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NEVADA TEST SITE

ANNUAL SITE ENVIRONMENTAL REPORT - 1992

VOLUME I

Work Performed Under
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U.S. DEPARTMENT OF ENERGY NEVADA OPERATIONS OFFICE ANNUAL SITE ENVIRONMENTAL REPORT - 1992

VOLUME I

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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 program conducted for the nuclear testing program and other nuclear and non-nuclear activities at the NTS. The two agencies have coordinated preparation of this third combined onsite and offsite report through sharing of information on environmental releases and meteorological, hydrological, and other supporting data used in dose-estimate calculations.

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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 Basic Environmental Compliance and Monitoring Program (BECAMP) and EPA Environmental Monitoring Systems Laboratory, Las Vegas (EMSL-LV), reviewers were valuable. Compilation and verification of onsite data were provided by Frank R. Grossman. The cooperative support of Daryl J. Thomè of the EMSL-LV in production of this combined onsite and offsite environmental report was 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 fundamental unit used to express the rate of radiations being produced from atomic nuclei transformations 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} bequerels to make one curie.

The roentgen (R) is the fundamental 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. A typical radiation exposure rate from natural radioactivity of cosmic and terrestrial sources is 0.005 to 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 in homes) 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
AEC	U.S. Atomic Energy Commission
AIRFA	American Indian Freedom Act
AIHA	American Industrial Hygiene Association
ALARA	as low as reasonably achievable
ALI	Annual Limit of Intake
ANSI	American National Standard Institute
ASD	REECo Analytical Services Department
ASME	American Society Mechanical Engineer
ASN	Air Surveillance Network
AVO	Amador Valley Operations, EG&G/EM
BECAMP	Basic Environmental Compliance and Monitoring Program
BNA	base/neutral/acid
BOD	biochemical oxygen demand
BWMF	Bulk Waste Management Facility
BWMS	Bulk Waste Management Site
CAA	Clean Air Act
CAP	College of American Pathologists
CAP88-PC	EPA software program for estimating doses
CCS	Calibration check standard
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
COD	chemical oxygen demand
CP	Control Point
CRMS	Community Radiation Monitoring Station
CX	Categorical Exclusion
DAC	Derived Air Concentration
DCG	Derived Concentration Guide
D&D	Decontamination and Decommissioning
DDR	Data Discrepancy Report
DF	diesel fuel
DNA	Defense Nuclear Agency
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
DSC	discrete state compartment
DWB	DOE, Defense Waste Branch
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.
EMAD	Engine Maintenance, Assembly and Disassembly
EML	DOE Environmental Measurements Laboratory
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 Program
ESA	Endangered Species 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 aerosol
HF	hydrofluoric acid
HPD	REECo Health Protection Department
HRMP	Hydrology/Radionuclide Migration Program (DRI)
HTO	tritiated water
ICP	inductively coupled plasma
ICRP	International Commission on Radiological Protection
ID	identification
IH	REECo Industrial Hygiene
IRCR	International Reference Center for Radioactivity
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 Regulations
LGFSTF	Liquified Gaseous Fuels Spill Test Facility
LINAC	DOE-EG&G/EM 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
MCL	Maximum Contaminant Levels
MDA	minimum detectable activity
MDC	minimum detectable concentration
MGD	million gallons per day
MBAS	methylene blue active substances
MSL	mean sea level

MSM	Mounds Strategic Material
MSN	Milk Surveillance Network (EMSL-LV)
MSR	Management Systems Review
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
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
NRACC	Nuclear Radiation Assessment Cross Check Program (EMSL-LV)
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
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
ORSP	Offsite Radiological Safety Program
PAT	NIOSH Proficiency Analytical Testing Program
PCB	polychorinated biphenyl
PHS	U.S. Public Health Service
PIC	pressurized ion chamber
POTW	Publicly Owned Treatment Works
ppb	parts per billion
ppm	parts per million
PTC	permit to construct
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.
RIDP	Radionuclide Inventory and Distribution Program
RI/FS	remedial investigation and feasibility study
RNMS	Radionuclide Migration Study
RPD	relative percent difference
RSD	relative standard deviation
RSL	Remote Sensing Laboratory
RSN	Raytheon Services Nevada
RSTN	Remote Seismic Test Network
RWMS	Radioactive Waste Management Site
s	sample standard deviation
SAM	Sample and Analysis Management System
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
SEE	specific effective energy
sem	standard error of the mean
SGZ	surface ground zero
SLB	shallow land burial
SLD	shallow land disposal
SMS	Strategic Materials Storage
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
TP	TRU Pad
TRU	transuranic
TSCA	Toxic Substances Control Act
TSI	Thermal System Insulation
TSS	total suspended solids
TTR	Tonopah Test Range
UCLA	University of California, Los Angeles
UNLV	University of Nevada, Las Vegas
URTD	upper respiratory tract disease
USDI	United States Department of Interior
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UST	underground storage tank
UTM	Universal Transmercater

List of Acronyms and Expressions, cont.

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

1.0 SUMMARY

Stuart C. Black and Alan R. Latham

Monitoring and surveillance on and around the NTS by DOE contractors and Site user organizations during 1992 indicated that underground nuclear testing operations were conducted in compliance with regulations, i.e., the dose the maximally exposed offsite individual could have received was less than 0.15 percent of the guideline for air exposure. All 1992 nuclear events took place during the first three quarters of the calendar year prior to the Congressional testing moratorium. 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 test operations was not detectable offsite, and no measurable net exposure to members of the offsite population was detected through the offsite dosimetry program. Using the CAP88-PC model and NTS radionuclide emissions data, the calculated maximum effective dose equivalent offsite would have been 0.012 mrem. Any person receiving this dose was also exposed to 78 mrem from natural background radiation. There were no nonradiological releases to the offsite area. Hazardous wastes were shipped to EPA-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.

Non-NTS support facilities 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 Restoration and Waste Management Division 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 can be considered to be in full compliance with environmental laws and regulations. As of March 31, 1993, 19 of the 105 environmental survey items and 16 of the 149 Tiger Team findings remain open. The remaining items require more time and funding before they can be completed. Progress on corrective actions to bring operations into compliance is reported to DOE Headquarters Environment 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 EIS/ODIS reports. In compliance with the National Emission Standards for Hazardous Air Pollutants (NESHAP), the data from these reports each year are cumulated and used as input to EPA's CAP88-PC software program to calculate potential annual 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 the radioactivity released onsite. Air emissions are monitored for source characterization and operational safety as well as for environmental surveillance purposes.

Air emissions in 1992 consisted primarily of small amounts of tritium and radioactive noble gases and iodine released to the atmosphere that were attributed to:

- Post-test drilling, mining, and/or sampling operations for three 1992 and one 1991 underground nuclear tests.

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

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

There was no "prompt venting" (dynamic release of radioactivity within the first hour following a test) from any of the six announced underground nuclear tests. Approximately 6 Ci of radioactivity were released during post-test operations for recovery of drilling cores and other samples from the underground detonation vicinity (Table 5.1). Diffuse emission sources included slightly above detectable amounts of HTO from the RWMS in Area 5, $^{239+240}$Pu from Area 3, and ^{85}Kr from Pahute Mesa. Table 1.1 shows the quantities of radionuclides released from all sources, including assumed loss of laboratory standards. None of the radioactive materials listed in this table was detected above ambient levels in the offsite area.

Onsite liquid discharges to containment ponds included approximately 2200 Ci of tritium. Evaporation of this material could have contributed tritiated water vapor to the atmosphere, but the amounts were too small to be detected by the tritium monitors offsite. No known liquid effluents were discharged to offsite areas.

1.2.1 OFFSITE MONITORING

The offsite radiological monitoring program is conducted around the NTS by the EPA's Environmental Monitoring Systems Laboratory, Las Vegas (EMSL-LV), under an Interagency Agreement. This program consists of several extensive environmental sampling, radiation detection, and dosimetry networks.

In 1992 the Air Surveillance Network (ASN) was made up of 30 continuously operating sampling locations surrounding the NTS and 77 standby stations (operated one or two weeks each quarter) in all states west of the Mississippi River. The 30 ASN stations included 19 located at Community Radiation Monitoring Program (CRMP) stations, described below. During 1992 no airborne radioactivity related to current nuclear testing at the NTS was detected on any sample from the ASN. Other than naturally occurring ^{7}Be, the only specific

Table 1.1 Radionuclide Emissions on the NTS - 1992[a]

Radionuclide	Half-life (years)	Quantity Released (Ci)
Airborne Releases:		
^{3}H	12.35	[b]0.41
^{37}Ar	0.096	2.9
^{39}Ar	269.	8.1×10^{-5}
^{85}Kr	10.72	281.
^{131}I	0.022	[b]7.7×10^{-5}
^{127}Xe	0.10	5.7×10^{-6}
^{129m}Xe	0.022	2.4×10^{-5}
^{131m}Xe	0.0326	0.015
^{133}Xe	0.0144	0.43
$^{239+240}Pu$	24065.	[b]2.5×10^{-3}
Tunnel and Decon Pad Ponds:		
^{3}H	12.35	[c]2200.
^{238}Pu	87.743	2.2×10^{-5}
$^{239+240}Pu$	24065.	7.0×10^{-3}
^{90}Sr	29.	6.4×10^{-4}
^{137}Cs	30.17	2.9×10^{-3}
Gross Beta	---	3.2×10^{-2}

(a) Assumes worst case point and diffuse source releases.
(b) Includes calculated data from air sampling results and/or loss of laboratory standards.
(c) This amount is assumed to evaporate to become an airborne release.

radionuclide detected by this network was ^{238}Pu or $^{239+240}Pu$ on a few air filter samples from Rachel, Nevada, and in Standby Air Surveillance Network (SASN) samples from New Mexico.

The Noble Gas and Tritium Surveillance Network (NGTSN) consisted of 21 offsite noble gas samplers (8 on standby) and 21 tritium-in-air samplers (seven on standby) located outside the NTS and exclusion areas in the states of Nevada, California, and Utah. During 1992 no radioactivity that could be related to NTS activities was detected at any NGTSN sampling station.

As in previous years, results for xenon and tritium were typically below the minimum detectable concentration (MDC). The results for krypton, 26×10^{-12} µCi/mL, although exceeding the MDC, were within the range of worldwide values expected from sampling background levels and the range was similar to last year's.

Sampling of Long-Term Hydrological Monitoring Program (LTHMP) wells and surface waters around the NTS showed only background radionuclide concentrations. The LTHMP also included groundwater and surface water monitoring at locations in Colorado, Mississippi, New Mexico, and Nevada where underground tests were conducted. The results obtained from analysis of samples collected at those locations were consistent with previous data except for a sample from a deep well at Project GASBUGGY where the tritium concentration appears to be increasing. No concentrations of radioactivity detected in water, milk, vegetation, soil, fish, or animal samples posed any significant health risk.

The Milk Surveillance Network (MSN) consisted of about 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 was detected in six SMSN and five MSN samples. Radiostrontium above the MDC was found in five MSN samples and in 17 SMSN samples. The ^{90}Sr was attributed to worldwide fallout. The levels in the SMSN have tended to decrease 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. Carrots, cabbage, broccoli, summer squash, and apples from several offsite locations contained normal ^{40}K activity. Small amounts of $^{239+240}$Pu and ^{90}Sr found on a few samples were attributed to incomplete washing of soil from the samples.

External exposure was monitored by a network of about 125 thermoluminescent dosimeters (TLDs) and 27 pressurized ion chambers (PICs). Due to a procedural error, the data from the TLDs will have to be reprocessed and are not yet reportable. The PIC network in the communities surrounding the NTS indicated background exposures ranging from 53 to 169 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 1992 counts were made on 281 individuals, of whom 107 were participants in the Offsite Internal Dosimetry Program. In general, 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.

No radioactivity attributable to NTS operations was detected by any of the monitoring networks. However, based on the NTS releases reported in Chapter 5, Table 5.1, atmospheric dispersion model calculations (CAP88-PC) indicated that the maximum potential effective dose equivalent to any offsite individual would have been 1.2×10^{-2} mrem (1.2×10^{-4} mSv), and the dose to the population within 80 kilometers of the emission sites would have been 2.9×10^{-2} person-rem (2.9×10^{-4} person-Sv). The hypothetical person receiving that dose was also exposed to 78 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.

A network of 18 Community Radiation Monitoring Program (CRMP) stations is operated by local residents. Each station is an integral part of the ASN, NGTSN, and TLD networks. In addition, they are equipped with a pressurized ion chamber (PIC) connected to a gamma-rate recorder. Each station also has 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. Another nine PICs with the same capabilities are distributed in other

Table 1.2 Summary of Effective Dose Equivalents from NTS Operations during 1992

	Maximum EDE at NTS Boundary[(a)]	Maximum EDE to an Individual[(b)]	Collective EDE to Population within 80 km of the NTS Sources
Dose	1.7×10^{-2} mrem (1.7×10^{-4} mSv)	$1.2 \pm 0.1 \times 10^{-2}$ mrem (1.2×10^{-4} mSv)	2.9×10^{-2} person-rem (2.9×10^{-4} person-Sv)
Location	Site boundary 60 km SSE of NTS Area 12	Indian Springs, 80 km SSE of NTS Area 12	21,700 people within 80 km of NTS Sources
NESHAP Standard	10 mrem per year (0.1 mSv per yr)	10 mrem per year (0.1 mSv per yr)	-----
Percentage of NESHAP	0.17	0.12	-----
Background	78 mrem (0.78 mSv)	78 mrem (0.78 mSv)	1660 person-rem (16.6 person Sv)
Percentage of Background	2.2×10^{-2}	1.5×10^{-2}	1.6×10^{-3}

(a) The maximum boundary dose is to a hypothetical individual who remains in the open continuously during the year at the NTS boundary located 60 km SSE from the Area 12 tunnel ponds.

(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 and assuming all tritiated water input to containment ponds was evaporated.

locations around the NTS. Samples and data from these CRMP stations are analyzed and reported by EMSL-LV and interpreted and reported by the Desert Research Institute, University of Nevada System. All measurements for 1992 were within the normal background range for the U.S.

1.2.2 ONSITE MONITORING

The onsite environmental surveillance program consists of 52 air sampling stations collecting particulates and reactive gases; 17 samplers collecting atmospheric moisture for tritium analysis; 10 samplers collecting air samples for noble gas analysis; 63 water sampling locations that include wells, springs, reservoirs, and ponds onsite; and 187 locations where TLDs are positioned for measurement of external gamma exposures. The locations of these environmental surveillance stations are shown in Chapter 4, Figures 4.1 through 4.4. Most of the measured radioactive air effluents on the NTS in 1992 arose from operations related to underground nuclear explosives tests conducted by the Defense Nuclear Agency/Department of Defense; and Los Alamos National Laboratory.

The primary release mechanisms for these effluents were operational activities such as drill-backs, minebacks, and tunnel purgings. Seepage of noble gases through the soil column to ground surface was a minor contributor to the measured effluents. The radioactive air effluents summarized in Table 1.1 are described specifically in Section 5, Table 5.2.

Approximately 2700 air samples were analyzed by gamma spectroscopy. Except for four isolated cases, all isotopes detected by gamma spectroscopy were naturally occurring in the environment (^{40}K, ^{7}Be, and members of the uranium and thorium series). Trace amounts of ^{95}Nb and ^{140}La were seen once each and ^{141}Ce twice at the P tunnel portal in samples collected during August 1992. Plutonium analyses of monthly composited air filters indicated an annual arithmetic average below 10^{-15} μCi/mL (10^{-4} Bq/m^3) of $^{239+240}Pu$ and 10^{-17} μCi/mL (10^{-6} Bq/m^3) of ^{238}Pu for all locations during 1992, with the majority of results for both isotopes being on the order of 10^{-18} μCi/mL (10^{-7} Bq/m^3). A slightly higher average was found in samples from the Area 3 air samplers, but that level was calculated to be only 0.01 percent of the Derived Air Concentration. 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, which is the same as the average reported by 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 fallout from the use of nuclear technology. As has been the case in the past, the ^{133}Xe results were below the detection limit except for a few instances when it was released subsequent to an underground test.

Throughout the year atmospheric moisture was collected for two-week periods at 17 locations on the NTS and analyzed for tritiated water content (HTO). The annual arithmetic average of $(5 \pm 10) \times 10^{-6}$ pCi/mL was similar to last year's average. The locations with the highest concentrations were those near the Radioactive Waste Management Site (RWMS) in Area 5, as would be expected, and at the Area 15 EPA Farm, which probably reflects a contribution from the SEDAN crater.

The primary radioactive liquid discharge to the onsite environment in 1992 was seepage from the test tunnels in Rainier Mesa (Area 12) contributing 147 million liters of water containing approximately 2200 Ci of tritium to containment ponds near the tunnels. Contaminated water discharges to the pond for the Area 6 Decontamination Facility (used for equipment decontamination) contributed about 5 x 10^{-3} Ci of tritium to the pond. For dose calculations, all of this tritiated water was assumed to have evaporated.

Surface water sampling was conducted monthly at 15 open reservoirs, 7 springs, 9 containment ponds, and quarterly at 3 sewage lagoons. A grab sample was taken from each of these surface water sites for analysis of gross beta, tritium, and gamma-emitter concentrations. Each quarter a sample was taken for plutonium analysis, and ^{90}Sr was analyzed once per year, for each location. Water samples from the springs, reservoirs, and lagoons contained background levels of gross beta, tritium, plutonium, and strontium. Samples collected from the tunnel containment ponds and the Area 6 Decontamination Facility pond contained detectable levels of radioactivity as would be expected.

Onsite water derived from onsite supply wells and distribution systems was sampled and analyzed monthly for radionuclides. The supply well average gross beta activity of 7.7 x 10^{-9}

μCi/mL was 3 percent of the Derived Concentration Guide (DCG) for ^{40}K (used for comparison purposes); gross alpha was 5.7 x 10^{-9} μCi/mL, which was 38 percent of the drinking water standard; ^{90}Sr was 3.3 x 10^{-10} μCi/mL (1.2 x 10^{-2} Bq/L) or 4 percent of the DCG; ^{3}H concentrations were -3.4 × 10^{-9} μCi/mL (-0.13 Bq/L) for the potable supply wells and 5.3 × 10^{-8} μCi/mL (2.0 Bq/L) for the non-potable supply wells with both less than 0.06 percent of the DCG; $^{239+240}Pu$ was 3.3 x 10^{-12} μCi/mL (1.2 x 10^{-4} Bq/L) or 0.05 percent of the DCG, and ^{238}Pu with a concentration of -2.0 x 10^{-11} μCi/mL (-7.4 x 10^{-4} Bq/L) was <0.01 percent of the DCG.

External gamma radiation exposure data from the onsite TLD network indicated the gamma exposure rates recorded during 1992 were not statistically different from the data collected in 1991. Recorded exposure rates ranged from 66 mR/year in Mercury to 4080 mR/year in a contaminated area in Area 5. Average annual exposure rates at NTS boundary TLD stations ranged from 77 to 205 mR/year and the annual average for all onsite "control" stations (considered uncontaminated) was 104 mR/year as compared to last years value of 112 mR/yr.

Special studies related to environmental radioactivity on the NTS continued under the Basic Environmental Compliance and Monitoring Program (BECAMP). The studies included investigating the movement of radionuclides on and around the NTS, and development of a human dose-assessment model specifically for the NTS.

BECAMP efforts in 1992 included (1) investigating the water-driven migration of plutonium in a wash in Area 11, (2) continuing the investigation on the estimation of realistic uncertainties of BECAMP dose-assessment model input parameters, and (3) continuing the characterization of resuspension processes from a plutonium-contaminated site.

1.2.3 LOW-LEVEL WASTE DISPOSAL

Environmental monitoring at and around the Area 5 RWMS indicated that radioactivity was just detectable at the waste site boundaries but not away from the area. This monitoring included air sampling, water sampling, tritium migration studies, and external gamma exposure measurement. Vadose zone monitoring for hazardous constituents has been installed at the Area 5 RWMS as a method of detecting any downward migration of radioactive waste.

The presence of plutonium on the NTS is primarily due to atmospheric and safety tests 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). Higher than normal levels of plutonium are still detected in several Areas on the NTS, and particularly in Area 3 where operational activities and vehicular traffic resuspend plutonium for detection by air sampling including the air samplers around the Area 3 RWMS.

1.2.4 RADIOLOGICAL MONITORING AT OFFSITE SUPPORT FACILITIES

Fenceline 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, CA. The 1992 results indicated that only background radiation was detected at the fenceline.

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 41 air quality permits 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 14 notifications to the state under NESHAP requirements in 1992.

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 five 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, pH, and dissolved solids were slightly exceeded in five wells. 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 exceedances, the state has been contacted to assist in developing a mitigation plan. Monitoring for polychlorinated biphenols as required by the Toxic Substances Control Act involved analysis of 170 samples. Only three of the samples exceeded 500 ppm.

At the Liquified Gaseous Fuels Spill Test Facility, 54 planned spill tests using chlorine, ammonia, chlorosulfonic acid, and oleum were conducted during 1992. 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.

In 1992, the fifth full year of flora and fauna monitoring under the BECAMP ecological studies, 11 ecology monitoring sites and 43 plots were surveyed for plants, animals, and reptiles. The 43 plots monitored included 17 for spring ephemeral plants, 13 for perennial plants, 8 for small mammals, and 5 for lizards. Many of these sites contained paired disturbed/undisturbed plots. Monitoring sites surveyed included the control baseline plot in southwestern Yucca Flat . Sites in disturbed areas of the NTS are monitored on a three year cycle. Three subsidence craters in northeastern Yucca Flat, first sampled in 1989, were resampled in 1992. To date, a total of 27 BECAMP ecology monitoring sites have been established on the NTS with many of the sites containing adjacent control plots.

Monitoring of feral horses continued in 1992 for the third consecutive year. Horse counts were made throughout the summer, one day a month, in regions around springs and well reservoirs, which resulted in a confident estimate of the feral horse population on the NTS. In addition, field observations were made of raptors, mule deer, and raven on the NTS. Desert tortoises in the Rock Valley/University of California, Los Angeles, study enclosures were surveyed twice in 1992.

1.4 COMPLIANCE ACTIVITIES

Besides conducting the nuclear explosives testing program in compliance with the various radiation protection standards and guides as issued by the International Commission on Radiological Protection (ICRP) and national authorities, DOE/NV is required to comply with various environmental protection acts and regulations. 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 preparation of two Environmental Impact Statements (EIS), one Preliminary EIS, 23 Environmental Assessments, and 89 Categorical Exclusions.

Wastewater discharges on the NTS are not regulated under National Pollutant Discharge Elimination System permits because all such discharges are to onsite sewage lagoons. Wastewater discharges from the non-NTS support facilities of EG&G Energy Measurements, Inc. were predominantly within the regulated levels established by city or county publicly owned treatment works. One notice of violation was issued to EG&G/EM, Santa Barbara Operations for exceeding the mercury discharge limit which was the result of mishandling a broken manometer.

Fourteen underground storage tanks that contained, or had contained, petroleum products were removed and an additional 14 were upgraded in 1992.

In 1992, 36 pre-activity surveys, required by the Archeological and Cultural History Preservation Act, were conducted for archaeological sites on the NTS, and reports on the findings prepared. These pre-activity surveys identified 38 sites containing previously unknown archaeological information. All potentially significant sites (including historical) were avoided by activities on the NTS. Also, during 1992, 45 pre-activty surveys were conducted to determine the presence of endangered or threatened plants or animals in accordance with the Endangered Species Act. Habitats were documented and Biological Opinions were obtained from the USFWS prior to activities that might have affected the desert tortoise.

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 1992 to detect the presence of any radioactivity that may be related to nuclear testing activities. No radioactivity was detected 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 although none exceeded 0.2% 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 GASBUGGGY began increasing about 1984, but this year, for the first time, ^{137}Cs was detected at a concentration of $6 \pm 1 \times 10^{-9}$ µCi/mL in samples from this well.

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 100 wells at strategic locations on and near the NTS. One of these special wells was completed in 1992 and two others are in process of completion. Also, eight existing wells were recompleted so that they could be used for obtaining characterization data.

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

1.6 RADIOACTIVE AND MIXED WASTE DISPOSAL

Two radioactive waste disposal facilities are operated on the NTS; the Area 5 Radioactive Waste Management Site (RWMS) and the Area 3 RWMS. During 1992 the RWMS received low-level waste generated at the NTS and other DOE facilities. Waste is disposed of in shallow pits, trenches, craters, and in deep, large-diameter augured shafts. Transuranic (TRU) wastes are stored on a curbed asphalt pad on pallets in 55 gal-drums and assorted steel boxes pending shipment to the Waste Isolation Pilot Plant (WIPP) in New Mexico. The Area 3 RWMS is used for disposal of bulk low-level waste and LLW that is contained in packages that are larger than those used at the Area 5 RWMS.

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 hazardous constituents are conducted at the RWMS. Environmental monitoring results for 1992 indicated that measurable radioactivity from waste disposal operations was detectable only in the immediate vicinity of the facilities.

Resource Conservation and Recovery Act (RCRA) hazardous waste disposal operations at the NTS require the shipment of nonradioactive hazardous materials to licensed disposal facilities offsite. No disposal of hazardous materials was performed at the NTS except as constituents of the Rocky Flats Plant mixed waste received from December 1988 through May 1990.

A Mixed Waste Management Unit (MWMU) is located just north of the RWMS and will be part of routine disposal operations. This area, covering approximately 10 ha (25 acres), will contain 18 landfill cells to be used for mixed waste disposal. In May 1990 mixed waste disposal operations ceased due to EPA issuance of the Land Disposal Restrictions of RCRA for the Third Thirds Wastes. Active mixed waste disposal operations at the NTS 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 quality assurance (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 quality assurance (QA) program includes conformance to best laboratory practice and implementation of the provisions of DOE Order 5700.6C. The external quality assurance 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 Nuclear Radiation Assessment and Cross Check Program (NRACC) conducted by the EPA Environmental Monitoring Systems Laboratory, Las Vegas (EMSL-LV); 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 U.S. Environmental Protection Agency (EPA) requires participation in a centrally managed quality assurance program (QA) by all EPA organizational units involved in environmental data collection. The QA program developed by the Nuclear Radiation Assessment Division (NRD) of the Environmental Monitoring Systems Laboratory, Las Vegas (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 (DOE) 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 this year were:

- In July 1992, two EPA Region IX RCRA inspectors performed an inspection of hazardous waste activities at NTS. The results of this evaluation were sent to the state of Nevada

Division of Environmental Protection (NDEP) for action. Although DOE/NV responded to the state on December 7, 1992 and acknowledged six violations, NDEP issued a Finding of Alleged Violation (FOAV) and Order on December 8, 1992 to DOE/NV and REECo for allegedly violating fourteen provisions of NAC 444.8632 - Compliance with Federal Standards.

- An FOAV and Order was issued by the state of Nevada in March 1992 relating to DOE/NV's and REECo's failure to comply with NRS 459.515 and NAC 444.8632. This involved 11 drums of soil on Yucca Lake which contained core samples taken from areas around the Decontamination Pond in Area 6. Analyses performed in September 1991 indicated trace amounts of solvents and the presence of small amounts of manmade isotopes. A review of laboratory analysis data on March 17, 1992, between the REECo Environmental Compliance and Waste Operations Departments, determined that the waste was non-regulated and the state was notified. Upon review, the state rescinded the FOAV on April 24, 1992.

- In January 1992, the state of Nevada issued DOE/NV and REECo written notice that it was assessing a penalty of $20,000 for two FOAVs issued to DOE/NV and REECo in November 1990 and June 1991. The penalty resulted from insufficient sampling of Rocky Flats pondcrete (Transuranic mixed waste) to fully characterize the waste, and increasing the size of the storage pad without prior NDEP approval. A settlement agreement was reached in June 1992. The agreement limits the quantity of TRU mixed waste on the storage pad, authorizes removal of the waste upon approval of the Waste Isolation Pilot Plant, and directs the construction of a cover for the waste.

- In mid 1990 the state of Nevada requested assistance from REECo to cleanup abandoned waste in Pahrump, Nevada. The site consisted of 780 containers of various sizes stored on wooden pallets. A REECo stamp was found on three 5-gal buckets, three containers bore a Defense Logistics Agency stamp, and the other containers bore no discernable labels to indicate ownership. Cleanup activities began in September 1990 and were completed by year's end. A final report from REECo was submitted to DOE/NV in June 1991 for transmittal to the state. Then in December 1992, REECo was notified of its potential liability for $48,608.63 in government incurred costs for stabilization and assessment actions at the Pahrump Drum Removal Site. DOE/NV Legal advised REECo on or about January 5, 1993 that DOE/HQ was not approving the payment, subject to further review. REECo was instructed to obtain further information and data supporting a possible offer/payment based on volumetric calculations, considering the existence of other Potentially Responsible Parties.

Some of the accomplishments for 1992 include:

- The REECo Analytical Chemistry Laboratory was granted certification to perform wastewater sample analysis of certain parameters by the state of Nevada in February 1993. The laboratory is certified for wastewater analysis of pH, total suspended solids (TSS), and Biochemical Oxygen Demand (BOD). The laboratory also has applied for certification to analyze drinking water samples for coliform, volatile organic compounds (VOCs), heavy metals, and trace minerals. Certification is awaiting state of Nevada review and audits.

- All DOE/NV quantitative goals and schedules for waste minimization were met. Total NTS hazardous waste generation was reduced by 1.5 percent compared with 1991, and by over 46.5 percent when compared with 1989 amounts. 1992 NTS wide recycling activities included 132 tons of office paper, 2.5 tons of aluminum, and 1946 tons of scrap metal.

- Notable improvements are ongoing in process modifications, product substitution, avoidance, and the recycling of products. REECo employees have developed a program to recycle printer and copier toner cartridges consequently reducing waste and creating a cost savings, and has generated work from other government agencies. Closed-loop effluent recycling, used in operations such as steam cleaning, has been an aggressive approach to waste minimization and eliminating a discharge into the environment. Benefits of having these units throughout the NTS are as follows: (1) saving 4.7 million gallons of water annually, (2) reducing operation and permit costs, and (3) a 90 percent reduction in hazardous waste generation. Two solvent stills recycle approximately 80 percent of all solvents and thinners used. This has greatly reduced the hazardous waste generation by recycling solvents up to four times before disposal is required.

- Five parts washers have been added to support the NTS vehicle fleet maintenance and support. These high pressure washers use nonhazardous soaps to completely eliminate the need for parts-cleaning solvents. This process modification has saved operational dollars and eliminated a hazardous waste stream.

- A Just-in-Time supply system is utilized which allows NTS contractors to reduce product stock and control potentially hazardous products.

