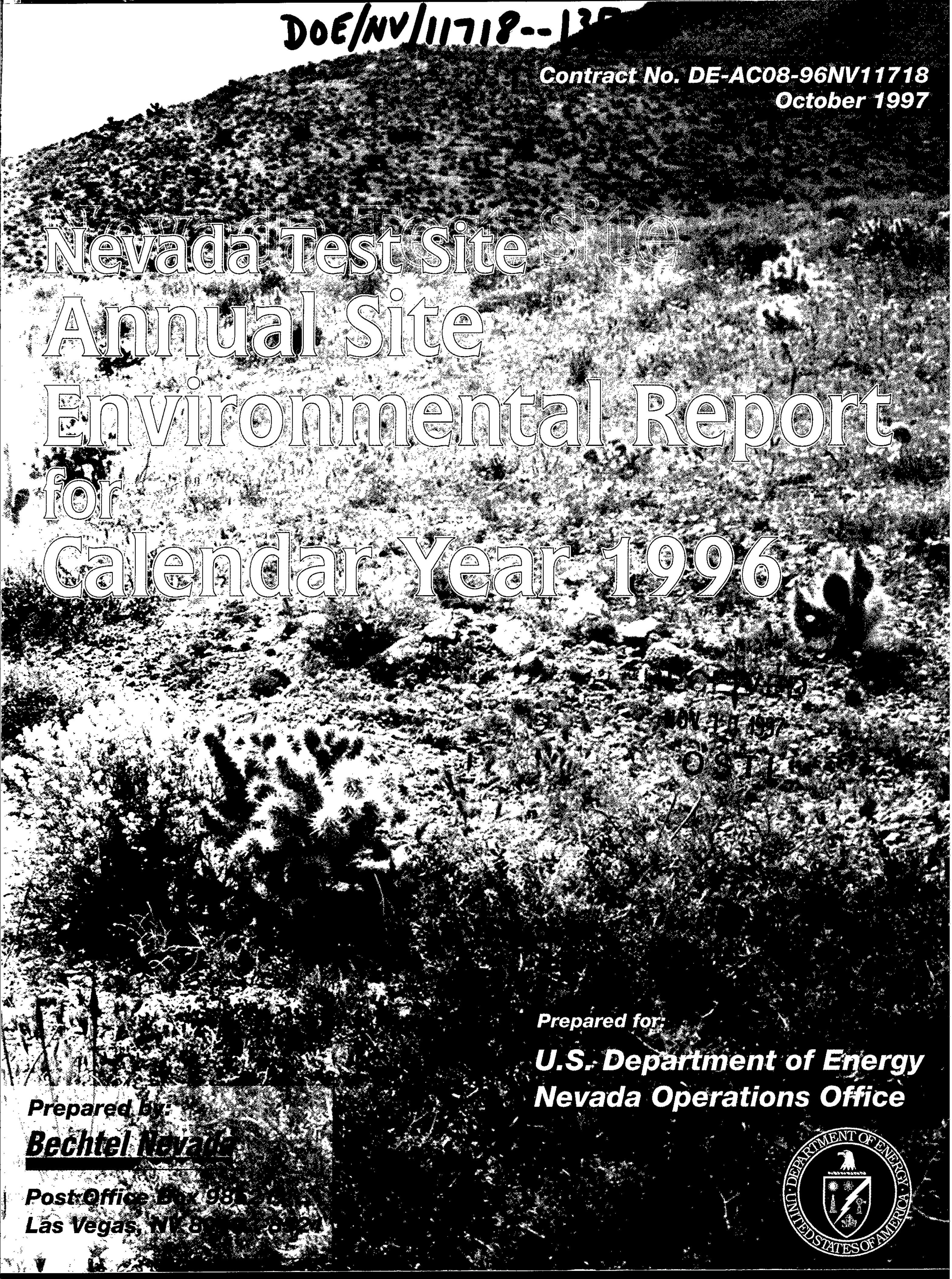
DOE/NV/11718--13[illegible]

Contract No. DE-AC08-96NV11718
October 1997

Nevada Test Site Annual Site Environmental Report for Calendar Year 1996



Prepared for:

U.S. Department of Energy
Nevada Operations Office

Prepared by:

Bechtel Nevada

Post Office Box 985[illegible]
Las Vegas, NV 8[illegible]

This report has been reproduced directly from the best available copy.

Available to DOE and DOE contractors from the:

Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, Tennessee 37831

Prices available from (423) 576-8401

Available to public from the:

National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Rd.
Springfield, VA 22161

Prices available from (703) 487-4650

DOE/NV/11718-137
UC-600

Nevada Test Site Annual Site Environmental Report for Calendar Year - 1996

Editors:
Stuart C. Black and Yvonne E. Townsend

October 1997

Work Performed Under Contract No. DE-AC08-96NV11718

Prepared for:
U.S. Department of Energy
Nevada Operations Office

Prepared by:
Bechtel Nevada
Post Office Box 98521
Las Vegas, NV 89193-8521

AUTHORS AND CONTRIBUTORS

1.0 Summary

Stuart C. Black, BN

2.0 Introduction

Colleen M. Beck, DRI
Stuart C. Black, BN
James W. Kesler, BN

3.0 Compliance Summary

Colleen M. Beck, DRI
Stuart C. Black, BN
Orin L. Haworth, BN
James W. Kesler, BN
Amadeo Sanchez, BN
George D. White, BN

4.1 Radiological Monitoring

Stuart C. Black, BN
Robert F. Grossman, BN
Orin L. Haworth, BN
Anita A. Mullen, EPA

4.2 Nonradiological Monitoring

Orin L. Haworth, BN
Charles A. Giesler, BN

4.3 Environmental Permits

Elizabeth C. Calman, BN
Orin L. Haworth, BN
James W. Kesler, BN
George D. White, BN

5.1 Radiological Effluent Monitoring

Robert F. Grossman, BN

5.2 Radiological Environmental Surveillance

Christopher A. Fontana, EPA
Robert F. Grossman, BN
Polly A. Huff, EPA
Terry Mouck, EPA
Anita A. Mullen, EPA
Mark D. Sells, EPA
Cathy A. Wills, BN

6.0 Dose Assessment

Stuart C. Black, BN
Anita A. Mullen, EPA

7.0 Nonradiological Monitoring Results

Richard B. Hunter, BN
Orin L. Haworth, BN
James W. Kesler, BN

8.0 Radioactive and Mixed Waste Storage and Disposal

Brian L. Dozier, BN
Deron Linkenheil, BN

9.0 Groundwater Protection

Max G. Davis, EPA
Brian L. Dozier, BN
Douglas W. Duncan, DOE

10.0 Laboratory Quality Assurance

Stuart C. Black, BN
Robert Elkins, BN
Mark D. Sells, EPA

Preceding Page Blank

FOREWORD

Prior to 1989, annual reports of environmental monitoring and assessment results for the Nevada Test Site (NTS) were prepared in two separate parts. Onsite effluent monitoring and environmental monitoring results were reported in an onsite report prepared by the U.S. Department of Energy, Nevada Operations Office (DOE/NV). Results of the Offsite Radiological Surveillance and Long-Term Hydrological Monitoring programs conducted by the U.S. Environmental Protection Agency's (EPA's) Laboratory (various names) in Las Vegas, Nevada, were reported separately by that Agency.

Beginning with the 1989 Annual Site Environmental Report for the NTS, these two documents were combined into a single report to provide a more comprehensive annual documentation of the environmental protection activities conducted for the nuclear testing program and other nuclear and non-nuclear operations at the NTS. The two agencies have coordinated preparation of this eighth combined onsite and offsite report through sharing of information on environmental surveillance and releases as well as meteorological, hydrological, and other supporting data used in dose-estimation calculations.

ACKNOWLEDGEMENTS

The skill, dedication, and perseverance of Angela L. McCurdy in text processing and graphics support were crucial to the production of this report. The review and advice offered by the DOE/NV's Environmental Protection Division (EPD) and the EPA's Radiation & Indoor Environments National Laboratory, Las Vegas (R&IE-LV) reviewers were invaluable. The efforts of N. George McNeill in coordinating the review of the 1996 ASER by the EPD was greatly appreciated. Compilation and verification of onsite data were provided by Robert F. Grossman, Balwan S. Hooda, and Orin L. Haworth. Compilation and verification of Bechtel Nevada's offsite data were provided by James W. Kesler. Statistical analyses of data were provided by Robert R. Kinnison. The cooperative support of Anita A. Mullen of the R&IE-LV in production of this combined onsite and offsite environmental report is greatly appreciated.

TABLE OF CONTENTS

Table of Contents, cont. Page

Table of Contents, cont.

Page

Table of Contents, cont.

Page

LIST OF FIGURES

List of Figures, cont. Page

LIST OF TABLES

List of Tables, cont. Page

MEASUREMENT UNITS AND NOMENCLATURE

Radioactivity data in this report are expressed in both traditional units (e.g., pCi/L) and International System (abbreviated SI) units. These units are explained below.

background Ambient background radiation to which people are exposed. Naturally occurring radioactive elements contained in the body, in the ground, and in construction materials, cosmic radiation, and radioactivity in the air all contribute to an average radiation dose equivalent to humans of about 350 mrem per year. In laboratory measurements of radioactivity in samples, background is the activity determined when a sample of distilled water is processed through the system (also called a blank).

becquerel Abbreviation Bq. The Bq is the SI unit for disintegration rate. 1 Bq = 1 disintegration per second.

concentration Usually expressed as µCi/mL, or pCi/m^3.

curie Abbreviation Ci. The historic unit for disintegration rate. 1 Ci = 3.7×10^{10} disintegrations per second = 3.7×10^{10} Bq. The usual submultiples of Ci are mCi (10^{-3} Ci or one thousandth Ci), µCi (10^{-6} Ci or one millionth Ci), and pCi (10^{-12} or one trillionth Ci).

EDE Effective dose equivalent - radiation dose corrected by various weighting factors that relate dose to the risk of serious effects.

rem Rem (for roentgen equivalent man) is the unit for expressing dose equivalent, or the energy imparted to a person when exposed to radiation. The commonly used subunit is the millirem (10^{-3} rem or one thousandth rem), abbreviated mrem.

roentgen Abbreviation R. A unit expressing the intensity of X or γ radiation at a point in air. The usual units are mR for 10^{-3} R (one thousandth R).

volume The SI unit for volume is m^3 (cubic meter). Other units used are liter (L) and mL (10^{-3} L or one thousandth liter). One cubic meter = 1,000 L.

The elements and corresponding symbols used in this report are:

Element	Symbol	Element	Symbol
Aluminum	Al	Iron	Fe
Americium	Am	Krypton	Kr
Argon	Ar	Lithium	Li
Arsenic	As	Mercury	Hg
Barium	Ba	Nitrogen	N
Beryllium	Be	Oxygen	O
Boron	B	Plutonium	Pu
Cadmium	Cd	Radium	Ra
Calcium	Ca	Radon	Rn
Carbon	C	Selenium	Se
Cesium	Cs	Sulfur	S
Chlorine	Cl	Strontium	Sr
Chromium	Cr	Technetium	Tc
Copper	C	Thorium	Th
Fluorine	F	Thulium	Tm
Germanium	Ge	Tritium	^3H
Hydrogen	H	Uranium	U
Iodine	I	Xenon	Xe

LIST OF ACRONYMS AND EXPRESSIONS

AEC	U.S. Atomic Energy Commission
AIRFA	American Indian Religious Freedom Act
Alara	As Low as Reasonably Achievable
ANOVA	Analysis of Variance
ARL/SORD	Air Resource Laboratory, Special Operations and Research Division
ASER	Annual Site Environmental Report
ASL	Analytical Services Laboratory
ASN	Air Surveillance Network
AVO	Amador Valley Operations
BECAMP	Basic Environmental Compliance and Monitoring Program
BN	Bechtel Nevada
BN/WMP/TS	Bechtel Nevada Waste Management Program, Technical Support
BOD	Biochemical Oxygen Demand
BoFF	Bureau of Federal Facilities, State of Nevada
CA	Composite Analysis
CAA	Clean Air Act
CAP88-PC	Clean Air Package 1988 (EPA software program for estimating doses)
CEDE	Committed Effective Dose Equivalent
CEI	Compliance Evaluation Inspection
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
C.F.R.	Code of Federal Regulations
CP	Control Point
CRMP	Community Radiation Monitoring Program
CTLP	Community Technical Liaison Program
CVIS	Computerized Video Imaging System
CWA	Clean Water Act
CX	Categorical Exclusion
CY	Calendar Year
DAC	Derived Air Concentration
DCG	Derived Concentration Guide
DDR	Data Discrepancy Report
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOE/HQ	DOE Headquarters
DOELAP	DOE Laboratory Accreditation Program
DOE/NV	DOE Nevada Operations Office
DQO	Data Quality Objectives
DRI	Desert Research Institute, University and Community College System, Nevada
DSWA	Defense Special Weapons Agency
EA	Environmental Assessment
EDE	Effective Dose Equivalent
EHS	Extremely Hazardous Substances
EIS	Environmental Impact Statement
ELU	Ecological Landform Unit
EMAC	Ecological Monitoring and Compliance
E-MAD	Engine Maintenance, Assembly and Disassembly (on the NTS)
EML	Environmental Measurements Laboratory (DOE)
EMP	Environmental Monitoring Plan

List of Acronyms and Expressions, cont.

EOD	Explosive Ordnance Disposal (NTS)
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Reporting and Community Right-to-Know Act
EPD	DOE Environmental Protection Division
ERP	Environmental Restoration Project
ESA	Endangered Species Act
ESS&H	Environment, Safety, Security, and Health
FFACO	Federal Facilities Agreement and Consent Order
FFCA	Federal Facilities Compliance Act
FONSI	Finding of No Significant Impact
FY	Fiscal Year
gal	Gallon
GBq	Gigabequerel (10^9 bequerels)
GCD	Greater Confinement Disposal
GIS	Geographical Information System
gpm	Gallons Per Minute
GZ	Ground Zero
HSC	Hazardous Material Spill Center
HTO	Tritiated Water
HWAS	Hazardous Waste Accumulation Storage
HWSU	Hazardous Waste Storage Unit
ICRP	International Commission on Radiological Protection
ID	Identification
JIT	Just-in-Time
keV	Kilo-electronvolt
LANL	Los Alamos National Laboratory
LAO	Los Alamos Operations (BN)
LDR	Land Disposal Restrictions
LLNL	Lawrence Livermore National Laboratory
LLW	low-level (radioactive) waste
LTHMP	Long-Term Hydrological Monitoring Program
LVAO	Las Vegas Area Operation
MAPEP	Mixed Analyte Performance Evaluation Program
MCL	Maximum Contaminant Level
MDC	Minimum Detectable Concentration
MEI	Maximally Exposed Individual
MQO	Measurement Quality Objectives
MSDS	Material Safety Data Sheet
MSL	Mean Sea Level
MSN	Milk Surveillance Network (R&IE-LV)
MWMU	Mixed Waste Management Unit
NAC	Nevada Administrative Code
NAFB	Nellis Air Force Base
NAGPRA	Native American Graves Protection and Repatriation Act
NDEP	Nevada Division of Environmental Protection
NDOW	Nevada Department of Wildlife
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants

List of Acronyms and Expressions, cont.

NHPA	National Historic Preservation Act
NIST	National Institute of Standards and Technology
NLVF	North Las Vegas Facility (BN)
NPDES	National Pollution Discharge Elimination System
NR	National Register of Historic Places
NRS	Nevada Revised Statutes
NSHPO	Nevada State Historical Preservation Office
NTS	Nevada Test Site
OPSEC	Operations Security
ORNL	Oak Ridge National Laboratory
ORSP	Offsite Radiological Safety Program
PA	Performance Assessment
PC	Printed Circuit
PCB	Polychlorinated Biphenyl
PE	Performance Evaluation
PEIS	Programmatic Environmental Impact Statement
PESP	Performance Evaluation Studies Program
pH	Hydrogen ion concentration
PHS	U.S. Public Health Service
PIC	Pressurized Ion Chamber
PPOA	Pollution Prevention Opportunity Assessments
ppb	Parts per Billion
ppm	Parts per Million
PRP	Peer Review Panel
QA	Quality Assurance
QAP	Quality Assessment Program
RCRA	Resource Conservation and Recovery Act
R&IE-LV	Radiation & Indoor Environment National Laboratory - Las Vegas (EPA)
REECo	Reynolds Electrical & Engineering Company, Inc.
ROI	Return on Investment
RSD	Relative Standard Deviation
RSL	Remote Sensing Laboratory (BN)
RWMS	Radioactive Waste Management Site
RWMS-3	Radioactive Waste Management Site, Area 3
RWMS-5	Radioactive Waste Management Site, Area 5
s	Sample Standard Deviation
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SGZ	Surface Ground Zero
SIC	Standard Industrial Classification
SMSY	Strategic Materials Storage Yard
SOC	Synthetic Organic Chemical (e.g., pesticides)
SOP	Standard Operating Procedure
STL	Special Technologies Laboratory (BN)
TCE	Trichloroethane
TLD	Thermoluminescent Dosimeter
TPH	Total Petroleum Hydrocarbon
TRU	Transuranic
TSCA	Toxic Substances Control Act

List of Acronyms and Expressions, cont.

TSD	Treatment, Storage and Disposal
TTR	Tonopah Test Range
UGTA	Underground Test Area
U.S.	United States of America
USAF	United States Air Force
USFWS	United States Fish and Wildlife Service
USGS	U.S. Geological Survey
UST	Underground Storage Tank
UTM	Universal Transverse Mercator
VOC	Volatile Organic Compound
WAC	Waste Acceptance Criteria
WAMO	Washington Aerial Measurements Operations (BN)
WIPP	Waste Isolation Pilot Plant
WMP	Waste Management Program
WMP/TS	Waste Management Project Technical Support (BN)
YMSCO	Yucca Mountain Site Characterization Office

1.0 SUMMARY

Monitoring and surveillance on and around the Nevada Test Site (NTS) by U.S. Department of Energy (DOE) contractors and NTS user organizations during 1996 indicated that operations on the NTS were conducted in compliance with applicable DOE, state, and federal regulations and guidelines. All discharges of radioactive liquids remained onsite in containment ponds, and there was no indication of potential migration of radioactivity to the offsite area through groundwater. Surveillance around the NTS indicated that airborne radioactivity from diffusion, evaporation of liquid effluents, or resuspension of soil was not detectable offsite, and exposure above background to members of the offsite population was not measured by the offsite monitoring program. Using the U.S. Environmental Protection Agency's (EPA) Clean Air Package 1988 (CAP88)-PC model and NTS radionuclide emissions and environmental monitoring data, the calculated effective dose equivalent (EDE) to the maximally exposed individual offsite would have been 0.11 mrem. This value is less than 2 percent of the federal dose limit prescribed for radionuclide air emissions. Any person receiving this dose would also have received 144 mrem from natural background radiation. There were no nonradiological releases to the offsite area. Hazardous wastes were shipped offsite to approved disposal facilities. Compliance with the various regulations stemming from the National Environmental Policy Act (NEPA) is being achieved and, where mandated, permits for air and water effluents and waste management have been obtained from the appropriate agencies. Cooperation with other agencies has resulted in seven different consent orders and agreements.

Support facilities at off-NTS locations have complied with the requirements of air quality permits and state or local wastewater discharge and hazardous waste permits as mandated for each location.

1.1 ENVIRONMENTAL MANAGEMENT

The DOE Nevada Operations Office (DOE/NV) is committed to increasing the quality of its management of NTS environmental resources. This has been promoted by the establishment of an Environmental Protection Division within the Office of Technical Services and upgrading the Environmental Management activities to the Assistant Manager level to address those environmental issues that have arisen in the course of performing the original primary mission of the DOE/NV, underground testing of nuclear explosive devices. An environmental survey in 1987 and a Tiger Team assessment in 1989 identified numerous issues that had to be resolved before DOE/NV could be considered to be in full compliance with environmental laws and regulations. At the end of 1996, all of the 149 Tiger Team findings had been satisfied.

Operational releases of radioactivity are reported soon after their occurrence. This year, only liquid effluents have been reported for the NTS. In compliance with the National Emission Standards for Hazardous Air Pollutants (NESHAP), as set forth in Title 40 Code of Federal Regulations (C.F.R.) 61, the accumulated annual data from these reports are used each year as part of the input to the EPA's CAP88-PC software program to calculate potential EDEs to people living beyond the boundaries of the NTS and the surrounding exclusion areas.

1.2 RADIOLOGICAL ENVIRONMENT

Radiological effluents in the form of air emissions and liquid discharges are normally released into the environment as a routine part of operations on the NTS. Radioactivity in liquid discharges released to onsite waste treatment or disposal systems (containment ponds) is monitored to assess the efficacy of treatment and control and to provide a quantitative and qualitative annual summary of released radioactivity. Air emissions are monitored for source characterization and operational safety as well as for environmental surveillance purposes.

Air emissions in 1996 consisted primarily of small amounts of tritium, radioactive noble gases, and plutonium released to the atmosphere that were attributed to:

- Diffusion of tritiated water (HTO) vapor in atmospheric moisture from evaporation of HTO from tunnel and characterization well containment ponds.
- Diffuse emissions calculated from the results of environmental surveillance activities.
- Resuspension of plutonium as measured with air sampling equipment or calculated by use of resuspension equations.
- Release of krypton-85 from tests under Pahute Mesa when atmospheric pressure changes occur. Such releases were statistically undetectable in 1996.

Diffuse emissions included HTO, only slightly above detection limits, from the Radioactive Waste Management Site in Area 5 (RWMS-5) and resuspended $^{239+240}$Pu from areas on the NTS where it was deposited by atmospheric nuclear tests or device safety tests in earlier years. Table 1.1 shows the quantities of radionuclides released from all sources, including postulated loss of laboratory standards. None of the radioactive materials listed in this table were detected in the offsite area above ambient levels.

Onsite liquid discharges to containment ponds included approximately 271 Ci (10 TBq) of tritium. This was about the same as last year's tritium releases, because effluent from characterization wells drilled in Area 20 continued during most of the year. Evaporation of this material could have contributed HTO to the atmosphere, but the amounts were too small to be detected by the tritium monitors onsite. No liquid effluents were discharged to offsite areas.

ONSITE ENVIRONMENTAL SURVEILLANCE

Environmental surveillance on the 3500 - km^2 (1350 - mi^2) NTS is designed to cover the entire area with some emphasis on areas of past nuclear testing and present operational activities. In 1996, samplers were operated at 49 locations to collect air particulate samples, at 16 locations to collect HTO in atmospheric moisture, and at 3 locations to collect air for analysis of noble gas content. Grab samples were collected frequently from water supply wells, water taps, springs, open reservoirs, containment ponds, and sewage lagoons. Thermoluminescent dosimeters (TLDs) were placed at 169 locations on the NTS to measure ambient gamma exposures.

Data from these networks are summarized as annual averages for each monitored location. Those locations with concentrations above the NTS average are assumed to reflect onsite emissions. These emissions arise from diffuse (areal) sources and from particular operational activities (e.g., radioactivity buried in the low-level waste [LLW] site).

Approximately 2,500 air samples were analyzed by gamma spectroscopy. All isotopes detected by gamma spectroscopy were naturally occurring in the environment (^{40}K, ^{7}Be, and members of the uranium and thorium series), except for a few instances where very low levels of ^{137}Cs were detected. Gross beta analysis of the air samples yielded an annual average for the network of 1.8×10^{-14} µCi/mL (0.74 mBq/m^3). Plutonium analyses of monthly or quarterly composited air filters indicated an annual arithmetic average below 10^{-16} µCi/mL (4 µBq/m^3) of $^{239+240}Pu$ and below 10^{-17} µCi/mL (0.4 µBq/m^3) of ^{238}Pu for all locations during 1996, with the majority of results for both isotopes being on the order of 10^{-18} µCi/mL (0.04 µBq/m^3). A slightly higher average was found in samples in certain areas, but that level was calculated to be only 0.01 percent of the Derived Concentration Guide (DCG) for exposure to the public. Higher than background levels of plutonium are to be expected in some air samples because atmospheric testing in the 1950s, and nuclear safety tests dispersed plutonium over a small portion of the surface of the NTS.

The annual average concentration of ^{85}Kr from the three noble gas monitoring stations was 25×10^{-12} µCi/mL (1 Bq/m^3). This concentration is similar to that reported in previous years and is attributed to worldwide distribution of ^{85}Kr from the use of nuclear technology.

Throughout the year atmospheric moisture was collected for two-week periods at 15 locations on the NTS and analyzed for HTO content. The annual arithmetic average of $(3.5 \pm 5.0) \times 10^{-6}$ pCi/mL (0.13 ± 0.18 Bq/m^3) was similar to last year's average. The highest annual average concentrations were at the E Tunnel pond, the SEDAN crater, and RWMS-5 locations, in that order. The primary radioactive liquid discharge to the onsite environment in 1996 was 120 Ci (4.4 Tbq) of tritium (as HTO) in effluent produced during drilling of characterization wells in Area 20. Seepage from E Tunnel in Rainier Mesa (Area 12) contributed 20 million liters of water containing about 11 Ci (0.41 Tbq) of tritium to containment ponds near the tunnels. For dose calculations, all of the HTO was assumed to have evaporated.

Surface water sampling was conducted quarterly at eight open reservoirs, seven springs, eight containment ponds, and an effluent and eight sewage lagoons. A grab sample was taken from each of these surface water sites for analysis of gross beta, tritium, gamma-emitters, and plutonium isotopes. Strontium-90 was analyzed once per year for each location. Water samples from the springs, reservoirs, and lagoons contained background levels of gross beta, tritium, plutonium, and strontium. Samples collected from the tunnel containment pond and characterization well effluent ponds contained detectable levels of radioactivity as would be expected.

Water from onsite supply wells and drinking water distribution systems was sampled and analyzed for radionuclides. The supply well average gross beta activity of 7.2×10^{-9} µCi/mL (0.27Bq/L) was 3 percent of the DCG for ^{40}K (used for comparison purposes); gross alpha was 6.2×10^{-9} µCi/mL (0.23 Bq/L), which was about 40 percent of the drinking water standard; the maximum ^{90}Sr measured was 0.26×10^{-10} µCi/mL (0.9 Bq/L), about 1 percent of the DCG; ^{3}H concentrations averaged about 1.9×10^{-9} µCi/mL (70 mBq/L), less than 0.002 percent of the DCG; $^{239+240}Pu$ and ^{238}Pu were both below their minimum detectable levels of about 2×10^{-11} µCi/mL (0.074 mBq/L).

Analysis of the TLD network showed that the 16 boundary station locations had an annual average exposure of 120 mR, and the 9 control stations annual average was 91 mR, both within the range of values previously reported.

OFFSITE ENVIRONMENTAL SURVEILLANCE

The offsite radiological monitoring program is conducted around the NTS by the EPA's

Radiation & Indoor Environments National Laboratory-Las Vegas (R&IE-LV), under an Interagency Agreement with DOE. This program consists of several environmental sampling, radiation detection, and dosimetry networks that are described below. These networks operated continuously during 1996.

The Air Surveillance Network (ASN) was made up of 20 continuously operating sampling locations surrounding the NTS. The ASN stations included 15 located at Community Technical Liaison Program (CTLP) stations, described below. During 1996, no airborne radioactivity related to current activities at the NTS was detected on any sample from the ASN. Other than naturally occurring ^{7}Be, the only specific radionuclide possibly detected by this network was ^{238}Pu or $^{239+240}$Pu on a few high-volume air-filter samples.

The Milk Surveillance Network consisted of 11 sampling locations within 300 km (186 mi) of the NTS, but samples were collected only from 10. Tritium, ^{89}Sr, and ^{90}Sr are rarely detected in milk samples at present. The levels in the milk network have decreased over time since reaching a maximum in 1964. The results from this network are consistent with previous data and indicate little or no change.

Other foods that have been analyzed regularly included meat from domestic or game animals collected on and around the NTS and fruit and vegetables from local gardens. None of these samples were collected this year.

In 1996, external exposure was monitored by a network of 51 TLDs and 27 pressurized ion chambers (PICs) located in towns and communities around the NTS. Also, there was a PIC located at the SALMON site near Baxterville, Mississippi. The PIC network in the communities surrounding the NTS indicated background exposures, ranging from 71 to 156 mR/yr, that were consistent with previous data and well within the range of background data in other areas of the United States. The exposures measured by the TLDs were slightly less as has been true in the past.

Sampling of Long-Term Hydrological Monitoring Program (LTHMP) wells and surface waters around the NTS showed only background radionuclide concentrations. The LTHMP also included groundwater and surface water monitoring at locations in Colorado, Mississippi, New Mexico, and Nevada where underground tests were conducted. The results obtained from analysis of samples collected at those locations were consistent with previous data except for a sample from a deep well at Project GASBUGGY where the ^{3}H and ^{137}Cs has been detected the last few years. No concentrations of radioactivity that were detected in air, water, milk, or animal samples posed any significant health risk to nearby residents.

A network of 15 CTLP stations was operated by local residents. Each station was an integral part of the ASN and TLD networks. In addition, they were equipped with a PIC connected to a gamma-rate recorder. Each station also had satellite telemetry transmitting equipment so that gamma exposure measurements acquired by the PICs are transmitted via the Geostationary Operational Environmental Satellite to the NTS and from there to the R&IE-LV by dedicated telephone line. Samples and data from these CTLP stations were analyzed and reported by R&IE-LV and interpreted and reported by the Desert Research Institute, University of Nevada System. All measurements for 1996 were consistent with previous years and were within the normal background range for the United States.

Although no radioactivity attributable to current NTS operations was detected by any of the offsite monitoring networks, based on the NTS releases reported in Table 1.1, an atmospheric dispersion model calculation (CAP88-PC) indicated that the maximum potential EDE to any offsite individual would have been 0.11 mrem (1.1×10^{-3} mSv), and the dose to the population within 80 km of the several emission sites on the NTS would have been 0.34 person-rem (3.4×10^{-3} person-Sv), both of which were less than last year. The hypothetical person receiving this dose would also have been exposed to 144 mrem from natural background radiation. A summary of the potential EDEs due to operations at the NTS is presented in Table 1.2.

ECOLOGICAL STUDIES

The Basic Environmental Compliance and Monitoring Program was redesigned to address changes in DOE/NV missions and commitment to manage land and facility resources based on the principles of ecosystem management and sustainable development. A comprehensive and adaptable guidance document for ecological monitoring was completed in May. The new program is designated as Environmental Monitoring and Compliance. The ecological monitoring tasks which were selected for 1996 included vegetation mapping within the range of the desert tortoise, characterizing the natural springs on the NTS, conducting a census of horse and chukar populations, and periodically monitoring man-made water sources to assess their affects on wildlife. The Environmental Assessment for the Hazardous Materials Spill Center (HSC) (formerly Liquefied Gaseous Fuels Spill Facility) calls for ecological monitoring of certain spill tests, and a monitoring plan was developed and implemented in 1996.

Field surveys were conducted from June through December to identify those natural NTS springs, seeps, tanks, and playas which could be designated by the U.S. Army Corps of Engineers as jurisdictional wetlands. A summary report of the survey findings is being prepared.

In January, a topical report titled, "Current Distribution, Habitat, and Status of Category 2 Candidate Plant Species on and near the U.S. Department of Energy's Nevada Test Site," was published. This report represents the culmination of several years of intensive field surveys and literature reviews on 11 Category 2 candidate plant species. The results of these surveys and a previous report on the Category 1 species, Beatley's milkvetch (*Astragalus beatleyae*), contributed to the removal of these species from the U.S. Fish and Wildlife Service (USFWS) candidate list.

LOW-LEVEL WASTE DISPOSAL

Environmental monitoring at the Radioactive Waste Management Site, Area 3 (RWMS-3) has detected plutonium in air samples. However, plutonium was detected in other air samples from Area 3 indicating that the source is resuspended plutonium. Elevated levels of plutonium have been detected in air samples from several areas on the NTS where operational activities and vehicular traffic resuspend plutonium for detection by air sampling. The presence of plutonium on the NTS is primarily due to atmospheric and safety tests conducted in the 1950s and 1960s. These tests spread plutonium in the eastern and northeastern areas of the NTS (see Chapter 2, Figure 2.3 for these locations).

Environmental monitoring at and around RWMS-5 indicated that radioactivity was just detectable at, but not beyond, the waste site boundaries. This monitoring included air sampling, water sampling, and external gamma exposure measurement. Vadose zone monitoring for hazardous constituents has been installed in the mixed waste disposal pit (Pit 3) in RWMS-5 as a method of detecting any downward migration of mixed waste. Also, one upgradient and two downgradient wells, installed to satisfy Resource Conservation and Recovery Act (RCRA) requirements for a mixed-waste disposal operation, have not yet detected migration of hazardous materials.

RADIOLOGICAL MONITORING AT OFFSITE SUPPORT FACILITIES

Fence line monitoring, using Panasonic UD-814 TLDs, was conducted at offsite DOE/NV support facilities in North Las Vegas, at Nellis Air Force Range Complex, and in Santa Barbara, California. The 1996 results indicated that only background radiation was detected at the fence line. In 1995, a small amount of tritium was accidently released from a calibration range building in North Las Vegas that was still detectable this year in the room where the release occurred. Monitoring of the release provided data for input into the CAP88-PC program for calculating offsite exposures. The maximum offsite exposure was calculated to be only 0.00025 mrem, which is less than last year and far below the EPA permissible limit of 10 mrem.

1.3 NONRADIOLOGICAL MONITORING

Nonradiological environmental monitoring of NTS operations involved only onsite monitoring because there were no discharges offsite that involved nonradiological hazardous materials. The primary environmental permit areas for the NTS were monitored to verify compliance with ambient air quality and the RCRA requirements. Air emissions sources common to the NTS included particulates from construction, aggregate production, and surface disturbances, fugitive dust from unpaved roads, fuel burning equipment, open burning, and fuel storage facilities. NTS environmental permits active during 1996, which were issued by the state of Nevada or by federal agencies, included 17 air quality permits involving emissions from construction of facilities, boilers, storage tanks, and open burning; 8 permits for onsite drinking water distribution systems; 1 permit for sewage discharges to lagoon collection systems; 7 permits for septage hauling; 1 incidental take permit for the threatened desert tortoise; and 1 permit for the collection and study of various species on the NTS. A RCRA permit has been obtained for general NTS operations and for two specific facilities on the NTS.

Permits at non-NTS operations included 16 air pollution control permits, 4 sewage discharge permits, and 4 hazardous material storage permits. Five EPA Generator Identification numbers were issued to the seven off-NTS operations, and three local RCRA-related permits were required at two of those operations.

The only nonradiological air emission of regulatory concern under the Clean Air Act (CAA) has been due to asbestos removal during building renovation projects and from insulated piping at various locations on the NTS. During 1996, there were no projects that required state of Nevada notifications. The annual estimate for non-scheduled asbestos demolition/renovation for fiscal year 1997 was sent to EPA Region 9 in December 1996.

RCRA requirements were met through an operating permit for hazardous waste storage, mixed waste storage, and explosive ordnance disposal operations. A Federal Facilities Agreement and Consent Order (FFACO) has been signed with the state that exempts the NTS from potential enforcement action related to mixed waste storage prohibition under RCRA.

The state conducted an annual Compliance Evaluation Inspection during 1996 and found only minor potential violations but will take no action on them.

As there are no liquid discharges to navigable waters, offsite surface water drainage systems, or publicly owned treatment works, no Clean Water Act (CWA), National Pollution Discharge Elimination System (NPDES) permits were required for NTS operations. Under the conditions of the state of Nevada operating permits, liquid discharges to onsite sewage lagoons are regularly tested for biochemical oxygen demand, pH, and total suspended solids. In addition to the state-required monitoring, these influents were also tested for RCRA-related constituents as an internal initiative to further protect the NTS environment.

In compliance with the Safe Drinking Water Act (SDWA) and eight state of Nevada drinking water supply system permits for onsite distribution systems supplied by onsite wells, drinking water systems are sampled monthly for residual chlorine, pH, bacteria, and, less frequently, for other water quality parameters. No exceedances have been found.

Monitoring for polychlorinated biphenyls as required by the Toxic Substances Control Act (TSCA) involved analysis of 43 various samples. None of the samples had results exceeding five parts per million.

At the HSC, 4 series of spill tests using 28 different chemicals were conducted during 1996. None of the tests generated enough airborne contaminants to be detected at the NTS boundary during or after the tests. Boundary monitoring was performed by R&IE-LV personnel.

1.4 COMPLIANCE ACTIVITIES

DOE/NV is required to comply with various environmental laws and regulations in the conduct of its operations. Monitoring activities required for compliance with the CAA, CWA, SDWA, TSCA, and RCRA are summarized above. Endangered Species Act activities include compliance with the USFWS Biological Opinion on Nevada Test Site Activities, USFWS Biological Opinion on Fortymile Canyon Activities, and preparation of Biological Assessments. Also, NEPA activities included action on 7 Environmental Assessments (EAs) and 34 Categorical Exclusions (CXs). Of these, only the CXs were initiated in 1996. The Record of Decision on the sitewide Environmental Impact Statement for the NTS and other test locations within the state of Nevada was published in December 1996.

Wastewater discharges at the NTS are not regulated under NPDES permits because all such discharges are to onsite sewage lagoons. Discharges to these lagoons are permitted under the Nevada Water Pollution Control Act. Wastewater discharges from the non-NTS support facilities were within the regulated levels established by city or county publicly owned treatment works.

During 1996, nine underground storage tanks were removed in accordance with state and federal regulations (see Chapter 3, Table 3.1). Reportable releases were discovered with the removal of tanks at three locations on the NTS.

In 1996, a cultural resource survey was conducted for historical and archaeological sites in Area 29. A data-recovery report for archeological data at a site in that area was prepared.

The American Indian Religious Freedom Act directs federal agencies to consult with Native Americans to protect their right to exercise their traditional religions. In 1996, work continued on a long-range study plan for Pahute and Ranier Mesas. The objective is to study a representative sample of all cultural resources on the Mesas.

Waste minimization and pollution prevention activities conducted at the NTS and its offsite facilities involve an intensive recycling program and active product substitution projects.

1.5 GROUNDWATER PROTECTION

A LTHMP was instituted in 1972 to be operated by the EPA under an Interagency Agreement. Surface and groundwaters were monitored on and around the NTS, at five sites in other states, and at two off-NTS locations in Nevada in 1996 to detect the presence in water supplies of any radioactivity that may be related to nuclear testing activities. No radioactivity was detected above background levels in the groundwater sampling network surrounding the NTS. Low levels of tritium, in the form of HTO, were detected in onsite wells as has occurred previously. None exceeded 33 percent of the National Primary Drinking Water Regulation level.

HTO was detected in samples from wells at formerly utilized sites, such as DRIBBLE (Mississippi), GNOME (New Mexico), and GASBUGGY (New Mexico) at levels consistent with previous experience. The ^{3}H and ^{137}Cs in water from Well EPNG 10-36 at GASBUGGY that began to be detected about 1984, was detected for the fifth year in a row.

Because wells that were drilled for water supply or exploratory purposes are used in the NTS monitoring program rather than wells drilled specifically for groundwater monitoring, a program of well drilling for groundwater characterization has been started. The design of the program is for installation or recompletion of groundwater characterization wells at strategic locations on and near the NTS. Through 1996, 13 of these wells have been drilled and 11 existing wells recompleted for a total of 24. Of these, five wells were completed and sampled on Pahute Mesa and three zones were developed and sampled in wells on Buckboard Mesa and Yucca Flat.

Other activities in this program included studies of groundwater transport of contaminants (radionuclide migration studies) and nonradiological monitoring for water quality assessment and RCRA requirements.

1.6 RADIOACTIVE AND MIXED WASTE STORAGE AND DISPOSAL

Two RWMSs are operated on the NTS, one each in Areas 3 and 5. During 1996, the RWMSs received LLW generated at the NTS and other DOE facilities. Waste is disposed of in shallow pits, trenches in the RWMS-5, and in selected craters in the RWMS-3. Transuranic (TRU) and TRU mixed wastes are stored on a curbed asphalt pad on pallets in overpacked 55-gal drums and assorted steel boxes pending shipment to the Waste Isolation Pilot Plant in New Mexico. The RWMS-3 is used for disposal of bulk LLW waste and LLW that is contained in packages that are larger than the specified standard size used at the RWMS-5.

Environmental monitoring at both sites included air sampling for radioactive particulates and HTO in air and external exposure measurements using TLDs. Water sampling and vadose zone monitoring for moisture and hazardous constituents are conducted at the RWMS-5. Environmental monitoring results for 1996 indicated that measurable radioactivity from waste disposal operations was detectable only in the immediate vicinity of the facilities.

Because the NTS is not a RCRA-permitted disposal facility, RCRA regulations require the shipment of nonradioactive hazardous waste to licensed disposal facilities offsite. No disposal of hazardous waste was performed at the NTS in 1996.

A Mixed Waste Management Unit (MWMU) is planned to be located immediately north of the existing pits within RWMS-5 and will be part of routine disposal operations. This area, designed to encompass 10 ha (25 acres), will contain eight landfill cells to be used for mixed waste disposal. Construction of the MWMU will commence upon completion of necessary NEPA documentation and issuance of a state of Nevada Part B Hazardous Waste Permit.

Mixed waste and LLW will only be accepted for disposal from generators (onsite and offsite) that have submitted a waste application that meets the requirements of the Waste Acceptance Criteria document (NTS 1996) and that have received DOE/NV approval of the waste stream(s) for disposal at NTS.

1.7 QUALITY ASSURANCE

The quality assurance (QA) program covering NTS activities has three components. There are QA programs for nonradiological analyses, for onsite radiological analyses, and for offsite radiological analyses conducted by EPA's R&IE-LV.

ONSITE NONRADIOLOGICAL QUALITY ASSURANCE

The onsite nonradiological QA was not operative during 1996 because budgetary restrictions caused deactivation of the laboratory. The offsite subcontract laboratories are monitored for their participation and performance in various performance evaluation programs.

ONSITE RADIOLOGICAL QUALITY ASSURANCE

The onsite radiological QA program includes conformance to best laboratory practice and implementation of the provisions of DOE Order 5700.6C. The external QA intercomparison program for radiological data QA consists of participation in the DOE Quality Assessment Program administered by the DOE Environmental Measurements Laboratory and the Performance Evaluation Studies Program conducted by the EPA's National Exposure Research Laboratory.

OFFSITE RADIOLOGICAL QUALITY ASSURANCE

The policy of the EPA requires participation in a centrally managed QA program by all EPA organizational units involved in environmental data collection. The QA program developed by the R&IE-LV for the Offsite Radiological Safety Program meets all requirements of EPA policy and also includes applicable elements of the DOE QA requirements and regulations. The program defines data quality objectives (DQOs), which are statements of the quality of data a decision maker needs to ensure that a decision based on those data is defensible. Achieved data quality may then be evaluated against these DQOs.

1.8 ISSUES AND ACCOMPLISHMENTS

PRINCIPAL COMPLIANCE PROBLEMS FOR 1996

- On June 28, 1994, the state of Nevada filed a Complaint for Declaratory Judgement and Injunction in the U.S. District Court against DOE. Nevada claims that DOE has failed to comply with NEPA requirements at the NTS and must initiate a single, sitewide EIS for all major federal actions at the NTS. The state was seeking to halt shipments of LLW from Fernald and all other transportation, receipt, storage, and disposal of mixed waste, hazardous waste, and defense waste and was also seeking to enjoin DOE from pursuing any "Weapons Complex" activities until publication of the EIS. In January 1995, the U.S. District Court dismissed the claims regarding Fernald waste and the sitewide EIS. The remaining claim, regarding disposal of LLW from offsite facilities is still unsettled.

- A notification letter was received regarding alleged potentially responsible party status connected with a commercial disposal site in California. The state notified DOE/NV that Omega Chemical Co., a hazardous waste treatment and storage facility, possessed documents indicating that DOE/NV had shipped hazardous waste to the site between 1988 and 1992. The company has declared bankruptcy and is unable to clean up the site. Jurisdiction of this site has been transferred to the EPA which, so far, has made no contact.

ACCOMPLISHMENTS FOR 1996

- The draft sitewide EIS for the NTS and offsite locations in the state of Nevada was released for public comment in February 1996. The EIS was approved for publication in August and the Record of Decision was published in December 1996.

- Work was performed on seven EAs during 1996, of which two were assessed in the EIS.

- Throughout 1996, DOE/NV continued to maintain and update the "DOE/NV Compliance Guide" (Volume III), a handbook containing procedures, formats, and guidelines for personnel responsible for NEPA compliance activities.

- Continued use of a Just-in-Time supply system allowed NTS contractors to reduce product stock and control potentially hazardous products.

- Progress continued on the NTS groundwater characterization program. Thirteen special wells have been completed and eleven existing wells have been recompleted to meet program requirements.

- The Waste Management Projects installed three pilot wells at RWMS-5 to monitor underground conditions. The data have also been used for site characterization. The uppermost groundwater table was found at approximately 244 m (800 ft). Only naturally occurring radioactivity was detected in the groundwater.

- DOE/NV has entered into several consent orders and agreements. These are: (1) a Memorandum of Understanding with the state covering radiological releases, (2) an Agreement in Principle with Nevada and Mississippi covering oversight of environment safety and health activities, (3) a Cooperative Agreement with Alaska's Fish and Wildlife Service, (4) a Settlement Agreement with the state to manage mixed TRU waste, (5) a FFACO for providing storage of low-level mixed waste generated at the NTS, and (6) a Programmatic Agreement with the state covering archaeological and historic preservation activities.

- The following remedial actions were completed in 1996:

  1) Plutonium-contaminated soil was removed from the site of the 1963 DOUBLE TRACKS nuclear device safety test on the Nellis Air Force Range Complex and the site was revegetated. The soil was disposed of in the LLW site in Area 3, NTS.

  2) The access shaft for the 1963 Project SHOAL underground test near Fallon, Nevada, was closed. The approximately 1,100-ft (433-m) deep shaft was filled with screened granite.

  3) The injection well at the Area 2 Bitcutter Shop was closed in place and the well at the Lawrence Livermore National Laboratory Postshot Containment Building was clean closed.

  4) One Corrective Action Unit under the FFACO, which described 23 abandoned lead sites on the NTS, was closed as all the sites have been remediated.

The environmental monitoring results presented in this report document that operational activities on the NTS in 1996 were conducted so that no measurable radiological exposure occurred to the offsite public. Calculation of the highest individual dose that could have been received by an offsite resident (based on estimation of onsite worst-case radioactive releases obtained by measurement or engineering calculation and assuming the person remained outside all year) equated to 0.11 mrem to a person living in Springdale, Nevada. This may be compared to that individual's exposure to 144 mrem from natural background radiation as measured by the PIC instrument at Beatty, Nevada.

There were no major incidents of nonradiological contaminant releases to the environment, and intensive efforts to characterize and protect the NTS environment, implemented in 1990, were continued in 1996.

Table 1.1 Radionuclide Emissions on the NTS - 1996[a]

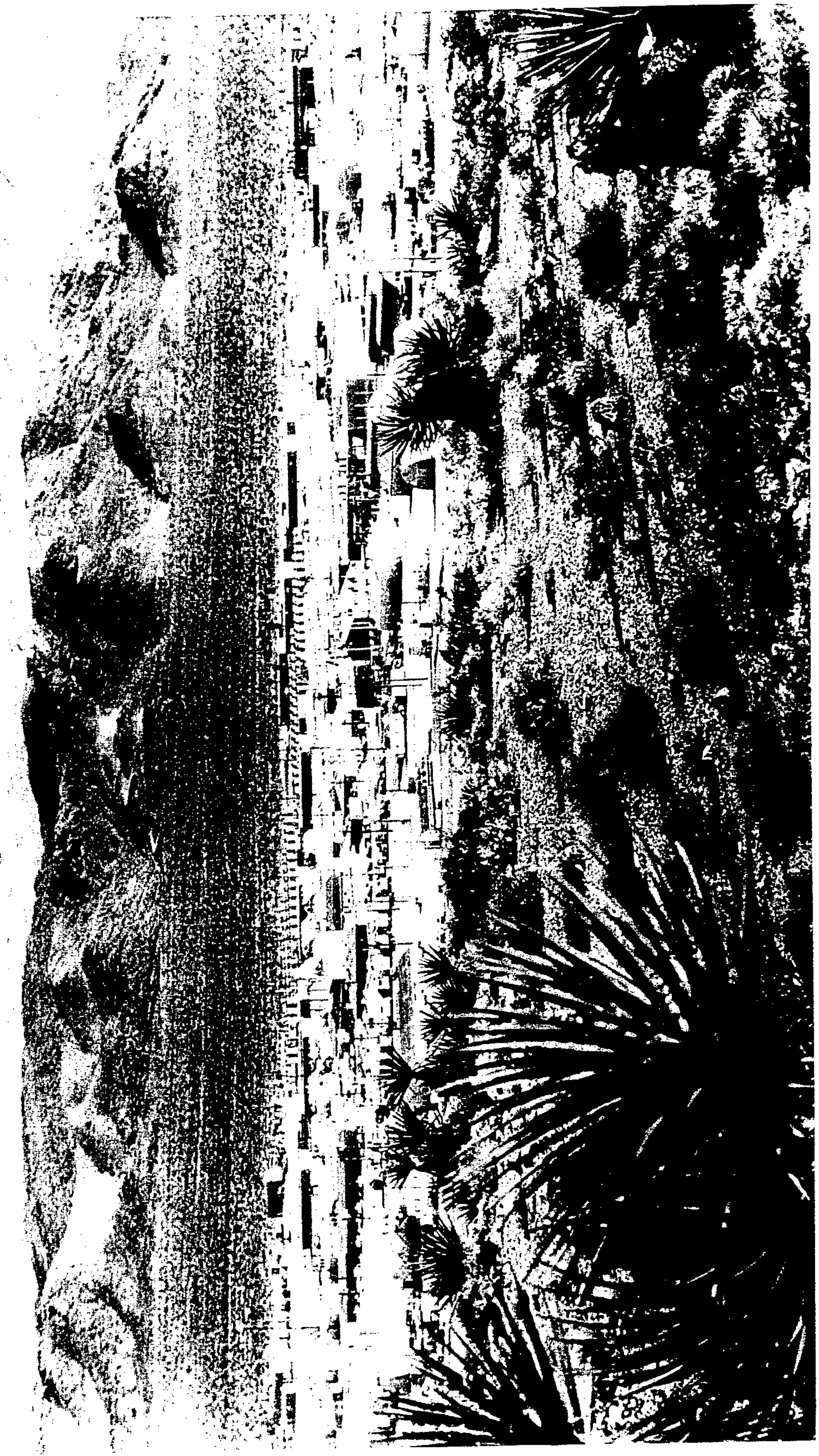
Radionuclide	Half-life (years)	Quantity Released (Ci) [b]
Airborne Releases:		
^{3}H	12.35	[c]0.35
^{85}Kr	10.72	0.019
$^{239+240}Pu$	24065.	[c]0.28
Containment Ponds:		
^{3}H	12.35	[d]130
^{238}Pu	87.743	3.4×10^{-6}
$^{239+240}Pu$	24065.	2.7×10^{-5}
^{90}Sr	29.	4.4×10^{-6}
^{137}Cs	30.17	1.5×10^{-3}
Gross Beta	---	1.2×10^{-3}

(a) Assumes worst-case point and diffuse source releases.
(b) Multiply by 37 to obtain GBq.
(c) Includes calculated data from air sampling results, postulated loss of laboratory standards, and calculated resuspension of surface deposits.
(d) This amount is assumed to evaporate to become an airborne release.

Table 1.2 Summary of Effective Dose Equivalents from NTS Operations During 1996

	Maximum EDE at NTS Boundary[a]	Maximum EDE to an Individual[b]	Collective EDE to Population within 80 km of the NTS Sources
Dose	0.12 mrem (1.2×10^{-3} mSv)	0.11 mrem (1.1×10^{-3} mSv)	0.34 person-rem (0.34×10^{-2} person Sv)
Location	Site boundary 40 km WNW of NTS CP-1	Springdale, NV 58 km WNW of NTS CP-1	32,210 people within 80 km of NTS Sources
NESHAP Standard	10 mrem per yr (0.1 mSv per yr)	10 mrem per yr (0.1 mSv per yr)	-----
Percentage of NESHAP	1.2	1.1	-----
Background	144 mrem (1.44 mSv)	144 mrem (1.44 mSv)	3064 person-rem (30.6 person Sv)
Percentage of Background	8.0×10^{-2}	8.0×10^{-2}	1.1×10^{-2}

(a) The maximum boundary dose is to a hypothetical individual who remains in the open continuously during the year at the NTS boundary located 40 km (25 mi) WNW from the NTS Control Point 1.
(b) The maximum individual dose is to an individual outside the NTS boundary at a residence where the highest dose-rate occurs as calculated by CAP88-PC (Version 1.0) using NTS effluents listed in Table 5.1, assuming all tritiated water input to containment ponds was evaporated, assuming resuspended plutonium was carried offsite, and summing the contributions from each NTS source.



View of Mercury, the Main Base Camp at the NTS

2.0 INTRODUCTION

The Nevada Test Site (NTS), located in southern Nevada, was the primary location for testing of nuclear explosives in the continental U.S. from 1951 to 1992. Historically, nuclear testing has included the following: (1) atmospheric testing in the 1950s and early 1960s; (2) underground testing in drilled, vertical holes and horizontal tunnels; (3) earth-cratering experiments; and (4) open-air nuclear reactor and engine testing. No nuclear tests were conducted in 1996. Non-nuclear testing included controlled spills of hazardous material at the Hazardous Materials Spill Center (HSC). Low-level radioactive and mixed waste disposal and storage facilities for defense waste are also operated on the NTS.

The NTS environment is characterized by desert valley and Great Basin mountain terrain and topography, with a climate, flora, and fauna typical of the southern Great Basin deserts. Restricted access and extended wind transport times are notable features of the remote location of the NTS and adjacent U.S. Air Force lands. Also characteristic of this area are the great depths to slow-moving groundwater and little or no surface water. These features afford protection to the inhabitants of the adjacent areas from potential exposure to radioactivity or other contaminants resulting from operations on the NTS. Population density within 150 km of the NTS is only 0.5 persons/km^2 versus approximately 29 persons/km^2 in the 48 contiguous states. The predominant use of land surrounding the NTS is open range for livestock grazing with scattered mining and recreational areas.

In addition to the NTS operations, U.S. Department of Energy, Nevada Operations Office (DOE/NV) is accountable for six non-NTS Bechtel Nevada (BN) facilities in five different cities. The BN operations support the DOE/NV programs with activities ranging from aerial measurements and aircraft maintenance to electronics and heavy industrial fabrication. All of these operations are in metropolitan areas.

2.1 NTS OPERATIONS

NTS DESCRIPTION

The NTS has been operated by the DOE as the on-continent test site for nuclear weapons testing. It is located in Nye County, Nevada, with the southeast corner lying about 105 km (65 mi) northwest of the city of Las Vegas, Nevada, as shown in Figure 2.1. The NTS encompasses about 3,500 km^2 (1,350 mi^2), an area larger than the state of Rhode Island. The dimensions of the NTS vary from 46 to 56 km (28 to 35 mi) in width (eastern to western border) and from 64 to 88 km (40 to 55 mi) in length (northern to southern border). The NTS is surrounded on the east, north, and west sides by public exclusion areas, previously designated the Nellis Air Force Base (NAFB) Bombing and Gunnery Range and the Tonopah Test Range (TTR) (see Figure 2.1). These two areas presently comprise the Nellis Air Force Range Complex, which provides a buffer zone varying from 24 to 104 km (15 to 65 mi) between the NTS and public lands. The combination of the Nellis Air Force Range Complex and the NTS is one of the largerunpopulated land areas in the United States, comprising some 14,200 km^2 (5,470 mi^2). Figure 2.2 shows the general layout of the NTS, including the location of major

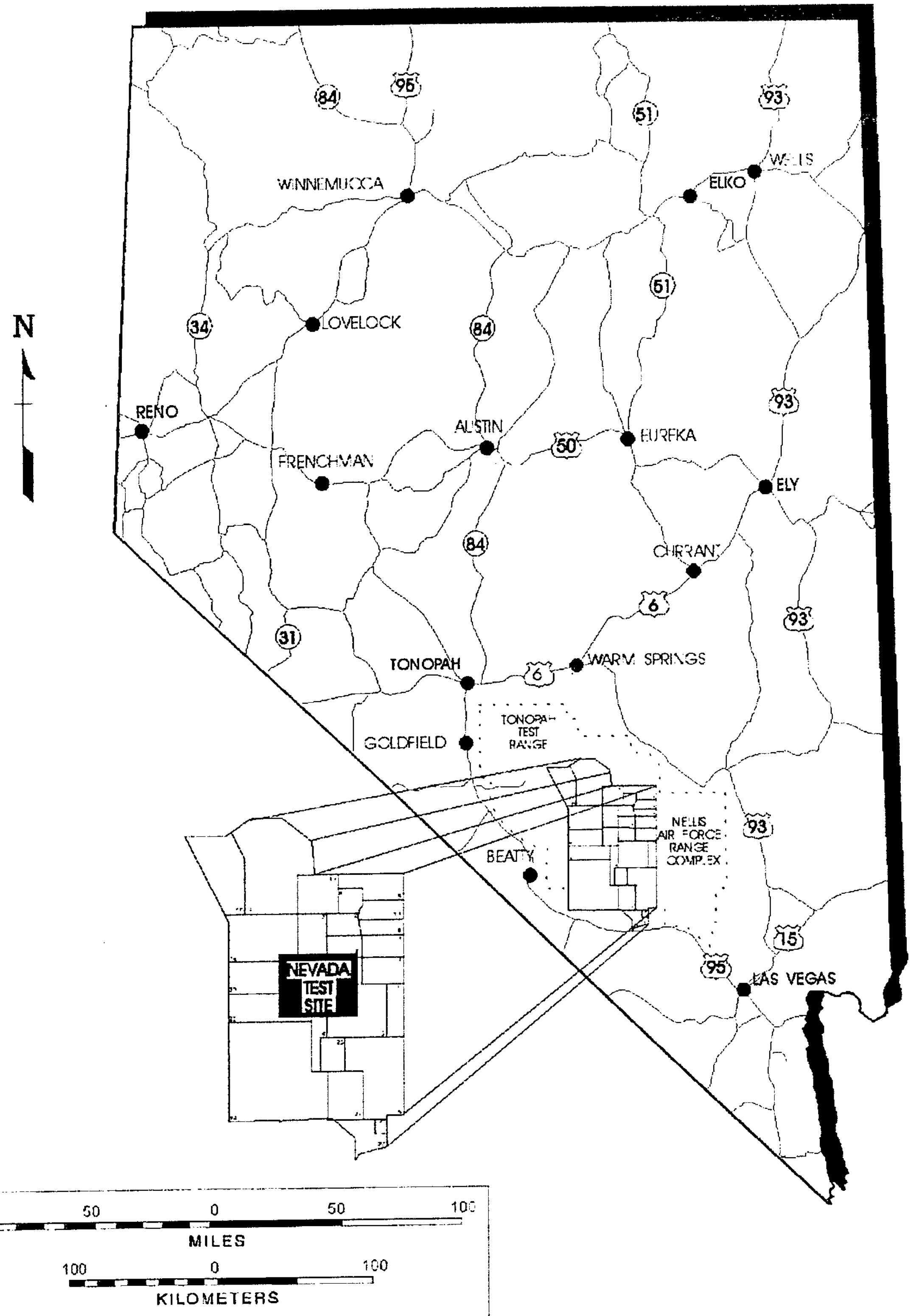


Figure 2.1 NTS Location in Nevada

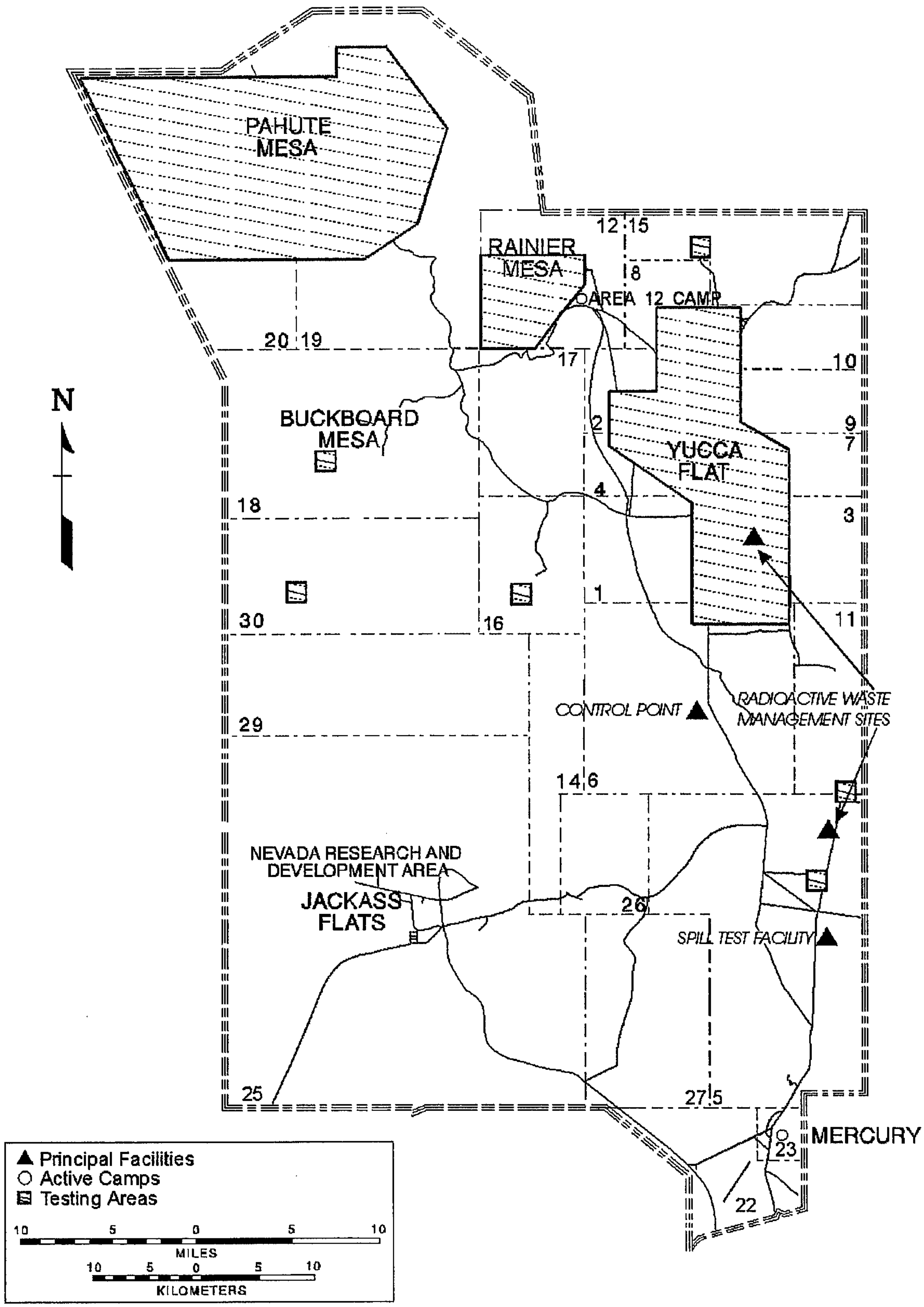


Figure 2.2 NTS Area Numbers, Principal Facilities, and Testing Areas

facilities and area numbers referred to in this report. The areas outlined in green in Figure 2.2 indicate the principal geographical areas used recently for underground nuclear testing. Mercury, Nevada, at the southern end of he NTS, is the main base camp for worker housing and administrative operations for the NTS. Area 12 Base Camp, at the northern end of the NTS, was another major worker housing and operations support facility.

MISSION AND NATURE OF OPERATIONS

The NTS has been the primary location for testing the nation's nuclear explosive devices since January 1951. Tests conducted through the 1950s were predominantly atmospheric tests. These tests involved a nuclear explosive device detonated while on the ground surface, on a steel tower, suspended from tethered balloons, or dropped from an aircraft. Several of the tests were non-nuclear, i.e., "safety" tests, involving destruction of a nuclear device with non-nuclear explosives. Safety tests resulted in dispersion of plutonium in the test vicinity. One of these test areas lies just north of the NTS boundary and four others involving transport-storage safety at the north end of the Nellis Air Force Range Complex (see Figure 2.3). All nuclear tests are listed in DOE/NV Report NVO-209 (DOE 1994a).

Underground nuclear tests were first conducted in 1957. Testing was discontinued during a moratorium that began in November 1958, but was resumed in September 1961 after tests by the Union of Soviet Socialist Republics (USSR) began. Four small atmospheric (surface) tests were conducted in 1961 and 1962. Two additional safety test series were conducted in the mid-1960s, one on the Nellis Air Force Range Complex and one on the TTR. Since late 1962, nearly all tests were conducted in sealed vertical shafts drilled into Yucca Flat and Pahute Mesa or in horizontal tunnels mined into Rainier Mesa. Five earth-cratering (shallow-burial) tests were conducted over the period of 1962 through 1968 as part of the Plowshare Program, which explored peaceful uses of nuclear explosives. The first and largest test (SEDAN) was detonated at the northern end of Yucca Flat. There have been no U.S. nuclear explosive tests since September 1992.

Other nuclear testing over the history of the NTS has included the Bare Reactor Experiment - Nevada series in the 1960s. These tests were performed with a 14-MeV neutron generator mounted on a 465-m (1,530-ft) steel tower, used to conduct neutron and gamma-ray interaction studies on various materials. From 1959 through 1973, a series of open-air nuclear reactor, nuclear engine, and nuclear furnace tests were conducted in Area 25. Also, a series of tests with a nuclear ramjet engine was conducted in Area 26.

Limited non-nuclear testing has also occurred at the NTS, including spills of hazardous materials at the HSC in Area 5. The tests conducted at the HSC, from the latter half of the 1980s to date, involved controlled spilling of liquid materials to study both spill control and mitigation measures and the resultant dispersion and transport of airborne clouds. These tests are cooperative studies involving private industry, the U.S. Department of Transportation, and the DOE. At the Explosive Ordnance Disposal in Area 11, explosive materials are destroyed, generally by detonation, with the amounts destroyed being limited in order to maintain downwind air concentrations within state limits.

Waste storage and disposal facilities for defense low-level radioactive waste (LLW) and mixed waste are located in Areas 3 and 5. At the Area 5 Radioactive Waste Management Site (RWMS-5), LLW from DOE-affiliated onsite and offsite generators are disposed of using standard shallow land disposal techniques. A greater confinement disposal technique was once used for disposal of wastes that had high specific activity, high mobility, or were not acceptable for normal disposal. This method of disposal is no longer used.

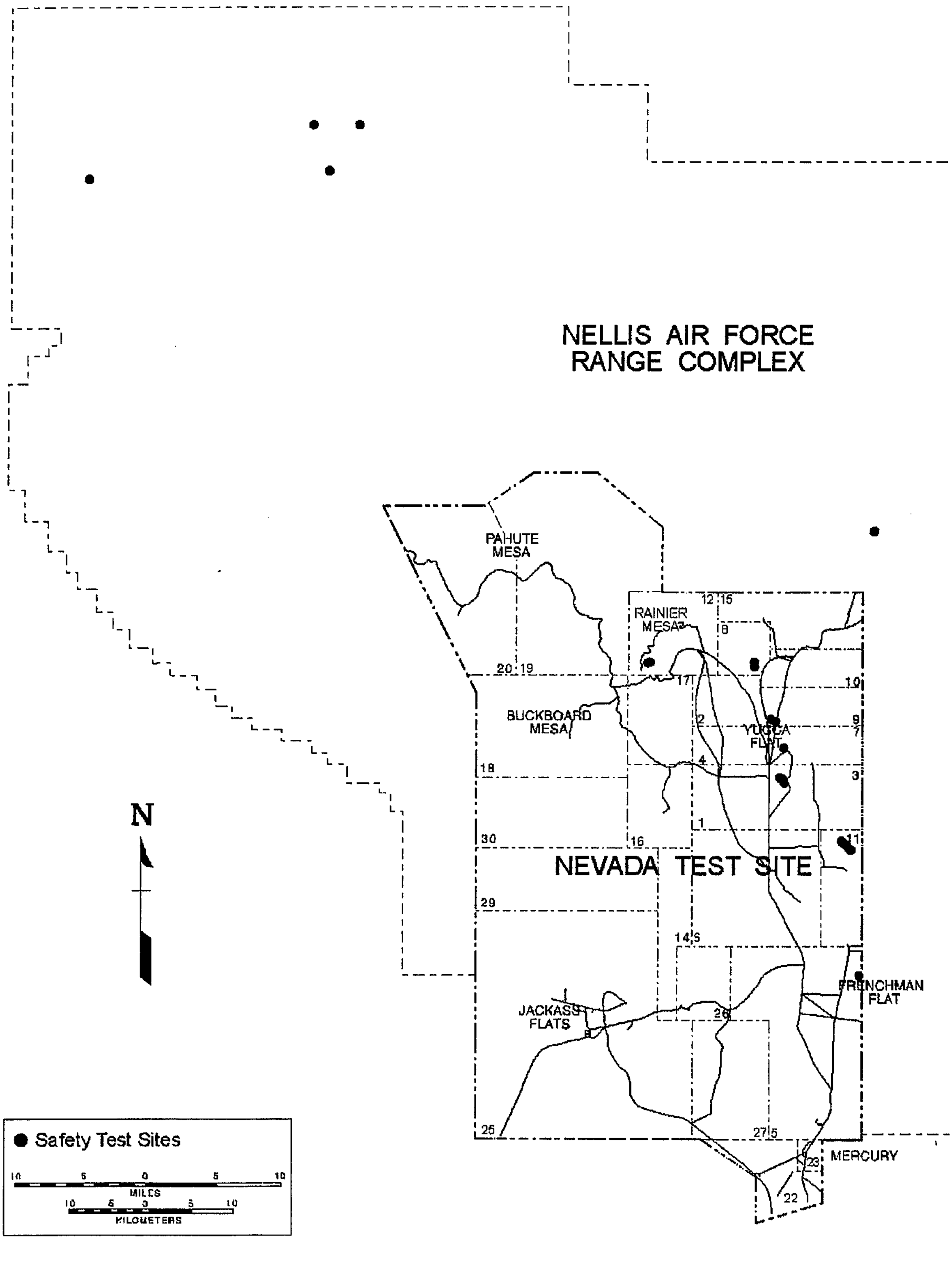


Figure 2.3 Location of Safety Tests on the NTS and the Nellis Air Force Range Complex

Transuranic (TRU) wastes are retrievably stored in surface containers at the RWMS-5 pending shipment to the Waste Isolation Pilot Plant (WIPP) facility in New Mexico. Nonradioactive hazardous wastes are accumulated at a special accumulation site before shipment to a licensed offsite disposal facility. At the Area 3 RWMS, bulk LLW (such as debris from atmospheric nuclear test locations) and LLW in large non-standard packages are emplaced and buried in selected surface subsidence craters (formed as a result of prior underground nuclear tests).

1996 ACTIVITIES

NUCLEAR TESTS

No nuclear explosives tests were conducted during 1996 due to the moratorium announced in late 1992. However, continuous environmental surveillance for radioactivity and radiation was conducted both onsite and offsite because of the large number of potential effluent sources that exist on the NTS as a result of the prior nuclear tests. The surveillance program and results are described in Chapters 4 and 5.

NTS-RELATED ACTIVITIES

LLW and mixed waste handling and disposal, TRU waste storage and monitoring prior to shipment to the WIPP in New Mexico, and remedial actions related to sites contaminated by tests of nuclear devices are some of the activities that occurred in 1996.

Compliance with state and federal environmental laws and regulations was another principal activity during 1996. Specifically included were actions related to: (1) National Environmental Policy Act documentation preparation, such as the Sitewide Environmental Impact Statement; (2) Clean Air Act compliance for asbestos renovation projects, radionuclide emissions, and state air quality permits; (3) Clean Water Act compliance involving state wastewater permits; (4) Safe Drinking Water Act compliance involving monitoring of drinking water distribution systems; (5) Resource Conservation and Recovery Act management of hazardous wastes; (6) Comprehensive Environmental Response, Compensation, and Liability Act reporting; and (7) Toxic Substances Control Act management of polychlorinated biphenyls. Also included were preactivity surveys to detect and document archaeological and historic sites on the NTS. Compliance with the Endangered Species Act involved conducting pre-operation surveys to document the status of state of Nevada and federally listed endangered or threatened plant and animal species.

HAZARDOUS MATERIALS SPILL CENTER

DOE/NV's HSC is a research and demonstration facility available on a user-fee basis to private and public sector test and training sponsors concerned with the safety aspects of hazardous chemicals. The site is located in Area 5 of the NTS and is maintained by BN. The HSC is the basic research tool for studying the dynamics of accidental releases of various hazardous materials. Discharges from the HSC tanks occur at a controlled rate and consist of a measured volume of hazardous test fluid released on a surface especially prepared to meet the test requirements. The facility has the capability for releasing large volumes of cryogenic and non-cryogenic liquids. Spill rates for the cryogenic system range up to 98-m^3/min (26,000-gpm) capability to release the entire contents of two tanks in two minutes. The non-cryogenic system can release materials at rates up to 19 m^3/min (5,000 gpm). Test sponsors can vary intake air humidity, temperature, release rate, and release volume in an 8-ft x 16-ft x 96-ft wind tunnel. There are two spill pads available for use in contained open air releases of volumes up to 3.8 m^3 (1,000 gal). An area has been added to provide the capability for determining the efficacy of protective suiting materials when exposed to high concentrations of toxic and hazardous gaseous materials.

An array of diagnostic sensors may be placed up to 16 km downwind of the spill point to obtain cloud-dispersion data. Deployment of the array is test-dependent and is not used for all experiments. The array can consist of up to 20 meteorological and 41 sensor stations to gather wind data and gaseous concentration data from a variety of sensors at various levels above ground. The array and associated data-acquisition system are linked to the HSC control point by means of telemetry. The operation and performance of the HSC are controlled and monitored from the Command Control and Data Acquisition System building located one mile from the test fluid spill area.

TOPOGRAPHY AND TERRAIN

The topography of the NTS is typical of the Great Basin Section of the Basin and Range physiographic province of Nevada, Arizona, and Utah. North-south-trending mountain ranges are separated by broad, flat-floored, and gently-sloped valleys. The topography is depicted in Figure 2.4. Elevations range from about 910 m (3,000 ft) above mean sea level (MSL) in the south and east, rising to 2,230 m (7,300 ft) in the mesa areas toward the northern and western boundaries. The slopes on the upland surfaces are steep and dissected, whereas the slopes on the lower surfaces are gentle and alluviated with rock debris from the adjacent highlands.

The principal effect upon the terrain from nuclear testing has been the creation of numerous dish-shaped surface subsidence craters, particularly in Yucca Flat. Most underground nuclear tests conducted in vertical shafts produced surface subsidence craters that occurred when the overburden above a nuclear cavity collapsed and formed a rubble "chimney" to the surface. A few craters have been formed as a result of tests conducted on or near the surface by shallow depth-of-burial cratering experiments, or following some tunnel events.

There are no continuously flowing streams on the NTS. Surface drainages for Yucca and Frenchman Flats closed-basin systems are onto the dry lake beds (playas) in each valley. The remaining areas of the NTS drain via arroyos and dry stream beds that carry water only during unusually intense or persistent storms. Rainfall or snow melt typically infiltrates quickly into the moisture-deficient soil or runs off in normally dry channels, where it evaporates and seeps into permeable sands and gravels. During extreme conditions, flash floods may occur.

GEOLOGY

The basic lithologic structure of the NTS is depicted in Figure 2.5. Investigations of the geology of the NTS, including detailed studies of numerous drill holes and tunnels, have been in progress by the U.S. Geological Survey and other organizations since 1951. Because of the large number of drilled holes, see Figure 2.6, the NTS is probably one of the better geologically characterized large areas within the United States.

