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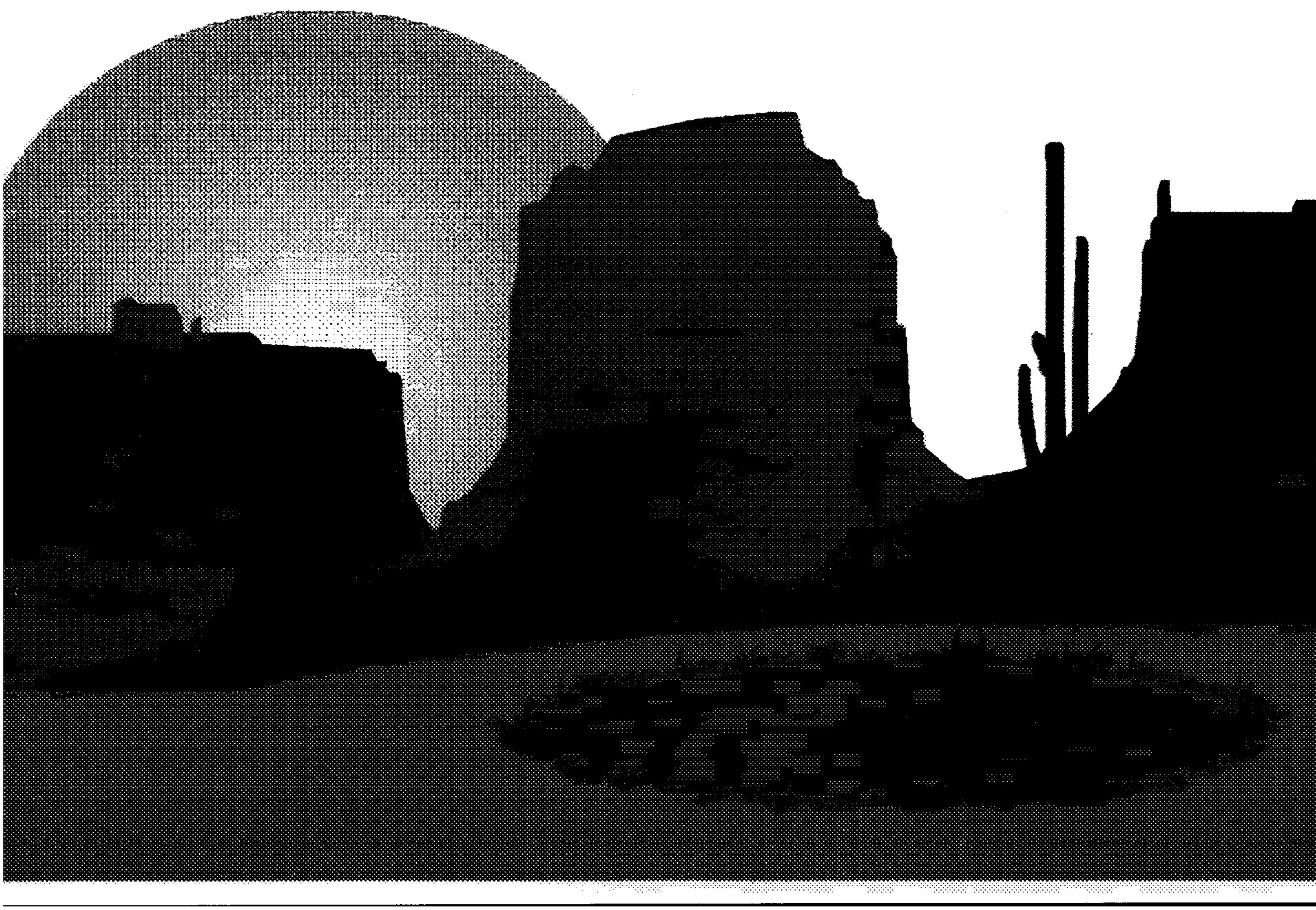
NEVADA TEST SITE

Annual Site Environmental Report-1994



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U.S. DEPARTMENT OF ENERGY NEVADA OPERATIONS OFFICE ANNUAL SITE ENVIRONMENTAL REPORT - 1994

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September 1995

Work Performed Under
Contract No. DE-AC08-94NV11432

Prepared for the

U.S. Department of Energy
Nevada Operations Office

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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 (EPA), Environmental Monitoring Systems Laboratory, 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 sixth 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 word processing and desktop publishing support were crucial to the production of this report. The review and advice offered by the Environmental Protection Division, Nevada Operations Office and the EPA Environmental Monitoring Systems Laboratory, Las Vegas (EMSL-LV) reviewers were invaluable. Compilation and verification of onsite data were provided by Fred D. Ferate, Robert F. Grossman, and Bernie S. Hooda. Statistical analyses of data were provided by Robert R. Kinnison and Lawrence E. Barker. The cooperative support of Anita A. Mullen of the EMSL-LV in production of this combined onsite and offsite environmental report is greatly appreciated.

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MEASUREMENT UNITS AND NOMENCLATURE

Radioactivity data in this report are expressed in curies, microcuries (one millionth of a curie), and picocuries (one millionth of a millionth). The curie (Ci) is the customary unit used to express the rate of atomic nuclei transformations that occur each second. A curie is 37 billion (37×10^9) nuclear transformations per second. The unit of becquerel is also used. A becquerel (Bq) is equal to one disintegration per second; therefore, it takes 3.7×10^{10} becquerels to equal one curie.

The roentgen (R) is the customary unit used to describe the intensity of gamma radiation at a given measurement point (in air). The radiation exposure rate to external sources of penetrating radioactivity is expressed in milliroentgens per hour (mR/h), or one-thousandth of a roentgen per hour. Radiation exposure rates in the U.S. from natural radioactivity of cosmic and terrestrial origin typically vary between 0.005 and 0.025 mR/h.

The rem (for roentgen equivalent man) is a unit describing dose equivalent, or the energy imparted to human tissue when exposed to radiation. Dose is expressed in rem, millirem (mrem), or microrem (µrem). A typical annual dose rate from natural radioactivity (excluding exposure to radon) is 100 to 130 mrem per year. The unit of sievert (Sv) is also used. One sievert is equivalent to 100 rem.

The elements and corresponding symbols used in this report are:

Element	Symbol	Element	Symbol
Actinium	Ac	Lead	Pb
Americium	Am	Polonium	Po
Argon	Ar	Plutonium	Pu
Boron	B	Protactinium	Pa
Beryllium	Be	Radium	Ra
Bismuth	Bi	Rhodium	Rh
Cadmium	Cd	Radon	Rn
Carbon	C	Ruthenium	Ru
Calcium	Ca	Sulfur	S
Cerium	Ce	Antimony	Sb
Cobalt	Co	Strontium	Sr
Cesium	Cs	Technetium	Tc
Hydrogen	H	Thallium	Tl
Iodine	I	Thorium	Th
Potassium	K	Thulium	Tm
Krypton	Kr	Tritium	^3H
Lithium	Li	Uranium	U
Lutetium	Lu	Xenon	Xe
Nitrogen	N	Zinc	Zn
Oxygen	O		

LIST OF ACRONYMS AND EXPRESSIONS

AAR	AIHA Asbestos Analysts Registry
ADTS	Automated Deficiency Tracking System
AEC	U.S. Atomic Energy Commission
AIRFA	American Indian Religious Freedom Act
AIHA	American Industrial Hygiene Association
ALARA	as low as reasonably achievable
ALI	Annual Limit of Intake
AMEM	Assistant Manager for Environmental Restoration and Waste Management
ANSI	American National Standard Institute
APCD	Air Pollution Control District
ARL/SORD	Air Resource Laboratory Special Operations and Research Division
ASD	REECo Analytical Services Department
ASER	Annual Site Environmental Report
ASME	American Society of Mechanical Engineers
ASN	Air Surveillance Network (EMSL-LV)
AVO	Amador Valley Operations, EG&G/EM
BAAQMD	Bay Area Air Quality Management District
BECAMP	Basic Environmental Compliance and Monitoring Program
BNA	base/neutral/acid
BOD	biochemical oxygen demand
CAA	Clean Air Act
CAP	College of American Pathologists
CAP88-PC	EPA software program for estimating doses
CCHD	Clark County Health Department
CCSD	Clark County Sanitation District
CEDE	Committed effective dose equivalent
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program (EPA)
COD	chemical oxygen demand
CP	Control Point
CRA	Classification Review Area
CRMP	Community Radiation Monitoring Program
CX	Categorical Exclusion
DAC	Derived Air Concentration
DAF	Device Assembly Facility
DCG	Derived Concentration Guide
D&D	Decontamination and Decommissioning
DDR	Data Discrepancy Report
DECON	Decontamination Facility, Area 6
DNA	Defense Nuclear Agency
DNR	Department of Natural Resources
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
DOI	U.S. Department of Interior

DOT	U.S. Department of Transportation
DQO	Data Quality Objectives
DRI	Desert Research Institute
EA	Environmental Assessment
ECD	REECo Environmental Compliance Department
EDE	Effective dose equivalent
EG&G	EG&G, Inc.
EG&G/EM	EG&G/Energy Measurements, Inc.
EHS	Extremely Hazardous Substances
Eh	Oxidation potential
EIS	Environmental Impact Statement
EIS/ODIS	Environmental Information System/Onsite Discharge Information System
ELPAT	Environmental Lead Proficiency Analytical Testing
EMAD	Engine Maintenance, Assembly and Disassembly
EML	Environmental Measurements Laboratory DOE/NY
EMSL-LV	EPA Environmental Monitoring Systems Laboratory, Las Vegas
EOD	Explosive Ordnance Disposal
EPA	U.S. Environmental Protection Agency
EPD	DOE Environmental Protection Division
EPTox	extraction procedure toxicity
ERP	Environmental Restoration Project
ERPESP	Environmental Radioactivity Performance Evaluation Studies Program
ERWM	Environmental Restoration & Waste Management
ESA	Endangered Species Act
ES&H	Environment, Safety, and Health
FFA	Federal Facilities Agreement
FFCA	Federal Facilities Compliance Act
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FOAV	Finding of Alleged Violation
GCD	Greater Confinement Disposal
GCP	Groundwater Characterization Project
GIS	geographical information system
GMX	Gadgets, Mechanics and Explosives
GOES	geostationary operational environmental satellite
GSD	Goleta Sanitation District
GZ	ground zero
HEPA	high-efficiency particulate filter
HF	hydrofluoric acid
HPD	REECo Health Protection Department
HRMP	Hydrologic Resources Management Program (DRI)
HSWA	Hazardous and Solid Waste Amendments
HSWA-5	Hazardous and Solid Waste Amendments, Area 5
HTO	tritiated water
HWAS	Hazardous Waste Accumulation Storage
ICP	inductively coupled plasma
ICRP	International Commission on Radiological Protection
ID	identification
IH	REECo Industrial Hygiene
IRCR	International Reference Center for Radioactivity

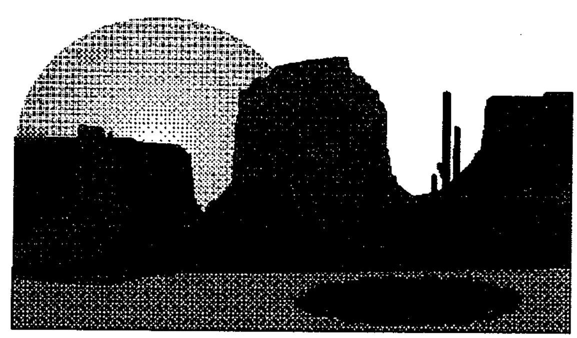
IT	International Technology Corp.
JIT	Just-in-Time
KAFB	Kirtland Air Force Base
KO	Kirtland Operations, EG&G/EM
LANL	Los Alamos National Laboratory
LAO	Los Alamos Operations, EG&G/EM
LCS	laboratory control standard
LDAS	REECo Laboratory Data Analysis System
LDR	Land Disposal Restrictions
LGFSTF	Liquified Gaseous Fuels Spill Test Facility
LINAC	linear accelerator
LLD	lower limit of detection
LLNL	Lawrence Livermore National Laboratory
LLW	low-level (radioactive) waste
LTHMP	Long-Term Hydrological Monitoring Program (EMSL-LV)
LVAO	Las Vegas Area Operations, EG&G/EM
MBAS	methylene blue active substances
MCL	Maximum Contaminant Levels
MDA	minimum detectable activity
MDC	minimum detectable concentration
MEI	maximally exposed individual
MGD	million gallons per day
MQO	Measurement Quality Objectives
MSL	mean sea level
MSM	Mounds Strategic Material
MSN	Milk Surveillance Network (EMSL-LV)
MWMF	Mixed Waste Management Facility
MWMU	Mixed Waste Management Unit
NAC	Nevada Administrative Code
NAEG	Nevada Applied Ecology Group
NAFB	Nellis Air Force Base
NAFR	Nellis Air Force Range
NAGPRA	Native American Graves Protection and Repatriation Act
NCR	nonconformance report
NCRP	National Council on Radiation Protection and Measurement
NDEP	Nevada Division of Environmental Protection
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NEST	Nuclear Emergency Search Team
NGTSN	Noble Gas and Tritium Surveillance Network (EMSL-LV)
NIOSH	National Institute of Occupational Safety and Health
NIST	National Institute of Standards and Technology
NLV	North Las Vegas, Nevada
NLVF	North Las Vegas Facility
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollution Discharge Elimination System
NPL	National Priority List
NPS	National Park Service
NR	National Register of Historic Places
NRC	National Response Center

NRD	EMSL-LV Nuclear Radiation Assessment Division
NRDS	Nuclear Rocket Development Station
NRS	Nevada Revised Statutes
NTS	Nevada Test Site
NTSO	DOE Nevada Test Site Operations Office
NV-ERP	Nevada Environmental Restoration Project
NVLAP	National Voluntary Laboratory Accreditation Program
offsite	in the immediate area off the NTS
onsite	on the NTS
O&M	Operations and Maintenance
OP	Operating Permit
OR	Occurrence Report
ORNL	Oak Ridge National Laboratory
ORSP	Offsite Radiological Safety Program
OSHA	Occupational Safety and Health Administration
PAT	NIOSH Proficiency Analytical Testing Program
PCB	polychlorinated biphenyl
PE	Performance Evaluation
pH	Hydrogen ion concentration
PHS	U.S. Public Health Service
PIC	pressurized ion chamber
POTW	Publicly Owned Treatment Works
PPA	Pollution Prevention Act
ppb	parts per billion
ppm	parts per million
QA	quality assurance
QAP	Quality Assessment Program
QC	quality control
QSG	Quality Support Group
RAM	remote area monitor
RC	residual chlorine
RCRA	Resource Conservation and Recovery Act
R&D	Research and Development
REECo	Reynolds Electrical & Engineering Company, Inc.
RESL	Radiological and Environmental Sciences Laboratory
RIDP	Radionuclide Inventory and Distribution Program
RI/FS	remedial investigation and feasibility study
RNMS	Radionuclide Migration Study
RPD	relative percent difference
RSD	EPA Radiation Science Division
RSD	relative standard deviation
RSL	Remote Sensing Laboratory
RSN	Raytheon Services Nevada
RSTN	Remote Seismic Test Network
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
SAM	Sample and Analysis Management System

List of Acronyms and Expressions, cont.

SARA	Superfund Amendments and Reauthorization Act
SASN	Standby Air Surveillance Network (EMSL-LV)
SBO	Santa Barbara Operations, EG&G/EM
SCARS	System Control and Receiving Station
SDWA	Safe Drinking Water Act
SGZ	surface ground zero
SLB	shallow land burial
SLD	shallow land disposal
SMSA	Strategic Materials Storage Area
SMSN	Standby Milk Surveillance Network (EMSL-LV)
SNL	Sandia National Laboratories
SOP	Standard Operating Procedure
STL	Special Technologies Laboratory, EG&G/EM
TCLP	toxicity characteristic leaching procedure
TDS	total dissolved solids
TLD	thermoluminescent dosimeter
TMI	Three Mile Island
TP	TRU Pad
TRU	transuranic
TSCA	Toxic Substances Control Act
TSD	Treatment, Storage and Disposal
TSI	Thermal System Insulation
TSS	total suspended solids
TTR	Tonopah Test Range
UCB	University California, Berkeley
UCLA	University of California, Los Angeles
UGTA	Underground Testing Areas
UNLV	University of Nevada, Las Vegas
URDS	upper respiratory disease syndrome
USDI	United States Department of Interior
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UST	underground storage tank
UTM	Universal Transverse Mercator
VOC	volatile organic compound
WAMD	Washington Aerial Measurements Department, EG&G/EM
WCO	Woburn Cathode Ray Tube Operations, EG&G/EM
WEB	Waste Examination Building
WHO	World Health Organization
WOD	REECo Waste Operations Department
WIPP	Waste Isolation Pilot Plant
WM & PPAP	Waste Minimization & Pollution Prevention Awareness Plan
WS	Water Supply

Summary



1.0 SUMMARY

Monitoring and surveillance on and around the Nevada Test Site (NTS) by DOE contractors and NTS user organizations during 1994 indicated that operations on the NTS were conducted in compliance with applicable federal and DOE 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 effluents, or resuspension was not detectable offsite, and no measurable net exposure to members of the offsite population was detected through the offsite dosimetry program. Using the Environmental Protection Agency's CAP88-PC model and NTS radionuclide emissions and environmental monitoring data, the calculated effective dose equivalent to the maximally exposed individual offsite would have been 0.15 mrem. This value is less than two percent of the federal dose limit due to radionuclide air emissions. Any person receiving this dose would also have received 124 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 is being achieved and, where mandated, permits for air and water discharges and waste management have been obtained from the appropriate agencies.

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

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 and a Health Protection Division within the Office of Environment, Safety, Security and Health and upgrading the Environmental Management activities to the Assistant Manager level to address those environmental issues that arise in the course of performing the 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 must be resolved before DOE/NV could be considered to be in full compliance with environmental laws and regulations. At the end of 1994, only one of the 149 Tiger Team findings remained open. Progress on corrective actions to bring operations into compliance is reported to DOE Headquarters Office of Environment, Safety and Health in a Quarterly Compliance Action Report.

Operational releases of radioactivity are reported soon after their occurrence to the Idaho National Engineering Laboratory through Environmental Information System/Onsite Discharge

Information System (EIS/ODIS) reports. In compliance with the National Emission Standards for Hazardous Air Pollutants (NESHAP), the accumulated annual data from these reports are used each year as input to the Environmental Protection Agency's (EPA) CAP88-PC software program to calculate potential effective dose equivalents 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 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 1994 consisted primarily of small amounts of tritium, radioactive noble gases, and plutonium released to the atmosphere that were attributed to:

- Diffusion of tritiated water vapor (HTO) in atmospheric moisture from evaporation of tritiated water from tunnel containment ponds.

- Continuing seepage of radioactive noble gases from higher yield (>20 kt) tests previously conducted on Pahute Mesa.

- Diffuse emissions calculated from the results of environmental surveillance activities.

- Resuspension of plutonium as measured with air sampling equipment.

Diffuse emissions included HTO, only slightly above detection limits, from the Radioactive Waste Management Site in Area 5 (RWMS-5), resuspended $^{239+240}Pu$ from areas on the NTS where it was deposited by atmospheric nuclear or device safety tests, and ^{85}Kr from Pahute Mesa. 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 above ambient levels in the offsite area.

Onsite liquid discharges to containment ponds included approximately 48 Ci (1.8 TBq) of tritium. This was about 7 percent of last year's tritium radioactivity because of efforts taken to seal the tunnels. Evaporation of this material could have contributed HTO to the atmosphere, but the amounts were too small to be detected by the tritium monitors offsite. No liquid effluents were discharged to offsite areas.

1.2.1 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 1994, there were 54 samplers for air particulates and reactive gases; 19 samplers collecting HTO in atmospheric moisture, and 10 samplers collecting air for analysis of noble gas content. Grab samples were collected frequently from water supply wells, springs, open reservoirs, containment ponds and sewage lagoons. Thermoluminescent dosimeters (TLDs) were placed at 201 locations on the NTS.

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 2700 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 six instances where very low levels of ^{137}Cs were detected. The gross beta annual average for the air sampling network was 2.1 x 10^{-14} µCi/mL. Plutonium analyses of monthly or quarterly composited air filters indicated an annual arithmetic average below 10^{-16} µCi/mL (4 x 10^{-6} Bq/m^3) of $^{239+240}$Pu and below 10^{-18} µCi/mL (4 x 10^{-8} Bq/m^3) of ^{238}Pu for all locations during 1994, with the majority of results for both isotopes being on the order of 10^{-18} µCi/mL (4 x 10^{-8} Bq/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 Air Concentration 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 (where chemical explosives were used to blow apart nuclear devices) deposited plutonium on a small portion of the surface of the NTS.

The annual average concentration of ^{85}Kr from the ten noble gas monitoring stations was 26 x 10^{-12} µCi/mL (1 Bq/m^3), which is slightly less than the average reported by EPA's Environmental Monitoring Systems Laboratory, Las Vegas (EMSL-LV) for the offsite noble gas sampling network. 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. As has been the case in the past, the average ^{133}Xe results were below the detection limit.

Throughout the year atmospheric moisture was collected for two-week periods at 19 locations on the NTS and analyzed for HTO content. The annual arithmetic average of (4.6 ± 7.6) x 10^{-6} pCi/mL (0.2 ± 0.3 Bq/m^3) was similar to last year's average. The locations on the border of the RWMS-5 and at the Area 15 EPA Farm had the highest concentrations. The primary radioactive liquid discharge to the onsite environment in 1994 was seepage from the test tunnels in Rainier Mesa (Area 12) that contributed 29 million liters of water containing about 48 Ci (1.8 Tbq) of tritium to containment ponds near the tunnels. For dose calculations, all of this tritiated water was assumed to have evaporated.

Surface water sampling was conducted quarterly at 12 open reservoirs, eight springs, one containment pond, and nine 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 containment pond contained detectable levels of radioactivity as would be expected.

Water from onsite supply wells and distribution systems was sampled and analyzed for radionuclides. The supply well average gross beta activity of 4.6 x 10^{-9} µCi/mL (0.17 Bq/L) was 2 percent of the Derived Concentration Guide (DCG) for ^{40}K (used for comparison purposes); gross alpha was 5.7 x 10^{-9} µCi/mL (0.22 Bq/L), which was 40 percent of the drinking water standard; ^{90}Sr was measured at 0.48 x 10^{-10} µCi/mL (1.9 Bq/L), about one percent of the DCG; ^{3}H concentrations averaged about 5.0 x 10^{-9} µCi/mL (0.19 Bq/L), less than 0.006 percent of the DCG; $^{239+240}$Pu was 5.7 x 10^{-12} µCi/mL (2.1 x 10^{-4} Bq/L), and ^{238}Pu was 1.2 x 10^{-12} µCi/mL (4.4 x 10^{-5} Bq/L), both below detectable levels.

Due to errors in TLD handling and processing external gamma radiation results for first and second quarters of 1994 are not available. Accordingly, station and network averages for 1994 were not calculated. Based on third and fourth quarters data, external gamma exposure rate results for 1994 appear to be significantly lower than 1993 results. Improvements have been made in TLD handling and processing procedures to ensure valid data are available in 1995 and subsequent years.

1.2.2 OFFSITE ENVIRONMENTAL SURVEILLANCE

The offsite radiological monitoring program is conducted around the NTS by the EPA's EMSL-LV, under an Interagency Agreement with DOE. This program consists of several extensive environmental sampling, radiation detection, and dosimetry networks that are described below. These networks operated as described for the first three quarters of 1994, but the total number of stations and types of analyses were significantly reduced in the last quarter.

For the first three quarters of 1994, the Air Surveillance Network (ASN) was made up of 30 continuously operating sampling locations surrounding the NTS and 77 standby stations (operated one week each quarter) in all states west of the Mississippi River. The 30 ASN stations included 18 located at Community Radiation Monitoring Program (CRMP) stations, described below. During 1994 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 air filter samples.

The Noble Gas and Tritium Surveillance Network (NGTSN) initially consisted of 21 offsite noble gas samplers (8 on standby) and 21 tritium-in-air samplers (7 on standby) located outside the NTS, associated and exclusion areas, in the states of Nevada, California, and Utah. During 1994 no radioactivity that could be related to NTS activities was detected at any NGTSN sampling station.

As in previous years, results for ^{133}Xe and HTO were typically below the minimum detectable concentration (MDC). The annual average results for krypton, 29 x 10^{-12} µCi/mL, although above the MDC, were within the range of worldwide values expected from sampling background levels and the range was similar to last year's.

The Milk Surveillance Network (MSN) consisted of 24 sampling locations within 300 km (186 mi) of the NTS and 115 Standby Milk Surveillance Network (SMSN) locations throughout the major milk sheds west of the Mississippi River. Tritium and ^{90}Sr are rarely detected in milk samples at present and ^{89}Sr is practically never detected. The levels in both milk networks have decreased over time since reaching a maximum in 1964. The results from these networks are consistent with previous data and indicate little or no change.

Other foods were analyzed regularly, most of which were meat from domestic or game animals collected on and around the NTS. The ^{90}Sr levels in samples of animal bone remained very low, as did $^{239+240}$Pu in both bone and liver samples. Beets and apples from several offsite locations contained normal ^{40}K activity. Small amounts of $^{239+240}$Pu and ^{238}Pu were found on a few samples.

In 1994, external exposure was monitored by a network of 127 TLDs and 27 pressurized ion chambers (PICs). The PIC network in the communities surrounding the NTS indicated background exposures, ranging from 73 to 164 mR/yr, that were consistent with previous data and well within the range of background data in other areas of the U.S.

Internal exposure was assessed by whole-body counting through use of a single germanium detector, lung counting with six semi-planar detectors, and bioassay through radiochemical procedures. In 1994 counts were made on 94 individuals, including 6 Desert Storm soldiers injured by depleted uranium shrapnel. In the other participants, the spectra obtained were representative of natural background with only normal ^{40}K being detected. No transuranics were detected in any lung counting data. Physical examination of offsite residents revealed only a normal, healthy population consistent with the age and sex distribution of that population.

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, Alaska, 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 tritium concentration appears to be increasing and ^{137}Cs has been detected. No concentrations of radioactivity detected in water, milk, vegetation, soil, fish, or animal samples posed any significant health risk.

A network of 18 CRMP stations was operated by local residents. Each station was an integral part of the ASN, NGTSN, 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 (GOES) to the NTS and from there to the EMSL-LV by dedicated telephone line. Samples and data from these CRMP stations were analyzed and reported by EMSL-LV and interpreted and reported by the Desert Research Institute, University of Nevada System. All measurements for 1994 were consistent with previous years and were within the normal background range for the U.S.

No radioactivity attributable to current NTS operations was detected by any of the offsite monitoring networks. However, based on the NTS releases reported in Table 1.1, atmospheric dispersion model calculations (CAP88-PC) indicated that the maximum potential effective dose equivalent to any offsite individual would have been 0.15 mrem (1.5×10^{-3} mSv), and the dose to the population within 80 kilometers of the emission sites would have been 0.52 person-rem (5.2×10^{-3} person-Sv). The hypothetical person receiving this dose would also have been exposed to 124 mrem from natural background radiation. A summary of the potential effective dose equivalents due to operations at the NTS is presented in Table 1.2.

1.2.3 ECOLOGICAL STUDIES

Studies conducted under DOE/NV-sponsored programs included monitoring the flora and fauna on the NTS to assess changes over time in ecological conditions and to provide information needed to document NTS compliance with environmental laws, regulations, and orders. The monitoring effort has been arranged into three interrelated phases of work: (1) a series of five non-disturbed study plots in test-impacted ecosystems that are monitored at one to five-year intervals to establish natural baseline conditions; (2) a series of study plots in representative disturbed areas that are monitored at three- to five-year intervals to determine impacts of disturbance, document site recovery, and investigate natural recovery processes; and (3) observations of birds and large mammals throughout the NTS.

In 1994, the seventh full year of flora and fauna monitoring, surveys were conducted at numerous sites for ephemeral plants, perennial plants, mammals, and reptiles. Many of these sites included paired disturbed/undisturbed plots. Three baseline sites were monitored and perennials and ephemerals were measured at all of them. Sites in disturbed areas are monitored on a three year cycle. In addition, baseline measurements were made near the Device Assembly Facility (DAF) in Frenchman Flat.

Monitoring of feral horses continued for the fifth consecutive year. All horses, including foals, were individually identified. In addition, field observations were made of raptors, mule deer, and raven in appropriate habitats throughout the NTS. Desert tortoises in the Rock Valley study enclosures were monitored in spring and fall, and free roaming tortoises were marked and measured when encountered by chance.

1.2.4 LOW-LEVEL WASTE DISPOSAL

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, tritium migration studies, 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.

Elevated levels of plutonium were detected in several areas on the NTS, particularly in Areas 3 and 9 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).

1.2.5 RADIOLOGICAL MONITORING AT OFFSITE SUPPORT FACILITIES

Fence line monitoring, using Panasonic UD-814 TLDs, was conducted at EG&G/EM's facilities in North Las Vegas, at Nellis Air Force Base, and in Santa Barbara, California. The 1994 results indicated that only background radiation was detected at the fence line.

1.3 NONRADIOLOGICAL MONITORING

Nonradiological environmental monitoring of NTS operations involved only onsite monitoring because there were no nonradiological hazardous material discharges offsite. The primary environmental permit areas for the NTS were monitored to verify compliance with ambient air quality and the Resource Conservation and Recovery Act (RCRA) requirements. Air emissions sources common to the NTS included particulates from construction, aggregate production, surface disturbances, fugitive dust from unpaved roads, fuel burning equipment, open burning, and fuel storage facilities. These emissions were covered by a series of 28 air quality permits and 20 permits to construct, issued by the state of Nevada. The only nonradiological air emission of regulatory concern under the Clean Air Act was due to asbestos removal during building renovation projects and from insulated piping at various locations onsite. There were four notifications to the state of Nevada in 1994, none requiring notification to the EPA Region 9 Office under NESHAP requirements.

RCRA-required monitoring included waste management and environmental compliance activities that necessitated the analysis of soil, water, sediment and oil samples. Low levels of targeted chemicals were found in several samples.

As there are no liquid discharges to navigable waters, offsite surface water drainage systems, or publicly owned treatment works, no Clean Water Act National Pollution Discharge Elimination System permits were required for NTS operations. Under the conditions of state of Nevada operating permits, liquid discharges to 13 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 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. Federal and state standards for fluorides and pH were slightly exceeded in the water system. In the case of fluorides, the state granted a variance to exceed Secondary fluoride standards as long as Primary standards were met. For the other exceedance, the state has been contacted to assist in developing a mitigation plan.

Monitoring for polychlorinated biphenols (PCB) as required by the Toxic Substances Control Act involved analysis of 358 various samples. All had no detectable or less than five parts per million PCBs.

At the Liquified Gaseous Fuels Spill Test Facility, eight series of spill tests using 22 different chemicals were conducted during 1994. 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 EMSL-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 Clean Air Act, Clean Water Act, Safe Drinking Water Act, Toxic Substances Control Act, and RCRA are summarized above. Also, National Environmental Policy Act activities included action on 11 Environmental Impact Statements (EIS), 10 Environmental Assessments (EA) and 67 Categorical Exclusions. Of these, ten Environmental Impact Statements, three Environmental Assessments and all 67 Categorical Exclusions were initiated in 1994.

Wastewater discharges at the NTS are not regulated under National Pollutant Discharge Elimination System 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 of EG&G Energy Measurements, Inc. (EG&G/EM) were within the regulated levels established by city or county publicly owned treatment works.

During 1994, 30 underground storage tanks were removed in accordance with state and federal regulations (see Chapter 3, Table 3.2). A total of seven tanks in Areas 12, 23, and 25 had reportable hydrocarbon releases and will require remedial action.

In 1994, 36 cultural resource surveys were conducted for historical and archaeological sites on the NTS, and reports on the findings were prepared. These surveys identified 64 sites containing previously unknown archaeological information. One data-recovery project was undertaken in 1994 and Native American monitors were present during the fieldwork.

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 1994, a technical report on this AIRFA Program was issued. This report includes recommendations of 17 tribal groups regarding the effects of DOE/NV's activities on Pahute and Rainier Mesas.

1.5 GROUNDWATER PROTECTION

DOE/NV instituted a Long-Term Hydrological Monitoring Program (LTHMP) in 1972 to be operated by the EPA under an Interagency Agreement. Groundwater was monitored on and around the NTS, at five sites in other states, and at two off-NTS locations in Nevada in 1994 to detect the presence 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 (MS), GNOME (NM), and GASBUGGY (NM) at levels consistent with previous experience. The tritium concentration in Well EPNG 10-36 at GASBUGGY began increasing about 1984, and ^{137}Cs was detected for the third 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, an extensive program of well drilling for groundwater characterization has been started. The design of the program is for installation of approximately 60 wells at strategic locations on and near the NTS. Twelve of these wells have been completed, two existing wells recompleted and water quality parameters are being collected for future use in the characterization project. 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 radioactive waste disposal facilities are operated on the NTS: the RWMS-5 and the Area 3 Radioactive Waste Management Site (RWMS-3). During 1994, the RWMSs received low-level waste generated at the NTS and other DOE facilities. Waste is disposed of in shallow pits, trenches, and selected craters. Transuranic (TRU) and TRU mixed wastes are stored on a curbed asphalt pad on pallets in overpacked 55 gallon drums and assorted steel boxes pending shipment to the Waste Isolation Pilot Plant (WIPP) in New Mexico. The RWMS-3 is used for disposal of bulk low-level 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 reactive gases and external exposure measurements using TLDs. Sampling for HTO in air, water sampling, tritium migration studies, and vadose zone monitoring for moisture and hazardous constituents are conducted at the RWMS-5. Environmental monitoring results for 1994 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 materials to licensed disposal facilities offsite. No disposal of hazardous materials was performed at the NTS in 1994.

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 hectares (25 acres), will contain 8 landfill cells to be used for mixed waste disposal. Construction of the MWMU will commence upon completion of necessary National Environmental Policy Act (NEPA) documentation and issuance of a state of Nevada Part B Permit.

Mixed waste and low-level waste will only be accepted for disposal from generators (onsite and offsite) that have submitted a waste application as required by NVO-325, Nevada Test Site Defense Waste Acceptance Criteria, Certification, and Transfer Requirements; that have verified compliance to NVO-325; 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 EMSL-LV.

1.7.1 ONSITE NONRADIOLOGICAL QUALITY ASSURANCE

The onsite nonradiological QA program included sample acceptance and control criteria, quality control (QC) procedures, and use of EPA approved methods. External QA includes interlaboratory comparisons through participation in the National Institute of Occupational Safety and Health (NIOSH) Proficiency Analytical Testing (PAT) Program, the American Industrial Hygiene Association (AIHA) Asbestos Analysts Registry (AAR) Program, the AIHA Bulk Asbestos Analysis Program, National Voluntary Laboratory Accreditation Program (NVLAP) Bulk Asbestos Fiber Analysis Program, and the College of American Pathologists (CAP) Analysis of Lead in Blood Program. Proficiency testing through participation in the EPA Contract Laboratory Program (CLP) was continued.

1.7.2 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 quality assurance consists of participation in the DOE Quality Assessment Program (QAP) administered by the DOE Environmental Measurements Laboratory (EML), the Environmental Radiation Performance Evaluation Studies Program (ERPESP) conducted by the EPA, and the quality assessment program sponsored by the International Reference Center for Radioactivity (IRCR) of the World Health Organization (WHO).

1.7.3 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 Radiation Sciences Division (RSD) of the EMSL-LV for the Offsite Radiological Safety Program (ORSP) meets all requirements of EPA policy, and also includes applicable elements of the Department of Energy QA requirements and regulations. The ORSP QA 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 1994

- On January 19, 1994, the state of Nevada Division of Environmental Protection (NDEP) issued a Finding of Alleged Violation (FOAV) to Lawrence Livermore National Laboratory (LLNL) and DOE/NV alleging RCRA violations for failure to adequately characterize hazardous waste. After verification sampling and an enforcement conference, no further action was taken.

- In June 1994, EPA accepted a settlement offer of $45,000 as reimbursement for costs incurred in the cleanup of a Superfund site in Pahrump, Nevada.

- 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, site-wide EIS for all major federal actions at the NTS. The state seeks to halt shipments of LLW from Fernald and 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 until publication of the EIS. The implications of this action for all ongoing and proposed NTS activities are of particular concern.

- On July 29, 1994, the NDEP issued an FOAV to DOE/NV and Reynolds Electrical & Engineering Company, Inc. (REECo) alleging failure to cease operation of a RCRA waste management unit that had lost interim operating status. This was a steam cleaning effluent pond in which recent effluent was observed.

- An EPA inspection of EG&G/EM's North Las Vegas anodizing operation alleged a failure to comply with federal pretreatment standards for chromium in wastewater and violating the prohibition of using dilution as a pretreatment method.

- In 1993 the state of Nevada indicated a desire to begin negotiating a two-party Federal Facilities Agreement (FFA). DOE/NV and state negotiations for this agreement continued in 1994. DOE Headquarters approved a draft FFA which had been forwarded in 1993. A Memorandum of Understanding is being formulated with the Defense Nuclear Agency (DNA) to address joint concerns. DNA is expected to be signatory to the FFA.

ACCOMPLISHMENTS FOR 1994

- DOE/NV participated in reviewing the following documents relating to storage of spent fuel and fissile materials: (1) a Programmatic Spent Nuclear Fuel EIS being prepared by DOE/Idaho; (2) a proposed EIS by DOE Headquarters, on continued operation of the Pantex Plant, with NTS as a potential alternative for relocation; and (3) a proposed EIS by DOE Headquarters for the storage and disposition of weapons-usable fissile materials with the NTS as one of the alternative sites.

- The Project CHARIOT sites in Alaska were remediated: soil, surface water, sediment, air, and biota samples were taken for analysis; the soil mound was removed; and other soil containing low levels of ^{137}Cs was transported to the NTS. The Site Assessment and Remedial Action Final Report was issued in September 1994 and public meetings held on October 5 regarding the findings.

- In August, DOE/NV personnel visited the Project CHARIOT revegetation site with U.S. Fish and Wildlife Service and Department of Natural Resources (DNR) personnel. DNR indicated that coverage of 40 to 60 percent was good for the first year and expect 80 to 85 percent coverage in another year.

- On May 13, 1994, DOE/NV issued an Action Memorandum to alter its NEPA strategy. DOE/NV will prepare a single EIS covering activities at the NTS and offsite test locations within the state of Nevada.

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

- Of the 149 Tiger Team findings from the 1989 assessment, only 1 remains to be resolved.

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

- At the state of Nevada's request, the Waste Management Program installed three pilot wells at RWMS-5. Underground conditions were carefully monitored, and the data have 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.

The environmental monitoring results presented in this report document that operational activities on the NTS in 1994 were conducted so that no 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 0.15 mrem to a person living in Amargosa Valley, Nevada. This may be compared to that individual's exposure to 124 mrem from natural background radiation as measured by the PIC at Amargosa Valley.

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 1994.

Table 1.1 Radionuclide Emissions on the NTS - 1994[a]

Radionuclide	Half-life (years)	Quantity Released (Ci) [b]
Airborne Releases:		
^{3}H	12.35	[c]0.63
^{85}Kr	10.72	200.
^{131}I	0.022	[c]1.1×10^{-6}
^{133}Xe	0.0144	0.16
$^{239+240}Pu$	24065.	[c]0.28
Tunnel Ponds:		
^{3}H	12.35	[d]47.3
^{238}Pu	87.743	2.0×10^{-5}
$^{239+240}Pu$	24065.	1.6×10^{-4}
^{90}Sr	29.	8.6×10^{-5}
^{137}Cs	30.17	1.7×10^{-3}
Gross Beta	---	2.1×10^{-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.

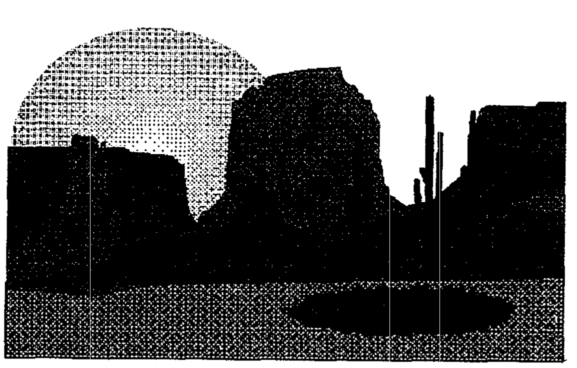
Table 1.2 Summary of Effective Dose Equivalents from NTS Operations during 1994

	Maximum EDE at NTS Boundary[a]	Maximum EDE to an Individual[b]	Collective EDE to Population within 80 km of the NTS Sources
Dose	0.157 mrem (1.6×10^{-3} mSv)	0.15 mrem (1.5×10^{-3} mSv)	0.52 person-rem (5.2×10^{-3} person-Sv)
Location	Site boundary 39 km SW of NTS CP-1	Amargosa Val., 42 km SW of NTS CP-1	33,740 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	1.6	1.5	-----
Background	124 mrem (1.24 mSv)	124 mrem (1.24 mSv)	3210 person-rem (32.1 person Sv)
Percentage of Background	1.3×10^{-1}	1.2×10^{-1}	1.6×10^{-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 39 km (24 mi) SW 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.

Introduction



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 until the present moratorium began. Historical testing has included: (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 1994. Limited non-nuclear testing has included controlled spills of hazardous material at the Liquefied Gaseous Fuels Spill Test Facility. 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 groundwaters and little or no surface water. These features afford protection to the inhabitants of the surrounding area from potential radiation exposures as a result of releases of radioactivity or other contaminants from operations on the NTS. Population density within 150 km of the NTS is only 0.5 persons per square kilometer versus approximately 29 persons per square kilometer in the 48 contiguous states. The predominant land use surrounding the NTS is open range used for livestock grazing with scattered mining and recreational areas.

In addition to the NTS operations, DOE/NV is accountable for eight non-NTS EG&G Energy Measurements, Inc. (EG&G/EM) facilities in eight different cities. In 1994, two EG&G/EM facilities were closed and one operation was taken over by another DOE contractor, leaving five EG&G/EM facilities in five different cities. The EG&G/EM 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.

The EPA's Environmental Monitoring Systems Laboratory in Las Vegas, Nevada (EMSL-LV), conducts hydrological studies at eight formerly used U.S. nuclear testing locations off the NTS. The last test conducted at any of these sites was in 1973 (Project RIO BLANCO in Colorado).

2.1 NTS OPERATIONS

2.1.1 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 3500 km^2 (1350 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 access exclusion areas, previously designated the Nellis Air Force Base (NAFB) Bombing and Gunnery Range and the Tonopah Test Range (Figure 2.1). These two areas comprise the Nellis Base Range, 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 Base Range and the NTS is one of the larger unpopulated land areas in the U.S., comprising some 14,200 km^2 (5470 mi^2). Figure 2.2 shows the general layout of the NTS, including the location of major facilities and area numbers referred to in this report. The areas outlined in green in Figure 2.2 indicate the principal geographical areas used for underground nuclear testing over the history of NTS operations. Mercury, Nevada, at the southern end of the NTS, is the main base camp for worker housing and administrative operations for the Site. Area 12 Base Camp, at the northern end of the NTS, was another major worker housing and operations support facility.

2.1.2 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 on the Nellis Base Range (see Figure 2.3). All nuclear tests have been listed in DOE/NV Report NVO-209 (DOE 1994).

Underground nuclear tests were first conducted in 1957. Testing was discontinued during a moratorium from November 1958 through September 1961. Four small atmospheric (surface) tests were conducted in 1961 and 1962 following the resumption of underground and atmospheric testing. Two additional safety test series were conducted in the mid-1960s, one on the previously designated NAFB Bombing and Gunnery Range and one on the Tonopah Test Range. Since late 1962 nearly all tests have been conducted in sealed vertical shafts drilled into the valley floor of Yucca Flat and the top of Pahute Mesa or in horizontal tunnels mined into the face of 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 (SEDAN) was detonated at the northern end of Yucca Flat.

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 (1530 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. Another series of tests with a nuclear ramjet engine was conducted in Area 26 by the Lawrence Livermore National Laboratory (LLNL), Livermore, California.

Limited non-nuclear testing has also occurred at the NTS, including spills of hazardous materials at the Liquefied Gaseous Fuels Spill Test Facility (LGFSTF) in Area 5. These tests, conducted 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 (DOT), and the DOE.

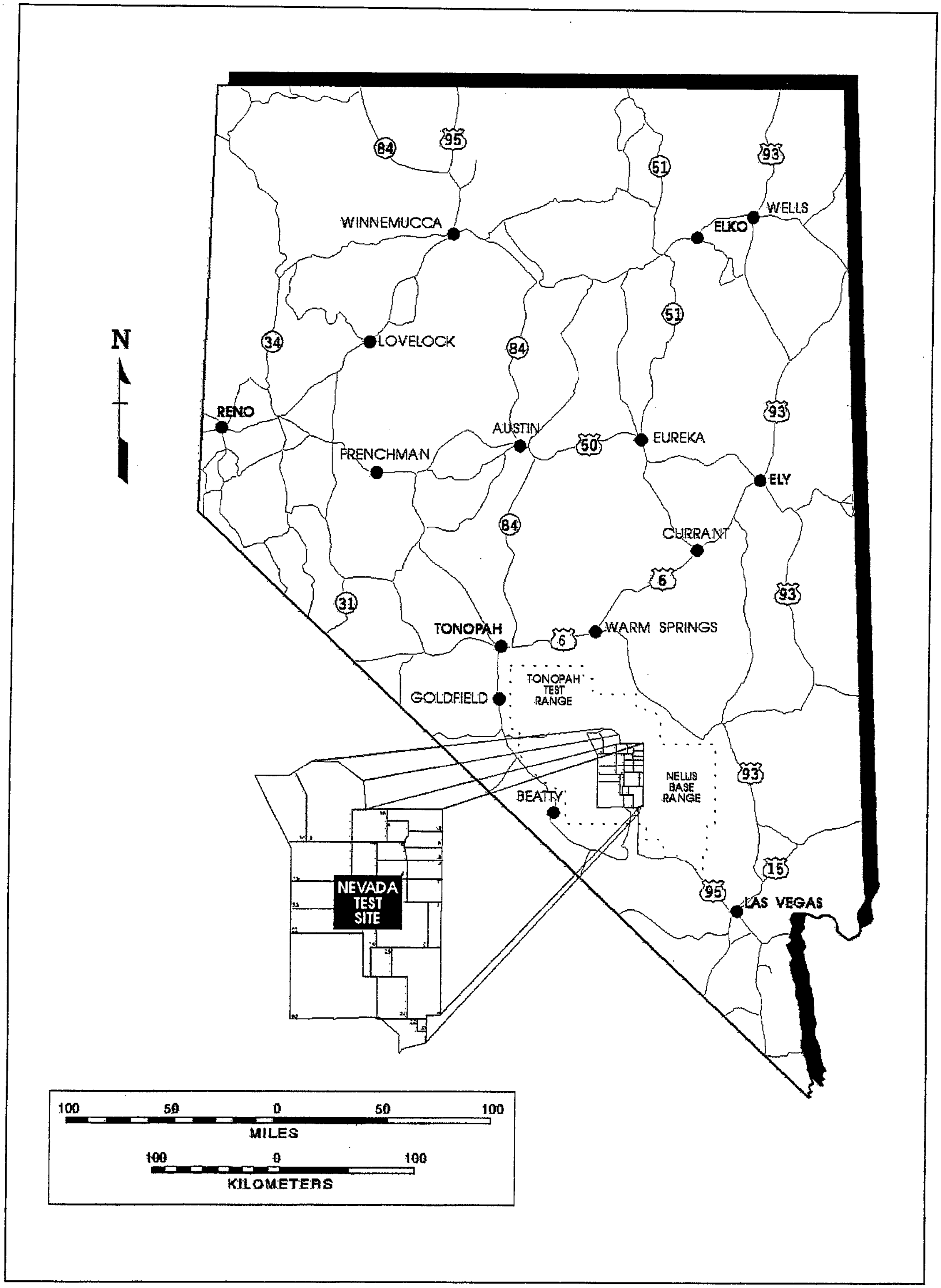


Figure 2.1 NTS Location

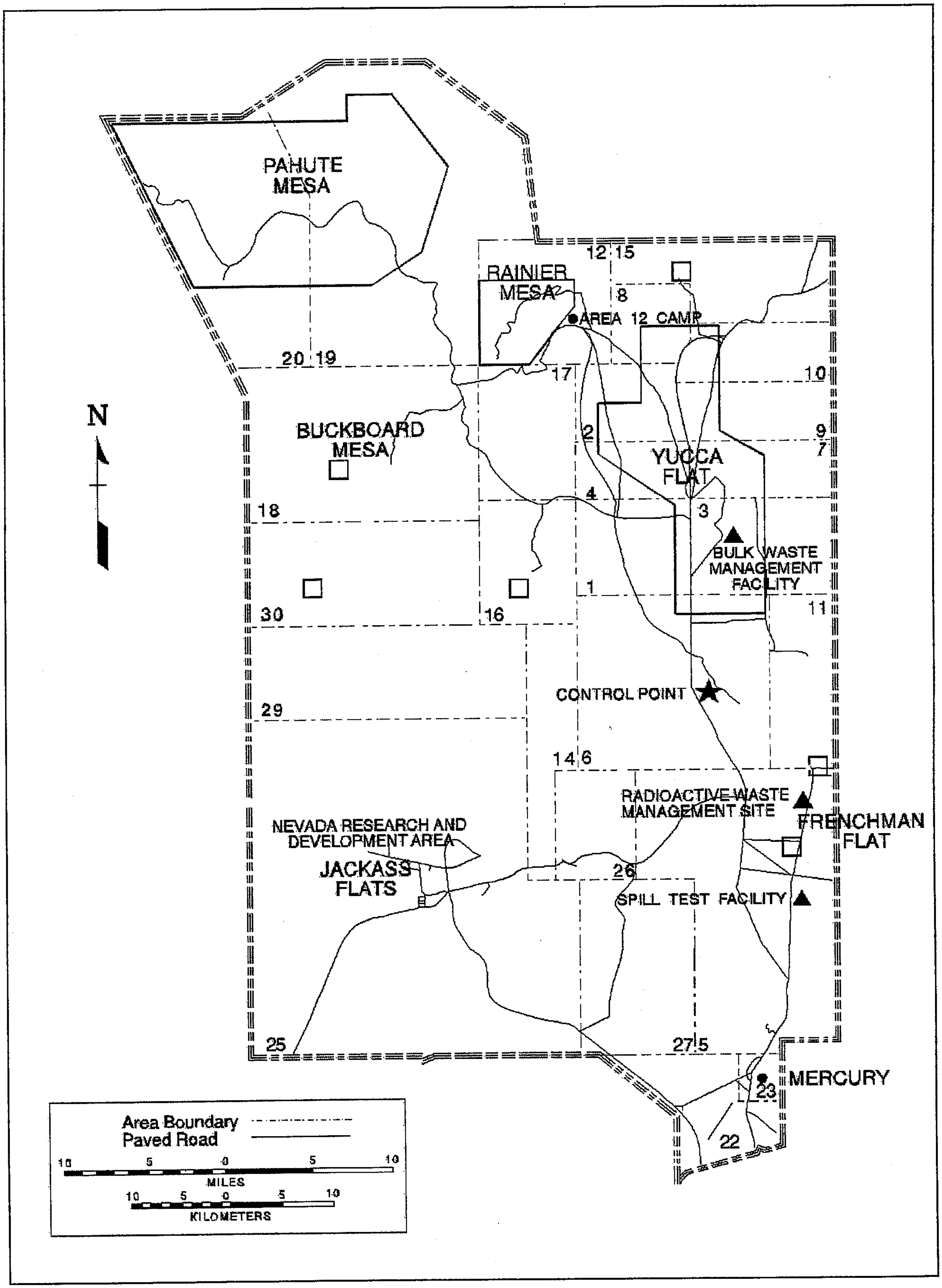


Figure 2.2 NTS Area Designations, Principal Facilities, and Testing Areas

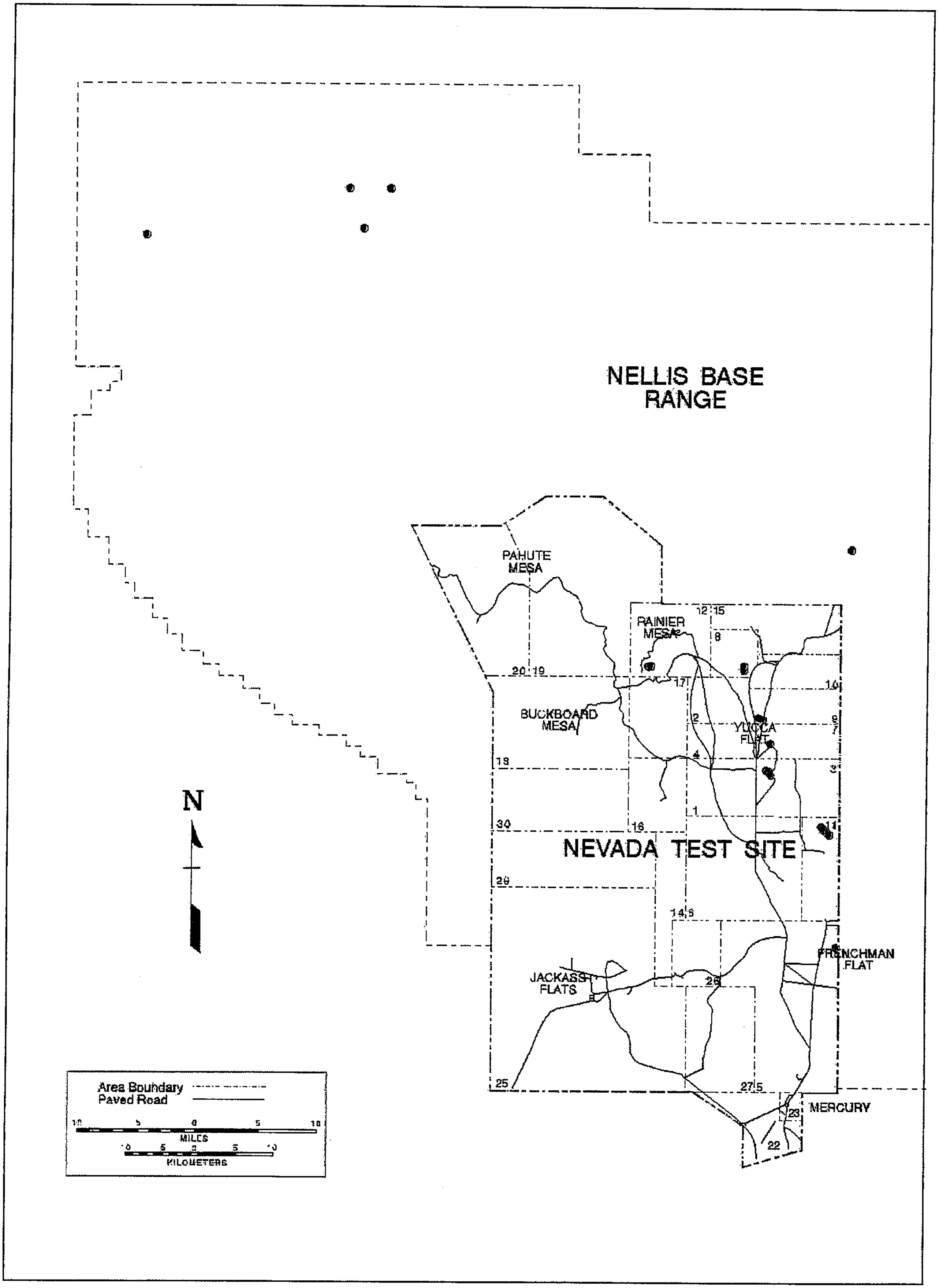


Figure 2.3 Location of Safety Shots in the Nellis Base Range

Waste storage and disposal facilities for defense radioactive and mixed waste are located in Areas 3 and 5. At the Area 5 Radioactive Waste Management Site (RWMS-5), low-level radioactive wastes (LLW) from DOE-affiliated onsite and offsite generators are disposed of using standard shallow land disposal techniques. The Greater Confinement Disposal technique which consists of deeper burial in 3 m (10 ft) diameter shafts 37.5 m (120 ft) deep also occurs at the RWMS-5. This technique was used for disposal of wastes that had high specific activity, high mobility, or were not acceptable at the Waste Isolation Pilot Plant (WIPP).

Transuranic wastes are retrievably stored in surface containers at the RWMS-5 pending shipment to the 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 RWMS-3 bulk LLW (such as debris from atmospheric nuclear test locations) and LLW in large non-standard packages, is emplaced and buried in selected surface subsidence craters (formed as a result of prior underground nuclear tests).

2.1.3 1994 ACTIVITIES

2.1.3.1 NUCLEAR TESTS

No nuclear explosives tests were conducted during 1994 due to the moratorium announced in late 1992. One exercise that was conducted was a drillback into the cavity formed by a nuclear test that was conducted in 1986. Also, 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 due to the prior 1054 nuclear tests. The surveillance program and results are described in Chapters 4 and 5.

2.1.3.2 LIQUEFIED GASEOUS FUELS SPILL TEST FACILITY (LGFSTF)

The U.S. Department of Energy's Liquefied Gaseous Fuels Spill Test Facility 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. The LGFSTF is maintained by EG&G/EM, and is the basic research tool for studying the dynamics of accidental releases of various hazardous materials.

Discharges from the LGFSTF 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 from 1,000 to 26,000 gpm with the capability to release the entire contents of two tanks in two minutes. The non-cryogenic system can release materials at rates of 500 to 5,000 gpm with the entire 24,000 gallons 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 gallons. An area has been added to provide the capability for determining the efficacy of totally encapsulated chemical 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 stations to gather wind speed and wind direction data and up to 41 sensor stations to gather data from a variety of sensors at various levels above ground. The array and associated data-acquisition system are linked to the LGFSTF control point by means of telemetry. The operation and performance of the LGFSTF are controlled and monitored from the Command Control and Data Acquisition System building located one mile from the test fluid spill area.

LGFSTF personnel monitor and record operating data, close-in and downwind meteorological data, and downwind gaseous concentrations. Calculation of the potential path of the test effluent is used to help control the test and monitor the data, which is done from a remote location. Eight series of spill tests were conducted in 1994.

2.1.4 TOPOGRAPHY AND TERRAIN

The topography of the NTS is typical of much 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 (3000 ft) above mean sea level (MSL) in the south and east, rising to 2230 m (7300 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.

2.1.5 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. As a result the NTS is probably one of the better geologically characterized large areas within the U.S. This is due to the large number of holes drilled onsite as shown in Figure 2.6.

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. Compared to the Paleozoic rocks, the Tertiary rocks are relatively undeformed, and dips are generally gentle. The alluvium is derived from erosion of Tertiary and Paleozoic rocks.

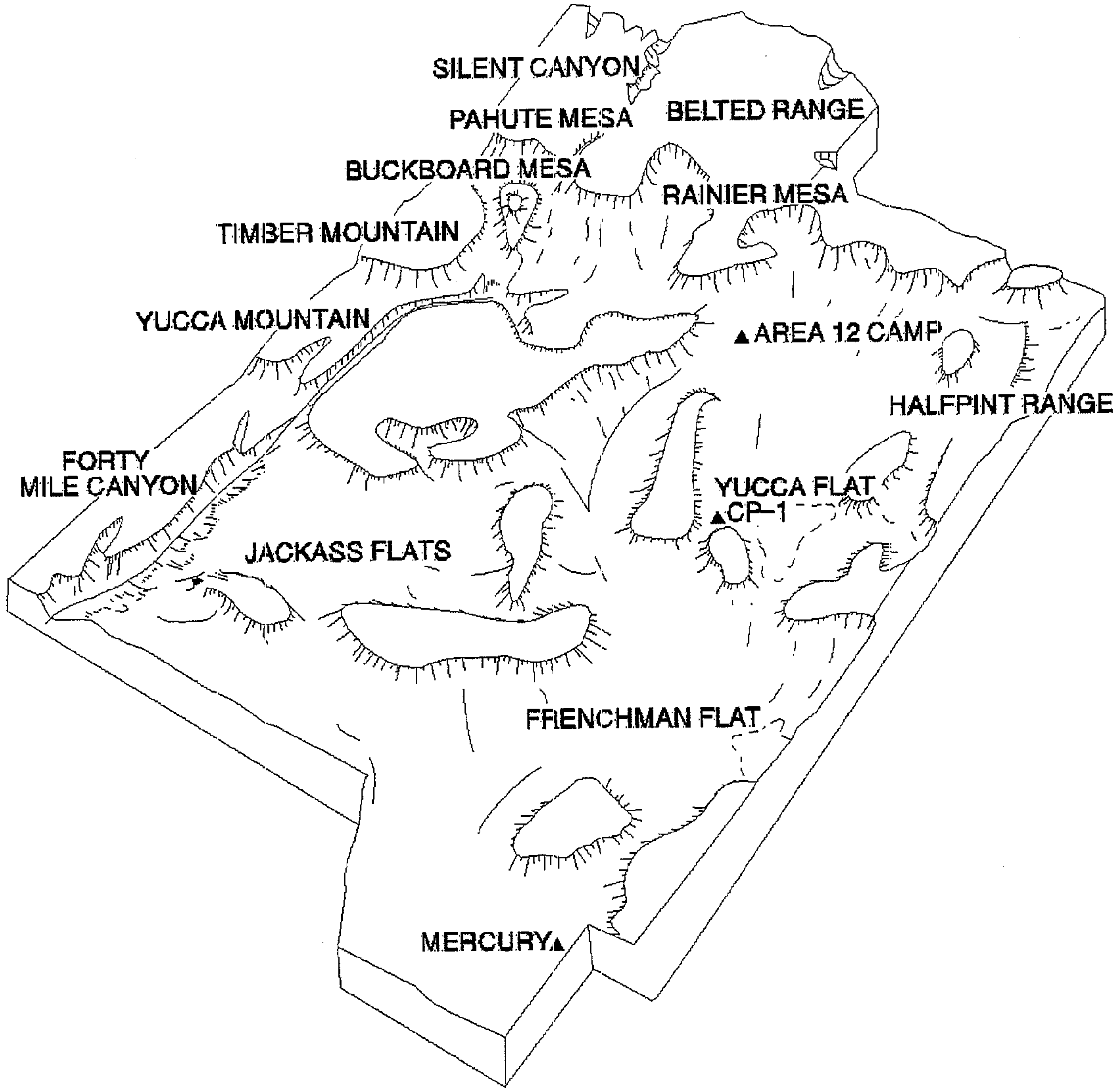


Figure 2.4 Topography of the NTS

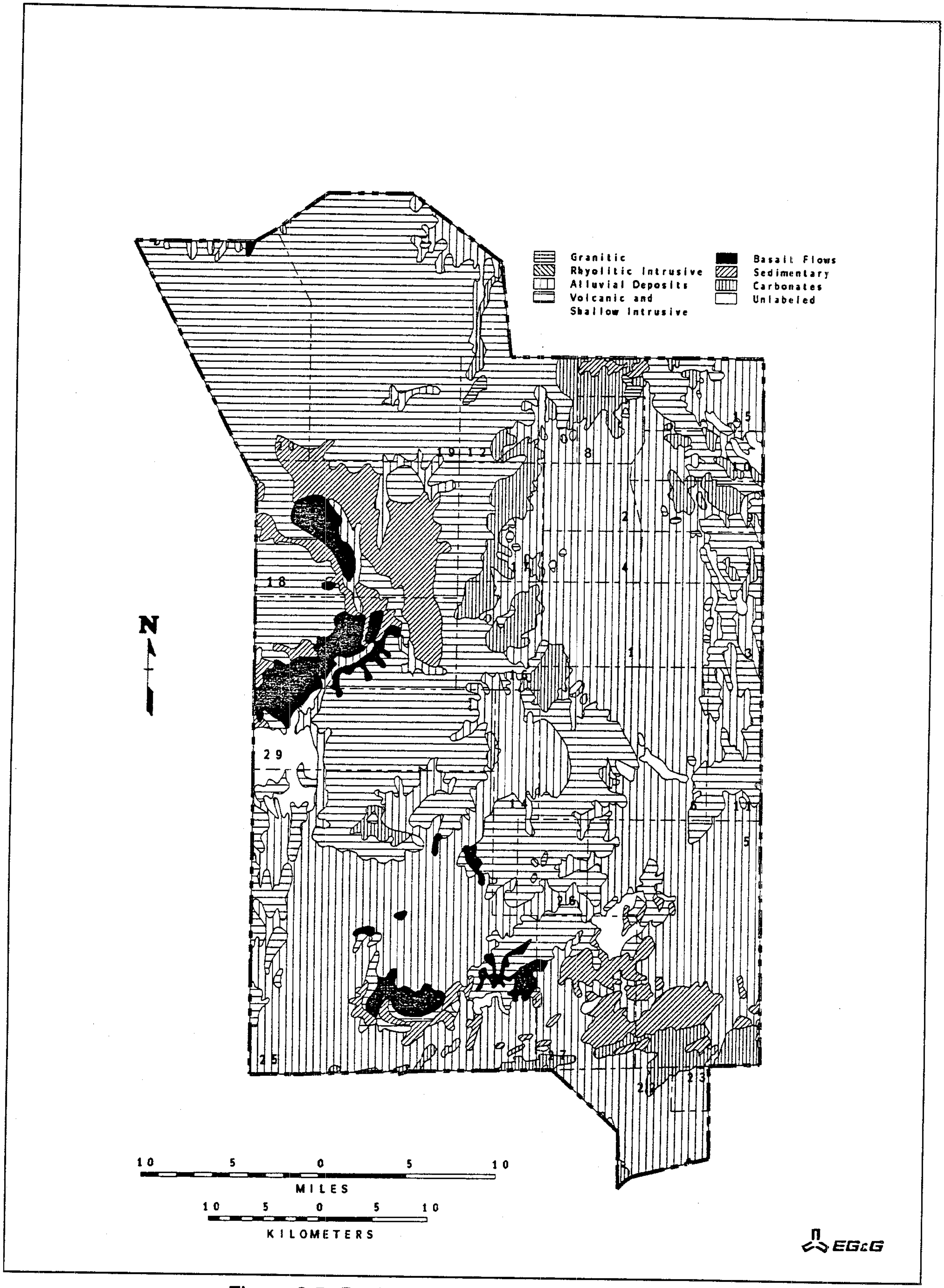


Figure 2.5 Basic Lithologic Structure of the NTS

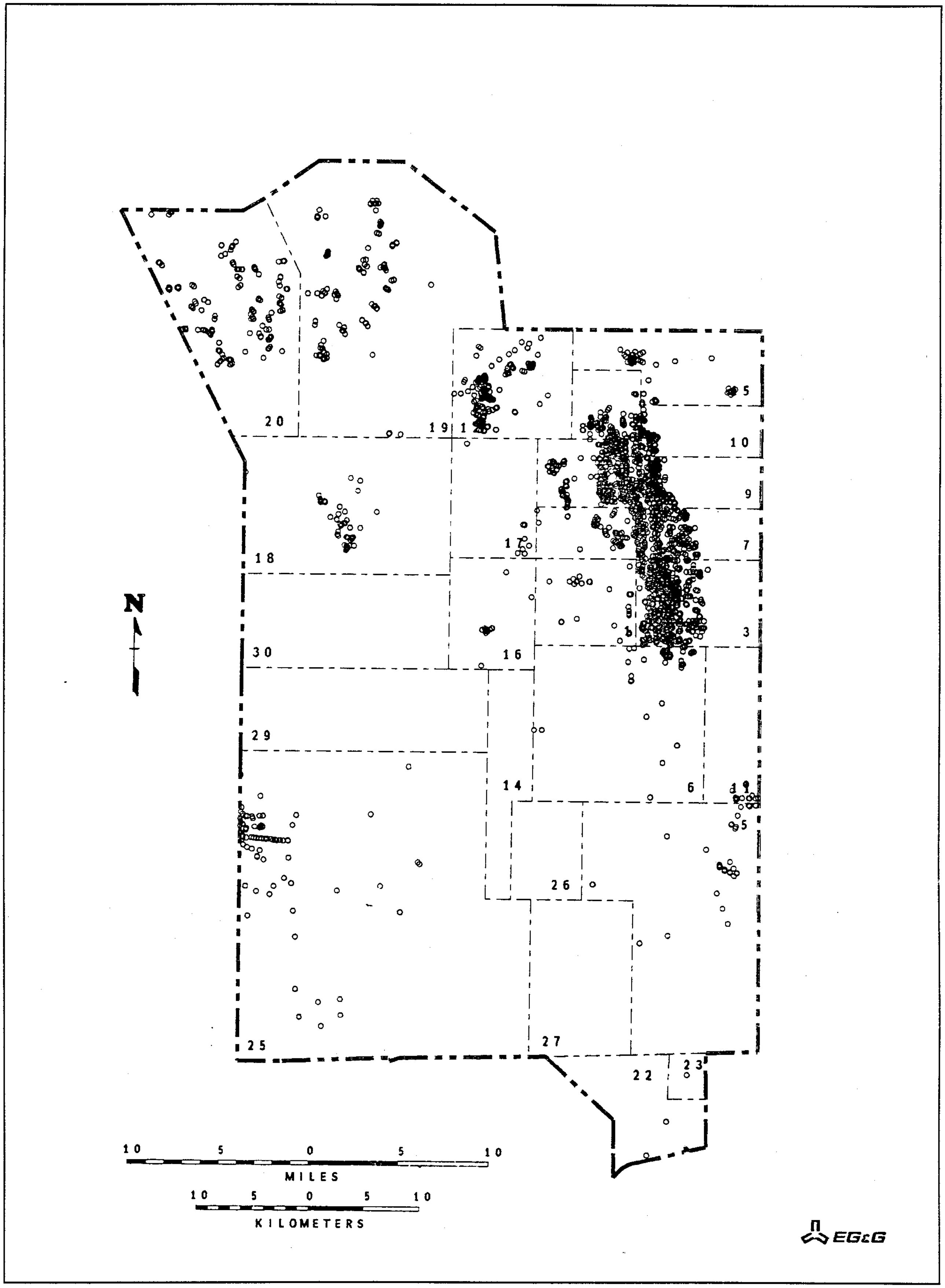


Figure 2.6 Drill Hole Locations on the NTS

The volcanic rocks of 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 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.

2.1.6 HYDROGEOLOGY

Some nuclear tests were conducted below the groundwater table, others were at varying depths above the groundwater table. 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. Nuclear tests below the water table have a greater potential for offsite migration. However, the great distance to offsite water supply wells or springs makes it unlikely for contaminants to be transported in significant quantities.

Depths to groundwater beneath 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 (2300 ft) beneath part of Pahute Mesa. In the eastern portions of the NTS, 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 is believed to 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 (1900 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 travels to 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.

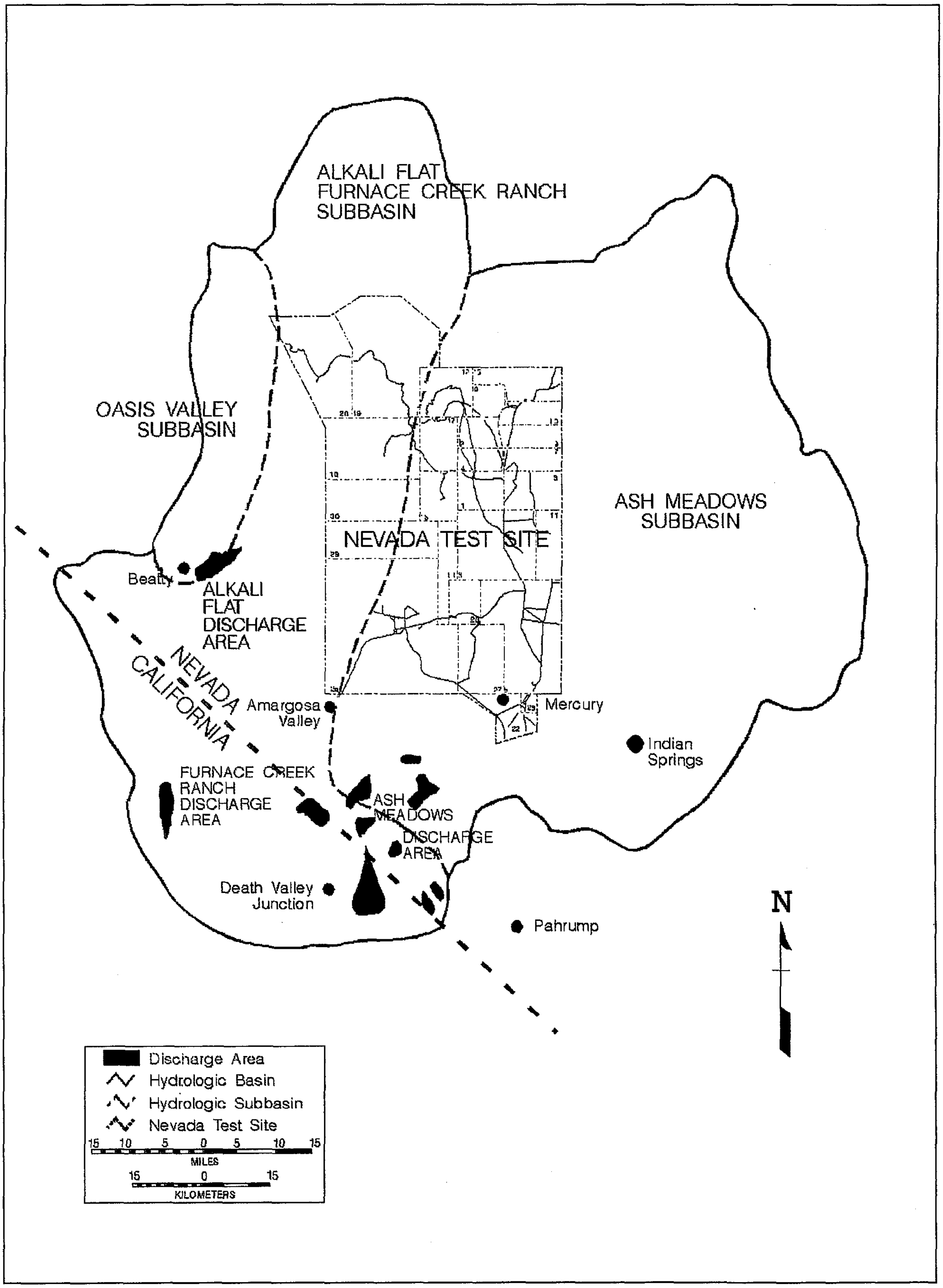


Figure 2.7 Groundwater Hydrologic Units of the NTS and Vicinity

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 1180 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 least 157 m (515 ft) beneath Frenchman playa increases to nearly 360 m (1180 ft) near the margins of the valley (Winograd and Thordarson 1975). 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 has not been defined and requires further investigation.