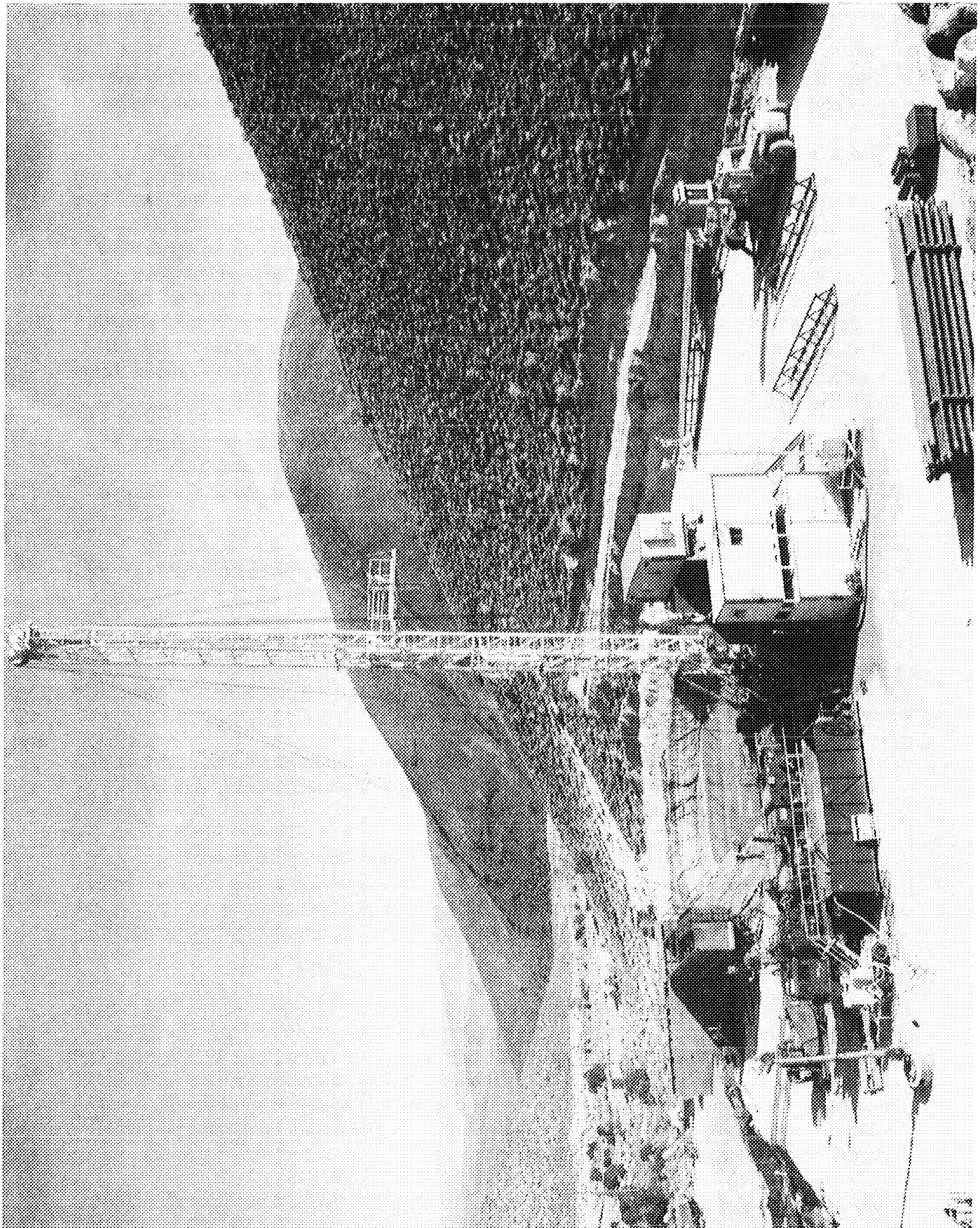
- Of the 149 Tiger Team findings from their 1989 assessment, as of March 31, 1992, 133 of them have been closed in accordance with the DOE/NV Procedure for Closure of Nevada Operations Office (NV) Action Plan, Revision No.0, July 13, 1990. Work continues on the remaining 16.

- Progress continued on the NTS groundwater characterization program. One special well has been completed, two others are in progress, and eight existing wells have been recompleted to meet program requirements.

- In 1992, efforts associated with the NTS American Indian Religious Freedom Act Compliance Program include conducting an ethnobotanical study on the NTS with Native Americans that involved participation by 17 tribes. The ethnographers spent 18 days at the NTS taking different groups of Native Americans to eight locations in Areas 12, 19, and 20.

The environmental monitoring results presented in this report document that the 1992 nuclear test operations were conducted with no detectable radiation exposure 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) equated to 0.012 mrem to a person living in Indian Springs, Nevada. This may be compared to that individual's exposure to 78 mrem from natural background radiation measured by the PIC at Indian Springs.

There were no major incidents of nonradiological contaminant releases to the environment, and ever more intensive efforts to continue characterizing and protecting the NTS environment implemented in 1990 were continued in 1992.



2.0 INTRODUCTION

Stuart C. Black, H. Bruce Gillen, and Alan R. Latham

The NTS, located in southern Nevada, has been the primary location for testing of nuclear explosives in the continental U.S. since 1951. 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. During 1992 DOE/NV announced that six underground nuclear tests were conducted at the NTS. Limited non-nuclear testing included controlled spills of hazardous material at the Liquified Gaseous Fuels Spill Test Facility (LGFSTF). Radioactive and mixed waste disposal facilities for U.S. defense waste were 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 nuclear testing operations. 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, DOE/NV is responsible for eight non-NTS EG&G Energy Measurements, Inc. (EG&G/EM) operations, in eight different cities. These operations support the DOE/NV nuclear test program in activities ranging from aerial measurements and aircraft maintenance to electronics and heavy industrial fabrication. All of these operations are located 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 is 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. (This figure and other figures in this chapter were generated with a computer-based geographical information system [GIS]. GIS-generated graphics in this report were prepared by EG&G Energy Measurements, Inc., Las Vegas, Nevada.) 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 NAFB Range Complex, which provides a buffer zone between the test areas and public lands. This buffer area varies from 24 to 104 km (15 to 65 mi) between the test areas and public lands. The combination of the NAFB Range Complex 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 shaded areas 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 Site, is the other 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 NAFB Range Complex (see Figure 2.3). All announced tests are listed in DOE/NV report NVO-209 (updated annually).

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. Four of these were in the northwestern quadrant of the NTS. The fifth 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 of experiments 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 shielding materials, electronic components, live organisms, and tissue-equivalent simulations for biomedical and environmental research. From 1959 through 1973 a series of open-air nuclear reactor, nuclear engine, and nuclear furnace tests were conducted in Area 25 at the Nuclear Rocket Development Station (now the Nevada

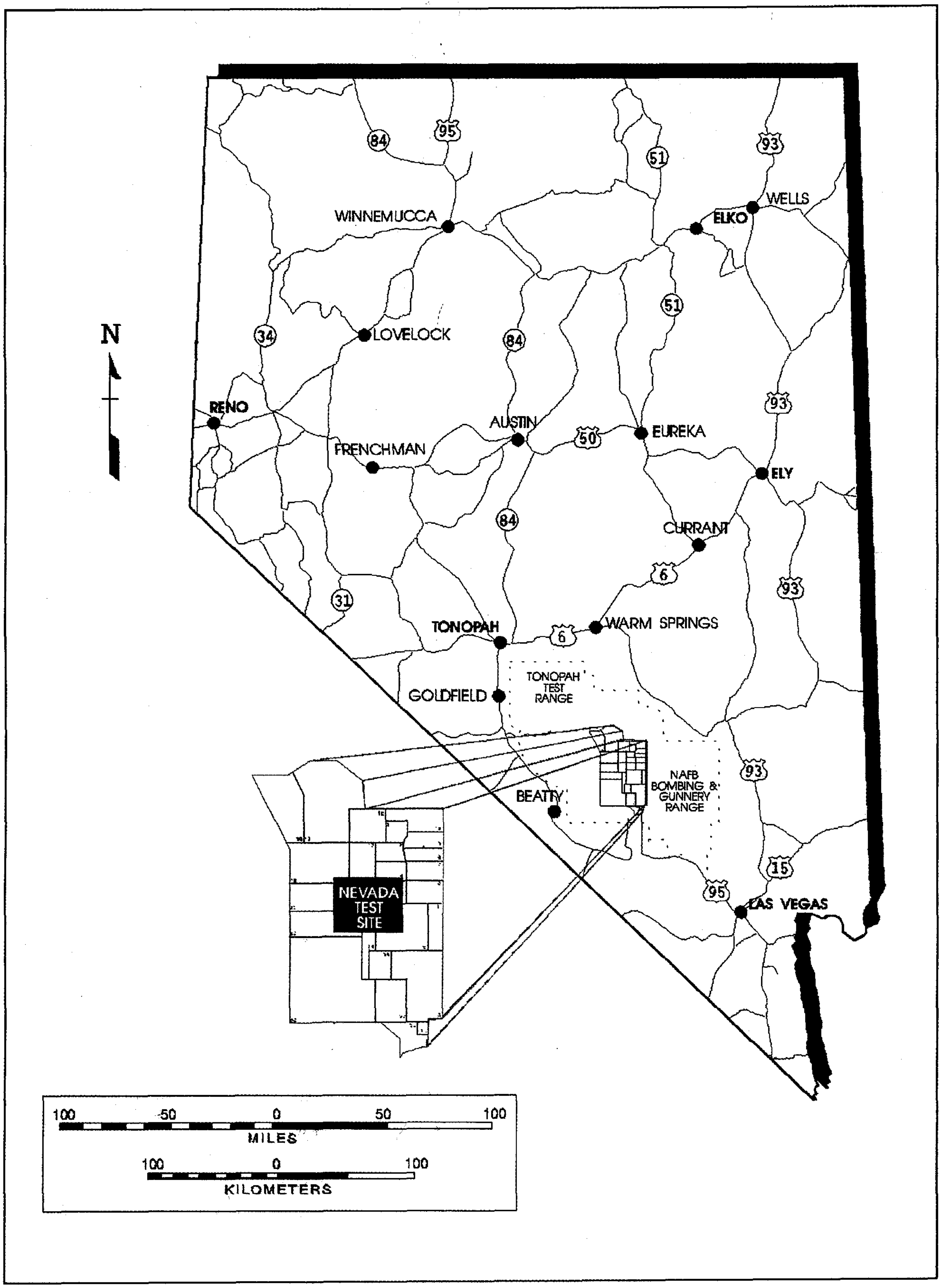


Figure 2.1 NTS Location

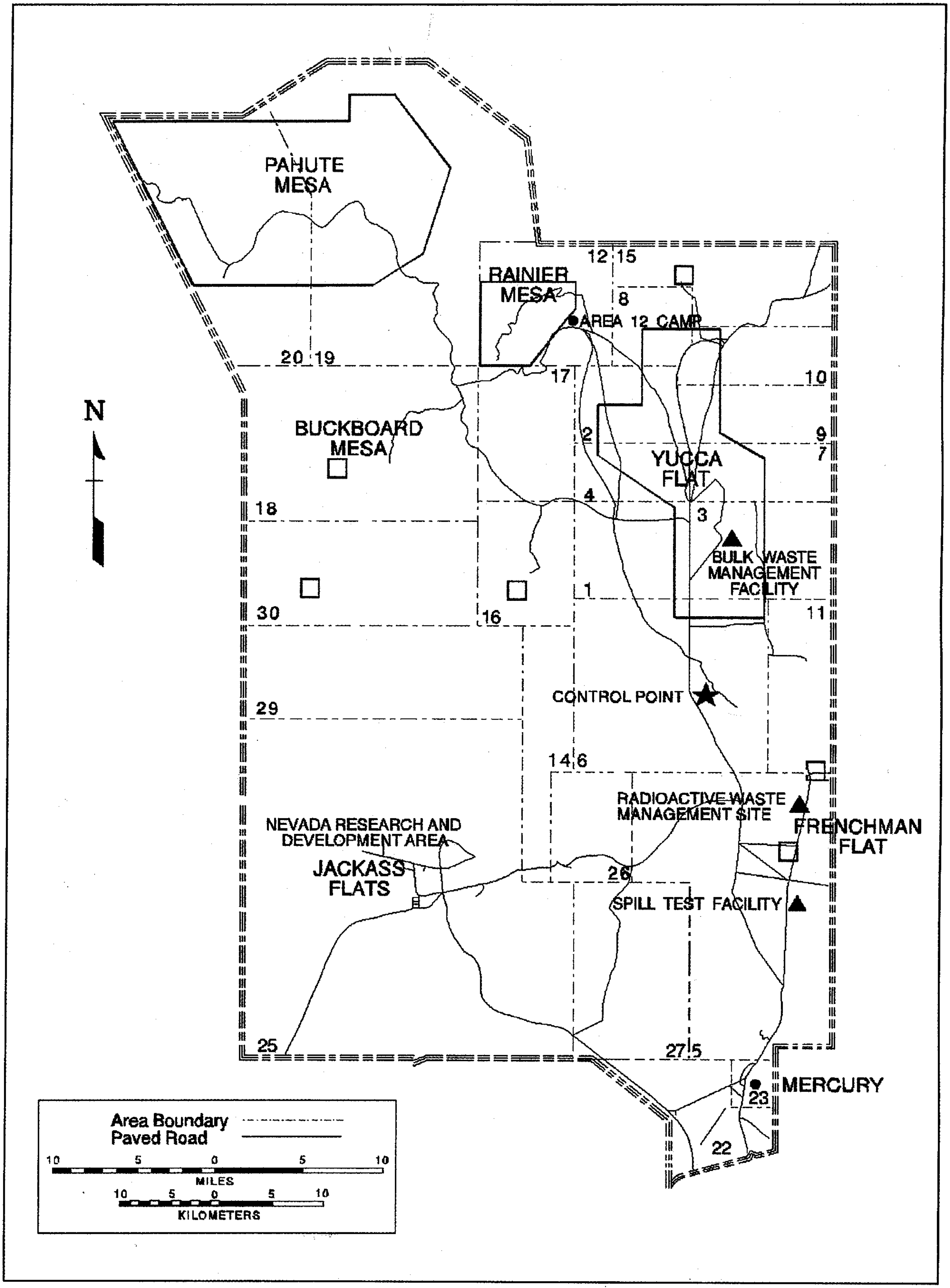


Figure 2.2 NTS Area Designations, Principal Facilities, and Testing Areas

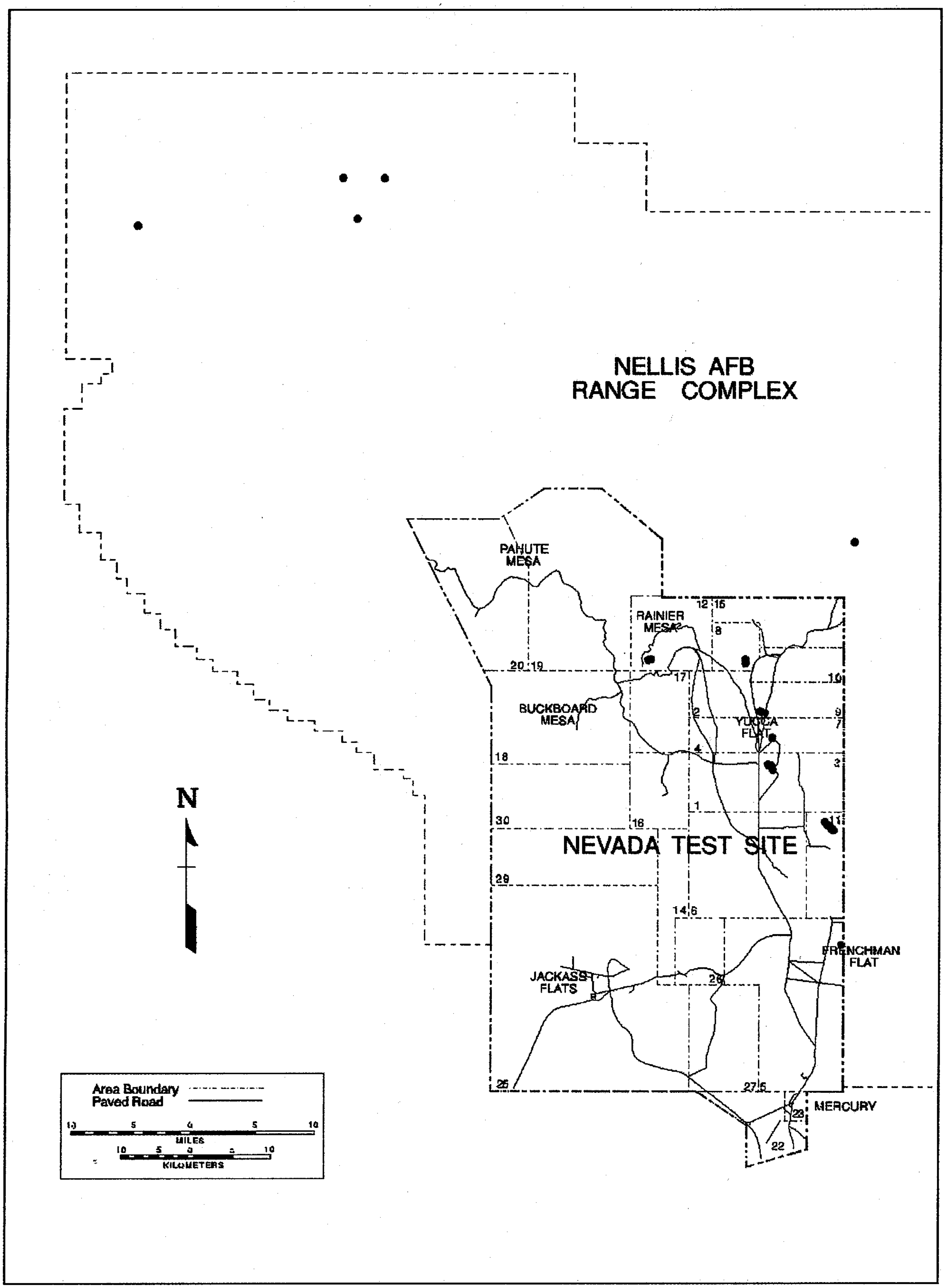


Figure 2.3 Location of Safety Shots in the NAFB Range Complex

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

Limited non-nuclear testing has also occurred at the NTS, including spills of hazardous materials at the 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 dispersion and transport of airborne clouds resulting from these spills. These tests are cooperative studies involving private industry, the U.S. Department of Transportation (DOT), and the DOE.

Waste disposal facilities for radioactive and mixed waste are also available at the NTS for DOE defense waste disposal. Disposal sites are located in Areas 3 and 5. At the Area 5 Radioactive Waste Management Site (RWMS), low-level radioactive waste from DOE-affiliated onsite and offsite generators and mixed waste from one offsite generator (Rocky Flats) are disposed of using standard shallow land disposal techniques. The Greater Confinement Disposal facility, consisting of a 3 m (10 ft) diameter shaft 37.5 m (120 ft) deep, is located at the Area 5 RWMS. This facility is used for experimental disposal of wastes not suited for shallow land burial because of high specific activity or because of a potential for migration into biopathways.

Transuranic wastes are retrievably stored in surface containers at the Area 5 RWMS pending shipment to the Waste Isolation Pilot Plant facility in New Mexico. Nonradioactive hazardous wastes are also accumulated at the Area 5 RWMS before shipment to an offsite disposal facility. At the Area 3 RWMS only bulk low-level radioactive waste (such as debris collected from atmospheric nuclear test locations) or low-level waste in large packages, is emplaced and buried in surface subsidence craters (formed as a result of underground nuclear tests).

2.1.3 1992 TEST ACTIVITIES

2.1.3.1 NUCLEAR TESTS

The underground nuclear tests conducted during 1992 (the period covered by this annual NTS environmental report) were designed and conducted by two national laboratories and the Defense Nuclear Agency (DNA). The Los Alamos National Laboratory (LANL) of Los Alamos, New Mexico, and LLNL conducted tests in support of DOE nuclear testing program objectives. Sandia National Laboratories (SNL) of Albuquerque, New Mexico, supported tests conducted by the DNA, which uses the NTS as a nuclear testing facility under an agreement with the DOE.

The DOE announced six underground nuclear tests at the NTS during l992. A list of these tests is provided in Table 2.1. (A summary of the environmental monitoring observations for each of these tests is provided in Chapter 5, Table 5.2.)

Underground testing is carefully designed to ensure containment of the explosive energy and radioactivity resulting from each nuclear explosion. After the nuclear device and related diagnostic equipment are lowered into the prepared vertical shaft or emplaced in the excavated tunnel, the hole or tunnel is closed with a containment system. Vertical holes are back-filled with sand and gravel, and three to six solid plugs are spaced throughout (referred

Table 2.1 Announced Underground Nuclear Tests at the NTS - 1992

Test Name	Date	Testing Organization
JUNCTION	03/26/92	LANL
DIAMOND FORTUNE	04/30/92	DNA
VICTORIA	06/19/92	LANL
GALENA	06/23/92	LLNL
HUNTERS TROPHY	09/18/92	DNA
DIVIDER	09/23/92	LANL

to as "stemming") to enhance containment capabilities. Stemming, including the plugs, forms a seal against leakage of gases to the atmosphere. The stemming material in tunnel tests normally consists of rock-matching grout emplaced close to the device and backed up by varying types, amounts, and combinations of grout and other stemming materials. Some tunnel tests may include a "line-of-sight" pipe with mechanical closure systems in the pipe to contain radioactivity. In addition, several large concrete and steel plugs block the tunnel between the experimental area and the portal to afford added protection against the possibility of gas escaping from the stemmed area.

During and following each test, both onsite and offsite monitoring are conducted to document radioactivity that might be released to the atmosphere. Releases might occur immediately following a test as a result of dynamic release (called a "venting" or "prompt" release) of material through cracks, fissures, or the containment system. During later hours, days, or weeks, a release may also occur as a result of slow transfer of gases (seepage) through the soil and rock overburden or through controlled releases as part of post-test diagnostic and sampling operations. The onsite effluent detection and monitoring systems, onsite and offsite environmental surveillance systems, and 1992 results from these monitoring efforts are described in this report.

2.1.3.2 LIQUIFIED GASEOUS FUELS SPILL TEST FACILITY

A total of 54 spill tests were conducted at the LGFSTF in Area 5 of the NTS. (Discussion of these tests is found in Chapter 4.) The LGFSTF is maintained by EG&G, Inc., and is the basic research tool for studying the dynamics of accidental releases of various hazardous materials. Discharges from the LGFSTF 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. LGFSTF personnel monitor and record operating data, close-in and downwind meteorological data, and downwind gaseous concentration levels. 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. Spills involving chlorine, ammonia, chlorosulfonic acid, and oleum were conducted in 1992 and the results monitored.

An array of diagnostic sensors may be placed up to 16 kilometers 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.

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 created when the overburden above a nuclear cavity collapsed and formed a rubble "chimney" to the surface (Figure 2.5). A few craters have been formed as a result of tests conducted on or near the surface during atmospheric testing, by shallow depth-of-burial cratering experiments, or following tunnel events.

There are no continuously flowing streams on the NTS. Surface drainages for the Yucca Flat and Frenchman Flat are in closed-basin systems, which drain onto the dry lake beds (playas) in each valley. The remaining area of the NTS drains 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 or seeps into permeable sands and gravels. During extreme conditions, flash floods may occur. The surface drainage channel pattern for the NTS and its immediate vicinity is displayed in Figure 2.6. The northwest portion (Pahute Mesa) of the NTS has integrated channel systems which carry runoff beyond NTS boundaries into the closed basins and playas in Kawich Valley and Gold Flat on the NAFB Range Complex. The western half and southernmost part of the NTS have channel systems which carry runoff from intense storms towards the southern boundary of the NTS and offsite towards the Amargosa Desert.

2.1.5 GEOLOGY

The basic lithologic structure of the NTS is depicted in Figure 2.7. 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 characterized large areas, geologically, within the U.S. This is due to the large number of holes drilled onsite as shown in Figure 2.8.

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

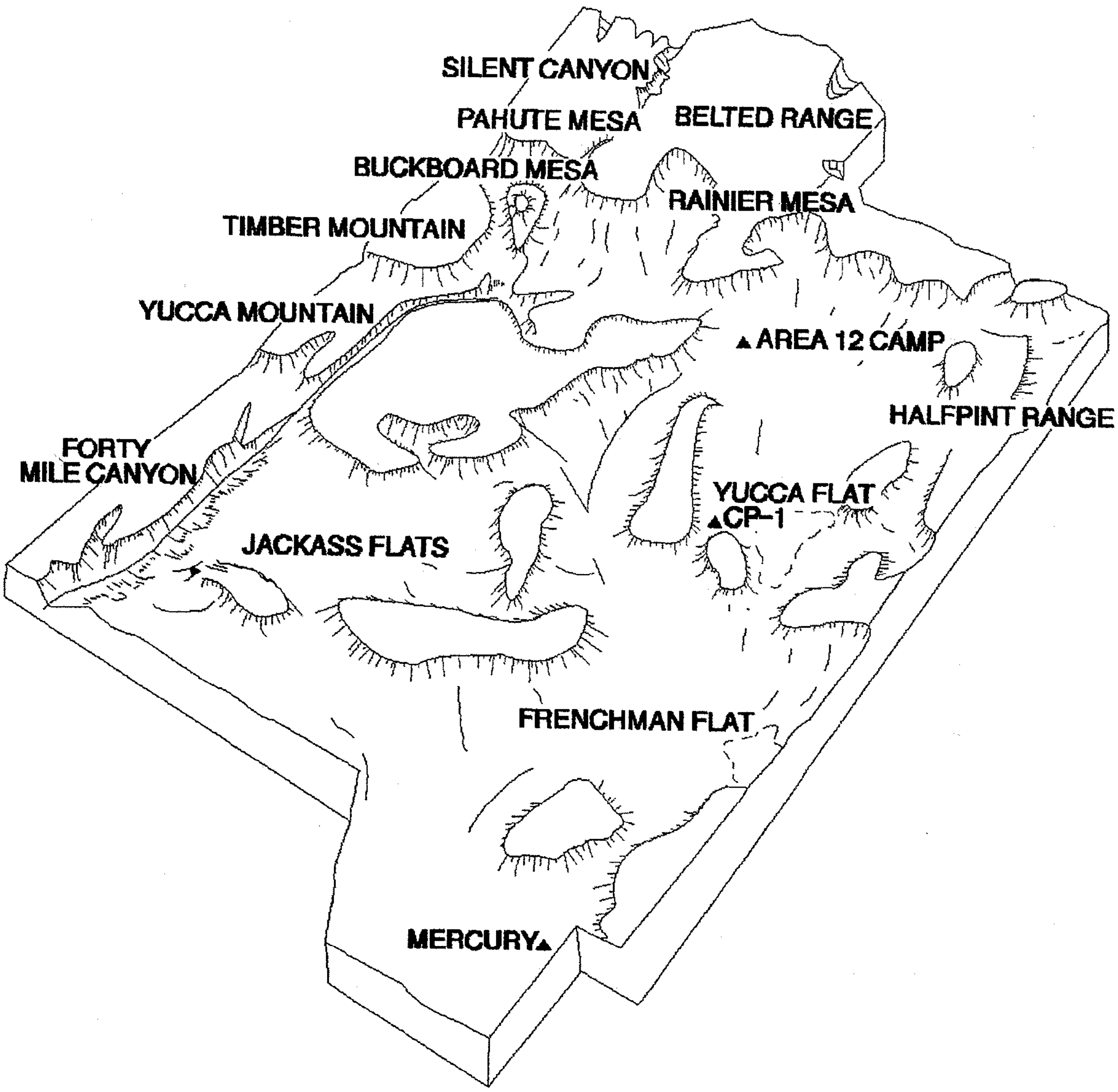


Figure 2.4 Topography of the NTS

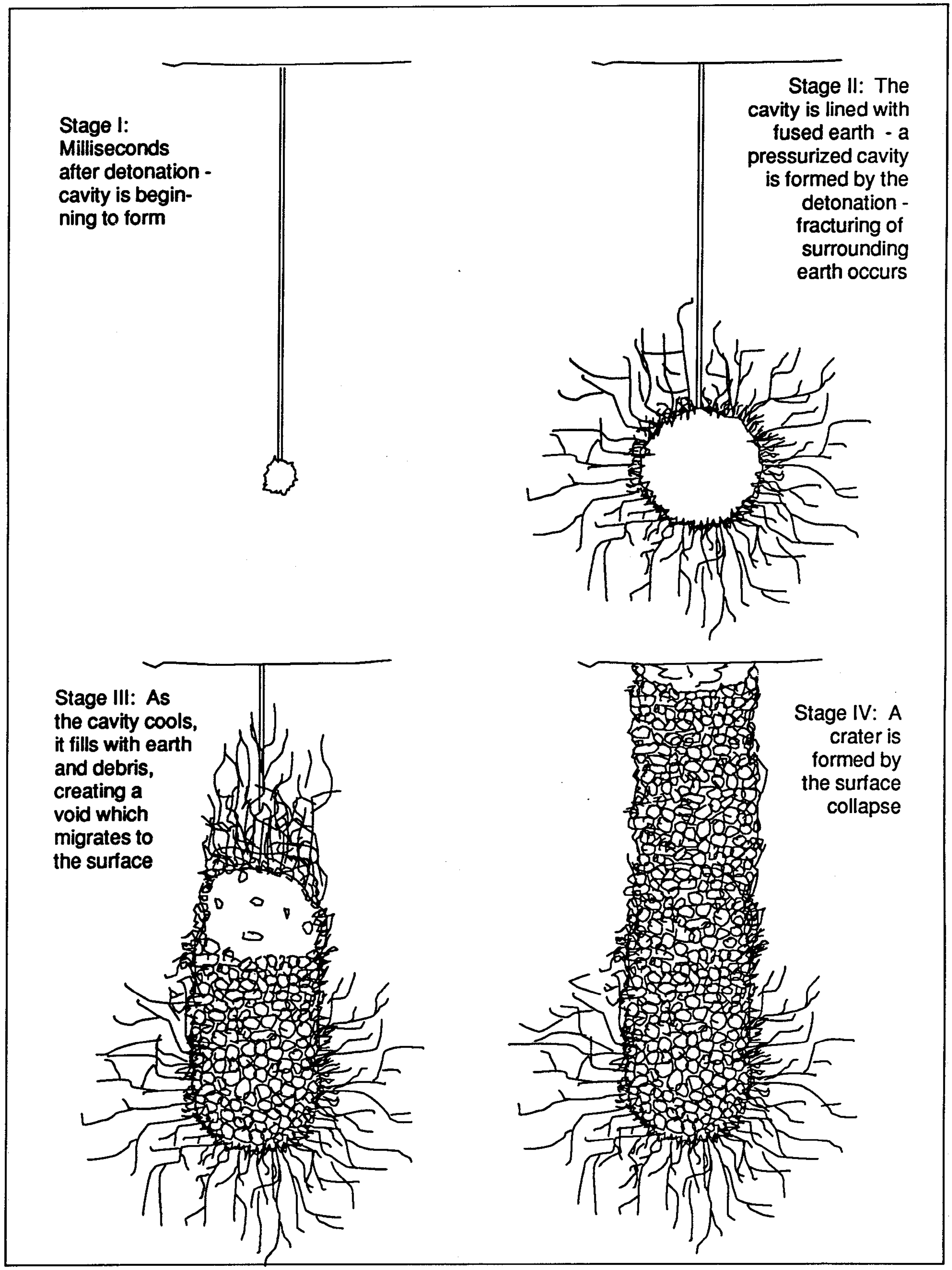


Figure 2.5 Formation of an Underground Nuclear Explosive Test Cavity, Rubble Chimney, and Surface Subsidence Crater