In general, the geology consists of three major rock units. These are: (1) complexly folded and faulted sedimentary rocks of Paleozoic age overlain at many places by; (2) volcanic tuffs and lavas of Tertiary age, which (in the valleys) are covered by; (3) alluvium of late Tertiary and Quaternary age. The sedimentary rocks of Paleozoic age are many thousands of feet thick and are comprised mainly of carbonate rocks (dolomite and limestone) in the upper and lower parts, separated by a middle section of clastic rocks (shale and quartzite). The volcanic rocks in the valleys are down-dropped and tilted along steeply dipping normal faults of late Tertiary age. The alluvium is rarely faulted and is derived from erosion of Tertiary and Paleozoic rocks. Compared to the Paleozoic rocks, the Tertiary rocks are relatively undeformed, and dips are generally gentle. The volcanic rocks of the Tertiary age are predominantly tuffs, which erupted from various volcanic centers and lavas, mostly of rhyolitic composition. The aggregate thickness of the volcanic rocks is many thousands of feet, but in most places the total thickness of the section is far less because of erosion or

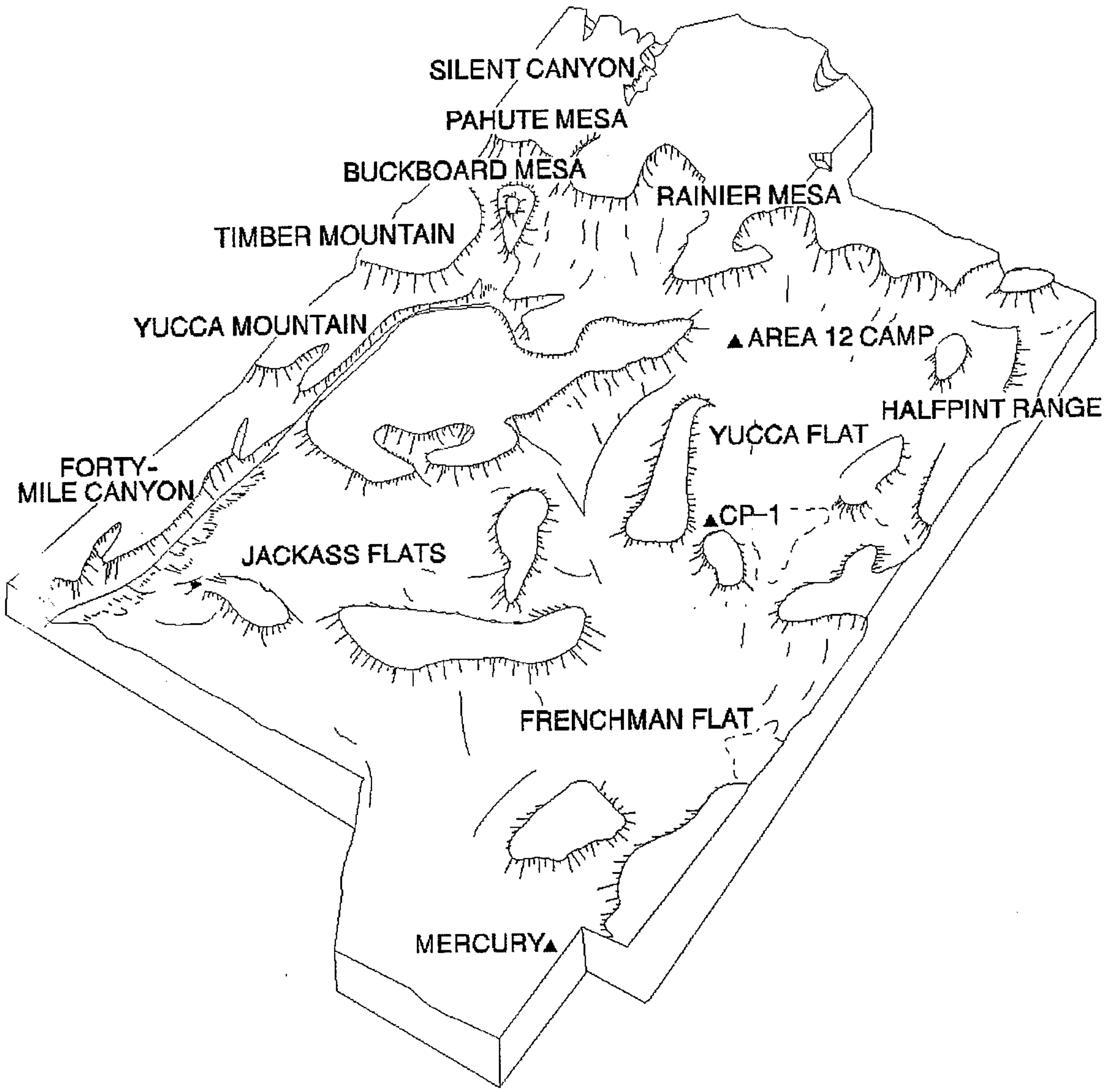


Figure 2.4 Topography of the NTS

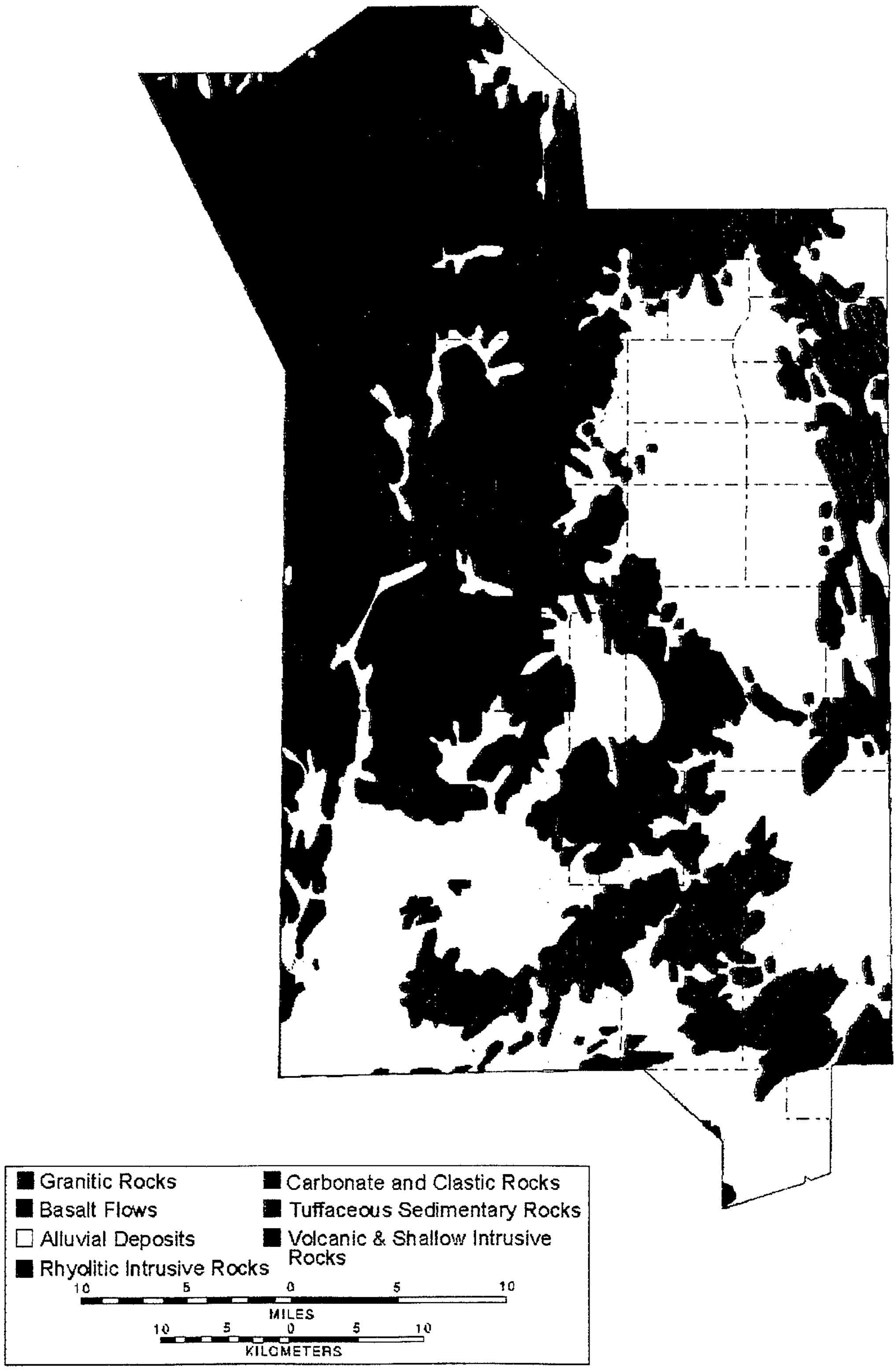


Figure 2.5 Basic Lithologic Structure of the NTS

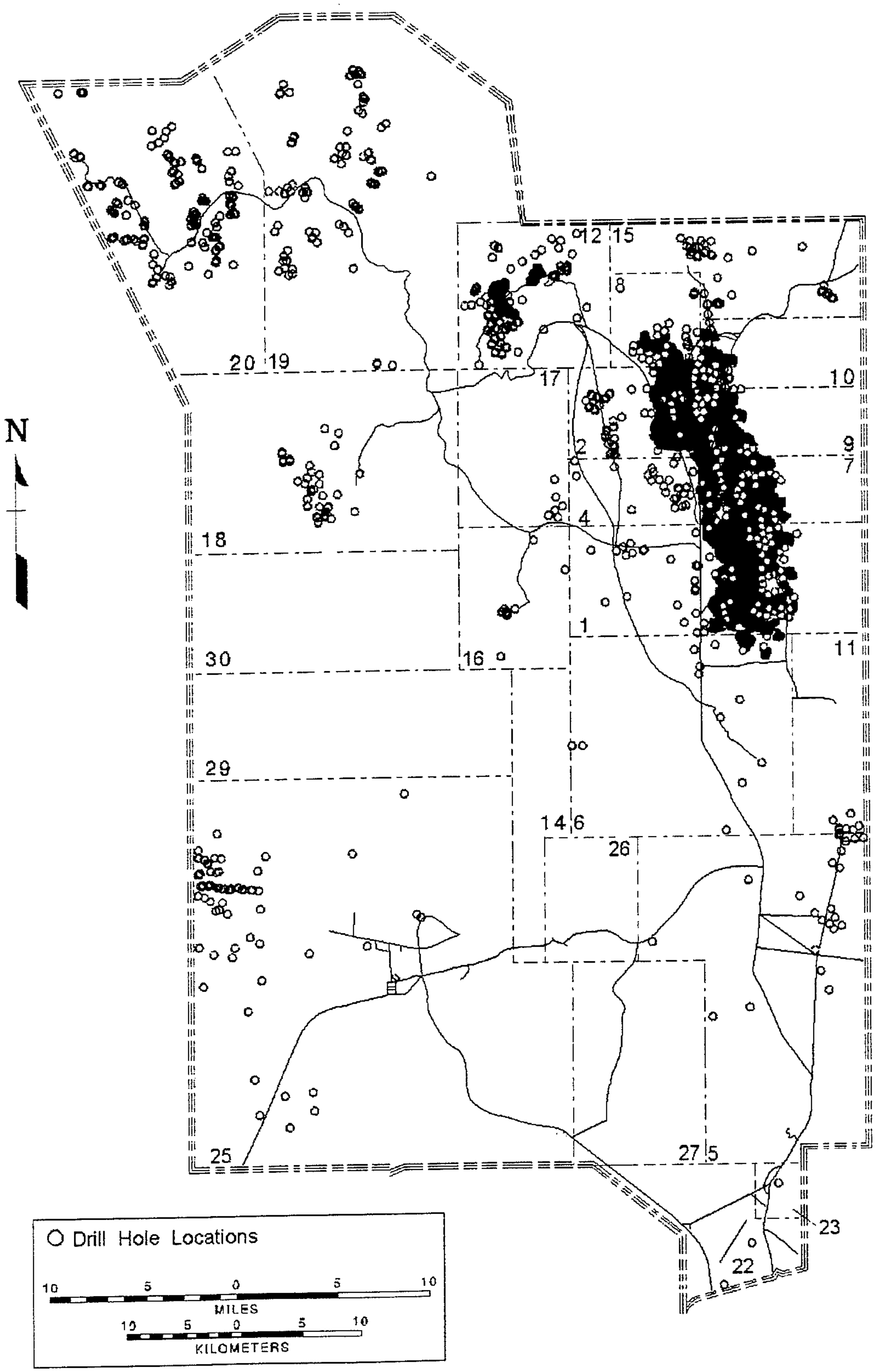


Figure 2.6 Drill Hole Locations on the NTS

nondeposition. These materials erupted before the collapse of large volcanic centers known as *calderas*. Alluvial materials fill the intermountain valleys and cover the adjacent slopes. These sediments attain thicknesses of 600 to 900 m (2000 to 3000 ft) in the central portions of the valleys. The alluvium in Yucca Flat is vertically offset along the prominent north-south-trending Yucca fault.

HYDROGEOLOGY

The deep aquifers, slow groundwater movement, and exceedingly slow downward movement of water in the overlying unsaturated zone serve as significant barriers to transport of radioactivity from unsaturated zone sources via groundwater, greatly limiting the potential for transport of radioactivity to offsite areas. Some historic nuclear tests were conducted below the groundwater table; others were at varying depths above the groundwater table. Nuclear tests below the groundwater table have a greater potential for offsite migration. However, the great distance to offsite water supply wells or springs makes it unlikely that contaminants will be transported in significant quantities.

Depths to groundwater beneath the NTS vary from about 157 m (515 ft) beneath the Frenchman Flat playa (Winograd and Thordarson 1975) in the southern part of the NTS to more than 700 m (2,300 ft) beneath part of Pahute Mesa. In the eastern portions, the water table occurs generally in the alluvium and volcanic rocks above the regional carbonate aquifer, and in the western portions it occurs predominantly in volcanic rocks. The flow in the shallower parts of the groundwater body is generally toward the major valleys (Yucca and Frenchman), where it may deflect downward to join the regional drainage to the southwest in the carbonate aquifer.

The hydrogeology of the underground nuclear testing areas on the NTS (Figure 2.7) has been summarized by the Desert Research Institute, University of Nevada System (Russell 1990). Yucca Flat is situated within the Ash Meadows groundwater subbasin. Groundwater occurs within the valley-fill, volcanic, and carbonate aquifers and in the volcanic and clastic aquitards. The depth to water generally ranges from 160 m (525 ft) to about 580 m (1,900 ft) below the ground surface. The tuff aquitard forms the principal Cenozoic hydrostratigraphic unit beneath the water table in the eastern two-thirds of the valley and is unconfined over most of its extent. The valley-fill aquifer is saturated in the central part of the valley and is unconfined (Winograd and Thordarson 1975).

Some underflow, past all of the subbasin discharge areas, probably reaches springs in Death Valley. Recharge for all of the subbasins most likely occurs by precipitation at higher elevations and infiltration along stream courses and in playas. Regional groundwater flow is from the upland recharge areas in the north and east towards discharge areas at Ash Meadows and Death Valley, southwest of the NTS. Due to the large topographic changes across the area and the importance of fractures to groundwater flow, local flow directions can be radically different from the regional trend. Groundwater is the only local source of drinking water in the NTS area. Drinking and industrial water supply wells for the NTS produce from the lower and upper carbonate, the volcanic and the valley-fill aquifers. Although a few springs emerge from perched groundwater lenses at the NTS, discharge rates are low, and spring water is not currently used for DOE activities. South of the NTS, private and public supply wells are completed in a valley-fill aquifer. Frenchman Flat is also within the Ash Meadows subbasin. Regional groundwater flow in this valley occurs within the major Cenozoic and Paleozoic hydrostratigraphic units at depths ranging from 157 to 360 m (515 to 1,180 ft) below the ground surface. Perched water is found as shallow as 20 m (66 ft) within the tuff and lava flow aquitards in the southwestern part of the valley. In general, the depth to water is at least 157 m (515 ft) beneath Frenchman playa and increases to nearly 360 m (1,180 ft) near the margins of the valley (Winograd and Thordarson 1975).

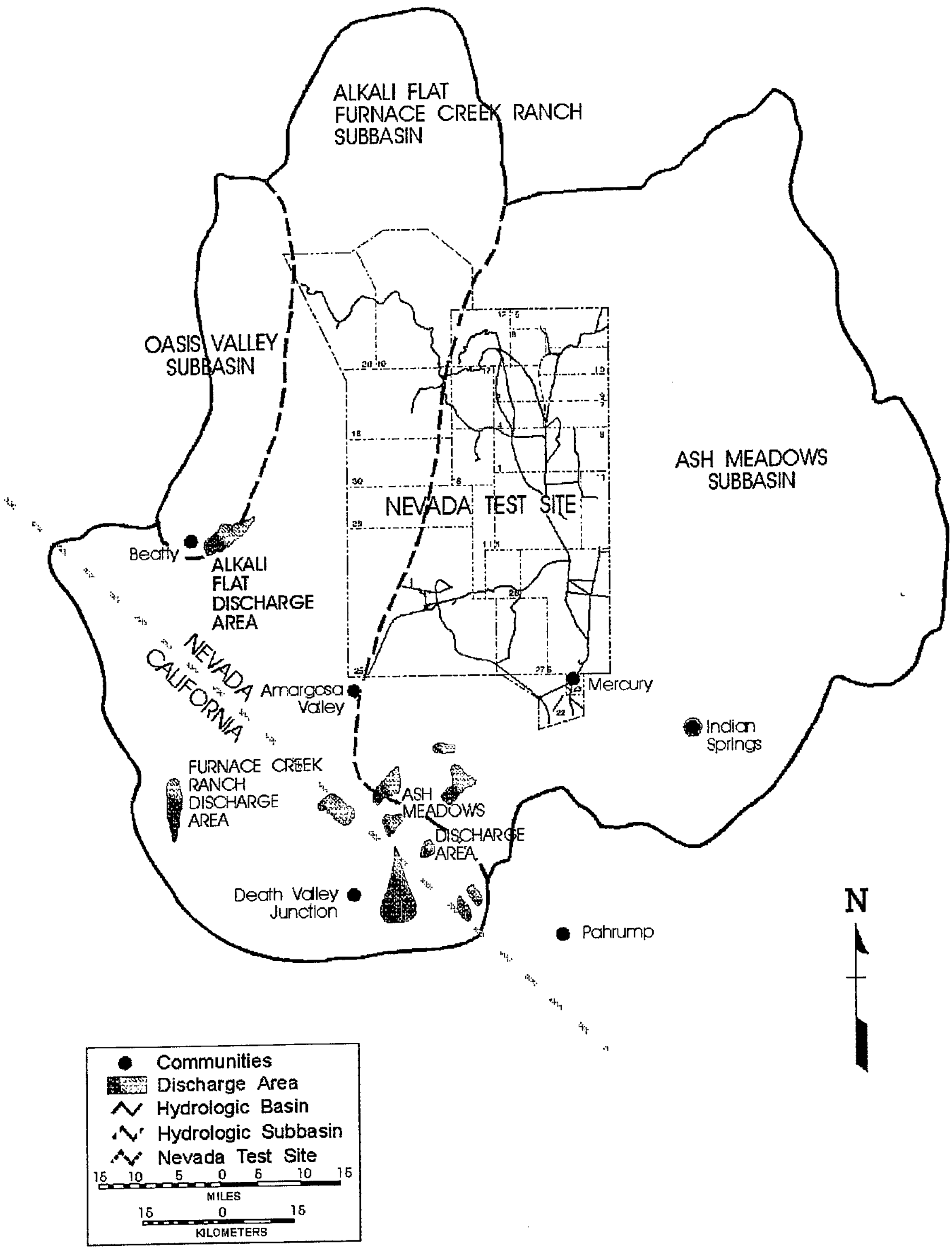


Figure 2.7 Groundwater Hydrologic Units of the NTS and Vicinity

The water table beneath Frenchman Flat is considerably shallower (and stratigraphically higher) than beneath Yucca Flat. Consequently, the areal extent of saturation in the valley-fill and volcanic aquifers is correspondingly greater.

Winograd and Thordarson (1975) hypothesized that groundwater within the Cenozoic units of Yucca and Frenchman Flats probably cannot leave these basins without passing through the underlying and surrounding lower carbonate aquifer. In addition, lateral gradients within the saturated volcanic units exist and may indicate groundwater flow toward the central areas of Yucca and Frenchman Flats prior to vertical drainage.

The only hydrostratigraphic units encountered at Pahute Mesa are the volcanic aquifers and aquitards. Pahute Mesa is thought to be a part of both the Oasis Valley and Alkali Flat/Furnace Creek Ranch subbasins. The location of the inter-basin boundary is uncertain. Groundwater is thought to move towards the south and southwest, through Oasis Valley, Crater Flat, and western Jackass Flats (Blankennagel and Weir 1973). Points of discharge are thought to include the springs in Oasis Valley, Alkali Flat, and Furnace Creek. The amount of recharge to Pahute Mesa and the amount of underflow which moves to the various points of discharge are not accurately known. Vertical gradients within Pahute Mesa suggest that flow may be downward in the eastern portion of the mesa but upward in the western part.

The hydrostratigraphic units beneath Rainier Mesa consist of the welded and bedded tuff aquifer, zeolitized tuff aquitard, the lower carbonate aquifer, and the tuffaceous and lower clastic aquitards. The volcanic aquifer and aquitards support a semiperched groundwater lens. Nuclear testing at Rainier Mesa was conducted within the tuff aquitard. Work by Thordarson (1965) indicates that the perched groundwater is moving downward into the underlying regional aquifer. Depending on the location of the subbasin boundary, Rainier Mesa groundwater may be part of either the Ash Meadows or the Alkali Flat/Furnace Creek Ranch subbasin. The regional flow from the mesa may be directed either towards Yucca Flat or, because of the intervening upper clastic aquitard, towards the Alkali Flat discharge area in the south. The nature of the regional flow system beneath Rainier Mesa requires further investigation.

CLIMATE AND METEOROLOGY

Precipitation levels on the NTS are low, runoff is intermittent, and the majority of the active testing areas onsite drain into closed basins on the NTS. Topography contributes to temporal and spatial variability of precipitation. For example, on the NTS the mesas receive an average annual precipitation of 9 in. (23 cm), which includes wintertime snow accumulations. The lower elevations receive approximately 6 in (15 cm) of precipitation annually, with occasional snow accumulations lasting only a matter of days (Quiring 1968).

Elevation also influences temperatures on the NTS. At an elevation of 2,000 m (6,560 ft) above MSL in Area 20 on Pahute Mesa, the average daily maximum temperatures range from 40 to 80 ^{o} F, and minimum temperatures from 21 to 57^{o} F (4 to 27^{o} C and -6 to 14^{o} C, respectively). In Area 6 (Yucca Flat, 1,200 m [3,940 ft MSL]), the average daily maximum temperatures range from 51 to 96^{o} F and the minimum temperatures from 28 to 62^{o} F (11 to 36^{o} C and -2 to 17^{o} C, respectively).

Wind direction and speed are important aspects of the environment at the NTS. The movements of large-scale pressure systems control the seasonal changes in the wind direction frequencies. Predominating winds are southerly from the south during summer and northerly during winter. The general downward slope in the terrain from north to south results in an intermediate scenario that is reflected in the characteristic diurnal wind reversal from southerly winds during the day to northerly winds at night. This north to south reversal is strongest in the summer and, on occasion, becomes intense enough to override the wind regime associated with large-scale pressure systems. This scenario is very sensitive to the orientation of the mountain slopes and valleys. At higher elevations such as Area 20, the average annual wind speed is 17 km/h (10 mi/h) but is only 11 km/h (7 mi/h) in the valleys, such as Yucca Flat. The prevailing wind direction during winter months is from the north-northeast and north-northwest, but it reverses in the summer months. The 1992 10-m wind roses for the NTS are shown in Figure 2.8.

FLORA AND FAUNA

The vegetation on most of the NTS includes various associations of desert shrubs typical of the Mojave or Great Basin Deserts or the zone of transition between these two. Extensive floral collection has yielded 711 taxa of vascular plants within or near the boundaries of the NTS (O'Farrell and Emery 1976). Associations of creosote bush, *Larrea tridentata*, which are characteristic of the Mojave Desert, dominate the vegetation mosaic on the bajadas of the southern NTS. Between 1,220 and 1,520 m (4,000 and 5,000 ft) in elevation in Yucca Flat, transitional associations are dominated by *Grayia spinosa-Lycium andersonii* (hopsage/desert thorn) associations, while the upper alluvial fans support *Coleogyne* types. Above 1,520 m (5,000 ft), the vegetation mosaic is dominated by sagebrush associations of *Artemisia tridentata* and *Artemisia arbuscula* subspecies *nova*. Above 1,830 m (6,000 ft), piñon pine and juniper mix with the sagebrush associations where there is suitable moisture for these trees. No plant species located on the NTS is currently on the federal endangered species list; however, the state of Nevada has placed *Astragalus beatleyae* on its critically endangered species list.

Most mammals on the NTS are small and secretive (often nocturnal in habitat), hence not often seen by casual observers. Rodents are the most important group of mammals on the NTS, based on distribution and relative abundance. Larger mammals include feral horses, mule deer, mountain lions, bobcats, coyote, kit foxes, and rabbits, among others. Among others Reptiles include: the desert tortoise, over 12 lizards, and 17 snakes; 4 of which are venomous. Bird species are mostly migrants or seasonal residents. Most nonrodent mammals have been placed in the "protected" classification by the state of Nevada. On August 4, 1989, the Mojave population of the desert tortoise, *Gopherus agassizii*, was placed on the endangered species list by the U.S. Fish and Wildlife Service. This population was relisted as threatened on April 2, 1990. The reasons for listing this population included deterioration, loss of habitat, and collection for pets. Other purposes included elevated levels of predation, loss from disease, and the inadequacy of existing regulatory mechanisms to protect tortoises and their habitat. The habitat of the desert tortoises on the NTS is found in the southern third of the NTS outside the recent areas of nuclear explosive test activities.

CULTURAL RESOURCES

Human habitation of the NTS area began at least as early as 10,000 years ago. Various indigenous cultures occupied the region in prehistoric times. The survey of less than 5 percent of the NTS area has located more than 2,000 archaeological sites which contain the only information available concerning the prehistoric inhabitants. The site types identified include rock quarries, tool-manufacturing areas, plant-processing locations, hunting locales, rock art, temporary camps, and permanent villages. The prehistoric people's lifestyle was sustained by a hunting and gathering economy which utilized all parts of the NTS. While major springs provided perennial water, the prehistoric people developed strategies to take advantage of intermittent fresh water sources in the arid region. In the nineteenth century, at the time of initial contact, the area was occupied by Paiute and Shoshone Indians.

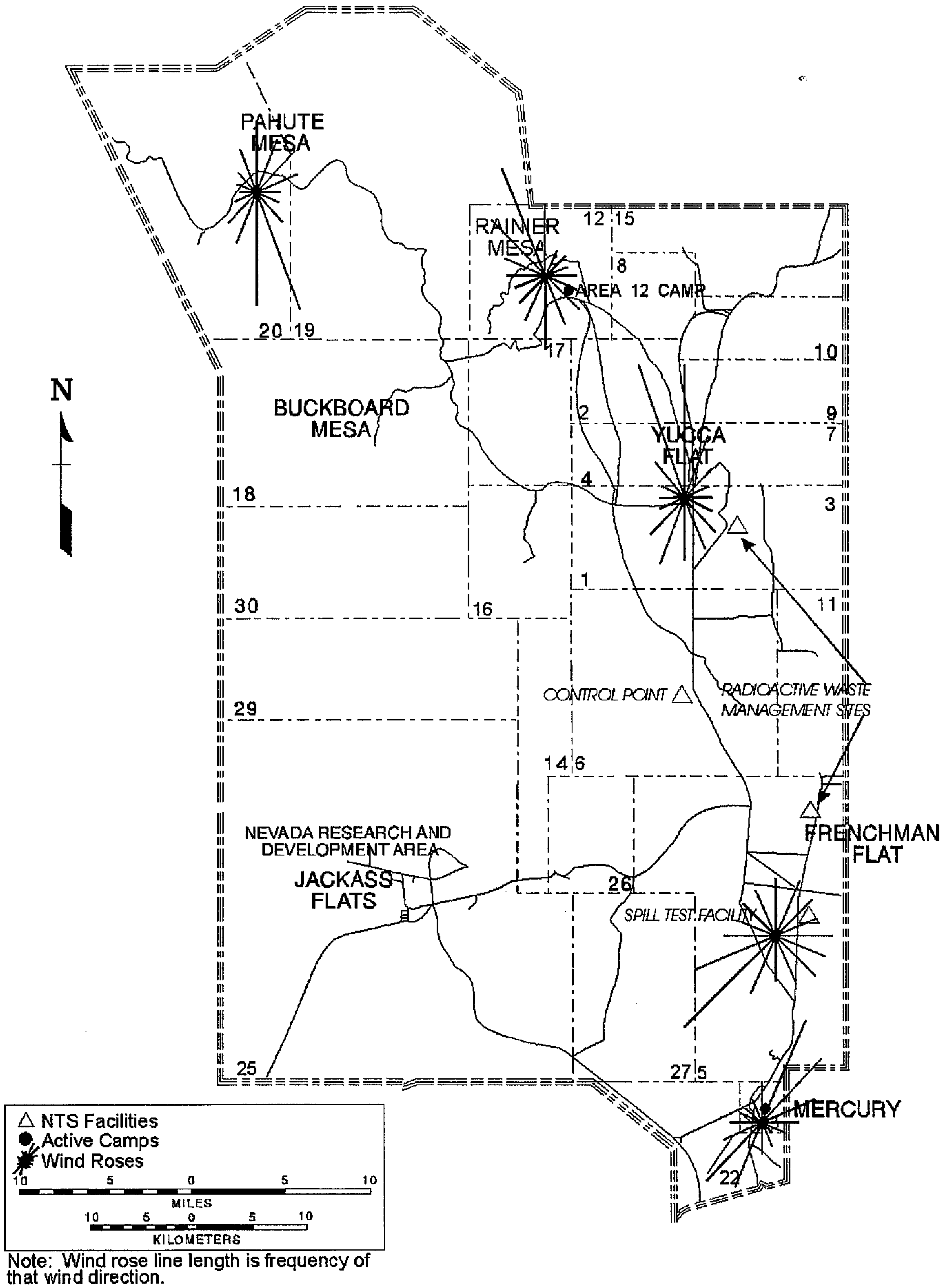


Figure 2.8 1992 Wind Rose Patterns for the NTS (Courtesy of Air Resource Laboratory, Special Operations & Research Division)

Prior to 1940, the historic occupation consisted of ranchers, miners, and Native Americans. Several natural springs were able to sustain livestock, ranchers, and miners. Stone cabins, corrals, and fencing stand today as testaments to these early settlers. The mining activities included two large mines: one at Wahmonie, the other at Climax Mine. Prospector claim markers are found in these and other parts of the NTS. Native Americans coexisted with the settlers and miners, utilizing the natural resources of the region and, in some cases, working for the new arrivals. They also maintained a connection with the land, especially areas important to them for religious and historical reasons. These locations, referred to as traditional cultural properties, continue to be significant to the Paiute and Shoshone Indians.

Between 1940 and 1950, the area now known as the NTS was under the jurisdiction of NAFB and was part of the Nellis Bombing and Gunnery Range. Very few locations associated with this time period have been identified. In 1950, the NTS was selected as the continental nuclear testing ground. Surveys have located and recorded many structures associated with nuclear testing. These structures are significant because of the importance of the nuclear testing program in the history of the United States, as well as its effects on the rest of the world.

DEMOGRAPHY

The population of the area surrounding the NTS has been estimated based on the 1990 Bureau of Census estimates (Department of Commerce 1990). Excluding Clark County, the major population center (over 1,000,000 in 1996), the population density within a 150-km (90-mi) radius of the NTS is about 0.5 persons/km^2. In comparison, the 48 adjoining states (1990 census) had a population density near 29 persons/km^2. The offsite area within 80 km (50 mi) of the NTS Control Point (CP) is predominantly rural. CP-1 (a building at the Control Point) historically has been the point from which distances from the NTS were determined. Several small communities are located in the area, the largest being in the Pahrump Valley. This growing rural community, with an estimated population of 20,000, is about 50 mi (80 km) south of CP-1. The Amargosa Farm area, which has a population of about 1,200, is approximately 50 km (30 mi) southwest of CP-1. The largest town in the near offsite area is Beatty, which has a population of about 1,500 and is approximately 65 km (40 mi) 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 estimated that the population within the boundaries ranges from 200 permanent residents during the summer months to as many as 5,000 tourists and campers on any particular day during holiday periods in the winter months. As many as 30,000 are in the area during "Death Valley Days" in the month of November. The largest nearby population in this desert is in the Ridgecrest-China Lake area about 190 km (118 mi) southwest of the NTS, containing about 28,000 people. The next largest is in the Barstow area located 265 km (165 mi) south-southwest of the NTS with a population of 24,000. The Owens Valley, where numerous small towns are located, lies 50 km (31 mi) west of Death Valley. The largest town in the Owens Valley is Bishop, located 225 km (140 mi) west-northwest of the NTS, with a population of 3,500.

The extreme southwestern region of Utah is more developed than the adjacent portion of Nevada. The largest community is St. George, located 220 km (137 mi) east of the NTS, with a population of 29,000. The next largest town, Cedar City, with a population of 14,000, is located 280 km (174 mi) east-northeast of the NTS.

The extreme northwestern region of Arizona is mostly rangeland except for that portion in the Lake Mead recreation area. In addition, several small communities lie along the Colorado River. The largest towns in the area are Bullhead City, 165 km (103 mi) south-southeast of the NTS, with a population estimate of 22,000, and Kingman, located 280 km (174 mi) southeast of the NTS, with a population of about 13,000.

SURROUNDING LAND USE

Figure 2.9 is a map of the offsite area showing a wide variety of land uses such as farming, mining, grazing, camping, fishing, and hunting within a 300-km (180-mi) radius of the CP-1. West of the NTS, elevations range from 85 m (280 ft) below MSL in Death Valley to 4,400 m (14,500 ft) above MSL in the Sierras, including parts of the Owens and San Joaquin agricultural valleys. 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 and Moapa Valleys, supporting irrigation for small-scale but intensive farming of a variety of crops. Grazing is also common in this area, particularly towards the northeast. The area north of the NTS is also mid-latitude steppe where the major agricultural activity is grazing of cattle and sheep, and a minor agricultural activity is growing of alfalfa hay. Many of the residents cultivate home gardens.

Recreational areas lie in all directions around the NTS and are used for such activities as hunting, fishing, and camping. In general the camping and fishing sites to the north of the NTS are not utilized in the winter months. Camping and fishing locations to the south are utilized throughout the year. The peak hunting season is from September through January.

2.2 NON-NTS FACILITIES

BN had several offsite operations in support of activities at the NTS under a contract with the DOE/NV. Those that were operational in support of NTS activities are described in the following sections. Each of these facilities is located in a metropolitan area.

City, county, and state regulations govern emissions, waste disposal, and sewage. No independent BN systems exist for sewage disposal or for supplying drinking water, and hazardous waste is moved off the facility sites for disposal. Radiation sources are sealed, and no radiological emissions are expected during normal facility operations.

AMADOR VALLEY OPERATIONS (AVO)

The AVO facility in Pleasanton, California, occupies a 5,520-m^2 (59,445-ft^2) two-story combination office/laboratory building. AVO is located near the Lawerence Livermore National Laboratory (LLNL) in Livermore, California, to simplify logistics and communications associated with BN support of LLNL programs. Although most of the work has been in support of NTS underground weapons testing, AVO also supports LLNL with optical alignment systems and a variety of mechanical and electrical engineering activities associated with energy research and development programs. Areas of environmental interest include two small chemical cleaning operations.

SPECIAL TECHNOLOGIES LABORATORY (STL)

STL is located in Santa Barbara, California. The current facilities occupy approximately 4,608 m^2 (49,600 ft^2) and consist of combination office/lab areas used primarily for engineering and electronic research. The research is conducted to develop a suite of sensor systems for testing and field deployment in support of DOE Headquarters and DOE/NV. Areas of environmental interest include a small printed circuit board operation, minor solvent cleaning operations, neutron activation, and pulsed X-ray system experiments.

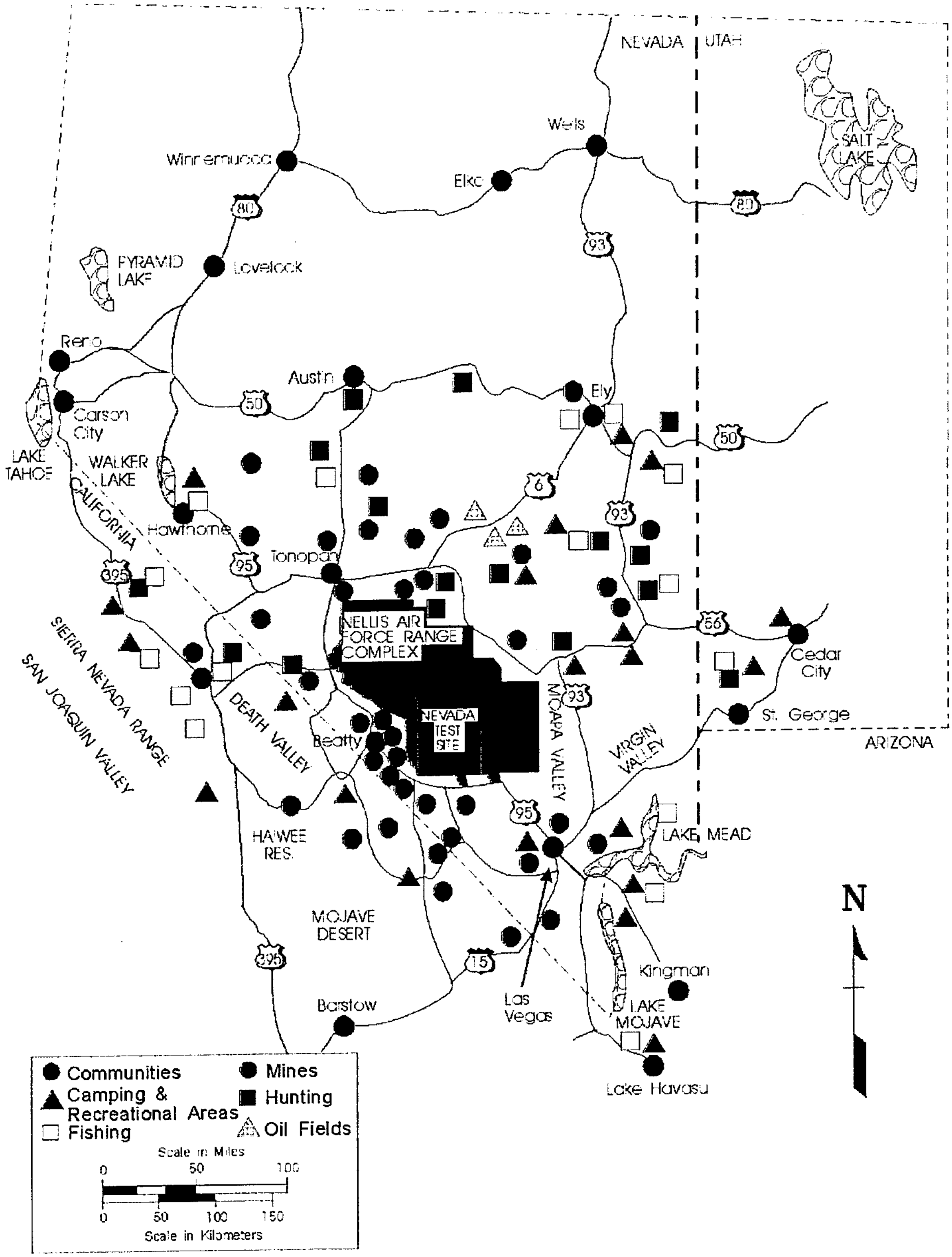


Figure 2.9 Land Use Around the NTS

LAS VEGAS AREA OPERATIONS (LVAO)

The LVAO includes the North Las Vegas Facility (NLVF) and the Remote Sensing Laboratory (RSL) on the NAFB in North Las Vegas, Nevada. These facilities provide technical support for the DOE/NV activities.

The NLVF includes multiple structures totaling about 53,820 m^2 (585,000 ft^2). At the facility there are numerous areas of environmental interest, including metal finishing operations, a radiation source range, an X-ray laboratory, solvent and chemical cleaning operations, small amounts of pesticide and herbicide application, photo laboratories, and hazardous waste generation and accumulation.

The RSL is an 11,000-m^2 (118,000-ft^2) facility located on a 14-ha (35-acre) site within the confines of the NAFB. The facility includes space for aircraft maintenance and operations, mechanical and electronics assembly, computer operations, photo processing, a light laboratory, warehousing, and emergency operations. Areas of environmental interest are photo processing, aircraft maintenance, and operations.

LOS ALAMOS OPERATIONS (LAO)

The LAO resides in a facility of approximately 4,645 m^2 (50,000 ft^2). It is a two-story combination engineering laboratory office complex located near the Los Alamos National Laboratory (LANL) facility to provide local support for LANL's programs. The work performed includes direct support to the LANL Science-Based Stockpile Stewardship program, the DOE Research and Development Program, and miscellaneous DOE cash-order work. LAO's primary activities are twofold: the design, fabrication, and fielding of data acquisition systems used in underground and above ground testing diagnostics; and the analysis of data from prior experiments. Areas of environmental interest include small solvent cleaning, metal machining operations, and a small photo laboratory.

WASHINGTON AERIAL MEASUREMENTS OPERATIONS (WAMO)

The WAMO, located at Andrews Air Force Base, consists of five buildings: a 186-m^2 (2,000-ft^2) Butler building used as office space; a 1,110-m^2 (12,000-ft^2) hangar, combination electronics laboratory, aircraft maintenance, and office complex; a 37-m^2 (400-ft^2) equipment service and storage building; and 186 m^2 (2,000 ft^2) in each of two other joint tenant buildings. WAMO operations provide an effective east coast emergency response capability and an eastern aerial survey capacity to the DOE/NV. Areas of environmental interest include minor solvent cleaning operations, used fuels, and oils.

2.3 NON-NTS UNDERGROUND TEST SITES

In past years, nuclear explosive tests were conducted for a variety of purposes at eight different non-NTS sites in the U.S. The events and their locations appear in Table 2.1 (AEC 1964, 1965, 1966, 1970, 1972, 1973a, 1973b)(DOE 1978, 1984, 1986)(PHS 1966). Those that were not sampled in 1996 are indicated. Activities at these locations generally are limited to annual sampling of surface and groundwater at over 200 wells, springs, etc., at locations near the sites where tests were conducted. However, a Remedial Investigation/Feasibility Study has begun at the Mississippi test location which will include significant new characterization activities. Sampling near three test sites on Amchitka Island, Alaska, occurs only periodically. Sampling results for these sites appear in Chapter 9 of this report.

Table 2.1 Non-NTS Nuclear Underground Test Sites

Event Name	Location	Purpose	Date of Test
GNOME	Carlsbad, New Mexico	Multi-purpose in salt	12/10/61
SHOAL	Fallon, Nevada	Test detection research	10/26/63
SALMON (Dribble)	Hattiesburg, Mississippi	Test detection research	10/22/64
LONG SHOT[(a)]	Amchitka Island, Alaska	Test detection research	10/29/65
STERLING (Dribble)	Hattiesburg, Mississippi	Test detection research	12/03/66
GASBUGGY	Farmington, New Mexico	Gas stimulation experiment	12/10/67
FAULTLESS	Central Nevada, Nevada	Seismic calibration	01/19/68
RULISON	Grand Valley, Colorado	Gas stimulation experiment	09/10/69
MILROW[(a)]	Amchitka Island, Alaska	Seismic calibration	10/02/69
CANNIKIN[(a)]	Amchitka Island, Alaska	Spartan missile warhead test	11/06/71
RIO BLANCO	Rifle, Colorado	Gas stimulation experiment	05/17/73

(a) Not sampled in 1996.

3.0 COMPLIANCE SUMMARY

Environmental compliance activities at the Nevada Test Site (NTS) during calendar year 1996 (CY96) involved the permitting and monitoring requirements of numerous state of Nevada and federal regulations. Primary activities included the following: (1) National Environmental Policy Act (NEPA) documentation preparation; (2) Clean Air Act (CAA) compliance for asbestos renovation projects, radionuclide emissions, and state air quality permits; (3) Clean Water Act (CWA) compliance involving state wastewater permits; (4) Safe Drinking Water Act (SDWA) compliance involving monitoring of drinking water distribution systems; (5) Resource Conservation and Recovery Act (RCRA) management of hazardous wastes; (6) Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) reporting; and (7) TSCA management of polychlorinated biphenyls. Also included were pre-activity surveys to detect and document archaeological and historic sites on the NTS. Compliance with the Endangered Species Act (ESA) involved conducting pre-operation surveys to document the status of state of Nevada and federally listed endangered or threatened plant and animal species. There were no activities requiring compliance with Executive Orders on Flood Plain Management or Protection of Wetlands.

Throughout 1996, the NTS was subject to several formal compliance agreements with regulatory agencies, including: a Programmatic Agreement with the Nevada Division of Historic Preservation and Archaeology and the Advisory Council on Historic Preservation; the U. S. Fish and Wildlife Service (USFWS) for protection of the desert tortoise; a Memorandum of Understanding with Nevada covering releases of radioactivity; a Federal Facilities Agreement and Consent Order (FFACO) with Nevada; Agreements in Principle with Nevada and Mississippi covering environment, safety, and health activities; and a Settlement Agreement to manage mixed transuranic (TRU) waste. Emphasis on waste control and minimization at the NTS continued in 1996.

In June 1994, the state of Nevada filed a Complaint for Declaratory Judgement and Injunction against the U.S. Department of Energy (DOE). This action seeks a judgement that DOE has failed to comply with NEPA requirements at the NTS. In January 1995, three of the claims in this case were dismissed by the U.S. District Court, the remainder are yet unresolved.

Compliance activities at the DOE Nevada Operations Office (DOE/NV) non-NTS facilities involved the permitting and monitoring requirements of (1) the CAA for airborne emissions, (2) the CWA for wastewater discharges, (3) SDWA regulations, (4) RCRA disposal of hazardous wastes, and (5) hazardous substance reporting. Waste minimization efforts continued at all locations.

3.1 COMPLIANCE STATUS

NATIONAL ENVIRONMENTAL POLICY ACT

Section 102 of the NEPA of 1969 requires all federal agencies to consider environmental effects and values and reasonable alternatives before making a decision to implement any major federal action which may have a significant impact on the human environment.

Since November 1994, DOE/NV has had full delegation of authority from DOE Headquarters (DOE/HQ) for Environmental Assessments (EAs), issuing Findings of No Significant Impact and associated floodplain and wetland action documentation relating to DOE/NV proposed actions.

Within DOE, three levels of documentation are used to demonstrate compliance with NEPA: (1) An Environmental Impact Statement (EIS) is a full disclosure of the potential environmental effects of proposed actions and the reasonable alternatives to those actions; (2) An EA is a concise discussion of a proposed action and alternatives and the potential environmental effects to determine if an EIS is necessary; and (3) A Categorical Exclusion (CX) is used for classes of activities which have been found to have no adverse environmental impacts, based on similar, previous activities. During 1996, DOE/NV was involved in activities under all three of these categories.

A Notice of Intent to prepare a sitewide EIS for the NTS and other test locations within the state of Nevada, including the Tonopah Test Range (TTR), portions of Nellis Air Force Range Complex, the Project SHOAL site, and the Central Nevada Test Area, was published in the Federal Register on August 10, 1994. The draft EIS was issued for public review and comment in February 1996. Public hearings and workshops were held to take oral and written comments, and a toll free number and post office box were established to receive comments. The public comment period closed on May 3, 1996. Public comments were addressed, and the draft EIS revised and approval to publish the final EIS was granted in August 1996. The final EIS distribution occurred in October 1996. The Record of Decision was published in December 1996.

Some effort was also expended on the following EISs or Programmatic EISs (PEIS) during 1996:

(1) Waste Management PEIS.
(2) Stockpile Stewardship and Management PEIS.
(3) Storage and Disposition of Weapons-Usable Fissile Materials PEIS.
(4) Disposition of Highly Enriched Uranium EIS.
(5) Los Alamos National Laboratory Sitewide EIS.
(6) Medical Isotopes Production Project: Molybdenum-99 and Related Isotopes EIS.
(7) Pantex Sitewide EIS.
(8) Yucca Mountain EIS.

There are no other EISs expected to be required within the next 24 months. However, involvement as a cooperating agency in supporting the preparation of a new Department of Air Force EIS on the renewal of the Nellis Air Force Range Complex withdrawal is anticipated.

Work was conducted on seven EAs during 1996. They include:

(1) Liquid Waste Treatment System, NTS, Area 6 (DOE/EA-1115).
(2) Sandia National Laboratories/New Mexico, Offsite Transportation of Low-Level Radioactive Waste (SNA92-059).
(3) DOUBLE TRACKS Site Remediation, Nellis Air Force Range Complex (DOE/EA-1136).
(4) NTS, Area 5, Radioactive Waste Management Site Access Improvement Project (DOE/EA-1144).
(5) Navy Thermal Treatment Unit Test, NTS, Area 5--Completed.

(6) Waste Examination Facility, Area 5, NTS--Canceled.
(7) Mixed Waste Disposal Units, Area 5, NTS--Canceled.

Items (6) and (7) were assessed in the sitewide EIS noted above.

Thirty-four CX documents were prepared during 1996.

Throughout CY96, the staff of the DOE/NV Environmental Protection Division (EPD) continued to maintain and update the NEPA Compliance Guide (Volume III), a quick reference handbook containing procedures, formats, and guidelines for those personnel responsible for DOE/NV's NEPA compliance activities. As noted in last year's annual summary, more than 70 controlled copies of the DOE/NV NEPA Compliance Guide have been distributed for use within the DOE/NV organization. The staff of the DOE/NV EPD prepared Volume III to supplement the NEPA Compliance Guides, Volumes I and II, prepared and distributed by the Office of NEPA Policy and Assistance, DOE/HQ.

CLEAN AIR ACT

The CAA and the state of Nevada air quality control compliance activities were limited to asbestos abatement, radionuclide monitoring, and reporting under the National Emission Standards for Hazardous Air Pollutants (NESHAP), and air quality permit compliance requirements. There was no criteria pollutant or prevention of significant deterioration monitoring requirements for NTS operations.

NTS NESHAP ASBESTOS COMPLIANCE

The state of Nevada Division of Occupational Safety and Health regulations (Nevada Revised Statutes [NRS] 618.760-805) requires that all asbestos abatement projects in Nevada, involving friable asbestos in quantities greater than or equal to three linear feet or three square feet, submit a Notification Form. Notifications are also required to be made to the U.S. Environmental Protection Agency (EPA) Region 9 for projects which disturb greater than 260 linear ft or 160 ft^2 of asbestos-containing material in accordance with Title 40 Code of Federal Regulations (C.F.R.) 61.145-146.

During 1996, there were no projects that required state of Nevada notifications be made. The annual estimate for non-scheduled asbestos demolition/renovation for fiscal year (FY) 1997 was sent to EPA Region 9 in December 1996.

RADIOACTIVE EMISSIONS ON THE NTS

NTS operations were conducted in compliance with the NESHAP radioactive air emission standards of Subpart H, of Title 40 C.F.R. 61. In compliance with those requirements, reports on airborne radioactive effluents are provided to DOE/HQ for submission to EPA.

There are two locations on the NTS where airborne radioactive effluents may be emitted from permanent stacks: (1) the tunnels in Rainier Mesa, and (2) the analytical laboratory hoods in the community of Mercury. Based on the amount of radioactivity handled, the exhaust from the analytical laboratories is considered negligible compared to other sources on the NTS and the tunnels have been sealed (although water still seeps from one). Present sources are gases from the ground caused by barometric pressure variations, evaporation of tritiated water (HTO) from containment ponds, diffusion of HTO vapor from the Area 5 Radioactive Waste Management Site (RWMS-5), and resuspension of plutonium contaminated soil from nuclear safety test and atmospheric test locations.

In the 1996 NTS NESHAP report for airborne radioactive effluents (Black 1997), airborne emission of HTO vapor from the containment ponds was conservatively reported as if all the liquid discharge into the ponds had evaporated and become airborne. For HTO vapor diffusing from the RWMS-5, plutonium particulate resuspension from Areas 3 and 9, and various other areas on and near the NTS, the airborne effluents were conservatively estimated as follows. The monitoring station with the maximum annual average concentration for the radionuclide in question was selected from among the surrounding sampling stations. An effective dose equivalent (EDE) was then calculated for that concentration. EPA's Clean Air Package 1988 (CAP88)-PC software program was used to determine what total activity would have to have been emitted from the geometric center of the region in question in order to produce that EDE. Resuspended radioactivity was estimated by employing a published formula and checking with offsite data.

Using these conservative estimates of air emissions in 1996 as input to the CAP88-PC computer model, the EDE would have been only 0.11 mrem, much less than the 10-mrem limit that is specified in Title 40 C.F.R. 61.

NTS AIR QUALITY PERMIT COMPLIANCE

Compliance with air quality permits is accomplished through permit reporting and renewals, and ongoing verification of operational compliance with permit specified limitations. (See Chapter 4, Table 4.3, for a listing of active permits.) Common air pollution sources at the NTS include aggregate production, stemming activities, surface disturbances, fugitive dust from unpaved roads, fuel burning equipment, open burning, and fuel storage facilities. The 1995 Air Quality Permit Data Report was sent to the state of Nevada on February 20, 1996. This report includes aggregate production, operating hours of permitted equipment, and a report of all surface disturbances of five acres or greater. In order to provide consistency in responses, the state provided forms, to be completed, which also included calculation of actual emissions. Hourly production rates were within permit specifications for 11 facilities. NTS air quality permits limit particulate emissions to 20 percent opacity, with the exception of one permit which limits opacity to 10 percent. Certification of personnel to perform visible emission opacity evaluations is required by the state, with recertification required every six months. During 1996, two Bechtel Nevada (BN) Environmental Compliance Department personnel and operational personnel were certified and/or recertified. In 1996, these personnel performed, at a minimum, semiannual visible emission evaluations of permitted air quality point sources. When visual evaluations determine that an emission exceeds the opacity requirement, corrective action is initiated. With the completion of modifications to the Area 1 Rotary Dryer, all NTS-permitted facilities are in full compliance with opacity limits specified in the Nevada Administrative Code.

During 1996, the state of Nevada personnel conducted three inspections of NTS equipment permitted under air quality operating permits or permits to construct. A Notice of Alleged Violation was issued during a June 1996 inspection of a cement blending/holding tank at the Area 6 Cementing Services for modifying the configuration of the facility without prior approval. In July 1996, two inspections were conducted of the bulk unleaded gasoline tanks in Areas 6 and 23. The interiors of both tanks were examined in July, while empty, to inspect the new internal floating roofs and to assess the general condition of the tanks. On July 10, 1996, a state inspector returned to Area 6 to observe refilling of the tank. No problems were noted on either of the inspections.

NON-NTS OPERATIONS

Under normal conditions, the operations at the six non-NTS facilities operated by DOE/NV do not produce radioactive effluents. The six are (1) the North Las Vegas Facility (NLVF), (2) the Remote Sensing Laboratory (RSL), (3) the Special Technologies Laboratory (STL), (4) the Amador Valley Operation (AVO), (5) the Los

Alamos Operation (LAO), and (6) the Washington Aerial Measurements Operation (WAMO).

Air quality operating permits were required for three of the six non-NTS operations. There were no effluent monitoring requirements associated with these permits. Compliance for each of these specific permits is discussed below. Nineteen emission units at the Las Vegas Area Operation (LVAO), which includes the NLVF and the RSL, were regulated during 1996 under conditions of 15 permits issued by the Clark County Health District in Las Vegas, Nevada.

The STL of Santa Barbara, California, holds a permit, issued by the County of Santa Barbara, to operate a vapor degreaser. The Air Pollution Control District Permit conditions include throughput limitations and record keeping requirements.

No air permits were held or required for the AVO, LAO, or WAMO facilities in 1996.

CLEAN WATER ACT

The Federal Water Pollution Control Act, as amended by the CWA, establishes ambient water quality standards and effluent discharge limitations which are generally applicable to facilities which discharge any materials into the waters of the United States. Discharges from DOE/NV facilities are primarily regulated under the laws and regulations of the facility host states. Monitoring and reporting requirements are typically included under state or local permit requirements. A complete listing of applicable permits appears in Section 4.3. There are no National Pollutant Discharge Elimination System (NPDES) permits for the NTS, as there are no wastewater discharges to onsite or offsite surface waters.

NTS OPERATIONS

Discharges of wastewater are regulated by the state of Nevada under the Nevada Water Pollution Control Act (NRS 445.131 - 354). The state of Nevada also regulates the design, construction, and operation of wastewater collection systems and treatment works. Wastewater monitoring at the NTS was limited to sampling wastewater influents to sewage lagoons and containment ponds.

State general permit GNEV93001, which regulates the ten usable sewage treatment facilities on the NTS, was issued by the Nevada Division of Environmental Protection (NDEP), and became effective on February 1, 1994. Hydrogeological modeling utilizing site-specific soil characteristics, vadose zone monitoring, groundwater monitoring, or lining an adequate portion of the impoundments at a specific facility were all accepted by NDEP as methods to comply with the permit requirements for protection of the groundwater.

Compliance with sewage lagoon discharge permit requirements was achieved with the following exceptions:

- The organic loading limits listed in the permit were exceeded only once throughout the year. High influent flow rates were recorded for the month of February along with a higher than normal biochemical oxygen demand (BOD) concentration at the Yucca Lake facility. The organic loading limit of 8.6 kg per day was exceeded by 1.02 kg per day. Depressed areas upgradient and downgradient of the parshall flume accumulated solids. The flume was also in a submerged condition which resulted in the recording of erroneous and elevated flows with the continuous flow measuring device. An insert for the flume was installed in April, and the depressed areas were filled to resolve this problem.

- An unauthorized discharge of approximately 8,000 gal. (30 m^3) of sewage from the Area 12 Camp collection system was discovered on

September 3, 1996, by BN Nonradioactive Waste Section staff. Sewage was found flowing from a manhole located downgradient and northeast of Building 12-5 at an approximate rate of one gallon per minute. The discharge extended around 1,500 ft (457 m) from the manhole, crossing an unpaved road twice before dissipating on its north side. The partial blockage was probably caused when recent flows, containing excessive solids and previously deposited solids within the system were transported to an area in the collection system which was constructed with turns greater than 45 degrees within 100 ft (30 m). This collection system, which is intermittently used, will be flushed before future sewage flows are initiated in an attempt to prevent blockages and discharges.

Two of six primary aerated sewage lagoons at the Area 23 facility were taken out of service on February 21, 1996, to reduce operation and maintenance costs. A review of the influent flow rates for the previous CY revealed that less than 100,000 gal (379 m^3) per day as 30-day averages were being received. This facility still has supplemental capacity for existing flows, since it has a design flow of 227,000 gal. (860 m^3) per day with all six aerated ponds in service. A third aerated pond was taken out of service in July 1996, as average flow rates less than 90,000 gal (341 m^3) per day were recorded for the first and second calendar quarters of 1996.

Permanent closure of the Area 2 Camp sewage lagoons was completed on May 8, 1996. This activity was performed in accordance with directions contained in a June 9, 1995, letter from the NDEP and an outline submitted to the NDEP on May 31, 1995. A request to remove the facility from the existing state general water pollution control permit was made in a June 6, 1996, letter to the NDEP.

An insert was installed within the three-inch parshall flume at the Area 6 Yucca Lake facility on April 11, 1996. This installation eliminated inaccurate influent flow measurements and BOD sampling. An elevation drop was furnished at the downgradient edge of the flume to prevent submerged conditions. Depressed areas immediately upgradient and downgradient of the flume were filled to prevent accumulation of solids.

An evaluation to determine the best method of influent flow measuring and sampling at the Area 6 Los Alamos National Laboratory (LANL) Camp raw sewage lift station was initiated on June 10, 1996, and completed on September 11, 1996. Flow measuring with pump timers and constant volume sampling every two hours during a ten-hour work day was recommended to obtain accurate data at this site. Five samples will be taken beginning at 7:30 a.m. and ending at 3:30 p.m. to satisfy permit requirements. The NDEP approval for these methods was received on November 8, 1996.

State NDEP certification of as-built engineering drawings for the RWMS-5 sewage lagoons was received on August 27, 1996. This facility was incorporated into the state general water pollution control permit on that date and is now subject to all permit requirements and conditions.

Attempts to terminate the surface discharge from the U-12e Tunnel portal by the Defense Special Weapons Agency were unsuccessful. The flow rate is still averaging approximately seven gallons per minute and is directed to infiltration ponds via an above ground pipeline for disposal.

The NDEP issued an initial draft permit in July 1996, which was sent to permittees for a preliminary review.

The state of Nevada compliance personnel inspected the NTS sewage lagoons on February 12, 1996. No alleged notices of violation or administrative orders were issued for noncompliance at these facilities.

Arsenic at a concentration of 0.91 mg/L was found within the Area 6 Yucca Lake infiltration basins in June of 1995. The general permit requires that an investigation be performed to determine the cause of any exceedance which is ten times the Nevada drinking water standard for specific inorganic constituents of infiltration basin liquids. In January 1996, a composite sample was taken and the result suggested that the 1995 sample be classified a false positive.

NON-NTS OPERATIONS

Four permits for wastewater discharges were held by non-NTS facilities. Monitoring and reporting were performed according to specific local requirements. The NLVF self-monitoring report was submitted in October 1996. Two outfalls and the burn pit batch discharge were monitored.

The Clark County, Nevada Sanitation District wastewater permit for the RSL required biannual monitoring of two outfalls, quarterly pH and monthly septage reports. RSL monitoring reports were submitted in May and December of 1996.

The STL holds wastewater permits for the Botello Road and Ekwill Street locations. There is no required self monitoring.

No wastewater permits were held for the AVO, LAO, or WAMO facilities in 1996.

SAFE DRINKING WATER ACT

NTS OPERATIONS

The SDWA primarily addresses quality of potable water supplies through sampling and monitoring requirements for drinking water systems. The state of Nevada has enacted and enforces SDWA regulations including system operations such as operation and maintenance, water haulage, operator certification, permitting, and sampling requirements. A list of state potable water permits is shown in Table 4.4, Chapter 4.

As required under state health regulations (NAC 445.244 ff.), potable water distribution systems at the NTS are monitored for residual chlorine content and coliform bacteria. Monitoring results for 1996 are discussed in Section 7.1; there were no incidents of positive coliform.

NTS potable water distribution systems are also monitored for volatile organic compounds, inorganic compounds, synthetic organic compounds, and other water quality parameters. These monitoring results are discussed in Section 7.1. Organic compounds were not detected in any NTS potable water distribution system. Nitrate, nitrite, and fluoride samples were also collected during 1996, with all of the results being below their maximum contaminant levels.

NTS WATER HAULAGE

To accommodate the diverse and often transient field work locations at the NTS, a (substantial) water haulage program is used. To ensure potability of hauled water, water is obtained from potable water fill stands and chlorinated to obtain a residual of at least one ppm in the hauling tank. Water in the hauling tank is sampled periodically for coliform bacteria. The state of Nevada decided in 1994 that water hauling trucks should be permitted as water distribution systems. Permits were obtained again in 1996 for the three trucks listed in Chapter 4, Table 4.4. There were no positive coliform sample results in 1996.

NON-NTS OPERATIONS

All non-NTS operations are on municipal water systems and have no compliance activities under the SDWA.

RCRA

The RCRA of 1976 and the Hazardous and Solid Waste Amendments of 1984 (Title 40 C.F.R. 260-281) constitute the statutory basis for the regulation of hazardous waste and underground storage tanks.

Under Section 3006 of RCRA, the EPA may authorize states to administer and enforce hazardous waste regulations. Nevada has received such authorization and acts as the primary regulator for many DOE/NV facilities. The Federal Facilities Compliance Act (FFCA) of 1992 extends the full range of enforcement authorities in federal, state, and local laws for management of hazardous wastes to federal facilities, including the NTS. A discussion of actions regarding the FFCA at the NTS is given in Section 3.1.

NTS RCRA COMPLIANCE

In 1995, DOE/NV received a RCRA Hazardous Waste Operating Permit for operating the Area 5 Hazardous Waste Storage Unit (HWSU) and the Area 11 Explosive Ordnance Disposal (EOD) Unit. In addition, the Part B Permit application was revised to include the Mixed Waste Storage Pad (now under interim status) and updated information concerning general facility conditions. During 1996, the permit was modified to include the change in Contractor and operational changes concerning the EOD and HWSU. The permit application for the Pit 3 Mixed Waste Disposal Unit is being developed.

On January 5, 1994, the state of Nevada and DOE/NV entered into a Mutual Consent Agreement, which allowed low-level radioactive mixed wastes generated on the NTS to be moved into storage at the RWMS-5 TRU pad. This was amended in June 1994 to include environmental restoration mixed waste generated in Nevada. Waste was already in storage at this facility and will continue to be held in storage until a final determination of the proper treatment and disposal technology is established by the EPA. Under the FFCA, these mixed wastes were exempt from storage prohibitions in the Land Disposal Restrictions until October 6, 1995. The NDEP specified that this exemption would be extended through February 1996, pending negotiations towards a signed FFCA Consent Order. A Consent Order was signed, effective March 27, 1996, requiring compliance with a Site Treatment Plan (DOE 1996a), which was also finalized in March 1996. Compliance with the Consent Order exempts the NTS from potential enforcement action resulting from the mixed waste storage prohibition under RCRA.

The NDEP conducted its annual Compliance Evaluation Inspection (CEI) from May-June 1996. Several minor potential violations were identified. In its cover letter transmitting the 1996 CEI report dated September 27, 1996, the NDEP stated that it would not pursue formal enforcement proceedings against DOE or BN with respect to these potential violations.

HAZARDOUS WASTE REPORTING FOR NON-NTS OPERATIONS

LVAO submitted to DOE/NV, in February 1996 for submission to the state of Nevada, the Hazardous Waste Generator biennial report for hazardous wastes generated at the NLVF under EPA Identification Number NVD097868731. No additional reports were required in 1996. At contract transition, the existing EPA ID numbers for the AVO, STL, and LAO locations were terminated. BN obtained new numbers for AVO and STL and will operate the LAO facility as a conditionally exempt small quantity generator.

UNDERGROUND STORAGE TANKS

NTS OPERATIONS

The NTS underground storage tank (UST) program continues to meet regulatory compliance schedules for the reporting, upgrading, or removal of documented USTs. Efforts are continuing to identify undocumented USTs at the NTS. Once identified, undocumented USTs are reported to the NDEP to satisfy state regulatory reporting requirements.

During 1996, nine USTs were removed in accordance with state and federal regulations (see Table 3.1). Reportable releases were discovered with the removal of tanks at the Area 2 Bunker 300, Area 9 Bunker 300, and Area 12 B Tunnel sites.

Remedial activities are planned at each site during 1997 if funding is available.

During segmentation activities of the tank removed from the Area 26 Disassembly Building (Tank 26-2201-2), a small quantity of sludge containing radionuclides was released to the concrete pad and a small area of the adjacent soil. A minor cleanup was initiated and completed. The waste is pending disposal at the Area 6 Decontamination Facility and the Area 5 TRU Pad.

NON-NTS OPERATIONS

There were no issues involving USTs at non-NTS locations during 1996.

COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT/SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT (SARA)

In April 1996, the DOE/NV, Department of Defense, and the NDEP entered into a FFACO pursuant to Section 120(a)(4) of CERCLA and Sections 6001 and 3004(u) of RCRA to address the environmental restoration of historic contaminated sites at the NTS, parts of TTR, parts of the Nellis Air Force Range Complex, the Central Nevada Test Area, and the Project SHOAL Area. Appendix VI of the FFACO describes the strategy that will be employed to plan, implement, and complete environmental corrective action at facilities where nuclear-related operations were conducted.

EMERGENCY REPORTING AND COMMUNITY RIGHT-TO-KNOW ACT (EPCRA)

Compliance with this Act is discussed in the paragraphs below and summarized in the following checklist:

SARA Title III Reports	NTS Compliance		
EPCRA	Yes	No	Not Required
302-302: Planning Notification	x		
304: EHS Release Notification			x
311-312: MSDS/Chemical Inventory	x		
313: TRI Reporting		x	

Additional compliance activities under CERCLA/SARA for 1996 included SARA Section 312, Tier II reporting, and SARA Section 313 reporting to the state of Nevada.

In 1992, the state of Nevada combined reporting requirements for the SARA Title III, Sections 301-312 Tier II report to include information for the "Nevada Fire Marshall Division, Uniform Fire Code Materials Report." The state renamed the document the "Nevada Combined Agency Hazardous Substances Report." The 1995 Nevada Combined Agency Hazardous Substances Report for the NTS was submitted to the state on February 23, 1996, and contained information on 37 different chemicals which were above the reporting threshold.

The combined SARA Section 312, Tier II Report for the Area 5 Hazardous Materials Spill Center and Areas 5 and 6 was submitted to DOE/NV in April 1996. Ammonia and sulfur dioxide exceeded the SARA Extremely Hazardous Substances (EHS) threshold planning quantity.

In compliance with Executive Order 12856, a Toxic Release Inventory Report required by Section 313 of the SARA Title III must be provided. In calender year 1995, no chemicals over the reporting threshold were handled so no report was required in 1996.

NON-NTS TIER II REPORTING UNDER SARA TITLE III

The Nevada Combined Agency Reports for the RSL and NLVF were submitted to

DOE/NV in April 1996. There were no reportable EHS at either facility.

STATE OF NEVADA CHEMICAL CATASTROPHE PREVENTION ACT

The state of Nevada Chemical Catastrophe Prevention Act of 1992 contains regulations for facilities defined as Highly Hazardous Substance Regulated Facilities. This law requires the registration of highly hazardous substances above predetermined thresholds. There were no reportable chemicals for 1995, and therefore no reports were submitted to the state in 1996.

TOXIC SUBSTANCES CONTROL ACT

State of Nevada regulations implementing the TSCA require submittal of an annual report describing polychlorinated biphenyl (PCB) control activities. The 1995 NTS PCB annual report was transmitted to EPA and the state of Nevada on May 15, 1996. The report included the quantity and status of PCB and PCB-contaminated transformers and electrical equipment at the NTS. Also reported were the number of shipments of PCBs and PCB-contaminated items from the NTS to an EPA-approved disposal facility. Fifty-two large and five small low volume PCB capacitors remain under the management of the LANL in Area 27 of the NTS. One PCB-containing transformer was repaired and put in service at the NTS in 1996, but was later found to still contain PCBs so it was removed from service again.

FEDERAL INSECTICIDE, FUNGICIDE, AND RODENTICIDE ACT

Pesticide usage included insecticides, herbicides, and rodenticides. Insecticides were applied twice a month at the food service and storage areas. Herbicides were applied once or twice a year at NTS sewage lagoons berms. All other pesticide applications were on an as-requested basis. General-use pesticides were preferred, although restricted-use herbicides and rodenticides were used. Contract companies applied pesticides at all non-NTS facilities in 1996.

Records were maintained on all pesticides used, both general and restricted. These records will be held for at least three years. State-sponsored training materials are available for all applicators. No unusual environmental activities occurred in 1996 at the NTS relating to the Federal Insecticide, Fungicide, and Rodenticide Act.

HISTORIC PRESERVATION

The National Historic Preservation Act (NHPA) requires federal agencies to consider any impact of their actions on cultural resources (archaeological sites, historic sites, historic structures, and traditional cultural properties) eligible for listing in the National Register (NR) of Historic Places. Accordingly, cultural resource surveys and other studies are conducted to assess any impacts NTS operations may have on such resources. When cultural resources eligible for the NR are found in a project area, and they cannot be avoided, plans are written for programs to recover data to mitigate the effects of the projects on these sites. Technical reports contain the results of these data recovery programs. One such report for archaeological data recovery at a site in Area 29 was completed and distributed in 1996.

The NHPA also requires that federal agencies inventory the cultural resources under their jurisdiction. In 1994, a survey of archaeological sites near four springs on the NTS was conducted. The results of this inventory were presented in a 1996 draft technical report that is in review. Additional inventory activities were conducted at rock art locations in Fortymile Canyon during May and December of 1996.

The American Indian Religious Freedom Act (AIRFA) directs federal agencies to consult with Native Americans to protect their right to exercise their traditional religions. In 1989, the NTS AIRFA Compliance Program was established as an aid in the development and implementation of a consultation plan, designed to solicit Native American comments regarding the effects of DOE/NV activities on Native American historic properties and Native American religions. The Native American Graves Protection and Repatriation Act (NAGPRA) requires federal agencies to consult with Native Americans regarding items in their artifact collections which may be associated funerary items, human remains, sacred objects, or objects of cultural patrimony. After conducting interviews with tribal elders, a report on the NAGPRA consultation was issued and used to guide decisions regarding the appropriate items to return to the tribal groups. In 1996, more than 200 archaeological items were returned to 17 Native American tribal groups. Several other items have been removed from the collection and, at the request of the tribes, temporarily left in storage.

As part of the Programmatic Agreement with the Nevada State Historic Preservation Office (NSHPO) and the Advisory Council on Historic Preservation, work continued on the Long Range Study Plan for Pahute and Rainier Mesas. The objective of the plan is to study a geographically representative sample of all cultural resources on Pahute and Rainier Mesas. A modification of this plan, known as Attachment A, requires a summary and synthesis of existing archaeological data from the Mesas and the preparation of three professional papers over a two-to three-year period. In 1995, a draft of the first paper on Cultural Chronology was completed. A draft of the Adaptive Strategies paper was completed in 1996 and reviewed externally. A paper on Environmental Change is in preparation. In 1996, one cultural resources survey was conducted on Pahute Mesa that located one archaeological site which was determined to be eligible for the NR. During the tenure of this agreement, no data recovery will be undertaken on the Mesas.

THREATENED AND ENDANGERED SPECIES PROTECTION

The ESA (Title 50 C.F.R. 17.11) requires federal agencies to insure that their actions do not jeopardize the continued existence of federally listed endangered or threatened species or their critical habitat. The American peregrine falcon is the only endangered species and the desert tortoise and bald eagle are the only threatened species which occur on the NTS. No threatened or endangered plants are known to occur on the site. Consultation with the USFWS resulted in receipt of a non-jeopardy Biological Opinion in April 1991 for planned activities at Fortymile Canyon on the NTS for a nine-year period and in May 1992 for planned activities at the NTS for a five-year period. Another non-jeopardy Biological Opinion was issued in August 1996 for planned activities at the NTS for a ten-year period.

The Desert Tortoise Compliance Program implemented the terms and conditions of the USFWS Biological Opinion and documented compliance actions taken by DOE/NV. The terms and conditions which were implemented in 1996 included the following: (1) tortoise clearance surveys for six projects (conducted within 24 hours from the start of project construction), (2) onsite monitoring of construction for three projects when heavy equipment was being used, (3) quarterly monitoring of tortoise-proof fencing around the Mercury grenade range and around sewage treatment and sanitary landfill facilities, (4) transect surveys around one project site believed to be outside suitable tortoise habitat, and (5) preparation of an annual compliance report for NTS activities that were conducted between August 1, 1996, and August 31, 1996, and submitted to USFWS in September.

From April through October, over 180 sample transects were surveyed on the NTS for the presence of desert tortoises or their sign in areas of unknown tortoise density. Areas of "none to very low" tortoise abundance will be identified by the sample transect data. These areas will not need to be surveyed prior to land-disturbing activities according to the new 1996 USFWS Biological Opinion. Results of these surveys will be analyzed and presented to the USFWS for their concurrence in 1997.

There is one bird (mountain plover [*Charadrius montanus*]) and two plant species (Clokey's eggvetch [*Astragalus oophorus* var. *clokeyanus*]), and Blue Diamond cholla [*Opuntia whipplei* var. *multigeniculata*]) which are known or expected to exist on the NTS that are candidates for listing by the USFWS under the ESA. In 1996, ten preconstruction biological surveys were conducted at proposed construction sites to determine the presence of these species. Survey results and mitigation recommendations were documented in survey reports. Field surveys to determine the presence and distribution of the two plant species on the NTS were also conducted in the spring and specimens of these plants were collected for positive identification. It was not possible in 1996 to determine these plants' distribution on the NTS because growing conditions were poor. Plants were either absent, or if they were present, no flowers or fruits were produced. In February, the USFWS removed 11 animals and 12 plants that are found on the NTS from the candidate species list.

EXECUTIVE ORDER 11988, FLOODPLAIN MANAGEMENT

There were no projects in 1996 which required consultation for floodplain management. NTS design criteria do not specifically address floodplain management; however, all projects are reviewed for areas which would be affected by a 100-year flood pursuant to DOE Order 6430.1A.

EXECUTIVE ORDER 11990, PROTECTION OF WETLANDS

There were no projects in 1996 which required consultation for protection of wetlands. NTS design criteria do not specifically address protection of wetlands; however, all projects are reviewed pursuant to the requirements of DOE Order 5400.1.

Field surveys were conducted from June through December to identify those natural NTS springs, seeps, tanks, and playas which could be designated by the U.S. Army Corps of Engineers as jurisdictional wetlands. A summary report of the survey findings will be completed in 1997.

EXECUTIVE ORDER 12856, FEDERAL COMPLIANCE WITH RIGHT-TO-KNOW LAWS AND POLLUTION PREVENTION REQUIREMENTS

Actions taken to comply with the requirements of this Order are discussed in Section 3.2.

3.2 CURRENT ENVIRONMENTAL COMPLIANCE ISSUES AND ACTIONS

There were numerous activities and actions relating to environmental compliance issues in 1996. These activities and actions are discussed below grouped by general area of applicability.

CLEAN AIR ACT

Modifications to the Area 1 Rotary Dryer that were completed in 1996 included the installation of new heat tiles, modifications to the storage silo, and installation of an additional baghouse. These modifications will enable the rotary dryer to operate in compliance with state opacity limits.

Internal floating lids were installed in the Areas 6 and 23 bulk unleaded gasoline tanks during June and July of 1996. The lids are expected to greatly reduce emissions of volatile organic compounds.

Under Title V, Part 70 of the CAA Amendments, all owners or operators of Part 70 sources must pay annual fees that are sufficient to cover costs of state operating permit programs. Annual maintenance and emissions fees for the NTS in 1995 were $17,500. In 1996, the fee schedule was revised to more fairly distribute the fees to those facilities contributing the greatest amount of emissions. Annual fees for facilities generating less than 25 tons of emissions were reduced from $3.36/ton to $0. Annual maintenance fees for construction-related activities were reduced from $75 per source to $0. The total actual emissions for the NTS for 1996 were only 6.5 tons, resulting in no maintenance and emissions fees.

To offset reductions in maintenance and emissions fees, permit fees were increased. The fees for a new Class II permit, renewal, or modification were increased from $250 to $1,800, $700, and $900, respectively. A Class I permit will cost $14,500, with fees of $7,500 and $1,500 for significant and minor modifications to the permit, respectively.

During a state inspection in June 1996, a Notice of Alleged Violation was issued for construction of a cement blending/holding tank at the Area 6 Cementing Services. Construction of the tank had been initiated after submitting a permit modification, but prior to receiving the modified permit. An Administrative Penalty of $1,000.00 was issued for the violation and paid by BN, although construction had commenced prior to BN assuming the management and operation contract for the NTS in January 1996.

CLEAN WATER ACT

A NPDES permit may be issued for the NLVF as part of the state implementation of the federal storm water discharge regulations. The federal storm water regulations identify regulated facilities by a Standard Industrial Classification (SIC) code. A survey conducted in accordance with guidance received from EPA Region 9 and the Office of Management and Budget revealed that the primary SIC code for the NLVF suggested that it was not an activity subject to those regulations. A survey report was prepared and submitted to the state of Nevada requesting a formal determination on the regulatory status of the NLVF. This is still pending.

Dewatering of septage and wintertime portable toilet waste was conducted in the Area 25 Engine Test Stand Number one sewage lagoon and two Area 12 sewage lagoon secondary infiltration basins during 1996, and will be used again in 1997 for this application.

A total of 12 active septic tank systems are in service on the NTS. Two active holding tanks which require replacement with an approved system are still in service on the NTS. Nine additional septic tank systems serve unoccupied buildings but will remain on active status unless permanently closed. Facility Managers have been informed of deficiencies noted during inspections.

Construction of the Area 23 Infiltration Basin Groundwater Monitoring Well was completed on February 27, 1996. Installation of a pump with cable and discharge piping and development of a completion report are still required to finish the project. Funding for purchase and installation of this equipment and material has been requested for FY97. The monitoring well must be functional by the expiration date of the permit, January 31, 1999, to comply with groundwater protection requirements contained in state general permit GNEV93001.

The installation of engineered liners within the Area 22 Gate 100 sewage lagoons was initiated on July 1, 1996 and completed on October 21, 1996. This facility is now in compliance with groundwater protection requirements contained in the state general water pollution control permit. Raw sewage which was directed to the secondary pond for construction within the primary lagoons still must be transferred back to the primaries when staff becomes available.

A report verifying the existence of an engineered liner in the Area 12 primary sewage lagoons was submitted to the NDEP on September 6, 1996. Inspections and soil sampling activities within the lagoons revealed that a minimum six inch thick engineered liner was installed in all the primary lagoons to a vertical depth of three feet. Analytical results indicate that the saturated hydraulic conductivity of the liners is 5.0 x 10^{-7} cm/sec or less. The NDEP concurred with the conclusions of the report and stipulated compliance with groundwater protection requirements in the state general permit for primary lagoon depths to three feet.

A bypass sewer line for the Area 25 Central Support primary sewage lagoon was constructed from November 12 through November 18 as a result of joint efforts between the BN Waste Management Project/Technical Support (BN/WMP/TS) and U.S. Department of Energy/Yucca Mountain Site Characterization Office (DOE/YMSCO) staffs. This line will provide for operational flexibility and in-situ primary lagoon infiltration rate measurements. Effectiveness of biological clogging on the existing soils will be documented before evaluations and conceptual designs on options for compliance with groundwater protection program are initiated. Saturated hydraulic conductivity testing of soils sampled from the bottom of the secondary lagoon with Yucca Lake secondary lagoon contents will be performed to verify the infiltration rate determined through in-situ measurements. BN/WMP/TS will continue to assist DOE/YMSCO in the design and construction of improvements at this facility if they are needed to attain permit compliance.