2.1.7 CLIMATE AND METEOROLOGY

Precipitation levels on the NTS are low, runoff is intermittent, and the majority of the active testing areas on the NTS drain into closed basins on the NTS. Annual precipitation in southern Nevada is very light and depends largely upon elevation. A characteristic of desert climates is the temporal and spatial variability of precipitation. Topography contributes to this variability. For example, on the NTS the mesas receive an average annual precipitation of 23 cm (9 in), which includes wintertime snow accumulations. The lower elevations receive approximately 15 cm (6 in) 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 2000 m (6560 ft) above MSL in Area 20 on Pahute Mesa, the average daily maximum temperatures range from 40 to 80° F, minimums from 21 to 57° F (4 to 27° C and -6 to 14° C, respectively). In Area 6 [Yucca Flat, 1200 m (3940 ft MSL)], the average daily maximums range from 51 to 96° F and the minimums from 28 to 62° F (11 to 36° C and -2 to 17° 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 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 ten-meter wind roses for the NTS are shown in Figure 2.8.

2.1.8 FLORA AND FAUNA

The greater part of the NTS is vegetated by various associations of desert shrubs typical of the Mojave or Great Basin Deserts or the zone of transition desert between these two. There are areas of desert woodland (piñon, juniper) at higher elevations. Even there, typical Great Basin shrubs, principally sagebrushes, are a conspicuous component of the vegetation. Although shrubs (or shrubs and small trees) are the dominant forms, herbaceous plants are well represented in the flora and play an important role in supporting animal life.

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 1220 and 1520 m (4000 and 5000 ft) in elevation in Yucca Flat, transitional associations are dominated by *Grayia spinosa-Lycium andersonii* (hopsage/desert thorn) associations, while the upper bajadas support *Coleogyne* types. Above 1520 m (5000 ft) the vegetation mosaic is dominated by sagebrush associations of *Artemisia tridentata* and *Artemisia arbuscula* subspecies *nova*. Above 1830 m (6000 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. Larger mammals include feral horses, burros, deer, mountain lions, bobcats, coyote, kit foxes, and rabbits. Reptiles include four species of venomous snakes. Bird species are mostly migrants or seasonal residents. Rodents are, in terms of distribution and relative abundance, the most important group of mammals on the NTS. Most nonrodent mammals have been placed in the "protected" classification by the state of Nevada.

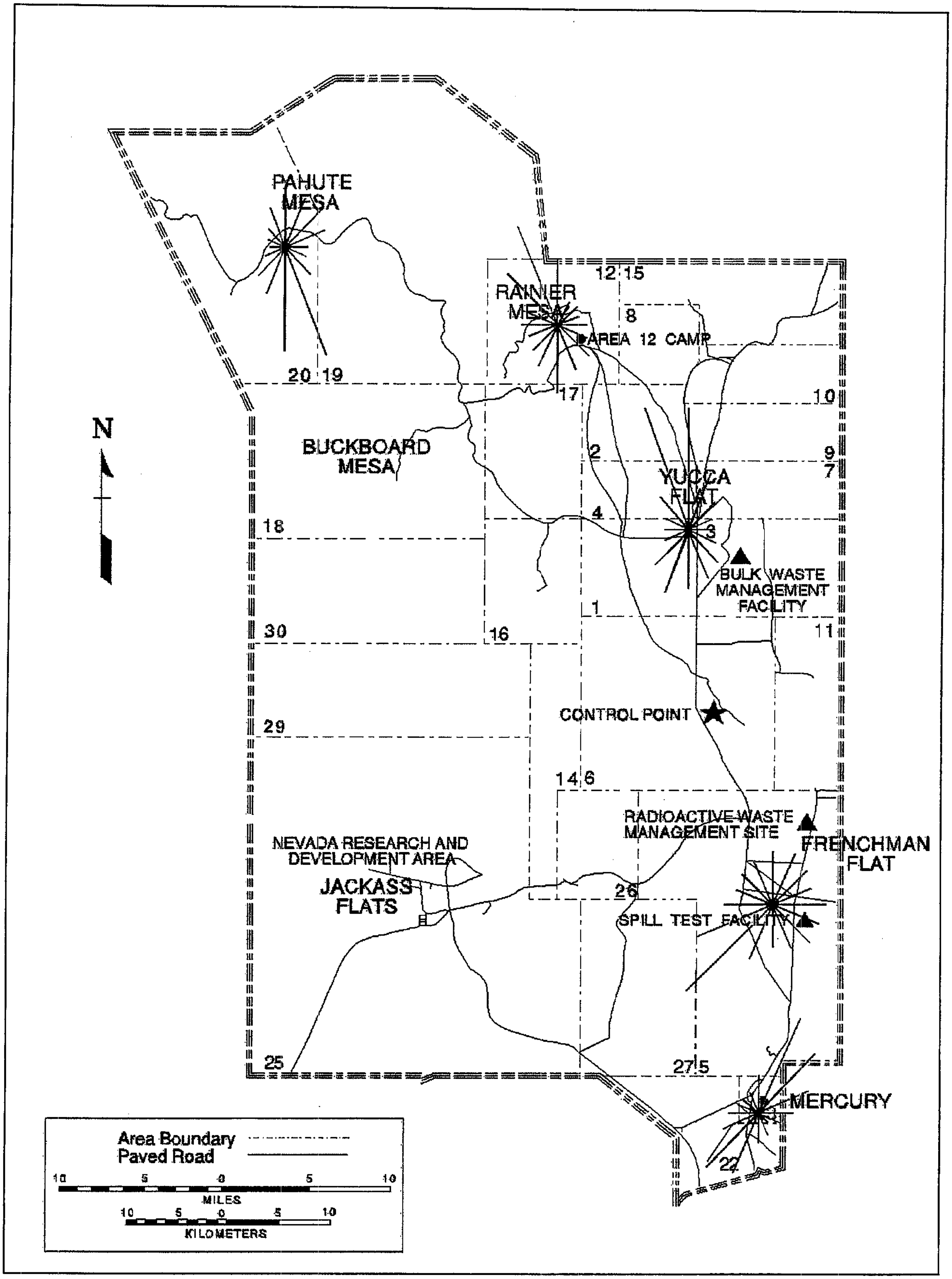


Figure 2.8 1992 Wind Rose Patterns for the NTS (Courtesy of Weather Services Nuclear Support Office, NOAA)

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 primary reasons for listing this population included deterioration and loss of habitat, collection for pets and other purposes, elevated levels of predation, loss of desert tortoises from disease, and the inadequacy of existing regulatory mechanisms to protect desert tortoises and their habitat. Tortoise habitat on the NTS is found in the southern third of the NTS outside the recent areas of nuclear test activities in Yucca Flat, Rainier Mesa, and Pahute Mesa.

2.1.9 CULTURAL RESOURCES

Human habitation of the NTS area ranges from at least as early as 10,000 years ago to the present. Various indigenous cultures occupied the region in prehistoric times. The survey of less than twenty percent of the NTS area has located more than two thousand 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 contact, the area was occupied by Paiute and Shoshone Indians.

Prior to 1940, the historic occupation consisted primarily of ranchers, miners and Native Americans. Several natural springs were able to sustain livestock and the ranches. 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 co-existed with the settlers and miners, utilizing the natural resources of the region and, in some cases, working for the new arrivals. The Native Americans 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 Nellis Air Force Base 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 established 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.

2.1.10 DEMOGRAPHY

The population of the area surrounding the NTS has been estimated based on 1990 Bureau of Census estimates (Department of Commerce 1990). Excluding Clark County, the major population center (over 900,000 in 1994), the population density within a 150-km (90-mi) radius of the NTS is about 0.5 persons per square kilometer. In comparison, the 48 adjoining states (1990 census) had a population density near 29 persons per square kilometer.

The offsite area within 80 km (50 mi) of the NTS Control Point 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 80 km (50 mi) south of CP-1. The Amargosa Farm area, which has a population of about 950, 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 1500 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 5000 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 1992 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 3500.

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 1991 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 1991 population estimate of 22,000, and Kingman, located 280 km (174 mi) southeast of the NTS, with a population of about 13,000.

2.1.11 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 4400 m (14,500 ft) above MSL in the Sierra Nevada Range, including parts of two major agricultural valleys (the Owens and San Joaquin). The areas south of the NTS are more uniform since the Mojave Desert ecosystem (mid-latitude desert) comprises most of this portion of Nevada, California, and Arizona. The areas east of the NTS are primarily mid-latitude steppe with some of the older river valleys, such as the Virgin River Valley and Moapa Valley, supporting irrigation for small-scale but intensive farming of a variety of crops. Grazing is also common in this area, particularly 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 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.

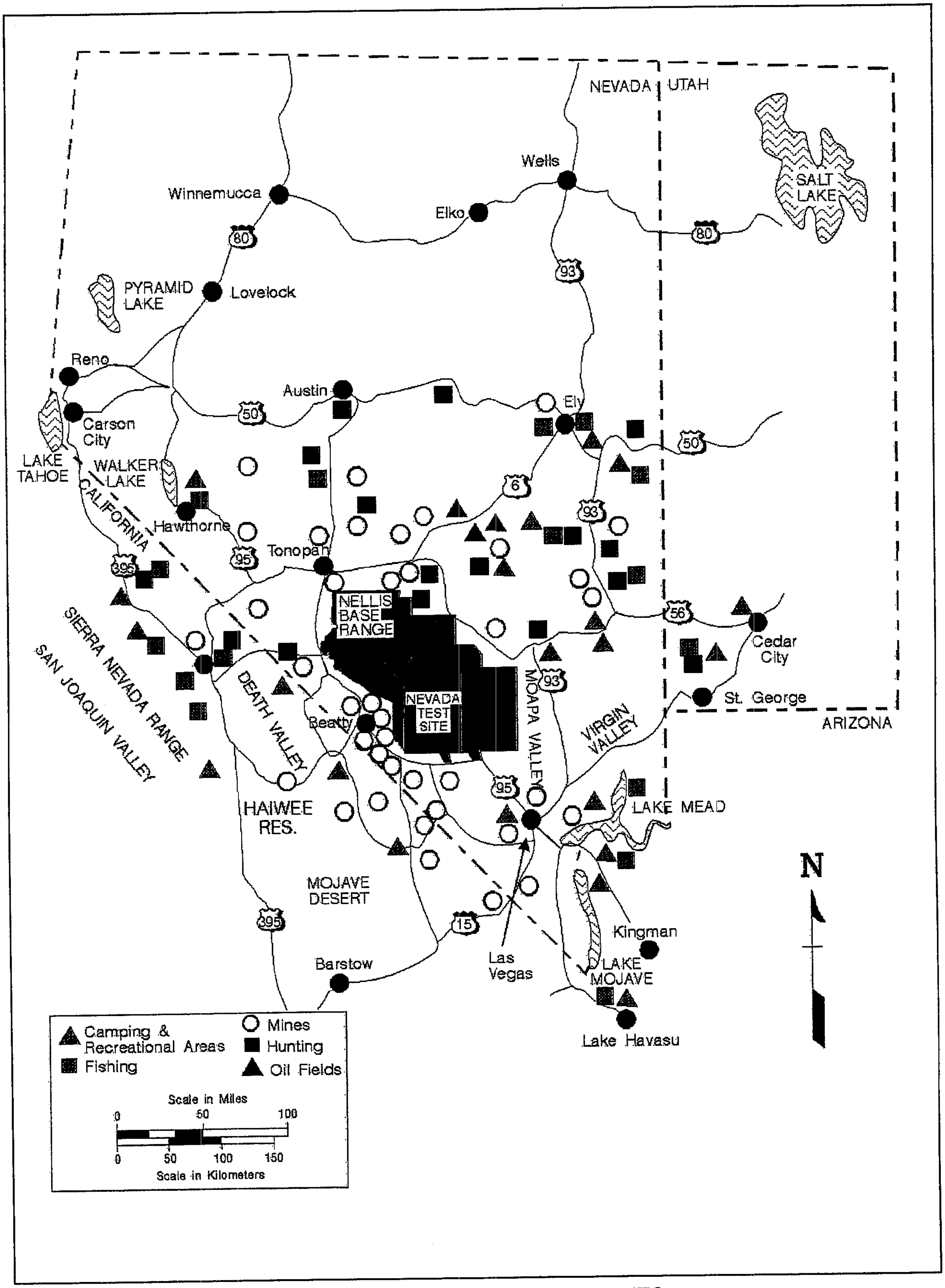


Figure 2.9 Land Use Around the NTS

2.2 NON-NTS FACILITIES

EG&G/EM has several offsite operations in support of activities at the NTS under a contract with the DOE/NV. Those that are operational in support of NTS activities are described in the following sections. Allied Signal Corporation took over the Kirtland Operations during 1994. Woburn Cathode-ray Tube Operations and Santa Barbara Operations shut down in 1994. Each of these facilities is located in a metropolitan area.

City, county, and state regulations govern emissions, waste disposal, and sewage. No independent EG&G/EM 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 possible during normal facility operations.

2.2.1 AMADOR VALLEY OPERATIONS (AVO)

The AVO facility in Pleasanton, California, occupies a 5520 m^2 (59,445 ft^2) two story combination office/laboratory building. AVO is located near the Lawrence Livermore National Laboratory (LLNL) in Livermore, California, to simplify logistics and communications associated with EG&G/EM support of LLNL programs. Most of the work is in support of NTS underground weapons testing, but 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.

2.2.2 KIRTLAND OPERATIONS (KO)

KO at Kirtland Air Force Base (KAFB) and in Albuquerque, New Mexico, consists of a 5200 m^2 (56,000 ft^2) complex of prefabricated metal buildings located on 16 ha (39.5 acres) at KAFB, and a 3250 m^2 (35,000 ft^2) industrial facility, called the Craddock Facility, located near the Albuquerque International Airport. KO provides technical support to Sandia National Laboratories (SNL), the DOE, the Department of Defense (DOD), and other federal agencies. In conjunction with DOE work, KO provides significant support to a variety of ongoing safeguards and security programs. KO is also responsible for operation of the System Control and Receiving Station (SCARS), a part of the DOE Remote Seismic Test Network (RSTN). Areas of environmental interest include small solvent cleaning and painting operations.

2.2.3 LAS VEGAS AREA OPERATIONS (LVAO)

The LVAO includes the North Las Vegas facility and the Remote Sensing Laboratory on the Nellis Air Force Base (NAFB) in North Las Vegas, Nevada. These facilities provide technical support for the DOE/NV test program.

The North Las Vegas facility 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 Remote Sensing Laboratory 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, and warehousing. Areas of environmental interest are photo processing and aircraft maintenance and operations.

2.2.4 LOS ALAMOS OPERATIONS (LAO)

The LAO resides in a facility of approximately 6040 m^2 (65,000 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 of the LANL testing program, the DOE Research and Development (R&D) 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 nuclear testing diagnostics and the analysis of data from underground and high-altitude experiments. In addition, two LAO operations build and field CORRTEX III recorders. Areas of environmental interest include small solvent cleaning, alodining, metal machining operations, and a small photo laboratory.

2.2.5 SANTA BARBARA OPERATIONS (SBO)

SBO occupies two facilities located in Goleta, California. The Robin Hill Road Facility, comprising 3700 m^2 (40,000 ft^2), includes a mercuric iodide crystal laboratory and a specialized radiation research building that houses the DOE-EG&G/EM linear accelerator (LINAC) with accompanying laboratories. Located at the Francis Botello Road Facility, 1130 m^2 (12,174 ft^2), is a small machine shop, laboratory buildings, and a source range.

In support of the DOE/NV, the SBO was established for R&D work in nuclear instrumentation and measurements with emphasis on radiation detectors, data acquisition systems, and fast pulse electronics. Through the years its facilities have been adapted to a wide range of R&D tasks. The SBO also describes and assesses the potential ecological impacts of various DOE projects on ecological systems of interest. Activities of environmental interest include a mercuric iodide laboratory (where mercuric iodide crystals are grown), minor solvent operations, and several fume hoods.

2.2.6 SPECIAL TECHNOLOGIES LABORATORY (STL)

The STL located in Santa Barbara, California, consists of approximately 3340 m^2 (36,000 ft^2) of a secure combination office/laboratory area 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 and a small vapor degreaser.

2.2.7 WASHINGTON AERIAL MEASUREMENTS DEPARTMENT (WAMD)

The WAMD, located at Andrews Air Force Base, consists of a 186 m^2 (2000 ft^2) Butler building used as office space; a 1110 m^2 (12,000 ft^2) combination electronics laboratory, aircraft maintenance, and office complex; and a portion of a large aircraft hangar. WAMD operations provide an effective East Coast Nuclear Emergency Search Team (NEST) response capability and an eastern aerial survey capacity to the DOE/NV. Areas of environmental interest include small solvent cleaning operations and used fuels and oils.

2.2.8 WOBURN CATHODE-RAY TUBE OPERATIONS (WCO)

The WCO in Woburn, Massachusetts, is comprised of a 1300 m^2 (14,000 ft^2) facility which is used to develop and manufacture advanced cathode-ray tubes and oscilloscopes in support of the DOE/NV LANL weapons test program. Areas of environmental interest include small solvent cleaning operations and several laboratory hoods, and a dry well for discharging uncontaminated, non-contact cooling water.

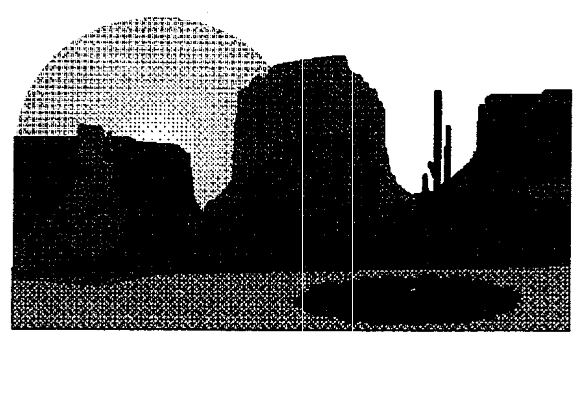
2.3 NON-NTS UNDERGROUND EVENT SITES

Previously, 11 nuclear tests were conducted for a variety of purposes at eight different non-NTS sites in the U.S. The events and their locations that were sampled in 1994 appear in Table 2.1. Activities at these locations generally are limited to annual sampling at over 200 wells, springs, and other sources at locations near sites where nuclear explosive 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 in odd numbered years. Sampling results for these sites appear in Chapter 9 of this volume.

Table 2.1 Non-NTS Nuclear Underground Test Sites Studied in 1994

Event Name	Location	Date of Test
GNOME	Carlsbad, New Mexico	12/10/61
SHOAL	Fallon, Nevada	10/26/63
SALMON (Dribble)	Hattiesburg, Mississippi	10/22/64
STERLING (Dribble)	Hattiesburg, Mississippi	12/03/66
GASBUGGY	Farmington, New Mexico	12/10/67
FAULTLESS	Central Nevada, Nevada	01/19/68
RULISON	Grand Valley, Colorado	09/10/69
RIO BLANCO	Rifle, Colorado	05/17/73

Compliance Summary



3.0 COMPLIANCE SUMMARY

Environmental compliance activities at the Nevada Test Site (NTS) during calendar year 1994 involved the permitting and monitoring requirements of numerous state of Nevada and federal regulations. Primary activities included: (1) National Environmental Protection Act (NEPA) documentation preparation; (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 (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 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. There were no activities requiring compliance with Executive Orders on Flood Plain Management or Protection of Wetlands.

Throughout 1994 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 United States Fish and Wildlife Service (USFWS) for protection of the desert tortoise; a Memorandum of Understanding with Nevada covering releases of radioactivity; Agreements in Principle with Nevada and Mississippi covering Environment, Safety, and Health (ES&H) activities; and a Settlement Agreement to manage mixed transuranic (TRU) waste. Emphasis on waste control and minimization at the NTS continued in 1994.

In June 1994 the state of Nevada filed a Complaint for Declaratory Judgement and Injunction against the Department of Energy (DOE). This action is seeking a judgement that DOE has failed to comply with NEPA requirements at the NTS. This action further seeks to halt all shipment of waste to NTS, and enjoin NTS from conducting any "Weapons Complex" activities until completion of a site wide Environmental Impact Statement.

Compliance activities at DOE/NV non-NTS facilities operated by EG&G/Energy Measurements, Inc. (EG&G/EM), involved the permitting and monitoring requirements of: (1) the Clean Air Act for airborne emissions, (2) the Clean Water Act for wastewater discharges, (3) state SDWA regulations, (4) RCRA disposal of hazardous wastes, and (5) hazardous substance reporting. Waste minimization efforts continued at all EG&G/EM operations.

3.1 COMPLIANCE STATUS

3.1.1 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.

The DOE/NV NEPA training course implemented by the Environmental Protection Division (EPD) and first presented in 1993, has been presented a total of four times through calendar year 1994. The DOE/NV NEPA Compliance Guide (Volume III), a quick-reference handbook containing procedures, formats, and guidelines, underwent a major revision in response to the new Secretarial Policy on NEPA, dated June 13, 1994.

On October 24, 1994, in accordance with the new Secretarial Policy on NEPA, DOE/NV requested full delegation of authority for Environmental Assessments (EAs), issuing Findings of No Significant Impact, and associated floodplain and wetland action documentation relating to DOE/NV proposed actions. In support of this request for delegation of authority, EPD prepared the necessary Internal Scoping Procedures, Public Participation Plan, and Quality Assurance Plan. The requested authority was delegated to DOE/NV by the Assistant Secretary for ES&H on November 2.

Within DOE there are three levels of documentation used to comply 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 Environmental Assessment (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, based on similar past activities, has been found to have no adverse environmental impacts. During 1994 DOE/NV was involved in activities under all three of these categories.

A Notice of Intent to prepare a site wide EIS for the Nevada Test Site (NTS) and other offsite test locations within the state of Nevada, including the Tonopah Test Range, portions of Nellis Air Force Range, the Project SHOAL site, and the Central Nevada Test Area, was published in the Federal Register on August 10, 1994. A series of public scoping meetings and other related briefings for the site wide EIS were conducted at various locations within Nevada and southwestern Utah. The public scoping period for the EIS ended November 10.

Work was conducted on ten EAs during 1994. They include:

(1) Liquified Gaseous Fuels Spill Test Facility, NTS, Area 5 (DOE/EA-0864)--approved and distributed as a final on December 7.
(2) Nevada Support Facility, at the north Las Vegas Facility, North Las Vegas, NV (DOE/EA-0955)--reviewed by the state of Nevada and local officials and in final rewrite at the end of 1994.
(3) Device Assembly Facility, NTS, Area 6 (DOE/EA-0971).
(4) Interim Storage of Nuclear Weapons at the NTS, Area 27 (DOE/EA-1031).

(5) Waste Examination Complex (within the Radioactive Waste Management Site), NTS, Area 5[1].
(6) TRU Waste Certification Building (within the Radioactive Waste Management Site), NTS, Area 5[2].
(7) Liquid Waste Treatment System, NTS, Area 6.
(8) Sewage Lagoon System, at the Radioactive Waste Management Site, NTS, Area 5--reviewed by state of Nevada and in final rewrite at the end of 1994.
(9) Fire Training Facility, NTS, Area 23.
(10) Solid Waste Disposal, NTS, Areas 5, 9, and 23.

Sixty-seven CX documents were processed during 1994 by DOE/NV.

In addition to these NEPA documents, the NTS is also being considered as an alternative site for proposed activities being analyzed in NEPA documents prepared by other DOE offices. These include: (1) Tritium Supply and Recycling Programmatic EIS, (2) Stockpile Stewardship and Management Programmatic EIS, (3) Waste Management Programmatic EIS, (4) Pantex Site Wide EIS, (5) Fernald Operable Unit 4 RI/FS/EIS, (6) Spent Nuclear Fuel Programmatic EIS, (7) Foreign Spent Nuclear Fuel EIS, and (8) Storage and Disposition of Fissile Nuclear Materials Programmatic EIS.

3.1.2 CLEAN AIR ACT

Clean Air Act and 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 were no criteria pollutant or prevention of significant deterioration monitoring requirements for NTS operations.

3.1.2.1 NTS NESHAP ASBESTOS COMPLIANCE

The state of Nevada, Division of Occupational Safety and Health, regulations (Nevada Revised Statutes [NRS] 618.760-805) require that all asbestos abatement projects in Nevada, involving friable asbestos in quantities greater than or equal to 3 linear ft or 3 ft^2, submit a Notification Form. Notifications are also required to be made to the EPA Region 9 for projects which disturb greater than 260 linear ft or 160 ft^2 of asbestos-containing material in accordance with 40 C.F.R. 61.145-146.

During 1994, four state of Nevada notifications were made, but no projects required notification to EPA Region 9. A list of these notifications appears in Table 3.1. Reynolds Electrical & Engineering Co., Inc. (REECo), collected and analyzed bulk, occupational, environmental, and clearance samples for these projects. The annual estimate for non-scheduled asbestos demolition/renovation for FY 1995 was sent to EPA Region 9 in November 1994.

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[1] Following DOEs determination to proceed with preparations of the NTS, site wide EIS, all further work on this EA was terminated.

[2] Further work on this EA was suspended pending DOE/HQ's programmatic approval of the transuranic (TRU) waste certification facility.

3.1.2.2 RADIOACTIVE EMISSIONS ON THE NTS

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

There are three locations on the NTS where airborne radioactive effluents may be emitted from permanent stacks: (1) the tunnels in Rainier Mesa, (2) clothes dryers for the anti-contamination clothing laundry facility (although most of the radioactivity removed from this clothing is in the wash water), and (3) the analytical laboratory hoods in the town of Mercury. Based on the amount of radioactivity handled, the exhausts from the laundry and the analytical laboratories are considered negligible compared to other sources on the NTS. Diffuse sources, which are difficult to monitor, include seepage of noble gases from the ground caused by barometric pressure variations, evaporation of tritiated water from containment ponds, diffusion of tritiated water vapor from the Radioactive Waste Management Site, Area 5 (RWMS-5), and resuspension of plutonium contaminated soil from safety and atmospheric test locations.

In the 1994 NTS NESHAP report for airborne radioactive effluents (Black 1995), effluents from the tunnel ventilation systems were not reported because the tunnels were inactive. The airborne emission of tritiated water vapor from the containment ponds was conservatively reported as if all the liquid discharge into the ponds had evaporated and become airborne. For tritiated water vapor diffusing from the RWMS-5, plutonium particulate resuspension from Areas 3 and 9, and seepage of ^{85}Kr from Pahute Mesa, 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 CAP88-PC software 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.

Using these best estimates of air emissions in 1994 as input to the CAP88-PC computer software model, the maximum potential individual EDE would have been only 0.15 mrem, much less than the 10 mrem limit specified in 40 C.F.R. 61.

3.1.2.3 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 1993 Air Quality Permit Data Report was sent to the state of Nevada on April 11, 1994. This report includes aggregate production, operating hours of permitted equipment, and a report of all surface disturbances of five acres or greater. Hourly production rates slightly exceeded permit specifications for two facilities, so modifications were sent to the state for the Area 1 Sandbag Facility and the Area 1 Aggregate Plant permit.

NTS air quality permits limit particulate emissions to 20 percent opacity. Certification to perform visible emissions opacity evaluations is required by the state, with recertification required every six months. During 1994, seven REECo Environmental Compliance Office personnel and five operational personnel were certified and/or recertified. In 1994 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 20 percent opacity requirement, corrective action is initiated. Only the Area 1 Rotary Dryer exceeds the 20 percent opacity requirement. Some modifications were made in 1993 to improve the situation, and final modifications are currently under way to bring the dryer into full compliance (see Section 3.2.1).

During 1994 state of Nevada personnel conducted several inspections of NTS equipment permitted under air quality operating permits or permits to construct. No findings or violations were issued.

3.1.2.4 NON-NTS EG&G/EM OPERATIONS

There are no activities that might produce radioactive effluents at any of the eight EG&G/EM operations with NTS projects. Clean Air Act issues involve only the nonradiological emissions covered by local permit requirements.

Air quality operating permits were required for three of the eight EG&G/EM operations. There were no effluent monitoring requirements associated with these permits. Compliance for each of these specific permits is discussed below.

Ninety-five emission units at the EG&G/EM, Las Vegas Area Operation (LVAO), which includes the North Las Vegas Facility (NLVF) and the Remote Sensing Laboratory (RSL), were regulated during 1994 under conditions of 28 permits issued by the Clark County Health District (CCHD), Las Vegas, Nevada. An air emissions update report was sent to DOE/NV on November 19, 1994, for submittal to the CCHD.

EG&G/EM, Amador Valley Operations (AVO) holds an operating permit issued by the Bay Area Air Quality Management District (BAAQMD) for two solvent cleaning operations. The permit places limits on the annual quantity of materials used and imposes record keeping requirements. Local air pollution regulations require businesses to discontinue use of aerosol spray paints containing more than 67 percent organics. Compliance has been maintained, and no routine monitoring activities have been required.

The County of Santa Barbara, Air Pollution Control District (APCD), issued a permit to EG&G/EM, Special Technologies Laboratory (STL) to operate a vapor degreaser. Permit conditions include throughput limitations and record keeping requirements.

EG&G/EM, Woburn Cathode Ray Tube Operations (WCO) was required to limit use of 1,1,1-trichloroethane to no more than one ton per year pursuant to a "Plans Approval" certificate (not an operating permit) issued by the local regulatory authority. Compliance has been maintained, and no routine monitoring or reports have been required.

3.1.3 CLEAN WATER ACT

The Federal Water Pollution Control Act, as amended by the Clean Water Act, establishes ambient water quality standards and effluent discharge limitations which are generally applicable to facilities which discharge any materials onto 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 DOE/NV facilities as there are no wastewater discharges to onsite or offsite surface waters.

3.1.3.1 NTS OPERATIONS

Discharges of wastewater are regulated by the state of Nevada under the Nevada Water Pollution Control Act. 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 all ten active sewage treatment facilities on the NTS, was issued by the Nevada Division of Environmental Protection (NDEP), and became effective on February 1, 1994. A meeting was held at the NDEP Carson City office with DOE, REECo and state representatives to discuss specific limits and requirements in the permit. Hydrogeological modeling utilizing site specific soil characteristics instead of vadose zone or groundwater monitoring, or lining all impoundments was accepted by the state as a method to comply with groundwater protection requirements.

Compliance with sewage lagoon discharge permit requirements was achieved with one exception. Automatic sampling equipment at the Area 6 Yucca Lake, Area 12, Area 22 Gate 100, and the Area 23 Mercury sewage lagoon facilities was found to be obtaining time weighted composite samples. The general permit requires flow weighted composite samples for locations equipped with automatic monitoring equipment. Time weighted composite samples will continue to be taken at the Area 12 facility. This sampler will be activated once per day at the existing low flows with the flow meter and sampler adjusted to their lower limits.

The general permit required the submittal of a Compliance Schedule which identified tasks for the determination of optimal methods for groundwater protection at each facility. The Compliance Schedule was approved by NDEP on June 29, 1994. The approved schedule requires that an Action Outline will be submitted to NDEP for review and approval 30 days prior to the start of each fiscal year. The Action Outlines become part of the Compliance Schedule and are subject to enforcement by NDEP if projects or portions of projects are not completed as indicated. One of four options for groundwater protection must be implemented at all active sewage lagoon facilities by January 31, 1999. A Compliance Evaluation of the acceptable methods to comply with the groundwater protection program was performed for each active sewage lagoon site. The most cost effective and feasible method was designated for each facility. Tentative actions for each fiscal year through 1998 have been developed to distribute projects over the life of the permit.

NDEP approved an Operations & Maintenance Manual for all the sewage lagoon facilities in November 1994 as required by the general permit. The state has recognized that facility usage is continually changing on the NTS, which often results in some primary lagoons not maintaining a three-foot minimum depth. The state recommends that reasonable attempts be employed to preserve the biomass, but extraordinary, costly, or labor intensive efforts are not required. The state also made recommendations for odor control. Negotiations with NDEP continue on the proposed General Permit for industrial wastewater discharges.

Compliance with the requirements in the U-12n Tunnel water pollution control permit was maintained throughout 1994. Mothballing of the tunnel was completed in April 1994. In May 1994 NDEP indicated that further monitoring for compliance with permit conditions could be suspended when conformance with the mothball plan had been established. The requirement for quarterly monitoring could be met by a simple statement on the absence of discharges until the permit is modified, revoked, or until otherwise instructed. The permit was voided by NDEP on its expiration date November 1994. Implementation of the Mothball Plan and monitoring of the plugs and seals were also found by NDEP to be satisfactory. A plan for plume investigation and mitigation was submitted to satisfy a requirement in the discharge permit. The investigations identified in this plan will become part of corrective actions to be addressed by the Federal Facilities Agreement and Consent Order.

State of Nevada compliance personnel routinely inspected the NTS sewage discharge lagoons and the U-12n Tunnel discharge ponds in 1994. No findings or notices of violation were issued for these permitted units.

3.1.3.2 NON-NTS EG&G/EM OPERATIONS

Permits for wastewater discharges were held for six non-NTS facilities. Monitoring and reporting were performed according to specific local requirements.

EG&G/EM, LVAO submitted self monitoring reports to local regulatory authorities for the NLVF and the RSL. The wastewater permit for the NLVF required biannual monitoring for two outfalls and monitoring of ten additional outfalls prior to discharging. NLVF monitoring reports were submitted in July and December 1994. RSL monitoring reports were submitted in June and December 1994.

EG&G/EM, Santa Barbara Operations (SBO) discontinued discharge of wastewater from the mercuric iodide laboratory. All wastewaters from this process are now treated offsite for disposal.

EG&G/EM, WCO submitted self monitoring reports required by wastewater discharge permit conditions to the Massachusetts Water Resources Authority.

No wastewater permits were held for EG&G/EM Kirtland Operations, Los Alamos Operations, or Washington Aerial Measurements Facility in 1994.

3.1.4 SAFE DRINKING WATER ACT

3.1.4.1 NTS OPERATIONS

The Safe Drinking Water Act (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.

As required under state health regulations, potable water distribution systems at the NTS are monitored for residual chlorine content and coliform bacteria. Monitoring results for 1994 are discussed in Section 7.1.1.1. There were no incidents of positive coliform in 1994.

NTS potable water distribution systems are also monitored for volatile organic compounds, inorganic compounds, and other water quality parameters. These monitoring results are discussed in Section 7.1.1.2. Volatile organic compounds were not detected in any NTS potable water distribution system. Primary water quality standards were met for all measured parameters. Some Nevada Secondary Standards were exceeded in well samples collected by the state in 1994. As shown in Table 7.2 none of these exceedances resulted in any regulatory action by the state, as the analytes pose no health risk. Analytes that remain high are Total Dissolved Solids in Wells C and C-1, and pH in Wells 5B and 5C.

3.1.4.2 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, the water is obtained from potable water fill stands, chlorinated in the truck, and then sampled for coliform bacteria. The state of Nevada decided during 1994 that water hauling trucks should be permitted as water distribution systems. Permits were obtained for the three trucks, and are listed in Chapter 4, Table 4.4.

In February, a routine sample from water haulage truck No. 84846 tested positive for the presence of coliform bacteria. Results were also positive for fecal coliform. A Stop Work Order was immediately issued, and the truck was removed from service, locked and tagged out. The water in the truck was super-chlorinated, drained, then the truck refilled with potable water and four samples collected. All samples tested negative for the presence of coliform, and the state allowed the truck to return to service.

3.1.4.3 NON-NTS EG&G/EM OPERATIONS

The EG&G/EM facility in Woburn, Massachusetts, has a dry well for discharging uncontaminated, noncontact cooling water into the ground. In January 1994, the Department of Environmental Protection Division of Water Pollution Control issued a new permit for this effluent. Permit conditions include self monitoring and monthly reporting. All parameters measured were found to be in compliance with permit conditions.

3.1.5 RESOURCE CONSERVATION AND RECOVERY ACT

The Resource Conservation and Recovery Act (RCRA) of 1976 and the Hazardous and Solid Waste Amendments (HSWA) of 1984 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 3.1.6.

3.1.5.1 NTS RCRA COMPLIANCE

Compliance activities under state of Nevada hazardous waste management regulations during 1994 included submission of revisions to the RCRA Part A and B application, submission of a biennial Waste Generator Report and response to state findings of alleged violation. The NDEP's Bureau of Federal Facilities staff routinely inspects NTS facilities and work sites.

As required under state of Nevada regulation, a Hazardous Waste Generator Report for Generator Identification Number NV3890090001 was sent to the state on March 30, 1994. As a result of a state review of this document in July 1994, it was discovered that the wording for one waste profile inadvertently included the words "non-regulated metals." A modification to the report was sent to the state in September 1994, changing the wording to reflect that the waste stream in question contained hazardous waste with regulated metals.

During 1994, DOE/NV revised and updated the RCRA Parts A and B permit applications. The application requested RCRA permits be issued for the management and operation of four NTS activities in Area 5 and one in Area 11. The finalized versions of the Part A and B permit applications were received back in December 1994, and the state will send them out for public comment in early 1995. A draft permit covering the Area 11 Explosives Ordinance Disposal (EOD) Facility and the Hazardous Waste Storage Facility, Area 5 (HWSF-5), will be sent by the state for review in early 1995.

On January 5, 1994, the state of Nevada and DOE/NV entered into a Mutual Consent Agreement, which will allow low level radioactive mixed wastes generated on the NTS to be moved into storage at the Area 5 RWMS TRU pad. A quantity of waste was already in storage at this facility and will continue to be held in storage until a final determination of the proper disposal technology is established by the EPA. Under the Federal Facilities Compliance Act, these mixed wastes are exempt from storage prohibitions in the Land Disposal Restrictions until October 6, 1995. NDEP has specified that this exemption may be extended for "...an even longer period, perhaps indefinitely."

In May 1994, the state performed an inspection of the DOE & REECo Waste Tracking System database using information supplied by DOE and REECo. The physical inspection of facilities to verify information in the database was performed on May 31, 1994. No violations of hazardous waste regulations were found during this inspection.

A Compliance Evaluation Inspection was conducted in July 1994 by personnel from EPA Region 9 and state of Nevada. The federal inspectors were evaluating the inspection being performed by the state.

The state issued four Findings of Alleged Violation (FOAV) jointly to the DOE/NV and REECo; DOE/NV, EG&G/EM and REECo; and DOE/NV and DNA in 1994 for failure to comply with state laws and regulations for hazardous waste management. These FOAVs are discussed below:

- During July and August 1994, two state inspectors, accompanied by two EPA Region 9 oversight inspectors, performed an inspection of hazardous waste activities at the NTS and evaluated the records at the RWMS-5, HWAS-5, Area 11 EOD Unit, and specified Satellite Accumulation Sites. In a letter dated September 8, 1994, the state sent the inspection report and requested a response by October 28 to the potential violations identified. DOE/NV and REECo responded in writing on October 7, 1994, acknowledging violations and listing corrective actions. The state issued a FOAV on October 12, 1994, to DOE/NV and REECo for allegedly violating provisions of NAC 444.8632 - Compliance with Federal Standards. Subsequently, the corrective actions indicated were accepted and no further action was proposed by the state.

- Also as a result of the state/EPA inspection, the state issued a FOAV and Order on October 10, 1994, to DOE/NV and DNA. The FOAV was issued because DNA had improperly managed hazardous waste which was being stored at Warehouse L in Area

12. Specifically it alleged that DOE/NV and DNA had: (1) generated solid wastes, but failed to properly characterize the contents of 106 drums; (2) improperly stored hazardous wastes at an unpermitted storage facility; (3) failed to properly mark the accumulation start date, label with the words "Hazardous Waste," place the EPA waste code on the drums, and inspect the drums; and (4) failed to maintain proper isle space for the drums and to keep written operating records. The position of DOE/NV and DNA that the materials were not wastes, but were recyclable or usable was denied by the state. No settlement has been reached, and corrective actions are still under review. Additional characterizing analytical data is to be made available to the state in 1995.

- A third FOAV from the state/EPA inspection was issued to DOE/NV, EG&G/EM and REECo on October 10, 1994. The FOAV alleged failure to train the person who is directing the training program for facility personnel in hazardous waste management procedures. A formal response to the FOAV was made, and a SHOW CAUSE hearing was held on November 9, 1994. At that hearing REECo and EG&G/EM provided sufficient documentation to demonstrate that, although not formally shown in corporate structure, appropriately designated personnel were responsible for these functions. The finding was closed in a letter from the state on November 18, 1994.

- On July 29, 1994, DOE/NV and REECo were issued a FOAV by NDEP for continuing discharge into a closed RCRA Unit, the Area 6 South Steam Cleaning Pond. When the unit was closed discharge lines from two facilities had not been indicated on the engineering drawing used, so were not properly sealed. Response to the FOAV was submitted to NDEP on August 25, and an enforcement hearing was held on September 7, 1994. During the hearing NDEP requested additional information, which was provided before ruling on the findings. A settlement was reached with NDEP by DOE/NV and REECo, and closure of the one finding is expected in early 1995.

3.1.5.2 HAZARDOUS WASTE REPORTING FOR NON-NTS, EG&G/EM OPERATIONS

EG&G/EM, LVAO submitted to DOE/NV, in February 1994, for submission to the state of Nevada, the Hazardous Waste Generator biennial report for hazardous wastes generated at the North Las Vegas Facility under EPA ID Number NVD097868731.

3.1.5.3 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 NDEP to satisfy state regulatory reporting requirements.

During 1994, 30 USTs were removed in accordance with state and federal regulations (see Table 3.2). Reportable releases were discovered with the removal of tanks at the Area 23 Bypass Road, at the Control Building, Power House, Technical Services Building, Technical Operations Building, and the Radsafe Building in Area 25, and at Area 12 N-Tunnel. Remedial activities have started at each of these release sites.

NON-NTS EG&G/EM OPERATIONS

Characterization began on January 1, 1992 at the RSL where 500 gallons of fuel were released on April 25, 1991 into the area surrounding the USTs. The tanks were pulled and the soil was excavated down to 14 ft below grade. It was discovered that soil contamination extended beyond 22 ft and would require remediation by some means other than excavation. The site was characterized, and a draft site remediation plan utilizing vapor extraction was developed. The plan was approved and implemented during the last quarter of 1993. A vapor extraction well was obtained by Converse Environmental Consultants. Remediation was completed in June of 1994. A Notification for Underground Storage Tank Closure was submitted by DOE to the Clark County Health District during September 1994.

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

Compliance activities under CERCLA/SARA for 1994 included SARA Section 312, Tier II reporting to the state of Nevada.

3.1.6.1 NTS TIER II REPORTING UNDER SARA TITLE III

The 1993 Nevada Combined Agency Hazardous Substances Report for the NTS was submitted to the state on March 1, 1994, and contained information on 31 different chemicals in 36 areas which were above the reporting threshold.

The possibility of listing the NTS on the National Priority List (NPL) of hazardous waste sites carries potential for extensive budget and operational impact. Although the NTS has not been listed on the NPL, planning for environmental mitigation and restoration are ongoing (see Section 3.2.8). The state of Nevada has taken action to negotiate a formal agreement with DOE/NV rather than waiting for the EPA to list the NTS on the NPL. This agreement would clearly establish the state's role and authority over sites requiring evaluation and corrective actions, and establish agreed-upon tasks, time schedules, and funding commitments. Negotiations continued in 1994 between the Department of Energy, the Defense Nuclear Agency and the NDEP to develop a Federal Facilities Agreement. A preliminary two year schedule of activities for the Environmental Restoration Program and Defense Programs projects was provided to NDEP.

3.1.6.2 NON-NTS TIER II REPORTING UNDER SARA TITLE III

The combined SARA Section 312, Tier II Report for the Area 5 Spill Test Facility and the EG&G/EM facilities in Areas 5 and 6 was submitted to DOE/NV in April 1994. Ammonia and sulfur dioxide exceeded the SARA Extremely Hazardous Substances (EHS) threshold planning quantity. The Nevada Combined Agency Reports for EG&G/EM's LVAO were submitted to DOE/NV in April 1994. There were no reportable EHS at the NLVF.

3.1.6.3 SARA TITLE SECTION 313 REPORTING

In compliance with Executive Order 12856 REECo compiled and forwarded data to DOE/NV/EPD in support of the Toxic Release Inventory Report required by Section 313 of the SARA Title III.

3.1.7 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. On July 19, 1994, DOE/NV submitted a report for the NTS that stated there were no reportable chemicals for the NTS during Calendar Year 1993.

3.1.8 TOXIC SUBSTANCES CONTROL ACT

State of Nevada regulations implementing the Toxic Substances Control Act require submission of an annual report describing polychlorinated biphenyl (PCB) control activities. The 1993 NTS PCB annual report was transmitted to EPA and the state of Nevada in June 1994. 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 and wastes from the NTS to an EPA approved disposal facility. Fifty-four (54) large and five small, low volume PCB capacitors remain under the management of the Los Alamos National Laboratory in Area 27 of the NTS.

3.1.9 FEDERAL INSECTICIDE, FUNGICIDE, AND RODENTICIDE ACT

During 1994, the application of pesticides at the NTS was conducted under the supervision of a REECo sanitarian who was certified as a pesticide applicator with the state of Nevada. 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 1994.

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 1994 at the NTS relating to the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).

3.1.10 HISTORIC PRESERVATION

The National Historic Preservation Act 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 of Historic Places (NR). Accordingly, DOE/NV conducts cultural resource surveys and other studies 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 operations on these sites. Technical reports contain the results of these data recovery programs. These studies and surveys are conducted by the Desert Research Institute, University and Community College System of Nevada (DRI).

In 1994, 36 surveys were conducted for historic properties on the NTS, and reports on the findings were prepared. These surveys identified 64 sites containing previously unknown archaeological information. One data-recovery project was undertaken in 1994 and Native American monitors were present during the fieldwork.

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 to assist DOE/NV 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 the expression of traditional Native American religions. In 1994, a technical report was issued that contains the recommendations from 17 tribal groups regarding the effects of DOE/NV's activities on Pahute and Rainier mesas.

As part of the Programmatic Agreement with the State Historic Preservation Office 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 the 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 1994 work was initiated on the summary and synthesis and will continue through at least 1995. Also required under Attachment A are intuitive surveys for endangered sites. In 1994 a survey was conducted on a portion of Rainier and Pahute Mesas. This survey identified nine new archaeological sites and re-recorded several others. During the tenure of this agreement, no data recovery will be undertaken on the mesas.

In accordance with the Native American Graves Protection and Repatriation Act (NAGPRA) federal agencies are required to consult with Native Americans regarding items in their artifacts collections, which may be unassociated and associated funerary items and human remains. In 1994, the 17 Native American tribal groups designated a subgroup which examined the 1993 NTS summary of the artifact collections and chose which items would be viewed by the tribal elders during consultations in 1995.

To comply with federal regulations in 36 C.F.R. 79, a multi-phase program is in progress to upgrade the NTS archaeological collection and archives. In 1994 DRI continued the piece-by piece inventory of the collection.

3.1.11 THREATENED AND ENDANGERED SPECIES PROTECTION

The Endangered Species Act (ESA) 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 and the bald eagle are the endangered species that have been documented on the NTS. The desert tortoise is the only threatened species on the NTS. DOE/NV consulted with the U.S. Fish and Wildlife Service (USFWS) and received a non-jeopardy Biological Opinion in May 1992 for planned activities at the NTS for a 5-year period. Included in the Biological Opinion were incidental take authorizations and specific terms and conditions that DOE/NV must implement to minimize take.

There are 21 species known or expected to occur on the NTS that are candidates for listing by the USFWS under the ESA. DOE/NV is gathering information to help the USFWS evaluate whether federal protection is justified for any of these candidate species. In 1994, DOE/NV conducted 40 preconstruction biological surveys at proposed construction sites to determine the presence of these species.

Survey results and mitigation recommendations were documented in survey reports. New populations of two Category 2 candidate plant species for federal listing were found as a result of the 1994 preconstruction surveys. These new candidate plant locations were digitized from topographic maps into the existing Geographic Information System (GIS) computer database. From this database, an updated GIS map was generated and delivered to DOE/NV. Four post-construction surveys were also conducted by DOE/NV. Survey results documented the amount of land disturbed by 1994 project activities.

A total of 19 construction projects involving heavy equipment in desert tortoise habitats were surveyed for tortoises before ground disturbing activities began. Construction activities were also monitored by a qualified biologist at these sites. Monitoring of heavy equipment operations at construction sites is required by the Biological Opinion to ensure that tortoises are not accidentally harmed. A report documenting all actions taken by DOE/NV to comply with the Biological Opinion between August 1,1993, and July 31, 1994, was submitted to USFWS.

After synthesizing the results of a study conducted in 1993, the report, "Northern Boundary of the Desert Tortoise Range on the Nevada Test Site" (EG&G/EM 1994), was published to more accurately define the northern boundary of the range of desert tortoises on the NTS. A revised map of the range of desert tortoises on NTS was presented in the report (see Figure 3.1). This information can be used to determine whether DOE/NV activities conducted along or near this boundary will affect desert tortoises.

The Nevada Test Site Tortoise Population Monitoring Study, a final report on the results of an NTS tortoise population monitoring study conducted in 1993 was prepared in the fall of 1994. The goal of the study was to determine and monitor the density of desert tortoises on NTS by using a quadrant sampling technique recommended by the USFWS. Based on the results of the first sampling session, DOE/NV discontinued this study because the sampling methods were not suitable for estimating tortoise population sizes in low density areas, such as those found on the NTS.

Blood samples were collected from 20 free-ranging tortoises on the NTS and 12 tortoises located in fenced enclosures in Rock Valley. The samples were analyzed by the University of Florida to detect antibodies to *Mycoplasma agassizii*, the likely cause of Upper Respiratory Disease Syndrome (URDS) in desert tortoises. URDS has been identified as one possible cause of desert tortoise population decline. Test results indicated that seven of the 20 free-ranging tortoises (35 percent) and three of the 12 penned tortoises (25 percent) on NTS may have been exposed to *M. agassizii.*

3.1.12 EXECUTIVE ORDER 11988, FLOODPLAIN MANAGEMENT

There were no projects in 1994 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.

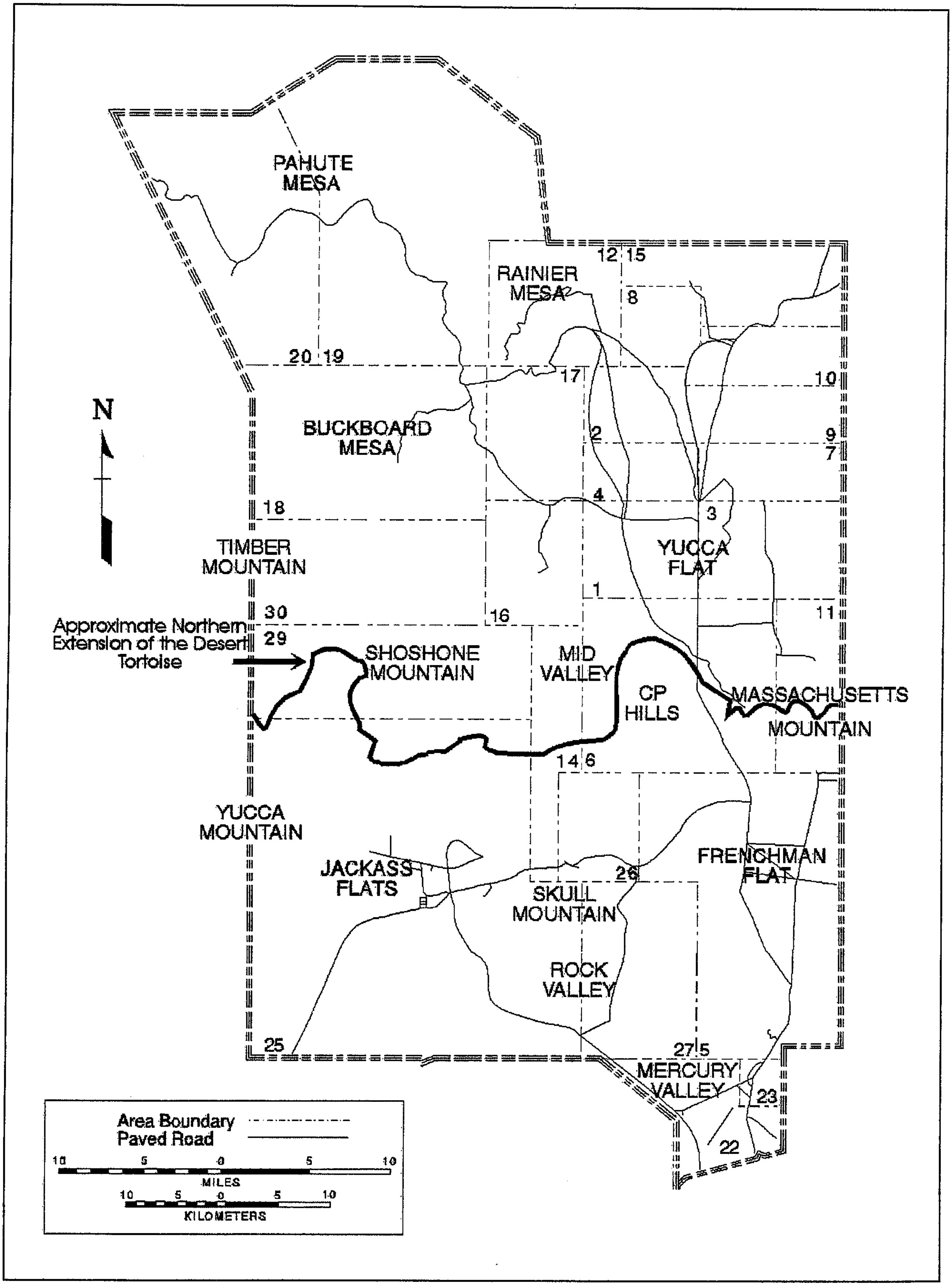


Figure 3.1 Range of Desert Tortoises on the NTS

3.1.13 EXECUTIVE ORDER 11990, PROTECTION OF WETLANDS

There were no projects in 1994 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.

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

Actions taken to comply with the requirements of this executive order are discussed in Section 3.2.6.

3.2 CURRENT ENVIRONMENTAL COMPLIANCE ISSUES AND ACTIONS

There were numerous activities and actions relating to environmental compliance issues in 1994. These activities and actions are discussed below grouped by general area of applicability.

3.2.1 CLEAN AIR ACT

Modifications to the Area 1 Rotary Dryer, including the installation of new heat tiles and modifications to the storage silo, are still in progress to bring the operation into full compliance with state opacity limits. The Area 3 Portec Hopper, which had been scheduled for relocation to the Area 1 Batch Plant, has not been in operation and will be dismantled and sold. A new dust collection system, including a baghouse, was installed at the Area 1 Batch Plant.

Under Title V, Part 70 of the Clean Air Act Amendments, all owners or operators of Part 70 sources must pay annual fees that are sufficient to cover costs of state operating permit programs. Accordingly, annual source maintenance and emission fees were assessed by the state in July 1994, for all NTS facilities operating under Air Quality Operating Permits. Annual fees for some of the facilities were in excess of $1000, with one fee as high as $5600. Since many of the facilities were not being used, their air quality permits were cancelled. Total fees for the remaining NTS facilities were approximately $15,500.

3.2.2 CLEAN WATER ACT

A NPDES permit may be issued for the NTS and the off-NTS EG&G/EM NLVF as part of the state implementation of the federal stormwater discharge regulations.

The federal stormwater regulations identify regulated facilities by a code specified as Standard Industrial Classification (SIC) code. A survey conducted in accordance with guidance received from Region 9 EPA 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 determination is still pending.

Dewatering of septage and winter portable toilets is conducted within the Area 25 Engine Test Stand No. 1 sewage lagoon, two of the Area 12 sewage lagoon secondary basins and the Area 2 sewage lagoon secondary basin. These systems were used for dewatering septage during 1994 and will continue to be used in 1995.

Construction of a double walled upper wastewater collection facility system for the Area 6 Decontamination Facility (DECON) was completed in April 1994. This system directs flow from the decontamination bays and laundry facility for storage before disposal. Wastewater from the decontamination process will be directed through a double-walled, sand-oil-water separator, and a lift station will pump all wastewaters into three Baker tanks for storage during analysis to confirm that a discharge to the domestic sewage system is allowed. An Operation & Maintenance Plan was also developed and approved by NDEP. Construction for connection of the sewage line from the DECON to the Area 6 Yucca Lake sewage lagoons was completed in April 1994 and the facility was placed into full service in May.

The abandonment of all inactive sewers on NTS was completed in June 1994. Inactive lines within the systems have been isolated at manholes, cleanouts, and diversion boxes to reduce the chance of future blockages, and unauthorized discharges. Maintenance schedules have been developed to clear sewer lines throughout the NTS which have been found to require regular preventive maintenance with a mobile jet cleaner. Four hundred feet of sewer line in the vicinity of the cafeteria was relined to improve flow and prevent blockage.

The Area 23 Fleet Operations Closed Loop Steam Cleaning Facility was completed in February 1994. The pumping of wastewater generated at Fleet Operations steam cleaning activities into the Area 23 sewage collection system was terminated at that time.

Wastewater analyses for pH, total suspended solids (TSS), and biochemical oxygen demand (BOD) are required by the state permits. During 1994, the REECo Analytical Chemistry Laboratory was closed, and all samples requiring chemical analysis were sent offsite beginning November 15, 1994.

An initial survey of active septic systems, completed in January 1991, in response to a Tiger Team Finding, revealed 37 active systems with state requirement deficiencies. A total of 48 systems have now been identified for corrective actions. This is an ongoing program that will take several years to complete.

The discharge of washdown-water from the Area 3 Mud Plant into U3al, an event crater, was terminated in July 1994. The wash-down water will be stored in Baker tanks and transported to UE-1r, an unlined drilling mud wastewater pond which is distant from event sites. The freshwater storage will be taken out of service and a direct connection made to the water supply line. NDEP tank has requested the submittal of supporting information on the site for review. Analytical results from the freshwater pond, event crater and water supply wells along with the saturated hydraulic conductivity of the UE-1r mud pond bottom have been submitted.

Sewage presently discharging into the CP-72 and CP-6 facilities will be diverted to the Yucca Lake collection system with the installation of a 2550 foot gravity sewer main. Engineered liners have been installed in the four Area 12 primary treatment lagoons and are intact to a depth of three feet which is adequate for compliance with existing low flow rates.

Hydrogeological modeling has been proposed for the Area 6 Device Assembly Facility (DAF) sewage lagoons, LANL Camp infiltration basins and the Yucca Lake infiltration basins. An engineered liner has already been installed in the primary treatment lagoons at the LANL Camp and Yucca Lake facilities. Hydrogeological modeling using shallow soil characteristics will also be performed at the Area 25 Test Cell C primary treatment lagoon if it is still in limited use in three years. Engineered liners will be installed within all impoundments at the Area 25 Central Support and the Area 22 Gate 100 facilities.

For sewage lagoon systems which receive an industrial flow of any kind the contents of all active primary lagoons must be sampled near the inlet lines for selected volatile organics, semi-volatile organics, pesticides and metals in April of each year. Infiltration basins containing 30 centimeters (cm) or more of liquid in January or June must be sampled for tritium, metals and selected salts, otherwise, they shall be sampled at the earliest time that the level rises above 30 cm.

3.2.3 SAFE DRINKING WATER ACT

An Operations and Maintenance Plan was developed for water system operations at the NTS and submitted to the state for review in 1992. After several rounds of comments, the state approved the plan on November 4, 1994.

Well 4A was connected to the Area 6 distribution system in June 1994, after the state sampled Well 4A and found the water quality to be acceptable.

A total of 72 facilities were identified in a 1993 survey requiring internal or external cross connection prevention devices. Funding was approved in late 1993, and the first twelve designs were completed. These plans will be sent to the state for approval. Although none of these modifications which require breaking water lines could start yet, REECo has been attaching anti-siphon devices on hose bibs and disconnecting water lines where state approval is not required.

In March, 1992, a potential cross connection was identified in the draining system for the Area 6 water fill stand which was corrected. However, there was concern about the design, so the fill stand was converted to a closed filling system with a backflow prevention assembly in-line. Engineering design for this system was approved by the state, and the modified fill stand was placed into service in June 1994.

The REECo Analytical Services Laboratory was closed in mid November 1994, and all drinking water compliance samples have been sent to a state approved laboratory.

Due to centralization of the declining work force at the NTS, the Area 2 and Area 3 water distribution systems ceased to be used in January 1994. No monthly bacteriological samples were collected for those systems after January (as indicated in Chapter 7.0, Table 7-1).

During 1994 quarterly samples were collected from Well 4 to monitor the nitrate level. The state-collected sample in 1993 was over half the allowable level, which requires four quarterly samples to be taken. So far, the nitrate levels remain within the allowable level, and the last required sample will be collected in 1995.

3.2.4 COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT

In mid 1990 the state of Nevada requested assistance from REECo to clean up abandoned waste in Pahrump, Nevada. The site consisted of 780 containers of various size, most of them 55-gal drums. A REECo stamp was found on three 5-gal buckets. Three containers bore a Defense Logistics Agency stamp; the others bore no discernable ownership labels.

Cleanup activities began in 1990, were completed by year's end and a final report was submitted to DOE/NV for transmittal to the state. In December 1992, REECo was notified by EPA of its potential liability for $48,608.63 in EPA-incurred costs for stabilization and assessment actions at the site, later revised to more than $93,000. REECo was instructed to obtain further information and data supporting a possible offer/payment based on volumetric calculations. In May 1994, $45,000 was payed as a final settlement to close the issue.

3.2.5 HISTORIC PRESERVATION

The Historic Structures Program continued in 1994. This is a multi-phase project focusing on assisting DOE/NV inventory and interpreting the cultural resources associated with NTS activities. During the first phase of this project, background research was conducted on structures associated with atmospheric testing. A draft report containing a preliminary inventory and evaluation of NTS structures was prepared and reviewed. Several more structures were evaluated in 1994. The final report will be issued in FY 1995.

Other efforts in 1994 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.

3.2.6 WASTE MINIMIZATION

3.2.6.1 NTS OPERATIONS

All NTS contractors and users have published Task Plans and Waste Minimization/Pollution Prevention Plans in accordance with DOE/NV requirements. These plans are designed to reduce waste generation and possible pollutant releases to the environment. Some contractors have revised their plans, incorporating the most current waste minimization requirements and Executive Orders, and are establishing ongoing goals for further improvements. These ongoing efforts provide 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 Superfund Amendments and Reauthorization Act (SARA), and the EPA 33/50 Pollution Prevention Program.
- Reduced exposure to civil and criminal liabilities under environmental laws.
- Reduced overhead costs and increased productivity through improved work processes and greater awareness.

The waste minimization program reflects DOE/NV goals and policies for waste minimization, pollution prevention and recycling, and represents an ongoing effort to make pollution prevention/waste minimization part of the NTS operating philosophy. In accordance with the Pollution Prevention Act of 1990 and this DOE policy, the following hierarchical approach to waste reduction is practiced and applies to all waste streams: (1) Prevent or reduce waste at the source whenever feasible; (2) Recycle, in an environmentally acceptable manner, waste that cannot feasibly be prevented; (3) Treat waste that cannot feasibly be prevented or recycled; (4) Dispose of waste only as a last resort.

All DOE/NV quantitative goals and schedules for 1994 were met or exceeded. Total NTS hazardous waste generation was reduced in 1994 over 1993 generated waste.

The NTS program recycles and returns to productive use significant quantities of materials. (see Table 3.3).

The REECo Just-in-Time (JIT) supply system now accounts for nearly 80 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.

Chlorofluorocarbon (freon) recycling equipment is in place at all NTS service and maintenance centers. All freon is recovered and reused, eliminating ozone-depleting substance emissions into the atmosphere almost completely. Approximately 150 service personnel have been trained and certified in the operation of this equipment. In 1994 these workers were recertified under a Federal EPA clause recognizing primary training efforts.

The DOE/NV, its contractors, and other agencies and users serve as members of the DOE/NV Waste Minimization Task Force which conducts pollution prevention campaigns, reaching all employees as well as the surrounding community. The Task Force has developed a Pollution Prevention and Waste Minimization training course which has been concurred in by DOE/NV and is available to all DOE/NV contractors and users.

3.2.6.2 NON-NTS EG&G/EM OPERATIONS

POLICIES AND PROCEDURES

During 1994, processes were evaluated for product substitution, cross-contamination control, or site treatment. Organizational Operating Procedure No. 31-C300-004.A, "Purchase Requisition Review" establishes the review requirements for the procurement of hazardous materials to ensure proper tracking and appropriate substitutes are identified.

TRAINING

EG&G/EM employees and management are trained on company policies, procedures, and rules and review waste minimization training videos. Fifteen Safety Specialists have completed the performance based training module entitled "Introduction to Waste Minimization Techniques." Many employees received refresher training during 1994.

PRODUCT SUBSTITUTION

EG&G/EM has made progress towards substituting chemicals that have a high stratospheric ozone depletion potential with chemicals that have a lower depletion potential. Most air conditioner refrigerants at EG&G/EM facilities have been substituted with HCFC-22 which has an ozone depletion potential five percent as compared to CFC-11 and CFC-12. Substitutions for 1,1,1-trichloroethane have either been implemented or are in the trial phase. Planisol is being used as a replacement for gross non-critical cleaning. Irradicon is being used on a trial basis as a supercritical cleaner. New less hazardous janitorial chemicals have replaced existing stock to minimize variety and quantity of chemical used and stored onsite. Over 1100 chemicals at Kirtland Operations were evaluated and 338 were discontinued.

The sheet metal shop at EG&G/EM, North Las Vegas Facility has replaced solvent based paints with water based paints for most applications, reducing the solvent waste stream from this facility by 250 gal per year.

RECYCLING

Freon recycling systems capable of capturing, cleaning and drying the freon for reuse are used for air conditioning systems EG&G/EM operates and maintains. EG&G/EM has also implemented a recycling program for HP Laser Jet II/III and Canon FAX toner cartridges. EG&G/EM recycled over 9,000 pounds of automotive batteries, 2,300 pounds of toner cartridges, and 368,000 pounds of OPSEC material.

TREATMENT/VOLUME REDUCTION

The EG&G/EM, RSL has a photo laboratory which develops 850 ft^2 of film per day. The effluent from the laboratory processes is captured, neutralized, and the silver removed and recycled. The effluent is then discharged to a publicly owned treatment works. The effluent is tested four times a day to verify it is within the permitted discharge limits.

REPORTS

The annual SEN-37-92 Annual Waste Reduction Report on waste generation and minimization was submitted to DOE in February in accordance with the requirements of DOE Order 5400.1, "General Environmental Protection Program."

3.2.7 SOLID/SANITARY WASTE

During 1994 sanitary landfills were operated in Areas 9 and 23. The amount of material disposed in each is provided in Chapter 7.0, Table 7.9.

In November, 1993, the NDEP enacted new solid waste regulations, consistent with the EPA's federal solid waste program, which affect the NTS Solid Waste Program. These regulations require municipal landfills to meet more stringent location, design, monitoring, and operation requirements. Several actions have been taken to ensure compliance with these new regulations. The NTS sanitary landfill at 10c Crater will be closed as a Class II disposal site by October 9, 1995. The 10c Crater will then be reopened as a Class III disposal site for construction waste. This will require a 5-10 foot soil barrier to be placed on top of the Class II site when it closes. The Mercury Class II landfill will be upgraded by the installation of a groundwater monitoring, or comparable, system by October 9, 1996.

Table 7.9 in Chapter 7.0 gives the amount of hydrocarbon contaminated soil disposed of in the Area 6 landfill in 1994. The O&M Plan for this facility was revised in 1994 to allow for the disposal of gasoline-contaminated soil. The revision indicates the sampling and analysis to be done to ensure lead and benzene concentrations meet the state criteria for disposal in the hydrocarbon landfill. The plan is awaiting state approval.

3.2.8 ENVIRONMENTAL RESTORATION/REMEDIATION ACTIVITIES

The NTS has an ongoing Environmental Restoration Program (ERP) for the characterization and restoration of contaminated facilities or areas. In 1994 characterization and restoration activities associated with the ERP included:

- The Area 27 EOD RCRA Unit was cleaned of all waste and closed in September 1994. Hazardous waste and hydrocarbon impacted soil was removed from the site along with explosive bolts and related materials. The site was regraded to the original contours.

- Post closure monitoring of the Mercury Landfill Hazardous Waste Trenches RCRA Closure Unit was done on a monthly basis for soil moisture. Monthly inspections of the two covers also occurred. The covers are performing as designed with no releases occurring. Minor maintenance on the edge of the covers was done to reduce soil erosion resulting from heavy precipitation events.

- Characterization of the U-3fi Injection Well RCRA Closure Unit began with preparations for drilling a monitoring well at the site.

- The discharge outfalls to the South and North Steam Cleaning Effluent Ponds were cut and plugged so that no liquids from two steam cleaning pads could discharge into the ponds. Water and sludge remaining in the south pond was sampled in August and the results indicate that the material is not a RCRA hazardous waste. Influent and effluent lines from several soil/oil/water separators attached to the ponds were plugged.

- Nineteen underground storage tanks were removed during 1994 under the Environmental Restoration Program and 11 others were removed under Defense Programs. Any tank contents were removed and properly disposed, and the soil around the tanks was sampled to ensure proper site closure.

- The contents of 23 abandoned septic tanks at 16 locations were sampled for a wide range of parameters. Site background samples were also taken at those locations.

- Continuation of studies of the environmental impact on groundwater from nuclear testing. To date eleven wells designed for the groundwater characterization program have been completed out of an estimated 50 wells to be installed by the end of 1999.

Other characterization or restoration activities not associated with the ERP included:

- The characterization of the Area 2 Pull Test Facility lead impacted soil and hydrocarbon release was completed. The remedial method selected was removal of approximately 140 cubic yards of soil which is scheduled for January 1995.

- Remediation was completed for two non-hazardous injection wells in Area 1 that had been used for disposal of steam cleaning effluent. The sites were closed by using large diameter (10- and 20- foot) auger drills to remove hydrocarbon impacted soil. This was cost effective over other remedial technologies.

- A sewer line was connected from Building 650 Laboratory to the Mercury sewage lagoon system. This had been connected to a leachfield, which is now a RCRA closure unit. No hazardous or radioactive waste was identified during sampling of the soil where the line was broken for the rerouting.

3.2.9 RADIATION PROTECTION

3.2.9.1 NTS OPERATIONS

Results of environmental monitoring on the NTS during 1994 indicated full compliance with the radiation exposure guidelines of DOE Order 5400.5, "Radiation Protection of the Public and the Environment" and the 40 C.F.R. 141 National Primary Drinking Water Regulations. Onsite air monitoring results showed average annual concentrations ranging from 0.32 percent of the DOE Order 5400.5 guidelines for tritium in air to 22 percent of the guidelines for $^{239+240}Pu$ in air. Drinking water supplies on the NTS contained less than 0.4 percent of the DOE Order 5400.5 guideline and less than 0.1 percent of the National Primary Drinking Water Regulation for tritium. Supply wells contained 0.01 percent of the DOE Order 5400.5 guideline for $^{239+240}Pu$. Comparisons were made to the guidelines for public consumption although the general public does not consume water from these supplies.

3.2.9.2 NON-NTS EG&G/EM OPERATIONS

There were no radioactive air emissions, no radioactive or nonradioactive surface water/liquid discharges, subsurface discharges through leaching, leaking, seepage into the soil column, well disposal, or burial at any of the EG&G/EM operations. Use of radioactive materials was primarily limited to sealed sources. Facilities which use radioactive sealed sources or radiation producing equipment, with the potential to expose the general population outside the property line to direct radiation, are: SBO during operation of the LINAC; STL during the operation of the sealed tube neutron generator; the RSL at Nellis Air Force Base; and the LVAO, NLVF A-1 Source Range. Sealed sources are tested periodically to assure there is no leakage of radioactive material. Fence line radiation monitoring was conducted at these facilities. At least two TLDs are at the fence line on each side of the facility. The TLDs are exchanged quarterly with additional control TLDs kept in a safe. The monitoring data were consistent with previous data indicating no exposures to the public from any of the monitored facilities.

