of the persons counted; an employee who recently moved to this area. Body burdens of Cs-137 in the offsite population detected in previous years were similar to those in other U.S. residents from California to New York. All spectra collected in 1981 were representative of normal background for people and showed only natural potassium-40 with the one exception mentioned above. No plutonium was detected in any of the phoswich spectra.

The concentration of tritium in urine samples from the offsite residents varied from <280 to 1,120 pCi/L with an average value of 274 pCi/L. The two values of 1,098 and 1,120 changed to <280 pCi/L when a second sample was analyzed. The concentrations measured were in the range of background levels measured in water and reflect only natural exposure.

As reported in previous years, medical examination of the offsite families revealed a generally healthy population. In regard to the hemato-

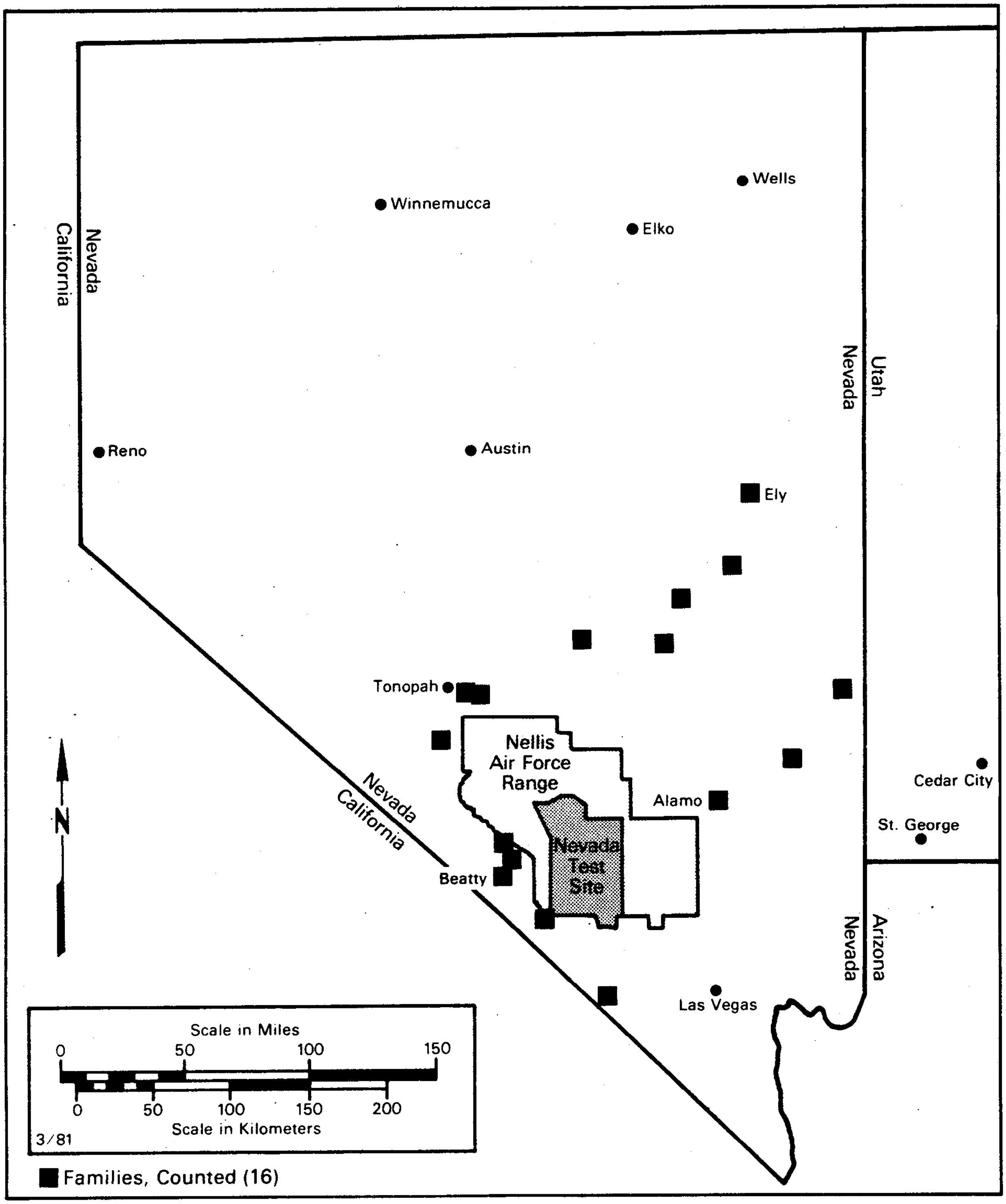


Figure 15. Location of families participating in the offsite Human Surveillance Program.

logical examinations and thyroid profiles, no abnormal results were observed which could be attributed to past or present NTS testing operations. A report on data for these families, "Results of a Surveillance Program for Persons Living Around the Nevada Test Site - 1971 to 1980," has been accepted for publication in Health Physics (Patzer and Kaye 1982).

A summary report of significant findings from the beginning of whole-body counting at the Laboratory in 1963 has been prepared and is being reviewed.

COMMUNITY MONITORING STATIONS

To increase public knowledge about and participation in radiological surveillance activities as conducted by DOE and EPA; the DOE, through an Interagency Agreement with EPA and contracts with the Desert Research Institute (DRI) of the University of Nevada, and the University of Utah, has established a network of 15 Community Monitoring Stations in the off-NTS areas. Each station is operated by a local resident, preferably a science teacher, who is trained in radiological surveillance methods by the University of Utah. The stations are equipped and maintained, and samples are collected and analyzed by EMSL-LV. DRI provides data interpretation to the communities involved.

Each station will contain one of the samplers for the ASN, NGTSN and Dosimetry networks discussed earlier, plus a pressurized ion chamber and recorder for immediate readout of external gamma exposure, and a recording barograph. All of the equipment is mounted on a stand at a convenient location in each community so the residents are aware of the surveillance and, if interested, can have ready access to the data. The station locations are those indicated in Figure 2 plus Shoshone, California; St. George, Cedar City and Salt Lake City, Utah.

Not all Community Monitoring Stations were in full operation by year's end 1981 so what data have been collected (ASN and NGTSN) are included in Appendix E.

CLAIMS INVESTIGATIONS

One of the public service functions of the EMSL-LV is to investigate claims of injury allegedly due to radiation originating from NTS activities. A physician and a veterinarian, qualified by education or experience in the field of radiobiology, investigate claims of radiation injury to determine whether or not radiation exposure may be involved.

Investigation of claims from people involves determining the type of illness, from examining physicians records and diagnoses, and determining the possibility of radiation exposure through residence history and examination of historical radiation surveillance data. These investigations can be conducted by the Medical Liaison Officers Network (MLON) or by the EMSL-LV physician, depending on where the claim is made. The MLON is composed of physicians, one from each state, who are trained in radiobiology.

An MLON Conference will be held at the Environmental Monitoring Systems Laboratory, Las Vegas, Nevada, during the fall of 1983. The purpose of the meeting will be to update current information on the biological effects of radiation, its diagnosis and treatment. During 1981 the MLON made 13 investigations of persons with alleged radiation claims, responded to nine inquires and completed seven evaluations.

The EMSL-LV veterinarian conducts similar investigations for claims of injury to domestic animals. In most cases the injuries investigated have been due to common causes such as bacterial infections or unusual events such as feeding on halogeton, a poisonous plant. In 1981 one potential claim was investigated; sudden death of two goat kids near Rachel, Nevada. By physical examination, histopathology and radionuclide analysis of samples, and from symptoms described by the owner, a diagnosis of enterotoxemia was made. Radiation exposure apparently played no role in this incident.

DOSE ASSESSMENT

Dose assessment calculations for NTS-related radioactivity are not included in this report because detectable levels of radioactivity from the 1981 nuclear testing program at the NTS were not observed offsite by any of the monitoring networks. Residual radioactivity was observed in waters from wells in other nuclear testing areas known to be contaminated during past nuclear tests at the Project Dribble Site near Hattiesburg, Mississippi, Project Gnome near Malaga, New Mexico, and at the Project Long Shot Site on Amchitka Island, Alaska. However, the waters from these contaminated wells are not used for drinking purposes.

An estimate of exposure of an average adult in Nevada due to world-wide radioactivity can be made based on the data from the monitoring networks. The principal data are strontium-90 in milk (1.9 pCi/L) from previous atmospheric tests; krypton-85 in air (24 pCi/m^3) from power reactors and reprocessing plants; and plutonium-239 in air (35 aCi/m^3) from previous atmospheric tests and the recent Chinese atmospheric test.

Assumptions:
1) Breathing rate = 7,300 m^3/a
2) Water intake = 438 L/a, milk = 1/2 of water or 219 L/a
3) 8,766 hr/a

From DOE/EP-0023 Appendix B (DOE 1981a); first-year Dose Factors are:

1) Kr-85 (immersion) 2,200 mrem/hr per μCi/mL, whole body (μCi/mL = 10^{12} pCi/m^3),

2) Sr-90 (ingestion) 45 mrem/μCi intake, whole body, and

3) Pu-239 (inhalation) 4,800 mrem/μCi to lung.

Calculated annual dose:

Kr-85: $2{,}200 \text{ mrem/hr} \times 8{,}766 \text{ hr/a} \times \frac{24 \text{ pCi/m}^3}{10^{12} \text{ pCi/m}^3} = 4.63 \times 10^{-4} \text{ mrem/a}$

Sr-90: $45 \text{ mrem/}\mu\text{Ci} \times 10^{-6} \ \mu\text{Ci/pCi} \times 1.9 \text{ pCi/L} \times 219 \text{ L/a} = 0.0187 \text{ mrem/a}$

Pu-239: $4.8 \times 10^{4} \text{ mrem/}\mu\text{Ci} \times 35 \text{ aCi/m}^3 \times 10^{-12} \ \mu\text{Ci/aCi} \times 7{,}300 \text{ m /a} = 0.0123 \text{ mrem/a}$

The total annual dose to the average adult in Nevada from world-wide radioactivity detected by EMSL-LV monitoring networks is then 0.0315 mrem. Natural radioactivity in the body (K-40, C-14, Ra-226, etc.) causes annual internal doses ranging from 26 to 36 mrem per year (FRC 1960), and the calculated internal dose is only 0.3 percent of this 10 mrem variation.

The external exposures to Nevadans range from 40 to 142 mrem/a as measured by the TLD network. In the U.S., external exposures range from 63 to 200 mrem/a, depending on elevation (sea coast or Rocky Mountains) and on the natural radioactivity in the soil (NCRP 1971). The exposures measured by the TLD's compare favorably with that range as the TLD station's altitude varies from 500 to over 7,000 feet above MSL and the uranium content in soil probably also varies markedly among stations.

The highest postulated annual dose estimate to man, from the results of the 1980 Biomonitoring Program, was calculated to be 0.4 mrem. This would result from the Cs-137 content of muscle from the NTS beef herd if an individual ate 0.5 kg per day for the whole year and if all the muscle tissue had the maximum measured cesium concentration.

SECTION 6

REFERENCES

ANSI, 1975. "American National Standard Performance Testing and Procedural Specifications for Thermoluminescent Dosimetry (Environmental Applications)." ANSI N545-1975. American National Standards Institute, Inc., New York, New York.

Bernhardt, D. E., A. A. Moghissi and J. A. Cochran, 1973. Atmospheric Concentrations of Fission Product Noble Gases, pp. 4-19, in Noble Gases, CONF-730915, 1973.

California, 1980. Personal communication with California county agents.

DOE, 1981a. A Guide for Environmental Radiological Surveillance at U.S. Department of Energy Installations. Report No. DOE/EP-0023, July 1981.

DOE, 1981b. Environmental Protection, Safety, and Health Protection Program for DOE Operations; Chapter XI. Requirements for Radiation Protection. Order DOE 5480.1, U.S. Department of Energy, April 1981.

DOE, 1981c. Environmental Protection, Safety, and Health Protection Information Reporting Requirements. Order DOE 5484.1, U.S. Department of Energy, Feburary 1981.

DOE, 1982. Personal communication from Health Physics Division, DOE/NV, April 1, 1982.

Eckel, E. B., ed. 1968. "Nevada Test Site." Memoir 110. The Geological Society of America, Inc., Boulder, Colorado.

EPA, 1981. "Environmental Radioactivity Laboratory Intercomparison Studies Program 1978-1979." EPA-600/4-81-004. Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, Las Vegas, Nevada. (Available from U.S. Department of Commerce, NTIS, Springfield, VA 22161.)

ERDA, 1977. "Final Environmental Impact Statement, Nye County, Nevada." ERDA-1551. U.S. Energy Research and Development Administration, Nevada Operations Office, Las Vegas, Nevada. (Available from U.S. Department of Commerce, NTIS, Springfield, VA 22161.)

Fenske, P. R. and T. M. Humphrey, Jr., 1980. "The Tatum Dome Project Lamar County, Mississippi" NVO-225. U.S. Department of Energy. Nevada Operations Office, Las Vegas, Nevada.

FRC, 1960. Background Material for the Development of Radiation Protection Standards. Staff Report No. 1, Federal Radiation Council, May 1960.

Giles, K. R., 1979. "A Summer Trapping Method for Mule Deer." EMSL-LV-0539-27. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada.

Holder, L. E. "National Network of Physicians Investigates Claims of Radiation Injury in the Non-Occupationally Exposed Population." American Journal of Public Health. October 1972.

Houghton, J. G., C. M. Sakamoto, and R. O. Gifford, 1975. "Nevada's Weather and Climate." Special Publication 2. Nevada Bureau of Mines and Geology, Mackay School of Mines, University of Nevada, Reno, Nevada. pp. 69-74.

Jarvis, A. N. and L. Siu, 1981. Environmental Radioactivity Laboratory Intercomparison Studies Program - FY 1981-82, EPA-600/4-81-004, Las Vegas, NV, February 1981.

National Park Service, 1980. Personal communication with Chief Ranger R. Rainer, Death Valley National Monument, Death Valley, California.

NCRP, 1975. Natural Background Radiation in the United States. NCRP Report No. 45, National Council on Radiation Protection and Measurements, November 1975.

NCRP, 1971. Basic Radiation Protection Criteria. NCRP Report No. 39, National Council on Radiation Protection and Measurements, January 1971.

Nevada Department of Agriculture, 1979. "Nevada Agricultural Statistics 1979." Nevada Crop and Livestock Reporting Service, Reno, Nevada.

Patzer, R. G. and M. E. Kaye, 1981. "Results of a Human Surveillance Program in the Offsite Area Surrounding the Nevada Test Site." Submitted to Health Physics to be published in 1982.

Potter, G. D., R. F. Grossman, W. A. Bliss, D. J. Thomé, 1980. "Offsite Environmental Monitoring Report for the Nevada Test Site and Other Test Areas used for Underground Nuclear Detonation, January through December 1979." EMSL-LV-0539-36. U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Las Vegas, Nevada.

Quiring, R. E., 1968. "Climatological Data, Nevada Test Site, Nuclear Rocket Development Station (NRDS)." ERLTM-ARL-7. ESSA Research Laboratories, Las Vegas, Nevada.

Smith, D. D. and V. E. Andrews, 1981. Selected Radioisotopes in Animal Tissues: ^{90}Sr and ^{137}Cs Measurements from 1956 to 1977. U.S. Environmental Protection Agency Report EPA-600/3-81-027 (DOE/DP/00539-040), April 1981.

Smith, D. D., K. R. Giles and D. E. Bernhardt, 1982. Animal Investigation Program 1980 Annual Report: Nevada Test Site and Vicinity. U.S. Environmental Protection Agency. In press, 1982.

Toonkel, L. E., 1980. "Appendix to Environmental Measurements Laboratory, Environmental Quarterly." EML-371 Appendix, UC--11. Environmental Measurements Laboratory. U.S. Department of Energy, New York, N.Y. 10014.

UNSCEAR, 1977. Sources and Effects of Ionizing Radiations, United Nations Scientific Committee on the Effects of Atomic Radiation 1977 Report to the General Assembly.

Utah Department of Agriculture, 1979. "Utah Agricultural Statistics, 1978." State of Utah Department of Agriculture, Salt Lake City, Utah.

APPENDIX A. SITE DATA

SITE DESCRIPTION

A summary of the uses of the NTS and its immediate environs is included in Section 3 of this report. More detailed data and descriptive maps are contained in this Appendix.

Location

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

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

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 A-1 (Houghton et al. 1975) summarizes the characteristics of climatic types for Nevada.

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.

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

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

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

Geology and Hydrology

Two major hydrologic systems shown in Figure A-1 exist on the NTS (ERDA 1977). Ground water in the northwestern part of the NTS or in the Pahute Mesa area has been reported to flow at a rate of 2 m to 180 m per year to the south and southwest toward the Ash Meadows Discharge Area in the Amargosa Desert. It is estimated that the ground water to the east of the NTS moves from north to south at a rate of not less than 2 m nor greater than 220 m per year. Carbon-14 analyses of this eastern ground water indicate that the lower velocity is nearer the true value. At Mercury Valley in the extreme southern part of the NTS, the eastern ground water flow shifts southwestward toward the Ash Meadows Discharge Area.

Land Use of NTS Environs

Figure A-2 is a map of the off-NTS area showing a wide variety of land uses, such as farming, mining, grazing, camping, fishing, and hunting within a 300-km radius of the NTS. For example, west of the NTS, elevations range from 85 m below MSL in Death Valley to 4,420 m above MSL in the Sierra Nevada Range. Parts of two major agricultural valleys (the Owens and San Joaquin) are included. The areas south of the NTS are more uniform since the Mojave Desert ecosystem (mid-latitude desert) comprises most of this portion of Nevada, California, and Arizona. The areas east of the NTS are primarily mid-latitude steppe with some of the older river valleys, such as the Virgin River Valley and Moapa Valley, supporting irrigation for small-scale but intensive farming of a variety of crops. Grazing is also common in this area, particularly to the northeast. The area north of the NTS is also mid-latitude steppe, where the major agricultural activity is grazing of cattle and sheep. Minor agriculture, primarily the growing of alfalfa hay, is found in this portion of the State within 300 km of the NTS Control Point-1 (CP-1). Many of the residents grow or have access to locally grown fruits and vegetables.

Many recreational areas, in all directions around the NTS (Figure A-2) 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.

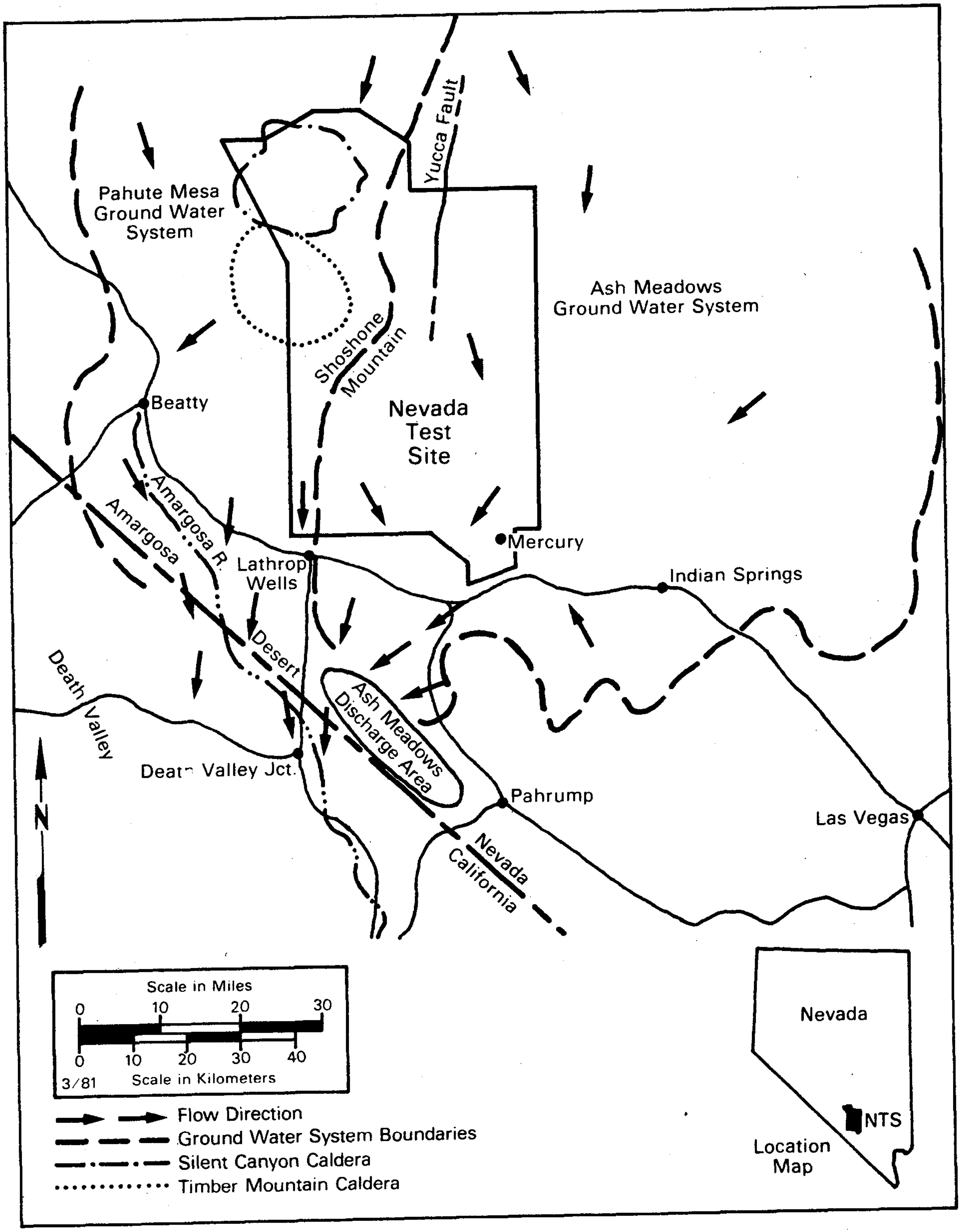


Figure A-1. Groundwater flow systems around the Nevada Test Site.