Funding for design of engineered liner installation within the Area 25 Reactor Control Point sewage lagoons was received from DOE/Asset Management Division in October of 1996. Engineering drawings for this installation have been completed but still require approval from the lessee and DOE. Funding for construction still must be secured by the lessee of the site after approval of the drawings.

The Area 25 Test Cell C will be taken out of service during the first quarter of 1997 to comply with SDWA regulations. No action will be required at the sewage lagoons to comply with the permit requirements at this time. Improvements will be implemented if use of the facility is needed in the future.

Soil investigations within and around the Yucca Lake secondary infiltration basins have demonstrated that existing pond bottom soils possess a saturated hydraulic conductivity which is equivalent to an engineered liner. Primary lagoons at this facility have been lined. A report is in preparation and will be submitted to the NDEP through DOE/EPD to address groundwater protection requirements at this site. No further action regarding this issue will be necessary if the NDEP concurs with the conclusions in the report and acknowledges the presence of natural barriers as in the Area 12 primary lagoons.

Soils investigations within and around the LANL Camp secondary infiltration basins are being performed in an attempt to demonstrate that existing bottom soils possess a saturated hydraulic conductivity which approaches or is equivalent to that of an engineered liner. Primary treatment lagoons at these facilities have been lined. Treated sewage used in saturated hydraulic conductivity tests will reduce the lower conductivity values of the fine soils present within the secondary basins. A report will be submitted to obtain compliance with groundwater protection requirements if an adequate barrier is illustrated within the existing basin construction.

Funding for design and installation of an engineered liner in the Area 6 Device Assembly Facility primary sewage lagoon was requested for FY97. The most feasible and cost effective method to comply with groundwater protection requirements at this site is to line the primary lagoon to attain full containment with existing flow rates.

Samples from the secondary lagoon bottom could not be obtained to perform preliminary soils investigations due to the preponderance of rocks and cobbles. Experience in performing in-situ infiltration rate testing of primary lagoons at the NTS indicates that existing soils would not attain acceptable infiltration rates to represent a natural barrier caused by biological plugging. The costs of hydrogeological modeling with site-specific soil characterization and installation of a groundwater monitoring well is currently more than the costs that would be incurred by lining the primary lagoon. The wetting front may have extended beyond the realistic depths of soil sampling or vadose zone moisture monitoring. Drilling activities would be more difficult in the local rocky soils.

Construction of the RWMS-5 sewage collection system and lagoons was completed in September 1995. Engineered liners have been installed within both primary lagoons and both secondary basins to comply with the groundwater protection requirements in the state general permit. As-built certification and sewage lagoon specifications were forwarded to the NDEP for approval and addendum to the general permit. The NDEP approved these on August 27, 1996.

SAFE DRINKING WATER ACT

Engineering design has been completed on approximately 50 buildings or facilities at the NTS requiring retrofit through installation of backflow prevention devices on water service lines. These facilities require over 110 separate installations. As of the end of 1996, work has been completed on all but one of the facilities.

The state conducted a vulnerability assessment early in 1996. Because of good operation of the system, the findings of that survey resulted in specific waivers of sampling and sampling frequencies that will reduce the operating costs of the water system.

In 1995, the state implemented a requirement to sample for synthetic organic compounds (SOCs). About 98 percent of the new requirements were met and the remainder were addressed in 1996. Since all results were below the reportable concentrations, in the vulnerability assessment report, the state agreed that SOC sampling could be waived in the third and fourth quarters of 1996 and revert to a ten-year cycle.

During 1996, several system improvements were made. A booster pump and two storage tanks were installed at Well 4A in Area 6. One new storage tank was brought online at Well UE-16d and in Mercury. The overflow/drain lines for storage tanks at Wells J-11 and J-13 were rerouted to correct a previous inspection deficiency. Lastly, approximately ten miles of water line was installed between the Well 5A booster pump and the Well 4A booster pump, which thus connected the water distribution systems servicing Areas 6 and 23.

There was a sanitary survey of the water distribution systems by the Nevada Bureau of Health Service during 1996 that resulted in several recommendations and four requirements. The four identified requirements were met by the end of 1996.

COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT

Other than the reporting covered in Section 3.1, there is no formal CERCLA program at the NTS. The FFACO with the state may preclude the NTS from being placed on the National Priority List. The FFACO will take more of a RCRA approach in remediating environmental problems.

HISTORIC PRESERVATION

Historic preservation studies and surveys are conducted by the Desert Research Institute (DRI), University and Community

College System of Nevada. In 1996, 23 surveys were conducted for historic properties on the NTS, and reports on the findings were prepared. These surveys identified 24 prehistoric and historic archaeological sites. Through consultation with the NSHPO, eight of these sites were considered eligible for the NR and no determination could be made for one. Work continued on historic structures associated with early NTS activities. The Historic American Building Survey data, required by the National Park Service for the Japanese Village, was accepted and the documents were forwarded to the Library of Congress. A study of the BILBY crater area documented both atmospheric and underground nuclear testing activities. Two buildings associated with nuclear rocket development were the focus of intensive research. Both were determined to be eligible for the NR. However, only the activities at E-MAD were determined to adversely affect the eligibility of the building, requiring Historic American Engineering Records documentation to be prepared in 1997.

Other efforts in 1996, included administration of the cultural resources program on the NTS, preparing management objectives and plans and promoting public relations and communications concerning the NTS archaeology and cultural resources program.

To comply with federal regulations in Title 36 C.F.R. 79, a multi-phase program is in progress to upgrade the NTS archaeological collection and archives. In 1996, DRI continued the piece-by-piece inventory of the lithic artifacts in the collection. More than 90 percent of the nearly 500,000 artifacts in the collection have been inventoried and repackaged according to federal requirements.

POLLUTION PREVENTION AND WASTE MINIMIZATION

IMPLEMENTATION

BN has published a Waste Minimization and Site Pollution Prevention Program Plan for the NTS and NLVFs in accordance with DOE/NV and DOE/HQ requirements. This plan is a guidance document utilized to reduce waste generation and any potential pollutant releases to the environment. BN reviews the plan annually and revises accordingly, incorporating the most current waste minimization requirements and Executive Orders. This allows for the establishment of ongoing goals for further improvements and provides for increased protection of public health and the environment, as well as:

- Reduced employee exposure.
- Reduced waste management and compliance costs.
- Reduced resource usage.
- Reduced inventories of chemicals that require reporting under the SARA and the EPA 33/50 Pollution Program.
- Reduced exposure to civil and criminal liabilities under environmental laws.
- Reduced overhead costs and increased productivity through improved work processes and greater awareness.

WASTE MINIMIZATION

All DOE/NV quantitative goals and deliverables for 1996 were met or exceeded. The total NTS hazardous waste generated was reduced in 1996 compared to waste generated in 1995. The NTS program recycles and returns to productive use significant quantities of materials.

The BN Just-in-Time (JIT) supply system continues to account for nearly 90 percent of all procurement actions, providing most common use items, e.g., cleansers and lubricants, to all NTS agencies. This program has significantly reduced on-hand stores, thereby reducing administrative and handling costs, and significantly reducing waste generation due to expiration of shelf life or overstock conditions. All parties benefit in reduced waste disposal and increased productivity.

PROCUREMENT CONTROLS

The purchase of any item that requires a Material Safety Data Sheet (MSDS), including JIT purchase requisitions, is screened by the Industrial Hygiene Section and Waste Management Project (WMP) personnel. This determines the need for the hazardous material request and the review of MSDSs for products not being purchased within the BN JIT system. These products may be approved or disapproved. The approval process relies on the health, safety, and environmental issues related to the product.

Purchase requisitions for the procurement of materials outside the JIT are reviewed by the WMP and the Industrial Hygiene Section when originated. If the waste generated by these materials has the potential to be regulated under CERCLA/RCRA, or has a potential of causing harm to individuals or the environment, the reviewers will approve that purchase only if there is no approved substitute for the product and the use of the product cannot be prevented by process modification.

AFFIRMATIVE PROCUREMENT

The DOE/NV and BN established an Affirmative Procurement Program to comply with the requirements of Executive Order 12873 to procure products containing recovered materials. This program focuses on paper, lubricating oil, tires, building insulation, and fly ash. In FY96, this program had a 2 percent decrease in the use of fly ash and a 10 percent decrease in the use of recycled building insulation, due to the reduction in construction projects on the NTS. BN procured 75.1 percent of non-General Services Administration paper, containing a minimum of 20 percent post consumer content; 1.3 percent of retread tires; and 98.5 percent of re-refined lubricating oils.

CHLOROFLUOROCARBON CONTROL

EPA certified chlorofluorocarbon (Freon) recycling equipment is used at all of the NTS service and maintenance centers. The Freon is reclaimed, recycled, and reused, therefore eliminating ozone depleting substance emissions into the atmosphere. Service personnel are trained and certified according to Section 608 of the 1990 CAA. Approximately 35 service personnel are currently certified to operate Freon recycling equipment. Additional EPA-certified equipment has been procured to assist in the systematic changeover of DOE motor vehicles from the use of R12 to R134a. The equipment reduces the use of ozone depleting chemicals and complies with EPA requirements. Approximately 25 percent of the DOE/NV fleet has been converted from R12 to R134a.

TRAINING

BN is committed to implementing an effective waste minimization, pollution prevention awareness, and recycling program. Every practical effort will be implemented to educate all employees in pollution prevention. Employee education will be accomplished through formal training, input from articles and newsletters, and other awareness program strategies.

Management and employees working in the environmental arena are instructed in BN waste minimization and pollution prevention policies and procedures. The level of instruction qualifies personnel to perform pollution prevention tasks. Environmental awareness training is presented to managers and employees, on an as needed basis.

PRODUCT SUBSTITUTION

BN substitutes chemicals to reduce hazardous waste and the potential release into the environment. In addition to the Freon substitution listed above, the following substitutions were made:

- Seventy-four mercury thermometers were replaced with electronic temperature probes and digital readouts, eliminating 2,288 g of mercury in the work place.
- The BN Fabricated Systems Support Section was utilizing a vapor degreaser

with 1,1,1-trichloroethane (TCE) to clean electronic circuit boards. The TCE is an ozone-depleting chemical and known carcinogen. A state-of-the art aqueous cleaning system was purchased, which allows the introduction of an environmentally-friendlier product. This eliminated the use of 90 gal of TCE annually.

- The Aircraft Maintenance Section at the RSL has replaced Safety Kleen solvent with Voltz II. The synthetic solvent is environmentally safe and is managed as non-hazardous waste.

POLLUTION PREVENTION OPPORTUNITY ASSESSMENTS (PPOAs)

BN implements waste minimization options involving source reduction and elimination via product substitution, reuse, and recycle. These efforts reduce the total volume of hazardous, radioactive, mixed, and nonhazardous solid waste streams generated and disposed of. Waste streams are carefully reviewed to identify opportunities for reducing or eliminating the volume and toxicity of wastes generated through PPOAs.

BN implements pollution prevention options in accordance with the Pollution Prevention Act hierarchy that states the following criteria should be implemented to prevent or reduce pollution at the source wherever feasible:

- Recycle wastes in an environmentally acceptable manner.
- Reuse if applicable.
- Treat wastes that cannot feasibly be reused or recycled.
- Dispose of wastes, only as a last resort.

Pollution prevention is the DOE's preferred approach to environmental management. BN's activities have reduced or eliminated hazardous chemicals and generated cost savings/avoidance in disposal, product, energy, and labor costs. Progress toward meeting mission objectives poses continuing challenges and opportunities for pollution prevention to reduce future risks and costs associated with managing wastes and pollutants.

The sitewide (NTS and NLVFs) waste reduction results have come from formal processes such as PPOAs, a Return on Investment (ROI) Project, solid and liquid waste recycling, affirmative procurement, and from employees knowledgeable with processes which generate waste or use hazardous chemicals.

PPOA is a systematic, planned, and documented procedure with the objective of identifying methods that reduce energy consumption or eliminate waste streams. The technical and economical feasibility of options are evaluated, and the most promising options are selected for implementation. Options include product substitution, cross contamination control, process change (i.e., use of different equipment or procedure), and onsite recycling. PPOAs have been conducted and implemented on items listed below.

To improve the recovery and reuse of antifreeze at the NTS Fleet Operations, a recycling machine was purchased, and a closed-loop, bulk-recycling system was manufactured onsite. The recycling unit makes the process efficient, reduces antifreeze disposal costs, and minimizes the purchase of antifreeze in the future. With the current scope-of-work at the NTS, approximately 1,000 gal will be recycled annually. If the antifreeze had to be managed and disposed of as hazardous waste, the annual cost for disposal would exceed $40,000. (Recycling/Reuse Process, PPOA.)

Two PPOAs were conducted at the RSL Photo Lab which resulted in process modification with an annual cost saving of $130,000. The photo lab utilizes a computerized video imaging system (CVIS) with dedicated enlargers and paper processors to analyze color negatives containing imagery for documentation, scientific, and publication applications, and to expose and develop the associated color prints. The CVIS and the print processors and their associated waste streams were the focal point of one PPOA. The RSL's Photo/Video Section also processes numerous types of 35-mm and 120-mm color print negative films through a washless mini-lab consisting of a film and a paper processor. The washless mini-lab and associated equipment are packaged in a self-contained transport pod for emergency response deployment occurrences. The film and print processes and their associated waste streams were the focal points of the second PPOA. (Process Improvement and Modification.)

A PPOA was performed on the Special Technologies printed circuit (PC) laboratory. The most viable recommendation was to decommission the PC Lab and outsource the fabrication of the PC boards. This action decreases the Special Technologies Laboratory Facility Industrial Wastewater Discharge Permit from a Class III to a Class II. The annual sampling requirements for the facility and regulators are reduced because regulatory requirements are less stringent for a Class II Permit. Disposal costs are reduced, a hazardous waste stream is eliminated, liability to BN is reduced, and the work environment is greatly improved. The vacated floor space is available for other functions. The purchase of 13 chemicals is eliminated, and the disposal of 573 gal of chemicals ceased, for an annual cost savings of $12,076.

The NLVF has 80 evaporative coolers, with a standard system discharging 4,050 gal of water per month. Cooler Guard was purchased and placed in the cooler reservoirs. This prevents build-up, extends pad life by a factor of three, and reduces maintenance costs. State-of-the-art bleed-off timers were installed in 14 cooler reservoirs, which will reduce water usage by at least 65 percent and enhance the cooling process. (Process Modification, PPOA.)

RETURN ON INVESTMENT (ROI)

The ROI program was initiated to demonstrate the economic benefit of implementing pollution prevention projects and focus on those with the potential for reducing operational costs. The ROI program is based upon total cost savings achieved across all DOE organizations compared to the dollars spent to implement the project. The ROI project listed below has been implemented and saves $30,000 in operational costs annually.

Chillers are used to cool the RSL's main facility. A hot plate and frame heat exchanger were installed between the condenser water and chilled water system. This provides "tower free" cooling during intermediate weather. The cost to retrofit the chiller was $107,000, with the energy saving pay-back period of three-and-a-half-years. (Retrofit Process, Life Cycle Cost Analysis.)

SOLID WASTE RECYCLING

The solid waste recycling program (high-grade paper, mixed paper, cardboard, and aluminum cans) at the NLVF is combined with the shredding of Operations Security (OPSEC) sensitive correspondence. During FY96, 364,000 lb of paper was redeemed for recycling, which included 103,000 lb of shredded OPSEC paper.

ENERGY-EFFICIENT PROJECTS

New T-8 fluorescent tubes and electronic ballasts were purchased for the NLVF. Consumption of electricity will be reduced, saving $8,515 annually with a pay-back period of 2.5 years.

Solar screens were installed on the windows of the B-3 facility at the NLVF. The screens reduced the consumption of electricity by 17,170 kWh/yr for a cost avoidance of $1,128 and a pay-back period of three years.

REPORTS

The Health Hazard Inventory database system is utilized by the Industrial Hygiene Department to track chemicals in the workplace and provide information used to author DOE/HQ, DOE/NV, local, state, and federal reports. Medgate software was purchased and installed to enhance the system. This process improvement enables the NTS to merge with the other locations using one system for gathering information to improve reports and makes it less costly to generate reports.

The SARA Section 313 chemical usage report and the 33-50 TRI Program Priority chemical usage report for CY95 were submitted to DOE/NV on May 20, 1996.

The 1995 Annual Report on Waste Generation and Waste Minimization Progress was submitted to DOE in September 1996, in accordance with the requirements of DOE Order 5400.1, "General Environmental Protection Program."

RECYCLING

BN has EPA-certified Freon recycling systems capable of capturing and regenerating Freon to be reused in the facility air conditioning systems. Other recycling activities are listed in Table 3.2.

SOLID/SANITARY WASTE

During 1996, sanitary landfills were operated in Areas 9 and 23. The amount of material disposed of in each is provided in Chapter 7.0, Table 7.6.

EPA regulations promulgated in 1991 required that Class II municipal solid waste landfills (i.e., those receiving less than 20 T/day of waste) be closed by October 5, 1995 (later delayed by two years). As the result of an agreement with the NDEP Bureau of Federal Facilities (NDEP/BoFF), the Class II landfill at U-10c Crater in Area 9 was closed on October 5, 1995, for retrofit as a Class III Site. The retrofit consisted of the installment of a barrier layer of at least four feet of native soil to segregate the different waste types and to inhibit leachate transport to the lower waste zone. In addition, five neutron monitoring tubes were installed in the barrier layer to monitor possible leachate production and water activity. Upon the NDEP approval of the installed barrier and operating plan, U-10c Crater was reopened in January 1996 as a Class III Site for the disposal of industrial solid waste and other inert waste. An application for a permit to operate U-10c Crater as a Class III industrial solid waste disposal site was submitted to the NDEP/BoFF in May 1996. The Class III permit application was revised and resubmitted in August 1996 in response to informal comments provided by the NDEP/BoFF. An application for a permit to operate the Area 23 landfill as a Class II solid waste disposal site was submitted to the NDEP/BoFF in October 1996.

Table 7.6 in Chapter 7 gives the amount of hydrocarbon contaminated soil disposed of in the Area 6 landfill in 1996. An application for a permit to operate the Area 6 hydrocarbon landfill as a Class III solid waste disposal site was submitted to the NDEP/BoFF in March 1996. Upon receipt of verbal comments from the NDEP/BoFF, a revised application was submitted in April 1996, followed by the receipt of a Notification of Completeness from the NDEP/BoFF in May 1996. An evaluation of the merits of the application was conducted and, as a result, minor changes were incorporated in the application document. A copy of the revised permit application was submitted to the NDEP/BoFF in August 1996.

Eleven inactive landfills that required closure according to solid waste regulations promulgated prior to 1991 have been identified by the NDEP/BoFF. Ten of the 11 Corrective Action Sites have been closed, and a closure report for each of the sites has been submitted to the NDEP/BoFF. The closure report for each of these ten sites includes identification of any post-closure monitoring requirements (including future reporting of such activities) and certification that each has been closed in accordance with the approved closure plan or corrective action plan. The closure report also includes certification that the metes and bounds of the Corrective Action Sites have been appropriately noted in the land withdrawal records as "land use restricted." These ten sites are subject to post-closure monitoring (inspections) and reporting for a minimum of five years.

The eleventh Corrective Action Site, U-3aus Crater, was removed from permanent closure consideration because of its remaining unused capacity and potential for future use as a solid waste disposal site. This site has been placed in Appendix II of the FFACO.

The NTS Cleanup Project, initiated in 1994, is an activity devised to remove and dispose or recycle, where applicable, nonhazardous debris and material and readily identify hazardous debris and material. Approximately 128,700 lb of solid waste was removed from Area 2 and properly disposed of in 1996. Also, 8,988 lb of lead materials and 16,720 lb of electrical cable were delivered to the NTS Salvage Yard for recycling and reclamation. NTS cleanup activity in Area 2 will continue in 1997 as funding and manpower become available.

ENVIRONMENTAL RESTORATION/REMEDIATION ACTIVITIES

The NTS has an ongoing Environmental Restoration Program (ERP) for the characterization and restoration of contaminated facilities or areas. In 1996, characterization and restoration activities associated with the ERP included:

- Post-closure monitoring, of the Mercury Landfill Hazardous Waste Trenches RCRA Closure Unit, was conducted on a quarterly basis for soil moisture. The covers are performing as designed with no releases occurring. Maintenance is anticipated in 1997 to seal the neutron tubes outside of the covers to prevent infiltration of water.

- Post-closure monitoring of the U-3fi Injection Well RCRA Closure Unit was conducted, on a monthly basis, for soil moisture from January to July, and quarterly thereafter, to establish a baseline. A change in the monitoring from volumetric moisture content to neutron counts was approved by the NDEP.

- Nine underground storage tanks were removed under the Environmental Restoration Program. All tank contents were removed and properly disposed, and the soil around the tanks was sampled for proper site closure.

- Closure of the Project SHOAL access shaft was completed to meet a DOE/NV milestone. The approximately 1,100-ft deep shaft was backfilled with screened granite from the existing muckpile with the concurrence of two state of Nevada regulatory divisions. The Project SHOAL area is located approximately 170 mi (274 km) northwest of the NTS.

- The Area 6 Decontamination Pond RCRA Closure Unit characterization was initiated. A ramp was constructed for drill rig access into the pond area. The characterization report, closure plan, and closure activities are planned for 1997.

- The Area 2 Bitcutter Shop and Lawrence Livermore National Laboratory (LLNL) Post Shot Containment Building Injection Wells RCRA Closure Unit were closed on September 27, 1996, to meet a DOE/NV milestone. The Bitcutter Shop injection well was closed in place without monitoring requirements. The LLNL Post Shot Containment Building Injection Well was cleaned and closed.

- The Area 25 Jr. Hot Cell disassembled materials were stored in a Radiological Management Area and monitored on a weekly basis. Attempts to locate a "party" interested in the hot cell were not successful. A sampling and analysis plan will be prepared and implemented in 1997 to evaluate potential disposal options.

- A characterization report was prepared for the Area 15 EPA Farm. Preparation of the Corrective Action Plan was temporarily halted because funding was reallocated to the Decommissioning and Decontamination activities listed next.

- Characterization of the Area 25 E-MAD Building was initiated as part of the NTS Decommissioning and Decontamination activities. Characterization and decontamination activities are anticipated to continue in 1997 for potential utilization of the facility by Kistler Aerospace.

- The Area 12 Fleet Operations Steam Cleaning Discharge Area characterization was completed. The Corrective Action Decision Document and Corrective Action Plan will be prepared and transmitted to the NDEP for concurrence during 1997. Remedial activities are planned for 1997.

- Characterization of the Area 6 Steam Cleaning Effluent Ponds RCRA Closure Unit was completed. Approximately 50 yd^3 of non-hazardous hydrocarbon and 70 yd^3 of hazardous soil were disposed of from the characterization activities. The Corrective Action Decision Document, Corrective Action Plan, and implementation of closure activities are planned for 1997.

- Work began in June 1996, on a process for removing plutonium contamination from the soil, at the DOUBLE TRACKS site, on the Nellis Air Force Range Complex. This activity was described in Environmental Assessment DOE/EA-1136, which had a Finding of No Significant Impact determination in March 1996. The contaminated surface soil was removed and stockpiled. The stockpiled soil was bagged and then trucked to Area 3 low-level waste site for disposal. The DOUBLE TRACKS site that was disturbed was stabilized with a short-term chemical stabilizer and reseeded in the fall as specified in the reclamation plan for the site. An irrigation study was completed at field trial plots located adjacent to the DOUBLE TRACKS site to evaluate the effectiveness of different irrigation strategies in reestablishing native plants. Information from these plots was used in designing the irrigation system and irrigation levels for the final revegetation efforts, at DOUBLE TRACKS, scheduled for winter and spring of 1997.

Also during 1996, one Corrective Action Unit under the FFACO, which described 23 abandoned lead sites at the NTS, was closed because all the lead sites were remediated; most of the material was recycled.

RADIATION PROTECTION

NTS OPERATIONS

Redesign of the environmental surveillance networks on the NTS during 1995 resulted in a reduction of monitoring costs while maintaining necessary and sufficient coverage. Results of this monitoring, during 1996, indicated full compliance with the radiation exposure guidelines of DOE Order 5400.5, "Radiation Protection of the Public and the Environment", and the Title 40 C.F.R. 141 National Primary Drinking Water Regulations. Onsite air monitoring results showed average annual concentrations ranging from 0.008 percent of the DOE Order 5400.5 guidelines for ^{85}Kr in air to 2.6 percent of the guidelines for $^{239+240}Pu$ in air. Drinking water supplies on the NTS contained less than 0.001 percent of the DOE Order 5400.5 guideline and less than 0.004 percent of the National Primary Drinking Water Regulation for tritium. Supply wells contained 0.0 percent of the DOE Order 5400.5 guideline for $^{239+240}Pu$.

NON-NTS BN OPERATIONS

Results of environmental monitoring at the off-NTS operations performing radiological work during 1996 indicate full compliance with the radiation exposure guidelines of DOE Order 5400.5 and Title 10 C.F.R. 835. No radioactive or nonradioactive surface water/liquid discharges, subsurface discharges through leaching, leaking, seepage into the soil column, well disposal, or burial occurred at any of the BN operations. Use of radioactive materials is primarily limited to sealed sources; however, unsealed tritium is used in some operations. A small seepage of tritium into the air at the NLVF Atlas Building (reported in 1995) continued during 1996. Facilities which use radioactive sources or radiation producing equipment, with the potential to expose the general population outside the property line to direct radiation, are: STL during the operation of the sealed tube neutron generator or during operation of the Febetron; the RSL at Nellis Air Force Base; and the Atlas, NLVF A-1 Source Range. Sealed sources are tested every six months to assure there is no leakage of radioactive material. Operation of any radiation generating devices is controlled by BN procedures. At least two thermoluminescent dosimeters (TLDs) are at the fence line on each side of these facilities that are exchanged quarterly with additional control TLDs kept in a shielded safe. The TLD results were consistent with previous data indicating no exposures to the public from any of the monitored facilities.

ENVIRONMENTAL COMPLIANCE AUDITS

In March 1993, an environmental compliance assessment was conducted by Reynolds Electrical & Engineering Co., Inc. (REECo) of all active REECo facilities and work sites at the NTS. Numerous deficiencies were corrected at the time of the assessment. Those deficiencies which were not correctable were assigned a system deficiency number and are being formally tracked by BN, the successor to REECo. The assessment identified approximately 55 of these system deficiencies. As of the end of 1996, only one of the identified deficiencies remains open.

OCCURRENCE REPORTING

Occurrences are environmental, health, and/or safety-related events which are reported in several categories in accordance with the requirements of DOE Order 5000.3B, "Occurrence Reporting and Processing of Operations Information." The reportable environmental occurrences for on-NTS facilities appear in Table 3.3. There were no reportable off-NTS environmental occurrences. An analysis of occurrences for 1996 as required by the Order showed that there were four main reasons for them: (1) management problems - 37 percent, (2) personnel error - 30 percent, (4) procedural problems - 7 percent, and (3) external phenomena - 18 percent.

LEGAL ACTIONS

On June 28, 1994, the state of Nevada filed a Complaint for Declaratory Judgement and Injunction against DOE in the U.S. District Court in Nevada. Nevada is seeking declaratory judgements that DOE has failed to comply with NEPA requirements at the NTS by not issuing a sitewide EIS for all major federal actions at the NTS and seeking orders to halt shipments of low-level radioactive waste from Fernald, as well as all other transportation, receipt, storage, and disposal of mixed waste, hazardous waste, and defense waste. The state is also seeking to enjoin DOE from pursuing any "Weapons Complex" activities, including nuclear testing, research, and development that will significantly impact the environment until publication of the sitewide EIS. In January 1995, the Court dismissed claims regarding an EIS, due to mootness, since DOE/NV had already begun the scoping process for a sitewide EIS, dismissed Nevada's claims regarding shipment of Fernald low-level waste, and dismissed claims regarding contents of the EIS as not yet ripe for adjudication. The remaining claim is regarding disposal of low-level radioactive waste from offsite facilities, and the issue was still unsettled at the close of 1996.

DOE/NV and REECo received a notification letter regarding alleged potentially responsible party status connected with a commercial disposal site in California. The California Department of Toxic Substances Control notified DOE/NV that Omega Chemical Co., a hazardous waste treatment and storage facility which recently declared bankruptcy and is unable to clean up the site, possessed records indicating that DOE/NV had shipped hazardous waste to the site between January 1988 and January 1992. Jurisdiction of this site has been transferred to the EPA, which has made no contact as of the close of 1996.

3.3 PERMIT SUMMARY

For facilities used in the operation and maintenance of the NTS and non-NTS facilities, the contractors providing such operation and support activities for the DOE/NV have been granted numerous permits by the appropriate regulatory authorities. In addition to the existing number of permits in 1996 (Table 3.4), the EOD Facility and the Area 5 Storage Facility of the RCRA Part B permit application were permitted, while the other units in the application are in various stages of the NDEP review for permission to construct or operate.

Table 3.1 Underground Storage Tank Activities - 1996

Location	Tank Number	Action Taken
Area 2, Vert. Pull Test	02-VPTF-1	Removal
Area 12, B-Tunnel	12-B-1	Removal
Area 12, Comm. Building	12-COMM-1	Removal
Area 23, Warehouse 7	23-W7-1	Removal
Area 23, Fire Station	23-425-1	Removal
Area 23, JTO Building	23-600-1	Removal
Area 25, R-MAD	25-3110-2	Removal
Area 25, E-MAD	25-3900-1	Removal
Area 26, Disassembly Building	26-2201-1	Removal

Table 3.2 NTS Recycling Activities - 1996

Material	Quantity
Office Paper	149.70 mt[(a)]
Aluminum (bulk)	314.80 mt
Aluminum cans	.90 mt
Used Motor Oil	74.40 mt
Cable	485.00 mt
Iron	3576.70 mt
Copper	201.30 mt
Batteries	326.00 mt
Tires	173.40 mt
Cardboard	.90 mt
Lead	129.00 mt

(a) metric ton (1,000 kg)

Off-NTS Recycling Activities, NLVF

Automotive Batteries	.90 mt[(a)]
Toner Cartridges	1.20 mt
SEC/High-Grade Paper	121.30 mt
Silver Recovery	.02 mt
Mixed Paper	34.60 mt
Cardboard	12.00 mt
Aluminum Cans	2.60 mt
Used Oil	1.00 mt

(a) metric ton (1,000 kg)

Table 3.3 Off-Normal Occurrences at NTS Facilities

Date	Report Number	Description	Status
03/25/96	NVOO-BNOO-NTS-1996-0004	Used oil spill (100 gal), pumper truck hose came loose	Complete
06/04/96	NVOO-BNOO-NTS-1996-0007	Petroleum Leakage from Abandoned Underground Storage Tank, Area 2	Complete
06/12/96	NVOO-BNOO-NTS-1996-0009	Radioactive Sludge released when Underground Storage Tank cut open, Area 6	Complete
09/06/96	NVOO-BNOO-NTS-1996-0014	Sewage release to ground due to clogged line, Area 12	Pending

Note: There were two historic petroleum leaks discovered on July 2, 1996, and July 23, 1996, when underground storage tanks were removed. According to new reporting guidelines, these were combined into the June 4, 1996, Occurrence Report.

Table 3.4 Environmental Permit Summary - 1996

	Air Pollution	Wastewater	Drinking Water	Number of EPA Generator User IDs	Hazardous Materials Storage Permit	Endangered Species Act
NTS	17	9	8	1[a]	3	2
Las Vegas Area Operations Office	15[b]	2		1[a]	2	
Amador Valley Operations				1	1	
Los Alamos Operations						
Special Technologies Laboratory (Santa Barbara)	1	2		2	1	
TOTAL	33	13	8	5	7	2

(a) Biennial Report Required.
(b) Routine Monitoring of Emissions is Not Required.

Air Monitoring for Compliance

4.0 ENVIRONMENTAL PROGRAM INFORMATION

The environmental monitoring and compliance programs for the Nevada Test Site (NTS) and several offsite facilities consist of radiological and nonradiological monitoring and environmental permit and operations compliance.

4.1 RADIOLOGICAL MONITORING

There are two radiological monitoring programs associated with the NTS, one onsite and the other offsite. The onsite program is conducted by Bechtel Nevada (BN), the operations & maintenance contractor for the NTS. BN is responsible for NTS environmental surveillance and effluent monitoring. Several other organizations, such as the Lawrence Livermore National Laboratory, Los Alamos National Laboratory (LANL), Desert Research Institute (DRI), International Technology Corp., and the U. S. Environmental Protection Agency (EPA) also make radiological measurements onsite. The offsite program is conducted by the EPA's Center for Environmental Restoration, Monitoring and Emergency Response of the Radiation & Indoor Environments National Laboratory in Las Vegas, Nevada (R&IE-LV) with support from the DRI.

ONSITE MONITORING

At the NTS radiological effluents may originate from tunnels, from underground test event sites (at or near surface ground zeros), and from facilities where radioactive materials are either used, processed, stored, or discharged. All of these sources have the potential to, or are known to discharge radioactive effluents into the environment. Two types of monitoring operations are used for these sources: (1) effluent monitoring, which measures radioactive material collected at the point of discharge; and (2) environmental surveillance, which measures radioactivity in the general environment.

Table 4.1 is a summary of the routine environmental surveillance program, as of the end of 1996. Air sampling is conducted for radioactive particulates, noble gases, and tritiated water (HTO) vapor. The sampling locations are shown in Figure 4.1. Figure 4.2 shows the locations where ambient gamma radiation monitoring is conducted on the NTS using thermoluminescent dosimeters (TLDs). Water samples are collected from springs, groundwater wells, well reservoirs, water taps, and waste disposal ponds (Figures 4.3 and 4.4).

CRITERIA

U.S. Department of Energy (DOE) Order 5400.1, "General Environmental Protection Program," establishes environmental protection program requirements, authorities, and responsibilities for DOE operations. These mandates require compliance with applicable federal, state, and local environmental protection regulations. Other DOE directives applicable to environmental monitoring include DOE Order 5480.11, "Radiation Protection for Occupational Workers"; DOE

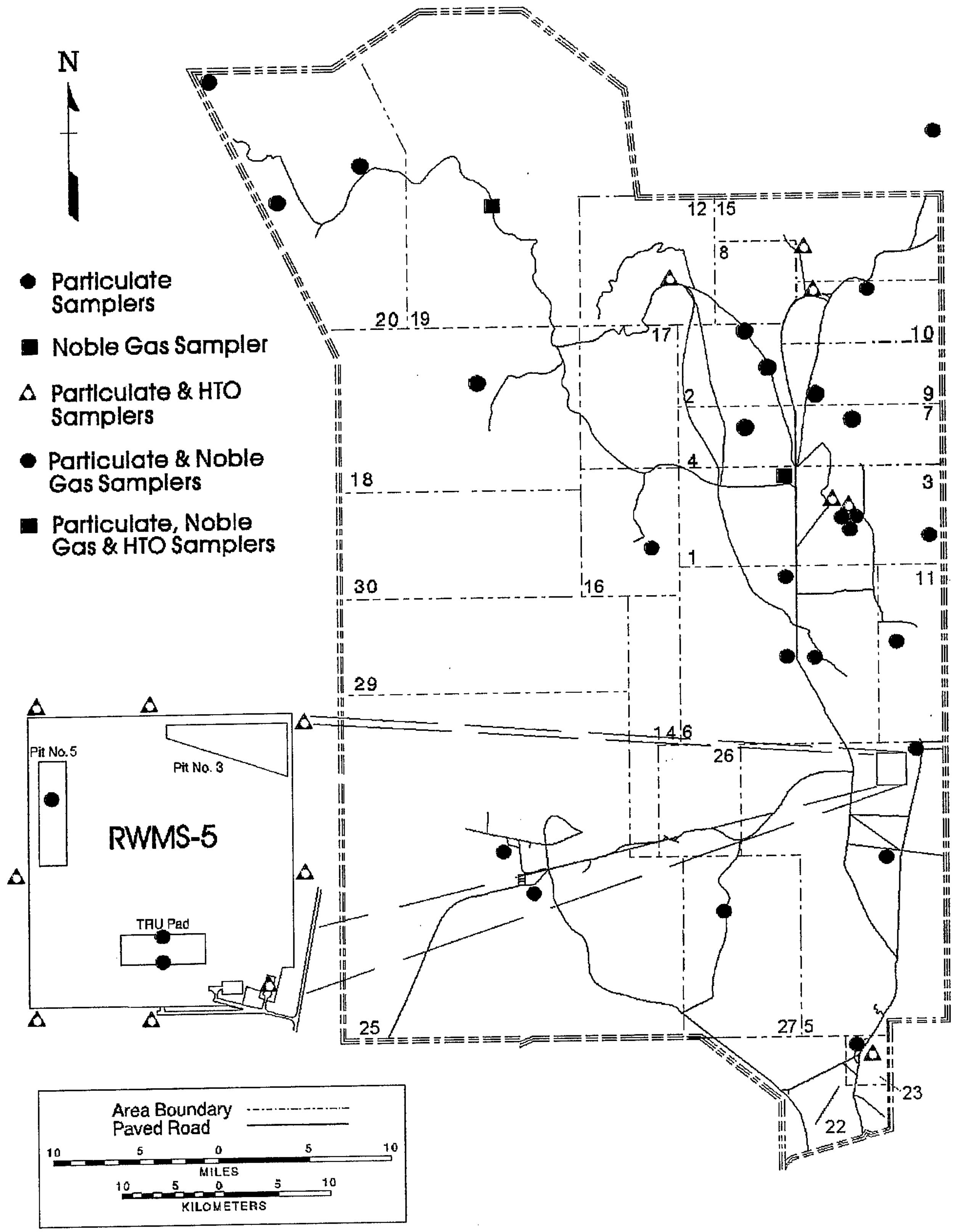


Figure 4.1 Air Sampling Stations on the NTS - 1996

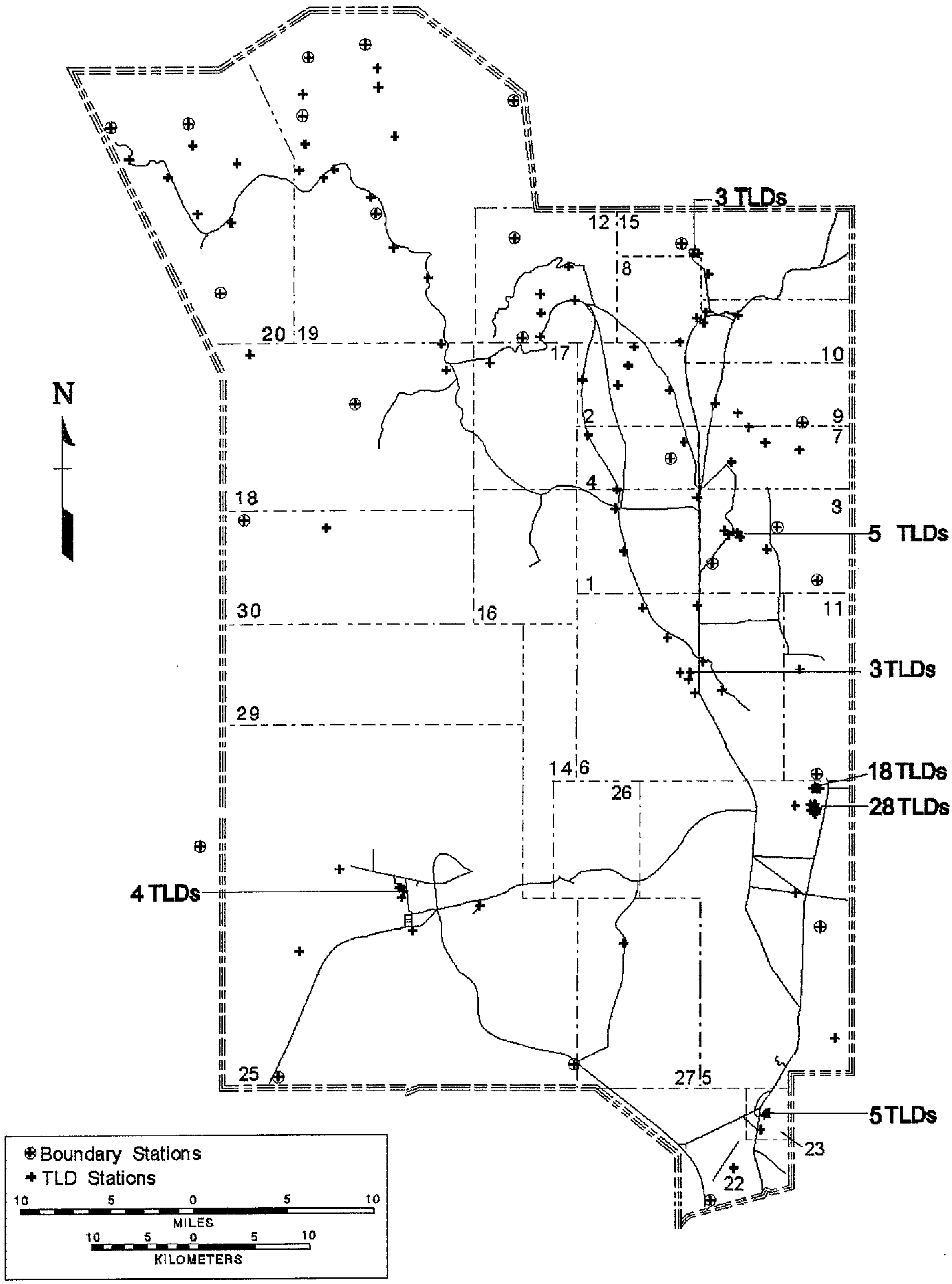


Figure 4.2 TLD Stations on the NTS (+) - 1996

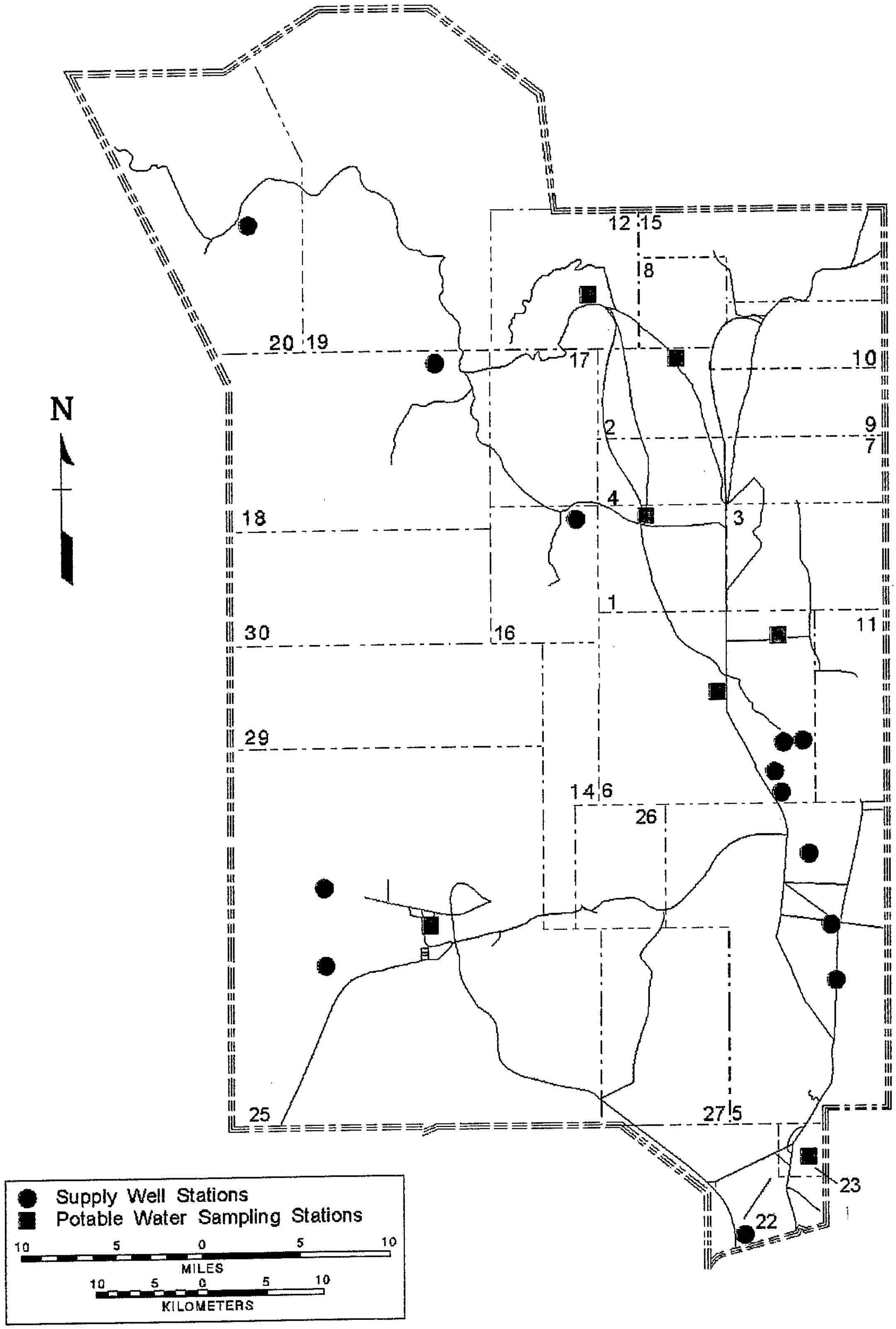


Figure 4.3 Supply Well and Potable Water Sampling Stations on the NTS - 1996

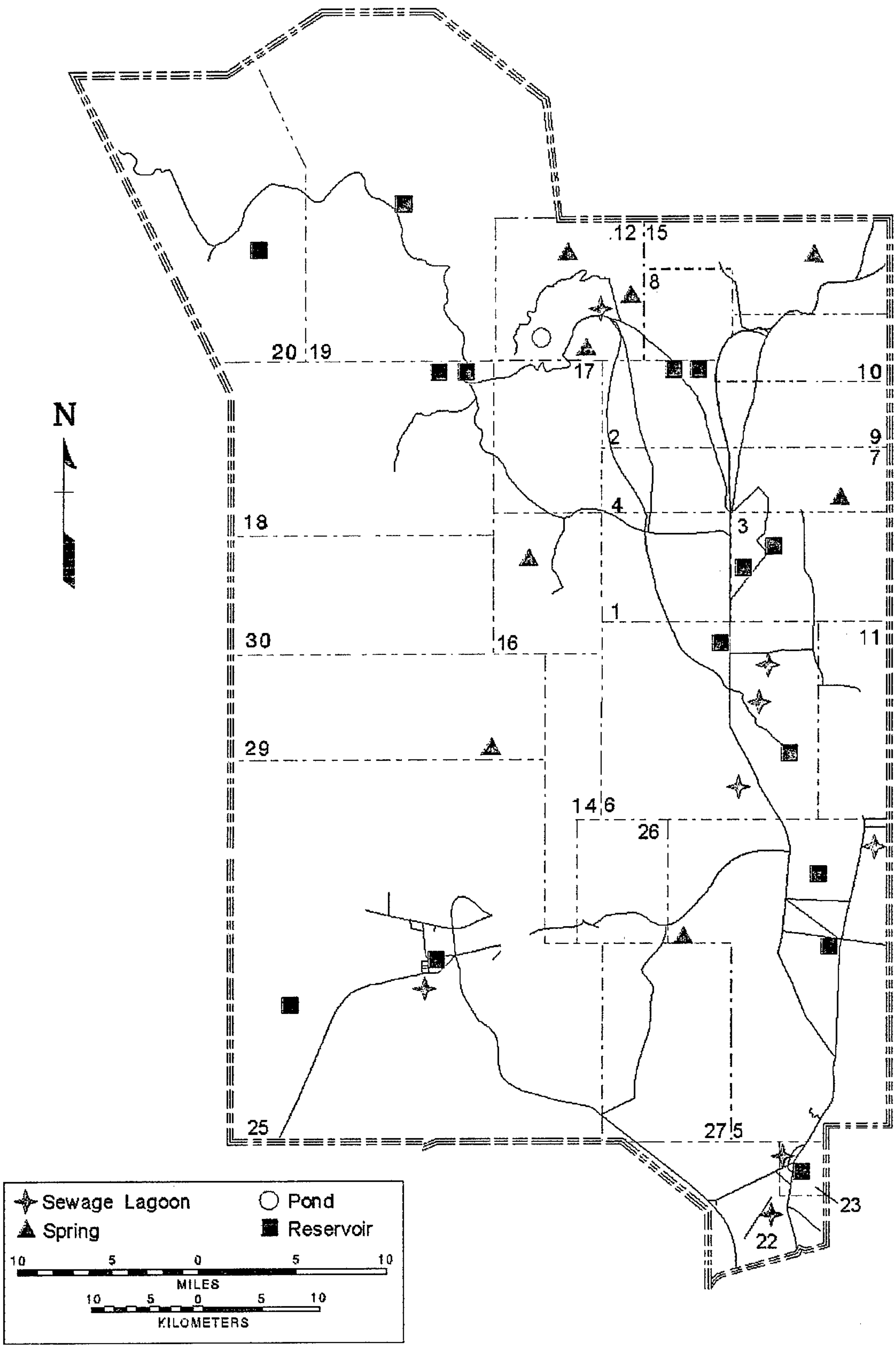


Figure 4.4 Surface Water Sampling Locations on the NTS - 1996

Order 5480.1B, "Environment, Safety, and Health Program for DOE Operations"; DOE Order 5484.1, "Environmental Protection, Safety, and Health Protection Information Reporting Requirements"; DOE Order 5400.5, "Radiation Protection of the Public and the Environment"; and DOE/EH-0173T, "Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance."

EFFLUENT MONITORING

During 1996, effluent monitoring at the NTS involved several operational facilities and some inactive locations. Due to the continuation of the moratorium on nuclear testing throughout 1996, effluent monitoring for nuclear tests was not required.

LIQUID EFFLUENT MONITORING

Radiologically contaminated water was discharged from E Tunnel in Rainier Mesa (Area 12). N and T Tunnels have been sealed to prevent such discharges. A grab sample was collected quarterly from the tunnel's effluent discharge point and from the tunnel's containment pond. These samples were analyzed for tritium (^{3}H), gross beta, ^{238}Pu, $^{239+240}Pu$ and gamma emitters. In addition, an annual sample was analyzed for ^{90}Sr. Tritium was the radionuclide most consistently detected at the tunnel sites. Other radionuclides were detected infrequently. Flow data obtained from the Defense Special Weapons Agency (formerly the Defense Nuclear Agency) was used to calculate the total volume discharged. Annual average radioactivity concentrations were calculated from the quarterly measurements. From these the total amount of radioactivity in the effluent was obtained.

Water pumped from wells drilled to obtain data for characterization of the NTS groundwater, was discharged into containment ponds. The total volume of water was obtained from the pond area and the water depth. An average concentration of tritium in water (HTO) was used to obtain the total volume of water discharged from the characterization wells. Tritium was the only radionuclide detected in these water samples.

Typical minimum detectable concentrations for water analyses were:

- Gross α: 1.4×10^{-9} µCi/mL (5.2×10^{-2} Bq/L)
- Gross ß: 1.2×10^{-9} µCi/mL (4.4×10^{-2} Bq/L)
- Gamma Spectroscopy: 0.1 to 20×10^{-7} µCi/mL (0.3 - 74 Bq/L) (Using a ^{137}Cs standard)
- Tritium (conventional): 7.2×10^{-7} µCi/mL (27 Bq/L)
- Tritium (enrichment): 1.4×10^{-8} µCi/mL (0.52 Bq/L)
- ^{90}Sr: 2.9×10^{-10} µCi/mL (1.1×10^{-2} Bq/L)
- ^{226}Ra: 1×10^{-9} µCi/mL (0.074 Bq/L)
- ^{238}Pu: 2×10^{-11} µCi/mL (7.4×10^{-4} Bq/L)
- $^{239+240}Pu$: 2×10^{-11} µCi/mL (7.4×10^{-4} Bq/L)

AIRBORNE EFFLUENT MONITORING

As the moratorium on nuclear testing, established in 1992, was continued throughout the year, airborne effluent monitoring was not required.

ENVIRONMENTAL SURVEILLANCE

Environmental surveillance was conducted onsite throughout the NTS. Equipment at fixed locations continuously sampled the ambient air to monitor for radioactive material content. Surface water and groundwater samples were routinely collected at pre-established locations and analyzed for radioactivity. Ambient gamma exposures were measured with TLDs placed at fixed locations.

AIR MONITORING

The environmental surveillance program operated samplers that were designed to detect airborne radioactive particles, radioactive noble gases, and ^{3}H as water vapor in the form $^{3}H^{3}HO$ or ^{3}HHO (HTO).

Air sampling units used to measure radioactive particulates and halogens were operated at 49 stations on the NTS (Figure 4.1) during 1996. These stations included 17 inside radioactive waste management facilities. By the end of the year, the number of stations had been reduced to 45 as the RWMS perimeter stations were reduced by 4. Access, worker population, geographical coverage, presence of radioactivity, and availability of electrical power were considered in site selection. During this year, air samplers powered by solar photovoltaic-battery systems were operated in ten contaminated areas where there was no commercial power.

An air sampling unit consisted of a positive displacement pump drawing approximately 140 L/min (5 cfm) of air through a nine-centimeter diameter Whatman GF/A glass-fiber filter for trapping particulates. Due to the moratorium on testing, the use of charcoal cartridges behind the particulate filter was suspended. The particulate filter was mounted in a plastic, cone-shaped sample holder. A dry-gas meter measured the volume of air sampled during the sampling period (typically seven days). The unit collected approximately 1,400 m^3 of air during the seven-day sampling period.

The filters were held for no less than five nor more than seven days prior to analysis to allow naturally occurring radon and its progeny to decay. Gross alpha counting (beginning in June 1996) and gross beta counting were performed with a gas-flow proportional counter for 20 min. The respective minimum detectable concentrations (MDCs) for these analyses, assuming typical counting parameters, were 9.8×10^{-16} μCi/mL (36 μBq/m^3), using a ^{239}Pu calibration source and 3.3×10^{-15} μCi/mL (120 μBq/m^3), using a ^{90}Sr calibration source. Gamma spectroscopy of the particulate filter was accomplished using germanium detectors with an input to a 2,000-channel spectrometer. This spectrometer was calibrated at one keV per channel from 0.02 to 2 MeV using a National Institute of Standards and Technology traceable mixed radionuclide source. The MDC for ^{137}Cs using this system was 8.2×10^{-15} μCi/mL (30 mBq/m^3).

Weekly air samples collected for radioactive waste operations in Areas 3 and 5 were composited on a monthly basis and radiochemically analyzed for ^{238}Pu and $^{239+240}Pu$. The weekly air filters collected from all other locations were composited quarterly and analyzed for plutonium. The filters were subjected to an acid dissolution and an ion-exchange recovery on a resin bed. Plutonium was eluted from the resin, precipitated, and collected on a filter for analysis. The chemical yield of the plutonium was determined with an internal ^{242}Pu tracer. Alpha spectroscopy was performed utilizing a solid-state silicon surface barrier detector. The MDC for ^{238}Pu and $^{239+240}Pu$ was approximately 1.6×10^{-17} μCi/mL (0.61 μBq/m^3).

Initially, noble gases were continuously sampled at ten locations and analyzed for ^{85}Kr and ^{133}Xe. This network was reduced to three locations by the beginning of the year, and ^{133}Xe analysis was discontinued. The noble gas samplers maintained a steady sampling flow rate of approximately 0.08 L/min. These sampling units were housed in a metal tool box with three metal air bottles attached to the sampling units with short hoses. A vacuum was maintained on the first bottle by pumping the sample into the other two bottles. The two collection bottles were exchanged weekly and contained a sample volume of about 400 L each at standard conditions.

The noble gases were separated from the atmospheric sample by cryogenic gas fractionation. Water and carbon dioxide were removed at room temperature, and the krypton and xenon were collected on charcoal at liquid nitrogen temperatures. These gases were transferred to a molecular sieve where they were separated from any remaining gases and from each other. The krypton was transferred to a scintillation vial and counted on a liquid scintillation counter. The MDC for ^{85}Kr was 9.6×10^{-12} µCi/mL (0.33 Bq/m^3).

Airborne HTO vapor was initially monitored at 16 locations throughout the NTS, but this was reduced to 12 locations during the year. For this monitoring, a small pump continuously drew air into the sampler at approximately 0.4 L/min, the total volume being measured with a dry gas meter. The HTO vapor was removed from the air stream by a silica-gel drying column followed by a drierite column. These columns were exchanged every two weeks. Appropriate aliquots of condensed moisture were obtained by heating the silica gel. The tritium activity was then obtained by liquid scintillation counting. The MDC for HTO vapor analysis was 3.2×10^{-12} µCi/mL (0.12 Bq/m^3) of air at standard conditions.

AMBIENT GAMMA MONITORING

Ambient gamma monitoring was conducted at 169 stations within the NTS (Figure 4.2), reduced to 160 by the end of the year through use of TLDs. The dosimeter used was the Panasonic UD-814AS environmental dosimeter, consisting of four elements housed in an air-tight, water-tight, ultraviolet-light-protected case. One element, made of lithium borate, was only slightly shielded in order to measure low-energy radiation. The other three elements, made of calcium sulfate, were shielded by 1,000 mg/cm^2 of plastic and lead to monitor penetrating gamma radiation only. TLDs were deployed in a holder placed about one meter above the ground and exchanged quarterly. Locations were chosen at the site boundary, where historical monitoring has occurred, or where operations or ground contamination occurred.

WATER MONITORING

Water samples were collected from selected potable tap-water points, water supply wells, natural springs, open reservoirs, sewage lagoons, and containment ponds. The frequency of collection and types of analyses performed for these types of samples are shown in Table 4.1. Sampling locations are shown on Figures 4.3 and 4.4, above.

A 500-mL aliquot was taken from the water sample, placed in a plastic bottle, and counted for gamma activity with a germanium detector. A 2.5-mL aliquot was used for ^3H analysis by liquid scintillation counting. The remainder of the original sample was evaporated to 15 mL, transferred to a stainless steel counting planchet, and evaporated to dryness after the addition of a wetting agent. Alpha and/or beta analyses were accomplished by counting the planchet samples for 100 minutes in a gas-flow proportional counter.

Tritium enrichment analyses were performed by concentrating the volume and tritium content of a 250-mL sample aliquot to 10 mL by electrolysis of the basic solution and analyzing a 5-mL portion of the concentrate by liquid scintillation counting.

The $^{226,228}Ra$ concentrations were determined from low-background gamma spectrometric analyses of radium sulfate. The samples were prepared by adding a barium carrier and ^{225}Ra tracer to 800 mL of sample, precipitating the barium and radium as a sulfate, separating the precipitate, and analyzing it by counting for 500 min in a low-level gamma spectroscopy facility.

The radiochemical procedure for plutonium was similar to that described in Section 4.1. Alpha spectroscopy was used to measure any ^{238}Pu, $^{239+240}Pu$, and the ^{242}Pu tracer present in the samples.

WASTE MANAGEMENT SITE MONITORING

Environmental surveillance on the NTS included Radioactive Waste Management Sites (RWMS). These sites are used for the disposal of low-level radioactive waste from the NTS and other DOE facilities. Shallow-land disposal in trenches and pits was done at the Area 5 RWMS (RWMS-5) and in subsidence craters at the Area 3 RWMS (RWMS-3).

RWMS-5 monitoring began with 17 permanent air particulate sampling stations, 9 permanent HTO vapor sampling stations, and 26 TLD stations placed inside and around the site. These were later changed to 7 air particulate and 4 HTO samplers, with no change in TLDs. The RWMS-3 is monitored by 4 air particulate and 1 HTO sampling stations and with several TLD stations located nearby.

SPECIAL ENVIRONMENTAL STUDIES

The Basic Environmental Compliance and Monitoring Program (BECAMP) used the past accomplishments of two former programs at the NTS, the Nevada Applied Ecology Group and the Radionuclide Inventory and Distribution Program. These programs were used in efforts to assess changes over time in the radiological conditions on the NTS, update human dose-assessment models, and provide information to DOE Nevada Operations Office (DOE/NV) for site restoration projects and compliance with environmental regulations. Most BECAMP missions were discontinued in 1996.

In 1995, the ecological monitoring studies conducted under BECAMP over the past eight years were reviewed. These studies monitored the flora and fauna on the NTS to assess changes in ecological conditions over time. In 1996, a new program entitled Ecological Monitoring and Compliance (EMAC) program was instituted. It is described in Section 4.2 of this Chapter.

OFFSITE MONITORING

Under the terms of an Interagency Agreement between DOE and EPA, EPA's Office of Radiation and Indoor Air assumed responsibility for the Offsite Radiation Safety Program in areas surrounding the NTS. In October 1996, these activities were assumed by the R&IE-LV, a component of the Office of Radiation and Indoor Air. The primary activity of the R&IE-LV program is routine monitoring of potential human exposure pathways. Public information and community assistance constitute secondary activities.

Due to the continuing moratorium on nuclear weapons testing, only three readiness exercises were conducted in 1996. For each of the three tests, R&IE-LV senior personnel served on the Test Controller's Scientific Advisory Panel and on the EPA offsite radiological safety staff.

Routine offsite environmental monitoring for compliance with National Emission Standards for Hazardous Air Pollutants (NESHAPs) and with DOE orders 5400.1 and 5400.5 continued throughout 1996.

Environmental monitoring networks, described in the following subsections, measure radioactivity in air, milk, and groundwater. These networks monitor the major potential pathways for transfer of radionuclides to man. Ambient gamma radiation levels are monitored using Reuter-Stokes pressurized ion chambers (PICs) and Panasonic TLDs. Groundwater on and around the NTS and in other states is monitored in the Long-Term Hydrological Monitoring Program (LTHMP). Data from these networks are used to calculate an annual exposure to the offsite residents.

A decreased number of Community Technical Liaison Programs (CTLPs), formerly Community Radiation Monitoring Program, stations that were established at prominent locations in a number of offsite communities continued to operate. The CTLP stations contain samplers for several of the monitoring networks and are managed by local residents. The DRI is a cooperator with R&IE-LV in the CTLP.

AIR MONITORING

The inhalation of radioactive airborne particles can be a major pathway for human exposure to radiation. The atmospheric monitoring networks are designed to detect environmental radioactivity from both NTS and non-NTS activities. Data from atmospheric monitoring can be used to determine the concentration and source of airborne radioactivity and to project the fallout patterns and durations of exposure to man.

The Air Surveillance Network (ASN) was originally designed to monitor the areas within 350 km (220 mi) of the NTS. Due to the current moratorium on nuclear weapons testing, DOE began reducing the area of the offsite monitoring networks to within approximately 130 km (80 mi) of the NTS. Station location depends in part on the availability of electrical power and a resident willing to operate the equipment.

At the beginning of 1996, the ASN consisted of 20 continuously operating sampling stations. During the year, two stations were discontinued and two new stations were added. The current network is shown in Figure 4.5. High-volume air samplers were operational at five of the stations at the beginning of the year and a sixth was added in April. Dismantling of the Standby ASN that began last year was completed this year.

The low-volume air samplers at each station are equipped to collect particulate radionuclides on 5-cm (2.0-in) diameter glass-fiber filters at a flow rate of about 80 m^3 (2,800 ft^3) per day. Filters are changed weekly (approximately 560 m^3 or 20,000 ft^3 of air sampled). Activated charcoal cartridges placed directly behind the filters to collect gaseous radioiodine are changed at the same time as the fiber filters. High-volume air samplers at selected stations collect particulate on 20-x 25-cm (8-x 10-in) glass-fiber filters at a flow rate of approximately 1,600 m^3 (58,000 ft^3) per day. Duplicate air samples are collected from two routine ASN stations each week. The duplicate samplers operate at randomly selected stations for three months and are then moved to new locations. One duplicate high-volume sampler is operated in the same manner as the duplicate low-volume sampler. High-volume samples are collected every two weeks (approximately 22,000 m^3 or 800,000 ft^3 of air is sampled).

At the R&IE-LV laboratory, both the glass-fiber filters and the charcoal cartridges were promptly analyzed by high-resolution gamma spectrometry. Each of the glass-fiber filters was then analyzed for gross alpha and gross beta activity 7 to 14 days after sample collection to allow time for the decay of naturally occurring radon/thoron progeny. Filters from high-volume air samplers were analyzed using high-resolution gamma spectrometry and then were composited by month for each station and analyzed for plutonium isotopes.

WATER MONITORING

As part of the LTHMP, R&IE-LV personnel routinely collect and analyze water samples from locations on the NTS and from sites in the surrounding offsite areas. Due to the scarcity of surface waters in the region, most of the samples are groundwater, collected from existing wells. Samples from specific locations are collected monthly, biannually, annually, or biennially in accordance with a preset schedule. Many of the drinking water supplies used by the offsite population are represented in the LTHMP samples. Results for the LTHMP samples, including those from sites in other states (described in Chapter 2) are discussed in Chapter 9.

MILK SURVEILLANCE NETWORK (MSN)

Milk is an important source for evaluating potential human exposures to radioactive

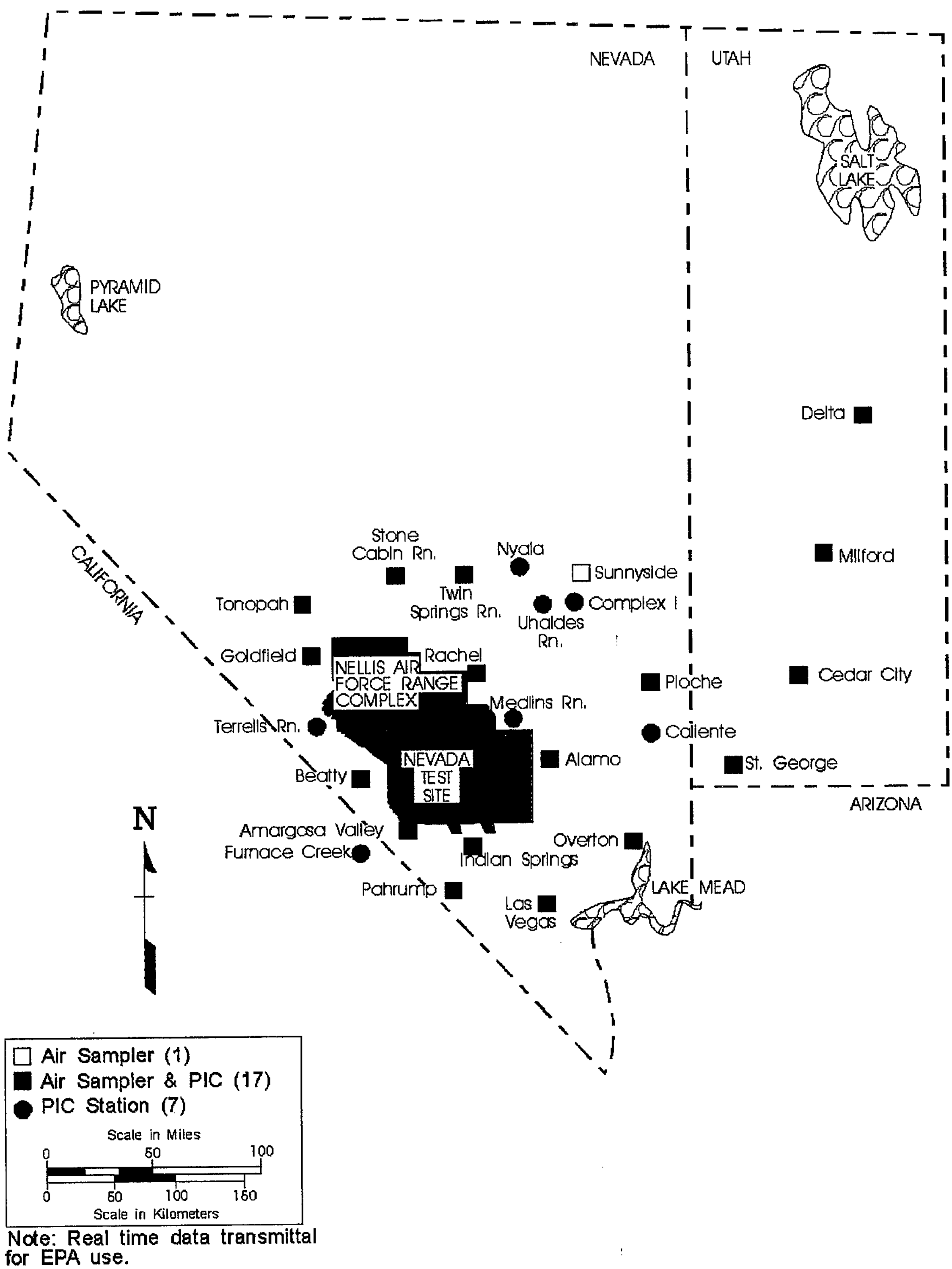


Figure 4.5 ASN and PIC Station Locations - 1996

material. It is one of the most universally consumed foodstuff and certain radionuclides are readily traceable through the chain from feed or forage to the consumer. This is particularly true of radioiodine isotopes which, when consumed in sufficient quantities, can cause impairment of thyroid function. Because dairy animals consume vegetation representing a large area and because many radionuclides are transferred to milk, analysis of milk samples yields information on the deposition of small amounts of radionuclides over a relatively large area.

The MSN includes commercial dairies and family-owned milk cows and goats representing the major milksheds within 300 km (186 mi) of the NTS. The 11 locations comprising the MSN at the beginning of 1996 and any changes are shown in Figure 4.6. Samples were collected from only ten of these locations because the Hafen Ranch in Ivins, Utah, was not milking during the collection period.

Raw milk was collected in 3.8-L (1-gal) cubitainers from each MSN location in July and preserved with formaldehyde. The samples were analyzed by high-resolution gamma spectrometry for gamma emitters and for ^{89}Sr and ^{90}Sr by radiochemical separation and beta counting. This network was designed to monitor areas adjacent to the NTS, which could be affected by a release of activity, as well as from areas unlikely to be so affected.

BIOMONITORING

The biomonitoring program for radionuclides has been discontinued. A summary report on the program is in preparation.

THERMOLUMINESCENT DOSIMETRY NETWORK

An essential component of environmental radiological assessments is external dosimetry. Such dosimetry is used to determine both individual and population exposure to ambient radiation, natural or otherwise.

The primary purpose of EPA's offsite environmental dosimetry program is to establish dose estimates to populations living in the areas surrounding the NTS. Panasonic Model UD-814 TLDs are used for environmental monitoring. The UD-814 consists of one element of $Li_2B_4O_7$:Cu and three elements of $CaSO_4$:Tm phosphors. The $CaSO_4$:Tm elements are behind a filter of approximately 1,000 mg/cm^2. An average of the corrected values for the latter three elements gives the total exposure for each TLD. For quality assurance purposes, two UD-814 TLDs are deployed at each fixed environmental station location. The TLDs are exchanged quarterly.

In addition to a fixed environmental TLD, EPA deploys personnel TLDs to individual volunteers, predominantly CTLP station managers and their alternates, living in areas surrounding the NTS.

Panasonic Model UD-802 TLDs are used for personnel monitoring. The UD-802 consists of two elements each of $Li_2B_4O_7$:Cu and $CaSO_4$:Tm phosphors. The phosphors are behind filters of approximately 17,300,300 and 1,000 mg/cm^2 respectively. With the use of different phosphors and filtrations, a dose algorithm can be applied to ratios of the different element responses. This process defines the radiation type and energy and provides data for assessing an absorbed dose equivalent to the participating individuals. These TLDs are also exchanged quarterly.

An average daily exposure rate was calculated for each quarterly exposure period and the average of the four values was multiplied by 365.25 to obtain the total annual exposure for a station.

New computers and software were installed in 1996 to increase report options, and further hardware upgrades will be completed in 1997.

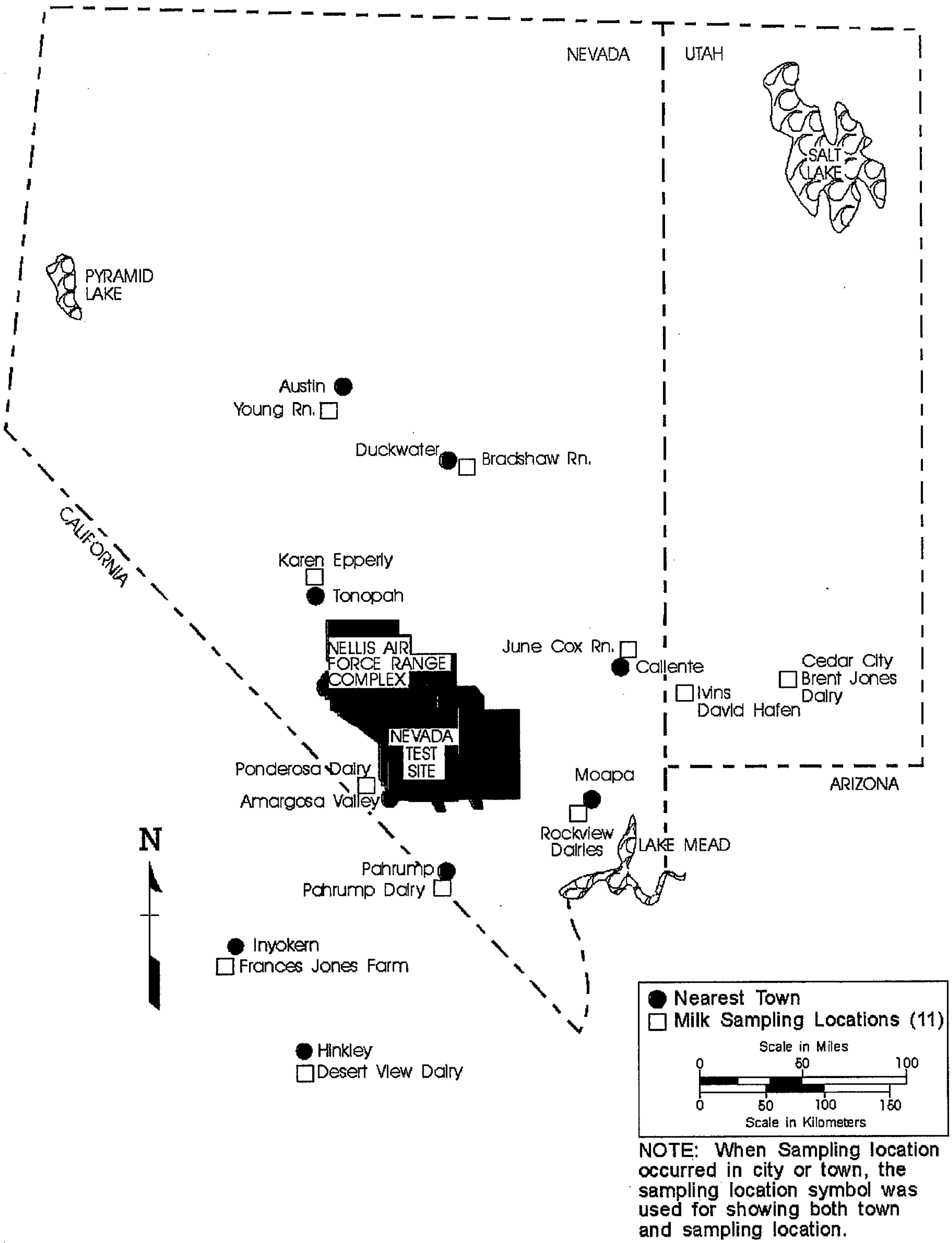


Figure 4.6 MSN Stations - 1996

In 1996, the TLD program consisted of 51 fixed environmental monitoring stations and 26 offsite personnel. Henderson and Boulder City, Nevada, and Furnace Creek, California, were added to the network in the fourth quarter. Figure 4.7 shows the fixed environmental TLD monitoring stations and the location of personnel monitoring participants.

PRESSURIZED ION CHAMBER (PIC) NETWORK

The PIC network uses Reuter-Stokes models 1011, 1012, and 1013 PICs. The PIC is a spherical shell filled with argon gas at 25 times atmospheric pressure. In the center of the chamber is a spherical electrode with an electrical charge opposite to the outer shell. When gamma radiation penetrates the sphere, ionization of the gas occurs and the negative ions are collected by the center electrode. The current thus generated is proportional to the radiation exposure.

The PIC measures gamma radiation exposure rates, and because of its sensitivity, may detect low-level exposures not detected by other monitoring methods. The primary function of the PIC network is to detect changes in ambient gamma radiation due to human activities. In the absence of such activities, ambient gamma radiation rates naturally differ among locations as they may change with altitude (cosmic radiation), with radioactivity in the soil (terrestrial radiation), and may vary slightly within a location due to weather patterns.

Near real-time telemetry-based data retrieval is achieved by a remote automated data acquisition system which collects data from the PIC and transmits it through the Geostationary Operational Environmental Satellite directly to a LANL receiver and then to R&IE-LV by a dedicated telephone line. In addition to telemetry retrieval, PIC data are also recorded on either magnetic tapes or magnetic cards which provide a backup for the telemetry data.

There are 27 PICs located in communities around the NTS and one in Mississippi, which provide near real-time estimates of gamma exposure rates. Stations at Henderson and Boulder City, Nevada, were added to the network in the fourth quarter of 1996. The PIC at Boulder City was vandalized after only five days of data collection. Another site in Boulder City is being proposed to prevent future incidents. The locations of the PICs are shown in Figure 4.5, for stations around the NTS.

INTERNAL DOSIMETRY NETWORK

This network has been discontinued, and a summary report of the program is in preparation.

COMMUNITY TECHNICAL LIAISON PROGRAM (CTLP)

Because of the successful experience with the Citizen's Monitoring Program during the purging of the Three Mile Island containment in 1980, the Community Radiation Monitoring Program (CRMP) was begun. Because of reductions in the scope of monitoring, the CRMP was changed to the CTLP. It now consists of stations located in the states of Nevada and Utah. In 1996, there were 15 stations located in these two states. The CTLP is a cooperative project of the DOE, EPA, and DRI.

DOE/NV sponsors the program. The EPA provides technical and scientific direction, maintains the instrumentation and sampling equipment, analyzes the collected samples, and interprets and reports the data. The DRI administers the program by hiring the local station managers and alternates, securing rights-of-way, providing utilities, and performing additional quality assurance checks of the data. Shown in Figure 4.8 are the locations of the CTLP stations.