3.2.10 ENVIRONMENTAL COMPLIANCE AUDITS

3.2.10.1 TIGER TEAM COMPLIANCE ASSESSMENT

The DOE Tiger Team Compliance Assessment of the NTS conducted from October 30 to December 1, 1989, was part of a 10-point initiative by the Secretary of Energy to conduct independent oversight compliance and management assessments of environmental, safety, and health programs at DOE facilities. The Team identified 149 deficiencies including 45 environmental "findings" in its assessment, none of which reflected situations which presented an immediate risk to public health or the environment. By the end of 1994, all but one of these deficiencies had been closed. This remaining deficiency involves management of NTS electrical service and has no environmental impact.

3.2.10.2 NTS ENVIRONMENTAL SURVEYS

In March 1993, an environmental compliance assessment was conducted by 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. The assessment identified approximately 55 of these system deficiencies. As of the end of 1994, three of the identified deficiencies remain open. As part of the Environmental Corrective Action Plan developed to prevent these problems from reoccurring, REECo line management is now required to perform monthly compliance inspections of their facilities, and to enter any deficiencies into REECo Automated Deficiency Tracking System (ADTS) for corrective action tracking. During 1994 line management inspections found 221 (43 percent) of the 511 environmental deficiencies that were entered into the ADTS.

3.2.11 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." A listing of the reportable occurrences for on-NTS support facilities and off-NTS locations appears in Tables 3.4 and 3.5, respectively. An analysis of occurrences for 1994 as required by DOE Order 5000.3B, showed that there were four main reasons for the occurrences. These were due to: (1) external phenomena - 37 percent, (2) management problems - 25 percent, (3) personnel error - 14 percent, and (4) equipment/material problems -14 percent.

3.2.12 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 and that DOE must initiate a single, site wide 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 site wide EIS. Prior to the suit, DOE/NV had already intended to begin the scoping process for a site wide EIS (see discussion in 3.1.1).

3.3 PERMIT SUMMARY

For facilities used in the operation and maintenance of the NTS and non-NTS facilities, the DOE/NV 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 1994 (Table 3.6), portions of the RCRA Part B permit applications were in various stages of NDEP review for the different units requesting permission to construct or operate.

Table 3.1 NESHAP Notifications to the state of Nevada for NTS Asbestos Activities - 1994

Area	Building	Friable Asbestos	Date
3	Rad Safe Office	1 linear foot of pipe insulation	February 1994
23	Weather Bureau	1546 square feet of acoustical ceiling tile	February 1994
23	102	24 linear feet of pipe insulation	June 1994
4	Bunker 4-300	90 linear feet of pipe insulation	August 1994

Table 3.2 Underground Storage Tank Activities - 1994

Area/Facility	Tank Number	Action Taken
11/Tweezer Facility	11-1-1	Removal
12/Construction Shop	12-8-1	Removal
12/Construction Shop	12-8-2	Removal
12/DOD Gas Station	12-9-1	Removal
12/Gas Station	12-9-2	Removal
15/Climax Mine	15-CM-1	Removal
23/Bypass Yard	23-BPY-1	Removal
25/Control Building	25-3101-1	Removal
25/Power House	25-3102-3	Removal
25/Power House	25-3102-4	Removal
25/RMAD	25-3110-1	Removal
25/Technical Services	25/3123-1	Removal
25/Technical Operations	25/3129-1	Removal
25/Radsafe	25-3152-1	Removal
26/Control Building	26-2101-1	Removal
26/Control Building	26-2101-2	Removal
26/Assembly Shop	26-2102-1	Removal
26/Compressor Building	26-2205-1	Removal
27/Technical Building	27-5310-1	Removal
12/N-Tunnel	12-N-2	Removal
12/N-Tunnel	12-N-3	Removal
12/P-Tunnel	12-P-1	Removal
12/T-Tunnel	12-T-2	Removal
12/Fleet Operations	12-16-4	Removal
12/Gas Station	12-26-1	Removal
12/Gas Station	12-26-2	Removal
12/Gas Station	12-26-3	Removal
23/Gas Station	23-752-1	Removal
23/Gas Station	23-752-2	Removal
23/Gas Station	23-752-3	Removal

Table 3.3 NTS Recycling Activities - 1994

Material	Quantity
Office Paper	410 tons
Aluminum (bulk)	130 tons
Aluminum cans	7 tons
Used Motor Oil	146 tons
Cable	640 tons
Light Iron	1697 tons
Heavy Iron	2219 tons
Brass & Copper	46 tons
Batteries	475 tons
Tires	310 tons
Cardboard	1 ton
Lead	365 tons
Off NTS Recycling Activities, NLV Facility	
Automotive Batteries	9,702 lbs
Toner Cartridges	2,316 lbs
OPSEC Material	368,514 lbs
Silver recovery	942 grams
Orosene gold	1 quart
Used oil	4,740 gallons
Cimperial cutting fluid	100 gallons

Table 3.4 Off-Normal Occurrences at NTS Facilities

Date	Report Number	Description	Status
01/19/94	NVOO-REEC-OMD2 1994-0001	Historical hydrocarbon spill found during excavation for new tank, Area 1	Complete
02/11/94	NVOO-REEC-OMD2 1994-0002	Scraper overturned, 10 gal hydraulic spilled, Area 1	Complete
02/15/94	NVOO-REEC-OMD2 1994-0004	Stained soil discovered during removal of UST, Area 27	Complete
02/15/94	NVOO-REEC-OMD2 1994-0005	Stained soil discovered during removal of UST, Area 12	Complete
03/03/94	NVOO-REEC-OMD1 1994-0001	Stained Soil discovered during removal of UST, Area 12 N Tunnel	Cancelled
03/07/94	NVOO-REEC-OMD2 1994-0003	Unleaded Gas Spill (20 gal) due to punctured fuel tank, Area 23	Complete
05/19/94	NVOO-REEC-EMD3 1994-0002	Possible pesticide contamination, Area 23	Complete
05/27/94	NVOO-REEC-OMD3 1994-0001	Hydraulic oil spill from dump trailer during salvage opr. (10 gal), Area 23	Complete

Table 3.4 (Off-Normal Occurrences at NTS Facilities, cont.)

Date	Report Number	Description	Status
07/21/94	NVOO-REEC-EMD0 1994-0001	Deteriorated supply line on generator leaked 10- to 20-gal diesel fuel, Area 6	Complete
08/02/94	NVOO-REEC-OMD0 1994-0002	Finding of alleged violation, hazardous waste regs., Area 6	Complete
08/18/94	NVOO-REEC-OMD3 1994-0002	Generator opr. during power outage spilled 90 gal diesel fuel, Area 23	Complete
08/25/94	NVOO-REEC-EMD0 1994-0002	Petroleum leakage from discovered under 3 USTs during removal, Area 25.	Complete
10/18/94	NVOO-GONV-ESMW 1994-0001	Tritium found in PM-2 well water, Area 20.	Complete
11/02/94	NVOO-REEC-EMD0 1994-0004	Soil contamination under abandoned USTs over years, Area 23 and 25.	Complete
11/08/94	NVOO-REEC-EMD0 1994-0005	Finding of alleged violation, hazardous waste regs.	Complete
11/16/94	NVOO-REEC-EMD0 1994-0006	Personal clothing contaminated from off-loading LLW, Area 5.	Complete
11/22/94	NVOO-REEC-OMD0 1994-0006	Spill 2.5 gals antifreeze, generator routine maintenance, Area 6.	Complete
12/12/94	NVOO-REEC-EMD0 1994-0007	Personal clothing contaminated from off-loading LLW, Area 5.	Complete
12/14/94	NVOO-RSNO-NTS 1994-0001	Hydrogen Sulfide generation caused building evacuation, Area 23.	Pending

Table 3.5 Off-Normal Environmental Occurrences at Off-NTS Support Facilities

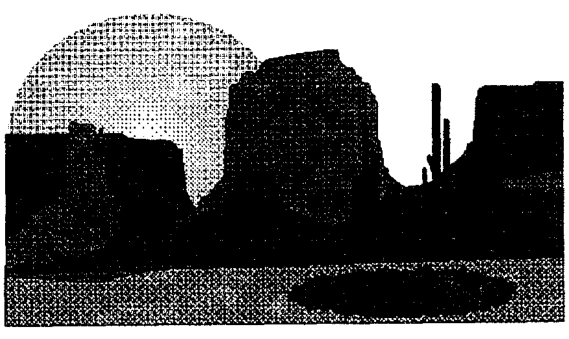
Date	Report Number	Description	Status
11/18/93	NVOO-EGGO-NLVO 1993-0010	Laser dye (ethylene glycol, methanol, and rhodamine) into city sewer from pipe leak.	Complete
12/16/93	NVOO-EGGO-AVOO 1993-0001	Notice of permit violation; freon throughput exceeded permit limits.	Complete
12/28/93	NVOO-EGGO-NLVO 1993-0011	Finding of Alleged Violation and Order: Violation of CWA by failure to pretreat chromium discharges.	Complete
01/18/94	NVOO-EGGO-STLO 1994-0001	Due to significant earthquake and power failure on 01/17/94, the Halon fire system was activated and Halon discharged into the Anechoic Chamber. It is presumed the discharge occurred on Monday, January 17, 1994.	Closed

Table 3.6 Environmental Permit Summary - 1994

	Air Pollution	Wastewater	Drinking Water	Number of EPA Generator User IDs	Nevada Hazardous Materials Storage Permit	Endangered Species Act	Storage of Flammables (City)
NTS	48	14	8	2[(a)]	1[(b)]	4	
Las Vegas Area Operations Office	15[(c)]	2		1[(a)]	2		
Amador Valley Operations	1			1			
Kirtland Operations				2			
Los Alamos Operations				1			
Santa Barbara Operations		2[(c)]		2			
Special Technologies Laboratory (Santa Barbara)	1	1[(c)]		1			
Woburn Cathode Ray Tube Operations	1	2[(d)]		1			1[(c)]
Washington Aerial Measurements Dept.							
TOTAL	66	21	8	11	3	4	1

(a) Biennial report required
(b) Area 5, Liquefied Gaseous Fuels Spill Test Facility
(c) Routine monitoring of emissions is not required
(d) One permit is for the discharge of uncontaminated noncontact cooling water into a dry well

Environmental Program Information



4.0 ENVIRONMENTAL PROGRAM INFORMATION

The environmental monitoring and compliance programs for the Nevada Test Site (NTS) and offsite EG&G Energy Measurements, Inc. (EG&G/EM) facilities consist of radiological monitoring, nonradiological monitoring, and environmental permits 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 several organizations. Reynolds Electrical & Engineering Co., Inc. (REECo), the operating contractor at the NTS, is responsible for environmental surveillance and effluent monitoring. Several other organizations, such as the Lawrence Livermore National Laboratory (LLNL), Los Alamos National Laboratory (LANL), Desert Research Institute (DRI), the U. S. Environmental Protection Agency (EPA), and participants in the Basic Environmental Compliance and Monitoring Program (BECAMP) also make radiological measurements onsite. The offsite program is conducted by the EPA's Environmental Monitoring Systems Laboratory in Las Vegas, Nevada (EMSL-LV).

4.1.1 ONSITE MONITORING

At the NTS radiological effluents may originate from tunnels, from underground test event sites [at or near surface ground zeros (SGZs)], 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. Air sampling is conducted for radioactive particulates, halogens, noble gases, and tritiated water vapor (see Figure 4.1 for sampling locations). Ambient gamma radiation monitoring is conducted throughout the NTS using thermoluminescent dosimeters (TLDs) (see Figure 4.2). Water from groundwater wells, springs, well reservoirs, water taps, and waste disposal ponds is analyzed for radioactivity (see Figures 4.3 and 4.4).

4.1.1.1 CRITERIA

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

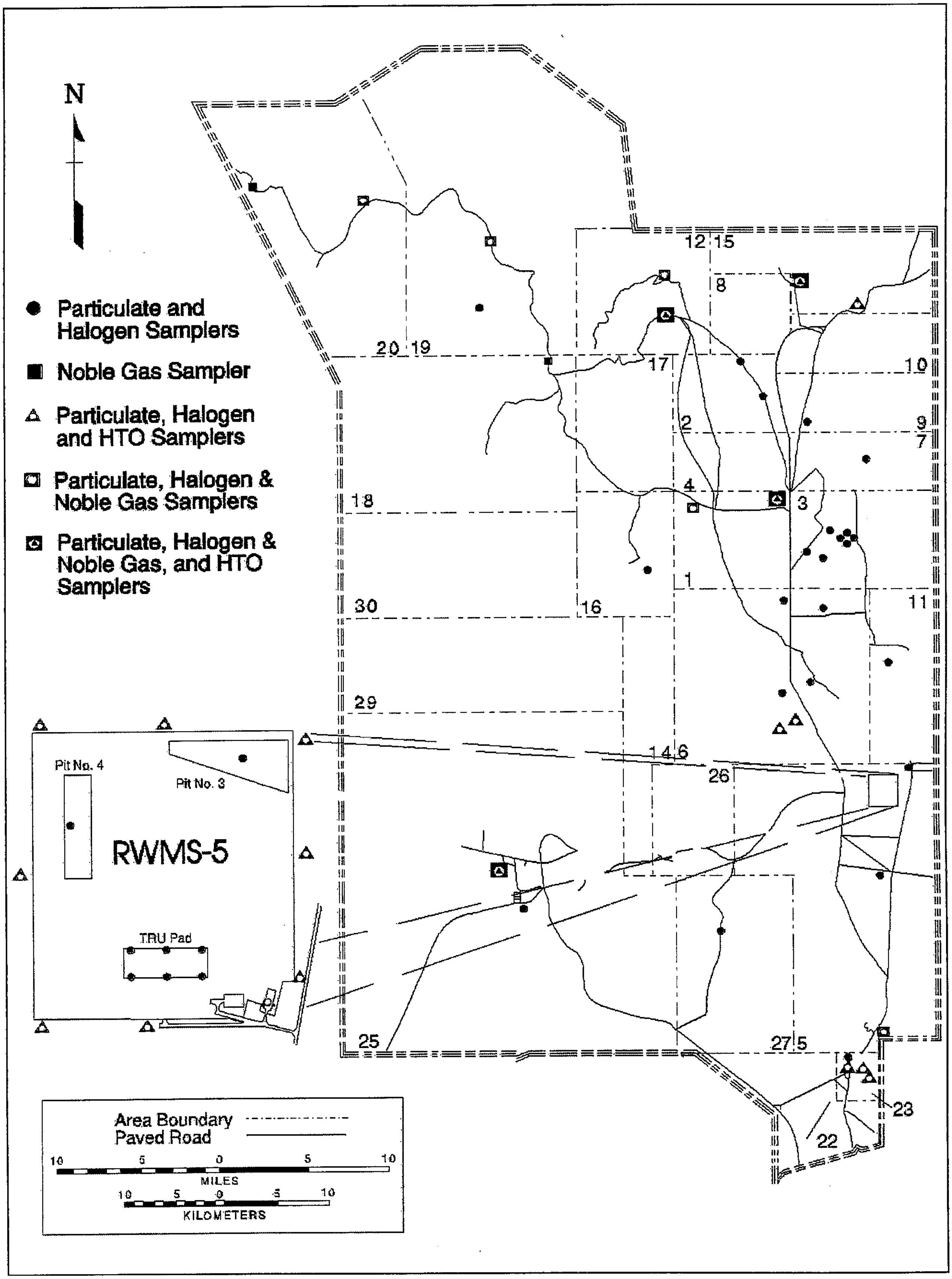


Figure 4.1 Air Sampling Stations on the NTS - 1994

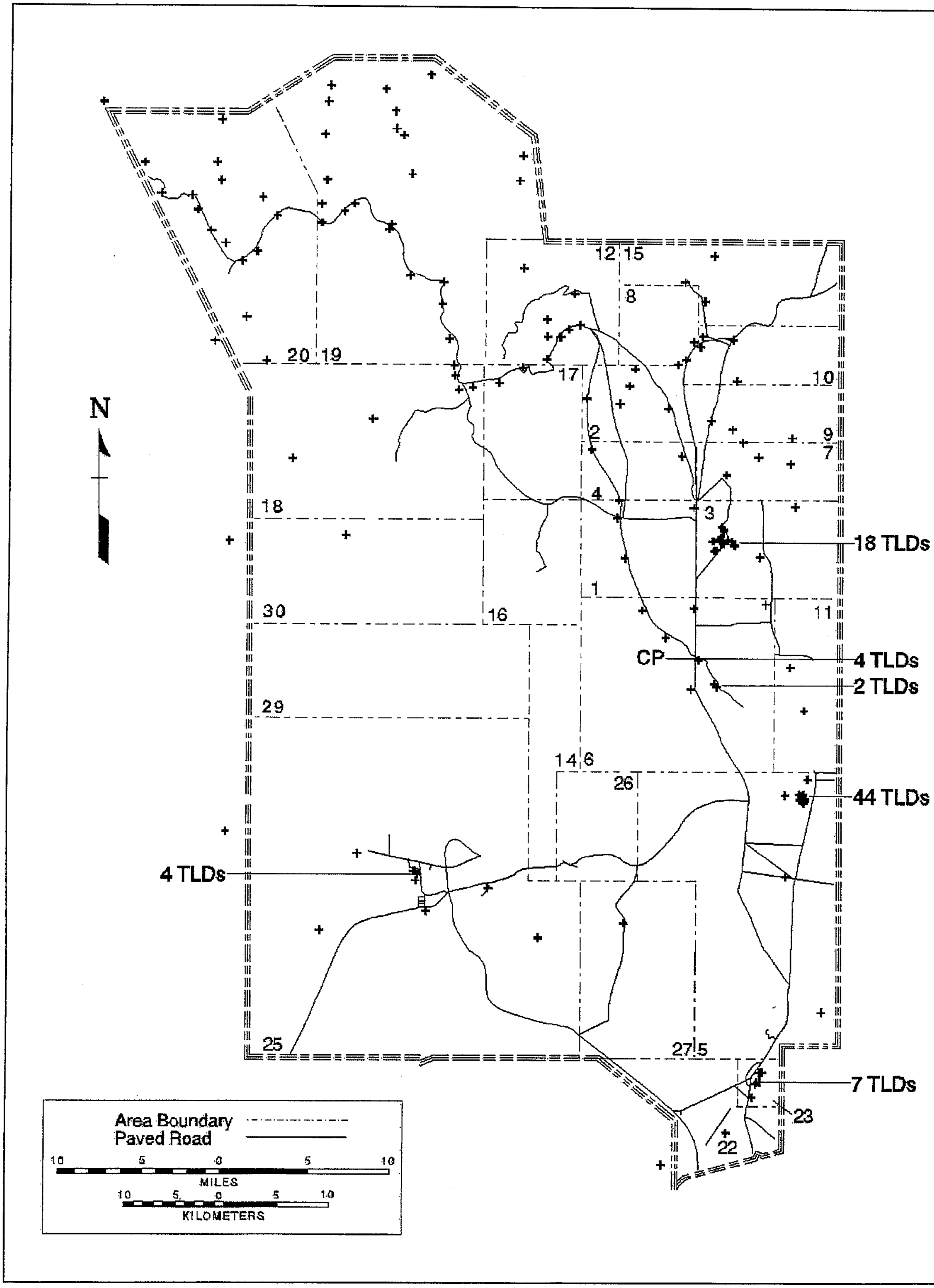


Figure 4.2 Thermoluminescent Dosimeter Stations on the NTS (+) - 1994

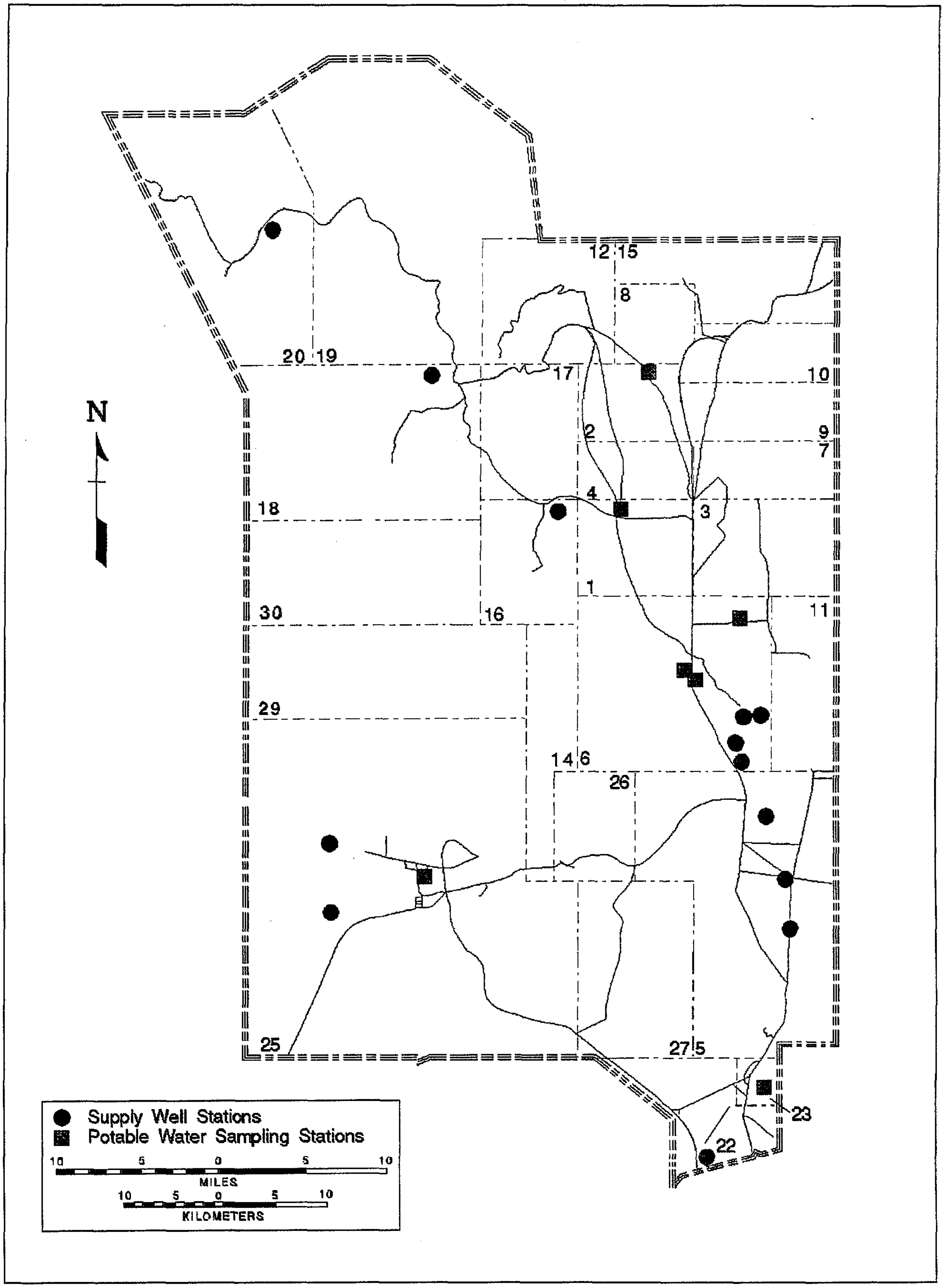


Figure 4.3 Supply Well and Potable Water Sampling Stations on the NTS - 1994

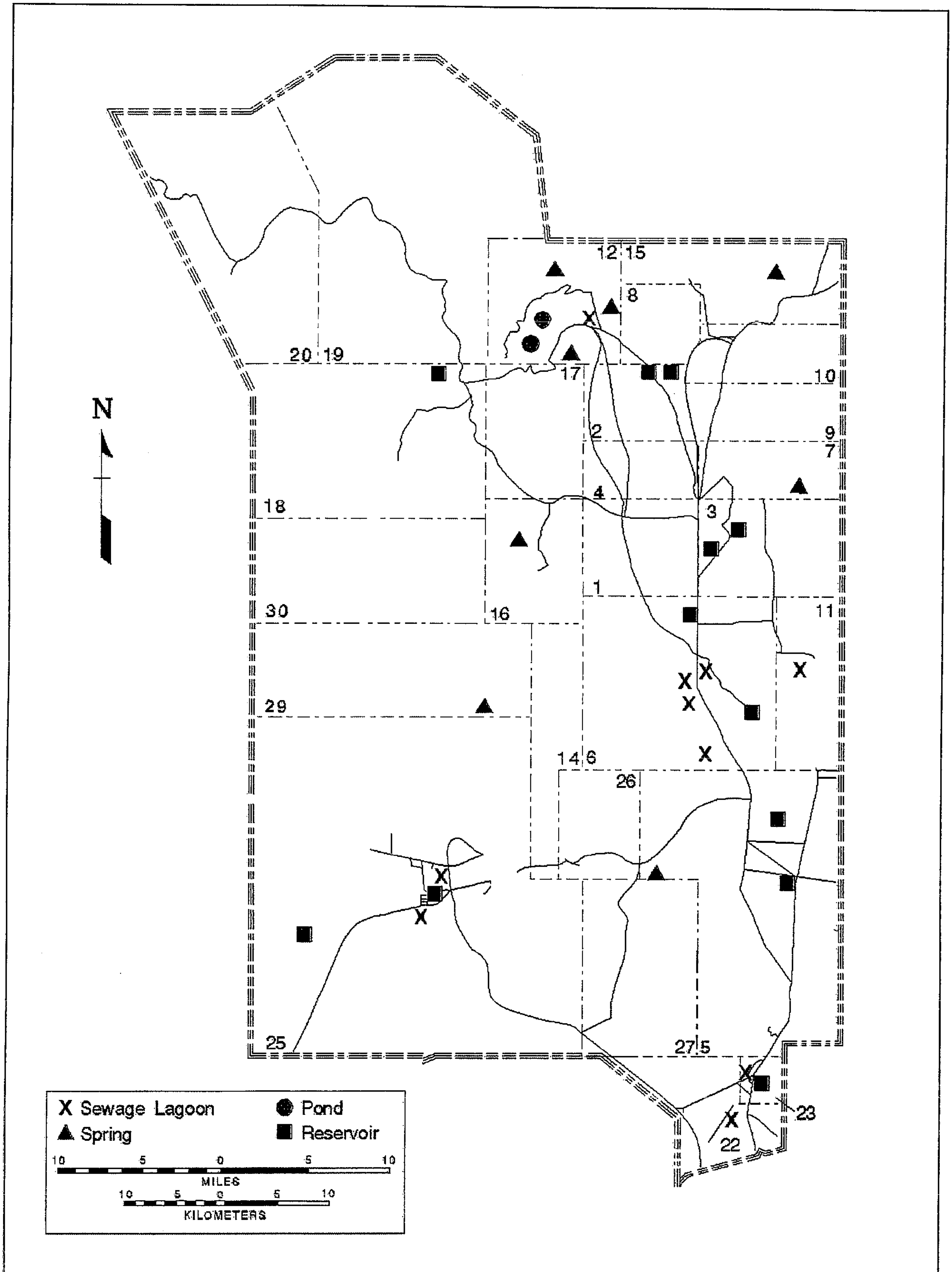


Figure 4.4 Surface Water Sampling Locations on the NTS - 1994

regulations. Other DOE directives applicable to environmental monitoring include DOE Order 5480.11, "Radiation Protection for Occupational Workers"; DOE Order 5480.1B, "Environment, Safety, and Health Program for Department of Energy 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."

4.1.1.2 EFFLUENT MONITORING

During 1994, effluent monitoring at the NTS involved tunnel discharge waters. Due to the continuation of the moratorium on nuclear testing throughout the year, no effluent monitoring for nuclear tests was required.

LIQUID EFFLUENT MONITORING

Radiologically contaminated water was discharged only from E Tunnel in the Rainier Mesa (Area 12) range. N and T Tunnels were sealed to prevent liquid effluent discharges. A grab sample was collected monthly from the tunnel's effluent discharge point and from the tunnel's holding pond. These samples were analyzed for tritium (^{3}H), gross beta, and gamma emitters. In addition, quarterly samples were analyzed for ^{238}Pu and $^{239+240}Pu$, and an annual sample was analyzed for ^{90}Sr. Tritium was the radionuclide most consistently detected at the tunnel sites. Other radionuclides were detected infrequently.

In previous years the flow rate of liquid effluents from the tunnel was measured by equipment installed by the DRI, University of Nevada. These previous measurements were used to quantify the total radiological effluent release for 1994. The quarterly average concentration of the radionuclide of interest in the effluent liquid was multiplied by the total quantity of liquid discharged based on the average flow rate for the quarter. This value was calculated for each quarter and summed to obtain the total liquid radiological effluent discharged.

Typical lower limits of detection for water analyses were:

- Gross α: 1×10^{-9} μCi/mL (3.7×10^{-2} Bq/L)
- Gross β: 1×10^{-9} μCi/mL (3.3×10^{-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): 5×10^{-7} μCi/mL (11 Bq/L)
- Tritium (enrichment): 2×10^{-8} μCi/mL (0.74 Bq/L)
- ^{90}Sr: 2×10^{-10} μCi/mL (7.4×10^{-3} 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 was continued throughout the year, airborne effluent monitoring was not required on Pahute Mesa.

4.1.1.3 ENVIRONMENTAL SURVEILLANCE

Environmental surveillance was conducted onsite throughout the NTS. Equipment at fixed, continuously sampling stations was used to monitor for radioactive materials in the air. Surface water and groundwater samples were routinely collected at pre-established locations.

AIR MONITORING

The environmental surveillance program maintained samplers designed to detect airborne radioactive particles, radioactive gases (including radioiodines and noble gases), and radioactive hydrogen (^3H) as water vapor in the form $^3H^3HO$ or ^3HHO.

Air sampling units were located at 54 stations on the NTS (see Figure 4.1) to measure radioactive particulates and halogens. These stations included 12 inside radioactive waste management facilities and 2 temporary stations for preoperational monitoring at the Device Assembly Facility (DAF). Access, worker population, geographical coverage, and availability of electrical power were considered in site selection.

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. This was followed by a charcoal cartridge for collecting radioiodines. The filter and cartridge were 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 1400 cubic meters of air during the 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 daughter products to decay. Gross beta counting was performed with a gas-flow proportional counter for 20 minutes. The lower limit of detection for gross beta, assuming typical counting parameters, was 2×10^{-15} µCi/mL (7.4×10^{-5} Bq/m^3) using a ^{90}Sr calibration source. Gamma spectroscopy of the filter and cartridge was accomplished using germanium detectors with an input to a 2000-channel spectrometer. This spectrometer was calibrated at 1 kiloelectronvolt (keV) per channel from 0.02 to 2 megaelectronvolts (MeV) using a National Institute of Standards and Technology (NIST) traceable mixed radionuclide source. The lower limit of detection for gamma spectroscopy is 5×10^{-15} µCi/mL (1.8×10^{-4} Bq/m^3) for ^{137}Cs.

Weekly air samples for a given sampling station were composited on a monthly basis and radiochemically analyzed for ^{238}Pu and $^{239+240}$Pu. In October the frequency of compositing filters was changed to quarterly, except for stations associated with radioactive waste operations and the DAF. The filters were subjected to an acid dissolution and an ion-exchange recovery on a resin bed. Plutonium was deposited by plating on a stainless steel disk. 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 lower limit of detection for ^{238}Pu and $^{239+240}$Pu was approximately 1×10^{-17} µCi/mL (3.7×10^{-7} Bq/m^3).

The radioactive noble gases ^{85}Kr and ^{133}Xe were continuously sampled at ten permanent locations. 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 liters 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 and xenon were transferred to separate scintillation vials and counted on a liquid scintillation counter. The lower limits of detection for ^{85}Kr and ^{133}Xe were 3×10^{-12} and 14×10^{-12} µCi/mL (0.1 and 0.5 Bq/m^3), respectively.

Airborne tritiated water vapor was monitored at 17 permanent locations throughout the NTS and at two temporary locations for preoperational monitoring at the DAF. A small electronic pump drew air continuously into the sampler at approximately 0.6 L/min. The tritiated water 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 lower limit of detection for tritiated water vapor analysis was 3×10^{-13} µCi/mL (0.011 Bq/m^3) of air.

AMBIENT GAMMA MONITORING

Ambient gamma monitoring was conducted at 201 stations within the NTS (see Figure 4.2) through use of thermoluminescent dosimeters (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 1000 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, 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.

A 500-mL aliquot was taken from the water sample, placed in a Nalgene 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 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 and analyzing a 5 mL portion of the concentrate by liquid scintillation counting. The ^{226,228}Ra concentrations were determined from low-background gamma spectrometry 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 counting for 500 minutes.

The radiochemical procedure for plutonium was similar to that previously described in this chapter under "Air Monitoring." Alpha spectroscopy was used to measure any ^{238}Pu, $^{239+240}$Pu, and the ^{242}Pu tracer present in the sample .

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 (LLW) from the NTS and other DOE facilities. Shallow disposal in trenches, pits, and augured shafts, was accomplished at the Area 5 RWMS (RWMS-5) and in subsidence craters at the Area 3 RWMS (RWMS-3).

RWMS-5 monitoring included 17 permanent air particulate/halogen sampling stations, nine permanent tritiated water vapor sampling stations, and 26 TLD stations placed inside and around the site. The RWMS-3 is monitored by four air particulate/halogen sampling stations with several TLD stations located nearby.

4.1.1.4 SPECIAL ENVIRONMENTAL STUDIES

The Basic Environmental Compliance and Monitoring Program (BECAMP) was involved in special studies at the NTS that focused on the movement of radionuclides through the environment and the resultant dose to man. BECAMP uses the past accomplishments of two former DOE/NV-sponsored programs at the NTS, the Nevada Applied Ecology Group (NAEG) and the Radionuclide Inventory and Distribution Program (RIDP), in ongoing efforts to design effective programs to assess changes over time in the radiological conditions on the NTS, update human dose-assessment models, and provide information to DOE/NV for site restoration projects and compliance with environmental regulations.

The main objective of one group in BECAMP (Task 1 - Movement of Radionuclides On and Around the NTS) is to determine the rate of movement of surface-deposited radionuclides in four categories: (1) horizontal movement, (2) water-driven erosional transport, (3) vertical migration, (4) and wind-driven resuspension.

A second task in the BECAMP program (Task 2 - Human Dose Assessment Models) is to update the NAEG/NTS dose-assessment model in order to assess the human dose from radionuclides found in soil on the NTS. The NAEG model is used to estimate the dose, via ingestion and inhalation, to man from $^{239+240}$Pu. The BECAMP dose-assessment model is an expanded version of the NAEG model that has been updated to include all significant radionuclides in the NTS environs and all exposure pathways.

No new studies or investigations were initiated by BECAMP in 1994, or on-going studies or reports completed.

4.1.2 OFFSITE MONITORING

Under the terms of an Interagency Agreement between DOE and EPA, EMSL-LV conducts the Offsite Radiation Safety Program (ORSP) in areas surrounding the NTS. When nuclear testing is conducted, personnel from EMSL-LV provide support for each nuclear weapons test. Public information and community assistance activities constitute a second component of the EMSL-LV program. The largest component is routine monitoring of potential human exposure pathways.

Due to the continuing moratorium on nuclear weapons testing, only simulated readiness tests were conducted in 1994. For each of the four tests, EMSL-LV senior personnel served on the Test Controller's Scientific Advisory Panel and on the EPA offsite radiological safety staff. Routine offsite environmental monitoring continued throughout 1994.

Environmental monitoring networks, described in the following subsections, measure radioactivity in air, atmospheric moisture, milk, local foodstuffs, and groundwater. These networks monitor the major potential pathways of radionuclide transfer to man via inhalation, submersion, and ingestion. Direct measurement of offsite resident exposure through the external and internal dosimetry programs provides confirmation of the exposures estimated via the monitoring networks. Ambient gamma radiation levels are monitored using Reuter-Stokes pressurized ion chambers (PICs) and Panasonic TLDs. Milk, game and domestic animals, and foodstuffs (fruits and vegetables) are routinely sampled and analyzed. Groundwater on and in the vicinity of the NTS is monitored in the Long-Term Hydrological Monitoring Program (LTHMP). Data from these monitoring networks are used to calculate an annual exposure dose to the offsite residents.

Town hall meetings and public information presentations were used to increase public awareness of NTS activities, disseminate radiation monitoring results, and to address concerns of residents related to environmental radiation and possible health effects. Community Radiation Monitoring Program (CRMP) stations were established in prominent locations in a number of offsite communities. The CRMP stations contained samplers for several of the monitoring networks and were managed by local residents. The University of Utah and DRI are cooperators with EMSL-LV in the CRMP.

4.1.2.1 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 NTS and non-NTS activities. Data from atmospheric monitoring can determine the concentration and source of airborne radioactivity and can project the fallout patterns and durations of exposure to man. Atmospheric monitoring networks include the Air Surveillance, Noble Gas, and Atmospheric Moisture (Tritium-in-Air) Networks.

The Air Surveillance Network (ASN) was originally designed to monitor the areas within 350 km (220 mi) of the NTS, with some concentration of stations in the prevailing downwind direction. Due to the current moratorium on nuclear weapons testing, DOE began reducing the area of the offsite monitoring networks to approximately 130 km (80 mi) of the NTS. Selection of station location depends in part on the availability of electrical power and a resident willing to operate the equipment. This continuously operating network is supplemented by a standby network encompassing the contiguous states west of the Mississippi River. Standby samplers are identical to those used at the active stations and are operated by state and municipal health department personnel or by other local residents.

At the beginning of 1994 the ASN consisted of 30 continuously operating sampling stations as shown in Figure 4.5 and 77 standby stations (Figure 4.6) that were scheduled to be activated one week per quarter. Several changes to the ASN were made during the last quarter of 1994. Ten active stations were placed on standby and four were transferred to the Yucca Mountain Project. The sampling equipment in Salt Lake City, Utah, was loaned to the University of Utah for use with University radiation monitoring programs and training. In December, seven additional stations were placed on standby status and five of the downwind stations were restarted. As a result, 16 routine stations changed status and 14 stations remain in the continuously operating network (see Figure 4.7). Fifteen sampling locations were deleted from the standby network during the fourth quarter of 1994 leaving a total of 73 stations, including the 11 transferred from the active network (see Figure 4.8). The standby air sampling network was not activated during the fourth quarter of 1994. Evaluation of new high volume samplers was begun at the Las Vegas station during 1994.

Low-volume air samplers at each station are equipped to collect particulate radionuclides on fiber filters and gaseous radioiodines in charcoal cartridges. Duplicate air samples are collected from three routine ASN stations each week. The duplicate samplers operate at randomly selected stations continuously for three months and are then moved to new locations. Particulates are collected on 5-cm (2.0-in) diameter glass-fiber filters at a flow rate of about 80 m^3 (2800 ft^3) per day. Filters are changed weekly (approximately 560 m^3 or 20,000 ft^3 air sampled). Activated charcoal cartridges placed directly behind the filters to collect gaseous radioiodine are changed at the same time as the filters.

At EMSL-LV, both the glass-fiber filters and the charcoal cartridges were initially analyzed by high-resolution gamma spectrometry; charcoal cartridges from standby stations were analyzed only if there was some indication of radioiodine. 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. Glass-fiber filters from selected stations were composited and analyzed for plutonium isotopes.

A second part of the EMSL-LV offsite air network was the Noble Gas and Tritium Surveillance Network (NGTSN). Radioactive xenon and krypton may be released into the atmosphere from research and power reactor facilities, fuel reprocessing facilities, and from nuclear testing. Because of it's short half-life, xenon decays before dispersing widely and so is rarely detectable. Krypton-85, with a 10.7 year half-life and no significant sinks (NCRP 1975), is dispersed more or less uniformly in the atmosphere. Considering the amount released, ^{85}Kr concentrations are expected to be detectable. Tritium is created by natural interactions in the upper atmosphere and is also emitted from nuclear reactors, reprocessing facilities (non-NTS facilities), and from nuclear testing.

The locations of the NGTSN stations are shown in Figure 4.9. The NGTSN was designed to detect any increase in offsite levels of noble gasses or tritium due to NTS emissions. Routinely operated network samplers were located in populated areas surrounding the NTS and standby samplers were located in more distant communities. In 1994, this network consisted of 13 routine noble gas and tritium-in-air samplers, plus seven on standby, located in the states of Nevada, Utah, and California. In addition, a tritium sampler was routinely operated near a nuclear research reactor in Salt Lake City, Utah.

Noble gas samplers collect approximately 0.6 m^3 (21 ft^3) of air by compressing it into storage tanks. The tanks were exchanged weekly and returned to the EMSL-LV. For the analysis,

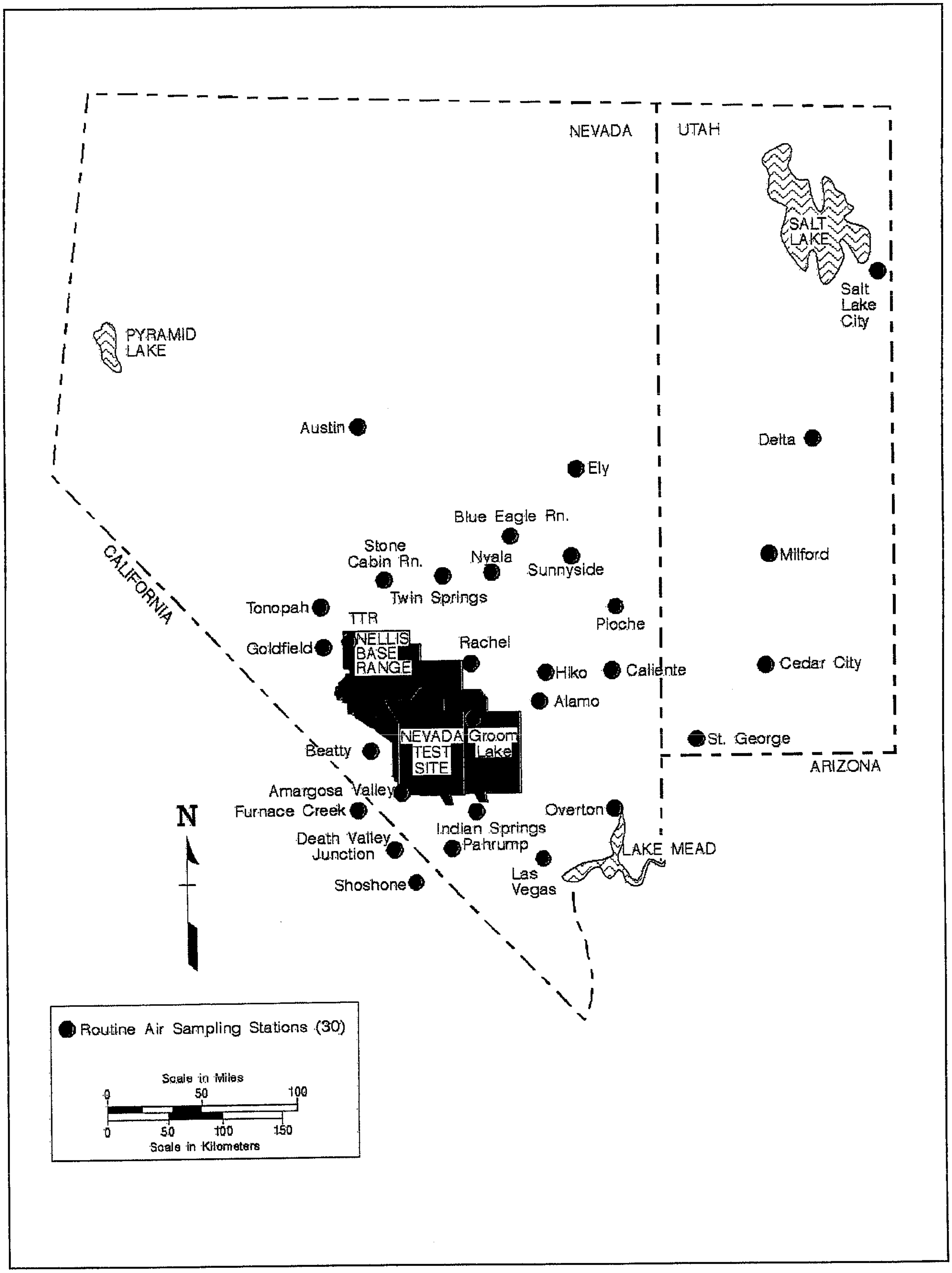


Figure 4.5 Air Surveillance Network Stations, January - September 1994

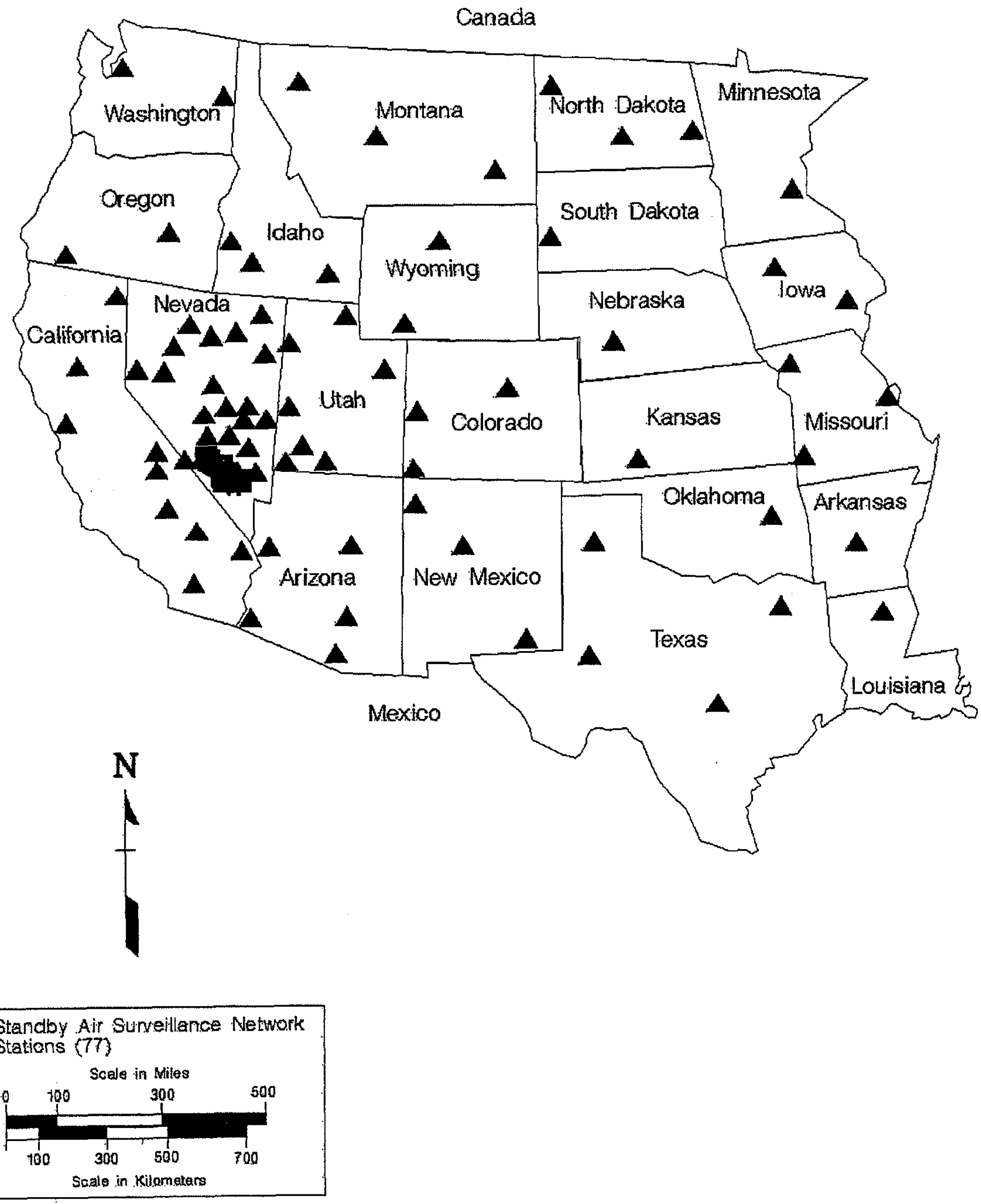


Figure 4.6 Standby Air Surveillance Network Stations, January - September 1994

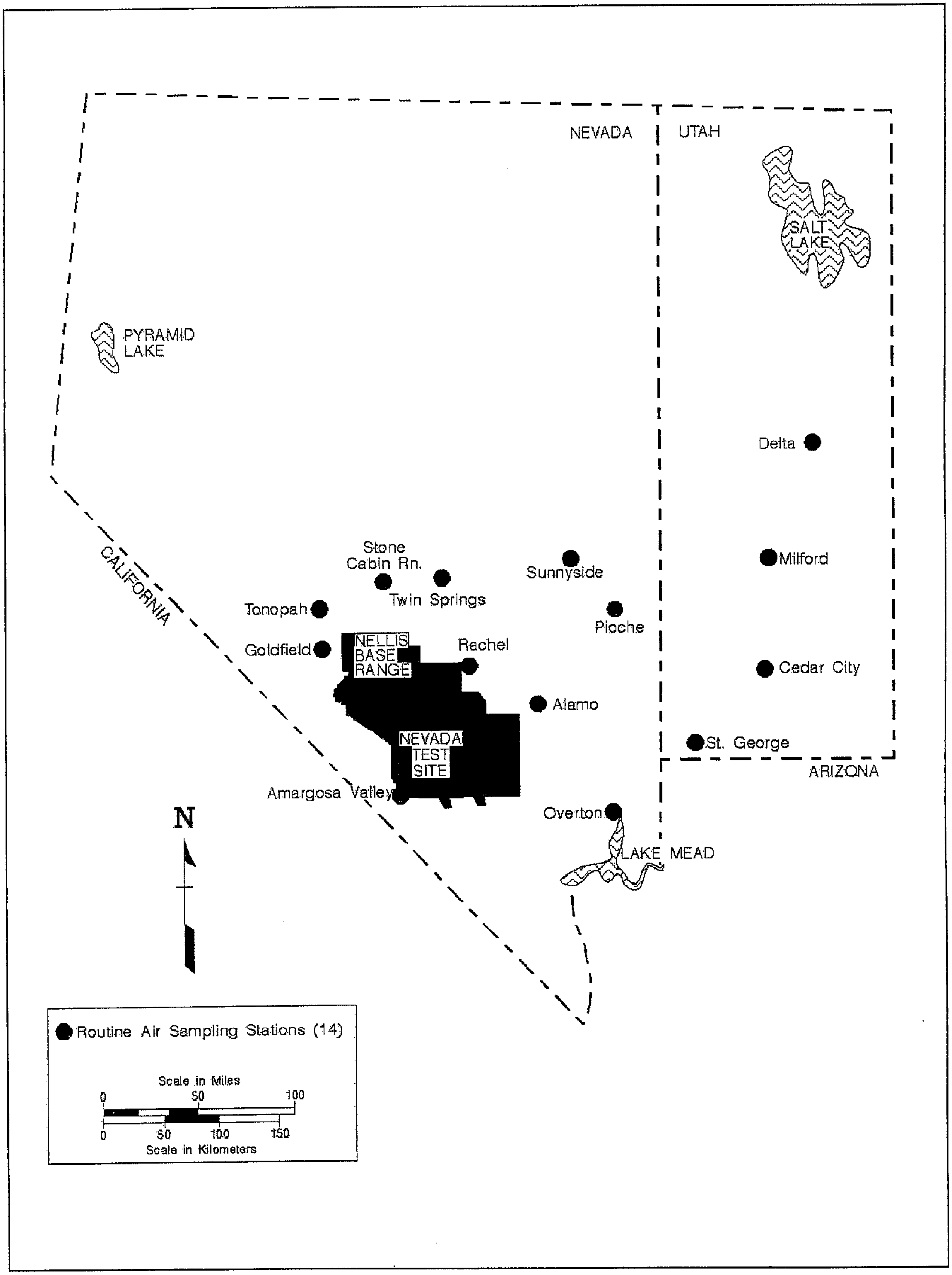


Figure 4.7 Air Surveillance Network Stations, Fourth Quarter - 1994

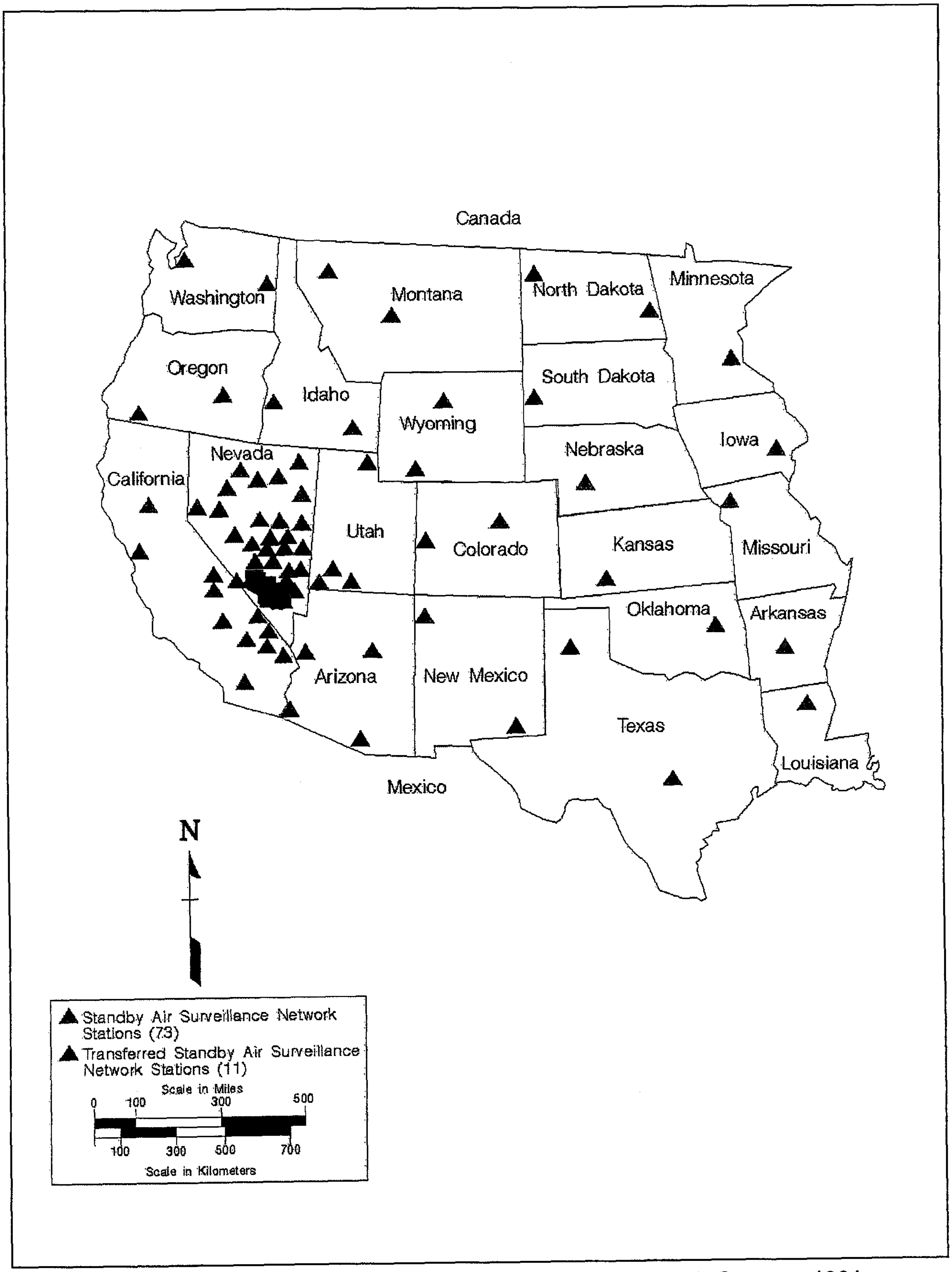


Figure 4.8 Standby Air Surveillance Network Stations, Fourth Quarter - 1994

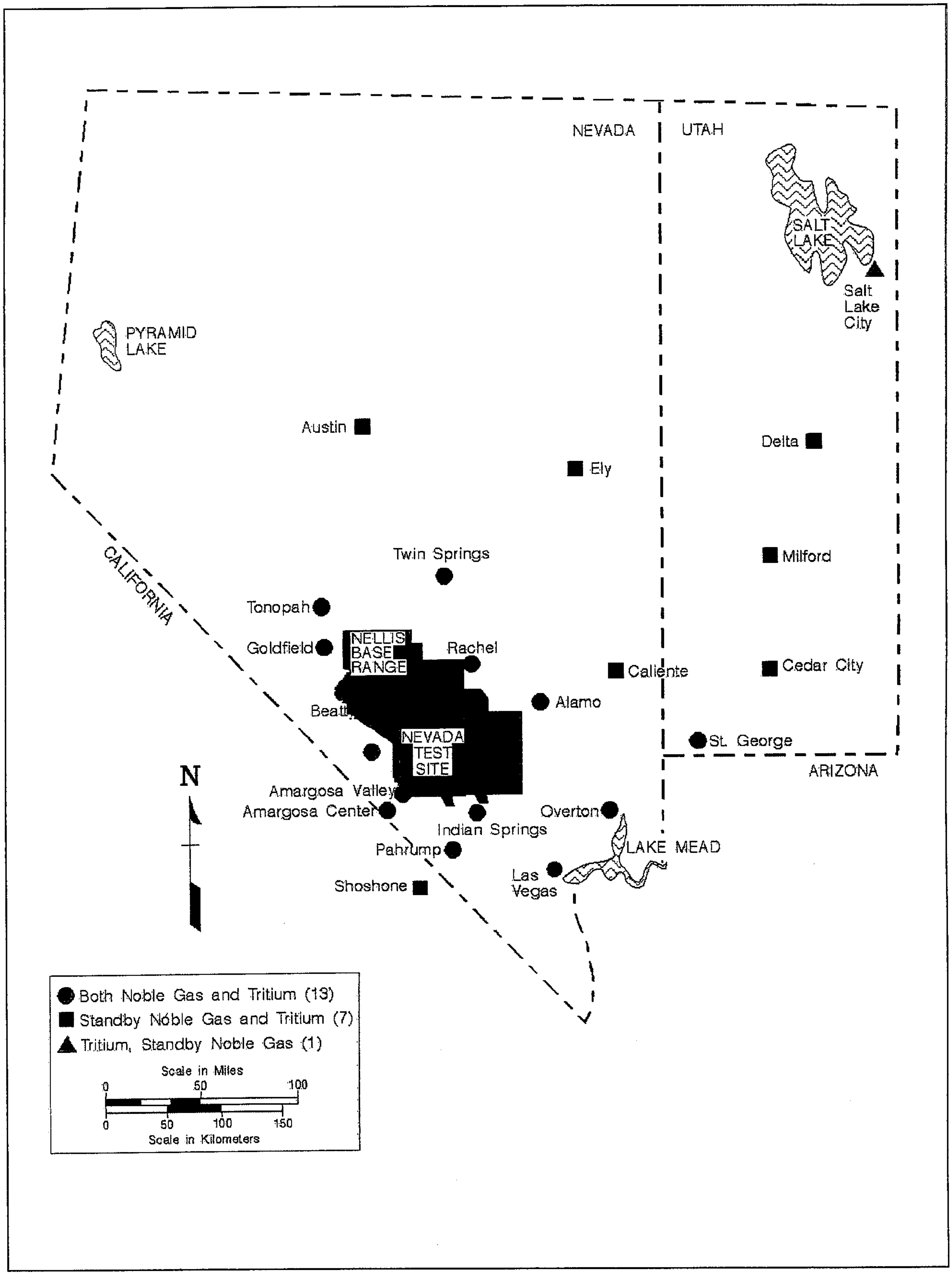


Figure 4.9 Offsite Noble Gas and Tritium Surveillance Network Stations - 1994

samples were condensed at liquid nitrogen temperature. Gas chromatography was then used to separate the various radionuclides which were dissolved in liquid scintillation "cocktails," and then counted in a liquid scintillation counter.

For tritium-in-air measurement, approximately 6 m^3 (212 ft^3) of air was drawn through a column of molecular sieve pellets over a 7-day sampling period. The water absorbed in the pellets was recovered and measured and the concentration of ^3H determined by liquid scintillation counting. The volume of recovered water and the ^3H concentration were used to calculate the concentration of HTO, the form most commonly encountered in the environment.

Due to budget constraints and the continuing moratorium on nuclear testing the entire Noble Gas and Tritium Surveillance Network was placed in standby status in September 1994.

4.1.2.2 WATER MONITORING

As part of the LTHMP, EMSL-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 are discussed in Chapter 9, Sections 9.5 and 9.6.

4.1.2.3 MILK SURVEILLANCE NETWORK (MSN)

Milk is an important resource for evaluating potential human exposures to radioactive material. It is one of the most universally consumed foodstuffs and certain radionuclides are readily traceable through the food 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 15 locations comprising the MSN at the beginning of 1994 are shown in Figure 4.10. Samples were collected from 14 of these locations in 1994. Changes in 1994 included five locations deleted and one added.

The Standby Milk Surveillance Network (SMSN) includes dairies and processing plants representing all major milksheds west of the Mississippi River. The network is activated annually by contacting cooperating Food and Drug Administration Regional Milk Specialists, who in turn contact state Dairy Regulators to enlist cooperating milk processors or producers. This annual activation permits trends to be monitored and maintains operational capability. The 115 locations comprising the SMSN in 1994 appear in Figure 4.11. Of these, 102 were sampled in 1994. This network has since been discontinued.

Raw milk was collected in 3.8-L (1-gal) Cubitainers and preserved with formaldehyde. Samples from the SMSN were mailed to the EMSL-LV where they were analyzed by high-resolution gamma spectrometry. One sample per quarter from each MSN location and samples from two locations in each state in the SMSN are analyzed for ^3H by liquid

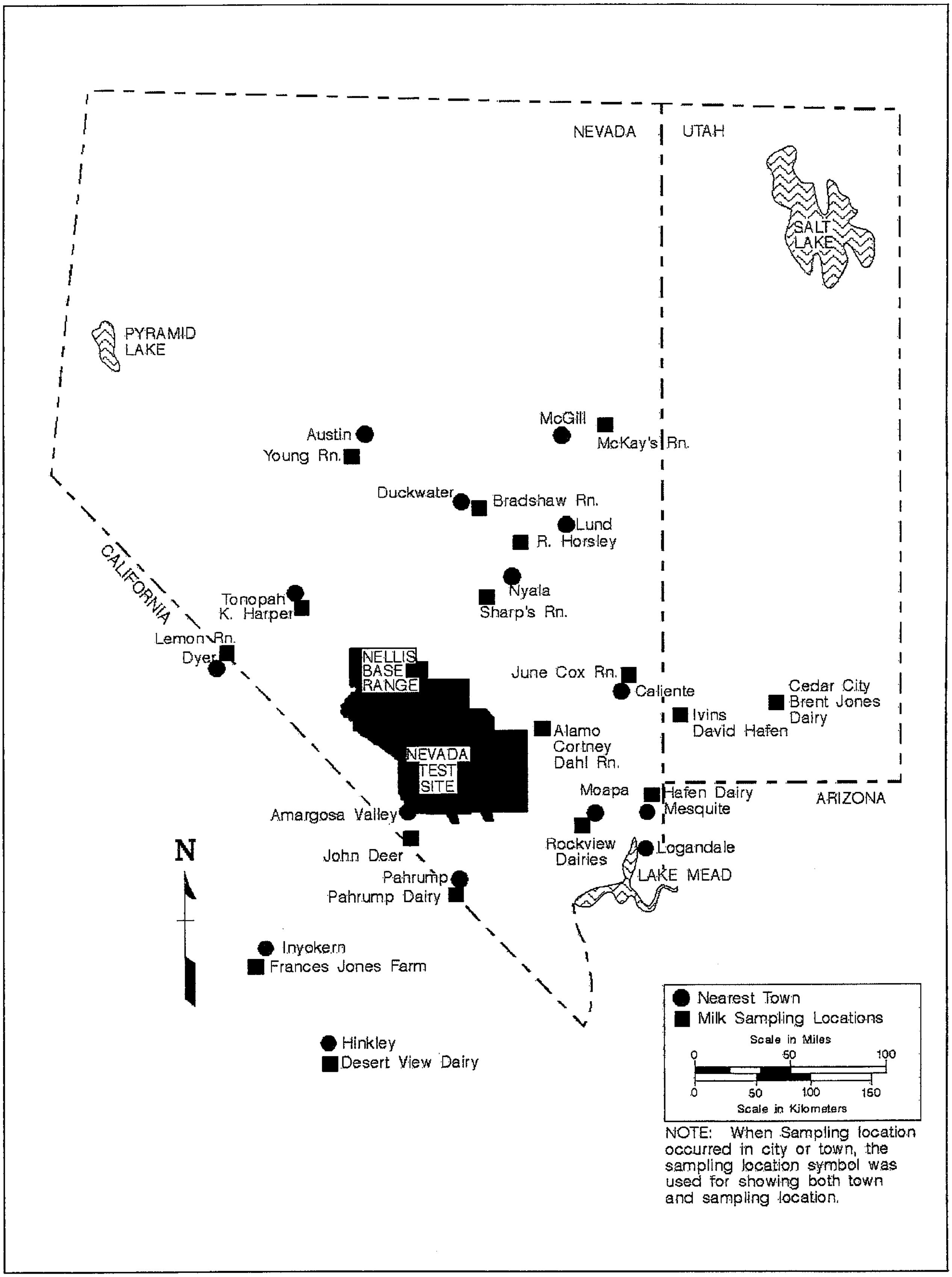


Figure 4.10 Milk Surveillance Network Stations - 1994

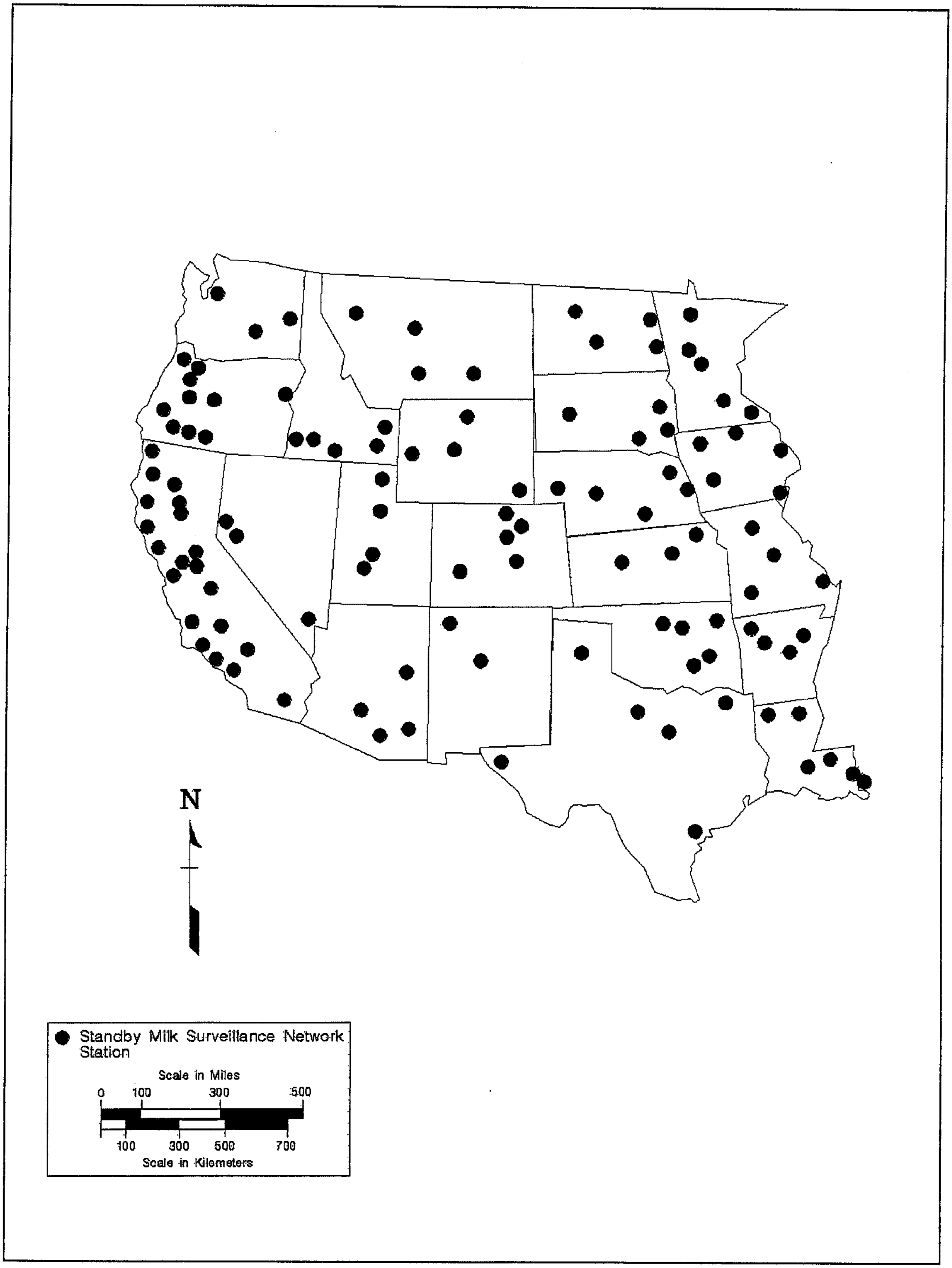


Figure 4.11 Standby Milk Surveillance Network Stations - 1994

scintillation counting 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.

The dairy animal and population census is continually updated for those areas within 385 km (240 mi) north and east of CP-1 and within 200 km (125 mi) south and west of it. The remainder of the Nevada counties and the western-most Utah counties are surveyed approximately every other year. The locations of processing plants and commercial dairy herds in Idaho and the remainder of Utah can be obtained from the milk and food sections of the individual state governments.

4.1.2.4 BIOMONITORING

Ingestion is one of the critical transport pathways for radionuclides to humans. Food crops may absorb radionuclides from the soil in which they are grown. Radionuclides may be found on the surface of fruits and vegetables from atmospheric deposition, resuspension, or in particles of soil adhering to vegetable surfaces. Weather variables, especially precipitation, can affect soil inventories of radionuclides. Grazing animals ingest radionuclides which may have been deposited on forage and also ingest soil which may contain radionuclides. These may accumulate in liver and muscle of the grazing animal to become available for human uptake.

The biomonitoring network includes the animal investigation program and monitoring of radionuclides in locally grown fruits and vegetables. The objective of the animal investigation program is to determine whether there is any potential for radionuclides to reach humans through the ingestion pathway. Mule deer are migratory; and the ranges of the herds on the NTS include lands outside the federal exclusionary area in which hunting is permitted. It is possible for a resident to consume meat from a deer which had become contaminated with radionuclides during its migration through the NTS.

During the years of atmospheric testing, fission products were carried outside the boundaries of the NTS and deposited in the offsite area. Longer-lived radionuclides, particularly plutonium and strontium isotopes, are still detected in soil and may be ingested by animals residing in those areas. Cattle are purchased from ranches where radionuclides are known to have been deposited. The locations where animals were collected in 1994 are shown in Figure 4.12.

Each year, attempts are made to collect four mule deer from the NTS, on a one per quarter schedule (see Figure 4.13). In addition one deer was collected in Nye County in the Cherry Creek area to be used as a comparison as shown in Figure 4.12. A deer is hunted by personnel with a special permit to carry weapons on the NTS. The deer is usually dressed in the field, with precautions taken to minimize risk of contamination. The location of the deer, weight, sex, condition, and other information are recorded on a field data form. Organs are removed and sealed in labeled sample bags. Later, at the NTS Farm Facility, samples are placed in 350-mL sealed aluminum cans for gamma counting. Samples of lung, liver, muscle, and rumen contents are split, one for analysis of gamma-emitting radionuclides and one for analysis of plutonium isotopes. Thyroid and fetus (when available), because of their small size, are analyzed only for gamma-emitting radionuclides. Samples of blood are analyzed for gamma-emitting radionuclides and tritium. Bone samples are shipped in a single batch each quarter to a contract laboratory for ashing and analyses for plutonium isotopes and strontium. All other analyses are done in the EMSL-LV Radioanalysis Laboratory.