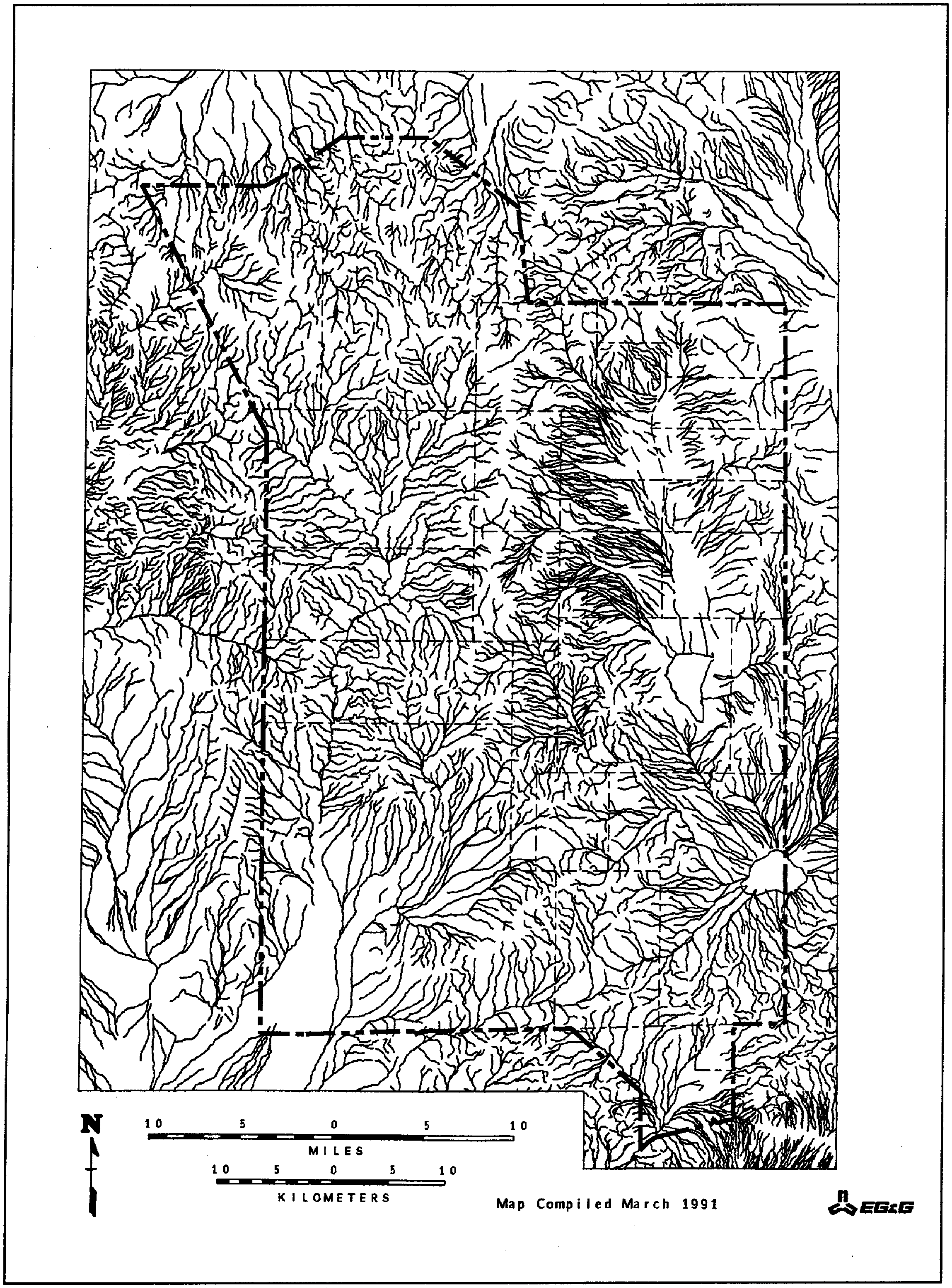


Figure 2.6 Surface Drainage Channel Pattern for the NTS

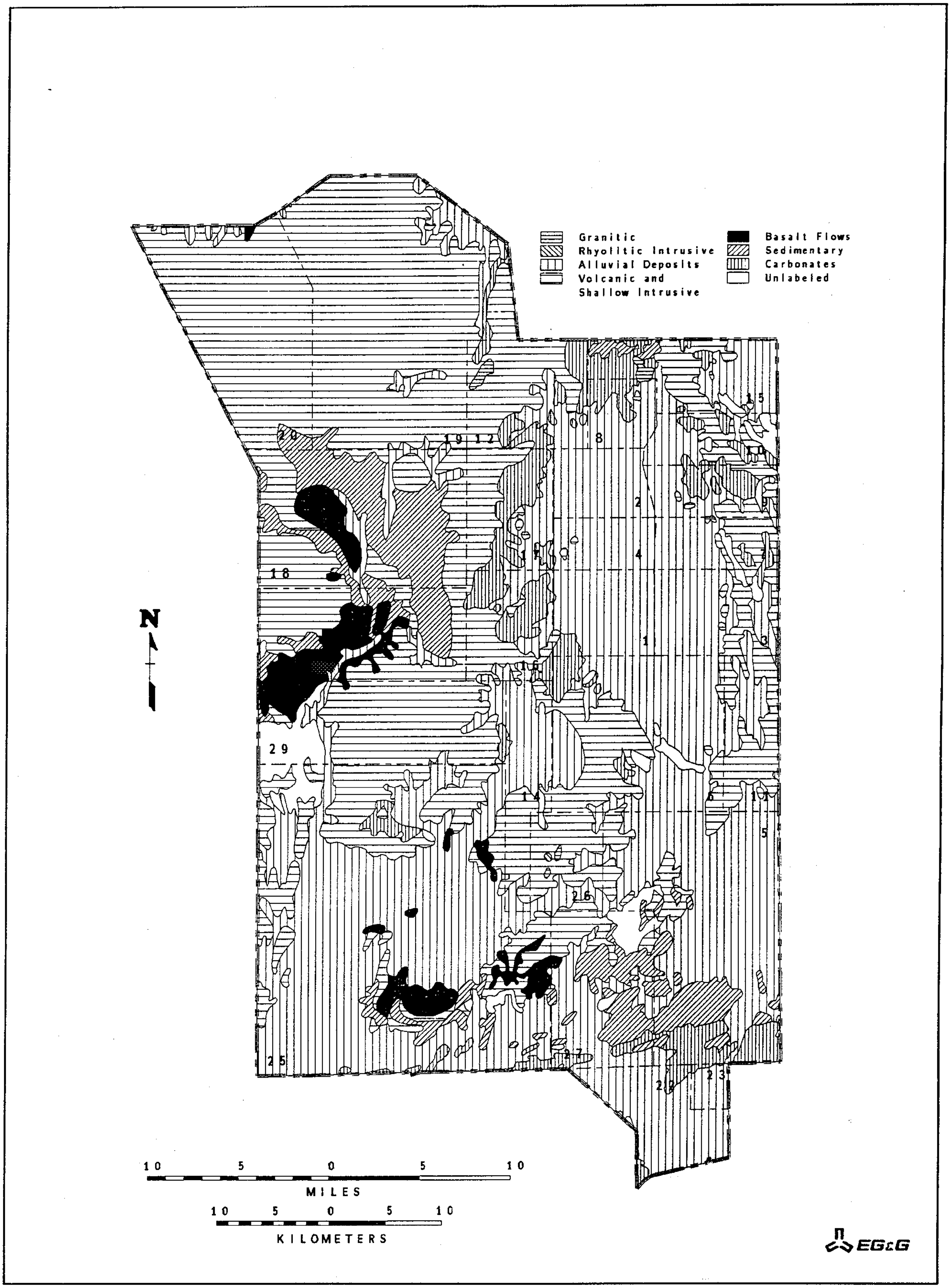


Figure 2.7 Basic Lithologic Structure of the NTS

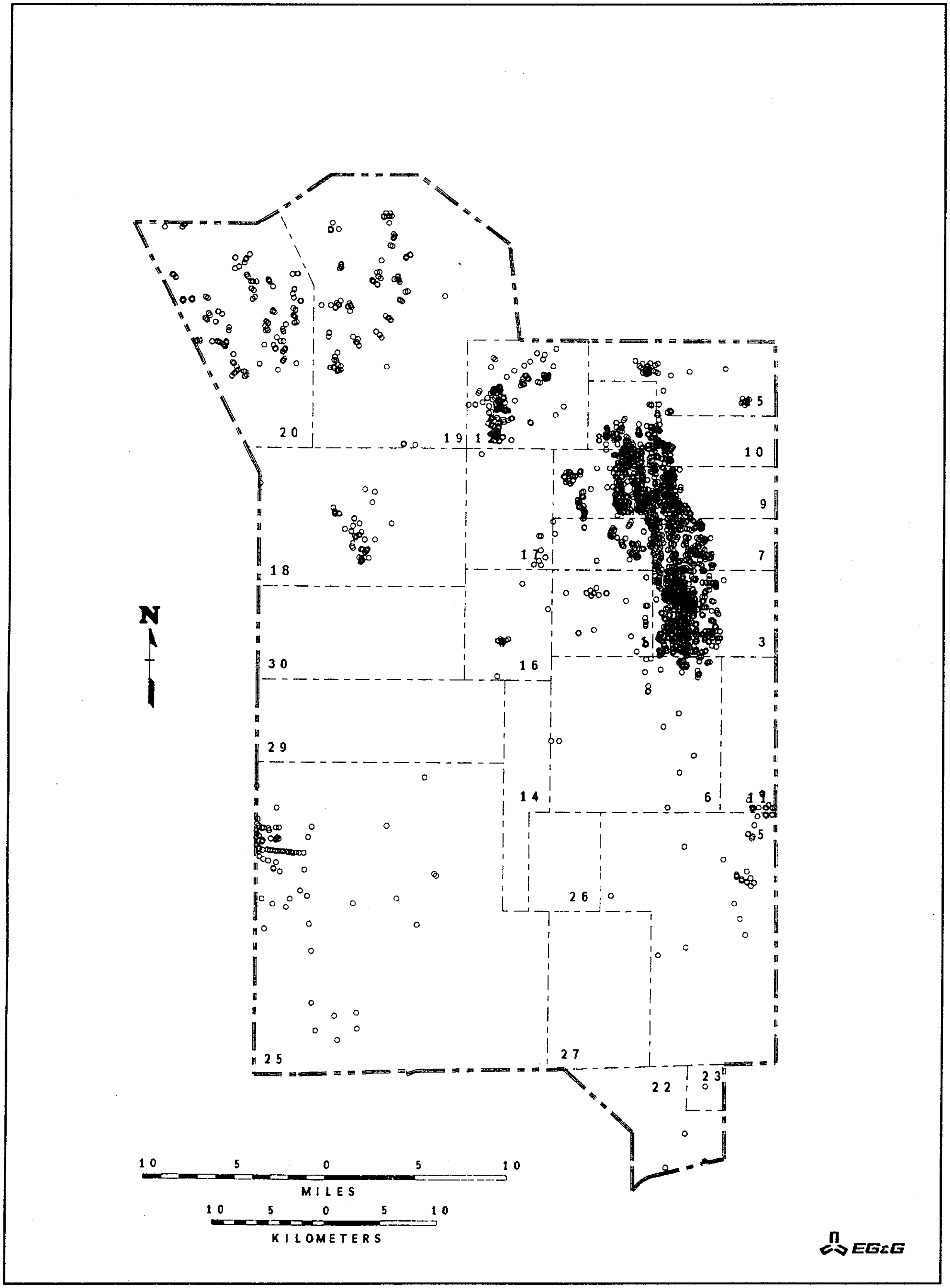


Figure 2.8 Drill Hole Locations on the NTS

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 the nearby hills of Tertiary and Paleozoic rocks.

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 are conducted below the groundwater table; the others are at varying depths above the groundwater table. Great depths to the groundwater table and the slow velocity of water movement in the saturated and unsaturated zones beneath the NTS are of particular significance in terms of low potential for radioactivity transport to offsite areas from nuclear tests or from shallow burial waste disposal sites. 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 underground sources via groundwater, greatly limiting the potential for transport of radioactivity to offsite areas.

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. The flow in the shallower parts of the groundwater body is generally toward the major valleys (Yucca and Frenchman) where it deflects downward to join the regional drainage to the southwest in the carbonate aquifer.

The hydrogeologic units at the NTS occur in three groundwater subbasins in the Death Valley groundwater basin. The actual subbasin boundaries are poorly defined, as shown in Figure 2.9. Groundwater beneath the eastern part of the NTS is in the Ash Meadows subbasin, defined by discharge through evapotranspiration along a spring line in Ash Meadows (south of the NTS). Most of the western NTS is in the Alkali Flat/Furnace Creek Ranch subbasin, which discharges by evapotranspiration at Alkali Flat and by spring discharge near Furnace Creek Ranch. Groundwater beneath the far northwestern corner of the NTS may be in the Oasis Valley subbasin, discharging by evapotranspiration in the Oasis Valley.

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 Site. 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

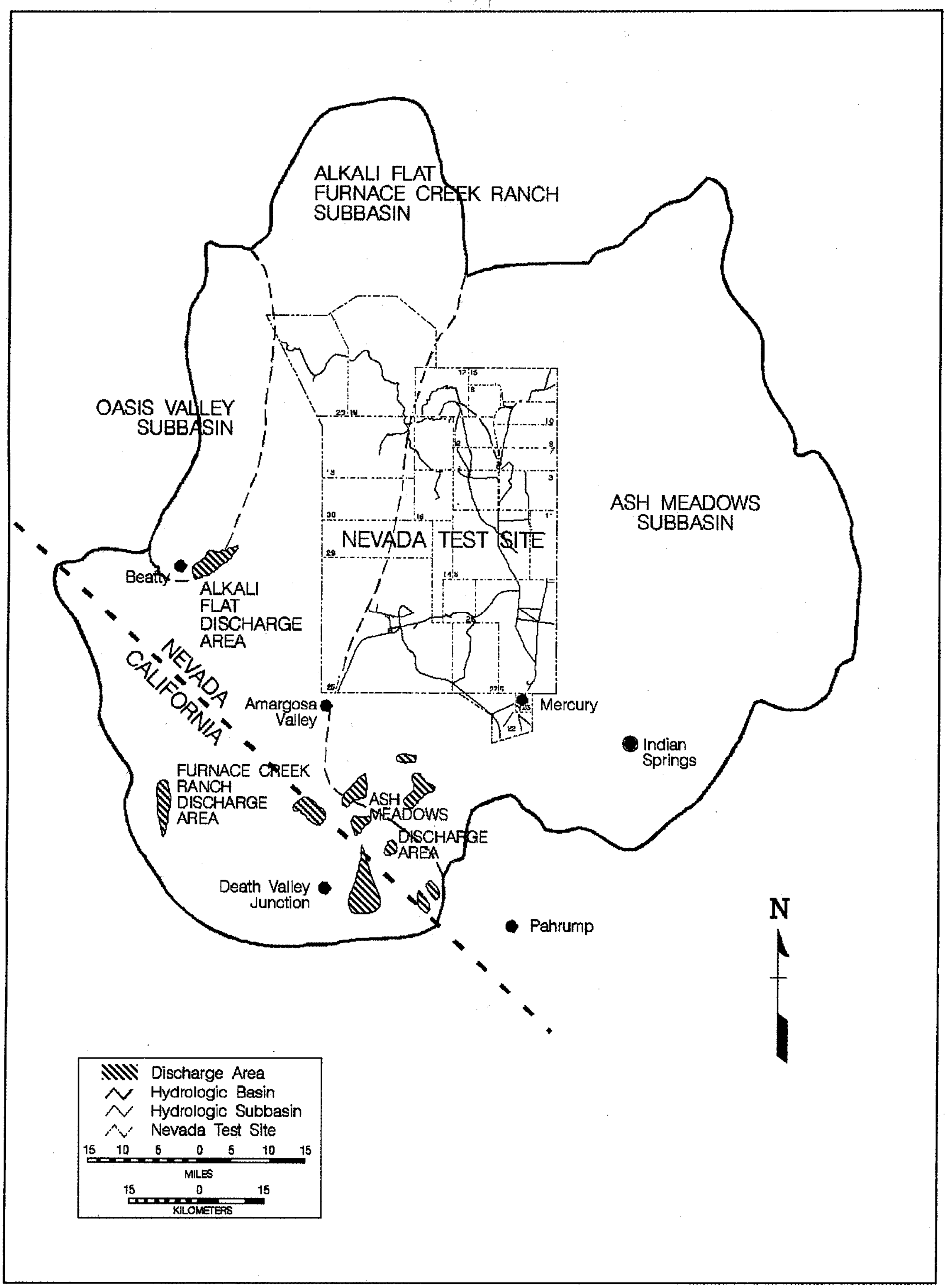


Figure 2.9 Groundwater Hydrologic Units of the NTS and Vicinity

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. Wildlife use the springs for drinking water. South of the NTS, private and public supply wells are completed in a valley-fill aquifer.

The hydrogeology of the underground nuclear testing areas on the NTS (Figure 2.9) has been summarized by the Desert Research Institute, University of Nevada System, in its report on the groundwater monitoring program for the NTS (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 welded tuff and bedded tuff aquifers are saturated beneath the central and northern parts of the valley and occur under both confined and unconfined conditions. The valley fill aquifer is saturated in the central part of the valley and is unconfined (Winograd and Thordarson 1975).

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 beneath Frenchman playa (157 m [515 ft]) and depths increase 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 (Blankennagel and Weir 1973).

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 is 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 Site. 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).

Precipitation usually falls in isolated showers with large variations in precipitation amounts within a shower area. Summer precipitation occurs mainly in July and August when intense heating of the ground below moist air masses (transported northward from the tropical Pacific Ocean through the Gulf of California and into the desert southwest) triggers thunderstorm development. On occasion a tropical storm will move northeastward from the west coast of Mexico, bringing widespread heavy precipitation to southern Nevada during September and/or October.

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/minimum temperatures are 4.4°/-2.2°C (40°/28°F) in January and 26.7°/16.7°C (80°/62°F) in July. In Area 6 (Yucca Flat, 1200 m (3920 ft MSL), the average daily maximum/minimum temperatures are 10.6°/-6.1°C (51°/21°F) in January and 35.6°/13.9°C (96°/57°F) in July.

Wind direction and speed are important aspects of the environment at the NTS. These are major factors in planning and conducting nuclear tests, where atmospheric transport is the primary potential route of contamination transport to onsite workers and offsite populations.

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 in Area 20, the average annual wind speed is 17 km/h (10 mi/h). The prevailing wind direction during winter months is from north-northeast, and, during summer months, winds prevail from the south. In Yucca Flat the average annual wind speed is 11 km/h (7 mi/h). The prevailing wind direction during winter months is north-northwest and during summer months is south-southwest. At Mercury the average annual wind speed is 13 km/h (8 mi/h),with a prevailing wind direction of northwest during the winter months and southwest during the summer months. The 1992 ten-meter wind roses for the NTS are shown in Figure 2.10.

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* ssp. *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.

In 1989 the desert tortoise, *Gopherus agassizii*, was placed on the endangered species list by the U.S. Department of Interior and was relisted as threatened in 1991. Tortoise habitats on the NTS are found in the southern third of the NTS outside the current areas of nuclear test activities in Yucca Flat, Rainier Mesa, and Pahute Mesa.

2.1.9 ARCHAEOLOGICAL AND HISTORICAL VALUES

Human habitation of the NTS area ranges from as early as 10,000 B.C. to the present. Various aboriginal cultures occupied the NTS area over this extended period as evidenced by the presence of artifacts at many surface sites and more substantial deposits of cultural material in several rock shelters. This period of aboriginal occupation was sustained primarily by a hunting and gathering economy based on using temporary campsites and shelters. The area was occupied by Paiute Indians at the time of the first known outside contact in 1849.

Because readily available surface water was the most important single determinant governing the location of human occupation, historic sites are often associated with prehistoric ones, both being situated near springs. As a consequence of this superposition of historic occupation, disturbance of certain aboriginal sites by modern man occurred long before use of

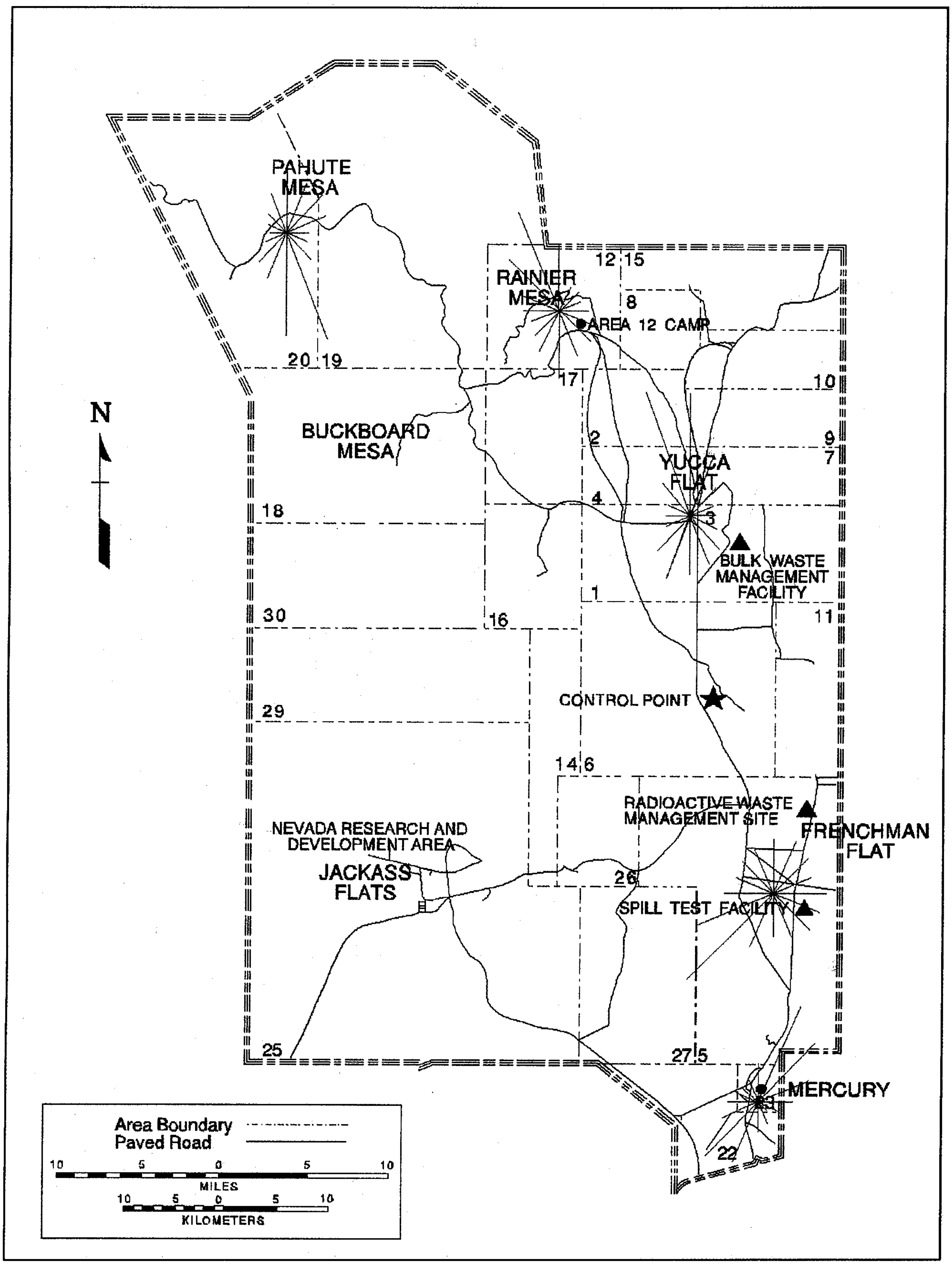


Figure 2.10 1992 Wind Rose Patterns for the NTS (Courtesy of Weather Services Nuclear Support Office, NOAA)

the area as a nuclear testing facility began. The larger valleys show little or no evidence of occupation. Together these areas comprise almost the entire floors of Yucca, Frenchman, and Jackass Flats. Thus, testing and associated operational activities have generally been most intense in those parts of the NTS valleys where archaeological and historic sites are absent. In contrast, there are many archeological sites on the Pahute and Rainier Mesas testing areas. Surveys of some of these NTS areas are documented in Reno and Pippin (1985) and Pippin (1986).

In addition to the archaeological sites, there are also some sites of historical interest on the NTS. The principal sites include the remains of primitive stone cabins with nearby corrals at three springs, a natural cave containing prospector's paraphernalia in Area 30, and crude remains of early mining and smelting activities.

2.1.10 DEMOGRAPHY

Figure 2.11 shows the current population of counties surrounding the NTS, based on 1990 Bureau of Census estimates (Department of Commerce 1990). Excluding Clark County, the major population center (approximately 741,000 in 1990), the population density within a 150-kilometer radius of the NTS is about 0.5 persons per square kilometer. In comparison, the 48 contiguous states (1990 census) had a population density of approximately 29 persons per square kilometer. The estimated average population density for Nevada in 1990 (including Clark County) was 2.8 persons per square kilometer.

The offsite area within 80 kilometers 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 15,000, is located 80 kilometers south of CP-1. The Amargosa Farm area, which has a population of about 950, is located about 50 km southwest of CP-1. The largest town in the near offsite area is Beatty, which has a population of about 1500 and is located approximately 65 kilometers 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 Monument boundaries ranges from a minimum of 200 permanent residents during the summer months to as many as 5000 tourists and campers on any particular day during the major 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 (104 km^2 or 40 mi^2) located 265 km (165 mi) south southwest of the NTS with a 1991 population of 21,000. 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 east of the NTS, with a 1991 population of 29,000. The next largest town, Cedar City, with a population of 13,000, is located 280 km east-northeast of the NTS.

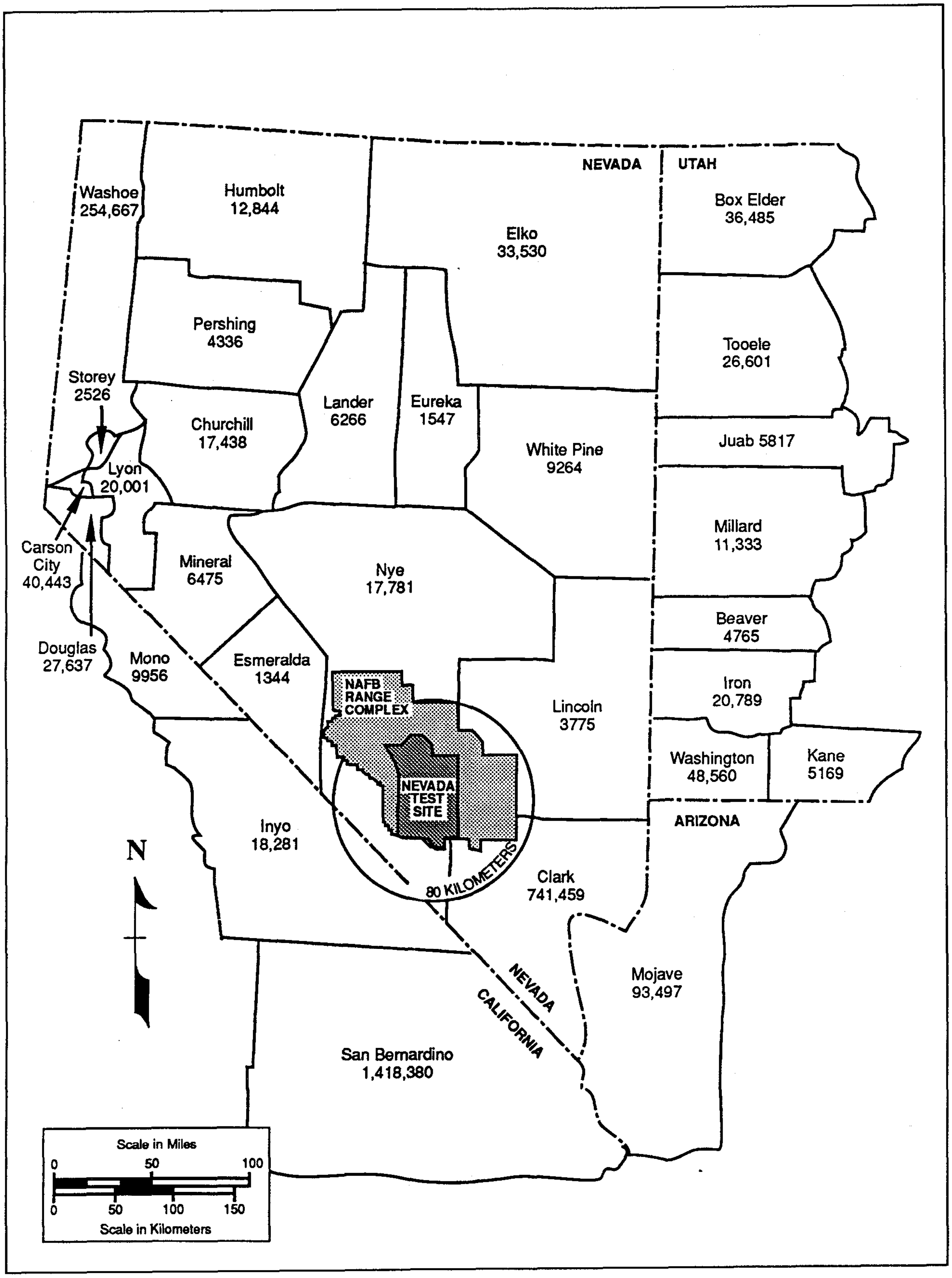


Figure 2.11 Population Distribution in Counties Surrounding the NTS (based on 1990 Census estimates)

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 kilometers south-southeast of the NTS, with a 1991 population estimate of 22,000, and Kingman, located 280 km southeast of the NTS, with a population of about 13,000.