Each station is operated by a local resident. In most cases, this resident is a high-school science teacher. Samples are analyzed at the R&IE-LV. Data interpretation is provided

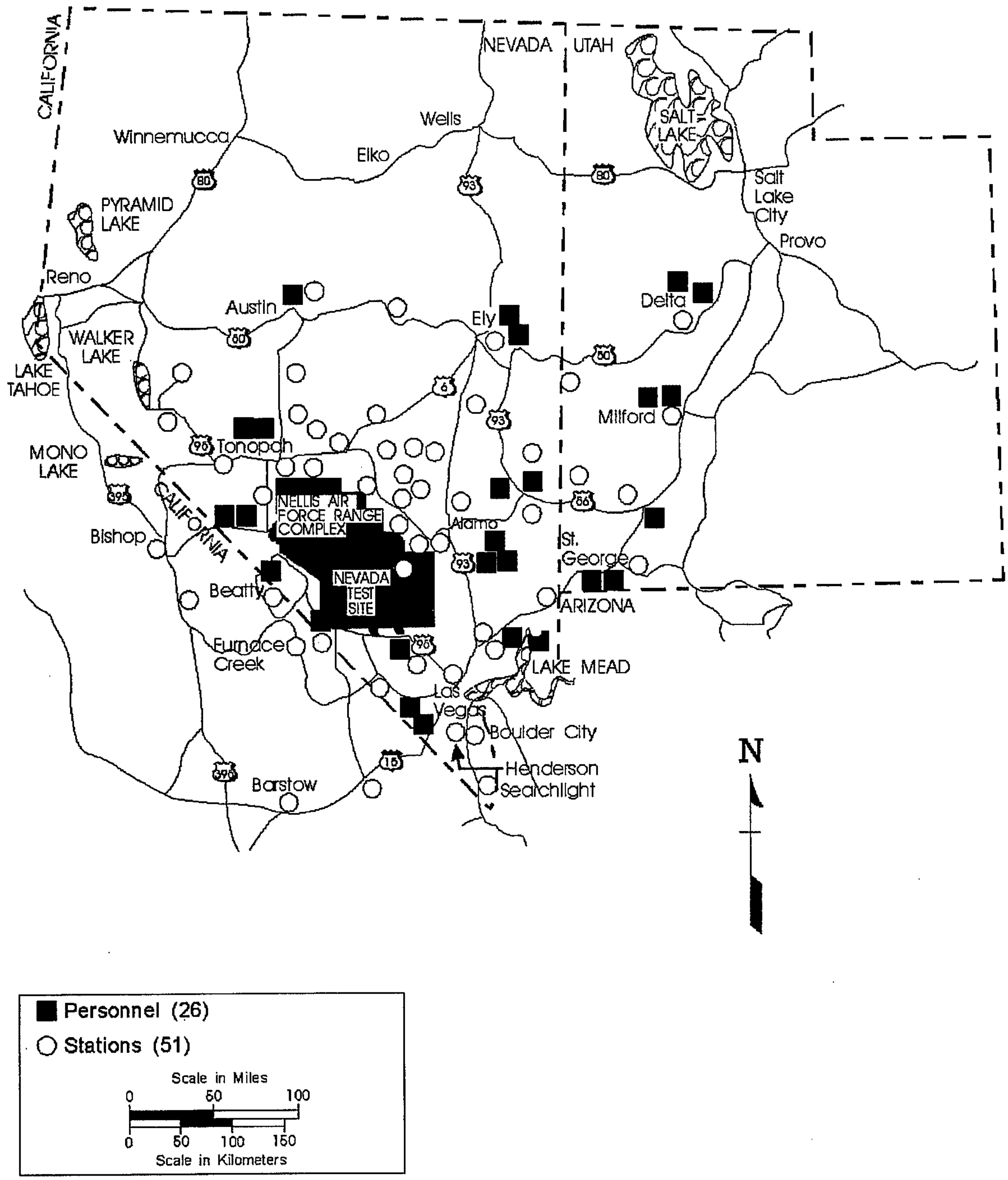


Figure 4.7 Location of TLD Fixed Stations and Personnel Monitoring Participants - 1996

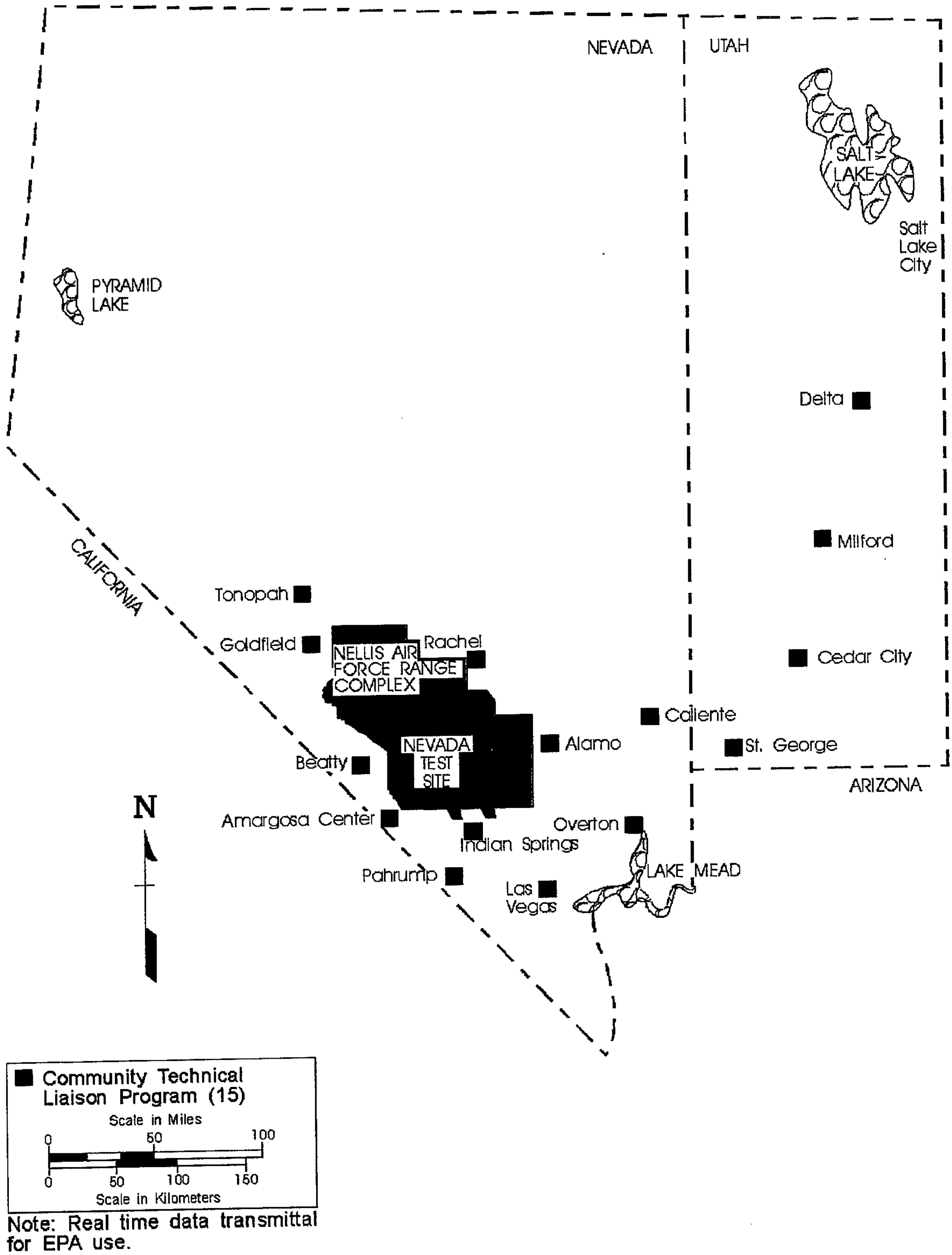


Figure 4.8 CTLP Station Locations - 1996

by DRI to the communities involved. All of the 15 CTLP stations had one of the samplers for the ASN and Noble Gas and Tritium Surveillance Network, on either routine or standby status, and a TLD. In addition, a PIC and recorder for immediate readout of external gamma exposure and a recording barograph are located at the station. All of the equipment is mounted on a stand at a prominent location in each community so the residents can become aware of the surveillance and, if interested, can check the data. Also, computer-generated reports of the PIC data are issued monthly for each station.

4.2 NONRADIOLOGICAL MONITORING

The 1996 nonradiological monitoring program for the NTS included onsite sampling of various environmental media and substances for compliance with federal and state regulations or permits and for ecological studies. The EMAC program, formerly part of BECAMP, performed habitat mapping in the southern third of the NTS, characterized NTS springs, monitored man-made water sources, conducted wild horse and chukar surveys, prepared a biological monitoring plan for the Hazardous Materials Spill Center (HSC), and surveyed for several former candidate species for federal listing under the Endangered Species Act. In 1996, nonradiological monitoring was conducted for four series of tests conducted at the HSC on the NTS.

Nonradiological monitoring of non-NTS DOE/NV facilities was conducted at three offsite facilities. This monitoring was limited to wastewater discharges to publicly owned treatment works.

NTS OPERATIONS MONITORING

ROUTINE MONITORING

As there were no industrial-type production facility operations on the NTS, there was no significant production of nonradiological air emissions or liquid discharges to the environment. Sources of potential contaminants were limited to construction support and NTS operational activities. This included motor pool facilities; large equipment and drill rig maintenance areas; cleaning, warehousing, and supply facilities; and general worker support facilities (including lodging and administrative offices) in the Mercury Base Camp, Area 12 Camp, and to a lesser extent in Area 20 and the NTS Control Point Complex in Area 6. The HSC in Area 5 is a source of potential release of nonradiological contaminants to the environment, depending on the individual tests conducted. In 1996, there were four series of tests, involving 28 different chemicals, conducted at this facility. Monitoring was performed to assure that the contaminants did not move to offsite areas. Since these HSC monitoring functions are performed by the R&IE-LV at the NTS boundary, they are described in Section 4.2. Routine nonradiological environmental monitoring on the NTS in 1996 was limited to:

- Sampling of drinking water distribution systems and water haulage trucks for Safe Drinking Water Act and state of Nevada compliance.
- Sewage lagoon influent and E Tunnel discharge sampling for compliance with state of Nevada operating permit requirements.
- Sampling of electrical equipment oil, soil, water, surfaces, and waste oil for the presence of polychlorinated biphenyls as part of Toxic Substance Control Act compliance.
- Asbestos sampling in conjunction with asbestos removal and renovation projects and in accordance with occupational safety and NESHAPs compliance.
- Sampling of soil, water, sediment, waste oil, and other media for Resource Conservation and Recovery Act (RCRA) constituents.

ECOLOGICAL MONITORING

The BECAMP was redesigned to address changes in DOE/NV missions and DOE's commitment to manage land and facility resources based on the principles of ecosystem management and sustainable development. A comprehensive and adaptable guidance document for ecological monitoring was completed in May. The new program is designated as EMAC. The ecological monitoring tasks which were selected for 1996 included vegetation mapping within the range of the desert tortoise, characterizing the natural springs on the NTS, conducting a census of horse and chukar populations, and periodically monitoring man-made water sources to assess their affects on wildlife. The Environmental Assessment for the HSC (formerly the Liquefied Gaseous Fuels Spill Test Facility) calls for ecological monitoring of certain spill tests, and a monitoring plan was developed and implemented in 1996.

CHARACTERIZATION OF NTS SPRINGS

From June through December, biologists visited 25 natural water sources at the NTS to determine if these mesic habitats qualify for jurisdictional wetlands protection. These included all known springs, seeps, tanks (natural rock basins), and ephemeral ponds. The presence of wetland plants, wetland hydrology, and hydric soils (all indicators for jurisdictional wetlands) was recorded at each site. A summary report of all findings will be completed in 1997. Permits would be required under section 404 of the Clean Water Act before any alterations of the aquatic habitat could be made at any of the NTS sites which qualify as jurisdictional wetlands.

MONITORING OF MAN-MADE WATER SOURCES

Quarterly monitoring of man-made water sources began in April to identify any possible impacts of these open water sources on wildlife. These water sources include plastic-lined, cement-lined, and/or earthen sumps, containment ponds, and sewage ponds located throughout the NTS.

HSC MONITORING

A document titled "Biological Monitoring Plan for Hazardous Materials Testing at the Liquefied Gaseous Fuels Spill Test Facility on the Nevada Test Site" was prepared in January. Biological monitoring is prescribed in the facility's programmatic Environmental Assessment for those chemicals that have either not been tested before, not been tested in large quantities, or for which there are uncertain modeling predictions of downwind air concentrations. The monitoring plan addresses how vegetation and animals will be sampled to determine test impacts under these circumstances and to verify that the spill program complies with pertinent state or federal environmental protection legislation. The plan calls for the establishment of three spatial control transects at three distances from the chemical release point, which have similar environmental and vegetational characteristics as their treatment transect counterparts. The establishment and first sampling of these control transects are currently scheduled for the first quarter of FY97, provided funding is approved.

After approval of the monitoring plan, chemical spill test plans for three experiments were reviewed: (1) Dual Source Experiments using propane and ammonia; (2) KITFOX Add-on Experiments using dibutyl phosphate, kerosene, nitric acid, nitrobenzene, tributyl phosphate, and triethyl phosphate; and (3) KITFOX Add-on Experiment MOROC using hydrochloric acid and nitrogen dioxide. The test plans were reviewed, and it was determined that all experiments would represent minimal risk and no field biological monitoring would be required. Letters documenting these reviews were submitted to the DOE Environmental Protection Division in June and July of 1996.

OFFSITE MONITORING

The HSC was established in the Frenchman Basin in Area 5 as a basic research tool for studying the dynamics of accidental releases of various hazardous materials and the effectiveness of mitigation procedures. The HSC was designed and equipped to (1) discharge a measured volume of a hazardous fluid at a controlled rate on a specially prepared surface; (2) monitor and record downwind gaseous concentrations, operating data, and close-in/downwind meteorological data; and (3) provide a means to control and monitor these functions from a remote location.

The Facility has the capability for releasing large volumes of cryogenic and non-cryogenic liquids at rapid rates through a 500-ft spill line to the experimental area supporting the tank farm. Spill rates for the cryogenic system range from 1,000 to 26,000 gpm with the capability to release the entire contents of both tanks in two minutes. The non-cryogenic system can be released at rates of 500-5,000 gpm with the entire 24,000 gal capable of being released in five minutes.

Test sponsors can vary intake air temperature, humidity, release rate, and release volume in an 8-ft x 16-ft x 96-ft wind tunnel. There are two spill pads available for use in contained open air releases of volumes of 50 - 1,000 gal. Test Area 4 has been added primarily to provide the testing capability for determining the efficacy of totally encapsulated chemical protective suiting materials when exposed to high concentrations of toxic and hazardous gaseous materials.

DOE/NV provides the facilities, security, and technical support, but all costs are borne by the organization conducting the tests. In 1996, four series of tests were conducted involving 28 different chemicals. The plans for each test series were examined by an Advisory Panel that consisted of DOE/NV and EPA's R&IE-LV professional personnel augmented by personnel from the organization performing the tests.

For each test, the R&IE-LV provided an advisor on offsite public health and safety for the Operations Controller's Test Safety Review Panel. At the beginning of each test series and, at other tests depending on projected need, a field monitoring technician from the EPA with appropriate air sampling equipment was deployed downwind of the test at the NTS boundary to measure chemical concentrations that may have reached the offsite area. Samples were collected with a hand-operated Dräger pump and sampling tube appropriate for the chemical being tested. Not all 1996 tests were monitored by R&IE-LV if professional judgement indicated that, based on previous experience with the chemical and the proposed test parameters, NTS boundary monitoring was unnecessary.

The EPA monitors at the NTS boundary, in contact by two-way radio, were always placed at the projected cloud center line.

NON-NTS FACILITY MONITORING

Although permits for the four non-NTS operations (see Table 3.4) included 16 air pollution, 4 wastewater, 4 local hazardous waste generator permits, and 4 hazardous materials permits, effluent monitoring was limited to wastewater discharges at 2 sites (see below). All results from routine monitoring were within the permit limits, and monitoring was limited to the following:

- North Las Vegas Facility (NLVF) - The NLVF self-monitoring report was submitted in October 1996. Two outfalls and the burn pit batch discharge are monitored.

- Remote Sensing Laboratory (RSL) - The Clark County Sanitation District wastewater permit for the RSL required biannual monitoring of two outfalls, quarterly pH, and monthly septage reports. RSL monitoring reports were submitted in May and December 1996.

The Special Technologies Laboratory (STL) holds wastewater permits for the Botello Road and Ekwill Street locations. There is no required self-monitoring.

4.3 ENVIRONMENTAL PERMITS

NTS environmental permits active during 1996, which were issued by the state of Nevada or federal agencies, included 18 air quality permits involving emissions from construction operation facilities, boilers, storage tanks, and open burning; 8 permits for onsite drinking water distribution systems; 1 permit for sewage discharges to lagoon collection systems; 7 permits for septage hauling; 1 incidental take permit for the threatened desert tortoise; and 1 permit for wildlife handling and collection. RCRA Part A and Part B permit applications, based on comments made by the state of Nevada, continued during 1996.

Non-NTS permits included 16 air pollution control permits and 4 sewage discharge permits. Four EPA Generator Identification (ID) numbers were issued to three offsite operations, and four local RCRA-related permits were required at the same three operations.

AIR QUALITY PERMITS

Air quality permits were required for numerous locations at the NTS and at two non-NTS facilities. They are listed in Table 3.4, Chapter 3.

NTS AIR QUALITY PERMITS

Table 4.2 is a listing of state of Nevada air quality operating or construction permits active in 1996. The expiration date indicated in the table for air quality permits to construct, identified with the prefix PC, is identified as "varies," because a permit to construct is generally valid until the time the state performs an inspection and an operating permit is issued.

During 1995, the Bureau of Air Quality began revising all air quality operating permits to meet the new Clean Air Act (CAA) requirements under Title V. The Nevada State Environmental Commission adopted regulations for the establishment of Class I and Class II operating permits. A Class I permit is required for existing and new major sources, incinerator units for solid waste, or affected sources as defined in NAC 445B.289. A major source is defined in the CAA as a source that has the potential (with emission controls) to emit (1) 100 tons or more per year of any one criteria pollutant, (2) 10 tons per year or more of any one hazardous air pollutant, or (3) 25 tons per year of any combination of hazardous air pollutants. A Class II operating permit is required of a source that does not meet the criteria for a major source. To determine whether a source is major or non-major, an emissions inventory must be developed that calculates potential emissions from permitted facilities and "insignificant" activities. A source is determined to be major if the potential emissions as calculated in the inventory meet the above criteria.

An emissions inventory was developed initially by the state of Nevada and then modified by DOE/NV during 1996. The total potential emissions met the criteria for a Class II permit. A Class II permit application for the NTS was originally submitted by DOE/NV to the state in April 1996, prior to development of the emissions inventory. A revised Class II application was submitted in November 1996, and it is anticipated that the Class II permit will be issued in February 1997. When issued, the new permit will replace all existing air quality permits on the NTS, except for the HSC and the open burn permits.

For Open Burn Permit Number 96-27, the Nevada Air Quality Officer must be notified of each burn no later than five days following the burn, either by telephone or written communication. During 1996, two open burns of explosives-contaminated debris were conducted in Area 27. As the Part A and B RCRA permit applications did not include burning of explosives in Area 27, these burn activities were transferred to the Area 11 Explosive Ordnance Disposal (EOD) site that received RCRA permit approval by the state during 1995.

The open burn permit for fire and radiological emergency response training exercises was renewed in October 1996 and issued as Permit Number 97-20. Many of the restrictions in the previous permit, 96-20, were not included in the new permit. Conditions no longer shown on the new permit include the requirement to submit an annual report of training exercises, hours in which exercises must be conducted, the number of training fires to be conducted, and a listing of materials that could not be burned. An annual report of burns was submitted to the state in 1996, which included 12 burn events for radiological emergency response training and 14 fire extinguisher exercises.

The NTS also has a Nevada Hazardous Materials Storage Permit Number 13-94-0034-X, issued by the state Fire Marshall (Table 4.7). This permit is renewed annually when a facility makes a report required by the state's Chemical Catastrophe Prevention Act (see Section 3.1).

In June 1996, a permit was issued for the DOUBLE TRACKS environmental restoration project, located on the Nellis Air Force Range Complex. The permit included a surface disturbance permit, and a site-specific permit attachment for permitted equipment that was relocated from the NTS to Nellis Air Force Range Complex. Upon completion of the DOUBLE TRACKS project in August 1996, a report documenting production amounts and operating hours was submitted to the state.

NON-NTS AIR QUALITY PERMITS

Fifteen air pollution control permits were active for emission units at the Las Vegas Area Operations (LVAO). These permits were issued through the Clark County Health District. Annual renewal is contingent upon payment of permit fees. Permits are amended and revised only if the situation under which the permit has been issued changes. STL has one air pollution control permit. For the other non-NTS operations, no permits have been required or the facilities have been exempted. Table 4.3 lists each of the required permits.

DRINKING WATER SYSTEM PERMITS

Five NTS drinking water system permits issued by the state of Nevada, as shown in Table 4.4, were renewed with new expiration dates. During 1994, the state of Nevada determined that the trucks used for hauling potable water should also have permits, so three additional permits were obtained. These permits were also renewed. No drinking water systems were maintained by non-NTS facilities.

SEWAGE DISCHARGE PERMITS

Sewage discharge permits from the state of Nevada, Division of Environmental Protection are listed in Table 4.5 and require submission of quarterly discharge monitoring reports.

NTS SEWAGE HAULING PERMITS

Permits issued by the state of Nevada Division of Health for six sewage hauling trucks for the NTS were renewed in November 1995 and are listed in Table 4.6.

NON-NTS SEWAGE PERMITS

Sewage permits were required for four locations at non-NTS operations. These included two permits at the LVAO facilities and two at the STL as shown in Table 4.5. Each was issued by the county or local municipality in which the facility was located.

RCRA PERMITS

NTS OPERATIONS

Hazardous waste generation activities at the NTS are performed under EPA Identification

(ID) Number NV3890090001. The NTS continues to be regulated by the 1995 NTS RCRA Hazardous Waste Operating Permit (No. NEV HW009) for the general operation of the facility and the specific operation of the Hazardous Waste Storage Unit and the EOD Unit. Three permit modifications have occurred since October 1, 1996. These modification include changes in the NTS Training Program and personnel changes in the Area 5 and Area 11 Emergency Management Plans. The Pit 3 Mixed Waste Disposal Unit located in the Area 5 RWMS continues to operate under RCRA Interim Status (see Table 4.7).

NON-NTS OPERATIONS

Four EPA Generator ID numbers have been issued to five non-NTS operations. In addition, three local ID numbers were required at one operation. Hazardous waste is managed at all locations using satellite accumulation areas. Three operations have centralized accumulation areas. All hazardous and industrial wastes are transported offsite to RCRA-permitted facilities for approved treatment and/or disposal.

ENDANGERED SPECIES ACT/WILDLIFE PERMITS

Federal and state permits have been issued to DOE/NV and to BN (Table 4.7). These permits are required for the conduct of DOE/NV activities in habitat of the threatened desert tortoise and for the study and collection of this threatened species and other wildlife. (All BN non-NTS facilities are located in existing metropolitan areas and are not subject to the Endangered Species Act.) Annual reports associated with these permits are filed as stipulated in each permit.

DOE/NV activities on the NTS comply with all terms and conditions of a desert tortoise incidental take authorization issued in a Biological Opinion (File Number 1-5-96-F-33) from the U.S. Fish and Wildlife Service (USFWS).

The Nevada Division of Wildlife issued a scientific collection permit to BN (Number S-12888) on January 5, 1996, for the collection and study of various species at the NTS. This permit expired on December 31, 1996.

Table 4.1 Summary of the Onsite Environmental Surveillance Program - 1996

Sample Type	Description	Collection Frequency	Number of Sampling Locations[(a)]	Type of Analysis
Air	Sampling through Whatman GF/A glass fiber filter and a charcoal cartridge	Weekly	44	Gamma spectroscopy, gross α & β,($^{238,239+240}$Pu, quarterly composite).
		Monthly	1	Gamma spectroscopy gross α & β,($^{238,239+240}$Pu quarterly composite).
	Low-volume sampling through silica gel	Biweekly	12	HTO (tritium oxide).
	Low-volume sampling	Weekly	3	^{85}Kr
Tap Water	Grab sample	Monthly	7	Gamma spectroscopy, gross β, ^{3}H, ($^{238,239+240}$Pu, gross α quarterly), (^{90}Sr annually).
Potable Supply Wells	Grab sample	Quarterly	10	Gamma spectroscopy, gross α & β, $^{226\,\&\,228}$Ra, $^{238,239+240}$Pu, ^{3}H enrich. ^{90}Sr
Non-Potable Supply Wells	Grab sample	Quarterly	2	Gamma spectroscopy, gross α & β, ^{3}H, (^{90}Sr annually) $^{238,239+240}$Pu.
Open Reservoirs[(a)]	Grab sample	Annually	15	Gamma spectroscopy, gross β, ^{3}H, $^{238,239+240}$Pu, ^{90}Sr
Natural Springs[(a)]	Grab sample	Annually	8	Gamma spectroscopy, gross β, ^{3}H, $^{238,239+240}$Pu, ^{90}Sr
Containment Ponds	Grab sample	Quarterly	1	Gamma spectroscopy, gross β, ^{3}H, $^{238,239+240}$Pu (^{90}Sr annually)
Sewage Lagoons[(a)]	Grab sample	Quarterly	9	Gamma spectroscopy, gross β, ^{3}H, $^{238,239+240}$Pu (^{90}Sr annually)
External Gamma Radiation Levels	UD-814AS thermoluminescent dosimeters	Quarterly	160	Total quarterly exposure

(a) Not all of these locations were sampled because of inaccessibility or lack of water.

Table 4.2 NTS Active Air Quality Permits - 1996

Permit No.	Facility or Operation	Expiration Date
AP9711-0549	Area 1 Facilities: Shaker Plant Rotary Dryer Aggregate Plant Concrete Batch Plant Sandbag Facility	03/21/00
AP9711-0554	Area 6 Facilities: Cementing Equip. (silos) Decontamination Facility Boiler Diesel Fuel Tank Gasoline Fuel Tank Slant Screen	11/21/99
AP9711-0555	Area 23 Facilities: Building 753 Boiler Cafeteria Boilers (2) Diesel Fuel Tank Gasoline Fuel Tank Slant Screen NTS Surfaces Disturbances WSI Incinerator	04/14/96
AP9711-0578	Area 5 Facilities: Slant Screen	05/05/00
AP9711-0664	Navy Thermal Treatment Unit	02/23/01
AP9611-0683	DOUBLE TRACKS Surface Disturbance (TTR)	06/12/01
OP 1975[(a)]	Area 2 Portable Stemming System	12/04/94
OP 1976[(a)]	Area 2 Portable Stemming System	12/04/94
OP 2625	Area 5 Spill Test Facility	11/02/97
OP 2744	Area 12 Cafeteria Boiler	03/23/98
OP 2849	Area 12 Concrete Batch Plant	12/02/98
OP 2850	Area 6 Portable Field Bins	12/02/98
PC 2988	Area 3 Two-Part Epoxy Batch Plant	Varies
PC 3246	Area 3 Mud Plant	Varies
PC 3774	Area 6 Portable Stemming System	Varies
OP 96-20	NTS Open Burn - Training	10/24/96
OP 95-24	Area 4 BEEF Facility	02/29/96

(a) Permits renewal submitted.

Table 4.3 Active Air Quality Permits, Non-NTS Facilities - 1996

Permit No.	Facility or Operation	
Las Vegas Area Operation[a]		
A38702	Hamada Offset Press, NLVF	02/28/98
A06501	Spray Paint Booth, NLVF	02/28/98
A06505	Time Saver Aluminum Sander, NLVF	02/28/98
A06506	Abrasive Blasting, NLVF	02/28/98
A06507	Trinco Dry Blast with Dry Bag Dust Filters, NLVF	02/28/98
A38701	Spray Paint Booth, NLVF	02/28/98
A06502	Vapor Degreasers #1	02/28/98
A06503	Three Emergency Generators, and Emergency Fire Control Equipment, NLVF	02/28/98
A38703	Emergency Generator, NLVF	02/28/98
A34801	Columbia Boiler Model WL-180, Penthouse #1, RSL	02/28/98
A34802	Columbia Boiler Model WL-90, Penthouse #1, RSL	02/28/98
A34803	4.0 MM BTU Water Heater #2, RSL	02/28/98
A34804	Cummins Emergency Generator and Emergency Fire Control Pump, RSL	02/28/98
A34805	Spray Paint Booth, RSL	02/28/98
A34811	Excimer Laser, RSL	Indef.
Special Technologies Laboratory[a]		
8477	Permit to Operate a 12 Gallon Capacity Vapor Degreaser	Indef.

(a) An annual fee is paid on these permits.

Table 4.4 NTS Drinking Water Supply System Permits - 1996

Permit No.	Area(s)	Expiration Date
NY-5024-12NC	Area 1	09/30/97
NY-4099-12C	Area 2 & 12	09/30/97
NY-360-12C	Area 23	09/30/97
NY-4098-12NCNT	Area 25	09/30/97
NY-5000-12NCNT	Area 6	09/30/97
NY-835-12NCNT	Sitewide Truck	09/30/97
NY-836-12NCNT	Sitewide Truck	09/30/97
NY-841-12NCNT	Sitewide Truck	09/30/97

Table 4.5 Sewage Discharge Permits - 1996

Permit No./Location	Areas	Expiration Date
	NTS Permits	
GNEV93001[a]	NTS General Permit	01/31/99
	Off-NTS Permits	
Las Vegas Area Operations		
CCSD-032/Remote Sensing Laboratory[a]		06/30/97
VEH-112/North Las Vegas Facility[a]		12/31/97
Special Technologies Laboratory		
AII-204/ Santa Barbara, California		12/31/98
III-331/ Santa Barbara, California		12/31/98

(a) Owner/Operator effluent monitoring required by permit.

Table 4.6 Permits for NTS Septic Waste Hauling Trucks - 1996

Permit Number	Vehicle Identification Number	Expiration Date
NY-17-03311	Septic Tank Pumper E-104573	11/30/97
NY-17-03312	Septic Tank Pumper E-104296	11/30/97
NY-17-03313	Septic Tank Pumper E-105293	11/30/97
NY-17-03314	Septic Tank Pumper E-105299	11/30/97
NY-17-03315	Septic Tank Pumper E-105919	11/30/97
NY-17-03317	Septic Tank Pumper E-105918	11/30/97
NY-17-03318	Septic Tank Pumping Subcontractor Vehicle	11/30/97

Table 4.7 Miscellaneous Permits

Permit	Type and Purpose	Expiration
NEV HW009	RCRA -- General NTS operation: Operation of Two Facilities	05/05/00
File 1-5-96-F-33	USFWS -- Desert Tortoise Incidental Take Authorization	08/00/06
NEV S-12888	Wildlife -- Collection and Study of Species on the NTS	12/31/96
Interim Status	RCRA Part B -- Pit 3 Mixed Waste Disposal Operation	On Permit Approval
13-94-0034-X	State Chemical Catastrophe Prevention Act Compliance	Renewal on report submission

The Northwest Region of the Mesas

5.0 RADIOLOGICAL MONITORING RESULTS

Radiological monitoring results from onsite environmental programs included effluent sampling results for airborne emissions and liquid discharges to containment ponds and environmental sampling results for onsite surveillance conducted by Bechtel Nevada (BN). Offsite environmental surveillance was conducted by the U.S. Environmental Protection Agency's (EPA's) Radiation and Indoor Environments National Laboratory - Las Vegas (R&IE-LV). Onsite monitoring results indicated that environmental concentrations of radioactivity resulting from Nevada Test Site (NTS) air emissions were statistically no different than background, except in the immediate vicinity of the emissions. These airborne emissions, and radioactive liquid discharges to onsite containment ponds, produced concentrations that were only a fractional percentage above background in terms of potential exposure of onsite workers. Offsite monitoring indicated that environmental radionuclide concentrations and exposure rates were statistically no different than background, with no measurable exposure of offsite residents from current NTS activities. Small amounts of tritium were detected in some vegetation collected onsite.

5.1 RADIOLOGICAL EFFLUENT MONITORING

Since no nuclear tests were performed at the NTS during 1996, monitoring efforts for radioactive effluents consisted primarily of routine air sampling and periodic sampling of liquid discharges to the Area 12 tunnel containment ponds. Air samples collected in and around the Area 5 Radioactive Waste Management Site (RWMS-5) indicated that no measurable radioactivity was detectable away from the area, although trace amounts of tritium were detected at its boundary. Samples in Area 3, at the Area 9 Bunker, and a few other areas showed above-background levels of $^{239+240}$Pu. Measured ^{85}Kr levels indicated little, if any, emission from Pahute Mesa as had been detected previously. By using data from the station with the highest annual average, replacing the diffuse source with an equivalent point source, and using CAP88-PC, upper limits of 0.27 Ci (10 GBq) of $^{239+240}$Pu, and 1.2 Ci (44 GBq) of ^{3}H were estimated for airborne emissions from the various contaminated areas on the NTS. The primary liquid effluent was water from area 20 characterization wells collected in containment ponds. Influents to these ponds contained 120 Ci (4.4 Tbq) of tritium.

EFFLUENT MONITORING PLAN

An important part of the "NTS Environmental Monitoring Plan" (EMP) (U.S. Department of Energy [DOE] 1991c), as required by DOE Order 5400.1 (DOE 1990b), is the onsite Effluent Monitoring Plan, in which the Area 12 tunnels, the Area 6 Decontamination Facility, nuclear test sites, RWMSs, and all other potential effluent sites throughout the NTS have been assessed for their potential to contribute to the dose to offsite residents.

Airborne radioactive effluents are the emissions on the NTS with the greatest potential for reaching members of the public. All radioactive liquid effluents from activities on the NTS are contained within its boundaries. For all activities on the NTS, the estimated effective dose equivalent to any member of the public from all airborne radionuclide emissions is much less than one mrem/yr. Requirements of the "National Emission Standards for Hazardous Air Pollutants" (NESHAP) are set forth in Title 40 C.F.R. 61.93(b)(4)(ii), and in Regulatory Guide DOE/EH-0173T (DOE 1991d). Compliance with these requirements is achieved by periodic measurements of effluents to confirm the low emission levels. For consistency with past practices, the monitoring methods and procedures developed over the years are being used with changes being introduced as conditions warrant.

AIRBORNE EFFLUENTS

No nuclear tests were performed during 1996, so there were no test-related effluents. The majority of radioactive air effluents at the NTS in 1996 originated from tritiated water (HTO) seeping from E Tunnel and pumped from characterization wells, resuspension of contaminated surface soil, and seepage of ^{85}Kr from underground tests with various amounts of other radionuclides calculated from monitoring data (see Table 5.1 for a listing of onsite releases).

An increase in efforts to monitor radioactive air emissions at the NTS began in November 1988, as a result of requirements in DOE Order 5400.1, DOE Order 5400.5, and Regulatory Guide DOE/EH-0173T, as well as from EPA requirements in the NESHAP, Title 40 C.F.R. 61. Known and potential effluent sources throughout the NTS were assessed for their potential to contribute to public dose and were considered in designing the Site Effluent Monitoring Plan, which forms part of the "Environmental Monitoring Plan, Nevada Test Site and Support Facilities," DOE/NV/10630-28, published in November 1991. This plan was updated in 1992 and 1993.

CHARACTERIZATION WELL EFFLUENT

As part of environmental restoration activities, the groundwater under the NTS is being characterized by drilling special wells for measuring the characteristics of NTS aquifers. In 1996, such wells were drilled near the cavity created by a nuclear explosive test. The water pumped from these wells into containment ponds was contaminated with tritium. Measurement of the tritium concentration and volume of water discharged gives a source term for this activity. The total discharged is shown in Table 5.1.

TUNNEL COMPLEX EFFLUENT

As noted above, there was fluid drainage from the E Tunnel complex during 1995. The HTO content is shown in Table 5.1.

RADIOACTIVE WASTE MANAGEMENT SITES

A permanent particulate sampler was located within disposal pit 5 at the RWMS-5. The 1996 annual average concentration of gross beta activity in samples taken within Pit 5 was 1.8×10^{-14} µCi/mL (0.67 mBq/m^3), the same as the site-wide average. Pit 5 was opened and this air sampler was installed in 1995. These results indicate that, except for trace amounts of tritium as noted below, the operations in the RWMS-5 are not contributing radiological effluents to the NTS environment. Average annual gross beta and plutonium results for 1996, from all the samples collected at the RWMS-5 facility, are shown in Figure 5.1.

Nine HTO samplers were located on the perimeter of RWMS-5 as shown in Figure 5.2. The 1996 annual average HTO concentration for the nine stations was 3.6×10^{-6} pCi/mL (0.13 Bq/m^3). The individual

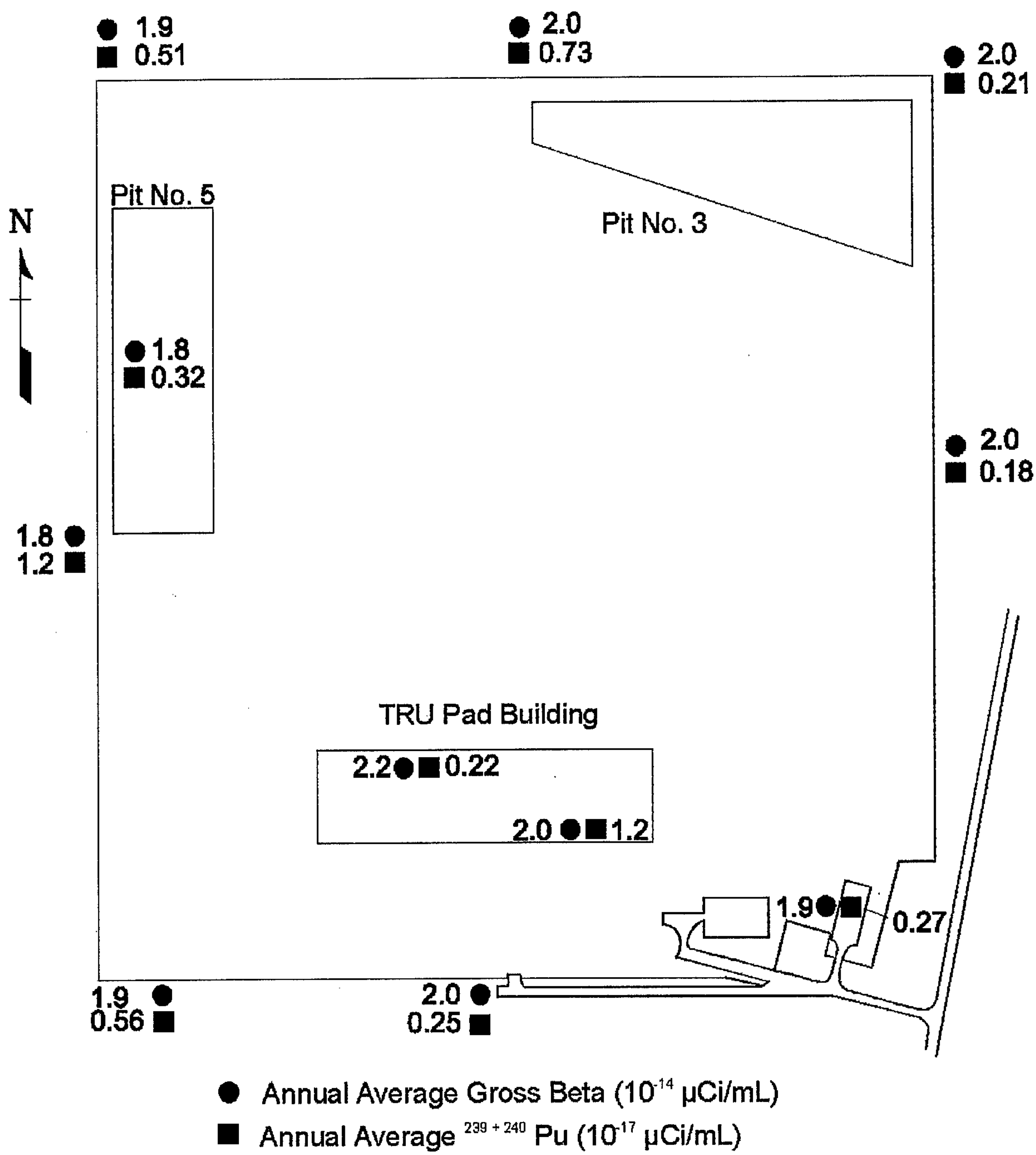


Figure 5.1 RWMS-5 Air Sampling Annual Average Results - 1996

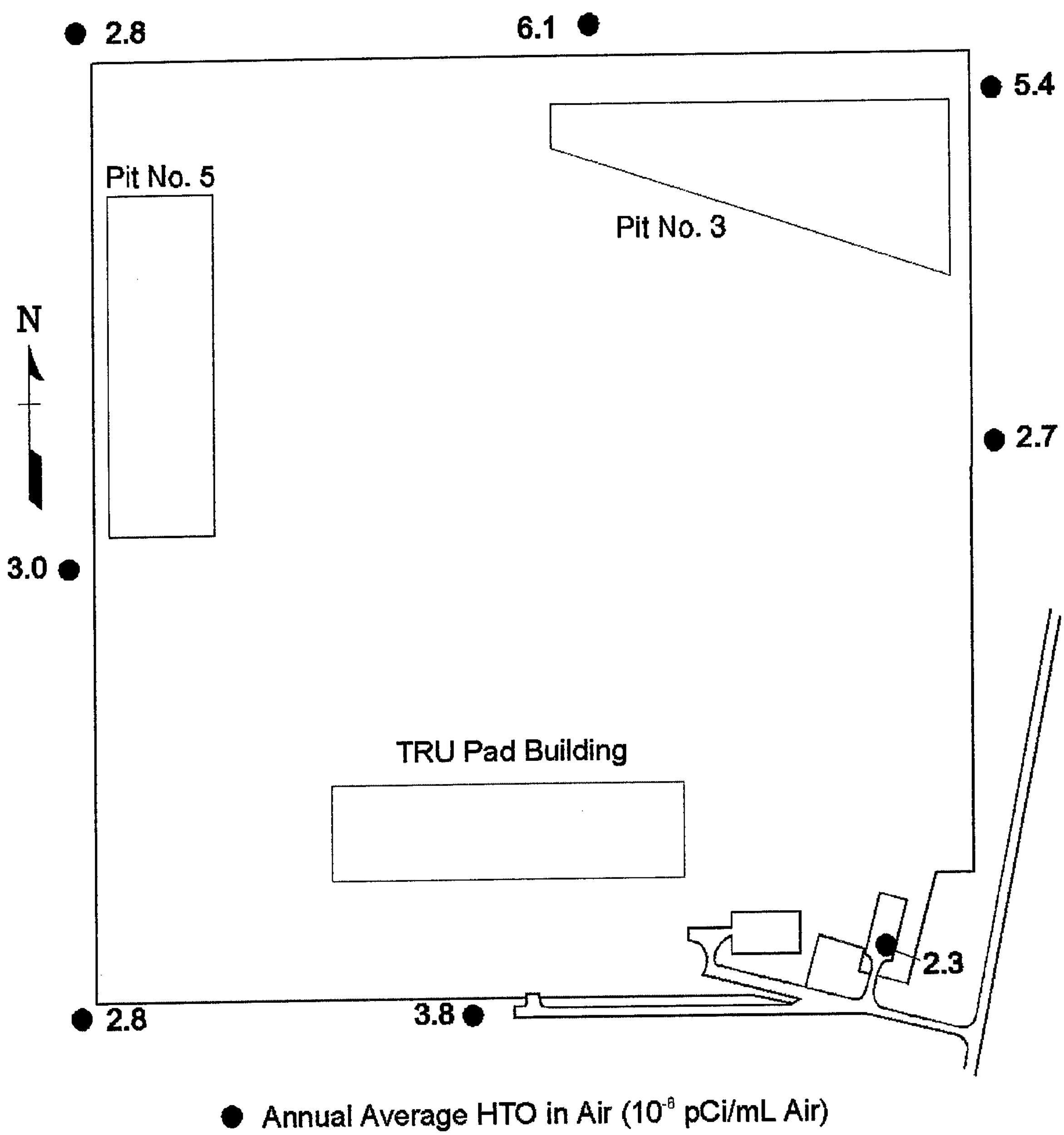


Figure 5.2 RWMS-5 HTO Annual Average Results - 1996

values are displayed in Figure 5.2. This value is less than 0.06 percent of the derived concentration guide (DCG) for HTO vapor in air.

The Area 3 RWMS (RWMS-3) is used for disposal of radiologically contaminated waste in packages that are unsuitable for disposal in the Area 5 facility. This waste is buried in subsidence craters much like waste is buried at the RWMS-5. The RWMS-3 is surrounded by four permanent particulate samplers located approximately north, south, east, and west of the burial pit. Several thermoluminescent dosimeters (TLDs) were distributed at the RWMS-3 and surrounding areas.

Although a statistical analysis shows that there are differences between NTS areas in levels of environmental exposure, there were not enough data to determine the pattern of the differences. Nevertheless, an examination of annual average exposure rates shows that the gamma exposure rates detected at the perimeter fences of RWMS-3 and RWMS-5 are similar to gamma exposure measurements taken at other locations on the NTS.

The gross beta 1996 annual average at the RWMS-3 of 1.6 x 10^{-14} µCi/mL was slightly lower than the 1995 average and was not statistically different at the 5 percent significance level from the site-wide average of 2.0 x 10^{-14} µCi/mL (0.74 mBq/m^3). However, $^{239+240}$Pu results indicated that levels of these radionuclides in the vicinity of the RWMS-3 were consistently above the NTS average. Vehicular traffic and operational activities in Area 3 apparently resuspended plutonium that was deposited on the soil surface during earlier nuclear explosives testing. These elevated $^{239+240}$Pu levels indicated that Area 3 is a diffuse source of effluents. Air sampling results are displayed in Tables 5.2, 5.3, 5.4, and 5.5.

LIQUID DISCHARGES

The radioactive liquid discharges at the NTS in 1996 originated from tunnel drainage and from water pumped from characterization wells in Area 20. Typically, all liquid discharges within the NTS have been held in containment ponds. Monthly grab samples were taken from each pond and, where possible, from the influent.

Radioactivity in liquid discharges released to the containment ponds was monitored to assess the efficacy of tunnel sealing and provide a quantitative and qualitative annual summary of the radioactivity released onsite for use in calculating doses for NESHAP compliance.

TUNNELS

Rainier Mesa in Area 12 is the location where nuclear tests were conducted within tunnels by the U.S. Department of Defense (DOD). Seepage water discharged from these tunnels was collected in containment ponds as described above. This water was usually contaminated with radionuclides, mainly ^{3}H, generated during nuclear tests in previous years.

Liquid effluents were discharged during 1996, only from E Tunnel. The liquid discharge from this tunnel decreased during 1996, compared to previous years, because of success in sealing the tunnels. Monitoring results indicated that the water discharged from E tunnel contained measurable quantities of ^{3}H and small amounts of other radionuclides. Total quantities of ^{3}H, ^{238}Pu, $^{239+240}$Pu, ^{90}Sr, ^{137}Cs, and beta activity were determined for this liquid effluent source and are listed in Table 5.1. No liquid effluents were discharged offsite.

CHARACTERIZATION WELL EFFLUENT

The total volume of liquid discharged to containment ponds from the characterization wells in Area 20 during 1996 was 2,980,000 gal (11,300 m^3) that contained 119.9 Ci of tritium. This included wells drilled in 1995 that were still being pumped and a new set of wells for this year.

DECONTAMINATION FACILITY

Since no nuclear tests were conducted in 1996, only insignificant amounts of materials were treated at the Decontamination Facility in Area 6. Until a new lined containment pond is constructed, any effluent from that facility will be captured in holding tanks and held for disposal.

5.2 RADIOLOGICAL ENVIRONMENTAL SURVEILLANCE

Onsite surveillance of airborne particulates, noble gases, and HTO vapor indicated concentrations that, with a few exceptions, were generally not statistically different from background concentrations. Tritium effluent was detectable from the low-level radioactive waste (LLW) site in Area 5 and plutonium was detectable on air samples at several locations on and off the NTS. Surface water samples collected from open reservoirs or natural springs and industrial-purpose water, exclusive of tunnel ponds, gave no indication of statistically significant contamination levels. External gamma exposure monitoring results indicated little change from 1995. A special environmental study measured tritium in water of plants collected NTS-wide. Results of offsite environmental surveillance by the EPA R&IE-LV showed that no NTS-related radioactivity was detected by the offsite monitoring networks and that there were no apparent net exposures detectable by the offsite dosimetry network.

ONSITE ENVIRONMENTAL SURVEILLANCE

At the end of 1996, the onsite radiological surveillance networks consisted of 45 air sampling stations; 3 radioactive noble gas sampling stations; 12 HTO vapor sampling stations; surface water samples from 8 open water supply reservoirs, 7 springs, 8 containment ponds plus an effluent, and 8 sewage lagoons; groundwater samples from 10 potable and 2 non-potable supply wells and 7 tap water locations; and 160 locations where TLDs measure gamma exposures. Summary tables for each of the analytes for this program are placed at the end of this chapter. Individual results for each collected sample are published separately and may be found in the "Environmental Data Report for the Nevada Test Site - 1996" (DOE/NV/11718-138, in prep.).

RADIOACTIVITY IN AIR

A total of 49 air sampling stations were operated at various times during the year. Four stations were deleted and four new ones added, so the network ended the year with 45 stations. Solar-photovoltaic, battery-powered samplers were placed at ten locations in or near contaminated areas where commercial power was unavailable. At each of the stations, particulate samples were collected weekly on glass-fiber filters. The filters were counted for gamma and gross alpha/beta activity, composited monthly for RWMS samplers, or quarterly for the remainder of the sampling locations, and then analyzed for ^{238}Pu and $^{239+240}Pu$. Due to the lack of any sources for airborne halogens, charcoal filters were not used in the air samplers this year.

In an effort to reduce analytical costs, gross alpha analyses of collected particulate filters was begun about midyear and compared to the later plutonium analyses. In general, there was no relation between gross alpha analyses (units of 10^{-15} μCi/mL) and $^{239+240}Pu$ analyses (units of 10^{-18} μCi/mL). However, all gross alpha analyses were above the mean minimum detectable concentration (MDC), so this monitoring will continue until the source of the alpha activity is identified. Air monitoring for the noble gases began at six fixed locations that were reduced to three by year's end. These air samples were collected weekly. A distillation process separated the radioactive noble gases from the sample for measurement.

HTO vapor was monitored at 16 locations on the NTS, but for only a portion of the year at five locations which were either terminated or added during the year. There were 12 sampling locations by the end of the year. Samples were collected every two weeks and analyzed for ^{3}H. Liquid scintillation counting was used for these measurements.

For the purpose of comparing measured quantities of airborne radioactivity to the Derived Air Concentrations (DAC), the guides for occupational exposures found in DOE Order 5480.11, and to the DCG, the guides for exposures to members of the general public found in DOE Order 5400.5, the following assumptions were made:

- The chemical species of the radionuclides detected was unknown so the most restrictive DAC or DCG was used (almost always Class Y compounds which take on the order of years to clear from the respiratory system). The DCG and DAC values used are listed in Table 5.6.
- For air sampling results, all of the gross beta activity detected was assumed to be ^{90}Sr, and the gross alpha activity was assumed to be naturally occurring uranium, thorium, and progeny.

AIR SAMPLING RESULTS

GROSS ALPHA

Figure 5.3 displays the average NTS gross alpha results for 1996. Air particulate samples were held for five to seven days prior to gross alpha/beta counting and gamma spectrum analysis, to allow for the decay of radon and radon progeny. Table 5.2 presents the network arithmetic averages, minimums, and maximums for gross alpha in air during 1996. All results exceeded the MDC. The network 1996 annual average gross alpha concentration was 2.1×10^{-15} µCi/mL (0.08 mBq/m^3). This concentration is about 0.03 percent of the $^{239+240}Pu$ DAC listed in DOE Order 5480.11 and about 100 percent of the 10 mrem DCG in DOE Order 5400.5. A statistical evaluation of the gross alpha concentrations indicated that a lognormal distribution provides an adequate approximation to the true distribution.

GROSS BETA

Figure 5.4 displays the average NTS gross beta results for 1996, and Table 5.3 presents the network arithmetic averages, minimums, and maximums for gross beta in air. All results exceeded the MDC, except for instances where the sample volume was unusually low. The network 1996 annual average gross beta concentration was 1.8×10^{-14} µCi/mL (0.67 mBq/m^3), slightly less than in 1995. This concentration is about 0.001 percent of the ^{90}Sr DAC listed in DOE Order 5480.11 and less than 3 percent of the 10 mrem DCG in DOE Order 5400.5. A statistical evaluation of the gross beta concentrations indicated that a lognormal distribution provides an adequate approximation to the true distribution. Although the average gross beta concentration for all stations was similar to last year's, the trend of weekly averages was different, being almost sinusoidal rather than increasing gradually throughout the year.

PLUTONIUM

The composite filter samples from each particulate sampling location were analyzed for ^{238}Pu and $^{239+240}Pu$. Figure 5.5 shows the airborne $^{239+240}Pu$ annual average results for each of the sampling locations. Tables 5.4 and 5.5 list the maximum, minimum, annual arithmetic mean, standard deviation, and the mean expressed as a percentage of the DCG for each sampling location, for $^{239+240}Pu$ and ^{238}Pu, respectively. The ranges in the annual mean concentrations for ^{238}Pu and

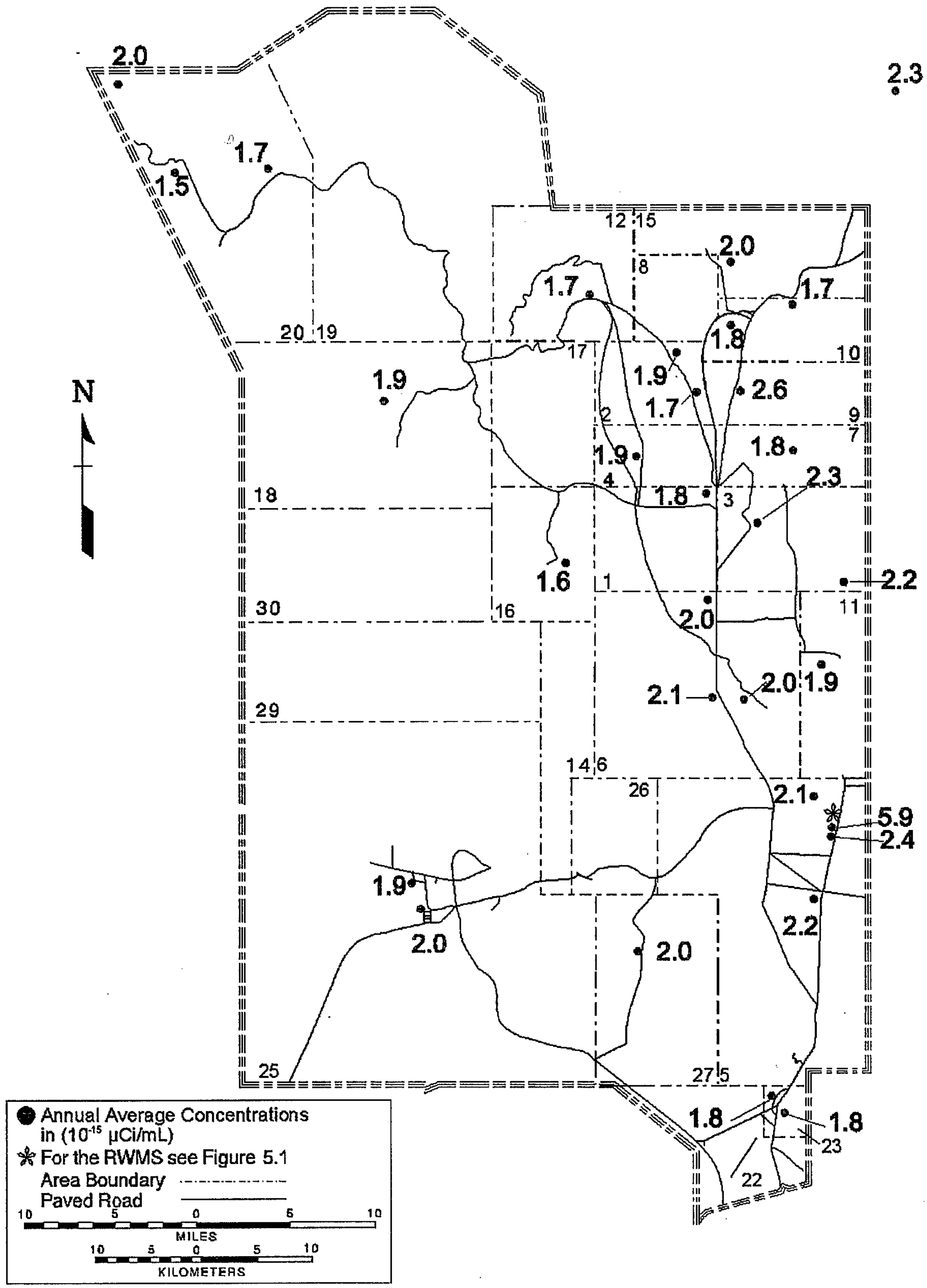


Figure 5.3 NTS Airborne Gross Alpha Annual Average Concentrations - 1996

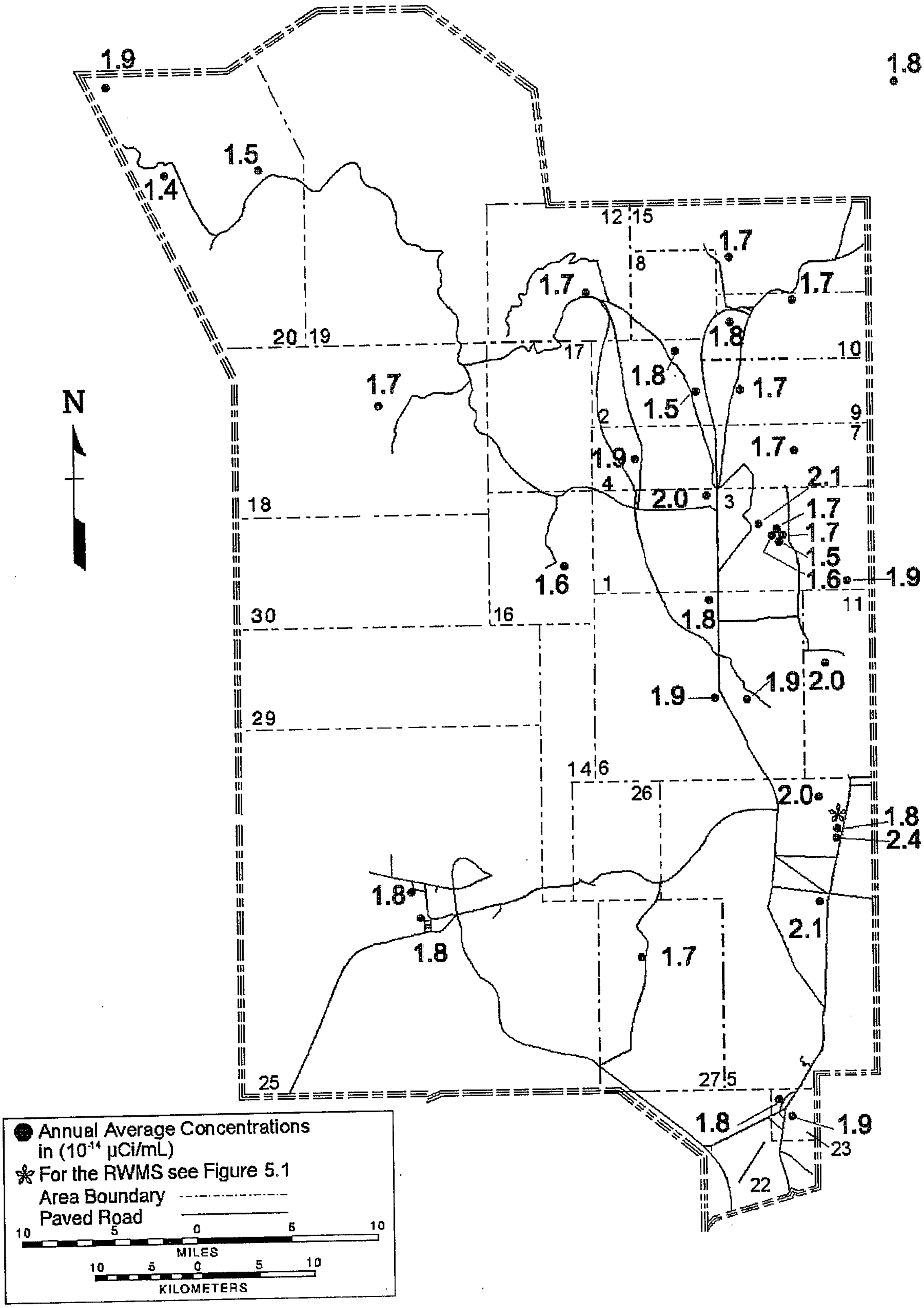


Figure 5.4 NTS Airborne Gross Beta Annual Average Concentrations - 1996

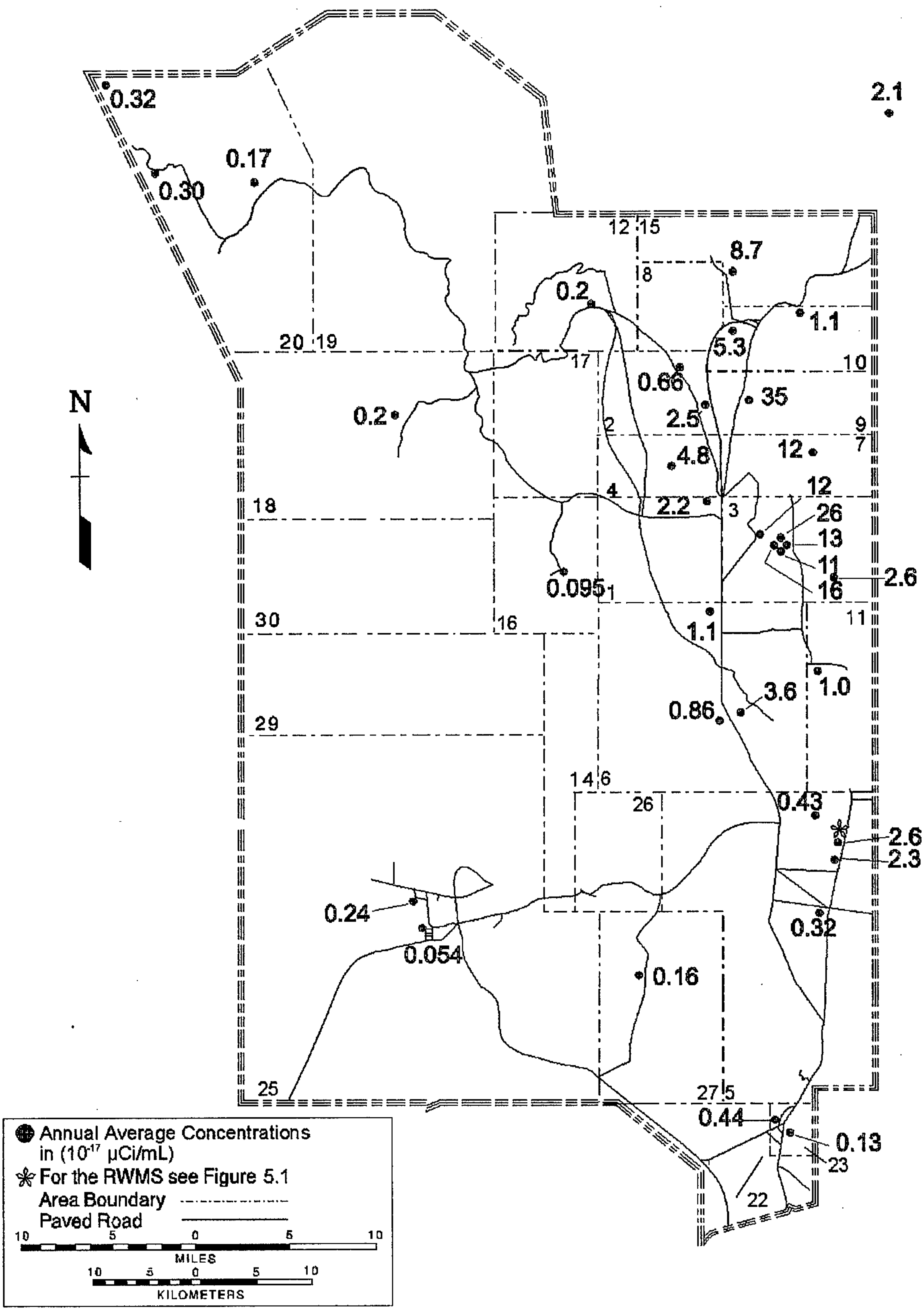


Figure 5.5 NTS Airborne $^{239+240}$Pu Annual Average Results - 1996

$^{239+240}Pu$ for all stations were -0.018 to 1.1 x 10^{-17} µCi/mL and 0.054 to 45 x 10^{-17} µCi/mL (-0.007 to 0.41 and 0.02 to 17 µBq/m^3), respectively. The arithmetic mean and standard deviation of ^{238}Pu in air for all stations were (1.0 ± 2.5) x 10^{-18} µCi/mL (0.037 ± 0.093 µBq/m^3). Most observed values of ^{238}Pu were well below the limit of detection. The arithmetic mean and standard deviation of $^{239+240}Pu$ in air for all stations were (5.2 ± 14) x 10^{-17} µCi/mL (1.9 ± 5.2 µBq/m^3). The network arithmetic mean for $^{239+240}Pu$ was 62 percent higher than the 1995 mean concentration, an increase that is within the statistical variation of all results.

During 1996, the maximum annual average $^{239+240}Pu$ concentration was found at the Area 52 DOUBLE TRACKS (probably due to cleanup activities) and the next highest at the Area 9 9-300 Bunker sampling locations. Results from samples taken at the DOUBLE TRACKS site averaged 45 x 10^{-17} µCi/mL (17 µBq/m^3) during 1996. This quantity was less than 1 percent of the DAC and 23 percent of the 10 mrem DCG. Historically, the highest concentrations of $^{239+240}Pu$ have occurred in Areas 3 and 9. A statistical analysis of the $^{239+240}Pu$ results suggests that, due to the heterogeneity of the variances, the differences among the areas are not statistically significant.

The presence of plutonium on the NTS is primarily due to atmospheric tests and tests in which nuclear devices were detonated with high explosives ("safety shots"). These latter tests spread low-fired plutonium in the eastern and northeastern areas of the NTS and in several areas in near offsite locations (see Chapter 2, Figure 2.3 for these locations). Two decades later, measurable levels of plutonium in air are still present, because meteorological and operational activities and vehicular traffic in these areas resuspend some of the ^{238}Pu and $^{239+240}Pu$ in the soil.

GAMMA

The glass-fiber filters used to collect particulates were analyzed by gamma spectroscopy. The only radionuclides detected by gamma spectroscopy were naturally occurring in the environment (^{40}K, ^{7}Be, and members of the uranium and thorium series), except for traces of an event-related radionuclide ,^{137}Cs, which was detected in nine samples. The concentration of ^{137}Cs in these samples was <0.1 percent of the 10 mrem DCG.

NOBLE GAS SAMPLING RESULTS

The three locations at which compressed air samples were routinely collected throughout the year are shown in Figure 5.6 with the annual averages of the ^{85}Kr analyses. All average concentrations were well below the DCG values of 3 x 10^{-7} µCi/mL (1.1 x 10^4 Bq/m^3) for ^{85}Kr. Summaries of the results are listed in Table 5.7. Individual results for each collected sample are published separately and may be found in the "Environmental Data Report for the Nevada Test Site - 1996" (DOE/NV/11717-138, in prep.).

As in the past, the levels of ^{85}Kr (half-life of 10.76 years) observed in the samples were from worldwide nuclear power and fuel processing operations, with possibly a small contribution of ^{85}Kr from underground nuclear tests conducted at the NTS. Xenon-133 analyses were not done this year, because its short half-life of 5.27 days and the moratorium on tests makes it unlikely that any would be detected on the NTS.

Again this year, the highest annual average concentration occurred in Area 20, at the Area 20 Camp, 26 x 10^{-12} µCi/mL (0.96 Bq/m^3), which is <0.01 percent of the 10 mrem DCG. The higher average for the samples collected in Area 20 was expected as it has been consistently higher in the past. However, statistical evaluation of these data showed that the average concentration for Area 20 was not significantly higher than the other averages at the 5 percent significance level. Each location had environmental levels of ^{85}Kr with occasional spikes attributed to

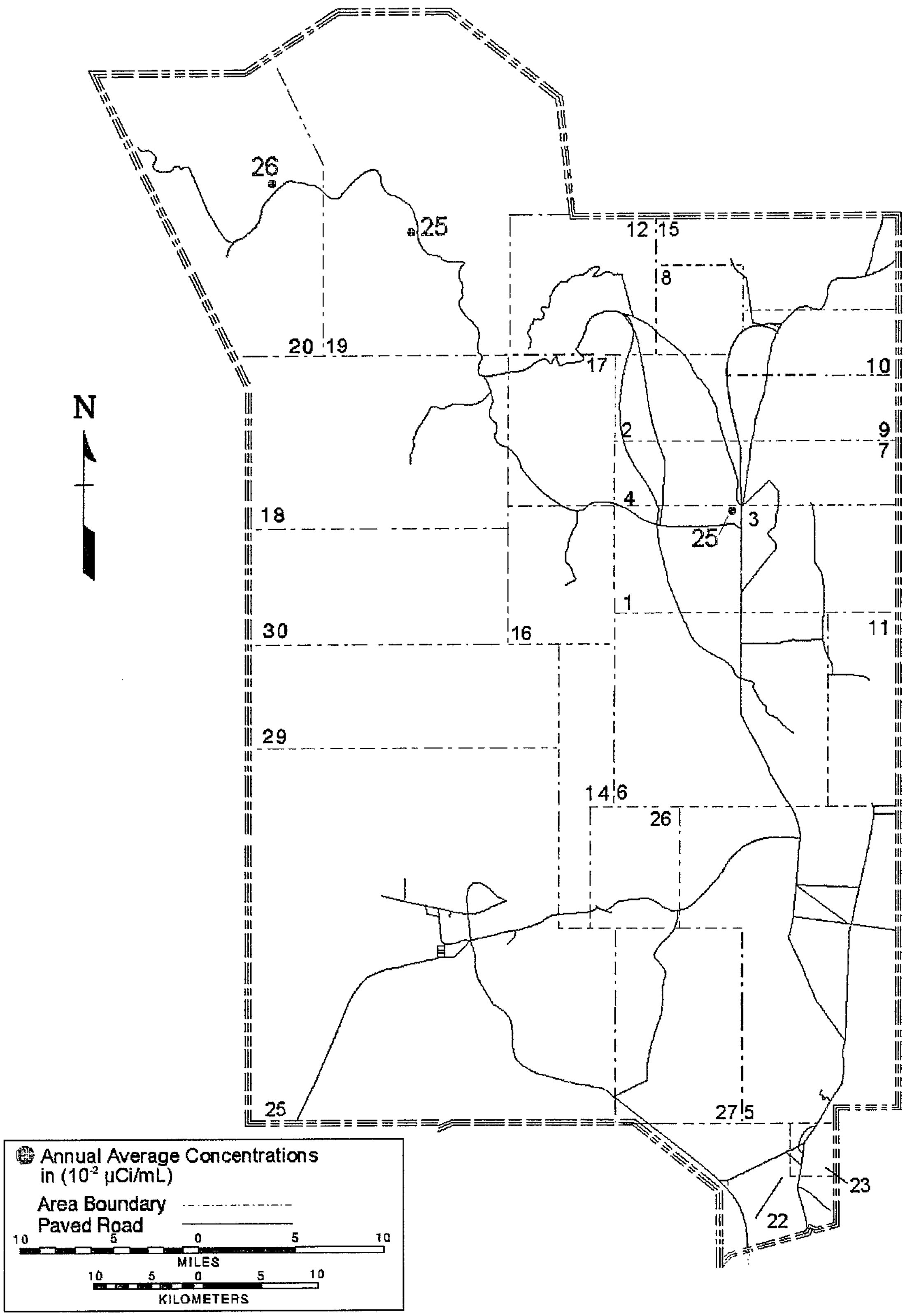


Figure 5.6 NTS ^{85}Kr Annual Average Concentrations - 1996

analytical problems and/or seepage of noble gases from the Pahute Mesa area. All data since 1982 were evaluated for any trend in concentrations. The network average ^{85}Kr concentrations were found to have remained relatively constant over this period.

TRITIATED WATER VAPOR SAMPLING RESULTS

The concentrations of HTO vapor determined from sampling conducted at the 16 NTS sampling stations are summarized in Table 5.8. Individual results for each collected sample and a statistical evaluation of the data are published separately and may be found in the "Environmental Data Report for the Nevada Test Site - 1996," (DOE/NV/11718-138, in prep.).

As shown in Table 5.8, the location having the highest annual average tritium concentration was the Area 12 E Tunnel Pond station with an average of 12 x 10^{-6} pCi/mL (0.44 Bq/m^3). This average was only 0.12 percent of the 10 mrem DCG for tritium. The annual average concentration at each station is shown in Figure 5.7 with the data for RWMS-5 in Figure 5.2.

The data were found to be lognormally distributed, therefore the natural logarithms of the individual concentrations were used in a one-way analysis of variance to test for differences between station means. This statistical testing also identified two separate groups of stations; the higher group includes stations known to be near sources of tritium, such as RWMS-5, the SEDAN crater, and the E Tunnel pond.

A review of the historical trend in concentrations at the NTS over the years 1982 through 1996 was made. The review found that the average tritium concentration for all environmental stations showed an exponential decrease from about 1.4 x 10^{-4} pCi/mL in 1982 to about 4.0 x 10^{-5} pCi/mL in 1987, followed by a decrease to the current value, 3.5 x 10^{-6} pCi/mL. The same trend was observed at all environmental stations, including the RWMS stations, which implies that the RWMS, although emitting measurable tritium, may not be the only source of tritium at the NTS.

RADIOACTIVITY IN SURFACE WATER

Surface water sampling at the NTS was conducted at eight open reservoirs, seven natural springs, eight containment ponds and an effluent, and eight sewage lagoons. The locations of these sources are shown in Figure 4.4. When water was available and the weather permitted, a grab sample was taken quarterly. The sample was analyzed for ^{3}H, gross beta, gamma activity, ^{238}Pu, $^{239+240}$Pu, and ^{90}Sr according to the schedule shown in Table 4.1. Sources of surface water were, for the most part, man-made; i.e., created for or by NTS operations. There is no known human consumption of any surface water on the NTS.

The annual average for each radionuclide analyzed in surface waters is presented in Table 5.9, along with the results from analysis of tunnel effluents. The annual averages for open reservoirs and natural springs (see Figure 5.8) are compared to the DCGs for ingested water. Gamma results for all sample locations indicated that radionuclide levels were consistently below the detection limit, except for samples from the E Tunnel effluent and ponds which had concentrations ranging up to 1.5 x 10^{-6} µCi/mL.

With the exception of containment ponds, no annual average concentration in surface waters was found to be statistically different from any other at the 5 percent significance level. The analytical results from the Area 12 containment ponds showed measurable quantities of radioactivity and displayed identifiable trends.