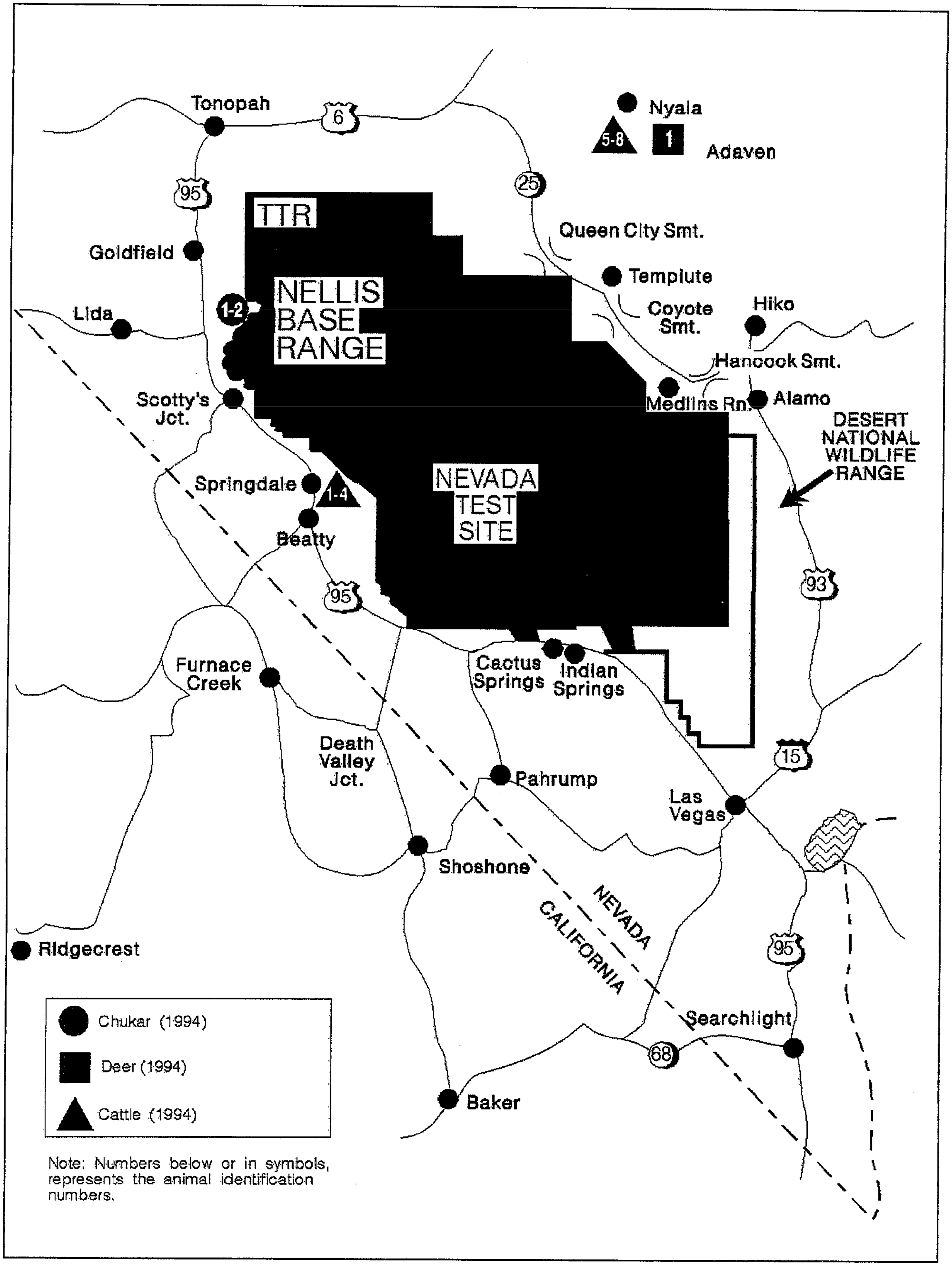


Figure 4.12 Offsite Collection Sites for Animals Sampled - 1994

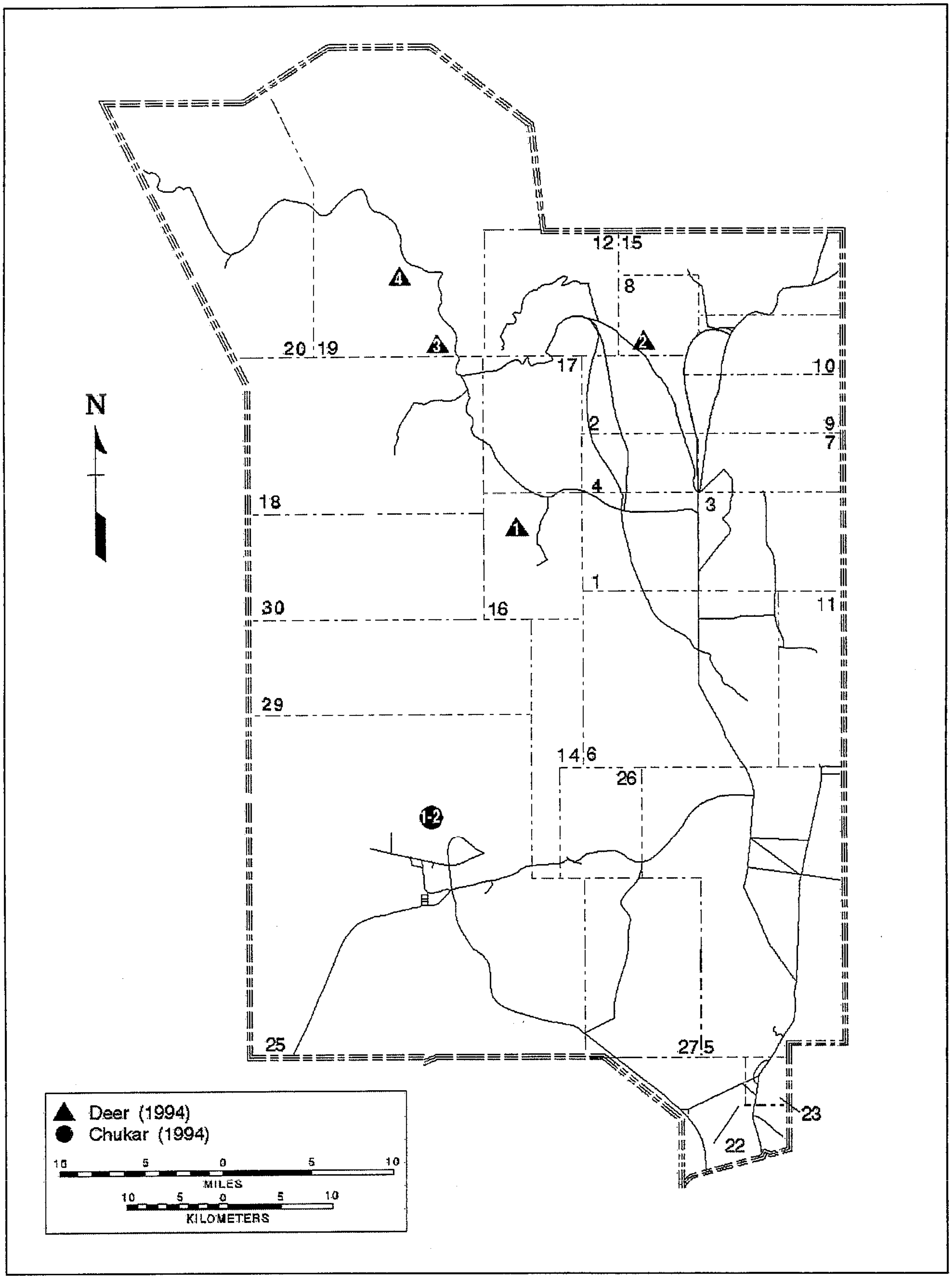


Figure 4.13 Onsite Collection Sites for Animal Sampled - 1994

Starting in 1993, the DOE and the state of Nevada requested the collection of quail and chukar on the NTS. This collection will be used to establish a baseline of possible radioactive contaminant levels in these game birds. In the future, chukar may be captured by the state of Nevada and relocated to other areas of the state to establish new breeding colonies. The locations of collection in 1994 are shown in Figure 4.13. No quail were collected.

In 1994, four cattle were purchased in the spring from the G.L. Coffer Ranch in Beatty, Nevada and four were purchased in the fall from the Norm Sharp Ranch at Nyala, Nevada. The NTS Farm Facility is used for the slaughter. Also, a bull from the old NTS herd was collected. This facility is designed to minimize risk of contamination. As with the mule deer, sampling information and sample weights are recorded on a field data form and samples are sealed in labeled sample bags. Samples of blood and soft tissues (lung, muscle, liver, thyroid, and kidney) are analyzed for gamma-emitting radionuclides; blood is also analyzed for tritium activity. Bone samples and a second liver sample are ashed and analyzed for plutonium isotopes; bone ash samples are also analyzed for strontium. A sample of the water used in processing the samples is also collected and analyzed.

In addition to animals, samples of locally grown fruits and vegetables were obtained in the fall of 1994 by donation from residents of farms in Rachel, Nevada; Penoyer Farm, Nevada; Uhalde Ranch, Nevada; Adaven, Nevada; Alamo, Nevada; Complex I, Nevada; Enoch, Utah; and, Santa Clara, Utah. The samples are analyzed by gamma spectrometry, then ashed and analyzed by radiochemistry for ^{90}Sr, and $^{238,\ 239+240}Pu$.

4.1.2.5 THERMOLUMINESCENT DOSIMETRY NETWORK

The primary function of the EMSL-LV environmental dosimetry program is to detect any increase in radiation levels in areas surrounding the NTS. This is accomplished by developing baseline information regarding ambient radiation levels from all radiation sources and looking for deviations from established trends. In addition to the environmental thermoluminescent dosimeter (TLD) program, EPA deploys personnel TLDs to individual volunteers living in areas surrounding the NTS. The information gathered from this program would help define possible exposures to residents in the event there were a release from the NTS.

The current TLD program utilizes Panasonic TLDs which are read by using the Panasonic Model UD-710A automatic dosimeter reader. The UD-802 personnel TLD incorporates two elements of $Li_2B_4O_7$:Cu and two elements of $CaSO_4$:Tm phosphors. With the use of different filtrations, a dose algorithm can be applied to look at ratios of the different elements and determine the radiation type and energy which provides a mechanism for establishing a dose equivalent. The UD-814 environmental TLD incorporates one element of $Li_2B_4O_7$:Cu and three elements of $CaSO_4$:Tm. An average of the corrected values for the three similar elements gives the total exposure for that TLD. Two UD-814 TLDs are deployed at each station per monitoring period.

In 1994, several environmental monitoring stations and personnel monitoring TLDs were discontinued due to a shift in mission at the NTS. Figure 4.14 shows fixed environmental monitoring stations and the location of personnel monitoring participants.

Exposures were determined for each deployment period by calculating an average daily exposure. The total average daily rate was calculated from the four deployment periods and then multiplied by 365 to obtain the total annual exposure for each station.

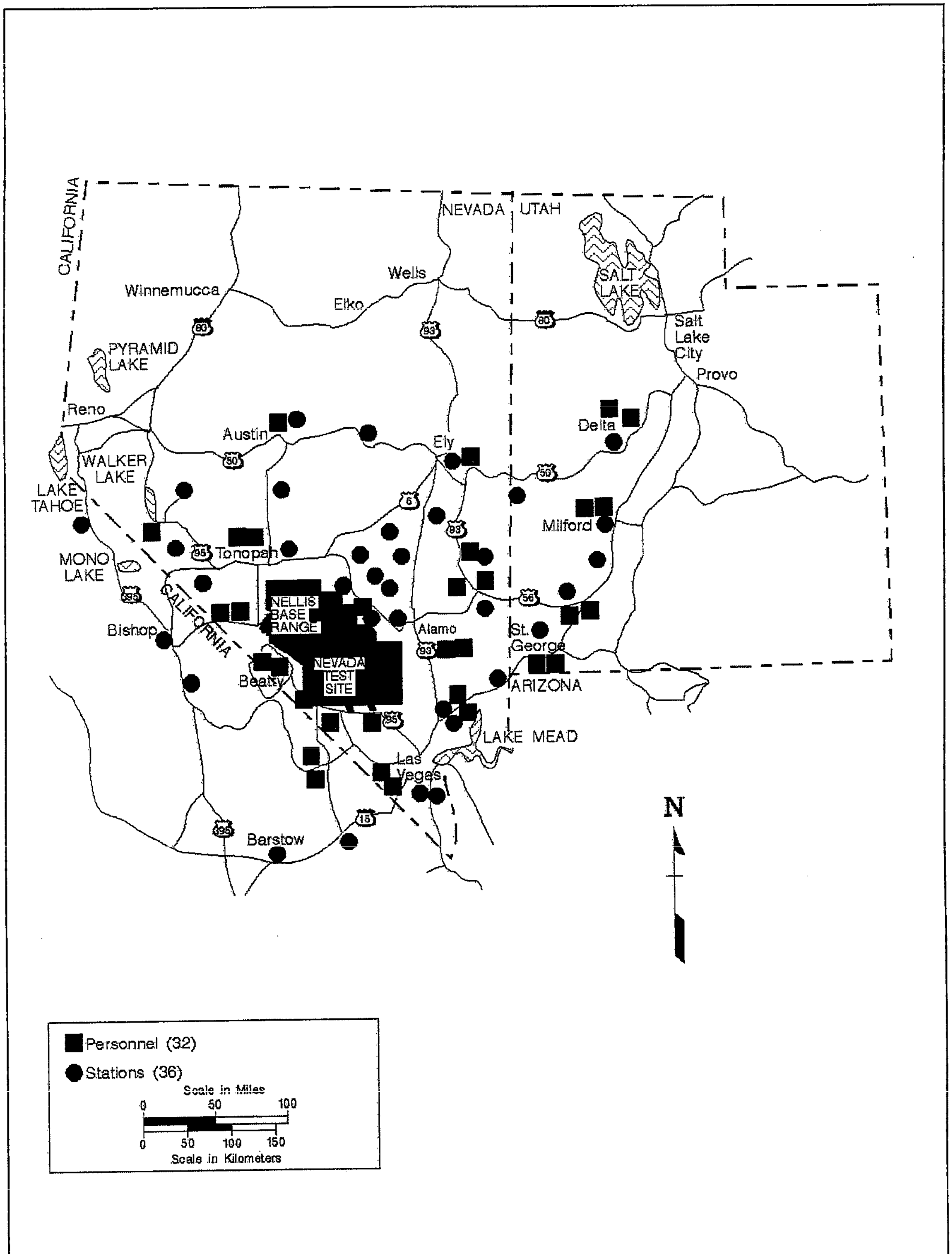


Figure 4.14 Thermoluminescent Dosimetry Fixed Environmental Stations and Personnel Monitoring Participants - 1994

During 1994 the EMSL-LV TLD program accreditation was renewed by the Department of Energy Laboratory Accreditation Program. This accreditation included successful completion of a three part blind performance testing phase and an onsite review of operations and associated documentation. In addition, during 1994 the EMSL-LV TLD laboratory participated in a collaborative study with the U.S. Army Primary Standards Laboratory that included blind performance testing and exposures to characterize reader response to radiation types not included in the DOELAP standard. Results obtained from this blind testing also confirmed that the results obtained by the EMSL-LV TLD program continue to be both accurate and reproducible within established performance standards.

4.1.2.6 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 a 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 electrical current generated is proportional to the radiation field.

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 rates vary with altitude (cosmic radiation), with radioactivity in the soil (terrestrial radiation), and also varies slightly within a location due to weather patterns.

There are 29 PICs located in communities around the NTS which provide near real-time estimates of gamma exposure rates. The locations of the PICs are shown in Figure 4.15. Prior to October 1994, PIC stations located at Terrell's Ranch, and Amargosa Valley Community Center were the only PICs that were part of the Yucca Mountain Project. In November, the PICs at Beatty, Indian Springs and Pahrump also became part of the Yucca Mountain Project. The EPA continues to maintain the equipment and collect data from these stations.

The near real-time telemetry-based data retrieval is achieved by the connection of each PIC to a device which collects and transmits the data through the Geostationary Operational Environmental Satellite directly to an NTS receiver and then to EMSL-LV by dedicated telephone line.

In addition to telemetry retrieval, PIC data are also recorded on either magnetic tapes and hardcopy strip charts or on magnetic cards. The magnetic tapes and cards provide a backup for the telemetry data.

4.1.2.7 INTERNAL DOSIMETRY NETWORK

Internal radiation exposure is caused by radionuclides that are ingested, absorbed, or inhaled and retained within the body. The EMSL-LV Internal Dosimetry Program employs two methods to detect body burdens: whole body counting (including lung counting) and urinalysis. A detailed discussion of this network may be found in Section 5.2.2.7 of this report.

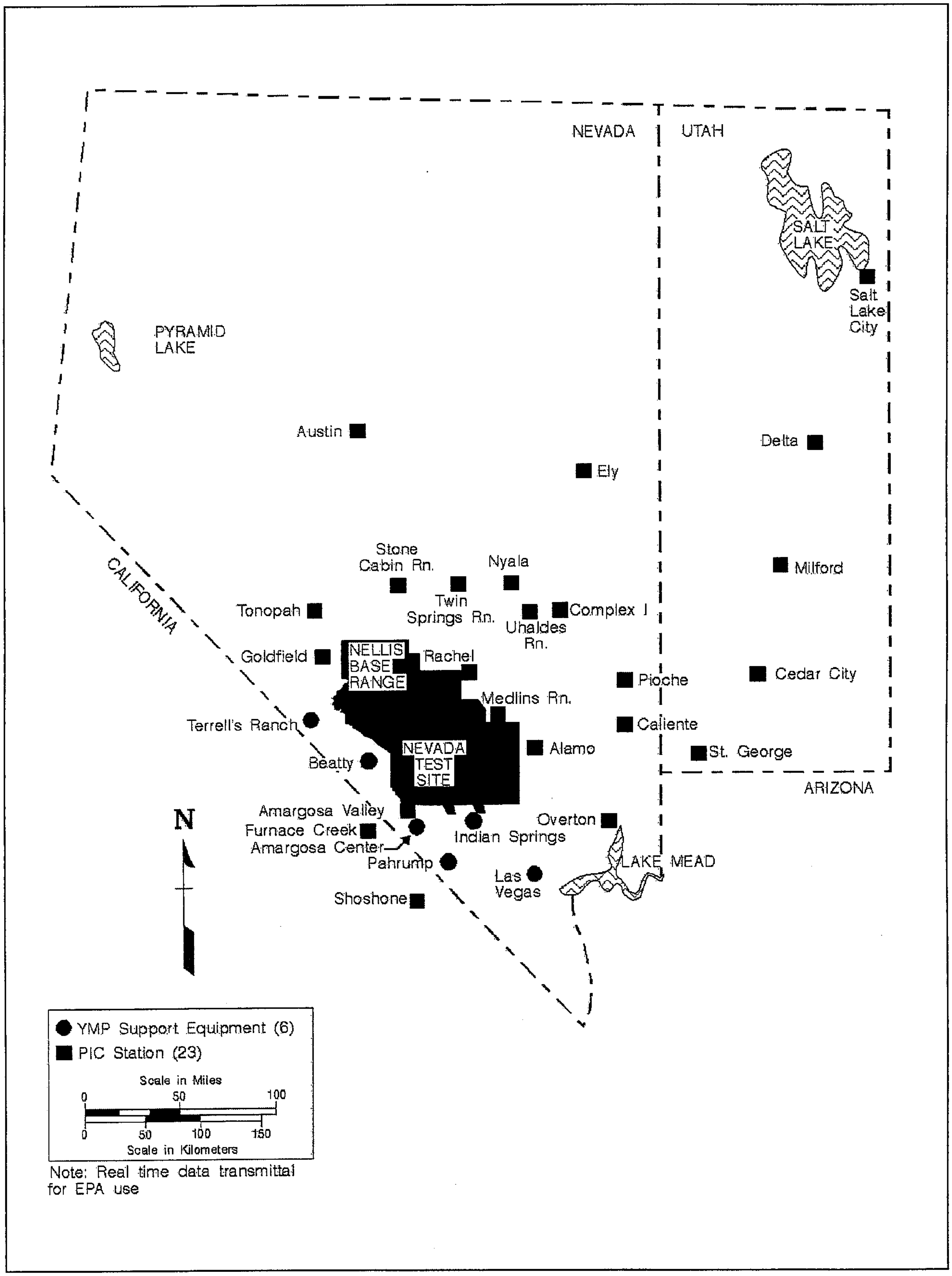


Figure 4.15 Pressurized Ion Chamber Network Station Locations - 1994

4.1.2.8 COMMUNITY RADIATION MONITORING PROGRAM

Because of the successful experience with the Citizen's Monitoring Program during the purging of the Three Mile Island (TMI) containment in 1980, the Community Radiation Monitoring Program (CRMP) consisting of stations located in the states of California, Nevada and Utah was begun. In 1994, there were 18 stations located in these three states. The CRMP is a cooperative project of the DOE, EPA, DRI, and University of Utah.

The DOE sponsored the program. The EPA provided technical and scientific direction, maintained the instrumentation and sampling equipment, analyzed the collected samples and interpreted and reported the data. The DRI administered 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. The University of Utah provided detailed training twice a year for the station managers and alternates on all issues related to nuclear science, radiological health and radiation monitoring.

Each station was operated by a local resident, in most cases a high-school science teacher. Samples were analyzed at the EMSL-LV. Data interpretation was provided by DRI to the communities involved. All of the 18 CRMP stations had one of the samplers for the ASN, NGTSN, on either routine or standby status, and TLD networks. In addition a PIC and recorder for immediate readout of external gamma exposure and a recording barograph were located at the station.

All of the equipment was mounted on a stand at a prominent location in each community so the residents were aware of the surveillance and, if interested, could check the data. Also, computer-generated reports of the PIC data were issued weekly for each station.

4.2 NONRADIOLOGICAL MONITORING

The 1994 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. BECAMP conducted studies in 1994 that included wildlife surveys and vegetation trend assessments in disturbed and undisturbed areas of the NTS. Nonradiological monitoring was conducted in 1994 for eight series of tests conducted at the Liquified Gaseous Fuels Spill Test Facility (LGFSTF) on the NTS.

Nonradiological monitoring of non-NTS DOE/NV facilities was conducted by EG&G/EM at three facilities. This monitoring was limited to wastewater discharges to publicly owned treatment works and into one dry well for returning uncontaminated, noncontact cooling water back to the ground.

4.2.1 NTS OPERATIONS MONITORING

4.2.1.1 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 operation activities. This included motor pool facilities; large equipment and drilling 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 LGFSTF in Area 5 is a source of potential release of nonradiological contaminants to the environment, depending on the individual tests conducted. In 1994 there were eight series of tests involving 22 different chemicals conducted at this facility. Monitoring was performed to assure these contaminants did not move to offsite areas. Since these monitoring functions are performed by the EMSL-LV at the NTS boundary, monitoring functions for the LGFSTF are described below in Section 4.2.2, "Offsite Monitoring." Routine nonradiological environmental monitoring on the NTS in 1994 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 N-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 (PCB) 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 National Emission Standards for Hazardous Air Pollutants (NESHAP) compliance;
- Sampling of soil, water, sediment, waste oil, and other media for RCRA constituents.

4.2.1.2 ECOLOGICAL STUDIES

Studies conducted under DOE/NV-sponsored programs included monitoring the flora and fauna on the NTS to assess changes in ecological conditions over time and to provide information needed to document NTS compliance with environmental laws, regulations, and orders. The monitoring effort has been arranged into three interrelated phases of work: (1) a series of five non-disturbed study plots in test-impacted ecosystems that are monitored at one to five-year intervals to establish natural baseline conditions; (2) a series of study plots in representative disturbed areas that are monitored at three- to five-year intervals to determine impacts of disturbance, document site recovery, and investigate natural recovery processes; and (3) observations of birds and large mammals throughout the NTS. Monitoring and survey work includes: (1) sampling vegetation to determine health, recovery, and utilization of vegetation in disturbed and undisturbed areas; (2) rodent trapping to determine the condition of individual animals and the continuity and stability of resident populations; (3) sampling a ubiquitous lizard to determine changes in abundance and health due to natural and man-made disturbances; (4) surveys to obtain information concerning resident populations of desert tortoises, kit foxes, rabbits, deer, and feral horses; and (5) the maintenance and preservation of the NTS herbarium, biological data archives, and ecology library.

In 1994, the seventh full year of flora and fauna monitoring, surveys were conducted of ephemeral plants, perennial plants, mammals, and reptiles at numerous sites. Many of these sites included paired disturbed/undisturbed plots.

Monitoring of feral horses continued for the fifth consecutive year. All horses, including foals, were individually identified. In addition, field observations were made of raptors, mule deer, and ravens in appropriate habitats throughout the NTS. Desert tortoises in the Rock Valley study enclosures were monitored in spring and fall, and free roaming tortoises were marked and measured when fortuitously encountered.

4.2.2 OFFSITE MONITORING

The LGFSTF 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 LGFSTF 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 down-wind gaseous concentrations, operating data, and close-in/down-wind 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 foot 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 gallons 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 gallons. 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 1994 eight series of tests were conducted involving 22 different chemicals. The plans for each test series were examined by an Advisory Panel that consisted of DOE/NV and EMSL-LV professional personnel augmented by personnel from the organization performing the tests.

For each test the EMSL-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 tests were monitored by EPA 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 at the time when the cloud was expected to arrive at the boundary, so the air samples would be collected at the time and place of maximum concentration. The exact location of the boundary monitor was adjusted during the test to ensure that monitoring was performed at the projected cloud center line.

4.2.3 NON-NTS FACILITY MONITORING

Although permits for the eight EG&G/EM non-NTS operations included 17 air pollution, 6 wastewater, 1 dry well for returning uncontaminated, non-contact cooling water back to the ground, and 3 local hazardous waste generator permits, effluent monitoring was limited to wastewater discharges (see below) at three sites. Four wastewater permits did not include effluent monitoring by EG&G/EM as a requirement. A description involving any unexpected emission was required for some permits, but again, monitoring was not required. All results from routine monitoring were within the permit limits, and monitoring activities were limited to the following:

- During 1994 EG&G/EM, Las Vegas Area Operation (LVAO), North Las Vegas Facility, was required to collect composite samples twice a year from two facility outfalls. Monitoring was also required from ten additional processes prior to discharging to the public sewer system. Biannual monitoring reports were submitted to the city of North Las Vegas in July and December 1994 for discharges that occurred during 1994. Monthly reports were required by EPA Region 9 for discharges from the ten outfalls within the NLVF.

- EG&G/EM, Woburn Cathode Ray Tube Operation (WCO), was not required to sample and submit monitoring reports for wastewater discharge to the sewer during 1994. WCO was required to submit monthly monitoring reports to the state of Massachusetts, Department of Environmental Protection on the uncontaminated, noncontact cooling water that was being discharged into a dry well. Monthly monitoring included measuring pH, temperature, and flow.

- EG&G/EM, LVAO, Remote Sensing Laboratory, was required to collect a composite sample twice a year from the photo laboratory effluent. Biannual monitoring reports were submitted to the Clark County Sanitation District on June and December of 1994. The RSL Facility operated under a Voluntary Schedule of Compliance for exceedance of the local limit of total cyanide to the public sewer system. EG&G/EM is installing a silver recovery electrolytic unit, evaporators, ion exchange system, an improved pH neutralization system, and associated plumbing and electrical systems. Installation will be complete by April 30, 1995.

4.3 ENVIRONMENTAL PERMITS

NTS environmental permits active during 1994 which were issued by the state of Nevada or Federal agencies included 48 air quality permits involving emissions from construction operation facilities, boilers, storage tanks, and open burning; 8 permits for onsite drinking water distribution systems; 5 permits for sewage discharges to lagoon collection systems; an N-Tunnel water pollution control permit; 8 permits for septage hauling; and 4 endangered species and wildlife scientific collection permits. Revisions to the Resource Conservation and Recovery Act (RCRA) Part A and Part B permit applications based on comments made be the state of Nevada, continued during 1994.

Non-NTS EG&G/EM permits included 17 air pollution control permits, 6 sewage discharge permits and 1 injection well permit. Nine EPA Generator Identification (ID) numbers were issued to seven EG&G/EM operations, and three local RCRA-related permits were required at two EG&G/EM operations.

4.3.1 AIR QUALITY PERMITS

Air quality permits were required for numerous locations at the NTS and at two non-NTS facilities.

4.3.1.1 NTS AIR QUALITY PERMITS

Table 4.2 is a listing of state of Nevada air quality operating or construction permits active in 1994. 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.

For OP 94-14, 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 1994 no 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 burning activities were transferred to the Area 11 Explosive Ordnance Disposal (EOD) Area that is included within the Part A and B application.

For OP 95-12, the Air Quality Officer no longer must be notified by telephone at least two working days in advance of each training exercise for Class A flammables, with a written summary of each exercise submitted within 15 days following the exercise. This summary, which includes the date, time, duration, exact location, and amount of flammables burned, is now included in an annual report. During 1994, 17 burn events which included 38 fires were conducted for radiological emergency response training. No training burns were conducted by onsite fire protection services, and no controlled burns for Class A flammables were held in 1994. Separate burn permits were issued for the demolition of old buildings and for a single burn which involved destruction of a Bradley vehicle.

4.3.1.2 NON-NTS AIR QUALITY PERMITS

Fifteen air pollution control permits were active for emission units at EG&G/EM 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 and WCO each had one air pollution control permit. For the other non-NTS, EG&G/EM operations, no permits have been required or the facilities have been exempted. Table 4.3 lists each of the required permits.

4.3.2 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 as shown. 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. No drinking water systems were maintained by non-NTS facilities.

4.3.3 SEWAGE DISCHARGE PERMITS

Sewage discharge permits from the state of Nevada, Division of Environmental Protection (NDEP), are listed in Table 4.5 and require submission of quarterly discharge monitoring reports. One NTS General Permit replaced all four individual system permits on January 31, 1994.

4.3.3.1 NTS SEWAGE HAULING PERMITS

Permits issued by the state of Nevada Division of Health for sewage hauling trucks for the NTS were renewed in November, 1994 and are listed in Table 4.6

4.3.3.2 NON-NTS SEWAGE PERMITS

Sewage permits were required for six of the eight non-NTS EG&G/EM operations. This included two permits at the Las Vegas Area Operations facilities, two at the Santa Barbara Operations facility, one at the Special Technologies Laboratory, and one at the Woburn Cathode Ray Tube Operations facility as shown in Table 4.5. Each was issued by the county or community in which the facility was located.

4.3.4 N-TUNNEL WATER POLLUTION CONTROL PERMIT

On November 2, 1992, the NDEP issued a water pollution control permit, number NEV92033, for the operation and closure of the wastewater treatment ponds at N-tunnel on the NTS. This permit became effective on November 12, 1992, and expired on the same date in 1994. The permit specified pond monitoring, quarterly reporting and management requirements.

4.3.5 INJECTION WELL PERMITS

Underground injection is not being used to dispose of industrial wastewater at the NTS. One injection well for uncontaminated noncontact cooling water at the EG&G/EM facility in Woburn, Massachusetts is subject to state overview. A discharge permit for this well was issued on

January 4, 1993. WCO was required to submit monthly monitoring reports to the state of Massachusetts, Department of Environmental Protection on the uncontaminated noncontact cooling water that was being discharged into a dry well. Monthly monitoring included measuring pH, temperature, and flow.

4.3.6 RCRA PERMITS

4.3.6.1 NTS OPERATIONS

Hazardous waste generation activities at the NTS continue to be performed under EPA ID Number NV3890090001. A Part A and Part B RCRA permit application has been submitted to the state of Nevada for the following NTS operations: Pit 3 Mixed Waste Disposal Units (existing), the Mixed Waste Disposal Units (proposed), the Area 5 Hazardous Waste Storage Unit (proposed), and the Area 11 Explosive Ordnance Disposal Area (existing) (see Section 3.1.5.1). Both of the existing units have achieved interim status.

The NTS also has a "Nevada Hazardous Materials Storage Permit," Number 13-94-0034-X, issued by the state Fire Marshall. This permit is renewed annually when a facility makes a report required by the Chemical Catastrophe Prevention Act (see Section 3.1.8).

4.3.6.2 NON-NTS FACILITIES

Nine EPA Generator ID numbers have been issued to seven EG&G/EM operations. In addition, three local ID numbers were required at two EG&G/EM operations. Hazardous waste is managed at these locations using satellite accumulation areas and a less than 90-day waste accumulation area. All hazardous and industrial chemical wastes are transported offsite to RCRA-permitted facilities for approved treatment and/or disposal.

4.3.7 ENDANGERED SPECIES ACT/WILDLIFE PERMITS

Federal and state permits have been issued to NTS entities for study of endangered species and wildlife. (All EG&G/EM non-NTS facilities are located in existing metropolitan areas and are not subject to the Endangered Species Act.) These biological studies include ongoing research on the desert tortoise. Annual reports are filed as stipulated in the permits.

Desert tortoise studies at the NTS are performed under endangered species permit numbers PRT-744522 issued to REECo in 1990 (expiration date: December 31, 1994), and PRT-781234 issued to EG&G/EM in 1994 (expiration date: May 30, 1998). Both of these permits were issued by the U.S. Fish and Wildlife Service. The REECo permit was not renewed because the personnel will be transferred to EG&G/EM in early 1995 and will work under that permit.

The state of Nevada Department of Wildlife issued a scientific collection permit, number S-9480 on January 1, 1994 for the collection and study of various species at the NTS. This permit expired on December 31, 1994.

The U.S. Fish and Wildlife Service issued REECo "Special Purpose Salvage" permit PRT-762816 on November 8, 1993. This permit allows for salvaging dead migratory birds and expires on December 31, 1995.

Table 4.1 Summary of Onsite Environmental Surveillance Program - 1994

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	54	Gamma spectroscopy, gross ß,($^{238,239+240}$Pu, monthly composite)[b]
	Low-volume sampling through silica gel	Biweekly	19	HTO (tritium oxide)
	Low-volume sampling	Weekly	10	^{85}Kr and ^{133}Xe
Potable Water	Grab sample	Monthly/ Quarterly	8	Gamma spectroscopy, gross ß, ^{3}H, ($^{238,239+240}$Pu, gross α quarterly), (^{90}Sr annually)
Potable Supply Wells	Grab sample	Quarterly	11	Gamma spectroscopy, gross ß, ^{3}H, ^{226}Ra, $^{238,239+240}$Pu, ^{3}H enrichment, gross α, ^{90}Sr quarterly
Non-Potable Supply Wells	Grab sample	Quarterly	3	Gamma spectroscopy, gross ß, ^{3}H, $^{238,239+240}$Pu, gross α, quarterly, (^{90}Sr annually)
Open Reservoirs	Grab sample	Quarterly	12	Gamma spectroscopy, gross ß, ^{3}H, $^{238,239+240}$Pu quarterly, (^{90}Sr annually)
Natural Springs	Grab sample	Quarterly	8	Gamma spectroscopy, gross ß, ^{3}H, $^{238,239+240}$Pu quarterly, (^{90}Sr annually)
Containment Ponds	Grab sample	Monthly	1	Gamma spectroscopy, gross ß, ^{3}H, $^{238,239+240}$Pu quarterly, (^{90}Sr annually)
Sewage Lagoons	Grab sample	Quarterly	9	Gamma spectroscopy, gross ß, ^{3}H, $^{238,239+240}$Pu quarterly, (^{90}Sr annually)
External Gamma Radiation Levels	UD-814AS thermoluminescent dosimeters	Quarterly	201	Total quarterly exposure

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

(b) Beginning with the fourth quarter of 1994, the air filters from stations, other than the 12 stations inside Radioactive Waste Management Sites (RWMS) in Areas 3 and 5, were composited quarterly for plutonium analyses. Monthly compositing of filters was continued for the stations inside the RWMS.

Table 4.2 NTS Active Air Quality Permits - 1994

Permit No.	Facility or Operation	Expiration Date
OP 94-5	Open burning, building demolition	07/24/95
OP 95-18[b]	Bradley Burn Test	12/31/94
OP 94-14[a]	Open burning, Area 27	11/28/94
OP 95-12	Open burning fire rescue	10/02/95
OP 2187	York-Shipley boiler	11/01/95
OP 2230	Rex LO-GO Concrete Batch Plant	02/19/96
OP 2275	Storage tank, DF #2	02/25/96
OP 2276	Storage tank, unleaded fuel	02/25/96
OP 2277	Storage tank, unleaded fuel	02/25/96
OP 2278	Storage tank, DF #2	02/25/96
OP 2428	Aggregate Plant	02/12/97
OP 2625	LGFSTF	11/02/97
OP 2745[a]	Cafeteria boiler, Ajax boiler	03/23/98
OP 2746[a]	Cafeteria boiler, Ajax boiler	03/23/98
OP 2744[a]	Area 12 Cafeteria boiler, Ajax boiler	03/23/98
OP 2743[a]	Surface area disturbances	03/23/98
OP 1966	Cement storage equipment, Area 6	11/21/94
OP 1972	Shaker Plant	12/04/94
OP 1973	CMI rotary dryer	12/04/94
OP 1974	Cedarapids crusher	12/04/94
OP 1975	Stemming Facility	12/04/94
OP 1976	Stemming Facility	12/04/94
OP 1978	Ajax boiler WOFD-6500	12/04/94
OP 1979	Aggregate Mixing/Hopper Plant	12/04/94
OP 2555[a]	Incinerator	08/17/97
OP 2674	Portable Ammonia Refrigeration System	12/14/97
OP 2850[a]	Portable cement bins, Area 6	12/02/98
OP 2849[a]	Concrete Batch Plant	12/02/98
PC 2707	Portable compressor	Varies
PC 2708	Portable compressor	Varies
PC 2709	Portable compressor	Varies
PC 2710	Portable compressor	Varies
PC 2711	Portable compressor	Varies
PC 2712	Portable compressor	Varies
PC 2823[b]	Portable jaw crusher	Varies
PC 2824[b]	Portable screen (C.R.)	Varies
PC 2825[b]	Portable screen (Tel.)	Varies
PC 2826[b]	Portable pugmill	Varies
PC 3061[b]	Portable stemming facility, Area 3	Varies
PC 3246	Area 3 Mud Plant	Varies
PC 3247[b]	Area 20 Portable Mud Plant	Varies
PC 3248[b]	Area 3 Portable Mud Plant	Varies
PC 2988	Area 3 Two-Part Epoxy Batch Plant	Varies
PC 3311	Area 1 Sandbag Facility	Varies
PC 3312[b]	Area 1 Portable Kolberg Screen	Varies
PC 3518[b]	Area Commander Crushing Plant	Varies
PC 3774	Portable stemming system, Area 6	Varies
PC 3910	Area 5 Portable Slant Screen	Varies

(a) Permits renewal submitted
(b) Permits cancelled or allowed to expire

Table 4.3 Active Air Quality Permits, Non-NTS Facilities - 1994

Permit No.	Facility or Operation
Las Vegas Area Operation[(a)]	
A38702	Hamada Offset Press, NLVF
A06501	Spray Paint Booth, NLVF
A06504	Timesaver Ferrous Sander, NLVF
A06505	Timesaver Aluminum Sander, NLVF
A06506	Abrasive Blasting, NLVF
A06507	Trinco Dry Blast with Dry Bag Dust Filters, NLVF
A38701	Spray Paint Booth, NLVF
A06502	Vapor Degreasers #1 and #2
A06503	Katolight and Kohler Emergency Generator, and Emergency Fire Control Equipment, NLVF
A38703	890 HP Emergency Generator, NLVF
A34801	2.7 MM BTU Boiler, RSL
A34802	1.253 MM BTU Boiler, RSL
A34803	4.0 MM BTU Water Heater #2, RSL
A34804	Cummins Emergency Generator and Emergency Fire Control Equipment, RSL
A34805	Spray Paint Booth, RSL
Special Technologies Laboratory[(a)]	
8477	Permit to Operate a 12 Gallon Capacity Vapor Degreaser

(a) An annual fee is paid on these permits; there are no expiration dates

Table 4.4 NTS Drinking Water Supply System Permits - 1994

Permit No.	Area(s)	Expiration Date
NY-5024-12NC	Area 1	09/30/95
NY-4099-12C	Area 2 & 12	09/30/95
NY-360-12C	Area 23	09/30/95
NY-4098-12NCNT	Area 25	09/30/95
NY-5000-12NCNT	Area 6	09/30/95
NY-835-12NCNT	Site Wide Truck	09/30/95
NY-836-12NCNT	Site Wide Truck	09/30/95
NY-841-12NCNT	Site Wide Truck	09/30/95

Table 4.5 Sewage Discharge Permits - 1994

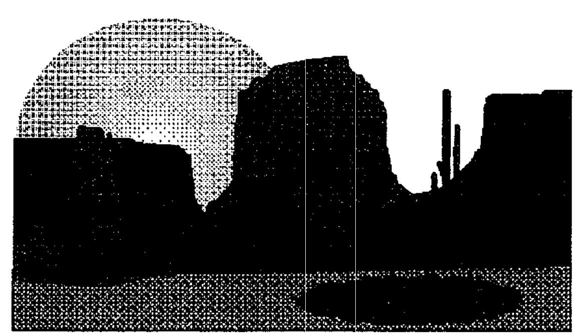
	NTS Permits	
Permit No./Location	Areas	Expiration Date
NEV87069	Area 2 (1), Area 6 (4)	02/28/94
NEV87076	Area 22, Area 23	02/28/94
NEV87060	Area 6 (1), Area 25 (4)	03/31/94
NEV87059	Area 12	02/28/94
GNEV93001[(a)]	NTS General Permit	01/31/99
	Off-NTS Permits	
Las Vegas Area Operations		
CCSD-032/Remote Sensing Laboratory[(a)]		
CLV-9/North Las Vegas Facility[(a)]		12/31/94
Santa Barbara Operations		
II-204/Goleta, California		
III-330/Goleta, California		12/31/95
Special Technologies Laboratory		
III-331/Santa Barbara, California		12/31/95
Woburn Cathode Ray[(a)] Tube Operations		
43 005 732-0		12/15/96

(a) Owner/Operator effluent monitoring required by permit

Table 4.6 NTS Septic Waste Hauling Trucks

Permit Number	Vehicle Identification Number	Expiration Date
NY-17-03310	Septic Tank Pumper E-104866	11/30/95
NY-17-03311	Septic Tank Pumper E-104573	11/30/95
NY-17-03312	Septic Tank Pumper E-104296	11/30/95
NY-17-03313	Septic Tank Pumper E-105293	11/30/95
NY-17-03314	Septic Tank Pumper E-105299	11/30/95
NY-17-03315	Septic Tank Pumper E-105919	11/30/95
NY-17-03317	Septic Tank Pumper E-105918	11/30/95
NY-17-03318	Septic Tank Pumping Subcontractor Vehicle	11/30/95

Radiological Monitoring Results



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 Reynolds Electrical & Engineering Co., Inc., (REECo). Offsite environmental surveillance was conducted by the EPA's Environmental Monitoring Systems Laboratory - Las Vegas (EMSL-LV). Onsite monitoring results indicated that environmental concentrations of radioactivity resulting from 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 test operations. Small amounts of radioactivity were detected in animal samples collected onsite and in some garden vegetables collected offsite.

5.1 RADIOLOGICAL EFFLUENT MONITORING

Since no nuclear tests were performed at the Nevada Test Site during 1994, monitoring efforts for radioactive effluents consisted primarily of routine air sampling and of periodic sampling of liquid discharges to the Area 12 tunnel containment ponds. One drillback into an old test cavity was performed in 1994 and a small amount of ^{133}Xe, used for calibration, was released to the environment. 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 on Pahute Mesa were about 4 pCi/m^3 (0.15 Bq/m^3) higher than the NTS average, due to atmospheric pumping of the krypton from past nuclear tests. In each case, 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 0.023 Ci (850 MBq) of $^{239+240}Pu$, 0.63 Ci (22 GBq) of ^3H and 200 Ci (7.4 TBq) of ^{85}Kr were estimated for airborne emissions from Area 3, from the RWMS-5, and from Pahute Mesa, respectively. Using a different model, an upper limit of 0.048 Ci (1.8 GBq) was estimated for airborne emissions of $^{239+240}Pu$ from the Area 9 Bunker. The primary liquid effluent was tunnel seepage water collected in a containment pond near the E-tunnel portal. Influent to this pond contained tritium (^3H), primarily, with a total tunnel discharge of 47.3 Ci (1.7 TBq).

5.1.1 EFFLUENT MONITORING PLAN

An important part of the NTS Environmental Monitoring Plan (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, Radioactive Waste Management Sites, and all other potential effluent sites throughout the NTS have been assessed for their potential to contribute to the public dose.

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/year. Requirements of the National Emission Standards for Hazardous Air Pollutants (NESHAP) are set forth in 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 dose 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.

5.1.2 AIRBORNE EFFLUENTS

No nuclear tests were performed during 1994 so there were no test-related effluents. The majority of radioactive air effluents at the NTS in 1994 originated from seepage of tritiated water from E Tunnel, 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). Effluent monitoring for a drillback into an old test cavity was calibrated by release of a small amount of radioxenon.

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 National Emission Standards for Hazardous Air Pollutants, 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.

5.1.2.1 POSTSHOT DRILLBACK MONITORING

Because of the moratorium on testing, no specific nuclear event monitoring was conducted at the NTS. However, one postshot drillback was carried out in 1994, by the Joint Test Organization during which 120 mCi of ^{133}Xe were released while performing instrument calibrations. Complete radiological safety coverage was provided during these activities.

5.1.2.2 TUNNEL COMPLEX EFFLUENT

As noted above, there was fluid drainage from the E Tunnel complex during 1994 with a small contribution from N Tunnel in the early part of the year. The HTO content is shown in Table 5.1.

5.1.2.3 RADIOACTIVE WASTE MANAGEMENT SITES (RWMS)

Two permanent particulate/halogen samplers were located within the disposal pits at the Area 5, RWMS (RWMS-5). As was the case in 1993, the 1994 annual average concentration of gross beta activity in samples taken within Pits 3 and 4 in Area 5 were about 2.1×10^{-14} µCi/mL (0.78 mBq/m^3). The NTS 1994 annual average gross beta concentration was also 2.1×10^{-14} µCi/mL (0.78 mBq/m^3). 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 1994 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 1994 annual average HTO concentration for the nine stations was 4.8×10^{-6} pCi/mL (0.18 Bq/m^3); the individual values are displayed in Figure 5.2. This value is less than 0.05 percent of the Derived Concentration Guide for tritiated water vapor in air.

Due to errors in processing and handling, thermoluminescent dosimeter (TLD) results for the first and second quarters of 1994 are not available. Accordingly, annual values for TLDs deployed surrounding the RWMS facility were not calculated. Third and fourth quarters TLD results appear to indicate that gamma exposure rates for 1994 were significantly lower than in 1993. (See Section 5.2.1.8 for further discussion.)

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 RWMS-5 perimeter are similar to gamma measurements taken at other locations on the NTS.

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/halogen samplers located approximately north, south, east, and west of the burial pit. Several TLDs were distributed at the RWMS-3 and surrounding areas.

The gross beta 1994 annual average at the RWMS-3 of 1.9×10^{-14} µCi/mL was the same as the 1993 average, and was not statistically different at the five percent significance level from the site-wide average of 2.1×10^{-14} µCi/mL (0.78 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 resuspend 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, and 5.4.

5.1.3 LIQUID DISCHARGES

The only radioactive liquid discharges at the NTS in 1994 originated from tunnel drainage. 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.

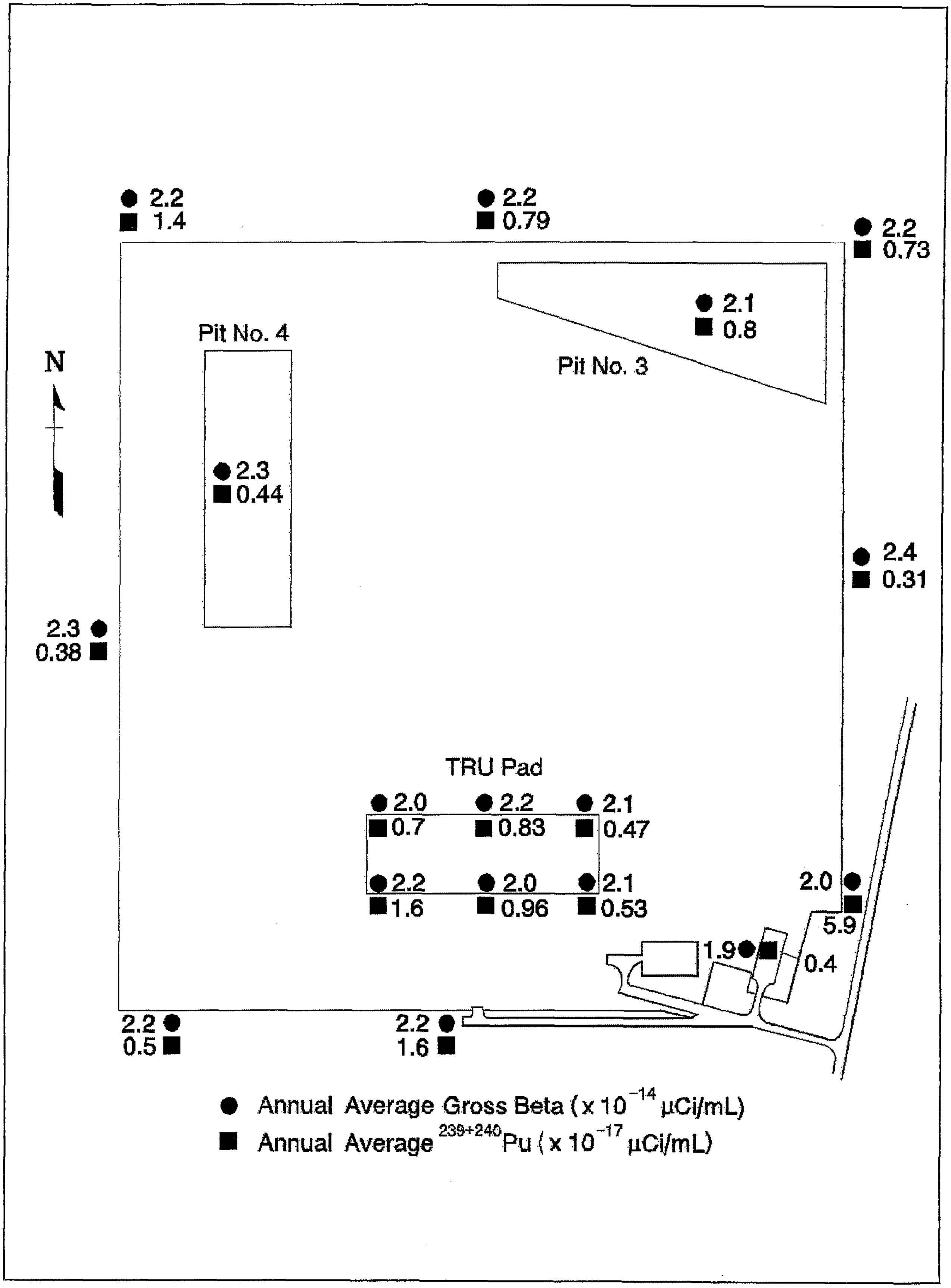


Figure 5.1 RWMS-5 Air Sampling Annual Average Results - 1994

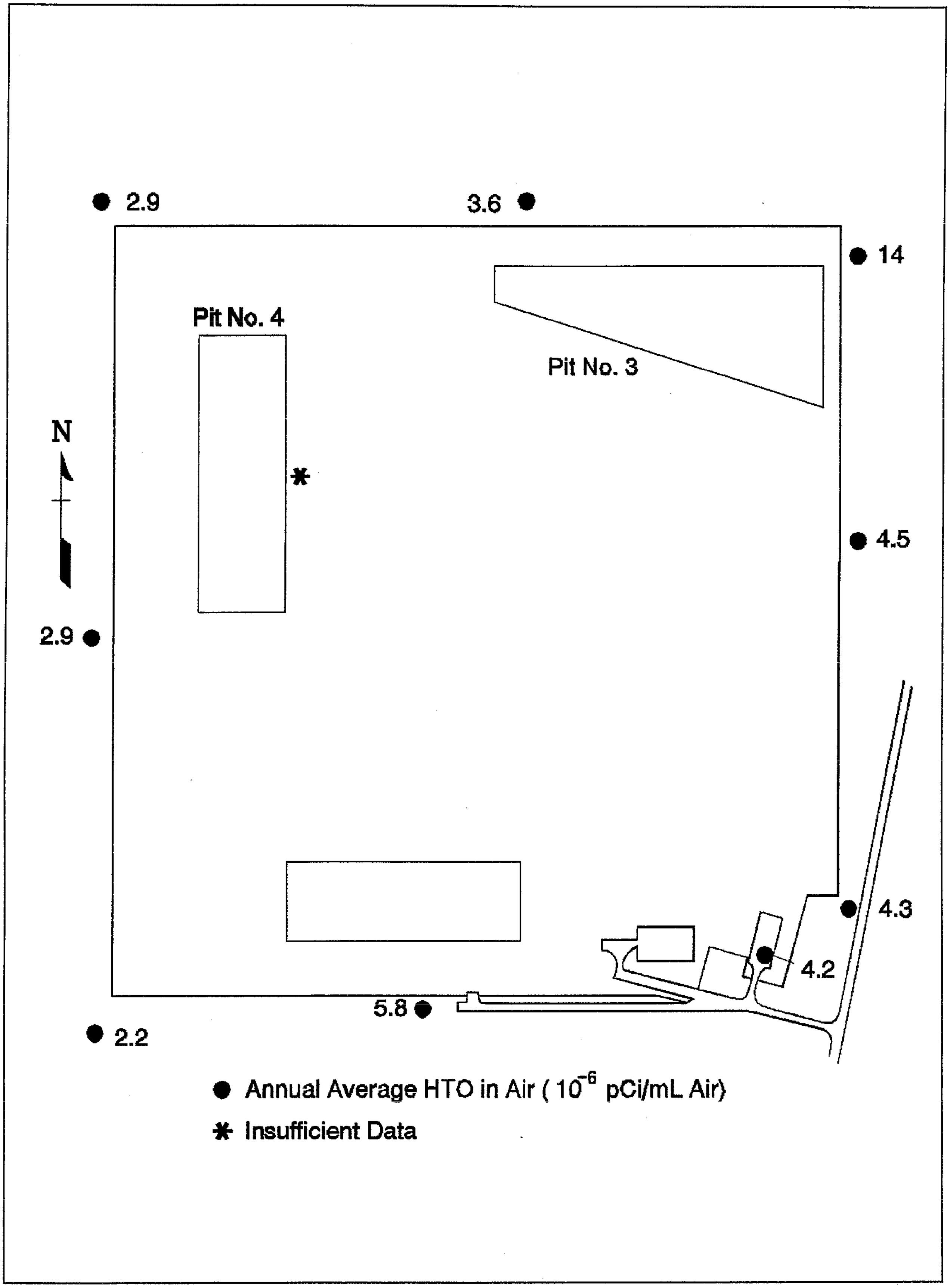


Figure 5.2 RWMS-5 HTO Annual Average Results - 1994

5.1.3.1 TUNNELS

Rainier Mesa in Area 12 is the location where nuclear tests were conducted within tunnels by the 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 1994 from two tunnels: N and E. The liquid discharge from the tunnels decreased appreciably during 1994 compared to previous years because of success in sealing the tunnels. Intermittent flow was observed from N Tunnel during the first quarter. The flow from T Tunnel was eliminated with the installation of plugs in 1993. Only at E Tunnel was the 1994 flow comparable to that for previous years.

Monitoring results indicated that the water discharged from these tunnels 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 each liquid effluent source and are listed in Table 5.1. No liquid effluents were discharged offsite.

5.1.3.2 DECONTAMINATION FACILITY

The Decontamination Facility, located in Area 6, was not used during 1994 since no nuclear tests were conducted. Until a new lined containment pond is constructed, any effluent from that Facility is intended to be captured in holding tanks and held for disposal. At the end of 1994, the infrastructure to accomplish this was still under construction.

5.2 RADIOLOGICAL ENVIRONMENTAL SURVEILLANCE

Onsite surveillance of airborne particulates, noble gases, and tritiated water vapor indicated concentrations that were generally not statistically different from background concentrations. 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 a decrease from 1993. The reason for this decrease is unknown but is being investigated. Special environmental studies included soil radionuclide transport studies and development of a NTS-specific dose assessment model. Results of offsite environmental surveillance by EPA EMSL-LV showed no NTS-related radioactivity was detected by the offsite monitoring networks and there were no apparent net exposures detectable by the offsite internal dosimetry network. Radionuclides were detectable at levels near the MDC in tissues from animals collected both on- and offsite and in some vegetables collected offsite.

5.2.1 ONSITE ENVIRONMENTAL SURVEILLANCE

During 1994 the onsite radiological surveillance networks consisted of 54 air sampling stations; 10 radioactive noble gas sampling stations; 19 tritiated water vapor sampling stations; surface water samples from 12 open water supply reservoirs, 8 springs, 1 containment pond, and 9 sewage lagoons; groundwater samples from 11 potable and 3 non-potable supply wells and 8 drinking water consumption points; and 201 locations where TLDs measure gamma exposures. Additional radiological studies are conducted through the Basic Environmental Compliance and Monitoring Program (BECAMP), including: investigating the movement of radionuclides on and around the NTS through horizontal movement, water-driven erosion, vertical migration, and wind-driven erosional resuspension; development of a human dose-assessment model specific to the environmental and radiological conditions of the NTS; and preparation of a peer-reviewed publication that addresses an important issue related to the potential environmental impacts of past, present, and future activities on the NTS. 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 - 1994" (DOE/NV/11432-176, in prep.).

5.2.1.1 RADIOACTIVITY IN AIR

Fifty-four air sampling stations were operated continuously. Two of the stations were added during the previous year near the Device Assembly Facility as part of a pre-operational monitoring program for the facility. At each of the stations, samples were collected weekly on glass fiber filters (for particulate) and charcoal cartridges (for halogens). The filters were counted for gamma and gross beta activity, composited monthly, and then analyzed for ^{238}Pu and $^{239+240}$Pu. Beginning with the fourth calendar quarter, the filters collected at all locations except the four U3AH/AT stations and the eight RWMS-5 TP, Pit 3, and Pit 4 stations were composited over a three month period. The charcoal cartridges were counted for gamma activity each week.

Air monitoring for the noble gases ^{85}Kr and ^{133}Xe was performed at ten fixed locations. These air samples were also collected weekly. A distillation process separated the radioactive krypton and xenon from the sample for measurement. Tritiated water vapor was monitored continuously at 19 locations, two of which were part of the pre-operational monitoring program for the Device Assembly Facility. 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 Derived Concentration Guides (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 5.5.

- For air sampling results, all of the gross beta activity detected was assumed to be ^{90}Sr.

5.2.1.2 AIR (PARTICULATE AND HALOGEN GAS) SAMPLING RESULTS

GROSS BETA

Figure 5.3 displays the average NTS gross beta results for 1994. Air particulate samples, except for Gate 200 in Area 5, were held for five to seven days prior to gross beta counting and gamma spectrum analysis to allow for the decay of radon and radon daughters. Table 5.2 presents the network arithmetic averages, minimums, and maximums for gross beta in air during 1994. All results exceeded the MDC, except for three instances where the sample volume was either unusually low or high. The network 1994 annual average gross beta concentration was 2.0 x 10^{-14} µCi/mL (0.74 mBq/m^{3}), similar to 1993. This concentration is 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 gross beta concentration average for all stations was the same as last year's, it was apparent that there was a slight increasing trend in concentrations throughout the year which changed abruptly to a decrease between October and December. This trend was observed at all stations and was similar to what was observed last year. An investigation into this trend was conducted. This investigation included reviewing sampling materials, laboratory procedures, instrumentation calibration and background, quality control, time correlations, weather patterns, and algorithms used to calculate results. No deficiency or discrepancy was found to which this trend could be attributed.

PLUTONIUM

The composite filter samples from each particulate sampling location were analyzed for ^{238}Pu and $^{239+240}$Pu. Figure 5.4 shows the airborne $^{239+240}$Pu annual average results for each of the sampling locations. Tables 5.3 and 5.4 list the maximum, minimum, annual arithmetic mean,

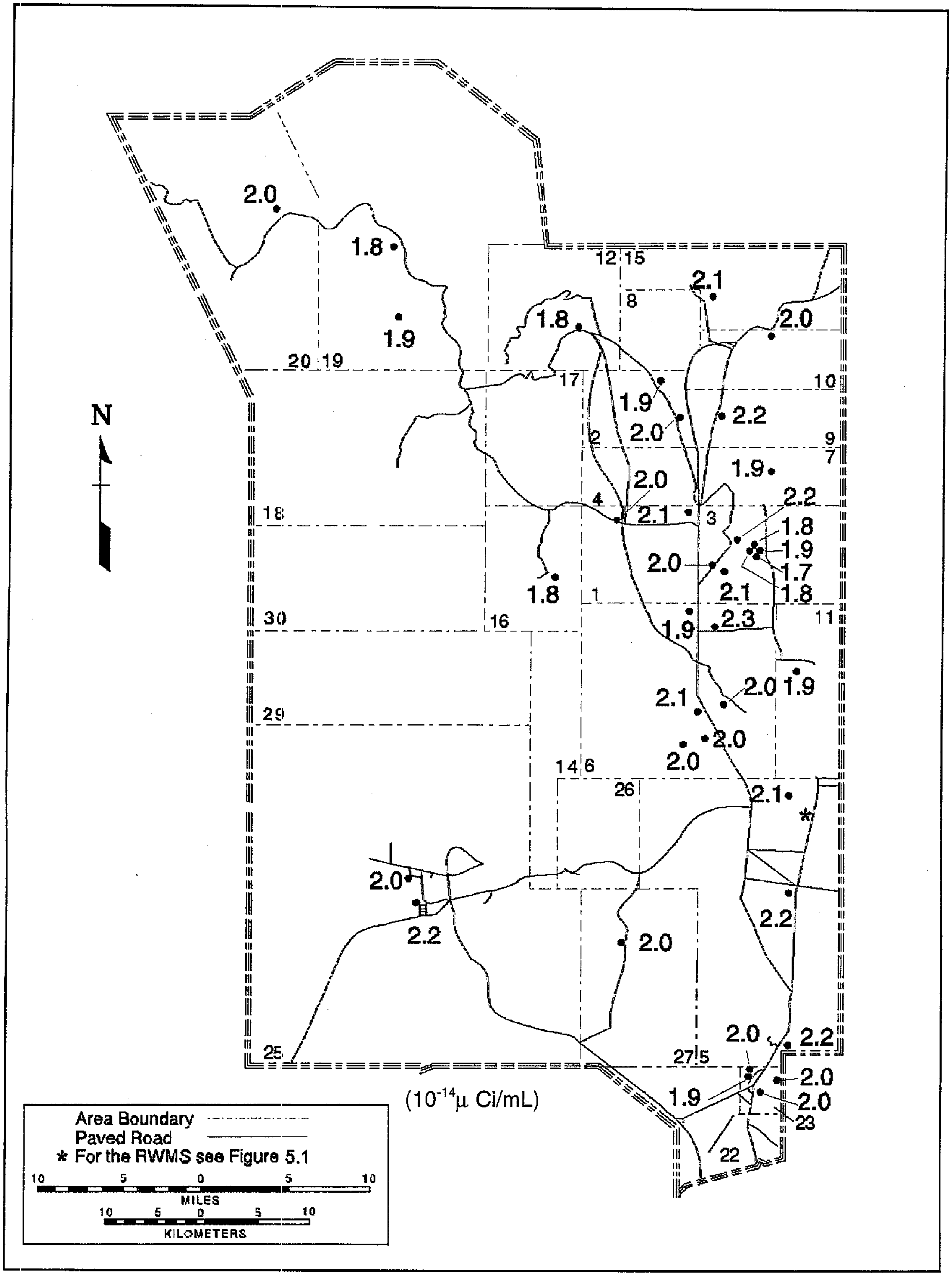


Figure 5.3 NTS Airborne Gross Beta Annual Average Concentrations - 1994

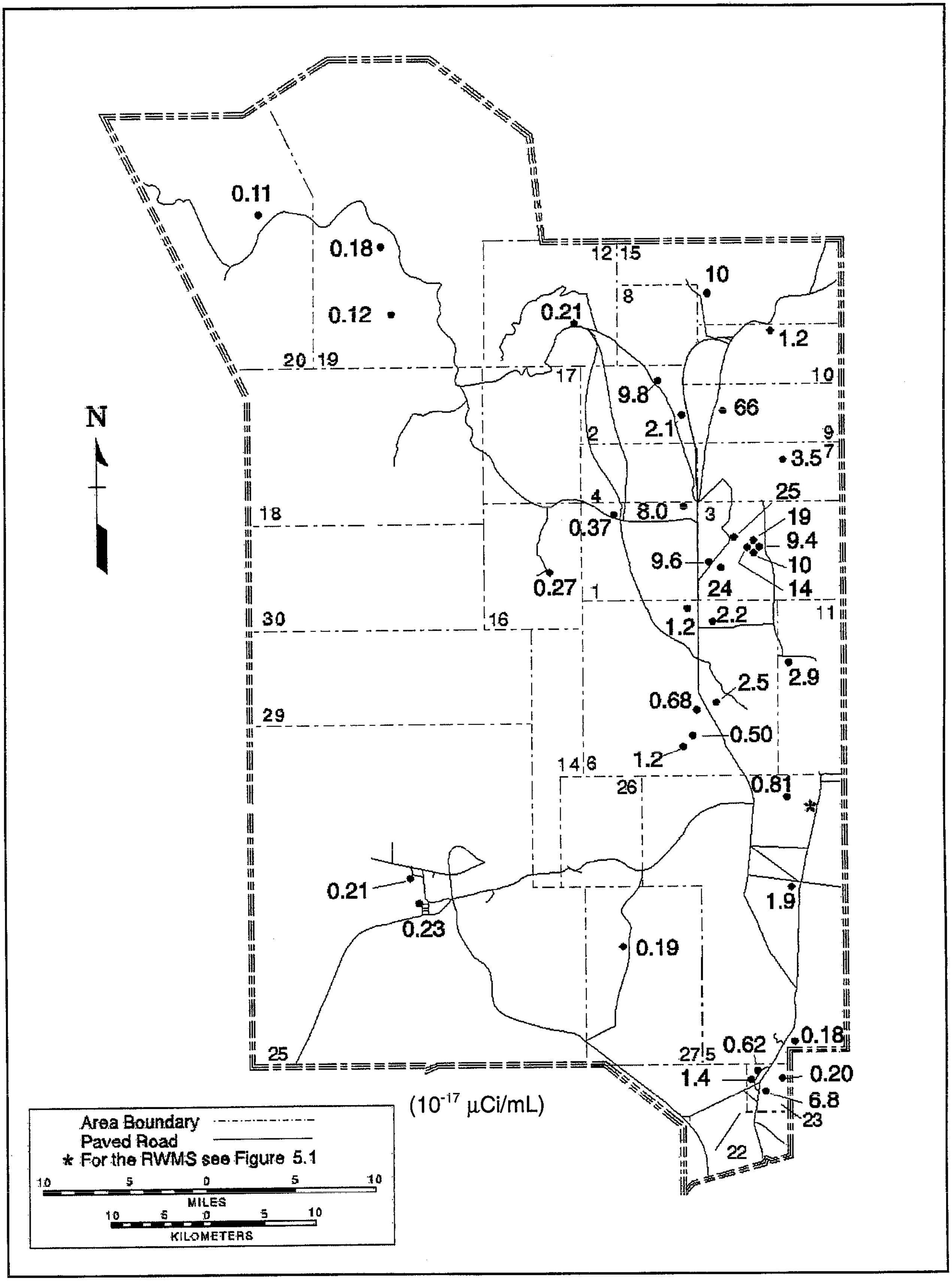


Figure 5.4 NTS Airborne $^{239+240}$Pu Annual Average Results - 1994

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 $^{239+240}Pu$ for all stations were -0.045 to 0.98 x 10^{-17} µCi/mL and 0.11 to 66 x 10^{-17} µCi/mL (-1.7 to 36 x 10^{-8} and 0.04 to 24 x 10^{-6} Bq/m^3), respectively. The arithmetic mean and standard deviation of ^{238}Pu in air for all stations were (9.3 ± 28) x 10^{-19} µCi/mL (3.4 ± 10 x 10^{-8} Bq/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 (4.8 ± 15) x 10^{-17} µCi/mL (1.8 ± 5.6] x 10^{-6} Bq/m^3). The network arithmetic mean for $^{239+240}Pu$ was 17 percent higher than the 1993 mean concentration, an increase that is within the statistical variation of the network results.

Because many of the measured values from the ^{238}Pu analyses were zero or negative after background subtraction, the geometric means and standard deviations were not calculated for this isotope. However, over 50 percent of the $^{239+240}Pu$ results were positive, therefore the geometric mean and standard deviation were determined to be 8.9 x 10^{-18} µCi/mL (0.33 µBq/m^3) and 6.2, respectively.

During 1994, the maximum annual average (mean) $^{239+240}Pu$ concentration was found at the Area 9, 9-300 Bunker sampling location. Results from samples taken at that location averaged 66 x 10^{-17} µCi/mL (24 µBq/m^3) during 1994. This quantity was 0.01 percent of the DAC and 33 percent of the 10 mrem DCG. Historically, the highest concentrations of $^{239+240}Pu$ have occurred in Areas 3 and 9. This is apparent from this year's averages for each of the areas; however, a statistical analysis of the $^{239+240}Pu$ results indicated that due to the heterogeneity of the variances, the differences reported 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 (see Chapter 2, Figure 2.3 for these locations). Two decades later, measurable levels of plutonium in air are still present. Because of operational activities and vehicular traffic in Areas 3 and 9, more of the ^{238}Pu and $^{239+240}Pu$ in the soil becomes airborne.

GAMMA

The charcoal cartridges used to collect halogen gases and the glass fiber filters used to collect particulates were analyzed by gamma spectroscopy. All 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 an event related radionuclide ,^{137}Cs, which was detected in six samples. All of these samples had ^{137}Cs concentrations <0.1 percent of the 10 mrem DCG.

5.2.1.3 NOBLE GAS SAMPLING RESULTS

The locations at which compressed air samples were routinely collected throughout the year are shown in Figure 5.5 with the annual averages of the ^{85}Kr and ^{133}Xe 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 and 5 x 10^{-8} µCi/mL (1.9 x 10^{3} Bq/m^3) for ^{133}Xe. The samplers at the indicated locations were operated continuously throughout the year except for those at the Area 19, Pahute Substation,

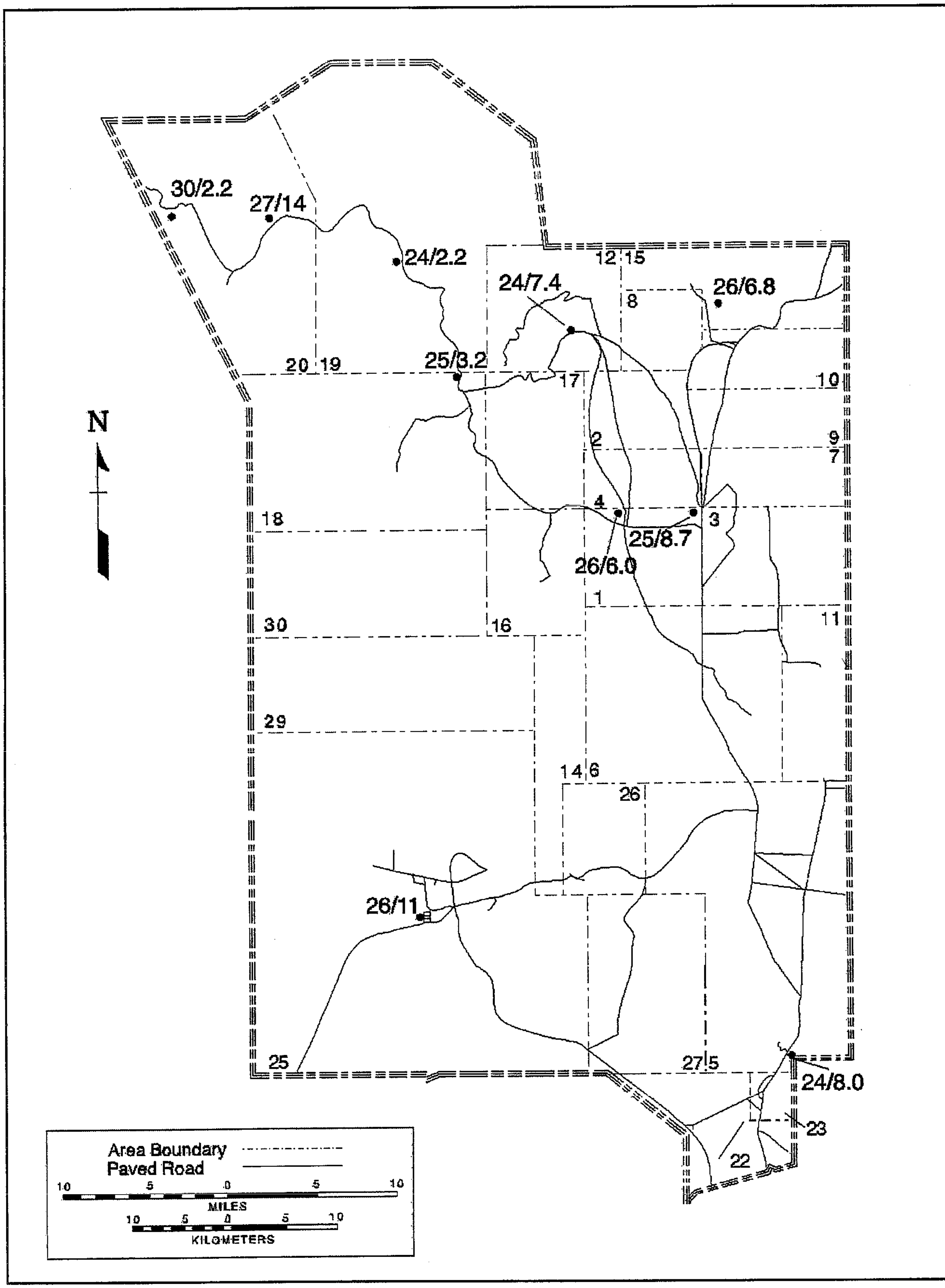


Figure 5.5 NTS $^{85}Kr/^{133}Xe$ Annual Average Concentrations - 1994

Area 20 Camp, and DDZ77 Transformer. Due to the closing of Areas 19 and 20 during the winter months, these stations did not begin sampling until April and May 1994. Summaries of the results are listed in Tables 5.6 and 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 - 1994" (DOE/NV/11432-176, in prep.).