2.1.11 SURROUNDING LAND USE

Figure 2.12 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-mile) 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. Minor agriculture, primarily the growing of alfalfa hay, is found in this portion of the state within 300 km (180 mi.) of CP-1. Many of the residents have access to locally grown fruits and vegetables.

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 northwest, north, and northeast of the NTS are utilized throughout the year except for the winter months. Camping and fishing locations to the southeast, south, and southwest are utilized throughout the entire year. The peak hunting season is from September through January.

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. These operations house the Amador Valley Operations (AVO), Pleasanton, California; Kirtland Operations (KO), that includes the Craddock Facility and facilities at Kirtland Air Force Base (KAFB), Albuquerque, New Mexico; Las Vegas Area Operations (LVAO) that include the Remote Sensing Laboratory at the NAFB and North Las Vegas Complex in North Las Vegas, Nevada; Los Alamos Operations (LAO), Los Alamos, New Mexico; Santa Barbara Operations (SBO) that includes the Robin Hill Road and Francis Botello Road Facilities, Goleta, California; Special Technologies Laboratory (STL), Santa Barbara, California; Washington Aerial Measurements Department (WAMD), Andrews Air Force Base, Maryland; and Woburn Cathode Ray Tube Operations (WCO), Woburn, Massachusetts. These locations are shown in Figure 2.13. 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

The AVO facility in Pleasanton, California, occupies a 9290 m^2 (100,000 ft^2) facility consisting of two large combination office/laboratory buildings, one two-story and one single-story. The facility is located near the Lawrence Livermore National Laboratory (LLNL) in Livermore,

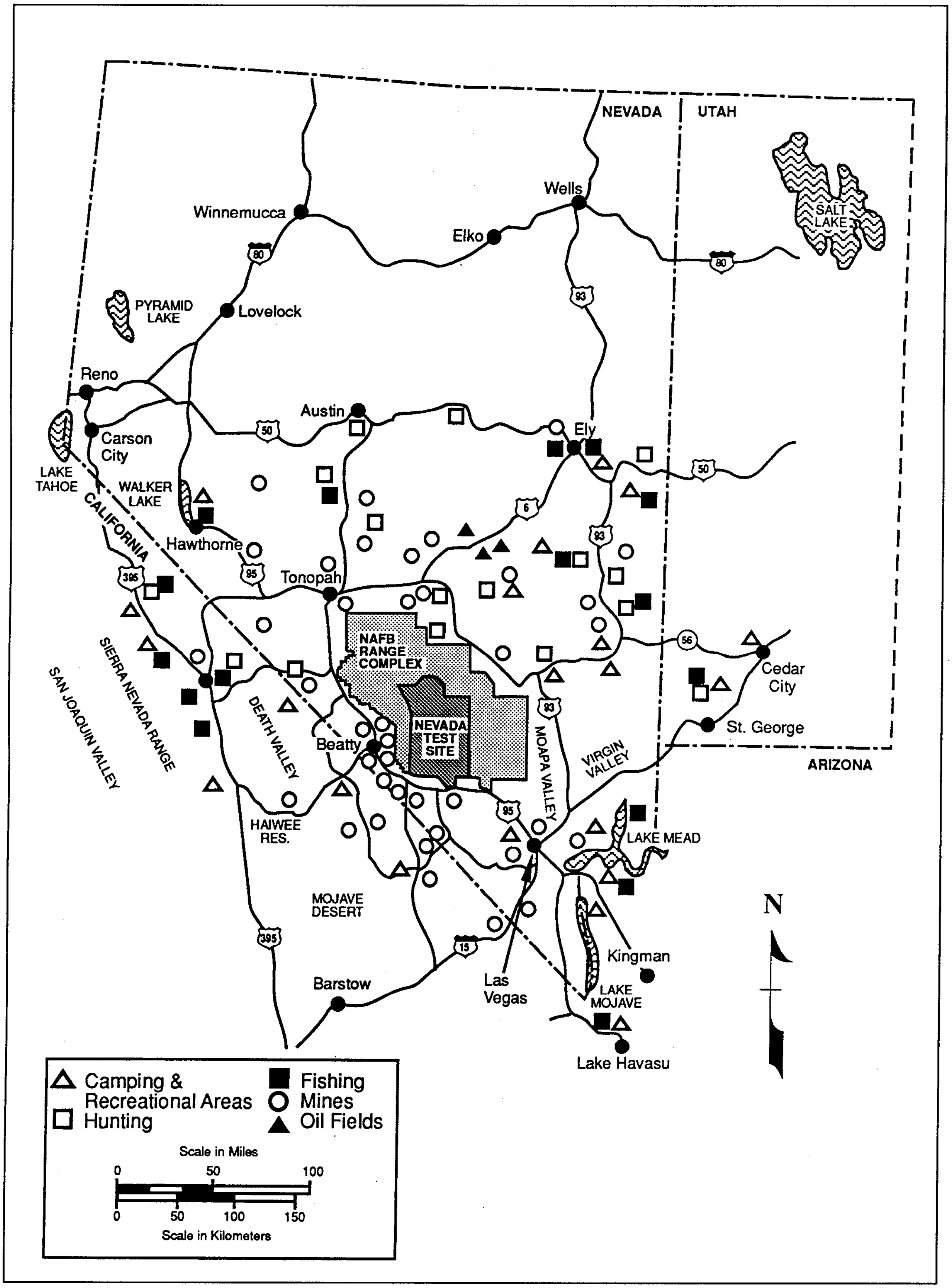


Figure 2.12 Land Use Around the NTS

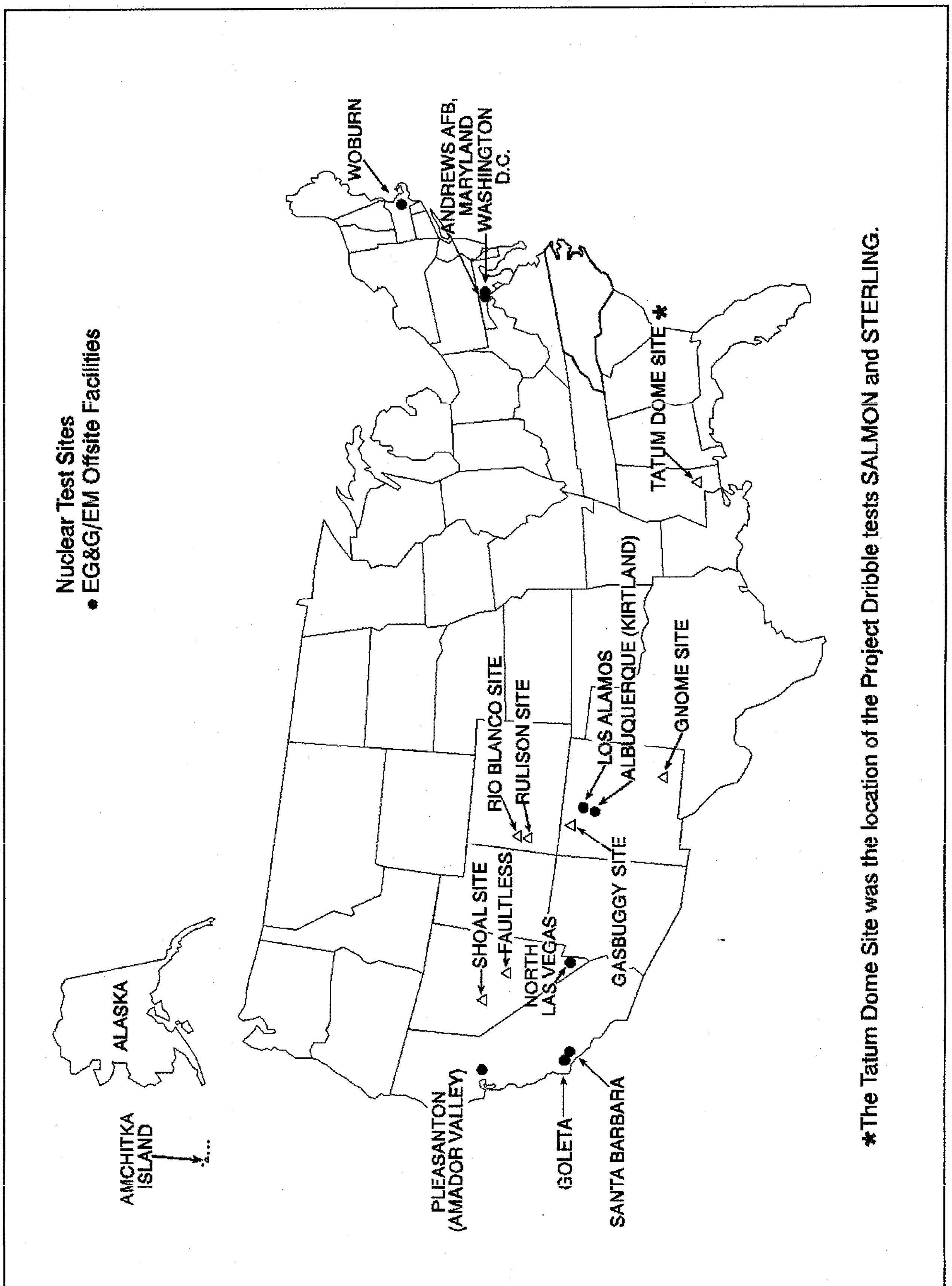


Figure 2.13 Locations of Non-NTS Operations and Underground Event Sites

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. AVO also supports LLNL with optical alignment systems, fast-streak camera and fast-streak tube fabrication, and a variety of mechanical and electrical engineering activities associated with energy research and development programs. Areas of environmental interest include several localized exhaust hoods and small chemical cleaning operations.

2.2.2 KIRTLAND OPERATIONS

KO at 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 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

The LVAO includes the North Las Vegas facility at 2621 Losee Road and the Remote Sensing Laboratory on the 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 54,455 m^2 (591,900 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 a 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

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 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: (1) the design, fabrication, and fielding of data acquisition systems used in underground nuclear testing diagnostics and (2) 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, metal machining operations, and a small photo laboratory.

2.2.5 SANTA BARBARA OPERATIONS

SBO occupies two facilities located in Santa Barbara, California. The Robin Hill Road Facility (50,000 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 (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. SBO also supports LLNL with optical-alignment systems, fast-streak camera fabrication, and a variety of mechanical and electrical engineering activities associated with energy R&D programs. Fields of specialized experience represented at SBO include the design and fabrication of cathode-ray tubes for use in the weapons test program. 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

The STL located in Santa Barbara, California, consists of approximately 3340 m^2 (36,000 ft^2) of 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 limited solvent cleaning operations. Areas of environmental interest include several localized exhaust hoods and small chemical cleaning operations.

2.2.7 WASHINGTON AERIAL MEASUREMENTS DEPARTMENT

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 provides an effective East Coast Nuclear Emergency Search Team (NEST) response capability and provides 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

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 Test Program for use in the 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.

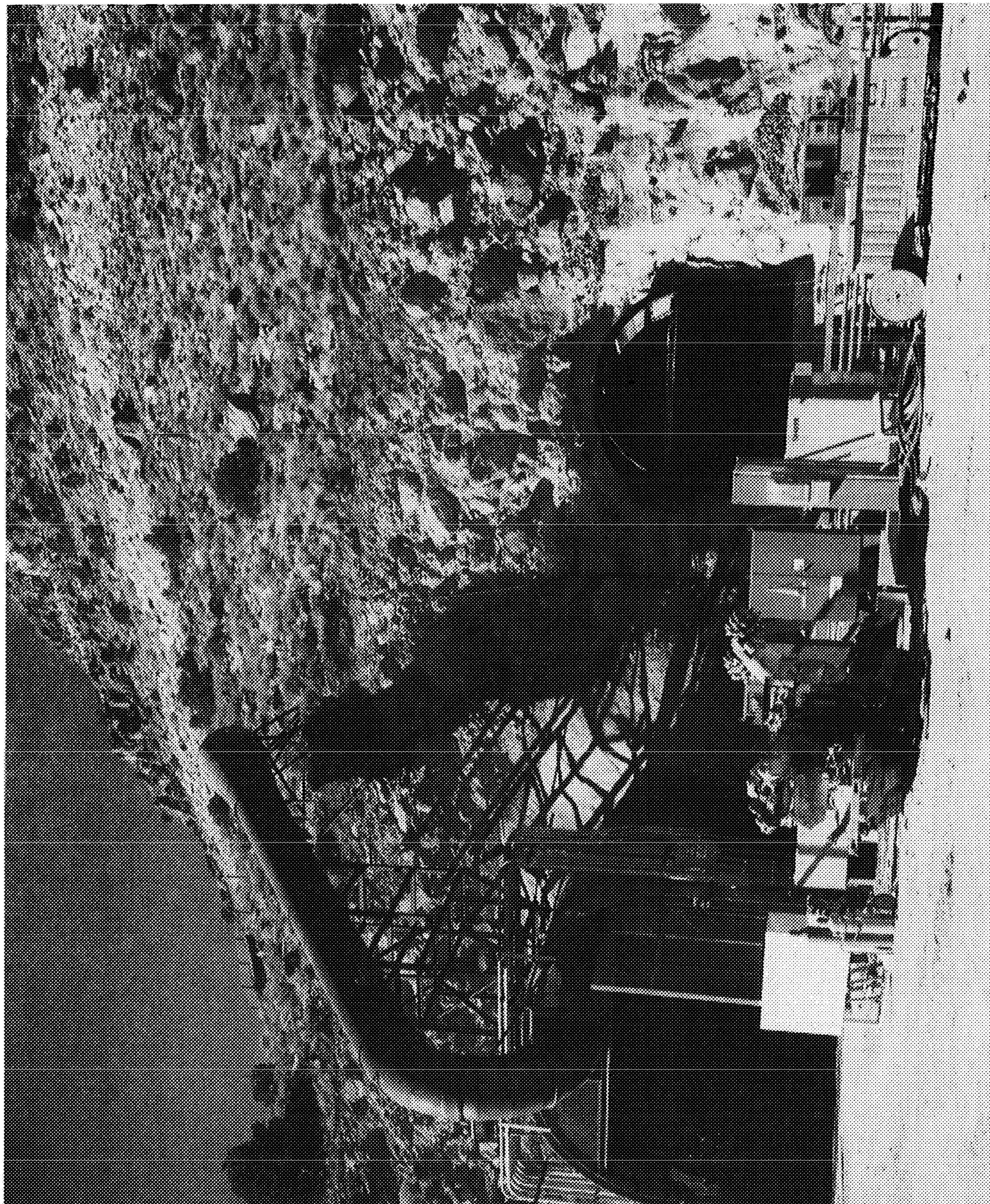
2.3 NON-NTS UNDERGROUND EVENT SITES

Previously, non-NTS tests were conducted at eight locations in various states of the U.S. These events and their locations appear in Figure 2.13 and Table 2.2. Activities at these

Table 2.2 Non-NTS Nuclear Underground Test Sites Studied in 1992

Event Name	Location	Date of Test
GNOME	Malaga, New Mexico	12/10/61
SHOAL	Fallon, Nevada	10/26/63
SALMON (Dribble)	Baxterville, Mississippi	10/22/64
STERLING (Dribble)	Baxterville, Mississippi	12/03/66
GASBUGGY	Gobernador, New Mexico	12/10/67
FAULTLESS	Blue Jay, Nevada	01/19/68
RULISON	Grand Valley, Colorado	09/10/69
RIO BLANCO	Rio Blanco, Colorado	05/17/73

locations generally are limited to annual sampling at 217 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 results for these sites appear in Chapter 9 of this volume.



3.0 COMPLIANCE SUMMARY

H. Bruce Gillen, Scott E. Patton, Scott A. Wade

In addition to conducting the nuclear testing programs in compliance with radiation protection guides and standards, the predominant environmental compliance activities at the NTS during the period from January 1992 through March 1993 involved hazardous waste management associated with Resource Conservation and Recovery Act (RCRA) requirements. Clean Air Act compliance involved sampling and reporting of asbestos renovation projects and state of Nevada air quality permit renewals and reporting. Toxic Substances Control Act (TSCA) compliance activities were concerned with polychlorinated biphenyl (PCB) management practices on the NTS. Compliance actions also included pre-operational surveys to detect and document archaeological and cultural history 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 11988, Flood Plain Management, or 11990, Protection of Wetlands.

Corrective actions are continuing as a response to the findings communicated by the DOE "Tiger Team" during its October 1989 assessment of environmental compliance and program management. Throughout 1992 the NTS was subject to three formal compliance agreements with federal or state regulatory agencies: the American Indian Religious Freedom Act Compliance Program; a Programmatic Agreement with the Nevada Division of Historic Preservation and Archaeology and the Advisory Council on Historic Preservation; and with the United States Fish and Wildlife Service (USFWS) for protection of the desert tortoise. No lawsuits have been identified that affect the DOE/NV's program obligations. Waste minimization efforts at the NTS were expanded in 1992.

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

3.1 NATIONAL ENVIRONMENTAL POLICY ACT

The National Environmental Policy Act (NEPA) requires that federal activities be evaluated for their impact to the environment. DOE/NV activities, both NTS and non-NTS, are evaluated for their impacts and whether th proper level of NEPA documentation is initiated. For 1992 NEPA related activities included two Environmental Impact Statements (EIS), 23 Environmental Assessments and 89 Categorical Exclusions. Table 3.1 lists these activities in chronological order with the assigned number and their present status. Two projects are indicated above as requiring EIS-level of NEPA documentation: the Space Nuclear Thermal Propulsion (SNTP)

Table 3.1 NEPA Documentation - 1989-1993

File Number	Description	Category	Review Status
NV-89-06	Depleted Uranium Tests, Ballistic Research Laboratory, Area 25	Environmental Assessment	Approved 10/30/92
NV-89-07	Mixed Waste Management Unit, Area 5	Environmental Assessment	DOE/HQ,EM
NV-89-21	Device Assembly Facility, Area 6	Environmental Assessment	RSN Prepares
NV-89-30	SCYLLA Facility in Area 26	Environmental Assessment	LANL
NV-90-13	NTS Groundwater Characterization Program	Environmental Assessment	Approved 8/18/92
NV-90-20	Road 5-01 Upgrade in Area 5	Categorical Exclusion	Approved 8/24/92
NV-90-51	Liquified Gaseous Fuels Spill Test Facility, Area 5	Environmental Assessment	DOE/HQ
NV-90-63	New Decontamination Pond, Area 6	Environmental Assessment	DOE/HQ
NV-90-96	Rainier Mesa Power Loop, Area 12	Environmental Assessment	Approved 8/11/92
NV-90-107	NTS Power Distribution	Environmental Assessment	PAI Prepares
NV-90-136	Temporary Monitor Trailer, Able Compound, Area 27	Categorical Exclusion	Cancelled
NV-90-137	Fleet Operations Steam Cleaning Pad, Area 12	Categorical Exclusion	Cancelled
NV-90-139	U.S./U.S.S.R. Onsite Inspection Team Housing, Nevada Test Site	Environmental Assessment	Cancelled
NV-90-144	Integrated Demonstration Project (remove Pu from soil), Area 25	Categorical Exclusion	Closed
NV-91-001	Demonstrated Decontaminating Technology for Pu-contaminated Soils	Environmental Assessment	DOE/HQ, EM
NV-91-016	Nevada Bell Optic Cable, Areas 5, 6, 22, and 23	Environmental Assessment	Approved 6/8/92
NV-91-022	Sewage Lagoon Monitoring, NTS	Categorical Exclusion	Cancelled
NV-91-031	Brilliant Pebbles Bren Tower Tether Test, Area 25	Environmental Assessment	Approved 4/13/92
NV-91-043	Treatability Studies for Contaminated Soil	Environmental Assessment	Approved 6/24/92

Table 3.1 (NEPA Documentation - 1989-1993, cont.)

File Number	Description	Category	Review Status
NV-92-001	Vending Machine Relocation	Categorical Exclusion	Approved 1/14/92
NV-92-002	DNA Recording Station, Area 12	Categorical Exclusion	Approved 1/4/92
NV-92-003	Power Cable for Sanitary Landfill, Area 9	Categorical Exclusion	Approved 2/3/92
NV-92-004	Upgrade Switching Stations, Areas 2, 12, 19	Categorical Exclusion	Approved 2/12/92
NV-92-005	Fire Protection Upgrades, Area 23	Categorical Exclusion	Approved 2/12/92
NV-92-006	Site Characterization Wells ER-20-2 and ER-6-1	Categorical Exclusion	Approved 4/16/92
NV-92-007	Land Reclamation Trials on the NTS	Categorical Exclusion	Approved 5/29/92
NV-92-008	Space Nuclear Thermal Propulsion, Area 14	Environmental Impact Statement	Preliminary Final
NV-92-009	EG&G Kirtland Area Office	Environmental Assessment	ECM/NV
NV-92-010	Four Steam Cleaning Systems, Areas 6 and 12	Categorical Exclusion	Approved 3/17/92
NV-92-012	Water Tank Repairs, Areas 12 and 27	Categorical Exclusion	Approved 3/25/92
NV-92-013	Building 710 Modifications, Area 23	Categorical Exclusion	Approved 3/25/92
NV-92-014	Test Logistics Support Facilities, Area 23	Categorical Exclusion	ECM/NV
NV-92-015	Second Story Addition, Remote Sensing Laboratory Facility, Nellis AFB	Categorical Exclusion	ECM/NV
NV-92-017	Ground Wave Emergency Network Relay Node Network Expansion, Area 25	Environmental Assessment Impact Statement	USAF
NV-92-019	Dormitories, NTS (94), Areas 12 and 23	Categorical Exclusion	NTSO/NV
NV-92-020	Environmental Restoration and Waste Management	Environmental Impact Statement	ERWM/NV
NV-92-023	Fire Hydrant Installation, Building 6-605, Area 6	Categorical Exclusion	Approved 5/7/92
NV-92-024	Fire Separation Walls, Building CP-70 and 23-425, Areas 6 and 23	Categorical Exclusion	Approved 5/7/92
NV-92-025	Spill Containment Berms, Bulk Fuel Facilities, Areas 6 and 23	Categorical Exclusion	Approved 5/7/92
NV-92-026	Transmission System Upgrades, Area 25	Environmental Assessment	ECM\NV

Table 3.1 (NEPA Documentation - 1989-1993, cont.)

File Number	Description	Category	Review Status
NV-92-027	Construct Small Covered Storage Shed, NLV	Categorical Exclusion	Approved 7/27/92
NV-92-028	Truck Scale Installation at Sanitary Landfill, Area 9	Categorical Exclusion	Approved 7/15/92
NV-92-029	Power Cable for New Base Station, Area 23	Categorical Exclusion	Approved 7/15/92
NV-92-030	Transportainer Placement, Area 23	Categorical Exclusion	Approved 7/15/92
NV-92-031	Upgrade of Communication Site, Area 19	Categorical Exclusion	Approved 7/17/92
NV-92-032	Aboveground Fuel Tank Upgrade, Area 1	Categorical Exclusion	Approved 7/17/92
NV-92-033	Modification of Electrical Substations	Categorical Exclusion	Approved 7/17/92
NV-92-034	Septic System Decontamination Facility, Area 6	Categorical Exclusion	Approved 7/17/92
NV-92-035	Aerosol Can Crusher Installation/Operation	Categorical Exclusion	Approved 8/24/92
NV-92-036	Implementation of Radioactive Waste Control Procedures	Categorical Exclusion	Approved 8/24/92
NV-92-037	Sewage System Upgrades, Areas 15, 25, 26	Categorical Exclusion	Approved 8/24/92
NV-92-038	Underground Storage Tank Modification/ Removals	Categorical Exclusion	Approved 7/17/92
NV-92-039	Decontamination Facility Yard Expansion, Area 6	Categorical Exclusion	Approved 8/24/92
NV-92-040	Modifications to the Radioactive Waste Management Site, Area 3	Categorical Exclusion	Approved 8/24/92
NV-92-041	Additional Use of Recyclable Materials Holding Area, Area 3	Categorical Exclusion	Approved 8/24/92
NV-92-042	Building C-1 QAL Area and Nurse's Station Modification, NLV	Categorical Exclusion	ECM/NV
NV-92-043	Building 3127 Renovation, Area 25	Categorical Exclusion	Approved 9/15/92
NV-92-044	Building 650 Plumbing Modification, Area 23	Categorical Exclusion	Approved 9/29/92
NV-92-045	Water Fill Stand Modifications, Area 6	Categorical Exclusion	Approved 9/29/92
NV-92-046	Pahute Mesa Road Repair, Area 19	Categorical Exclusion	Approved 9/29/92
NV-92-047	Water Fill Stand, Area 9 Sanitary Landfill	Categorical Exclusion	Approved 9/29/92

Table 3.1 (NEPA Documentation - 1989-1993, cont.)

File Number	Description	Category	Review Status
NV-92-001	Vending Machine Relocation	Categorical Exclusion	Approved 1/14/92
NV-92-002	DNA Recording Station, Area 12	Categorical Exclusion	Approved 1/4/92
NV-92-003	Power Cable for Sanitary Landfill, Area 9	Categorical Exclusion	Approved 2/3/92
NV-92-004	Upgrade Switching Stations, Areas 2, 12, 19	Categorical Exclusion	Approved 2/12/92
NV-92-005	Fire Protection Upgrades, Area 23	Categorical Exclusion	Approved 2/12/92
NV-92-006	Site Characterization Wells ER-20-2 and ER-6-1	Categorical Exclusion	Approved 4/16/92
NV-92-007	Land Reclamation Trials on the NTS	Categorical Exclusion	Approved 5/29/92
NV-92-008	Space Nuclear Thermal Propulsion, Area 14	Environmental Impact Statement	Preliminary Final
NV-92-009	EG&G Kirtland Area Office	Environmental Assessment	ECM/NV
NV-92-010	Four Steam Cleaning Systems, Areas 6 and 12	Categorical Exclusion	Approved 3/17/92
NV-92-012	Water Tank Repairs, Areas 12 and 27	Categorical Exclusion	Approved 3/25/92
NV-92-013	Building 710 Modifications, Area 23	Categorical Exclusion	Approved 3/25/92
NV-92-014	Test Logistics Support Facilities, Area 23	Categorical Exclusion	ECM/NV
NV-92-015	Second Story Addition, Remote Sensing Laboratory Facility, Nellis AFB	Categorical Exclusion	ECM/NV
NV-92-017	Ground Wave Emergency Network Relay Node Network Expansion, Area 25	Environmental Assessment Impact Statement	USAF
NV-92-019	Dormitories, NTS (94), Areas 12 and 23	Categorical Exclusion	NTSO/NV
NV-92-020	Environmental Restoration and Waste Management	Environmental Impact Statement	ERWM/NV
NV-92-023	Fire Hydrant Installation, Building 6-605, Area 6	Categorical Exclusion	Approved 5/7/92
NV-92-024	Fire Separation Walls, Building CP-70 and 23-425, Areas 6 and 23	Categorical Exclusion	Approved 5/7/92
NV-92-025	Spill Containment Berms, Bulk Fuel Facilities, Areas 6 and 23	Categorical Exclusion	Approved 5/7/92
NV-92-026	Transmission System Upgrades, Area 25	Environmental Assessment	ECM\NV

Table 3.1 (NEPA Documentation - 1989-1993, cont.)

File Number	Description	Category	Review Status
NV-92-027	Construct Small Covered Storage Shed, NLV	Categorical Exclusion	Approved 7/27/92
NV-92-028	Truck Scale Installation at Sanitary Landfill, Area 9	Categorical Exclusion	Approved 7/15/92
NV-92-029	Power Cable for New Base Station, Area 23	Categorical Exclusion	Approved 7/15/92
NV-92-030	Transportainer Placement, Area 23	Categorical Exclusion	Approved 7/15/92
NV-92-031	Upgrade of Communication Site, Area 19	Categorical Exclusion	Approved 7/17/92
NV-92-032	Aboveground Fuel Tank Upgrade, Area 1	Categorical Exclusion	Approved 7/17/92
NV-92-033	Modification of Electrical Substations	Categorical Exclusion	Approved 7/17/92
NV-92-034	Septic System Decontamination Facility, Area 6	Categorical Exclusion	Approved 7/17/92
NV-92-035	Aerosol Can Crusher Installation/Operation	Categorical Exclusion	Approved 8/24/92
NV-92-036	Implementation of Radioactive Waste Control Procedures	Categorical Exclusion	Approved 8/24/92
NV-92-037	Sewage System Upgrades, Areas 15, 25, 26	Categorical Exclusion	Approved 8/24/92
NV-92-038	Underground Storage Tank Modification/ Removals	Categorical Exclusion	Approved 7/17/92
NV-92-039	Decontamination Facility Yard Expansion, Area 6	Categorical Exclusion	Approved 8/24/92
NV-92-040	Modifications to the Radioactive Waste Management Site, Area 3	Categorical Exclusion	Approved 8/24/92
NV-92-041	Additional Use of Recyclable Materials Holding Area, Area 3	Categorical Exclusion	Approved 8/24/92
NV-92-042	Building C-1 QAL Area and Nurse's Station Modification, NLV	Categorical Exclusion	ECM/NV
NV-92-043	Building 3127 Renovation, Area 25	Categorical Exclusion	Approved 9/15/92
NV-92-044	Building 650 Plumbing Modification, Area 23	Categorical Exclusion	Approved 9/29/92
NV-92-045	Water Fill Stand Modifications, Area 6	Categorical Exclusion	Approved 9/29/92
NV-92-046	Pahute Mesa Road Repair, Area 19	Categorical Exclusion	Approved 9/29/92
NV-92-047	Water Fill Stand, Area 9 Sanitary Landfill	Categorical Exclusion	Approved 9/29/92

Table 3.1 (NEPA Documentation - 1989-1993, cont.)