OPEN RESERVOIRS

Open reservoirs have been established at various locations on the NTS for industrial uses. The annual average concentrations of

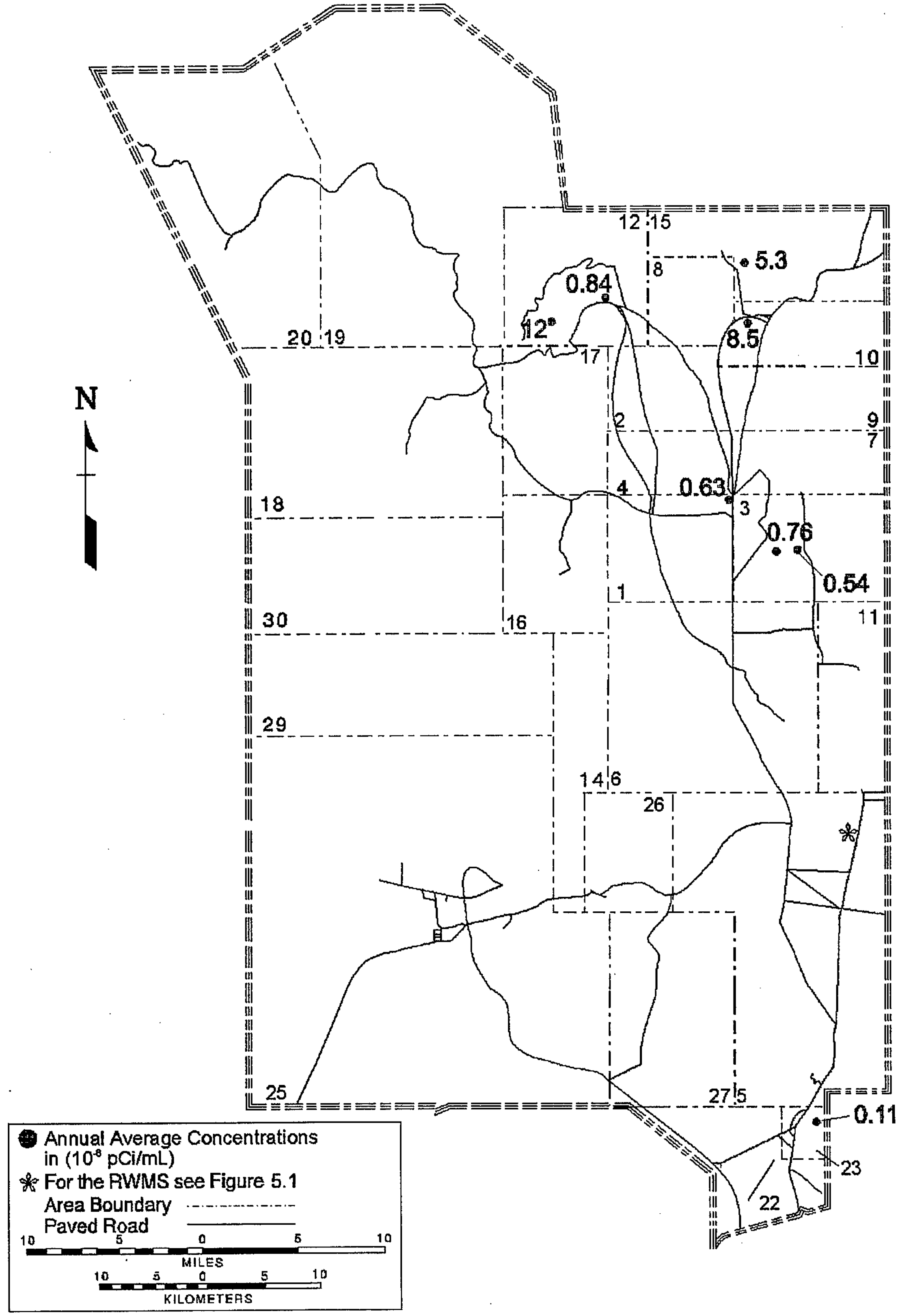
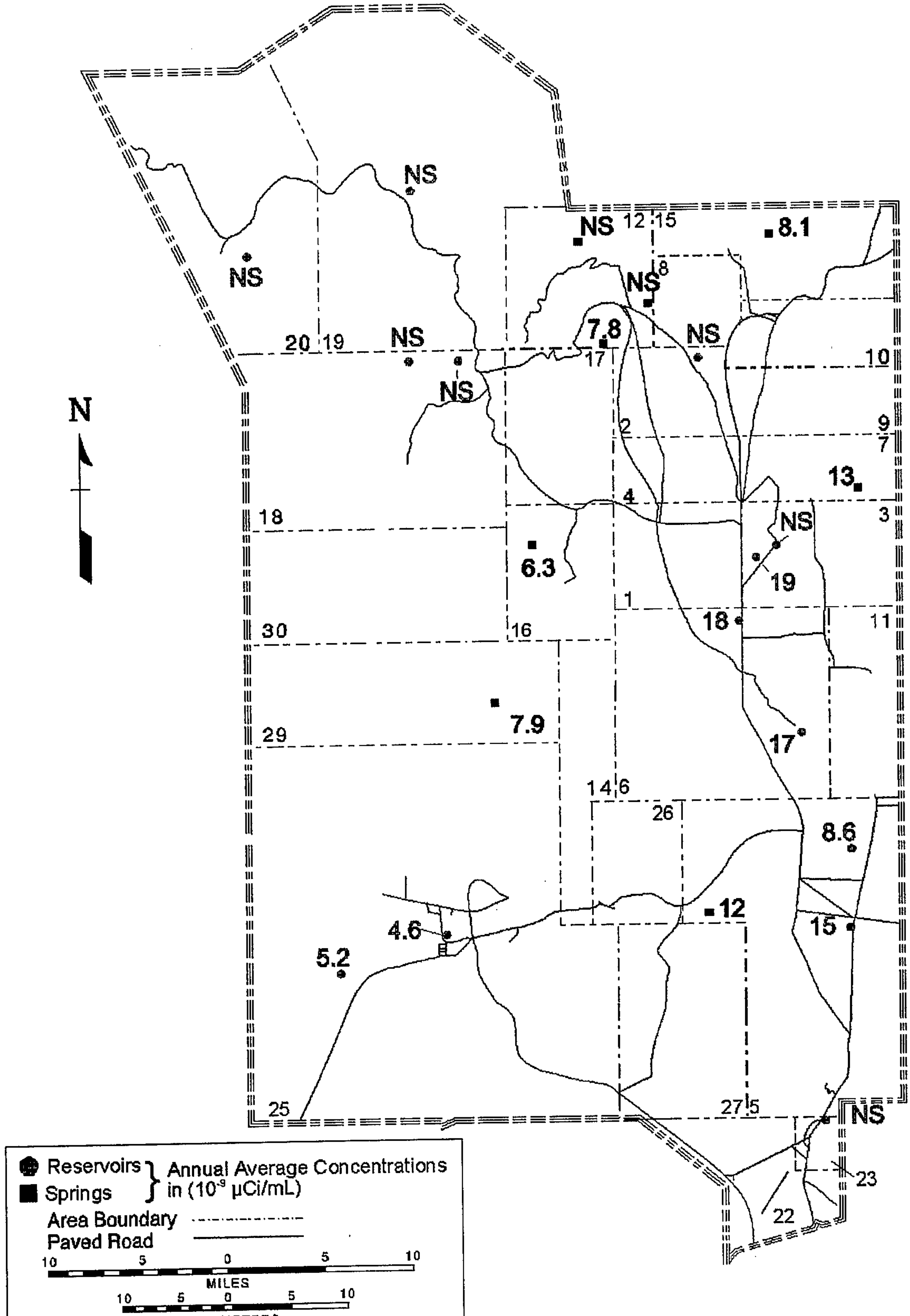


Figure 5.7 NTS HTO Vapor Annual Average Concentrations - 1996



Note: NS - No Sample, Reservoir Dry

Figure 5.8 Annual Average Gross Beta in Surface Water - 1996 gross beta were compared to the DCGs for ingested water listed in DOE Order 5400.5, even though there was no known consumption of these waters. The appropriate data are shown in Table 5.10.

NATURAL SPRINGS

Of the nine natural springs found onsite, (i.e., spring-supplied pools located within the NTS), only seven had enough water to be sampled. These springs were a source of drinking water for wild animals on the NTS. The annual average gross beta results for each spring are shown in Table 5.11 and compared to the ^{90}Sr DCG for drinking water, although the water is not used for drinking. The highest result was for Area 7, Reitman Seep, but it was still below the DCG.

CONTAINMENT PONDS

Due to the sealing of the tunnels by the end of the year 1993, liquid effluents ceased at all except E Tunnel. The E Tunnel containment pond was fenced and posted with radiological warning signs. During each sampling, a grab sample was taken from the E Tunnel containment pond and at the effluent discharge point. The samples were analyzed for ^{3}H, ^{90}Sr, ^{238}Pu, $^{239+240}$Pu, gross beta, and gamma activity in accordance with the schedule in Table 4.1. The annual average of gross beta analyses from each sampling location is listed in Table 5.12 and compared to the DCG for ingested water. This water is not used for drinking.

The effluent from characterization wells drilled in Area 20 was discharged into containment ponds. The total liquid discharged was calculated from the measured area and water depth of the pond. By multiplying that volume by the averaged ^{3}H concentration of collected samples, shown in Table 5.9, the total amount of tritium discharged (130 Ci or 4.8 Tbq) was calculated.

SEWAGE LAGOONS

Samples were collected quarterly during this year from eight sewage lagoons on the network at the end of 1996. Each of the lagoons is part of a closed system used for evaporative treatment of sanitary waste. The lagoons are located in Areas 5, 6, 12, 22, 23, and 25. There was no known contact by the working population during the year. The annual gross beta concentration averages for all lagoons ranged between 7.7 and 33 x 10^{-9} µCi/mL (0.28 to 1.2 Bq/L). No radioactivity was detected above the MDCs for ^{3}H or ^{90}Sr. No event-related radioactivity was detected by gamma spectrometric analyses.

Concentrations of ^{238}Pu and $^{239+240}$Pu above the MDC were found in the February 13 sample from the Area 23 Sewage Lagoon. The respective concentrations were 6.3 x 10^{-11} and 3.3 x 10^{-9} µCi/mL (0.0023 and 0.12 Bq/L). This was attributed to accumulation of old fallout (from tests in the atmosphere in the 1950s and 1960s) in the sewer-line sediments, which became loosened when the lines were flushed with water. Sediment samples collected from the sewage lagoon, after this finding was noted, also had detectable levels of plutonium. The radiochemistry laboratory that uses the same sewer system was eliminated as a source since the ratio of $^{239+240}$Pu to ^{238}Pu in the sediment was 50, (the range of that ratio in air and soil samples is 50 to 100) while that ratio in the laboratory standard was 3,000.

RADIOACTIVITY IN SUPPLY WELL WATER

The principal water distribution system on the NTS is potentially the critical pathway for ingestion of waterborne radionuclides. Consequently, the water distribution system is sampled and evaluated frequently. At the start of 1996, the NTS water system consisted of 12 supply wells, 10 of which supplied potable water to onsite distribution systems. The drinking water is pumped from the wells to the points of consumption. The supply wells were sampled on a quarterly basis. Drinking water is sampled at end-points to provide a constant check of the radioactivity and to allow end-use activity comparisons to the radioactivity of the water in the supply wells. In this section, analytical results are presented from samples taken at the 12 supply wells. Each well was sampled and analyzed as noted in the schedule in Table 4.1.

The locations of the supply wells are shown in Figure 5.9. Water from these wells (ten potable and two nonpotable) was used for a variety of purposes during 1996. Samples were collected from those wells which could potentially provide water for human consumption. These data were used to help document the radiological characteristics of the NTS groundwater system. The sample results are maintained in a database so that long-term trends and changes can be studied. Table 5.13 lists the drinking water sources, and Table 5.14 lists the potable and nonpotable supply wells and their respective radioactivity averages. No event-related radionuclides were detected by gamma spectrometry. Included in the table are the median MDCs for each of the measurements for comparison to the concentration averages for each location. For various operational reasons, samples could not be collected from all locations every sampling period.

GROSS BETA

As shown in Table 5.14, the gross beta concentration averages for all the supply wells were above the median MDC of the measurement. The highest average gross beta activity occurred at Well C1 and was 1.4 x 10^{-8} µCi/mL (0.52 Bq/L), which was 4.7 percent of the DCG for ^{40}K and 35 percent of the DCG for ^{90}Sr based upon 4 mrem effective dose equivalent (EDE) per year. In earlier reports (Scoggins 1983 and Scoggins 1984), it was noted that the majority of gross beta activity was attributable to naturally occurring ^{40}K. The gross beta annual averages are shown at their supply well sampling locations in Figure 5.9. All concentration averages were comparable to those reported last year.

TRITIUM

As shown in Table 5.14 the average tritium concentrations at all locations were below the average MDC of the measurement (note that the MDC was 14 x 10^{-9} µCi/mL, based on tritium enrichment analysis).

PLUTONIUM

All supply water samples analyzed for ^{238}Pu and $^{239+240}$Pu had concentrations below their MDC's of about 2.0 x 10^{-11} µCi/mL, which are 1.9 and 2.0 percent of their respective DCGs adjusted to a 4 mrem EDE per year. Table 5.14 lists the concentration averages for these nuclides for each location.

GROSS ALPHA

As shown in Table 5.14, the average gross alpha concentration for all of the supply wells, except for Well 8, were above the median MDC of 1.4 x 10^{-9} µCi/mL. The highest concentration from the potable wells occurred in samples from the Area 5, Well 5C, and was 12 x 10^{-9} µCi/mL (0.44 Bq/L). This is acceptable according to the EPA drinking water standard (Title 40 Code of Federal Regulations [C.F.R.] 141) as long as the combined concentration of ^{226}Ra and ^{228}Ra is less than 5 x 10^{-9} µCi/mL (0.18 Bq/L). The combined Ra concentration for this well was less than the combined MDC of 3.2 x 10^{-9} µCi/mL (0.12 Bq/L).

STRONTIUM

Beginning in 1994, ^{90}Sr analyses were changed from annually to quarterly on samples collected from the potable supply wells, but analyses on non-potable supply wells remained on an annual basis. The concentration averages of ^{90}Sr for each location, as shown in Table 5.14, were below the median MDC.

RADIOACTIVITY IN DRINKING WATER

As a check on any effect the water distribution system might have on water

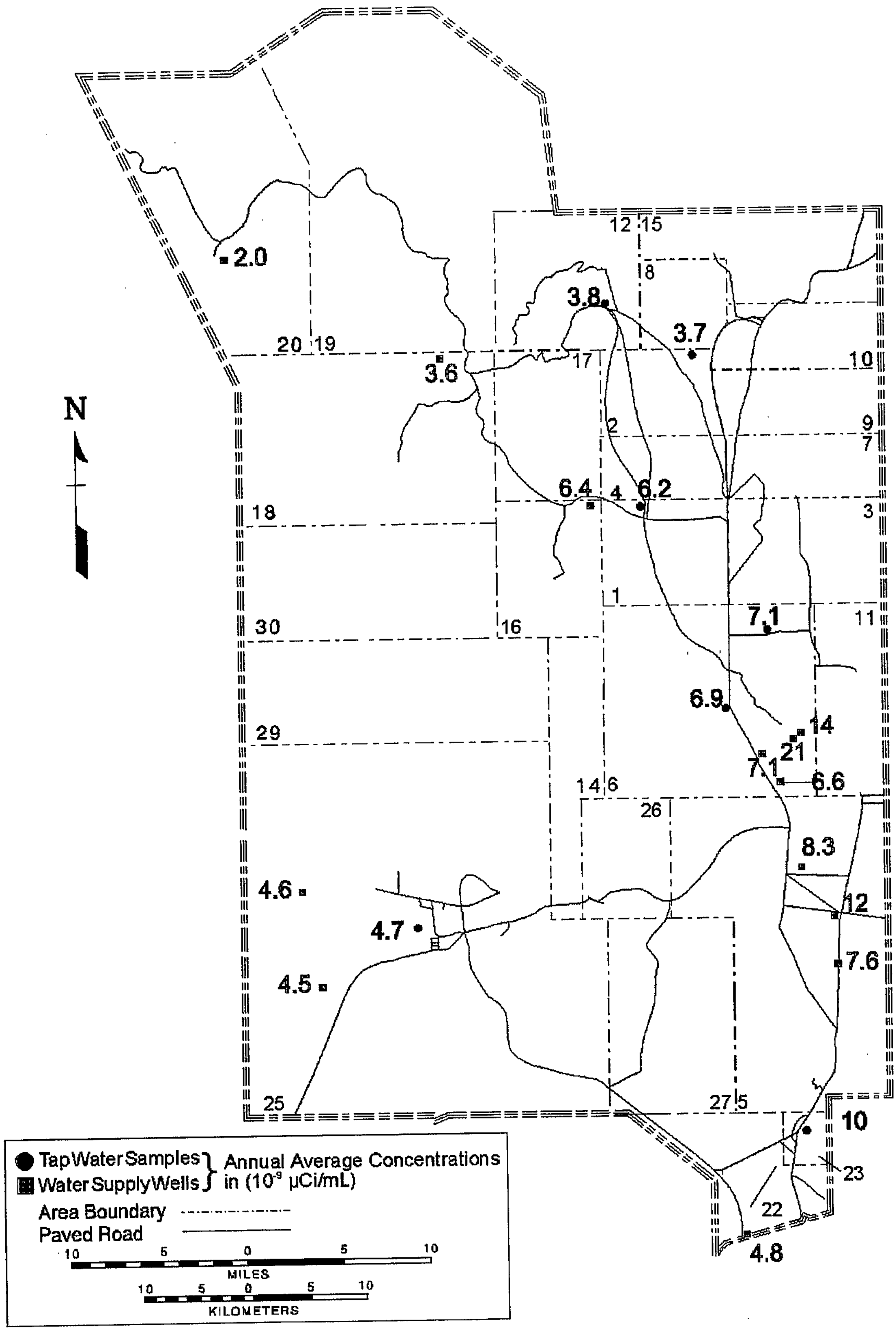


Figure 5.9 Annual Average Gross Beta in Supply Wells and Tap Water - 1996

quality, seven water system end-points (labeled tap water in Figure 5.9) were sampled. In order to ensure that all of the water available for consumption was being considered, each drinking water system was identified. The drinking water network at the NTS was found to consist of five drinking water systems. The components of the five are shown in Table 5.13. These systems, fed by ten potable supply wells, are the source of the water for seven end-points. Table 5.15 lists the annual concentration averages for all the analyses performed on the end-point samples. No event-related radionuclides were detected by gamma spectrometry.

GROSS BETA

As in previous years, the gross beta concentration averages for all end-points were above the median MDC of the measurements. The highest annual average occurred in the Area 23 Cafeteria, 10 x 10^{-9} µCi/mL (0.37 Bq/L). This annual average was 3.3 and 25 percent of the DCG for ^{40}K and ^{90}Sr, respectively, adjusted to an annual 4 mrem EDE.

TRITIUM

The annual average tritium concentrations, as shown in Table 5.15, were all less than the median MDC of 7.2 x 10^{-7} µCi/mL. The tritium concentrations for all end-point water samples, which were determined by a conventional liquid scintillation counting method, are expected to be lower than the MDC, because the levels of tritium in the potable supply wells were near the median tritium enrichment MDC of 1.4 x 10^{-8} µCi/mL (0.52 Bq/L). These MDC values are 0.9 percent and 0.018 percent, respectively, of the drinking water DCG adjusted to a 4 mrem (0.04 mSv) EDE.

PLUTONIUM

The annual averages of $^{239+240}$Pu and ^{238}Pu for each end-point were below the median MDC of the measurements, which were both less than 2 percent of the 4 mrem DCG. These isotopes are not normally detected in drinking water.

GROSS ALPHA

In accordance with the National Primary Drinking Water Regulations (Title 40 C.F.R. 141), gross alpha measurements were made on quarterly samples from the drinking water systems, namely the potable supply wells reported in the previous section of this report. As added assurance that no radioactivity gets into the systems between the supply wells and end-point users, measurements of gross alpha are also made on quarterly samples from the end-points. As shown in Table 5.15, the annual concentration averages for gross alpha radioactivity in tap water samples collected at five locations, exceeded the screening level at which ^{226}Ra analysis is required, 5 pCi/L (0.19 Bq/L). Samples from the supply wells were collected and analyzed for both ^{226}Ra and ^{228}Ra. As shown by the radium results in Table 5.16, the sum of the average concentrations for ^{226}Ra and ^{228}Ra were all less than 5 pCi/L so the onsite systems were in compliance with drinking water regulations.

STRONTIUM

As indicated by Table 5.15, the ^{90}Sr results for samples collected from all the selected end-points had concentrations that were less than the median MDC of the measurements.

TRITIUM CONCENTRATIONS IN NTS VEGETATION

Previous studies of radioactivity in vegetation collected on the NTS have reported tritium in the water from plants collected in areas assumed to be non-contaminated. To explore this finding, a project was initiated to collect water from plants from known contaminated areas as well as from plants from control areas.

Samples were collected around known sources at two random points per square minute (approximately one square nautical mile) and at one random point per five square minutes elsewhere. The deepest rooted trees or shrubs in the area were sampled preferentially, usually two plants per location. Water was distilled at low temperatures from the samples and analyzed by the standard tritium-in-air procedures (2.5 mL counted for 70 minutes). Summary results are shown in Table 5.17.

Six of the samples with higher concentration (10^{-4} µCi/mL range) came from *Tamarix* sp. trees growing in the CAMBRIC ditch, used to determine if there were diurnal fluctuations in plant tritium content. No diurnal variation was seen, so sampling could occur all day. Sources probably responsible for most of the higher values are SEDAN crater throw out, infiltrated water from the CAMBRIC ditch, the Rainier Mesa tunnel ponds (dried up now), and the SCHOONER-CABRIOLET-PALANQUIN area. Plants at some locations had low concentrations of tritium, the source of which was unidentified.

EXTERNAL GAMMA EXPOSURES - ONSITE AREA

The TLD network at the NTS in 1996 began with 169 TLDs at fixed locations. Each TLD is fixed on a stake about one meter above the ground to measure ambient beta and gamma radiation. There were 17 TLD locations discontinued, 4 that were relocated, and 8 added at new locations. The year ended with 160 TLD stations. Fifteen of the existing stations had been established as the boundary locations and were reachable by truck as stated in the previous year's report.

Environmental monitoring is done with the UD-814 dosimeters of special design. The UD-814 is a modification of UD-804 environmental dosimeter with the addition of a $Li_2B_4O_7$:Cu element in position one encapsulated in 14 mg/cm^2 to monitor beta particles in the environment. The remaining three elements are replicates of $CaSO_4$:Tm encapsulated in 1,000 mg/cm^2 of plastic and lead. Since $CaSO_4$ is about 30 times more sensitive than $Li_2B_4O_7$:Cu, it makes an excellent phosphor to measure the low doses (10 mR/month) generally encountered in low-level radiation environments. The results for boundary locations are given in Table 5.18. The annual rates ranged from 61 mR/yr to 166 mR/yr.

A group of locations which were not, to the best available knowledge, influenced by radiological contamination, and had been monitored for many years served as controls for the NTS. The data from these locations are presented in Table 5.19. The annual rates ranged from 50 mR/yr to 124 mR/yr, with an overall network average exposure rate of 0.23 mR/day or 84 mR/yr.

An investigation of historical trends in onsite environmental gamma levels, as measured by the TLD network, showed no significant differences among years until 1993, except for data from 1987 (dosimetry system changed) and 1988 (due to a calibration problem). A change in procedure introduced an additional significant change in historical trend data in 1994. A description of this analysis is published separately and may be found in the "Environmental Data Report for the Nevada Test Site - 1996" (DOE/NV/11718-138, in prep.).

OFFSITE ENVIRONMENTAL SURVEILLANCE

The R&IE-LV offsite environmental surveillance program was operated to detect any releases of radioactivity related to current NTS activities which could potentially result in human exposure. Monitoring was concentrated on possible human exposure pathways. Monitoring locations were generally selected to represent inhabited areas around the NTS. Monitoring was not designed to provide full spatial characterization of the offsite area, nor was the monitoring designed to detect all types of radioactivity arising from all natural and man-made sources. Possible pathways monitored included inhalation, ingestion, and external exposure. In brief (a full description is in Chapter 4), the following was done.

Alpha, beta, and gamma radiation in air were monitored by the Air Surveillance Network

(ASN), which included 20 continuously operating stations around the NTS. Noble gas and atmospheric moisture samplers were discontinued in 1994. Groundwater and some surface water supplies were sampled regularly in the Long-Term Hydrological Monitoring Program (LTHMP). Water sampling locations included 37 wells on the NTS, or immediately outside its borders and 32 locations in the offsite area. Not all locations are sampled every year. The Milk Surveillance Network (MSN) consisted of annual collections from 11 locations in the immediate offsite area, of which 10 were sampled this year. The network included family-owned cows and goats and commercial dairies.

External gamma radiation was monitored by the Pressurized Ion Chamber (PIC) Network and the TLD Network. The PIC network included 27 stations that were connected by satellite telemetry to the NTS for real-time data collection. Approximately 26 local residents voluntarily participated in the TLD network and another 51 TLDs were located at fixed environmental stations.

The results of monitoring conducted in 1996 are discussed in the following subsections for each of the environmental surveillance networks mentioned above. No major accidental releases of radionuclides from the NTS were reported in 1996. All individual sample data are published separately, but summary data are included herein.

AIR MONITORING NETWORKS

The following sections describe results for the ASN. The atmospheric monitoring network measures the major radionuclides which could potentially be emitted from activities on the NTS, as well as naturally occurring radionuclides. This network represents the possible inhalation exposure pathway for the general public.

AIR SURVEILLANCE NETWORK

Gamma spectrometry was performed promptly on all ASN high- and low-volume samples. The majority of the samples were gamma-spectrum negligible (i.e., no gamma-emitting radionuclides detected). Naturally occurring ^{7}Be was detected occasionally by the low-volume network of samplers. It was detected consistently by the high-volume sample method with an average annual activity of 2.4×10^{-13} µCi/mL.

As in previous years, the gross beta results from the low-volume sampling network consistently exceeded the analytical MDC. The annual average gross beta activity was $1.42 \pm 0.58 \times 10^{-14}$ µCi/mL ($5.3 \pm 2.1 \times 10^{-4}$ Bq/m^3). Summary results for the ASN are in Table 5.20. Individual results are published separately and may be found in the "Environmental Data Report for the Nevada Test Site - 1996," (DOE/NV/11718-138, in prep.).

Gross alpha analysis was performed on all low-volume network samples. The average annual gross alpha activity was 1.3×10^{-15} µCi/mL (48 µBq/m^3). Summary results for the ASN are shown in Table 5.21.

Samples collected at high-volume sampling sites were composited by month and analyzed for plutonium isotopes. Due to a lower limit of detection for high-volume sampling and analysis methods, environmental levels of plutonium were occasionally detected at all six of the sampling sites. This report contains results for samples collected during the third and fourth quarter of 1995 and throughout calendar year 1996 (CY96) (Table 5.22). The maximum average concentration of plutonium was in a sample from Amargosa Valley (Lathrop Wells), but was just 1.3 percent of the DCG.

WATER MONITORING

Environmental surveillance of water in the offsite areas is conducted as part of the LTHMP. Results are discussed in Chapter 9 of this report.

MILK SURVEILLANCE NETWORK

The average total potassium concentration derived from naturally occurring ^{40}K activity was 1.5 g/L for samples analyzed by gamma spectrometry. Selected MSN milk samples were analyzed for ^{89}Sr and ^{90}Sr, and the results are similar to those obtained in previous years; neither increasing nor decreasing trends are evident. The MSN network average values are shown in Table 5.23 for ^{89}Sr and ^{90}Sr.

THERMOLUMINESCENT DOSIMETRY NETWORK

OFFSITE STATION NETWORK

There were 51 offsite environmental stations monitored using TLDs. Figure 4.7 shows current fixed environmental monitoring locations. Total annual exposure for 1996 ranged from 59 mR (0.59 mSv) per year at St. George, Utah, to 133 mR (1.3 mSv) per year at Manhattan, Nevada, with a mean annual exposure of 93 mR (0.93 mSv) per year for all operating locations. The next highest annual exposure was 130 mR (1.3 mSv) per year at Queen City Summit, Nevada. These results are consistent with those for 1995.

OFFSITE PERSONNEL NETWORK

Twenty-five offsite residents were issued TLDs to monitor their annual dose equivalent. Locations of personnel monitoring participants are also shown in Figure 4.7. Annual whole body dose equivalents ranged from a low of 48 mrem (0.48 mSv) to a high of 125 mrem (1.2 mSv) with a mean of 96 mrem (0.96 mSv) for all monitored personnel during 1996. These results are similar to those for 1995.

PRESSURIZED ION CHAMBER NETWORK

The PIC data presented in this section are based on monthly averages of gamma exposure rates from each station. Table 5.24 contains the number of monthly averages available from each station and the maximum, minimum, mean, standard deviation, and median of the monthly averages. The mean ranged from 8.0 μR/hr at Pahrump, Nevada, to 17.7 μR/hr at Tonopah, Nevada, or annual exposures from 71 to 156 mR (18 to 40 μC/kg). The table shows the total mR/yr (calculation based on the mean of the monthly averages) and the average gamma exposure rate for each station. Background levels of environmental gamma exposure rates in the United States (from the combined effects of terrestrial and cosmic sources) vary between 49 and 247 mR/yr (13 to 64 μC/kg-yr) (BEIR III 1980). The annual exposure levels observed at each PIC station are well within these United States background levels. Figure 5.10 shows the distribution of the monthly averages from each PIC station. The horizontal lines extend from the mean value (◆) to the minimum and maximum values. The vertical lines are the approximate United States background range.

The data from Milford, Rachel, Twin Springs, and Uhalde's Ranch stations show the greatest range and the most variability. These data are within a few tenths μR/hr from those of last year.

NON-NTS BN FACILITY MONITORING

BN facilities which use radioactive sources or radiation producing equipment with the potential to expose the general population outside the property line to direct radiation are as follows: the Special Technologies Laboratory (STL) during operation of the Sealed Tube Neutron Generator, STL during operation of the Febetron, the Remote Sensing Laboratory (RSL) at Nellis Air Force Base, the North Las Vegas Facility (NLVF) Atlas A-1 Source Range, and the Washington Aerial Measurements Operation (WAMO). Sealed sources are tested every six months to ensure there is no leakage of radioactive material and the data are kept in the BN Radiation Protection Records.

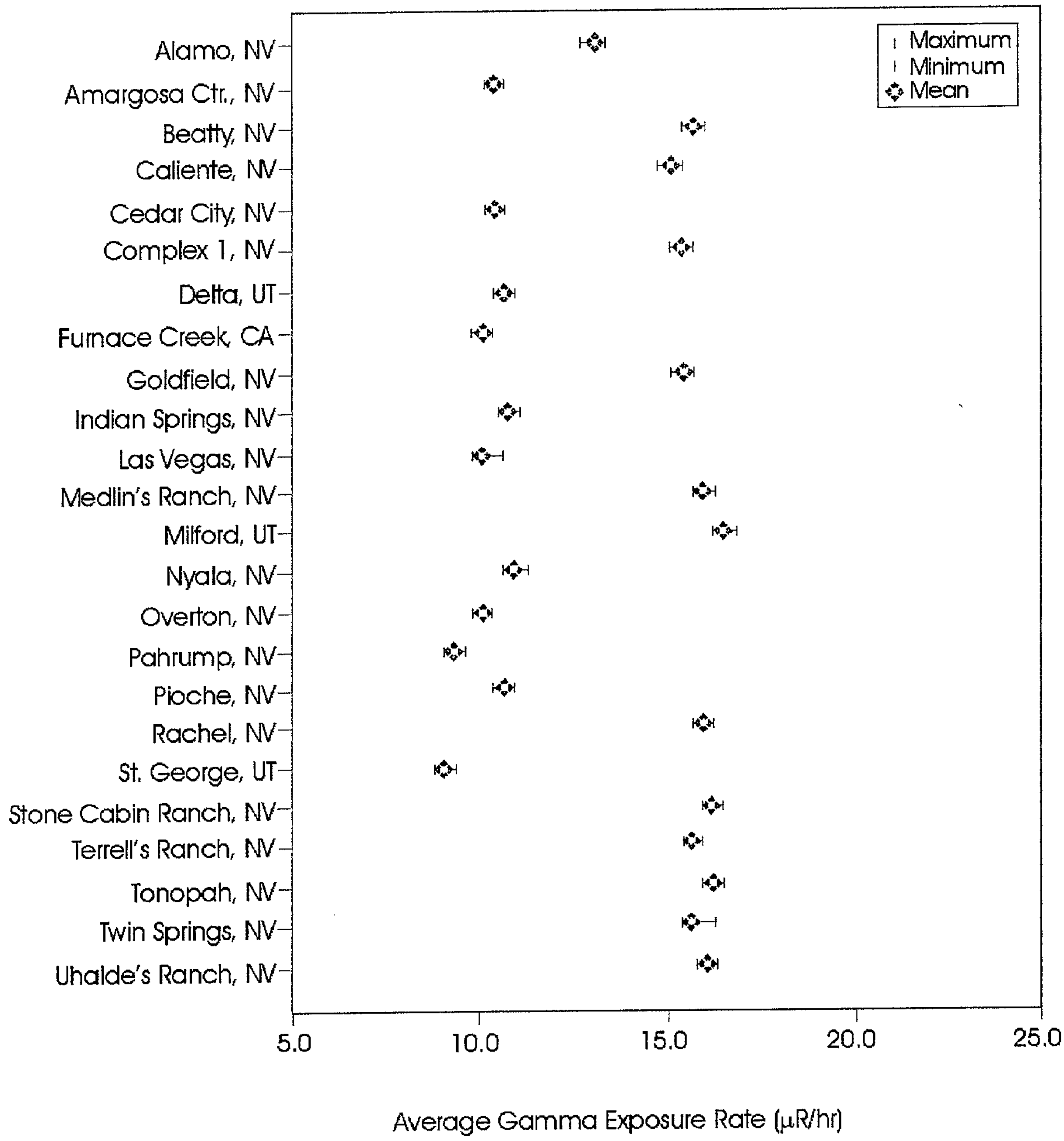


Figure 5.10 Distribution of Averages from Each PIC Network Station - 1996

Operation of radiation-generating devices is controlled by BN procedures.

Fence line radiation monitoring at STL, RSL, NLVF, and WAMO was conducted during 1996 using Panasonic Type UD-814 TLDs. At least two TLDs were at the fence line on each side of any facility. TLDs were exchanged on a quarterly basis with additional control TLDs kept in a shielded safe. These TLD results are given in Table 5.25. TLD results were not available for WAMO. The range of results, 52 to 115 mR/yr, is within the background range in the continental United States.

Table 5.1 NTS Radionuclide Emissions - 1996

Onsite Liquid Discharges

Containment Ponds	Curies[(a)] ^{3}H	^{90}Sr	^{137}Cs	^{238}Pu	$^{239+240}Pu$
Area 12, E Tunnel	1.1×10^{1}	4.4×10^{-5}	1.5×10^{-3}	3.4×10^{-6}	2.7×10^{-5}
Area 20, Well ER-20-5	1.1×10^{2}				
Area 20, Well ER-20-6	8.2×10^{0}				
TOTAL	1.3×10^{2}	4.4×10^{-5}	1.5×10^{-3}	3.4×10^{-6}	2.7×10^{-5}

Airborne Effluent Releases

Facility Name (Airborne Releases)	Curies[(a)] ^{3}H[(b)]	$^{239+240}Pu$
Areas 3 and 9[(c)]		0.036
Area 5, RWMS[(d)]	3.5×10^{-1}	
Atlas Facility[(d)]	5.2×10^{-3}	
SEDAN Crater[(d)]	1.4×10^{2}	
Other Areas[(c)]		0.24
TOTAL	1.2×10^{-0}	0.28

(a) Multiply by 3.7×10^{10} to obtain Bq. Calculated releases from laboratory spills and losses are included in Table 1.1.
(b) In the form of tritiated water vapor, primarily HTO.
(c) Resuspension from known surface deposits.
(d) Calculated from air sampler data.

Table 5.2 Airborne Gross Alpha Concentrations on the NTS - 1996

Location	Number	Gross Alpha Concentration (10^{-15} μCi/mL) Maximum	Minimum	Arithmetic Mean	Standard Deviation
Area 1, BJY	25	3.1	0.96	1.8	0.58
Area 2, Complex	26	3.7	0.81	1.9	0.63
Area 2, 2-1 Substation	25	4.3	0.28	1.7	0.83
Area 3, Mud Plant	25	4.3	0.70	2.3	1.1
Area 3, Well ER-3-1	27	4.5	0.87	2.2	0.89
Area 4, Bunker T-4	25	3.3	0.93	1.9	0.52
Area 5, WEF North	3	2.8	1.7	2.2	0.59
Area 5, WEF South	4	3.0	1.7	2.4	0.57
Area 5, DOD Yard	27	4.0	0.90	2.1	0.70
Area 5, Well 5B	27	3.6	0.88	2.2	0.62
Area 6, Yucca	24	3.1	0.89	2.0	0.56
Area 6, CP-6	27	3.1	0.92	2.1	0.54
Area 6, Well 3	26	3.3	0.63	2.0	0.66
Area 7, UE7ns	25	5.0	0.35	1.8	0.91
Area 9, Area 9-300	27	6.5	0.87	2.6	1.2
Area 10, Gate 700 S	26	3.3	0.59	1.7	0.63
Area 10, SEDAN Crater	26	3.0	0.65	1.8	0.66
Area 11, Gate 293	26	3.4	0.93	1.9	0.55
Area 12, 12 Complex	26	2.8	0.44	1.7	0.51
Area 13, Project 57	31	4.8	0.88	2.3	0.92
Area 15, EPA Farm	26	5.4	0.59	2.0	0.96
Area 16, 3545 Substation	25	4.3	0.17	1.7	0.80
Area 18, Well UE-18t	26	3.4	0.54	1.9	0.73
Area 20, CABRIOLET	3	2.0	1.2	1.5	0.40
Area 20, SCHOONER	26	3.6	0.56	2.0	0.80
Area 20, Complex	26	3.3	0.32	1.7	0.83
Area 23, Building 790 No. 2	27	3.2	0.76	1.8	0.71
Area 23, H&S Building	27	3.1	0.22	1.8	0.72
Area 25, E-MAD N	27	4.0	0.57	1.9	0.75
Area 25, NRDS	27	4.3	0.65	2.0	0.77
Area 27, Cafeteria	22	3.2	0.95	2.0	0.61
TTR, DOUBLE TRACKS	28	32	0.34	3.7	5.9
TTR, CLEAN SLATE I	19	3.8	0.12	2.3	1.1
TTR, CLEAN SLATE III	29	5.1	1.2	2.5	1.0

Median MDC = 0.54 x 10^{-15} μCi/mL

Table 5.3 Airborne Gross Beta Concentrations on the NTS - 1996

Location	Number	Gross Beta Concentration (10^{-14} μCi/mL) Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG
Area 1, BJY	51	3.5	0.83	2.0	0.58	2.2
Area 2, Complex	50	3.2	0.85	1.8	0.54	2.0
Area 2, 2-1 Substation	51	3.1	0.41	1.5	0.62	1.7

Median MDC = 1.5 x 10^{-15} μCi/mL

Table 5.3 (Airborne Gross Beta Concentrations on the NTS - 1996, cont.)

Location	Number	Gross Beta Concentration (10^{-14} µCi/mL) Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG
Area 3, U3ah/at S	50	2.6	0.70	1.5	0.43	1.7
Area 3, U3ah/at E	50	3.0	0.75	1.7	0.53	1.9
Area 3, U3ah/at N	45	3.2	0.81	1.7	0.57	1.9
Area 3, U3ah/at W	50	2.6	0.69	1.6	0.51	1.8
Area 3, Mud Plant	51	4.8	0.85	2.1	0.78	2.3
Area 3, Well ER-3-1	49	3.7	0.60	1.9	0.70	2.1
Area 4, Bunker T-4	50	3.5	0.86	1.9	0.56	2.1
Area 5, RWMS Pit 5	50	3.1	0.68	1.8	0.54	2.0
Area 5, RWMS No. 4	51	3.7	1.0	2.0	0.61	2.2
Area 5, RWMS No. 5	43	3.6	1.2	2.0	0.54	2.2
Area 5, RWMS No. 6	52	3.7	0.81	1.9	0.58	2.1
Area 5, RWMS No. 7	39	3.5	0.83	1.8	0.56	2.0
Area 5, RWMS No. 8	51	3.2	1.0	1.9	0.52	2.1
Area 5, RWMS No. 9	41	3.8	0.88	2.0	0.64	2.2
Area 5, DOD Yard	51	4.2	0.95	2.0	0.69	2.2
Area 5, RWMS No. 3	43	3.9	0.76	2.0	0.56	2.2
Area 5, RWMS No. 1	52	3.2	0.86	1.9	0.53	2.1
Area 5, WEF North	3	2.5	1.2	1.8	0.66	2.0
Area 5, WEF South	4	3.1	1.8	2.4	0.68	2.7
Area 5, RWMS TP Bldg. N	51	5.6	0.69	2.2	0.98	2.4
Area 5, RWMS TP Bldg. S	50	4.5	0.80	2.0	0.82	2.2
Area 5, Well 5B	52	3.6	0.94	2.1	0.58	2.3
Area 6, Yucca	47	3.2	0.97	1.9	0.53	2.1
Area 6, CP-6	51	3.6	0.78	1.9	0.62	2.1
Area 6, Well 3	52	4.0	0.82	1.8	0.62	2.0
Area 7, UE7ns	51	3.5	0.66	1.7	0.57	1.9
Area 9, Area 9-300	53	3.4	0.61	1.7	0.59	1.9
Area 10, Gate 700 S	50	3.3	0.79	1.7	0.55	1.9
Area 10, SEDAN Crater	52	3.4	0.62	1.8	0.55	2.0
Area 11, Gate 293	52	5.3	0.93	2.0	0.73	2.2
Area 12, 12 Complex	51	2.9	0.03	1.7	0.57	1.9
Area 13, Project 57	51	3.7	0.84	1.8	0.54	2.0
Area 15, EPA Farm	51	3.4	0.84	1.7	0.55	1.9
Area 16, 3545 Substation	48	3.2	0.63	1.6	0.56	1.8
Area 18, Well UE-18t	49	3.3	0.68	1.7	0.55	1.9
Area 20, SCHOONER	48	3.6	0.88	1.9	0.60	2.1
Area 20, Complex	52	3.0	0.33	1.5	0.57	1.7
Area 20, CABRIOLET	3	1.8	0.83	1.5	0.54	1.6
Area 23, Building 790 No. 2	53	3.6	0.86	1.8	0.56	2.0
Area 23, H&S Building	53	3.3	0.83	1.9	0.56	2.1
Area 25, E-MAD N	52	3.7	0.69	1.8	0.56	2.0
Area 25, NRDS	53	3.6	0.68	1.8	0.60	2.0
Area 27, Cafeteria	47	3.3	0.72	1.7	0.56	1.9
TTR, DOUBLE TRACKS	49	2.6	0.74	1.6	0.41	1.8
TTR, CLEAN SLATE I	18	3.7	1.1	2.1	0.70	2.4
TTR, CLEAN SLATE III	52	3.2	0.94	1.8	0.57	2.0

Median MDC = 1.5×10^{-15} µCi/mL

Table 5.4 Airborne $^{239+240}Pu$ Concentrations on the NTS - 1996

Location	Number	$^{239+240}Pu$ Concentration (10^{-17} µCi/mL) Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG
Area 1, BJY	4	75	2.3	22	36	11
Area 2, Complex	4	1.1	0.23	0.66	0.39	0.33
Area 2, 2-1 Substation	4	5.8	0.13	2.5	2.7	1.2
Area 3, U3ah/at South	10	25	1.9	11	7.2	5.5
Area 3, U3ah/at East	10	31	2.5	13	10	6.5
Area 3, U3ah/at North	10	80	3.9	26	23	13
Area 3, U3ah/at West	10	36	5.0	16	10	8.0
Area 3, Mud Plant	4	26	0.08	12	11	6.0
Area 3, Well ER-3-1	4	5.4	0.35	2.6	2.4	1.3
Area 4, Bunker T-4	4	8.1	2.1	4.8	2.5	2.4
Area 5, RWMS Pit 5	10	1.0	-0.076	0.32	0.37	0.16
Area 5, RWMS No. 4	10	0.82	-0.015	0.21	0.27	0.10
Area 5, RWMS No. 5	9	3.1	0.12	0.73	0.99	0.36
Area 5, RWMS No. 6	10	1.2	-0.009	0.51	0.36	0.26
Area 5, RWMS No. 7	9	7.3	0.075	1.2	2.3	0.60
Area 5, RWMS No. 8	10	1.4	0.12	0.56	0.40	0.28
Area 5, RWMS No. 9	9	0.67	0.076	0.25	0.19	0.12
Area 5, DOD	4	0.65	0.21	0.43	0.21	0.26
Area 5, RWMS No. 3	9	0.38	0.086	0.18	0.09	0.09
Area 5, RWMS No. 1	10	0.47	-0.026	0.27	0.15	0.13
Area 5, WEF North	1			2.6		1.3
Area 5, WEF South	1			2.3		1.1
Area 5, RWMS TP Bldg. N	10	0.63	-0.026	0.22	0.19	0.11
Area 5, RWMS TP Bldg. S	10	10	-0.020	1.2	3.2	0.60
Area 5, Well 5B	4	0.41	0.28	0.32	0.06	0.16
Area 6, Yucca	4	11	0.81	3.6	5.2	1.8
Area 6, CP-6	4	1.2	0.56	0.86	0.33	0.43
Area 6, Well 3	4	1.6	0.34	1.1	0.54	0.55
Area 7, UE7ns	4	45	0.50	12	22	6.0
Area 9, Area 9-300	4	61	7.9	35	25	1.8
Area 10, Gate 700 South	4	3.1	0.32	1.1	1.4	0.55
Area 10, SEDAN Crater	4	8.4	3.4	5.3	2.4	2.7
Area 11, Gate 293	4	1.9	0.50	1.0	0.65	0.5
Area 12, Complex	4	0.37	-0.007	0.20	0.16	0.1
Area 13, Project 57	4	2.9	0.43	2.1	1.1	1.1
Area 15, EPA Farm	4	24	2.2	8.7	11	4.2
Area 16, 3545 Substation	4	0.18	-0.004	0.095	0.078	0.05
Area 18, Well UE-18t	4	0.35	0.12	0.20	0.11	0.1
Area 20, SCHOONER	4	0.60	0.19	0.31	0.19	0.15
Area 20, Complex	4	0.30	0.083	0.17	0.093	0.08
Area 20, CABRIOLET	1			0.30		0.15
Area 23, Building 790 No. 2	4	1.1	0.15	0.44	0.46	0.22
Area 23, H&S Bldg.	4	0.15	0.086	0.13	0.029	0.06
Area 25, E-MAD N	4	0.71	-0.008	0.24	0.32	0.12
Area 25, NRDS	4	0.13	-0.004	0.054	0.056	0.03
Area 27, Cafeteria	4	0.26	0.11	0.16	0.071	0.08
Area 52, DOUBLE TRACKS	4	140	0.3	45	65	22
TTR, CLEAN SLATE I	2	45	2.8	24	30	12
TTR, CLEAN SLATE III	4	0.42	0.10	0.19	0.15	0.10

Median MDC = 3.2×10^{-18} µCi/mL

Table 5.5 Airborne ^{238}Pu Concentrations on the NTS - 1996

Location	Number	^{238}Pu Concentration (10^{-17} µCi/mL) Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG
Area 1, BJY	4	0.76	0.025	0.24	0.35	0.08
Area 2, Complex	4	0.058	-0.014	0.027	0.030	<0.01
Area 2, 2-1 Substation	4	0.24	-0.012	0.063	0.12	0.02
Area 3, U3ah/at S	10	0.58	-0.016	0.21	0.21	0.07
Area 3, U3ah/at E	10	0.57	-0.024	0.16	0.17	0.48
Area 3, U3ah/at N	10	1.9	-0.076	0.43	0.63	0.14
Area 3, U3ah/at W	10	0.60	-0.068	0.19	0.23	0.06
Area 3, Mud Plant	4	0.32	-0.024	0.14	0.15	0.05
Area 3, Well ER-3-1	4	0.18	-0.014	0.047	0.089	0.02
Area 4, Bunker T-4	4	1.5	0.88	1.1	0.28	0.37
Area 5, RWMS Pit 5	10	0.16	-0.065	0.008	0.084	<0.01
Area 5, RWMS No. 4	10	0.11	-0.054	-0.002	0.056	<0.01
Area 5, RWMS No. 5	9	0.26	-0.067	0.056	0.11	0.02
Area 5, RWMS No. 6	10	0.39	-0.077	0.01	0.14	<0.01
Area 5, RWMS No. 7	9	0.24	-0.046	0.027	0.094	<0.01
Area 5, RWMS No. 8	10	0.15	-0.065	0.024	0.075	<0.01
Area 5, RWMS No. 9	9	0.15	-0.16	-0.018	0.084	<0.01
Area 5, DOD Yard	4	-0.003	-0.016	-0.008	0.006	<0.01
Area 5, RWMS No. 3	9	0.44	-0.069	0.060	0.19	0.02
Area 5, RWMS No. 1	10	0.052	-0.074	-0.018	0.042	<0.01
Area 5, WEF North	1			-0.011		<0.01
Area 5, WEF South	1			-0.013		<0.01
Area 5, RWMS TP Bldg. N	10	0.22	-0.054	0.058	0.075	0.02
Area 5, RWMS TP Bldg. S	10	0.21	-0.065	0.017	0.087	<0.01
Area 5, Well 5B	4	0.033	-0.014	0.010	0.024	<0.01
Area 6, Yucca Waste Pond	4	0.28	-0.013	0.062	0.14	0.02
Area 6, CP-6	4	0.077	-0.014	0.031	0.049	0.01
Area 6, Well 3	4	0.10	0.026	0.052	0.036	0.02
Area 7, UE7ns	4	0.50	-0.006	0.15	0.023	0.05
Area 9, 9-300 Bunker	4	0.92	0.17	0.59	0.35	0.2
Area 10, Gate 700 S	4	0.095	-0.013	0.038	0.045	0.01
Area 10, SEDAN Crater	4	0.63	0.11	0.37	0.25	0.12
Area 11, Gate 293	4	0.025	-0.018	-0.001	0.018	<0.01
Area 12, Complex	4	0.10	-0.006	0.028	0.05	0.01
Area 13, Project 57	4	0.31	0.019	0.10	0.14	,0.04
Area 15, EPA Farm	4	0.47	0.019	0.16	0.21	0.05
Area 16, 3545 Substation	4	0.021	-0.019	-0.003	0.017	<0.01
Area 18, Well UE-18t	4	0.019	-0.017	-0.002	0.015	<0.01
Area 20, SCHOONER	4	0.39	0.10	0.23	0.13	0.08
Area 20, Complex	4	0.052	-0.018	0.006	0.031	<0.01
Area 20, CABRIOLET	1			-0.01		<0.01
Area 23, Building 790 No. 2	4	-0.003	-0.007	-0.006	0.002	<0.01
Area 23, H&S Building	4	0.032	-0.008	0.011	0.020	<0.01
Area 25, E-MAD N	4	0.073	-0.017	0.021	0.040	<0.01
Area 25, NRDS	4	0.083	0.020	0.043	0.027	<0.01
Area 27, Cafeteria	4	0.11	-0.009	0.040	0.052	0.01
Area 52, DOUBLE TRACKS	4	1.1	-0.005	0.36	0.51	0.12
TTR, CLEAN SLATE I	2	0.097	-0.003	0.047	0.070	0.02
TTR, CLEAN SLATE III	4	0.023	-0.021	-0.002	0.018	<0.01

Median MDC = 2.9×10^{-18} µCi/mL

Table 5.6 Derived Limits for Radionuclides in Air and Water

Radionuclide	DAC (Air)[(a)] µCi/mL	DCG (Air)[(b)] µCi/mL	DCG (Water)[(c)] µCi/mL
^{3}H	2×10^{-5}	1×10^{-8}	8×10^{-5}
^{40}K	2×10^{-7}	9×10^{-11}	3×10^{-7}
^{85}Kr [(d)]	1×10^{-4}	3×10^{-7}	-
^{89}Sr	6×10^{-8}	3×10^{-11}	8×10^{-7}
^{90}Sr	2×10^{-9}	9×10^{-13}	4×10^{-8}
^{133}Xe	1×10^{-4}	5×10^{-8}	-
^{137}Cs	5×10^{-5}	4×10^{-11}	1×10^{-7}
^{226}Ra	3×10^{-10}	1×10^{-13}	4×10^{-9}
^{238}Pu[(a)]	7×10^{-12}	3×10^{-15}	2×10^{-9}
$^{239+240}Pu$[(a)]	6×10^{-12}	2×10^{-15}	1×10^{-9}

(a) DAC - The Derived Air Concentration used for limiting radiation exposures of workers. The values are based on either a stochastic effective dose equivalent of 5 rem or a nonstochastic organ dose of 50 rem, which ever is more limiting (DOE Order 5480.11). Class Y is used for plutonium.

(b) DCG - Derived Concentration Guides are reference values for conducting radiological protection programs at operational DOE facilities and sites. The DCG values are for an effective dose equivalent of 10 mrem (0.1 mSv) (inhalation) for a year as required by 40 C.F.R. 61.92 and DOE Order 5400.5.

(c) The values listed for beta and photon emitters in the table are based on 4 mrem committed effective dose equivalent for the radionuclide taken into the body by ingestion of water during one year (730 L).

(d) Nonstochastic value.

Table 5.7 Summary of NTS ^{85}Kr Concentrations - 1996

		^{85}Kr Concentration (10^{-12} µCi/mL)				
Location	Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as % DCG
Area 1, BJY	43	46	6.2	25	7.2	<0.01
Area 19, Pahute Substa.[(a)]	38	40	2.8	25	7.8	<0.01
Area 20, Dispensary	43	42	2.3	26	10	<0.01
All Stations	124	46	2.3	25	8.6	<0.01

Average MDC was 6.4×10^{-12} µCi/mL

(a) Excludes anomalous value of 96 in weekly sample collected July 17, 1997.

Table 5.8 Airborne Tritium Concentrations on the NTS - 1996

Location	Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG
		^3H Concentration (10^{-6} pCi/mL)				
Area 1, BJY	25	3.1	-2.0	0.63	0.89	<0.01
Area 3, Mud Plant	24	3.1	-0.81	0.76	0.88	<0.01
Area 3, U-3ah/at N	13	5.0	-2.7	0.54	5.8	<0.01
Area 5, RWMS No. 1	26	5.4	-2.0	2.3	1.7	0.023
Area 5, RWMS No. 3	21	7.6	-0.054	2.7	2.0	0.027
Area 5, RWMS No. 4	27	17	0.22	5.4	4.1	0.054
Area 5, RWMS No. 5	21	65	0.59	6.1	2.1	0.061
Area 5, RWMS No. 6	26	9.3	-0.30	2.8	2.4	0.028
Area 5, RWMS No. 7	19	6.0	0.43	3.0	1.6	0.030
Area 5, RWMS No. 8	23	7.4	-0.082	2.8	2.2	0.028
Area 5, RWMS No. 9	19	6.4	1.1	3.8	1.7	0.038
Area 10, SEDAN Crater	25	26	1.5	8.5	6.9	0.085
Area 12, Complex	24	5.5	-1.2	0.84	1.3	<0.01
Area 12, E Tunnel Pond No.1	25	35	-0.48	12	9.8	0.12
Area 15, EPA Farm	23	14.	1.7	5.3	2.9	0.053
Area 23, H&S Building	24	1.1	-0.85	0.11	0.53	<0.01
All Stations	365	65	-2.7	3.7	5.8	0.037

Average MDC ± 1 standard deviation was $(1.7 \pm 1.0) \times 10^{-6}$ pCi/mL

Table 5.9 Radioactivity in NTS Surface Waters - 1996

Source of Water	Number of Locations	Gross ß	Tritium	^{238}Pu	$^{239+240}$Pu	^{90}Sr	% of DCG Range[(a)]
		Annual Average Concentrations (10^{-9} µCi/mL)					
Open Reservoirs	8	12	75	-.0020	-6.2×10^{-4}	-0.060	<0.01-0.1
Natural Springs	7	9.2	61	-0.0018	0.015	-0.084	<0.01-0.15
Containment Ponds							
E Tunnel	3[(b)]	121	9.7×10^5	0.31	2.6	1.1	[(c)]
Well ER-20-5	3	--	7.0×10^5	--	--	--	[(c)]
Well ER-20-6	3		1.0×10^7				
Sewage Lagoons	8	22	-48	0.00047	0.098	-0.080	[(c)]

(a) DCG based on value for drinking water (4 mrem EDE).
(b) Two ponds and an effluent.
(c) Not a potable water source.

Table 5.10 NTS Open Reservoir Gross Beta Analysis Results - 1996

Location	Gross Beta Concentration (10^{-9} μCi/mL) Concentration	Concentration as %DCG[(a)]
Area 2, Mud Plant Reservoir	5.3	13
Area 2, Well 2 Reservoir [(b)]	-	-
Area 3, Mud Plant Reservoir[(b)]	-	-
Area 3, Well A Reservoir	19	48
Area 5, UE-5c Reservoir	8.6	22
Area 5, Well 5B Reservoir	15	38
Area 6, Well 3 Reservoir	18	45
Area 6, Well C1 Reservoir	17	43
Area 18, Camp 17 Reservoir	15	38
Area 18, Well 8 Reservoir[(b)]	-	-
Area 19, UE-19c Reservoir[(b)]	-	-
Area 20, Well 20A Reservoir[(b)]	-	-
Area 23, Swimming Pool[(b)]	-	-
Area 25, Well J-11 Reservoir	4.6	12
Area 25, Well J-12 Reservoir	5.2	13

(a) DCG based on ^{90}Sr value for drinking water (4 mrem EDE).
(b) Reservoir was dry.

Table 5.11 NTS Natural Spring Gross Beta Analysis Results - 1996

Location	Gross Beta Concentration (10^{-9} μCi/mL) Concentration	Concentration as %DCG[(a)]
Area 5, Cane Spring	12	30
Area 7, Reitmann Seep	13	33
Area 12, Captain Jack	7.8	20
Area 12, Gold Meadows[(b)]	---	
Area 12, White Rock Spring	9.0	23
Area 15, Tub Spring	8.1	20
Area 16, Tippipah Spring	6.3	16
Area 29, Topopah Spring	7.9	20

Note: Annual samples only.

(a) DCG based on ^{90}Sr value for drinking water (4 mrem EDE).
(b) Pool was dry.

Table 5.12 NTS Containment Pond Gross Beta Analysis Results - 1996

Location	Number	Gross Beta Concentration (10^{-9} µCi/mL) Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG[(a)]
Area 12, E Tunnel Effluent	4	220	61	120	72	300
Area 12, E Tunnel Pond No. 1	2	140	130	140	1.4	350
Area 12, E Tunnel Pond No. 2	1	--	--	93	--	230

(a) DCG based on ^{90}Sr value for drinking water (4 mrem EDE).

Table 5.13 NTS Drinking Water Sources - 1996

System	Supply Wells	End-Point
No. 1	Wells C1, 4, 4A	Area 6, Cafeteria Area 6, Building 6-900
No. 2	Well 8	Area 2, Restroom Area 12, Building 12-23
No. 3	Well UE-16d	Area 1, Building 101
No. 4	Wells 5B, Well 5C, and Army No. 1	Area 23, Cafeteria
No. 5	Wells J-12, J-13	Area 25, Building 4221

Table 5.14 NTS Supply Well Radioactivity Averages - 1996

Description	µCi/mL Gross Beta	^{3}H	$^{239+240}$Pu	^{238}Pu	Gross Alpha	^{90}Sr[(a)]
Potable Water Supply Wells						
Area 5, Well 5C	8.3×10^{-9}	1.4×10^{-9}	-2.4×10^{-12}	-2.8×10^{-12}	1.2×10^{-8}	-4.8×10^{-11}
Area 6, Well 4	7.1×10^{-9}	2.9×10^{-9}	-2.9×10^{-12}	-4.3×10^{-12}	9.3×10^{-9}	-8.4×10^{-11}
Area 6, Well 4A	6.6×10^{-9}	1.4×10^{-9}	1.7×10^{-12}	-7.9×10^{-13}	9.9×10^{-9}	2.6×10^{-11}
Area 5, Well 5B	1.2×10^{-8}	3.0×10^{-9}	-1.8×10^{-12}	-8.2×10^{-13}	6.1×10^{-9}	-3.5×10^{-11}
Area 6, Well C1	1.4×10^{-8}	4.2×10^{-9}	-2.7×10^{-12}	1.5×10^{-12}	8.3×10^{-9}	-6.4×10^{-12}
Area 6, Well C[(a)]	---	---	---	---	---	---
Area 16, Well UE-16d	6.4×10^{-9}	2.1×10^{-9}	-3.4×10^{-12}	-2.6×10^{-12}	6.7×10^{-9}	-2.6×10^{-11}
Area 18, Well 8	3.6×10^{-9}	2.9×10^{-10}	-3.5×10^{-12}	-3.0×10^{-12}	7.7×10^{-10}	-4.5×10^{-11}
Area 22, Army Well No.1	4.8×10^{-9}	5.3×10^{-9}	-2.6×10^{-12}	-2.7×10^{-12}	5.4×10^{-9}	-5.1×10^{-11}
Area 25, Well J-12	4.5×10^{-9}	-3.3×10^{-10}	-2.6×10^{-12}	-3.5×10^{-12}	1.5×10^{-9}	-1.7×10^{-11}
Area 25, Well J-13	4.6×10^{-9}	-9.8×10^{-10}	-1.1×10^{-12}	-2.9×10^{-12}	2.3×10^{-9}	-4.2×10^{-11}
Non-Potable Water Supply Wells						
Area 5, Well UE-5c	7.6×10^{-9}	-4.0×10^{-9}	-2.7×10^{-12}	-1.9×10^{-12}	7.4×10^{-9}	-3.3×10^{-11}
Area 19, Well UE-19c[(a)]	---	---	---	---	---	---
Area 20, Well U-20[(b)]	2.7×10^{-9}	-1.5×10^{-8}	-6.4×10^{-12}	8.4×10^{-12}	8.4×10^{-9}	-2.4×10^{-10}
Median MDC	1.2×10^{-9}	1.4×10^{-8}	2.0×10^{-11}	1.9×10^{-11}	1.4×10^{-9}	2.9×10^{-10}

(a) Pump not operating.
(b) One sample collected, pump not operating.

Table 5.15 Radioactivity Averages for NTS Consumption Points - 1996

Description	Gross Beta (µCi/mL)	^{3}H	$^{239+240}Pu$	^{238}Pu	Gross Alpha	^{90}Sr (a)
Area 1, Bldg. 101 (b)	6.2×10^{-9}	-1.2×10^{-7}	-2.8×10^{-12}	-2.7×10^{-12}	7.5×10^{-9}	-1.2×10^{-10}
Area 2, Restroom	3.7×10^{-9}	-1.3×10^{-9}	-3.5×10^{-12}	-1.4×10^{-12}	1.0×10^{-9}	-1.6×11^{-10}
Area 6, Cafeteria	6.9×10^{-9}	-5.2×10^{-8}	-2.4×10^{-12}	-1.5×10^{-12}	8.8×10^{-9}	-8.3×10^{-11}
Area 6, Bldg. 6-900	7.1×10^{-9}	1.3×10^{-8}	-1.7×10^{-12}	-2.0×10^{-12}	8.2×10^{-9}	-5.5×10^{-11}
Area 12, Bldg. 12-23	3.8×10^{-9}	2.0×10^{-7}	-3.8×10^{-12}	-1.3×10^{-12}	7.7×10^{-10}	-3.6×10^{-11}
Area 23, Cafeteria	1.0×10^{-8}	6.3×10^{-8}	-4.1×10^{-12}	-3.8×10^{-12}	6.5×10^{-9}	-5.1×10^{-11}
Area 25, Bldg. 4221	4.7×10^{-9}	-2.0×10^{-8}	9.8×10^{-13}	-3.2×10^{-13}	1.7×10^{-9}	9.2×10^{-12}
Median MDC	1.2×10^{-9}	7.2×10^{-7}	1.9×10^{-11}	1.8×10^{-11}	1.4×10^{-9}	3.1×10^{-10}

(a) ^{90}Sr values are for one sample.
(b) One sample collected from Area 1 Ice House when Building 101 inaccessible.

Table 5.16 Radium Analysis Results for NTS Potable Water Supply Wells - 1996

Location	Number	^{226}Ra Arithmetic Mean (Concentrations 10^{-9} µCi/mL)	Standard Deviation	^{228}Ra Arithmetic Mean	Standard Deviation
Area 5, Well 5B	4	1.3	1.1	0.14	0.31
Area 5, Well 5C	4	-0.23	1.4	0.23	0.46
Area 6, Well 4	4	1.5	2.0	-0.094	0.31
Area 6, Well 4A	3	1.1	0.62	0.12	0.17
Area 6, Well C (a)	---	---	---	---	---
Area 6, Well C-1	4	2.5	2.2	0.46	0.34
Area 16, Well UE-16d	4	2.3	1.7	0.40	0.43
Area 18, Well 8	4	1.1	1.6	-0.45	0.70
Area 23, Army Well No. 1	4	0.21	0.88	0.43	0.82
Area 25, Well J-12	4	0.96	0.67	0.14	0.40
Area 25, Well J-13	4	0.89	1.5	0.22	0.54
Median MDC		2.2		0.99	

(a) No samples, pump inoperative.

Table 5.17 Tritium Concentration in Water from Plants (µCi/mL) by NTS Area - 1996

Area	Mean	Maximum	Minimum	Number
1	8.6×10^{-08}	1.1×10^{-06}	-3.0×10^{-07}	12
2	6.5×10^{-06}	2.6×10^{-05}	-2.3×10^{-07}	8
3	1.5×10^{-06}	2.1×10^{-05}	-2.5×10^{-07}	31
4	7.3×10^{-07}	5.7×10^{-06}	-1.8×10^{-07}	8

Average MDC = 4.5×10^{-07} µCi/mL

Table 5.17 (Tritium Concentration in Water from Plants [μCi/mL] by NTS Area - 1996, cont.)

Area	Mean	Maximum	Minimum	Number
5	2.5×10^{-05}	2.5×10^{-04}	-2.6×10^{-07}	54
6	6.1×10^{-08}	5.2×10^{-07}	-3.1×10^{-07}	32
7	7.8×10^{-08}	3.6×10^{-07}	-1.5×10^{-07}	10
8	1.9×10^{-06}	9.8×10^{-06}	-1.1×10^{-07}	14
9	1.8×10^{-06}	1.6×10^{-05}	-1.1×10^{-07}	9
10	4.2×10^{-03}	5.0×10^{-02}	-1.5×10^{-07}	25
11	1.4×10^{-07}	3.9×10^{-07}	-2.0×10^{-07}	5
12	3.9×10^{-06}	6.3×10^{-05}	-3.5×10^{-07}	51
14	-1.9×10^{-07}	6.4×10^{-08}	-9.8×10^{-07}	5
15	6.8×10^{-07}	3.9×10^{-06}	-1.2×10^{-08}	12
16	7.4×10^{-06}	3.1×10^{-05}	-3.1×10^{-07}	5
17	1.1×10^{-06}	1.4×10^{-05}	-2.5×10^{-07}	13
18	-4.1×10^{-08}	3.7×10^{-07}	-4.3×10^{-07}	51
19	3.7×10^{-08}	1.4×10^{-06}	-4.5×10^{-07}	24
20	4.2×10^{-06}	1.1×10^{-04}	-3.8×10^{-07}	96
22	5.0×10^{-07}	4.1×10^{-06}	-3.3×10^{-07}	10
23	1.4×10^{-07}	5.0×10^{-07}	-1.5×10^{-07}	8
25	-4.3×10^{-08}	3.1×10^{-07}	-3.9×10^{-07}	47
27	1.0×10^{-07}	1.6×10^{-06}	-3.8×10^{-07}	20
29	3.2×10^{-08}	4.2×10^{-07}	-2.2×10^{-07}	12
30	1.9×10^{-07}	5.3×10^{-06}	-2.8×10^{-07}	40
ALL	1.8×10^{-04}	5.0×10^{-02}	-9.8×10^{-07}	602

Average MDC = 4.5×10^{-07} μCi/mL

Table 5.18 NTS Boundary Gamma Monitoring Results Summary - 1996

Location	First Quarter (mR/day)	Second Quarter (mR/day)	Third Quarter (mR/day)	Fourth Quarter (mR/day)	Annual Average (mR/d)	(mR/yr)
310 15E Substation	0.26	0.26	0.26	0.23	0.25	93
342 Stake C-31	0.36	0.42	0.42	0.40	0.40	150
355 Gold Meadows	0.29	0.29	0.27	(a)	0.28	100
365 Stake R-29	0.39	0.39	0.42	0.41	0.40	150
382 Stake J-41	0.33	0.36	0.36	0.35	0.35	130
383 Stake LC-4	0.47	0.45	0.44	0.44	0.45	170
384 Stake A-118	0.37	0.41	0.42	0.40	0.40	150
386 Papoose Lake Road	0.22	0.22	0.20	0.19	0.21	76
387 Gate 19-3P	0.40	0.40	0.41	(a)	0.40	150
388 Hill Top	0.37	0.34	0.35	0.34	0.35	130
389 East of U11B	0.34	0.31	0.31	0.31	0.32	120
400 Army Well No. 1	(a)	0.21	0.21	0.22	0.21	78
402 3.3 Mi. SE of Agg. Pit	0.17	0.17	0.16	0.17	0.17	61
403 Guard Station 510	0.31	0.38	0.33	0.36	0.35	130
404 Yucca Mountain	0.35	0.34	0.34	0.38	0.35	130
405 Gate 30-3P, Cat Canyon	(a)	0.44	0.43	0.51	0.45	160

(a) Missing TLD.

Table 5.19 NTS TLD Control Station Comparison, 1990-1996

Area	Station	Exposure Rate (mR/day) 1990	1991	1992	1993	1994	1995	1996
5	Well 5B	0.34	0.36	0.31	0.39	0.34	0.30	0.30
6	CP-6	0.25	0.24	0.23	0.30	0.19	0.19	0.21
6	Yucca Oil Storage	0.32	0.33	0.31	0.37	0.27	0.26	0.28
23	Building 650 Dosimetry	0.20	0.19	0.18	0.26	0.15	0.15	0.14
23	Building 650 Roof	0.19	0.19	0.18	0.25	0.14	0.15	0.14
23	Post Office	0.23	0.24	0.23	0.30	0.21	0.20	0.18
25	HENRE Site	0.39	0.40	0.36	0.45	0.32	0.33	0.34
25	NRDS Warehouse	0.39	0.39	0.37	0.46	0.33	0.36	0.32
27	Cafeteria	0.40	0.42	0.39	0.46	0.33	0.33	0.34
Network Average		0.30	0.31	0.28	0.36	0.25	0.25	0.25

Table 5.20 Gross Beta Results for the Offsite Air Surveillance Network - 1996

Gross Beta Concentration (10^{-14} µCi/mL [0.37 mBq/m^3])

Sampling Location	Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation
Alamo, NV	52	2.56	0.53	1.4	0.47
Amargosa Center, NV	52	4.64	0.59	1.6	0.65
Beatty, NV	52	2.95	0.53	1.5	0.48
Boulder City, NV	09	3.09	0.34	1.4	0.87
Clark Station, NV Stone Cabin Ranch	52	2.74	0.50	1.5	0.48
Goldfield, NV	51	2.72	0.49	1.4	0.52
Henderson, NV	13	3.04	0.22	1.5	0.88
Indian Springs, NV	50	2.49	0.02	1.3	0.49
Las Vegas, NV	52	2.44	0.24	1.3	0.44
Overton, NV	50	3.37	0.62	1.5	0.58
Pahrump, NV	50	2.26	0.48	1.4	0.47
Pioche, NV	50	2.21	0.66	1.4	0.44
Rachel, NV	49	2.50	0.22	1.4	0.49
Sunnyside, NV	50	2.73	-0.05	1.4	0.51
Tonopah, NV	52	2.22	0.48	1.3	0.41
Twin Springs, NV Fallini's Ranch	50	2.73	0.26	1.6	0.56
Cedar City, UT	52	3.06	0.18	1.2	0.61
Delta, UT	49	3.04	0.22	1.5	0.88
Milford, UT	53	5.74	0.19	1.5	0.82
St. George, UT	22	5.38	0.66	1.8	1.0

Mean MDC: 2.4 x 10^{-15} µCi/mL   Standard Deviation of Mean MDC: 0.36 x 10^{-15} µCi/mL

Table 5.21 Gross Alpha Results for the Offsite Air Surveillance Network - 1996

Sampling Location	Number	Concentration (10^{-15} µCi/mL [37 µBq/m^3]) Maximum	Minimum	Arithmetic Mean	Standard Deviation
Alamo, NV	52	5.9	0.4	1.6	0.94
Amargosa Center, NV	52	6.6	0.0	1.6	1.1
Beatty, NV	52	2.8	0.2	1.1	0.64
Boulder City, NV	09	4.1	1.3	2.6	1.0
Clark Station, NV Stone Cabin Ranch	52	4.5	0.5	2.0	0.72
Goldfield, NV	51	3.2	0.2	1.0	0.60
Henderson	13	3.6	0.8	2.3	0.84
Indian Springs, NV	50	3.9	0.2	1.0	0.70
Las Vegas, NV	52	2.9	0.2	1.5	0.74
Overton, NV	50	6.3	-0.1	1.2	1.1
Pahrump, NV	50	4.0	-0.2	1.0	0.81
Pioche, NV	49	3.6	-0.2	0.95	0.66
Rachel, NV	49	4.3	0.1	1.3	0.98
Sunnyside, NV	50	1.6	0.0	0.74	0.43
Tonopah, NV	52	2.9	-0.3	0.92	0.56
Twin Springs, NV Fallini's Ranch	50	3.2	-0.1	1.2	0.77
Cedar City, UT	52	3.5	0.2	1.6	0.78
Delta, UT	49	7.1	0.1	1.4	1.2
Milford, UT	53	1.6	0.0	0.74	0.43
St. George, UT	22	3.6	-0.2	0.95	0.66

Mean MDC: 7.7 x 10^{-16} µCi/mL   Standard Deviation of Mean MDC: 2.4 x 10^{-16} µCi/mL

Table 5.22 Offsite High Volume Airborne Plutonium Concentrations - 1996

Composite Sampling Location	Number	^{238}Pu Concentration (10^{-18} µCi/mL) Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG (a)
Alamo, NV	18	0.54	-0.09	0.17	0.16	(b)
Goldfield, NV	17	0.51	0.00	0.21	0.16	(b)
Las Vegas, NV	11	0.86	0.24	0.11	0.27	(b)
Lathrop Wells, NV	4	1.40	0.13	0.59	0.52	(b)
Tonopah, NV	15	0.42	-0.09	0.14	0.15	(b)
Rachel, NV	7	0.94	-0.45	0.14	0.41	(b)
Amargosa Center, NV	10	0.94	-0.08	0.20	0.27	(b)

Mean MDC: 0.58 x 10^{-18} µCi/mL   Standard Deviation of Mean MDC: 1.36 x 10^{-18} µCi/mL

(a) Derived Concentration Guide; Established by DOE Order as 3 x 10^{-15} µCi/mL.
(b) Not applicable, result less than MDC.
Note: To convert from µCi/mL to Bq/m^3 multiply by 3.7x10^{10} (e.g., [1.8x10^{-18}] x [37x10^9] = 67 nBq/m^3).

Table 5.22 (Offsite High Volume Airborne Plutonium Concentrations - 1996, cont.)

		$^{239+240}Pu$ Concentration (10^{-18} µCi/mL)				
Composite Sampling Location	Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG (a)
Alamo, NV	18	4.9	0.07	1.5	1.2	0.05
Goldfield, NV	17	9.7	0.06	1.7	2.2	0.06
Las Vegas, NV	11	2.2	0.00	0.86	0.64	0.03
Lathrop Wells, NV	4	115	0.70	38	46	1.3
Tonopah, NV	15	2.9	0.19	0.95	0.73	0.03
Rachel, NV	7	66	0.39	13	22	0.42
Amargosa Center, NV	10	1.6	0.23	0.69	0.42	0.02

Mean MDC: 0.53×10^{-18} µCi/mL   Standard Deviation of Mean MDC: 0.90×10^{-18} µCi/mL

(a) Derived Concentration Guide; Established by DOE Order as 3×10^{-15} µCi/mL.
(b) Not applicable, result less than MDC.
Note: To convert from µCi/mL to Bq/m³ multiply by 3.7×10^{10} (e.g., $[1.8 \times 10^{-18}] \times [37 \times 10^{9}] = 67$ nBq/m³).

Table 5.23 Summary of Radionuclides Detected in Milk Samples

Milk Surveillance Network
No. of samples with results > MDC
(Network average concentration in pCi/L)

	1996	1995	1994
^{3}H	Not Analyzed	0(37)	0(85)
^{89}Sr	0(0.01)	0(0.03)	0(0.22)
^{90}Sr	0(0.63)	0(0.61)	2(0.44)

Table 5.24 Summary of Gamma Exposure Rates as Measured by PIC - 1996

		Gamma Exposure Rate (µR/hr)						
Station	Number of Weekly Averages	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Median	mR/yr	1996 Mean (µR/hr)
Alamo, NV	281	13.3	12.1	12.8	1.08	13.0	113	12.9
Amargosa Center, NV	267	11.6	10.5	10.9	0.73	11.0	96	11.0
Beatty, NV	283	17.0	15.9	16.3	1.08	16.0	144	16.4

Note: Multiply µR/hr by 2.6×10^{-4} to obtain $\mu C \cdot kg^{-1} \cdot hr^{-1}$.

Table 5.24 (Summary of Gamma Exposure Rates as Measured by PIC - 1996, cont.)

Station	Number of Weekly Averages	Gamma Exposure Rate (µR/hr) Maximum	Minimum	Arithmetic Mean	Standard Deviation	Median	mR/yr	1996 Mean (µR/hr)
Caliente, NV	262	15.1	13.6	14.2	0.48	14.0	125	14.3
Cedar City, UT	277	12.3	10.8	11.5	0.83	12.0	102	11.6
Complex I, NV	275	16.0	14.5	15.3	0.86	15.0	134	15.3
Delta, UT	266	12.7	11.2	12.0	0.71	12.0	105	12.0
Furnace Creek, CA	267	10.3	9.1	9.7	0.64	10.0	85	9.7
Goldfield, NV	242	15.8	14.4	15.2	1.16	15.0	133	15.2
Indian Springs, NV	253	11.9	10.8	11.2	1.06	11.0	99	11.3
Las Vegas, NV	359	10.7	8.7	9.4	0.16	9.4	82	9.4
Medlin's Ranch, NV	276	17.0	15.8	16.3	0.68	16.0	143	16.3
Milford, UT	275	18.6	17.0	17.7	0.93	18.0	155	17.7
Nyala, NV	223	12.8	11.3	12.0	0.21	12.0	105	12.0
Overton, NV	270	10.3	9.2	9.8	0.62	10.0	87	9.9
Pahrump, NV	269	8.9	7.9	8.0	0.41	8.0	71	8.1
Pioche, NV	248	12.1	10.8	11.5	2.03	12.0	101	11.5
Rachel, NV	255	17.2	15.9	16.4	1.37	17.0	145	16.5
St. George, UT	266	9.1	7.9	8.1	0.75	8.0	72	8.2
Stone Cabin Ranch, NV	274	18.4	16.9	17.5	1.22	18.0	154	17.6
Terrell's Ranch, NV	276	16.9	15.7	16.1	0.84	16.0	141	16.1
Tonopah, NV	275	18.5	17.1	17.7	1.22	18.0	156	17.8
Twin Springs, NV	262	17.7	15.7	17.6	1.0	16.0	144	16.4
Uhalde's Ranch, NV	276	18.0	16.6	17.2	0.73	17.0	152	17.3

Note: Multiply µR/hr by 2.6×10^{-4} to obtain $\mu C \cdot kg^{-1} \cdot hr^{-1}$.

Table 5.25 BN Offsite Boundary Line Monitoring Data - 1996

Remote Sensing Laboratory/Nellis

Station ID#	Description	1st Qtr. (mR)	2nd Qtr. (mR)	3rd Qtr. (mR)	4th Qtr. (mR)	CY-96 (mR)
RS-022	SE Fence--Near Gate	21.3	19.3	19.1	20.9	81
RS-023	SE Fence--Near Gate	21.0	19.3	18.7	20.8	80
RS-024	S Fence--Center	19.5	(a)	16.7	18.7	55
RS-025	S Fence--Center	19.3	17.5	16.7	18.6	72
RS-026	SW Fence--Near Gate	17.2	15.4	14.3	15.2	62
RS-027	SW Fence--Near Gate	16.9	15.1	13.7	15.5	61
RS-028	NW Fence--Near Gate	19.8	15.7	14.0	16.4	66
RS-029	NW Fence--Near Gate	17.8	15.7	14.0	15.8	63
RS-030	N Fence--Center	20.7	18.1	23.6	19.4	82
RS-031	N Fence--Center	20.1	18.7	17.3	19.4	76
RS-032	NE Fence--Near Corner	16.6	14.8	13.1	15.5	60
RS-033	NE Fence--Near Corner	17.5	14.5	13.7	15.8	61
RS-098	Control - 1	26.0	27.4	24.7	28.6	107
RS-099	Control - 2	26.3	26.8	25.0	29.0	107

(a) Not available, missing data.

Table 5.25 (BN Offsite Boundary Line Monitoring Data - 1996, cont.)