As in the past, the levels of ^{85}Kr (half-life of 10.76 years) observed in the samples were from world-wide nuclear power and fuel processing operations, with a small contribution of ^{85}Kr from underground nuclear tests at the NTS. Xenon-133 is rarely detected in the environment due to its short half-life of 5.27 days, so when any is detected it is usually attributed to nuclear testing operations at the NTS.

KRYPTON-85

A summary of all ^{85}Kr results appears in Table 5.6. Again this year the highest annual average concentration occurred in Area 20, at the Area 20 DDZ77, 30 x 10^{-12} μCi/mL (1.1 Bq/m^3), which is 0.01 percent of the 10 mrem DCG. The lowest annual average, 24 x 10^{-12} μCi/mL (0.89 Bq/m^3), occurred at three stations. The higher average for the samples collected in Area 20 was expected as it is in the northern portion of the NTS in the proximity of the sites where seepage of noble gases from the ground has been observed in the past. Stations in this area have had the highest concentration of noble gases for the last several years.

Nevertheless, statistical evaluation of these data showed that the average concentration for Area 20 was not significantly higher than the other averages at the five percent significance level. Each location had environmental levels of ^{85}Kr with occasional spikes attributed to seepage of noble gases from the Pahute Mesa area. All data since 1982 were evaluated for any trend in concentrations. The ^{85}Kr concentrations were found to have remained relatively constant over this period.

XENON-133

Table 5.7 summarizes the ^{133}Xe results for samples collected during the first six month of 1995 at each location. Laboratory problems caused by budget constraints led to a high bias in the ^{133}Xe results during the last six months of the year so they are not included in the data summary tables and the statistical analyses. The highest average concentration was 14 x 10^{-12} μCi/mL (0.51 Bq/m^3) at Area 20, DDZ77, which is in the northwestern portion of the test site. All other average concentrations were ≤ the MDC of about 47 x 10^{-12} μCi/mL (0.41 Bq/m$^{3)}$), which is 0.022 percent of the 10 mrem DCG.

All of the weekly concentrations varied around the MDC. Forty-six percent of the ^{133}Xe concentrations were slightly above the median MDC of 47 x 10^{-12} μCi/mL. However, these values were considered to be statistical anomalies and not due to any nuclear test because there have been no tests since 1992, and any xenon from past tests would have decayed away.

5.2.1.4 TRITIATED WATER VAPOR SAMPLING RESULTS

The concentrations of tritiated water vapor determined from sampling conducted at 17 permanent sampling stations and two temporary stations near the Device Assemble Facility are summarized in Table 5.8. Individual results for each collected sample are published separately and may be found in the "Environmental Data Report for the Nevada Test Site - 1994," (DOE/NV/11432-176, in prep.), which also includes a statistical evaluation of the data.

As shown in Table 5.8, the location having the highest annual average tritium concentration was the Area 5 RWMS No. 4 station with an average of 14 x 10^{-6} pCi/mL (0.52 Bq/m^3). This average was only 0.14 percent of the 10 mrem DCG for tritium. The annual average concentration at each station is shown on the map in Figure 5.6.

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 three separate groups of stations, similar to those found in the data for 1993. The annual concentration averages at the locations in the higher grouping were 0.14 percent or less of the 10 mrem DCG.

A review of the historical trend in concentrations at the NTS over the years 1982 through 1994 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 steady decrease to the current value, 3.2 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.

5.2.1.5 RADIOACTIVITY IN SURFACE WATER

Surface water sampling at the NTS was conducted at 12 open reservoirs, 8 natural springs, 2 containment ponds or effluents, and 9 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 each month from each surface water location through February 1994 after which each location was sampled quarterly. The sample was analyzed for ^{3}H, gross beta, and gamma activity. Each quarter an additional sample was collected and analyzed for ^{238}Pu and $^{239+240}$Pu, and in July a sample was collected for ^{90}Sr analysis. Surface water at the NTS was scarce during this year because of the continuing drought. Sources of surface water were, for the most part, man-made, 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 5.7) 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 containment ponds.

With the exception of containment ponds, no annual average concentration in surface waters was found to be statistically different from any other at the five 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 radioactivity 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.

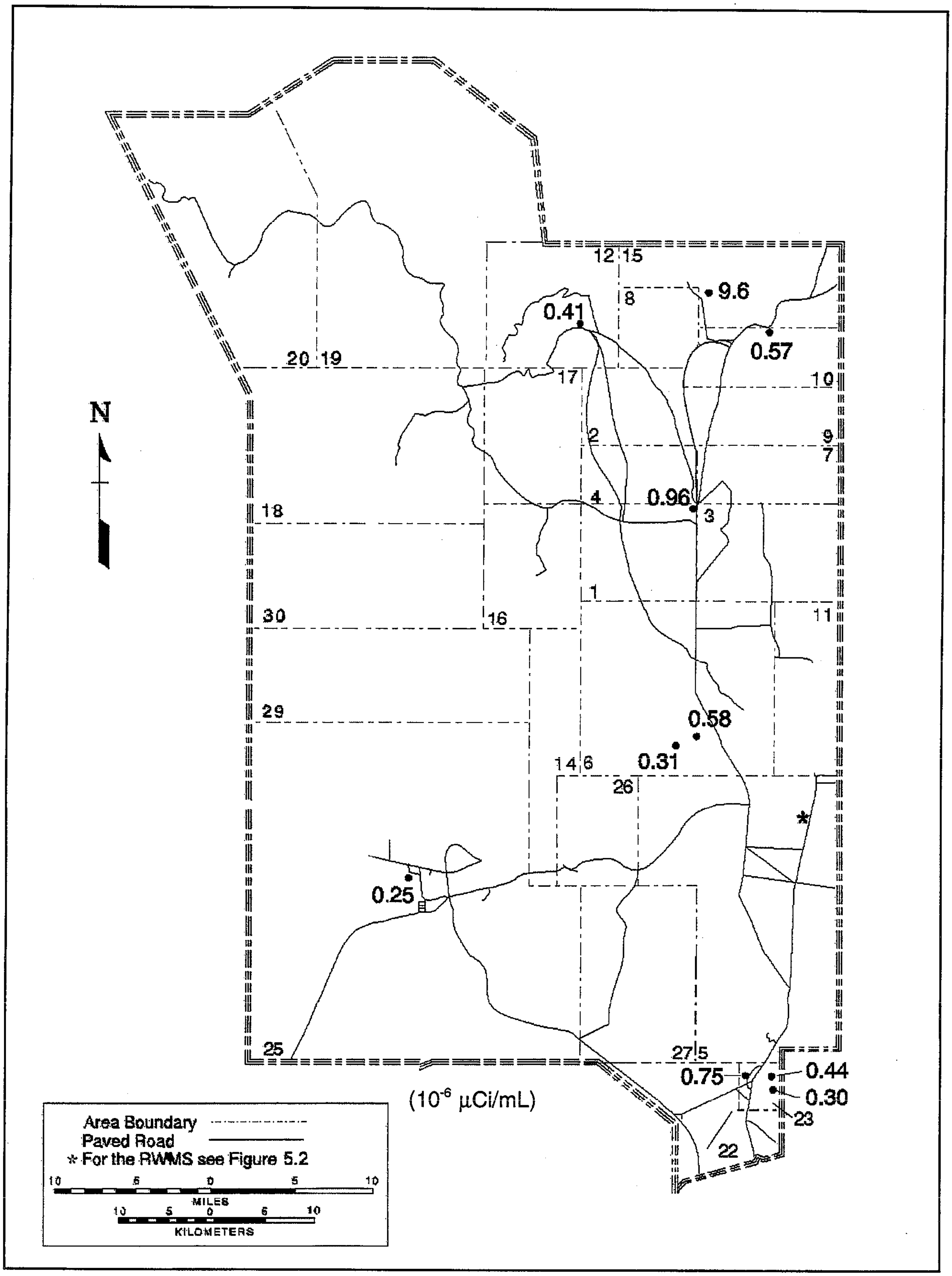


Figure 5.6 NTS Tritiated Water Vapor Annual Average Concentrations - 1994

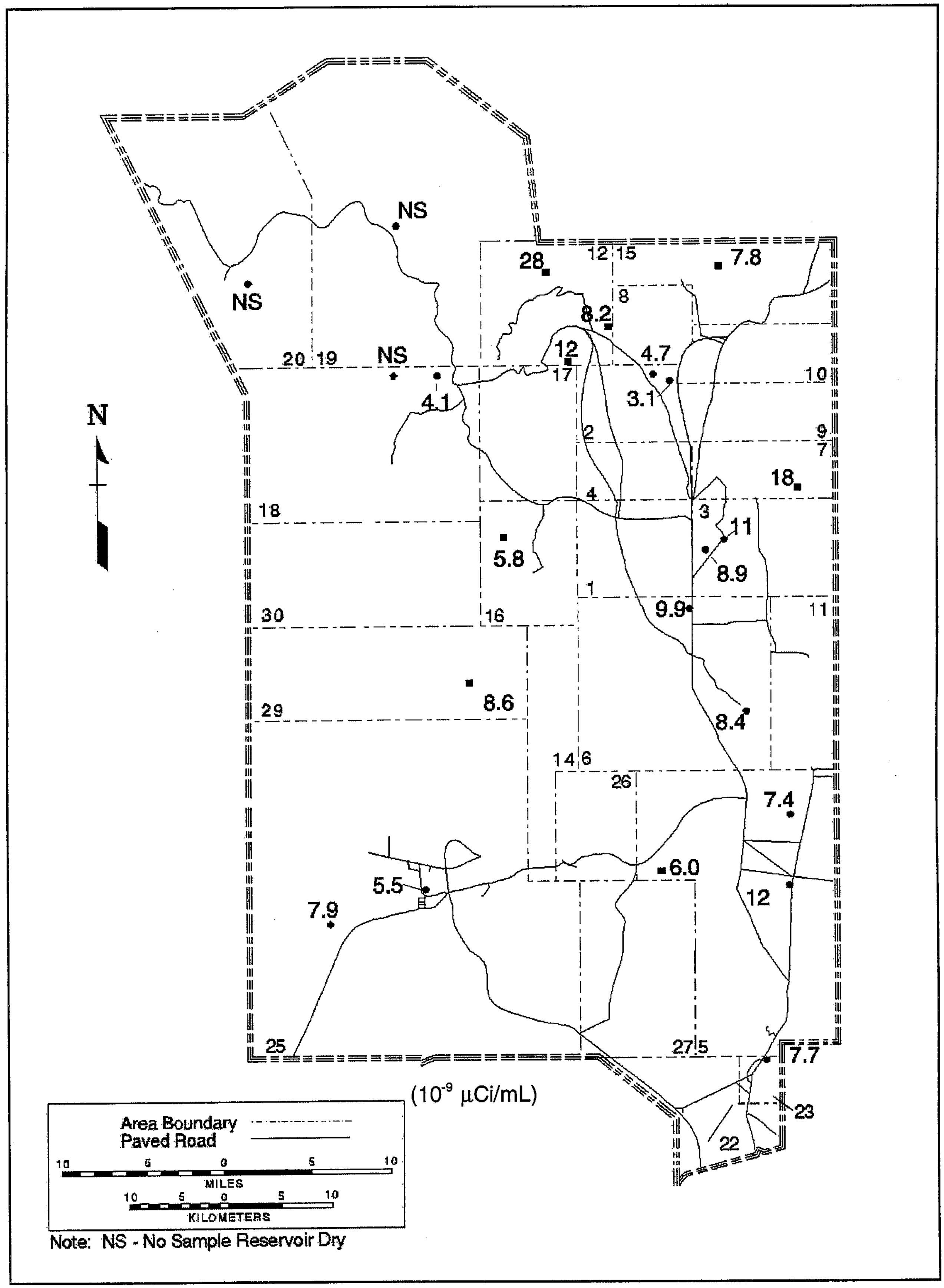


Figure 5.7 Annual Average Gross Beta in Open Reservoirs(•) and Natural Springs(■) - 1994

NATURAL SPRINGS

Of the nine natural springs found onsite, (i.e. spring-supplied pools located within the NTS) seven were consistently sampled. At Gold Meadows, water was available for sampling only once. 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; however, the water is not used for drinking. The highest result was for Area 12, Gold Meadows which 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 of 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; however, the water is not used for drinking.

SEWAGE LAGOONS

Samples were collected quarterly during this year from the nine sewage lagoons on the network at the end of 1993. Each of the lagoons is part of a closed system used for evaporative treatment of sanitary waste. The lagoons are located in Areas 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 1.1 to 3.0 x 10^{-8} µCi/mL (0.41 to 1.1 Bq/L). No radioactivity was detected above the MDCs for tritium and ^{238}Pu. ^{90}Sr slightly above the MDC was detected in single samples collected at the Area 23, Area 6, and Area 12 Sewage Ponds. Levels of $^{239+240}$Pu were also detected slightly above the MDC in two samples, one collected in April and one in November. No event-related radioactivity was detected by gamma spectrometry analyses.

5.2.1.6 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 1994 the NTS water system consisted of 14 supply wells (operation of well UE-19c has since ceased), 11 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 13 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 5.8. Water from these wells (11 potable and 2 non-potable) was used for a variety of purposes during 1994. Samples were collected from those wells which could potentially provide water for onsite human consumption. These data were used to help document the radiological characteristics of the NTS groundwater system. The sample results were maintained in a data base so that long-term trends and changes could be studied. Table 5.13 lists the potable and non-potable supply wells and their respective radioactivity averages; no event-related radionuclides were detected by gamma

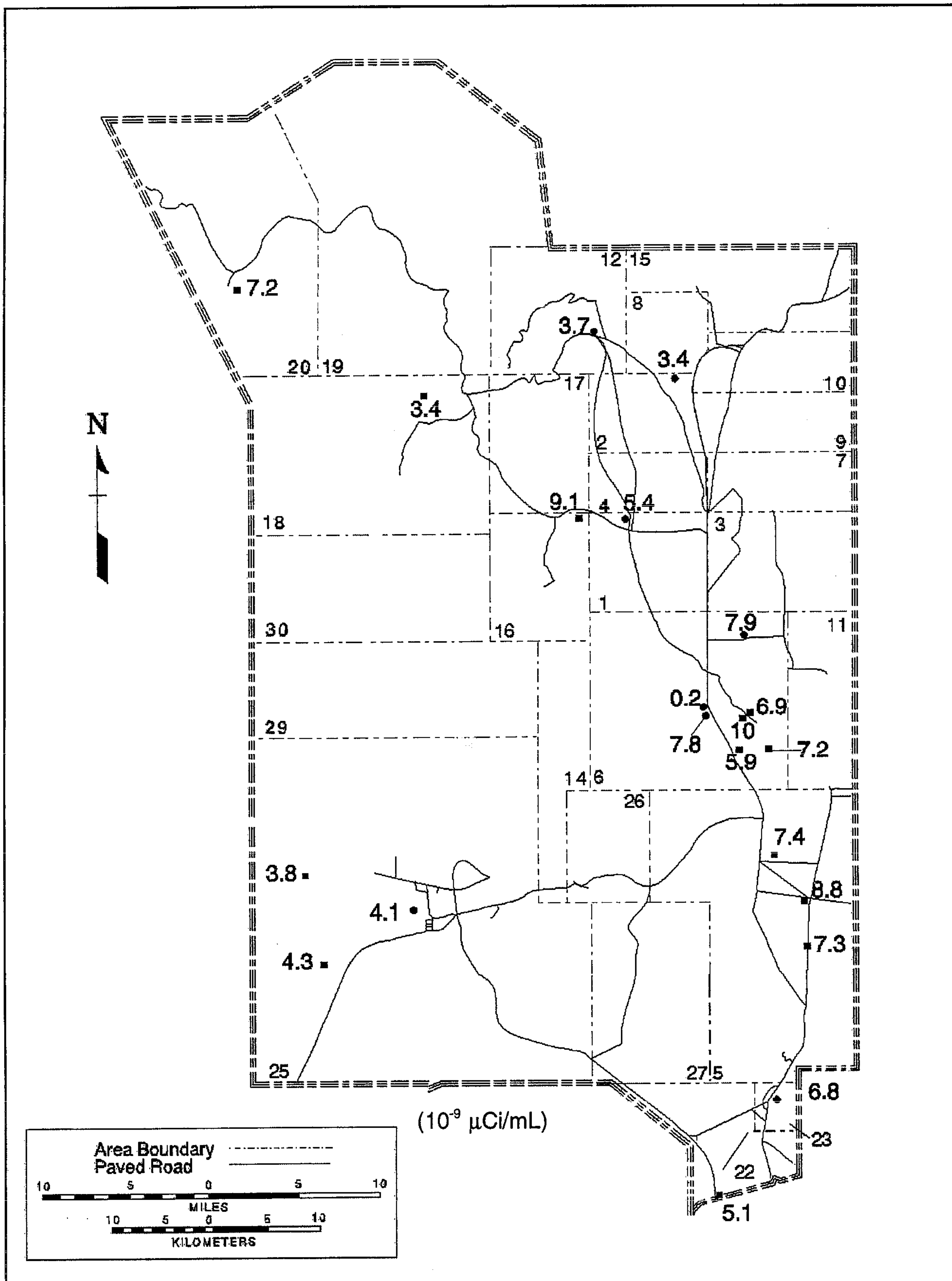


Figure 5.8 Annual Average Gross Beta in Supply Wells (■) and Potable Water (•) - 1994

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 month. Due to the limited operation of the Area 5 Well 5b, only three water samples were collected during the year. In August 1994 Well 5b was also authorized for use as a potable water supply well. As the result of pump break-down and the closing of Area 20, only one sample was collected from Well U-20.

GROSS BETA

As shown in Table 5.13, the gross beta concentration averages for all the supply wells were above the median MDC of the measurement. The highest average gross beta activity for potable supply wells, occurring at Well C-1, was 1.0 x 10^{-8} μCi/mL (0.37 Bq/L), which was 3.3 percent of the DCG for ^{40}K and 25 percent of the DCG for ^{90}Sr based upon 4 mrem EDE per year. In previous reports (Scoggins 1983 and Scoggins 1984), it was reported 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 5.8. All concentration averages were comparable to those reported last year.

TRITIUM

As shown in Table 5.13 the average tritium concentrations at all locations, except Well C-1, were below the average MDC of the measurement (note that the MDC was 12 x 10^{-9} μCi/mL for the tritium enrichment analyses but was 4.5 x 10^{-7} μCi/mL for the conventional analyses on the non-potable well samples).

PLUTONIUM

All supply water samples analyzed for ^{238}Pu and $^{239+240}$Pu had concentrations below their MDCs of about 1.3 x 10^{-11} μCi/mL, which are 0.6 percent and 1.3 percent of their respective DCGs adjusted to a 4 mrem EDE per year. Table 5.13 lists the concentration averages for these nuclides for each location.

GROSS ALPHA

As shown in Table 5.13, the average gross alpha concentration for all of the supply wells, except for Well 8, was above the median MDC of 8.6 x 10^{-10} μCi/mL. The highest concentration from the potable wells occurred in samples from the Area 5; Well 5C, and was 9.1 x 10^{-9} μCi/mL (0.34 Bq/L). This is acceptable according to the EPA drinking water standard 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 this at 8.4 x 10^{-10} μCi/mL (0.03 Bq/L).

STRONTIUM

Beginning in 1994, ^{90}Sr analyses were changed from annually to quarterly on samples collected from the potable supply wells. Note that the ^{90}Sr results for the non-potable supply wells are for single samples and not an average. Concentrations of ^{90}Sr slightly above the MDC of the measurement were reported for 49 percent of the samples from the supply wells. This is apparent from Table 5.13, which shows about half of the ^{90}Sr concentration averages above the median MDC. The highest concentration average was 2.2 x $10^{-10}$$\mu$Ci/mL for samples collected from the Area 5, Well 5B. This average is only 0.55 percent of the 4 mrem DCG.

5.2.1.7 RADIOACTIVITY IN DRINKING WATER

As a check on any effect the water distribution system might have on water quality, eight end-points (labelled potable water in Figure 5.8) 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 5.14. These systems, fed by eleven potable supply wells, are the source of the water for seven end-points. Water from the eighth end-point, Area 6 Bottled Water, is provided by a commercial vendor. 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 (except for Area 6, Bottled Water) were above the median MDC of the measurements. The highest annual average occurred in Area 6, Building 6-900, 7.9 x 10^{-9} µCi/mL (0.28 Bq/L). This annual average was 2.6 percent and 20 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 minimum detectable concentration of 4.6 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 below or near the median tritium enrichment MDC of 1.2 x 10^{-8} µCi/mL (0.44 Bq/L). These MDC values of 4.6 x 10^{-7} and 1.2 x 10^{-8} µCi/mL are 0.6 percent and 0.01 percent, respectively, of the drinking water DCG adjusted to a 4 mrem (0.04 mSv) EDE per year.

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 1.5 and 0.7 percent, respectively, of the 4 mrem DCG. Normally, these radionuclides are not detected in drinking water.

GROSS ALPHA

In accordance with the National Primary Drinking Water Regulations (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 samples collected at four of the end-points 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 equal to or less than the median MDC of the measurements except for Area 2, restroom. The concentration at this location, 1.3×10^{-10} µCi/mL (0.005 Bq/L), was only 0.3 percent of the 4 mrem DCG.

5.2.1.8 EXTERNAL GAMMA EXPOSURES - ONSITE AREA

TLDs were deployed at 201 locations throughout the NTS to measure ambient gamma radiation levels. These were Panasonic dosimeters, designed to measure the gamma radiation levels typical of the environment. Eight stations were added to the network during 1994 as part of an ongoing effort to establish an alternate set of boundary locations reachable by truck. The boundary stations listed in the 1994 report and in reports for previous years, with one or two exceptions, are reachable only by helicopter.

In 1993 it was found that the network average was 15 percent higher than in 1992. A review of TLD program procedures was undertaken, and is still in progress. Results of this review will be published separately.

Preliminary results of the review have indicated at least two areas for improvement. First, proper compensation for the exposure gathered by TLDs between annealing and placement in the field, and between collection and readout, had not always been made. An attempt has been made to control this factor more carefully for the 1994 data; further improvements will be implemented in the future.

Second, the use of reference TLDs pre-exposed to known levels of radiation has been incorporated in the procedure for readout of 1994 field environmental TLDs. It is expected that this change in method will generally result in a decrease in reported values.

First quarter TLDS were processed using incorrect referenced TLD values. Insufficient data were available to reconstruct valid results. Second quarter TLDs were not properly controlled prior to and following field exposures. Insufficient data were available to ensure valid non-field exposure corrections. Accordingly, valid TLD results for first and second quarters of 1994 are not available. Due to the large uncertainty in extrapolating annual values from only two quarters of data, annual station and network values were not calculated, except for boundary and control TLDs as discussed below. Improvements in TLD processing and handling have been made to ensure valid TLD results are available for 1995 and subsequent years. Analyses of the TLD data and individual results are published separately and may be found in the "Environmental Data Report for the Nevada Test Site - 1994," (DOE/NV/11432-176, in prep.). Annual average exposure rates were extrapolated from third and fourth quarters results for NTS boundary and control TLDs. Table 5.17 displays these results for boundary locations. These locations were close to the NTS boundary and most were reachable only via helicopter. The data collected at these locations were not statistically different from the control location data.

A group of locations which were not, to the best available knowledge, influenced by radiological contamination, served as controls for the NTS. The data from these locations are presented in Table 5.18. The overall network extrapolated average exposure rate was 0.25 mR/day or 93 mR/year.

An investigation of historical trends in onsite environmental gamma levels as measured by the TLD network showed no significant differences between years until 1993, except for data from

1987 (dosimetry system changed) and 1988 (due to a calibration problem). The change in procedure described above has 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 - 1994," (DOE/NV/11432-176, in prep.).

5.2.2 OFFSITE ENVIRONMENTAL SURVEILLANCE

The EMSL-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 so 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 manmade sources. Possible pathways monitored included inhalation, ingestion, and external exposure. Alpha, beta, and gamma radiation in air were monitored by the Air Surveillance Network (ASN), which included 30 continuously operating stations around the NTS and 77 standby samplers (SASN) in states west of the Mississippi River. Noble gas and atmospheric moisture samplers were continuously operated at 13 locations around the NTS. Identical samplers were maintained in standby status at another seven locations. In Salt Lake City, atmospheric moisture was continuously monitored while a noble gas sampler was maintained on standby status. 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. The Milk Surveillance Network (MSN) consisted of 24 locations sampled monthly in the immediate offsite area. The network included family-owned cows and goats and commercial dairies. In addition, most major milksheds west of the Mississippi River, represented by 110 locations in 1994, were sampled annually through the Standby Milk Surveillance Network (SMSN). Cattle from ranches in the offsite area and mule deer from the NTS were all included in the Biomonitoring Network, as were locally grown fruits and vegetables obtained by donation from residents.

External gamma radiation was monitored by the Pressurized Ion Chamber (PIC) Network and the Thermoluminescent Dosimeter (TLD) Network. The PIC network included 27 stations that were connected by satellite telemetry to the NTS for real-time data collection. Approximately 65 local residents voluntarily participated in the TLD network and another 127 TLDs were located at fixed environmental stations. In 1994, 56 offsite residents participated in the Offsite Dosimetry Network which includes an annual whole body and lung count and urinalysis. Internal dosimetry monitoring was also conducted for potential occupational exposure of workers under the Radiological Safety Program.

The results of monitoring conducted in 1994 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 1994. All individual sample data are published separately, but summary data are included herein.

5.2.2.1 AIR MONITORING NETWORKS

The following sections describe results for the ASN and its associated standby network (SASN), noble gas samplers, and atmospheric moisture samplers. The atmospheric monitoring networks measure the major radionuclides which could potentially be emitted from activities on the NTS, as well as naturally occurring radionuclides. Collectively, these networks represent the possible inhalation and submersion components of radiation exposure pathways to the general public.

AIR AND STANDBY AIR SURVEILLANCE NETWORKS

Gamma spectrometry was performed on all ASN and SASN samples. The majority of the samples were gamma-spectrum negligible (i.e., no gamma-emitting radionuclides detected). Naturally occurring ^{7}Be, averaging 2.9 x 10^{-13} µCi/mL, was detected occasionally.

As in previous years, the gross beta results from both networks consistently exceeded the analytical minimum detectable activity concentration (MDC). The annual average gross beta activity was 1.5 ± 0.6 x 10^{-14} µCi/mL (5.6 ± 2.2 x 10^{-4} Bq/m^{3}) for the ASN and 1.5 ± 0.7 x 10^{-14} µCi/mL (5.6 ± 2.6 x 10^{-4} Bq/m^{3}) for the SASN. Summary results for the ASN are in Table 5.19 and are published separately for the SASN and may be found in the "Environmental Data Report for the Nevada Test Site - 1994," (DOE/NV/11432-176, in prep.).

Gross alpha analysis was performed on all samples. The average annual gross alpha activities were 1.1 x 10^{-15} µCi/mL (41 µBq/m^{3}) for both networks. Summary results for the ASN are shown in Table 5.20.

Selected air prefilters were also analyzed for plutonium isotopes. This report contains results for samples collected during the fourth quarter of 1993 and the first and second quarter of 1994, presented in Table 5.21. Due to the length of time required for analysis, the data for the third and fourth quarter are not available but will be included in the combined report for 1995. Although annual average values were essentially nondetectable, one sample exceeded the MDC. This was a composite sample from Rachel, NV for $^{239+240}$Pu analysis. None of the standby air network samples exceeded the MDC for ^{238}Pu or $^{239+240}$Pu.

TRITIUM IN ATMOSPHERIC MOISTURE (HTO)

The HTO network average for the first nine months of 1994 was 2.9 x 10^{-7} pCi/mL (0.018 Bq/m^{3}). Summary results are given in Table 5.22. The mean MDC was 3.4 x 10^{-5} pCi/mL. Samples from the Tritium Surveillance Network exceeded the MDC.

NOBLE GAS SAMPLING NETWORK

All samples were analyzed for ^{85}Kr and ^{133}Xe and the summary results are given in Table 5.23. Eight standby stations were operated quarterly to ascertain operational status but the samples were not analyzed. The annual averages for the continuously operated samplers were 2.9 x 10^{-11} µCi/mL (1.0 Bq/m^{3}) for ^{85}Kr and -5.7 x 10^{-11} µCi/mL (-2.0 Bq/m^{3}) for ^{133}Xe. As expected, all ^{133}Xe results were below the average MDC of 18 x 10^{-12} µCi/mL. The ^{85}Kr results were all above the average MDC of 5.9 x 10^{-12} µCi/mL.

5.2.2.2 WATER MONITORING

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

5.2.2.3 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 and SMSN milk samples were analyzed for ^{3}H, ^{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 5.24 for ^{3}H, ^{89}Sr, and ^{90}Sr. Individual results for each collected sample are published separately and may be found in the "Environmental Data Report for the Nevada Test Site - 1994" (DOE/NV/11432-176, in prep.).

5.2.2.4 BIOMONITORING

Sites where animals were collected in late 1993 and 1994 are shown in Chapter 4, Figures 4.12 and 4.13. The Bighorn Sheep samples, collected and analyzed for the last 38 years, are no longer being collected due to the lack of hunter response. The results of all collected samples are shown in Table 5.25.

MULE DEER

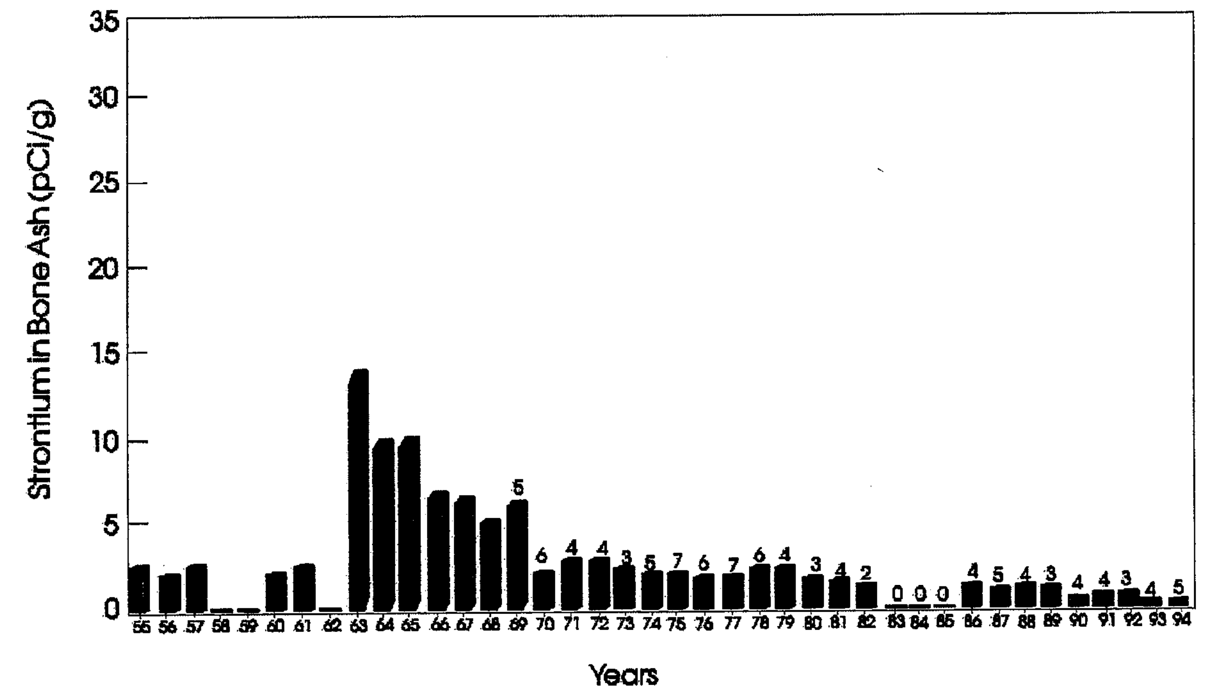
Blood samples are analyzed for gamma-emitting radionuclides and tritium. Soft tissue samples (lung, muscle, liver, thyroid, rumen contents, and fetus, when available) are analyzed for gamma-emitting radionuclides. Additionally, samples of soft tissues and bones were ashed and then analyzed for plutonium isotopes; ashed bone samples were also analyzed for ^{90}Sr. Samples of thyroid and fetal tissue are not ashed due to their small size. The mule deer collected in the first quarter of 1994 was a 4-5 year old male in good condition, that collected in the second quarter was a male 1-2 years old in good condition, that collected in the third quarter was a male 4-5 years old in good condition, and that collected in the fourth quarter was a male 7-8 years old. A female deer was collected during the third quarter of 1994 offsite in the Cherry Creek area near Adaven, Nevada. This deer was used as a control sample for the onsite collections.

Plutonium-239/240 was found at 1 pCi/g ash in a deer liver (MDC = 0.01 pCi/g) and was found above the MDC in a lung, a muscle and most rumen and bone samples. Tritium at 2800 pCi/L (MDC = 445 pCi/L) was detected in one blood sample. Strontium-90 above the MDC was found in one bone sample, concentration of 0.96 pCi/g of ash, and the median value was 0.73 pCi/g (0.027 Bq/g) consistent with the long-term downward trend of strontium in bone. The control deer, from near Adaven, Nevada, had radionuclide levels less than the MDC in all tissues analyzed. The average ^{90}Sr levels found in mule deer bone ash since 1955 are shown in Figure 5.9.

The only significant histopathology found in the deer was vascular lesions in the lungs of NTS deer No. 2. They resembled an immune-mediated vasculitie but were more likely due to parasitic migration through pulmonary tissues.

CHUKAR

During the fourth quarter of 1994 two chukars were collected in Esmeralda County by Nevada Department of Wildlife personnel to be used as controls for chukars collected at NTS. Two chukars were also collected in Area 25 of the NTS. No tritium was found in the internal organ or muscle samples of the chukar and no strontium above the MDC was found in ashed bone samples. The bone from a chukar collected in Esmeralda County had plutonium concentrations slightly above the MDC.



Note: Nos. above bars represent No. of samples

Figure 5.9 Average Strontium Levels in Mule Deer, 1955 - 1994

CATTLE

Blood and soft tissues (lung, muscle, liver, thyroid, kidney and fetal tissue, when available) are analyzed for gamma-emitting radionuclides; blood is also analyzed for tritium activity.

Samples of liver, bone, and fetal tissue are ashed and analyzed for plutonium isotopes; bone and fetus samples are also analyzed for ^{90}Sr. Duplicate liver and bone samples from two animals in each group of four are prepared and analyzed.

The four cattle purchased in May 1994 from the G. L. Coffers Ranch in Beatty, Nevada, had detectable concentrations of ^{90}Sr and the plutoniums in some bone ash samples. Most of the liver ash samples had concentrations below the MDC except for an 0.061 pCi/g of $^{239+240}Pu$ in one sample. A bull collected in Area 18 of the NTS had plutonium and ^{90}Sr concentrations similar to those of the offsite cattle.

The four cattle purchased in September from the Sharp Ranch, Nyala, Nevada, had two bone samples with detectable ^{90}Sr at (6.7 and 9.0) x 10^{-4} pCi/g, and a liver sample with detectable $^{239+240}Pu$ at 9.0 x 10^{-3} pCi/g (0.3 mBq/g). The average ^{90}Sr levels found in cattle bone ash since 1955 are shown in Figure 5.10.

The bull collected in Area 18 was the last known animal from the NTS beef herd that foraged Area 18. Upon necropsy this animal was found to have ocular squamous cell carcinoma with metastasis to the lung and kidney. One cow from Nyala was also found to have ocular squamous cell carcinoma. No other significant pathology was reported in any of the other cattle.

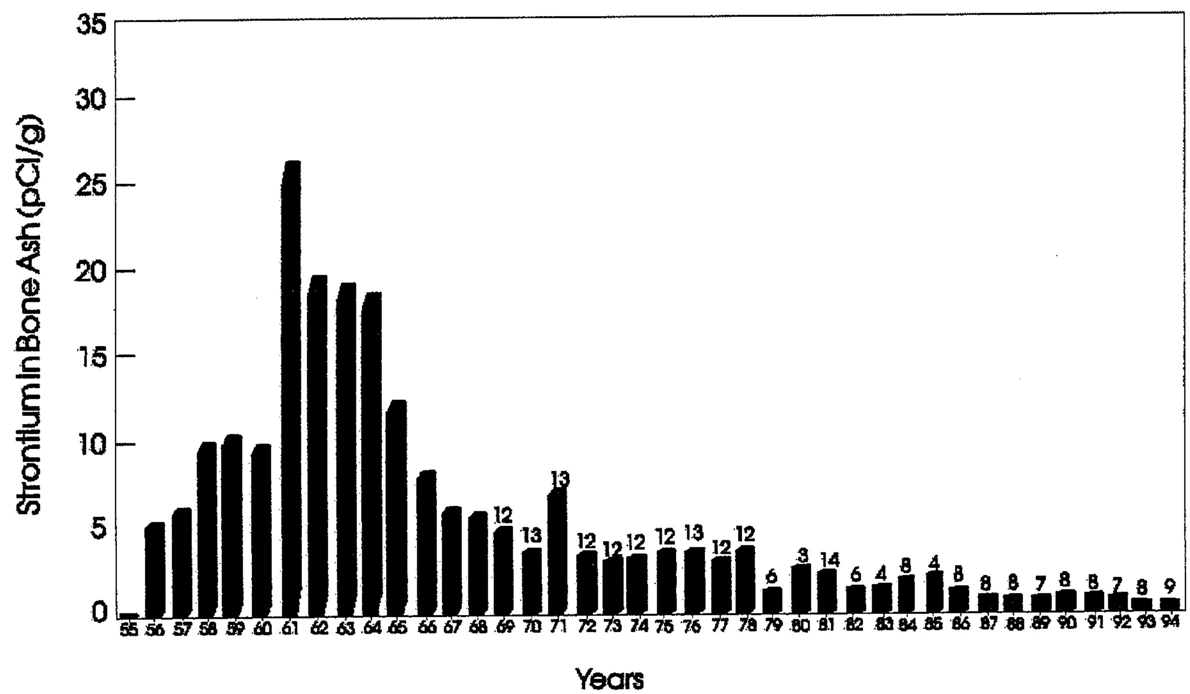


Figure 5.10 Average Strontium Levels in Cattle, 1955 - 1994

FRUITS AND VEGETABLES

In the fall of 1994, samples beets and apples were donated by residents of Rachel and Adaven, Nevada. The samples were analyzed for gamma-emitting radionuclides and only naturally occurring ^{40}K was detected. All samples were analyzed for tritium, and aliquots were ashed and analyzed for ^{90}Sr, ^{238}Pu and $^{239+240}Pu$. All ^{3}H samples were less than the MDA. All samples had detectable levels of $^{239+240}Pu$ and an apple sample from Uhalde Ranch, Adaven, Nevada had detectable ^{238}Pu at 3.2 (MDC = 2.8) fCi/g (0.12 mBq/g). The results are listed in Table 5.26.

5.2.2.5 THERMOLUMINESCENT DOSIMETRY NETWORK

OFFSITE STATION NETWORK

There were 125 offsite environmental stations monitored using TLDs in the first nine months of 1994. Figure 4.14 shows current fixed environmental monitoring locations. Total annual exposure for 1994 ranged from 54 mR (0.54 mSv) per year at Las Vegas Airport station to 334 mR (3.34 mSv) per year at Warm Springs No. 2, Nevada, with a mean annual exposure of 95.6 mR (0.96 mSv) per year for all operating locations. The station located in Warm Springs No. 2, Nevada, consistently shows exposure levels higher than all other locations due to the elevated levels of naturally occurring radioactive materials present in the stream near the monitoring location. The next highest annual exposure was 156 mR per year at Austin, Nevada.

OFFSITE PERSONNEL NETWORK

Offsite personnel were issued TLDs to monitor their annual absorbed dose equivalent. Locations of personnel monitoring participants are shown in Figure 4.14. Annual whole body absorbed dose equivalents ranged from a low of 64.3 mrem (.64 mSv) to a high of 140 mrem (1.4 mSv) with a mean of 115 mrem (1.2 mSv) for all monitored personnel during 1994. Individual results for each collected sample are published separately and may be found in the "Environmental Data Report for the Nevada Test Site - 1994" (DOE/NV/11432-176, in prep.).

5.2.2.6 PRESSURIZED ION CHAMBER NETWORK

The PIC data presented in this section are based on weekly averages of gamma exposure rates from each station.

Table 5.27 contains the number of weekly averages available from each station and the maximum, minimum, mean, standard deviation, and median of the weekly averages. The mean ranged from 8.2 μR/hr at St George, UT to 18.8 μR/hr at Stone Cabin Ranch, NV or annual exposures from 73 to 164 mR (19 to 43 μC/kg). For each station, this table also shows the total mR/yr (calculated based on the mean of the weekly averages) and the average gamma exposure rate from 1993. Background levels of environmental gamma exposure rates in the U.S. (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 U.S. background levels. Figure 5.11 shows the distribution of the weekly averages from each PIC station arranged by ascending means (represented by filled circles). The horizontal lines extend from the box to the minimum and maximum values. The data from the Austin, Overton, Rachel and Uhalde's Ranch stations show the greatest range and the most variability. Data from the Austin station have historically shown a natural fluctuation during the winter months (EPA 1994).

5.2.2.7 INTERNAL DOSIMETRY NETWORK

The EMSL-LV Internal Dosimetry Program was developed to identify the presence of radionuclides that have been ingested, absorbed, or inhaled by offsite residents, and to determine the total quantities of these contaminants and their possible health effects. To accomplish this task, a Whole Body Counting facility is operated at the laboratory in which semi-conductor detectors are used to scan participants for gamma- or X-rays that could indicate that a radioactive burden has accumulated. A routine scan involves a 1000 to 2000-second data collection time with a large volume detector placed near a reclining individual inside a heavily shielded vault. Scans of the lungs are conducted in a similar manner with an array of detectors that are highly sensitive to nuclides such as plutonium or uranium.

The Internal Dosimetry Program currently includes the monitoring of participants in the Offsite Dosimetry Network (which consists of individuals that live in the area surrounding the Nevada Test Site) and the Radiological Safety Program (consisting of selected government and contractor employees), members of other federal, state, or local institutions, and the general public. In 1994, a total of 92 whole body scans were conducted, including six of former Desert Storms soldiers who were injured with depleted uranium shrapnel. No radioactivity above normal background levels was detected in any of the remaining 86 spectra.

In addition to whole body and lung scans, tritium analysis of urine is conducted at EMSL-LV for members of the Offsite Dosimetry Network and workers with possible radiation exposures. In 1994, 44 urine specimens were collected and analyzed to determine tritium concentration.

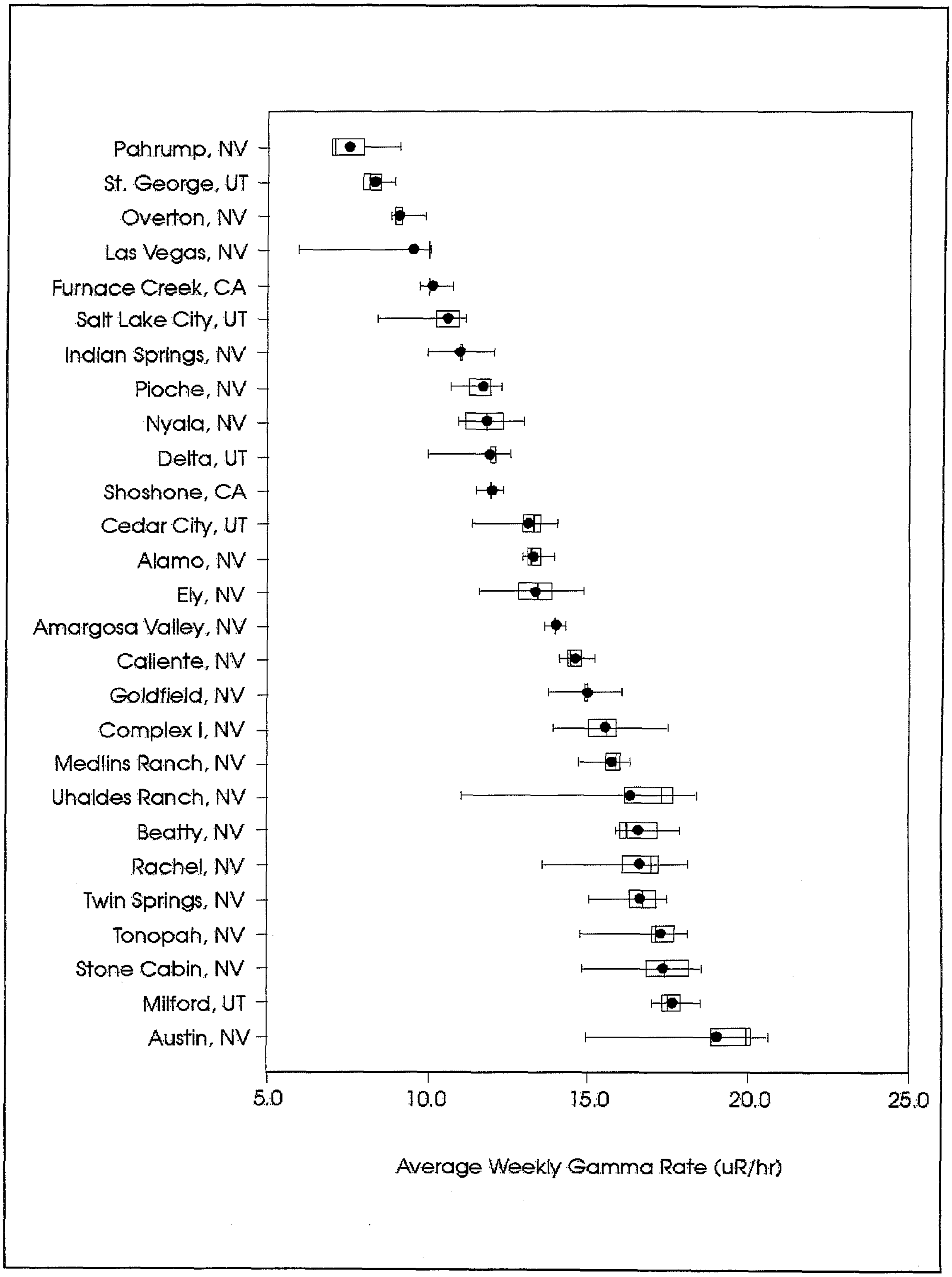


Figure 5.11 Distribution of Weekly Averages from Each PIC Network Station - 1994

Of these, one showed a result higher than the minimum detectable concentration for the analytical method with a value of 3.4×10^{-9} µCi/mL (13 Bq/L). If this concentration were assumed to be equal to the average intake concentration of tritium for the specimen donor, it would correspond to less than 2 percent of the allowable intake concentration stated in the 1979 drinking water regulation (2.0×10^{-5} µCi/mL or 740 Bq/L).

5.2.3 NON-NTS EG&G/EM FACILITY MONITORING

EG&G/EM facilities which use radioactive sealed sources or radiation producing equipment with the potential to expose the general population outside the property line to direct radiation are: Santa Barbara Operation (SBO), during operation of the LINAC; the Special Technologies Laboratory (STL), during operation of the Sealed Tube Neutron Generator; the Remote Sensing Laboratory (RSL) at Nellis Air Force Base; and the Las Vegas Area Operation's (LVAO) North Las Vegas Facility (NLVF) A-1 Source Range. Sealed sources are tested periodically to assure there is no leakage of radioactive material. The data from sealed source testing are kept in the EG&G/EM Radiation Protection Records.

Fence line radiation monitoring at SBO, RSL, LVAO was conducted during 1994 using Panasonic Type UD-814 TLDs. At least two TLDs were at the fence line on each side of the facility. TLDs were exchanged on a quarterly basis with additional control TLDs kept in a shielded safe. These TLD results are given in Table 5.28. The range of results, 61 to 160 mR/yr, is within the background range in the continental U.S.

Table 5.1 NTS Radionuclide Emissions - 1994

Onsite Liquid Discharges

Containment Ponds	Gross Beta	^{3}H	^{90}Sr	^{137}Cs	^{238}Pu	$^{239+240}Pu$
	Curies[(a)]					
Area 12, E Tunnel	2.1×10^{-3}	4.7×10^{1}	8.6×10^{-5}	1.7×10^{-3}	2.0×10^{-5}	1.6×10^{-4}
Area 12, N Tunnel		2.6×10^{-2}				
TOTAL	2.1×10^{-3}	4.7×10^{1}	8.6×10^{-5}	1.7×10^{-3}	2.0×10^{-5}	1.6×10^{-4}

Airborne Effluent Releases

Facility Name (Airborne Releases)	^{3}H[(b)]	^{85}Kr	^{133}Xe	$^{239+240}Pu$
	Curies[(a)]			
Area 3[(c)]				0.023
Area 5, RWMS[(c)]	6.3×10^{-1}			
Area 7 (Drillback)			1.2×10^{-1}	
Area 9 Bunker[(c)]				0.048
Pahute Mesa		200		
Other Areas[(d)]				0.21
TOTAL	6.3×10^{-1}	200	1.2×10^{-1}	0.28

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

Table 5.2 Airborne Gross Beta Concentrations on the NTS - 1994

Location	Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG
		Gross Beta Concentration (10^{-14} μCi/mL)				
Area 1, Gravel Pit	52	3.5	1.3	2.0	0.44	2.2
Area 1, BJY	49	4.1	1.2	2.1	0.56	2.3
Area 2, Complex	52	3.4	1.1	1.9	0.58	2.1
Area 2, 2-1 Substation	51	3.6	1.2	2.0	0.55	2.2
Area 3, Complex # 2	49	3.5	1.2	2.1	0.48	2.3
Area 3, U3AH/AT S	51	2.9	1.0	1.7	0.39	1.9
Area 3, U3AH/AT E	52	3.3	1.0	1.9	0.48	2.1
Area 3, U3AH/AT N	48	3.3	1.0	1.8	0.50	2.0
Area 3, U3AH/AT W	51	3.2	0.94	1.8	0.47	2.0
Area 3, Complex	44	3.8	1.2	2.0	0.58	2.2
Area 3, Mud Plant	51	3.4	1.3	2.2	0.49	2.4
Area 5, RWMS #4	52	3.8	1.3	2.2	0.52	2.4
Area 5, RWMS #5	52	3.9	1.1	2.2	0.57	2.4
Area 5, RWMS #6	51	3.5	1.4	2.2	0.46	2.4
Area 5, RWMS #7	48	4.2	1.2	2.3	0.61	2.6
Area 5, RWMS #8	51	3.7	1.2	2.2	0.48	2.4
Area 5, RWMS Pit-3	51	4.0	1.4	2.1	0.50	2.3
Area 5, RWMS #9	50	3.5	1.0	2.2	0.45	2.4
Area 5, Gate 200 S	51	4.2	1.2	2.2	0.59	2.4
Area 5, Dod Yard	52	3.8	1.1	2.1	0.54	2.3
Area 5, RWMS #2	51	3.6	1.0	2.0	0.50	2.2
Area 5, RWMS #3	52	4.3	1.1	2.4	0.63	2.7
Area 5, RWMS #1	52	5.2	1.1	1.9	0.65	2.1
Area 5, RWMS TP SE	51	3.8	0.77	2.1	0.61	2.3
Area 5, RWMS TP S	51	3.5	1.2	2.0	0.47	2.2
Area 5, RWMS TP SW	52	3.8	1.4	2.2	0.53	2.4
Area 5, RWMS TP NW	50	3.3	1.2	2.0	0.48	2.2
Area 5, RWMS TP N	52	3.9	1.4	2.2	0.51	2.2
Area 5, RWMS TP NE	51	3.7	1.2	2.1	0.47	2.3
Area 5, RWMS Pit-4	52	14.	1.2	2.3	1.8	2.6
Area 5, Well 5B	51	4.1	1.2	2.2	0.62	2.4
Area 6, Yucca Waste Pond	51	4.2	0.85	2.0	0.80	2.2
Area 6, DAF NE	50	3.6	1.0	2.0	0.52	2.2
Area 6, DAF SSE	51	3.4	0.79	2.0	0.56	2.2
Area 6, Building 6-900	51	4.2	1.3	2.3	0.59	2.6
Area 6, CP-6	51	3.8	1.4	2.1	0.52	2.3
Area 6, Well 3	51	3.2	1.1	1.9	0.45	2.1
Area 7, Ue7ns	50	2.8	0.88	1.9	0.46	2.1
Area 9, 9-300 Bunker	42	3.8	1.2	2.2	0.57	2.4
Area 10, Gate 700 S	52	3.6	1.1	2.0	0.52	2.2
Area 11, Gate 293	49	3.5	1.0	1.9	0.47	2.1
Area 12, 12 Complex	52	3.5	1.0	1.8	0.51	2.0
Area 15, EPA Farm	51	3.9	1.3	2.1	0.53	2.3
Area 16, 3545 Substation	50	3.2	0.74	1.8	0.45	2.0
Area 19, Echo Peak	33	2.8	1.0	1.9	0.42	2.1
Area 19, Pahute Substation	38	2.8	1.0	1.8	0.42	2.0
Area 20, Complex	34	3.2	1.2	2.0	0.44	2.2
Area 23, Building 790 #2	50	3.5	0.71	2.0	0.51	2.2
Area 23, Building 790	51	3.8	1.1	1.9	0.49	2.1
Area 23, East Boundary	52	3.6	0.86	2.0	0.47	2.2
Area 23, H&S Building	52	3.5	1.1	2.0	0.59	2.2
Area 25, EMAD-N	52	4.0	1.2	2.0	0.48	2.2
Area 25, NRDS	51	4.1	1.1	2.2	0.58	2.4
Area 27, Cafeteria	51	3.6	1.2	2.0	0.49	2.2

Median MDC = 1.5 x 10^{-15} μCi/mL

Table 5.3 Airborne $^{239+240}Pu$ Concentrations on the NTS - 1994

		$^{239+240}Pu$ Concentration (10^{-17} μCi/mL)				
Location	Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG
Area 1, Gravel Pit	10	1.1	0.00	0.37	0.34	0.18
Area 1, BJY	10	24.	0.80	8.0	7.1	4.0
Area 2, Complex	10	91.	0.11	9.8	28.	4.9
Area 2, 2-1 Substation	9	5.9	0.24	2.1	1.7	1.0
Area 3, Complex # 2	10	110.	0.11	24.	32.	12.0
Area 3, U3AH/AT S	12	34.	0.69	10.	9.4	5.0
Area 3, U3AH/AT E	12	28.	0.60	9.4	8.9	4.7
Area 3, U3AH/AT N	12	110.	0.48	19.	32.	9.5
Area 3, U3AH/AT W	12	44	0.75	14.	14.	7.0
Area 3, Complex	10	20.	0.16	9.6	6.5	4.8
Area 3, Mud Plant	10	68.	5.9	25.	19.	12
Area 5, RWMS #4	9	2.9	0.026	0.73	0.86	0.36
Area 5, RWMS #5	10	4.2	0.097	0.79	1.2	0.40
Area 5, RWMS #6	10	6.0	0.17	1.4	1.8	0.70
Area 5, RWMS #7	10	0.91	0.069	0.38	0.28	0.19
Area 5, RWMS #8	10	1.4	0.075	0.50	0.40	0.25
Area 5, RWMS Pit-3	12	3.0	0.00	0.80	1.0	0.40
Area 5, RWMS #9	10	6.2	0.00	1.6	2.1	0.80
Area 5, Gate 200 S	10	0.73	-0.027	0.18	0.25	0.09
Area 5, DoD Yard	10	5.5	0.00	0.81	1.7	0.40
Area 5, RWMS #2	10	52.	0.00	5.9	16.	3.0
Area 5, RWMS #3	10	0.78	-0.020	0.31	0.22	0.15
Area 5, RWMS #1	10	0.88	-0.013	0.40	0.31	0.20
Area 5, RWMS TP SE	12	1.9	0.00	0.53	0.50	0.26
Area 5, RWMS TP S	11	5.6	-0.063	0.96	1.7	0.48
Area 5, RWMS TP SW	11	13.	0.060	1.6	3.9	0.80
Area 5, RWMS TP NW	12	2.6	-0.041	0.70	0.76	0.35
Area 5, RWMS TP N	12	7.1	-0.048	0.83	2.0	0.42
Area 5, RWMS TP NE	12	1.2	0.00	0.47	0.31	0.24
Area 5, RWMS Pit-4	12	2.7	0.057	0.44	0.75	0.22
Area 5, Well 5B	12	12.	0.11	1.9	3.7	0.95
Area 6, Yucca Waste Pond	10	5.9	0.47	2.5	1.8	1.2
Area 6, DAF NE	11	2.5	0.00	0.50	0.76	0.25
Area 6, DAF SSE	11	5.9	0.14	1.2	1.6	0.60
Area 6, Building 6-900	10	6.4	0.00	2.2	1.8	1.1
Area 6, CP-6	10	1.7	0.00	0.68	0.46	0.34
Area 6, Well 3	10	2.9	0.24	1.2	0.75	0.60
Area 7, Ue7ns	10	12.	0.00	3.5	3.7	1.8
Area 9, 9-300 Bunker	10	160.	24.	66.	48.	33
Area 10, Gate 700 S	10	3.6	0.13	1.2	1.1	0.6
Area 11, Gate 293	10	11.	0.14	2.9	3.4	1.4
Area 12, Gate 12	10	0.71	0.00	0.21	0.22	0.10
Area 15, EPA Farm	10	40.	0.41	10.	12.	5.0
Area 16, 3545 Substation	10	0.84	-0.094	0.27	0.32	0.14
Area 19, Echo Peak	6	0.28	0.039	0.12	0.12	0.06
Area 19, Pahute Substation	7	0.32	-0.027	0.18	0.14	0.09
Area 20, Complex	6	0.20	0.00	0.11	0.069	0.06
Area 23, Building 790 #2	10	4.3	-0.020	0.62	1.3	0.31
Area 23, Building 790	10	11.	0.00	1.4	3.4	0.70
Area 23, East Boundary	10	0.45	0.00	0.20	0.12	0.10
Area 23, H&S Building	10	68.	-0.030	6.8	22.	3.4
Area 25, EMAD-N	10	0.62	0.00	0.21	0.17	0.11
Area 25, NRDS	10	0.72	0.00	0.23	0.23	0.12
Area 27, Cafeteria	10	0.37	0.00	0.19	0.14	0.03

Median MDC = 5.0×10^{-18} μCi/ml

Table 5.4 Airborne ^{238}Pu Concentrations on the NTS - 1994

		^{238}Pu Concentration (10^{-17} μCi/mL)				
Location	Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG
Area 1, Gravel Pit	10	0.24	-0.10	0.069	0.10	2.3
Area 1, BJY	10	0.56	-0.066	0.20	0.21	0.067
Area 2, Complex	10	0.68	-0.029	0.094	0.24	0.031
Area 2, 2-1 Substation	9	0.12	-0.19	-0.045	0.095	0.015
Area 3, Complex # 2	10	1.6	0.020	0.34	0.48	0.11
Area 3, U3AH/AT S	12	0.81	-0.015	0.22	0.23	0.0733
Area 3, U3AH/AT E	12	0.79	-0.026	0.17	0.24	0.057
Area 3, U3AH/AT N	12	1.3	0.024	0.24	0.41	0.080
Area 3, U3AH/AT W	12	1.2	-0.025	0.38	0.47	0.13
Area 3, Complex	10	0.49	-1.1	0.034	0.44	0.011
Area 3, Mud Plant	10	1.4	0.0	0.50	0.44	0.16
Area 5, RWMS #4	9	0.14	-0.14	0.016	0.079	<0.01
Area 5, RWMS #5	10	0.062	-0.11	-0.007	0.043	<0.01
Area 5, RWMS #6	10	0.078	-0.14	-0.009	0.054	<0.01
Area 5, RWMS #7	10	0.36	-0.004	0.045	0.11	0.015
Area 5, RWMS #8	10	0.00	-0.066	-0.008	0.020	<0.01
Area 5, RWMS Pit-3	12	0.33	-0.090	0.054	0.13	0.018
Area 5, RWMS #9	10	0.18	-0.088	0.055	0.086	0.018
Area 5, Gate 200 S	10	0.12	-0.14	0.013	0.072	<0.01
Area 5, DoD Yard	10	0.17	-0.11	-0.003	0.071	<0.01
Area 5, RWMS #2	10	0.66	-0.009	0.068	0.21	0.023
Area 5, RWMS #3	10	0.31	-0.12	0.042	0.12	0.014
Area 5, RWMS #1	10	0.80	-0.12	0.083	0.26	0.028
Area 5, RWMS TP SE	12	0.13	-0.018	0.016	0.052	<0.01
Area 5, RWMS TP S	11	0.10	-0.097	-0.004	0.046	<0.01
Area 5, RWMS TP SW	11	0.37	-0.14	0.061	0.14	0.020
Area 5, RWMS TP NW	12	0.23	-0.14	0.004	0.091	<0.01
Area 5, RWMS TP N	12	0.35	-0.017	0.066	0.13	0.022
Area 5, RWMS TP NE	12	0.25	-0.014	0.018	0.086	<0.01
Area 5, RWMS Pit-4	12	1.1	-0.018	0.15	0.33	0.050
Area 5, Well 5B	10	0.11	-0.46	-0.038	0.15	0.013
Area 6, Yucca Waste Pond	10	0.16	-0.18	0.008	0.087	<0.01
Area 6, DAF NE	11	0.26	-0.025	0.038	0.084	0.013
Area 6, DAF SSE	11	0.11	-0.12	-0.005	0.053	<0.01
Area 6, Building 6-900	10	0.33	-0.099	0.086	0.14	0.029
Area 6, CP-6	10	0.18	-0.080	0.012	0.079	<0.01
Area 6, Well 3	10	0.11	-0.12	0.026	0.079	<0.01
Area 7, Ue7ns	10	0.19	-0.11	-0.004	0.082	<0.01
Area 9, 9-300 Bunker	10	2.6	0.00	0.98	0.84	0.33
Area 10, Gate 700 S	10	0.24	-0.12	0.056	0.13	0.019
Area 11, Gate 293	10	0.35	-0.077	0.11	0.15	0.037
Area 12, Gate 12	10	0.12	-0.093	0.012	0.063	<0.01
Area 15, EPA Farm	10	0.88	-0.005	0.30	0.30	0.10
Area 16, 3545 Substation	10	0.096	-0.094	0.007	0.051	<0.01

Median MDC = 5.0×10^{-18} μCi/mL

Table 5.4 (Airborne ^{238}Pu Concentrations on the NTS - 1994, cont.)