File Number	Description	Category	Review Status
NV-92-048	Abandoned Septic Tank Characterization, Areas 12, 15, 25, and 26	Categorical Exclusion	Approved 9/29/92
NV-92-049	New Office Building, Radioactive Waste Management Site, Area 5	Categorical Exclusion	Approved 10/23/92
NV-92-050	Installation of Concrete Storage Shed, Building 1792, Andrews AFB	Categorical Exclusion	Approved 11/30/92
NV-92-051	RI/FS at the Tatum Dome Test Site, Lamar County, Mississippi	Categorical Exclusion	Approved 10/27/92
NV-92-052	Lawrence Livermore National Laboratory Mine Detection Demonstration at NTS	Categorical Exclusion	Approved 02/04/93
NV-92-053	Decontamination Wastewater Plumbing Modification	Categorical Exclusion	Approved 11/6/92
NV-92-054	N Tunnel Modification, Area 12	Categorical Exclusion	Approved 11/6/92
NV-92-055	Closed Loop Steam Cleaning System, NTS Area 1 Subdock	Categorical Exclusion	Approved 12/7/92
NV-92-056	Construction of Tortoise Overwintering Site, Area 23	Categorical Exclusion	Approved 12/11/92
NV-92-057	Soils Trench Excavation, Radioactive Waste Management Site, Area 5	Categorical Exclusion	Approved 12/22/92
NV-92-058	T Tunnel Modifications, Area 12	Categorical Exclusion	Approved 12/18/92
NV-92-059	Characterization of Contamination in U2bu Subsidence Crater, Area 2	Categorical Exclusion	Approved 12/18/92
NV-92-060	Characterization of Bitcutter Shop and LLNL Postshot Injection Wells, Area 2	Categorical Exclusion	Approved 12/22/92
NV-92-061	Characterization of Contamination at U3fi Injection Well, Area 3	Categorical Exclusion	Approved 12/22/92
NV-92-062	Characterization of Contamination from the Steam Cleaning Effluent Ponds, Area 6	Categorical Exclusion	Approved 12/22/92
NV-92-063	Characterization of the Explosive Ordnance Disposal Facility, Area 27	Categorical Exclusion	Approved 12/22/92
NV-92-064	Aircraft Test Flight Related Ground Survey at Yucca Flat Dry Lake Bed, NTS	Categorical Exclusion	Approved 12/18/92

Table 3.1 (NEPA Documentation - 1989-1993, cont.)

File Number	Description	Category	Review Status
NV-92-065	Additional Office Trailers, Building 653, Area 23	Categorical Exclusion	Approved 12/28/92
NV-92-066	Underground Storage Tank Removals, NTS	Categorical Exclusion	Approved 12/28/92
NV-92-067	Removal and Disposal of Hydrocarbon Contaminated Soil, NTS	Categorical Exclusion	Approved 01/11/93
NV-92-068	Sanitary Sewer Connection, Area 6	Categorical Exclusion	Approved 01/11/93
NV-92-069	Four Steam Cleaning Systems, Areas 6 and 12	Categorical Exclusion	Approved 01/11/93
NV-92-070	Replacement of Circuit Switcher, Yucca Substation, Area 3	Categorical Exclusion	Approved 01/11/93
NV-93-001	Demonstration Testing of Underground Contained Burn of Solid Rocket Motor Propellants and Explosives in an NTS Tunnel	Environmental Assessment	Proposed
NV-93-002	Plumbing modifications, Quonset 800, Area 23	Categorical Exclusion	Approved 2/04/93
NV-93-003	Underground Storage Tank Modifications	Categorical Exclusion	Approved 2/04/93
NV-93-004	Transuranic (TRU) Waste Certification Building, Area 5	Environmental Assessment	WMD/NV
NV-93-005	Renovate Existing Roadways, NTS	Categorical Exclusion	ECM/NV
NV-93-006	138 Kv. Substation Modernization, NTS	Categorical Exclusion	ECM/NV
NV-93-007	Waste Examination Building, Area 5	Environmental Assessment	WMD/NV
NV-93-008	Sewage Lagoon at RWMS, Area 5	Environmental Assessment	WMD/NV
NV-93-011	Tower Module Storage Area, Revitalization Subproject, Construction Facilities, Area 6	Categorical Exclusion	ECM/NV
NV-93-012	Installation of Buried Cable, Area 6	Categorical Exclusion	Approved 03/26/93
NV-93-013	Information Repository Location for Office Administrative CERCLA Records, NTS	Categorical Exclusion	Pending
NV-93-020	Replacement of Transformer, F F Substation, Area 5	Categorical Exclusion	Approved 03/26/93
NV-93-021	Installation of Buried Conduit, Area 27	Categorical Exclusion	Approved 03/26/93

Table 3.1 (NEPA Documentation - 1989-1993, cont.)

File Number	Description	Category	Review Status
	Off NTS NEPA Documentation - 1992		
NV-92-011	North Las Vegas Facility	Environmental Assessment	DOE/HQ DP
NV-92-015	Second story addition, RSL	Categorical Exclusion	Pending
NV-92-016	WAMD Detachment Operations Facility	Categorical Exclusion	Pending
NV-92-018	Add acoustical soundproofing to an existing room at SBO	Categorical Exclusion	Approved 4/24/92
NV-92-021	Construct garages at 6 locations to park fuel tankers	Categorical Exclusion	Approved 5/12/92
NV-92-022	Pave around (10) existing site foundations	Categorical Exclusion	Approved 5/12/92
NV-92-027	Construct a small covered storage shed NLVF	Categorical Exclusion	Approved 7/27/92
NV-92-050	Installation of a storage shed	Categorical Exclusion	Approved 11/30/92
NV-92-064	Aircraft flight-related ground survey, NTS	Categorical Exclusion	Approved 12/18/92
NV-93-010	EG&G/EM Special Technology Laboratory	Environmental Assessment	Approved 03/26/93
NV-93-014	Periodic Calib. of Aerial Rad. Survey Sys.	Categorical Exclusion	Approved 03/26/93
NV-93-015	Training & Test Flts., Aerial Rad. Surveys	Categorical Exclusion	Approved 03/26/93
NV-93-016	Training & Test Flts., NTS Cloud Tracking	Categorical Exclusion	Approved 03/26/93
NV-93-017	Temp. Plcmnt. of Microwave Ranging Sys.	Categorical Exclusion	Approved 03/26/93
NV-93-018	Temp. Plcmnt. of Global Pos. Sat. Receiver	Categorical Exclusion	Approved 03/26/93
NV-93-019	Temp. Plcmnt. of VHF Ranging Transponder	Categorical Exclusion	Approved 03/26/93
NV-93-022	Small Laser Experiment Shed	Categorical Exclusion	Approved 03/26/93

project and environmental restoration and waste management (ERWM) activities at the NTS. The EIS for the SNTP, a Department of Defense project, evaluates several locations in the continental United States, including Area 14 of the NTS, for the testing of a nuclear propulsion system. The EIS for the ERWM activities will evaluate impacts for restoration and waste management activities at the NTS.

3.2 CLEAN AIR ACT

Activities conducted for compliance with the Clean Air Act and state air quality regulations included compliance with the National Emissions Standards for Hazardous Air Pollutants (NESHAP) asbestos abatement projects and radiological reporting and monitoring, compliance with ambient air quality standards, and compliance with air quality permit requirements at NTS and non-NTS facilities.

3.2.1 NTS OPERATIONS

Clean Air Act and state of Nevada air quality control compliance requirements were limited to asbestos abatement and radionuclide monitoring and reporting under NESHAP, and air quality permit compliance requirements. Compliance with asbestos regulations, radioactive emissions, and air quality permits are discussed below. There are no criteria pollutant or prevention of significant deterioration monitoring requirements for NTS operations.

3.2.1.1 NESHAP ASBESTOS COMPLIANCE

In January 1990 the state of Nevada, Division of Occupational Safety and Health, issued regulations (Nevada Revised Statutes [NRS] 618.760-805) requiring that all contractors intending to engage in asbestos abatement projects (involving friable asbestos in quantities greater than or equal to 3 lin ft or 3 ft^2) in Nevada submit a Notification Form. This form was required by the Division ten days before beginning any work at an asbestos abatement project site. Notifications were also required to be made to the EPA Region 9 for projects which disturbed greater than 260 lin ft or 160 ft^2 of asbestos containing material in accordance with 40 CFR 61.145-146.

During 1992 no demolition or renovation projects were conducted which required NESHAP notification to EPA Region 9. Several state of Nevada notifications were made for asbestos renovation and abatement projects in accordance with the requirements of NRS 618.760-805. Reynolds Electrical & Engineering Co., Inc. (REECo), collected and analyzed bulk, occupational, environmental, and clearance samples for these projects. A list of the state of Nevada notifications appears in Table 3.2.

Table 3.2 NESHAP Notifications to the state of Nevada for NTS Asbestos Activities - 1992

Area	Building	Friable Asbestos	Date
23	106	16 linear feet of pipe insulation	June 1992
	107	14 linear feet of pipe insulation	June 1992
	501	9 linear feet of pipe insulation	June 1992
	502	20 linear feet of pipe insulation	June 1992
	503	18 linear feet of pipe insulation	June 1992
	504	16 linear feet of pipe insulation	July 1992
	505	16 linear feet of pipe insulation	July 1992
	506	20 linear feet of pipe insulation	July 1992
	507	16 linear feet of pipe insulation	August 1992
	508	15 linear feet of pipe insulation	August 1992
	513	17 linear feet of pipe insulation	August 1992
	514	17 linear feet of pipe insulation	August 1992
	515	20 linear feet of pipe insulation	September 1992
12	30	13 linear feet of pipe insulation	May 1992

3.2.1.2 RADIOACTIVE EMISSIONS

NTS operations were conducted in compliance with the radioactive air emission standards of NESHAP. On August 7, 1990, EPA Region 9 requested a review of NTS operations with respect to compliance with 40 CFR 61, Subparts H and Q. NTS operations are subject to Subpart H only. In compliance with reporting requirements, the 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. These include air ventilation exhaust stacks (1) on the tunnels in Rainier Mesa, (2) on 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) for the analytical laboratory hoods in Mercury. Based on the amount of material handled, the exhaust from the laundry and the analytical laboratories are considered negligible compared to other sources on the NTS. Sources that 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 in Area 5, and resuspension of plutonium contaminated soil from safety test sites.

Using best estimates of air emissions in 1992 as input to EPA's CAP88-PC computer software model the maximum potential individual effective dose equivalent was only 0.012 mrem, much less than the 10 mrem specified in 40 CFR 61.

In the NESHAP report for airborne radioactive effluents emitted from the NTS during calendar year 1992, the effluents from the tunnel ventilation systems were reported on the basis of operational measurements and calculations. The airborne emission of tritiated water vapor from the containment ponds was conservatively reported as if all the liquid discharge into the ponds during 1992 had evaporated and become airborne. For tritiated water vapor diffusing from the Area 5 RWMS, plutonium particulate resuspension around the Bulk Waste Management Facility in Area 3, and seepage of ^{85}Kr from Pahute Mesa, the airborne effluents were conservatively estimated. The procedure followed was to select, from among the surrounding sampling stations, that station which showed the maximum annual average concentration for the radionuclide detected. The CAP88-PC software was then used, in each case, 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 measured concentration.

Other emissions occur from operational activities such as drillbacks into test cavities (to obtain diagnostic and other data) and purging of tunnel systems after nuclear tests (to facilitate re-entry activities). The NTS user laboratories that conduct these nuclear tests have developed effluent monitoring procedures that are accurate within a factor of two for such operational activities. Considering the low levels of maximum offsite exposures that have been reported in the recent past, this accuracy has been considered acceptable.

In September of 1991, to assure compliance with 40 CFR 61.93 and in order to provide confirmatory data for the tunnel effluent calculations, an isokinetic sampling unit was installed in the ventilation duct near the portal of P Tunnel, and has been in use during 1992 to monitor tritiated water vapor, noble gases, radioiodines and radioactive particulates. Discussions with EPA Region 9 personnel indicate that the NTS is in full compliance.

3.2.1.3 NTS AIR QUALITY PERMIT COMPLIANCE

NTS air quality permit compliance is accomplished through permit reporting and renewals, and ongoing verification of operational compliance with permit specified limitations. (See Table 4.7, Section 4.3.1 for a listing of active permits.) Common air pollution sources at the NTS included aggregate production, stemming activities, surface disturbances, fugitive dust from unpaved roads, fuel burning equipment, open burning, and fuel storage facilities.

The 1991 Air Quality Permit Data Report was submitted by the DOE/NV to the state of Nevada on April 2, 1992. The 1992 Report was submitted to DOE/NV on March 5, 1993. Following DOE/NVs review, the report will be transmitted to the state of Nevada. The Air Quality Permit Data Report includes aggregate production, operating hours of permitted equipment, and a report of all surface disturbances of five acres or greater and is provided to the state annually to satisfy the air quality permit annual reporting requirement.

NTS air quality permits limit particulate emissions to 20 percent opacity. To verify compliance with this opacity requirement, REECo Environmental Compliance Department (ECD) staff perform, at a minimum, biannual visible emission evaluations of permitted air quality point sources. Certification to perform visible emissions evaluations is required by the state, with recertification required every six months. During 1992, six REECo ECD personnel were certified and/or recertified. Where visual emission evaluations determined exceedance of the 20 percent opacity requirement, corrective action is initiated. Seven permitted equipment/processes, such as weapons event stemming operations, have been identified as routinely exceeding the 20 percent opacity requirement. Engineered or operational corrective actions to rectify these exceedances are under evaluation by DOE/NV. Also under consideration are recommendations made during a fugitive dust study of permitted equipment and surface disturbance operations completed by The Mark Group in July, 1992. (See Section 3.19.1)

During 1992 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.

During 1992 and the first calendar year quarter of 1993, five new air quality permits were issued by the state of Nevada. These new permits are identified in Table 3.3.

Table 3.3 New Air Quality Permits to Construct - 1992

Permit No.	Facility or Operation
PC 3246	Area 3 Mud Plant
PC 3247	Area 20 Portable Mud Plant
PC 3248	Area 3 Portable Mud Plant
PC 3311	Area 1 Sandbagging Operation
PC 3312	Area 1 Kolberg Screen

3.2.2 NON-NTS EG&G/EM OPERATIONS

3.2.2.1 RADIOLOGICAL REPORTING

There are no activities at any EG&G/EM operations that produce radioactive effluents. Clean Air Act issues affect only the nonradiological emissions covered by local permit requirements.

3.2.2.2 AIR QUALITY PERMITS

Air quality permits were required for three of the eight non-NTS, EG&G/EM operations although there were no effluent monitoring requirements associated with these permits. Specific compliance issues are discussed below.

Eighteen emission units at the EG&G/EM, Las Vegas Area Operation (LVAO), North Las Vegas Facility (NLVF) and Remote Sensing Laboratory (RSL) are regulated and permitted with the Clark County Health District (CCHD), Las Vegas, Nevada. A growth allowance issued by the CCHD allows LVAO to add new emission units without going through the permit application process.

EG&G/EM, Amador Valley Operations (AVO) holds an operating permit issued by the Bay Area Air Quality Management District for three solvent cleaning operations. The permit conditions place limits on the annual quantity of materials used and impose record keeping requirements. Local air pollution regulations required businesses to discontinue use of aerosol spray paints containing more than 67% organics. Compliance has been maintained although no routine monitoring activities were mandated to verify such compliance.

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. A notice of violation was issued by the APCD for failing to post operating instructions above the vapor degreaser.

EG&G/EM, Woburn Cathode Ray Tube Operations (WCO) was required by local regulations to limit use of 1,1,1-trichloroethane to no more than one ton/yr. Compliance has been maintained although no routine monitoring or reports were mandated to verify this requirement.

3.3 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. The Clean Water Act regulations are generally applicable to facilities which discharge any materials onto the waters of the United States. There are no National Pollutant Discharge Elimination System (NPDES) permits, under the Clean Water Act, for DOE/NV facilities as there are no wastewater discharges to onsite or offsite surface waters. Discharges from DOE/NV facilities are primarily regulated under the laws and regulations of the facility host states. Monitoring and reporting were limited to these states, as well as, local permit requirements. A complete listing of these permits appears in Section 4.3.

3.3.1 NTS OPERATIONS

Discharges of wastewater to the surface waters of the state of Nevada are regulated under the Nevada Water Pollution Control Act. The state of Nevada also regulates the design, construction, and operation of sanitary sewage collection systems. Sewage discharge permits at the NTS are addressed in Section 4.3.3. A water pollution control permit was issued for the U-12n tunnel discharge at the NTS (addressed in Section 4.3.4.) A 180-day temporary water pollution control permit was issued for the NTS Area 12 Fleet Operations steam cleaning facility discharge (addressed in Section 4.3.5). Compliance status for the sewage discharge permits and the water pollution control permits is addressed below. Water monitoring at the NTS was limited to sampling wastewater influents to lagoons and ponds. The results of this sampling are summarized in Section 7.1.2 of this volume.

Compliance with sewage discharge permit requirements was achieved with the exception of exceedance of the lagoon influent flow for the April 1992 reporting period for the NTS Area 6 Yucca Lake sewage lagoon system and the June 1992 reporting period for the NTS Area 6 Los Alamos National Laboratory (LANL) lagoon system. The Yucca Lake influent flow permit limitation was exceeded due to sequential additions of potable water to rectify a septic lagoon condition. The LANL influent flow permit limitation was exceeded due to miscalibration of the continuous flow meter and improper positioning of the float on the wet well. Both lagoon systems met permit requirements during the rest of the reporting period.

A remaining issue of non-compliance with sewage lagoon discharge permits concerns a permit requirement for maintenance of a three-foot minimum depth for NTS primary lagoons. A total of eight lagoon systems did not meet this requirement during 1992. Not achieving this requirement is attributable to reduction in use or non-use of several of the lagoons and is related to diminished NTS activities. The state of Nevada was petitioned on February 10, 1992, to modify the three-foot depth on several sewage discharge permits. The DOE/NV is currently pursuing this issue with the state.

An unauthorized discharge of sewage resulting from a blockage in a main line of the Area 12 collection system occurred in late 1992. This discharge met the requirements of an "upset" under the Area 12 sewage collection permit. See Section 3.19.2.

In partial resolution of the Notice and Finding of Alleged Violation issued by the state of Nevada in 1991 for the improper modification of tunnel wastewater ponds at U-12n Tunnel and the lack of a discharge permit for the same ponds, a 180 day temporary water pollution control permit was issued for the U-12n Tunnel discharge. This permit was followed by a two year individual water pollution control permit which became effective on November 12, 1992. All wastewater flows have been fully contained in impoundments throughout this year. Compliance requirements specified under this permit were met. The compliance schedule in the discharge permit requires that a mothball plan for the elimination of the discharge be completed by November 12, 1993.

A 180 day temporary water pollution control permit was issued by the NDEP for the Area 12 Fleet Operations Steam Cleaning Facility on July 15, 1992. It allowed the continued operation of the existing system under certain conditions and monitoring requirements. Steam cleaning activities under this permit ceased in August 1992. A closed loop steam cleaning replacement system was to be in place by the expiration date of the permit. However, the construction of the replacement steam cleaning unit was indefinitely postponed at the Area 12 facility as a results of programmatic changes at the NTS. During the period of the permit all compliance requirements specified under the permit were met.

The state of Nevada Bureau of Federal Facilities compliance personnel routinely inspected the NTS sewage discharge lagoons and the U-12n tunnel discharge ponds in 1992. No findings or notices of violation were issued for these permitted units.

3.3.2 NON-NTS EG&G/EM OPERATIONS

Permits for wastewater discharge were held for six of the eight non-NTS, EG&G/EM-operations, and monitoring and reporting were accomplished according to the dictates of state and local governments. No wastewater permits were held for the Los Alamos Operations, or Washington D.C. Aerial Measurements Department in 1992.

EG&G/EM, LVAO submitted self monitoring reports to local regulatory authorities for the North Las Vegas Facility and the Remote Sensing Laboratory. A new wastewater discharge permit was issued for the North Las Vegas Facility by the City of North Las Vegas.

EG&G/EM, SBO received a notice of violation from the Goleta Sanitation District (GSD) for exceeding the facility discharge concentration limit for mercury (25 ppb) identified during a routine GSD surveillance of SBO facility effluent. The problem was not associated with the operation of the mercuric iodide laboratory, but resulted from the mishandling of a broken manometer. No fines were levied by the GSD.

EG&G/EM, KO submitted self monitoring reports required by permit conditions to the city of Albuquerque for the alodining shop effluent at the Craddock facility. In November, 1992, the Alodining Shop was decontaminated and decommissioned thereby eliminating the regulated wastewater discharge from that facility.

EG&G/EM, Amador Valley Operations wastewater discharge permit number 3671-101 was revised to a zero discharge status on February 27,1992.

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

3.4 SAFE DRINKING WATER ACT

Safe Drinking Water Act (SDWA) regulations apply to onsite potable water sources at the NTS and an injection well at the EG&G/EM facility in Woburn, Massachusetts. Permit information and the associated required monitoring are discussed in Section 4.3.

3.4.1 NTS OPERATIONS

The SDWA primarily addresses sampling and monitoring requirements for water systems. The state of Nevada has enacted and enforces the SDWA regulations. The state also regulates daily system operations, such as operation and maintenance, water haulage, operator certification, permitting, and sampling requirements.

The number and location of NTS work force personnel serviced by permitted water distribution systems as reported to the state of Nevada in 1991, is included as Table 3.4. Due to programmatic cut-backs, this service population is expected to be reduced.

Table 3.4 Well, Population, and Community/Noncommunity Status Information for Public Drinking Water Systems at the NTS - 1992

Permit No.	Area(s)	Population	Status	Wells
360-12C	22, 23	1500	Community	5C, Army
4097-12NC[(1)]	03	200	Non-Community	Hauled water[(3)]
5000-12NC	06, 27	1000[(2)]	Non-Community	C, C1, 4
4098-12NC	25	200	Non-Community	J12, J13
4099-12C	02, 12	1000[(2)]	Community	8
5024-12NC	01	200	Non-Community	UE16d

(1) This permit has been allowed to expire as personnel in the Area 3 camp have been relocated to Area 6.

(2) The population for permits 4099-12C and 5000-12NC have been rounded up to assure proper sampling frequency.

(3) Water for the Area 3 distribution system (4097-12NC) is not supplied by a water well. Instead the water is hauled from a Fill Stand at the Area 6 distribution system.

As required under state health regulations, potable water distribution systems at the NTS are monitored for residual chlorine content and the absence of coliform bacteria. Monitoring results for these parameters are presented in Section 7.1.1.1. Incidents where analyses indicated the presence of coliform bacteria are indicated below. The state of Nevada was immediately notified of each coliform positive sample.

- Water samples collected at the Area 3 Cafeteria on February 7 and 20, 1992, were positive for total coliforms. Immediately following notification of the positive samples by the laboratory, the Cafeteria was posted to inform the user population. Repeat samples following each occurrence were negative and postings were removed.

- A water sample collected at the Area 6 Fill Stand on March 17, 1992, was positive for total coliforms. Three followup samples taken on March 24, 1992, were negative. The Fill Stand was not used in the interim.

- A water sample collected at the NTS Area 23 Building 790 on March 13, 1992, was positive for coliforms. Multiple followup samples taken on March 18, 1992, were negative. The building was posted during the interim.

NTS potable water distribution systems are also monitored for volatile organic compounds, inorganic compounds, and water quality standards. Monitoring results for these parameters are presented in Section 7.1.1.2. Volatile organics compounds were not detected in any NTS potable water distribution systems. Primary water quality standards were met for all parameters. Incidents where analyses indicated the exceedance of a state of Nevada Secondary Standard are indicated below:

- The sample from the NTS Area 25 water distribution system had a fluoride level of 2.0 ppm which is at the threshold limit of state of Nevada Secondary Standard (2.0 ppm). Following 1990 sampling results which indicated elevated fluoride concentrations, the DOE petitioned the state of Nevada for a variance to fluoride requirements for the Area 25 distribution system. In January 1991 the state of Nevada approved a variance request with the caveat that the system be sampled on an annual basis to ensure that the fluoride level does not exceed the Primary Standard of 4.0 ppm, and that the user population be noticed of the elevated fluoride levels. The user population was initially notified in November 1990.

- The sample for the NTS Area 6 water distribution system had a total dissolved solids level of 690 ppm which exceeded the state of Nevada Secondary Standard of 500 ppm. The user population was initially notified in November 1990. Neither engineered controls or a variance is anticipated to be pursued.

Well 5C which supplies the Mercury (Area 23) distribution system, continues to exhibit an elevated pH at the well head. However, mixing with the other well that supplies the Mercury system, Army Well, lowers the pH to within the state requirements. A carbon dioxide injection system is planned for installation at Well 5C to rectify the pH problem.

Clarification regarding regulatory requirements for nitrates was made during 1992. Sample results for nitrates may be compared to a regulatory limit of ten parts per million (ppm) nitrogen in nitrate or 45 ppm total nitrates. Sample results from previous years for Well 4 were approximately 18 ppm and were erroneously compared to the nitrogen in nitrates standard rather than the total nitrate standard. Consequently these results were reported as in violation of the standard where in reality they were not.

A break in the water line from Army Well 1 to Mercury occurred on July 6, 1992. The break occurred over the weekend and required immediate attention. Personnel notifications were not completed as directed by the state.

The state of Nevada did not issue any findings or notices of violation relating to drinking water quality during 1992 and the first quarter of 1993.

3.4.2 NTS WATER HAULAGE

To accommodate the diverse, and often transient, field work locations at the NTS, a substantial water haulage program is in place. To ensure potability of water delivered to the field work locations, the water is obtained from potable fill stands, chlorinated in the truck, and then sampled for coliform bacteria. One incident of coliform bacteria in a water haulage truck occurred and is discussed below. The state of Nevada was immediately notified of the coliform positive sample.

- On June 30, 1992, a water haulage truck sample tested positive for total coliform bacteria. The REECo Fleet Operations Department removed the truck from service and the truck was sampled. The sample results were negative and the truck was put back into service. However, guidance from the state at the time was unclear as to sampling requirements for positive samples from water haulage trucks. After discussions with the state, DOE/NV decided that four samples must be taken after state notification. REECo implemented procedural changes to reflect this requirement.

No other incidents of non-compliance occurred relating to haulage of potable water at the NTS during 1992 and the first quarter of 1993. The state of Nevada did not issue any findings or notices of violation relating to potable water haulage.

3.4.3 NON-NTS EG&G/EM OPERATIONS

The EG&G/EM facility in Woburn, Massachusetts, has an injection well for discharging uncontaminated, noncontact cooling water into the ground. On January 4, 1993, the Massachusetts Department of Environmental Protection Division of Water Pollution Control issued a permit for this effluent. Permit Conditions include self monitoring and reporting requirements.

3.5 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. Several host states (e.g., California, Nevada, etc.) for DOE/NV facilities have received such authorization. Activities during 1992 and the first quarter of 1993 included RCRA compliance, underground storage tank, and waste minimization programs at NTS and non-NTS facilities.

3.5.1 NTS RCRA COMPLIANCE

Compliance activities under state of Nevada hazardous waste management program during 1992 and the first quarter of 1993 included submission of the biennial report, submission of revisions to the RCRA Part A and B application, loss of interim status for the NTS Area 6 Decontamination Pond and the NTS Area 23 Building 650 Leachfield, and response to state findings of alleged violation (addressed in section 3.19.3). The Nevada Division of Environmental Protection's Bureau of Federal Facilities staff routinely inspects NTS facilities and work sites.

As required under state of Nevada regulation, the 1991 Hazardous Waste Generator Report for Generator Identification Number NV3890090001 was sent to the state on March 30, 1992. As a result of a review of this document in January 1993, it was discovered that information on the thermal treatment of explosives at the Area 11 Explosive Ordnance Disposal (EOD) Unit was inadvertently omitted. A modification to the 1991 Generator Report was sent to the state of Nevada on January 19, 1993. Recent changes to state of Nevada hazardous waste regulations will now only require submission of Generator Reports on even calendar years. Accordingly, the next Generator Report will be transmitted in early 1994 and will summarize hazardous waste activities for the years of 1992 and 1993.

Raytheon Services Nevada (RSN) revised and updated the Part A and B RCRA permit applications which were last submitted to the state in 1988. On July 29, 1992, DOE/NV submitted the revised permit applications to the state for review. The application requests that permits be issued for the management and operation of Pit 3 in the Area 5 Radioactive Waste Management Site (RWMS), Mixed Waste Disposal Cells in Area 5 RWMS, the Transuranic (TRU) Waste Storage Pad in Area 5 RWMS, the Area 5 Hazardous Waste Accumulation Storage (HWAS) Unit, and the Area 11 Explosive Ordnance Disposal Unit. On November 24, 1992, the state notified DOE/NV of issues of concern established during their preliminary completeness review. RSN prepared a response for DOE/NV to one of the issues. This response was transmitted by DOE/NV to the state of Nevada on February 22, 1993. A separate response on the waste analysis plan issue is under preparation by DOE/NV.

The NTS Area 6 Decontamination Pond and NTS Area 23 Building 650 Leachfield had been mentioned as RCRA mixed waste management units in Part A applications for interim status prior to November 8, 1988. Under 40 CFR 270.73, if a Part B application for any site was not submitted by November 8, 1988, then interim status for that facility would terminate on November 8, 1992. Due to this regulation, discharge cessation activities were initiated in October 1992. All hazardous waste flows to the leachfield were terminated by 1986. Since no RCRA materials are discharged in Building 650, discharges were rerouted to the existing sewer lines. Flows to the Decontamination Pond were stopped in early November. Start up of the temporary discharge management facilities for the decontamination facility is planned for mid 1993. Plans for a permanent discharge effluent management system will be submitted to the state following DOE/NV concurrence.

The state of Nevada issued several Findings of Alleged Violation (FOAV) jointly to the DOE/NV and REECo in 1992 and the first quarter of 1993 for failure to comply with state laws and regulations for hazardous waste management. These FOAVs are discussed in detail in Section 3.19.3.

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

EG&G/EM, LVAO submitted to DOE/NV the Hazardous Waste Generator biennial report for hazardous wastes generated at the North Las Vegas Facility under EPA ID Number NVD097868731. DOE/NV submitted the report to the state of Nevada. A response to the Congressional Inquiry concerning the procurement process for offsite waste contractors was provided to DOE/NV Defense Waste Operations.

3.5.3 UNDERGROUND STORAGE TANKS

3.5.3.1 NON-NTS EG&G/EM OPERATIONS

Onsite characterization began on January 1, 1992 at the Remote Sensing Laboratory where 500 gallons of fuel were released April 25, 1991 into the area surrounding the underground storage tanks. 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 developed. Site remediation will begin subsequent to plan review and approval.

3.5.3.2 NTS OPERATIONS

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

Fourteen USTs containing petroleum products were removed (see Table 3.5) in 1992 in accordance with state and Federal regulations. Eleven of the removed tanks were abandoned USTs discovered during efforts to identify undocumented USTs at the NTS. Of the 17 tanks that were temporarily closed in 1991, fourteen were upgraded, and three were removed because Program requirements were not identified to warrant continued usage of the tanks.