North Las Vegas Facility

Station ID#	Description	1st Qtr. (mR)	2nd Qtr. (mR)	3rd Qtr. (mR)	4th Qtr. (mR)	CY-96 (mR)
LV-055	NW Corner Fence/Gate C6	19.7	19.4	21.6	19.6	80
LV-056	NW Corner Fence/Gate C6	20.6	18.8	20.1	19.6	79
LV-057	N Fence--West End A-12	18.5	14.5	16.1	15.1	64
LV-058	N Fence--West End A-12	23.1	15.4	16.1	15.9	70
LV-059	N Fence--West End A-4	18.8	14.8	16.1	15.6	65
LV-060	N Fence--West End A-4	19.1	14.8	16.6	15.9	66
LV-061	NE Corner Fence/A-12	17.0	13.3	14.6	13.6	59
LV-062	NE Corner Fence/A-12	16.5	13.9	15.8	13.6	60
LV-063	E Fence/Center A-Complex	16.7	13.0	15.5	14.2	59
LV-064	E Fence/Center A-Complex	17.0	13.3	15.5	13.7	60
LV-065	NLV Badge Off (A-7)/A-2	16.2	12.7	14.6	13.1	57
LV-066	NLV Badge Off (A-7)/A-2	15.9	12.7	15.2	13.1	57
LV-067	E Fence/North End B-Complex	17.3	(a)	15.8	14.5	48
LV-068	E Fence/North End B-Complex	17.3	14.5	16.1	14.5	62
LV-069	E Fence/South End B-Complex	17.9	14.8	16.9	15.1	65
LV-070	E Fence/South End B-Complex	26.6	14.8	18.7	14.8	75
LV-071	S Fence/Center/Next to Sub	17.9	14.8	16.9	15.3	65
LV-072	S Fence/Center/Next to Sub	18.2	14.8	16.6	15.4	65
LV-073	SW Corner/Gate C-1	19.7	14.2	15.8	14.2	64
LV-074	SW Corner/Gate C-1	17.6	14.2	16.3	14.5	63
LV-075	C-1 W End Guard Gate	22.0	18.0	20.1	(a)	60
LV-076	C-1 W End Guard Gate	21.8	17.7	19.0	18.8	77
LV-077	W Fence/Gate C-3	18.2	14.8	16.9	15.4	65
LV-078	W Fence/Gate C-3	18.8	14.8	16.3	(a)	50
LV-079	NW End A-13/Double G	18.8	15.0	16.3	14.8	65
LV-080	NW End A-13/Double G	19.4	14.5	16.9	15.9	67
LV-098	Control - 1	18.8	10.4	11.1	9.7	50
LV-099	Control - 2	19.1	10.4	11.7	9.1	50

Special Technologies Laboratory

Station ID#	Description	1st Qtr. (mR)	2nd Qtr. (mR)	3rd Qtr. (mR)	4th Qtr. (mR)	CY-96 (mR)
ST197	Bldg. 226, West Fence	18.2	20.2	21.7	20.9	81
ST198	Bldg. 226, West Fence	18.5	19.6	21.4	21.5	81
ST199	Bldg. 229-C, L Side of Sliding Gate	19.9	20.4	22.2	22.4	85
ST200	Bldg. 229-C, L Side of Sliding Gate	18.8	21.3	23.4	23.3	87
ST201	Bldg. 227, E Fence	17.0	19.9	22.2	22.1	81
ST202	Bldg. 227, E Fence	16.7	20.5	22.0	21.8	81
ST205	Bldg. 227, NE Corner Step	16.4	20.7	21.4	21.8	80
ST206	Bldg. 227, NE Corner Step	17.9	20.5	27.5	22.4	88
ST207	Bldg. 227, NE Fence	19.6	21.3	21.7	23.3	86
ST208	Bldg. 227, NE Fence	20.5	21.3	21.9	23.0	87
ST209	Bldg. 227, Behind CF Shed	19.6	21.3	25.0	23.0	89
ST210	Bldg. 227, Behind CF Shed	19.3	21.3	23.1	22.4	86
ST213	Bldg. 227, SE Fence Corner	19.3	21.9	23.1	24.2	89
ST214	Bldg. 227, SE Fence Corner	19.4	21.3	22.8	23.3	87
ST141	Bldg. 227, Rear on Fence	21.7	22.5	24.0	19.4	88
Control		14.1	16.4	18.4	19.7	69
Control		15.2	16.7	18.7	20.3	71

(a) Not available, missing data.

Rainier Mesa and Stockade Wash

6.0 DOSE ASSESSMENT

The offsite environmental surveillance system, operated around the Nevada Test Site (NTS) by the U.S. Environmental Protection Agency's (EPA's) Radiation and Indoor Environments National Laboratory in Las Vegas (R&IE-LV), measured no radiation exposures attributable to recent NTS operations. However, using onsite emission measurements, estimates provided by U.S. Department of Energy (DOE) and calculated resuspension data as input to the EPA's Clean Air Package 1988 (CAP88)-PC model, a potential effective dose equivalent (EDE) to the maximally exposed individual (MEI) was calculated to be 0.11 mrem (1.1×10^{-3} mSv) to a hypothetical resident of Springdale, Nevada, located 58 km (36 mi) west-northwest of Control Point 1 (CP-1) on the NTS. The calculated population dose (collective EDE) to the approximately 32,210 residents living within 80 km (50 mi) from each of the NTS airborne emission sources was 0.34 person-rem (3.4×10^{-3} person-Sv). Monitoring network data indicated a 1996 exposure to the MEI of 144 mrem (1.44 mSv) from normal background radiation. The calculated dose to this individual from worldwide distributions of radioactivity as measured from surveillance networks was 0.023 mrem (2.3×10^{-4} mSv). These maximum dose estimates, excluding background, are less than 1 percent of the most restrictive standard.

6.1 ESTIMATED DOSE FROM NTS ACTIVITIES

The potential EDE to the offsite population due to NTS activities is estimated annually. Two methods are used to estimate the EDE to residents in the offsite area in order to determine the community potentially most impacted by airborne releases of radioactivity from the NTS. In the first method, effluent release estimates, based on monitoring data or calculated resuspension of deposited radioactivity, and meteorological data are used as inputs to EPA's CAP88-PC model which then produces estimated EDEs. The second method entails using data from the Offsite Radiological Safety Program (ORSP) with documented assumptions and conversion factors to calculate the committed effective dose equivalent (CEDE). The latter method provides an estimate of the EDE to a hypothetical individual continuously present outdoors at the location of interest that includes both NTS emissions and worldwide fallout. In addition, a collective EDE is calculated by the first method for the total offsite population residing within 80 km (50 mi) of each of the NTS emission sources. Background radiation measurements are used to provide a comparison with the calculated EDEs. In the absence of detectable releases of radiation from the NTS, the Pressurized Ion Chamber (PIC) network provides a measurement of background gamma radiation in the offsite area.

There are four sources of possible radiation exposure to the population of Nevada, some of which were monitored by EPA's offsite monitoring networks during 1996. These were:

- Background radiation due to natural sources such as cosmic radiation, radioactivity in soil, and ^{7}Be in air.

- Worldwide distributions of man-made radioactivity, such as ^{90}Sr in milk and plutonium in soil.

- Operational releases of radioactivity from the NTS, including those from drill-back and purging activities when they occur.

- Radioactivity that was accumulated in migratory game animals during their residence on the NTS.

Operational releases and calculated sources of radioactive emissions from the NTS are used as input data for CAP88-PC to provide estimates of exposures to offsite populations. The other three sources of exposure listed above are discussed below.

ESTIMATED DOSE USING REPORTED NTS EMISSIONS

Onsite source emission measurements, as provided by DOE, are listed in Chapter 5, Table 5.1, and include tritium, radioactive noble gases, and plutonium. These are estimates of releases made at the point of origin. Meteorological data collected by the Air Resources Laboratory Special Operations and Research Division (ARL/SORD) were used to construct wind roses and stability arrays for the following areas: Mercury, Area 12, Area 20, Yucca Flat, and the Radioactive Waste Management Site (RWMS) in Area 5. A calculation of estimated dose from NTS effluents was performed using EPA's CAP88-PC model (EPA 1992). The results of the model indicated that the hypothetical individual with the maximum calculated dose from airborne NTS radioactivity would reside at Springdale, Nevada, 58 km (36 mi) west-northwest of CP-1. The maximum dose to that individual could have been 0.11 mrem (1.1×10^{-3} mSv). For comparison, data from the PIC monitoring network indicated a 1996 dose of 144 mrem (1.44 mSv) from background gamma radiation occurring in that area. The population living within a radius of 80 km (50 mi) from the airborne sources on the NTS was estimated to be 32,210 individuals, based on 1995 population data. The collective population dose within 80 km (50 mi) from each of these sources was calculated to be 0.34 person-rem (3.4×10^{-3} person-Sv). Activity concentrations in air that would cause these calculated doses are much higher than actually detected by the offsite monitoring network. For example, 0.107 mrem of the calculated EDE to the MEI is due to plutonium. The annual average plutonium concentration in air that would cause this EDE is 4.1×10^{-17} µCi/mL. This is about 20 times the annual average plutonium in air measured in Goldfield, Nevada, (nearest community) of 0.19×10^{-17} µCi/mL (Chapter 5, Table 5.22). Table 6.1 summarizes the annual contributions to the EDEs due to 1996 NTS operations as calculated by use of CAP88-PC and the radionuclides listed in Chapter 5, Table 5.1.

Input data for the CAP88-PC model included meteorological data from ARL/SORD and effluent release data calculated from monitoring results and from resuspension estimates. These release data are known to be estimates and the meteorological data are mesoscale; e.g., representative of an area approximately 40 km (25 mi) or less around the point of collection. However, these data are considered sufficient for model input, primarily because the model itself is not designed for complex terrain such as that on and around the NTS. Errors introduced by the use of the effluent and meteorological data are small compared to the errors inherent in the model. The model results are considered over-estimates of the dose to offsite residents. This has been confirmed by comparison with the offsite monitoring results.

ESTIMATED DOSE USING MONITORING NETWORK DATA

Potential CEDEs to individuals may be estimated from the concentrations of radioactivity, as measured by the EPA monitoring networks during 1996. Actual results obtained in analysis are used; the majority of which are less than the reported minimum detectable concentration (MDC). No krypton or tritium in air data were collected offsite, so the onsite krypton for this year, and an average value for previous year's offsite tritium were used. No vegetable or animal samples were collected in 1996, so calculations for these intakes are not done.

Data quality objectives (DQOs) for precision and accuracy are, by necessity, less stringent for values near the MDC, so confidence intervals around the input data are broad. The concentrations of radioactivity detected by the monitoring networks and used in the calculation of potential CEDEs are shown in Table 6.2.

The concentrations given in Table 6.2 are expressed in terms of activity per unit volume. These concentrations are converted to a dose by using the assumptions and dose conversion factors described below. The dose conversion factors assume continuous presence at a fixed location and no loss of radioactivity in storage or handling of ingested materials.

- Adult respiration rate = 8400 m^3/yr (ICRP 1975)
- Milk intake (average for 20 and 40 yr old) = 110 L/yr (ICRP 1975)
- Water consumption = 2 L/day (ICRP 1975)

The EDE conversion factors are derived from Federal Guidance Report No. 11 (EPA 1988). Those used here are:

- ^{3}H:
  6.4 x 10^{-8} mrem/pCi (ingestion or inhalation)
- ^{7}Be:
  2.6 x 10^{-7} mrem/pCi (inhalation)
- ^{90}Sr:
  1.4 x 10^{-4} mrem/pCi (ingestion)
- ^{85}Kr:
  1.5 x 10^{-5} mrem/yr per pCi/m^3 (submersion)
- $^{238,239+240}$Pu:
  3.7 x 10^{-4} mrem/pCi (ingestion, f_1=10^{-4})
  3.1 x 10^{-1} mrem/pCi (inhalation, Class Y)

The algorithm for the internal dose calculation is:

- (concentration) x (intake in volume [mass]/unit time) x (CEDE conversion factors) = CEDE

As an example calculation, the following is the result of breathing a concentration of tritium in air of 0.2 pCi/m^3:

- (2 x 10^{-1} pCi/m^3) x (8400 m^3/yr) x (6.4 x 10^{-8} mrem/pCi) = 1.1 x 10^{-4} mrem/yr

However, in calculating the inhalation CEDE from ^{3}H, the value must be increased by 50 percent to account for skin absorption (ICRP 1979). The total dose in one year, therefore, is 1.1 x 10^{-4} x 1.5 = 1.6 x 10^{-4} mrem/yr. Dose calculations from ORSP data are summarized in Table 6.2.

The individual CEDEs, from the various pathways, added together give a total of 0.015 mrem/yr. Total EDEs can be calculated based on different combinations of data. If the interest was in just one area, for example, the concentrations from those stations closest to that area could be substituted into the equations used herein.

In 1996, because of budget cuts and the standby status of nuclear device testing, samples of game animals and garden vegetables were not collected. Also, the noble gas and tritium sampling network was discontinued in the offsite locations, and the air sampling network was reduced. In order to calculate an EDE for a resident of Springdale, Nevada, using the MEI from the CAP88-PC operation, it is necessary to make some assumptions. The NTS average krypton-85 concentration is representative of statewide levels so it can be used. Also, tritium in air does not change much from year to year so previous data for that can be used. Finally, Goldfield, Nevada, has the nearest air sampler to Springdale, Nevada, so its plutonium concentration is used to calculate the EDE.

6.2 DOSE (EDE) FROM BACKGROUND RADIATION

In addition to external radiation exposure due to cosmic rays and gamma radiation from naturally occurring radionuclides in soil (e.g., ^{40}K, U, and Th and their progeny), there is a contribution from ^{7}Be that is formed in the atmosphere by cosmic ray interactions with oxygen and nitrogen. The annual average ^{7}Be concentration measured by the offsite surveillance network was 0.24 pCi/m^3. With a dose conversion factor for inhalation of 2.6 x 10^{-7} mrem/pCi, and a breathing volume of 8,400 m^3/yr, this equates to a dose of 5.2 x 10^{-4} mrem as calculated in Table 6.2. This is a negligible quantity when compared with the PIC network measurements that vary from 73 to 156 mR/year, depending on location.

6.3 SUMMARY

The offsite environmental surveillance system operated around the NTS by EPA's R&IE-LV detected no radiological exposures that could be attributed to recent NTS operations, but a calculated EDE of 0.015 mrem can be obtained, if certain assumptions are made, as shown in Table 6.2. Calculation with the CAP88-PC model, using estimated or calculated effluents from the NTS during 1996, resulted in a maximum dose of 0.11 mrem (1.1 x 10^{-3} mSv) to a hypothetical resident of Springdale, Nevada, 14 km (9 mi) west of the NTS boundary. Based on monitoring network data, this dose is calculated to be 0.005 mrem. This latter EDE is about 5 percent of the dose obtained from CAP88-PC calculation. This maximum dose estimate is less than 1 percent of the International Commission on Radiological Protection (ICRP) recommendation that an annual EDE for the general public not exceed 100 mrem/yr (ICRP 1985). The calculated population dose (collective EDE) to the approximately 32,210 residents living within 80 km (50 mi) of each of the NTS airborne emission sources was 0.34 person-rem (3.4 x 10^{-3} person-Sv). Background radiation yielded a CEDE of 3,064 person-rem (30.6 person-Sv).

Data from the PIC gamma monitoring indicated a 1996 dose of 144 mrem from background gamma radiation measured in the Springdale area. The CEDE calculated from the monitoring networks or the model, as discussed above, is a negligible amount by comparison. The uncertainty (2σ) for the PIC measurement at the 144 mrem exposure level is approximately 5 percent. Extrapolating to the calculated annual exposure at Springdale, Nevada, yields a total uncertainty of approximately 7 mrem which is greater than either of the calculated EDEs. Because the estimated dose from NTS activities is less than 1 mrem (the lowest level for which DQOs are defined, as given in Chapter 10), no conclusions can be made regarding the achieved data quality as compared to the DQOs for this insignificant dose.

Table 6.1 Summary of Effective Dose Equivalents from NTS Operations - 1996

	Maximum EDE at NTS Boundary[(a)]	Maximum EDE to an Individual[(b)]	Collective EDE to Population within 80 km of the NTS Sources
Dose	0.12 mrem (1.2×10^{-3} mSv)	0.11 mrem (1.1×10^{-3} mSv)	0.34 person-rem (3.4×10^{-3} person-Sv)
Location	Site boundary 40 km WNW of NTS CP-1	Springdale, NV 58 km WNW of NTS CP-1	32,210 people within 80 km of NTS Sources
NESHAP[(c)] Standard	10 mrem per yr (0.1 mSv per yr)	10 mrem per yr (0.1 mSv per yr)	-----
Percentage of NESHAP	1.2	1.1	-----
Background	144 mrem (1.44 mSv)	144 mrem (1.44 mSv)	3064 person-rem (30.6 person-Sv)
Percentage of Background	0.08	0.08	0.011

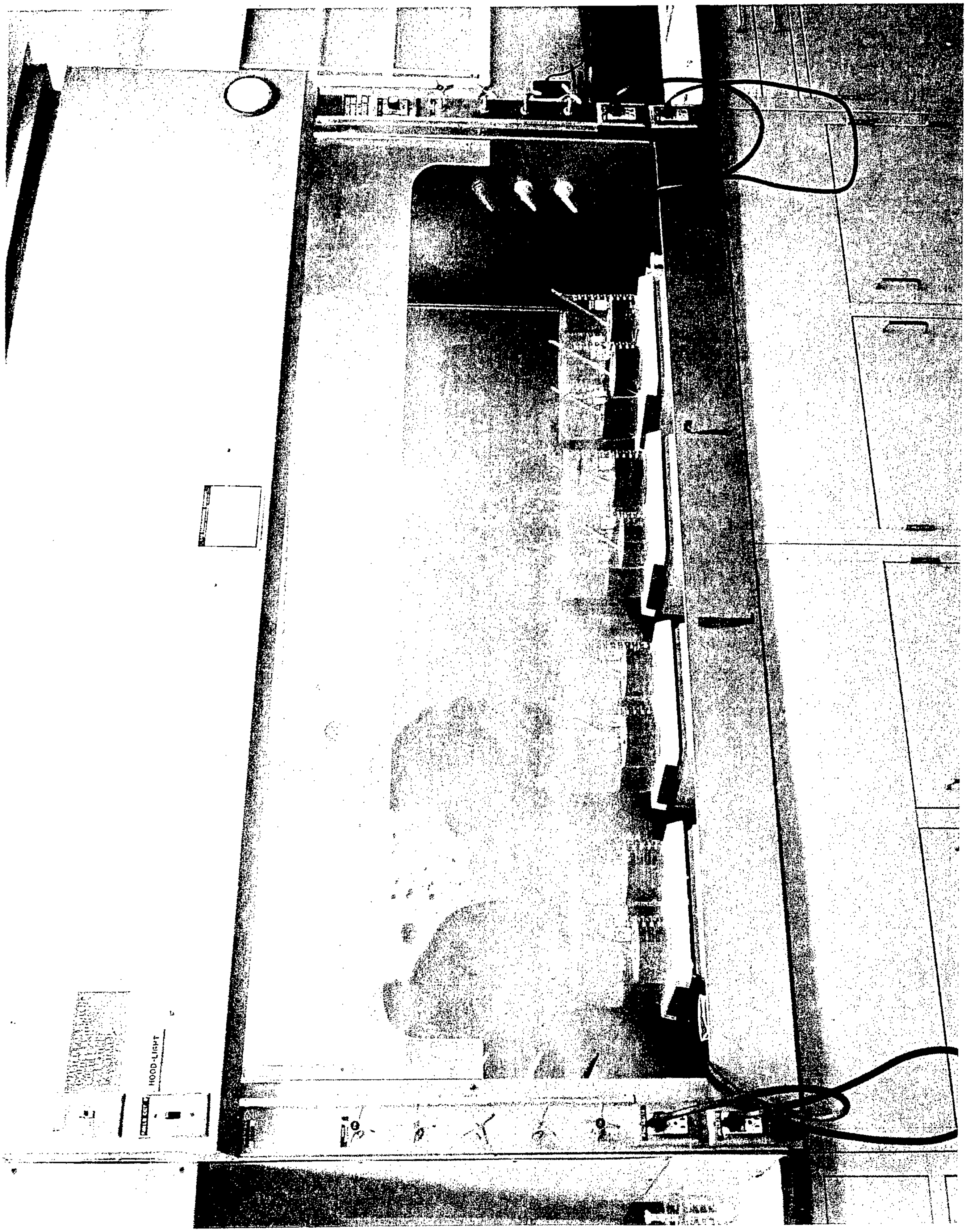
(a) The maximum boundary dose is to a hypothetical individual who remains in the open continuously during the year at the NTS boundary located 40 km (25 mi) west-northwest from CP-1.
(b) The maximum individual dose is to a person outside the NTS boundary at a residence where the highest dose-rate occurs as calculated by CAP88-PC (Version 1.0) using NTS effluents listed in Table 5.1 and assuming all tritiated water input to the Area 12 containment ponds was evaporated.
(c) National Emission Standards for Hazardous Air Pollutants.

Table 6.2 Monitoring Networks Data Used in Dose Calculations - 1996

Medium	Radionuclide	Concentration	Mrem\Year	Comment
Meat				Not collected this year
Milk	^{90}Sr	0.63 [(a)] (0.023)	9.7×10^{-3}	Concentration is the average of all network results
	^{3}H	0	0	Not Analyzed
Drinking Water	^{3}H	0.71 [(a)] (0.026)	3.3×10^{-5}	Concentration is the average from wells in the area
Vegetables				Not collected this year
Air	^{3}H	0.2 [(b)] (0.007)	1.6×10^{-4}	Concentration is average network result (1994 data)
	^{7}Be	0.24 [(b)] (0.010)	5.2×10^{-4}	Annual average for Goldfield, Nevada
	^{85}Kr	25.2 [(b)] (0.93)	3.8×10^{-4}	NTS network average
	$^{239+240}Pu$	1.7×10^{-6} [(b)] (6.3×10^{-8})	4.4×10^{-3}	Annual average for Goldfield, Nevada

TOTAL (Air = 5.5×10^{-3}, Liquids = 9.7×10^{-3}) = 1.5×10^{-2} mrem/yr

(a) Units are pCi/L and Bq/L.
(b) Units are pCi/m^3 and Bq/m^3.



Analyzing Bioassay Samples at Building 650 Laboratory

7.0 NONRADIOLOGICAL MONITORING RESULTS

Nonradiological monitoring of the Nevada Test Site (NTS) operations was confined to onsite monitoring as there were no nonradiological discharges to the offsite environment. Types of monitoring conducted included (1) drinking water distribution systems for Safe Drinking Water Act (SDWA) compliance, (2) sewage influents to lagoons for state of Nevada permit requirements, (3) polychlorinated biphenyls (PCBs) as part of Toxic Substance Control Act compliance, (4) asbestos monitoring for asbestos removal and renovation projects, (5) groundwater monitoring under the waste site in Area 5 for Resource Conservation and Recovery Act (RCRA) compliance, and (6) environmental media for hazardous characteristics and constituents. Wild horses and chukar were also monitored as components of an NTS ecological monitoring program that is being reviewed and redesigned.

7.1 ENVIRONMENTAL SAMPLES

SAFE DRINKING WATER ACT

Water sampling was conducted for analysis of bacteria, volatile organic compounds (VOCs), inorganic constituents, and water quality as required by the SDWA and state of Nevada regulations. Samples were taken at various locations throughout all drinking water distribution systems on the NTS. Common sampling points were restroom and cafeteria sinks (see Chapter 4, Figure 4.3). All samples were collected according to accepted practices, and the analyses were performed by state approved laboratories. Analyses were performed in accordance with Nevada Administrative Code 445 and Title 40 Code of Federal Regulations (C.F.R.) Part 141.

BACTERIOLOGICAL SAMPLING

Samples were submitted to the state-approved Associated Pathologists Laboratories in Las Vegas, Nevada, for coliform analyses. All water distribution systems were tested once a month, with the number of people being served determining the number of samples collected. If coliform bacteria are present, the system must be shut down and chlorinated. In order to reopen the system, three or four consecutive samples must meet state requirements, depending again on the number of people served. There were no incidents of positive coliform bacteria results during 1996.

Residual chlorine and pH levels were determined at the collection point by using colorimetric methods approved by the state. The results were recorded in Bechtel Nevada's (BN's) drinking water sample logbook, and the chlorine residual level was recorded on an analysis form.

Samples from each truck which hauled potable water from NTS wells to work areas were also analyzed for coliform bacteria. During 1996, the state relaxed the requirement to test every truck load of water, to testing each of the three trucks weekly. There were no positive coliform sample results in 1996 that required superchlorination and resampling.

CHEMICAL ANALYSIS

Chemical analysis in 1996 consisted of (1) VOCs, (2) synthetic organic chemicals (SOCs), and (3) inorganics.

ORGANIC COMPOUND ANALYSIS

Samples for VOCs and SOCs were collected during the second quarter of 1996 from all NTS potable water wells. The samples were analyzed by a state-approved laboratory. None of the results were above quantitation limits.

INORGANIC COMPOUND ANALYSIS AND WATER QUALITY

To comply with a 1991 variance to the Area 25 water system permit, fluoride samples need to be taken annually before July 31 to confirm that the fluoride concentration is less than four parts per million. Samples taken from Area 25 wells J-12 and J-13 in the second quarter of 1996 confirmed that the fluoride concentration was acceptable.

Nitrate and nitrite samples were also collected and determined to satisfy state requirements.

CLEAN WATER ACT

NTS OPERATIONS

The NTS General Permit requires quarterly reporting for biochemical oxygen demand (BOD) and specific conductance, organic loading rates, and water depths in infiltration basins. It also requires reporting of second quarter influent toxics sampling. The results of this sampling are shown in Tables 7.1 to 7.4, respectively. All values in these tables are in compliance with the permit requirements.

The permit also requires monitoring of the infiltration basins which attain a depth of 30 cm or more in January and June for parameters listed in Appendix II of the permit. Sampling is required as soon as any other system exceeds the 30 cm. Three secondary ponds at the Area 23 facility usually contain the required depth, but are excluded as needing the sampling in Part III.C.4 of the permit. During 1996, the Yucca Lake system exceeded the 30 cm in the first two quarters, and these sampling results are given in Table 7.5.

NON-NTS SAMPLING RESULTS

Only the North Las Vegas Facility (NLVF) and the Remote Sensing Laboratory (RSL) were required by permit to sample and analyze wastewater effluent and submit self-monitoring reports.

The NLVF self-monitoring report was submitted in October 1996. Two outfalls and the burn pit batch discharge are monitored.

The Clark County Sanitation District wastewater permit for the RSL required biannual monitoring of two outfalls, quarterly pH and monthly septage reports. RSL monitoring reports were submitted in May and December 1996.

NON-HAZARDOUS SOLID WASTE DISPOSAL

Monitoring of the three landfills was limited to recording daily refuse amounts by weight. All waste disposed of in the Area 23 landfill was weighed at the Gate 100 weighing station. All waste disposed of in the U-10c Crater in Area 9 was weighed at the landfill on a new weighing station. Waste for the hydrocarbon landfill in Area 6 was weighed at the Area 6 weighing station. About 7,570 tons of waste were disposed of in the Areas 6, 9, and 23 landfills, as shown in Table 7.6.

TOXIC SUBSTANCES CONTROL ACT

During 1996, a total of 43 samples were analyzed for PCBs. No sample results were reported with concentrations greater than five parts per million.

NATIONAL EMISSION STANDARDS FOR HAZARDOUS AIR POLLUTANTS

During 1996, 50 bulk or general area air samples were collected and analyzed in conjunction with asbestos removal and renovation projects at the NTS. The sample volume was divided equally between bulk and general area air samples.

RESOURCE CONSERVATION AND RECOVERY ACT

A total of 1,350 chemical analyses were performed in 1996 in support of waste management and environmental compliance activities at the NTS. Groundwater monitoring, included in these analyses, is described in the following paragraphs.

During 1992, three pilot wells (UE5PW-1, UE5PW-2, UE5PW-3) were drilled through the vadose zone into the uppermost aquifer under the Area 5 Radioactive Waste Management Site (RWMS-5). The principal purpose of these wells was to characterize the hydrogeology of the vadose zone under the waste disposal cells at RWMS-5. This characterization is consistent with the leakage-detection requirements for interim treatment, storage, and disposal (TSD) facilities required by the U.S. Environmental Protection Agency (EPA) and the state of Nevada.

In accordance with Title 40 C.F.R. 265 - Subpart F, operators of interim status TSD facilities are required to collect quarterly samples for one year from a minimum of one upgradient and three downgradient wells for characterization of background water quality. The first collection of these characterization data were performed in 1993. In 1994, and subsequently, the frequency was reduced to semi-annual and results were statistically compared with the initial characterization data.

Sampling protocols for characterization and detection data collection were based on the "RCRA Groundwater Monitoring Technical Enforcement Guidance Document" (EPA 1986). Groundwater elevation was measured prior to each sampling event. Water was withdrawn from each well with dedicated submersible double piston pumps for the purpose of purging and collecting samples. Temperature, pH, and specific conductance were monitored during purging and until the conclusion of sampling. Samples were collected and analyzed in accordance with written procedures that specified sample collection methodology, sample preservation, sample shipment, analytical procedures, and chain-of-custody control. Preservative measures were applied in the field to all samples at the time of removal from each well. Based on characterization results during 1993, and detection monitoring results for 1994 through 1996, the uppermost aquifer beneath the RWMS-5 disposal cells is suitable for use as drinking water or for agricultural purposes. The analyses performed for these samples can be found in Table 7.7. No chemical or radiological contaminants attributable to either U.S. Department of Energy, Nevada Operations Office's (DOE/NV's) weapons testing or waste management activities have been detected in the three wells.

SPECIAL STUDIES

Four series of tests were conducted involving 28 different chemicals at the Hazardous Materials Spill Center (HSC) in 1996. Pursuant to the agreement between HSC and the state of Nevada, the EPA is invited to participate in both the spill test advisory panels and the field monitoring. Although substantial amounts of the chemicals were released during the tests, no hazardous concentrations were detected at the NTS boundary by EPA monitors.

7.2 ECOLOGICAL CONDITIONS

All components of the DOE/NV-sponsored Basic Environmental Compliance and Monitoring Program were evaluated in 1995 for their ability to meet current DOE/NV objectives given changes in NTS missions and DOE policy. Work began on developing a comprehensive NTS ecological monitoring program focused on site-specific compliance with the National Environmental Policy Act and the new Federal Land and Facility Use Management Policy. During data evaluations and program development efforts, field data on annual and perennial plants, reptiles, small mammals, and deer were not collected. Data collection was resumed in part, as necessary, under the revised monitoring program initiated in 1996. The revised program and an adaptable guidance document for ecological monitoring were completed in May 1996. The new program is designated as the Ecological Monitoring and Compliance Program. The ecological monitoring tasks which were selected for 1996 included vegetation mapping within the range of the desert tortoise, characterizing the natural springs on the NTS, censuring horse and chukar populations, and periodically monitoring man-made water sources to assess their affects on wildlife. In addition, the Environmental Assessment for the HSC calls for ecological monitoring of certain spill tests, and a monitoring plan was developed and implemented in 1996.

FLORA

In January, BN published and distributed the DOE/NV topical report titled, "Current Distribution, Habitat, and Status of Category 2 Candidate Plant Species on and near the U.S. Department of Energy's Nevada Test Site." This report represents the culmination of several years of intensive field surveys and literature reviews on 11 Category 2 candidate plant species. The results of these surveys and a previous report on the Category 1 species, Beatley's milkvetch (*Astragalus beatleyae*), contributed to the removal of these species from the U.S. Fish and Wildlife Service candidate list in February 1996.

HABITAT MAPPING

Several spatial coverages or vegetation maps of plant communities and tortoise habitats at the NTS were developed during 1996. The first was a geo-referenced (i.e., corrected for Universal Transverse Mercator [UTM coordinates]) and Geographical Information System (GIS)-compatible revision of Janice Beatley's 1976 vegetation map showing major plant associations at the NTS. This map, although relatively generalized, permits usage with GIS software and correlation to other GIS data collected on the NTS. The second mapping effort involved refining the classification of vegetation on the NTS to identify habitat and nonhabitat for desert tortoises and other sensitive species. Using regular and multi-spectral aerial photographs of the NTS, ecological landform units (ELUs) were identified. These are areas with similar slope, aspect, soil, hydrology, vegetation, and wildlife. These areas were then described during field surveys. Within each ELU, one or more 200-m transects were sampled for the frequency of perennial shrubs by species. At each sample transect, UTM coordinates were taken to establish their location, and photographs of the ground-level landscape were taken. This information was entered into computer databases for ease of access. The locations of the nearly 500 vegetation sampling transects were then linked to database tables and site photographs. This information database can display the distribution of every plant species identified along the transects within the southern third of the NTS, which roughly corresponds to the range of the desert tortoise on the NTS. The ELU data will also facilitate correlation of tortoise sign and presence with vegetation, soils, geology, and other site features that may be important to identify habitats that sustain tortoise populations or other sensitive species.

FAUNA

Field surveys were conducted in 1996 for some of these former candidate animal species to determine their abundance and distribution. Information gathered will be helpful to prevent possible listing of the species in the future. These species included the chuckwalla (*Sauromalus obesus*), western burrowing owl (*Speotyto cunicularia*), and seven species of bats. The seven species of bats included the small-footed myotis (*Myotis ciliolabrum*), long-eared myotis (*M. evotis*), fringed myotis (*M. thysanodes*), long-legged myotis (*M.

volans), big free-tailed bat (*Nyctinomops macrotis*), pale Townsend's big-eared bat (*Plecotus townsendii pattescens*), and the spotted bat (*Euderma maculatum*). A GIS map of this year's survey sites and survey data was prepared in September 1996.

HORSE SURVEYS

Surveys were conducted in 1996 to monitor the size of the NTS horse population. Two techniques for estimating horse abundance were compared in 1996: a count of all horses observed versus mark-recapture sampling. Based on the counting technique, 42 horses were identified during 12 days of field surveys. The population estimate based on six days of mark-recapture sampling was 40 horses. The 95 percent likelihood interval for this population estimate was 33 to 41. The mark-recapture sampling technique yielded as accurate a population estimate as the direct count of horses in half the time. It was determined that the mark-recapture technique will be used for subsequent surveys.

Only one foal was observed during the summer of 1996. The number of foals born this spring is unknown. Ten adults and one foal observed in 1995 were missing in 1996, representing a 20 percent decline in the population. Over the past three years, the feral horse population at the NTS has declined 25 percent from 56 to 42 horses.

CHUKAR SURVEYS

The Nevada Department of Wildlife (NDOW) did not request permission this year to trap and remove chukar from the NTS. Therefore, summer brood surveys, similar to those conducted last year, were not performed. However, biologists recorded all opportunistic sightings of chukar while performing other field tasks on the NTS. Low numbers of adults (less than 40) and no young were observed around springs and the forward areas of the NTS. The largest group of chukar observed was at Topopah Spring in September, which numbered about 150 birds. Chukar surveys are still planned during years when NDOW personnel request permission to trap and remove them.

FIELD SURVEYS FOR FORMER CANDIDATE SPECIES

Chuckwalla surveys were conducted every month from May through August of 1996. Seventeen chuckwallas were observed in May, one in July, and one in August. Chuckwalla scat was found at 93 separate locations (62 percent) searched. The 19 chuckwallas were observed at only 18 separate locations (12 percent) searched. Overall, chuckwalla activity was detected at 104 of 150 locations (69 percent) searched. A GIS chuckwalla distribution map was developed based on the survey results. Chuckwalla are restricted to an area which roughly corresponds to the distribution of the desert tortoise. A detailed report of survey findings will be prepared in 1997.

Burrowing owl surveys were conducted weekly for 12 weeks ending in mid-July. Fifteen burrowing owl pairs were found. Burrowing owls were not observed on the NTS at elevations higher than 1,400 m (approximately 4,600 ft) and occur in open habitat of low-lying shrubs or grasslands. A GIS map of the distribution of all known burrowing owls on the NTS was prepared in September. A detailed report of survey findings will be prepared in 1997.

Mist netting for bats took place at eight sites on the NTS for more than 14 nights from May through July of 1996. The eight sites included Pahute Lake, Well J-12, Pond C-1, Reitman's Seep, Area 17 Pond, NUWAX Pond, Area 2 Mudplant, and J-11 Pond. At Pahute Lake, three spotted bats (*Euderma maculatum*) were captured and their feeding vocalizations were heard throughout the night. The spotted bat is a current state-protected species as well as a former Category 2 candidate species. At Area 17 Pond, one spotted bat was also captured, and this species' feeding vocalizations were recorded on July 1 and July 17, 1996. In addition, a spotted bat vocalization was heard on July 1,1996, over Boullion Sumps by biologists listening for bat vocalizations. These are the first capture records of this species on the NTS, and historically only a few capture records exist for southern Nevada. A total of 1,083 bats, representing ten species, were captured across all sites. Six of the species captured are former Category 2 candidate species. A GIS map of the trap locations and trap results was prepared in September 1996. A detailed report of survey findings will be prepared in 1997.

OTHER MONITORING

A total of three coyotes and five mule deer were found dead as a result of drowning or entrapment in plastic-lined sumps. Of the three canines, one was found in a sump at drill site ER-6-1, one in a sump at ER-20-5, and one in a sump at ER-20-6. The mule deer were found in sumps at ER-20-6. All of these sumps had one animal ladder (made of plastic fencing). The sumps at ER-20-5 and ER-20-6 are ponds which contain tritiated groundwater. The fences around the sumps at these sites are in good condition, yet they do not deter coyotes or mule deer from entry. No animal mortalities were observed in any of the earthen or cement-lined sumps or ponds. It was recommended that an ecological risk assessment be conducted to evaluate risks associated with wildlife exposure to tritiated water versus those associated with entrapment and the cost of preventing entrapment. The following mitigation measures are being considered: (1) To prevent wildlife access or death from entrapment, chain link fences ten-feet high will be constructed around sumps of contaminated water to effectively exclude mule deer and coyotes; (2) To prevent wildlife death from entrapment, fill material will be dumped on top of the lining along one side of lined sumps to form a gradual earthen access and escape ramp.

Selected water sources on the NTS were surveyed to evaluate their effect on the distribution of horses. Camp 17 Pond in Area 18, and Captain Jack Spring in Area 12 received the heaviest use by horses in 1996. Well 2 Pond was dry during 1996, and 12 horses appeared to shift their major summer use to Captain Jack Spring. Limited use was made of the Area 2 Mud Plant Pond. An estimated 30 horses appear dependent on Camp 17 Pond during summer and fall in years when Gold Meadows Spring becomes dry. Monitoring of horse use of selected springs and well reservoirs at the NTS suggests that the distribution of horses in 1996 has not changed significantly from that observed in previous years.

Table 7.1 Influent Quality - 1996

Facility	1st Quarter BOD5[a] (mg/L)	1st Quarter S.C.[b] (µmhos/cm)	2nd Quarter BOD5 (mg/L)	2nd Quarter S.C. (µmhos/cm)	3rd Quarter BOD5 (mg/L)	3rd Quarter S.C. (µmhos)	4th Quarter BOD5 (mg/L)	4th Quarter S.C. (µmhos/cm)
Gate 100	294	1.58	476	1.40	159	1.00	313	1.13
Mercury	173	0.80	98	0.80	137	0.87	194	0.64
Yucca Lake	392	0.73	98	0.86	75	0.77	95	0.38
Tweezer	199	1.16	81	0.76	214	1.54	308	1.09
CP-6	0	0	0	0	0	0	0	0
CP-72	0	0	0	0	0	0	0	0
DAF	120	1.50	20	1.22	132	0.97	76	0.81
Reactor Control	350	0.94	0	0	0	0	60	0.30
Test Stand 1	0	0	0	0	0	0	0	0
Base Camp 25	264	0.80	164	0.91	44	0.68	92	0.61
Base Camp 12	20	0.29	13	0.48	6	0.30	6	0.28
Test Cell C	0	0	0	0	0	0	0	0
RWMS Site 5	1236	1.21	391	1.30	80	0.68	60	0.95

(a) Biochemical Oxygen Demand - 5-day Incubation.
(b) Specific Conductance.

Table 7.2 Organic Loading Rates - 1996

Facility	Limit (Kg/day)	(Jan-Mar) Mean Daily Load	(Apr-June) Mean Daily Load	(Jul-Sept) Mean Daily Load	(Oct-Dec) Mean Daily Load
Metered Rates					
Mercury	172	51.24	38.14	34.49	49.17
LANL on Tweezer	5.0	3.06	0.92	0.92	2.99
Yucca Lake	8.6	9.62[a]	4.48	1.73	4.64
Base Camp 12	54	0.21	0.04	0.04	0.06
RWMS Site 5	0.995	1.88[a]	0.56	0.15	0.02
Calculated Rates					
CP-6	8.7	0	0	0	0
CP-72	1.1	0	0	0	0
DAF	7.6	0.51	0.25	2.51	0.27
Reactor Control	4.2	2.08	0	0	0.15
Eng Test Stand	2.3	0	0	0	0
Test Cell C	1.3	0	0	0	0
Base Camp 25	7.4	2.41	1.19	0.81	0.14
Gate 100	2.4	0.60	1.77	0.32	1.07

(a) Considered to be an anomalous value.

Table 7.3 Pond Water Depths in Infiltration Basins - 1996

Impound	Maximum Operating Depth, cm	Average Depth, cm (1st Quarter)	Average Depth, cm (2nd Quarter)	Average Depth, cm (3rd Quarter)	Average Depth, cm (4th Quarter)
Gate 100, Basin	90	0	0	14	25
Mercury, Basin	180	0	0	0	0
Yucca Lake					
North Basin	140	42	75	88	118
South Basin	140	42	16	0	0
Tweezer					
East Basin	244	0	0	0	0
West Basin	244	0	0	0	0
CP-6					
East Basin	90	0	0	0	0
West Basin	90	10	0	0	0
CP-72	90	0	0	0	0
DAF					
Basin 1	150	0	0	0	0
Basin 2	150	0	0	0	0
Reactor Control, Basin	130	0	0	0	0
Test Stand 1, Basin	90	0	0	0	0
Test Cell C, Basin	90	0	0	0	0
Base Camp 25, Basin	100	0	0	0	0
Base Camp 12, Basin 1	120	0	0	0	0
Base Camp 12, Basin 2	120	0	0	0	0
Base Camp 12, Basin 3	120	0	0	0	0
Base Camp 12, Basin 4	120	0	0	0	0
Base Camp 12, Basin 5	120	0	0	0	0

Table 7.4 Influent Toxics for Facilities that Received Industrial Wastewater - 1996

Parameter	Compliance Limit (mg/L)	Mercury Measurement (mg/L)	Area 25 Base Camp Measurement (mg/L)	Area 6 DAF Measurement (mg/L)	Area 5 RWMS Measurement (mg/L)	Area 6 LANL Measurement (mg/L)	Area 6 Yucca Lake Measurement (mg/L)
Arsenic	5.0	0.0205	0.0183	0.0139	0.0104	(a)	(a)
Barium	100	(a)	(a)	(a)	(a)	(a)	(a)
Cadmium	1.0	(a)	(a)	(a)	(a)	(a)	(a)
Chromium	5.0	(a)	(a)	(a)	(a)	(a)	(a)
Lead	5.0	0.0051	(a)	(a)	(a)	(a)	0.0143
Mercury	0.2	(a)	(a)	(a)	(a)	(a)	(a)
Selenium	1.0	(a)	(a)	(a)	(a)	(a)	(a)
Silver	5.0	(a)	(a)	(a)	(a)	(a)	(a)
Benzene	0.5	(a)	(a)	(a)	(a)	(a)	(a)
Carbon Tertachloride	0.5	(a)	(a)	(a)	(a)	(a)	(a)
Chlorobenzene	100	(a)	(a)	(a)	(a)	(a)	(a)
Chloroform	6.0	(a)	(a)	(a)	(a)	(a)	(a)
1,4-dichlorobenzene	7.5	(a)	(a)	(a)	(a)	(a)	(a)
1,2-dichlorobenzene	0.5	(a)	(a)	(a)	(a)	(a)	(a)
1,1-dichloroethylene	0.7	(a)	(a)	(a)	(a)	(a)	(a)
Methylethyl Ketone	200	(a)	(a)	(a)	(a)	(a)	(a)

(a) Not Detected.

Note: Volatile samples were taken from each primary lagoon as they can not be composited. No volatiles were detected during this reporting period. Future measurements for volatile samples from facilities with multiple primary lagoons will be average values.

Table 7.4 (Influent Toxics for Facilities that Received Industrial Wastewater - 1996, cont.)

Parameter	Compliance Limit (mg/L)	Mercury Measurement (mg/L)	Area 25 Base Camp Measurement (mg/L)	Area 6 DAF Measurement (mg/L)	Area 5 RWMS Measurement (mg/L)	Area 6 LANL Measurement (mg/L)	Area 6 Yucca Lake Measurement (mg/L)
Pyridine	5.0	(a)	(a)	(a)	(a)	(a)	(a)
Tetrachloroethylene	0.7	(a)	(a)	(a)	(a)	(a)	(a)
Trichloroethylene	0.5	(a)	(a)	(a)	(a)	(a)	(a)
Vinyl Chloride	0.2	(a)	(a)	(a)	(a)	(a)	(a)
Cresol, total	200	0.012	(a)	(a)	(a)	0.061	0.013
2,4-dinitrotoluene	0.13	(a)	(a)	(a)	(a)	(a)	(a)
Hexachlorobenzene	0.13	(a)	(a)	(a)	(a)	(a)	(a)
Hexachlorobutadiene	0.5	(a)	(a)	(a)	(a)	(a)	(a)
Nitrobenzene	2.0	(a)	(a)	(a)	(a)	(a)	(a)
Pentachlorophenol	100	(a)	(a)	(a)	(a)	(a)	(a)
2,4,5-trichlorophenol	400	(a)	(a)	(a)	(a)	(a)	(a)
2,4,6-trichlorophenol	2.0	(a)	(a)	(a)	(a)	(a)	(a)
Chlorodane	0.03	(a)	(a)	(a)	(a)	(a)	(a)
Endrin	0.02	(a)	(a)	(a)	(a)	(a)	(a)
Heptachlor	0.008	(a)	(a)	(a)	(a)	(a)	(a)
Lindane	0.4	(a)	(a)	(a)	(a)	(a)	(a)
Methoxychlor	10.0	(a)	(a)	(a)	(a)	(a)	(a)
Toxaphene	0.5	(a)	(a)	(a)	(a)	(a)	(a)
2,4-D	10.0	(a)	(a)	(a)	(a)	(a)	(a)
2,4,5-TP (Silvex)	1.0	(a)	(a)	(a)	(a)	(a)	(a)

(a) Not Detected.

Note: Volatile samples were taken from each primary lagoon as they can not be composited. No volatiles were detected during this reporting period. Future measurements for volatile samples from facilities with multiple primary lagoons will be average values.

Table 7.5 Sampling Data for Infiltration Ponds Containing 30 cm or More - 1996

Parameter	Action Level mg/L	A-6 Yucca Lake Q1 Result mg/L	A-6 Yucca Lake Q2 Result mg/L
Arsenic	0.5	0.0099	0.0086
Cadmium	0.1	<0.001	(b)
Chromium	0.5	0.0424	(b)
Lead	0.5	0.0079	(b)
Selenium	0.1	<0.003	(b)
Silver	0.5	0.0065	(b)
Nitrate Nitrogen	100	<0.02	(b)
Sulfate	5000	100	110
Chloride	1000	160	110
Fluoride	40	1.7	2.1
Tritium(a)	Monitor Only	(b)	(b)

(a) Unit for tritium is 10^{-7} μCi/cc.
(b) Not Detected.

Table 7.6 Quantity of Waste Disposed of in Landfills - 1996

	Quantity (in pounds)		
Month	Area 9	Area 23	Area 6
January	0	402,890	0
February	278,597	267,540	15,320
March	191,835	164,070	1,100
April	864,742	236,530	129,430
May	783,690	323,100	6,200
June	412,290	257,020	47,852
July	430,000	135,000	477,200
August	810,600	277,600	2,400
September	734,600	943,200	57,800
October	070,970	316,340	51,400
November	17,400	162,680	17,400
December	805,280	1,442,580	0
Total	9,399,984	4,928,550	806,102

Table 7.7 Groundwater Monitoring Parameters at the RWMS-5 - 1996

Parameters Determining Suitability of Groundwater

Total and Dissolved Metals - As, Ba, Cd, Cr, Hg, Ag, Pb, Se
Total and Dissolved Gross Alpha/Beta

Parameters Establishing Water Quality

Chloride
Total and Dissolved Fe, Mn, Na
Phenols
Sulfate

Indicators of Contamination

pH
Conductivity
Total Organic Carbon
Total Organic Halogen

Additional Selected Parameters

Volatile Organics (8270)
Tritium

8.0 RADIOACTIVE AND MIXED WASTE STORAGE AND DISPOSAL

Disposal of low-level radioactive waste (LLW) from the U.S. Department of Energy (DOE)-approved generators occurs at two areas on the Nevada Test Site (NTS). Disposal of packaged LLW at the Radioactive Waste Management Site, Area 5 (RWMS-5) is in shallow pits and trenches. LLW packaged in large bulk waste containers, and unpackaged bulk waste (only from the NTS) are buried in selected subsidence craters at the RWMS, Area 3 (RWMS-3).

Hazardous waste and specific categories of radioactive waste are stored above ground in Area 5. Transuranic (TRU) waste categorized as mixed waste, i.e., radioactive material mixed with hazardous waste, is stored in a covered building on a specially constructed Resource Conservation and Recovery Act (RCRA)-designed pad. The TRU waste will be characterized for proposed disposal at the Waste Isolation Pilot Plant (WIPP) in New Mexico. Low-level radioactive mixed waste is currently being stored on the TRU waste storage pad before permanent disposal. Uranium ore residues are stored north of the RWMS-5. Hazardous wastes generated on the NTS are accumulated at the Hazardous Waste Accumulation Site (HWAS) east of the RWMS-5 before shipment to an offsite treatment, storage, and disposal (TSD) facility.

During 1996, environmental monitoring involved air sampling, radiation dose rate surveys, groundwater analysis, and environmental sampling. Air samples were collected at RWMS-3 and RWMS-5 for analysis of gross beta radiation, photon-emitting radionuclides, plutonium, and tritium. Tritium arising from the disposal of LLW was the only airborne radionuclide detected at the RWMS-5. All radionuclide concentrations were well below derived concentration guides (DCGs). Gamma radiation fields were monitored by thermoluminescent dosimeters (TLDs). Gamma doses greater than background were detected at the RWMS-5 in areas where waste is stored or disposed. Neutron radiation fields at the perimeter of the TRU waste storage pad were monitored by proton recoil dosimeters. Radiation exposure rates were consistent with historical ranges.

8.1 WASTE DISPOSAL OPERATIONS

Radioactive waste disposal was initiated at Area 5 on the NTS in 1961. By July 1976, six out of nine developed trenches had been filled with LLW. In 1978, waste disposal operations were expanded when the DOE established the Radioactive Waste Management Project for the disposal of defense-related LLW, from the NTS, from offsite DOE generators, and from U.S. Department of Defense facilities.

In 1987, the state of Nevada granted the NTS interim status for the disposal of low-level mixed waste in Pit 3 of the RWMS-5. LLW disposed prior to 1986 may contain low levels of constituents that would be regulated as hazardous waste under RCRA (Title 40 C.F.R. 260-281). Mixed waste disposal was curtailed in 1990 by the DOE due to the possible presence of Land Disposal Restrictions (LDR) constituents. The state of Nevada later directed that DOE provide National Environmental Policy Act (NEPA) documentation and implement a state-approved Waste Analysis Plan. No offsite mixed waste has been received for disposal since 1990. Mixed waste generated on the NTS may be disposed of in Pit 3 of the RWMS-5 if LDR requirements are met. The RWMS-3 has been used for the disposal of bulk atmospheric test debris, bulk LLW in large containers, and packaged LLW.

Hazardous waste generated on the NTS is accumulated at the HWAS which is adjacent to and east of the RWMS-5. At this site, the hazardous waste is prepared for shipment to an offsite TSD facility. Hazardous waste is not accepted from offsite generators.

AREA 5 RADIOACTIVE WASTE MANAGEMENT SITE

The RWMS-5 occupies approximately 296 ha (732 acres) and is located in the northern area of Frenchman Flat, approximately 26 km (16 mi) north of the NTS main gate. Currently, 37 ha (92 acres) are posted as radiological areas used for waste storage and disposal. Before 1968, Area 5 had been used for the testing of conventional weapons and both above and below ground testing of nuclear weapons.

The general surface geology of the area is alluvial sediment derived from tuffaceous material. The basin contains up to 305 m (1,000 ft) of alluvium from the surrounding mountain ranges. The disposal site is located on a gently sloping alluvial fan extending southward from the Massachusetts Mountains, which lie approximately 3.3 km (2 mi) to the north. The slope of the terrain is 2 percent near the disposal site, but increases to 3 percent to the west. Two shallow dry washes cross the site, from the northwest and from the northeast. An earthen dike has been constructed along the western, northern, and eastern borders of the RWMS-5 to prevent water flow into the disposal area.

Disposal of waste occurs in shallow land burial trenches and pits at depths ranging from 4.6 m to 9.1 m (15 to 30 ft). Deeper trenches have been constructed for wastes that generate radon. Pits and trenches that reach full capacity are temporarily covered by 2.4 m (8 ft) of soil until a permanent closure cap is constructed. Disposal of high-specific activity waste has occurred in augured shafts that are 36 m (120 ft) in depth, termed Greater Confinement Disposal (GCD). When disposal capacity is reached, GCD shafts are filled with soil from 21 m (70 ft) to the surface.

LLW is accepted for disposal from generators that have received approval from DOE Headquarters and DOE Nevada Operations Office (DOE/NV). During 1996, the NTS Waste Acceptance Criteria (WAC) were revised to make the acceptance process more efficient (NTS WAC, Rev. 0, September 1996). The requirement for the generator to develop a waste application was replaced by a waste profile format. The profile requires nearly the same information as did the waste application, but it streamlines the documentation process. The new criteria require a programmatic audit of the waste generator every three years instead of every year, an annual assessment to be performed to ensure generator compliance, and it provides clarification on the reporting of radionuclides. Overall, the new criteria will be more consistent with industry standards, and they will streamline the approval process, reduce generator facility costs, and increase resources for environmental cleanup.

During 1996, LLW from 16 generators was disposed of at RWMS-5. A volume of 7,293 m^3 (2.58×10^5 ft^3) containing a total of 7,692 Ci (285 TBq) of radioactivity was disposed of at the RWMS-5. This was a decrease in volume but an increase in radioactivity from the previous year (see Table 8.1). Tritium accounted for approximately 96 percent of total radioactivity disposed of (see Table 8.2). The majority of the remaining radioactivity was attributed to isotopes of uranium.

RWMS-5 MIXED WASTE MANAGEMENT UNIT (MWMU)

A MWMU is planned for construction in the northeastern area of the RWMS-5. The proposed MWMU will cover approximately 10 ha (25 acres) and contain eight landfill cells. Mixed waste disposal operations at the NTS will recommence under interim status in Pit 3 upon completion of NEPA documentation, approval of the Waste Analysis Plan, and issuance of a state RCRA Part B Permit. In the interim, an agreement between DOE/NV and the NDEP has been negotiated that allows low-level mixed waste generated on the NTS to be stored on the TRU waste storage pad until characterization. If the waste meets or is treated to meet LDR requirements, it may be disposed of in Pit 3, RWMS-5.

RWMS-5 GROUNDWATER MONITORING

Data collection was initiated in 1993 and continued through 1996 to monitor the groundwater chemistry under the waste disposal cells at RWMS-5. The purpose of this monitoring is to determine if the disposal facility is in compliance with RCRA requirements. Sampling is being performed using three pilot wells drilled in 1992 into the uppermost aquifer under the disposal cells. Further information on this study can be found in Section 9.2 of this document and in the "1996 Groundwater Monitoring Report" (Bechtel 1996).

AREA 3 RADIOACTIVE WASTE MANAGEMENT SITE

The RWMS-3 lies at an elevation of 1,230 m (4,050 ft) and covers approximately 20 ha (50 acres). It is located in the center of Yucca Flat approximately 5 mi north of the Yucca Dry Lake Bed. Alluvial sediments that are about 1,500 ft deep underlie the site. Atmospheric and underground nuclear tests have been conducted in several areas in Yucca Flat including Area 3. Safety tests have resulted in the dispersion of plutonium in surface soils in Area 3.

The RWMS-3 is used for the management of bulk debris from aboveground nuclear tests and packaged bulk LLW generated offsite. Subsidence craters formed by underground nuclear tests are used for disposal. The subsidence craters range in depth from 15 to 24 m (49 to 78 ft) and are filled by alternating layers of stacked waste packages and 3 ft of clean fill dirt. Two craters, U-3ax and U-3bl, have been filled to date. A 2.5-m (8-ft) thick operational cap of clean soil extending 1.2 m (4 ft) above grade has been used for temporary closure of U-3ax/bl craters. The adjacent craters U-3ah/at are currently being used for LLW disposal.

In 1996, the RWMS-3 received 7,033 m^3 (2.48×10^5 ft^3) of waste containing 5.75 Ci (213 GBq) of radioactivity (see Table 8.3) from four generators. This was a decrease in the volume of waste but a slight increase in the amount of radioactivity disposed of when compared to 1995. Isotopes of plutonium and ^{241}Am from the cleanup of the DOUBLE TRACKS site on the Nellis Air Force Range Complex about 14 mi (22 km) east of Goldfield, Nevada, accounted for approximately 88.6 percent of the total radioactivity disposed of during 1996 (see Table 8.4). Isotopes of uranium accounted for approximately 11 percent.

STRATEGIC MATERIALS STORAGE YARD (SMSY)

The SMSY is used for storage of mixed waste that consists of residues from the processing of uranium ores from the Mound Plant in Miamisburg, Ohio. On a mass basis, this material is primarily ^{238}U and iron. The residues contain approximately 290 Ci (11 TBq) of total radioactivity. The residue material is packaged in steel drums inside wooden boxes that are stored inside steel cargo containers. A total of 28 cargo containers is stored on concrete pads that are surrounded by a control fence. Required inspections are performed routinely to ensure that the integrity of the waste containers is maintained. Opening of the cargo containers for inspection is controlled following established as low as reasonably achievable (ALARA) principles to reduce radiation exposure to personnel.

The original management plan for this material was treatment and disposal. During 1996, DOE/NV determined that transferring this material to a mill for additional uranium extraction will expedite the handling of this material by two years and will recycle approximately 260 m^3 of the material. For further information on managing this material, please refer to the "NTS Site Treatment Plan" (DOE 1996a).

TRANSURANIC WASTE STORAGE

The TRU waste storage pad is located in the southeast corner of the RWMS-5. The pad is used for interim storage of TRU waste previously received from Lawrence Livermore National Laboratory. During 1992, all of the mixed TRU waste packaged in 55-gal drums was overpacked into 85-gal steel drums with carbon filter vents. This waste is stored in a covered building that is located on a curbed asphalt pad surrounded by a security fence. The pad and waste storage configuration comply with RCRA, Title 40 C.F.R. 265, Subpart I.

Inspections of all mixed TRU waste containers are performed weekly, while inspections of the TRU waste storage pad are performed monthly. The current inventory is awaiting permanent disposal at the WIPP. This waste will be characterized and packaged for certification according to WIPP criteria. DOE/NV plans to examine this waste in the Waste Examination Facility scheduled to be completed in 1997 at RWMS-5. Further information on this material is contained in the "NTS Site Treatment Plan" referred to above.

8.2 ENVIRONMENTAL MONITORING AT WASTE STORAGE AND DISPOSAL SITES

The Analytical Services Laboratory, Environmental Monitoring Group is responsible for collection of samples and verifying sample results. The Radioanalytical Section is responsible for analysis of the samples. Collection and analysis of samples are performed in accordance with approved operating procedures. The Waste Management Project reviews the sampling results for any unexpected trends.

AIR MONITORING

Air sampling is conducted at eight (reduced to four in the fourth quarter) stations along the perimeter of the RWMS-5 fence for both particulates and tritiated water (HTO), at two stations inside the TRU waste storage cover, and at one station in Pit 5 for particulates. Two samplers inside the TRU cover building along with the perimeter samplers were determined to provide adequate monitoring for the TRU waste storage facility. Originally, there were six stations that surrounded the TRU waste storage facility. Air sampling is also conducted for particulates at four stations along the perimeter of the U-3ah/at craters and for HTO at one station north of the craters at RWMS-3.

Air samplers operate at an air flow rate of approximately 140 L (5.0 ft^3) per minute. Sampling media is a 9-cm (approximately 4-in) glass-fiber filter. Filters are exchanged on a weekly basis. Each filter is analyzed for gross beta/gamma radiation. The filters are composited quarterly for samplers located at the perimeter of RWMS-5 and monthly for all other sample locations and analyzed for ^{238}Pu and $^{239+240}Pu$. Samplers for HTO in air are located with the particulate samplers along the perimeter of the RWMS-5. Sampling for radioiodine was discontinued in 1995, because radioiodine is not expected to be produced from LLW disposal operations. Radioiodine was measured in the past because of its production during nuclear testing.

RWMS-5 AIR MONITORING

Tritium, ^{238}Pu,$^{239+240}$Pu, and gross beta activity were measured in air at the RWMS-5 during 1996. Composite data for the first three radionuclides (see Table 8.5) include both RWMS-5 onsite and perimeter air sampling. The 1996 airborne plutonium levels were generally lower than those in 1995. The range was from <0 to 73 x 10^{-18} µCi/mL with a network average concentration of 4.9 x 10^{-18} µCi/mL (0.18 µBq/m^3). The maximum annual average concentration was 1.2 x 10^{-17} µCi/mL (0.44 µBq/m^3). That maximum average concentration is only 0.6 percent of the 10 mrem per year modified DCG for $^{239+240}$Pu (2 x 10^{-15} µCi/mL [74 Bq/m^3]) (DOE Order 5400.5). The average air concentration of ^{238}Pu was approximately a factor of 30 lower than the airborne concentration of $^{239+240}$Pu. Airborne plutonium in Area 5 is probably due to resuspension of contaminated soils and not attributable to the waste disposed of in this LLW site.

The average HTO concentration was 3.2 x 10^{-12} µCi/mL (0.12 Bq/m^3) and the highest annual average was 5.4 x 10^{-12} µCi/mL (0.2 Bq/m^3). The high value is less than 0.06 percent of the 10 mrem per year modified DCG for HTO (1 x 10^{-8} µCi/mL [370 Bq/m^3]). Tritium is associated with waste disposal operations. The levels of tritium have remained consistent with historical averages. The average HTO air concentration in 1996 was in the range of the 1994 average concentration of 4.9 x 10^{-12} µCi/mL (0.18 Bq/m^3) and the 1995 average concentration of 5.8 x 10^{-12} µCi/mL (0.21 Bq/m^3). Gross beta air concentration results are used as a screening tool to check if a significant release occurred and if other radionuclides warrant analysis. The results were in the range of 10^{-14} and 10^{-15} µCi/mL. These levels are consistent with levels for previous years and with the sitewide average gross beta concentration.

RWMS-3 AIR MONITORING

Traces of plutonium (^{238}Pu and $^{239+240}$Pu) were detected in air at all of the RWMS-3 samplers in 1996. The average air concentration of $^{239+240}$Pu in 1996 was 1.65 x 10^{-16} µCi/mL (6.1 µBq/m^3), which was slightly more than the 1995 average of 0.89 x 10^{-16} µCi/mL (3.3 µBq/m^3). The average air concentration of ^{238}Pu was approximately a factor of 150 lower than the average concentration of $^{239+240}$Pu. The highest average concentration of $^{239+240}$Pu detected in 1996 was 26 x 10^{-17} µCi/mL (9.6 µBq/m^3), which is far below the Derived Air Concentration for $^{239+240}$Pu. Airborne plutonium is most likely due to resuspension of soils contaminated by atmospheric weapons testing and is not attributable to the waste being disposed of at this site. Gross beta air concentrations were consistent with the RWMS-5 results.

The HTO in air average concentration was 0.54 x 10^{-12} µCi/mL (20 mBq/m^3), and the maximum concentration was 5.0 x 10^{-12} µCi/mL (0.18 Bq/m^3), both less than the RWMS-5 results.

RADIATION EXPOSURE RATES

Areas where disposal operations take place are radiologically controlled through engineering and administrative controls to ensure radiation exposures are ALARA. Workers are thoroughly trained in exposure reduction techniques and ALARA practices. Worker radiation doses have remained below ALARA administrative goals that are considerably less than the DOE occupational limit.

GAMMA EXPOSURE

TLDs were deployed at 44 locations at RWMS-5 and at 5 locations at RWMS-3 disposal site U-3ah/at to measure the gamma radiation exposure (see Table 8.6).

Ten TLDs were placed within the perimeter of RWMS-5, including six TLDs around the TRU waste storage pad, two TLDs in Pit 3, and two TLDs in the operational disposal Pits 4 and 5. The TLDs in the pits were about 100 ft (30 m) from the waste stacks. Fifteen TLDs were located at the perimeter of the RWMS-5 site and one was placed at the facility office. All the TLDs were exchanged and analyzed quarterly.

The TLDs located at the perimeter of RWMS-3 and RWMS-5 had exposures that were at or slightly above background levels (see Table 8.6). Exposure rates at the TRU pad, in the operational disposal pits of RWMS-5 and at the Strategic Materials Storage Yard were above background due to their proximity to the radioactive waste containers. No significant increases were identified when comparing the 1996 exposure rates with historical levels.

NEUTRON DOSE EQUIVALENTS

Neutron dose equivalents were measured at six locations at the perimeter of the TRU waste storage pad. The dose equivalents for 1996 ranged from the detection limit of 80 mrem to 168 mrem per year. Neutron doses for 1996 were consistent with previous results.

VADOSE ZONE MONITORING FOR MIXED WASTE DISPOSAL

A vadose zone monitoring program has been implemented to allow earlier detection of potential contaminant migration from the mixed waste disposal pit (Pit 3) at the RWMS-5 and under U-3ah/at and U-3ax/bl craters at RWMS-3. Monitoring is conducted in 24 access tubes. Tubes are installed through the operational cover (approximately 8 ft), waste zone (20 - 30 ft), and ten feet of soil below the pit floor. Drill casings are angled under the disposal craters in RWMS-3. Tubes are monitored quarterly with neutron moisture meters to detect wetting fronts from precipitation. Wetting fronts that progressed through the operational cap and into the waste zone could indicate that contaminant migration might have occurred. In 1996, as in the past, no wetting fronts have been detected below the operational cap.

TRITIUM MIGRATION STUDIES AT THE RWMS-5

The results of the tritium migration study at the GCD site have shown that the waste buried between depths of 70 and 120 ft has remained isolated from the accessible environment (i.e., the land surface). In addition, sampling of plants and near surface soil above shallow land disposal cells in RWMS-5 have shown a seasonal variation in tritium concentration. The results have indicated that worker and public radiation exposures are negligible.

Table 8.1 Low-Level Waste Disposed of at the RWMS-5, 1993 - 1996

Calendar Year	Volume of LLW Disposed (m^3)	Activity of LLW Disposed (Ci)
1996	7293	7.69×10^3
1995	9171	5.56×10^2
1994	12300	5.17×10^4
1993	8327	3.00×10^4

Table 8.2 Radionuclides Disposed of at the RWMS-5 - 1996

Radionuclide	Activity (Ci)	Percent of Total Activity
^{3}H	7354.292	95.608
^{238}U	184.218	2.395
^{234}U	80.979	1.053
^{228}Th	15.648	0.203
^{232}Th	14.540	0.189
^{228}Ra	13.641	0.177
^{99}Tc	9.057	0.118
^{235}U	4.567	0.059
^{230}Th	4.534	0.059
^{241}Pu	4.403	0.057
^{236}U	3.007	0.039
^{239}Pu	1.166	0.015
^{90}Sr	0.453	0.006
^{137}Cs	0.373	0.005
^{226}Ra	0.329	0.004
^{240}Pu	0.243	0.003
^{238}Pu	0.199	0.003
^{241}Am	0.182	0.002
^{210}Pb	0.155	0.002
Other	0.143	0.002
Total	7692	100.000

Table 8.3 Low-Level Waste Disposed of at the RWMS-3, 1993 - 1996

Calendar Year	Volume of LLW Disposed (m^3)	Activity of LLW Disposed (Ci)
1996	7033	5.7
1995	11073	3.1
1994	10550	0.21
1993	9848	0.24

Table 8.4 Radionuclides Disposed of at the RWMS-3 - 1996

Radionuclide	Activity (Ci)	Percent of Total Activity
^{239}Pu	3.160	55.00
^{241}Pu	1.419	24.70
^{238}U	0.359	6.25
^{240}Pu	0.299	5.20
^{234}U	0.249	4.33
^{241}Am	0.213	3.71
^{99}Tc	0.021	0.37
^{235}U	0.013	0.23
^{236}U	0.012	0.21
Total	5.7	100

Table 8.5 Air Monitoring Results for Various Radionuclides at the RWMS-5, 1994 - 1996

Year	$^{239+240}Pu$ (x 10^{-17} µCi/mL)	^{238}Pu (x 10^{-17} µCi/mL)	Tritium (x 10^{-6} pCi/mL)
Average 1996	0.51	0.02	3.2
High Average 1996	1.2	0.06	5.4
Average 1995	0.6	0.013	5.7
High Average 1995	3.4	0.11	15
Average 1994	1.1	0.038	4.9
High Average 1994	5.9	0.15	14
Derived Concentration Guide (10 mrem for nonworkers)	200	300	10^4

Table 8.6 External Gamma Exposure Measured by TLDs at the RWMS - 1996

Calendar Year	Number of Dosimeters	Average (mR/y)	Standard Deviation (mR/y)
RWMS-5, perimeter	16	121	7.1
RWMS-5, TRU pad, Pit 3 and 5	10	376	401
RWMS-3, U-3ah/at perimeter	9	147	24.2
Strategic Material Storage Yard	18	1948	1201

Area 5 Disposal Pit #4 Showing Stacking Conditions

9.0 GROUNDWATER PROTECTION

The primary mission of the U.S. Department of Energy, Nevada Operations Office (DOE/NV) at the Nevada Test Site (NTS) has been the testing of nuclear devices and their components. The DOE/NV's Environmental Protection Policy Statement outlines a general policy of preventing pollutants generated by such tests from reaching groundwater, but it also recognizes that some options for groundwater protection are precluded by an increased risk of atmospheric releases and potential violation of international agreements. Therefore, the DOE/NV groundwater protection policy represents a balance between strict compliance with atmospheric release agreements and minimization of groundwater impacts. Groundwater protection is implemented by various programs that address compliance with regulatory requirements, minimization of waste streams, closure and monitoring of waste facilities, remedial investigations, groundwater monitoring, and environmental research.

The Nevada Environmental Restoration Project (ERP) goals are to safeguard the public's health and safety and to protect the environment. This involves the assessment and cleanup of contaminated sites and facilities to meet standards required by federal and state environmental laws. In 1996, DOE formalized an agreement with the state for implementing corrective actions based on public health and environmental considerations in a cost-effective and cooperative manner. Investigation and cleanup activities continued on the NTS and Nellis Air Force Range Complex, and at offsite locations in the state of Nevada and other states.

DOE/NV instituted a Long-Term Hydrological Monitoring Program (LTHMP) in 1972 to be operated by the U.S. Environmental Protection Agency (EPA) under an Interagency Agreement. In 1996, groundwater was monitored on and around the NTS, at five sites in other states, and at two off-NTS locations in Nevada to detect any radioactivity that may be related to previous nuclear testing activities. Although tritium initially seeped from two of the offsite tests, the tritium levels in wells at both these sites have been decreasing and were well below the National Primary Drinking Water Regulation levels. NTS supply wells were monitored for gross alpha and beta activity as well as for tritium levels.

9.1 EXISTING GROUNDWATER CONDITIONS

HYDROGEOLOGY OF THE NTS

The NTS has three general water-bearing units: the lower carbonate aquifer, volcanic aquifers, and valley-fill aquifers. The water table occurs variably in the latter two units while groundwater in the lower carbonate aquifer occurs under confined conditions. The depth to the saturated zone is highly variable, but is generally at least 150 m (approximately 500 ft) below the land surface, and is often more than 300 m (approximately 1000 ft). The hydrogeologic units, at the NTS, occur in three groundwater subbasins in the Death Valley Groundwater Basin (see Chapter 2, Figure 2.9, for a diagram of these systems). The actual subbasin boundaries are poorly defined, but what is known about the basin hydrology is summarized below.

Groundwater beneath the eastern part of the NTS is in the Ash Meadows Subbasin and discharges along a spring line in Ash Meadows, south of the NTS. Most of the western NTS is in the Alkali Flat-Furnace Creek Subbasin with discharges occurring by evapotranspiration at Alkali Flat and by spring flow near Furnace Creek Ranch. Groundwater beneath the far northwestern corner of the NTS may be in the Oasis Valley Subbasin which discharges by evapotranspiration in Oasis Valley. Some underflow from the subbasin discharge areas probably travels to springs in Death Valley. Regional groundwater flow is from the upland recharge areas in the north and east toward discharge areas in Ash Meadows and Death Valley, southwest of the NTS. Because of large topographic changes across the area and the importance of fractures to groundwater flow, local flow directions may be radically different from the regional trend (Laczniak et al., 1996).

HYDROGEOLOGY OF NON-NTS UNDERGROUND TEST SITES

The following descriptions of the hydrogeology of non-NTS underground test sites are summarized from Chapman and Hokett, 1991.

FALLON, NEVADA

The Project SHOAL site is located in the granitic uplift of the Sand Spring Range. The highland area around the site is a regional groundwater recharge area, with regional discharge occurring to the west in Fourmile Flat and Eightmile Flat, and to the northeast in Dixie Valley. Evidence suggests that a groundwater divide exists northwest of the site and that the main component of lateral movement of groundwater near the site is southeast toward Fairview Valley. Groundwater in Fairview Valley moves north to the discharge areas in Dixie Valley. Groundwater in Fairview Valley occurs in three separate alluvial aquifers that are separated by clay aquitards. Ground-water flow velocities through the granite to the alluvial aquifers of Fairview Valley are calculated to be very low (Chapman and Hokett 1991).

BLUE JAY, NEVADA

The Project FAULTLESS site is located in a thick sequence of alluvial material underlain by volcanic rocks in the northern portion of Hot Creek Valley. Recharge to the alluvial aquifer and volcanic aquifer occurs in the higher mountain ranges to the west, with groundwater flowing toward the east-central portion of the valley, and discharging by evapotranspiration and underflow to Railroad Valley.

AMCHITKA ISLAND, ALASKA

The groundwater system of Amchitka Island is typical of an island-arc chain with a freshwater lens floating on seawater in fractured volcanic rocks. Active freshwater circulation occurs by precipitation, recharging the water table with a curving flow path downward in the interior of the island and upward flow near the coast. Generally, the hydraulic gradient is from the axis of the island toward the coast. Groundwater travel times have been estimated to be between 23 and 103 years from the test cavities to the Bering Sea.

RIO BLANCO, COLORADO

Project RIO BLANCO is located in the Fort Union and Mesa Verde sandstones in the Piceance Creek Basin. Three aquifers comprise the majority of the groundwater resources: a shallow alluvial aquifer, the upper "A" potable aquifer, and the lower "B" saline aquifer. The "A" and "B" aquifers are separated by the Mahogany Oil Shale aquitard. These aquifers lie well above the test depth. The alluvial aquifer is the primary source of groundwater in the area with flow to the northeast toward the Piceance Creek. Recharge to the alluvial aquifer occurs by downward infiltration of precipitation and surface water, and by upward leakage from underlying aquifers. The "A" aquifer is larger in areal extent than the overlying alluvial aquifer with the permeability in the "A" aquifer controlled by a vertical fracture system. The "B" aquifer exhibits minimal communication with the "A" aquifer.

GRAND VALLEY, COLORADO

Project RULISON is located in the Mesa Verde Sandstone which is overlain by alluvium, the Green River Formation (shale and marlstone), the Wasatch Formation (clay and shale), and the Ohio Creek Formation (conglomerate). The direction of groundwater flow is thought to be northward. The principal groundwater resources of the area are in the alluvial aquifer, which is separated from the test horizon by great thicknesses of low-permeability formations. Pressure tests of deep water-bearing zones indicated very little mobile water.

BAXTERVILLE, MISSISSIPPI

Project DRIBBLE and the Miracle Play Program were conducted in the Tatum Salt Dome (also known as the SALMON Site). The Tatum Salt Dome interrupts and deforms the lower units of coastal marine deposits in the area, has low permeability, and allows little water movement. Seven hydrologic units are recognized in the area, exclusive of the salt dome and its anhydrite caprock. These are, from the surface downward, the Surficial Aquifer, the Local Aquifer, and Aquifers 1, 2, 3, 4, and 5. These aquifers consist of sands and gravels, sandstones, shales, and limestones with low-permeability clay beds acting as aquitards. The natural flow has been disrupted by pumping from the upper aquifers and by injection of oil-field brines into Aquifer 5. The transient conditions and lack of data result in uncertainties in groundwater flow directions.

GOBERNADOR, NEW MEXICO

Project GASBUGGY is located on the eastern side of the San Juan Basin. The direction of groundwater movement is not well known, but is thought to be to the northwest in the Ojo Alamo sandstone toward the San Juan River. The test was conducted in the underlying Pictured Cliffs sandstone and Lewis Shale, which are not known to yield substantial amounts of water. Therate of groundwater movement in the Ojo Alamo sandstone is estimated to be approximately 0.01 m/yr.

MALAGA, NEW MEXICO

The Project GNOME site is located in the northern part of the Delaware Basin which contains sedimentary rocks and a thick sequence of evaporites. The test was conducted in the halites of the Salado Formation which is overlain by the Rustler Formation, the Dewey Lake Redbeds, and alluvial deposits. The Rustler Formation contains three water-bearing zones; a dissolution residue at its base, the Culebra Dolomite, and the Magenta Dolomite. The Culebra Dolomite is the most regionally extensive aquifer in the area. The groundwater in the Culebra is saline, but is suitable for domestic and stock uses. Groundwater in the Culebra flows to the west and southwest toward the Pecos River.