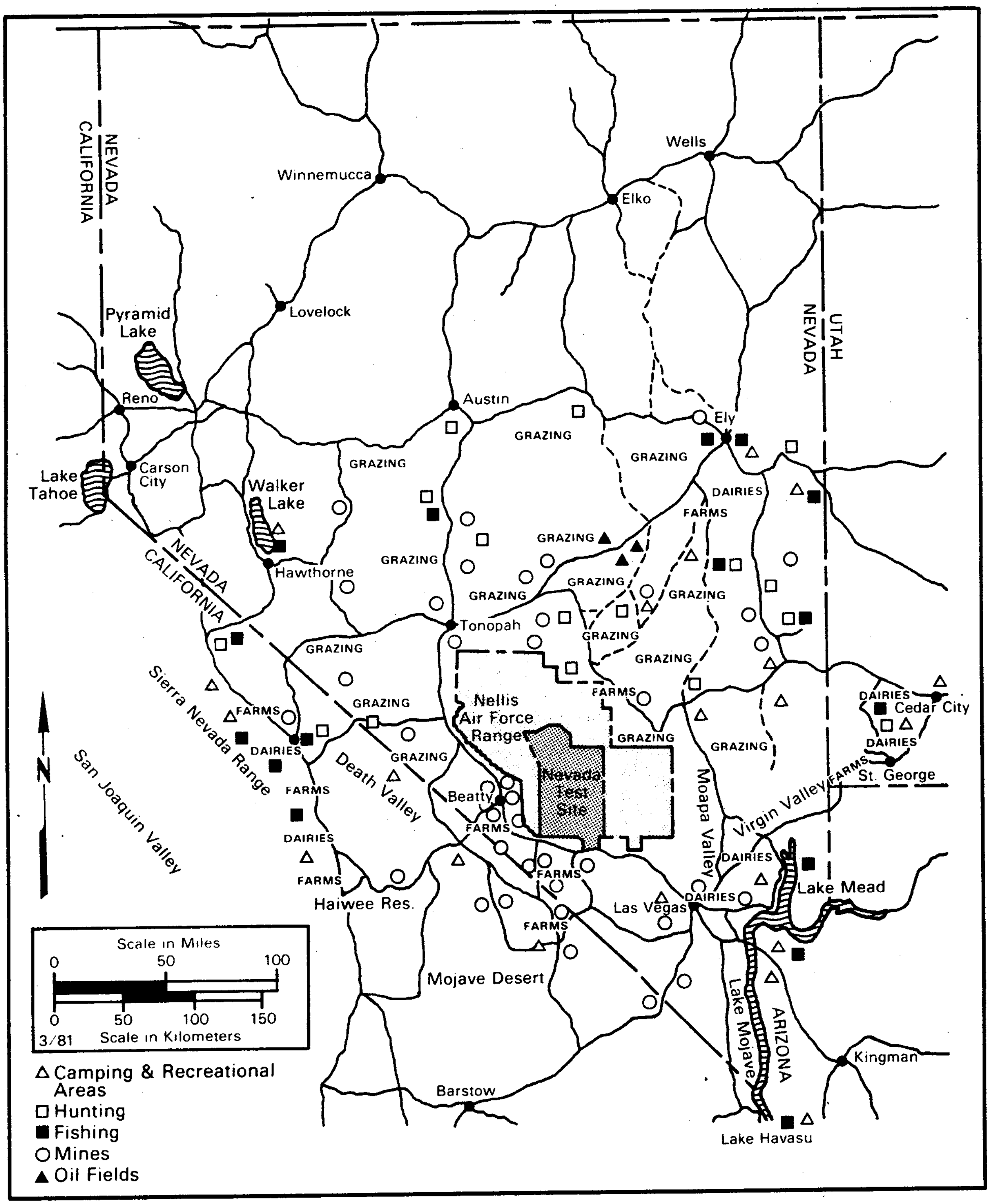


Figure A-2. General land use within 300 km of the Nevada Test Site.

Population Distribution

Figure A-3 shows the current population of counties surrounding the NTS based on preliminary 1980 census figures. Excluding Clark County, the major population center (approximately 462,000 in 1980), the population density within a 150 km radius of the NTS is about 0.5 persons per square kilometer. For comparison, the 48 contiguous states (1980 census) had a population density of approximately 29 persons per square kilometer. The estimated average population density for Nevada in 1980 was 2.8 persons per square kilometer.

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

The Mojave Desert of California, which includes Death Valley National Monument, lies along the southwestern border of Nevada. The National Park Service (1980) estimates that the population within the Monument boundaries ranges from a minimum of 900 permanent residents during the summer months to as many as 35,000 tourists and campers on any particular day during the major holiday periods in the winter months, and as many as 80,000 during "Death Valley Days" in the month of November. The largest town and contiguous populated area in the Mojave Desert is Barstow, located 265 km south-southwest of the NTS, with a population of about 17,600. The next largest populated area is the Ridgecrest-China Lake area, which has a population of about 20,000 and is located about 190 km southwest of the NTS. The Owens Valley, where numerous small towns are located, lies about 50 km west of Death Valley. The largest town in Owens Valley is Bishop, located 225 km west-northwest of the NTS, with a population of about 5,300 including contiguous populated areas.

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

The extreme northwestern region of Arizona is mostly range land except for that portion in the Lake Mead Recreation Area. In addition, several small communities lie along the Colorado River. The largest town in the area is Kingman, located 280 km southeast of the NTS, with a population of about 9,200. Figures A-4 through A-7 show the domestic animal populations in the counties near the NTS.

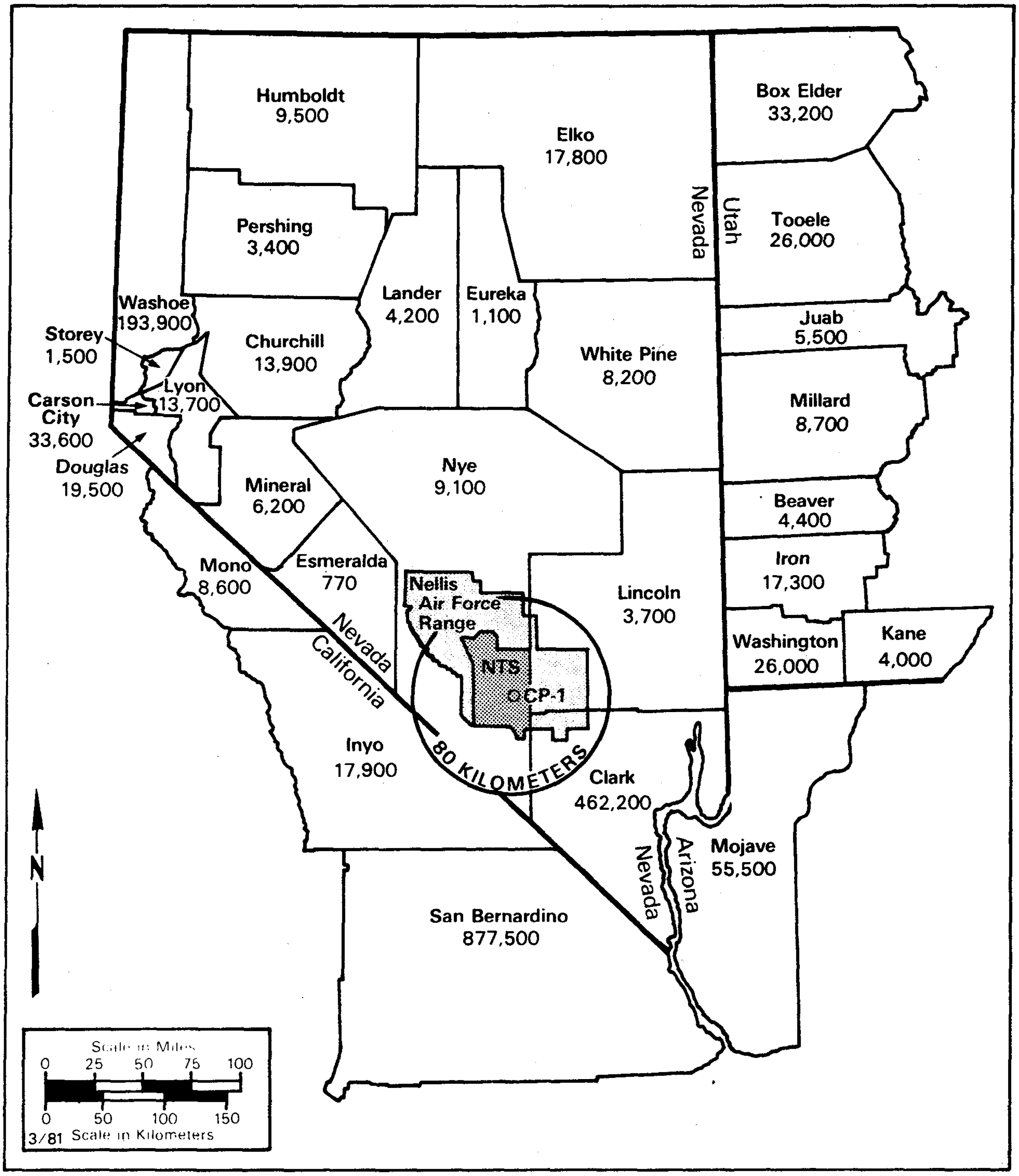


Figure A-3. Population of Arizona, California, Nevada, and Utah counties near the Nevada Test site (1980).

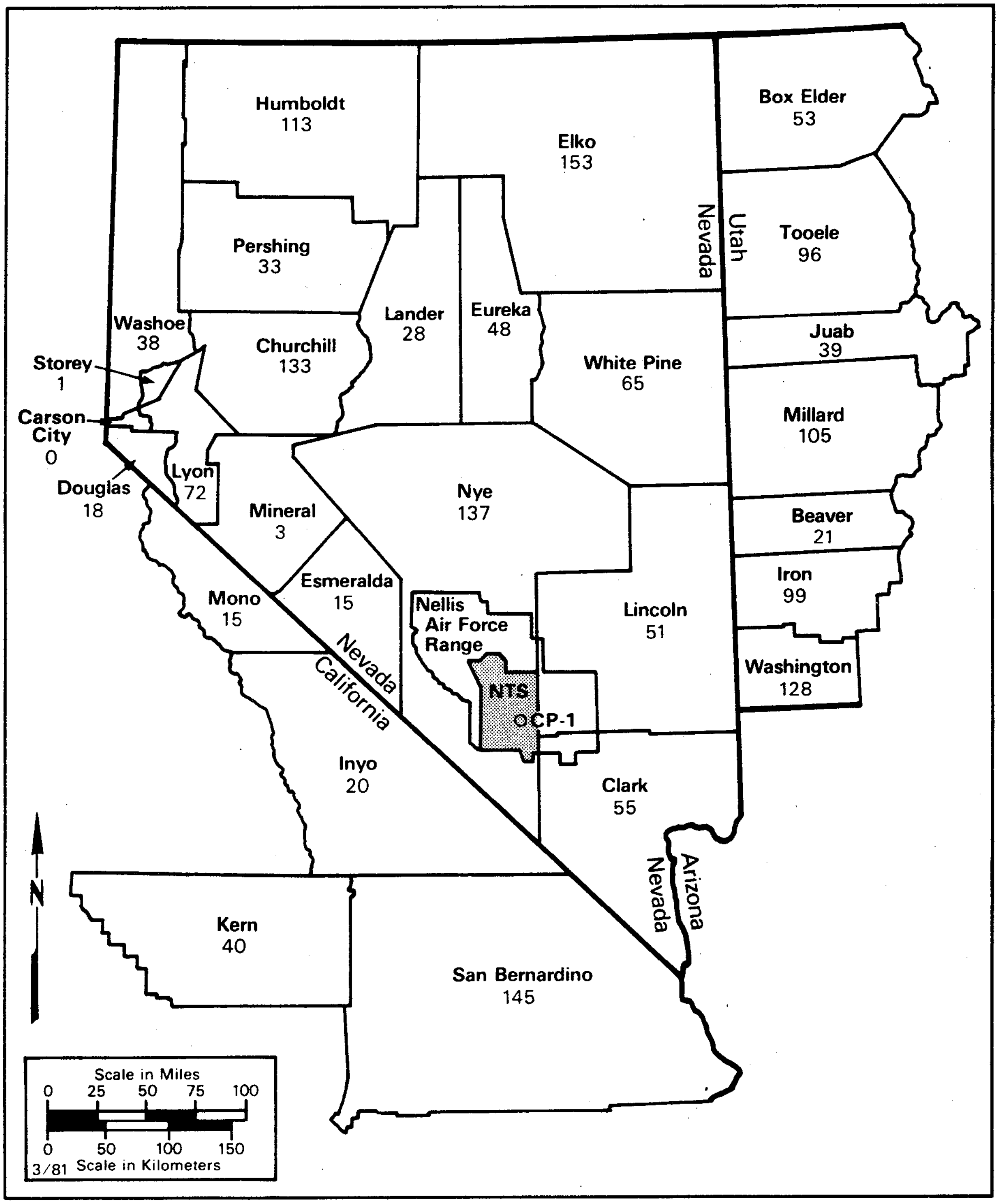


Figure A-4. Distribution and number of family milk cows and goats, by county.

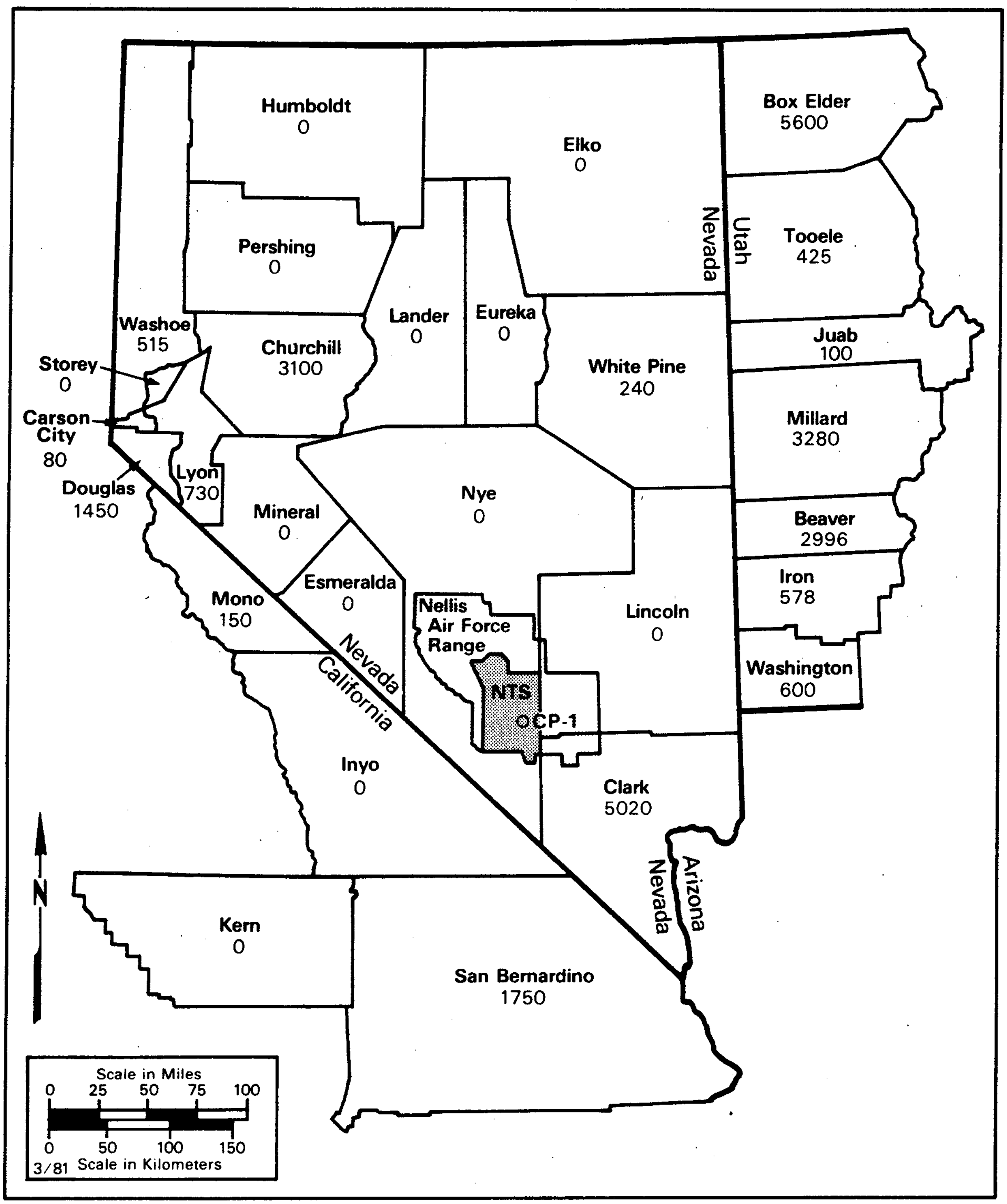


Figure A-5. Distribution of dairy cows, by county.

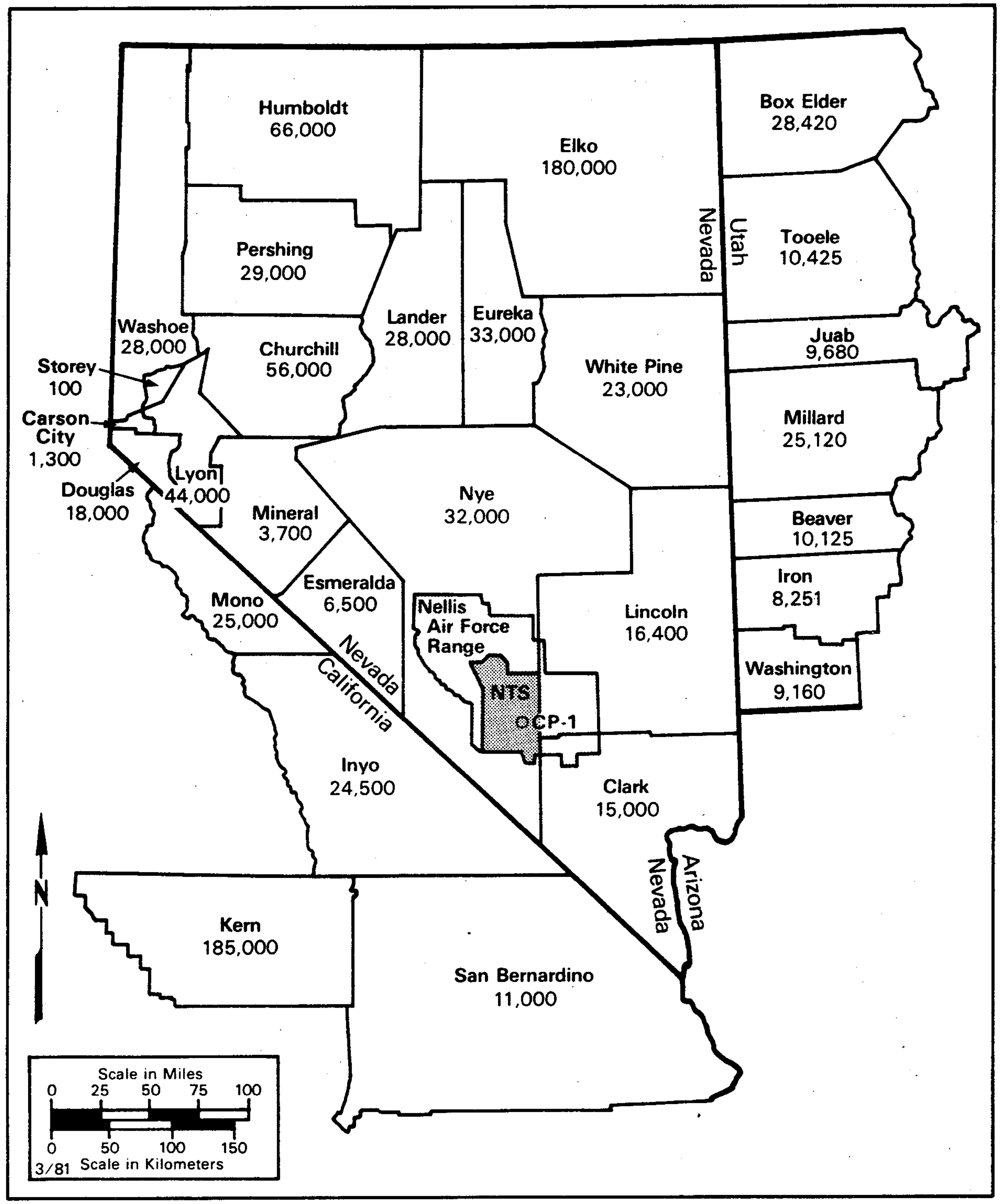


Figure A-6. Distribution of beef cattle, by county.