Location	Number	^{238}Pu Concentration (10^{-17} µCi/mL) Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG
Area 19, Echo Peak	6	0.41	-0.012	0.18	0.16	0.060
Area 19, Pahute Substation	7	0.26	-0.007	0.046	0.098	0.015
Area 20, Complex	6	0.28	-0.011	0.066	0.11	0.022
Area 23, Building 790 #2	10	0.12	-0.009	0.014	0.040	<0.01
Area 23, Building 790	10	0.33	-0.013	0.033	0.10	0.011
Area 23, East Boundary	10	0.16	-0.008	0.017	0.050	<0.01
Area 23, H&S Building	10	0.44	-0.013	0.072	0.14	0.024
Area 25, EMAD-N	10	0.16	-0.078	0.039	0.080	0.013
Area 25, NRDS	10	0.14	-0.078	0.021	0.062	<0.01
Area 27, Cafeteria	10	0.16	-0.076	0.026	0.069	<0.01

Median MDC = 5.0×10^{-18} µCi/mL

Table 5.5 Derived Limits for Radionuclides in Air and Water

Radionuclide	DAC (Air)(a)	µCi/mL DCG (Air)(b)	DCG (Water)(c)
^{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, whichever 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 5.6 Summary of NTS ^{85}Kr Concentrations - 1994

		^{85}Kr Concentration (10^{-12} µCi/mL)				
Location	Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as % DCG
Area 1, BJY	49	52	-3.2	25	11	<0.01
Area 1, Gravel Pit	48	47	7.7	26	8.4	<0.01
Area 5, Gate 200 S.	45	57	-3.3	24	11	<0.01
Area 12, Camp	44	40	9.9	24	6.5	<0.01
Area 15, EPA Farm	43	45	0.0	26	9.4	<0.01
Area 18, Gate 400	43	52	0.22	25	8.3	<0.01
Area 19, Pahute Substation	30	44	4.5	24	8.5	<0.01
Area 20, Dispensary	30	49	6.0	27	11	<0.01
Area 20, DDZ77 Trans.	27	55	21	30	7.8	0.01
Area 25, E-MAD	48	41	-0.40	26	8.4	<0.01
All Stations	407	55	-3.4	26	9.1	<0.01

Table 5.7 Summary of NTS ^{133}Xe Concentrations - First 6 Months of 1994

		^{133}Xe Concentrations (10^{-12} µCi/mL)				
Location	Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as % DCG
Area 1, BJY	25	64	-25	8.7	21	0.017
Area 1, Gravel Pit	21	46	-27	6.0	14	0.012
Area 5, Gate 200	21	61	-41	8.0	21	0.016
Area 12, Camp	22	42	-19	7.4	15	0.015
Area 15, EPA Farm	18	26	-12	6.8	10	0.014
Area 18, Gate 400	21	32	-33	3.2	14	<0.01
Area 19, Pahute Substation	8	49	-33	2.2	24	<0.01
Area 20, Dispensary	7	41	-19	14	23	0.028
Area 20, DDZ77 Trans.	4	33	-70	2.2	46	<0.01
Area 25, E-MAD	23	52	-6.8	11	15	0.022
All Stations	170	64	-70	6.7	19	0.013

Table 5.8 Airborne Tritium Concentrations on the NTS - 1994

Location	Number	^{3}H Concentration (10^{-6} pCi/mL) Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG
Area 1, BJY	23	4.0	-2.2	0.96	1.4	<0.01
Area 5, RWMS No. 1	25	12	0.16	4.2	2.7	0.04
Area 5, RWMS No. 2	25	13	-0.50	4.3	3.6	0.04
Area 5, RWMS No. 3	26	28	-0.85	4.5	5.5	0.04
Area 5, RWMS No. 4	26	47	0.44	14	12	0.014
Area 5, RWMS No. 5	26	12	0.056	3.6	2.8	0.04
Area 5, RWMS No. 6	26	16	-1.8	2.9	3.4	0.03
Area 5, RWMS No. 7	26	6.6	-0.57	2.0	1.8	0.02
Area 5, RWMS No. 8	24	9.3	0.22	2.2	2.2	0.02
Area 5, RWMS No. 9	25	16	0.082	5.8	3.4	0.06
Area 6, DAF NE	25	2.3	-1.4	0.58	0.96	<0.01
Area 6, DAF SSE	26	5.1	-2.9	0.31	0.18	<0.01
Area 10, Gate 700 South	24	2.2	-0.98	0.57	0.86	<0.01
Area 12, Complex	24	2.6	-1.1	0.41	0.96	<0.01
Area 15, EPA Farm	25	37	2.3	9.6	6.9	0.10
Area 23, Building 790 No. 2	24	3.6	-2.2	0.75	1.3	<0.01
Area 23, East Boundary	25	4.1	-1.2	0.44	1.2	<0.01
Area 23, H&S Building	25	1.7	-0.75	0.30	0.58	<0.01
Area 25, E-MAD North	26	2.9	-2.0	0.25	1.4	<0.01
All Stations	477	47	-2.9	3.2	5.8	0.03

Average MDC ± 1 standard deviation was (1.5 ± 0.6) x 10^{-6} pCi/mL

Table 5.9 Radioactivity in NTS Surface Waters - 1994

Source of Water	Number of Locations	Annual Average Concentrations (10^{-9} µCi/mL) Gross β	Tritium	^{238}Pu	$^{239+240}$Pu	^{90}Sr[(a)]	% of DCG Range[(b)]
Open Reservoirs	12	7.5	-4.1	5.9 x 10^{-4}	0.0032	0.20	<0.01-0.50
Natural Springs	8	10	-0.21	0.011	0.37	0.19	<0.01-37
Containment Ponds							
T Tunnel[(b)]	-	-	-	-	-	-	-
N Tunnel[(b)]	-	-	-	-	-	-	-
E Tunnel	2	54	1.8 x 106	0.67	5.5	2.6	[(c)]
Decon Facility[(b)]	-	-	-	-	-	-	-
Sewage Lagoons	9	19	-13	-0.0013	-0.0025	0.072	[(c)]

(a) DCG based on value for drinking water (4 mrem EDE)
(b) No samples collected due to stopping of effluent and to evaporation of pond(s)
(c) Not a potable water source

Table 5.10 NTS Open Reservoir Gross Beta Analysis Results - 1994

Location	Number	Gross Beta Concentration (10^{-9} µCi/mL) Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG[(a)]
Area 2, Mud Plant Reservoir	5	4.9	3.1	3.2	1.5	7.8
Area 2, Well 2 Reservoir	5	6.3	2.8	4.7	1.4	12
Area 3, Mud Plant Reservoir	5	13	9.3	11	1.6	28
Area 3, Well A Reservoir	5	9.7	7.4	8.9	0.94	22
Area 5, UE-5c Reservoir	5	8.1	6.2	7.4	0.83	19
Area 5, Well 5B Reservoir	5	13	11	12	0.74	30
Area 6, Well 3 Reservoir	5	12	7.7	9.9	1.5	25
Area 6, Well C1 Reservoir	5	12	4.7	8.4	2.9	21
Area 18, Camp 17 Reservoir	5	5.5	3.1	4.1	0.93	10
Area 18, Well 8 Reservoir[(b)]	-	-	-	-	-	-
Area 19, UE-19c Reservoir[(b)]	-	-	-	-	-	-
Area 20, Well 20A Reservoir[(b)]	-	-	-	-	-	-
Area 23, Swimming Pool	5	14	4.5	7.7	3.5	19
Area 25, Well J-11 Reservoir	5	7.5	4.6	5.5	1.2	14
Area 25, Well J-12 Reservoir	5	12	5.1	7.9	3.0	20

(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 - 1994

Location	Number	Gross Beta Concentration (10^{-9} µCi/mL) Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG[(a)]
Area 5, Cane Spring	5	7.8	5.3	6.0	0.99	15
Area 7, Reitmann Seep	5	32	11	18	9.2	45
Area 12, Captain Jack	3	14	10	12	2.2	30
Area 12, Gold Meadows	1	28	28	28	-	70
Area 12, White Rock Spring	5	9.4	6.4	8.2	1.3	21
Area 15, Tub Spring	4	10	6.2	7.8	1.6	20
Area 16, Tippipah Spring	5	8.2	4.8	5.8	1.4	15
Area 29, Topopah Spring	4	11	6.9	8.6	1.9	22

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

Table 5.12 NTS Containment Pond Gross Beta Analysis Results - 1994

Location	Number	Gross Beta Concentration (10^{-9} μCi/mL) Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG[a]
Area 12, E Tunnel Effluent	6	58	44	54	5.4	135
Area 12, E Tunnel Pond No. 1	8	69	38	55	12	138
Area 12, N Tunnel Effluent[b]	-	-	-	-	-	-
Area 12, N Tunnel Pond No. 1[b]	-	-	-	-	-	-
Area 12, N Tunnel Pond No. 2[b]	-	-	-	-	-	-
Area 12, N Tunnel Pond No. 3[b]	-	-	-	-	-	-
Area 12, T Tunnel Effluent[c]	-	-	-	-	-	-
Area 12, T Tunnel Pond No. 1[b]	-	-	-	-	-	-
Area 12, T Tunnel Pond No. 2[b]	-	-	-	-	-	-
Area 12, T Tunnel Pond No. 3[b]	-	-	-	-	-	-

(a) DCG based on ^{90}Sr value for drinking water (4 mrem EDE)
(b) Tunnel sealed by end of year 1993

Table 5.13 NTS Supply Well Radioactivity Averages - 1994

Description	Gross Beta (μCi/mL)	^{3}H	$^{239+240}Pu$	^{238}Pu	Gross Alpha	^{90}Sr[a]
Potable Water Supply Wells						
Area 5, Well 5C	7.3×10^{-9}	2.3×10^{-9}	5.0×10^{-12}	4.6×10^{-13}	9.1×10^{-9}	1.2×10^{-10}
Area 6, Well 4	5.9×10^{-9}	5.2×10^{-12}	2.6×10^{-12}	7.0×10^{-13}	7.4×10^{-9}	1.8×10^{-10}
Area 6, Well 4A[b]	7.2×10^{-9}	-1.8×10^{-9}	4.7×10^{-13}	-1.2×10^{-12}	8.0×10^{-9}	-6.3×10^{-11}
Area 5, Well 5B	8.8×10^{-9}	2.4×10^{-9}	-4.8×10^{-13}	5.9×10^{-13}	5.0×10^{-9}	2.2×10^{-10}
Area 6, Well C	6.9×10^{-9}	6.6×10^{-9}	4.9×10^{-13}	-5.9×10^{-12}	5.7×10^{-9}	6.1×10^{-11}
Area 6, Well C1	1.0×10^{-8}	1.2×10^{-8}	1.5×10^{-12}	-7.7×10^{-13}	8.2×10^{-9}	5.4×10^{-11}
Area 16, Well UE-16d	9.1×10^{-9}	-1.9×10^{-10}	2.6×10^{-12}	7.8×10^{-13}	8.1×10^{-9}	1.6×10^{-10}
Area 18, Well 8	3.4×10^{-9}	1.1×10^{-9}	2.5×10^{-12}	-2.1×10^{-12}	6.1×10^{-10}	2.0×10^{-11}
Area 22, Army Well No. 1	5.1×10^{-9}	-3.8×10^{-10}	-9.6×10^{-13}	-1.7×10^{-13}	3.7×10^{-9}	9.0×10^{-11}
Area 25, Well J-12	4.3×10^{-9}	1.4×10^{-9}	2.9×10^{-12}	-2.1×10^{-12}	1.4×10^{-9}	9.2×10^{-11}
Area 25, Well J-13	3.8×10^{-9}	6.0×10^{-12}	2.1×10^{-12}	-7.1×10^{-13}	2.0×10^{-9}	1.4×10^{-10}
Non-Potable Water Supply Wells						
Area 5, Well UE-5c[b]	7.4×10^{-9}	2.2×10^{-9}	2.8×10^{-11}	5.6×10^{-13}	9.6×10^{-9}	1.3×10^{-10}
Area 20, Well U-20[b]	7.2×10^{-9}	-5.0×10^{-9}	-2.1×10^{-12}	4.7×10^{-12}	1.1×10^{-8}	NA
Median MDC	1.6×9^{-10}	1.2×10^{-8}	1.3×10^{-11}	1.3×10^{-11}	8.6×10^{-10}	1.2×10^{-10}

(a) ^{90}Sr values for the non-potable supply wells are for only one or two samples
(b) Only one sample collected
NA Not analyzed

Table 5.14 NTS Drinking Water Sources - 1994

System	Supply Wells	End-point
No. 1	Wells C, 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
--	None	Area 6, Bottled Water

Table 5.15 Radioactivity Averages for NTS End-Use Consumption Points - 1994

	μCi/mL					
Description	Gross Beta	^{3}H	$^{239+240}Pu$	^{238}Pu	Gross Alpha	^{90}Sr(a)
Area 1, Building 101	5.4×10^{-9}	4.3×10^{-8}	6.3×10^{-13}	1.9×10^{-12}	5.1×10^{-9}	7.2×10^{-11}
Area 2, Restroom	3.4×10^{-9}	9.5×10^{-8}	2.2×10^{-12}	1.3×10^{-12}	3.7×10^{-10}	1.3×11^{-10}
Area 6, Bottled Water(b)	1.6×10^{-10}	6.7×10^{-8}	0.0	0.0	-3.8×10^{-10}	NA
Area 6, Cafeteria	1.4×10^{-8}(c)	-1.1×10^{-8}	4.6×10^{-13}	1.7×10^{-12}	7.7×10^{-9}	-2.8×10^{-11}
Area 6, Building 6-900	7.9×10^{-9}	2.7×10^{-7}(d)	4.2×10^{-12}	-2.0×10^{-13}	7.1×10^{-9}	-5.1×10^{-11}
Area 12, Building 12-23	3.7×10^{-9}	8.0×10^{-8}	2.0×10^{-12}	-7.1×10^{-13}	1.8×10^{-9}	3.8×10^{-11}
Area 23, Cafeteria	6.8×10^{-9}	4.9×10^{-8}	6.0×10^{-13}	1.3×10^{-12}	5.8×10^{-9}	1.1×10^{-10}
Area 25, Building 4221	4.1×10^{-9}	7.0×10^{-9}	1.0×10^{-12}	-1.6×10^{-13}	1.2×10^{-9}	6.5×10^{-11}
Median MDC	7.6×10^{-10}	4.6×10^{-7}	1.5×10^{-11}	1.4×10^{-11}	8.5×10^{-10}	1.1×10^{-10}

(a) ^{90}Sr values are for one sample
(b) Sampling of this non-NTS source was terminated after collection of March 1994 sample
(c) With anomalous value of 1.1×10^{-7} μCi/mL omitted, the mean was 7.8×10^{-9} μCi/mL
(d) With anomalous value of 3.8×10^{-6} μCi/mL omitted, the mean was 5.2×10^{-8} μCi/mL
NA Not analyzed

Table 5.16 Radium Analysis Results for NTS Drinking Water - 1994

		Concentrations (10^{-9} μCi/mL)			
Location	Number	^{226}Ra Arithmetic Mean	Standard Deviation	^{228}Ra Arithmetic Mean	Standard Deviation
Area 5, Well 5B	4	0.84	0.94	0.11	0.22
Area 5, Well 5C	4	0.84	0.34	-0.17	0.22
Area 6, Well 4	4	0.66	0.75	0.11	0.26
Area 6, Well 4A	1	0.72	-	0.45	-
Area 6, Well C	4	2.4	0.36	0.46	0.30
Area 6, Well C-1	4	1.9	1.0	0.72	0.82
Area 16, Well UE-16d	4	1.7	0.96	0.16	0.14
Area 18, Well 8	4	0.76	1.1	-0.057	0.30
Area 23, Army Well No. 1	4	0.96	0.60	0.28	0.34
Area 25, Well J-12	4	0.75	0.77	0.058	0.16
Area 25, Well J-13	4	0.90	0.42	0.046	0.10

Table 5.17 NTS Boundary Gamma Monitoring Result Summary - 1994

Area	Location	First Quarter (mR/day)	Second Quarter (mR/day)	Third Quarter (mR/day)	Fourth Quarter (mR/day)	Average (mR/day)	1993 Annual Exposure (mR/yr)	1994 Annual Exposure (mR/yr)
3	Boundary TLD Station 358	[a]	[b]	0.17	0.17	0.17	102	62
15	Boundary TLD Station 356	[a]	[b]	0.39	0.39	0.39	147	143
10	Boundary TLD Station 357	[a]	[b]	0.19	0.19	0.19	127	70
11	Boundary TLD Station 359	[a]	[b]	0.37	0.36	0.36	200	133
5	Boundary TLD Station 360	[a]	[b]	0.15	0.15	0.15	96	54
12	Boundary TLD Station 355	[a]	[b]	0.27	0.26	0.27	135	97
20	Boundary TLD Station 352	[a]	[b]	0.23	0.23	0.23	131	85
19	Boundary TLD Station 353	[a]	[b]	0.39	0.40	0.39	170	144
19	Boundary TLD Station 354	[a]	[b]	0.39	0.36	0.38	163	138
20	Boundary TLD Station 350	[a]	[b]	0.44	0.45	0.45	240	163
20	Boundary TLD Station 351	[a]	[b]	0.41	0.39	0.40	179	146
22	Boundary TLD Station 346	[a]	[b]	0.16	0.15	0.16	100	58
25	Boundary TLD Station 347	[a]	[b]	0.25	0.25	0.25	128	92
30	Boundary TLD Station 349	[a]	[b]	0.39	0.37	0.38	195	140
25	Boundary TLD Station 348	[a]	[b]	0.35	0.36	0.36	164	130

(a) Results lost due to error in processing
(b) Results lost due to error in TLD handling

Table 5.18 NTS TLD Control Station Comparison - 1988-1994

Area	Station	Exposure Rate (mR/day) 1988	1989	1990	1991	1992	1993	1994[a]
5	Well 5B	0.43	0.36	0.34	0.37	0.31	0.40	0.34
6	CP-6	0.36	0.27	0.25	0.25	0.23	0.30	0.19
6	Yucca Oil Storage	0.29	0.32	0.32	0.33	0.31	0.37	0.27
23	Building 650 Dosimetry	0.26	0.19	0.20	0.19	0.18	0.26	0.15
23	Building 650 Roof	0.24	0.18	0.19	0.19	0.18	0.25	0.14
23	Post Office	0.29	0.23	0.23	0.24	0.23	0.30	0.21
25	HENRE Site	0.47	0.38	0.39	0.40	0.36	0.45	0.31
25	NRDS Warehouse	0.46	0.38	0.39	0.39	0.37	0.46	0.33
27	Cafeteria	0.49	0.32	0.40	0.42	0.39	0.46	0.33
Network Average		0.37	0.29	0.30	0.31	0.28	0.36	0.25

(a) Based on third and fourth quarter data

Table 5.19 Gross Beta Results for the Offsite Air Surveillance Network - 1994

Sampling Location	Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation
	Gross Beta Concentration (10^{-14} µCi/mL [0.37 mBq/m^3])				
Death Valley Junction, CA	47	3.18	0.53	1.51	0.51
Furnace Creek, CA	45	6.37	0.18	2.30	1.00
Shoshone, CA	40	3.16	0.54	1.65	0.47
Alamo, NV	51	2.67	0.46	1.52	0.44
Amargosa Valley, NV	47	2.39	0.76	1.40	0.40
Austin, NV	39	2.30	0.63	1.40	0.39
Beatty, NV	43	2.72	0.84	1.51	0.37
Caliente, NV	37	2.39	0.21	1.40	0.43
Clark Station, NV					
Stone Cabin Ranch	52	3.22	0.92	1.54	0.44
Currant, NV					
Blue Eagle Ranch	45	3.54	-0.03	1.21	0.68
Ely, NV	38	1.74	0.54	1.25	0.35
Goldfield, NV	52	2.87	0.77	1.61	0.40
Groom Lake, NV	38	3.81	0.89	1.81	0.61
Hiko, NV	50	2.62	-0.02	1.67	0.50
Indian Springs, NV	42	2.64	0.70	1.54	0.44
Las Vegas, NV	44	3.31	1.04	1.70	0.52
Nyala, NV	52	3.60	0.75	1.47	0.65
Overton, NV	40	3.86	1.08	1.78	0.47
Pahrump, NV	46	3.21	0.51	1.41	0.52
Pioche, NV	49	2.90	0.72	1.48	0.42
Rachel, NV	51	5.28	0.52	1.63	0.70
Sunnyside, NV	44	3.06	0.71	1.53	0.46
Tonopah, NV	50	2.64	0.68	1.51	0.41
Tonopah Test Range, NV	50	3.08	0.82	1.56	0.44
Twin Springs, NV					
Fallini's Ranch	51	4.70	0.94	1.90	0.77
Cedar City, UT	40	2.24	0.32	1.37	0.44
Delta, UT	33	2.60	0.17	1.23	0.40
Milford, UT	40	2.52	0.49	1.36	0.43
Salt Lake City, UT	39	2.68	0.62	1.52	0.46
St. George, UT	40	4.50	0.89	1.65	0.62

Mean MDC: 2.37×10^{-15} µCi/mL   Standard Deviation of Mean MDC: 3.3×10^{-16} µCi/mL

Table 5.20 Gross Alpha Results for the Offsite Air Surveillance Network - 1994

Sampling Location	Number	Concentration (10^{-15} µCi/mL [37 µBq/m^3]) Maximum	Minimum	Arithmetic Mean	Standard Deviation
Death Valley Jct, CA	47	3.30	0.10	1.33	0.82
Furnace Creek, CA	44	3.90	0.00	1.36	0.91
Shoshone, CA	40	2.70	0.10	0.90	0.59
Alamo, NV	51	3.20	0.00	1.18	0.75
Amargosa Valley, NV	47	3.10	-0.20	1.12	0.66
Austin, NV	39	3.60	0.00	1.43	0.87
Beatty, NV	43	3.20	0.30	1.30	0.63
Caliente, NV	37	2.40	-0.30	0.96	0.62
Clark Station, NV					
Stone Cabin Ranch	52	3.20	0.30	1.68	0.77
Currant, NV					
Blue Eagle Ranch	45	2.40	-0.20	0.81	0.58
Ely, NV	38	3.00	-0.20	0.80	0.58
Goldfield, NV	52	2.30	0.10	0.91	0.49
Groom Lake, NV	38	4.30	0.30	1.83	0.78
Hiko, NV	50	2.90	-0.20	1.21	0.70
Indian Springs, NV	42	3.10	-0.20	0.95	0.70
Las Vegas, NV	44	3.20	0.00	1.19	0.77
Nyala, NV	52	3.30	0.00	1.07	0.65
Overton, NV	40	3.70	0.00	1.15	0.69
Pahrump, NV	46	2.40	-0.20	0.85	0.47
Pioche, NV	49	2.50	-0.20	0.85	0.58
Rachel, NV	51	3.60	0.00	1.11	0.70
Sunnyside, NV	44	3.00	0.10	0.99	0.63
Tonopah, NV	50	2.60	-0.10	1.05	0.60
Tonopah Test Range, NV	50	4.80	0.00	1.40	0.98
Twin Springs, NV					
Fallini's Ranch	51	2.20	-0.10	0.87	0.55
Cedar City, UT	40	3.20	-0.20	1.48	0.75
Delta, UT	33	1.90	-0.30	0.76	0.52
Milford, UT	40	3.60	-0.10	0.88	0.58
Salt Lake City, UT	39	1.90	0.20	0.91	0.46
St. George, UT	40	3.90	0.00	0.99	0.67

Mean MDC: 7.06 x 10^{-16} µCi/mL Standard Deviation of Mean MDC:2.27 x 10^{-16} µCi/mL

Table 5.21 Offsite Airborne Plutonium Concentrations - 1994

Composite Sampling Location	Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG
		^{238}Pu Concentration (10^{-18} µCi/mL)				
Alamo, NV	9	5.9	-1.2	1.4	2.2	NA
Amargosa Valley, NV	9	2.4	-6.8	-1.0	3.4	NA
Las Vegas, NV	7	2.9	-6.8	-1.0	3.4	NA
Rachel, NV	9	1.9	-2.2	0.2	1.5	NA

Mean MDC: 7.2 x 10^{-18} µCi/mL   Standard Deviation of Mean MDC: 4.8 x 10^{-18} µCi/mL

Composite Sampling Location	Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG
		$^{239+240}$Pu Concentration (10^{-18} µCi/mL)				
Alamo, NV	9	4.2	-2.0	1.0	2.1	NA
Amargosa Valley, NV	9	7.5	0.0	1.8	2.3	NA
Las Vegas, NV	7	1.1	-5.8	-0.9	2.3	NA
Rachel, NV	9	134.7	-2.5	15.2	44.8	0.51

Mean MDC: 8.1 x 10^{-18} µCi/mL   Standard Deviation of Mean MDC: 6.1 x 10^{-18} µCi/mL

DCG Derived Concentration Guide; Established by DOE Order as 3 x 10^{-15} µCi/mL
NA Not applicable, result less than MDC.
To convert from µCi/mL to Bq/m^3 multiply by 3.7 x 10^{10} (e.g., [7.1 x 10^{-18}] x [37 x 10^9] = 26

Table 5.22 Offsite Atmospheric Tritium Results for Routine Samplers - 1994

Sampling Location	Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG
		HTO Concentration (10^{-6} pCi/mL)				
Alamo, NV	38	2.4	-3.7	0.1	1.4	0.001
Amargosa Valley, NV	38	2.4	-1.9	0.2	1.0	0.002
Amargosa Valley Community Center, NV	36	4.3	-3.0	0.4	1.5	0.004
Beatty, NV	37	4.2	-2.6	0.2	1.5	0.002
Goldfield, NV	37	3.2	-3.1	-0.0	1.6	0.000
Indian Springs, NV	38	2.7	-1.9	0.2	0.9	0.002
Las Vegas, NV	33	4.0	-4.0	0.2	1.7	0.001
Overton, NV	38	7.8	-3.7	0.2	2.1	0.002
Pahrump, NV	36	2.9	-2.3	0.4	1.2	0.004
Rachel, NV	38	4.1	-2.1	0.6	1.4	0.006
Tonopah, NV	38	2.4	-4.2	0.1	1.3	0.001
Twin Springs, NV Fallini's Ranch	37	2.3	-2.1	0.2	1.0	0.002
Salt Lake City, UT	30	5.2	-0.9	1.1	1.4	0.011
St. George, UT	36	2.8	-2.8	0.2	1.5	0.002

Mean MDC: 3.4 x 10^{-5} pCi/mL   Standard Deviation of Mean MDC: 1.3 x 10^{-5} pCi/mL

DCG Derived Concentration Guide; Established by DOE Order as 1 x 10^{-2} pCi/mL
MDC Minimum Detectable Concentration
Multiply table value by 37 to get mBq/m^3 (4.8 x 37 = 180 mBq/m^3)

Table 5.23 Offsite Noble Gas Results for Routine Samplers - 1994

^{85}Kr Concentration (10^{-12} µCi/mL)

Sampling Location	Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG
Alamo, NV	30	32	24	29	1.9	0.005
Amargosa Valley, NV	34	33	22	29	2.6	0.005
Amargosa Valley Community Center, NV	25	33	26	30	1.6	0.005
Beatty, NV	30	33	25	28	1.7	0.005
Goldfield, NV	32	31	23	28	1.9	0.005
Indian Springs, NV	34	33	25	30	2.3	0.005
Las Vegas, NV	37	33	22	28	2.6	0.005
Overton, NV	35	32	23	29	1.9	0.005
Pahrump, NV	33	34	25	29	2.4	0.005
Rachel, NV	34	32	21	28	2.8	0.005
Tonopah, NV	34	32	24	28	2.1	0.005
Twin Springs, NV Fallini's Ranch	37	32	23	29	2	0.005
St. George, UT	34	31	23	28	1.8	0.005

Mean MDC: 5.9×10^{-12} µCi/mL Standard Deviation of Mean MDC: $.9 \times 10^{-12}$ µCi/mL

^{133}Xe Concentration (10^{-12} µCi/mL)

Sampling Location	Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG
Alamo, NV	29	5.7	-23.0	-6.8	7.2	NA
Amargosa Valley, NV	34	5.9	-17.0	-3.9	5.2	NA
Amargosa Valley Community Center, NV	25	6.9	-17.0	-6.0	6.6	NA
Beatty, NV	30	5.4	-22.0	-5.3	5.9	NA
Goldfield, NV	33	4.9	-31.0	-7.4	8.2	NA
Indian Springs, NV	34	6.4	-16.0	-3.3	5.3	NA
Las Vegas, NV	37	7.2	-11.0	-3.4	3.8	NA
Overton, NV	36	5.6	-21.0	-6.2	6.5	NA
Pahrump, NV	33	4.7	-16.0	-3.3	5.0	NA
Rachel, NV	34	8.2	-37.0	-8.9	8.8	NA
Tonopah, NV	35	4.9	-23.0	-6.9	6.6	NA
Twin Springs, NV Fallini's Ranch	37	7.6	-21.0	-6.4	6.2	NA
St. George, UT	35	3.3	-19.0	-5.7	5.6	NA

Mean MDC: 18.0×10^{-12} µCi/mL Standard Deviation of Mean MDC: 7.0×10^{-12} µCi/mL

DCGDerived Concentration Guide; Established by DOE Order as 3×10^{-7} for Kr, 5×10^{-8} for Xe.
Multiply table value by 0.037 to obtain Bq/m^3, e.g., 32 x 0.037 = 1.2 Bq/m^3.
NA Not applicable, result is <MDC

Table 5.24 Summary of Radionuclides Detected in Milk Samples

	Milk Surveillance Network: No. of samples with results > MDC (Network average concentration in pCi/L)				Standby Milk Surveillance Network: No. of samples with results > MDC (Network average concentration in pCi/L)		
	1994	1993	1992		1994	1993	1992
^{3}H	0(85)	0(120)	5(150)	^{3}H	0(64)	0(160)	6(160)
^{89}Sr	0(0.22)	0(-0.18)	4(-0.011)	^{89}Sr	1(0.52)	1(0.008)	4(0.38)
^{90}Sr	0(0.44)	2(0.55)	5(0.65)	^{90}Sr	12(1.1)	16(1.1)	17(0.99)

Table 5.25 Radiochemical Results for Animal Samples - 1994

Sample Type	Parameter	No.	Maximum	Minimum	Median[(a)]	Standard Deviation	Median MDC ± std.dev.
Cattle Blood	$^{3}H^{(b)}$	9	201.	13.	143.	1.63	2.6 ± .61
Cattle Liver	% Ash	9	44.	1.1	1.3		
	$^{238}Pu^{(c)}$		6.3	0	2.3	3.9	8.4 ± 8.5
	$^{239+240}Pu^{(c)}$		61.*	-1.4	12.*	18.	8.5 ± 8.1
Cattle Bone	% Ash	9	48.	13.	16.		
	$^{90}Sr^{(d)}$		1.4	0.16	0.5	3.8	0.6 ± .03
	$^{238}Pu^{(c)}$		6.7*	-0.4	0.72	2.9	6.6 ± 5.4
	$^{239+240}Pu^{(c)}$		19.*	0.71	1.9	6.8	7.3 ± 5.5
Cattle Fetus	% Ash	**NO FETUS THIS YEAR**					
	$^{90}Sr^{(d)}$						
	$^{238}Pu^{(c)}$						
	$^{239}Pu^{(c)}$						
Deer Blood	$^{3}H^{(b)}$	5	2770*	3.7	40.	12.	4.4 ± 0.3
Deer Liver	% Ash	5	1.4	1.3	1.3		
	$^{238}Pu^{(c)}$		20.*	0.0019	0.025	8.8	9.7 ± 4.8
	$^{239+240}Pu^{(c)}$		1000.*	0.025	3.3	420	9.7 ± 58.
Deer Lung	% Ash	5	1.1	1.1	1.0		
	$^{238}Pu^{(c)}$		2.5	0	1.3	1.9	6.3 ± 2.4
	$^{239+240}Pu^{(c)}$		19.*	1.3	6.5*	8.2	2.0 ± 2.5

* Result is greater than the minimum detectable concentration
(a) Median used instead of mean because small number of samples and large range
(b) Units are 10^{-7} µCi/mL
(c) Units are 10^{-3} pCi/g ash
(d) Units are pCi/g ash

Table 5.25 (Radiochemical Results for Animal Samples - 1994, cont.)

Sample Type	Parameter	No.	Maximum	Minimum	Median[(a)]	Standard Deviation	Median MDC ± std.dev.
Deer	% Ash	5	1.19	1.09	1.15		
Muscle	$^{238}Pu^{(c)}$		2.7	0.8	2.2	.81	4.3 ± 3.2
	$^{239+240}Pu^{(c)}$		9.*	1.5	2.4	4.8	2.4 ± 3.7
Deer Rumen	% Ash	5	1.92	1.45	1.8		
Content	$^{238}Pu^{(c)}$		26.4*	00	1.7	12.	11.2 ± 4.7
	$^{239+240}Pu^{(c)}$		130.*	4.9	10.2*	54.	7.2 ± 2.0
Deer Bone	% Ash	5	34	30	32		
	$^{90}Sr^{(d)}$		0.96*	.29	.73*	3.8	0.67 ± .19
	$^{238}Pu^{(c)}$		-6.3	00	-1.5	3.2	2.2 ± 3.0
	$^{239+240}Pu^{(c)}$		-4.5	0.00009	1.7	2.8	2.2 ± 3.0
Chukar NTS							
Chukar Internal		1					
Organs	$^{3}H^{(b)}$	1	-130.				450.
Muscle	$^{3}H^{(b)}$	1	-63.				350.
Esmeralda Co.							
Organs	$^{3}H^{(b)}$	1	-140.				350.
Muscle	$^{3}H^{(b)}$	1	-43.				450.
Chukar NTS	% Ash	1	10				
Bone	$^{90}Sr^{(d)}$		0.64				0.73
	$^{238}Pu^{(c)}$		1.0				2.7
	$^{239+240}Pu^{(c)}$		1.2				2.7
Esmeralda Co.							
Chukar	% Ash	1	5				
Bone	$^{90}Sr^{(d)}$		0.64				.72
	$^{238}Pu^{(c)}$		3.5*				3.17
	$^{239+240}Pu^{(c)}$		17.5*				10.9

* Result is greater than the minimum detectable concentration
(a) Median used instead of mean because small number of samples and large range
(b) Units are 10^{-7} μCi/mL
(c) Units are 10^{-3} pCi/g ash
(d) Units are pCi/g ash

Table 5.26 Detectable ^{3}H, ^{90}Sr, ^{238}Pu and $^{239+240}Pu$ Concentrations in Vegetables - 1994

Vegetable	Collection Location	% Ash	^{3}H ± 1s pCi/L (MDC)	^{238}Pu ± 1s 10^{-3} pCi/g (MDC)	^{90}Sr ± 1s pCi/g ash (MDC)	$^{239+240}Pu$ ± 1s 10^{-3} pCi/g ash (MDC)
Beets	Rachel, NV	0.80	---	---	---	4.4 ± 2.2(3.0)
Apples	Adaven, NV	0.88	---	---	---	3.4 ± 1.7(2.3)
	Uhalde Rn, NV	0.84	---	3.2 ± 1.8(2.8)	---	4.2 ± 2.1(2.8)

Table 5.27 Summary of Weekly Gamma Exposure Rates as Measured by Pressurized Ion Chamber 1994

Station	Number of Weekly Averages	Gamma Exposure Rate (μR/hr) Maximum	Minimum	Arithmetic Mean	Standard Deviation	Median	mR/yr	1993 Mean (μR/hr)
Furnace Creek, CA	52	11.3	10.0	10.4	0.37	10.3	91	10.1
Shoshone, CA	52	12.0	11.0	11.4	0.28	11.3	100	12.0
Alamo, NV	52	13.4	12.6	12.9	0.18	12.9	113	12.0
Amargosa Valley, NV	50	14.5	13.9	14.1	0.19	14.0	124	14.0
Austin, NV	49	19.6	16.0	18.3	1.03	18.9	161	19.0
Beatty, NV	52	18.3	16.9	17.5	0.44	17.4	153	16.5
Caliente, NV	52	15.3	14.0	14.5	0.28	14.5	127	14.6
Complex I, NV	52	16.2	14.7	15.6	0.34	15.7	137	15.5
Ely, NV	52	14.0	12.1	13.3	0.41	13.3	117	13.4
Goldfield, NV	52	15.9	14.6	15.2	0.40	15.2	134	14.9
Indian Springs, NV	49	12.1	11.0	11.6	0.30	11.6	102	11.0
Las Vegas, NV	47	9.8	8.9	9.2	0.27	9.1	81	9.5
Medlin's Ranch, NV	48	17.0	15.1	16.0	0.54	15.9	140	15.8
Nyala, NV	52	12.6	11.8	12.0	0.15	12.0	105	11.9
Overton, NV	41	10.4	7.6	9.4	0.87	9.7	82	9.1
Pahrump, NV	49	9.1	8.1	8.8	0.25	8.9	77	7.5
Pioche, NV	52	11.7	10.9	11.3	0.19	11.3	99	11.8
Rachel, NV	51	18.8	15.4	17.1	0.78	17.0	150	16.6
Stone Cabin Ranch, NV	52	20.3	17.2	18.7	0.67	18.8	164	17.3
Tonopah, NV	50	18.5	17.1	17.9	0.39	17.9	157	17.2
Twin Springs, NV	46	18.0	16.0	16.8	0.51	16.9	147	16.6
Uhalde's Ranch, NV	52	17.4	13.7	16.7	0.78	17.0	146	16.3
Cedar City, UT	52	12.0	10.9	11.2	0.25	11.1	98	13.1
Delta, UT	52	12.6	11.5	12.0	0.20	12.0	105	11.9
Milford, UT	51	18.7	16.2	17.6	0.49	17.5	154	17.6
Salt Lake City, UT	40	11.6	9.0	10.3	0.66	10.3	90	10.6
St. George, UT	46	8.9	8.0	8.3	0.25	8.2	73	8.3

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

Table 5.28 EG&G/EM Boundary Line Monitoring Data - 1994

Facility: EG&G - Remote Sensing Laboratory/Nellis

Station ID#	Description	1st Qtr. (mR)	2nd Qtr. (mR)	3rd Qtr. (mR)	4th Qtr. (mR)	CY-94 (mR)
RS-022	Southeast Fence--Near Gate	27.3	25.0	21.3	23.7	97.3
RS-023	Southeast Fence--Near Gate	26.7	25.0	21.6	23.3	96.6
RS-024	South Fence--Center	25.3	23.6	19.6	22.0	90.5
RS-025	South Fence--Center	24.7	22.3	19.3	20.7	87.0
RS-026	Southwest Fence--Near Gate	21.3	19.6	16.6	17.3	74.8
RS-027	Southwest Fence--Near Gate	22.0	20.6	16.6	17.7	76.9
RS-028	Northwest Fence--Near Gate	22.7	19.6	17.0	18.0	77.3
RS-029	Northwest Fence--Near Gate	21.7	20.6	16.6	17.3	76.2
RS-030	North Fence--Center	25.3	22.3	20.3	21.7	89.6
RS-031	North Fence--Center	26.7	24.0	20.3	21.7	72.7
RS-032	Northeast Fence--Near Corner	21.3	19.0	16.0	17.0	73.3
RS-033	Northeast Fence--Near Corner	21.0	19.0	17.6	32.0	89.6
RS-098	Control - 1	18.3	17.0	13.6	23.0	71.9
RS-099	Control - 2	18.0	17.3	14.0	13.7	63.0

Facility: EG&G - Atlas/Las Vegas

Station ID#	Description	1st Qtr. (mR)	2nd Qtr. (mR)	3rd Qtr. (mR)	4th Qtr. (mR)	CY-94 (mR)
LV-055	Northwest Corner Fence/Gate C6	25.3	24.0	20.3	21.7	91.3
LV-056	Northwest Corner Fence/Gate C6	26.3	23.3	20.6	21.3	91.5
LV-057	North Fence--West End A-12	23.3	21.6	18.0	20.3	83.2
LV-058	North Fence--West End A-12	24.5	21.0	18.3	20.7	84.5
LV-059	North Fence--West End A-4	24.0	21.0	18.6	20.0	83.6
LV-060	North Fence--West End A-4	22.7	21.3	19.3	19.7	83.0
LV-061	Northeast Corner Fence/A-12	22.0	20.3	21.3	18.3	81.9
LV-062	Northeast Corner Fence/A-12	20.3	19.0	17.3	18.0	74.6
LV-063	East Fence/Center A-Complex	22.0	20.0	17.0	18.3	77.3
LV-064	East Fence/Center A-Complex	21.7	19.6	17.0	18.7	77.0
LV-065	NLV Badge Off (A-7)/A-2	21.3	18.6	21.6	18.3	79.8
LV-066	NLV Badge Off (A-7)/A-2	21.3	18.6	21.3	26.0	87.2
LV-067	East Fence/North End B-Complex	23.3	20.0	16.0	18.7	78.0
LV-068	East Fence/North End B-Complex	22.3	21.0	17.3	19.3	79.9
LV-069	East Fence/South End B-Complex	22.0	21.3	18.0	19.7	81.0
LV-070	East Fence/South End B-Complex	22.3	21.6	18.6	19.3	81.8
LV-071	South Fence/Center/Next to Sub	23.3	21.3	18.6	19.3	82.5
LV-072	South Fence/Center/Next to Sub	24.0	21.0	18.3	20.0	83.3
LV-073	Southwest Corner/Gate C-1	23.0	21.0	18.0	19.3	81.3
LV-074	Southwest Corner/Gate C-1	22.7	21.0	18.6	19.7	82.0
LV-075	C-1 West End Guard Gate	26.7	25.0	21.6	23.3	96.6
LV-076	C-1 West End Guard Gate	27.0	24.3	22.3	23.0	96.6
LV-077	West Fence/Gate C-3	23.3	21.3	19.0	20.0	83.6
LV-078	West Fence/Gate C-3	23.0	21.6	19.3	20.3	84.2
LV-079	Northwest End A-13/Double G	23.7	21.6	19.0	20.3	84.6
LV-O80	Northwest End A-13/Double G	24.3	21.6	19.3	20.0	85.2
LV-098	Control - 1	18.7	15.6	13.0	13.7	61.0
LV-099	Control - 2	17.7	15.6	14.0	14.0	61.3

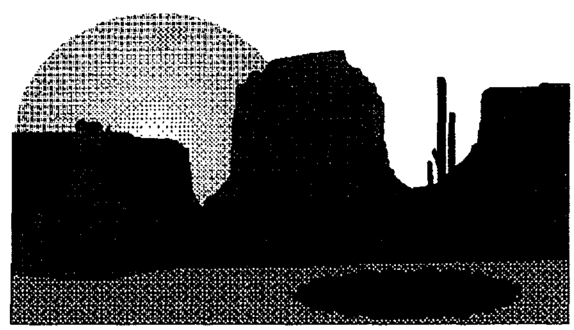
Table 5.28 (EG&G/EM Boundary Line Monitoring Data - 1994, cont.)

Facility: EG&G - Santa Barbara

Station ID#	Description	1st Qtr. (mR)	2nd Qtr. (mR)	3rd Qtr. (mR)	4th Qtr. (mR)	CY-94 (mR)
SB-001	Building 130--Northwest Column	30.3	27.0	27.6	28.3	113.2
SB-002	Building 130--Northwest Column	32.0	27.3	29.0	27.7	116.0
SB-003	Building 130--North Center Column	33.3	28.3	29.0	29.7	120.3
SB-004	Building 130--North Center Column	32.3	28.0	29.6	28.3	118.2
SB-005	Building 130--North Fence Opp Comp	30.3	27.6	29.6	30.0	117.5
SB-006	Building 130--North Fence Opp Comp	32.0	27.0	29.3	29.7	118.0
SB-007	Building 130--South Fence Near FCP	32.3	29.0	29.3	31.3	121.9
SB-008	Building 130--South Fence Near FCP	34.3	27.6	31.3	30.0	123.2
SB-009	Building 130--South Fence APP Center	33.7	27.6	29.3	31.0	121.6
SB-010	Building 130--South Fence APP Center	33.0	28.3	30.0	30.3	121.6
SB-011	Building 130--South Fence APP Center	33.0	28.3	29.3	30.0	120.6
SB-012	Building 130--Southeast Fence by Dump	32.7	28.3	30.6	31.0	122.6
SB-013	Building 130--North Fence Canopy	32.3	30.3	31.3	33.0	126.9
SB-014	Building 130--North Fence Canopy	32.0	27.0	29.0	58.0	146.0
SB-015	Building 131--Driveway Gate	*	30.0	29.6	29.6	*
SB-016	Building 131--Driveway Gate	32.0	39.3	29.6	29.7	130.6
SB-017	Building 131--Corner East Fence	37.7	28.6	31.3	31.7	129.3
SB-018	Building 131--Corner East Fence	35.0	29.0	30.6	31.3	125.9
SB-019	Building 131--East Fence Opp X-ray	33.3	28.0	29.6	26.7	117.6
SB-020	Building 131--East Fence Opp X-ray	32.0	28.3	31.3	30.3	121.9
SB-021	Building 131--East Fence Opp 90'	40.0	34.3	35.3	29.0	138.6
SB-022	Building 131--East Fence Opp 90'	36.7	32.6	36.3	30.0	135.6
SB-023	Building 131--Southeast Fence Top Steps	33.0	28.3	31.3	29.0	121.6
SB-024	Building 131--Southeast Fence Top Steps	32.7	46.3	29.3	29.3	137.6
SB-025	Building 131--Southeast Fence Corner	31.0	27.0	29.6	29.0	116.6
SB-026	Building 131--Southeast Fence Corner	31.3	27.0	27.3	28.7	114.3
SB-027	Building 131--South Fence Shed	33.7	30.7	30.0	28.7	123.1
SB-028	Building 131--South Fence Shed	31.3	28.3	29.6	29.3	118.5
SB-029	Building 226--West Fence	30.0	27.3	29.0	29.3	115.6
SB-030	Building 226--West Fence	31.0	26.0	28.3	28.0	113.3
SB-031	Building 229-C--West Fence Left GT	*	30.3	33.6	34.3	*
SB-032	Building 229-C--West Fence Left GT	32.0	31.3	32.3	37.7	133.3
SB-033	Building 227--East Fence	35.7	39.0	49.0	36.3	160.0
SB-034	Building 227--East Fence	36.3	28.0	38.3	35.7	138.3
SB-035	Building 227--East Fence Northeast Corner	31.3	26.6	29.3	28.0	115.2
SB-036	Building 227--East Fence Northeast Corner	32.0	28.0	29.0	27.7	116.7
SB-037	Building 227--Northeast Corner Step	31.7	27.6	27.6	28.3	115.2
SB-038	Building 227--Northeast Corner Step	31.0	27.3	29.0	33.7	121.0
SB-039	Building 227--Northeast Fence	31.0	28.6	26.6	30.7	116.9
SB-040	Building 227--Northeast Fence	30.7	27.6	27.3	30.3	115.9
SB-041	Building 227--Behind CF Shed	32.0	27.6	30.0	32.7	122.3
SB-042	Building 227--Behind CF Shed	31.7	28.6	29.0	32.3	121.6
SB-043	Building 227--East Fence Center	32.3	28.6	28.6	28.3	117.8
SB-044	Building 227--East Fence Center	32.3	29.0	28.3	28.7	118.3
SB-045	Building 227--Southeast Fence Corner	31.7	28.3	30.6	29.3	119.9
SB-046	Building 227--Southeast Fence Corner	32.7	28.0	29.3	29.3	119.3
SB-208	Building 227--Rear of Fence	33.7	32.6	31.3	33.3	130.9
SB-209	Building 231--Rear of Fence	32.3	32.0	32.3	33.0	129.6
SB-300	South Fence Near Eye Wash	32.7	*	31.0	30.0	*
	Control - 1	*	23.0	*	*	*
	Control - 2	*	30.3	*	*	*

* Not available, missing data

Dose Assessment



6.0 DOSE ASSESSMENT

The extensive offsite environmental surveillance system operated around the NTS by EPA/EMSL-LV measured no radiation exposures that could be attributed to recent NTS operations. The potential Effective Dose Equivalent (EDE) to the maximally exposed offsite resident (MEI) was calculated to be 0.15 mrem (1.5×10^{-3} mSv) to a hypothetical resident of Amargosa Valley, NV located 42 km (26 mi) SW of Control Point 1 (CP-1), on the NTS. This value was based on onsite source emission measurements, estimates provided by DOE, and calculated resuspension data input to EPA's CAP88-PC model. The calculated population dose (collective effective dose equivalent) to the approximately 33,740 residents living within 80 km (50 mi) from each of the NTS airborne emission sources was 0.52 person-rem (5.2×10^{-3} person-Sv). Monitoring network data indicated a 1994 exposure to the MEI of 124 mrem (1.24 mSv) from normal background radiation. The calculated dose to this individual from world-wide distributions of radioactivity as measured from surveillance networks was 0.015 mrem (1.5×10^{-4} mSv). An EDE of 5×10^{-4} mrem (5×10^{-6} mSv) was included that would be received if edible tissues from a contaminated deer collected on the NTS were to be consumed. All of these maximum dose estimates, excluding background, are <1 percent of the most restrictive standard.

6.1 ESTIMATED DOSE FROM NEVADA TEST SITE ACTIVITIES

The potential Effective Dose Equivalent (EDE) to the offsite population due to NTS activities is estimated annually. Two methods are used to calculate 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 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 PIC network provides a measurement of background gamma radiation in the offsite area.

There are four pathways of possible radiation exposure to the population of Nevada that were monitored by EPA's offsite monitoring networks during 1994. These four pathways were:

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

- Worldwide distributions of manmade radioactivity, such as ^{90}Sr in milk, ^{85}Kr in air, and plutonium in soil.

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

- 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 treated in Section 6.1.2 below.

6.1.1 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 radioiodine. These are estimates of releases made at the point of origin. Meteorological data collected by the Special Operations and Research Division, Air Resources Laboratory (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 Amargosa Valley, Nevada, 42 km (26 mi) SE of CP-1. The maximum dose to that individual would be 0.15 mrem (1.5×10^{-3} mSv). For comparison, data from the PIC monitoring network indicated a 1994 dose of 124 mrem (1.24 mSv) from background gamma radiation occurring in Amargosa Valley. The population living within a radius of 80 km (50 mi) from the airborne sources on the NTS was estimated to be 33,740 individuals, based on 1994 data. The collective population dose within 80 km (50 mi) from each of these sources was calculated to be 0.52 person-rem (5.2×10^{-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, 0.15 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 32 times the annual average measured plutonium in air in Amargosa Valley. Table 6.1 summarizes the annual contributions to the EDEs due to 1994 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 include meteorological data from ARL/SORD and effluent release data reported by DOE. The effluent 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 so the model results are considered over-estimates of the dose to offsite residents. This was confirmed by use of the offsite monitoring results.

6.1.2 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 1994. Actual results obtained in analysis are used; the majority of which are less than the reported Minimum Detectable Concentration (MDC).

Data quality objectives 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 or weight. 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 meat and vegetables through storage and cooking.

- Adult respiration rate = 8400 m^3/yr (ICRP 1975)
- Milk intake (average for 20 and 40 yr old) = 110 L/yr (ICRP 1975)
- Consumption of beef liver = 0.5 lb/wk (11.5 kg/yr)
- An average deer has 100 lb (45 kg) of meat
- Water consumption = 2 L/day (ICRP 1975)
- Fresh vegetable consumption = 516 g/day (1.1 lb/day) for a four-month growing season (ICRP 1975). For the beets and apples used herein, assume 129 g/day each.

The Effective Dose Equivalent (EDE) conversion factors are derived from EPA-520/1-88-020 (Federal Guidance Report No. 11). Those used here are:

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

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

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

The dose from consumption of a mule deer collected on the NTS is included in Table 6.2. The individual CEDEs from the various pathways added together give a total of 0.015

mrem/yr. The additional dose from ingestion of deer meat and liver containing the $^{239+240}Pu$ activities given in Table 6.2 would be:

$$\{[(2.8 \times 10^{-2} \text{ pCi/kg}) \times (45 \text{ kg meat})] + [(4.3 \times 10^{-2} \text{ pCi/kg}) \times (0.28 \text{ kg liver})]\} \times (3.7 \times 10^{-4} \text{ mrem/pCi}) = 4.7 \times 10^{-4} \text{ mrem}$$

The weight of the liver (280 g) used in the above equation is the median weight of the livers from the three mule deer obtained in 1993 (not measured in 1994).

Total EDEs can be calculated based on different combinations of data. If an individual were interested in just one area, for example, the concentrations from those stations closest to that area could be substituted into the equations used herein.

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, uranium and thorium daughters), 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 0.29 pCi/m^3. With a dose conversion factor for inhalation of 2.6×10^{-7} mrem/pCi, and an annual breathing volume of 8400 m^3/yr, this equates to a dose of 6.3×10^{-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 164 mR/year, depending on location.

6.3 SUMMARY

The extensive offsite environmental surveillance system operated around the NTS by EPA's EMSL-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. Calculation with the CAP88-PC model, using estimated or calculated effluents from the NTS during 1994, resulted in a maximum dose of 0.15 mrem (1.5×10^{-3} mSv) to a hypothetical resident of Amargosa Valley, NV, 3 km (1.9 mi) SE of the NTS boundary. Based on monitoring network data, this dose is calculated to be 0.015 mrem. This latter EDE is about 10% 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 effective dose equivalent for the general public not exceed 100 mrem/yr (ICRP 1985). The calculated population dose (collective effective dose equivalent) to the approximately 33,740 residents living within 80 km (50 mi) of each of the NTS airborne emission sources was 0.52 person-rem (5.2×10^{-3} person-Sv). Background radiation would yield a CEDE of 3210 person-rem (32.1 person-Sv).

Data from the PIC gamma monitoring indicated a 1994 dose of 124 mrem from background gamma radiation measured in Amargosa Valley. 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 124 mrem exposure level is approximately 5 percent. Extrapolating to the calculated annual exposure at Amargosa Valley, Nevada, yields a total uncertainty of approximately 6 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 Data Quality Objectives (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 during 1994

	Maximum EDE at NTS Boundary[(a)]	Maximum EDE to an Individual[(b)]	Collective EDE to Population within 80 km of the NTS Sources
Dose	0.157 mrem (1.6×10^{-3} mSv)	0.15 mrem (1.5×10^{-3} mSv)	0.52 person-rem (5.2×10^{-3} person-Sv)
Location	Site boundary 39 km SW of NTS CP-1	Amargosa Valley 42 km SW of NTS CP-1	33,740 people within 80 km of NTS Sources
NESHAP[(c)] Standard	10 mrem per year (0.1 mSv per yr)	10 mrem per year (0.1 mSv per yr)	-----
Percentage of NESHAP	1.6	1.5	-----
Background	124 mrem (1.2 mSv)	124 mrem (1.2 mSv)	3210 person-rem (32.1 person Sv)
Percentage of Background	0.13	0.12	0.016

(a) The maximum boundary dose is to a hypothetical individual who remains in the open continuously during the year at the NTS boundary located 39 km (24 mi) 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

Medium	Radionuclide	Concentration	mrem\year	Comment
Animals				
Beef Liver	$^{239+240}Pu$	1.56×10^{-1} (5.8×10^{-3})[(a)]	6.6×10^{-4}	Concentrations are the median for each tissue type
Deer Muscle	$^{239+240}Pu$	2.8×10^{-2} (1.0×10^{-3})[(a)]	4.7×10^{-4}	
Deer Liver	$^{239+240}Pu$	4.3×10^{-2} (1.6×10^{-3})[(a)]	4.4×10^{-6}	

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

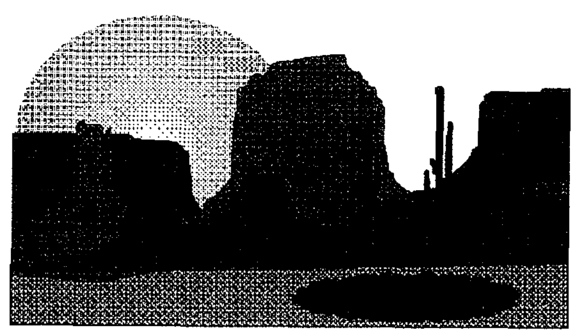
Table 6.2 (Monitoring Networks Data used in Dose Calculations, cont.)

Medium	Radionuclide	Concentration	mrem\year	Comment
Milk	^{90}Sr	0.44 (0.016)$^{(b)}$	6.8×10^{-3}	Concentration is the average of all network results
	^{3}H	85 (3.1)$^{(b)}$	6.0×10^{-4}	Concentration is the average of all network results
Drinking Water	^{3}H	1.4 (0.05)$^{(b)}$	6.5×10^{-5}	Concentration is the average from Amargosa Valley Well
Vegetables				
Beets	$^{239+240}Pu$	3.5×10^{-2} $(1.3 \times 10^{-3})^{(a)}$	2.1×10^{-4}	Observed concentrations
Apples	$^{239+240}Pu$	3.3×10^{-2} $(1.2 \times 10^{-3})^{(a)}$	2.0×10^{-4}	
	^{238}Pu	2.7×10^{-2} $(1.0 \times 10^{-13})^{(a)}$	1.6×10^{-4}	
Air	^{3}H	0.2 (0.007)$^{(c)}$	1.6×10^{-4}	Concentrations are average or median network results
	^{7}Be	0.29 (0.011)$^{(c)}$	6.3×10^{-4}	
	^{85}Kr	29 (1.1)$^{(c)}$	4.4×10^{-4}	
	$^{239+240}Pu$	1.8×10^{-6} $(6.7 \times 10^{-8})^{(c)}$	4.7×10^{-3}	

TOTAL (Air = 5.9×10^{-3}, Liquids = 7.5×10^{-3}, Veg. = 5.7×10^{-4}, Meat = 1.1×10^{-3}) = 1.5×10^{-2} mrem/yr

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

Nonradiological Monitoring Results



7.0 NONRADIOLOGICAL MONITORING RESULTS

Nonradiological monitoring of 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 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) environmental media for hazardous characteristics and constituents. Flora, fauna, and other environmental conditions were also monitored for population trends and impacts.

7.1 ENVIRONMENTAL SAMPLES

7.1.1 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 Safe Drinking Water Act and state of Nevada regulations. Samples were taken at various locations throughout all drinking water distribution systems on the NTS by Reynolds Electrical & Engineering Co., Inc. (REECo). Common sampling points were rest room 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 (NAC) 445 and 40 C.F.R. Part 141.

7.1.1.1 BACTERIOLOGICAL SAMPLING

From January through November, samples were analyzed for coliform bacteria by the REECo Analytical Services Department's (ASD) Analytical Chemistry Laboratory. Beginning in December 1994 coliform samples were submitted to the state-approved Associated Pathologists Laboratories in Las Vegas, Nevada. 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 1994.

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

Sample results for 1994 for coliform and RC are given in Table 7.1, along with applicable state of Nevada permit numbers. The RC results are paired with the coliform results from each specific sample. The RC results were all within state permit limits.

Samples from each truck which hauled potable water from NTS wells to work areas were analyzed for coliform bacteria. One truck sample in February 1994 tested positive, so the truck was taken out of service until it had been super-chlorinated and four successive samples tested negative.

7.1.1.2 Chemical Analysis

Chemical analysis in 1994 consisted of: (1) volatile organic compounds (VOCs), (2) resampling for water quality constituents in wells found to exceed the Maximum Concentration Levels (MCL) in 1993, and (3) nitrate levels from Well 4.

VOLATILE ORGANIC COMPOUND ANALYSIS

Samples for VOCs were collected during December 1994 from all NTS potable water wells. The samples were analyzed by a state approved laboratory. None of the results for VOCs were above quantitation limits.

INORGANIC COMPOUND ANALYSIS AND WATER QUALITY

Samples for inorganic compounds and water quality were collected in accordance with 40 C.F.R. 141.11 and NAC 445 in September 1993 by the state inspector. The analytical results for these samples indicated that some state Secondary Standards were exceeded. These exceedances were not a health threat. Each of the wells with exceedances were sampled three additional times in 1994 to assess the validity of the 1993 sample. These resampling results are given in Table 7.2.

The nitrate sample collected for Well 4 during 1993 did not exceed the MCL; however, because it was over 50 percent of the MCL the well must be sampled for four quarters. This resampling will not be completed until 1995, but all samples collected in 1994 were under the MCL.

7.1.2 CLEAN WATER ACT

7.1.2.1 NTS OPERATIONS

The four state of Nevada sewage lagoon system operating permits were replaced by one general permit in January 1994. The sampling and measurements for pH, flow rate, biochemical oxygen demand (BOD), and total dissolved solids (TDS) that were required by the previous individual permits were taken in January, and are shown in Table 7.3. The new general permit requires quarterly reporting for BOD, Specific Conductance (SC), organic loading rates, and water depths in infiltration basins. It also requires reporting of annual influent toxics sampling. The results of this sampling are shown in Tables 7.4 to 7.7 respectively. All values in these tables are in compliance with the permit requirements.

A water pollution control permit was issued for the U-12n Tunnel discharge effective November 12, 1992. This permit requires quarterly monitoring and reporting. In the first quarter of 1994 there was still measurable flow, as reported in Table 7.8. Due to insufficient or no flow, no effluent constituent sampling was required during 1994.

7.1.2.2 NON-NTS SAMPLING RESULTS

Only the EG&G/EM, Las Vegas Area Operation (LVAO), including the North Las Vegas Operation and the Remote Sensing Laboratory, was required by permit to sample and analyze wastewater effluent and submit monitoring reports. Effluent monitoring demonstrated that LVAO operations were in compliance with the limits specified in its permit.

7.1.3 NON-HAZARDOUS SOLID WASTE DISPOSAL

Monitoring of the three sanitary landfills was limited to recording daily refuse amounts by weight. The state has no permit system for these but did approve the Operation & Maintenance manuals. All waste disposed of in the Area 23 landfill was weighed at the Gate 100 weighing station. All waste disposed of in 10c Crater (Area 9) was weighed right at the landfill on a new weighing station. About 20,160 tons of waste were disposed of in the Areas 6, 9, and 23 sanitary landfills as shown in Table 7.9.

7.1.4 TOXIC SUBSTANCES CONTROL ACT (TSCA)

During 1994, a total of 358 samples were analyzed for PCBs. All but seven of the PCB samples were analyzed at the REECo ASD Analytical Chemistry Laboratory. The last seven samples of the year were sent to an accredited outside laboratory when the REECo Analytical Chemistry Laboratory was directed by DOE/NV to quit analyzing samples after November 15, 1994. All the 1994 PCB sample results were either nondetectable or less than five parts per million.

7.1.5 NATIONAL EMISSION STANDARDS FOR HAZARDOUS AIR POLLUTANTS

During 1994, 1976 bulk or general air samples were collected and analyzed in conjunction with asbestos removal and renovation projects at the NTS. Of the 1833 bulk samples collected, 415 were positive for asbestos and 1418 were negative. A total of 143 general area air samples were collected and analyzed for asbestos. Twenty-seven (27) samples were positive, while the remaining 116 were negative.

7.1.6 RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)

A total of 5568 chemical analyses were performed in 1994 in support of waste management and environmental compliance activities at the NTS. Table 7.10 gives a breakdown of these analyses by matrix and analysis type. Approximately 90 percent of these analyses were performed onsite at the REECo Analytical Laboratory.

7.1.7 SPECIAL STUDIES

Eight series of tests, involving 22 different chemicals were conducted at the Liquified Gaseous Fuels Spill Test Facility (LGFSTF) in 1994. Pursuant to the agreement between LGFSTF and the state of Nevada, the EPA is invited to participate in spill test panels and field monitoring.

7.2 ECOLOGICAL CONDITIONS

Monitoring of flora and fauna on the NTS was conducted by the DOE/NV-sponsored Basic Environmental Compliance and Monitoring Program (BECAMP). Activities included measurements on annual and perennial plants, reptiles, rodents, deer, and feral horses. Trends in plant and animal populations were determined on an annually monitored baseline site and several disturbed sites monitored on a multiyear schedule. Larger animals and birds were monitored sitewide. Major findings from this monitoring are discussed below. As in previous years, complete results and analyses will be presented in an annual report (Hunter 1994).

7.2.1 FLORA

Perennial plants were examined on five above-ground test areas in Yucca Flat. Three were last sampled in 1991, and two in 1990. The vegetation on the five sites varied considerably, as did changes since the last evaluation. Two sites showed either no growth or reduction in cover. T1 and T3 test areas in central Yucca Flat continued to show minimal cover (<1 percent, 6.9 and 0.4 m^3/ha respectively) of the bunchgrass *Oryzopsis hymenoides* (Indian rice grass). On T3 previously observed scattered plants of *Mirabilis pudica*, a rhizomatous herb that dies annually to ground level, have disappeared. A few plants of *Viguiera multiflora*, another short lived herbaceous plant, were found on T1. This species has been increasing on NTS roadsides and is evidently also invading the blast areas.

T4 test area was dominated by a sparse population of the shrub *Hymenoclea salsola*, (cheese bush). Growth of that species and the herb *Sphaeralcea ambigua* (desert mallow) increased shrub live volume to a value near that of the control area (426.5 versus 469.4 m^3/ha). This is due in part to the loss of live volume in the control area from the drought in recent years.

T2 test area, in the Northwestern corner of Yucca Flat, had no live plants in 1990, but in 1994 there were 34 new *Chrysothamnus nauseosus* (rubber rabbitbrush) shrubs and one new *Hymenoclea salsola* on a 100 m^2 transect. Total live perennial plant volume was only six percent of control volume (35.2 versus 569.9 m^3/ha), but represented a significant increase over the 1990 census. Germination of *C. nauseosus* is a significant event in the recovery of vegetation on the T2 test area.

The Sedan cratering test of July 1962 resulted in removal of vegetation within a radius of about 4500 feet from the blast site. Early reports (Martin 1963) indicated differential recovery in the area scoured free of vegetation (outside 2500 feet) and the inner ring buried by earth thrown out of the crater. Perennial plant transects were censused at 1000, 3000, and 5000 feet to determine changes since 1991 in the throw-out zone, blast zone, and control respectively.

At 1000 feet germination of the bunchgrass *Oryzopsis hymenoides* increased plant numbers from 96 to 396 per 100 m^2. Total live volume increased from 4.5 to 23.6 m^3/ha, which was near the value in 1988 (Hunter 1992). Other bunchgrasses also increased slightly in number with *Sitanion jubatum* increasing from 0 to 3 and *Stipa speciosa* from 7 to 10 plants per 100 m^2. Grasses at this distance first appeared between 1976 and 1983 (Romney et al. 1985), and the 1994 data indicate a slow increase in numbers but continued absence of shrubs.

At 3000 feet numbers of perennial plants decreased from 116 to 108 per 100 m^2, primarily due to death of *Oryzopsis hymenoides.* Live volume increased from 341 to 586 m^3/ha (72 percent), dominated by the shrub *Hymenoclea salsola* (526 m^3/ha). The death of *Oryzopsis hymenoides* and its failure to increase as observed at 1000 feet can be attributed to competition with the *Hymenoclea salsola*. Total live volume was 60 percent of control volume, indicating good ecosystem functional recovery at this distance. Species present were largely limited to those common to disturbed areas.

The control transect at 5000 feet increased in live volume from 816 to 973 m^3/ha (+19 percent). It was dominated, as in the past, by *Coleogyne ramosissima* (blackbrush - 709 m^3/ha), but *Hymenoclea salsola* increased from 10.8 to 74.8 m^3/ha (+692 percent), indicating recent weather patterns have favored *Hymenoclea salsola*. There were only four bunchgrasses in the control transect, much reduced from censuses from 1965 through 1988 (measured at 4500 feet rather than 5000 through 1983), and attributable to drought kill in 1989-90. Competition with established shrubs was the likely cause of the failure of bunchgrasses to reestablish at this location.

The baseline site (YUF001) in Southwestern Yucca Flat declined in perennial numbers from 245 to 195 per 100 m^2, and in volume from 1917 to 1826 m^3/ha, associated with reduced rainfall in 1994. The decline in numbers was primarily in herbaceous species, though 7 of 16 seedlings of the small shrub *Artemisia spinescens* also died. Major volume changes were associated with dieback of *Atriplex canescens* (fourwing saltbush, -21 percent), which fruited heavily in 1993, and increases in some dominant long-lived shrubs (*Grayia spinosa* +14 percent and *Lycium andersonii* +21 percent). Based on an equation correlating rainfall at this site with precipitation (Hunter 1994), predicted total volume should have been 1803 m^3/ha, 1 percent less than was measured.

Ephemeral plant numbers were reduced in 1994 compared to 1993 on the YUF001. Baseline plot density was 112/m^2 in 1994 versus 1762/m^2 in 1993, while biomass was reduced to 1.6 versus 18 g/m^2. Except for T2 ephemeral densities were considerably higher on the blast areas than on the control plots (ranging from 3 to 22 times higher, with a maximum of 1372/m^2 on T3). Biomass ranged from 4 to 17 times higher (maximum 48 g/m^2 on T2). The one blast area with ephemeral plant populations approximately equal to its control's was T4, where shrub volume was nearly equal to its control. These data support the hypothesis that shrub removal enhances ephemeral growth and production. Introduced species made up 78 to 100 percent of the measured densities with a median of 96 percent for the sites discussed above.

7.2.2 FAUNA

In 1994 three sets of tower blast sites and their controls were examined. Each set consisted of a blast area plot and a nearby control plot. The T3 set also included a plot that had been partially revegetated by planting. Results of these studies are summarized for each taxon below.

7.2.2.1 REPTILES

Reptile studies on the NTS focus on the side-blotched lizard (*Uta stansburiana*) which is both widespread and abundant enough for analysis. Monitoring on the Yucca Flat baseline plot

(YUF001) continued to show no long term trend in side-blotched lizard numbers. This suggests that indirect effects of DOE operations have not deleteriously affected lizards in this area.

Examination of blast sites revealed large differences between these sites and their nearby controls even though the blasts took place 38 years ago. Blast sites were not consistent in response, with distributions of side-blotched lizards on the T3 blast site more similar to those on the T3 control than blast and control plots at the other locations. The overall pattern is for control plots to contain more side-blotched lizards than blast sites in the spring, but have similar numbers by summer. Blast sites contained as little as 10 percent of control plot densities. Snout-vent length, weight and age differences between blast and control plots suggest blast sites were occupied by adult side-blotched lizards, while the control plots contain a mixture of young and adults. This implies that it is hard for younger side-blotched lizards to become established or persist on blast sites relative to control areas. Qualitatively similar results were obtained from plots near Sedan Crater, another blast site where radioactive material was vented into the air, and the ground was cleared of vegetation by the blast. These results suggest that vegetative removal and/or release of radioactive material into the air may have very long term effects on lizard populations.

7.2.2.2 SMALL MAMMALS

Small mammals were trapped at two baseline sites, five blast areas, a gopher-denuded area, a fenced site, and a revegetated site. Trapping at the eight disturbance sites included adjacent undisturbed controls. Rodent samples were also taken around townsites and populated areas, and in some remote areas, to collect blood samples for hantavirus analysis. In addition blood samples were taken from rodents captured above buried low-level radioactive waste to check for tritium and gamma-emitting radionuclides.

Numbers of small mammals living on the Yucca Flat baseline site (YUF001) increased slightly from 1993. The chisel-toothed kangaroo rat *(Dipodomys microps)* was the most common species, outnumbering the next most common, Merriam's kangaroo rat *(Dipodomys merriami)* by almost three to one. Results for the baseline site in Frenchman Flat indicate that the small mammal community there has returned to pre-drought numbers. Similar conclusions may be made concerning rodents in a previously irradiated fenced plot and control in Rock Valley. Blast areas from above-ground testing in the 1950's continued to show little recovery in small mammal biota. Number and diversity of species were consistently lower on the blast areas than on controls. The lack of shrub cover clearly favored the presence *of Dipodomys merriami* over any other species. Three sites at different distances from the Sedan Crater showed an inverse relationship between distance from the crater (decrease in impact) and *Dipodomys merriami* density. There was a direct relationship between distance and species diversity.

Revegetation (in 1989) of a site in eastern Yucca Flat has aided recovery of rodents. In 1988 only eleven rodents were captured compared to 64 in 1994.

Seventeen *Dipodomys merriami* and three *Ammospermophilus leucurus* (antelope ground squirrels) were captured at the Area 5 Low Level Radioactive Waste Burial site. Blood samples were taken and analyzed for tritium and gamma-emitting radionuclides. Nineteen of the twenty rodents had tritium levels above detection limits. *D. merriami* showed the highest levels, but no pattern emerged correlating location of capture, age, or size of animal. Two kangaroo rats had ^{137}Cs and one had ^{212}Pb at levels near detection limits.

7.2.2.3 LARGE MAMMALS AND BIRDS

During 1994 horses were located by driving roads and hiking into selected areas on foot in northern areas of the NTS. Fifty-six adult horses remained in the population by the fall of 1994, a reduction of about 7 individuals from 1993. Three of seven foals were known to survive through the fall. One foal carcass was located in July of 1994, the apparent victim of a mountain lion.

Four fresh horse scats were collected and analyzed for tritium. Low levels of tritium were present in all four horses with an average value of approximately 5580 pCi/L of moisture (range 2550 - 8410 pCi/L).

Grass samples were collected for tritium analysis from random locations within the NTS horse range. Ten of eleven grass samples contained detectable tritium. Nine of the samples, excluding a sample from near Sedan Crater, averaged about 3890 pCi/L of moisture (range 1690 - 7000 pCi/L), roughly equivalent to the tritium activity found in the horse scats. The Sedan Crater sample measured 1,150,000 pCi/L. These data suggest that horses are ingesting small quantities of tritium through grazing and not from drinking at contaminated ponds, as was previously postulated. Currently E tunnel pond is the only tritium contaminated drinking water source potentially available to horses, but at present there is no evidence that horses use this pond.

Three nights of spotlighting for deer were performed during October 1994 on Pahute and Rainier Mesas. Mean sighting rates dropped about 50 percent below 1993 levels, possibly attributable to drier conditions in 1994 and/or closure of three well reservoirs normally used by deer as water sources.

Raptors were censused by road surveys along pole-lines on Frenchman and Yucca Flats. Raven nest locations on Frenchman and Yucca Flats were monitored for occupancy and production of nestling and fledgling birds.

7.2.3 HANTAVIRUS

Four areas of high human population and four areas away from most worker activity were sampled in 1994 for the presence of hantavirus antibodies. Blood samples were drawn from all *Peromyscus* and related species (i.e. Muridae family) and representative individuals of other rodent species (*Heteromyids* and ground squirrels). Four of 31 *Peromyscus maniculatus* (deer mice) were positive, but none of 54 samples from other species showed evidence of hantavirus infection. The occurrence of deer mice carrying the virus corresponded to the distribution of *Peromyscus maniculatus* abundance, based on BECAMP trapping results for the last eight years. *Peromyscus* from the southern two-thirds of the NTS had not been exposed or were not carriers. It is likely that the virus is present throughout the NTS but that densities are so low in some areas that occurrence and transmission between rodents is low.

Sample size of the hantavirus study was low due to the lower density of *Peromyscus* in 1994, after unusually high densities in 1993. An example of the decrease in deer mouse density was the Area 19 site PAM007. The density of deer mice at PAM007 decreased from 52/ha in 1993 to 16/ha in 1994. In 1993, four of 17 were seropositive for hantavirus (23 percent) while in 1994 three of 21 were (14 percent). Results suggest the prevalence of hantavirus on the NTS varies both spatially and temporally.

Table 7.1 Monthly Monitoring Results for NTS Potable Water Systems - 1994[a]

Area	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
PERMIT NY-360-12C												
Area 22												
RC	0.6	0.5	0.8	1.1	1.0	1.0	1.0	1.0	1.0	1.0	0.5	0.6
Coliform	0	0	0	0	0	0	0	0	0	0	0	0
Area 23												
RC	0.9	1.0	0.9	1.1	1.0	2.0	2.5	2.5	1.0	2.0	1.0	0.8
Coliform	0	0	0	0	0	0	0	0	0	0	0	0
RC	0.9	1.0	0.9	1.1	1.0	1.0	2.5	1.0	1.0	2.0	1.0	0.8
Coliform	0	0	0	0	0	0	0	0	0	0	0	0
RC	0.9	1.0	0.9	1.1	1.4	.08	2.0	1.0	1.0	2.0	1.0	0.8
Coliform	0	0	0	0	0	0	0	0	0	0	0	0
RC	--	--	--	--	1.4	.08	1.0	0.5	--	--	--	--
Coliform	--	--	--	--	0	0	0	0	--	--	--	--
RC	--	--	--	--	--	--	1.0	--	--	--	--	--
Coliform	--	--	--	--	--	--	0	--	--	--	--	--
RC	--	--	--	--	--	--	1.0	--	--	--	--	--
Coliform	--	--	--	--	--	--	0	--	--	--	--	--
Area 23 Fill Stand												
RC	--	--	--	--	--	--	--	--	--	--	--	--
Coliform	--	--	--	--	--	--	--	--	--	--	--	--
PERMIT NY-4098-12NC												
Area 25												
RC	1.1	0.5	2.0	1.1	1.0	1.0	0.8	0.5	0.5	1.0	1.0	0.8
Coliform	0	0	0	0	0	0	0	0	0	0	0	0
PERMIT NY-4099 12NC												
Area 2												
RC	0.6	[b]										
Coliform	0											
Area 12												
RC	0.6	1.0	1.0	0.8	.05	0.8	.05	.05	.05	0.8	0.5	0.4
Coliform	0	0	0	0	0	0	0	0	0	0	0	0
RC	0.6	1.0	1.0	0.8	.05	0.5	.05	.05	.05	1.0	0.8	1.0
Coliform	0	0	0	0	0	0	0	0	0	0	0	0

(a) RC - residual chlorine in parts per million (ppm); coliform colony count is in number/100 mL.
(b) In February, sampling discontinued in Areas 2 and 3; personnel moved to Area 6.

Table 7.1 (Monthly Monitoring Results for NTS Potable Water Systems - 1994 [(a)], cont.)

Area	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
				PERMIT NY-5000-12NC								
Area 6												
RC	1.0	0.5	0.6	1.2	.05	1.0	1.0	0.6	1.0	1.0	0.6	1.0
Coliform	0	0	0	0	0	0	0	0	0	0	0	0
RC	1.0	0.5	0.6	1.2	.05	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Coliform	0	0	0	0	0	0	0	0	0	0	0	0
RC	1.0	0.5	0.6	1.2	1.0	1.0	1.5	1.0	1.0	1.0	1.0	1.5
Coliform	0	0	0	0	0	0	0	0	0	0	0	0
RC	--	--	--	--	--	--	--	1.0	--	--	--	--
Coliform	--	--	--	--	--	--	--	0	--	--	--	--
Area 6 Fill Stand												
RC	--	--	3.0	--	--	--	--	1.0	--	--	--	--
Coliform	--	--	0	--	--	--	--	0	--	--	--	--
RC	--	--	3.0	--	--	--	--	--	--	--	--	--
Coliform	--	--	0	--	--	--	--	--	--	--	--	--
Area 6 Sample of Water at Area 27												
RC	0.9	0.5	0.8	0.0	.05	.05	1.0	1.0	1.0	1.0	0.1	0.3
Coliform	0	0	0	0	0	0	0	0	0	0	0	0
RC	--	--	--	1.0	--	--	--	--	--	--	--	--
Coliform	--	--	--	0	--	--	--	--	--	--	--	--
RC	--	--	--	1.0	--	--	--	--	--	--	--	--
Coliform	--	--	--	0	--	--	--	--	--	--	--	--
RC	--	--	--	1.5	--	--	--	--	--	--	--	--
Coliform	--	--	--	0	--	--	--	--	--	--	--	--
				PERMIT NY-5024-12NC								
Area 1												
RC	0.8	0.6	1.1	0.5	1.0	1.0	1.0	1.5	1.0	1.0	1.0	0.6
Coliform	0	0	0	0	0	0	0	0	0	0	0	0
				PERMIT NY-4097-12NC								
Area 3												
RC	1.0	[(b)]										
Coliform	0											
RC	0.6											
Coliform	0											
RC	0.4											
Coliform	0											

(a) RC - residual chlorine in parts per million (ppm); coliform colony count is in number/100 mL.
(b) In February, sampling discontinued in Areas 2 and 3; personnel moved to Area 6.

Table 7.2 Resampling Results for Secondary Standard Compliance

Sample Site	Analyte	1993 State Sample	1994 May 5 Sample	1994 May 12 Sample	1994 June 15 Sample	1994 Average	MCL
Truck 84847	Color	17	1	5	1	2.3	15
Truck 84847	Iron	1.06	0.063	0.26	0.36	0.23	0.6
Well C-1	Iron	0.67	0.36	0.009	0.016	0.13	0.6
Well C-1	TDS[(a)]	639	640	650	630	640[(c)]	500
Well 8	Iron	1.0	0.077	ND[(b)]	0.019	0.05	0.6
Well C	TDS[(a)]	639	650	650	610	633[(c)]	500
Well 5B	pH	8.6	8.57	8.48	8.47	8.5	8.5
Well 5C	pH	8.93	8.58	8.77	8.78	8.71[(c)]	8.5
A-25 Bldg. 4222	pH	8.66	8.57	8.42	8.32	8.44	8.5

(a) TDS - Total Dissolved Solids
(b) ND - Not Detected
(c) Exceeds Maximum Contaminant Level (MCL)

Table 7.3 pH, BOD, Flow Rate and TSS in NTS Sewage Lagoon Influents - January 1994

	1st Quarter Results	State Limits
pH		
Yucca Lake	(a)	6.0 to 9.0
Area 6, CP-6	(a)	6.0 to 9.0
Area 6, CP-72	(a)	6.0 to 9.0
Area 6 LANL	(a)	6.0 to 9.0
Area 6 DAF	(a)	6.0 to 9.0
Area 2	(a)	6.0 to 9.0
Area 12	(a)	6.0 to 9.0
Area 22, Gate	8.37	6.0 to 9.0
Area 23	8.31	6.0 to 9.0
Area 25, Reactor Control	(a)	6.0 to 9.0

(a) No sampling required
(b) No flow

Table 7.3 (pH, BOD, Flow Rate and TSS in NTS Sewage Lagoon Influents - January 1994, cont.)