AREAS OF POSSIBLE GROUNDWATER CONTAMINATION AT THE NTS

In 1996, DOE/NV analyzed and confirmed the location of 908 underground tests in 878 holes at the NTS (Figure 9.1). Approximately one third (259) of these tests were at or below the water table (DOE 1996a). The principal by-products from these tests were heavy metals and a wide variety of

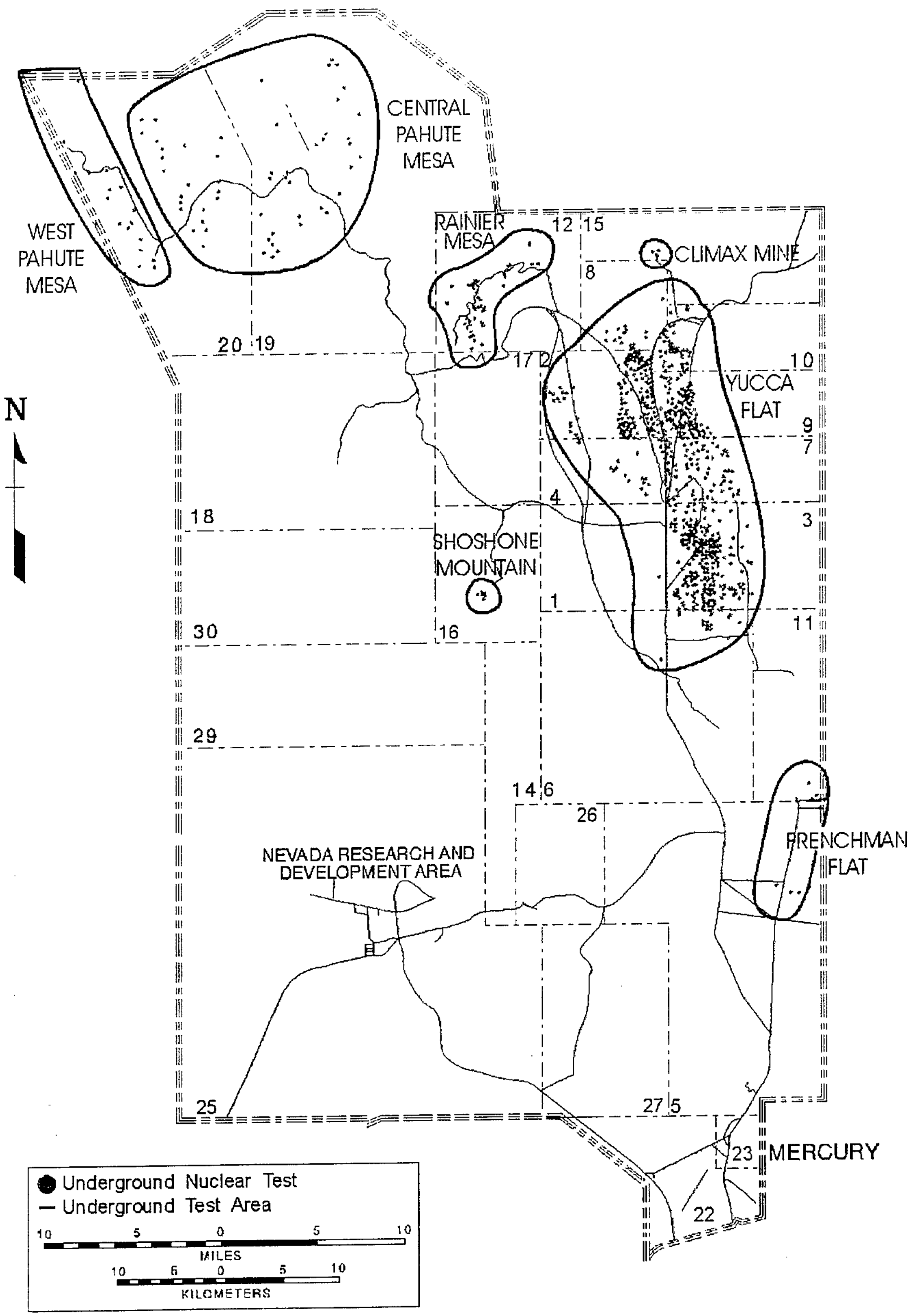


Figure 9.1 Areas of Potential Groundwater Contamination on the NTS

radionuclides with differing half-lives and decay products. Detonations within, or near, the regional water table have contaminated the local groundwater with over 60 radionuclides being present in significant quantities. Tritium is the most abundant radionuclide, with an estimated 100 million Curies present in or near the water table (DOE 1996c). Table 9.1 is a listing of routine sampling locations, onsite and offsite, where well water samples contained tritium concentrations greater than 0.2 percent of the National Primary Drinking Water Standards.

Surface activities associated with underground testing and other NTS activities such as disposal of low-level radioactive and mixed wastes, spill testing of hazardous liquefied gaseous fuels, and transport of radioactive materials, also pose potential soil and groundwater contamination risks. The types of possible contaminants found on the surface of the NTS include radionuclides, organic compounds, metals, and residues from plastics, epoxy, and drilling muds. A wide variety of surface facilities, such as former injection wells, leach fields, sumps, waste storage facilities, tunnel containment ponds and muck piles, and storage tanks, may have contaminated the soil and shallow unsaturated zone of the NTS. The known sites are categorized by type and listed in Appendices II, III, and IV of the Federal Facility Agreement and Consent Order (FFACO), jointly agreed to by DOE, the U. S. Department of Defense (DOD), and the Nevada Division of Environmental Protection (NDEP). The great depths to groundwater and the arid climate mitigate the potential for mobilization of surface and shallow subsurface contamination. However, contaminants entering the carbonate bedrock from Rainier Mesa tunnel ponds, contaminated wastes injected into deep wells, underground tests near the water table, and wastes disposed into subsidence craters have the potential to reach groundwater.

GROUNDWATER MONITORING

GROUNDWATER QUANTITY

Water levels are monitored by the U.S. Geological Survey (USGS) on and around the NTS at approximately 156 measurement locations annually. Data for the 1995 water year are reported in Bauer et al., 1996, the most recent publication. Results are used in regional and local groundwater models, but are not routinely analyzed for water level trends. However, no significant water level impacts associated with groundwater usage were detected in 1996.

Water usage on the test site is monitored by the both the USGS and Bechtel Nevada (BN). The data are reported in Bauer et al., 1996. Water use at the test site continues to decline owing to the cessation of underground nuclear testing in 1992 and was about 1.33×10^6 m^3 (351×10^6 gal) in 1996.

GROUNDWATER QUALITY

Groundwater quality was determined by monitoring wells and springs both onsite and offsite. The results from onsite water supply wells, environmental surveillance for radioactivity in groundwater monitoring wells, and springs are presented in Chapter 4. Results from offsite water supply wells and springs are presented in Section 9. Monitoring of groundwater discharging from the E Tunnel in Area 12 is discussed in Chapter 5. Groundwater monitoring at the Area 5 Radioactive Waste Management Site (RWMS-5) is detailed in Chapter 8. The remainder of this chapter summarizes analyses of water for chemical constituents, radioisotopes, and stable isotopes in order to comply with environmental permits, better characterize NTS groundwater quality, and support regional groundwater flow and transport models.

A monitoring well, SM23-1, was drilled next to the sewage lagoon in Area 23 as part of the general discharge permit for the site (see

Chapter 3). The objectives of the well were to obtain water samples to determine the extent to which liquid from the sewage lagoons had infiltrated into the subsurface, provide data for the computer modeling of sewage lagoon performance, and provide a groundwater monitoring point below the sewage lagoons. Groundwater was encountered at 398 m (1,306 ft) below ground surface and the well was completed in the uppermost water-producing zone. The well was not developed and sampled in 1996.

Groundwater contamination was detected in Pahute Mesa Exploratory Hole #2 in 1993, and the Hydrologic Resources Management Program initiated a multi-organization investigation to determine the source of contamination. Tritium in water at an average level of 6.9 x 10^{-4} µCi/mL (25.600 Bq/L) was detected at the most contaminated interval 610 m (2,000 ft) below the surface. The data indicate that several possible mechanisms could account for the migration of contamination from the Schooner underground test 270 m (886 ft) to the southeast of the well. The most probable pathway for radionuclides to enter the well water involves contaminated ejecta from the test entering the wellbore soon after the test rather than groundwater migration or prompt injection of radionuclides from the Schooner test (Russell and Locke 1996).

Analysis of groundwater in 18 wells in Yucca Flat for the environmental isotopes $^{2}H/^{1}H$, $^{18}O/^{16}O$, $^{13}C/^{12}C$, $^{14}C/C$, and $^{87}Sr/^{86}Sr$ was reported in 1996. Results indicate that groundwater in Yucca Flat ascends from depth, possibly along a fault, at a calculated rate of about 9 m/yr (30 ft/yr) (Kenneally 1996).

DOE continued efforts to create a long-term monitoring program for wells in or near underground nuclear event cavities. The program objectives are to characterize the hydrologic source term and evaluate the decay and potential migration of radionuclides through monitoring at or near the source. Los Alamos National Laboratory and Lawrence Livermore National Laboratory (LLNL) monitored water at the ALMENDRO, TYBO, BULLION, and CHESHIRE events on Pahute Mesa and the CAMBRIC event in Frenchman Flat (Thompson 1997). A summary report from both laboratories will be released in 1997.

9.2 GROUNDWATER PROTECTION

DOE/NV has instituted a policy regarding protection of the environment. This policy states: "A principal objective of the DOE/NV policy is to assure the minimization of potential impacts on the environment, including groundwater, from underground testing. An ongoing program to monitor and assess the effectiveness of groundwater protection efforts will be enhanced so that resources are allocated based on current understanding of the effectiveness of groundwater protection programs." Groundwater protection activities contained within DOE/NV programs are described below.

WASTE MINIMIZATION AND POLLUTION PREVENTION AWARENESS PROGRAM

The Waste Minimization and Pollution Prevention Awareness Program is designed to reduce waste generation and possible pollutant releases to the environment, increasing the protection of employees and the public. All DOE/NV contractors and NTS users who exceed the EPA criteria for small-quantity generators have established implementation plans in accordance with DOE/NV requirements. Contractor programs ensure that waste minimization activities are in accordance with federal, state, and local environmental laws and regulations and DOE Orders. A discussion of 1996 activities is given in Chapter 3.

SITING FOR UNDERGROUND NUCLEAR TESTS

The draft DOE/NV Procedural Instruction "Siting Criteria for Protection of Groundwater at the Nevada Test Site" (NV PI 97-001) defines five criteria for siting underground nuclear tests based upon the current understanding of the effects of testing on the groundwater environment. Before an emplacement hole or emplacement drift can be used for a test, documentation must be submitted by the sponsoring user to the DOE/NV Assistant Manager for National Security to show compliance with these criteria, which are:

- Future testing should utilize previously used areas of testing.
- Tests with working points at or below the water table should be minimized. Testing within perched water conditions is excluded from this criterion.
- Working points should be placed no closer than two cavity radii from any regional carbonate aquifer.
- Emplacement holes should not be sited within 1,500 m of the NTS boundary where groundwater leaves the NTS.
- Emplacement holes which extend more than two cavity radii or 30 m, whichever is greater, beneath the working point should be plugged to prevent the open borehole from becoming a preferential pathway for groundwater contamination.

WASTE TREATMENT, STORAGE, AND DISPOSAL

DOE/NV currently operates two disposal facilities in Areas 3 and 5 at the NTS for low-level radioactive waste (LLW) generated by DOE and the DOD facilities. The RWMS-5 also serves as a temporary storage area for LLNL transuranic wastes which will be shipped, upon final certification, to the Waste Isolation Pilot Plant in New Mexico for disposal. All hazardous wastes generated at the NTS are stored at a Hazardous Waste Accumulation Site in Area 5 until shipped offsite to EPA-approved commercial disposal facilities. Uranium-ore residues designated as strategic materials are stored north of the RWMS-5. The Area 3 RWMS (RWMS-3) is used for the disposal of nonstandard packaged LLW from offsite and unpackaged bulk wastes from the NTS.

In 1996, one mixed waste shipment, a Nevada-generated shipping cask, was disposed of at RWMS-5. The disposal was in the Pit 3 facility, a Resource Conservation and Recovery Act (RCRA) interim status permitted facility.

In accordance with Title 40 C.F.R. 265 - Subpart F, operators of interim status treatment, storage, and disposal facilities are required to collect quarterly samples for one year from one upgradient and three downgradient wells for characterization of background water quality. Sampling protocols for characterization and detection data collection were based on the RCRA Groundwater Monitoring Technical Enforcement Guidance Document (EPA 1986). Groundwater elevation was measured prior to each sampling event. The first collections of these characterization data were performed in 1993. Subsequent semi-annual sampling was continued through 1996 and results were statistically compared with the initial characterization data.

Based on characterization results during 1993 and detection monitoring results through 1996, the uppermost aquifer beneath the RWMS-5 disposal cells is suitable for use as drinking water or for agricultural purposes. The analyses performed for these samples can be found in Table 9.2. No chemical or radiological contaminants attributable to either DOE weapons testing or waste management activities have been detected in the three wells.

In accordance with DOE Order 5820.2A, "Radioactive Waste Management," DOE/NV prepared and submitted a Performance Assessment (PA) for LLW disposal at the

RWMS-5. In 1996, the DOE Headquarters (DOE/HQ)-appointed Peer Review Panel (PRP) found the RWMS-5 PA to be technically acceptable following a rigorous 15-month review. Comments from the PRP were addressed in addenda to the PA and the final PA is being revised for publication and resubmittal to DOE/HQ in 1997.

The Area RWMS-3 PA is in full progress. Efforts in 1996 focused on hydrogeologic characterization through borehole drilling and sample analysis, surface geologic mapping, flood studies, inadvertent human intruder studies, and source inventory analysis. Characterization boreholes were installed at a slant beneath active surface-subsidence craters where waste is disposed, as well as vertically within the chimney structure of the reserve craters intended for future waste disposal. Completion of the draft RWMS-3 PA is scheduled for 1997.

In April 1996, DOE and the Defense Nuclear Facilities Safety Board agreed that a Composite Analysis (CA) of the pre-1988 waste source term, and all other sources of radioactive contamination in the ground that are potentially interactive with the LLW disposal facility materials, be performed. The CA serves as a long-term management planning tool to evaluate total radiological risk to the public at site-determined compliance points and boundaries. A source-screening assessment was completed for Yucca Flat basin as a first step in preparing the RWMS-3 CA; the CA is scheduled for delivery to DOE/HQ with the PA in 1997. The pre-1988 source inventory for the RWMS-5 CA is in progress and the completed CA is due to DOE/HQ in 1999.

WELLHEAD RECONSTRUCTION AND WELL REHABILITATION

The Hydrologic Resources Management Program completed an investigation of all existing boreholes within one kilometer of underground nuclear tests conducted in the water table or within 50 m of the water table. One objective of the review was to determine if boreholes existed which could provide a pathway for preferential vertical migration of radionuclides associated with nearby tests. A second objective was to identify holes that could be converted into monitoring wells or kept in reserve for potential monitoring use in the future.

Out of approximately 250 wells examined, 40 were determined to meet the distance criteria and were investigated in detail to determine their drilling and construction history, lithology and hydrologic units penetrated, and current conditions. Recommendations were made to plug, recondition, or recomplete the wells.

SEWAGE LAGOON UPGRADES

In 1996, sewage lagoon upgrades were completed which resulted in a lower potential for migration of contaminants to the groundwater. Specific information is contained in Chapter 3.

9.3 ENVIRONMENTAL RESTORATION

The Nevada ERP was begun in the late 1980s to address contamination resulting primarily from nuclear weapons testing and related support operations. The goals of the project are to safeguard the public's health and safety and to protect the environment. This involves the assessment and cleanup of contaminated sites and facilities to meet standards required by federal and state environmental laws. Approximately 878 sites used for historic underground nuclear tests will be investigated, along with areas where more than 100 aboveground tests were conducted. Additionally, 1,500 other sites that were used for support operations will potentially require environmental remediation.

The DOE/NV is working closely with representatives of the state of Nevada to ensure compliance with applicable environmental regulations. A FFACO was signed by the DOE, DOD, and NDEP in May

1996. The FFACO provides a mechanism for implementing corrective actions based on public health and environmental considerations in a cost-effective and cooperative manner. It also establishes a framework for identifying, prioritizing, investigating, remediating, and monitoring contaminated DOE sites in Nevada. The FFACO's corrective action requirements supersede some portions of the NTS RCRA Permit issued in May 1995.

Investigations and remediations follow a strategy for investigation and remediation outlined in Appendix VI, Corrective Action Strategy, of the FFACO. The strategy is based on four steps: (1) identifying corrective action sites, (2) grouping the sites into corrective action units, (3) prioritizing the units for funding and work, and (4) implementing investigations or actions as applicable. The sites are broadly organized into underground test area sites, industrial sites, soil sites, and off sites. Information related to investigation and cleanup activities as it relates to groundwater protection follows.

UNDERGROUND TEST AREA (UGTA) SITES

The UGTA Project focused on drilling, testing, and sampling wells near underground nuclear tests. The drilling program was conducted in order to determine radiochemical and hydrogeologic conditions near tests in support of modeling at the scale of Corrective Action Units. Contaminated fluid produced during drilling and sampling was managed in accordance with the UGTA Waste Management Plan to prevent degradation of groundwater. Evaporation of tritiated water from the drilling operations is included in the calculations for compliance with the National Emissions Standard for Hazardous Air Pollutants.

Accomplishments of the UGTA project in 1996 include the completion, development, and sampling of two wells at the TYBO underground nuclear test and three wells at the BULLION test on Pahute Mesa. Other activities included the development and sampling of one zone in well ER-3-1 in Yucca Flat and two zones in well ER-30-1 on Buckboard Mesa. In general, results show no evidence of man-made radionuclides in the Yucca Flat and Buckboard Mesa wells, and expected levels of contamination in the near-event wells on Pahute Mesa. Results are scheduled for publication in 1997.

INDUSTRIAL SITES AND DECONTAMINATION AND DECOMMISSIONING

CLOSURE IN PLACE OF CORRECTIVE ACTION UNIT NO. 90: AREA 2 BITCUTTER AND POSTSHOT CONTAINMENT SHOPS INJECTION WELLS

The Bitcutter and Postshot Containment Shop injection wells are located in Area 2 at the NTS. Three wells were installed for disposal of fluids used during shop operations for several years during the early 1980s. Two wells are associated with the Bitcutter shop (one inside and one outside) and one is associated with the Postshot Containment Shop.

In 1995, DOE/NV ERP concluded characterization activities which included drilling 15 investigative boreholes, downhole video inspection within the inside Bitcutter Shop well, and sampling the sludge contained in the Postshot Injection well. The results for the inside Bitcutter Shop well indicated concentrations of Total Petroleum Hydrocarbon (TPH) above the NDEP action level of 100 ppm and RCRA-listed wastes present at trace levels above regulatory thresholds. Soil samples taken at the Postshot and outside Bitcutter Shop wells indicated TPH levels below regulatory levels. No radiological contamination was found at any of the three wells.

The method of closure for the Postshot Injection well was to remove any liquid or sludge from the hole, grout the casing, and place a concrete cap on top of the well. The inside Bitcutter Shop well was plugged with cement and a concrete cap was placed above the well. No further action was taken on the outside Bitcutter Shop well since the casing and TPH-impacted soil were removed during characterization. The well caps are six inches above the ground surface and sloped to promote runoff of precipitation. These facilities and other NTS facilities with RCRA closure plans are listed in Table 9.3.

ABANDONED UNDERGROUND STORAGE TANKS

Nine abandoned underground storage tanks were removed from various areas of the NTS.

SOIL SITES

In 1996, radiologically contaminated soils from the DOUBLE TRACKS site, on the Nellis Air Force Range Complex, northwest of the NTS were removed and disposed of in Area 3 on the NTS. However, these contaminated soils were at the ground surface and did not contaminate the subsurface or groundwater. Therefore, they are not discussed further here.

OFFSITE LOCATIONS

The offsite areas are described in Section 9.1 of this chapter. Activities related to groundwater protection at these sites are conducted as part of the ERP. Investigation and cleanup at these sites are being conducted in accordance with the FFACO with the state of Nevada for the two sites in Nevada, SHOAL and FAULTLESS. In the remainder of the states, agreements will be developed as the restoration activities proceed. Following is a summary of activities at sites where activities were conducted during 1996.

At the Project SHOAL site, an investigation plan was completed and approved, four monitoring wells were installed, and shallow soil sampling in the mudpits was completed.

At the Project RULISON site, an assessment of radionuclide movement from the site was completed by the Desert Research Institute (DRI) (Earman et al., 1996a). A voluntary, interim remedial action was completed in cooperation with the state of Colorado. Approximately 14,000 m^3 (3.7 million gal) of water was removed from the pond occupying the former mudpit and 18,600 m^3 (24,400 yd^3) of TPH-contaminated sediment was excavated, stabilized, transported, and disposed of. The pond was lined and restored. Soil test borings were completed and monitoring wells were drilled to allow long-term monitoring. The final corrective action report and risk assessment were submitted to the state of Colorado for approval.

At the RIO BLANCO site, historical information and data were compiled and evaluated. An assessment of radionuclide movement from the site was completed by the DRI (Chapman et al., 1996a).

At the Project GNOME site, historical information and data were compiled and evaluated. The DRI reported on historical tracer tests (Pohll and Pohlmann 1996) and performed a preliminary risk assessment (Earman et al., 1996b).

At the Project GASBUGGY Site, historical information and data was compiled and evaluated. The DRI assessed radionuclide movement from the site (Chapman et al., 1996b).

At the Project DRIBBLE (SALMON) site, access roads were repaired, a waste management facility was constructed, and 13 new shallow groundwater monitoring wells were installed and logged.

9.4 LONG-TERM HYDROLOGICAL MONITORING PROGRAM (LTHMP)

The EPA's Radiation and Indoor Environments National Laboratory in Las Vegas (R&IE-LV) is responsible for operation of the LTHMP, including sample collection, analysis, and data reporting. From the early 1950s until implementation of the LTHMP in 1972, monitoring of ground and surface waters was done by the U.S. Public Health Service (PHS), the USGS, and the U.S. Atomic Energy Commission (AEC) contractor organizations. The LTHMP consists of routine radiological monitoring, analysis, and reporting of samples collected from specific wells on the NTS and of wells, springs, and surface waters in the offsite area around the NTS. Samples are also collected from sites in Nevada, Colorado, New Mexico, Mississippi, and Alaska where nuclear tests have been conducted. In 1965, tritium escaped from the LONG SHOT test on Amchitka Island and contaminated the shallow groundwater, and during cleanup and disposal operations, shallow groundwater at the Tatum Dome Test Site in Mississippi was contaminated with tritium. The tritium concentration in water at both of these sites has steadily decreased and was well below the drinking water standard when last sampled.

A discussion of LTHMP sampling and analysis procedures, and the locations sampled is provided below. Summaries of the 1996 sampling results for each of the offsite LTHMP locations is provided in Section 9.6. More detailed sampling results for the LTHMP are being published separately in the "Environmental Data Report for the Nevada Test Site - 1996," (DOE/NV/11718-138, in prep.).

SAMPLING AND ANALYSIS PROCEDURES

The procedures for the analysis of samples collected for this report are described by Johns et al., 1979 and are summarized in Table 9.4. These include gamma spectral analysis and radiochemical analysis for tritium. The procedures are based on a standard methodology for the stated analytical procedures. Two methods for tritium analysis were performed: conventional and electrolytic enrichment. The samples were initially analyzed for tritium by the conventional method followed by enrichment analysis if the results were less than 700 pCi/L (26 Bq/L). In late 1995, it was decided that only 25 percent of the samples would be analyzed by the electrolytic enrichment method. The samples selected have a tritium result of less than 700 pCi/L by the conventional method and are from locations that are in position to show possible migration. Two 250-mL glass bottles and a 1-gal plastic container are filled at each sampling location. At the sample collection sites, the pH, conductivity, water temperature, and sampling depth are measured and recorded when the sample is collected. For wells with operating pumps, the samples were collected at the nearest convenient outlet. If the well has no pump, a truck-mounted sampling unit is used. With this unit, it is possible to collect 3-L samples from wells as deep as 1,800 m (5,900 ft).

The first time samples are collected from a well, $^{89,90}Sr$, $^{238,239+240}Pu$, and uranium isotopes are determined by radiochemical analysis, in addition to analysis mentioned above. The 250-mL samples are analyzed for tritium and the 1-gal sample from each site is analyzed by gamma spectrometry.

ACTIVITIES ON AND AROUND THE NEVADA TEST SITE

NEVADA TEST SITE MONITORING

The present sample locations on the NTS, or immediately outside its borders on federally owned land are shown in Figure 9.2. All sampling locations are selected by DOE and primarily represent potable water supplies. In 1995, sampling on the NTS was modified so that EPA only samples wells without pumps and, for Quality Assurance purposes,

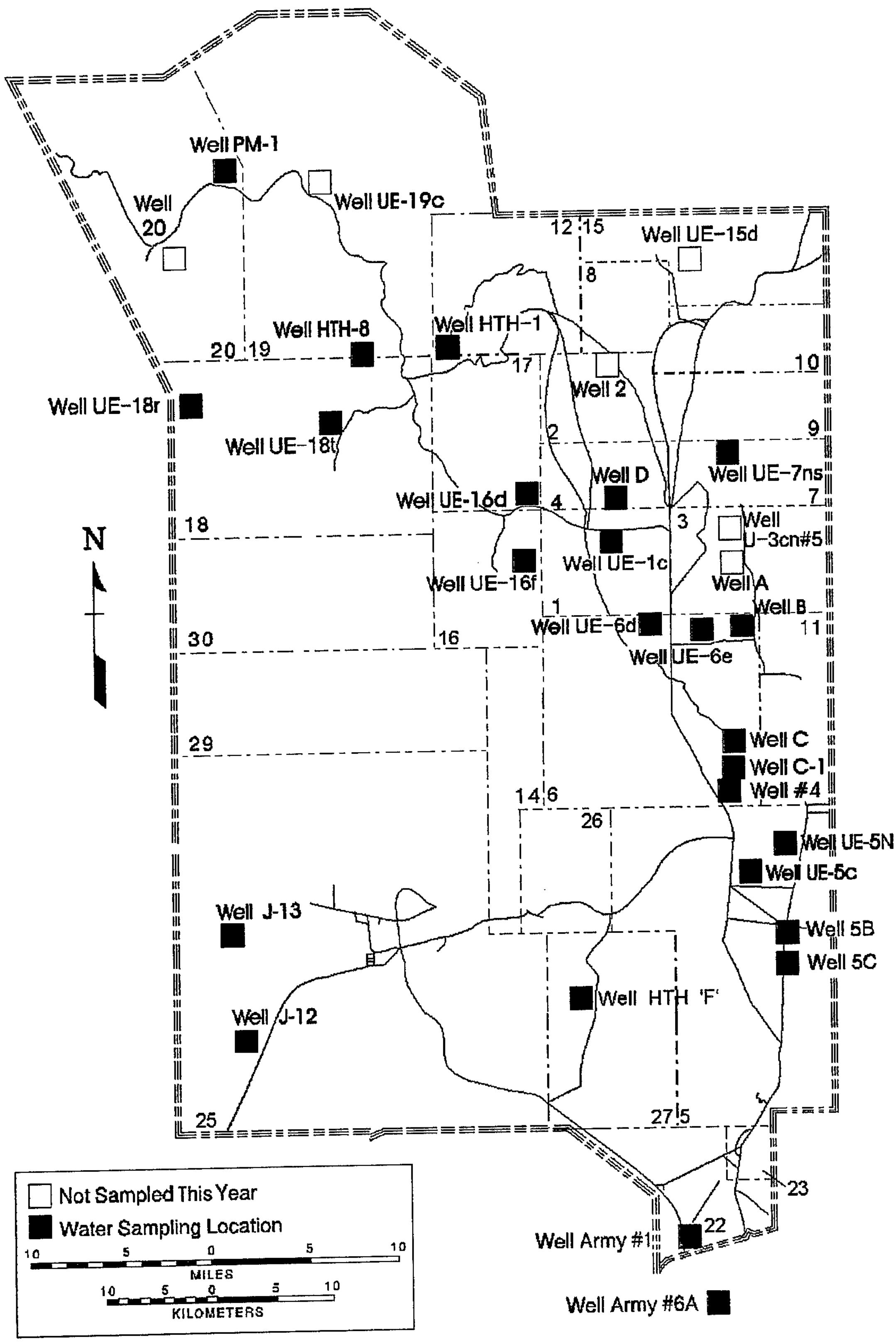


Figure 9.2 Wells on the NTS Included in the LTHMP - 1996

collects samples from 10 percent of the potable wells sampled by BN. A total of 21 wells was scheduled to be sampled, but only 19 wells were sampled for various reasons.

All samples were analyzed by gamma spectrometry and for tritium. No gamma-emitting radionuclides were detected in any of the NTS samples collected in 1996. Summary results of tritium analyses are given in Table 9.5. The highest average tritium activity was 4.5 x 10^4 pCi/L (1,700 Bq/L) in a sample from Well UE-5n. This activity is less than 60 percent of the Derived Concentration Guide (DCG) for tritium established in DOE Order 5400.5 for comparison with the dose limit (4 mrem) in the National Primary Drinking Water Regulations. Eight of the wells sampled yielded tritium results greater than the minimum detectable concentration (MDC). The trend in tritium concentration in samples from Test Well B is shown in Figure 9.3 and is typical of a well with decreasing tritium concentrations. Well UE-7ns was routinely sampled between 1978 and 1987 and sampling began again in 1992. An increasing trend in tritium activity was evident at the time sampling ceased in 1987. Recent results have shown a decrease from those previous results, although the present result is higher than results for 1995.

OFFSITE MONITORING IN THE VICINITY OF THE NEVADA TEST SITE

The monitoring sites in the area around the NTS are shown in Figure 9.4. Most of the sampling locations represent drinking water sources for rural residents or public drinking water supplies for the communities in the area. The sampling locations include 12 wells, 9 springs, and a surface water site. All of the locations are sampled quarterly or semiannually. Gamma spectrometric analyses are performed on the samples when collected. No man-made gamma-emitting radionuclides were detected in any sample. Tritium analyses are performed on a semiannual basis. Adaven Spring is the only site which consistently shows detectable tritium activity. The tritium activity in this spring represents environmental levels that have been decreasing over time. All results for this project for 1996 are shown in Table 9.6.

9.5 LTHMP AT OFF-NTS NUCLEAR DEVICE TEST LOCATIONS

Sampling for the LTHMP is conducted at sites of past nuclear device testing in other parts of the United States to ensure the safety of public drinking water supplies and, where suitable sampling points are available, to monitor any migration of radionuclides from the test cavity. Annual sampling of surface and ground waters is conducted at the Projects SHOAL and FAULTLESS sites in Nevada, the Projects GASBUGGY and GNOME sites in New Mexico, the Projects RULISON and RIO BLANCO sites in Colorado, and the Project DRIBBLE (SALMON) site in Mississippi. Sampling is normally conducted in odd numbered years on Amchitka Island, Alaska, and at the site of Projects CANNIKIN, LONG SHOT, and MILROW. Sampling was not done in 1995 due to lack of funding.

The sampling procedure is the same as that used for sites on the NTS and offsite areas (described in Section 9.4), with the exception that two 3.8-L samples are collected in Cubitainers. The second sample serves as a backup or as a duplicate sample.

Because of the variability noted in past years in samples from the shallow monitoring wells near Project DRIBBLE (SALMON) ground zero (GZ), the sampling procedure as modified several years ago. A second sample is taken after pumping for a specified period of time or after the well has been pumped dry and permitted to recharge. These second samples may be representative of formation water, whereas the first samples may be more indicative of recent rainfall.

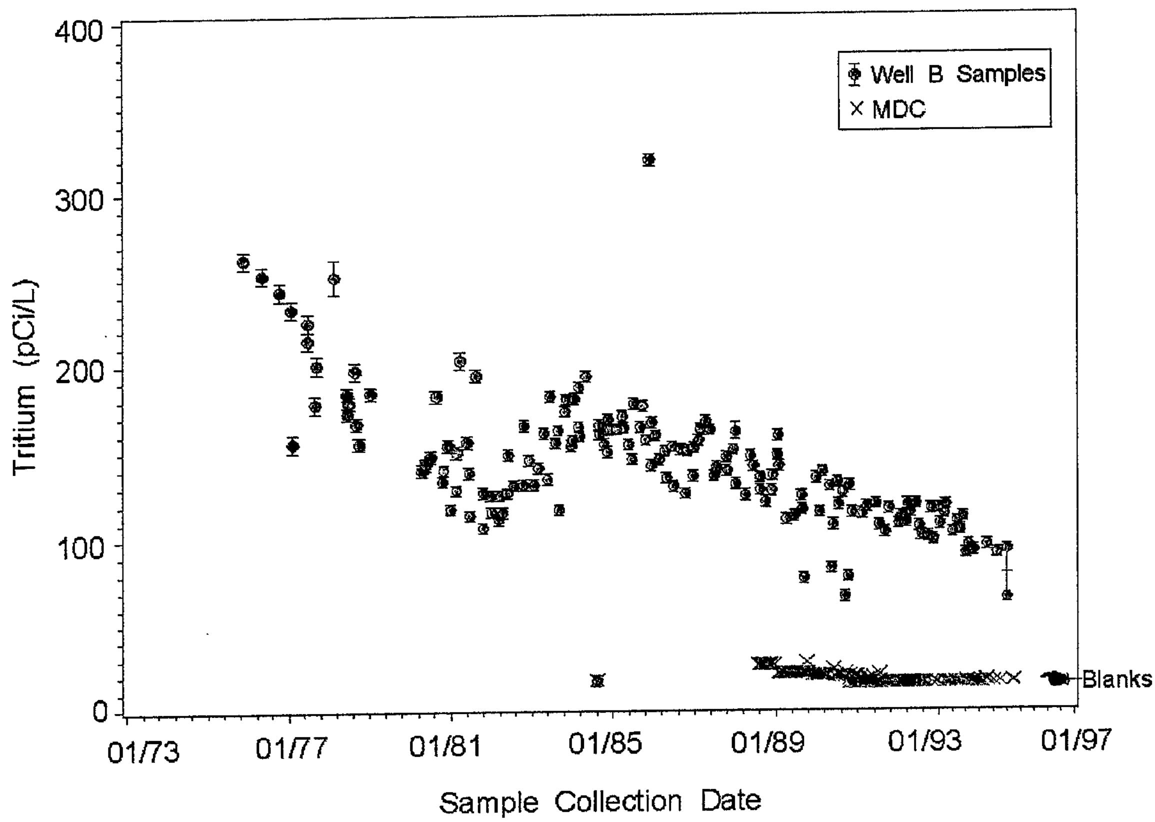


Figure 9.3 Tritium Concentration Trends in Test Well B on the NTS

PROJECT FAULTLESS

Project FAULTLESS was a "calibration test" conducted on January 19, 1968, in a sparsely populated area near Blue Jay Maintenance Station, Nevada. The test had a yield between 200 and 1,000 kt and was designed to test the behavior of seismic waves and to determine the usefulness of the site for high-yield tests. The emplacement depth was 975 m (3,199 ft). A surface crater was created, but as an irregular block along local faults rather than as a saucer-shaped depression. The area is characterized by basin and range topography, with alluvium overlying tuffaceous sediments. The working point of the test was in tuff. The groundwater flow is generally from the highlands to the valley and through the valley to Twin Springs Ranch and Railroad Valley (Chapman and Hokett 1991).

Sampling was conducted on March 6 and 7, 1996, at locations shown in Figure 9.5. Routine sampling locations include one spring and five wells of varying depths. The Bias Well was not sampled because the ranch was closed and Six Mile Well was not sampled because the pump was removed. A new sampling location (site C Complex) was established to replace the Bias Ranch Well. This site is approximately 8 mi from Blue Jay Maintenance Station and is approximately 20 mi from surface ground zero (SGZ).

At least two wells (HTH-1 and HTH-2) are positioned to intercept migration from the test cavity, should it occur (Chapman and Hokett 1991). All samples yielded negligible gamma activity.

Tritium concentrations were less than the MDC. These results are all consistent with results obtained in previous years. The

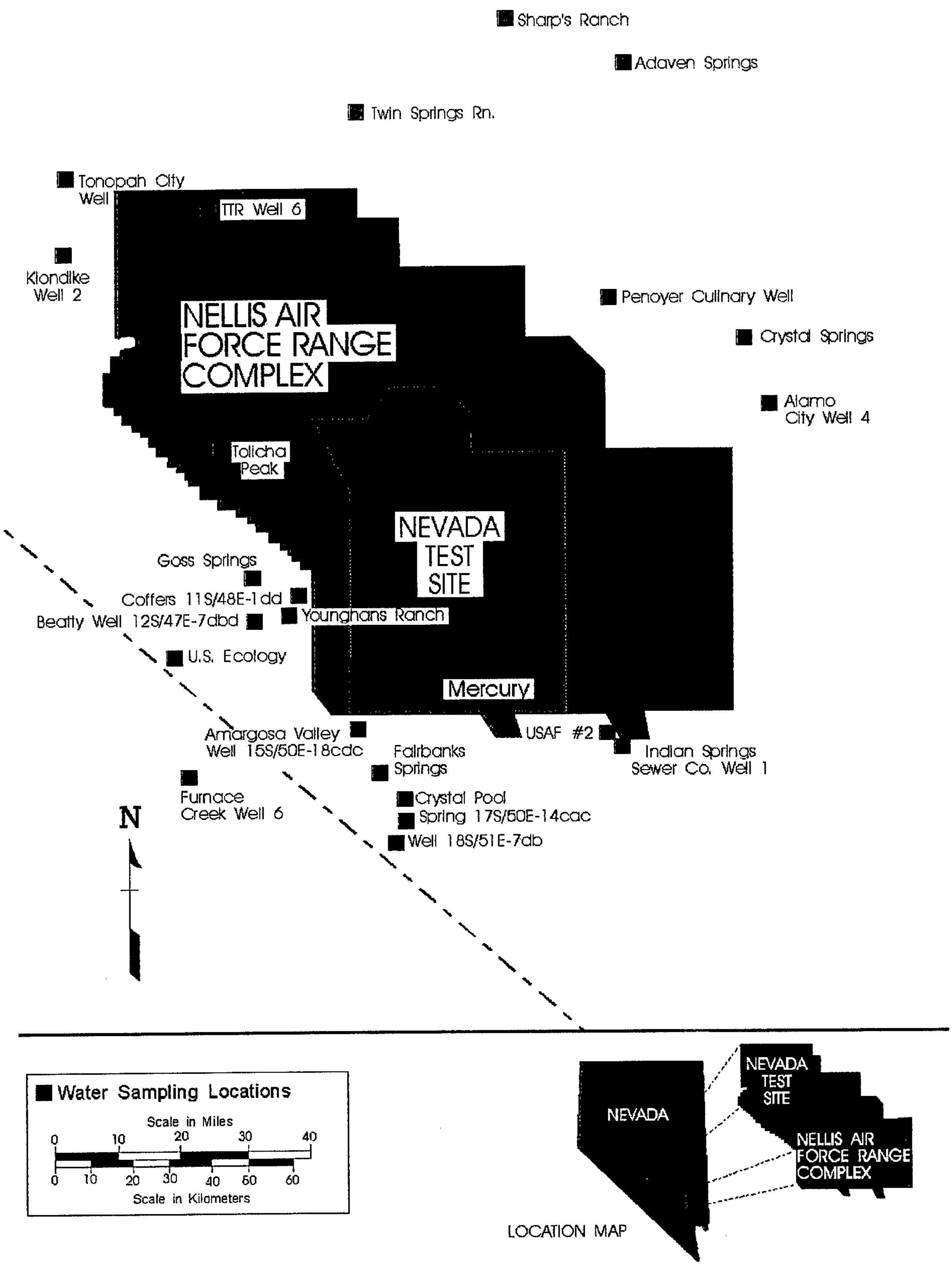


Figure 9.4 Wells Outside the NTS Included in the LTHMP - 1996

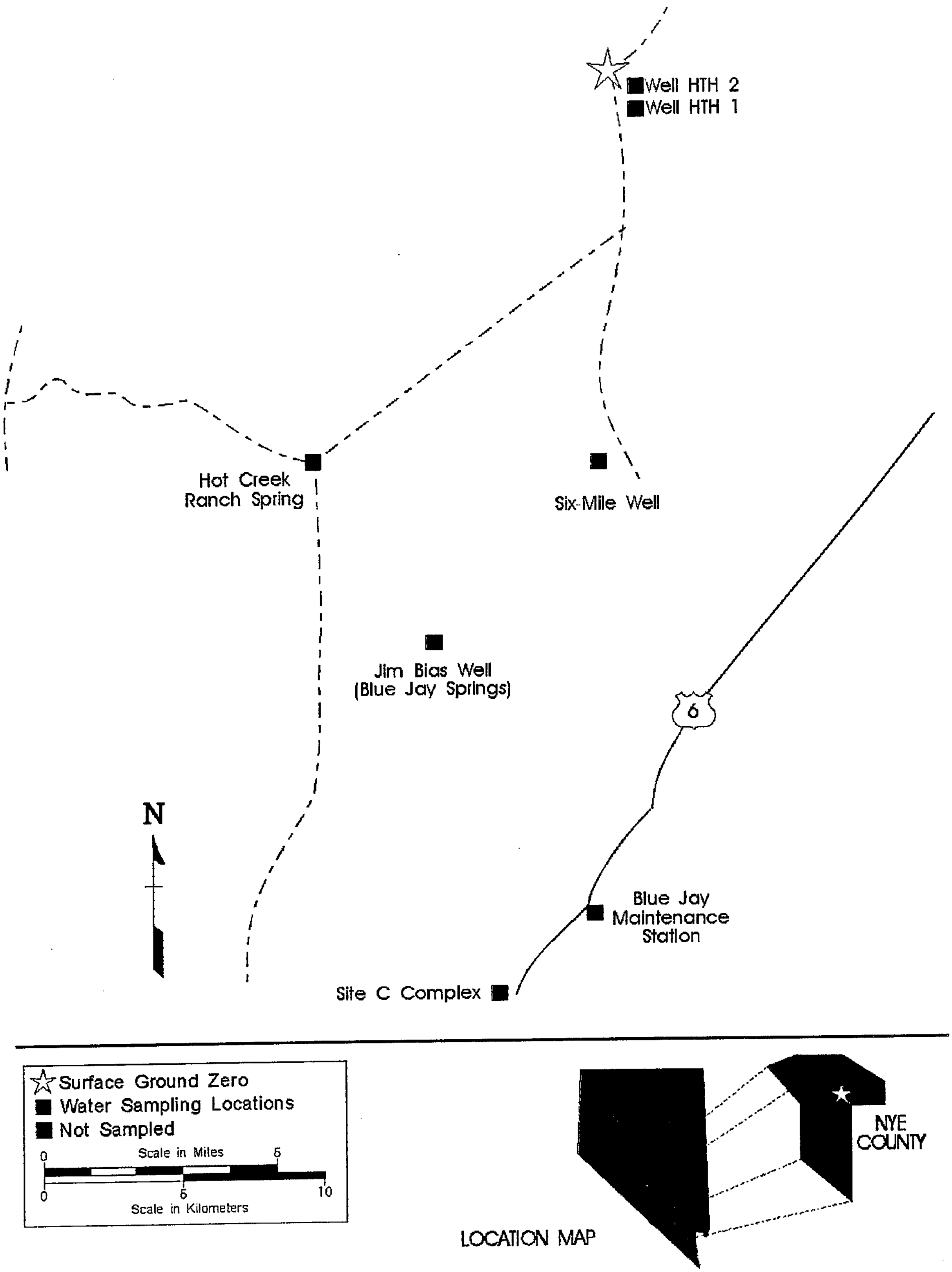


Figure 9.5 LTHMP Sampling Locations for Project FAULTLESS - 1996

results for tritium indicate that, to date, migration into the sampled wells has not taken place and no event-related radioactivity has entered area drinking water supplies.

PROJECT SHOAL

Project SHOAL, a 12-kt test emplaced at 365 m (1,198 ft), was conducted on October 26, 1963, in a sparsely populated area near Frenchman Station, Nevada. The test, part of the Vela Uniform Program, was designed to investigate detection of a nuclear detonation in an active earthquake zone. The working point was in granite and no surface crater was created. An effluent was released during drillback but was detected onsite only and consisted of 110 Ci of ^{131}Xe and ^{133}Xe, and less than 1.0 Ci of ^{131}I.

Samples were collected on March 4 and 5, 1996. The sampling locations are shown in Figure 9.6. Only five of the seven routine wells were sampled. No sample was collected from Spring Windmill because the pump was removed. No sample was collected from Well H-2 because the well was locked and no key was available to EPA at the time of sampling. The routine sampling locations include one spring, one windmill, and five wells of varying depths. At least one location, Well HS-1, should intercept radioactivity migrating from the test cavity, should it occur (Chapman and Hokett 1991). Gamma-ray spectral analysis results indicated that no man-made gamma-emitting radionuclides were present in any samples above the MDC. All tritium results were also below the MDC.

PROJECT RULISON

Cosponsored by the AEC and Austral Oil Company under the Plowshare Program, Project RULISON was designed to stimulate natural gas recovery in the Mesa Verde formation. The test, conducted near Grand Valley, Colorado, on September 10, 1969, consisted of a 40-kt nuclear explosive emplaced at a depth of 2,568 m (8,425 ft). Production testing began in 1970 and was completed in April 1971. Cleanup was initiated in 1972 and the wells were plugged in 1976. Some surface contamination resulted from decontamination of drilling equipment and fallout from gas flaring. Contaminated soil was removed during the cleanup operations.

Sampling was conducted June 4-7, 1996, with collection of samples from eight out of nine wells in the area of Grand Valley and Rulison, Colorado. The spring 300 yards from SGZ was dry. Routine sampling locations are shown in Figure 9.7, including the Grand Valley municipal drinking water supply springs, water supply wells for five local ranches, and three sites in the vicinity of SGZ, including one test well, a surface-discharge spring which was dry and a surface sampling location on Battlement Creek. Seven new monitoring wells were completed at the RULISON Site in 1995 as part of the Remedial Investigation and Feasibility Study. These wells will be added to the LTHMP in 1998.

Tritium has never been observed in measurable concentrations in the Grand Valley City Springs. All of the remaining sampling sites show detectable levels of tritium, which have generally exhibited a stable or decreasing trend over the last two decades. The range of tritium activity in 1996 was from 242 ± 140 pCi/L (9 Bq/L) at Battlement Creek, to 112 ± 6.9 pCi/L (4.1 Bq/L) at Lee Hayward Ranch. All values were less than 1 percent of the DCG. The detectable tritium activities were probably a result of the high natural background in the area. This was supported by the DRI analysis, which indicated that most of the sampling locations were shallow, drawing water from the surficial aquifer which was unlikely to become contaminated by any radionuclides arising from the Project RULISON cavity (Chapman and Hokett 1991). All samples were analyzed for presence of gamma-ray emitting radionuclides. None were detected above the MDC.

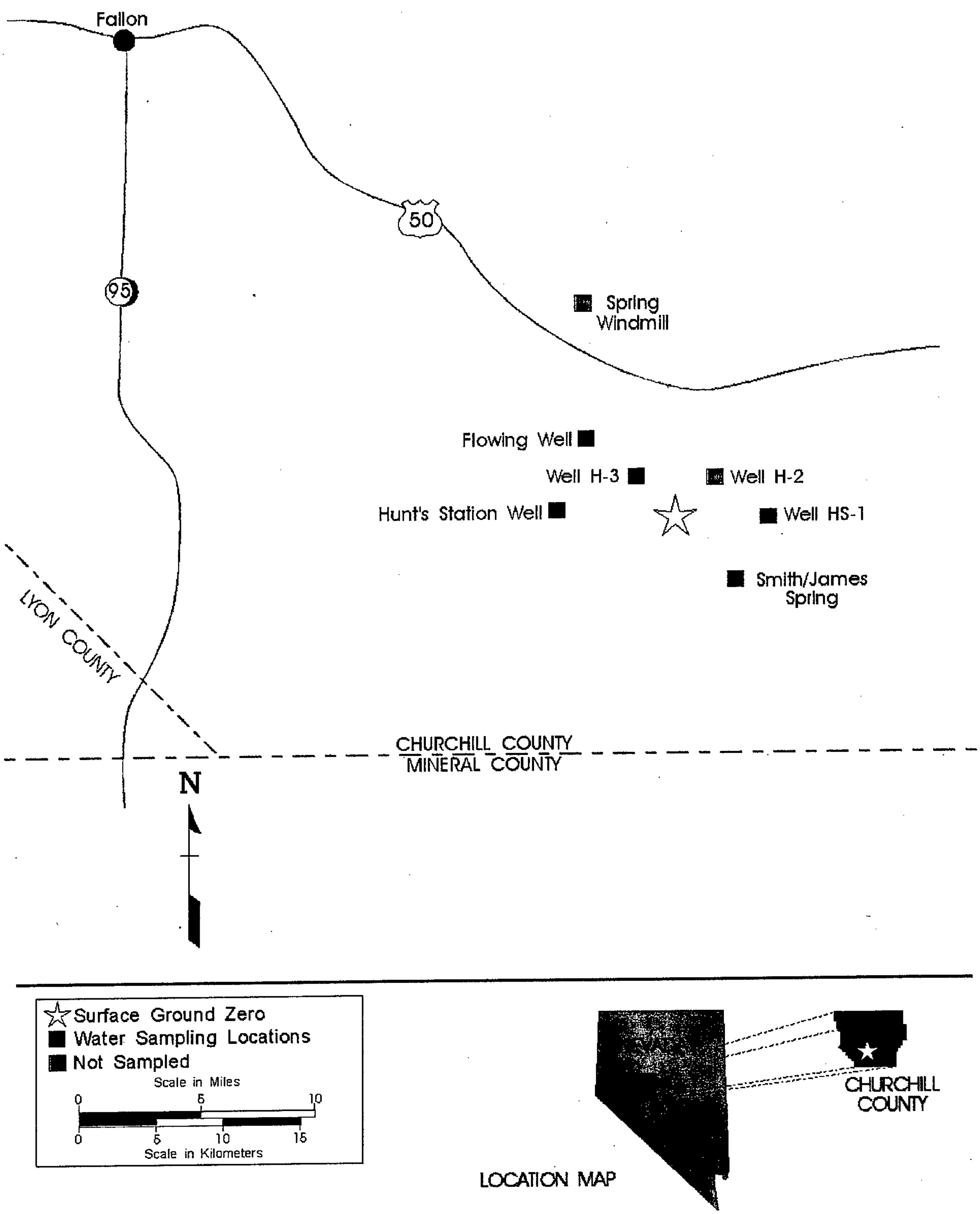


Figure 9.6 LTHMP Sampling Locations for Project SHOAL - 1996

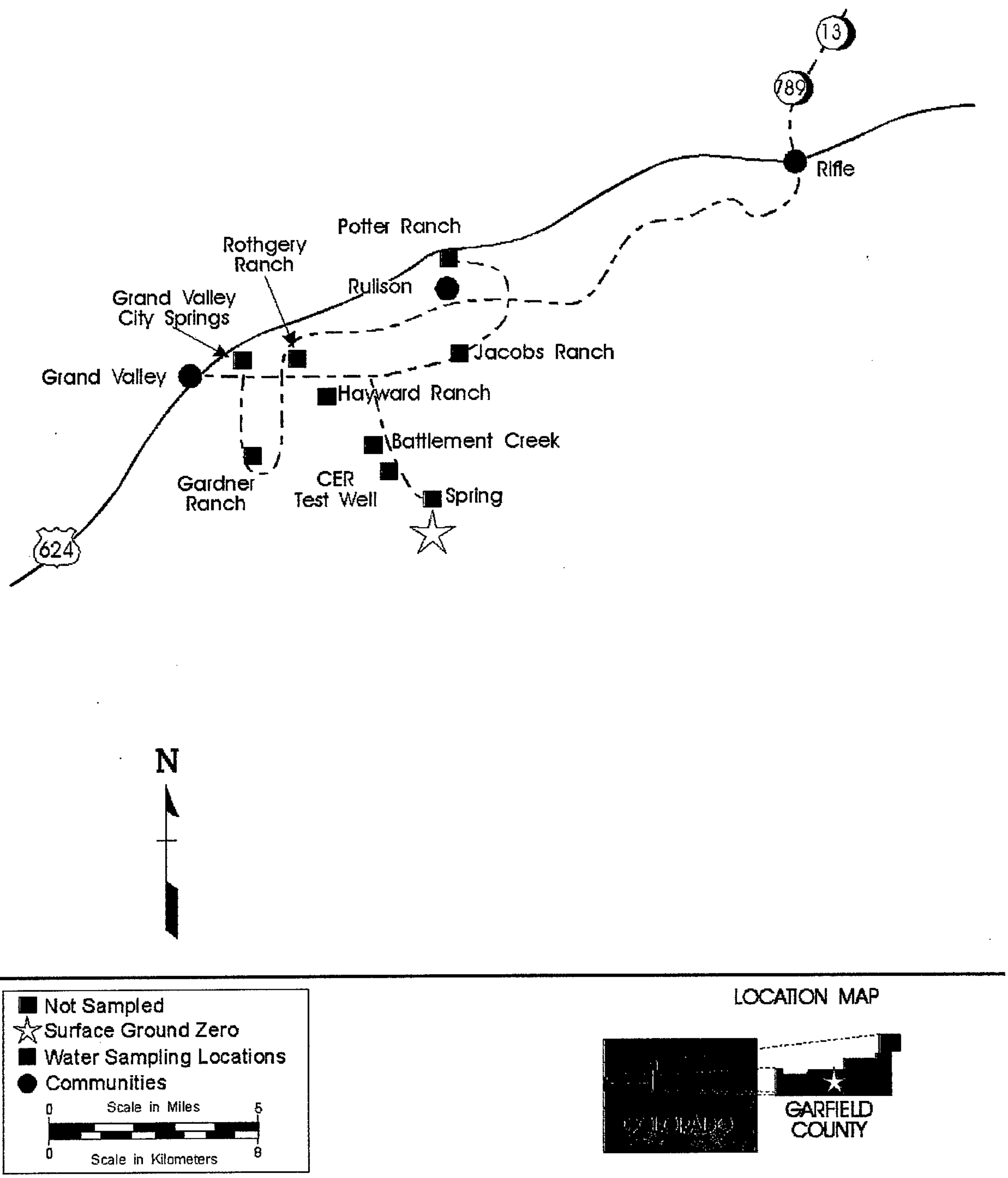


Figure 9.7 LTHMP Sampling Locations for Project RULISON - 1996

PROJECT RIO BLANCO

Project RIO BLANCO a joint government-industry test designed to stimulate natural gas flow was conducted under the Plowshare Program. The test was conducted on May 17, 1973, at a location between Rifle and Meeker Colorado. Three nuclear explosives with a total yield of 99 kt were emplaced at 1780-, 1920-, and 2040-m (5840-, 6299-, and 6693-ft) depths in the Ft. Union and Mesa Verde formations. Production testing continued to 1976 when cleanup and restoration activities were completed. Tritiated water produced during testing was injected to 1710 m (5610 ft) in a nearby gas well.

Samples were collected June 6 and 7, 1996, from the sampling sites shown in Figure 9.8. Only 13 of the 14 routine wells were sampled. No sample was collected from Brennan Windmill because the pump was inoperable. The sample taken from CER #1; was lost in transit. The routine sampling locations included three springs and six wells. Three of the wells are located near the cavity and at least two of the wells (Wells RB-D-01 and RB-D-03) were suitable for monitoring possible migration of radioactivity from the cavity.

No radioactive materials attributable to the RIO BLANCO test were detected in samples collected in the offsite areas during June 1996. Three of the eleven samples collected were above the MDC for tritium and the rest were less than the MDC. The tritium concentrations are well below 20,000 pCi/L level defined in the EPA National Primary Drinking Water Regulations (Title 40 C.F.R. 141). All samples were analyzed for presence of gamma-ray emitting radionuclides, and none were detected. The tritium concentrations were consistent with those collected previously at this site.

PROJECT GNOME

Project GNOME, conducted on December 10, 1961, near Carlsbad, New Mexico, was a multipurpose test performed in a salt formation. A slightly more than 3-kt nuclear explosive was emplaced at 371 m (1217 ft) depth in the Salado salt formation. Radioactive gases were unexpectedly vented during the test. The USGS conducted a tracer study in 1963, involving injection of 20 Ci ^{3}H, 10 Ci ^{137}Cs, 10 Ci ^{90}Sr, and 4 Ci ^{131}I (740, 370, 370, and 150 GBq, respectively) into Well USGS-8 and pumping water from Well USGS-4. During cleanup activities in 1968-69, contaminated material was placed in the test cavity access well. More material was slurried into the cavity and drifts in 1979.

Sampling at Project GNOME was conducted June 22 - 25, 1996. The routine sampling sites, depicted in Figure 9.9, include nine monitoring wells in the vicinity of GZ and the municipal supplies at Loving and Carlsbad, New Mexico. Stock tanks at wells PHS 8, PHS 9, and PHS 10, were sampled at the request of DOE. Tritium results from stock tank PHS 8 was greater than the MDC. The remaining two were below the MDC.

Tritium results greater than the MDC were detected in water samples from seven of the nine sampling locations in the immediate vicinity of GZ. Tritium activities in Wells DD-1, LRL-7, USGS-4, and USGS-8 ranged from 5 x 10^3 pCi/L (185 Bq/L) in Well LRL-7 to 6.8 x 10^7 pCi/L (2.5 MBq/L) in Well DD-1. Well DD-1 collects water from the test cavity; Well LRL-7 collects water from a sidedrift; and Wells USGS-4 and -8 were used in the radionuclide tracer study conducted by the USGS. None of these wells are sources of potable water.

In addition to tritium, ^{137}Cs and ^{90}Sr concentrations were observed in samples from Wells DD-1, LRL-7, and USGS-8 and ^{90}Sr activity was detected in Well USGS-4 as in previous years (see Table 9.1). The remaining two wells with detectable tritium concentrations were PHS-6 and -8, with results less than 0.02 percent of the DCG. No tritium was detected in the remaining sampling locations, including Well USGS-1, which the DRI analysis (Chapman and Hokett 1991) indicated is positioned to detect any migration of radioactivity from the cavity.

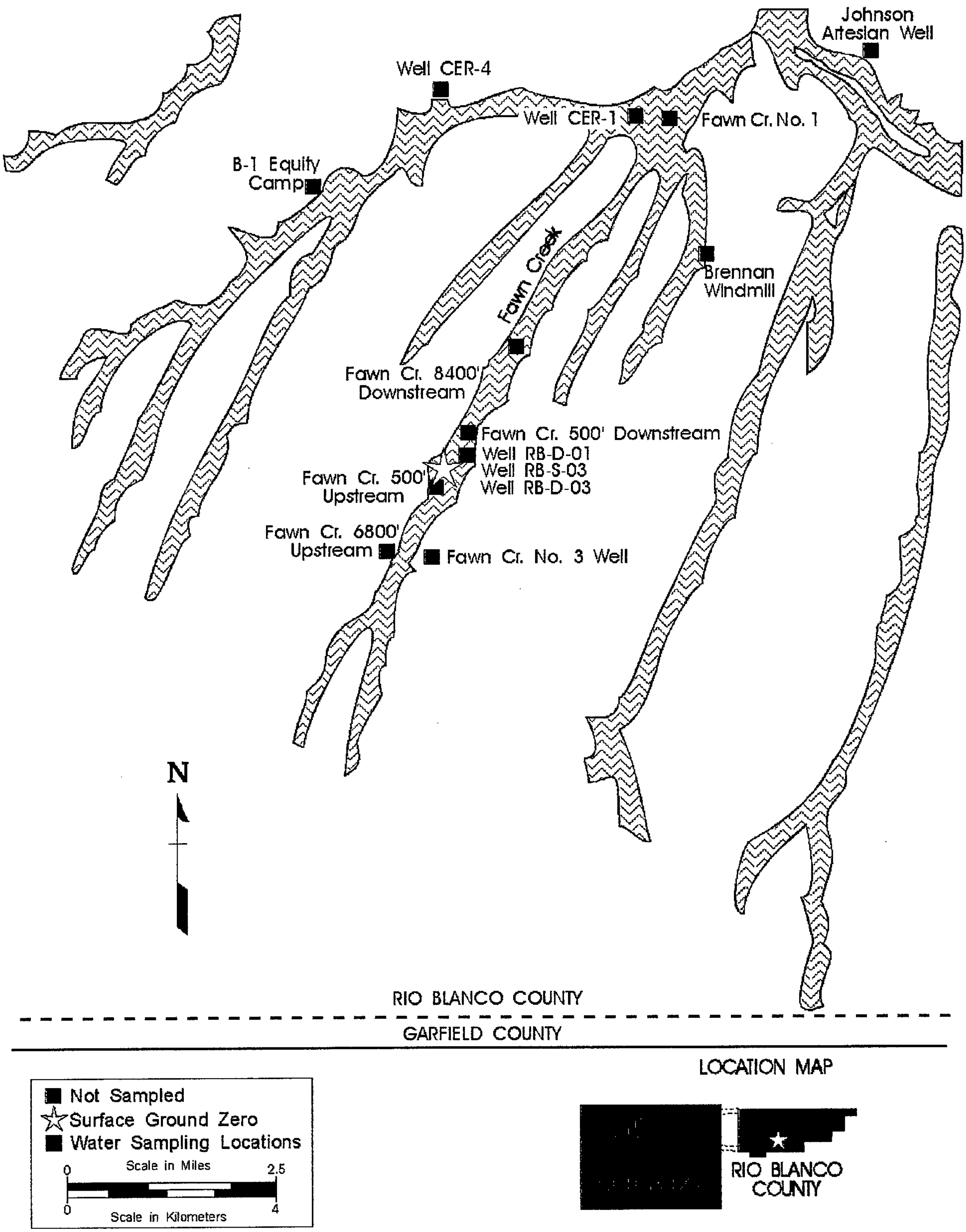


Figure 9.8 LTHMP Sampling Locations for Project RIO BLANCO - 1996

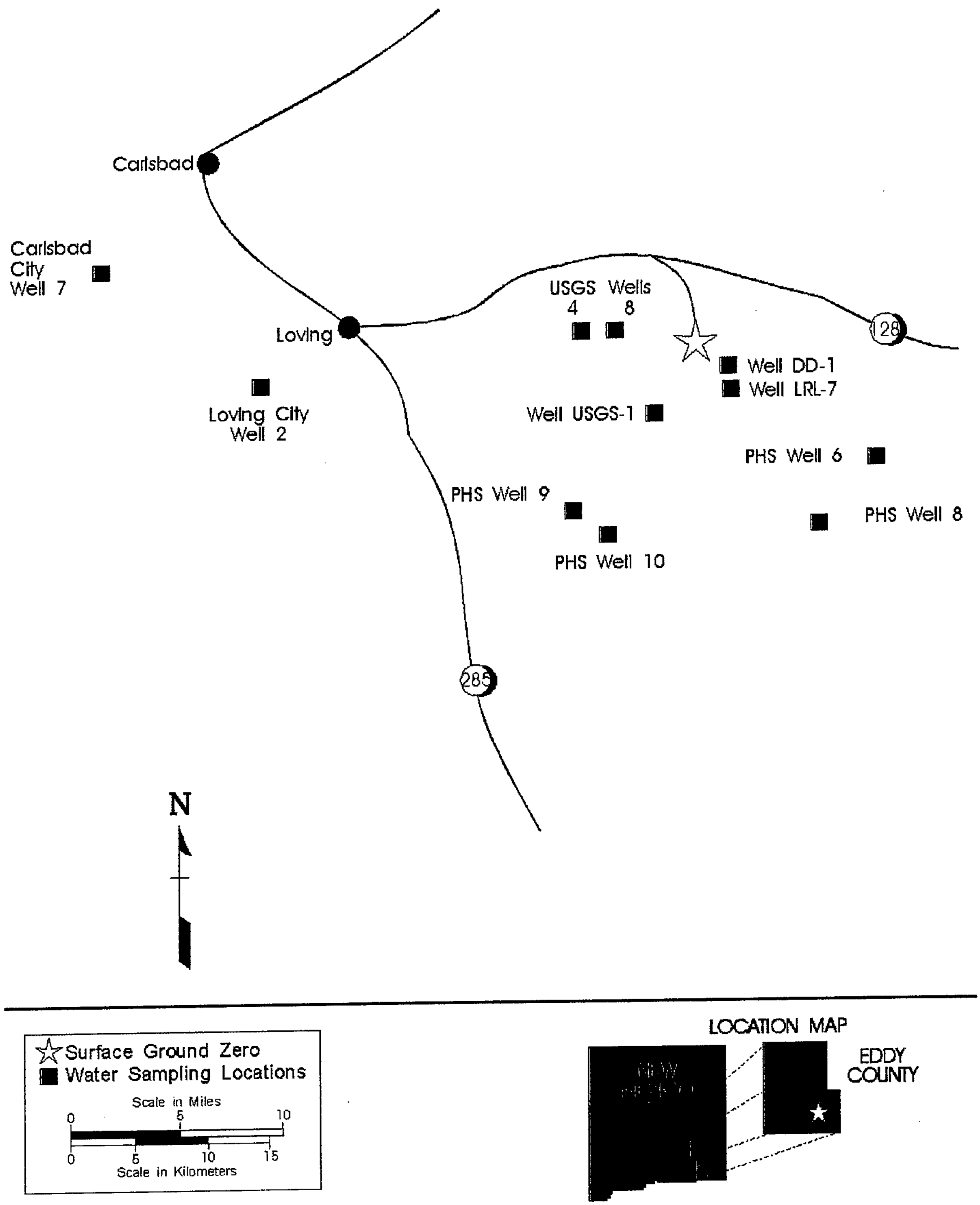


Figure 9.9 LTHMP Sampling Locations for Project GNOME - 1996

PROJECT GASBUGGY

Project GASBUGGY was a Plowshare Program test co-sponsored by the U.S. Government and El Paso Natural Gas. Conducted near Farmington, New Mexico, on December 10, 1967, the test was designed to stimulate a low productivity natural gas reservoir. A nuclear explosive with a 29-kt yield was emplaced at a depth of 1,290 m (4,240 ft). Production testing was completed in 1976 and restoration activities were completed in July 1978.

The principal aquifers near the test site are the Ojo Alamo sandstone, an aquifer containing non-potable water located above the test cavity and the San Jose formation and Nacimiento formation, both surficial aquifers containing potable water. The flow regime of the San Juan Basin is not well known, although it is likely that the Ojo Alamo sandstone discharges to the San Juan River 50 mi northwest of the GASBUGGY site. Hydrologic gradients in the vicinity are downward, but upward gas migration is possible (Chapman and Hokett 1991).

Sampling at GASBUGGY was conducted during June 1996. Only ten samples were collected at the designated sampling locations shown in Figure 9.10. The Bixler Ranch has been sealed up and the pond north of Well 30.3.32.343N was dry.

The three springs sampling sites yielded tritium activities of 26 ± 4.3 pCi/L for Bubbling Springs, 43 ± 4.0 pCi/L for Cedar Springs, and 54 ± 6.2 pCi/L for Cave Springs (0.96, 1.6, and 2.0 Bq/L, respectively), which were less than 0.2 percent of the DCG and similar to the range seen in previous years. Tritium samples from the three shallow wells were all below the average MDC.

Well EPNG 10-36, a gas well located 132 m (435 ft) northwest of the test cavity, with a sampling depth of approximately 1,100 m (3,600 ft), has yielded detectable tritium activities since 1984. The sample collected in June 1996 contained tritium at a concentration of 130 ± 5.2 pCi/L (4.8 Bq/L). The migration mechanism and route is not currently known, although an analysis by DRI indicated two feasible routes, one through the Printed Cliffs sandstones and the other one through the Ojo Alamo sandstone, one of the principal aquifers in the region (Chapman et al., 1996b). In either case, fractures extending from the cavity may be the primary or a contributing mechanism.

All gamma-ray spectral analysis results indicated that no man-made gamma-emitting radionuclides were present in any offsite samples. Tritium concentrations of water samples collected onsite and offsite are consistent with those of past studies at the GASBUGGY site.

PROJECT DRIBBLE (SALMON)

Project DRIBBLE was comprised of two nuclear and two gas explosive tests, conducted in the SALMON test site area of Mississippi under the Vela Uniform Program. The purpose of Project DRIBBLE was to study the effects of decoupling on seismic signals produced by nuclear explosives tests. The first test, SALMON, was a nuclear device with a yield of about 5.3 kt, detonated on October 22, 1964, at a depth of 826 m (2,710 ft). This test created the cavity used for the subsequent tests, including STERLING, a nuclear test conducted on December 3, 1966, with a yield of 380 tons, and the two gas explosions, DIODE TUBE (on February 2, 1969) and HUMID WATER (on April 19, 1970). The ground surface and shallow groundwater aquifers were contaminated by disposal of drilling muds and fluids in surface pits. The radioactive contamination was primarily limited to the unsaturated zone and upper, nonpotable aquifers. Shallow wells, labeled HMH wells on Figure 9.11, have been added to the area near surface GZ to monitor this contamination. In addition to the monitoring wells near GZ, extensive sampling of water wells is conducted in the nearby offsite area as shown in Figure 9.12.

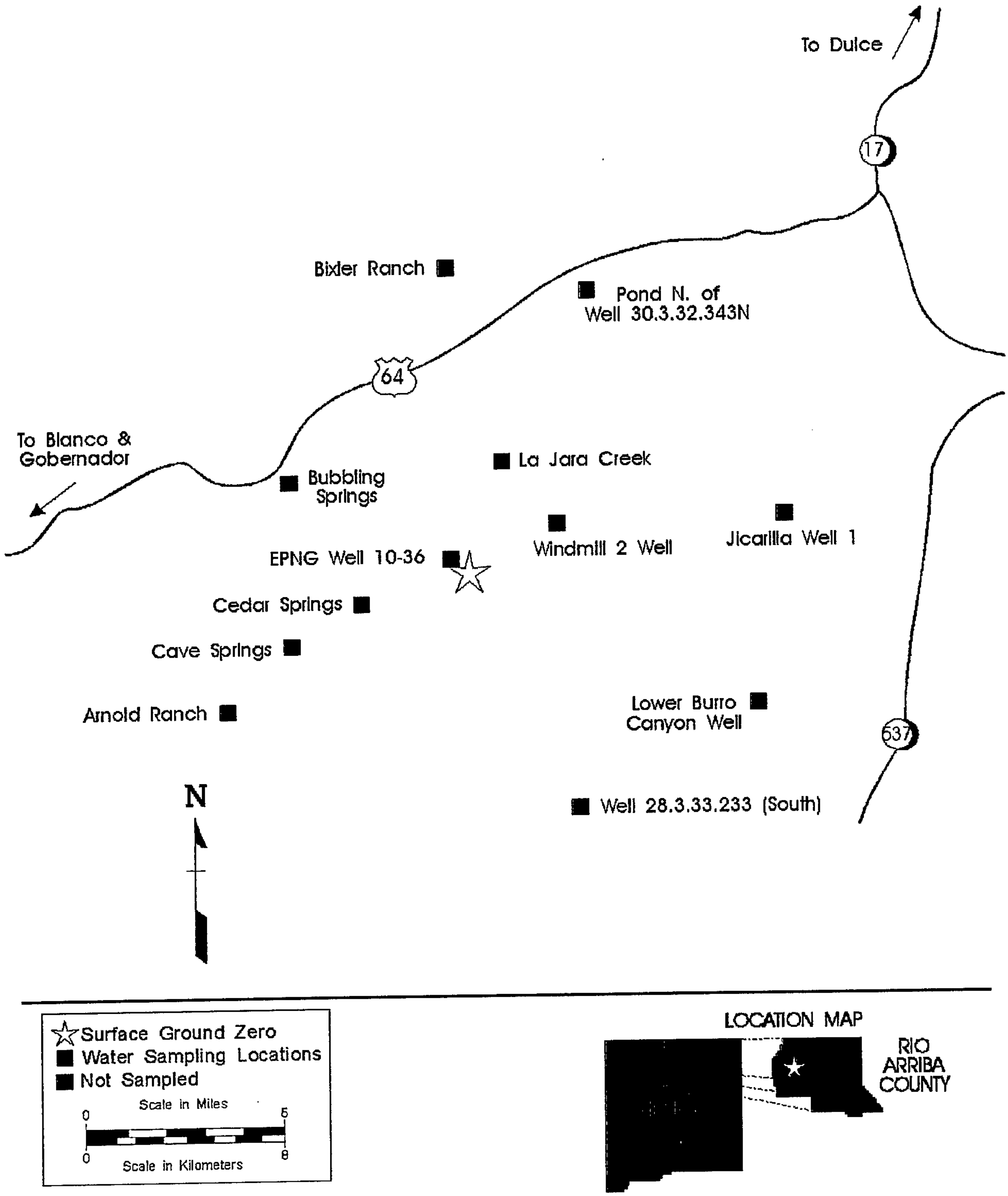


Figure 9.10 LTHMP Sampling Locations for Project GASBUGGY - 1996

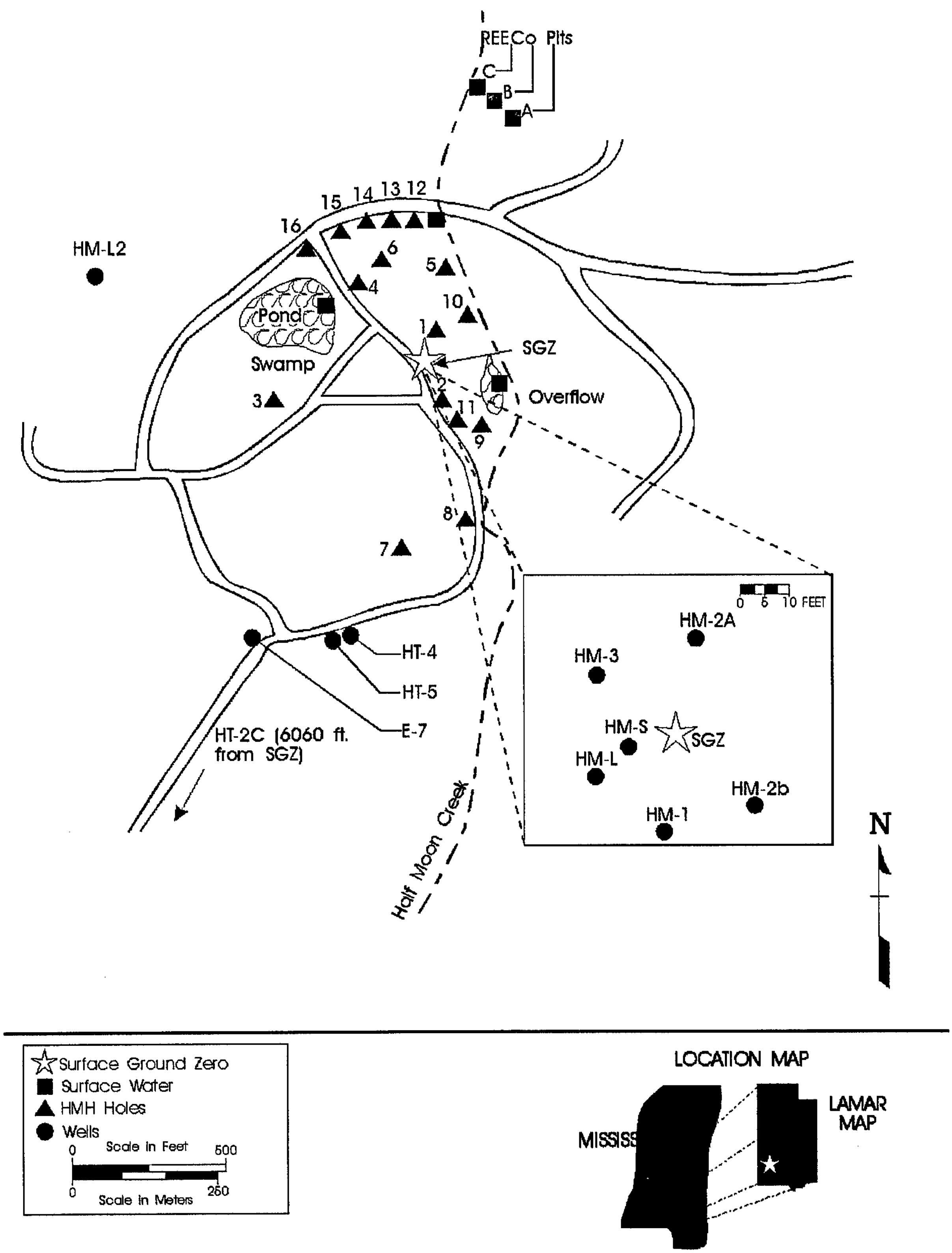


Figure 9.11 LTHMP Sampling Locations for Project DRIBBLE (SALMON), Near Ground Zero - 1996

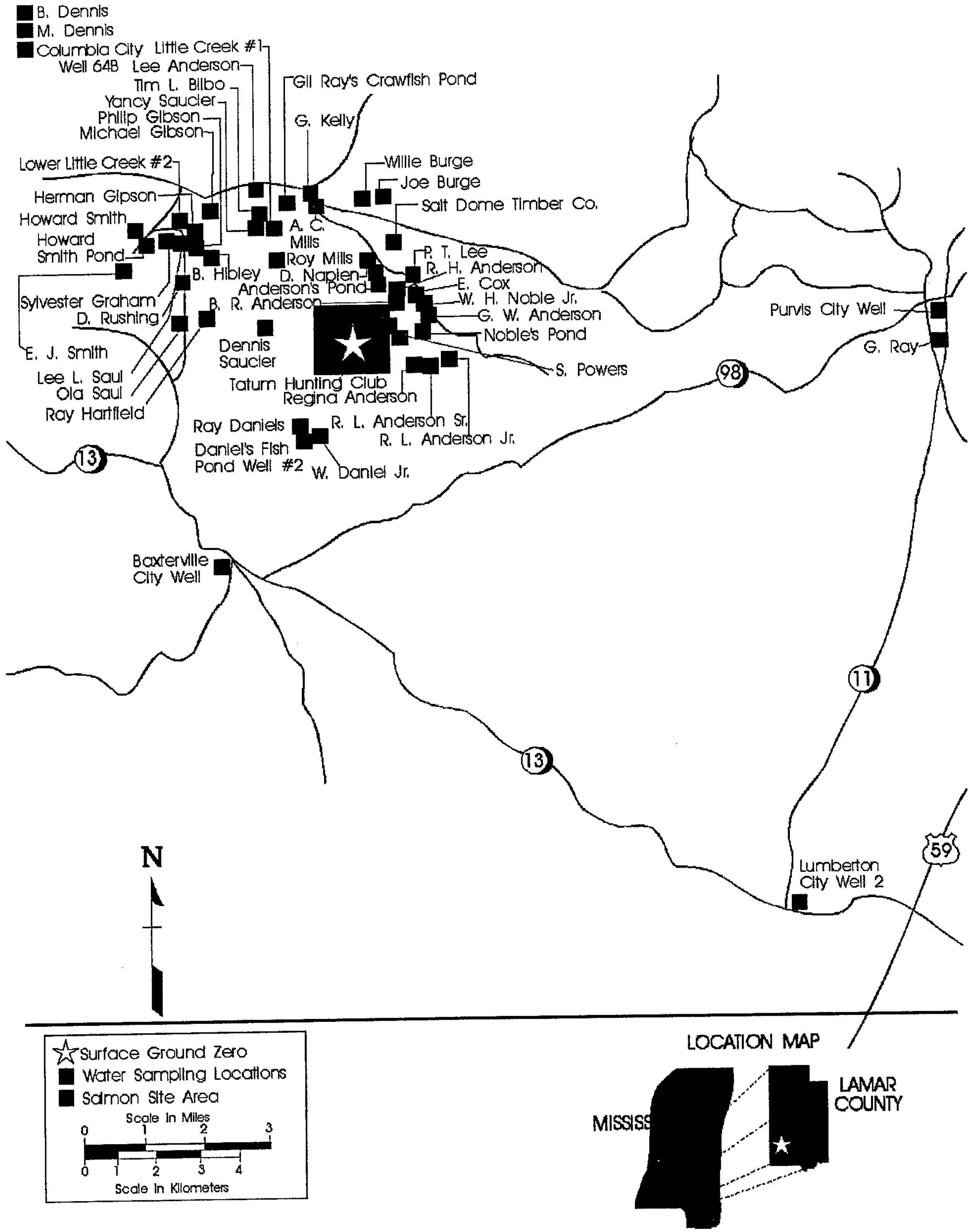


Figure 9.12 LTHMP Sampling Locations for Project DRIBBLE (SALMON), Towns and Residences - 1996

Of the twenty-eight wells that are sampled on the SALMON test site, five regularly have tritium values above those expected in surface water samples. In the 52 samples collected from offsite sampling locations, tritium activities ranged from less than the MDC to 28 pCi/L (1.0 Bq/L), 0.02 percent of the DCG. These results do not exceed the natural tritium activity expected in rainwater in the area. In general, results for each location were similar to results obtained in previous years. Long-term decreasing trends in tritium concentrations are evident only for those locations that had detectable tritium activity at the beginning of the LTHMP, such as in the samples from the Baxterville City Well depicted in Figure 9.13 and Well HM-S shown in Figure 9.14.