Observations and laboratory analytical results indicate three of the fourteen 1992 UST removal sites have hydrocarbon contaminated soil above the state regulatory limits. Two of the contaminant sites (Areas 25 and 26 Power House Tanks) appear to be the result of Historical spilling. The Area 12 Fleet Operations site contamination is the result of a leaking tank. Work Plans are being developed for the characterization of these three sites.

In addition, 14 tanks were upgraded with dual wall fiberglass pipes, leak detection, spill/overfill protection, and in-tank monitoring equipment. The upgraded tanks were tightness-tested to ensure integrity; all tanks passed the regulatory criteria of 0.1 gal/h. Soil samples were collected prior to or during the upgrade activities in all but the Area 6 Gasoline Station to evaluate whether past releases had occurred at the sites. Results indicated none of the sites were contaminated above state regulatory levels. Utility placement prevented the use of excavation equipment to characterize the Area 6 Gasoline Station. Alternative characterization means such as using a drill rig or a van mounted pneumatic sampler may be employed to determine the presence of hydrocarbon contamination.

Characterization work (drilling and sampling) continues at the Areas 12 and 23 Gasoline Stations to evaluate site conditions and remediation options.

Table 3.5 Underground Storage Tank Activities - 1992

Area/Facility	Tank Number	Action Taken
6/Yucca Lake Airstrip	6-YA-1	Removal
11/Tweezer Facility	11-2-1	Removal
	11-2-2	Removal
12/Fleet Operations	12-16-2	Removal
	12-16-3	Removal
22/Desert Rock Airstrip	22-DRA-2	Removal
23/210	23-210-1	Removal
25/Power House	25-3102-1	Removal
	25-3102-2	Removal
25/Old Gas Station	26-OGS-1	Removal
26/Power House	26-2104-1	Removal
	26-2104-2	Removal
26/Pluto	26-2204-1	Removal
	26-2204-2	Removal

3.5.4 WASTE MINIMIZATION

3.5.4.1 NTS OPERATIONS

The DOE/NV Waste Minimization and Pollution Prevention Awareness Plan was published in June 1991. All contractors and users have published implementation plans in accordance with the DOE requirement. The plans are designed to reduce waste generation and possible pollutant releases to the environment at all NTS facilities. These ongoing efforts offer increased protection of public health and the environment. Additional benefits include:

- Reduced waste management and compliance costs
- Reduced resource usage
- Reduction in 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

The waste minimization program reflects DOE/NV goals and policies for waste minimization 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 (PPA) and the DOE policy, a hierarchical approach to waste reduction is practiced and applies to all waste streams. The hierarchy follows this order: (1) Prevent or reduce pollution at the source whenever feasible, (2) Recycle, in an environmentally acceptable manner, pollution that cannot feasibly be prevented, (3) Treat pollution that cannot feasibly be prevented or recycled, and (4) Dispose of, or otherwise release into the environment, pollution only as a last resort.

All DOE/NV quantitative goals and schedules were met. Total NTS hazardous waste generation was reduced by 1.5 percent compared with 1991, and over 46.5 percent when compared with 1989 amounts. NTS wide recycling activities for 1992 are indicated in Table 3.6.

Notable improvements are ongoing in process modifications, product substitution, avoidance, and the recycling of products. REECo employees have developed a program to recycle printer and copier toner cartridges consequently reducing waste and creating a cost savings, and has generated work from other government agencies. Closed loop effluent recycling, used in operations such as steam cleaning, has been an aggressive approach to waste

Table 3.6 NTS Recycling Activities

Material	1991 (tons)	1992 (tons)
Office Paper	63.3	132
Aluminum	1.10	2.50
Cardboard	0.60	0.40
Scrap Metals	1285.	1946.

minimization and eliminating a discharge into the environment. Benefits of having these units throughout the NTS are as follows: (1) saving 4.7 million gallons of water annually, (2) reducing operation and permit costs, and (3) a 90 percent reduction in hazardous waste generation. Two solvent stills recycle approximately 80 percent of all solvents and thinners used. This has greatly reduced the hazardous waste generation by recycling solvents up to four times before disposal is necessitated.

Five parts washers have been added to support the NTS vehicle fleet maintenance and support. These high pressure washers which use nonhazardous soaps have completely eliminated the need for parts-cleaning solvents. This process modification has saved operational dollars and eliminated a hazardous waste stream.

A Just-in-Time (JIT) supply system is utilized which allows NTS contractors to reduce product stock and control potentially hazardous products.

The DOE/NV, NTS contractors, and other agencies and users serve as members of the DOE/NV Waste Minimization Task Force. This Task Force conducts a yearly pollution prevention campaign, reaching all NTS employees as well as the surrounding community.

The DOE/NV Waste Minimization Task Force has developed a Pollution Prevention and Waste Minimization training course which has undergone pilot implementation to REECo employees in early 1993. Upon final DOE/NV concurrence on the lesson plan, this training course will be formally implemented.

3.5.4.2 NON-NTS EG&G/EM OPERATIONS

Policies and Procedures

The EG&G/EM Waste Minimization and Pollution Prevention Awareness Implementation Plan was submitted to DOE/NV on December 20, 1991. The plan describes EG&G/EM waste minimization policy, objectives and goals. A formalized system of waste minimization was developed through the implementation of EG&G/EM Policy No. 31-70, Waste Minimization and Pollution Prevention; and Standard Operating Procedure 31-006/A, Hazardous Waste Minimization Plan. All EG&G/EM operations were required to evaluate waste generating processes for product substitution, cross-contamination control, or site treatment. Viable minimization activities were identified and prioritized for implementation.

Training

EG&G/EM employees and management are indoctrinated on company policies, procedures, and rules and are provided the opportunity to review waste minimization training videos. Facility environmental coordinators are provided the opportunity to attend offsite conferences, seminars, and training courses.

Product Substitution

EG&G/EM has made some 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 a reduced ozone depletion potential of 0.05 as opposed to CFC-11 and CFC-12 which have an ozone depletion potential of 1.0.

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.

The sheet metal shop at the EG&G/EM, NLV facility has replaced solvent based paints with water base paints for most applications reducing the solvent waste stream from this facility by 250 gal/yr.

Recycling

Freon recycling systems have been used for air conditioning systems EG&G/EM operates and maintains which are capable of capturing, cleaning and drying the freon for reuse. EG&G/EM has also implemented a recycling program for HP Laser Jet II/III and Canon FAX toner cartridges.

Treatment/Volume Reduction

In August, 1992, the EG&G/EM, LVAO, printed circuit board shop was decontaminated and decommissioned (D&D). A batch wastewater treatment unit was used to treat wastewater generated from the D&D process. The wastewater was discharged to the publicly owned treatment works (POTW) after testing to confirm the effluent met permitted discharge standards and the filter cake was managed as hazardous waste.

The EG&G/EM, Remote Sensing Laboratory, 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 before it is discharged to the POTW. The effluent is tested 4 times a day to verify it is within the permitted discharge limits.

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

Compliance activities under CERCLA/SARA for 1992 and the first quarter of 1993 included: (1) National Response Center (NRC) notification of underground tests at the NTS, (2) Tier II reporting under SARA Section 312 and (3) Non-CERCLA/SARA Reporting to the state of Nevada.

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, environmental planning for environmental mitigation and environmental restoration continued (See section 3.19.4).

3.6.1 REPORTING OF UNDERGROUND TESTS TO THE NRC

In 1987 a DOE/HQ task force determined that underground nuclear device testing areas are CERCLA sites. Under CERCLA all releases of hazardous or extremely hazardous substances that exceed reportable quantities must be reported to the National Response Center (NRC). Following further review of the issue and reporting procedures by the DOE/NV and EPA, the DOE/NV began reporting nuclear tests to the NRC in 1989. This reporting is in accordance with Section 103 of CERCLA and Section 304 of SARA. Following a test the NRC is notified of the test and of which typical test profile to reference. During 1992 the DOE/NV continued reporting underground tests to the state of Nevada, Emergency Management Division, as part of this reporting procedure.

3.6.2 TIER II REPORTING UNDER SARA TITLE III

A Tier II report was filed with the DOE/NV on February 26, 1992 and again on February 25, 1993, for the LVAO North Las Vegas Facility. Four tier II reports were filed by March 2, 1992, and again on February 25, 1993 for fuel storage facilities managed by the Remote Sensing Laboratory. A Tier II report was prepared and submitted for EG&G/EM, WCO on February 13, 1992 and on February 24, 1993.

In 1992, the state of Nevada modified the reporting requirements for the SARA Section 312 Tier II report to include information on the Nevada State Fire Marshall Division Uniform Fire Code Materials Report. The state renamed this document the Nevada Combined Agency Hazardous Substances Report. This report was submitted to the state on July 16, 1992, and reported on 20 different chemicals in 27 areas which were above the threshold.

3.6.3 NON-CERCLA/SARA REPORTING TO THE STATE OF NEVADA

State of Nevada Senate Bill 641 created the Highly Hazardous Substance Regulated Facility. This Bill was enacted as the Chemical Catastrophe Prevention Act of 1992. The NTS became regulated under this law through exceedance of the allowable threshold limit for four chemicals stored and utilized onsite. Approximately 3600 pounds of chlorine gas were stored and/or utilized at the NTS for chlorination of potable water distribution systems, potable water hauling trucks, and the Mercury swimming pool. The registration form reporting this chlorine gas was submitted to the state on April 1, 1992. At the Area 5 Spill Test Facility, four chemicals exceeded thresholds and were reported: 4594 pounds of oleum, 5200 pounds of hydrofluoric acid, 6000 pounds of chlorine gas, and 6870 pounds of anhydrous ammonia. The registration forms reporting the oleum and hydrofluoric acid at the Spill Test Facility were submitted to the state on June 23, 1992. The registration forms reporting the chlorine gas and anhydrous ammonia at the Spill Test Facility were submitted on July 10, 1992. An additional 18000 pounds of anhydrous ammonia (see Section 3.2.1.3 for air quality permitting information for this ammonia) were utilized for weapons testing activities by the LLNL. The registration form reporting this chemical was submitted to the state on July 30, 1992. Following registration, a "Report on Safety" was developed and transmitted to the state for each of these chemicals.

3.7 TOXIC SUBSTANCES CONTROL ACT

State of Nevada regulations which implement the Toxic Substances Control Act require submission of an annual report describing polychlorinated biphenyl (PCB) control activities. The NTS PCB annual report was transmitted to EPA and the state of Nevada in June, 1992. The report included the quantity and status of PCB and PCB contaminated transformers and electrical equipment at the NTS. Also reported were the number of shipments of PCBs and PCB contaminated items from the NTS to an EPA approved disposal facility. The three PCB contaminated transformers and regulators which were under the 90 day period for reclassification were successfully reclassified in 1992 to non-PCB status. There remain 55 large PCB Capacitors, and four small, low volume PCB Capacitors under the management of the LANL in Area 27 of the NTS.

3.8 FEDERAL INSECTICIDE, FUNGICIDE, AND RODENTICIDE ACT

During 1992 REECo was responsible for the application of pesticides at the NTS. The program was operated under the supervision of a company sanitarian who was certified as a pesticide applicator with the state of Nevada. The program consisted of application, training, record maintenance, and scheduling. No unusual environmental activities occurred in 1992 at the NTS relating to the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).

Pesticides were stored in an approved storage facility located in Area 23. 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 applied on an as-requested basis. General-use pesticides were used for most applications, although restricted-use herbicides and rodenticides were used upon occasion.

Records were maintained on all pesticides used, both general and restricted. These records will be held for at least three years. All applicators are provided the opportunity to receive state-sponsored training materials.

Contract companies applied pesticides at all non-NTS facilities in 1992.

3.9 SOLID/SANITARY WASTE

In March 1992 the construction landfills in Areas 3, 20, and 25 were closed. Remaining in active operational status are sanitary landfills located in Areas 9 and 23. The closure of the construction landfills enables the landfill operating organization, the REECo Waste Operations Department, to consolidate solid waste disposal and exercise much greater control over waste disposal.

Effective December 31, 1991, the state of Nevada prohibited land disposal of soil contaminated with hydrocarbons at concentrations above 100 ppm of total petroleum hydrocarbons by Solid Waste-846 test method number 8015, modified. Hydrocarbon contaminated soil predominately originates from spills or leaks of oil or other hydrocarbon based liquids onto soil. Following this disposal prohibition, hydrocarbon contaminated soil was stockpiled while alternative disposal means were under consideration by DOE/NV. In mid 1992, the state clarified requirements necessary for land disposal of hydrocarbon contaminated soil. Based on these clarified requirements, the inactive Area 6 sanitary landfill was proposed for soil disposal, and an O & M plan for disposal of hydrocarbon contaminated soil into this landfill was developed and provided to the state for review. Inclusive in this plan are the installation of neutron moisture monitoring wells at the Area 6 landfill. Final approval of the O & M plan was received in February 1993. The Area 6 landfill is expected to open for disposal of hydrocarbon contaminated soil in May 1993.

3.10 ARCHAEOLOGICAL AND CULTURAL HISTORY PRESERVATION

The National Historic Preservation Act requires federal agencies to take into account any impact their actions might have upon historic sites listed in the National Register of Historic Places. In compliance with this law, the DOE/NV contracted pre-activity surveys and other studies to assess any impacts NTS operations may have on historical and archaeological sites found on the NTS. From the findings of the surveys, plans can be written for the recovery of data to mitigate the effects of operations on these sites. When the plans have been finalized, data recovery programs culminate in technical reports on the scientific findings of the programs. The responsibility for conducting these studies belongs to a group (Task 5 - Compliance with Environmental Regulations/Archaeology) within the DOE/NV-sponsored Basic Environmental Compliance and Monitoring Program (BECAMP).

In 1992, 36 pre-activity surveys were conducted for archaeological sites on the NTS and reports on the findings were prepared. These pre-activity surveys identified 38 sites containing previously unknown archaeological information. These sites were added to the cultural resources inventory files and site records. One test excavation was conducted to determine whether or not a site was significant; the testing data indicated that the site was not significant. All potentially significant sites, including historic structures, were avoided by activities at the NTS. No data-recovery projects were undertaken. Other efforts in 1992 included assisting DOE/NV in the management of cultural resources on the NTS, preparing management objectives and plans, and assisting in public relations and communication concerning the NTS archaeology and cultural resources program.

In response to recent federal legislation, a multi-phase program was initiated to upgrade the NTS archaeological collection and archives. In 1992, the collections and archives were moved to a new facility. A general inventory of the collection was completed and all the materials were reboxed and retagged.

As part of the Programmatic Agreement with the Nevada Division of Historic Preservation and Archaeology 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. In 1992, four of the six 1991 data recovery projects were completed and the technical reports were issued. The technical reports for the remaining two 1991 data recovery projects are being prepared. Four additional sample units were surveyed in 1992 and reconnaissance reports were prepared. Data recovery plans were written and approved for two of the sample units with data recovery scheduled for 1993.

Initiation of the American Indian Religious Freedom Act (AIRFA) Compliance Program occurred in 1989. The act directs federal agencies to consult with Native Americans to protect their right to exercise their traditional religions. The purpose of the NTS AIRFA Compliance Program is 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. The program requires (1) a literature review of baseline documents about Native American concerns on the NTS, (2) development of a study plan on how the DOE/NV is considering the effects of NTS operations on Native American concerns, (3) consultation with Native Americans who have concerns on the NTS, including coordinating field visits, (4) preparation of a draft report on the findings of the study plan and consultations with recommendations for mitigation of adverse effects on Native American concerns, and (5) completion of a final report which has been reviewed by appropriate state of Nevada and federal agencies. A literature review and evaluation of baseline documents about Native American concerns on the NTS were completed in 1990. This information was assembled in a draft baseline document and was used in the preparation of a draft study plan. In 1991 the final versions of these documents were completed and consultations with Native American tribes were initiated.

In 1992, efforts associated with the NTS AIRFA Compliance Program include conducting an ethnobotanical study on the NTS with Native Americans that involved participation by 17 tribes. The ethnographers spent 18 days at the NTS taking different groups of Native Americans to eight locations in Areas 12, 19, and 20. Interviews were conducted with each of the Native Americans at each locale. Plant identifications were verified by a botanist from the Community College of southern Nevada. Four, three-day Native American ethnoarchaeological visits to the NTS were conducted, with tribal representatives visiting 10 archaeological sites on each tour. Ethnographers from the University of Arizona and DRI interviewed each of the tribal representatives at every site. In addition, a Native American monitoring program was established for the Long-Range Study Plan. There tribal representatives accompanied the field crews during data recovery on Pahute and Rainier Mesas.

The Historic Structures Program was initiated in 1992. 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 with a one-week field visit by an architectural historian.

Additional activities in 1992 included the preparation of a new interpretive exhibit for display in the NTS Cafeteria in Mercury that shows the origin of the obsidian used for artifacts on the NTS and near Yucca Mountain. The Pahute and Rainier Mesas Long-Range Study Plan was revised and updated to address the concerns of the Nevada Division of Historic Preservation and Archeology (NDHPA) and a peer review of the program was conducted.

3.11 ENDANGERED SPECIES PROTECTION

The Endangered Species Act (ESA) requires federal agencies to assure that their actions do not (1) jeopardize the continued existence of federally listed endangered or threatened plant or animal species or (2) result in the destruction or adverse modification of critical habitat for these species. In compliance with this law, the DOE/NV contracts pre-activity surveys and other studies to identify the locations and areas occupied by protected species. The responsibility for conducting these studies belongs to a group (Task 5 - Compliance with Environmental Regulations/Endangered Species) within the DOE/NV-sponsored BECAMP. There are currently 22 species of concern found on the NTS. Under the ESA, there are 11 plants, two mammals, one reptile, and six bird species that are Category 1 or 2 species. One reptile and one bird species are listed as threatened and endangered, respectively. Fourteen other species found on the NTS are protected by other regulations (i.e. Wild Free-Roaming Horse and Burro Act). Efforts in 1992 included identifying locations of Category 1 and 2 candidate species and assessments of NTS activities on the desert tortoise, *Gopherus agassizii.*

During 1992, 45 pre-activity surveys were conducted to determine the presence of threatened or endangered species. Survey results and recommendations were documented in 44 reports. Significant survey findings included a location of potential habitat of the plant *Astragalus beatleyae,* (in Area 20) and locating populations of the plant *Penstemon pahutensis,* (two in Area 19 and one in Area 15). Baseline maps for updating federally listed Category 1 and 2 plant distribution maps were compiled.

The *Astragalus beatleyae* Conservation Agreement between the DOE/NV and the U.S. Fish and Wildlife Service (USFWS), signed in 1989, expired in 1991. Work associated with the Conservation Agreement included (1) the preparation of a species management plan; (2) pre-activity surveys to identify and protect populations from disturbance; (3) a monitoring program of field surveys to document species' life history, assess the viability of known populations, and locate new populations; (4) documentation of known populations on maps filed with the DOE/NV; and (5) fencing of the species' type locality. As part of the agreement, a field monitoring study, concluded in 1992, was conducted to collect sufficient information to enable DOE/NV and USFWS to evaluate if the species requires further federal protection.

In 1992, data collection for the three-year field monitoring study was completed and the data was archived in a computerized database. Summary statistics were computed and analyses were performed to describe the life history, reproductive potential, and population trends of *A. beatleyae.* A draft summary report was prepared and was submitted to DOE/NV at the end of 1992. This report will be provided to USFWS along with future species management recommendations.

The USFWS listed the Mojave desert tortoise *(Gopherus agassizii)* as a "threatened species" north and west of the Colorado River in April 1990. The primary reasons for listing the desert tortoise were the continued loss of habitat and the rapid decline in tortoise numbers due to disease, habitat destruction by human activities, and other factors. In 1990 a USFWS permit, required for handling desert tortoises, and a state of Nevada scientific collection permit for the study of desert tortoises on the NTS were received by EG&G/EM. The desert tortoise distribution on the NTS is patchy and primarily in the southern third of the NTS. Larger numbers of tortoises appear to inhabit the bajadas surrounding Jackass Flats, Frenchman Flat, most of Rock Valley, and Mercury Valley. Densities of tortoises on the NTS are generally low and range from 0 to 45 individuals per square mile, with most habitats probably having densities of 0 to 20 individuals per square mile.

Three Biological Opinions on the effects of NTS activities on desert tortoises, as required by the ESA, were issued by the USFWS in 1992. A Biological Opinion includes terms and conditions which must be implemented for NTS activities to ensure protection of the desert tortoises. The three Biological Opinions were for the Nevada Bell fiber optic cable project, the housing project in Area 25, and for NTS activities conducted by the DOE/NV through 1995. In addition, pre-activity survey reports were prepared on the effects of several projects on NTS desert tortoise populations. Other activities associated with the desert tortoise program at the NTS included conducting searches for tortoises at several sites that may be impacted by activities at the NTS, and identifying and searching tortoise relocation sites that may be used for mitigation of activities at the NTS.

3.12 DOE/NV AUDITS

DOE/NV contractors are routinely audited to identify potential environmental compliance problems. A DOE/HQ inspection of the NTS was conducted in 1987, and a DOE/NV audit was made of the LVAO facilities at both North Las Vegas locations in 1990.

3.12.1 NTS ENVIRONMENTAL SURVEYS

The Department of Energy's Defense Programs' Office of Inspections conducted a technical safety appraisal of the NTS from March 16 through 27, 1992. This appraisal evaluated environmental, safety and health programs. A report was issued on May 13, 1992, in which the Nevada Operations Office was judged to be performing at acceptable to superior levels for the functional areas evaluated. No formal response was required to the report. Recommendation for improvements to the environmental program made within the report are under implementation.

From September 8 to 11, 1992, DOE/NV and Professional Analysis Inc. (PAI) conducted an inspection of the NTS Area 5 Radioactive Waste Management Site (RWMS), Area 5 Hazardous Waste Accumulation Site (HWAS) and NTS Area 11 Explosive Ordnance Disposal (EOD) Unit. The inspection was in response to the Region IX EPA compliance evaluation inspection performed in July, and consisted of a site visit and inspection of all records for these sites. No report was issued on this inspection.

From March 8 to 24, 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 have been assigned a system deficiency number and are being formally tracked. The assessment identified approximately 55 of these system deficiencies. A deficiency is defined as a direct violation of an environmental requirement, such as an environmental regulation, or any REECo environmental company procedure or policy. The majority of identified deficiencies can be classified in five general categories: improper management of aerosol cans, improper management of containers, improper hazardous waste satellite accumulation area management, unidentified hydrocarbon stains, and uncharacterized discharges. Corrective actions for these deficiencies have been initiated.

3.12.2 NON-NTS EG&G/EM AUDITS

The DOE Office of Environmental Audit, conducted an environmental audit of EG&G/EM Santa Barbara Operations, Special Technologies Laboratory, and Las Vegas Area Operations including the Remote Sensing Laboratory and the North Las Vegas Facility. There were 22 findings and 4 noteworthy practices. The findings were not considered to be indicative of significant programmatic failings. Seventeen findings are currently ready for formal closure. Corrective actions for the remaining 5 findings have not yet been fully implemented.

3.13 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 over 100 DOE operating facilities.

The Tiger Team identified 149 deficiencies including 45 environmental "findings" in its assessment of the NTS, none of which reflected situations which presented an immediate risk to public health or the environment. Potential noncompliance findings included 35 irregularities with federal or state of Nevada environmental regulations and/or DOE Orders. Ten findings represented conditions which were judged not to meet "best management practices," i.e., practices which could be improved through application of available or improved methods.

In response to the Tiger Team report, the DOE/NV developed an action plan to address each of the findings. In many cases the planned actions were straightforward and could be readily implemented. Others required or will require substantial funding and years to implement. A schedule for accomplishing all actions was established in 1990, and, assuming funding is made available, all work is planned to be completed by September 30, 1996.

The "most significant findings" identified by the environmental sub-team of the Tiger Team included:

- Incomplete waste characterization for wastes slated for onsite and offsite disposal

- Radioactive wastes being accepted at the Area 3 and Area 5 radioactive waste disposal sites from generators not approved in accordance with DOE/NV procedures

- Various wastes generated on the NTS were managed with insufficient knowledge of hazardous waste-related components in the waste streams

Work continues on responding to these issues. As of March 24, 1993, 133 of the 149 findings have been closed in accordance with the DOE/NV Procedure for Closure of Nevada Operations Office (NV) Action Plan, Revision No. 0, July 13, 1990.

3.14 RADIATION PROTECTION

3.14.1 NTS OPERATIONS

Results of environmental monitoring on the NTS during 1992 indicated full compliance with the radiation exposure guidelines of DOE Order 5480.11, "Radiation Protection for Occupational Workers," DOE Order 5400.5, "Radiation Protection of the Public and the Environment," and the 40 CFR 141 National Primary Drinking Water Regulations. Onsite air monitoring results showed average annual concentrations ranging from 9 x 10^{-4} percent of the DOE Order 5400.5 guidelines for ^{85}Kr to 0.6 percent of the guidelines for $^{239+240}$Pu in air. Drinking water supplies on the NTS contained less than 0.001 percent of the DOE Order 5400.5 guideline and less than 0.1 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. The guideline concentrations in DOE Order

5480.11 for occupational workers are one hundred to one thousand times higher than those for the public.

3.14.2 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; the Remote Sensing Laboratory 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 initiated at these facilities. At least two TLDs are at the fence line on each side of the facility. The TLDs are exchanged quarterly with an additional control TLD kept in a safe.

The 1992 fence line radiation monitoring data from the subject facilities demonstrate that only background levels of radiation are present at the boundary.

3.15 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 5000.3A, "Occurrence Reporting and Processing of Operations Information." A listing of the reportable occurrences for off-NTS support facilities and on-NTS locations appears in Tables 3.7 and 3.8.

Table 3.7 Off-Normal Environmental Occurrences at Off-NTS Support Facilities

Date	Report No.	Description	Status
09/21/92	NVOO-EGGO-NLVO 1992-0015	Accidental release of solutions containing heavy metals into the soil through a floor crack-B-1 Plating Room	Investigation continuing
06/25/92	NVOO-EGGO-SBOO 1992-001	Facility wastewater effluent showed excessive levels of mercury	Closed
08/14/92	NVOO-EGGO-NLVO 1992-0010	Release of All-Purpose Clean-All located	Final report submitted for closure
11/04/92	NVOO-EGGO-RSLO 1992-0003	Hydraulic fluid spill onto soil	Final report submitted for closure

Table 3.8 Occurrences at NTS Facilities

Date	Report Number	Description	Status
01/25/91	NVOO-REEC-OMDO 1991-0011	80 ft^3 soil contaminated with hydrocarbon spills over many years, Area 12, T Tunnel	A characterization plan will will be prepared
05/03/91	NVOO-REEC-OMDO 1991-1001	Soil contamination found while drilling monitoring wells Mercury gas station	Monitoring wells installed, further characterization is necessary
05/07/91	NVOO-REEC-OMDO 1991-1002	Spill 30 gal hydraulic fluid onto soil, Area 6, Equipment Yard	Soil excavated and disposed, final report sent to the state in 6/92
06/17/91	NVOO-REEC-OMDO 1991-1008	Leak of 50 gal waste oil from tank, Area 6, Heavy-duty Shop	Soil excavated and disposed, final report sent to the state in 5/92
06/20/91	NVOO-REEC-EHDO 1991-1008	≈10 ft^3 soil contaminated with petroleum product from leaking drum, Area 25, Building 3113	Awaiting funding for site characterization
07/16/91	NVOO-REEC-EHDO 1991-1010	Soil contamination from hydrocarbon spills over many years, Area 23, Fire Training Area	Work plan to characterize site will be developed following funding
07/18/91	NVOO-REEC-SSDO 1991-1002	Spilled hydraulic oil from excessed equipment, Area 25, MX Yard	Soil excavated and disposed into U10c landfill
07/18/91	NVOO-REEC-OMDO 1991-1017	30 yd^3 contaminated from washing equipment with diesel fuel, Area 6, LANL Construction Facility	Soil excavated and disposed into U10c landfill
07/24/91	Not Assigned	Pavement subject to oil leaks from generators over many years, Area 18, Pahute Mesa airstrip	Some soil excavated and disposed, further characterization required
07/24/91	NVOO-REEC-OMDO 1991-1011	Samples from water haulage trucks exceed coliform standards	Corrective actions are under implementation
07/30/91	NVOO-REEC-EHDO 1991-1011	Monitoring for closure of hazardous waste trench found medical waste trench, Area 23	Phase I characterization completed, closure will be initiated in 3/93
08/02/91	NVOO-REEC-OMDO 1991-1023	Soil contamination from leak in UST, Area 12 Service Station	Characterization report to be developed
09/09/91	NVOO-REEC-EHDO 1991-1019	Stopped disposal of septage in Areas 12 and 23 sewage lagoons, may modify bacterial action	Septage disposal solution accepted by the state
09/10/91	NVOO-REEC-OMDO 1991-1027	10-15 gal oil spilled from portable storage tank, Area 6	Soil excavated and disposed in U10c landfill

Table 3.8 (Occurrences at NTS Facilities, cont.)

Date	Report Number	Description	Status
09/18/91	NVOO-REEC-OMDO 1991-1028	Oil spilled while pumping into tanker with open valve, Area 6 Compound	Soil excavated and disposed in U10c landfill
10/11/91	NVOO-REEC-OMDO 1991-1032	20 gal oil released from Ideco drill rig at U19bk, Area 19	Soil excavated and disposed in U10c landfill
10/23/91	NVOO-REEC-OMDO 1991-1036	30-40 gal diesel fuel spilled from motor grader, Area 2	Soil excavated and disposed in U10c landfill
10/29/91	NVOO-REEC-OMDO 1991-1038	20 gal oil spilled on ground from forklift, Area 2	Soil excavated and disposed in U10c landfill
10/31/91	NVOO-REEC-OMDO 1991-1040	10 gal fuel leaked from pressurized fuel line to boiler, Area 6	One section of line has been replaced, more line will have to be replaced; further characterization is necessary
11/21/91	NVOO-REEC-OMDO 1991-1042	Hydraulic oil released from Ringer Crane, Area 4	Cesium-137 present, soil will be disposed as radioactive waste
11/21/91	NVOO-REEC-YMPO 1991-1001	25-30 gal diesel spilled from open valve on fuel tank, Area 25	Soil excavated and disposed in U10c landfill
01/10/92	NVOO-REEC-ADMN 1992-0003	Waste oil release at LANL construction site, Area 6	Soil excavated, awaiting approved disposal
01/15/92	NVOO-RSNO-NTS 1992-0001	10 gal of hydraulic oil spilled on soil	Sampled and excavated, awaiting approved disposal
01/17/92	NVOO-REEC-OMDO 1992-0002	73 gal hydraulic oil spill, Op. Equipment Yard, Area 6	Soil excavated, awaiting approved disposal
01/22/92	NVOO-REEC-EHDO-1992-0001	Plugged sewer line caused an overflow of grey water onto DOE/NTSO parking lot, Area 23	Line cleaned, gray water washed from parking lot
01/23/92	NVOO-REEC-OMDO 1992-0003	50 gal of motor oil release from sight glass on a generator at U2gj, Area 2	Sampled and excavated; More excavation needed, soil stockpiled awaiting approved disposal
02/12/92	NVOO-REEC-OMDO 1992-0006	Various abandoned drill sites in Area 12	Sites will be characterized upon funding
02/13/92	NVOO-REEC-OMDO 1992-0005	Historic spill of oil and Pb at Pull Test Facility, Area 2	Characterization report provided to DOE/NV in in 9/92
02/13/92	NVOO-REEC-OMDO 1992-0007	Drinking water sample positive for coliforms, Area 3 Canteen	Resample of water showed no coliforms

Table 3.8 (Occurrences at NTS Facilities, cont.)