	1st Quarter Results	State Limits
pH		
Area 25, Central Support	(a)	6.0 to 9.0
Area 25, Engine Test Stand	(a)	6.0 to 9.0
Area 25, Test Cell "C"	(a)	6.0 to 9.0
FLOW RATE (in millions of gallons per day)		
Area 6, Yucca Lake	0.0056	0.01
Area 6, CP-6	0.0008	0.0078
Area 6, CP-72	0.0002	0.0006
Area 6 DAF	0.0004	0.0055
Area 6 LANL	(b)	0.0066
Area 2	(a)	0.0009
Area 12	0.0012	0.072
Area 22, Gate	0.0012	0.0015
Area 23	0.136	0.227
Area 25, Reactor Control	(b)	0.0015
Area 25, Central Support	0.0012	0.0036
Area 25, Engine Test Stand	(b)	0.0012
Area 25, Test Cell "C"	(b)	0.0008
BOD (mg/L)		
Area 6, Yucca Lake	(a)	No Standard
Area 12	(a)	No Standard
Area 23	280	No Standard
Area 25, Reactor Control	(a)	No Standard
TSS (mg/L)		
Area 6, Yucca Lake	(a)	No Standard
Area 12	(a)	No Standard
Area 23	104	No Standard
Area 25, Reactor Control	(a)	No Standard

(a) No sampling required
(b) No flow

Table 7.4 Influent Quality

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	225	1.04	256	1.43	119	1.04	128	1.22
Mercury	590	1.07	328	.97	144	0.89	242	1.05
Yucca Lake	185	1.31	761*	1.49	67	0.85	87	0.77
Tweezer	0	0	188	1.43	84	0.81	215	1.48
CP-6	280	1.69	131	1.29	214	0.94	174	0.94
CP-72	0	0	0	0	0	0	96	0.65
DAF	220	.71	76	.54	87	1.23	18	0.75
Reactor Control	0	0	0	0	0	0	180	1.02
Test Stand 1	0	0	0	0	0	0	0	0
Base Camp 25	470	.99	163	.92	137	0.71	95	0.95
Base Camp 12	0	0	188	.29	52	0.37	26	0.28
Base Camp 2	0	0	0	0	0	0	0	0
Test Cell C	--		0	0	0	0	0	0

(a) Biochemical Oxygen Demand
(b) Specific Conductance
(*) Considered to be an anomalous result

Table 7.5 Organic Loading Rates

Facility	Limit (Kg/day)	(Feb-Mar 1994) Mean Daily Load	(Apr-June 1994) Mean Daily Load	(Jul-Sept 1994) Mean Daily Load	(Oct-Dec 1994) Mean Daily Load
Metered Rates					
Mercury	172	272[a]	129	61.0	72.7
Yucca Lake	8.6	4.38	23.2[a]	1.18	3.62
Base Camp 12	54	N/A[b]	1.75	0.20	0.06
Calculated Rates					
CP-6	8.7	0.90	0.69	1.22	0.99
CP-72	1.1	0	0[b]	0[b]	0.15
DAF	7.6	0.21	1.54	0.56	0.20
Reactor Control	4.2	N/A[b]	0[b]	0[b]	1.41
Eng Test Stand	2.3	N/A[b]	0[b]	0[b]	0[b]
Test Cell C	1.3	N/A[b]	0[b]	0[b]	0[b]
Base Camp 25	7.4	2.03	1.54	1.12	0.82
Base Camp 2	1.2	N/A[b]	0[b]	0[b]	0[b]
Gate 100	2.4	1.02	1.07	0.63	0.58
LANL on Tweezer	5.0	N/A[c]	0.96	1.59	1.44

(a) Considered to be anomalous values
(b) Samples not taken due to inadequate or nonexistent flow
(c) Sampling scheduled for April 1994

Table 7.6 Pond Water Depths in Infiltration Basins

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	46	18	4.3	3
Mercury, Basin	180	0	0	0	0
Yucca Lake					
North Basin	140	56	13	0	3
South Basin	140	26	37	0	1
Tweezer					
East Basin	244	0	0	0	0
West Basin	244	0	0	0	0
CP-6					
East Basin	90	5	2	0	0
West Basin	90	15	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
Base Camp 2, Basin	90	0	0	0	0

Table 7.7 Influent Toxics for Facilities that Receive Industrial Wastewater

Parameter	Compliance Limit (mg/L)	Mercury Measurement (mg/L)	Area 25 Central Support Measurement (mg/L)	Area 6 DAF Measurement (mg/L)	Area 6 CP Measurement (mg/L)	Area 6 LANL Measurement (mg/L)	Area 6 Yucca Lake Measurement (mg/L)
Arsenic	5.0	ND	ND	ND	ND	ND	ND
Barium	100	0.042	0.031	0.012	0.019	0.077	0.034
Cadmium	1.0	ND	ND	ND	ND	ND	ND
Chromium	5.0	ND	ND	ND	ND	ND	ND
Lead	5.0	ND	ND	ND	ND	ND	ND
Mercury	0.2	ND	<0.00043	0.0006	ND	<0.00043	ND
Selenium	1.0	ND	ND	ND	ND	ND	ND
Silver	5.0	<0.067	<0.067	ND	ND	ND	ND
Benzene	0.5	ND	ND	ND	ND	ND	ND
Carbon Tertachloride	0.5	ND	ND	ND	ND	ND	ND
Chlorobenzene	100	ND	ND	ND	ND	ND	ND
Chloroform	6.0	ND	ND	ND	ND	ND	ND
1,4-dichlorobenzene	7.5	ND	ND	ND	ND	ND	ND
1,2-dichlorobenzene	0.5	ND	ND	ND	ND	ND	ND
1,1-dichloroethylene	0.7	ND	ND	ND	ND	ND	ND
Methylethyl Ketone	200	ND	ND	12	ND	ND	ND
Pyridine	5.0	ND	ND	ND	ND	ND	ND
Tetrachloroethylene	0.7	ND	ND	ND	ND	ND	ND
Trichloroethylene	0.5	ND	ND	ND	ND	ND	ND
Vinyl Chloride	0.2	ND	ND	ND	ND	ND	ND
Cresol, total	200	ND	ND	ND	ND	ND	ND
2,4-dinitrotoluene	0.13	ND	ND	ND	ND	ND	ND
Hexachlorobenzene	0.13	ND	ND	ND	ND	ND	ND
Hexachlorobutadiene	0.5	ND	ND	ND	ND	ND	ND
Nitrobenzene	2.0	ND	ND	ND	ND	ND	ND
Pentachlorophenol	100	ND	ND	ND	ND	ND	ND
2,4,5-trichlorophenol	400	ND	ND	ND	ND	ND	ND
2,4,6-trichlorophenol	2.0	ND	ND	ND	ND	ND	ND
Chlorodane	0.03	ND	ND	ND	ND	ND	ND
Endrin	0.02	ND	ND	ND	ND	ND	ND
Heptachlor	0.008	ND	ND	ND	ND	ND	ND
Lindane	0.4	ND	ND	ND	ND	ND	ND
Methoxychlor	10.0	ND	ND	ND	ND	ND	ND
Toxaphene	0.5	ND	ND	ND	ND	ND	ND
2,4-D	10.0	ND	ND	ND	ND	ND	ND
2,4,5-TP (Silvex)	1.0	ND	ND	ND	ND	ND	ND

ND - 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 7.8 N-Tunnel Drainage Monitoring Station Continuous Sampling Results

January 1994 [(a)]

Parameter	Units	Mean	Range of Average Daily Values
Flow Rate	Liters/Minute	3.985	.012 - 39.27
Total Flow	Liters	1.78×10^5	---

February 1994

Parameter	Units	Mean	Range of Average Daily Values
Flow Rate	Liters/Minute	.0048	0 - 0.012
Total Flow	Liters	6.91×10^1	---

March 1994

Parameter	Units	Mean	Range of Average Daily Values
Flow Rate	Liters/Minute	No Flow	No Flow
Total Flow	Liters	No Flow	---

No effluent constituent sampling was done in 1994; no flow measurements taken after March

(a) Insufficient flow for continuous flow measuring equipment

Table 7.9 Quantity of Waste Disposed of in Landfills - 1994

	Quantity (in pounds)		
Month	Area 9	Area 23	Area 6
January	1,367,580	0	1,452,030
February	1,407,160	192,100	500,320
March	2,782,782	292,700	1,896,310
April	954,500	224,620	2,298,680
May	765,615	237,210	363,700
June	1,767,452	235,580	2,957,320
July	1,588,950	187,640	59,160
August	1,715,675	375,330	384,790
September	1,710,750	244,435	664,720
October	1,662,560	227,170	585,590
November	3,559,407	316,380	219,070
December	6,879,680	219,340	26,700
Total	26,162,111	2,752,505	11,408,390

Table 7.10 Number of RCRA Samples Analyzed - 1994

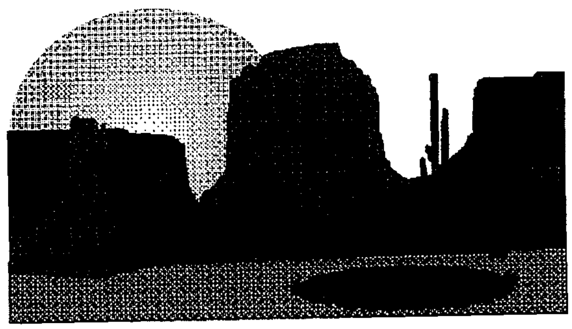
Sample Type Analysis	Soil	Water	Oil	Other	Total
Volatile Organic	439	176	176	87	878
Semi-volatile Organic	283	114	114	56	567
ICP Metals[(a)]	431	172	172	86	861
TCLP Metals[(b)]	398	159	159	79	795
pH	180	72	72	35	359
Flashpoint	106	42	42	21	211
TPH[(c)]	609	244	244	121	1218
Chlor-D-tect	146	58	58	29	291
PCB/Pest	194	78	78	38	388
Total	2786	1115	1115	552	5568

(a) "ICP Metals" refers to samples analyzed on an inductively coupled plasma spectrometer for the presence of certain metals

(b) "TCLP Metals" refers to samples that have been subjected to the EPA approved "toxicity characteristic leaching procedure

(c) "TPH" (Total Petroleum Hydrocarbons) refers to samples usually associated with underground storage tanks and fuel spills

Radioactive and Mixed Waste Storage and Disposal



8.0 RADIOACTIVE AND MIXED WASTE STORAGE AND DISPOSAL

Disposal of low-level radioactive waste (LLW) from DOE approved generators occurs at two areas on the NTS. Disposal of packaged LLW at the Area 5 Radioactive Waste Management Site (RWMS-5) is in shallow pits and trenches. Packaged LLW, low specific activity LLW packaged in large bulk waste containers, and unpackaged bulk waste (only from the NTS) are buried in selected subsidence craters at the Area 3 RWMS (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 under cover on a specially constructed Resource Conservation and Recovery Act (RCRA) designed pad designated as the TRU waste storage 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. Waste uranium ore residues, formerly designated as a strategic material, are stored north of the RWMS-5. Analytical data from sampling performed in 1994 indicate that the uranium ore residues are mixed waste. Hazardous wastes generated on the NTS are accumulated at the Hazardous Waste Accumulation Site east of the RWMS-5 before shipment to an offsite treatment, storage and disposal facility.

During 1994, environmental monitoring involved air sampling, radiation dose rate surveys, ground water 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 was the only airborne radionuclide detected at the RWMS-5 from the disposal of radioactive waste. All radionuclide concentrations were well below derived concentration guides (DCG). Gamma radiation fields were monitored by thermoluminescent dosimeters (TLD). Gamma doses greater than background were detected at the RWMS-5 entry gate and in areas where waste is stored above ground. Neutron radiation fields at the perimeter of the TRU waste storage pad were monitored by proton recoil dosimeters. External radiation dose equivalent rates were well below occupational limits.

8.1 WASTE DISPOSAL OPERATIONS

Radioactive waste disposal was initiated at Area 5 on the NTS in 1961. By July 1976, six trenches 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 and from offsite DOE generators and DOD facilities. The state of Nevada granted the NTS interim status in 1987 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. Mixed waste disposal was curtailed in 1990 by the DOE due to concerns about the presence of Land Disposal Restricted (LDR) constituents. The state of Nevada later directed that the 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 Hazardous Waste Accumulation Site which is adjacent to and east of the RWMS-5. At this site, the hazardous waste is prepared for shipment to an offsite treatment, storage and disposal facility. Hazardous waste is not accepted from offsite generators.

8.1.1 AREA 5 RADIOACTIVE WASTE MANAGEMENT SITE

The RWMS-5 occupies approximately 296 hectares (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 hectares (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 interspersed with tuffaceous material. The basin is filled with up to 305 m (1000 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 two 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.

In the past, disposal of LLW and mixed wastes occurred in shallow land burial trenches and pits at depths ranging from 4.6 m to 9.1 m (15 to 30 ft). Pits and trenches that have reached full capacity are temporarily covered by 2.8 m (9 ft) of soil until a permanent closure cap is constructed. In addition, disposal of high specific activity waste occurred in augured shafts 36 m (120 ft) deep. When disposal capacity is reached, Greater Confinement Disposal (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/HQ and DOE/NV. Prior to receiving approval, generators must submit an application detailing the characterization of the waste for disposal and their waste certification program. The waste program must meet NVO-325 (Revision 1), "Nevada Test Site Defense Waste Acceptance Criteria, Certification, and Transfer Requirements." Approval may be granted if an audit shows that the waste characterization meets the requirements and the waste certification plan has been satisfactorily implemented. Approved generator programs are reviewed and audited annually.

During 1994, LLW from 12 generators amounting to 12,300 m^3 (4.345 x 10^5 ft^3) containing a total of 51.7 kCi (1.91 PBq) of radioactivity was received at the RWMS-5. Tritium accounted for over 98.4 percent of total radioactivity. The majority of the remaining radioactivity is attributed to: ^{90}Sr, ^{137}Cs, ^{238}Pu, ^{234}U, ^{235}U, and ^{238}U. By the end of 1994, the RWMS-5 had a cumulative waste volume of 1.8 x 10^5 m^3 (6.5 x 10^6 ft^3) containing 9.9 MCi (0.37 EBq), neglecting radioactive decay.

A Mixed Waste Management Unit (MWMU) is planned for construction in the northeastern area of the RWMS-5. The proposed MWMU will cover approximately 10 hectares (25 acres) and contain 8 landfill cells. Mixed waste disposal operations at the NTS will re-commence under interim status in Pit 3 upon completion of NEPA documentation and a state approved Waste Analysis Plan. Disposal operations at the MWMU will be initiated upon issuance of a state RCRA Part B Permit. In the interim, an agreement between DOE/NV and the Nevada Division of Environmental Protection has been negotiated that allows low-level mixed waste generated on the NTS to be stored on the TRU waste storage pad until permanent treatment or disposal.

8.1.1.1 RWMS-5 GROUNDWATER MONITORING

Data collection was initiated in 1993 and was continued during 1994 to monitor the groundwater chemistry under the waste disposal cells at RWMS-5. The purpose of this study is to determine the water quality and the flow gradients. 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 9.2.2.3 of this document and in the "1994 Groundwater Monitoring Report."

8.1.2 AREA 3 RADIOACTIVE WASTE MANAGEMENT SITE

The RWMS-3 lies at an elevation of 1230 m (4050 ft) and covers approximately 20 hectares (50 acres). It is located in the center of Yucca Flat approximately 8 miles north of the Yucca Dry Lake Bed. The site is located on nearly 457 m (1500 ft) of alluvial and tuffaceous sediments. 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 above ground 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 clean fill dirt. 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 the craters. A total volume of 3.05 x 10^5 m^3 (1.077 x 10^7 ft^3) of LLW originally containing 1528 Ci (56 TBq) has been disposed at the RWMS-3. Tritium accounts for approximately 87 percent of the total radioactivity disposed. Fission products and depleted uranium primarily account for the remainder. Two craters, U-3ax and U-3bl, have been filled to date. U-3ah/at is currently open and contains almost 47,460 m^3 (1.676 x 10^6 ft^3) of atmospheric testing debris. In 1994 the RWMS-3 received 10,550 m^3 (3.737 x 10^5 ft^3) of waste containing 0.213 Ci (7.9 GBq) of radioactivity. ^{234}U and ^{238}U accounted for approximately 90.4 percent of the total radioactivity buried in 1994.

8.1.3 STRATEGIC MATERIALS STORAGE YARD

The strategic materials storage yard is used for storage 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 are highly enriched in ^{230}Th and ^{231}Pa and contain approximately 290 Ci (11 TBq) of total radioactivity. The residues were recently declared as waste by the Office of Basic Energy Sciences. Analytical data from sampling performed in 1994 indicated that the residues are mixed waste. This waste will continue to be stored north of the RWMS-5 pending treatment and disposal.

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 routinely performed to ensure the integrity of the waste containers. Opening of the cargo containers for inspection is controlled following established ALARA practices to reduce radiation exposure to personnel.

8.1.4 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 (LLNL). During 1992, all of the mixed TRU waste packaged in 55 gal drums was overpacked into steel drums with carbon filter vents. The waste is stored on a curbed asphalt pad surrounded by a security fence. The pad and waste storage configuration comply with RCRA 40 C.F.R. 265, Subpart I. Construction of a cover for the TRU waste storage pad was completed in 1994, and transfer of the waste into the cover building will be completed early in 1995.

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 Waste Isolation Pilot Plant (WIPP). This waste will be characterized and packaged for certification according to WIPP criteria.

8.2 ENVIRONMENTAL MONITORING AT WASTE STORAGE AND DISPOSAL SITES

The Reynolds Electrical & Engineering Co., Inc. (REECo), Analytical Services Department (ASD), Environmental Section is responsible for collection of samples and verifying sample results. The ASD Radioanalytical Section is responsible for analysis of the samples. Collection and analysis of samples are performed in accordance with approved operating procedures. The Waste Operations Department reviews the sampling results for any unexpected trends.

8.2.1 AIR MONITORING

Air sampling is conducted at nine stations along the perimeter of the RWMS-5 fence, six stations along the perimeter of the TRU waste storage pad, and two stations inside disposal pits inside the RWMS-5. Air sampling is also conducted at four stations along the perimeter of the U-3ah/at craters at the Area 3 RWMS. The air samplers operate at an air flow rate of approximately 140 L (5.0 ft^3) per minute. The sampling media are a 10 cm (4 in) glass-fiber filter and a charcoal cartridge that are exchanged weekly. Each filter is analyzed for gross beta radiation and each filter and cartridge for photon-emitting radionuclides. The filters are composited and analyzed monthly for ^{238}Pu and $^{239+240}$Pu. Samplers for tritiated water (HTO) are located with the nine particulate samplers along the perimeter of the RWMS-5 fence.

Tritium, ^{238}Pu, $^{239+240}$Pu, and naturally occurring radionuclides were detected in air at the RWMS-5 during 1994. The average concentration of $^{239+240}$Pu measured was 1.1 x 10^{-17} µCi/mL (0.41 µBq/m^3), where the maximum concentration measured during the year was 52 x 10^{-17} µCi/mL (19 µBq/m^3). The average concentration is approximately 0.6 percent of the derived concentration guide (DCG) [2 x 10^{-15} µCi/mL (74 Bq/m^3)] for $^{239+240}$Pu found in DOE Order 5400.5 modified for the 10 mrem limit for airborne radioactivity in 40 C.F.R. 61. The air concentration of ^{238}Pu was approximately a factor of 100 lower than the air concentration of $^{239+240}$Pu. Airborne plutonium in Area 5 is most likely due to resuspension of contaminated soils and not attributable to waste disposal activities. The progeny of the primordial radionuclides ^{232}Th and ^{238}U, the naturally occurring radionuclide ^{40}K and the cosmogenic radionuclide ^{7}Be were also detected but at levels consistent with background. No radioiodines were detected. Tritium is routinely detected at the RWMS-5 at radioactivity concentrations slightly greater than the mean concentration for the NTS. The highest concentration detected in a sample was 47 x 10^{-6} pCi/mL (1.7 Bq/m^3). This level is approximately 0.5 percent of the DCG for HTO [1 x 10^{-8} µCi/mL (148 Bq/m^3)] in DOE Order 5400.5 modified for the 10 mrem limit in 40 C.F.R. 61. The average 1994 tritium air concentration for all sample locations at RWMS-5 was 4.9 x 10^{-6} pCi/mL (0.18 Bq/m^3); this level is slightly less than the 1993 average of 7.9 x 10^{-6} pCi/mL (0.29 Bq/m^3).

Naturally occurring radionuclides and traces of plutonium (^{238}Pu and $^{239+240}$Pu) were detected in air at all of the Area 3 samplers in 1994. The highest concentration of $^{239+240}$Pu detected was 110 x 10^{-17} µCi/mL (41 µBq/m^3) which is 55 percent of the 10 mrem adjusted DCG for $^{239+240}$Pu in DOE Order 5400.5. The average concentration was 13.1 x 10^{-17} µCi/mL (4.9 µBq/m^3). The air concentration of ^{238}Pu was approximately a factor of 100 lower than the air concentration of $^{239+240}$Pu. The airborne plutonium is most likely due to resuspension of soils contaminated by atmospheric weapons testing, and is not attributable to waste disposal activities.

8.2.2 EXTERNAL GAMMA EXPOSURES

Thermoluminescent dosimeters (TLDs) were deployed at 44 locations at the RWMS-5 to measure exposure to gamma radiation. Ten TLDs were placed within the perimeter including six TLDs around the TRU waste storage pad and two TLDs each in Pits 3 and 4 approximately 30 m (100 ft) from the waste stacks. Fifteen TLDs were located at the perimeter of the site and one was placed at the facility office. Another 18 TLDs were located around the Strategic Materials Storage Yard (SMSY). All TLDs were exchanged and analyzed quarterly.

Due to errors in TLD processing and handling exposure results for first and second quarters for 1994 are not available. Accordingly, due to the large uncertainties in extrapolating from only two quarters of data, annual average exposure rates were not calculated for the TLDs posted at the RWMS facilities. Based on a review of third and fourth quarters data, exposure rates at the RWMS facilities appeared to be generally consistent with 1993 results.

Exposure was monitored at the RWMS-3 at 19 sites located at the perimeter of the craters used for disposal. The majority of the exposure at the RWMS-3 is attributable to contamination from weapons testing and safety tests.

8.2.3 NEUTRON DOSE EQUIVALENTS

Neutron dose equivalents were measured at six locations at the perimeter of the TRU waste storage pad. The dose equivalents for 1994 ranged from 59 to 190 mrem. The perimeter of the TRU waste storage pad is not routinely occupied.

8.2.4 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. 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 below the pit floor. Tubes are monitored quarterly with neutron moisture meters to detect wetting fronts through the operational cap. Wetting fronts that progressed through the operational cap would indicate moisture in the waste zone and an increased probability of potential contaminant migration.

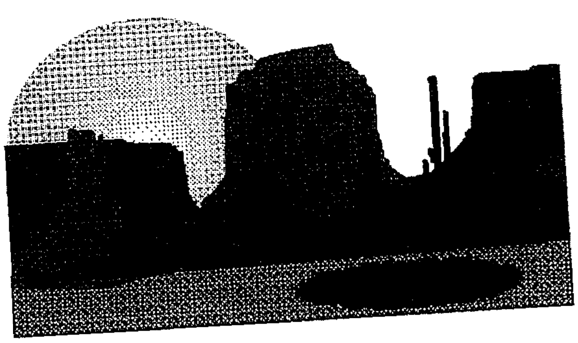
Monitoring for moisture was conducted in January, April, June, and December (December data has not been compiled or evaluated) in 1994. No wetting fronts progressed through the eight feet of operational cap as reported in "Area 5 Low-Level Radioactive Waste Management Site Pit 3 Mixed Waste Neutron Logging Report."

8.2.5 TRITIUM MIGRATION STUDIES AT THE RWMS-5

Subsurface tritium migration studies of four sites at the RWMS-5 to test package integrity are being conducted by personnel from the University of California, Berkeley (UCB) (Schulz, et al. 1991). In the past, various types of packaging have been used for transport and containment of tritiated waste. During placement and burial of the waste packages, several sampling lines were secured to the outside of the packages that lead to the UCB sample control trailer. No significant changes were detected in soil pore gas samples in 1994.

In addition, a detailed transpiration study was conducted at the RWMS-5 to monitor tritium migration from buried waste. A total of 503 plant samples and 23 samples from small mammals were collected. Elevated levels of tritium in plants and animals were detected. Additional measurements are being considered to quantify the overall impacts from these releases. Worker radiation exposure from the contaminated plants and animals is minimal.

Groundwater Protection



9.0 GROUNDWATER PROTECTION

The primary mission of the 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 from reaching groundwater, but it also recognizes that some options for groundwater protection are precluded by an increased risk of atmospheric environmental 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. 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 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.

An extensive program of well drilling at the NTS for groundwater characterization continued in 1994. This program will continue until the location, quantity, and movement of groundwater and contaminants are sufficiently understood to support a Remedial Investigation and Feasibility Study (RI/FS). The RI/FS will evaluate potential groundwater contaminant transport pathways, risks associated with these pathways, and possible remedial actions. Approximately 30 - 60 new wells are planned, including some existing wells that will be recompleted to obtain characterization data. Current wells being drilled are positioned to maximize the geologic and hydrologic data obtained for each major underground testing area.

DOE/NV instituted a Long-Term Hydrological Monitoring Program (LTHMP) in 1972 to be operated by the EPA under an Interagency Agreement. In 1994 groundwater was monitored on and around the NTS, at six 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. In 1965 tritium escaped from the LONG SHOT test on Amchitka Island and contaminated the groundwater, and, during cleanup and disposal operations, shallow groundwater at the Tatum Dome Test Site in Mississippi was contaminated by tritium. The tritium levels in wells at both these sites are 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 tritium levels.

9.1 EXISTING GROUNDWATER CONDITIONS

9.1.1 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 variously 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 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 discharge 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 (Waddell 1982).

9.1.2 HYDROGEOLOGY OF NON-NTS UNDERGROUND EVENT SITES

The following descriptions of the hydrology of non-NTS underground event sites are summarized from Chapman and Hokett 1991.

9.1.2.1 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. Groundwater flow velocities through the granite to the alluvial aquifers of Fairview Valley are calculated to be very slow (Chapman and Hokett 1991).

9.1.2.2 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.

9.1.2.3 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.

9.1.2.4 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.

9.1.2.5 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.

9.1.2.6 BAXTERVILLE, MISSISSIPPI

Project DRIBBLE and the Miracle Play Program were conducted in the Tatum Salt Dome. 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.

9.1.2.7 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. The rate of groundwater movement in the Ojo Alamo Sandstone is estimated to be approximately 0.01 meters per year.

9.1.2.8 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.

9.1.3 AREAS OF POSSIBLE GROUNDWATER CONTAMINATION AT THE NTS

A preliminary assessment of underground and surface contamination at the NTS was conducted by the DOE in 1987 and submitted to the Environmental Protection Agency (EPA) Region 9. The survey delineated known and potential sources of groundwater contamination at the NTS including underground nuclear testing areas and surface facilities (Figure 9.1). Information from this document and from DOE/NV's "Site Specific Plan for Environmental Restoration and Waste Management, Five Year Plan," was used to describe the possible areas of groundwater contamination at the NTS. Table 9.1 is a listing of routine sampling locations at NTS and off-NTS sites where 1994 groundwater samples contained levels of man-made radioactivity greater than 0.2 percent of the standards in the National Primary Drinking Water Regulations.

To date, over 1050 announced nuclear tests have been conducted at the NTS with the majority of them occurring in Yucca Flat, Frenchmen Flat, Pahute Mesa, Rainier Mesa, and Shoshone Mountain. The principal by-products from these tests were heavy metals and a wide variety of radionuclides with differing half-lives and decay products. Detonations within, or near, the regional water table may have contaminated the local groundwater with radionuclides, principally tritium.

Surface activities associated with underground testing and other NTS activities such as disposal of low-level radioactive and mixed wastes, spill testing of hazardous liquified gaseous fuels, and testing 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, hydrocarbons, 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. Because of the great depths to groundwater and the arid climate, the potential for mobilization of surface and shallow subsurface contamination is minimal. However, contaminants entering 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.

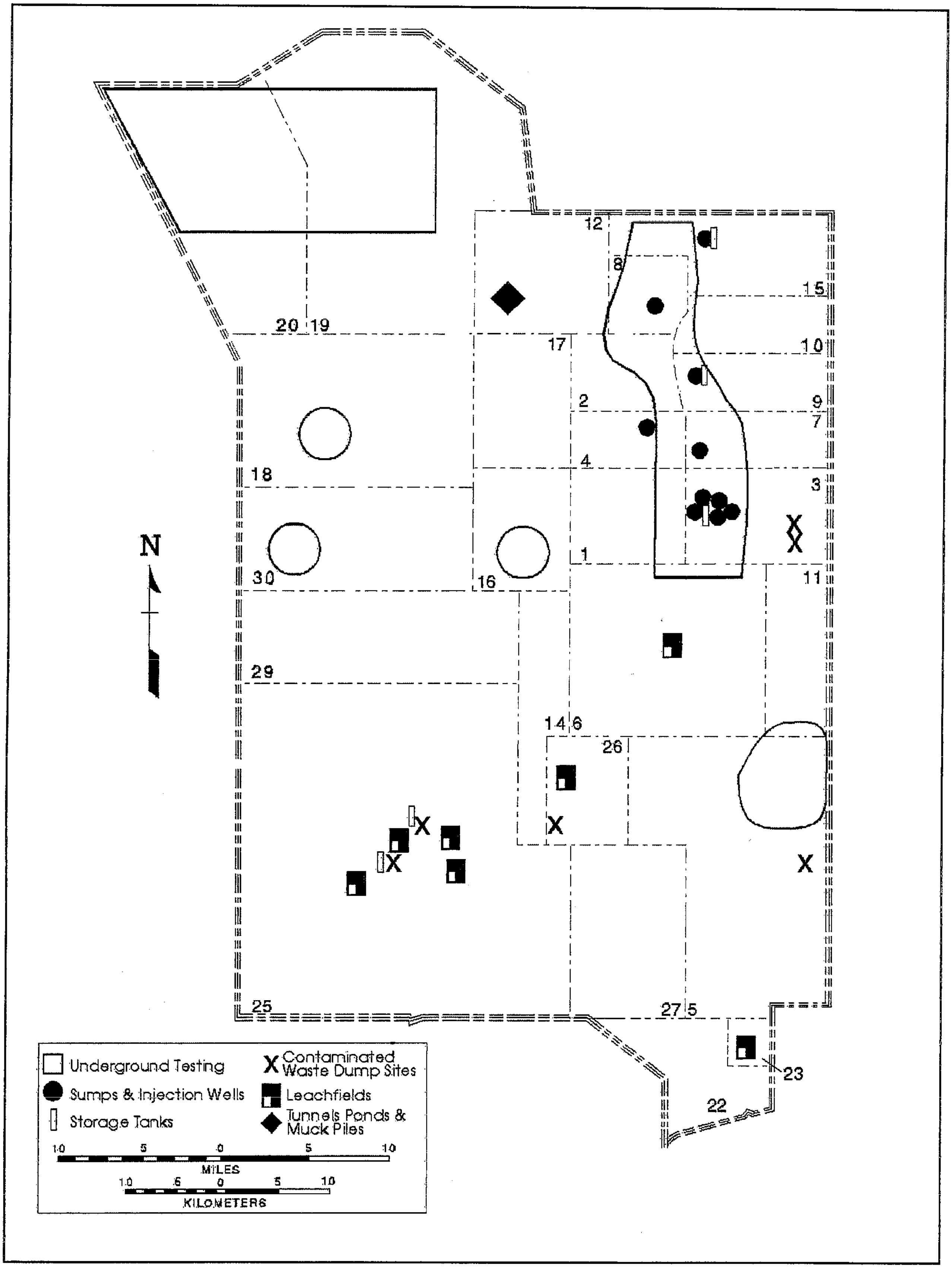


Figure 9.1 Areas of Potential Groundwater Contamination on the NTS

9.2 GROUNDWATER PROTECTION

Groundwater protection activities contained within DOE/NV programs are described below.

9.2.1 GROUNDWATER PROTECTION FOR UNDERGROUND NUCLEAR TESTS

The DOE/NV standard operating procedure "Protection of Groundwater at Nuclear Test Locations" (NTS-SOP 5417), 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 Environmental Restoration and Waste Management Division (AMEM) to show compliance with these criteria, which are:

- Future testing should utilize previously used areas of testing.
- Minimize tests with working points at or below the water table. 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 meters of the NTS boundary where groundwater leaves the NTS.
- Emplacement holes which extend more than two cavity radii or 30 meters, whichever is greater, beneath the working point should be plugged to prevent the open borehole from becoming a preferential pathway for groundwater contamination.

The Hydrologic Resources Management Program (HRMP) reviews the emplacement hole documentation for technical content and the DOE/NV Environmental Protection Division (EPD) reviews the documentation for environmental compliance. Based on recommendations by AMEM, HRMP, and EPD, the proposed location will either be approved or modifications recommended. If groundwater levels encountered during drilling of the emplacement holes are substantially different than predicted, the acceptability of the emplacement hole will be re-evaluated.

9.2.2 GROUNDWATER PROTECTION FOR SURFACE FACILITIES

Because of the large distance from the surface to groundwater, there is a minimal risk of groundwater contamination from surface activities at the NTS. Nonetheless, provisions for groundwater protection from surface activities have been established in several programs: (1) Waste Minimization and Pollution Prevention Awareness; (2) Decontamination and Decommissioning; and (3) Waste Treatment, Storage, and Disposal.

9.2.2.1 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 that 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 1994 activities is given in Section 3.2.6.

9.2.2.2 DECONTAMINATION AND DECOMMISSIONING PROGRAM

The Decontamination and Decommissioning Program identifies inactive radiologically contaminated facilities, assesses the extent of contamination, minimizes its spread, and ensures that facilities are maintained in a safe manner pending determination of final disposition. Eight facilities at the NTS have been identified for decontamination and decommissioning.

9.2.2.3 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 DOD facilities. The Area 5 Radioactive Waste Management Site (RWMS-5) also serves as a temporary storage area for Lawrence Livermore National Laboratory (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 non-standard packaged radioactive low-level waste from offsite and unpackaged bulk wastes from the NTS.

Mixed waste disposal facilities are presently operating under the Resource Conservation and Recovery Act (RCRA) interim status pending completion of the RCRA permitting process. Site characterization activities are being performed in support of the RCRA Part B permit application and will evaluate the potential for the release and migration of waste from the waste disposal activities. Because of the great depth to groundwater at the NTS, vadose zone studies and monitoring are also being conducted to detect the migration of contaminants from the waste facilities.

During 1992, three pilot wells (UE5PW-1, UE5PW-2, UE5PW-3) were drilled through the vadose zone into the uppermost aquifer under the 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 of the uppermost aquifer is consistent with the leakage detection requirements for interim treatment, storage, and disposal (TSD) facilities required by EPA (EPA 1993) and the state of Nevada.

In accordance with 40 C.F.R. 265 - Subpart F, operators of interim status TSDs are required to collect quarterly samples for one year from one upgradient and three downgradient wells for characterization of background water quality. The first collections of these characterization data were performed in 1993. In subsequent years the sampling frequency will be reduced to annual and results will be 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 sample collection. Temperature, pH, specific conductance, and Eh were monitored during purging and at the conclusion of sampling. Dissolved oxygen and turbidity were also measured during purging and at 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. Samples for analyses requiring separation into dissolved and total fractions (metals, gross alpha, gross beta, and gamma-emitting radionuclides) were filtered in the field. 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, 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.

9.3 ENVIRONMENTAL RESTORATION

The Nevada Environmental Restoration Project (NV-ERP) was established to assess past hazardous and radioactive waste contamination that may have occurred as a result of operations at DOE facilities. For those sites that could pose a threat to human health, welfare, and/or the environment, remedial actions consistent with the National Oil and Hazardous Substances Pollution Contingency Plan are developed. The NV-ERP has been designed to ensure DOE/NV compliance with federal laws such as RCRA; Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); and the Superfund Amendments and Reauthorization Act (SARA). CERCLA and SARA are the primary legislative acts governing remedial action at former hazardous waste disposal sites. These acts require the development of a Remedial Investigation and Feasibility Study (RI/FS) to assess the potential risks present at a site and to develop and evaluate remedial actions. The ERP has been modified to include a RI/FS for all former DOE/NV hazardous waste disposal and expended nuclear test sites. As an initial action a site characterization is conducted to determine the type of contamination present, the extent and concentration of contaminants, and to identify and delineate potential contaminant transport pathways.

9.3.1 UNDERGROUND NUCLEAR TESTING SITES

The hydrogeologic regime in the vicinity of the NTS is not well enough understood to ensure compliance with DOE/NV's objectives. Under the NV-ERP, the Groundwater Characterization Project (GCP) was designed to gain a better understanding of the location, quantity, and movement of groundwater and contaminants at the NTS. Knowledge gained from the GCP was to be used in developing a RI/FS. In 1993, the GCP was officially incorporated into the Underground Testing Areas (UGTA) RI/FS which will evaluate potential groundwater contaminant transport pathways, the risks associated with those pathways, and possible remedial actions. The UGTA RI/FS is administered by International Technology Corporation (IT) for the NV-ERP and includes: (1) Program Planning, (2) Technology Development, and (3) Field Investigations.

Program Planning develops program objectives, work plans and schedules and is a joint effort between IT, LLNL, Los Alamos National Laboratory (LANL), Defense Nuclear Agency, U. S. Geological Survey (USGS), Desert Research Institute (DRI), Raytheon Services of Nevada, and Reynolds Electrical and Engineering Co., Inc. (REECo). Technology Development develops innovative technologies to address hydrogeologic problems unique to the NTS. In

1994, such technologies included: (1) a time-domain refractometer moisture detection system to locate the water table during drilling; (2) application and use of progressive cavity pumps to develop wells ER-30-1, ER-3-1, ER-3-2, and ER-19-1; (3) data compilation for development of a 3-D groundwater model using MODFLOW-P, and a 1-D transport model using MODPATH; and (4) development of a source term data base. In Field Investigations, wells are drilled to obtain geologic and hydrologic information for each major underground testing area. Geologic information gained during drilling will be used to optimize testing of different hydrologic units and to determine well-screen intervals. Hydrogeologic information will be used to determine the directions and rates of groundwater flow in three dimensions, determine spatial and temporal variations in the directions and rates of groundwater flow, and quantify parameters that control these factors. In 1994, the following wells were drilled: UE10j, ER-3-2, ER-6-2, ER-30-1, ER-6-1, ER-3-1, ER-19-1, and U-20 and UE-19c water wells.

9.3.2 SURFACE FACILITIES

Because of the arid climate and the great depths to groundwater, any contaminants found in the near-surface environment are unlikely to migrate to or contaminate groundwater. However, liquid wastes distributed to leachfields, unlined ponds, and subsidence craters could introduce contaminants into the unsaturated zone and supply the mechanisms necessary to transport contaminants to the local groundwater table. Injection of liquid wastes into wells also greatly increases the potential for contamination of groundwater by shortening the pathway to the water table and supplying a medium of transport. Corrective actions, RI/FS's, and RCRA closures are planned for various NTS leachfields, ponds, subsidence craters, and injection wells.

9.3.2.1 RAINIER MESA TUNNEL PONDS

Nuclear devices have been tested in horizontal tunnels mined into Rainier Mesa at the NTS. The tests were conducted in zeolitized volcanic tuffs which act as a perching layer for water infiltrating from the mesa surface. During normal mining operations, fractures containing water are intercepted creating artificial springs in the tunnels. Periodically these waters contained radionuclides from underground nuclear tests, and were drained out of the tunnels into unlined evaporation ponds. Mining and related operations also released organic compounds and heavy metals to the tunnel effluent. In 1994, N Tunnel and T Tunnel were plugged, at year's end, E Tunnel was in the process of being plugged.

9.3.2.2 SURFACE OPERATIONAL SUPPORT FACILITIES

NTS operational support facilities such as ponds, sumps, lagoons, leachfields, and injection wells have been identified for assessment of contamination. Corrective actions, RI/FS's, and RCRA closures are being conducted to bring facilities into compliance with current regulations, characterize and remediate contaminated facilities, and close disposal sites.

Corrective actions being taken at NTS sewage lagoons, steam-cleaning pads and lagoons, and decontamination facilities include: (1) building of concrete pads with drains, (2) oil/water separators, (3) permitting of disposal systems, and (4) lining of ponds and lagoons. In 1993, preparation of RI/FS work plans for some facilities was initiated. As part of the RCRA site closure process, discharges of liquid wastes to injection wells, leachfields, and subsidence craters are being eliminated. NTS facilities with RCRA 1993 closure plans are shown in Table 9.3. Of the facilities listed, the Area 27 Explosive Ordinance Facility (EOD) was cleaned and closed in November 1994.

9.4 HYDROLOGIC RESOURCES MANAGEMENT PROGRAM

The Hydrology/Radionuclide Migration Program has previously provided information and support on radionuclide and hazardous substance source terms, near-field hydrology, site hydrology, and contamination transport. Many of this program's historic work elements, in particular, source characterization and subsurface transport of contaminants, have been assumed by AMEM and the UGTA Operable Unit. Accordingly, the name, mission, and objectives of this program have been redefined. The Hydrologic Resources Management Program (HRMP) is now responsible for groundwater stewardship, hydrology and radionuclide characterization for operations support, and integrated monitoring.

HRMP activities are conducted by agencies such as LLNL, LANL, USGS, and DRI with expertise in sciences required to study the subsurface effects of the weapons testing program. Program organization is divided into four broad categories: (1) Program Coordination and Technical Support, (2) Operational Support, (3) Groundwater Protection, and (4) Groundwater Monitoring.

9.4.1 PROGRAM COORDINATION AND TECHNICAL SUPPORT

The primary purpose of the HRMP program coordination and technical support task was to carry out the many different activities of the HRMP program that are not directly related to the individual research projects in the program. Such activities included attending program planning, review, and coordination meetings; writing, editing, and reviewing project reports, work plans, proposals, and other documents; providing radiation safety training; and processing security badge requests, conducting security briefings, and preparing security plans and regulations. These and other general administrative, programmatic, field, and laboratory support activities were preformed as needed throughout FY 1994. The main objective of the task is the planning, developing, managing, budgeting, and coordination of the DRI HRMP program.

Task 5. Hydrostratigraphic Units at the Nevada Test Site: A thesis by Deborah Dale on hydrostratigraphic units was completed and a paper on this subject was presented at the G. S. A. Annual Meeting in Boston. This thesis is in the process of becoming a DRI publication. Additional work by two students is continuing in the Yucca Flat and Pahute Mesa areas which should lead to a Master's Thesis.

Task 7. Infiltration of Craters in Yucca Flat: This was an investigation of the drainage area and its changes over time of a typical crater, in conjunction with craters in Area Five. A second purpose was the investigation of the water budget of a crater and the infiltration of water from surface run-off to the groundwater table. A letter report by Sam Hokett and David Gillespie was delivered to DOE/NV.

Task 8. Overview of Radionuclide Migration at the Nevada Test Site: This task was to prepare a paper on the above named subject. This work was not completed in FY 94 due to other demands on the Principal Investigator for this task, and will be accomplished in the second quarter of FY 95.

9.4.2 OPERATIONAL SUPPORT

The purpose of this task was to provide operational support in regards to hydrology to other elements of the HRMP program (LANL, LLNL, AND USGS) and the NTS mission. Work proposed under this task emphasized hydrologic and environmental restoration issues that are closely tied to weapons testing. As weapons testing has stopped, this task has been changed or reduced greatly in scope.

Task 2. Origin of Elevated Water Levels: The purpose of this task is to explain the presence of unexpected shallow levels of water in emplacement holes at two of the three major testing areas. Several reports including a video presentation were prepared on this task.

Task 3. Chemically Labelling Standing Water: Changes in tracer content with time for a well in Pahute Mesa were measured. A letter report was produced for this task.

9.4.2.1 WATER-LEVEL ALTITUDES

The USGS collects water-level elevation measurements in wells, emplacement holes, and test holes to support operations at the NTS. These data along with other hydrogeologic data are maintained in a computerized database. Both historical and current data are used to produce water-table altitude maps to estimate the depth to water at proposed weapons testing sites and to determine aquifer properties.

9.4.2.2 YUCCA FLAT HYDROLOGY

Unusually high hydraulic pressures observed in Yucca Flat present problems with respect to nuclear testing by increasing engineering and material costs and causing concern for radionuclide migration. Hydraulic information necessary to understand and to mitigate problems caused by the high pressure zone in Yucca Flat is being collected. Depth to water was measured continuously with pressure transducers in wells UE-3e#4 and UE-4t. Periodic measurements were collected in post-shot hole U-4ups2a.

9.4.2.3 EVALUATION OF AQUIFER PROPERTIES

Analysis of the frequency response of water levels in wells and boreholes to earth tides, atmospheric loading, and seismic events was initiated. Continuous water-level measurements from pressure transducers were analyzed to evaluate whether hydrologic properties of hydrogeologic units at the NTS could be determined without conducting conventional aquifer pumping tests. Equipment was modified to improve measurement of water-level response, and several techniques for defining hydraulic properties were evaluated.

9.4.2.4 DRILLBACK ACTIVITIES AT NUCLEAR TEST SITES

Drillback cores were collected from six underground nuclear events by LLNL. Explosive debris from these drillback sites consisted of mixtures of glass, silicates, and oxides. Measurable radioactivity was observed in crystalline and vitreous debris and included both refractory and volatile fission products. LANL also conducted drillback activities at two underground nuclear events, U-2gg and U-7a. Water samples were collected from borehole U-2ggpsa3a and were analyzed for tritium and ^{85}Kr with the results listed in Table 9.4.

9.4.2.5 PAHUTE MESA GROUNDWATER LEVELS

During drilling at Pahute Mesa, water is often encountered in emplacement holes well above the predicted elevation of the local groundwater table. These waters may be perched groundwater or fluids that are introduced during drilling. A tracer was added to drilling fluids during drilling of emplacement hole U-19bh in 1991 to evaluate the origin of this water. Analysis of tracer concentration in water in the emplacement hole after drilling suggests that this water originates from perched groundwater that lies above the bottom of the borehole. The long-term lack of decline in tracer content indicates that only a small reservoir of perched water is drained into and remains stagnant in the bottom of the borehole. Initial numerical computer modeling of infiltrated drilling fluids and seepage from a perched aquifer also suggest that this anomalous water originates from perched aquifers. Analysis of tracer in U-19bh during 1994 showed no decrease in total tracer mass indicating that the water in the borehole remained stagnant. During 1994, tracer was added to another borehole, U-19bk. Preliminary results suggest that water in this borehole is also isolated and not part of the local water table. Although Pahute Mesa is considered to be a recharge area for the local hydrologic basin, these tracer studies to date do not suggest significant movement of perched groundwater at Pahute Mesa. Tracer samples will continue to be collected from these boreholes and analyzed during 1995 to verify these preliminary findings.

9.4.2.6 GROUNDWATER RECHARGE AT UNDERGROUND NUCLEAR TEST SUBSIDENCE CRATERS

Two wells, one within a subsidence crater at underground nuclear test U-3fd and one adjacent to the crater, were instrumented with thermistor strings to evaluate the potential of using geothermal data to estimate groundwater recharge in a subsidence crater. Preliminary data from the first four months of the study indicate that soil temperatures 15 meters below the surface are unaffected by seasonal temperature variations and can be used to calculate geothermal gradients. Calculated thermal gradients in the two wells show the crater environment to have three times as large a gradient as outside the crater. These preliminary data suggest that thermal gradient variations may be caused by either higher moisture content within crater soils or greater downward movement of water within the crater.

9.4.3 GROUNDWATER PROTECTION

The primary purpose of this task was to develop a wellhead protection program for the NTS by meeting all EPA requirements. Each production well at the NTS was analyzed for the zone of influence, zone of contribution, and zone of capture.

Task 1. Wellhead Protection Program: A wellhead protection program for the NTS that meets the EPA requirements was developed. This will serve as a practical guideline for decision makers to determine the upper bounds on the pumping rate for selected reliability measures. Several reports were produced for this tasks as well as a scientific journal article.

Task 3. Update of Groundwater Classification for the NTS: Recently, there has been renewed interest in the classification of NTS groundwater and thus interest in updating the previous work. This project reviewed the revised EPA classification guidance document, compared it with the 1986 guidelines followed previously, and identified parts of the classification that must be changed. These changes were then researched and a new classification determined. The results were incorporated into a new report describing the general NTS hydrogeology and the classification of groundwater units entitled "Classification of Groundwater at the Nevada Test Site" and approved for publication by DOE/NV.

9.4.3.1 RADIONUCLIDE TRANSPORT STUDIES

When released to the groundwater system, radionuclides and toxic metals can react with various components of the groundwater, host rock, groundwater colloids, and organic compounds to form insoluble phases, solution species, and soluble complexes that can control radionuclide and metal migration behavior. Laboratory-scale studies examining the transport of radionuclides by colloids in groundwater are continuing at LANL. Presently, research is focused on developing techniques and models to describe the transport of silica colloids through columns of glass beads. The next stages will include labeling of colloids with radioactive materials, and passing colloid-containing fluids through crushed volcanic tuffs and simulated fractures.

9.4.3.2 WELLHEAD PROTECTION

In a wellhead protection program, wellhead protection areas are delineated and used to assess and manage contaminant sources near individual water-supply wells. Usually, the hydraulic properties of the aquifers where water-supply wells produce water are used to develop wellhead protection areas. Because of the limited knowledge of hydraulic properties at the NTS and the great expense of conducting field tests to determine hydraulic properties, wellhead protection areas were developed by taking into consideration the large uncertainty of NTS aquifer hydraulic properties. Ultimate capture zones of 50 and 95 percent reliability levels were developed for each well as were time-dependent capture zones of 50, 67, and 95 percent reliability levels.

9.4.3.3 CLASSIFICATION OF NEVADA TEST SITE GROUNDWATER

Groundwater at the NTS was classified according to U.S. Environmental Protection Agency's groundwater protection guidelines. As a consequence of the large size of the NTS and the standard definition of a Classification Review Area (CRA), the NTS's CRA encompasses the entire NTS and is sufficiently large to allow confident determination of the use and value of groundwater and identification of potentially affected users. The CRA was subdivided into eight groundwater units including two main aquifers: the lower carbonate aquifer system and the Cenozoic aquifer system. None of the NTS groundwater was classified as Class I (special groundwater of unusually high value that is highly vulnerable to contamination and is an irreplaceable source of drinking water to a substantial population and/or ecologically vital). The lower carbonate aquifer in the eastern and southern part of the NTS CRA, the Cenozoic aquifer system in the southwest, the Cenozoic aquifer system in Frenchman Flat, and the Cenozoic aquifer system at Pahute Mesa are all current sources of drinking water and were classified as Class IIA. The lower carbonate aquifer in the northeast and northwest parts of the NTS CRA and the Cenozoic aquifer system in Yucca Flat and Mercury Valley were classified as Class IIB, potential sources of drinking water.

9.4.4 GROUNDWATER MONITORING

Groundwater monitoring at the NTS is an ongoing activity conducted by several different DOE/NV contractors and is conducted to satisfy environmental, and health and safety regulations of the state of Nevada, EPA, and DOE. Groundwater monitoring is also conducted to determine the presence and movement of radionuclides produced from underground nuclear testing.

The purpose of this project is to evaluate the existing NTS onsite groundwater monitoring programs and make recommendations on modifying the groundwater monitoring activities as needed so DOE/NV can satisfy regulatory requirements and administer programs in an integrated manner at a minimum cost.

Task 3. Tritium Committee: DRI participated in proposed enriched tritium inter-laboratory comparison program and attended all meetings as appropriate.

Task 4. Groundwater Monitoring Programs Evaluation: DRI evaluated existing NTS on-site groundwater monitoring programs and made recommendations on modifying monitoring network design in a report to DOE/NV.

Task 5. Well Evaluation for Plugging and Abandonment: As many wells as possible, about forty, were evaluated during FY 94. The initial investigation determined the number, location, and known physical and hydrological information for wells at the NTS and consisted of examining the records of RSN, LLNL, and LANL.

9.4.4.1 MONITORING OF GROUNDWATER LEVELS

Depth-to-water measurements in a network of 50 selected wells, test holes, and emplacement holes at the NTS and at 40 other wells and test holes in areas adjacent to the NTS were made in 1994. Continuous water-level measurements were also made at seven wells and piezometers using pressure transducers. These wells and piezometers were UE-2ce, U-3cn, UE-4t#1, UE-4t#2, UE-3e4#1, UE-3e4#3, and PM-2.

9.4.4.2 GROUNDWATER SAMPLING

Groundwater samples from the NTS obtained under the HRMP were collected and analyzed for radionuclides by LLNL, LANL, and the USGS [tritium analysis of USGS samples was done by the EPA's Environmental Monitoring Systems Laboratory in Las Vegas, Nevada (EMSL-LV)]. The results of these analyses are given in Table 9.4. Comparison of these data with historical data from the same wells suggest that analytical results of samples collected by bailing do not correlate well with samples collected by pumping. For example, well RNM-2S pumped continuously from 1975 through 1991 had a tritium concentration of 11 Bq/mL when pumping ceased. Subsequent bailed samples varied in concentrations from 0.2 to 6 Bq/mL. In 1994, well RNM-2S was pumped for 4 hours and samples were collected periodically. Results indicate that tritium concentrations increased during pumping and stabilized at the same concentration observed in 1991 when continuous pumping was terminated. These observations suggest that the tritium concentrations of bailed samples from wells at the NTS are probably not representative of groundwater.

9.5 LONG-TERM HYDROLOGICAL MONITORING PROGRAM (LTHMP)

The EPA's EMSL-LV is responsible for operation of the LTHMP, including sample collection, analysis, and data reporting. From the early 1950s until implementation of the LTHMP, monitoring of ground and surface waters was done by the U.S. Public Health Service (PHS), the USGS, and AEC contractor organizations. The LTHMP conducts routine radiological monitoring of specific wells on the NTS and of wells, springs, and surface waters in the offsite area around the NTS. In addition, sampling is conducted at other locations in the U.S. where nuclear weapons tests have been conducted including sites in Nevada, Colorado, New Mexico, Mississippi, and Alaska.

A discussion of LTHMP sampling and analysis procedures and locations is provided below. Summaries of the 1994 sampling results for each of the off-site 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 - 1994," (DOE/NV/11432-176, in prep.).

9.5.1 SAMPLING AND ANALYSIS PROCEDURES

Under standard operating procedures three samples are collected from each source. Two samples are collected in 500-mL glass bottles to be analyzed for tritium. The results from one of these samples are reported while the other sample serves as a backup in case of loss or as a duplicate sample. The third sample is collected in a 3.8-L plastic container (Cubitainer). At LTHMP sites other than the NTS and vicinity, two cubitainer samples are collected. One of these is analyzed by gamma spectrometry and the other is stored as a backup or for duplicate analysis. At a few locations, because of limited water supply, only 500-mL samples for tritium analysis are collected.

For wells with operating pumps, the samples are 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 three-liter samples from wells as deep as 1800 meters (5,900 ft). At the normal sample collection sites, the pH, conductivity, water temperature, and sampling depth are measured and recorded when the sample is collected.

The first time samples are collected from a well, ^{89,90}Sr, $^{238,239+240}$Pu, and uranium isotopes are determined by radiochemistry. At least one of the cubitainer samples from each site is analyzed by gamma spectrometry. If conventional tritium analysis results are close to or less than the minimum detectable concentration (MDC) (approximately 400 to 700 pCi/L), the sample is concentrated by electrolysis (i.e., enrichment) and reanalyzed. This enrichment reduces the MDC to approximately 5 to 7 pCi/L.

9.5.2 ACTIVITIES ON AND AROUND THE NEVADA TEST SITE

9.5.2.1 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 drinking water supplies. Thirty-six wells were scheduled to be sampled in 1994 but, for various reasons, eight could not be sampled this year.

All samples were analyzed by gamma spectrometry and for tritium by the enrichment method. No gamma-emitting radionuclides were detected in any of the NTS samples collected in 1994. Summary results of tritium analyses are given in Table 9.5. The highest tritium activity was 2.6×10^4 pCi/L in a sample from Well UE-5n. This activity is less than 33 percent of the Derived Concentration Guide (DCG) for tritium established in DOE Order 5400.5, "Radiation Protection of the Public and the Environment," for comparison with the dose limit (4 mrem) in the National Primary Drinking Water Regulations. Three of the quarterly sampled wells and 10 of the wells sampled semiannually yielded tritium results greater than the MDC. Two of the monthly sampled wells, Test Well B and water Well C, have consistently shown detectable tritium over their sampling history. Figure 9.3 shows the decreasing trend in Test Well B.

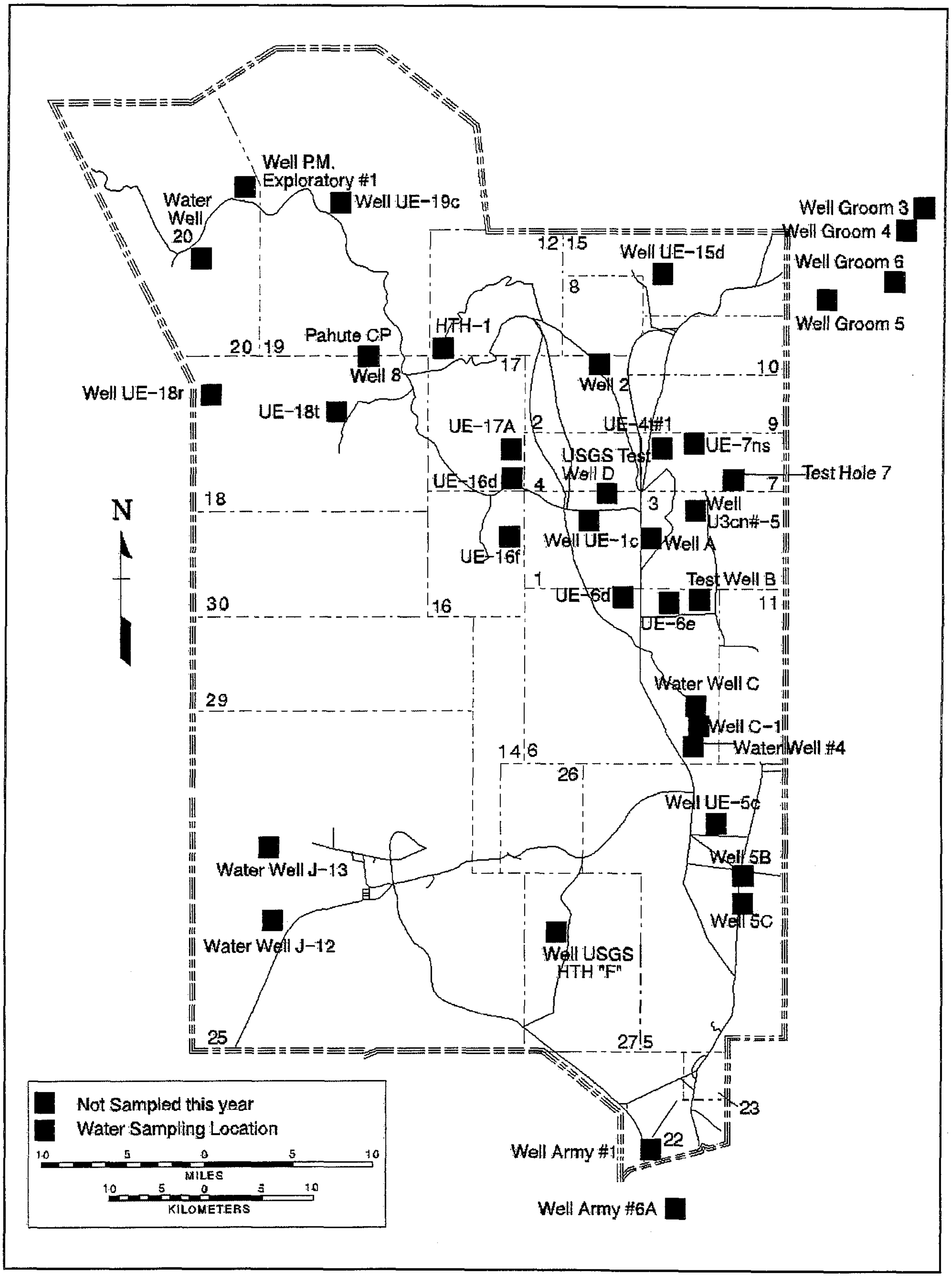


Figure 9.2 Wells on the NTS Included in the LTHMP

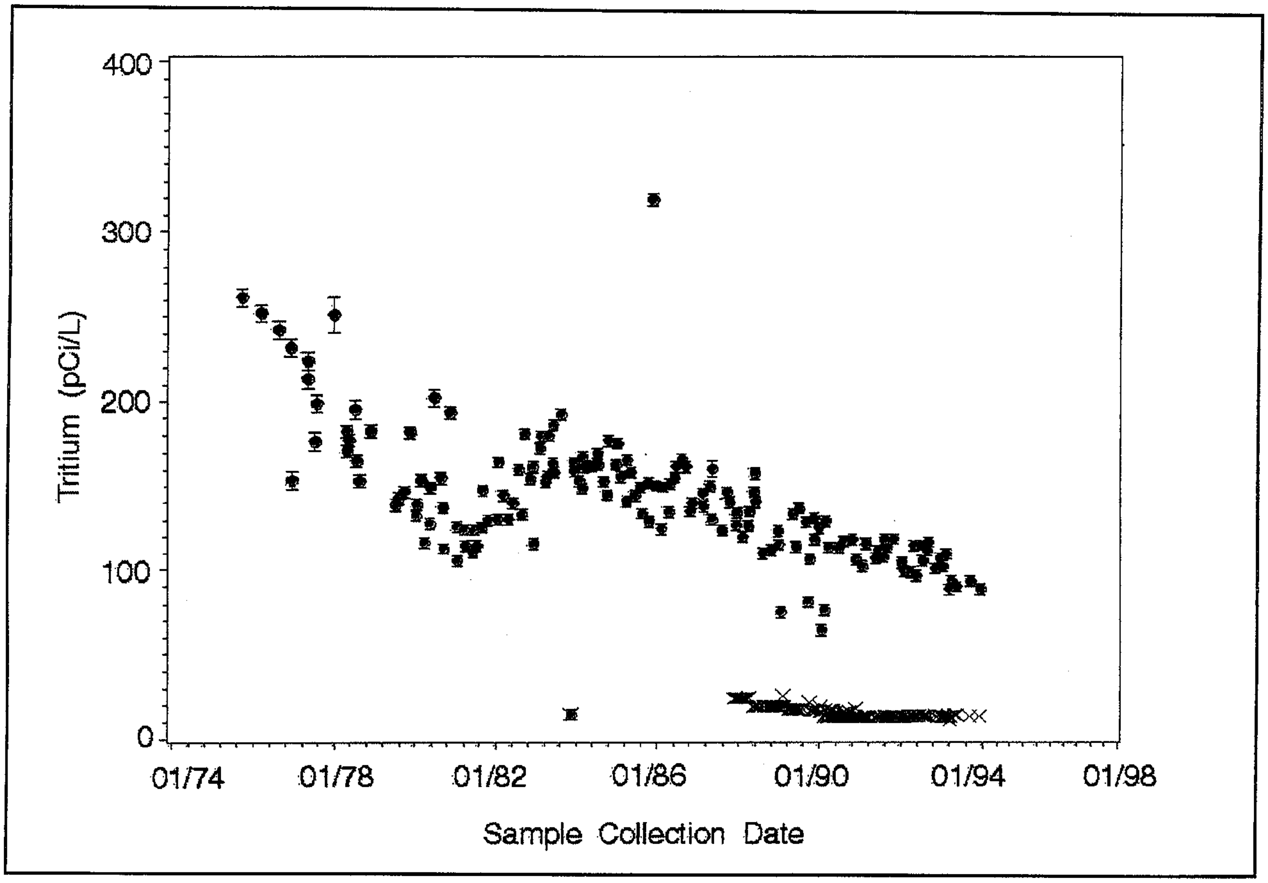


Figure 9.3 Tritium Concentration Trends in Test Well B on the NTS

Four of the sampling locations do not have sufficient data to discern any trends as they have only recently been sampled. Well UE-7ns was routinely sampled between 1976 and 1987 and sampling began again in 1992. An increasing trend in tritium activity was evident at the time sampling ceased in 1987. The results for 1992 and 1993 have shown a decrease from these previous results. Results obtained from Well C-1 indicated a decreasing trend in tritium concentration from 1970 through 1979 but a stable level since then.

9.5.2.2 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 23 wells, seven springs, and a surface water site. All of the locations are sampled monthly except for Penoyer Well 13 and Penoyer Wells 7 and 8 which are in operation only part of the year.

Gamma spectrometric analysis are performed on the samples collected monthly. No gamma-emitting radionuclides were detected in any sample. Tritium analyses are performed on a semiannual basis using the enrichment method. Over the last decade, only three sites have consistently shown detectable tritium activity: (1) Lake Mead Intake (Boulder City), (2) Adaven Spring (Adaven), and (3) Specie Springs (Beatty). In all three cases, the tritium activity represents environmental levels that have been decreasing over time as shown in Figure 9.5 for samples from Lake Mead, Nevada. This Lake Mead site may be affected by rainfall containing scavenged atmospheric tritium. Individual sample results are being published separately in the "Environmental Data Report for the Nevada Test Site - 1994," (DOE/NV/11432-176, in prep.).

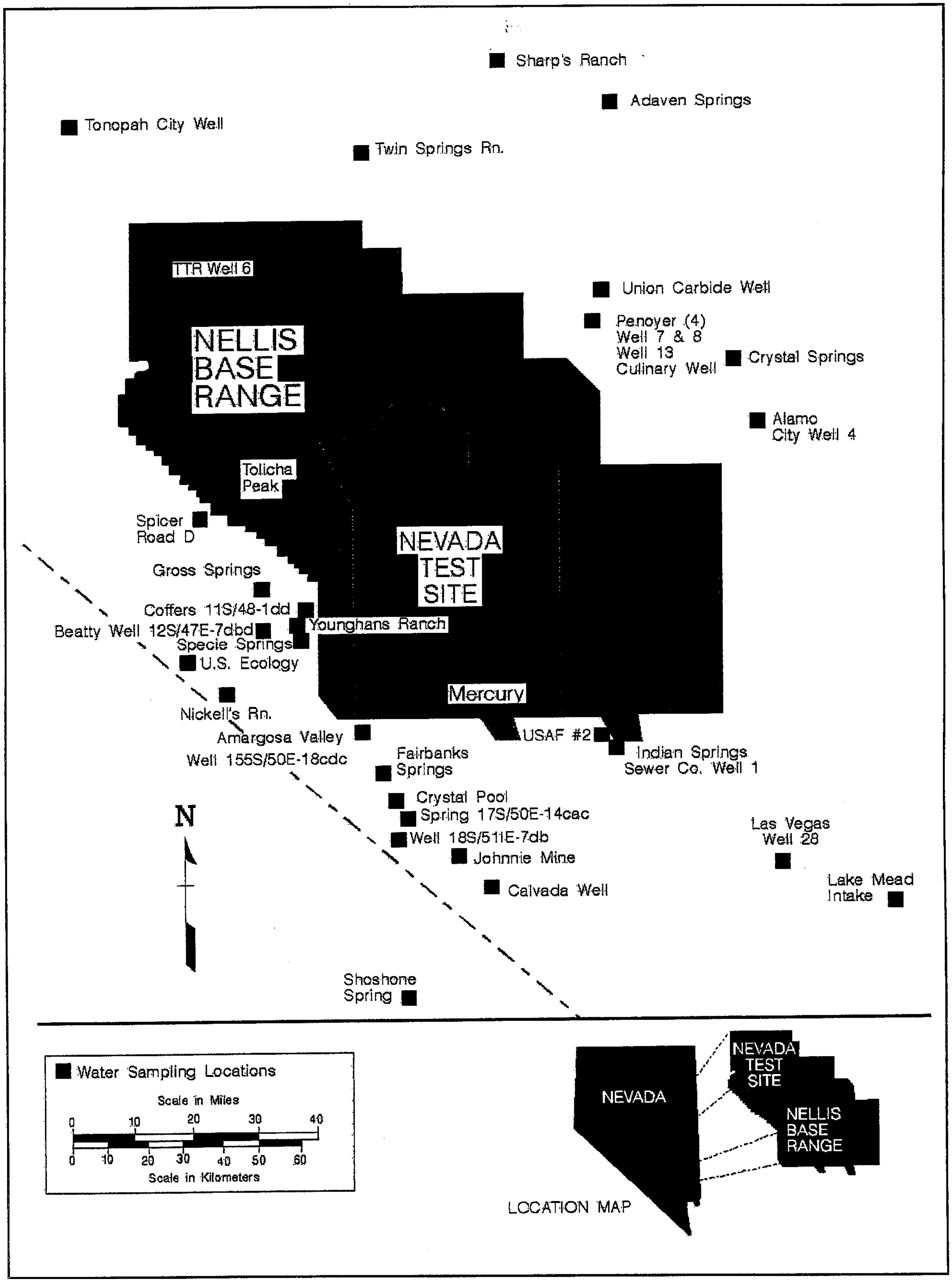


Figure 9.4 Wells Outside the NTS Included in the LTHMP

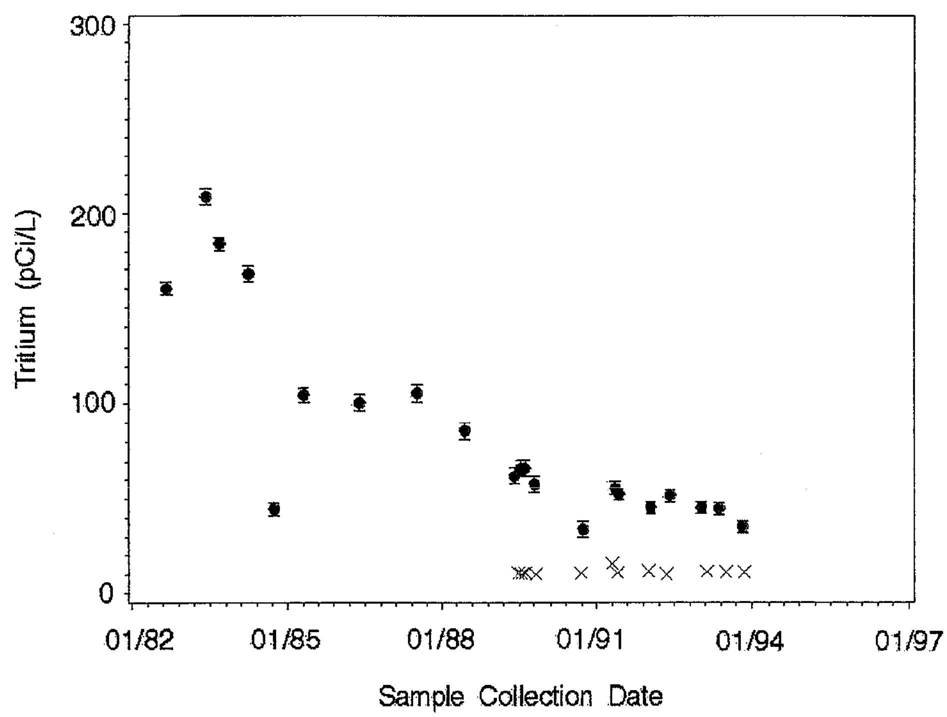


Figure 9.5 Tritium Results in Water from Lake Mead, Nevada

9.6 LTHMP AT OFF-NTS NUCLEAR DEVICE TEST LOCATIONS

The LTHMP conducts sampling at sites of past nuclear device testing in other parts of the U.S. 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 site in Mississippi. Sampling was conducted in both the spring and fall to determine rainfall dilution of ^{3}H concentration at the Mississippi site. Sampling is conducted in odd numbered years, on Amchitka Island, Alaska, site of Projects CANNIKIN, LONG SHOT, and MILROW.

The sampling procedure is the same as that used for sites on the NTS and offsite areas (described in Section 9.5.1), 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 ground zero (GZ), the sampling procedure was 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 refill with water. These second samples may be representative of formation water, whereas the first samples may be more indicative of recent rainfall.

9.6.1 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 of less than 1 megaton (Mt) 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 (3199 ft). A surface crater was created, but as an irregular block along local faults rather than as a saucer-shaped depression.

Sampling was conducted on July 26 - 27, 1994 at locations shown in Figure 9.6 which include one spring and five wells of varying depths. All of these locations are being used as, or are suitable for, drinking water supplies. At least two wells (HTH-1 and HTH-2) are positioned to intercept potential migration from the test cavity (Chapman and Hokett, 1991). All samples yielded negligible gamma activity. The only sample with tritium activity (19 ± 10 pCi/L) above the MDC was from HTH-1. These results are consistent with results obtained in previous years, and indicate that migration of radioactivity from the test cavity has not occurred.

9.6.2 PROJECT SHOAL

Project SHOAL, a 12-kiloton (kt) test emplaced at 365 m (1198 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.

Samples were collected in November, 1994. The routine sampling locations (see Figure 9.7) include one spring, one windmill, and four wells of varying depths. Four of these six sampling locations were sampled. At least one location, Well HS-1, should intercept radioactivity migrating from the test cavity (Chapman and Hokett, 1991).

No gamma activity was detected in any of the samples. A tritium result of 34 ± 2.2 pCi/L, 0.04 percent of the DCG, was detected in the water sample from Smith/James Spring, but all remaining samples yielded tritium results less than the MDC. The result for Smith/James Springs is consistent with values obtained in previous years, as shown in Figure 9.8. The most probable source of this tritium is assumed to be rainwater infiltration, not the Project SHOAL cavity.