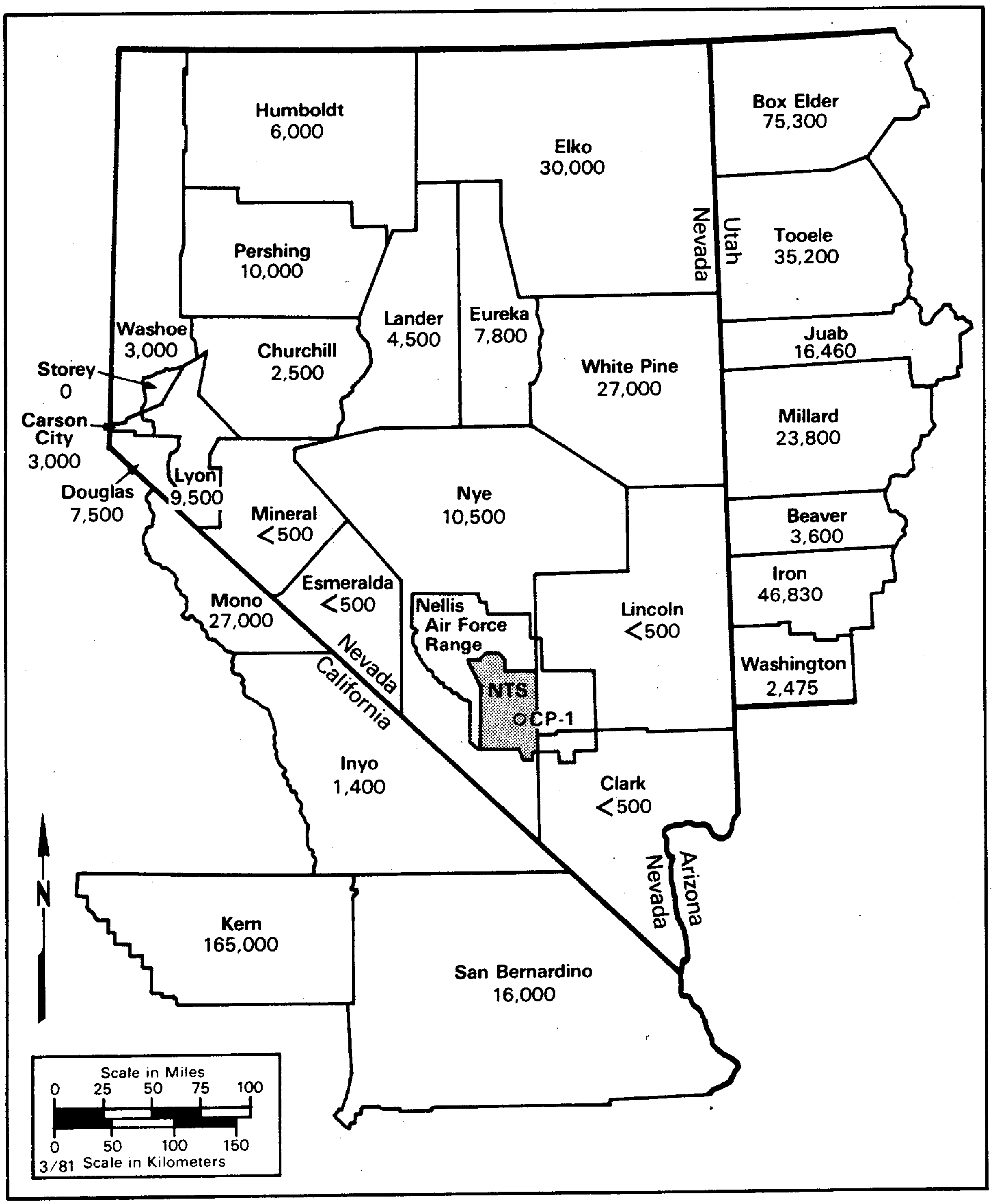


Figure A-7. Distribution of sheep, by county.

APPENDIX B. SAMPLE ANALYSIS PROCEDURES

ANALYTICAL PROCEDURES

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

TABLE B-1. SUMMARY OF ANALYTICAL PROCEDURES

Type of Analysis	Analytical Equipment	Counting Period (min)	Analytical Procedures	Sample Size	Approximate Detection Limit*
NaI(Tl) Gamma Spectrometry‡	NaI detector calibrated at 10 keV per channel (0.05-2.0 MeV range).	10 min. for air charcoal cartridges	Radionuclide concentrations quantified from gamma spectral data by computer using a least squares technique.	700-1200 m^3 for air charcoal cartridge samples.	0.04 pCi/m^3.
IG Ge(Li) Gamma Spectrometry‡	IG or Ge(Li) detector calibrated at 0.5 keV/channel (0.04 to 2 MeV range) individual detector efficiencies ranging from ~15% to 35%.	Individual air filters, 30 min; air filter composites, ~1200 min. 100 min for milk, water, suspended solids.	Radionuclide concentration quantified from gamma spectral data by on-line computer program. Radionuclides in air filter composite samples are identified only.	700-1200 m^3 for air filters; 4 liters for milk and water.	For routine milk and water generally, ~10 pCi/L for most common fallout radionuclides in a simple spectrum. Filters for LTHMP suspended solids, 6 pCi/L. Air filters, 0.04 pCi/m^3.
Gross beta on air filters	Low-level end window, gas flow proportional counter with a 12.7 cm diameter window (80 $\mu g/cm^2$)	30	Samples are counted after decay of naturally-occurring radon-thoron daughters and, if necessary, extrapolated to mid-point of collection in accordance with $t^{-1.2}$ decay or an experimentally-derived decay.	700-1200 m^3	0.5 pCi/sample.

(continued)

TABLE B-1. (Continued)

Type of Analysis	Analytical Equipment	Counting Period (min)	Analytical Procedures	Sample Size	Approximate Detection Limit*
$^{89-90}Sr$	Low-background thin-window, gas-flow proportional counter with a 5.7-cm diameter window (80 $\mu g/cm^2$)	50	Separation of strontium by wet chemical method. After an ingrowth period, yttrium is separated and ^{90}Sr activity is calculated from the activity of the ^{90}Y daughter. ^{89}Sr activity is obtained by decay curve analysis.	1.0 liter for milk or water. 0.1-1 kg for tissue.	^{89}Sr = 5 pCi/L ^{90}Sr = 2 pCi/L.
^3H	Automatic liquid scintillation counter with output printer.	200	Sample prepared by distillation.	5 ml for water	400 pCi/L.
H Enrichment (Long-Term Hydrological Samples)	Automatic scintillation counter with output printer.	200	Sample concentrated by electrolysis followed by distillation.	250 ml for water	10 pCi/L.
$^{238,239}Pu$	Alpha spectrometer with 450 mm, 300-μm depletion depth, silicon surface barrier detectors operated in vacuum chambers.	1000-1400	Water sample or acid-digested tissue samples separated by ion exchange, electroplated on stainless steel planchet.	1.0 liter for water; 0.1-1 kg for tissue; 5,000-10,000 m^3 for air.	^{238}Pu = 0.08 pCi/L ^{239}Pu = 0.04 pCi/L for water. For tissue samples, 0.04 pCi per total sample for all isotopes; 5-10 aCi/m^3 for plutonium on air filters.
^{85}Kr, ^{133}Xe, ^{135}Xe	Automatic liquid scintillation counter with output printer.	200	Physical separation by gas chromatography; dissolved in toluene "cocktail" for counting.	0.4-1.0 m^3 for air	^{85}Kr, ^{133}Xe, ^{135}Xe = 4 pCi/m^3.

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

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

APPENDIX C. QUALITY ASSURANCE PROCEDURES

PRECISION OF ANALYSIS

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

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

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

TABLE C-1. SAMPLES AND ANALYSES FOR DUPLICATE SAMPLING PROGRAM

Surveillance Network	Number of Sampling Locations	Samples Collected Per Year	Sets of Duplicate Samples Collected	Number Per Set	Sample Analysis
ASN	121	7,400	456	2	Gross beta, γ Spectrometry
NGTSN	11	572	56	2	^{85}Kr, ^{3}H, HTO, H_2O
Dosimetry	81	315	315	4-6	Effective dose from gamma
SMSN	150	150	32	2	^{40}K
LTHMP	134	254	27	2	^{3}H

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

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

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

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

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

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

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

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

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

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

---

*Snedecor, G. W., and W. G. Cochran. Statistical Methods. The Iowa State University Press, Ames, Iowa. 6th Ed. 1967. pp. 39-47.
**Freund, J. E. Mathematical Statistics. Prentice Hall, Englewood, New Jersey. 1962. pp 189-235.

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

To estimate the precision of counting, approximately 10 percent of all samples are counted a second time. These are unknown to the analyst. Since all such replicate counting gave results within the counting error, the precision data in Table C-2 represent errors principally in sample collection and analysis.

TABLE C-2. UPPER CONFIDENCE LIMITS OF SAMPLING AND ANALYTICAL ERRORS

Surveillance Network	Analysis	Sets of Replicate Samples Evaluated	Expected Geometric Std. Dev. (antilog $\tilde{s}$)	99% UCL of Total Error (Geometric mean times appropriate value below)
ASN	Gross β (1978 data)	533	2.03	6.2
	^{7}Be	34	1.36	2.2
	^{95}Zr	35	1.43	2.5
	^{95}Nb	87	1.59	3.3
	^{103}Ru	33	1.62	3.5
	^{141}Ce	9	1.14	1.4
NGTSN	^{85}Kr	30	1.084	1.2
	^{3}H	17	1.23	1.7
	HTO (1978 data)	20	2.29	8.4
	H_2O	12	1.10	1.3
Dosimetry	γ (TLD)	315	1.042	1.1
SMSN	^{40}K (1978 data)	32	1.086	1.2
LTHMP	^{3}H (conv.)	7	1.24	1.7
	^{3}H (enrich.)	20	1.25	1.8

ACCURACY OF ANALYSIS

Data from the analysis of intercomparison samples are statistically analyzed and compared to known values and values obtained from other participating laboratories. A summary of the statistical analysis is given in Table C-3, which compares the mean of three replicate analyses with the known value. The normalized deviation is a measure of the accuracy of the analysis when compared to the known concentration. The determination of this parameter is explained in detail separately. If the value of this parameter (in multiples of standard normal deviate, unitless) lies between control limits of -3 and +3, the precision or accuracy of the analysis is within normal statistical variation. However, if the parameters exceed these limits, one must suspect that there is some other cause other than normal statistical variations that contributed to the difference between the measured values and the known value. As shown by this table, the strontium-90 analysis for milk samples exceeded the control limit in two out of four cross-checks and nearly exceeded it on one other. The problem was attributed to contamination in the yttrium carrier for which an over-correction was made. A new supply of uncontaminated yttrium carrier is now in use.

TABLE C-3. 1981 QUALITY ASSURANCE INTERCOMPARISON RESULTS

Analysis	Month	Mean of Replicate Analyses (x 10^{-9} μCi/ml)	Known Value (x 10^{-9} μCi/ml)	Normalized Deviation from: Known Conc.
^{3}H in water	Feb	1709	1760	-0.3
	Apr	Lost*	2710	-
	Jun	1627	1950	-1.6
	Aug	2672	2630	0.2
	Oct	2184	2210	-0.1
	Dec	2623	2700	-0.4
^{60}Co in water	Feb	22	25	-1.2
	Jun	16	17	-0.5
	Oct	20	22	-0.8
^{106}Ru	Feb	<45	0	-
	Jun	<75	15	-
	Oct	<75	0	-
^{134}Cs in water	Feb	30	36	-2.2
	Jun	18	21	-1.0
	Oct	16	21	-1.6
^{137}Cs in water	Feb	<5	4	-
	Jun	29	31	-0.6
	Oct	28	32	-1.4

(continued)

TABLE C-3. (Continued)

Analysis	Month	Mean of Replicate Analyses (x 10^{-9} μCi/ml)	Known Value (x 10^{-9} μCi/ml)	Normalized Deviation from: Known Conc.
^{131}I in milk	Jan	23	26	-0.5
	May	25	26	-0.2
	Jul	<5	0	-
	Oct	50	52	0.0
^{89}Sr in milk**	Jan	<5	0	-
	Apr	<55	0	-
	Jul	22	25	-0.9
	Oct	<46	5	-
^{90}Sr in milk**	Jan	4.2	20	-18.2
	Apr	20	20	-0.2
	Jul	12	17	-6.2
	Oct	16	18	-2.9
^{137}Cs in milk	Jan	39	43	-0.8
	May	19	22	-0.9
	Jul	29	31	-0.7
	Oct	25	25	0.1
^{140}Ba in milk	Jan	<6	0	-
	May	<6	0	-
	Jul	<6	0	-
^{137}Cs in air filters (pCi/filter)	Mar	13	14	0.5
	Jun	20	16	1.3
	Sep	22	19	0.9

*These became contaminated in the laboratory. The source of the contamination was identified and the procedure changed to prevent a recurrence of the problem.

**These analyses were performed by Government contractor.

QUALITY ASSURANCE-DOSIMETRY

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

To determine accuracy of the data obtained from the TLD systems, dosimeters are periodically submitted to the University of Texas School of Public Health for intercomparisons of environmental dosimeters. Dosimeters were submitted to the Fifth International Intercomparison in August 1980 (Table C-4). All TLD measurements are performed in conformance with standards proposed by the American National Standards Institute (ANSI 1975).

TABLE C-4. SUMMARY RESULTS OF THE FIFTH INTERNATIONAL INTERCOMPARISON OF ENVIRONMENTAL DOSIMETERS

Quantity	Mean	Standard Deviation	Comments
Summary of "Beginning" Exposure Laboratory Results (mR):			
EMSL-LV Dosimeters	66.4	5.0	EMSL-LV results 12% lower than all dosimeters and 11.7% lower than the calculated exposure.
All Dosimeters	75.8	20.2	
Calculated Exposure	75.2	3.8	
Summary of "End" Exposure Laboratory Results (mR):			
EMSL-LV Dosimeters	80.2	6.0	EMSL-LV results 11.6% lower than all dosimeters and 9.3% lower than the calculated exposure.
All Dosimeters	90.7	15.6	
Calculated Exposure	88.4	4.4	
Summary of Field Results (mR):			
EMSL-LV Dosimeters	24.0	1.8	EMSL-LV results 20% lower than all dosimeters and 20% lower than the calculated exposure.
All Dosimeters	30.2	7.3	
Calculated Exposure	30.0	3.0	

APPENDIX D. RADIATION PROTECTION STANDARDS FOR EXTERNAL AND INTERNAL EXPOSURE

DOE ANNUAL DOSE COMMITMENT

The annual dose commitment tabulated below is from "Basic Radiation Protection Criteria" in NCRP Report No. 39.

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

DOE CONCENTRATION GUIDES

The concentration guides (CG's) in Table D-1 are from the DOE Order 5480.1, Chapter XI, "Requirements for Radiation Protection." All values are annual average concentrations. The Concentration Guides are based on a suitable sample of the exposed population in an uncontrolled area; occupational guides are used for noble gases and tritium exposures at the on-NTS stations. The final column lists the Minimum Detectable Concentration from Appendix B as a percent of the CG.

TABLE D-1

Network or Program	Sampling Medium	Radio-nuclide	CG	MDC as % of CG
			(pCi/m^3)	
Air Surveillance Network	air	^{7}Be	1.3×10^{4}	3.1×10^{-4}
		^{95}Zr	3.3×10^{2}	1.2×10^{-2}
		^{95}Nb	1.0×10^{3}	4.0×10^{-3}
		^{99}Mo	2.3×10^{3}	1.7×10^{-3}
		^{103}Ru	1.0×10^{3}	4.0×10^{-3}
		^{131}I	3.3×10^{1}	1.2×10^{-1}
		^{132}Te	1.3×10^{3}	3.1×10^{-3}
		^{137}Cs	1.7×10^{2}	2.4×10^{-2}
		^{140}Ba	3.3×10^{2}	1.2×10^{-2}
		^{140}La	1.3×10^{3}	3.1×10^{-3}
		^{141}Ce	1.7×10^{3}	2.4×10^{-3}
		^{144}Ce	6.7×10^{1}	6.0×10^{-2}
		^{239}Pu	3.3×10^{-1}	3.0×10^{-15}
Noble Gas and Tritium Surveillance Network, On-NTS	air	^{85}Kr	1.0×10^{7}	4.0×10^{-5}
		^{3}H	5.0×10^{6}	8.0×10^{-3}
		^{133}Xe	1.0×10^{7}	4.0×10^{-5}
		^{135}Xe	4.0×10^{6}	1.0×10^{-4}
Noble Gas and Tritium Surveillance Network, Off-NTS	air	^{85}Kr	1.0×10^{5}	4.0×10^{-3}
		^{3}H	6.7×10^{4}	6.0×10^{-1}
		^{133}Xe	1.0×10^{5}	4.0×10^{-3}
		^{135}Xe	3.3×10^{4}	1.2×10^{-2}
			(pCi/L)	
Long-Term Hydrological Program	water	^{3}H	1.0×10^{6}	1.0×10^{-3}
		^{89}Sr	1.0×10^{3}	5.0×10^{-1}
		^{90}Sr	1.0×10^{2}	2.0×10^{-0}
		^{137}Cs	6.7×10^{3}	1.5×10^{-1}
		^{226}Ra	1.0×10^{1}	
		^{234}U	1.3×10^{3}	
		^{235}U	1.3×10^{3}	
		^{238}U	2.0×10^{2}	
		^{238}Pu	1.7×10^{3}	4.7×10^{-3}
		^{239}Pu	1.7×10^{3}	2.4×10^{-3}
Milk Surveillance Networks	milk	^{3}H	1.0×10^{6}	1.0×10^{-3}
		^{137}Cs	6.7×10^{3}	1.5×10^{-1}
		^{89}Sr	1.0×10^{3}	5.0×10^{-1}
		^{90}Sr	1.0×10^{2}	2.0×10^{-0}

APPENDIX E. DATA SUMMARY FOR MONITORING NETWORKS

TABLE E-1. 1981 SUMMARY OF ANALYTICAL RESULTS FOR AIR SURVEILLANCE NETWORK CONTINUOUSLY OPERATING STATIONS

Sampling Location	No. Days Detected	Type of Radio-activity	Radioactivity Conc. (pCi/m^3) Max	Min	Avg/a*
Death Valley Jct., CA	126.3	^{7}Be	0.54	0.14	0.094
	182.2	^{95}Nb	0.36	0.019	0.071
	111.1	^{95}Zr	0.89	0.025	0.038
	111.1	^{103}Ru	0.12	0.027	0.017
	58.1	^{141}Ce	0.089	0.027	0.0076
	21.8	^{144}Ce	0.19	0.023	0.0084
Furnace Creek, CA	129.8	^{7}Be	0.47	0.15	0.094
	160.9	^{95}Nb	0.76	0.022	0.066
	102.7	^{95}Zr	0.33	0.030	0.029
	84.6	^{103}Ru	0.11	0.022	0.013
	45.1	^{141}Ce	0.068	0.018	0.0058
	10.7	^{144}Ce	0.19	0.099	0.0044
Shoshone, CA	81.3	^{7}Be	0.43	0.19	0.063
	171.6	^{95}Nb	0.33	0.031	0.071
	96.8	^{95}Zr	0.18	0.044	0.028
	96.1	^{103}Ru	0.11	0.019	0.014
	3.0	^{106}Ru	0.19	0.19	0.0016
	40.9	^{141}Ce	0.074	0.026	0.0054
	11.0	^{144}Ce	0.17	0.12	0.0044
Alamo, NV	65.6	^{7}Be	0.47	0.15	0.054
	144.2	^{95}Nb	0.42	0.013	0.065
	85.5	^{95}Zr	0.96	0.049	0.039
	85.4	^{103}Ru	0.28	0.021	0.016
	36.1	^{141}Ce	0.061	0.026	0.0044
	16.9	^{144}Ce	0.22	0.13	0.0077

(continued)

TABLE E-1. (Continued)

Sampling Location	No. Days Detected	Type of Radio-activity	Radioactivity Conc. (pCi/m^3) Max	Min	Avg/a*
Area 51, NTS, NV	93.9	^{7}Be	0.57	0.17	0.11
	122.8	^{95}Nb	0.46	0.030	0.077
	73.0	^{95}Zr	0.27	0.052	0.032
	74.1	^{103}Ru	0.12	0.020	0.016
	31.0	^{141}Ce	0.072	0.024	0.0054
	17.1	^{144}Ce	0.24	0.15	0.012
Beatty, NV	95.0	^{7}Be	0.57	0.19	0.093
	158.5	^{95}Nb	0.51	0.014	0.075
	100.6	^{95}Zr	0.23	0.059	0.036
	92.7	^{103}Ru	0.49	0.027	0.020
	44.8	^{141}Ce	0.099	0.027	0.0072
	8.0	^{144}Ce	0.19	0.11	0.0036
Blue Eagle Ranch, NV	64.9	^{7}Be	0.66	0.21	0.073
	134.4	^{95}Nb	0.57	0.031	0.068
	85.6	^{95}Zr	0.33	0.060	0.031
	88.4	^{103}Ru	0.16	0.026	0.016
	30.1	^{141}Ce	0.10	0.028	0.0045
	11.0	^{144}Ce	0.30	0.17	0.0068
Glendale, NV	50.4	^{7}Be	0.89	0.17	0.060
	139.8	^{95}Nb	0.83	0.016	0.084
	70.3	^{95}Zr	0.33	0.051	0.029
	69.1	^{103}Ru	0.42	0.024	0.019
	2.9	^{137}Cs	0.030	0.030	0.00032
	31.6	^{141}Ce	0.083	0.029	0.0055
	8.9	^{144}Ce	0.40	0.13	0.0076
Goldfield, NV	104.6	^{7}Be	0.62	0.20	0.12
	161.6	^{95}Nb	0.45	0.019	0.084
	89.6	^{95}Zr	0.24	0.044	0.036
	88.6	^{103}Ru	0.14	0.040	0.019
	39.6	^{141}Ce	0.085	0.033	0.0068
	12.0	^{144}Ce	0.29	0.024	0.0079
Hiko, NV	125.6	^{7}Be	0.67	0.20	0.13
	155.8	^{95}Nb	1.0	0.022	0.084
	75.9	^{95}Zr	0.71	0.055	0.034
	90.7	^{103}Ru	0.14	0.025	0.015
	40.9	^{141}Ce	0.10	0.022	0.0056
	21.9	^{144}Ce	0.52	0.14	0.016