Due to the high rainfall in the area, the normal sampling procedure is modified for the shallow onsite wells as described in Section 9.5. Of the 32 locations sampled onsite (20 sites sampled twice), 14 yielded tritium activities greater than the MDC ineither the first or second sample. Of these, eight yielded results higher than normal background (approximately 60 pCi/L [2.2 Bq/L]) as shown in Table 9.1. The locations where the highest tritium activities were measured generally correspond to areas of known contamination. Decreasing trends are evident for the wells where high tritium activities have been found, such as Well HM-S depicted in Figure 9.14. No tritium concentrations above normal background values were detected in any offsite samples. Man-made gamma-ray emitting radionuclides were not detected in any sample collected in this study.

Results of sampling related to Project DRIBBLE (SALMON) are discussed in greater detail in Onsite and Offsite Environmental Monitoring Report, "Radiation Monitoring around SALMON Test Site," Lamar County, Mississippi, April 1996 (Davis 1996, available from R&IE-LV).

AMCHITKA ISLAND, ALASKA

Sampling is normally conducted biennially on odd years but a low budget prevented collection during 1995. The next sampling is scheduled for 1997.

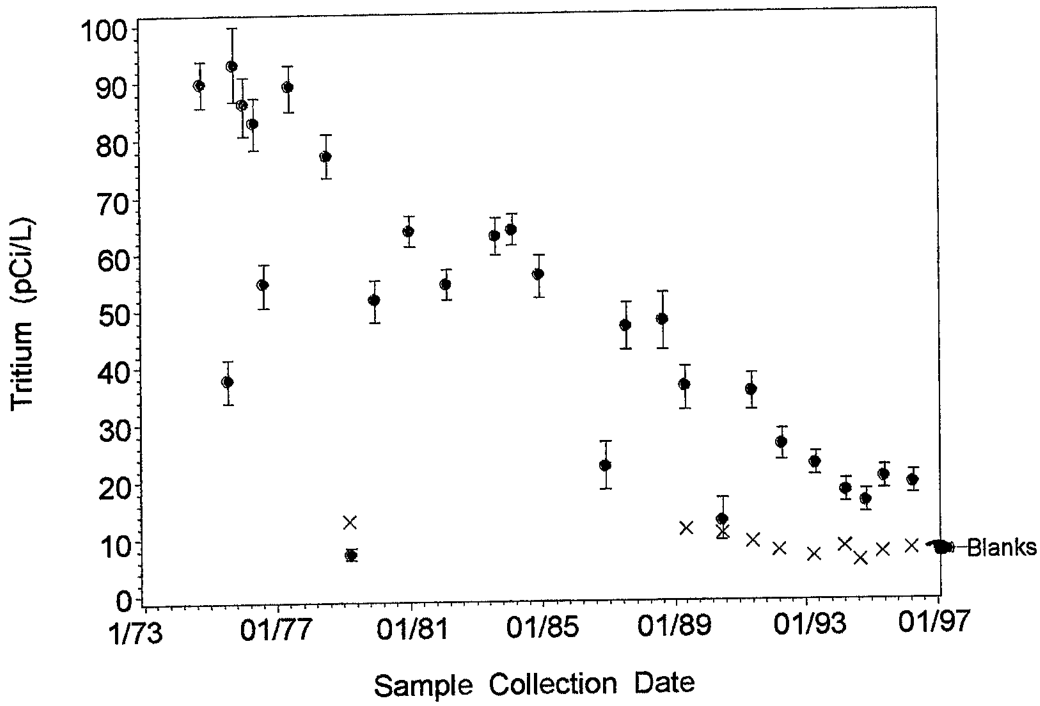


Figure 9.13 Tritium Results Trends in Baxterville, Public Drinking Water Supply - 1996

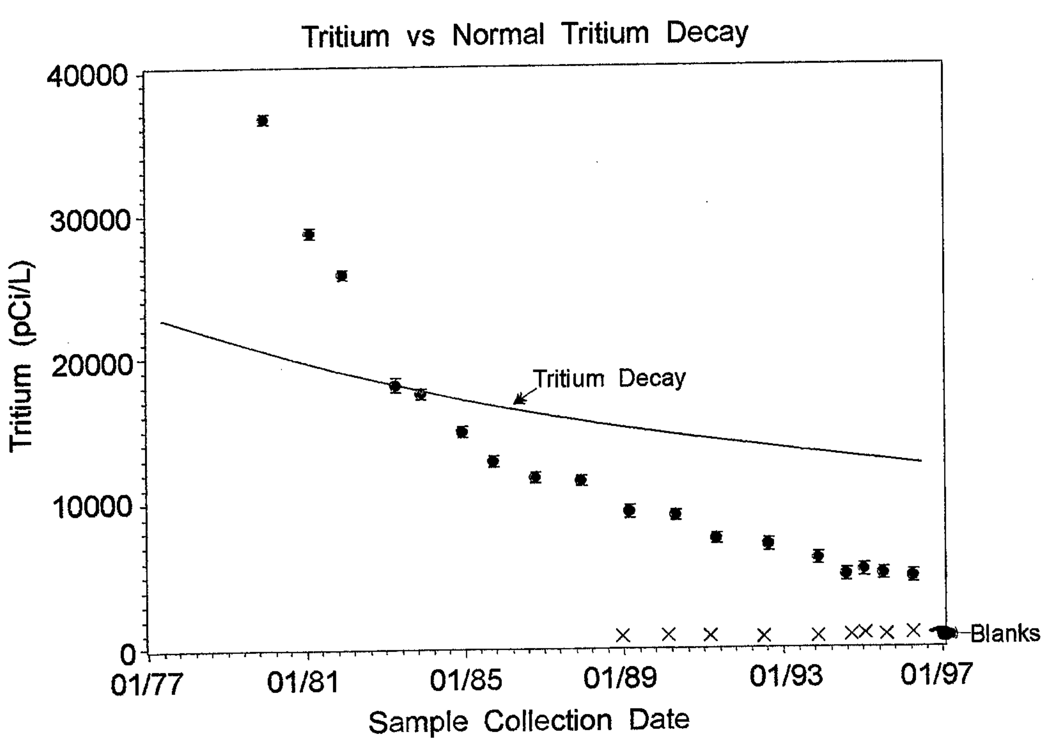


Figure 9.14 Tritium Results in Well HM-S, SALMON Site, Project DRIBBLE - 1996

Table 9.1 Locations with Detectable Man-Made Radioactivity - 1996[a]

Sampling Location	Radionuclide	Concentration $\times 10^{-9}$ µCi/mL
	NTS Onsite Network	
Well PM-1	^{3}H	200
Well UE-5n	^{3}H	45,000
Well UE-6d	^{3}H	700
Well UE-7ns	^{3}H	500
Well UE-18t	^{3}H	200
	Project DRIBBLE, Mississippi (B)	
Well HMH-1	^{3}H	2,100
Well HMH-2	^{3}H	230
Well HMH-5	^{3}H	1,200
Well HM-L	^{3}H	1,200
Well HM-S	^{3}H	4,400
Half Moon Creek Overflow	^{3}H	210
REECo Pit B	^{3}H	240
REECo Pit C	^{3}H	260
	Project GNOME, New Mexico	
Well DD-1	^{3}H	6.8×10^{7}
	^{90}Sr	10,000
	^{137}Cs	7.3×10^{5}
Well LRL-7	^{3}H	5,300
	^{90}Sr	2.1
	^{137}Cs	100
Well USGS-4	^{3}H	90,000
	^{90}Sr	3,500
	^{137}Cs	<5.6
Well USGS-8	^{3}H	77,000
	^{90}Sr	4,000
	^{137}Cs	6.8

(a) Only ^{3}H concentrations greater than 0.2 percent of the 4 mrem DCG are shown (i.e., greater than 1.6×10^{-7} µCi/mL [160 pCi/L {6 Bq/L}]). Detectable levels of other man-made radioisotopes are also shown.

Table 9.2 Groundwater Monitoring Parameters at the RWMS-5

Parameters Determining Suitability of Groundwater

Total and Dissolved Metals - As, Ba, Cd, Cr, Hg, Ag, Pb, Se
Total and Dissolved Gross Alpha/Beta

Parameters Establishing Water Quality

Chloride
Total and Dissolved Fe, Mn, Na
Phenols
Sulfate

Indicators of Contamination

pH
Conductivity
Total Organic Carbon
Total Organic Halogen

Additional Selected Parameters

Volatile Organics (8270)
Tritium

Table 9.3 NTS Facilities with RCRA Closure Plans

Area	Designation
Area 2	Bitcutter Shop & LLNL Post Shot Shop
Area 2	U-2bu Subsidence Crater
Area 3	U-3fi Injection Well (closed)
Area 6	Decontamination Facility Evaporation Pond
Area 6	Steam Cleaning Effluent Pond
Area 23	Building 650 Leachfield
Area 23	Hazardous Waste Trenches (closed)
Area 27	Explosive Ordnance Disposal Facility (closed)

Table 9.4 Summary of EPA Analytical Procedures - 1996

Type of Analysis	Analytical Equipment	Counting Period (Min)	Analytical Procedures	Sample Size	Approximate Detection Limit[a]
HpGe Gamma[b]	HpGe detector calibrated at 0.5 keV/ channel	100	Radionuclide concentration quantified from gamma spectral data by online computer program.	3.5L	Varies with radionuclides and detector used, ^{137}Cs 7 pCi/L
^{3}H	Automatic liquid scintillation counter	300	Sample prepared by distillation.	5-10 mL	300 to 700 pCi/L
^{3}H+ Enrichment	Automatic liquid scintillation counter	300	Sample concentrated by electrolysis followed by distillation.	250 mL	5 pCi/L

(a) The detection limit is defined as the smallest amount of radioactivity that can be reliably detected, i.e., probability of Type I and Type II error at 5 percent each (DOE 1981).
(b) Gamma spectrometry using a high purity intrinsic germanium (HpGe) detector.

Table 9.5 LTHMP Summary of Tritium Results for NTS Network - 1996

Tritium Concentration (pCi/L)

Location	Number	Maximum	Minimum	Arithmetic Mean	1 Sigma	Mean as %DCG[a]	Mean MDC
Test Well B	1	230	230	230	70	0.26	220
Test Well D	1	38	38	38	70	(b)	220
Well UE-6d	2	724	633	680	180	0.75	110
Well UE-6e	2	190	170	180	67	(b)	210
Well UE-7ns	2	496	466	480	160	0.53	210
Well UE-16f	1	8.1	8.1	8.1	1.7	0.01	5.5
Well UE-18r	2	230	28	130	67	(b)	210
Well UE-18t	1	220	220	220	3.5	0.24	7.0
Well 6A Army	2	3.3	-1.3	1.0	0.35	(b)	4.2
Well HTH-1	1	-77	-77	-77	70	(b)	230
Well PM-1	1	210	210	210	3.1	0.23	6.0
Well U3CN-5	0	Packer In Hole					
Well UE-1c	2	114	93	100	62	(b)	210
Well UE-15d		Pump Inoperative					
Well HTH "F"	1	93	93	93	65	(b)	240
Well C-1	1	270	270	270	68	0.30	220
Well 1 Army	1	-77	-77	-77	68	(b)	230
Well 5B	2	1.8	77	39	20	(b)	110
Well 5C	2	38	0.18	19	10	(b)	110
Well UE-5n	2	52500	38100	45000	13000	50	210
Well J-13	1	77	77	77	70	(b)	230

Note: Conventional and/or enrichment tritium analysis techniques were used for the samples summarized in this table.

(a) DCG - Derived Concentration Guide; established by DOE Order as 90,000 pCi/L for water.
(b) NA - Not applicable; percent of concentration guide is not applicable as the tritium result is less than the MDC or the water is known to be nonpotable.

Table 9.6 LTHMP Summary of Tritium Results for Wells Near the NTS - 1996

Location	Number of Samples[a]	Tritium Concentration (pCi/L) Max.	Min.	Mean	1 s.d.	% of DCG[b]	Mean MDC
Adaven							
Adaven Spring	2	28	19	22	1.7	0.02	5.1
	2	110	0	55	67	(c)	220
Alamo							
Well 4 City	1	--	--	-2.3	3.0	(c)	10
	1	--	--	39	68	(c)	220
Ash Meadows							
Crystal Pool	3	2.9	-2.9	-0.3	1.9	6.3	
	1	--	--	150	67	(c)	210
Fairbanks Spring	2	0.33	-1.1	-0.8	1.7	(c)	5.8
	0						
17S-50E-14cac	1	--	--	0.8	1.8	(c)	5.8
	1	--	--	0	68	(c)	220
Well 18S-51E-7db	1	--	--	1.0	1.4	(c)	4.3
	1	--	--	39	68	(c)	220
Beatty							
Low Level Waste Site	1	--	--	6.2	1.8	<0.01	5.9
	3	190	0	94	65	(c)	220
Tolicha Peak	1	--	--	-2.8	1.6	(c)	5.4
	3	110	0	57	66	(c)	220
11S-48E-1dd Coffer's	1	--	--	-0.6	1.6	(c)	5.4
	3	150	38	110	67	(c)	220
12S-47E-7dbd City	1	--	--	-1.0	2.2	(c)	7.5
	1	--	--	0	68	(c)	220
Younghans Ranch House Well	0						
	3	190	-77	59	67	(c)	220
Boulder City							
Lake Mead Intake	1	--	--	40	1.8	0.04	4.9
	0						
Clark Station							
TTR Well 6	0						
	2	56	39	48	67	(c)	220
Goldfield							
Klondike #2 Well	0						
	2	39	-38	0.5	140		220

(a) For each sample: First row is from enrichment analysis, second row from conventional analysis.

(b) DCG - Derived Concentration Guide. Established by DOE Order as 90,000 pCi/L.

(c) Not applicable. Percent of concentration guide is not applicable because the result is less than the MDC or the water is known to be nonpotable.

Table 9.6 (LTHMP Summary of Tritium Results for Wells Near the NTS - 1996, cont.)

Location	Number of Samples[a]	Tritium Concentration (pCi/L) Max.	Min.	Mean	1 s.d.	% of DCG	Mean MDC
Hiko							
Crystal Springs	1	--	--	-1.7	3.1	(c)	10
	1	--	--	0	68	(c)	220
Indian Springs							
Sewer Co. Well 1	0						
	1	--	--	0	68	(c)	220
Air Force Well 2	1	--	--	2.6	1.3	(c)	4.3
	1	--	--	0	68	(c)	220
Lathrop Wells							
15S-50E-18cdc City	1	--	--	-0.08	1.2	(c)	4.0
	1	--	--	0	68	(c)	220
Nyala							
Sharp's Ranch	1	--	--	2.0	3.2	(c)	10
	1	--	--	0	68	(c)	220
Oasis Valley							
Goss Springs	DRY						
Rachel							
Penoyer Culinary	1	--	--	1.2	1.4	(c)	4.8
	3	150	56	95	67	(c)	210
Tonopah							
City Well	0						
	2	39	-19	10	66	(c)	220
Warm Springs							
Twin Springs Ranch	1	--	--	0.6	1.3	(c)	4.3
	3	470	56	320	67	(c)	220

(a) For each sample: First row is from enrichment analysis, second row from conventional analysis.

(b) DCG - Derived Concentration Guide. Established by DOE Order as 90,000 pCi/L.

(c) Not applicable. Percent of concentration guide is not applicable because the result is less than the MDC or the water is known to be nonpotable.

Area 23 Tunnel Ponds

10.0 LABORATORY QUALITY ASSURANCE

It is the policy of U.S. Department of Energy Nevada Operations Office (DOE/NV) that all data produced for its environmental surveillance and effluent monitoring programs be of known quality. Therefore, a quality assurance (QA) program is used for collection and analysis of samples for radiological and nonradiological parameters to ensure that data produced by the laboratory meets customer- and regulatory-defined requirements. Data quality is assured through process-based QA, procedure-specific QA, data quality objectives (DQOs), and performance evaluation programs. The external QA program for radiological data consists of participation in the U.S. Department of Energy (DOE) Quality Assessment Program (QAP) administered by the DOE Environmental Measurements Laboratory (EML), and the Environmental Radiological Performance Evaluation Studies Program (PESP) conducted by the U.S. Environmental Protection Agency (EPA) National Exposure Research Laboratory in Las Vegas. The radiological external QA program also consists of participation in the DOE Laboratory Accreditation Program (DOELAP) Radiobioassay In-Vitro study administered by DOE; and the Oak Ridge National Laboratories (ORNL) radiobioassay study conducted by ORNL in Oak Ridge, Tennessee. The QA program for nonradiological data was accomplished by using commercial laboratories with appropriate certification or accreditation by state or government agencies.

The environmental surveillance program off the Nevada Test Site (NTS) was conducted by EPA's Radiation and Indoor Environment National Laboratory-Las Vegas (R&IE-LV). The QA program developed by R&IE-LV for the Offsite Radiological Safety Program (ORSP) meets all requirements of EPA policy, and also includes applicable elements of the DOE/NV QA requirements and regulations. The ORSP QA program defines DQOs, which are statements of the quality of data a decision maker needs to ensure that a decision based on that data is defensible.

10.1 POLICY

Environmental surveillance, conducted onsite by Bechtel Nevada (BN) and offsite by EPA's R&IE-LV, is governed by DOE QA policy as set forth in DOE Order 5700.6C. The Order outlines ten specific elements that must be considered for compliance with the QA policy. These elements are:

1. Program
2. Personnel Training & Qualification
3. Quality Improvement
4. Documents and Records
5. Work Processes
6. Design
7. Procurement
8. Data Acceptance and Review
9. Management Assessment
10. Independent Assessment

In addition, R&IE-LV meets the EPA policy which states that all decisions which are dependent on environmental data must be supported by data of known quality. EPA policy requires participation in a centrally managed QA Program by all EPA elements as well as those monitoring and measurement efforts supported or mandated through contracts, regulations, or other formalized agreements. Further, EPA policy requires participation in a QA Program by all EPA organizational units involved in environmental data collection. The QA policies and requirements of R&IE-LV are summarized in the "Quality Management Plan" (EPA/ORIA 1996). The QA policies and requirements specific to the ORSP are documented in the "Quality Assurance Program Plan for the Nuclear Radiation Assessment Division Offsite Radiation Safety Program" (EPA 1992 [in revision]). The requirements of these documents establish a framework for consistency in the continuing application of quality assurance standards and implementing procedures in support of the ORSP. Administrative and technical implementing procedures based on these QA requirements are maintained in appropriate manuals or are described in standard operating procedures (SOPs) of the R&IE-LV.

10.2 OVERVIEW OF THE LABORATORY QA PROGRAM

The BN Analytical Services Laboratory (ASL) implements the requirements of DOE Order 5700.6C, "Quality Assurance" through integrated quality procedures. The quality of data and results is ensured through both process-based and procedure-specific QA.

Procedure-specific QA begins with the development and implementation of SOPs which contain the analytical methodologies and required quality control samples for a given analysis. Personnel performing a given analysis are trained and qualified for that analysis, including the successful analysis of a quality control sample. Analysis-specific operational checks and calibration standards traceable to either the National Institute of Standards and Technology (NIST) or the EPA are required. Quality control samples, e.g., spikes, blanks, and replicates, are included for each analytical procedure. Compliance to analytical procedures is measured through procedure-specific assessments or surveillances.

An essential component of process-based QA is data review and verification to assess data usability. Data review requires a systematic, independent review against pre-established criteria to verify that the data are valid for their intended use. Initial data processing is performed by the analyst or health physicist generating the data. An independent review is then performed by another analyst or health physicist to ensure that data processing has been correctly performed and that the reported analytical results correspond to the data acquired and processed. Data checks are made for internal consistency, proper identification, transmittal errors, calculation errors, and transcription errors. Supervisory review of data is required prior to release of the data to sample management personnel for data verification. Data verification ensures that the reported results correctly represent the sampling and/or analyses performed, and includes assessment of quality control sample results. Data processing by sample management personnel ensures that analytical results meet project requirements. Data discrepancies identified during the data review and verification process are documented on data discrepancy reports (DDRs). DDRs are reviewed and compiled quarterly to discern systematic problems.

Process-based QA programs also include periodic operational checks of analytical parameters such as reagent water quality and storage temperatures. Periodic calibration is required for all measuring equipment such as analytical balances, analytical weights, and thermometers. The overall effectiveness of the QA program is determined through systematic assessments of analytical activities. Systematic problems are documented and corrective actions tracked through System Deficiency Reports.

Similar procedures and methodologies are used by R&IE-LV to ensure the quality of environmental radiological data collected off the NTS.

10.3 DATA AND MEASUREMENT QUALITY OBJECTIVES

DATA QUALITY OBJECTIVES

DQOs delineate the circumstances under which measurements are made, and define the acceptable variability in the measured data. DQOs are based on the decision(s) to be made, the range of sampling possibilities, what measurements will be made, where the samples will be taken, how the measurements will be used, and what calculations will be performed on the measurement data to arrive at the final desired result(s). Associated measurement quality objectives (MQO), which define acceptable variability in the measured data, are established to ensure the quality of the measurements.

DECISIONS TO BE MADE

The primary decisions to be made, based on radiological environmental surveillance measurements, are whether, due to NTS activities: (1) any member of the general public, outside the site boundaries, receives an effective dose equivalent (EDE) that exceeds regulatory limits; (2) there is detectable contamination of the environment; or (3) there is a biological effect. A potential EDE to a member of the public from NTS activities is much more likely to be due to inhalation or ingestion of radionuclides which have reached the person through one or more pathways, such as transport through the air (inhalation exposure), or through water and/or foodstuffs (ingestion exposure), than to be due to external exposure. A pathway may be quite complex; e.g., the food pathway could include airborne radioactivity falling on soil and plants, also being absorbed by plants, which are eaten by an animal, which is then eaten by a member of the public. At the NTS because of the depth of aquifers, negligible horizontal or vertical transport, lack of surface water flows and little rain, very sparse vegetation and animal populations, lack of food grown for human consumption, and large distances to the nearest member of the public, the airborne pathway is by far the most important for a possible EDE to a member of the public.

Decisions made based on nonradiological data are related to waste characterization, extent and characterization of spills, compliance with regulatory limits for environmental contaminants, and possible worker exposure(s).

RANGE OF SAMPLING POSSIBILITIES

Determination of the numbers, types and locations of radiological sampling stations is based on factors such as the location of possible sources, isotopes of concern, wind and weather patterns, the geographical distribution of human populations, the levels of risk involved, the desired sensitivity of the measurements, physical accessibility to sampling locations, and financial constraints. The numbers, types, and location of nonradiological samples are typically defined by regulatory actions on the NTS and are determined by environmental compliance or waste operations activities. Workplace and personnel monitoring to determine possible worker exposures is conducted by Industrial Hygienists and Health Physicists from the Environmental, Safety, Security and Health (ESS&H) Department.

MEASUREMENTS TO BE MADE

Radioanalyses are made of air, water, or other media samples to determine the types and amounts of radioactivity in them. These measurements are then converted to radioactivity concentrations by dividing by the sample volume or weight, which is measured separately. Nonradiological inorganic or organic constituents in air, water, soil, and sludge samples are analyzed and reported by commercial laboratories under contract to BN. Methods and procedures used to measure possible worker exposures to nonradiological hazards are defined by Occupational Safety and Health Administration or National Institute of Occupational Safety and Health protocols. Typical contaminants for which ESS&H personnel collect samples and request analyses are asbestos, solvents, and welding metals. Sample media which are analyzed include urine, blood, air filters, charcoal tubes, and bulk asbestos.

SAMPLING LOCATIONS

The locations of routine radiological environmental surveillance sampling both on and off the NTS are described in Chapters 4 and 5 of this report. Onsite sampling methodologies are described in BN's Environmental Management SOPs, and offsite methodologies by similar R&IE-LV procedures. The locations of nonradiological environmental sampling and monitoring are determined through site remediation and characterization activities and by permit requirements.

USE OF THE MEASUREMENTS

There are several techniques to estimate the EDE to a member of the public. One technique is to measure the radionuclide concentrations at the location(s) of interest and use established methodologies to estimate the EDE a person at that location could receive. Another technique is to measure radionuclide concentrations at specific points within the site and to use established models to calculate concentrations at other, offsite locations of interest. The potential EDE to a person at such a location could then be estimated. This second technique is the one used for most of the environmental surveillance data measured at the NTS.

CALCULATIONS TO BE PERFORMED

The EDE of greatest interest is the EDE to the maximally exposed individual (MEI). The MEI is located where, based on measured radioactivity concentrations and distances from all contributing NTS sources, the calculational model gives the greatest potential EDE for any member of the public. The assumptions used in the calculational model are conservative; i.e., the calculated EDE to the MEI most certainly exceeds the EDE any member of the public would actually receive. The model used at the NTS is EPA's CAP88-PC, a wind dispersion model approved for this purpose.

MEASUREMENT QUALITY OBJECTIVES

MQOs are commonly described in terms of representativeness, comparability, completeness, precision, and accuracy. Although the assessment of the first two characteristics must be essentially qualitative, definite numerical goals may be set and quantitative assessments performed for the latter three.

REPRESENTATIVENESS

Representativeness is the degree to which a sample is truly representative of the sampled medium, i.e., the degree to which measured analytical concentrations represent the concentrations in the medium being sampled (Stanley and Verner 1985). Representativeness also refers to whether the locations and frequency of sampling are such that calculational models will lead to a correct estimate of potential EDE to a member of the public when measured radioactivity concentrations are put into the model. An environmental monitoring plan for the NTS, DOE/NV/10630-28, "Environmental Monitoring Plan, Nevada Test Site and Support Facilities" has been established to achieve representativeness for environmental data. Factors which were considered in designing this monitoring plan include locations of known and potential sources, historical and operational knowledge of isotopes and pathways of concern, hydrological, and topographical data, and locations of human populations.

COMPARABILITY

Comparability refers to the degree of confidence and consistency we have in our analytical results, or defined as "the confidence with which one data set can be compared to another" (Stanley and Verner 1985). To achieve comparability in measurement data, sample collection and handling, laboratory analyses, and data analysis and validation are performed in accordance with established SOPs. Standard reporting units and a consistent number of significant digits are used. Instruments are calibrated using NIST-traceable sources. Each batch of field samples is accompanied by a spiked sample with a known quantity of the compound(s) of interest. Extensive QA measures are used for all analytical processes. In addition, comparability is attained through comparison of external performance audit results to those achieved by other laboratories participating in the EPA PESP.

COMPLETENESS

Completeness is defined as the percentage of samples collected versus those which had been scheduled to be collected, or the percentage of valid analysis results versus the results which would have been obtained if all samples had been obtained and correctly analyzed. Realistically, samples can be lost during shipping, handling, preparation, and analysis, or not collected as scheduled. Also data entry or transcription errors can be made. The BN completeness objectives for all radiological samples and analyses have been set at 90 percent for sample collection and 85 percent for analyses, or 75 percent overall. R&IE-LV's completeness objective for the Long-Term Hydrological Monitoring Program is 80 percent and for the other networks is 90 percent.

Completeness for inorganic and organic analyses is based on the number of valid results received versus the number requested.

PRECISION

Precision refers to "the degree of mutual agreement characteristic of independent measurements as the result of repeated application of the process under specified conditions" (Taylor 1987). Practically, precision is determined by comparing the results obtained from performing the same analysis on split samples, or on duplicate samples taken at the same time from the same location, maintaining sampling and analytical conditions as nearly identical as possible. Precision for samples is determined by comparing results for duplicate samples of particulates in air, tritiated water vapor, noble gases, and some types of water samples. For thermoluminescent dosimeters (TLDs), precision is assessed from variations in the three $CaSO_4$ elements of each TLD. Precision is expressed quantitatively as the percent relative standard deviation (%RSD), i.e., the ratio of the standard deviation of the measurements being compared to their mean converted to percent. The smaller the value of the %RSD, the greater is the precision of the measurement. The precision objectives are shown in Table 10.1. They are a function of the concentration of radioactivity in the samples; i.e., the analysis of samples with concentrations near zero will have low precision while samples with higher concentrations will have proportionately higher precision.

ACCURACY

Accuracy refers to how well we can measure the true value of a given quantity and can be defined as "the degree of agreement of a measured value with the true or expected value of the quantity of concern" (Taylor 1987). For practical purposes, assessments of accuracy for ASL are done by performing measurements on special quality assurance samples prepared, using stringent quality control, by laboratories which specialize in preparing such samples. The values of the activities of these samples are not known by the staff of the ASL until several months after the measurements are made and the results sent back to the quality assurance laboratory. These sample values are unknown to the analysts and serve to measure the accuracy of the analytical procedures. The accuracy of these measurements, which is assumed to extend to other similar measurements performed by the laboratory, may be defined as the ratio of the measured value divided by the true value, expressed as a percent. Percent bias is the complement of percent accuracy, i.e., %Bias = 100 - % accuracy. The smaller the percent bias, the more accurate are the measurements. Table 10.2 shows the accuracy objectives of the ASL and of the R&IE-LV.

Measurements of sample volumes should be accurate to ± 5 percent for aqueous samples (water and milk) and to ± 10 percent for air and soil samples. The sensitivity of radiochemical and gamma spectrometric analyses must allow no more than a 5 percent risk of either a false negative or false positive value. Control limits for accuracy, monitored with matrix spike samples, are required to be no greater than ± 20 percent for all gross alpha and gross beta analyses and for gamma spectrometric analyses.

Both the R&IE-LV and ASL participate in several interlaboratory performance evaluation (PE) programs such as EPA's PESP and EML's QAP and the DOELAP for TLDs. The ASL also participates in two bioassay programs, DOELAP and ORNL.

The accuracy of the TLDs is tested every two or three years by DOELAP. This involves a three-part, single blind, performance testing program followed by an independent onsite assessment of the overall program. Both BN and R&IE-LV participate in this program.

Once the data have been finalized, they are compared to the MQOs. Completeness, accuracy, and precision statistics are calculated. If data fail to meet one or more of the established MQOs, they may still be used in data analysis; however, the data and any interpretive results must be qualified. Current and historical data are maintained in an access-controlled database.

All sample results exceeding the traditional natural background activity range are investigated. If data are found to be associated with a non-environmental condition, e.g., a check of the instrument using a calibration source, the data are flagged and are not included in calculations of averages, etc. Only data verified to be associated with a non-environmental condition are flagged; all other data are used in calculation of averages and other statistics, even if the condition is traced to a source other than the NTS.

10.4 RESULTS FOR COMPLETENESS, PRECISION, AND ACCURACY

Summary data for completeness, precision, and accuracy are provided in Tables 10.3 to 10.6. Complete data used in these MQO's for 1995 may be found in the "Environmental Data Report for the Nevada Test Site - 1996" (DOE/NV/11718-138, in prep.).

COMPLETENESS

The analysis completeness data for calendar year 1996 are shown in Table 10.3. These percentages represent all analyses which were carried to completion, and include some analyses for which the results were found to be invalid for other reasons. Had objectives not been met for some analyses, other factors would be used to assess acceptability, e.g., fit of the data to a trend or consistency with results from samples collected before and after.

The completeness of MQOs for the onsite networks were met or exceeded in all cases. For the offsite networks, the MQOs were met or exceeded except for the high volume and pressurized ion chamber networks, where field equipment malfunction prevented complete collections.

PRECISION

From replicate samples collected and analyzed throughout the year, the %RSD was calculated for various types of analyses and sampling media. The results of these calculations are shown in Table 10.4 for both the onsite and offsite networks. In addition to examination of %RSDs for individual duplicate pairs, an overall precision estimate was determined by calculating the pooled standard deviation, based on the algorithm given in Taylor (1987). To convert to a unitless value, the pooled standard deviation was divided by the grand mean and multiplied by 100 to yield a %RSD. The table presents the pooled data and estimates of overall precision. The pooled standard deviations and %RSD indicate the estimated achieved precision for samples.

For the R&IE-LV, the samples not meeting the precision MQO were low activity, air particulate samples in which ^{7}Be was detected. The precision data for all other analyses were well within their respective MQOs. The R&IE-LV data presented in Table 10.4 include only those duplicate pairs that exceeded the minimum detectable concentration (MDC).

For the ASL, there was one analysis that failed to meet the MQO, namely, gross alpha in air. Subsequent investigation of the analytical procedure revealed equipment and procedure problems for part of the year that have since been corrected. A reason for the low precision in some of the analyses was the low activity in these environmental samples, e.g., for tritium in air, the few that were useful for calculation of precision barely exceeded the MDC.

ACCURACY

The ASL and R&IE-LV accuracy objectives were measured through participation in the interlaboratory comparison and quality assessment programs discussed below.

RADIOLOGICAL PERFORMANCE EVALUATION RESULTS

The external radiological PESP consisted of participation in the QAP conducted by DOE/EML and the PESP conducted by EPA. These programs serve to evaluate the performance of the radiological laboratory and to identify problems requiring corrective actions.

Summaries of the 1996 results of the interlaboratory performance evaluation and quality assessment programs conducted by the EPA and DOE/EML are provided in Tables 10.5 and 10.6. The last column in each table (percent Bias) is the accuracy of analysis and may be compared to the objectives listed in Table 10.2. The individual radionuclide recoveries are listed in tables which are being published separately in the "Environmental Data Report for the Nevada Test Site - 1996" (DOE/NV/11718-138, in prep.).

Accuracy, as percent difference or percent bias is calculated by:

$$\%BIAS = \left(\frac{C_m - C_a}{C_a}\right) 100$$

where:

$\%BIAS$ = *percent bias*
C_m = *measured sample activity*
C_a = *known sample activity*

The R&IE-LV failed the accuracy MQO in only 1 of the 24 analyses attempted in the EPA PE Study. In the EML QAP, 14 of the 42 analyses performed exceeded the DQO of ± 20 percent. In 1996, R&IE-LV maintained accreditation by DOELAP for the personnel TLD program. Quality Assurance checks are routinely performed to ensure compliance with applicable performance standards. Software and hardware changes have been implemented that will increase the Panasonic TLD systems report capability and reader sensitivity to lower energy radiation. When final performance testing and accreditation is completed, the new hard- and software will then be used for dose of record.

BN's ASL results exceeded the three normalized deviation limits in 7 of the 58 analyses attempted. The MQOs for accuracy in analysis of DOE/EML samples were not met in only 2 of the 25 samples supplied.

CORRECTIVE ACTIONS IMPLEMENTED IN RESPONSE TO PERFORMANCE EVALUATION PROGRAMS

BN results were generally within the control limits determined by the program sponsors. Results which were not within acceptable performance limits were investigated, and corrective actions taken to prevent reoccurrence. Corrective actions included a new process for preparing and including quality control samples, training of analysts, and an improved tracking system for PE samples.

In the R&IE-LV, the 1996 results that did not meet analysis criteria were investigated to determine the cause of the reported error. Corrective actions were implemented, including the addition of personnel to perform reviews on data entry and counting system output to detect and correct potential operator error.

COMPARABILITY

The EPA PESP and the EML/QAP provide results to each laboratory participating in each study that include a grand average for all values, excluding outliers. A normalized deviation statistic compares each laboratory's result (mean of three replicates) to the known value and to the grand average. If the value of this statistic (in multiples of standard normal deviate, unitless) lies between control limits of -3 and +3, the accuracy (deviation from known value) or comparability (deviation from grand average) is within normal statistical variation.

Data from the 1996 intercomparison studies for all variables measured were compared with the grand average to calculate a normalized deviation for the R&IE-LV results. With the exception of one gamma spectroscopy sample, all analyses were within three standard normal deviate units of the grand mean, and most were within two normalized deviate units. This indicates acceptable comparability of the R&IE-LV results with the 98 to 186 laboratories participating in the EPA PESP.

One of the two EML studies for 1996 was reported outside of acceptable limits for gamma spectroscopy in both air and water matrices. Follow up investigation established a volume data entry error in both cases. Corrective actions were implemented.

R&IE-LV began participating in the DOE Mixed Analyte Performance Evaluation Program (MAPEP) during 1996. Analysis of water and soil matrix samples was performed with all analytical results within the acceptable bias limit of ±20 percent.

The onsite ASL's results in the EML QAP were acceptable. There were only two instances in which the ASL results were greater than the MQO. The EPA PESP includes a grand average (average result from all participating laboratories, less outliers) in its report to participants. Using the formula for percent bias described above, the percent bias of the ASL results as compared to the grand average was calculated for each analysis. The outcome for this calculation did not differ from the accuracy results reported above. Thus comparability of the ASL results is the same as its accuracy on PE samples as reported above.

SPIKE AND REAGENT BLANK DATA

Reagent blanks prepared by ASL were analyzed for the same radionuclides as the samples. All 242 reagent blank results wereless than the MDC of the analysis for which the blanks were designed.

A similar number of spike samples were prepared by ASL. The accuracy (as percent recovery) varied from 67 to 117 percent for the eight different analyses. The standarddeviations of these percent recoveries is a measure of precision. These ranged from 3.5 to 14.6 percent for seven of the analyses. The uranium analysis procedure had a standard deviation of 58 percent, because of three spikes that were just barely above the MDC.

Table 10.1 Precision Objectives Expressed as Percents

Analysis	ASL Conc. > 10 MDC	4 MDC ≤ Conc.10 ≤ MDC
Gross Alpha	±30	±60
Gross Beta	±30	±60
Gamma Spectrometry	±30	±60
Scintillation Counting	±30	±60
Alpha Spectrometry	±20	±50
Noble Gas Analysis	±30	±40

Note: The precision objective for TLDs at environmental levels is 10 percent.

	R&IE-LV	
Conventional Tritium	±10	±30
Strontium (in milk)	±10	±30
Thorium	±10	±30
Uranium	±10	±30
Enriched Tritium	±20	±30
Strontium (in other media)	±20	±30
Plutonium	±20	±30

Table 10.2 Accuracy Objectives Expressed as Percent Bias

Analysis	ASL Conc. > 10 MDC	4 MDC ≤ Conc.10 ≤ MDC
Gross Alpha	±20	±50
Gross Beta	±20	±50
Gamma Spectrometry	±20	±50
Scintillation Counting	±20	±50
Alpha-Spectrometry	±20	±50
Noble Gas Analysis	±30	±60

Note: The objective for TLDs is 20 percent for exposures <10 mR and 10 percent for ≥10 mR.

	R&IE-LV	
Tritium, Conventional	±10	±30%
Strontium (Milk)	±10	±30%
Thorium	±10	±30%
Uranium	±10	±30%
Tritium, Enriched	±20	±30%
Strontium (other media)	±20	±30%
Plutonium	±20	±30%
TLDs	Meet DOELAP Criteria	

Table 10.3 Analysis Completeness Data for Calendar Year - 1996

Analysis	Medium	Completeness Percent BN	Completeness Percent R&IE-LV
Gross Alpha/Beta	Low Volume Particulate Air Filter	97.3	95.5
Plutonium	High Volume Particulate Air Filter	--	85.3
Plutonium	Low Volume Particulate Air Filter	97.8	--
Gamma Spectrometry	Low Volume Particulate Air Filter	98.0	95.5
Gamma Spectrometry	Low Volume Charcoal Air Filter	(a)	95.5
Gamma Spectrometry	High Volume Particulate Air Filter	(a)	85.3
Tritiated Water	Air	90.6	(a)
Krypton-85	Air	81.4	(a)
Gross Alpha	Potable Water Taps	100	
Gross Beta	Potable Water Taps	100	(a)
Gamma Spectrometry	Potable Water Taps	100	(a)
Tritiated Water	Potable Water Taps	100	(a)
Plutonium	Potable Water Taps	100	(a)
Gross Beta	Wells, Reservoirs, Springs, Ponds	95.3	(a)
Plutonium	Wells, Reservoirs, Springs, Ponds	95.3	(a)
Gamma Spectrometry	Wells, Reservoirs, Springs, Ponds	98.5	98.0
Tritiated Water	Wells, Reservoirs, Springs, Ponds	95.3	97.8
Strontium-90	Wells, Reservoirs, Springs, Ponds	98.5	(a)
Gross Alpha	Potable Wells and Taps	96.9	(a)
Tritium	Milk	(a)	93.5
Strontium	Milk	(a)	93.5
Pressurized Ion Chamber	Ambient Radiation	(a)	73.9
TLDs, Environmental	Ambient Radiation	90.2	93.9
TLDs, Personnel	Ambient Radiation	(a)	86.3

(a) Analyses not performed.

Table 10.4 Precision Estimates from Replicate Sampling - 1996

Analysis	Number of Replicate Analyses	Precision Estimate % RSD
ASL		
Gross Beta in Air	50	7.0
Gamma in Air	48	1.6
Gross Alpha in Air	28	50.7
Gross Alpha in Potable Water	28	5.1
Gross Beta in Potable Water	35	15.1
HTO in Tunnel Effluent	7	6.4
Pu in Tunnel Effluent	14	1.5
R&IE-LV		
Gross Alpha in Air	84	28.5
Gross Beta in Air	145	18.0
Gamma Spectrometry (Low-Vol ^{7}Be)	14	36.2
Gamma Spectrometry (Hi-Vol ^{7}Be)	11	46.8
Tritium in Water (enriched)	12	7.9
Tritium in Water (unenriched)	2	26.2

Table 10.5 Accuracy of R&IE-LV Radioanalyses (EML QAP and PESP) - 1996

Water Samples Range of Results - pCi/L

Analysis	No.	PESP	R&IE-LV	% Bias
Gross Alpha	5	10 - 75	12 - 71	-4.2 - 20
Gross Beta	5	7 - 167	13 - 162	-3.2 - 13
Gamma Spec.[a]	5	10 - 745	12 - 6300	-9 - 790
Strontium	2	10 - 25	12 - 24	-4 - 23
Alpha Spec.	5	5 - 58	5 - 55	-6 - 3
Tritium	2	10880 - 22000	10800 - 21300	3.1 - -0.4

(a) One group of samples submitted for gamma spectrometric evaluation included an incorrect dilution factor, thus a reporting error. Positive % Bias for the remaining samples was a maximum of 12 for the 1996 reporting period.

% Bias Range for Analysis of EML QAP Samples

Analysis	No.	Air	Soil	Vegetation	Water
Plutonium	13	-3.1 - 6.5	-30 - 1.9	-11 - 13	0.5 - 1.3
Uranium	4	(a)	(a)	(a)	0.8 - 20
Strontium	5	(a)	-100	-100 - -91	-11 - 15
Tritium	2	(a)	(a)	(a)	-16 - -11
Gamma Spec.	19	-5.2 - 18	(a)	(a)	25 - 28

(a) No sample.

% Bias Range for Analysis of MAPEP QAP Samples

Analysis	No.	Air	Soil	Vegetation	Water
Plutonium	4	(a)	1.4 - 3.9	(a)	-4.0 - -4.8
Strontium	1	(a)	(a)	(a)	-15
Gamma Spec.	3	(a)	(a)	(a)	-5.6 - 4.6

(a) No sample.

Table 10.6 Accuracy of ASL Radioanalyses (EPA PESP and EML QAP) - 1996

Analysis Water Samples	No.	BN/ASL Average pCi/L	EPA QA Normalized Deviation[a] Known	Grand Avg.
^{60}Co	5	15.7 - 109	0.23 - 3.46[b]	0.15 - 3.77[b]
^{65}Zn	2	48.7 - 342	2.41 - 4.73[b]	1.86 - 4.36[b]
^{134}Cs	5	414 - 80.3	-1.50 - 1.02	-0.50 - 2.57

(a) No sample.
(b) Results exceed 3 Normalized Deviations.

Table 10.6 (Accuracy of ASL Radioanalyses [EPA PESP and EML QAP] - 1996, cont.)

Analysis Water Samples	No.	BN/ASL Average pCi/L	EPA QA Normalized Deviation[(a)] Known	Grand Avg.
^{137}Cs	5	31.3 - 200	0.46 - 4.62[(b)]	-0.08 - 4.15[(b)]
^{133}Ba	2	70 - 717	-0.65 - 1.73	-0.07 - 2.48
^{89}Sr	5	13.3 - 68	-1.73 - 1.15	-0.89 - 1.03
^{90}Sr	4	10.3 - 18.7	-2.19 - 0.12	-1.74 - 0.05
^{131}I	2	40 - 74	1.65 - 3.75[(b)]	1.27 - 3.58[(b)]
Tritium	2	10060 - 22800	-1.30 - 0.65	-0.84 - 0.89
^{226}Ra	4	6.9 - 27.2	-1.19 - 13.4[(b)]	-0.85 - 13.3[(b)]
^{228}Ra	5	3.4 - 22.6	-2.22 - 3.26[(b)]	-2.62 - 3.38[(b)]
U (nat.)	5	10.0 - 41.2	[(b)]-5.13 - -0.04	[(b)]-4.27 - 0.29
Gross Alpha	6	10.0 - 85.5	-1.95 - -0.09	-0.33 - 0.41
Gross Beta	6	6.6 - 151	-2.57 - 0.17	-2.61 - -0.06

(a) ± 3 Normalized Deviation is acceptable.
(b) Results exceed 3 Normalized Deviations.

% Bias Range for Analysis of EML QAP Samples

Analysis	No.	Air	Soil	Vegetation	Water
Americium	2	-26 - -14	(a)	-10 - 28	-2.1 - 7
Plutonium	4	-23 - 0	-8 - -2.6	-15 - 0	-12 - 2
Uranium	5	-8 - 7.5	-3 - -10	(a)	1 - 10
Strontium	2	-11 - -5.1	-16 - -3	-9 - -5	0 - 1.4
Tritium	2	(a)	(a)	(a)	-17 - -14
Gamma Spec.	6	-51 - 8.4	-20 - 4	1 - 79	-20 - 9
Gross Alpha	2	-19 - 63	(a)	(a)	3 - 5.4
Gross Beta	2	4 - 202	(a)	(a)	-17 - 13

(a) No sample.

Cactus in Bloom in Area 5

REFERENCES

Bauer, D. J., B. J. Foster, J. D. Joyner, and R. A. Swanson, 1996, "Water Resources Data - Nevada - Water Year 1995," Water Data Report NV-95-1, U.S. Geological Survey, Carson City, NV.

Bechtel Nevada, 1996a, "Area 5 Radioactive Waste Management Site, Groundwater Monitoring Program," Unnumbered Report, Waste Management Operations, Environmental Management Division, BN, Las Vegas, NV.

Bechtel Nevada, 1996b, "Biological Monitoring Plan for Hazardous Materials Testing at the Liquefied Gaseous Fuels Spill Test Facility on the Nevada Test Site," Unnumbered Report, Ecological Sciences, Environmental Restoration and Waste Management Division, BN, Las Vegas, NV.

BEIR III, 1980, "The Effects on Populations of Exposure to Low Levels of Ionizing Radiation: 1980," Committee on the Biological Effects of Ionizing Radiation III, National Academy Press, 2101 Constitution Ave, N.W., Washington, D.C. 20418.

Black, S. C., 1997, "National Emission Standards for Hazardous Air Pollutants Submittal 1996," Report DOE/NV/11718-116, Bechtel Nevada, Las Vegas, NV.

Blankennagel, R. K. and J. E. Weir, 1973, "Geohydrology of the Eastern Part of Pahute Mesa, Nevada Test Site, Nye County, Nevada," U.S. Geological Survey Prof. Paper 712-B.

Blomquist, K. W., T. A. Lindeman, G. E. Lyon, D. C. Steen, C. A. Wills, S. A. Flick and W. K. Ostler, 1995, Current Distribution, Habitat, and Status of Category 2 Candidate Plant Species On and Near the U.S. Department of Energy's Nevada Test Site," Report EGG 11265-1149, EG&G/Energy Measurements, Las Vegas, NV.

Chapman, J. B. and S. L. Hokett, 1991, "Evaluation of Groundwater Monitoring at Offsite Nuclear Test Areas," DOE Nevada Field Office Report DOE/NV/10845-07, Las Vegas, NV.

Chapman, J., S. Earman, and R. Andricevic, 1996a, "Assessment of Hydrologic Transport of Radionuclides from the Rio Blanco Underground Nuclear Test Site, Colorado," Report DOE/NV/11508-19, Desert Research Institute, Las Vegas, NV.

Chapman, J., T. Mihevc, and B. Lyles, 1996b, "Tritium Migration at the Gasbuggy Site: Evaluation of Possible Hydrologic Pathways," Report DOE/NV/11508-12, Desert Research Institute, Las Vegas, NV.

Code of Federal Regulations, 1993, "Occupational Radiation Protection," Title 10, Part 835, U.S. Department of Energy.

Code of Federal Regulations, 1966, "Protection of Historic and Cultural Properties," Title 36, Part 79.

Code of Federal Regulations, 1973, "Threatened and Endangered Species Regulations," Title 50, Parts 17.11 and 17.12, U.S. Fish and Wildlife Service. Code of Federal Regulations, 1969, "National Environmental Policy Act," Title 40, Parts 1500 - 1508, Council on Environmental Quality.

Code of Federal Regulations, 1976, "National Primary Drinking Water Regulations," Title 40, Part 141, U.S. Environmental Protection Agency.

Code of Federal Regulations, 1977, "Clean Water Act Regulations," Title 40, Parts 110 to 136. U.S. Environmental Protection Agency.

Code of Federal Regulations, 1984, "Resource Conservation and Recovery Act Regulations," Title 40, Parts 260 to 281, U.S. Environmental Protection Agency.

Code of Federal Regulations, 1986, "Superfund, Emergency Planning and Community Right-to-Know Act Regulations," Title 40, Parts 300 - 373, U.S. Environmental Protection Agency.

Code of Federal Regulations, 1989, "National Emission Standards for Hazardous Air Pollutants," Title 40, Part 61, U.S. Environmental Protection Agency.

Davis, M. G., 1996, "Annual Water Sampling and Analysis at the Salmon Test Site Area, Lamar County MS, April 1996" Report EPA 420-R-96-019, Radiation Sciences Laboratory, U.S. Environmental Protection Agency, Las Vegas, NV.

Earman, S., J. Chapman, and R. Andricevic, 1996a, "Assessment of Hydrologic Transport of Radionuclides from the Rulison Underground Nuclear Test Site, Colorado," Report DOE/NV/11508-17, Desert Research Institute, Las Vegas, NV.

Earman, S., J. Chapman, K. Pohlmann, and R. Andricevic, 1996b, "Assessment of Hydrologic Transport of Radionuclides from the Gnome Underground Nuclear Test Site, New Mexico," Report DOE/NV/11508-11, Desert Research Institute, Las Vegas, NV.

EG&G/EM (EG&G Energy Measurements), 1994, "The Northern Boundary of the Desert Tortoise Range on the Nevada Test Site," U.S. Department of Energy Topical Report EGG 111265-1103, 20pp.

International Commission on Radiological Protection, 1975, "Report of the Task Group on Standard Man," ICRP Publication 23, Pergamon Press, New York.

International Commission on Radiological Protection, 1979, "Limits for Intake by Workers," ICRP Publication 30, Supplement to Part 1, Pergamon Press, New York.

International Commission on Radiological Protection, 1985, Insert to "Quantitative Bases for Developing an Index of Harm," ICRP Publication 45, Pergamon Press, New York.

Johns, F. B., P. B. Hahn, D. J. Thome', and E. W. Brethauer, 1979, "Radiochemical and Analytical Procedures for Analysis of Environmental Samples," Report EMSL-LV-0539-17, Environmental Monitoring Systems Laboratory, U.S. Environmental Protection Agency, Las Vegas, NV.

Kenneally, J. M., 1996, "Isotopic Characteristics of Groundwater Beneath Yucca Flat, Nevada, and Inferences about Groundwater Sources and Flow." Master of Science Thesis, University of California, Berkeley, CA.

Laczniak, R. J., J. C. Cole, D. A. Sawyer, and D. A. Trudeau, 1996, "Summary of Hydrogeologic Controls on Ground-Water Flow at the Nevada Test Site, Nye County, Nevada," Water Resources Investigation Report 96-4109, U.S. Geological Survey, Carson City, NV.

National Council on Radiation Protection and Measurement, 1975, "Krypton-85 in the Atmosphere," NCRP Report No. 44, Washington D.C.

Nevada Administrative Code 445A-890, "Public Water Systems."

Nevada Revised Statutes, "Public Health and Safety/Water Pollution Control," Title 40, Chapter 445A, and Nevada Administrative Code 445A.247.

Nevada Revised Statutes, "Public Health and Safety/Disposal of Hazardous Waste," Title 40, Chapter 459, and Nevada Administrative Code 444.8632.

Nevada Test Site, 1997, Annual Update for the Nevada Test Site Site Treatment Plan, Waste Management Division, Nevada Operations Office, DOE.

Nevada Test Site, 1996, Waste Acceptance Criteria, Report NTSWAC (Rev. 0), Waste Management Division, Nevada Operations Office, DOE.

O'Farrell, T. P. and L. A. Emery, 1976, "Ecology of the Nevada Test Site: A Narrative Summary and Annotated Bibliography," Report NVO-167, Desert Research Institute, University of Nevada, Las Vegas, NV.

Pohll, G. and K. Pohlmann, 1996, "Evaluation of the Radionuclide Tracer Test Conducted at the Project Gnome Underground Nuclear Test Site, New Mexico," Report DOE/NV/11508-08, Desert Research Institute, Las Vegas, NV.

Quiring, R. E., 1968, "Climatological Data, Nevada Test Site, Nuclear Rocket Development Station," ESSA Research Laboratory Report ERLTM-ARL-7, Las Vegas, NV.

Russell, C. E., 1990, "Assessment of the Nevada Test Site Monitoring Well System," Report DOE/NV/10384-31, Water Resources Center, Desert Research Institute, University of Nevada, Las Vegas, NV.

Russell, G. M. and G.L. Locke, 1996, "Summary of Data Concerning Radiological Contamination at Well PM-2, Nevada Test Site, Nye County, Nevada," Open-File Report 96-599, U.S. Geological Survey, Carson City, NV.

Scoggins, W. A., 1983, "Environmental Surveillance Report for the Nevada Test Site, January 1982 through December 1982," DOE/NVO-410-76, Reynolds Electrical & Engineering Co., Inc., Las Vegas, NV.

Scoggins, W. A., 1984, "Environmental Surveillance Report for the Nevada Test Site, January 1983 through December 1983," DOE/NVO-10327-4, Reynolds Electrical & Engineering Co., Inc., Las Vegas, NV.

References, cont.

Stanley, T. W. and S. S. Verner, 1985, "The U.S. Environmental Protection Agency's Quality Assurance Program," in J. K. Taylor and T. W. Stanley (eds.), *Quality Assurance for Environmental Measurements,* ASTM STP-867, Philadelphia, Pennsylvania.

Taylor, J. K., 1987, "Quality Assurance of Chemical Measurements," Chapter 4, Lewis Publications.

Thompson, J. L., 1997, "Laboratory and Field Studies Related to the Hydrologic Resources Management Program, October 1, 1995 - September 30, 1995," Report LA-13270-PR, Los Alamos National Laboratory, Los Alamos, NM.

Thordarson, W., 1965, "Perched Ground Water in Zeolitized Bedded Tuff, Rainier Mesa and Vicinity, Nevada Test Site," U.S. Geological Survey Open-File Report TEI-862.

U.S. Atomic Energy Commission, 1964, "Project Manager's Report, Project SHOAL," Report NVO-11, Nevada Operations Office, Las Vegas, NV.

U.S. Atomic Energy Commission, 1965, "Project GNOME - the Environment Created by a Nuclear Explosion in Salt," Report PNE-107F, Nevada Operations Office, Las Vegas, NV.

U.S. Atomic Energy Commission, 1966, "Report of the AEC Deputy Test Manager: Project LONG SHOT," Report NVO-26, .Nevada Operations Office, Las Vegas, NV.

U.S. Atomic Energy Commission , 1970, "Physical and Biological Effects: MILROW Event," Report NVO-79, Nevada Operations Office, Las Vegas, NV.

U.S. Atomic Energy Commission , 1972, "Draft Environmental Statement: Rio Blanco Gas Stimulation Project," Report WASH-1519, Washington, D.C.

U.S. Atomic Energy Commission, 1973, "Long Term Surveillance Plan, Central Nevada Test Area," Report NVO-90, Appendix 2, Nevada Operations Office, Las Vegas, NV.

U.S. Atomic Energy Commission, 1973, "Physical and Biological Effects: CANNIKIN Event," Report NVO-123, Nevada Operations Office, Las Vegas, NV.

U.S. Department of Commerce, 1990, "Population Count Pursuant to Public Law 94-171," Bureau of Census, Washington, D.C.

U.S. Department of Energy, 1978, "Special Study, Tatum Dome Test Site, Lamar County, Mississippi, Final Report," Report NVO-200, Nevada Operations Office, Las Vegas, NV.

U.S. Department of Energy, 1984, "Long-Term Hydrologic Monitoring Program, RULISON Event Site, Grand Valley, Colorado," Report NVO-273, Nevada Operations Office, Las Vegas, NV.

U.S. Department of Energy, 1986, "Long-Term Hydrologic Monitoring Program, Project GASBUGGY, Rio Arriba County, New Mexico," Report NVO-277, Nevada Operations Office, Las Vegas, NV.

References, cont.

U.S. Department of Energy, 1988b, "Radioactive Waste Management," DOE Order 5820.2A.

U.S. Department of Energy, 1990a, "Occurrence Reporting and Processing of Operations Information," DOE Order 5000.3B.

U.S. Department of Energy, 1990b, "General Environmental Protection Program," DOE Order 5400.1.

U.S. Department of Energy, 1990c, "Radiation Protection of the Public and the Environment," DOE Order 5400.5.

U.S. Department of Energy, 1990d, "Environmental Protection, Safety, and Health Protection Program for DOE Operations," DOE Order 5480.1B.

U.S. Department of Energy, 1990e, "Radiation Protection for Occupational Workers," DOE Order 5480.11.

U.S. Department of Energy, 1990f, "Environmental Protection, Safety, and Health Protection Information Reporting Requirements," DOE Order 5484.1.

U.S. Department of Energy, 1991a, "Quality Assurance," DOE Order 5700.6C.

U.S. Department of Energy, 1991b, "General Design Criteria Manual," DOE Order 6430.1A.

U.S. Department of Energy, 1990g, "Site Specific Plan for Environmental Restoration and Waste Management," Report DOE/NV-336, Nevada Operations Office, Las Vegas, NV.

U.S. Department of Energy, 1991c, "Environmental Monitoring Plan, Nevada Test Site and Support Facilities," Report DOE/NV/10630-28, Nevada Operations Office, Las Vegas, NV.

U.S. Department of Energy, 1991d, "Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance," Report DOE/EH-0173T, Washington, D.C.

U.S. Department of Energy, 1994a, "United States Nuclear Tests: July 1945 through September 1992," Report DOE/NV-209 (Revision 14), Nevada Operations Office, Las Vegas, NV.

U.S. Department of Energy, 1994b, "Site Characterization and Monitoring Data from Area 5 Pilot Wells, Nye County, Nevada," DOE/NV/11432-74, Reynolds Electrical & Engineering Co., Inc., Las Vegas, NV.

U.S. Department of Energy, 1995a, "Nevada Operations Office Annual Site Environmental Report - 1994," DOE/NV/11432-175, Reynolds Electrical & Engineering Co., Inc., Las Vegas, NV.

U.S. Department of Energy, 1995b, "Environmental Data Report for the Nevada Test Site - 1995," DOE/NV/11718-038, in prep., Bechtel Nevada, Las Vegas, NV.

References, cont.

U.S. Department of Energy, 1996a, "Nevada Test Site Site Treatment Plan," Report DOE/NV-397, Rev. 2, Nevada Operations Office, Las Vegas, NV.

U.S. Department of Energy, 1996b, "Shaft and Tunnel Nuclear Detonations at the Nevada Test Site: Development of a Primary Database for Estimation of Potential Interactions with the Regional Groundwater System," Report DOE/NV-464, Nevada Operations Office, Las Vegas, NV.

U.S. Department of Energy, 1996c, "Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada," Report DOE/EIS-0243, Nevada Operations Office, Las Vegas, NV.

U.S. Environmental Protection Agency, 1976, "Quality Assurance Handbook for Air Pollution Measurement Systems," Report EPA/600/9-76/005, Office of Research and Development, Research Triangle Park, NC.

U.S. Environmental Protection Agency, 1983, "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans - QAMS-005/80," Office of Research and Development, Report EPA/600/4-83/004, Washington, D.C.

U.S. Environmental Protection Agency, 1986, "RCRA Groundwater Monitoring Technical Enforcement Guidance Document," Office of Solid Waste and Emergency Response Report No. OSWER-9950.1, 208pp.

U.S. Environmental Protection Agency, 1987, "Quality Assurance Program Plan," EPA/600/X-87/241, Environmental Monitoring Systems Laboratory, P.O. Box 93478, Las Vegas, NV 89193-3478.

U.S. Environmental Protection Agency, 1988, "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Ingestion, and Submersion," Federal Guidance Report No. 11, EPA/520/1-88/020, Washington, D.C.

U.S. Environmental Protection Agency, 1992a, "User's Guide for CAP88-PC, Version 1.0," Office of Radiation Programs, Las Vegas Facility, Report 402-B-92-001.

U.S. Environmental Protection Agency, 1992b, "Quality Assurance Program Plan - Offsite Radiological Safety Program," Report EPA/600/X-92/xxx, Nuclear Radiation Assessment Division, Environmental Monitoring Systems Laboratory, Las Vegas, NV.

U.S. Environmental Protection Agency, 1996, "Quality Management Plan ," Report EPA/600/X-93-024, Office of Radiation and Indoor Air, Washington, D.C.

U.S. Environmental Protection Agency, 1994, "Environmental Radioactivity Performance Evaluation Studies Program and Radioactive Standards Distribution Program," Report EPA/600/R-94/xxx, Environmental Monitoring Systems Laboratory, Las Vegas, NV.

U.S. Nuclear Regulatory Commission, 1991, "NRC TLD Direct Radiation Monitoring Network Progress Report, October to December, 1991," NUREG-0873, 11: No. 4, U.S. Nuclear Regulatory Commission, Region 1, U.S. Government Printing Office, Washington, D.C.

References, cont.

U.S. Public Health Service, 1966, "Final Report of Off-Site Surveillance for the SALMON Event of Project DRIBBLE," Report VUF-1021, Southwestern Radiological Health Laboratory, Las Vegas, NV.

Winograd, I. J. and W. Thordarson, 1975, "Hydrogeologic and Hydrochemical Framework, South-Central Great Basin, Nevada-California, with Special Reference to the Nevada Test Site," U.S. Geological Survey Professional Paper 712-c, U.S. Government Printing Office, Washington, D.C.

DISTRIBUTION LIST

DOE/HQ

Assistant Secretary for Defense Programs (DP-1 FORS), U.S. Department of Energy, 1000 Independence Avenue SW, Washington, D.C. 20585

Assistant Secretary for Environment, Safety, and Health (EH-1 FORS), U.S. Department of Energy, 1000 Independence Avenue SW, Washington, D.C. 20585 (10)

Assistant Secretary for Environmental Management (EM-1 FORS), U.S. Department of Energy, 1000 Independence Avenue SW, Washington, D.C. 20585

Principal Deputy Assistant Secretary for Defense Programs (DP-2 FORS), U.S. Department of Energy, 1000 Independence Avenue SW, Washington, D.C. 20585

Deputy Assistant Secretary for Research and Development (DP-10 FORS), U.S. Department of Energy, 1000 Independence Avenue SW, Washington, D.C. 20585

Deputy Assistant Secretary for Planning & Resource Management (DP-40 FORS), U.S. Department of Energy, 1000 Independence Avenue SW, Washington, MD 20585 (3)

Deputy Assistant Secretary, Office of Compliance and Program Coordination (EM-20 FORS), U.S. Department of Energy, 1000 Independence Ave. SW, Washington, D.C. 20585

Deputy Assistant Secretary, Office of Waste Management (EM-30 FORS), U.S. Department of Energy, 1000 Independence Avenue SW, Washington, D.C. 20585

Deputy Assistant Secretary, Office of Environmental Restoration (EM-40 FORS), U.S. Department of Energy, 1000 Independence Avenue SW, Washington, D.C. 20585

Director, Office of RD&T Facilities (DP-13 GTN), U.S. Department of Energy, 19901 Germantown Road, Germantown, MD 20545

Director, LLNL/NTS Facility Management Division (DP-13 GTN), U.S. Department of Energy, 19901 Germantown Road, Germantown, MD 20545

Director, Office of Reconfiguration (DP-25 FORS), U.S. Department of Energy, 1000 Independence Avenue SW, Washington, D.C. 20585 (5)

Director, Office of Environmental Support (DP-34 FORS), U.S. Department of Energy, 1000 Independence Avenue SW, Washington, D.C. 20585

Director, Environmental Compliance Division (EH-22 FORS), U.S. Department of Energy, 1000 Independence Avenue SW, Washington, D.C. 20585 (3)

Director, Office of Environmental Audit (EH-24 FORS), U.S. Department of Energy, 1000 Independence Avenue SW, Washington, D.C. 20585

Director, Office of Energy Research (ER-1 FORS), U.S. Department of Energy, 1000 Independence Avenue SW, Washington, D.C. 20585

Associate Director, Office of Health and Environmental Research (ER-70 GTN), U.S. Department of Energy, 19901 Germantown Road, Germantown, MD 20545

Director, Office of Field Management (FM-1 FORS), U.S. Department of Energy, 1000 Independence Avenue SW, Washington, D.C. 20585

Director, Office of Civilian Radioactive Waste Management (RW-1 FORS), U.S. Department of Energy, 1000 Independence Avenue SW, Washington, D.C. 20585

DOE/NV

Manager, Nevada Operations Office, U.S. Department of Energy, P. O. Box 98518, Las Vegas, NV 89193-8518, M/S 505

Assistant Manager for Technical Services, Nevada Operations Office, U.S. Department of Energy, P. O. Box 98518, Las Vegas, NV 89193-8518, M/S 505

Assistant Manager for National Security, Nevada Operations Office, U.S. Department of Energy, P. O. Box 98518, Las Vegas, NV 89193-8518, M/S 505

Assistant Manager for Environmental Management, Nevada Operations Office, U.S. Department of Energy, P. O. Box 98518, Las Vegas, NV 89193-8518, M/S 505

Assistant Manager for Business & Financial Services, Nevada Operations Office, U.S. Department of Energy, P. O. Box 98518, Las Vegas, NV 89193-8518, M/S 505

Director, Public Affairs and Information Office, Nevada Operations Office, U.S. Department of Energy, P. O. Box 98518, Las Vegas, NV 89193-8518, M/S 505 (2)

Director, Defense Projects Division, Nevada Operations Office, U.S. Department of Energy, P. O. Box 98518, Las Vegas, NV 89193-8518, M/S 505

Director, Waste Management Division, Nevada Operations Office, U.S. Department of Energy, P. O. Box 98518, Las Vegas, NV 89193-8518, M/S 505

Deputy Assistant Manager for Technical Services, Nevada Operations Office, U.S. Department of Energy, P. O. Box 98518, Las Vegas, NV 89193-8518, M/S 505

Director, Safety and Health Division, Nevada Operations Office, U.S. Department of Energy P. O. Box 98518, Las Vegas, NV 89193-8518, M/S 505

Director, Resources Management Division, Nevada Operations Office, Nevada Operations Office, U.S. Department of Energy, P. O. Box 98518, Las Vegas, NV 89193-8518, M/S 505

Director, Environmental Protection Division, Nevada Operations Office, U.S. Department of Energy, P. O. Box 98518, Las Vegas, NV 89193-8518, M/S 505

Distribution, cont.

N. George McNeill, Environmental Protection Division, Nevada Operations Office, U.S. Department of Energy, P. O. Box 98518, Las Vegas, NV 89193-8518, M/S 505

Director, Energy Technologies Division, Nevada Operations Office, U.S. Department of Energy, P. O. Box 98518, Las Vegas, NV 89193-8518, M/S 505

Technical Information Resource Center, Nevada Operations Office, U.S. Department of Energy, P. O. Box 98518, Las Vegas, NV 89193-8518, M/S 505

EPA

Assistant Administrator for Radiation and Indoor Air, U.S. Environmental Protection Agency, 401 M Street SW, Washington, D.C. 20460

Director, Criteria and Standards (ANR-460 ORP), U.S. Environmental Protection Agency, 401 M Street SW, Washington, D.C. 20460

Director, Analysis & Support Division (ANR-461 ORP), U.S. Environmental Protection Agency, 401 M Street SW, Washington, D.C. 20460

Director, Air & Toxic Division, Region IX, U.S. Environmental Protection Agency, 75 Hawthorne Street, San Francisco, CA 94103

Regional Radiation Representative, Region VIII, U.S. Environmental Protection Agency, 999 18th Street Suite 500, Denver, CO 80202

Regional Radiation Representative, Region VI, U.S. Environmental Protection Agency, First Interstate Bank Tower Suite 1200, 1445 Ross Avenue, Dallas, TX 75202

Regional Radiation Representative, Region X, U.S. Environmental Protection Agency, 1200 6th Avenue, Seattle, WA 98101

Regional Radiation Representative, Region VII, U.S. Environmental Protection Agency, 726 Minnesota Avenue, Kansas City, KS 66101

Director, Radiation & Indoor Environments National Laboratory (R&IE), U.S. Environmental Protection Agency, P. O. Box 98517, Las Vegas, NV 89193-8517, M/S 513

Deputy Director, Radiation & Indoor Environments National Laboratory, U.S. Environmental Protection Agency, P. O. Box 98517, Las Vegas, NV 89193-8517, M/S 513

Director, Center for Environmental Restoration, Monitoring and Emergency Response, R&IE-LV, U.S. Environmental Protection Agency, P. O. Box 98517, Las Vegas, NV 89193-8517, M/S 513

Anita A. Mullen, Center for Environmental Restoration, Monitoring, and Emergency Response, R&IE-LV, U.S. Environmental Protection Agency, P. O. Box 98517, Las Vegas, NV 89193-8517, M/S 513

Distribution, cont.

Angela Haag, Center for Environmental Restoration, Monitoring and Emergency Response, R&IE-LV, U.S. Environmental Protection Agency, P. O. Box 98517, Las Vegas, NV 89193-8517, M/S 513

Departments of Environment and Health

Radiological Health Section, Bureau of Health Protection Services, 505 E. King Street Room 203, Carson City, NV 89710

Al Tinney, Bureau of Health Protection Services, 620 Belrose Street, Las Vegas, NV 89158-5242

Paul Liebendorfer, Nevada Division of Environmental Protection, Capitol Complex, 333 W. Nye Lane, Carson City, NV 89710

Clem Goewert, NDEP, 555 E. Washington Ave., Suite 4300, Las Vegas, NV 89101

Clinton Case, NDEP, Capitol Complex, 333 W. Nye Lane, Carson City, NV 89710

Charles Bubak, NDEP, 555 E. Washington Ave., Suite 4300, Las Vegas, NV 89101

Larry Franks, Radiological Health Section, NDEP, 620 Belrose Street, Las Vegas, NV 89158-5242

Director, Environmental Improvement Division, Department of Health and Environment, 1190 Saint Francis Drive, Santa Fe, NM 87503

Director, Radiation and Hazardous Waste Control Division, Department of Health, 4210 E. 11th Avenue, Denver, CO 80220

Director, Bureau of Radiation and Occupational Health, 288 N. 1460 West, P. O. Box 16690, Salt Lake City, UT 84116-0690

Director, Division of Air Quality, State Department of Health, 150 N. 1950 West, Salt Lake City, UT 84116

Director, Health Department, 88 E. Fiddlers Canyon, Suite 8, Cedar City, UT 84720

Chief, Department of Health and Social Services, Radiological Health Program, P. O. Box H-02, Juneau, AK 99811

Chief, Radiological Health Branch, Department of Health Services, 1232 Q Street, Sacramento, CA 95814

Public Health Physicist, Radiological Health Section, Orange County Health Care Agency, P. O. Box 355, Santa Ana, CA 92705

Distribution, cont.

Director, Department of Health Services, Occupational Health and Radiation Management, 2615 S. Grand Avenue, Room 608, Los Angeles, CA 90007

Director, Santa Barbara Health Care Services, 315 Camino Del Remedio, Santa Barbara, CA 93110

Director, Division of Radiological Health, State Board of Health, P. O. Box 1700, Jackson, MS 39215-1700

Director, Arizona Radiation Regulatory Agency, 4814 S. 40th Street, Phoenix, AZ 85040

LANL

C. F. Eberhart, M/S F670, Los Alamos National Laboratory, P. O. Box 1663, Los Alamos, NM 87545 (2)

C. F. Costa, Los Alamos National Laboratory, P. O. Box 0, Mercury, NV 89023 M/S 900

Julie A. Carpenter, Los Alamos National Laboratory, P. O. Box 0, Mercury, NV 89023 M/S NTS967

Edward H. Essington, M/S J495, Los Alamos National Laboratory, P. O. Box 1663, Los Alamos, NM 87545

LLNL

Resident Manager, Lawrence Livermore National Laboratory, P. O. Box 45, Mercury, NV 89023, M/S 777

J. M. Haeberlin, Lawrence Livermore National Laboratory, P. O. Box 45, Mercury, NV 89023, M/S 777

J. Shinn, Environmental Science Division L-453, Lawrence Livermore National Laboratory, P. O. Box 808, Livermore, CA 94551

J. Fischer, Chemistry and Materials Division L-311, Lawrence Livermore National Laboratory, P. O. Box 808, Livermore, CA 94551

Jim Kercher, Health and Ecological Assessment Division, L-524, Lawrence Livermore National Laboratory, P. O. Box 808, Livermore, CA 94551

Lynn Anspaugh, Risk Sciences Center, L-453, Lawrence Livermore National Laboratory, P. O. Box 808, Livermore, CA 94551

Bob Schock, Energy Program L-641, Lawrence Livermore National Laboratory, P. O. Box 808, Livermore, CA 94551

Distribution, cont.

David Smith, L-231, Lawrence Livermore National Laboratory, P. O. Box 808,
Livermore, CA 94551

SNL

Resident Manager, Sandia National Laboratories, P. O. Box 238, Mercury, NV 89023
M/S NTS944

James H. Metcalf, Sandia National Laboratories, P. O. Box 238, Mercury, NV 89023
M/S NTS944

Roger Smith, Sandia National Laboratories, P. O. Box 871, Tonopah, NV 89023

DSWA

David A. Bedsun, Defense Special Weapons Agency, P. O. Box 98539,
Las Vegas, NV 89193-8518, M/S 573

Battelle

R. O. Gilbert, Sigma 3, Battelle Pacific Northwest Laboratory, P. O. Box 999,
Richland, WA 99352

Manager, Environmental Restoration and Waste Management, Pacific Northwest Laboratories,
P. O. Box 999, Richland, WA 99352

DRI

Colleen M. Beck, Desert Research Institute, 755 E. Flamingo Road, Las Vegas, NV 89120,
M/S 505.

Roger L. Jacobson, Desert Research Institute, 755 E. Flamingo Road, Las Vegas, NV 89120,
M/S 505 (3)

BN

Manager, Bechtel Nevada, P. O. Box 98521, Las Vegas, NV 89193-8521, M/S NLV001

Manager, Environmental Management Division, Bechtel Nevada, P. O. Box 98521,
Las Vegas, NV 89193-8521, M/S NLV022 (2)

Manager, Waste Management Department, Bechtel Nevada, P. O. Box 98521,
Las Vegas, NV 89193-8521, M/S NLV080

Martha E. DeMarre, Coordination and Information Center, Bechtel Nevada, P. O. Box 98521,
Las Vegas, NV 89193-8521, M/S NLV040

Robert F. Grossman, Environmental Management Division, Bechtel Nevada, P. O. Box 98521,
Las Vegas, NV 89193-8521, M/S NTS279

Distribution, cont.

R. R. Kinnison, Environmental Management Division, Bechtel Nevada, P. O. Box 98521, Las Vegas, NV 89193-8521, M/S NLV082

J. W. Kessler, Environmental Compliance Office, Bechtel Nevada, P. O. Box 98521, Las Vegas, NV 89193-8521,M/S NLV042

R. B. Hunter, Environmental Management Division, Bechtel Nevada, P. O. Box 98521, Las Vegas, NV 89193-8521, M/S NTS279

C. A. Wills, Bechtel Nevada, P. O. Box 98521, Las Vegas, NV 89193-8521, M/S NLV081

O. L. Haworth, Environmental Management Division, Bechtel Nevada, P. O. Box 98521, Las Vegas, NV 89193-8521, M/S NTS110

D. Linkenheil, Waste Management Department, Bechtel Nevada, P. O. Box 98521, Las Vegas, NV 89193-8521, M/S NLV080

Daniel A. Gonzalez, Environmental Management Division, Bechtel Nevada, P. O. Box 98521, Las Vegas, NV 89193-8521, M/S NTS270

D. P. Schlick, Environmental Management Division, Bechtel Nevada, P. O. Box 98521, Las Vegas, NV 89193-8521, M/S NTS405.

T. Van Sittert, Environmental Management Division, Bechtel Nevada, P. O. Box 98521, Las Vegas, NV 89193-8521, M/S NLV022

Miscellaneous

E. W. Chew, U.S. Department of Energy, 785 Doe Place, Idaho Falls, ID 83402, M/S 4149

Environmental Protection Department, Mason and Hanger, Silas-Mason Co., Inc., Pantex Plant, P. O. Box 30020, Amarillo, TX 79177

Manager, Health Protection Department, Westinghouse Savannah River Company, P. O. Box 616, Aiken, SC 29802

Jeff Tappan, Westinghouse Corporation, 101 Convention Center Drive, Las Vegas, NV 89109

Office of Scientific and Technical Information, Technical Center, U.S. Department of Energy, P. O. Box 62, Oak Ridge, TN 37831 (2)

UNLV Library Government Documents, University of Nevada-Las Vegas, P. O. Box 457013, Las Vegas, NV 89154-7013

UNR Getchell Library, University of Nevada-Reno, Reno, NV 89557-0044

E. A. Hopper UDAF/EV, 4551 Devlin Drive, Nellis AFB, NV 89191-6828

Distribution, cont.

Ann-Marie Choephel, Nuclear Waste Repository Project Office, P.O. Box 1767, Tonopah, NV 89049

Steve Deandi, Western Governmental Association, 223 Old P. O. Road, Boulder, CO 80302

Waste Policy Institute, Attn: Diane Watson, Savannah River Research Campus, 227 Gateway Drive, Aiken, SC 29803

M98050563

Report Number (14) DOE/NV/11718--137

Publ. Date (11) 199710

Sponsor Code (18) DOE/EH, XF

UC Category (19) UC-600, DOE/ER

DOE