9.6.3 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 2568 m (8425 ft). Production testing began in 1970 and was completed in April 1971. Cleanup was initiated in 1972 and 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 completed on May 29, 1994 with collection of 9 samples in the area of Grand Valley and Rulison, Colorado. Routine sampling locations, shown in Figure 9.9, include the Grand Valley municipal drinking water supply springs, water supply wells for five local ranches, and three sites in the vicinity of GZ, including one test well, a surface-discharge spring, and a surface sampling location on Battlement Creek. An analysis of the sampling

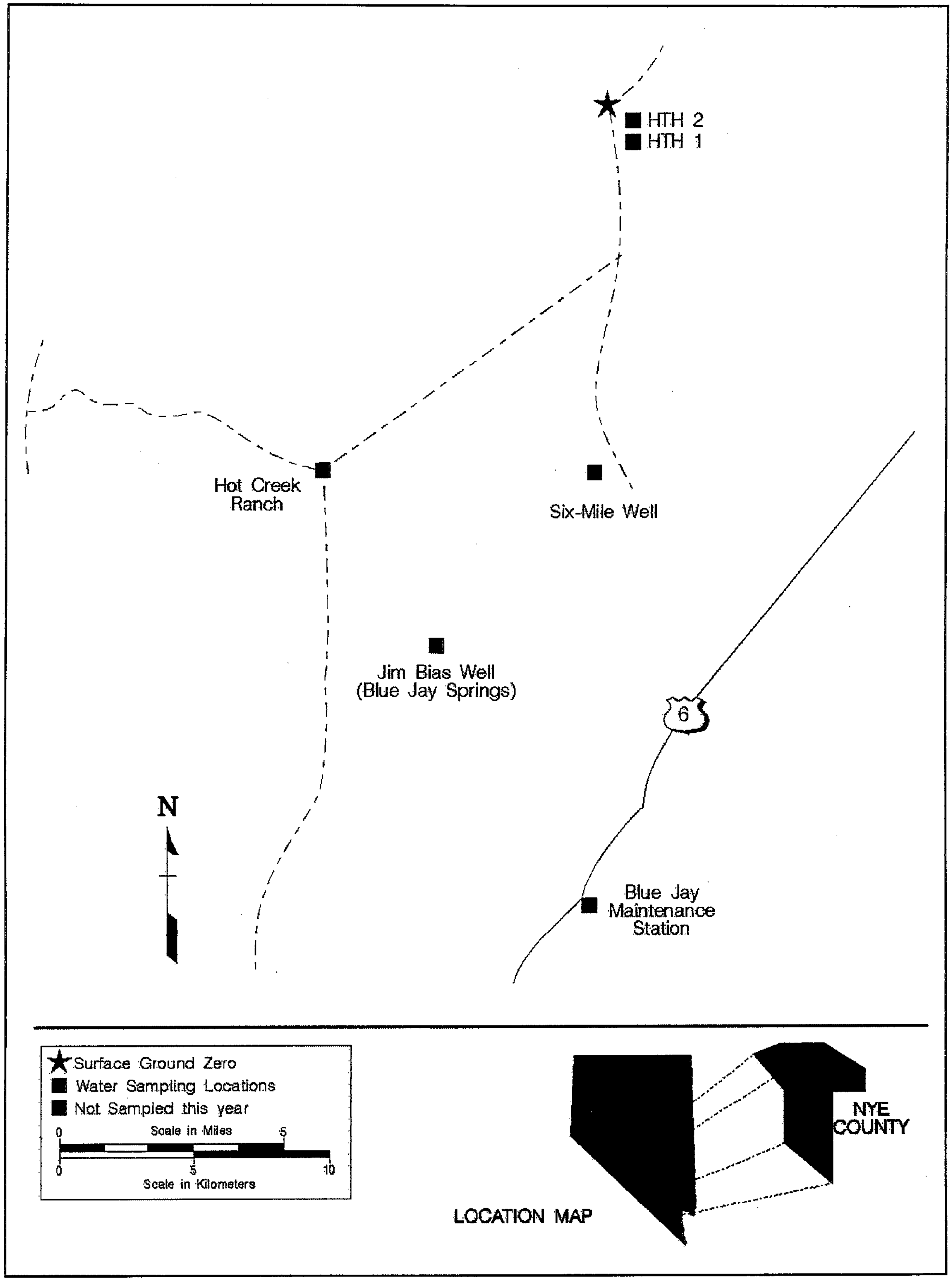


Figure 9.6 LTHMP Sampling Locations for Project FAULTLESS - 1994

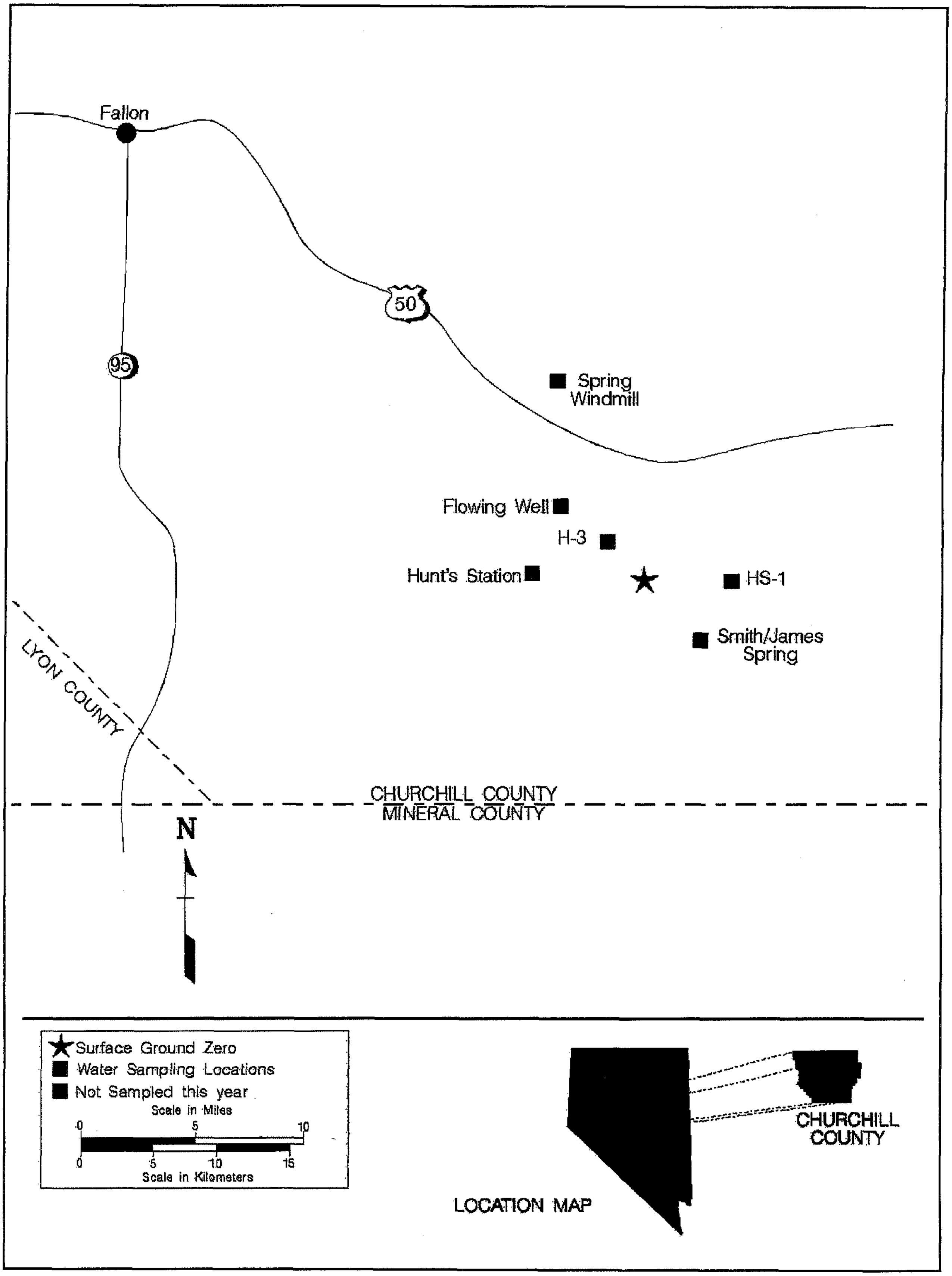


Figure 9.7 LTHMP Sampling Locations for Project SHOAL - 1994

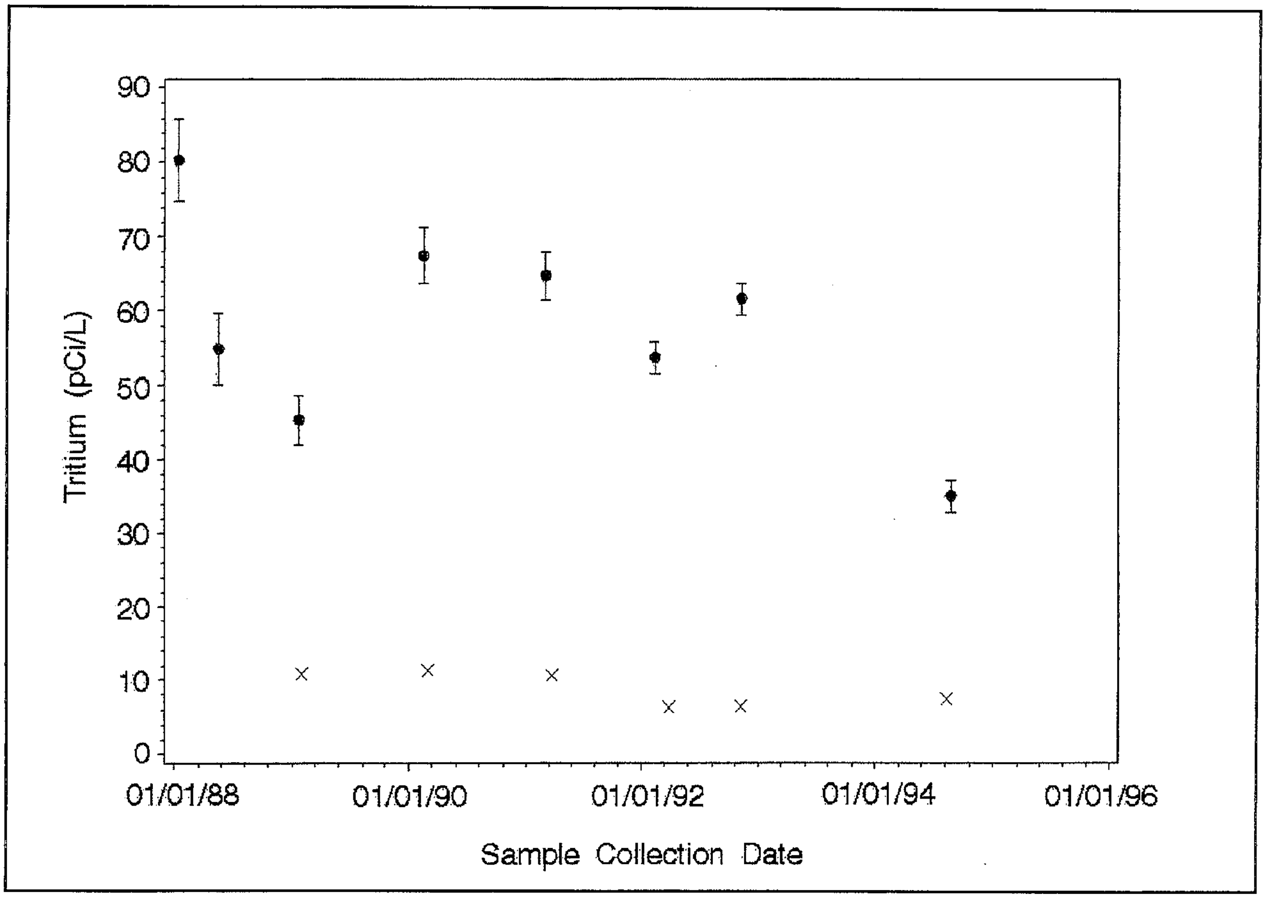


Figure 9.8 Tritium Results in Water from Smith/James Spring, Nevada

locations indicated that none are likely to detect migration of radionuclides from the test cavity (Chapman and Hokett, 1991).

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 1994 was from 48 ± 2.0 pCi/L at Battlement Creek, to 100 ± 2.3 pCi/L at Lee Hayward Ranch. All values were less than one percent of the DCG. The detectable tritium activities are probably a result of the high natural background in the area. This is supported by the DRI analysis, which indicated that most of the sampling locations are shallow, drawing water from the surficial aquifer which is unlikely to become contaminated by any radionuclides arising from the Project RULISON cavity (Chapman and Hokett, 1991).

9.6.4 PROJECT RIO BLANCO

Project RIO BLANCO was a joint government-industry test designed to stimulate natural gas flow and was conducted under the Plowshare Program. The test was conducted on May 17, 1973, at a location between Rifle and Meeker, Colorado. Three 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 May 26 - 27, 1994 from the sampling sites, shown in Figure 9.10, which include two shallow supply wells, six surface water sites along Fawn Creek, three springs, and three wells located near the cavity. At least two of the wells (Wells RB-D-01 and

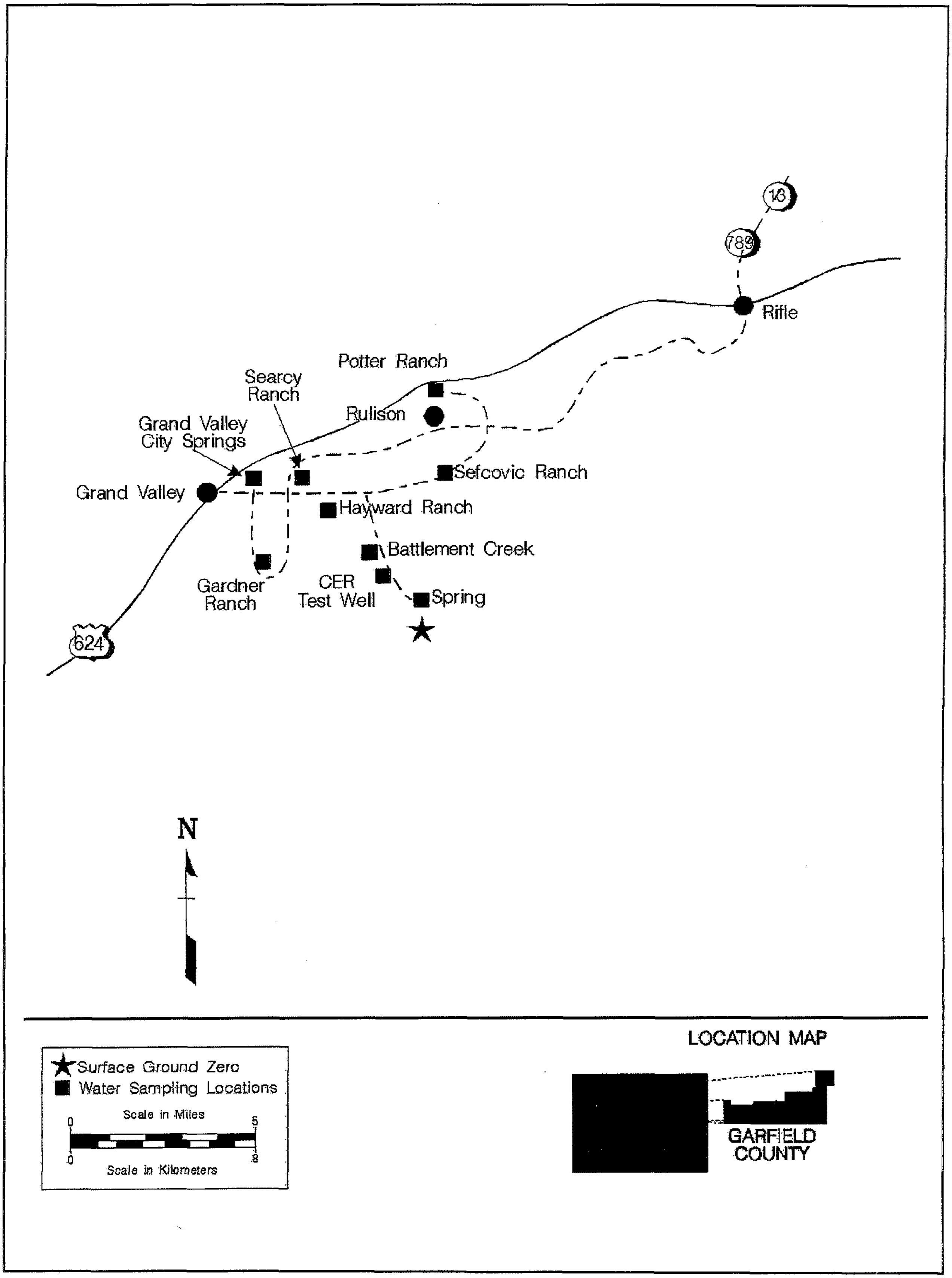


Figure 9.9 LTHMP Sampling Locations for Project RULISON - 1994

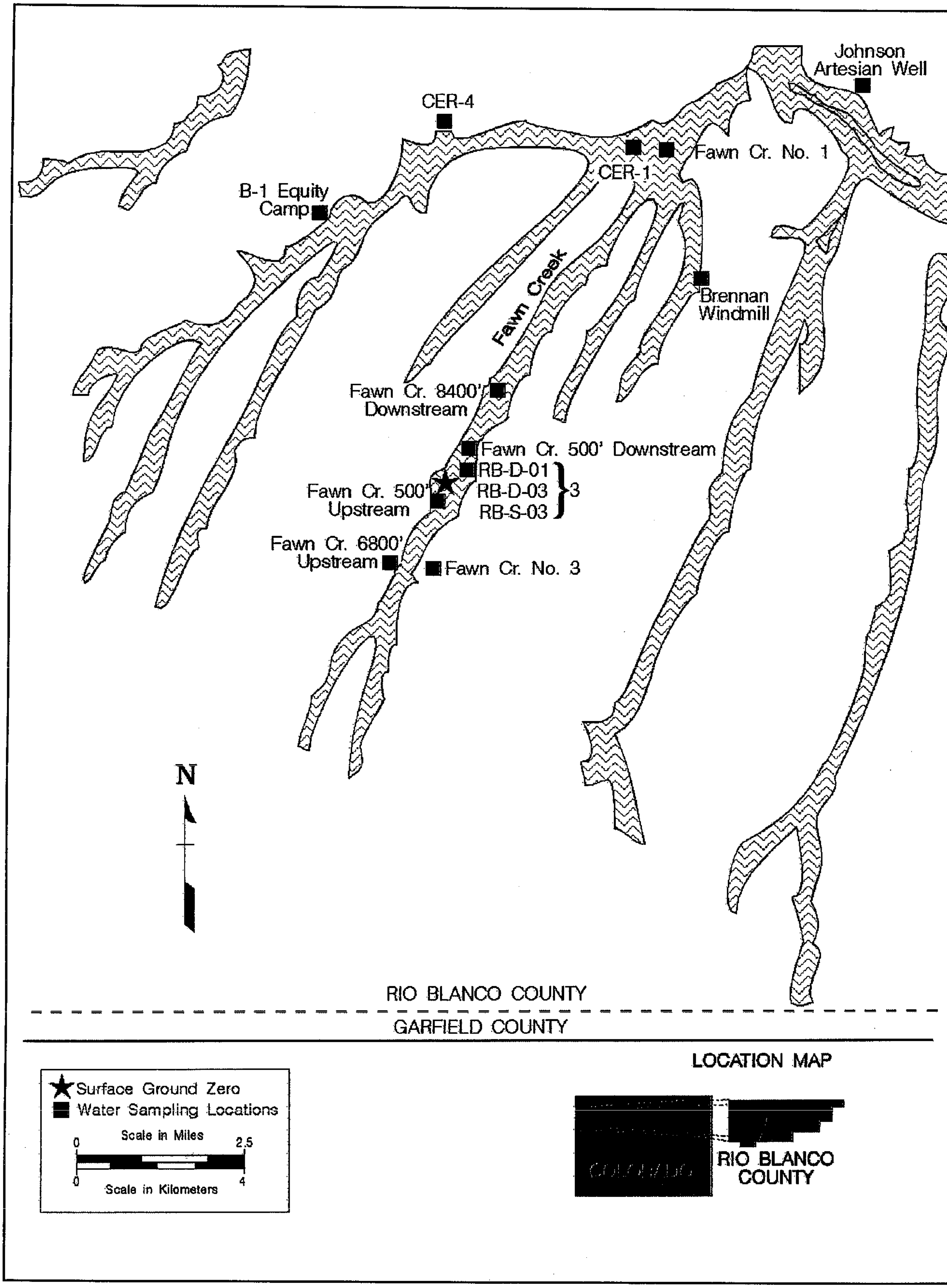


Figure 9.10 LTHMP Sampling Locations for Project RIO BLANCO, Colorado

RB-D-03) are suitable for monitoring possible migration of radioactivity from the cavity. There is no statistically significant difference between sites located upstream and downstream of the cavity area. There was no detectable tritium in the three monitoring wells, indicating migration from the test cavity has not been detected. No gamma activity was detected in any sample.

9.6.5 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 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 completed between June 1 - 3, 1994. The routine sampling sites, depicted in Figure 9.11, include nine monitoring wells in the vicinity of GZ, and the municipal supplies at Loving and Carlsbad, New Mexico.

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 6.2 ± 10^{3} pCi/L in Well LRL-7 to 9.1810^{7} pCi/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 USGS. None of these wells supply potable water. In addition to tritium, ^{137}Cs concentrations were observed in samples from Wells DD-1, LRL-7, and USGS-8, while ^{90}Sr activity was detected in Wells DD-1, USGS-4 and USGS-8. The remaining two wells with detectable tritium concentrations were PHS wells 6 and 8, with results less than 0.04 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.

9.6.6 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 1290 m (4240 ft). Production testing was completed in 1976 and restoration activities were completed in July 1978.

Samples were obtained May 22 through 24, 1994. The 12 routine sampling locations included six wells, one windmill, three springs, and two surface water sites, as depicted in Figure 9.12. The two surface water sampling sites and three springs yielded tritium activities that were less than 0.05 percent of the DCG, similar to the activity seen in previous years. Tritium activities in three shallow wells which were sampled this year varied from 8.8 to 13 ± 1.5 pCi/L. The sample from the windmill was less than the MDC.

Well EPNG 10-36, a well located 132 m (435 ft) northwest of the test cavity with a sampling depth of approximately 1100 m (3600 ft), had yielded tritium activities between 100 and 560 pCi/L in the years since 1984. The sample collected in 1994 yielded a tritium activity of 310 ± 4 pCi/L and ^{137}Cs activity of 5.9 ± 1.0 pCi/L. The tritium activity is roughly the same as observed in 1993, but the ^{137}Cs activity is a decrease from last year.

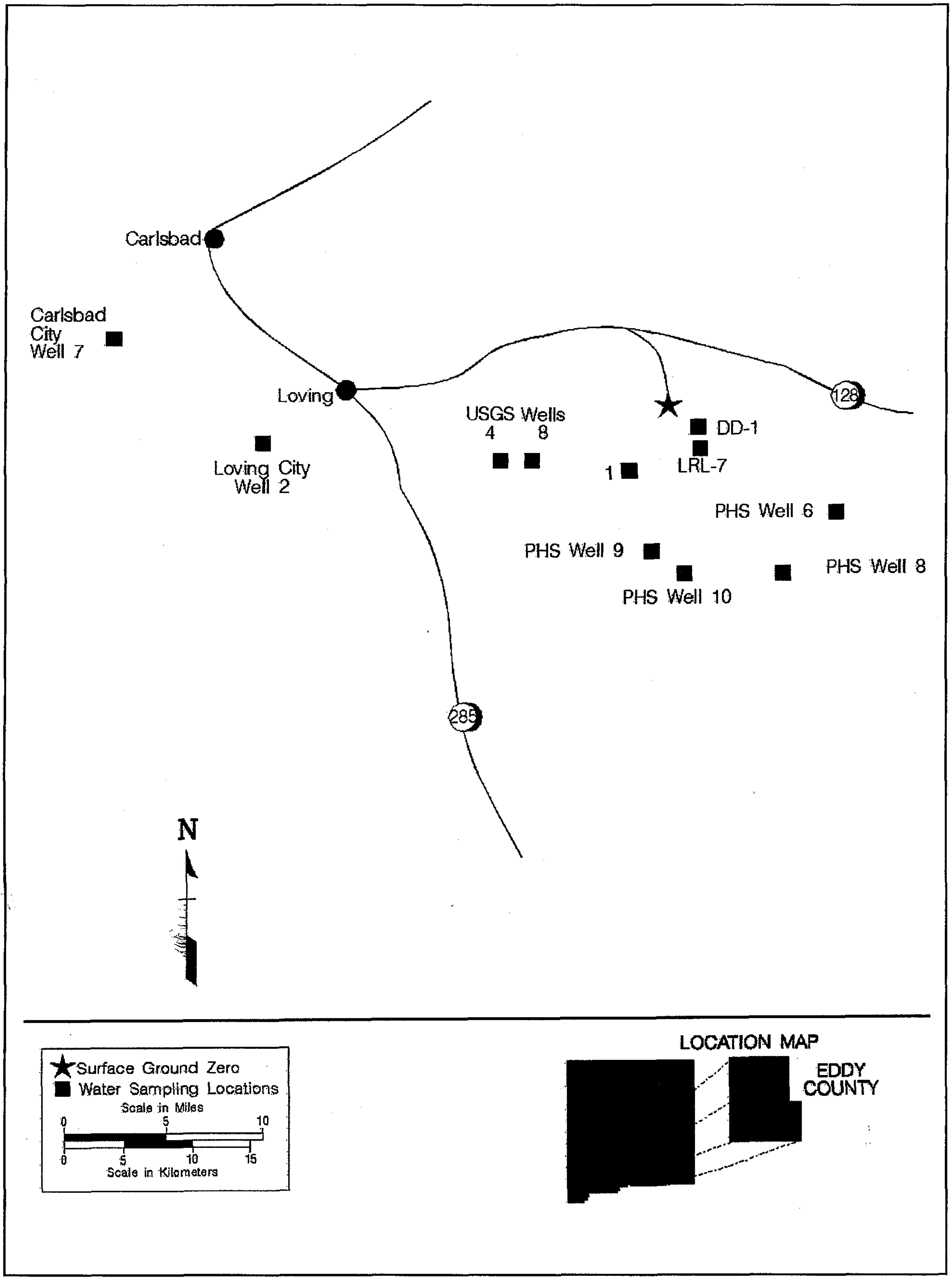


Figure 9.11 LTHMP Sampling Locations for Project GNOME - 1994

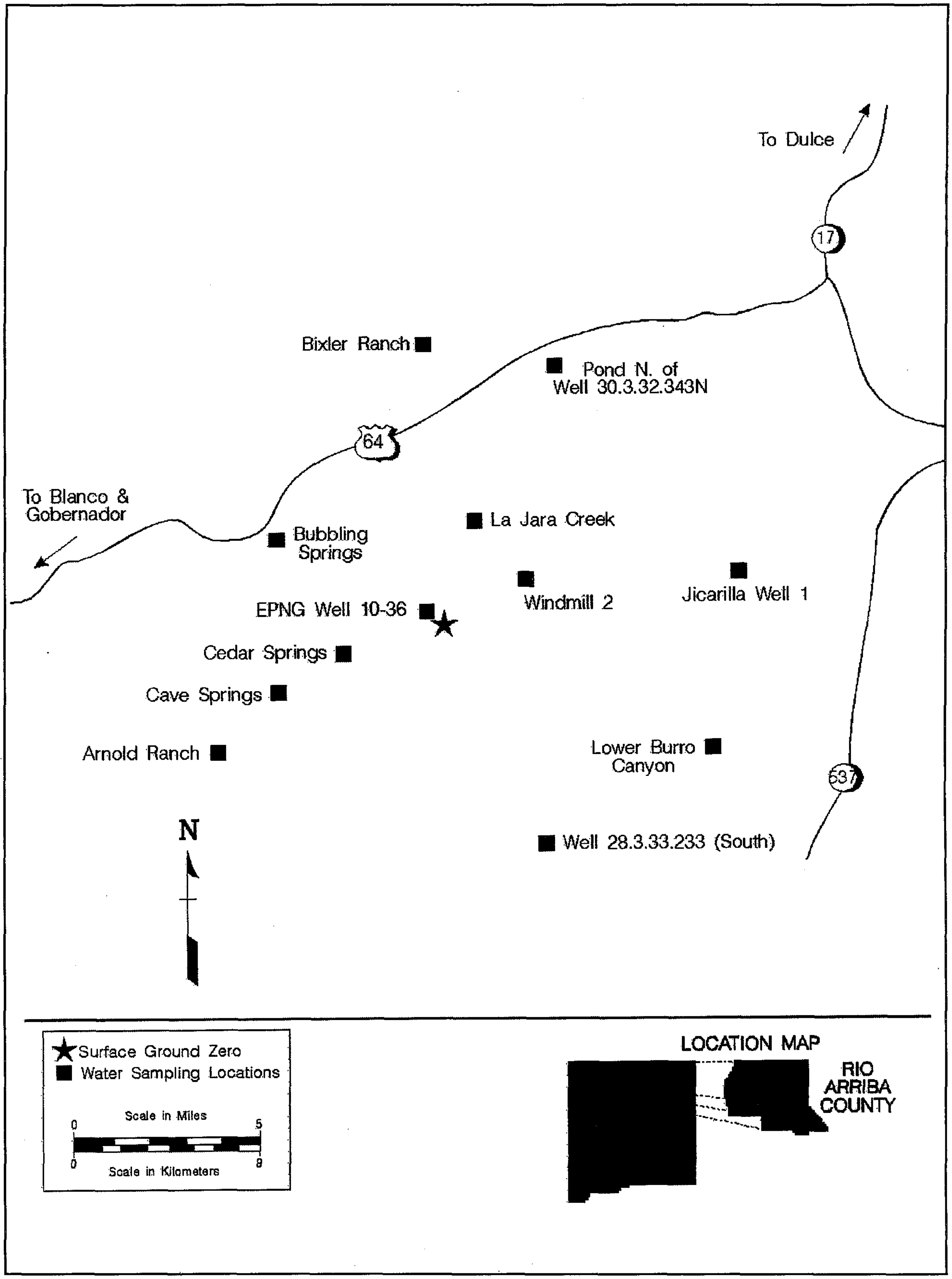


Figure 9.12 LTHMP Sampling Locations for Project GASBUGGY - 1994

The presence of fission products in samples collected from EPNG 10-36 confirms that migration from the Project GASBUGGY cavity is occurring. The migration mechanism and route are not currently known, although an analysis by DRI indicated two feasible routes, one through the Painted Cliffs sandstone and the other through the Ojo Alamo sandstone, one of the principal aquifers in the region (Chapman and Hokett, 1991). In either case, fractures extending from the cavity may be the primary or a contributing mechanism.

9.6.7 PROJECT DRIBBLE

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 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 (2710 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 2/2/69) and HUMID WATER (on 4/19/70). 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 9.13, 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 9.14.

A total of 158 samples was collected on and in the vicinity of the SALMON Test Site in April 1994, and sampling was repeated in September with the collection of 161 samples. In the 52 samples collected from offsite sampling locations, tritium activities ranged from less than the MDC to 38 pCi/L, 0.05 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 a few locations, such as the Baxterville City Well, depicted in Figure 9.15.

Due to the high rainfall in the area, the normal sampling procedure is modified for the shallow onsite wells as described in Section 9.6. Of the 32 locations sampled onsite (14 sites sampled twice), all yielded tritium activities greater than the MDC in either the first or second sample. Of these, nine yielded results higher than normal background (approximately 60 pCi/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 9.16. A special study of water supplies at the Salmon Test Site in Lamar County, Mississippi, was conducted in September of 1994. A comparison of the results to those obtained in April 1994, revealed no evidence of significant seasonal variation in the tritium concentrations in water samples collected from the surrounding areas. No tritium concentrations above normal background values were detected in any offsite samples. Some water supplies from the onsite area showed a concentration increase in the dry season, and have been observed to fluctuate throughout the year. No $^{238,239+240}Pu$ or ^{90}Sr was detected in well waters from the surface ground zero area, and gross alpha/beta activities in the shallow HMH series well waters were within drinking water regulation guidelines. Man-made gamma-ray emitting radionuclides were not detected in any sample collected in this study. Results of sampling related to Project DRIBBLE are discussed in greater detail in Onsite and Offsite Environmental Monitoring Report, "Radiation Monitoring around SALMON Test Site," Lamar County, Mississippi, April 1994.

9.6.8 AMCHITKA ISLAND, ALASKA

Sampling is conducted every two years, with the next sampling scheduled for 1995.

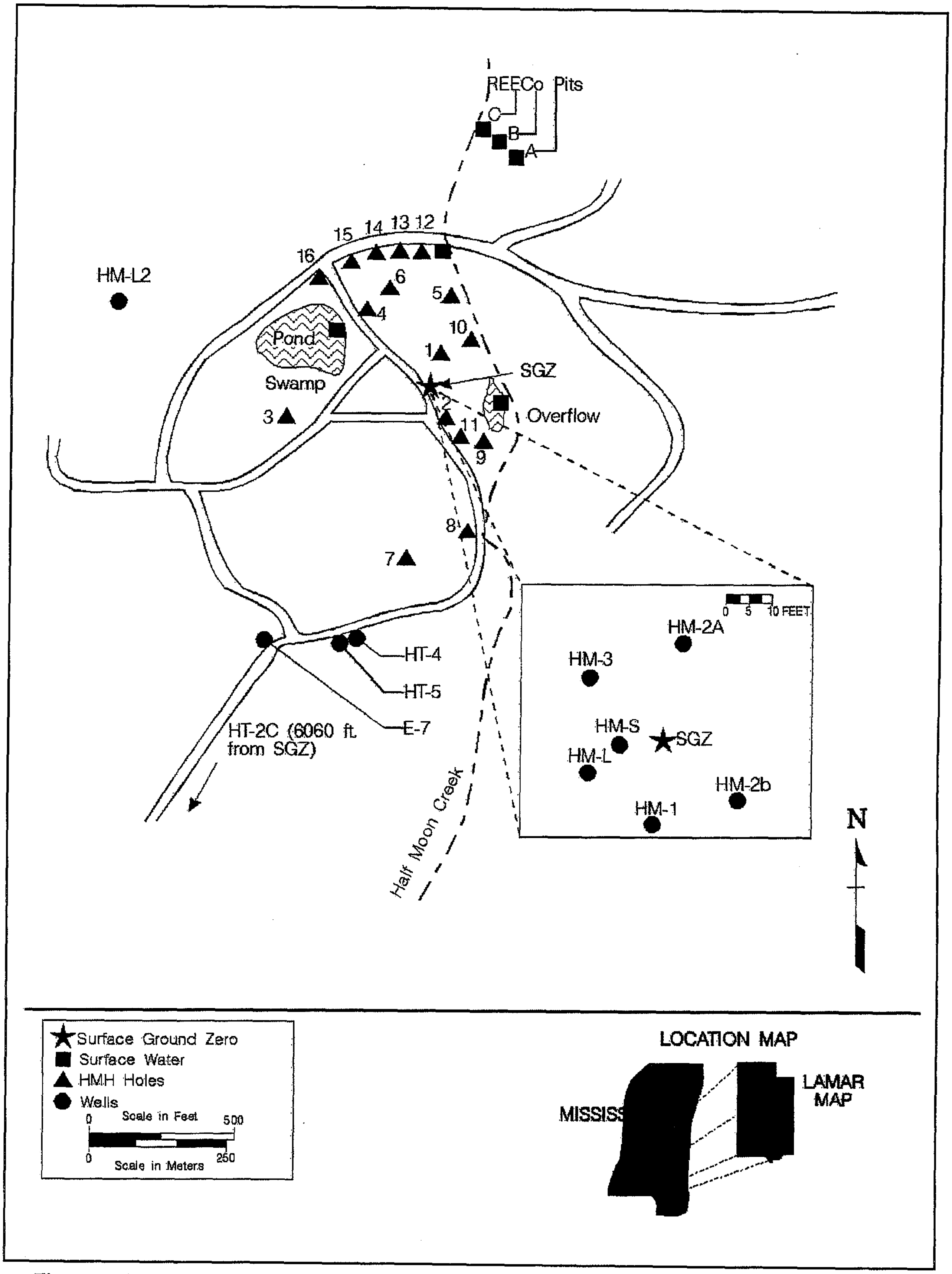


Figure 9.13 LTHMP Sampling Locations for Project DRIBBLE, Near Ground Zero - 1994

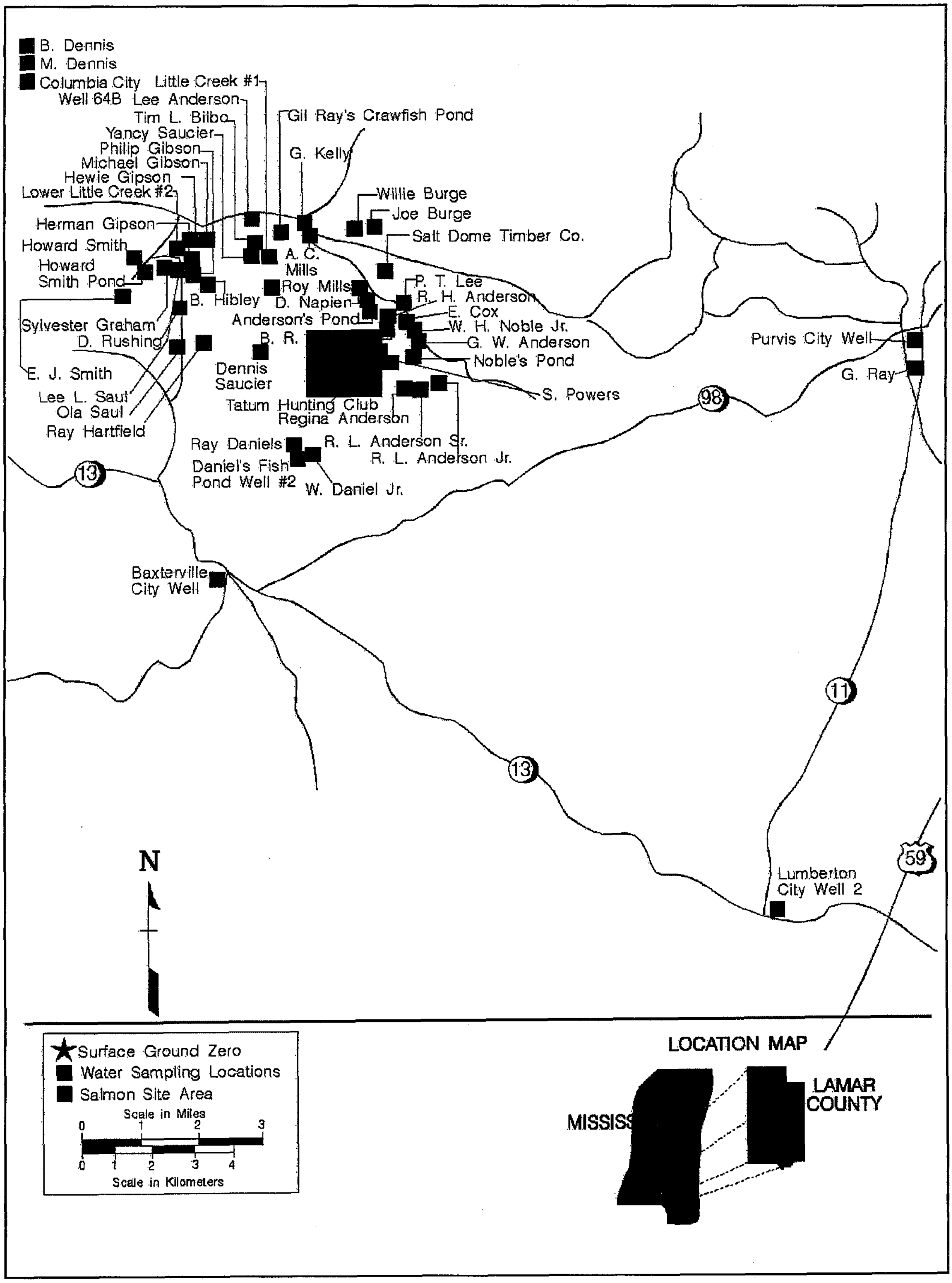


Figure 9.14 LTHMP Sampling Locations for Project DRIBBLE, Towns and Residences - 1994

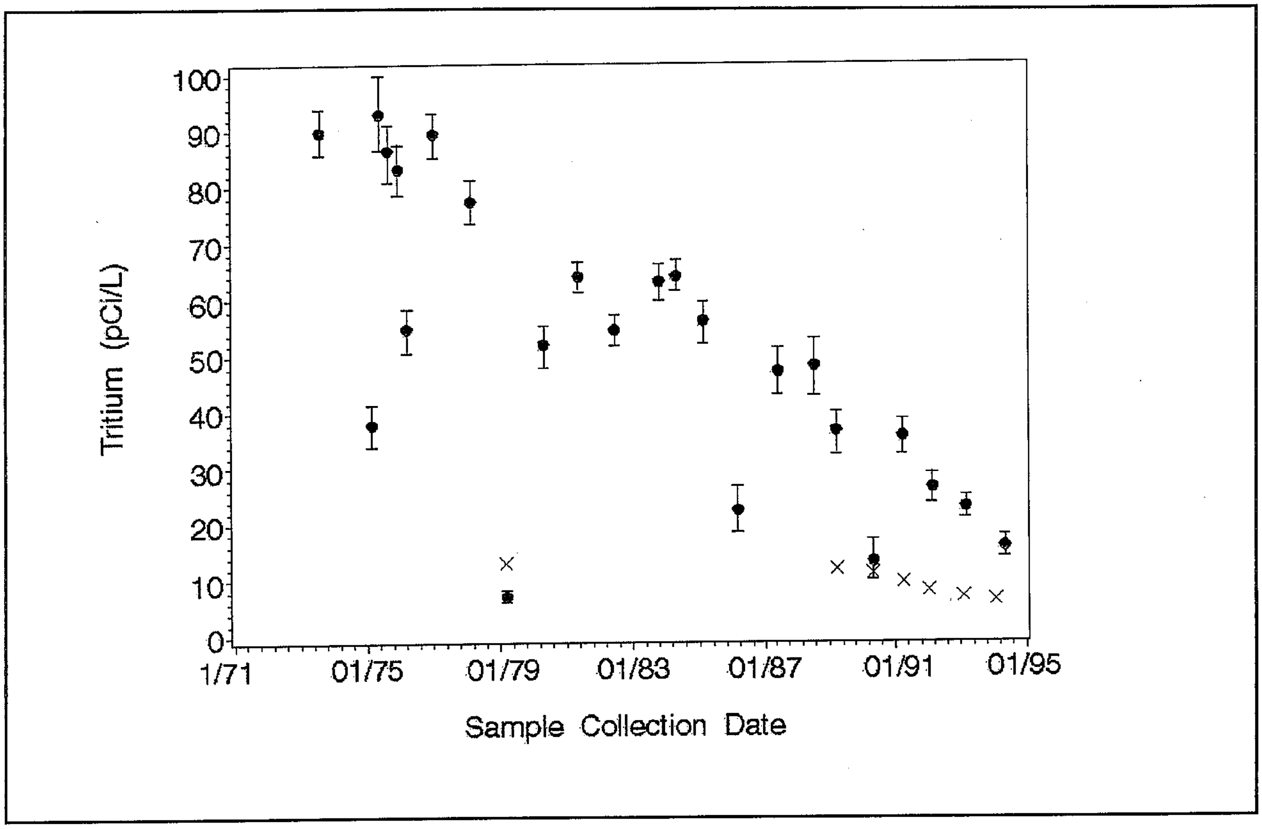


Figure 9.15 Tritium Results Trends in Baxterville, MS Public Drinking Water Supply - 1994

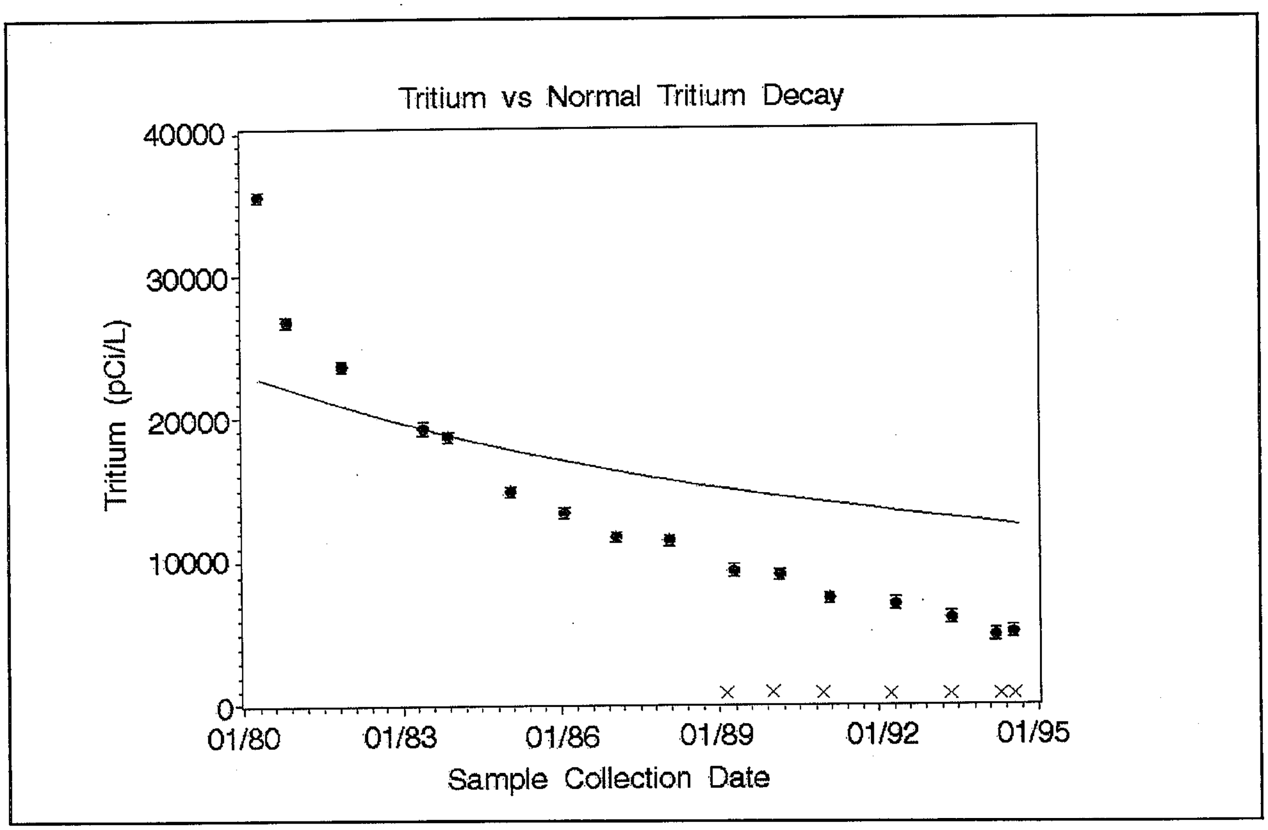


Figure 9.16 Tritium Results in Well HM-S, SALMON Site, Project DRIBBLE - 1994

Table 9.1 Locations With Detectable Man-Made Radioactivity in 1994 [(a)]

Sampling Location	Radionuclide	Concentration x 10^{-9} µCi/mL
NTS Onsite Network		
Well PM-1	^{3}H	200
Well UE-5n	^{3}H	2.2×10^{4}
Well UE-6d	^{3}H	710
Well UE-7ns	^{3}H	270
Well UE-18t	^{3}H	170
Well A	^{3}H	170
Project DRIBBLE, Mississippi		
Well HMH-1	^{3}H	1050, 16000[(b)]
Well HMH-2	^{3}H	7900, 9600
Well HMH-5	^{3}H	3100, 3400
Well HMH-10	^{3}H	---, 560
Well HM-L	^{3}H	690, 820
Well HM-S	^{3}H	4800, 4800
Half Moon Creek Overflow	^{3}H	380, 200
REECo Pit B	^{3}H	---, 740
REECo Pit C	^{3}H	---, 1600
Project GASBUGGY, New Mexico		
Well EPNG 10-36	^{3}H	310
	^{137}Cs	5.9
Project GNOME, New Mexico		
Well DD-1	^{3}H	9.2×10^{7}
	^{90}Sr	1.4×10^{4}
	^{137}Cs	1.0×10^{6}
Well LRL-7	^{3}H	6.2×10^{3}
	^{137}Cs	110
Well USGS-4	^{3}H	1.0×10^{5}
	^{90}Sr	5.0×10^{3}
Well USGS-8	^{3}H	8.0×10^{4}
	^{90}Sr	3.9×10^{3}
	^{137}Cs	66

(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.

(b) Project DRIBBLE wells were sampled in April and in September, --- = no sample

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)
Total and Dissolved Gamma-Emitting Radionuclides
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
Area 6	Decontamination Facility Evaporation Pond
Area 6	Steam Cleaning Effluent Pond
Area 23	Building 650 Leachfield
Area 23	Hazardous Waste Trenches
Area 27	Explosive Ordnance Disposal Facility

Table 9.4 Analytical Results of NTS Groundwater Samples Collected by HRMP in 1994

Well	Date	Depth (m)	H-3 Bq/L	Kr-85 Bq/L	Cs-137 Bq/L	Lab
RNM-1	8/3/94		40	<0.04		LANL
RNM-1	9/13/94		<40	<0.04	0.2	LANL
RNM-2S	9/29/94 (1135hr)		520			LANL
RNM-2S	9/29/94 (1148hr)		4400			LANL
RNM-2S	9/29/94 (1253hr)		11000			LANL
RNM-2S	9/29/94 (1408hr)		11000			LANL
RNM-2S	9/29/94 (1412hr)		11000	0.65		LANL
RNM-2S	9/29/94 (1416hr)		11000	0.62	$<4 \times 10^{-4}$	LANL
U-4t	8/31/93	311	40	0.1		LANL
UE-3e#4	8/25/93	497	18000	5.8		LANL
UE-3e#4	8/26/93	544	2000	0.44		LANL
UE-3e#4	8/25/93	655	363,000	190		LANL
PM-2	5/3/94	305	810			LANL
PM-2	5/4/94	823	26,000			LLNL
PM-2	5/4/94	823	27,000			LLNL
PM-2	5/4/94	823	26,000			LLNL
PM-2	5/4/94	914	26,000			LLNL
PM-2	5/4/94	914	26,000			LLNL
PM-2	5/4/94	914	26,000			LLNL
PM-2	5/4/94	305	800	0.09		LLNL
PM-2	5/4/94	823	25,000	<0.04		LLNL
PM-2	5/4/94	914	23,000	0.09		LLNL
U-20n	9/14/94	686	2,290,000	20		LANL
U-20n	9/14/94	746	2,240,000			LANL
U-20n	9/14/94	807	2,290,000	10		LANL
U2ggps3a	9/21/94		280	0.4		LANL

Table 9.5 Long-Term Hydrological Monitoring Program Summary of Tritium Results for Nevada Test Site Network, 1994

		Tritium Concentration (pCi/L)					
Location	Number	Maximum	Minimum	Arithmetic Mean	1 Sigma	Mean as %DCG	Mean MDC
Test Well B	4	93	70	79	31	0.10%	5.0
Test Well D	3	4.4	-2.2	0.61	0.93	NA	6.1
Test Well 7	4	13	-6.2	2.2	1.2	NA	5.5
Well Army 1	5	7.2	0.7	3.3	1.9	NA	1.9
Well Army 6A	3	24	-0.09	10	1.7	0.01%	6.0
Water Well C	5	7	2.6	4.8	2.5	NA	5.1

Conventional and/or enrichment tritium analysis techniques were used for the samples summarized in this table.

DCG Derived Concentration Guide; established by DOE Order as 80,000 pCi/L for water.
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 9.5 (Long-Term Hydrological Monitoring Program Summary of Tritium Results for Nevada Test Site Network, 1994, cont.)

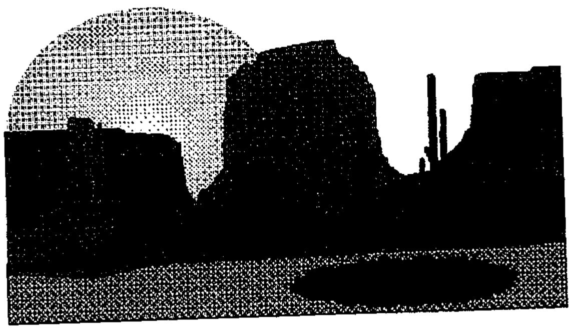
Location	Number	Tritium Concentration (pCi/L) Maximum	Minimum	Arithmetic Mean	1 Sigma	Mean as %DCG	Mean MDC
Well C-1	5	32	7.3	22	10	0.03%	5.6
Well Groom 3	4	7.3	2.5	4.1	2.1	NA	5.2
Well Groom 4	Well Down						
Water Well 4	4	2.6	-1.2	0.6	0.75	NA	5.4
Well Groom 5	4	2.9	0.96	1.6	1.1	NA	5.3
Well 5B	4	2.1	0.05	0.94	0.86	NA	5.4
Water Well 5C	5	2.5	-5.0	-0.78	0.45	NA	6.0
Well Groom 6	4	3.2	-1.0	1.2	1.1	NA	5.0
Well HTH 8	4	2.0	-5.5	-0.53	0.84	NA	5.3
Water Well 20	Well Down						
Well HTH 1	2	21	10	15	6.1	0.02%	5.4
Well J-12	4	0.85	-3.6	-0.55	0.7	NA	6.3
Well J-13	4	0.48	-1.8	-0.41	0.28	NA	5.3
Well P.M. Expl.1	1	200	200	200	2.6	0.25%	4.2
Well UE-1C	4	1.8	-1.8	0.41	0.89	NA	5.6
Well UE-5C	5	3	-1.4	1.7	1.4	NA	5.2
Well UE-7NS	4	290	250	270	100	0.34%	6.0
Well UE-16D	3	2.1	-2.6	-0.19	0.58	NA	5.8
Well UE-16F	2	8.3	4.9	6.6	3.3	0.01%	6.6
Well UE-17A	3	1.1	-4.1	-1.3	0.62	NA	5.1
Well UE-18R	3	4.9	2.1	3.9	2.1	NA	5.0
Well UE-18T	4	250	46	170	63	0.21%	5.9
Well A	1	170	170	170	3.4	0.21%	7.2
Water Well 2	Well Down						
Well USGS HTH-F	Well Down						
Well U-3CN-5	Well Down						
Well UE-4T-1	Instrument in hole						
Well UE-6E	2	13	12	12.5	3.9	0.02%	4.9
Well UE-15D	Well Down						
Well UE-19C	Well Down						
Well UE-5N	5	26000	15000	22000	9400	28%	358
Well UE-6D	2	750	670	710	190	0.89%	221
Well 4A	2	0.19	-2.70	-1.26	0.95	NA	6.3
Pilot Well 1	1	0.16	0.16	0.16	1.8	NA	5.8

Conventional and/or enrichment tritium analysis techniques were used for the samples summarized in this table.

DCG Derived Concentration Guide; established by DOE Order as 80,000 pCi/L for water.

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.

Laboratory Quality Assurance



10.0 LABORATORY QUALITY ASSURANCE

It is the policy of DOE/NV that all data produced for its environmental surveillance and effluent monitoring programs be of known quality. Therefore, a quality assurance (QA) program for collection and analysis of samples for radiological and nonradiological parameters ensures 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 Department of Energy (DOE) Quality Assessment Program (QAP) administered by the DOE Environmental Measurements Laboratory (EML), the Environmental Radioactivity Performance Evaluation Studies Program (ERPESP) conducted by the EPA's Environmental Monitoring Systems Laboratory in Las Vegas (EMSL-LV), and the quality assessment program sponsored by the International Reference Center for Radioactivity (IRCR) of the World Health Organization (WHO). The radiological external QA program also consists of participation in the DOE Laboratory Accreditation Program (DOELAP) Radiobioassay In-Vitro study administered by DOE; the Oak Ridge National Laboratories (ORNL) radiobioassay study conducted by ORNL in Oak Ridge, Tennessee; and the Tritium Enrichment program sponsored by the DOE Nevada Operations Office Environmental Protection Division (DOE/NV/EPD). The external QA program for nonradiological data consisted of participation in the National Institute of Occupational Safety and Health (NIOSH) Proficiency Analytical Testing (PAT) Program; the American Industrial Hygiene Association (AIHA) Asbestos Analysts Registry (AAR) Program; the AIHA Bulk Asbestos Analysis Program, National Voluntary Laboratory Accreditation Program (NVLAP) Bulk Asbestos Fiber Analysis Program; the College of American Pathologists (CAP) Analysis of Lead in Blood Program; the Environmental Lead Proficiency Analytical Testing program administered by the American Industrial Hygiene Association; and the state of Nevada water pollution and water supply laboratory performance evaluation programs.

The environmental surveillance program off the Nevada Test Site was conducted by EMSL-LV. The QA program developed by the Radiation Sciences Division (RSD) of EMSL-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 Reynolds Electrical & Engineering Company, Inc. (REECo) and offsite by the EMSL-LV, is governed by DOE QA policy as set forth in DOE Order 5700.6C. The Order outlines 10 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, EMSL-LV meets the U. S. Environmental Protection Agency (EPA) policy which states that all decisions which are dependent on environmental data are supported by data of known quality. EPA policy requires participation in a centrally managed Quality Assurance 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 EMSL-LV are summarized in the "Quality Management Plan" (EPA 1994a). Policies and requirements specific to the Offsite Radiological Safety Program (ORSP) are documented in the "Quality Assurance Program Plan for the Nuclear Radiation Assessment Division Offsite Radiation Safety Program" (EPA 1992b). 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 (SOP) of the EMSL-LV RSD.

10.2 OVERVIEW OF THE LABORATORY QA PROGRAM

The REECo Analytical Services Department (ASD) implements the requirements of DOE Order 5700.6C, "Quality Assurance" through integrated quality procedures. The quality of data and results is assured 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 quality assurance 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 quality assurance 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 quality assurance 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 EMSL-LV to ensure the quality of environmental data collected off the NTS.

10.3 DATA AND MEASUREMENT QUALITY OBJECTIVES

10.3.1 DATA QUALITY OBJECTIVES

Data quality objectives delineate the circumstances under which measurements are made, and define the acceptable variability in the measured data. Data quality objectives describe 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, which define acceptable variability in the measured data, are established to ensure the quality of the measurements.

10.3.1.1 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 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 due to 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).

10.3.1.2 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. Work place and personnel monitoring to determine possible worker exposures is conducted by Health Protection Department (HPD) Industrial Hygienists and Health Physicists.

10.3.1.3 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 using EPA approved methods, such as, EPA Method No. 1311, Toxicity Characteristic Leaching Procedure; EPA Method No. 6010, Inductively Coupled Plasma Analysis for Inorganic Analytes; EPA Method No. 8270, Analysis of Semivolatile Organic Compounds, etc. Methods and procedures used to measure possible worker exposures to nonradiological hazards are defined by Occupational Safety and Health Administration (OSHA) or National Institute of Occupational Safety and Health (NIOSH) protocols. Typical contaminants for which HPD 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.

10.3.1.4 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 REECo's Environmental Section SOPs. The locations of nonradiological environmental sampling and monitoring are determined through site remediation and characterization activities and by permit requirements.

10.3.1.5 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.

10.3.1.6 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.

10.3.2 MEASUREMENT QUALITY OBJECTIVES

Measurement quality objectives (MQO) 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.

10.3.2.1 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 input 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.

10.3.2.2 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 ERPESP.

10.3.2.3 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 REECo completeness objectives for all radiological samples and analyses have been set at 90 percent for sample collection and 85 percent for analyses. EMSL-LV's completeness objective for the LTHMP is 80 percent and for the other networks is 90 percent.

Completeness for inorganic and organic analyses is based on a comparison to hold time. Hold times are regulatory defined times within which organic and inorganic extractions or analyses must be performed. Hold times are analyte specific, i.e., twenty-four hours for a pH analysis, fourteen days for volatile organic compounds, or six months for inorganic analytes. Sample analyses which are performed outside the regulatory-defined hold times are considered invalid.

10.3.2.4 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 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.

10.3.2.5 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 ASD 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 ASD staff until several months after the measurements are made and the results sent back to the quality assurance laboratory. Additionally, quality control samples with known values are submitted to the Laboratories by the ASD Quality Support Group. 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., 100 - % accuracy. The smaller the percent bias, the more accurate are the measurements. Table 10.2 shows the ASD and EMSL-LV accuracy objectives.

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 EMSL-LV and ASD laboratories participate in several interlaboratory performance evaluation (PE) programs such as EPA's ERPESP and EML's QAP and the DOELAP for TLDs. The ASD Laboratory also participates in the World Health Organization program and two bioassay programs, DOELAP and ORNL.

The ASD Laboratory also participates in the NIOSH PAT, AIHA AAR, CAP, ELPAT, NVLAP, DOELAP, Round Robin, and the state of Nevada water pollution (WP) and water supply (WS) programs. These PE programs provide an independent check of the accuracy of REECo analytical measurements.

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 REECo and EMSL-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 10.7. Complete data for these measurement quality objectives for 1994 may be found in the "Environmental Data Report for the Nevada Test Site, 1994" (DOE/NV/11432-176, in prep.).

10.4.1 COMPLETENESS

The analysis completeness data for calendar year 1994 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 compared to the total analyses expected from the samples scheduled for the year.

The completeness MQOs for the onsite networks were met or exceeded in all cases except for ^{133}Xe collection and analyses. For the offsite networks, the MQOs were met or exceeded except for the noble gas network. The completeness was >89%, just short of the 90 percent objective.

10.4.2 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 EMSL-LV Laboratory, the samples not meeting the precision MQO were low activity, air particulate samples analyzed for gross alpha in air. The data would still be useful as many of the individual samples met the MQO and the others would serve as an alerting mechanism, suggesting an event that requires some investigation. The precision data for all other analyses were well within their respective MQOs.

For the ASD Laboratory, there was one analysis that failed to meet the MQO, namely, krypton-85 in air. Subsequent investigation of the analytical procedure revealed equipment and procedure problems for part of the year that have since been corrected. One 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.

10.4.3 ACCURACY

The ASD and EMSL-LV accuracy objectives were measured through participation in the interlaboratory comparison and quality assessment programs discussed below.

10.4.3.1 RADIOLOGICAL PERFORMANCE EVALUATION RESULTS

The external radiological Performance Evaluation (PE) program consisted of participation in the QAP conducted by DOE/EML and the ERPESP conducted by EPA. These programs serve to evaluate the performance of the radiological laboratory and to identify problems requiring corrective actions.

Summaries of the 1994 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, 1994" (DOE/NV/11432-176, 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 EMSL-LV Laboratory failed the accuracy MQO in 8 of the 47 analyses attempted in the EPA PE Study. Four of those that failed the MQO were blind PE samples. In the EML QAP, on the other hand, only 2 of the 28 analyses performed exceeded the DQO of ± 20 percent. In addition to obtaining renewed accreditation by DOELAP for the environmental TLD program, EMSL-LV also participated in the U.S. Army TMDE Activity which had the objectives of a QA check on the DOELAP categories and a data gathering activity on performance characteristics of personnel TLDs. The results of this blind testing confirmed that the EMSL-LV TLD program was accurate and reproducible within the established performance standards.

REECo's ASD Laboratory accuracy in the EPA ERPESP was acceptable. Only 3 of the 49 samples failed the MQO. These were for strontium analyses. The MQOs for accuracy in analysis of DOE/EML samples were not met in only 2 of the 59 samples supplied.

10.4.3.2 NONRADIOLOGICAL PERFORMANCE EVALUATION RESULTS

The external nonradiological PE program consisted of participation in the NIOSH PAT program, CAP Lead in Blood Program, and AIHA AAR program. These programs serve to evaluate the performance of the nonradiological laboratory and identify problems requiring corrective actions.

Summaries of the 1994 results of the interlaboratory comparison and QA programs conducted by the NIOSH PAT, CAP, and AIHA AAR are provided in Table 10.7. In general, performance on volatile organic analysis was poor with many outlier results. The results for metals, blood lead, and asbestos were within control limits established by the various agencies conducting the studies.

10.4.3.3 CORRECTIVE ACTIONS IMPLEMENTED IN RESPONSE TO PERFORMANCE EVALUATION PROGRAMS

REECo 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, the use of an internal standard for solvents, and an improved tracking system for PE samples.

10.4.4 COMPARABILITY

The EPA Performance Evaluation Program 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 1994 intercomparison studies for all variables measured were compared with the grand average to calculate a normalized deviation for the EMSL-LV results. There were three instances in which the EMSL-LV Laboratory results deviated from the grand average by more than three standard normal deviate units. These were ^{60}Co, ^{134}Cs and ^{137}Cs in the October blind performance evaluation study sample. All other 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 EMSL-LV Laboratory results with the 73 to 262 laboratories participating in the EPA Performance Evaluation Study Program.

The onsite ASD Laboratory's results in the EML QAP were closer to the mean (grand average) of all participating laboratories than they were to the EML known value. In only 7 of the 59 comparisons did the ratio of ASD to the grand average indicate more bias than the ratio of ASD to EML so the ASD results were more comparable to those produced by other radioanalytical laboratories than to the value supplied by the program operator. Similarly, the EPA ERPESP 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 ASD results as compared to the grand average was calculated for each analysis. The average bias from the EPA stated value was -6.2 percent while the average deviation from the grand average was -5.3 percent so, again, the ASD results were closer to the grand average than to the known value and indicated acceptable comparability.

Table 10.1 Precision Objectives Expressed as Percents

Analysis	Conc. > 10 MDC	4 MDC ≤ Conc. ≤ 10 MDC
	ASD Laboratory	
Gross Alpha	±30	±60
Gross Beta	±30	±60
Gamma Spectrometry	±30	±60
Scintillation Counting	±30	±60
Alpha Spectrometry	±20	±50

Note: The precision objective for TLDs at environmental levels is 10 percent.

Analysis	Conc. > 10 MDC	4 MDC ≤ Conc. ≤ 10 MDC
	EMSL-LV Laboratory	
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
Noble Gases	±20	±30
Plutonium	±20	±30

Table 10.2 Accuracy Objectives Expressed as Percent Bias

Analysis	Conc. > 10 MDC	4 MDC ≤ Conc. ≤ 10 MDC
	ASD Laboratory	
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 accuracy objective for TLDs is 20 percent for exposures < 10 mR and 10 percent for exposures ≥ 10 mR.

Analysis	Conc. > 10 MDC	4 MDC ≤ Conc. ≤ 10 MDC
	EMSL-LV Laboratory	
Tritium, Conventional	±10	±30% of MDC
Strontium (Milk)	±10	±30% of MDC
Thorium	±10	±30% of MDC
Uranium	±10	±30% of MDC
Tritium, Enriched	±20	±30% of MDC
Strontium (other media)	±20	±30% of MDC
Plutonium	±20	±30% of MDC
Noble Gases	±20	±30% of MDC
TLDs	Meet DOELAP Criteria	

Table 10.3 Analysis Completeness Data for Calendar Year 1994

Analysis	Medium	Completeness, % REECo	Completeness, % EMSL-LV
Gross Beta	Particulate Air Filter	96.3	97.7
Plutonium	Particulate Air Filter	96.3	97.6
Gamma Spectrometry	Particulate Air Filter	96.3	97.0
Gamma Spectrometry	Charcoal Air Filter	96.3	97.0
Tritiated Water	Air	92.9	96.7
Krypton-85	Air	87.0	89.2
Xenon-133	Air	55.0	89.2
Gross Beta	Potable Water Endpoints	93.6	---
Gamma Spectrometry	Potable Water Endpoints	93.6	---
Tritiated Water	Potable Water Endpoints	93.6	---
Plutonium	Potable Water Endpoints	96.6	---
Gross Beta	Wells, Reservoirs, Springs, Ponds	91.6	---
Plutonium	Wells, Reservoirs, Springs, Ponds	95.5	---
Gamma Spectrometry	Wells, Reservoirs, Springs, Ponds	91.6	90.5
Tritiated Water	Wells, Reservoirs, Springs, Ponds	91.6	90.5
Strontium-90	Wells, Reservoirs, Springs, Ponds	95.5	---
Gross Alpha	Potable Wells and Endpoints	98.7	---
Tritium	Milk	---	92.6
Strontium	Milk	---	92.6
Animal Investigation	Tissues	---	95.7
Pressurized Ion Chamber	Ambient Radiation	---	95.1
TLDs	Ambient Radiation	---	---

--- Analyses not performed

Table 10.4 Precision Estimates from Replicate Sampling - 1994

Analysis	Number of Replicate Analyses	Precision Estimate % RSD
	ASD Laboratory	
Gross Beta in Air	40	17.5
Gamma in Air	33	23.6
Tritium in Air	9	47.8
^{85}Kr in Air	93	61.6
Gross Alpha in Potable Water	16	29.7
Gross Beta in Potable Water	7	41.2
Gross Beta in Tunnel Effluent	13	22.8
HTO in Tunnel Effluent	13	1.0
Pu in Tunnel Effluent	14	9.8
^{90}Sr in Tunnel Effluent	2	28.2
	EMSL-LV Laboratory	
Gross Alpha in Air	157	31.5
Gross Beta in Air	278	12.7
Gamma Spectrometry (^{7}Be)	9	13.3
^{85}Kr in Air	37	6.9
Tritium in Water (enriched)	45	7.4
Potassium in Milk	88	9.4
TLDs	488	10
Bioassay (^{3}H spike)	10	2
AIP Ash Samples (Pu)	3	>30

Table 10.5 Accuracy of EMSL-LV Radioanalyses (EML QAP and ERPESP) - 1994

Analysis	No.	ERPESP	EMSL-LV	% Bias	
		Water Samples Range of Results - pCi/L			
Gross Alpha	5	15 - 86	15 - 90	-3 - 34	
Gross Beta	5	10 - 142	14 - 137	-6.2 - 40	
Gamma Spec	25	14 - 252	14 - 183	-27 - 108	(80,94,&108 %RSD from PE samples)
Strontium	6	14 - 30	14 - 26	-11 - 25	
Alpha Spec	5	10 - 53	10 - 53	-18 - 1.6	
		Air Filter Samples Range of Results - pCi/L			
Gross Alpha	1	35	35	0.9	
Gross Beta	1	56	58	3.0	
^{137}Cs	1	15	16	4.7	
		Milk Samples Range of Results - pCi/L			
^{90}Sr	1	15	18	22	
^{131}I	1	75	78	4.0	
^{137}Cs	1	59	66	12	
Potassium	1	1715	1728	0.8	

Analysis	No.	Air	Soil	Vegetation	Water
		%Bias Range for Analysis of EML QAP Samples			
Plutonium	4	-22 - 8.1	-10 - -3.2	5.4 - 18	-14 - -0.9
Uranium	1	--	--	--	8.6
Strontium	2	--	--	5.1 - 15	2.2 - 12
Tritium	2	--	--	--	-2.3 - 5.3
Gamma Spec	13	-7.7 - 24	--	--	-14 - 11

Table 10.6 Accuracy of ASD Radioanalyses (ERPESP and EML QAP) - 1994

Analysis	No.	REECo/ASD	ERPESP	%Bias	
		Water Samples Range of Results - pCi/L			
Gross Alpha	4	10 - 81	10 - 86	-14 - -4	
Gross Beta	4	5 - 117	10 - 142	-50 - +14	1 outlier
Gamma Spec	21	20 - 106	20 - 134	-18 - +15	
Strontium	8	7 - 20	14 - 30	-50 - +7	
Alpha Spec	6	9.6 - 46	9.9 - 53	-24 - +28	
Tritium	2	4740 - 9590	4940 - 9950	-4 - -3.5	
		Air Filter Samples Range of Results - pCi/L			
Gross Alpha	1	34.7	35	-0.8	
Gross Beta	1	58	56	+3.6	
^{137}Cs	1	18.3	15	+22	
^{90}Sr	1	24.3	20	+22	

Analysis	No.	Air	Soil	Vegetation	Water
		%Bias Range for Analysis of EML QAP Samples			
Americium	2	-17 - -16	--	-16	-10
Plutonium	4	+9 - +18	-46 - -22	-3 - +8	-14 - -0.9
Uranium	2	-42	-19 - -14	--	-16 - -14
Strontium	2	-30	+2 - +29	-16	-10 - +12
Tritium	2	--	--	--	-11 - -1
Gamma Spec	16	-28 - +42	-8	+6 - +17	-8 - +11

Table 10.7 ASD Laboratory Results: Analysis of Intercomparison Study Samples - 1994

Analyte	No.	ASD Results	Actual Value[a]	%Bias	
		Range of Results for NIOSH-PAT Samples			
Cadmium (mg)	12	0.0046-0.0196	0.0050-0.0196	-13 - -1	2 outliers
Chromium (mg)	8	0.0957-0.2399	0.0939-0.2387	0 - +4	
Lead (mg)	12	0.0205-0.0888	0.0212-0.0938	-10 - +2	
Zinc (mg)	4	0.0625-0.1600	0.0698-0.1814	-12 - -10	
Silica (mg)	12	0.0328-0.1551	0.0388-0.1306	-30 - +19	
Asbestos (fiber/mm²)	12	87-890	103-800.2	-16 - +28	
		Solvents (mg)			
Trichloroethylene	4	0.2616-1.1387	0.4545-1.1494		All outliers
Trichloroethane	4	0.4448-1.1339	0.2220-0.9827		All outliers
Tetrachloroethylene	4	0.3712-1.1206	0.3304-1.0064	+6 - +13	1 outlier
Chloroform	4	0.2260-1.0890	0.4141-0.9656	+12 - +13	2 outliers
Carbon Tetrachloride	4	0.1990-1.1150	0.2139-0.9548	-7 - +12	1 outlier
Dichloroethane	4	0.3000-1.0900	0.2754-0.9744	+9	2 outliers
Benzene	4	0.1470-0.4466	0.2113-0.4522	-3 - +3	
o-Xylene	4	0.3436-0.9522	0.3486-0.9843	-3 - -1	
Toluene	4	0.2358-0.8828	0.2353-0.9112	-3 - 0	
		CAP Program			
Blood Lead (µg/dL)	10	3.2 - 112.1	3.43 - 98.06	-7 - +31	
		AAR Program			
Asbestos (fibers/mm²)	28	122 - 748	134 - 638	-30 - +19	

(a) Value provided by supplier of sample

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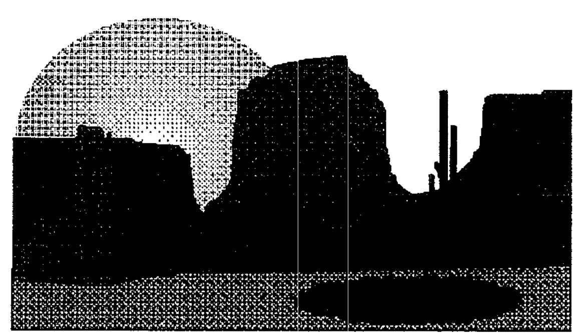

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