(continued)

TABLE E-1. (Continued)

Sampling Location	No. Days Detected	Type of Radio-activity	Radioactivity Conc. (pCi/m^3) Max	Min	Avg/a*
Indian Springs, NV	68.1	^{7}Be	0.52	0.16	0.057
	144.8	^{95}Nb	0.41	0.020	0.060
	84.0	^{95}Zr	0.25	0.057	0.027
	78.8	^{103}Ru	0.17	0.020	0.011
	31.0	^{141}Ce	0.091	0.027	0.0042
	9.0	^{144}Ce	0.30	0.18	0.0055
Las Vegas, NV	76.2	^{7}Be	0.70	0.014	0.063
	152.5	^{95}Nb	0.50	0.028	0.073
	97.3	^{95}Zr	0.27	0.045	0.033
	92.9	^{103}Ru	0.15	0.022	0.017
	5.0	^{106}Ru	0.22	0.11	0.0022
	55.8	^{141}Ce	0.090	0.024	0.0075
	13.0	^{144}Ce	0.26	0.11	0.0059
Lathrop Wells, NV	91.7	^{7}Be	0.61	0.22	0.085
	165.7	^{95}Nb	0.74	0.032	0.076
	102.8	^{95}Zr	0.31	0.048	0.031
	86.3	^{103}Ru	0.13	0.018	0.013
	54.3	^{141}Ce	0.088	0.018	0.0078
	9.0	^{144}Ce	0.15	0.13	0.0035
Nyala, NV	107.0	^{7}Be	0.68	0.19	0.11
	157.0	^{95}Nb	0.72	0.028	0.090
	97.0	^{95}Zr	0.36	0.052	0.039
	87.0	^{103}Ru	0.18	0.039	0.019
	2.0	^{137}Cs	0.019	0.019	0.00010
	42.0	^{141}Ce	0.090	0.034	0.0064
	19.0	^{144}Ce	0.48	0.084	0.010
Overton, NV			Gamma scan negligible		
Pahrump, NV	67.9	^{7}Be	0.94	0.20	0.063
	161.8	^{95}Nb	0.41	0.019	0.070
	100.9	^{95}Zr	0.87	0.054	0.035
	102.9	^{103}Ru	0.12	0.023	0.017
	49.0	^{141}Ce	0.093	0.025	0.0073
	7.0	^{144}Ce	0.18	0.16	0.0033

(continued)

TABLE E-1. (Continued)

Sampling Location	No. Days Detected	Type of Radio-activity	Radioactivity Conc. (pCi/m^3)		
			Max	Min	Avg/a*
Robinson Trailer	70.3	^{7}Be	0.62	0.049	0.066
Park, Rachel,	134.2	^{95}Nb	0.41	0.021	0.066
NV	77.9	^{95}Zr	0.31	0.041	0.029
	89.8	^{103}Ru	0.36	0.025	0.018
	57.0	^{141}Ce	0.070	0.027	0.082
	3.1	^{144}Ce	0.14	0.14	0.0013
Scotty's Junction,	121.7	^{7}Be	0.55	0.18	0.11
NV	173.3	^{95}Nb	0.46	0.019	0.069
	83.4	^{95}Zr	0.25	0.044	0.026
	94.4	^{103}Ru	0.098	0.031	0.015
	40.0	^{141}Ce	0.072	0.030	0.0048
	7.0	^{144}Ce	0.25	0.16	0.0037
Stone Cabin Ranch,	56.5	^{7}Be	0.75	0.20	0.062
NV	101.9	^{95}Nb	0.58	0.038	0.063
	49.6	^{95}Zr	0.39	0.061	0.025
	61.2	^{103}Ru	0.17	0.028	0.017
	31.7	^{141}Ce	0.12	0.039	0.0075
Sunnyside,	82.1	^{7}Be	0.63	0.18	0.085
NV	163.7	^{95}Nb	0.44	0.021	0.095
	90.0	^{95}Zr	0.30	0.040	0.038
	102.0	^{103}Ru	0.17	0.030	0.026
	49.0	^{141}Ce	0.10	0.034	0.0098
	8.9	^{144}Ce	0.36	0.12	0.0072
Tonopah,	82.8	^{7}Be	1.1	0.19	0.088
NV	154.9	^{95}Nb	0.59	0.026	0.085
	102.0	^{95}Zr	0.29	0.054	0.039
	91.0	^{103}Ru	0.12	0.028	0.019
	35.1	^{141}Ce	0.12	0.037	0.0060
	12.0	^{141}Ce	0.32	0.16	0.0076
Tonopah Test Range,	140.4	^{7}Be	0.61	0.17	0.17
NV	142.4	^{95}Nb	0.46	0.025	0.096
	76.6	^{95}Zr	0.25	0.070	0.040
	78.2	^{103}Ru	0.12	0.031	0.022
	55.9	^{141}Ce	0.084	0.033	0.010
	8.9	^{144}Ce	0.26	0.17	0.0068

(continued)

TABLE E-1. (Continued)

Sampling Location	No. Days Detected	Type of Radio-activity	Radioactivity Conc. (pCi/m^3) Max	Min	Avg/a*
Twin Springs Ranch, NV	58.9	^{7}Be	0.56	0.22	0.13
	5.0	^{95}Nb	0.059	0.042	0.0017
Cedar City, UT			Gamma scan negligible		
Delta, UT	77.0	^{7}Be	0.64	0.16	0.075
	149.2	^{95}Nb	0.69	0.027	0.067
	61.2	^{95}Zr	0.23	0.023	0.021
	77.1	^{103}Ru	0.19	0.024	0.012
	17.3	^{141}Ce	0.086	0.033	0.0028
	3.1	^{144}Ce	0.17	0.17	0.0015
Milford, UT	93.5	^{7}Be	0.44	0.14	0.093
	139.5	^{95}Nb	0.47	0.019	0.083
	70.8	^{95}Zr	0.27	0.079	0.032
	74.1	^{103}Ru	0.13	0.038	0.016
	36.0	^{141}Ce	0.078	0.024	0.0052
	17.0	^{144}Ce	0.27	0.12	0.011
St. George, UT	97.7	^{7}Be	0.56	0.018	0.086
	175.3	^{95}Nb	0.72	0.016	0.082
	107.8	^{95}Zr	0.31	0.030	0.038
	93.4	^{103}Ru	0.17	0.030	0.016
	43.0	^{141}Ce	0.070	0.030	0.0054
	18.8	^{144}Ce	0.30	0.12	0.097

*Avg/a is time-weighted average (over total operating time of sampler) for use in exposure calculations.

TABLE E-2. 1981 SUMMARY OF ANALYTICAL RESULTS FOR AIR SURVEILLANCE NETWORK STANDBY STATIONS - OPERATED 1 OR 2 WEEKS PER QUARTER

Sampling Location	No. Days Detected	Type of Radio-activity	Radioactivity Conc. (pCi/m^3) C_{max}	C_{min}	C_{avg}*
Kingman, AZ	2.0	^{7}Be	0.25	0.25	0.072
Phoenix, AZ	4.0	^{7}Be	0.17	0.17	0.084
Baker, CA	3.9	^{7}Be	0.24	0.24	0.095
Bishop, CA	3.9	^{7}Be	0.23	0.23	0.12
Indio, CA	2.0	^{7}Be	0.30	0.30	0.074
Ridgecrest, CA	3.0	^{7}Be	0.22	0.22	0.093
Denver, CO	3.8	^{7}Be	0.26	0.26	0.12
Grand Junction, CO	2.2	^{7}Be	0.37	0.37	0.10
Boise, ID	3.0	^{7}Be	0.22	0.22	0.084
Idaho Falls, ID	4.0	^{7}Be	0.21	0.21	0.10
Mountain Home, ID	2.0	^{7}Be	1.2	1.2	0.30
New Orleans, LA	2.0	^{7}Be	0.19	0.19	0.054
Clayton, MO	3.0	^{7}Be	0.11	0.11	0.048
St. Joseph, MO	2.0	^{7}Be	0.19	0.19	0.053
Bozeman, MT	2.2	^{7}Be	0.35	0.35	0.12
Battle Mountain, NV	2.0	^{7}Be	0.37	0.37	0.11
Blue Jay, NV	2.0	^{7}Be	0.63	0.63	0.18
Caliente, NV	3.1	^{7}Be	0.28	0.28	0.12
Duckwater, NV	2.0	^{7}Be	0.47	0.47	0.13

(continued)

TABLE E-2. (Continued)

Sampling Location	No. Days Detected	Type of Radio-activity	Radioactivity Conc. (pCi/m^3) C_{max}	C_{min}	C_{avg}*
Fallon, NV	2.0	^{7}Be	0.51	0.51	0.15
Lovelock, NV	2.0	^{7}Be	0.35	0.35	0.098
Mesquite, NV	2.0	^{7}Be	0.29	0.29	0.082
Warm Springs, NV	4.0	^{7}Be	0.47	0.46	0.27
	2.0	^{95}Nb	0.038	0.038	0.011
Wells, NV	2.0	^{7}Be	0.43	0.43	0.12
Albuquerque, NM	3.0	^{7}Be	0.63	0.63	0.14
Capitol Reef Nat'l Monument, UT	6.0	^{7}Be	0.33	0.26	0.21
Enterprise, UT	3.0	^{7}Be	0.27	0.27	0.12
Garrison, UT	3.0	^{7}Be	0.31	0.31	0.12
Monticello, UT	1.9	^{7}Be	0.47	0.47	0.14
Parowan, UT	2.0	^{7}Be	0.52	0.52	0.26
Casper, WY	2.0	^{7}Be	0.47	0.47	0.12
Rock Springs, WY	3.0	^{7}Be	0.30	0.30	0.13

*C_{avg} based on total operating time.

(continued)

TABLE E-2. (Continued)

Sampling Location	Sampling Location	Sampling Location
The gamma scan was negligible for the following stations:		
Seligman, AZ	Missoula, MT	Burns, OR
Winslow, AZ	North Platte, NB	Aberdeen, SD
Little Rock, AR	Currant, NV (Angle Worm Ranch)	Rapid City, SD
Lone Pine, CA	Elko, NV	Abilene, TX
Needles, CA	Ely, NV	Amarillo, TX
Pueblo, CO	Eureka, NV	Austin, TX
Pocatello, ID	Frenchman Station, NV	Fort Worth, TX
Preston, ID	Lund, NV	Dugway, UT
Twin Falls, ID	Pioche, NV	Logan, UT
Iowa City, IA	Reno, NV	Provo, UT
Sioux City, IA	Round Mountain, NV	Vernal, UT
Dodge City, KS	Winnemucca, NV	Wendover, UT
Lake Charles, LA	Carlsbad, NM	Seattle, WA
Monroe, LA	Muskogee, OK	Spokane, WA
Minneapolis, MN	Norman, OK	Worland, WY
Joplin, MO	Medford, OR	
Billings, MT		

TABLE E-3. 1981 SUMMARY OF ANALYTICAL RESULTS FOR THE NOBLE GAS AND TRITIUM SURVEILLANCE NETWORK

Sampling Location	No. Days Detected	Radionuclide	Radioactivity Conc. (pCi/m^3) Max	Min	Avg/a**	% of Conc. Guide†
Alamo, NV	42.9	^{85}Kr	31	22	26	0.03
	42.9	^{133}Xe	<19	<11	<11	<0.01
	42.9	^{3}H in atm. m.*	<0.46	<0.38	<0.38	--
	42.9	^{3}H as HTO in air	<2.1	1.3	<1.3	<0.01
Beatty, NV	352.6	^{85}Kr	31	18	24	0.02
	337.2	^{133}Xe	<45	<6.2	<6.2	<0.01
	363.8	^{3}H in atm. m.*	1.5	<0.37	<0.37	--
	363.8	^{3}H as HTO in air	11	<0.78	1.8	<0.01
Hiko, NV	318.8	^{85}Kr	31	14	24	0.02
	318.8	^{133}Xe	<37	<7.0	<7.0	<0.01
	296.8	^{3}H in atm. m.*	1.0	<0.30	<0.30	--
	296.8	^{3}H as HTO in air	6.6	0.64	1.0	<0.01
Indian Springs, NV	361.6	^{85}Kr	31	18	24	0.02
	361.6	^{133}Xe	<40	<7.6	<7.6	<0.01
	342.7	^{3}H in atm. m.*	0.99	<0.37	<0.37	--
	342.7	^{3}H as HTO in air	5.1	0.56	0.80	<0.01
Las Vegas, NV	77.8	^{85}Kr	30	16	24	0.02
	84.6	^{133}Xe	<81	<6.1	8.0	<0.01
	90.9	^{3}H in atm. m.*	0.55	<0.30	<0.30	--
	90.9	^{3}H as HTO in air	4.0	<1.3	<1.3	<0.01
Lathrop Wells, NV	368.8	^{85}Kr	31	16	23	0.02
	360.7	^{133}Xe	<78	<5.8	<5.8	<0.01
	327.7	^{3}H in atm. m.*	1.1	<0.37	<0.37	--
	327.7	^{3}H as HTO in air	4.8	<1.3	1.4	<0.01
Area 15, NTS, NV	356.9	^{85}Kr	33	18	25	<0.01
	356.9	^{133}Xe	<130	<4.9	<4.9	<0.01
	341.7	^{3}H in atm. m.*	23	<0.37	5.7	--
	341.7	^{3}H as HTO in air	90	<2.1	25	<0.01
Area 400, NTS, NV	278.9	^{85}Kr	33	15	23	<0.01
	278.9	^{133}Xe	<63	<3.1	3.5	<0.01
	345.7	^{3}H in atm. m.*	2.7	<0.37	0.39	--
	345.7	^{3}H as HTO in air	10	<1.1	1.7	<0.01

(continued)

TABLE E-3. (Continued)

Sampling Location	No. Days Detected	Radionuclide	Radioactivity Conc. (pCi/m^3) Max	Min	Avg/a**	% of Conc. Guide†
Mercury, NTS, NV	302.3	^{85}Kr	30	16	23	<0.01
	316.3	^{133}Xe	<40	<2.8	4.6	<0.01
	355.7	^{3}H in atm. m.*	2.0	<0.37	0.41	--
	355.7	^{3}H as HTO in air	9.6	1.3	2.0	<0.01
Area 51, NTS,‡ NV	350.5	^{85}Kr	32	18	24	<0.01
	343.5	^{133}Xe	<62	<2.2	4.2	<0.01
	277.0	^{3}H in atm. m.*	9.0	<0.37	0.63	--
	277.0	^{3}H as HTO in air	25	0.63	2.5	<0.01
BJY, NTS, NV	311.6	^{85}Kr	39	18	26	<0.01
	320.9	^{133}Xe	1,500	<3.2	45	<0.01
	340.7	^{3}H in atm. m.*	13	0.86	3.7	--
	340.7	^{3}H as HTO in air	32	1.7	12	<0.01
Area 12, NTS, NV	322.9	^{85}Kr	33	15	24	<0.01
	328.8	^{133}Xe	<33	<4.6	5.0	<0.01
	308.5	^{3}H in atm. m.*	15	<0.46	4.4	--
	308.5	^{3}H as HTO in air	51	<1.4	16	<0.01
Overton, NV	7.0	^{85}Kr	26	26	26	0.03
	7.0	^{133}Xe	<13	<13	<13	<0.01
	23.0	^{3}H in atm. m.*	<0.42	<0.38	<0.38	--
	23.0	^{3}H as HTO in air	<3.1	<1.5	<1.5	<0.01
Pahrump, NV	95.6	^{85}Kr	29	15	23	0.02
	95.6	^{133}Xe	<43	<6.4	6.5	<0.01
	99.7	^{3}H in atm. m.*	0.49	<0.30	<0.30	--
	99.7	^{3}H as HTO in air	5.3	<1.1	1.5	<0.01
Rachel, NV	304.2	^{85}Kr	33	13	24	0.02
	297.2	^{133}Xe	<78	<4.5	4.7	<0.01
	361.4	^{3}H in atm. m.*	0.91	<0.30	<0.30	--
	361.4	^{3}H as HTO in air	<5.0	<1.3	<1.3	<0.01

(continued)

TABLE E-3. (Continued)

Sampling Location	No. Days Detected	Radionuclide	Radioactivity Conc. (pCi/m^3) Max	Min	Avg/a**	% of Conc. Guide†
Tonopah, NV	339.1	^{85}Kr	31	17	25	0.02
	338.0	^{133}Xe	<50	<6.4	<6.4	<0.01
	350.0	^{3}H in atm. m.*	0.87	<0.30	<0.30	--
	350.0	^{3}H as HTO in air	5.8	<0.83	1.1	<0.01

*Concentrations of tritium in atmospheric moisture (atm. m.) are expressed as pCi per ml of water collected.

**Avg/a is time-weighted average, over total operating time.

†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 D for Concentration Guides.

‡Also known as Groom Lake.

TABLE E-4. 1981 SUMMARY OF GROSS BETA ANALYSES AT FIVE ASN STATIONS

Sampling Location	No. Days Analyzed	Analyte	Concentration (pCi/m^3)		
			Minimum	Maximum	Average
Shoshone, CA	165.6	Gross β	0.012	0.17	0.047
Las Vegas, NV	120.2	Gross β	0.012	0.10	0.044
Delta, UT	158.4	Gross β	0.012	0.12	0.047
Milford, UT	117.6	Gross β	0.012	0.13	0.048
St. George, UT	147.7	Bross β	0.013	0.14	0.053

TABLE E-5. 1981 SUMMARY OF PLUTONIUM CONCENTRATIONS AT SELECTED AIR SURVEILLANCE NETWORK STATIONS*

Sampling Location	No. Days Sampled	^{238}Pu Concentration (aCi/m^3)			^{239}Pu Concentration (aCi/m^3)		
		Max	Min	Avg	Max	Min	Avg
Barstow, CA	35.1	3.4	-1.8	1.1	80	12	38
St. Joseph, MO	49.2	3.4	-4.6	0.44	84	6.8	30
Las Vegas, NV	332.9	18	-0.99	1.3	137	1.3	42
Lathrop Wells, NV	345.2	7.0	0.32	2.7	110	4.6	33
Rachel, NV	350.2	12	-0.69	3.0	102	5.1	31
Albuquerque, NM	54.3	16	0.89	6.7	155	23	83
Medford, OR	40.6	18	-2.8	3.4	52	8.3	24
Aberdeen, SD	48.0	4.8	-5.8	-0.20	44	2.9	32
Austin, TX	50.1	1.8	-2.1	1.1	48	2.2	14
Provo, UT	42.8	7.1	-4.5	1.9	69	15	31
Spokane, WA	43.0	20	-5.0	2.6	43	1.8	14

*CG for ^{238}Pu = 23,000 aCi/m^3, for ^{239}Pu = 20,000 aCi/m^3

TABLE E-6. 1981 SUMMARY OF TRITIUM RESULTS FOR THE NTS MONTHLY LONG-TERM HYDROLOGICAL MONITORING PROGRAM

Sampling Location	No. Samples*	Tritium Concentration (pCi/L) Max	Min	Avg	% of Conc. Guide**
Well 8	12	<11	<6	<6	<0.01
Well U3CN-5	12	22	<7	<7	<0.01
Well A	10	<9	<7	<7	<0.01
Well C	12	64	16	34	<0.01
Well 5c	12	<11	<7	<7	<0.01
Army Well No. 1	12	<12	<7	<7	<0.01
Well 2	11	15	<7	<7	<0.01
Test Well B	11	190	99	120	<0.01
Well J-13	12	12	<7	<7	<0.01
Well UE7ns	12	1,700	1,000	1,400	0.14
Well U19c	12	<11	<6	<6	<0.01
Well 3	12	17	<6	<6	<0.01
Well 4	12	<11	<6	<6	<0.01

*Some samples could not be collected every month because of adverse weather conditions or inoperative pumps.