Date	Report Number	Description	Status
02/18/92	NVOO-REEC-OMDO 1992-0009	Hydraulic oil release, Fuel and Lube Yard, Area 6	Soil excavated, awaiting approved disposal
02/18/92	NVOO-REEC-OMDO 1992-0011	Spill of hydraulic oil, Fuel and Lube, Area 6	Soil excavated, awaiting approved disposal
02/24/92	NVOO-REEC-ADMN 1992-0005	50 - 100 gal diesel fuel spill Mud Plant, Area 3	Workplan submitted to DOE/NV
02/24/92	NVOO-REEC-OMDO 1992-0014	80 gal hydraulic oil spilled, Op. Equipment Yard, Area 6	Soil excavated, awaiting approved disposal
03/24/92	NVOO-REEC-OMDO 1992-0018	Historic oil spill covering 280 ft^2, Crane Yard, Area 2	Soil excavated, awaiting approved disposal
03/24/92	NVOO-REEC-OMDO 1992-0019	Diesel fuel spill, N Tunnel Road Area 12	Unauthorized disposal at U10c landfill, report made to the state
03/30/92	NVOO-REEC-OMDO 1992-0021	20 gal of hydraulic fluid spilled on concrete apron, Area 12	Soil excavated, awaiting approved disposal
04/01/92	NVOO-REEC-YMPD 1992-0002	Diesel fuel spill from overfilling of generators and an above ground tank at UZ-1 drill site, Area 25	Soil excavated, Disposed off-site 3/93
04/08/92	NVOO-REEC-OMDO 1992-0022	Hydraulic oil spill from oil press at Decontamination Facility, Area 6	Sampled and excavated; Awaiting approved disposal
05/01/92	NVOO-REEC-OMDO 1992-0029	16 gal spill of hydraulic fluid from a crane	Excavated; Awaiting approved disposal
04/23/92	NVOO-REEC-OMDO 1992-0025	Hydraulic oil leak from bull dozer at Operations Equipment yard, Area 6	Sampled and excavated; Awaiting approved disposal
06/02/92	NVOO-REEC-OMDO 1992-0030	Historical spill of waste oil at Area 3 Mechanics Yard	Awaiting action
06/16/92	NVOO-EGGO-TSO 1992-0001	State-reportable, asbestos above acceptable level	Procedure developed
06/18/92	NVOO-REEC-OMDO 1992-0036	Backup of skim line from steam cleaning clarifier; Approximately 30 gal Area 6	Sampled and excavated;. Awaiting approved disposal
06/19/92	NVOO-REEC-OMDO 1992-0035	Spill of 23 gal of gasoline at the Area 12 interim gas station	Cleaned up, awaiting disposal
07/13/92	NVOO-REEC-OMDO 1992-0042	Historical spill at various abandoned drill sites in Area 19	Awaiting action

Table 3.8 (Occurrences at NTS Facilities, cont.)

Date	Report Number	Description	Status
07/16/92	NVOO-REEC-OMDO 1992-0043	20 gal spill at above ground tank, Tweezer Facility, Area 11	Excavated, awaiting approved disposal
07/23/92	NVOO-REEC-OMDO 1992-0045	Historical release from a UST at Building 12-16, Area 12	Awaiting action
08/06/92	NVOO-EGGO-NTSO 1992-0004	Gasoline leak inside trailer	Open
08/13/92	NVOO-REEC-EHDO 1992-0008	Trace radioactive contamination found in trailer number 1E3739 while unloading at RWMS, Area 5	Generator notified
08/25/92	NVOO-REEC-YMPD 1992-0004	Historical release of waste oil at Area 25 Yucca Mountain Project Subdock	Excavated, awaiting approved disposal
09/01/92	NVOO-REEC-OMDO 1992-0054	15 gal spill from a generator sight glass	Excavated, awaiting approved disposal
09/01/92	NVOO-RSNO-NTS 1992-0003	Historic spill at Atlas Wireline facility Well 3 Yard, Area 6	Excavated, awaiting approved disposal
09/02/92	NVOO-REEC-OMDO 1992-0053	Spill of waste oil at Operations Equipment yard, Area 6	Excavated, awaiting approved disposal
09/14/92	NVOO-REEC-OMDO 1992-0056	Backup from sewer grey water onto soil from plugged line at Area 12	Cleaned up
09/25/92	NVOO-REEC-OMDO 1992-0058	20 gallon spill of hydraulic fluid at U3ml post shot, Area 3	Excavated, awaiting approved disposal
09/28/92	NVOO-REEC-SSDO 1992-0005	Historic release from UST at Building 26-2104, Area 26	Excavated and sampled
09/28/92	NVOO-REEC-OMDO 1992-0060	Historic release from UST at Building 25-3102, Area 25	Excavated and sampled
10/15/92	NVOO-REEC-EHDO 1992-0015	Spill of hydraulic oil; Located at Area 5 Pilot Well #2	Excavated, awaiting approved disposal
10/19/92	NVOO-REEC-OMDO 1992-0063	Spill of grease/oil at Fleet Operations, Area 23	Sampled and excavated, awaiting approved disposal
10/23/92	NVOO-REEC-OMDO 1992-0064	25 gal diesel spill at Area 6 gas station	Excavated, awaiting approved disposal
11/04/92	NVOO-REEC-YMPD 1992-0006	Hydraulic fluid spill at NRG-6 Drill Site, Yucca Mountain Project, Area 25	Sampled and excavated; Awaiting approved disposal

Table 3.8 (Occurrences at NTS Facilities, cont.)

Date	Report Number	Description	Status
11/12/92	NVOO-REEC-OMDO 1992-0074	30 gal diesel fuel spill at Fuel and Lube Yard, Area 6	Excavated; Awaiting approved disposal
11/12/92	NVOO-REEC-OMDO 1992-0075	Release of one gallon of radioactive water from drum following incident with muck car	Cleaned up
12/04/92	NVOO-REEC-OMDO 1992-0078	Hydraulic oil spill at N-Tunnel Upper Yard, Area 12	Sampled and excavated; Awaiting approved disposal
12/10/92	NVOO-REEC-EHDO 1992-0019	Issuance of FOAV and Order by the state of Nevada for RCRA violations	DOE/NV and REECo have prepared a response
12/10/92	NVOO-REEC-YMPD 1992-0007	Hydraulic oil spill of 8.5 gal at Well J-13 Fill Stand, Yucca Mountain Project, Area 25	Sampled and excavated; Awaiting approved disposal
01/13/93	NVOO-REEC-OMDO 1993-0007	Historic hydrocarbon release from non-hazardous injection wells, Area 1	Sampled; Further characterization to be completed
01/27/93	NVOO-REEC-OMDO 1993-0013	10 gal hydraulic fluid spill near U10j, Area 10	Excavated. Awaiting approved disposal
02/04/93	NVOO-REEC-OMDO 1993-0015	20 gal antifreeze spill at near Well J-13, Area 25	Excavated. Awaiting approved disposal
02/08/93	NVOO-REEC-OMDO 1993-0017	Gross alpha and beta above effluent discharge levels at GCP well ER-6-2	Under evaluation
02/09/93	NVOO-REEC-YMPD 1993-0002	Historic oil spill at C-hole complex, Area 25	Under evaluation
02/16/93	NVOO-REEC-OMDO 1993-0019	Diesel oil spill at Borrow Pit #1, Area 25	Excavated, further excavation necessary
02/26/93	NVOO-REEC-EHDO 1993-0003	Issuance of FOAV and Order by the state of Nevada for RCRA violations	DOE/NV and REECo have prepared a response
03/10/93	NVOO-REEC-EHDO 1993-0004	Fuel spill at the RWMS, Area 5	Sampled and excavated Awaiting approved disposal
03/17/93	NVOO-REEC-OMDO 1993-0028	Diesel fuel spill from overfilling underground tank at Device Assembly Facility, Area 6	Sampled and excavated, awaiting approved disposal
03/15/93	NVOO-REEC-YMPD 1993-0005	Oil spill north of subdock, Area 25	Under evaluation
03/12/93	NVOO-REEC-YMPD 1993-0007	Antifreeze spill at Exploratory Studies Facility north portal, Area 25	Under evaluation

3.16 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 1992 (shown in Table 3.9), five RCRA permits were in various stages of the approval process at the end of 1992.

3.17 EXECUTIVE ORDER 11988, FLOODPLAIN MANAGEMENT

There were no projects in 1992 which required consultation for floodplain management. NTS design criteria does 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.

3.18 EXECUTIVE ORDER 11990, PROTECTION OF WETLANDS

There were no projects in 1992 which required consultation for protection of wetlands. NTS design criteria does not specifically address protection of wetlands, however, all projects are reviewed pursuant to the requirements of DOE Order 5400.1.

3.19 CURRENT COMPLIANCE ISSUES AND ACTIONS

This section summarizes reporting milestones, major ongoing issues, alleged violations, and significant accomplishments for calendar year 1992 and the first calendar year quarter of 1993. Topics are provided under the corresponding regulatory Act, if appropriate.

3.19.1 CLEAN AIR ACT

State of Nevada air quality inspectors conducted several compliance inspections of permitted air pollution point sources in 1992. These inspections included visual amazon evaluations of the NTS Area 12 portable storage bins, Area 1 Aggregate and Batch Plants, LLNL ammonia refrigeration system, various portable compressors, the Area 12 Batch Plant, and the Area 6 portable storage bins. All equipment was in operation during the inspections and visual emissions were below the permit limit of 20 percent. No findings or notices of violation were issued as a result of these inspections. The inspection of the Area 12 portable storage bins examined a dust collection system installed in December 1991 to resolve a state of Nevada Notice of Violation issued in July, 1991.

As a proactive means of evaluating NTS air quality emissions, a fugitive dust study of permitted equipment and surface disturbance operations was completed by The Mark Group in July, 1992. Recommendations made by The Mark Group included the installation of an electrostatic precipitator at the Area 1 Shaker Plant, and the installation of a cyclone separator at the Area 1 Rotary Dryer. It was also recommended that the Area 3 Portec Hopper, scheduled for relocation to the Area 1 Batch Plant, be outfitted with a cyclone separator. This same separator could also be used by the Area 1 Batch Plant. These recommendations are currently being evaluated by DOE/NV.

Table 3.9 Environmental Permit Summary - 1992

	Air Pollution	Wastewater	Drinking Water	Number of EPA Generator User IDs	County Hazardous Waste Generator	Endangered Species Act	Storage of Flammables (City)
NTS	41	5	5	2[a]		1	
Las Vegas Area Operations Office	28[b]	2		1[a]			
Amador Valley Operations	1	1		1			
Kirtland Operations		1		2			
Los Alamos Operations				1			
Santa Barbara Operations		2[b]		2			
Special Technologies Laboratory (Santa Barbara)	1	1[b]		1			
Woburn Cathode Ray Tube Operations	1	1		1			1[b]
Washington Aerial Measurements Dept.							
TOTAL	72	13	5	11		1	1

(a) Biennial report required.
(b) Routine monitoring of emissions is not required.

3.19.2 CLEAN WATER ACT

A NPDES permit may be issued for the NTS as part of state implementation of the federal Stormwater Discharge regulations. Public hearings were held in December 1992 on the state of Nevada Stormwater Discharge General Permit to solicit public and industry comments prior to final state regulatory promulgation. The state of Nevada Division of Environmental Protection (NDEP) must determine if waters of the United States exist on the NTS and if requirements under federal Stormwater Discharge regulations are relevant to the NTS.

In partial resolution of the Notice and Finding of Alleged Violation issued by the state of Nevada in 1991 for the improper modification of tunnel wastewater ponds at U-12n Tunnel and the lack of a discharge permit for the same ponds, a 180 day temporary water pollution control permit was issued for the U-12n Tunnel discharge. This permit was followed by a two year individual water pollution control permit which became effective on November 12, 1992. All wastewater flows have been fully contained in impoundments throughout this year. The compliance schedule in the discharge permit requires that a mothball plan for the elimination of the discharge be completed by November 12, 1993.

The Operations and Maintenance (O & M) Manual for the Area 23 Sewage Lagoon was utilized to develop a combined O & M Manual for all the sewage lagoons on the NTS. Through the DOE/NV this combined O & M Manual was provided to the state of Nevada NDEP for approval. The NDEP returned the Manual with minor comments. A response to the NDEP comments on the revised O & M Manual was forwarded to DOE/NV on December 21, 1992.

A 180 day temporary water pollution control permit was issued by the NDEP for the Area 12 Fleet Operations Steam Cleaning Facility on July 15, 1992. It allowed the continued operation of the existing system under certain conditions and monitoring requirements. Steam cleaning activities under this permit ceased in August 1992. A closed loop steam cleaning replacement system was to be in place by the expiration date of the permit. However, the construction of the replacement steam cleaning unit was indefinitely postponed at the Area 12 facility as a results of programmatic changes at the NTS.

A short solution for the treatment of septage and portable toilet waste was developed and approved by the state of Nevada. The state took issue to the previous means of disposal of portable toilet waste into the NTS Areas 6, 12, and 23 sewage lagoon systems. Specifically, the state asserted that addition of portable toilet waste significantly impacted the microbial breakdown efficiency in the aforementioned lagoons. Information provided to the state demonstrated that breakdown efficiency was not impacted except during winter when portable toilet waste basin have an antifreeze additive. As a corrective measure, septage and winter time portable toilet waste will be discharged into either the Area 25 Engine Test Stand #1 sewage lagoons which service an inactive facility, or into the Area 12 sewage lagoon secondary basins for dewatering. A Management Outline which provides for the effective management and control of this activity has been prepared.

As a proactive means of for assuring protection of NTS Area 23 sewage lagoon microbial breakdown, the REECo Environmental Compliance Department has established a service connection discharge policy for photographic processing effluent. This policy establishes a maximum silver limit of 2 ppm for the service connection (e.g., drain) disposal of spent photographic processing fixer solutions. Disposal of these fixer solutions under this policy is limited to connections which are serviced by the Area 23 sewage collection system.

Improvements to the Area 22 Gate 100 sewage lagoons were completed in 1992. The two existing ponds were converted to two separate primary cells, and a new larger secondary disposal basin was constructed.

Discharge of wastewaters originating from a radioanalytical laboratory, Building 650 in Area 23, into a septic leach field was discontinued. The waste water discharge was connected into the Area 23 sewage lagoon system. This leachfield had been previously identified as a RCRA mixed waste management unit and will undergo state approved closure. To meet regulatory requirements, the wastewater discharge to the leachfield ceased prior to the November 8, 1992 regulatory deadline for loss of interim status for mixed waste management facilities. Radioactive waste discharges into the laboratory waste water were discontinued in 1979. Hazardous waste discharges were eliminated by 1986 (See Section 3.5.1).

Discharge from the Area 6 Decontamination (DECON) Facility into the evaporation pond was discontinued prior to the November 8, 1992 deadline as the pond and pipeline are also identified for closure as a RCRA mixed waste management unit. The introduction of hazardous waste into the DECON pond was eliminated in 1988. Plans for a temporary DECON facility effluent collection system were formulated and construction is scheduled for completion in early 1993. The engineering design of the permanent system is under final preparation. A closed loop wastewater treatment unit with double walled piping will be part of the permanent system (See Section 3.5.1).

An unauthorized discharge of sewage resulting from a blockage in a main line of the Area 12 collection system resulted in the NDEP requiring the development of an action plan for the abandonment of inactive sewer lines and service laterals as well as procedures and a schedule for flushing and cleaning sewer lines and mains. The action plan for the abandonment of inactive sewer lines and service laterals was submitted to the state by DOE/NV on January 22, 1993.

Clearing of a plugged effluent line at the Area 23 Fleet Operations Steam Cleaning Facility culminated in an unauthorized discharge of pollutants and hydrocarbons. To satisfy NDEP requirements following the occurrence, the visibly contaminated soils were sampled and removed for disposal, improvements in the line were installed, maintenance practices for the facility were reviewed and improved, and a schedule for the construction of a closed loop steam cleaning system was developed and submitted. The closed loop system is scheduled for completion in August 1993.

The REECo Analytical Services Laboratory was granted certification to perform wastewater sample analysis of certain parameters by the state of Nevada in February 1993. The laboratory is certified for wastewater analysis of pH, total suspended solids (TSS), and Biochemical Oxygen Demand (BOD).

As part of planned actions for Tiger Team Finding SW/CF-3, an investigation was conducted to determine which abandoned septic tank systems at the NTS can be closed using state regulations and which systems need to be sampled for potential hazardous/radioactive contamination. Because these systems were abandoned, detailed knowledge of disposal activities are not available. SW/CF-3 listed 30 abandoned systems from a 1987 report. During the course of the investigation, 44 systems were eventually identified. Of these, 11 were scheduled for closure by the Environmental Restoration Program. The remaining 33 systems included 10 which were still active or soon to be reactivated, 16 which will require sampling prior to closure, five which can be closed without sampling, and two systems which require further investigation. A Work Plan for the Phase I characterization of the abandoned septic tanks has been developed.

A survey of active septic systems, completed in January 1991, in response to Tiger Team Finding SW/CF-5, revealed 37 active systems with state requirement's deficiencies. Corrective actions have been assigned to responsible department managers.

3.19.3 SAFE DRINKING WATER ACT

On September 20, 1992, the state of Nevada was provided information regarding the reactivation of well 5B to augment the Area 23 Mercury water distribution system. DOE/NV chose to remove well 5B from service in the late 1980's. On February 17, 1993, the state indicated that approval was contingent upon the submission of: a notice to be provided Mercury water users of the well water's high pH, and a well 5B water pH monitoring schedule. DOE/NV subsequently chose to pursue installation of a carbon dioxide injection system to rectify the pH problem for wells 5B and 5C.

An Operations and Maintenance Plan was developed to address standard operating procedures for water system operations at the NTS. The plan contains information on the distribution systems, permits, general maintenance, emergency repairs, system chlorination, sampling requirements, and record-keeping. A draft copy of the plan was submitted to the state for review in 1992. Comments from the state are currently being incorporated into the Plan.

Engineering drawings for a new NTS water well, Well 4A, were submitted to the state of Nevada for review and approval. Well 4A will supplement the Area 6 water distribution system. The state of Nevada did not approve the plans for Well 4A and responded with a list of regulatory requirements that must be addressed on engineering drawing prior to state approval. Appropriate changes are being made to the engineering drawings.

In 1992, REECo completed a cross connection survey of all active, inactive, and sporadically used NTS buildings utilizing American Water Works Association certified Cross Connection Control Program Specialists. These inspections were completed in February 1993. A report on the cross connection surveys of active buildings was provided to DOE/NV in 1992. Survey reports have been transmitted to RSN to initiate engineering design for the devices. A total of 72 facilities were identified in the survey reports as requiring internal or external cross connection prevention devices.

The state of Nevada sponsored a training course for water system operator certification at the NTS from March 9, 1992 to April 7, 1992. Two REECo personnel received Water Distribution System and Water Treatment System Operator Grade I Certification.

The state of Nevada classified the NTS water systems as requiring a Grade II Water System Operator Certification. A REECo Water and Steam Section superintendent was granted a Grade II Certification in early 1993.

A Water Conservation Plan was developed according to state of Nevada Bill 360 and submitted to the state for approval on April 30, 1992. The plan was approved by the state on June 1, 1992.

In March, 1992, a potential cross connection was identified in the draining system for the Area 6 water fill stand and the REECo Site Maintenance Department corrected the problem. However, the existing design still provided a potential for airborne bacteriological contamination during water truck filling operations. To correct this design concern, the Area 6 fill stand will be converted to a closed filling system with a backflow prevention assembly in-line. Engineering design for this system was completed and submitted to the state of Nevada for review and approval in mid 1992. With DOE/NV and state concurrence, the Area 6 fill stand will be used until an approved system is installed.

NTS personnel reviewed a draft copy of the state of Nevada's water haulage policy in December, 1992. Comments regarding fill stand design, chlorination procedures, sampling and other concerns were transmitted to the state in January, 1993. This state policy is largely based on NTS lessons learned from water haulage.

The REECo Analytical Services Laboratory has applied for certification to analyze drinking water samples for coliform, volatile organic compounds (VOCs), heavy metals, and trace minerals. Certification is awaiting state of Nevada review and audits.

3.19.4 RESOURCE CONSERVATION AND RECOVERY ACT

On January 22, 1992, the state of Nevada issued DOE/NV and REECo written notice that it was assessing a penalty of $20,000 for two Findings of Alleged Violations (FOAVs) issued to DOE/NV and REECo in November 1990 and June 1991. The penalty resulted from insufficient sampling of Rocky Flats pondcrete [Transuranic (TRU) mixed waste] to fully characterize the waste, and increasing the size of the storage pad without prior NDEP approval. A settlement agreement was reached by all parties in June 1992. The agreement limited the quantity of TRU mixed waste on the storage pad, initiated removal of the waste upon approval of the Waste Isolation Pilot Plant (WIPP), and directed the construction of a cover for the waste upon NDEP's approval.

A Finding of Alleged Violation (FOAV) and Order was issued by the state of Nevada on March 31, 1992 relating to the Department of Energy's and Reynolds Electrical & Engineering Co., Inc's (REECo) failure to comply with NRS 459.515 and NAC 444.8632. This involved 11 drums of soil on Yucca Lake which had been inspected by the state on January 22, 1992 and the state determined to be abandoned. The material in question was core samples taken from areas around the Area 6 Decontamination Pond. Analyses performed in September 1991 indicated trace amounts of solvents and the presence of small amounts of manmade isotopes. Until the issue of the manmade isotopes could be resolved, the material was stored in place. Another review of laboratory analysis data on March 17, 1992, between the REECo Environmental Compliance Department and Waste Operations Department, determined that the waste was non-regulated and could be moved to the Area 3 temporary waste storage area. DOE/NV responded to the FOAV and Order on April 20, 1992. Upon review, the state rescinded the FOAV on April 24, 1992. As the drums were considered non-hazardous solid waste, they were subsequently sent to an onsite sanitary landfill and buried in May 1992.

On July 20 and 21, 1992, two EPA Region IX RCRA inspectors performed an inspection of hazardous waste activities at NTS and evaluated the records at the Area 5 Radioactive Waste Management Site (RWMS), Area 5 Hazardous Waste Accumulation Site (HWAS) and Area 11 Explosive Ordnance Disposal (EOD) Unit. As the state of Nevada has been authorized by the EPA to implement RCRA regulations, the results of this evaluation were sent to the state of Nevada Division of Environmental Protection (NDEP) for action. In a letter, dated October 7, 1992, NDEP sent a transmittal of the EPA CEI report and requested a response by December 8, 1992 to the nineteen potential violations identified. Prior to December 8, DOE/NV and REECo had conversations with NDEP to clarify the concerns and resolve the alleged violations. Although the DOE/NV responded on December 7, 1992 and acknowledged six violations, NDEP issued a Finding of Alleged Violation (FOAV) and Order on December 8, 1992 to the Department of Energy and Reynolds Electrical & Engineering Co., Inc. (REECo) for allegedly violating fourteen provisions of NAC 444.8632 - Compliance with Federal Standards. On January 20, 1993, DOE/NV and REECo met with NDEP officials to discuss the alleged violations. Further legal and administrative details remain to be worked out between DOE/NV, REECo and the state.

On February 23, 1993, the state issued a FOAV and Order to the Department of Energy and REECo for violating the provisions of NAC 444.8632. The state's position and basis for issuing this FOAV is that hazardous wastes were improperly discharged during laboratory operations at Area 23 building 650 at the NTS. Specifically, it is alleged that waste water was discharged that contained solvents (FOO1 through FOO5 waste codes) and a pH of less than 2.0 after regulatory deadlines prohibiting such disposal. The discharge was to a leachfield. The position of DOE and REECo is that the wastewater pH was greater than 2.0 and solvents were not improperly discharged. A meeting with the state of Nevada was conducted on March 26, 1993, to discuss this FOAV. As a result of this meeting, the state has dropped the allegation that solvents were improperly dispersed. The state requested additional information concerning an alleged material in an effluent sampling container which may have erroneously biased the pH reading to below 2.0. The state has allowed 30 days from the date of this meeting for responses to its inquiries and also for provision of information on procedural contracts which will ensure proper disposal of solvents and corrosive discharges.

On March 2, 1993, the state of Nevada conducted a formal inspection of the Area 23 Fleet Operations shops and yard areas. A March 3, 1993, letter from the state of Nevada to DOE/NV requested additional information from DOE/NV on eight drums observed during the inspection. The March 3, 1993, letter also stated that two instances of improper disposal of waste aerosol cans had been observed and that FOAV will be issued for these violations following completion of the inspection report. A response to this letter is under preparation with expected transmittal to the state by April 5, 1993.

In mid 1990 the state of Nevada requested assistance from REECo to cleanup abandoned waste at 2291 Blosser Ranch Road, Pahrump, Nevada. The site consisted of 780 containers of various size, most of them 55 gal-drums. Most containers were stored on wooden pallets. A REECo stamp was found on three 5-gal buckets. Three of the containers bore a Defense Logistics Agency stamp; the other containers bore no discernable labels to indicate ownership. Cleanup activities began on September 21, 1990 and were completed by year's end. A final report from REECo was submitted to DOE/NV in June, 1991, for transmittal to the state of Nevada. Then in December 1992, REECo was notified of its potential liability for $48,608.63 in government incurred costs for stabilization and assessment actions at the Pahrump Drum Removal Site. DOE/NV Legal advised REECo on or about January 5, 1993 that DOE/HQ was not approving the payment, subject to further review. REECo was instructed to obtain further information and data supporting a possible offer/payment based on volumetric calculations, considering the existence of other Potentially Responsible Parties (PRPs). The suitability of payment is the subject of ongoing discussions between DOE/NV and REECo.

3.19.5 ENVIRONMENTAL RESTORATION/REMEDIATION ACTIVITIES

The NTS has an ongoing program for the characterization and restoration of contaminated facilities or areas. In 1992 characterization and restoration activities included:

- IT Corporation initiated a study of the environmental impact on groundwater from nuclear testing. To date five wells have been completed out of an estimated 100 wells to be completed by the end of 1999.

- REECo documented 18 abandoned underground septic tanks which require removal, and prepared a database to track their status. From this information, REECo prepared a work plan for the removal of the tanks. Implementation of the plan is schedule to begin in early 1993.

- REECo characterized the extent of lead contamination at the Area 2 Pull Test Facility in August 1992. A protective cover was recommended for remediation in an October 1992 report.

- REECo continued its effort on closure of the hazardous waste trenches at the Mercury landfill. A second phase of sampling was performed in July 1992, and resulted in an amended Closure Plan in November 1992. Comments on the plan have been received from the state with a preliminary approval to commence work on the protective cap in March 1993. The final Closure Plan will be submitted to the state in early 1993.

4.0 ENVIRONMENTAL PROGRAM INFORMATION

The environmental monitoring and compliance programs for the 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

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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 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.

Air sampling was conducted for radioactive particulates, halogens, noble gases, and tritiated water vapor (see Figure 4.1 for sampling locations). Ambient gamma radiation monitoring was conducted throughout the Site (see Figure 4.2). Potable water from groundwater wells, spring water, well reservoirs, and waste disposal ponds were sampled for radiological substances (see Figures 4.3 and 4.4). These tasks made up the environmental surveillance program on the NTS. Table 4.1 is a summary of the routine environmental surveillance program.