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

TABLE E-7. 1981 TRITIUM RESULTS FOR THE NTS SEMI-ANNUAL LONG-TERM HYDROLOGICAL MONITORING PROGRAM

Sampling Location	Date	Sample Type	Tritium Concentration (pCi/L)	% of Conc. Guide*
NTS, Well UE15d	1/06	Well	60	<0.01
	(Pump inoperative during 2nd sampling period)			
NTS, Test Well D	1/07	Well	8	<0.01
	7/23	Well	<7	<0.01
NTS, Well UE1c	1/07	Well	<5	<0.01
	7/23	Well	<7	<0.01
NTS, Well C-1	1/21	Well	<4	<0.01
	7/21	Well	<4	<0.01
NTS, Well UE5C	1/22	Well	<4	<0.01
	7/22	Well	<7	<0.01
NTS, Well 5b	1/22	Well	<5	<0.01
	7/22	Well	<7	<0.01
NTS, Test Well F	(Pump inoperative during 1981)			
NTS, Well UE18r	(Equipment down hole during 1981)			
Ash Meadows, NV, Crystal Pool	1/09	Spring	<5	<0.01
	7/27	Spring	<7	<0.01
Ash Meadows, NV, Well 18S/51E-7DB	1/09	Well	<5	<0.01
	7/27	Well	<7	<0.01
Ash Meadows, NV, Well 17S/50E-14CAC	1/09	Well	<5	<0.01
	7/27	Well	<7	<0.01
Ash Meadows, NV, Fairbanks Springs	1/09	Spring	<5	<0.01
	7/27	Spring	<7	<0.01
Beatty, NV, City Supply, 12S/47E-7DBD	1/20	Well	<5	<0.01
	7/28	Well	<7	<0.01

(continued)

TABLE E-7. (Continued)

Sampling Location	Date	Sample Type	Tritium Concentration (pCi/L)	% of Conc. Guide*
Beatty, NV, Nuclear Engineering Co.	1/20	Well	<5	<0.01
	7/29	Well	<7	<0.01
Beatty, NV, Coffers Well, 11S/48/1DD	1/08	Well	<5	<0.01
	7/29	Well	<7	<0.01
Indian Springs, NV, USAF No. 2	1/06	Well	<8	<0.01
	7/20	Well	<13	<0.01
Indian Springs, NV, Sewer Co. Inc., Well No. 1	1/06	Well	<5	<0.01
	7/20	Well	<7	<0.01
Lathrop Wells, NV, City Supply	1/08	Well	<5	<0.01
	7/28	Well	<7	<0.01
Springdale, NV, Goss Springs	1/08	Spring	<5	<0.01
	7/28	Spring	<7	<0.01

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

TABLE E-8. 1981 TRITIUM RESULTS FOR THE NTS ANNUAL LONG-TERM HYDROLOGICAL MONITORING PROGRAM

Sampling Location	Date	Sample Type	Tritium Concentration (pCi/L)	% of Conc. Guide*
Shoshone, CA Shoshone Spring	8/11	Spring	7	<0.01
Hiko, NV Crystal Springs	8/13	Spring	<7	<0.01
Alamo, NV City Supply	8/13	Well	<7	<0.01
Warm Springs, NV Twin Springs Ranch	8/12	Spring	<7	<0.01
Nyala, NV Sharp Ranch	8/12	Well	<7	<0.01
Adaven, NV Adaven Spring	8/12	Spring	<7	<0.01
Pahrump, NV Calvada Well 3	8/11	Well	<7	<0.01
Tonopah, NV City Supply	8/11	Well	<7	<0.01
Clark Station, NV Tonopah Test Range Well 6	8/12	Well	<7	<0.01
Las Vegas, NV Water District Well No. 28	8/06	Well	<7	<0.01
Tempiute, NV Union Carbide Well	8/13	Well	<7	<0.01

*See Appendix D for Concentration Guides.

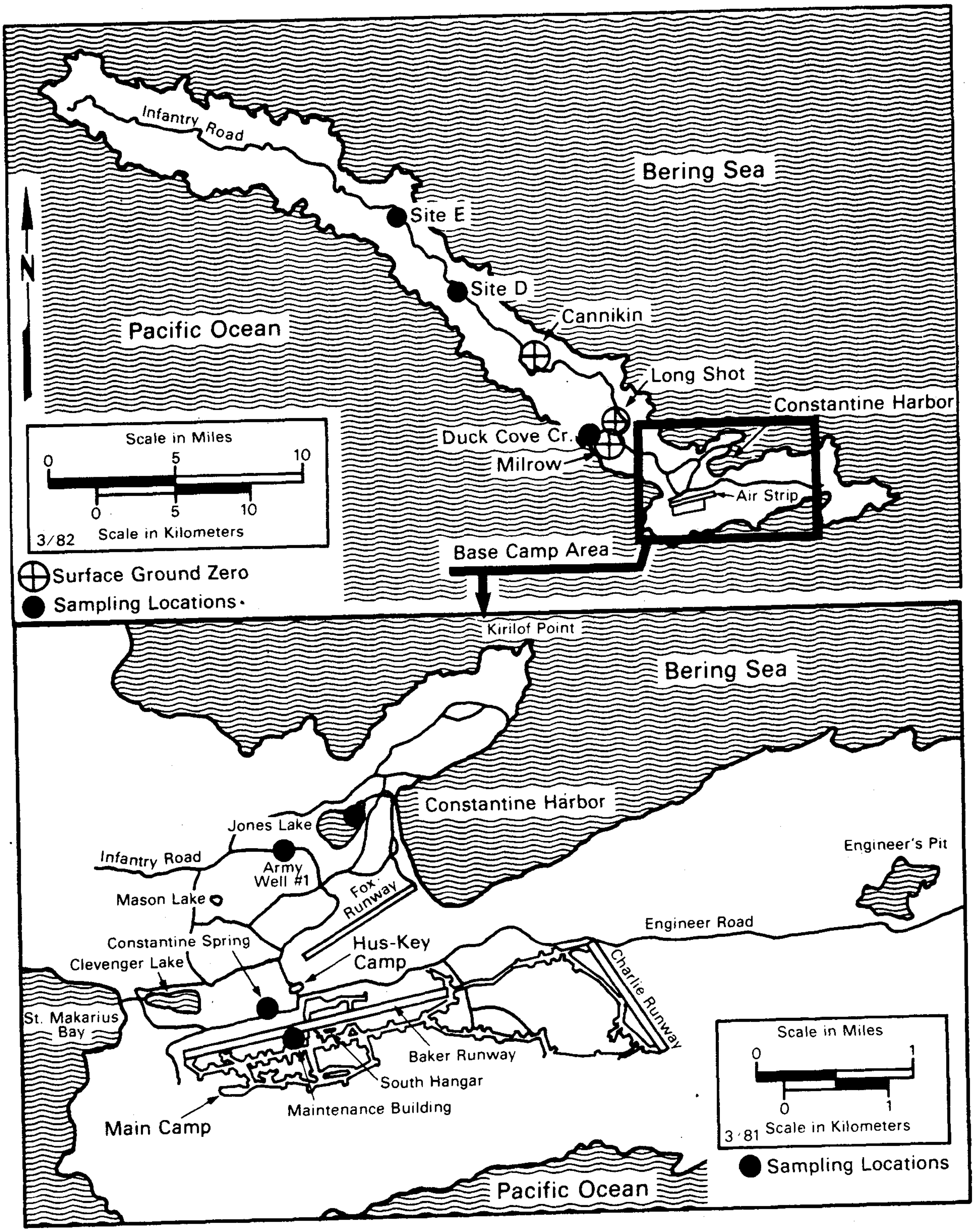


Figure E-1. Amchitka Island and Background sampling locations for the LTHMP.

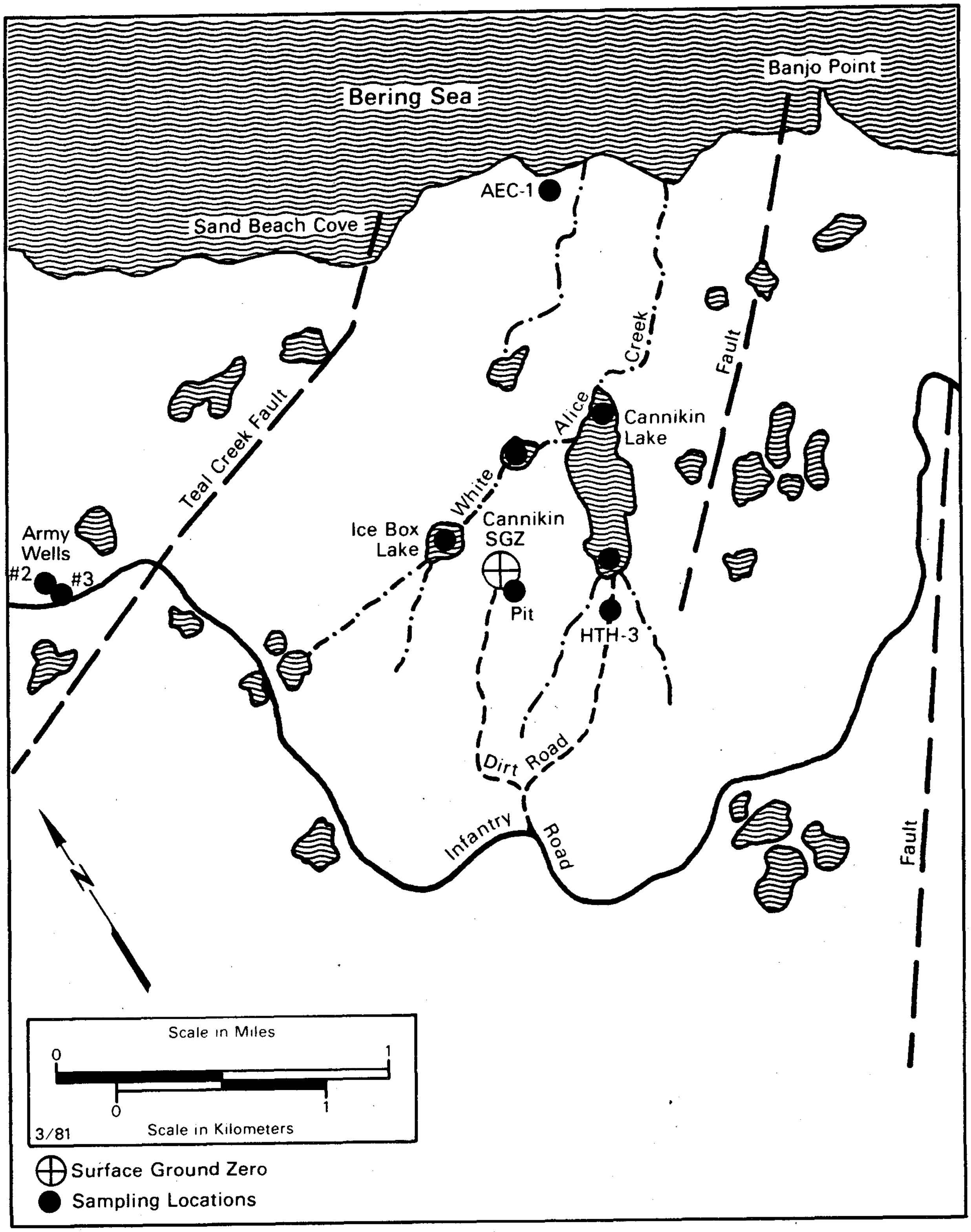
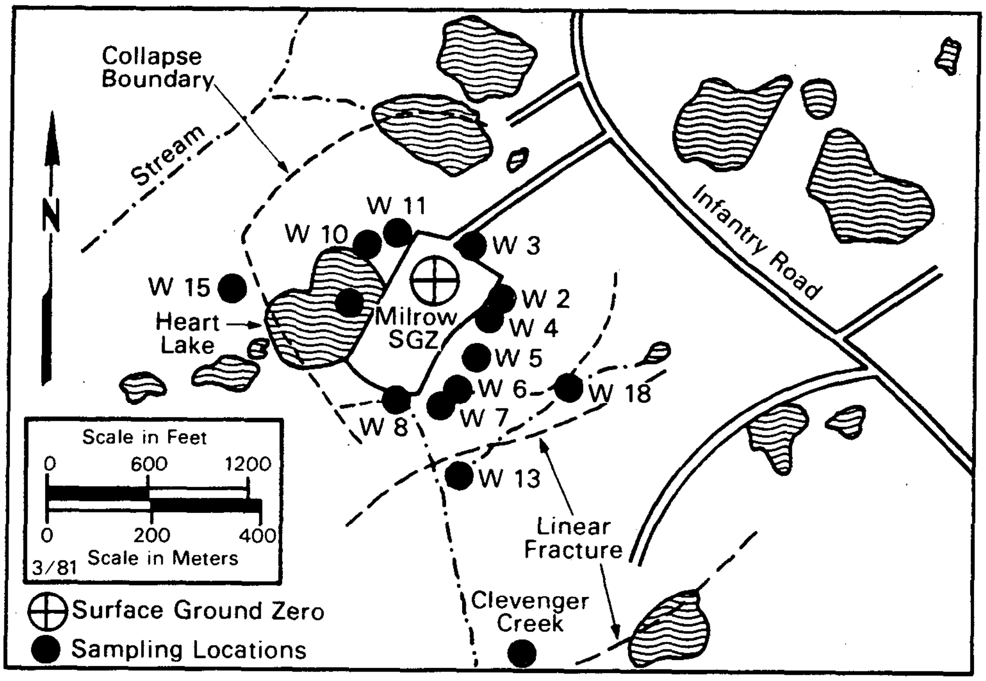


Figure E-2. LTHMP sampling locations for Project Cannikin.

TABLE E-9. 1981 TRITIUM RESULTS FOR THE OFF-NTS LONG-TERM HYDROLOGICAL MONITORING PROGRAM (ANNUAL SAMPLES)

Sampling Location	Date	Sample Type	Tritium Concentration (pCi/L)	% of Conc. Guide*
PROJECT CANNIKIN -- AMCHITKA, ALASKA				
Well HTH-3	10/03	Well	57	<0.01
Ice Box Lake	10/03	Lake	48	<0.01
White Alice Creek	(No sample collected - dry)			
South end Cannikin Lake	10/03	Lake	43	<0.01
North end Cannikin Lake	10/03	Lake	42	<0.01
Well AEC-1	(No sample collected)			
Pit SGZ	10/03	Pit	39	<0.01
PROJECT MILROW -- AMCHITKA, ALASKA:				
Heart Lake	10/04	Lake	37	<0.01
Well W-5	10/04	Well	36	<0.01
Well W-6	(No sample collected - dry)			
Well W-8	10/04	Well	36	<0.01
Well W-15	10/04	Well	35	<0.01
Well W-10	10/04	Well	42	<0.01
Well W-11	10/04	Well	79	<0.01
Well W-3	10/04	Well	39	<0.01
Well W-2	10/04	Well	39	<0.01
Clevenger Creek	10/04	Creek	43	<0.01
Well W-4	10/04	Well	39	<0.01
Well W-7	10/04	Well	40	<0.01
Well W-13	10/04	Well	52	<0.01
Well W-18	10/04	Well	28	<0.01
PROJECT LONG SHOT -- ALASKA				
Amchitka, AK:				
Well WL-2	10/05	Well	290	<0.03

(continued)



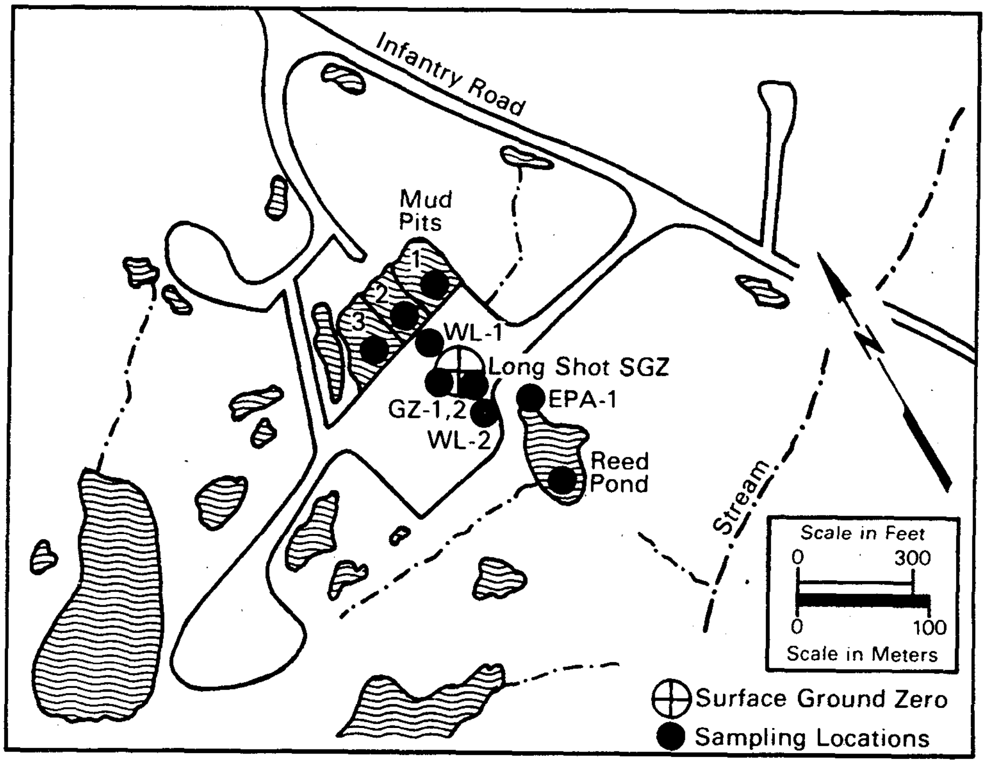


Figure E-3. LTHMP sampling locations for Projects Milrow and Long Shot.

TABLE E-9. (Continued)

Sampling Location	Date	Sample Type	Tritium Concentration (pCi/L)	% of Conc. Guide*
Amchitka, AK: (continued)				
EPA Well-1	10/05	Well	44	<0.01
Reed Pond	10/05	Pond	36	<0.01
Well GZ 1	10/05	Well	4,200	0.42
Well GZ 2	10/05	Well	240	0.02
Well WL-1	10/05	Well	52	<0.01
Mud Pit 1	10/05	Pond	530	0.05
Mud Pit 2	10/05	Pond	850	0.08
Mud Pit 3	10/05	Pond	1,400	0.14
BACKGROUND SAMPLES -- ALASKA				
Amchitka, AK:				
Constantine Spring	10/04	Spring	68	<0.01
Jones Lake	10/04	Lake	37	<0.01
Army Well 1	10/04	Well	48	<0.01
Army Well 2	10/04	Well	25	<0.01
Army Well 3	10/03	Well	67	<0.01
Site E Hydro Explor Hole	10/3	Well	150	0.02
Site D Hydro Explor Hole	10/03	Well	57	<0.01
Rain Sample	10/04	Rain	22	<0.01
Rain Sample	10/09	Rain	22	<0.01
Duck Cove Creek	10/04	Creek	51	<0.01

(continued)

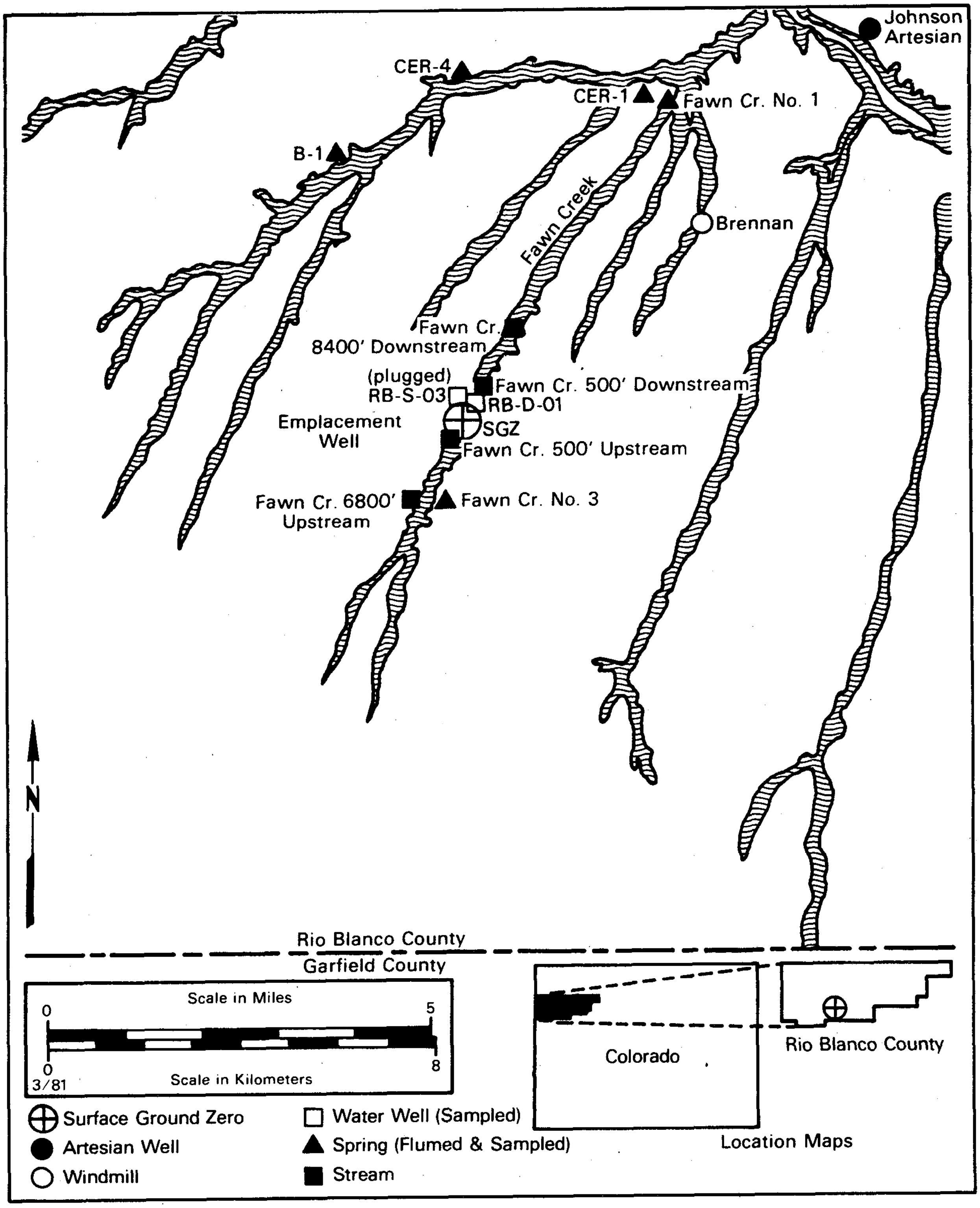


Figure E-4. LTHMP sampling locations for Project Rio Blanco.

TABLE E-9. (Continued)

Sampling Location	Date	Sample Type	Tritium Concentration (pCi/L)	% of Conc. Guide*
Rio Blanco, CO:				
Fawn Creek 6,800 ft upstream from SGZ	6/12	Creek	93	<0.01
Fawn Creek 500 ft upstream from SGZ	6/12	Creek	69	<0.01
Fawn Creek 500 ft downstream from SGZ	6/12	Creek	69	<0.01
Fawn Creek 8,400 ft downstream from SGZ	6/12	Creek	54	<0.01
Fawn Creek No. 1	6/12	Spring	53	<0.01
Fawn Creek No. 3	6/12	Spring	77	<0.01
CER No. 1 Black Sulphur	6/12	Spring	95	<0.01
CER No. 4 Black Sulphur	6/12	Spring	110	0.01
B-1 Equity Camp	6/12	Spring	110	0.01
Brennan Windmill	6/12	Well	<10	<0.01
Johnson Artesian Well	6/12	Well	12	<0.01
Well RB-D-01	6/14	Well	20	<0.01

(continued)

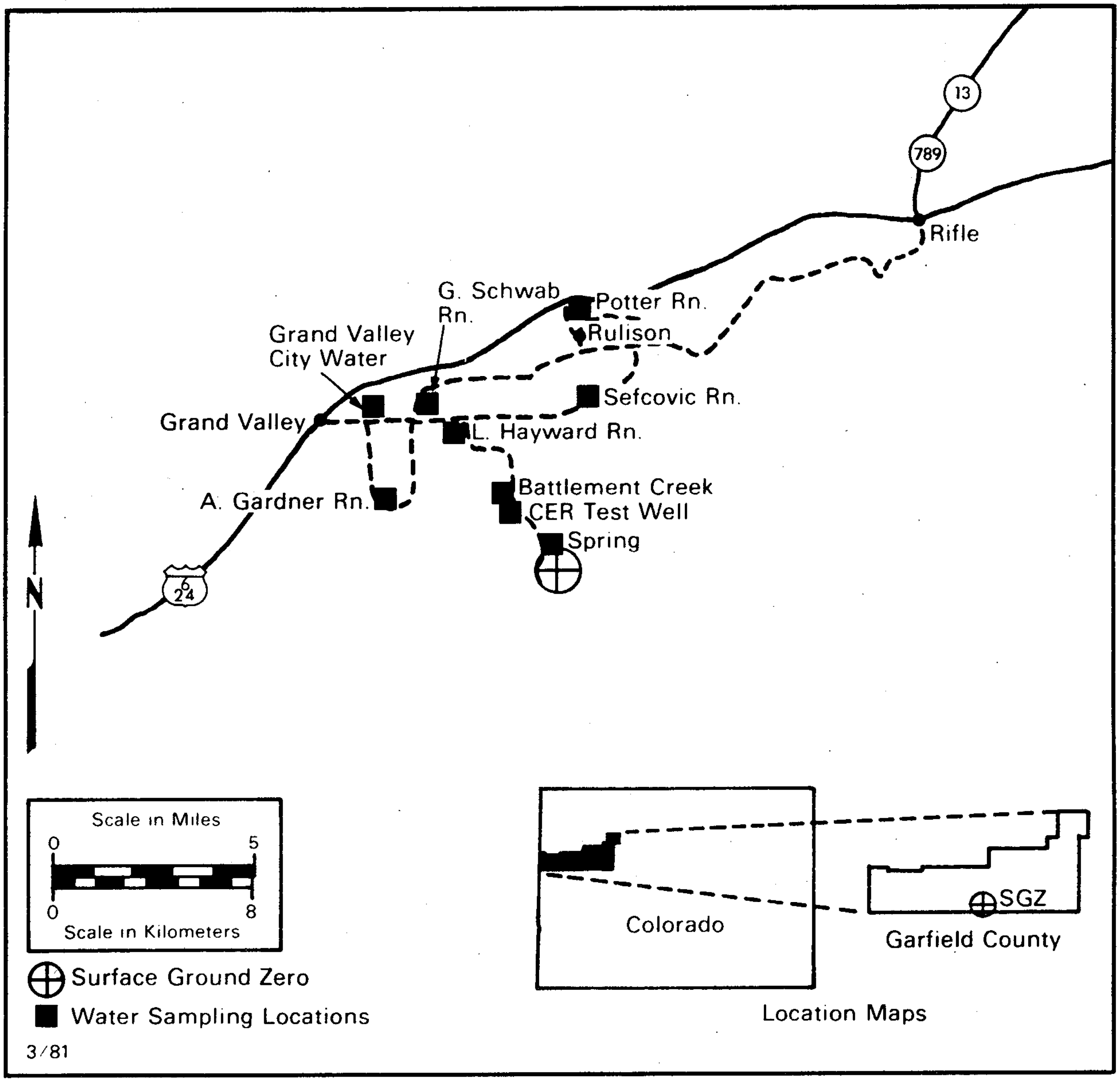


Figure E-5. LTHMP sampling locations for Project Rulison.

TABLE E-9. (Continued)

Sampling Location	Date	Sample Type	Tritium Concentration (pCi/L)	% of Conc. Guide*
PROJECT RULISON -- COLORADO				
Rulison, CO:				
Lee L. Hayward Ranch	6/10	Well	250	0.02
Robert Searcy Ranch (G. Schwab)	6/10	Well	250	0.02
Felix Sefcovic Ranch	6/10	Well	290	0.03
Potter Ranch	6/10	Spring	200	0.02
Grand Valley, CO:				
Albert Gardner Ranch	6/10	Well	240	0.02
City Spring	6/10	Spring	46	<0.01
Spring 300 Yds. NW of GZ	6/11	Spring	130	0.01
Battlement Creek	6/11	Creek	200	0.02
CER Test Well	6/11	Well	190	0.02

(continued)

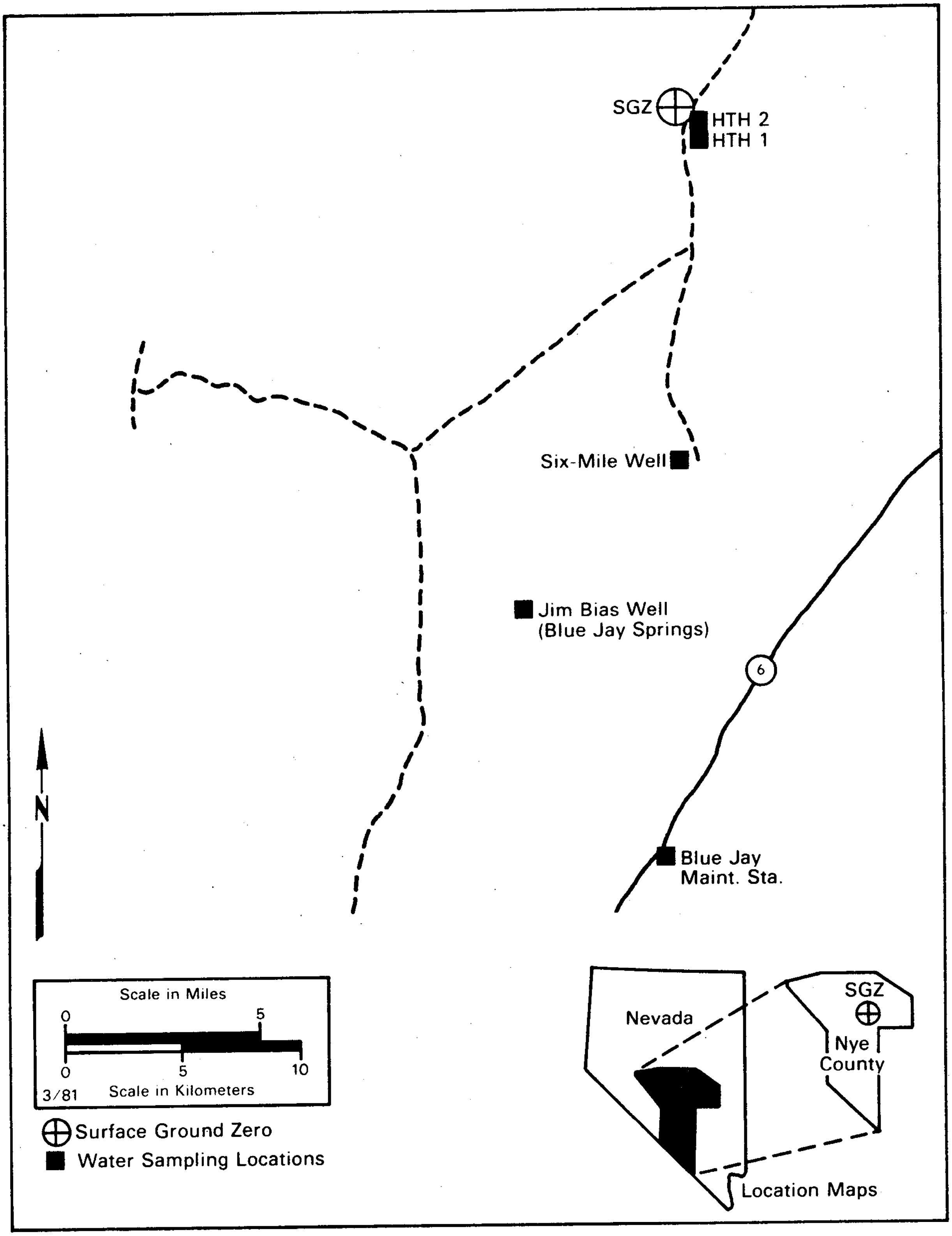


Figure E-6. LTHMP sampling locations for Project Faultless.

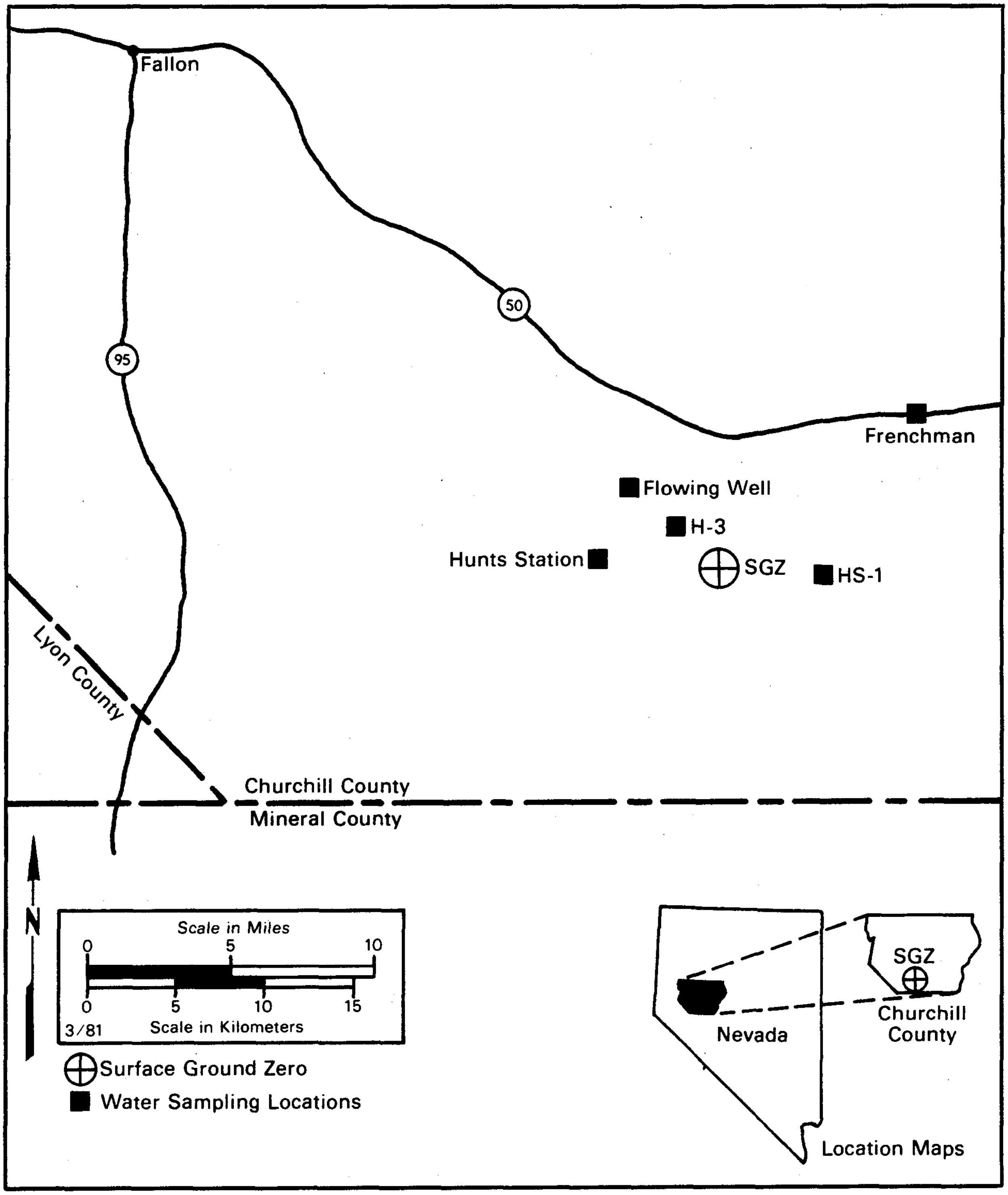


Figure E-7. LTHMP sampling locations for Project Shoal.

TABLE E-9. (Continued)

Sampling Location	Date	Sample Type	Tritium Concentration (pCi/L)	% of Conc. Guide*
PROJECT FAULTLESS -- NEVADA				
Blue Jay, NV:				
Maintenance Sta.	6/23	Well	<10	<0.01
Sixmile Well	6/23	Well	<10	<0.01
Well HTH-1	6/24	Well	<10	<0.01
Well HTH-2	6/24	Well	<10	<0.01
Jim Bias Well	6/23	Well	<7	<0.01
PROJECT SHOAL (FALLON) -- NEVADA				
Frenchman, NV:				
Frenchman Station	5/20	Well	<10	<0.01
Well HS-1	5/20	Well	<10	<0.01
Well H-3	(Pump inoperative)			
Flowing Well	5/21	Well	11	<0.01
Hunts Station	5/20	Well	<10	<0.01

(continued)

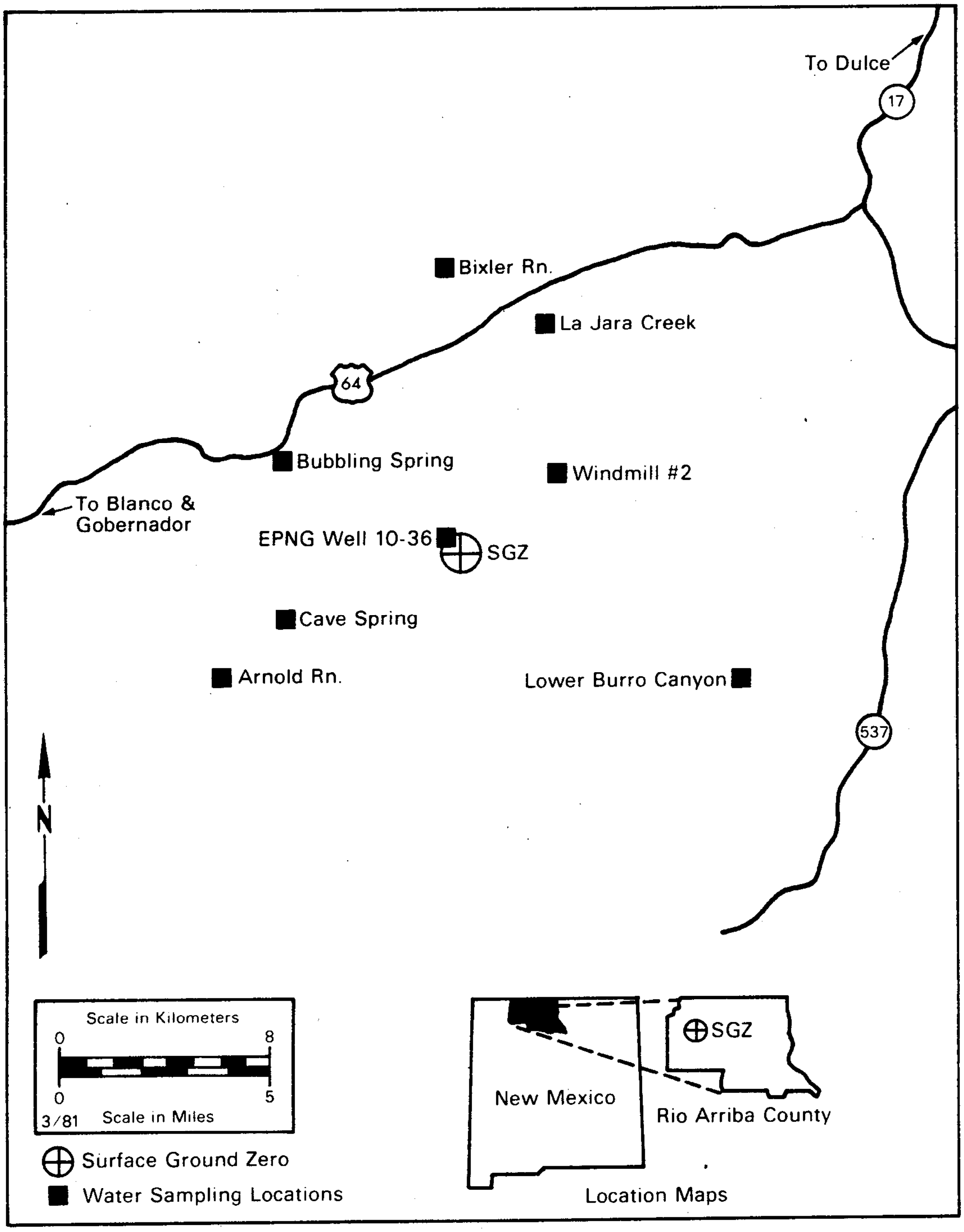


Figure E-8. LTHMP sampling locations for Project Gasbuggy.

TABLE E-9. (Continued)

Sampling Location	Date	Sample Type	Tritium Concentration (pCi/L)	% of Conc. Guide*
PROJECT GASBUGGY -- NEW MEXICO				
Gobernador, NM:				
Arnold Ranch	5/15	Spring	35	<0.01
Lower Burro Canyon	5/13	Well	20	<0.01
Fred Bixler Ranch	5/15	Well	26	<0.01
Cave Springs	5/13	Spring	49	<0.01
Windmill No. 2	5/13	Well	24	<0.01
Bubbling Springs	5/13	Spring	110	0.01
EPNG Well 10-36	5/14	Well	46	<0.01
La Jara Creek	5/13	Creek	78	<0.01
PROJECT GNOME -- NEW MEXICO				
Malaga, NM:				
USGS Well 1	5/07	Well	<12	<0.01
USGS Well 4	5/10	Well	400,000**	40
USGS Well 8	5/10	Well	340,000**	34
PHS Well 6	5/07	Well	64	<0.01
PHS Well 8	5/07	Well	29	<0.01
PHS Well 9	5/06	Well	<7	<0.01
PHS Well 10	5/07	Well	20	<0.01
Pecos River Pumping Station	5/06	Well	<12	<0.01
Well LRL-7	5/10	Well	39,000**	1
Well DD-1	5/09	Well	1.8×10^{8}**	6,000
Loving, City Well No. 2	5/07	Well	72	<0.01
Carlsbad, City Well No. 7	5/08	Well	15	<0.01

(continued)

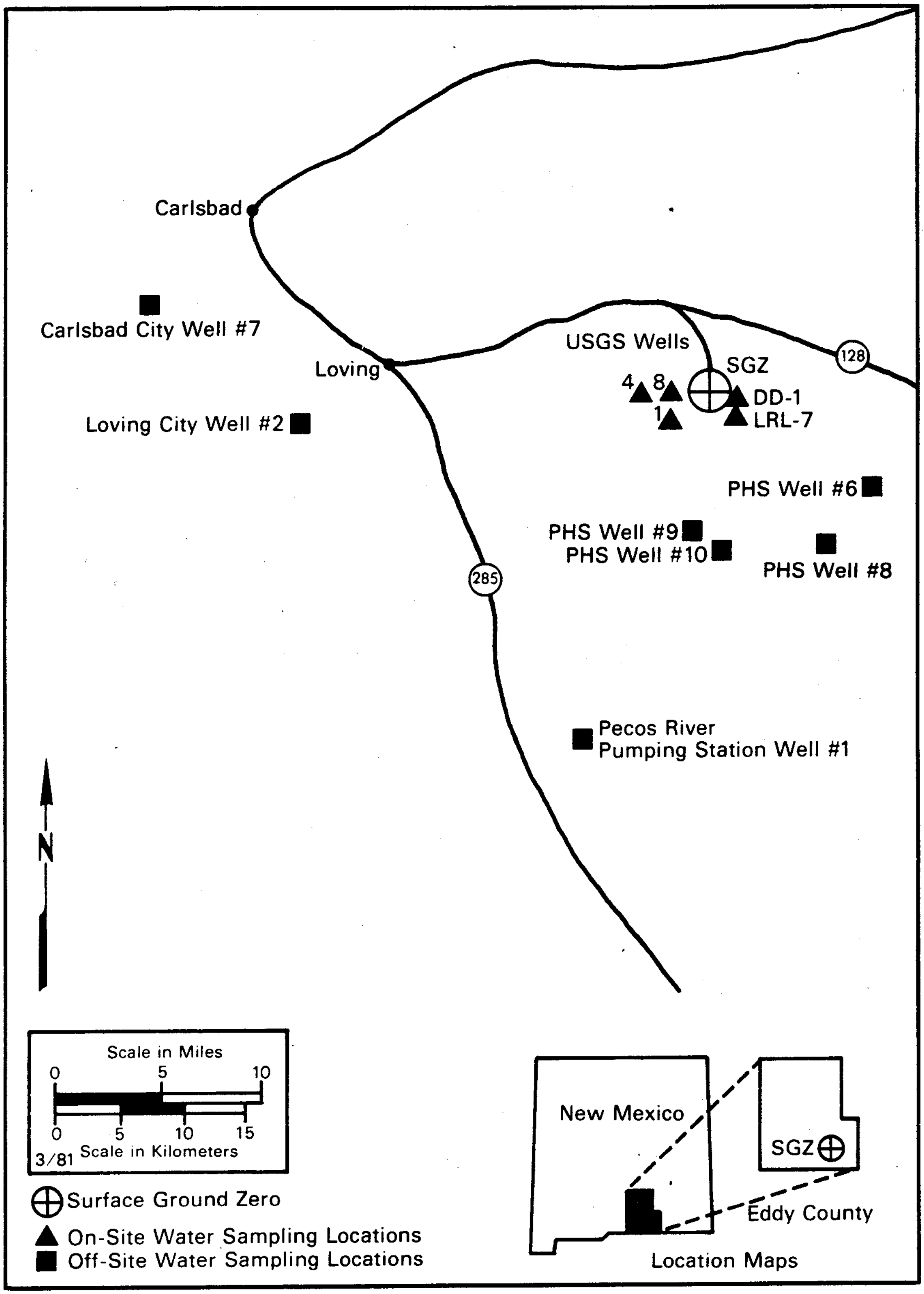


Figure E-9. LTHMP sampling stations for Project Gnome.

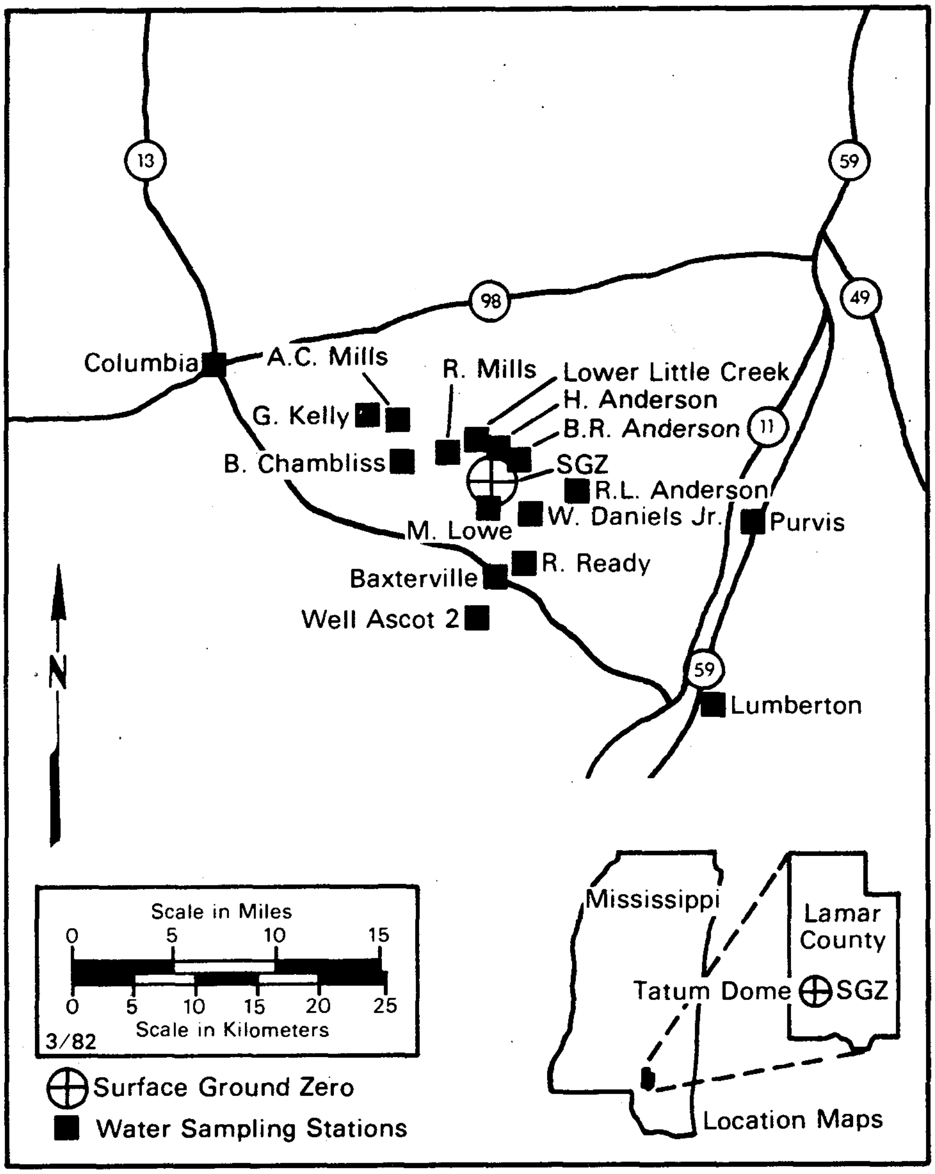


Figure E-10. LTHMP sampling locations for Project Dribble - towns and residences.

TABLE E-9. (Continued)

Sampling Location	Date	Sample Type	Tritium Concentration (pCi/L)	% of Conc. Guide*

**These samples also had the following detectable concentration:

Location	Radionuclide	Concentration (pCi/L)	% CG
Malaga, NM:			
USGS Well No. 4	^{90}Sr	8,300	8,300
	^{137}Cs	16	0.23
USGS Well No. 8	^{90}Sr	3,400	3,400
	^{137}Cs	29	0.43
Well LRL-7	^{90}Sr	870	870
	^{137}Cs	350	5.2
	^{234}U	0.17	<0.02
	^{238}U	0.15	<0.08
	^{226}Ra	6.0	60
Well DD-1	^{90}Sr	310,000	310,000
	^{137}Cs	900,000	13,000
	^{239}Pu	12	0.7

Sampling Location	Date	Sample Type	Tritium Concentration (pCi/L)	% of Conc. Guide*
PROJECT DRIBBLE -- MISSISSIPPI				
Baxterville, MS:				
City Supply	3/23	Well	63	<0.01
Lower Little Creek	3/30	Stream	12	<0.01
R. L. Anderson residence	3/30	Well	35	<0.01
M. Lowe residence	3/21	Well	44	<0.01
R. Ready residence	3/23	Well	92	<0.01
W. Daniels residence	3/23	Well	28	<0.01
B. Chambliss residence	3/21	Well	<10	<0.01

(continued)

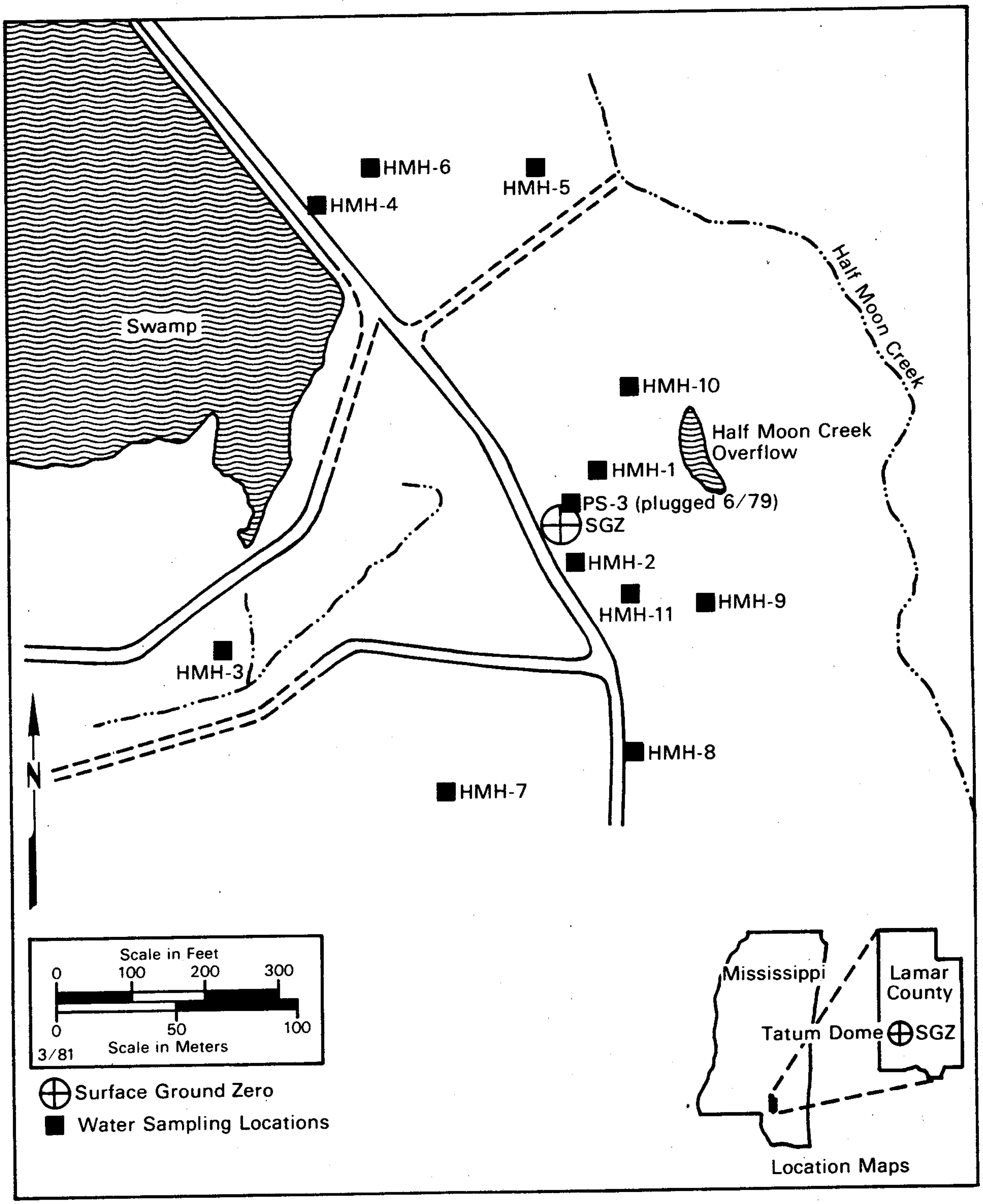


Figure E-11. LTHMP sampling locations for Project Dribble - near GZ.

TABLE E-9. (Continued)

Sampling Location	Date	Sample Type	Tritium Concentration (pCi/L)	% of Conc. Guide*
B. R. Anderson residence	3/23	Well	29	<0.01
R. Mills residence	3/21	Well	31	<0.01
A. C. Mills residence	3/21	Well	<10	<0.01
G. Kelly residence	3/21	Well	<10	<0.01
H. Anderson residence	3/23	Well	30	<0.01
Well Ascot No. 2	3/31	Well	<10	<0.01
Columbia, City Well 64B	3/23	Well	<10	<0.01
Lumberton, City Well 2	3/23	Well	<10	<0.01
Purvis, City Supply	3/23	Well	<10	<0.01
Baxterville, MS:				
Half Moon Creek Overflow	3/25	Stream	830	0.03
Well HMH-1	3/25	Well	12,000	1.2
Well HMH-2	3/25	Well	37	<0.01
Well HMH-3	3/25	Well	170	0.02
Well HMH-4	3/25	Well	29	<0.01
Well HMH-5	3/25	Well	6,500	0.65
Well HMH-6	3/25	Well	230	0.02
Well HMH-7	3/25	Well	550	0.06
Well HMH-8	3/25	Well	35	<0.01
Well HMH-9	3/25	Well	85	<0.01
Well HMH-10	3/25	Well	41	<0.01
Well HMH-11	3/25	Well	200	0.02

(continued)

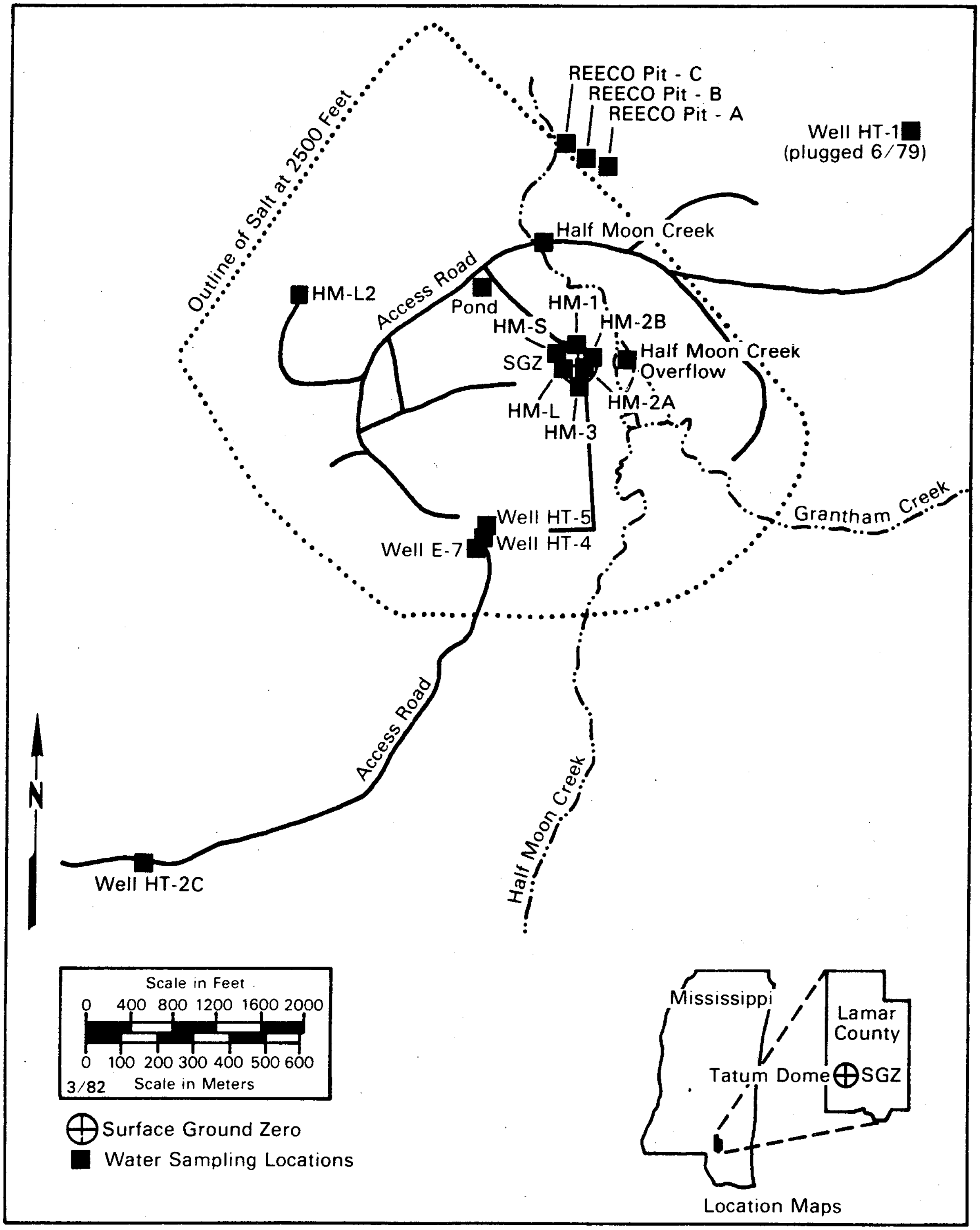


Figure E-12. LTHMP sampling locations for Project Dribble - near salt dome.

TABLE E-9. (Continued)

Sampling Location	Date	Sample Type	Tritium Concentration (pCi/L)	% of Conc. Guide*
Baxterville, MS:				
Well HM-3	3/30	Well	<10	<0.01
Well HM-S	3/24	Well	28,000	2.8
Well HM-1	3/27	Well	<10	<0.01
Well HM-L	4/03	Well	2,700	0.27
Well HM-2A	3/28	Well	<10	<0.01
Well HM-2B	3/28	Well	<10	<0.01
Half Moon Creek	3/25	Well	12	<0.01
REECo Pit Drainage-A	3/24	Well	41	<0.01
REECo Pit Drainage-B	3/24	Pond	2,500	0.25
REECo Pit Drainage-C	3/24	Pond	300	0.03
Well HM-L2**	4/06	Well	19	<0.01
Pond West of GZ	3/25	Pond	26	<0.01
Well HT-2C	4/05	Well	18	<0.01
Well HT-4	4/04	Well	29	<0.01
Well HT-5	4/04	Well	21	<0.01
Well E-7	4/05	Well	<10	<0.01

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

**This sample also had concentrations of the following radionuclides

		Concentration (pCi/L)	% CG
Well HM-L2	^{234}U	0.21	<0.02
	^{238}U	0.12	0.06
	^{226}Ra	2.6	26
	^{235}U	0.027	<0.01
	^{90}Sr	7.0	7

TABLE E-10. 1981 SUMMARY OF ANALYTICAL RESULTS FOR THE MILK SURVEILLANCE NETWORK

Sampling Location	Sample Type*	No. of Samples	Radio-nuclide	Radioactivity Conc. (pCi/L) Max	Min	Avg
Hinkley, CA, Bill Nelson Dairy	12	4	^{89}Sr	<40	<4	<4
		4	^{90}Sr	<4	<0.8	2.0
Keough Hot Spgs., CA Yribarren Ranch	13	3	^{89}Sr	<20	<3	<3
		3	^{90}Sr	<2	<2	<2
Ridgecrest, CA, Jane Szymanski Ranch	13	2	^{89}Sr	<40	<4	<4
		2	^{90}Sr	<5	2.1	3.2
Alamo, NV, Buckhorn Ranch	13	3	^{89}Sr	<30	<3	<3
		3	^{90}Sr	<3	1.2	1.6
Austin, NV, Young's Ranch	13	4	^{3}H	1,400	<300	560
		4	^{89}Sr	<40	<2	<2
		4	^{90}Sr	<5	<0.8	2.2
Currant, NV, Blue Eagle Ranch	13	3	^{89}Sr	<30	<5	<5
		3	^{90}Sr	<3	<2	1.7
Currant, NV, Manzonie Ranch	13	2	^{89}Sr	<30	<4	<4
		2	^{90}Sr	<4	<0.9	1.6
Hiko, NV, Darrel Hansen Ranch	13	3	^{3}H	450	<400	<400
		3	^{89}Sr	<50	<3	<3
		3	^{90}Sr	<5	0.92	3.0
Las Vegas, NV, LDS Dairy Farm	12	4	^{3}H	<500	<300	<300
		3	^{89}Sr	<20	<3	<3
		3	^{90}Sr	1.9	<2	1.3
Lathrop Wells, NV, R.J. Eastman Ranch	13	3	^{89}Sr	<30	<3	<3
		3	^{90}Sr	<4	0.96	1.8
Lida, NV, Lida Livestock Co.	13	2	^{89}Sr	<20	<4	<4
		2	^{90}Sr	2.7	1.7	2.2

(continued)

TABLE E-10. (Continued)

Sampling Location	Sample Type*	No. of Samples	Radio-nuclide	Radioactivity Conc. (pCi/L) Max	Min	Avg
Lund, NV, McKenzie Dairy	12	4	^{3}H	620	<300	<300
		4	^{89}Sr	<50	<3	<3
		4	^{90}Sr	5.4	<0.8	1.8
Mesquite, NV, Hughes Bros. Dairy	12	4	^{3}H	890	<300	<300
		4	^{89}Sr	<40	<4	<4
		4	^{90}Sr	<4	0.92	0.96
Moapa, NV, Agman Seventy-Five, Inc.	12	4	^{89}Sr	<40	<3	<3
		4	^{90}Sr	4.7	0.88	2.7
Nyala, NV, Sharp's Ranch	13	4	^{3}H	<500	<300	<300
		4	^{89}Sr	<200	<0.9	<0.9
		4	^{90}Sr	7.3	<0.5	2.2
Overton, NV, Robison Dairy	12	2	^{89}Sr	<40	<10	<10
		2	^{90}Sr	<4	<4	<4
Caliente, NV, June Cox Ranch	13	4	^{89}Sr	<30	<2	<2
		4	^{90}Sr	<4	0.71	1.5
Round Mountain, NV, Berg Ranch	13	2	^{89}Sr	<30	<30	<30
		2	^{90}Sr	<8	3.9	<4
Cedar City, UT, Western General Dairy	12	4	^{89}Sr	<80	<4	<4
		4	^{90}Sr	<9	<2	2.7
St. George, UT, Cottam Dairy	12	1	^{89}Sr	<0.7	<0.7	<0.7
		1	^{90}Sr	0.30	0.30	0.30
St. George UT, Droubay Dairy	12	3	^{89}Sr	<50	<5	<5
		3	^{90}Sr	<5	1.9	<2

*12 = Raw milk from Grade A producer(s); 13 = raw milk from family cow(s).

TABLE E-11. 1981 SUMMARY OF ANALYTICAL RESULTS FOR STANDBY MILK SURVEILLANCE NETWORK

Sampling Location	Collection Date 1981	Tritium pCi/L	Sr pCi/L	Sr pCi/L
Bordens Little Rock, Ark.	8/20	<440	<110	5.4
Pondre Valley Dairy Ft. Collins, Colo.	8/03	<420	NA	NA
Meadow Gold Dairies Boise, Idaho	9/09	NA	<99	<2.6
Swiss Valley Farms Davenport, Iowa	8/05	<420	<45	1.4
Millers Farm Dairy Topeka, Kan.	8/04	<420	<35	1.3
Assoc. Milk Producers Rochester, Minn.	9/11	NA	<69	4.9
Mid-America Dairymen Chillicothe, Mo.	8/04	<420	<350	<8
Darigold Farms Bozeman, Mont.	8/03	<420	<27	0.9
Mid-America Dairymen North Platte, Neb.	8/09	<420	<61	2.5
Cass Clay Creamery Inc. Fargo, N. Dak.	8/04	<440	<70	<1.6
Okla. State Penitentiary McAlester, Okla.	8/26	<290	<73	<2.2
Mayflower-Dairygold Farms Portland, Ore.	9/09	<290	<62	2.5
Dairy Gold Foods Cheyenne, Wyo.	8/01	<420	<64	<1.4
Average		<400	<89	2 ± 1.8

TABLE E-12. 1981 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/a)
Adaven, NV	01/13/81	01/20/82	0.36	0.34	0.35	128
Alamo, NV	01/14/81	01/08/82	0.23	0.21	0.22	80
American Borate, NV	01/06/81	01/05/82	0.26	0.25	0.26	95
Area 51-NTS, NV	01/06/81	01/11/82	0.20	0.16	0.18	66
Austin, NV	01/07/81	01/12/82	0.33	0.26	0.30	110
Baker, CA	01/20/81	01/11/82	0.22	0.21	0.22	80
Barstow, CA	01/20/81	01/11/82	0.29	0.29	0.29	106
Beatty, NV	01/07/81	01/05/82	0.27	0.24	0.26	95
Bishop, CA	01/22/81	01/12/82	0.32	0.24	0.27	99
Blue Eagle Ranch, NV	01/13/81	01/06/82	0.17	0.16	0.17	62
Blue Jay, NV	01/08/81	01/12/82	0.32	0.30	0.31	113
Cactus Springs, NV	01/06/81	01/04/82	0.16	0.15	0.16	58
Caliente, NV	01/13/81	01/06/82	0.30	0.29	0.29	106
Carp, NV	01/16/81	01/07/82	0.29	0.28	0.29	106
Casey's Ranch, NV	01/07/81	01/12/82	0.21	0.17	0.20	73
Cedar City, UT	01/07/81	01/05/82	0.20	0.19	0.20	73
Clark Station, NV	01/08/81	01/11/82	0.32	0.29	0.31	113
Complex 1, NV	01/13/81	01/20/32	0.29	0.27	0.28	102
Corn Creek Station, NV	01/06/81	01/04/82	0.15	0.14	0.14	51
Coyote Summit, NV	01/06/81	01/11/82	0.38	0.32	0.34	124
Currant, NV	01/13/81	01/06/82	0.28	0.26	0.28	102
Death Valley Jct., CA	01/22/81	01/14/82	0.20	0.20	0.20	73
Diablo Maint. Sta., NV	01/07/81	01/11/82	0.36	0.32	0.34	124
Duckwater, NV	01/13/81	01/06/82	0.28	0.26	0.27	99
Elgin, NV	01/16/81	01/07/82	0.33	0.31	0.32	117
Ely, NV	01/08/81	01/07/82	0.21	0.20	0.20	73
Enterprise, UT	01/07/81	01/05/82	0.27	0.26	0.27	99
Eureka, NV	01/07/81	01/11/82	0.30	0.28	0.29	106

(continued)

TABLE E-12. (Continued)

Station Location	Measurement Period		Dose Equivalent Rate (mrem/d) Max.	Min.	Avg.	Annual Adjusted Dose Equivalent (mrem/a)
Furnace Creek, CA	01/22/81	01/14/82	0.17	0.16	0.17	62
Garrison, UT	01/08/81	01/07/82	0.19	0.18	0.18	66
Geyser Maint. Sta., NV	01/08/81	01/07/82	0.29	0.26	0.28	102
Glendale, UT	01/06/81	01/04/82	0.16	0.15	0.15	55
Goldfield, NV	01/06/81	01/13/82	0.25	0.23	0.24	88
Hancock Summit, NV	01/06/81	01/11/82	0.39	0.38	0.39	142
Hiko, NV	01/14/81	01/08/82	0.21	0.19	0.20	73
Hot Creek Ranch, NV	01/08/81	01/11/82	0.25	0.23	0.24	88
Independence, CA	01/21/81	01/12/82	0.26	0.25	0.25	91
Indian Springs, NV	01/06/81	01/04/82	0.17	0.15	0.16	58
Kirkeby Ranch, NV	01/08/81	01/07/82	0.21	0.20	0.20	73
Koynes, NV	01/07/81	01/13/82	0.27	0.24	0.25	91
Las Vegas (Airport), NV	01/07/81	01/04/82	0.14	0.13	0.13	47
Las Vegas (Placak), NV	01/07/81	01/04/82	0.14	0.13	0.13	47
Las Vegas (UNLV), NV[1]	09/28/81	01/04/82	0.11	0.11	0.11	40
Las Vegas (USDI), NV	01/07/81	01/04/82	0.16	0.16	0.16	58
Lathrop Wells, NV	01/06/81	01/05/82	0.27	0.26	0.26	95
Lavada's Market, NV	01/07/81	01/05/82	0.24	0.23	0.24	88
Lida, NV	01/06/81	01/13/82	0.27	0.26	0.26	95
Lone Pine, CA	01/21/81	01/12/82	0.27	0.26	0.26	95
Lund, NV	01/09/81	01/08/82	0.24	0.23	0.23	84
Mammoth Mtn., CA	01/21/81	01/13/82	0.35	0.22	0.27	99
Manhattan, NV	01/07/81	01/12/82	0.34	0.32	0.33	120
Mesquite, NV	01/06/81	01/04/82	0.18	0.17	0.17	62
Nevada Farms, NV	01/06/81	01/11/82	0.33	0.30	0.31	113
Nyala, NV	01/07/81	01/12/82	0.21	0.19	0.20	73
Olancha, CA	01/21/81	01/12/82	0.26	0.24	0.25	91
Pahrump, NV	01/08/81	01/04/82	0.17	0.14	0.16	58

(continued)

TABLE E-12. (Continued)

Station Location	Measurement Period		Dose Equivalent Rate (mrem/d) Max.	Min.	Avg.	Annual Adjusted Dose Equivalent (mrem/a)
Pine Creek Ranch, NV	01/13/81	01/20/82	0.33	0.32	0.32	117
Pioche, NV	01/13/81	01/06/82	0.22	0.22	0.22	80
Queen City Summit, NV	01/06/81	01/11/82	0.46	0.34	0.38	139
Rachel, NV	01/06/81	01/11/82	0.30	0.28	0.29	106
Reed Ranch, NV	01/06/81	09/11/82	0.34	0.30	0.32	117
Ridgecrest, CA	01/20/81	01/12/82	0.24	0.23	0.23	84
Round Mountain, NV	01/07/81	01/12/82	0.31	0.29	0.30	106
Rox, NV[2]	06/22/81	01/04/82	0.22	0.18	0.20	73
Scotty's Junction, NV	01/06/81	01/13/82	0.28	0.26	0.26	95
Sherri's Bar, NV	01/13/81	01/08/82	0.20	0.20	0.20	73
Shoshone, CA	01/22/81	01/14/82	0.28	0.23	0.26	95
Springdale, NV	01/08/81	01/06/82	0.30	0.29	0.29	106
Spring Meadows, NV	01/06/81	01/05/82	0.17	0.16	0.16	58
St. George, UT	01/07/81	01/04/82	0.18	0.16	0.17	62
Stone Cabin Ranch, NV	01/08/81	01/12/82	0.36	0.29	0.32	117
Sunnyside, NV	01/09/81	01/08/82	0.18	0.17	0.18	66
Tempiute, NV	01/07/81	01/13/82	0.32	0.29	0.30	110
Tonopah, NV	01/06/81	01/12/82	0.31	0.28	0.29	106
Tonopah Test Range, NV	01/07/81	01/12/82	0.27	0.26	0.26	95
Twin Springs Ranch, NV	01/08/81	01/12/82	0.30	0.27	0.28	102
U.S. Ecology, NV	01/07/81	01/05/82	0.32	0.30	0.31	113
Valley Crest, CA	01/22/81	01/14/82	0.15	0.15	0.15	55
Warm Springs, NV	01/07/81	01/11/82	0.30	0.29	0.30	110
Young's Ranch, NV	01/07/81	01/12/82	0.26	0.23	0.24	88

[1]Station established Fourth Quarter 1981
[2]TLD's from Rox, Nevada, were stolen First and Second Quarter 1981

TABLE E-13. 1981 SUMMARY OF RADIATION DOSES FOR OFFSITE RESIDENTS

Resident No.	Background Station Location	Period of Measurement		Dose Equivalent Rate (mrem/d)			Annual Net Exposure (mrem)
		Issue	Collect	Max.	Min.	Avg.	
1	Tonopah, NV	01/06/81	09/29/81	0.23	0.21	0.22	0.0
2	Caliente, NV	01/13/81	01/12/82	0.25	0.23	0.24	0.0
3	Blue Jay, NV	01/08/81	01/12/82	0.33	0.27	0.30	0.0
4	Glendale, NV	01/06/81	10/05/81	0.19	0.17	0.18	3.0
5	Lathrop Wells, NV	01/07/81	01/05/82	0.25	0.23	0.24	0.0
6	Indian Springs, NV	01/06/81	01/08/82	0.14	0.13	0.14	0.0
7	Goldfield, NV	01/06/81	01/13/82	0.21	0.20	0.21	0.0
8	Twin Springs Ranch, NV	01/08/81	01/12/82	0.28	0.22	0.26	0.0
9	Blue Eagle Ranch, NV	01/13/81	01/06/82	0.17	0.17	0.17	0.0
10	Complex 1, NV	01/13/81	01/20/82	0.31	0.26	0.27	3.1
11	Complex 1, NV	01/13/81	01/20/82	0.27	0.26	0.26	0.0
12	Corn Creek, NV	01/06/81	01/04/82	0.14	0.12	0.13	0.0
13	Koynes Ranch, NV	01/07/81	01/13/82	0.20	0.15	0.18	0.0
14	Hancock Summit, NV	01/06/81	01/11/82	0.24	0.21	0.22	0.0
15	Hancock Summit, NV	01/06/81	01/11/82	0.24	0.21	0.23	0.0
17	Nyala, NV	01/07/81	01/12/82	0.22	0.18	0.19	0.0
18	Nyala, NV	01/07/81	01/12/82	0.24	0.19	0.21	0.0
19	Goldfield, NV	01/06/81	01/13/82	0.23	0.19	0.21	0.0
21	Beatty, NV	01/07/81	01/05/82	0.27	0.24	0.26	0.0
22	Alamo, NV	01/14/81	01/08/82	0.19	0.17	0.18	0.0
23	Alamo, NV	01/16/81	04/09/81	0.20	0.20	0.20	0.0
24	Corn Creek, NV	01/06/81	01/04/82	0.12	0.10	0.11	0.0
25	Corn Creek, NV	01/06/81	01/04/82	0.18	0.14	0.17	9.9
26	Tempiute, NV	04/06/81	09/28/81	0.32	0.22	0.27	0.0
27	Pahrump, NV	04/08/81	01/07/82	0.19	0.13	0.16	1.7
28	Hot Creek Ranch, NV	04/07/81	01/12/82	0.27	0.25	0.26	0.0
29	Stone Cabin Ranch, NV	04/07/81	01/12/82	0.27	0.26	0.27	0.0
30	Rachel, NV	04/06/81	01/13/82	0.24	0.22	0.23	0.0
31	Queen City Summit, NV	04/07/81	06/29/81	0.36	0.36	0.36	0.0

(continued)

TABLE E-13. (Continued)

Resident No.	Background Station Location	Period of Measurement: Issue	Period of Measurement: Collect	Dose Equivalent Rate (mrem/d): Max.	Min.	Avg.	Annual Net Exposure (mrem)
32	Lida, NV	03/31/81	06/22/81	0.20	0.20	0.20	0.0
33	Lathrop Wells, NV	04/06/81	01/08/82	0.25	0.21	0.23	0.0
34	Furnace Creek, CA	04/02/81	10/07/81	0.16	0.16	0.16	0.0
35	Death Valley Jct., CA	04/02/81	01/14/82	0.20	0.19	0.20	0.0
36	Pahrump, NV	09/29/81	01/04/82	0.13	0.13	0.13	0.0
37	Indian Springs, NV	09/28/81	01/04/82	0.15	0.15	0.15	0.0
38	Beatty, NV	09/28/81	01/04/82	0.30	0.30	0.30	4.4
39	Shoshone, CA	10/07/81	01/15/82	0.21	0.21	0.21	0.0
40	Goldfield, NV	09/29/81	01/13/82	0.22	0.22	0.22	0.0
41	Austin, NV	09/29/81	01/12/82	0.27	0.27	0.27	0.0
42	Tonopah, NV	09/29/81	01/13/82	0.23	0.23	0.23	0.0
43	Alamo, NV	09/28/81	01/08/82	0.20	0.20	0.20	0.0
44	Cedar City, UT	10/06/81	01/05/82	0.20	0.20	0.20	0.0
45	St. George, UT	10/06/81	01/04/82	0.16	0.16	0.16	0.0
46	Overton, NV	10/06/81	01/04/82	0.19	0.19	0.19	0.0
47	Ely, NV	09/28/81	01/07/82	0.18	0.18	0.18	0.0
48	Rachel, NV	11/10/81	01/13/82	0.23	0.23	0.23	0.0
49	Las Vegas, UNLV	09/28/81	01/13/82	0.40	0.40	0.40	29.0

TECHNICAL REPORT DATA *(Please read Instructions on the reverse before completing)*		
1. REPORT NO. EPA-600/4-82-061	2. DOE/DP/00539-046	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE OFFSITE ENVIRONMENTAL MONITORING REPORT Radiation monitoring around U.S. nuclear test areas, calendar year 1981		5. REPORT DATE August 1982
		6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) S. C. Black, R. F. Grossman, A. A. Mullen, G. D. Potter, D. D. Smith and J. L. Hopper		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Environmental Monitoring Systems Laboratory Office of Research and Development U. S. Environmental Protection Agency Las Vegas, Nevada 89114		10. PROGRAM ELEMENT NO. X6EH10
		11. CONTRACT/GRANT NO. IAG DE-AI08-76DP00539
12. SPONSORING AGENCY NAME AND ADDRESS U.S. Department of Energy Nevada Operations Office P. O. Box 14100 Las Vegas, NV 89114		13. TYPE OF REPORT AND PERIOD COVERED Response - 1981
		14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

Prepared for the U.S. Department of Energy under Interagency Agreement No. DE-AI08-76DP00539

16. ABSTRACT

This report covers the routine environmental monitoring for radioactive materials in various media and for radiation in areas which may be affected by nuclear testing activities conducted by the Environmental Monitoring Systems Laboratory in Las Vegas. These activities are conducted to document compliance with standards, to identify trends, and to provide information to the public. It summarizes these activities for Calendar Year 1981.

The monitoring networks detected no radioactivity in the various media which could be attributed to U.S. nuclear testing. Small amounts of fission products were detected in air samples as a result of the People's Republic of China nuclear test and atmospheric krypton-85 increased, following the trend beginning in 1960, due to increased use of nuclear technology. Strontium-90 in milk and cesium-137 in meat samples continued the slow decline as observed for the last several years.

17. KEY WORDS AND DOCUMENT ANALYSIS

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

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS *(This Report)* UNCLASSIFIED	21. NO. OF PAGES 123
RELEASE TO THE PUBLIC	20. SECURITY CLASS *(This page)* UNCLASSIFIED	22. PRICE

DISTRIBUTION

Standard UC-41 Distribution
Environmental Monitoring and Support Laboratory-Las Vegas, NV
Mahlon E. Gates, Manager, DOE/NV, Las Vegas, NV
Ray D. Duncan, Deputy Manager, DOE/NV, Las Vegas, NV
David F. Miller, DOE/NV, Las Vegas, NV
Robert M. Nelson, DOE/NV, Las Vegas, NV
Robert W. Newman, DOE/NV, Las Vegas, NV
Paul B. Dunaway, DOE/NV, Las Vegas, NV
Bruce W. Church, DOE/NV, Las Vegas, NV
Chief, NOB/DNA, DOE/NV, Las Vegas, NV
Dorothy A. Nowack, DOE/NV, Las Vegas, NV
Paul Mudra, DOE/NV, Las Vegas, NV
Shed R. Elliott, DOE/NV, Las Vegas, NV
Ernest D. Campbell, DOE/NV, Las Vegas, NV
Thomas M. Humphrey, DOE/NV, Las Vegas, NV
Marshall Page, Jr., DOE/NV, Las Vegas, NV
Peter K. Fitzsimmons, DOE/NV, Las Vegas, NV
Winnie Howard, DOE/NV, Las Vegas, NV
Harold F. Mueller, NOAA/WSNSO, DOE/NV, Las Vegas, NV
Virgil Quinn, NOAA/WSNSO, DOE/NV, Washington, DC
Jack Pollack, CER Geonuclear Corporation, Las Vegas, NV
C. D. Jackson, DOE/SAN, San Francisco Operations Office, Oakland, CA 94612
D. E. Patterson, DOE, Washington, DC
Major General W. W. Hoover, Director, OMA, DOE, Washington, DC
Gordon Facer, OMA, DOE, Washington, DC
Andrew J. Pressesky, DOE, Washington, DC
Assistant Secretary for the Environment, DOE, Washington, DC
Gilbert J. Ferber, ARL/NOAA, Silver Springs, MD
Supervisor, Radiological Health Section, State of Nevada, Carson City, NV 89710
Assistant Administrator for Research and Development, EPA, Washington, DC
Deputy Assistant Administrator for Radiation Programs, EPA, Washington, DC
Deputy Assistant Administrator for Monitoring Systems and Quality Assurance, ORD, EPA, Washington, DC
Director, Division of Technology Assessment, ORP, EPA, Washington, DC
Director, Environmental Analysis Division, ORP, EPA, Washington, DC
Regional Administrator, EPA, Region IV, Atlanta, GA
Regional Radiation Representative, EPA, Region IV, Atlanta, GA
Director, Div. of Radiological Health, State Board of Health, Jackson, MS 39205
Regional Administrator, EPA, Region VI, Dallas, TX
Regional Radiation Representative, EPA, Region VI, Dallas, TX

DISTRIBUTION (Continued)

Director, Environmental Improvement Div., Dept. of Health and Environment, Santa Fe, NM 87503
Regional Administrator, EPA, Region VIII, Denver, CO
Regional Radiation Representative, EPA, Region VIII, Denver, CO
Director, Radiation and Hazardous Waste Control Div., Dept. of Health, Denver, CO 80220
Director, Bureau of Radiation and Occupational Health, Salt Lake City, UT 84103
Regional Administrator, EPA, Region IX, San Francisco, CA
Regional Radiation Representative, EPA, Region IX, San Francisco, CA
Chief, Radiological Health Section, Dept. of Health Services, Sacramento, CA 95814
Eastern Environmental Radiation Facility, EPA, Montgomery, AL
Library, EPA, Washington, DC
Kenneth M. Oswald, LLNL, Mercury, NV
Roger E. Batzel, LLNL, Livermore, CA
John C. Hopkins, LANL, Los Alamos, NM
Jerome E. Dummer, LANL, Los Alamos, NM
Billy P. Smith, REECo, Mercury, NV
Arden E. Bicker, REECo, Mercury, NV
Leonard Kreisler, M.D., REECo, Mercury, NV
John McNeill, U.S. Arms Control and Development Agency, Washington, DC
George E. Tucker, Sandia National Laboratories, Albuquerque, NM
Albert E. Doles, Eberline Instrument Co., Santa Fe, NM
Robert H. Wilson, University of Rochester, Rochester, NY
Richard S. Davidson, Battelle Memorial Institute, Columbus, OH
J. P. Corley, Battelle Memorial Institute, Richland, WA
Office of the President, Desert Research Institute, University of Nevada, Reno, NV
Paul Fenske, DRI, Reno, NV
William Wilson, USGS, Juneau, AK
M. Marcy Williamson, Director, Radiological and Environmental Sciences Laboratory, DOE, Idaho Falls, ID
Director, Arizona Radiation Regulatory Agency, Tempe, AZ 85281