4.1.1.1 CRITERIA

DOE Order 5400.1, "General Environmental Protection Program," published in November of 1988, established the onsite environmental protection program requirements, authorities, and

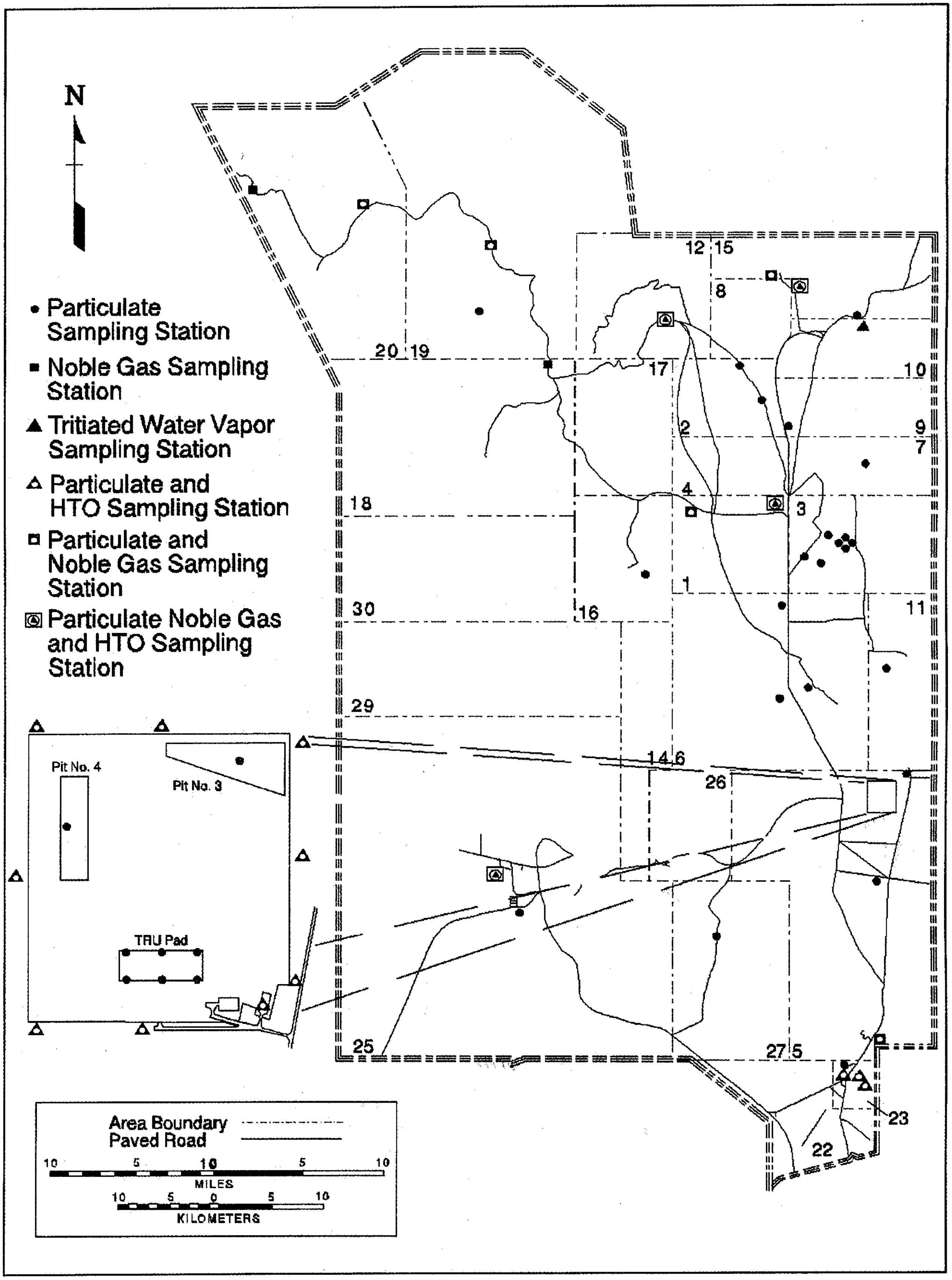


Figure 4.1 Air Sampling Stations on the NTS - 1992

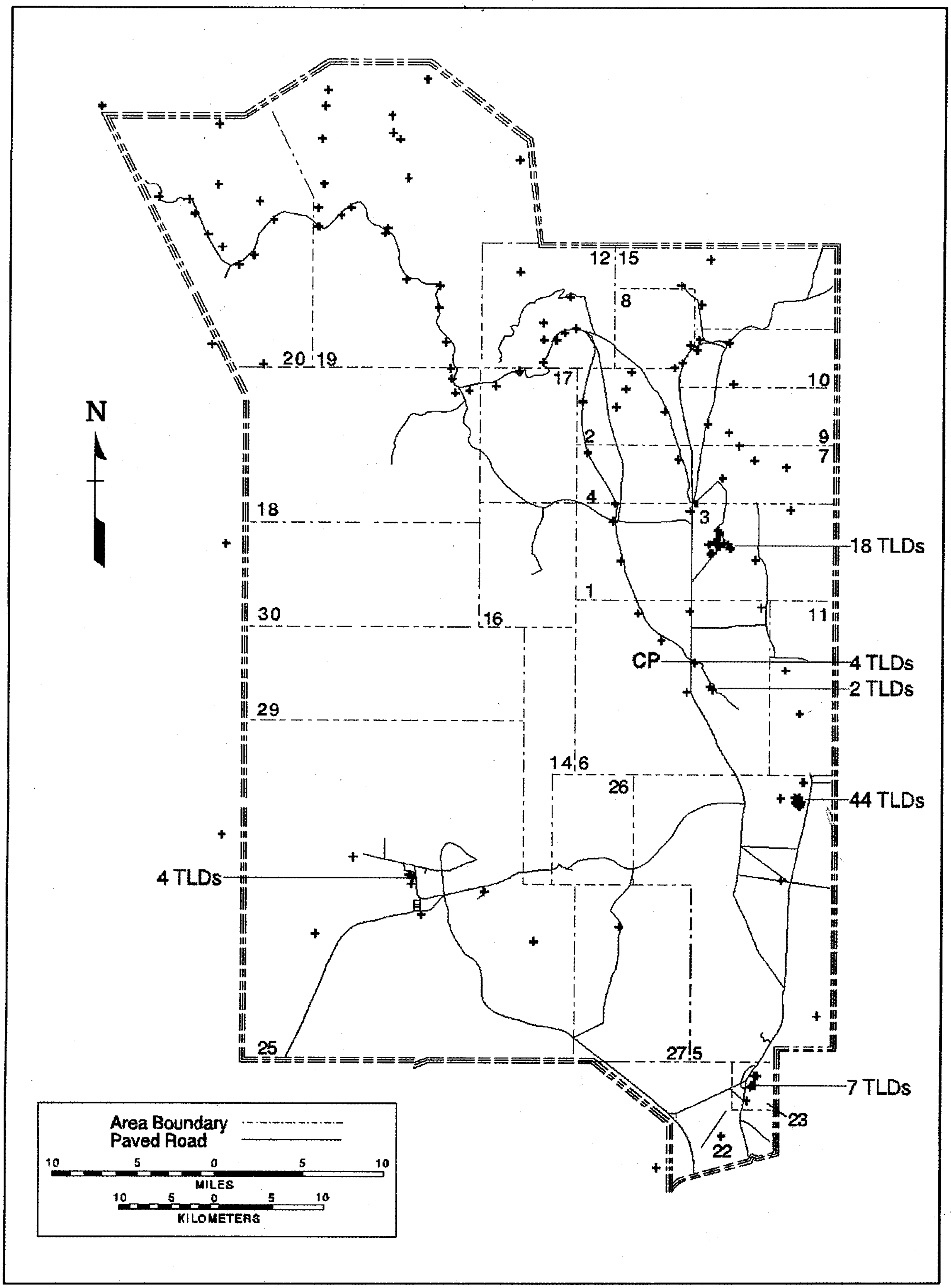


Figure 4.2 Thermoluminescent Dosimeter Stations on the NTS - 1992

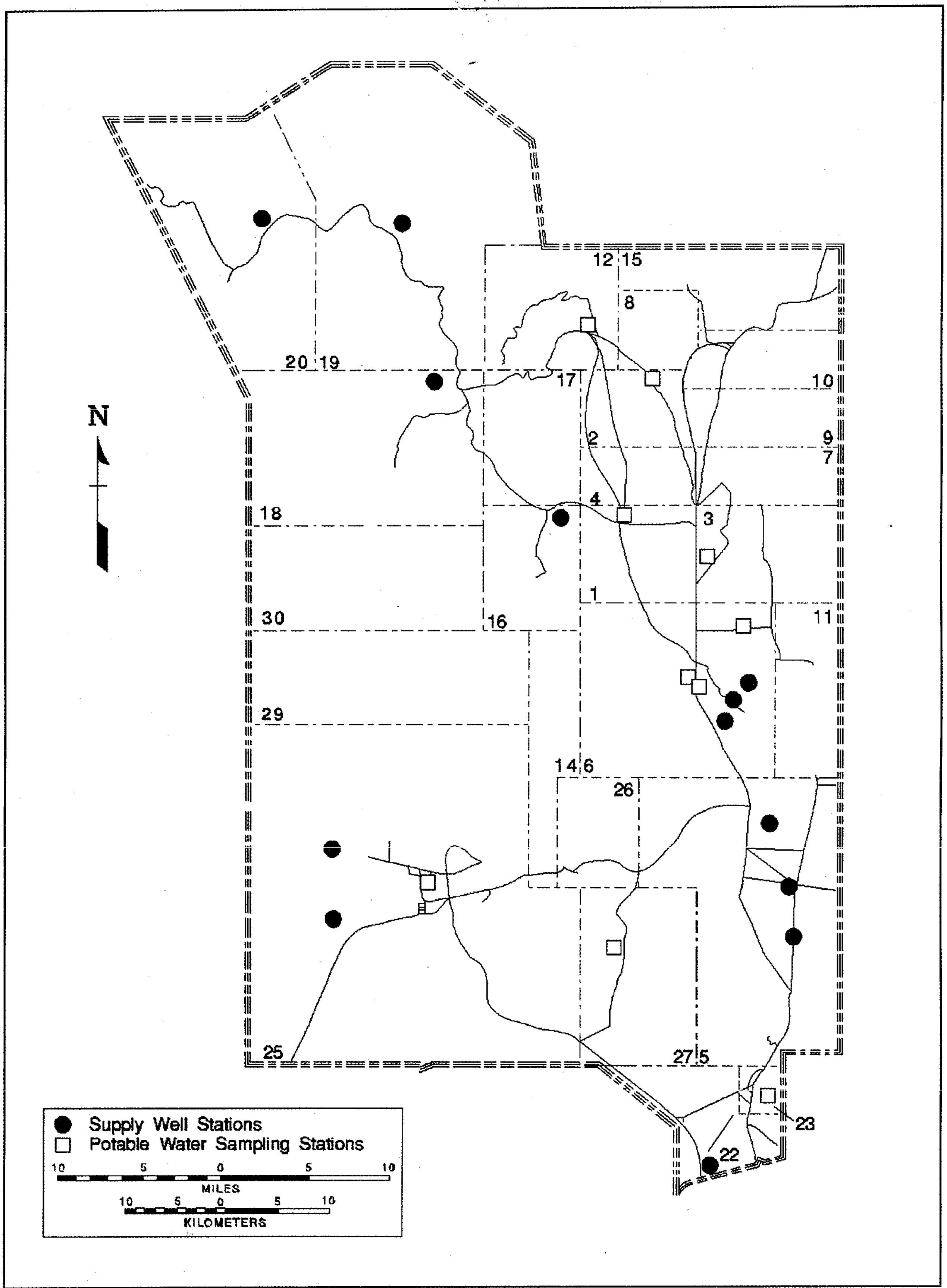


Figure 4.3 Supply Well and Potable Water Sampling Stations on the NTS - 1992

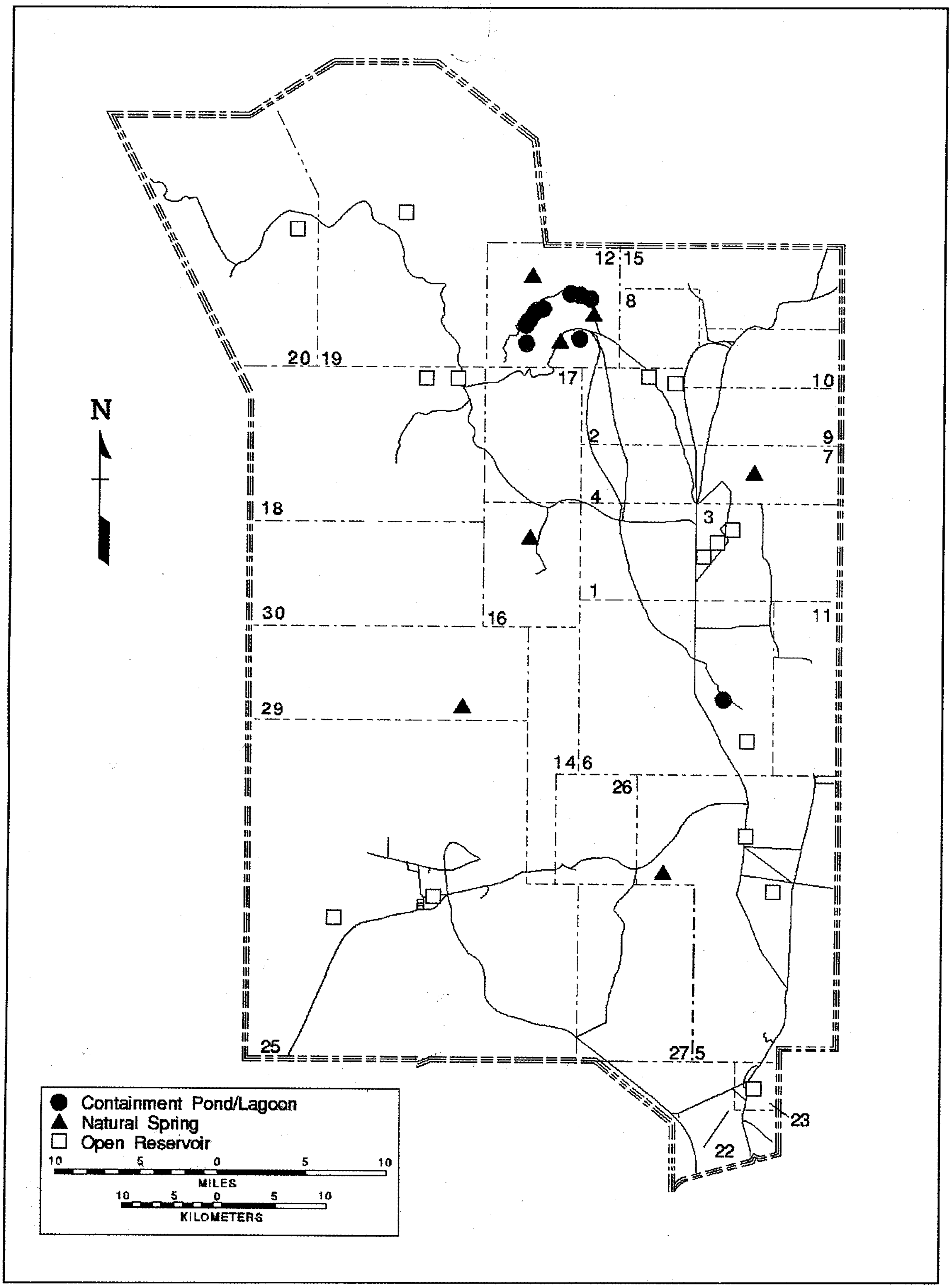


Figure 4.4 Surface Water Sampling Locations on the NTS - 1992

Table 4.1 Summary of Onsite Environmental Sampling Program - 1992

Sample Type	Description	Collection Frequency	Number of Sampling Locations[(a)]	Type of Analysis
Air	Sampling through Whattman GF/A glass fiber filter and a charcoal cartridge	Weekly	52	Gamma spectroscopy, gross ß,($^{238,239+240}$Pu, monthly composite)
	Low-volume sampling through silica gel	Biweekly	17	HTO (tritium oxide)
	Low-volume sampling	Weekly	10	^{85}Kr and ^{133}Xe
Potable Water	Grab sample	Weekly	9	Gamma spectroscopy, gross ß, ^{3}H, ($^{238,239+240}$Pu, gross α quarterly), (^{90}Sr annually)
Potable Supply Wells	Grab sample	Monthly	9	Gamma spectroscopy, gross ß, ^{3}H, ($^{238,239+240}$Pu,) ^{226}Ra, ^{3}H enrichment, gross α, quarterly), (^{90}Sr annually)
Non-Potable Supply Wells	Grab sample	Monthly	4	Gamma spectroscopy, gross ß, ^{3}H, ($^{238,239+240}$Pu, gross α, quarterly), (^{90}Sr annually)
Open Reservoirs	Grab sample	Monthly	15	Gamma spectroscopy, gross ß, ^{3}H, ($^{238,239+240}$Pu quarterly), (^{90}Sr annually)
Natural Springs	Grab sample	Monthly	7	Gamma spectroscopy, gross ß, ^{3}H, ($^{238,239+240}$Pu quarterly), (^{90}Sr annually)

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

Table 4.1 (Summary of Onsite Environmental Sampling Program - 1992, cont.)

Sample Type	Description	Collection Frequency	Number of Sampling Locations[a]	Type of Analysis
Containment Ponds	Grab sample	Monthly	9	Gamma spectroscopy, gross ß, ^{3}H, ($^{238,239+240}Pu$ quarterly), (^{90}Sr annually)
Sewage Lagoons	Grab sample	Quarterly	3	Gamma spectroscopy, gross ß, ^{3}H, ($^{238,239+240}Pu$ quarterly), (^{90}Sr annually)
External Gamma Radiation Levels	UD-814AS thermoluminescent dosimeters	Quarterly	187	Total quarterly exposure

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

responsibilities for DOE operations. These mandates required compliance with applicable federal, state, and local environmental protection regulations. Other orders 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

Effluent monitoring efforts at the NTS focused on monitoring nuclear test event sites, tunnel discharge waters, and the Area 6 radiological Decontamination Facility. During 1992 effluent monitoring was conducted at four of the eight test event sites, four tunnel facilities, and one decontamination facility.

LIQUID EFFLUENT MONITORING

Radiologically contaminated water was discharged from N, T, and E Tunnels in the Rainier Mesa (Area 12) range. A grab sample was collected monthly from each tunnel's effluent discharge point and from each tunnel's contaminated water holding ponds. 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.

The liquid effluents from the tunnel were measured by equipment installed by the Desert Research Institute, University of Nevada. The results of these efforts were used to quantify the total annual radiological effluent release. The quarterly average concentration (in curies/gallon) of the radionuclide of interest in the effluent liquid was multiplied by the total quantity of liquid discharged from the tunnel during the quarter based on the average flow rate for the quarter. This value was calculated for each tunnel and summed to obtain the total liquid radiological effluent discharged from the facility.

The flow to the Area 6 Decontamination Facility holding pond was estimated by using the number of gallons measured to clean a truck and multiplying by the number of trucks cleaned per year. Then the total quantity of water discharged was multiplied by the concentration of ^{3}H in the water. During 1992 there were no radionuclides other than ^{3}H and occasional trace amounts of ^{238}Pu and $^{239+240}Pu$ detected in the pond influent.

Typical lower limits of detection for water analyses were:

- Gross α: 2×10^{-9} μCi/mL (7.4×10^{-2} Bq/L)
- Gross ß: 3×10^{-9} μCi/mL (0.11 Bq/L)
- Gamma Spectroscopy: 2×10^{-7} μCi/mL (7.4 Bq/L) (Using a ^{137}Cs standard)
- Tritium (conventional): 3×10^{-7} μCi/mL (11 Bq/L)
- Tritium (enrichment): 2×10^{-8} μCi/mL (0.74 Bq/L)
- ^{90}Sr: 1×10^{-9} μCi/mL (0.037 Bq/L)
- ^{226}Ra: 2×10^{-9} μCi/mL (0.074 Bq/L)
- ^{238}Pu: 1×10^{-10} μCi/mL (3.7×10^{-3} Bq/L)
- $^{239+240}Pu$: 5×10^{-11} μCi/mL (1.8×10^{-3} Bq/L)

AIRBORNE EFFLUENT MONITORING

A Pahute Mesa event in Area 19 was monitored for ^{85}Kr and ^{133}Xe. For this event two portable noble gas samplers were placed in the vicinity of the SGZ. Portable noble gas samplers were used to detect any seeps of noble gases created from the fission process. The portable noble gas sampling unit used was similar in design to the permanent sampler used for environmental surveillance. The sampling system is described in "Environmental Surveillance" below.

To validate that the existing methods of determining effluents from tunnel activities comply with the periodic confirmatory requirements of 40CFR61, "National Emission Standards for Air Pollutants: Radionuclides" and DOE/EH-0173T Regulatory Guide, an isokinetic sampling system was operated to continuously sample from the P tunnel ventilation pipe during 1992.

The system collects cumulative samples of airborne particulates, radioiodine, noble gases, and tritiated water vapor. The samples are collected and analyzed weekly.

4.1.1.3 ENVIRONMENTAL SURVEILLANCE

Environmental surveillance was conducted onsite throughout the NTS. Equipment at several fixed, continuously sampling stations was used to monitor for radioactive materials in the air, surface water, and groundwater.

AIR MONITORING

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

Air sampling units were located at 52 stations on the NTS to measure radionuclides in the form of particulates and halogens. All placements were chosen primarily to provide monitoring of radioactivity at sites with high worker population density. Geographical coverage, access, and availability of commercial power were also considered in site selection.

An air sampling unit consisted of a positive displacement pump drawing air through a nine-centimeter diameter Whattman GF/A glass fiber filter for trapping particulates, followed by a charcoal cartridge for collecting radioiodines. The filter and cartridge were mounted in a plastic, cone-shaped sample holder. The unit drew approximately 140 L/min of air. A dry-gas meter measured the volume of air displaced over 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, calibrated at 1 kiloelectronvolt (keV) per channel from 0.02 to 2 megaelectronvolts (MeV) using a 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}).

Weekly air samples for a given sampling station were prepared in batches on a monthly basis and radiochemically analyzed for ^{238}Pu and $^{239+240}$Pu. This procedure incorporated 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 ^{236}Pu tracer, which was changed to ^{242}Pu in March 1992. 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 determined in continuous samples of air taken at ten permanent locations. The noble gas samplers maintained a steady sampling flow rate for one week. Noble gas sampling units were housed in a metal tool box and, with the exception of a few minor differences, were identical to the portable units used to monitor effluents. Three metal air bottles were 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 flow rate was approximately 80 mL/min. 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 8×10^{-12} and 25×10^{-12} $\mu Ci/mL$ (0.3 and 0.9 Bq/m^3), respectively.

Airborne tritiated water vapor was monitored at 17 permanent locations throughout the NTS. Constant air flow over moisture-collecting material was maintained for a two-week period, during which airborne moisture was extracted and, at the end of the sampling period, transferred to the onsite laboratory for analysis. The airborne ^3H sampler was capable of unattended operation for up to two weeks in desert areas. A small electronic pump drew air into the apparatus at approximately 0.6 L/min, and the tritiated water vapor was removed from the air stream by a silica-gel drying column followed by a drierite column. 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} $\mu Ci/mL$ (0.011 Bq/m^3) of air.

AMBIENT GAMMA MONITORING

Ambient gamma monitoring was conducted at 187 stations within the NTS through use of thermoluminescent dosimeters (TLDs). A TLD emits light when it is heated after having been exposed to radiation, hence the term "thermoluminescent." The total amount of light given off by the TLD crystal is proportional to the amount of energy absorbed from the radiation; therefore, the intensity of light emitted from the TLD crystal is directly proportional to the radiation exposure.

The dosimeter used was the UD-814AS environmental dosimeter manufactured by Panasonic. It consists of four elements housed in an air-tight, water-tight, ultraviolet-light-protected case. The first element, made of lithium borate, was only slightly shielded in order to capture 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 for a period of one calendar quarter. Each TLD in its holder was placed about one meter above the ground at each monitoring location.

WATER MONITORING

Water samples were collected at various frequencies from selected potable water consumption points, supply wells, natural springs, open reservoirs, sewage lagoons, and containment ponds. The frequency of collection was determined on the basis of a preliminary radiological pathways analysis. Potable tap water was collected weekly; supply wells, springs, reservoirs, and containment ponds were sampled monthly; and sewage lagoons were sampled quarterly. Samples were collected in one-liter glass containers. All samples were analyzed for gross beta, tritium, and gamma-emitting radionuclides. Plutonium analyses were performed on a quarterly basis and strontium analyses annually. Samples of potable well water were also analyzed on a quarterly basis for gross alpha, for tritium by the enrichment method, and for ^{226}Ra.

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 5-mL aliquot was used for ^{3}H 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}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.

For the quarterly and annual analyses of water samples, an additional one liter sample was collected for non-potable water and an additional two liters for potable water. 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 and $^{239+240}Pu$ present in the sample.

WASTE MANAGEMENT SITE MONITORING

Environmental surveillance was conducted on the NTS at the fencelines of the Radioactive Waste Management Project sites. These sites were used for the disposal of radioactive waste materials as low-level waste (LLW) from the NTS and from other DOE facilities. Shallow disposal in trenches, pits, and augured shafts, was accomplished at the Area 5 Radioactive Waste Management Site (RWMS) and in subsidence craters at the Area 3 Bulk Waste Management Facility (BWMF).

The Area 5 RWMS contains the LLW disposal unit, the transuranic waste storage cell, and the Greater Confinement Disposal Unit. The Area 3 BWMF accepts large packages of LLW, most of which is contaminated soil. The packages are deposited in subsidence craters (craters which result from surface ground collapse after underground nuclear detonations, see Chapter 2, Figure 2.5).

Ambient monitoring included 17 permanent air particulate/halogen sampling stations, nine permanent tritiated water vapor sampling stations placed on and around the RWMS in Area 5, and 26 TLD stations.

The BWMF is surrounded by four air particulate/halogen sampling stations with several TLD stations located nearby.

RADIONUCLIDE MIGRATION AND UPTAKE STUDIES

A series of studies on the potential of subsurface radionuclide migration were continued on the NTS by the DRI, USGS, LANL, and LLNL (See Section 9.3.2). These studies included:

- Field research on contamination enhancement of groundwater by water drainage through subsidence craters

- Study of precipitation recharge effects on Pahute Mesa groundwater recharge

- Unsaturated zone migration of radionuclides in the vicinity of the CAMBRIC event migration study site ditch (see Section 6.1.2.2); (Although the well was closed down at the end of August 1991, observations of the water in the ditch as it evaporated continued through the end of the year)

- Geologic formation fluid pressure studies in Area 3 and Area 4

- Experiments on the role of colloidal transport of radionuclides in groundwater

4.1.1.4 SPECIAL ENVIRONMENTAL STUDIES

The Basic Environmental Compliance and Monitoring Program (BECAMP) was involved in special studies on the NTS that focused on both the movement of radionuclides through the environment and the resultant dose to man. BECAMP used 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) has been to determine the rate of movement of surface-deposited radionuclides in four categories: horizontal movement, water-driven erosional transport, vertical migration, and wind-driven resuspension. Efforts in 1992 included (1) documenting the preliminary results from a characterization study of resuspension processes from a plutonium-contaminated site, (2) conducting an investigation of the water-driven migration of plutonium in a wash that passes through a plutonium-contaminated soil site, and (3) conducting a preliminary investigation into the migration of radionuclides down a wash in Area 20.

A second task in the BECAMP program (Task 2 - Human Dose Assessment Models) has been to update the NAEG/NTS dose-assessment model. The NAEG/NTS model estimates 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. An analysis of the NAEG model for sensitivity of calculated doses to relative variations in levels of radionuclides in soil and for uncertainty in model parameters was conducted in 1991 (Kercher and Anspaugh 1991). In 1992, work continued on the estimation of realistic uncertainties of model input parameters that involved analyzing NTS soil-plutonium concentrations and resuspension data. From this work, a second and related investigation was conducted to analyze the uncertainties in predicted radionuclide body burdens and doses from discrete and continuous stochastic source terms. Another group within BECAMP (Task 4 - Annual Peer-Reviewed Publications) has been assigned the task of preparing a major yearly thematic, peer-reviewed publication that addresses an important issue related to the potential environmental impacts of past, present, and future activities at the NTS and its environs. In 1992 a paper dealing with the possible differential movement of plutonium isotopes (^{238}Pu versus $^{239+240}$Pu) in the NTS environment was completed and submitted for publication (Gilbert, et al. 1992).

4.1.2 OFFSITE MONITORING

Under the terms of an Interagency Agreement between DOE and EPA, the EPA EMSL-LV conducts the Offsite Radiation Safety Program (ORSP) in the areas surrounding the NTS. Personnel from EMSL-LV provide support for each nuclear weapons test conducted at the NTS as one component of the program. Another component is public information and community assistance activities. The third and largest component of EMSL-LV's program is routine monitoring of potential human exposure pathways.

For each nuclear weapons test conducted at the NTS in 1992, EMSL-LV monitoring technicians were stationed in the predicted downwind direction and, for the one test of a magnitude which could cause detectable offsite ground motion, at underground mines in the area. Senior EPA personnel served on the Test Controller's Scientific Advisory Panel. Tests were only conducted when meteorological conditions were such that any release would have been carried towards sparsely populated, controllable areas. Radiation sampling and tracking aircraft operated by EG&G/EM were flown over the NTS immediately following each test to gather meteorological and radiological data. There were no prompt releases of radioactive material from tests conducted in 1992; had a release occurred, the monitoring technicians would have deployed mobile monitoring instruments as directed from the NTS Control Point via two-way radio communications, implemented protective actions, and collected samples for prompt analysis. Information from the radiation sampling and tracking aircraft would have assisted in positioning the EMSL-LV mobile radiation monitoring technicians.

Town hall meetings and public information presentations provide a forum for increasing public awareness of NTS activities, disseminating radiation monitoring results, and addressing concerns of residents related to environmental radiation and possible health effects. This community education outreach program is discussed in Section 4.1.2.9. Community Radiation Monitoring Program (CRMP) stations have been established in prominent locations in a number of offsite communities. The CRMP stations contain samplers for several of the monitoring networks and are managed by local residents. The University of Utah and Desert Research Institute (DRI) are cooperators with EPA in the CRMP. The CRMP is discussed in Section 4.1.2.8.

Environmental monitoring networks, described in the following subsections, measure radioactivity in air, atmospheric moisture, milk, local foodstuffs, and groundwater. These networks monitor the major 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 measured in the monitoring networks. Ambient gamma radiation levels are continuously monitored at selected locations using Reuter-Stokes pressurized ion chambers (PICs) and Panasonic thermoluminescent dosimeters (TLDs). Atmospheric monitoring equipment includes air samplers, noble gas samplers, and atmospheric moisture (tritium-in-air) samplers. 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, as described in Chapter 6, "Dose Assessment."

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 radiation 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 Sampling Network (ASN) is designed to monitor the areas within 350 km (220 mi) of the NTS, with some concentration of stations in the prevailing downwind direction. Station location is dependent upon the availability of electrical power and, at stations distant from the NTS, on 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. The 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.

During 1992 the ASN consisted of 30 continuously operating sampling stations (see Figure 4.5 for these locations) and 77 standby stations (Figure 4.6) that were activated one week per quarter. There were no changes in the ASN in 1992; the last major network change was reassignment of three stations to the Yucca Mountain Program on December 1, 1991. The only change in the standby network was the reactivation of an air sampler in Lida, Nevada in the second quarter of 1992.

The low-volume air sampler at each station is equipped to collect particulate radionuclides on fiber filters and gaseous radioiodines in charcoal cartridges. The filters and charcoal cartridge samples from all active stations and the filters from standby stations receive complete analyses at the EMSL-LV Radioanalysis Laboratory. The charcoal cartridge samples from standby stations are analyzed only if there is some reason to expect the presence of radioiodines. There were no high-volume air samplers operated in 1992.

Samples of airborne particulates are collected at each active station 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 after sampler operation periods of one week (approximately 560 m^3 or 20,000 ft^3). 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 prefilters and the charcoal cartridges are initially analyzed by high-resolution gamma spectrometry. Each of the prefilters is then analyzed for gross alpha and gross beta activity. These gross analyses are performed on the prefilters 7 to 14 days after sample collection to allow time for the decay of naturally occurring radon-thoron daughter products. Selected prefilters are then composited (combined and digested) and analyzed for plutonium isotopes.

A second part of the EMSL-LV offsite air network is the Noble Gas and Tritium Surveillance Network (NGTSN). Noble gases may be released into the atmosphere from research and power reactor facilities, fuel reprocessing facilities, and from nuclear testing. Noble gases may also be released during drillbacks and tunnel purgings, which take place after a nuclear test. Environmental levels of the xenons, with their very short half-lives, are normally below the minimum detectable concentration (MDC). Krypton-85 disperses more or less uniformly

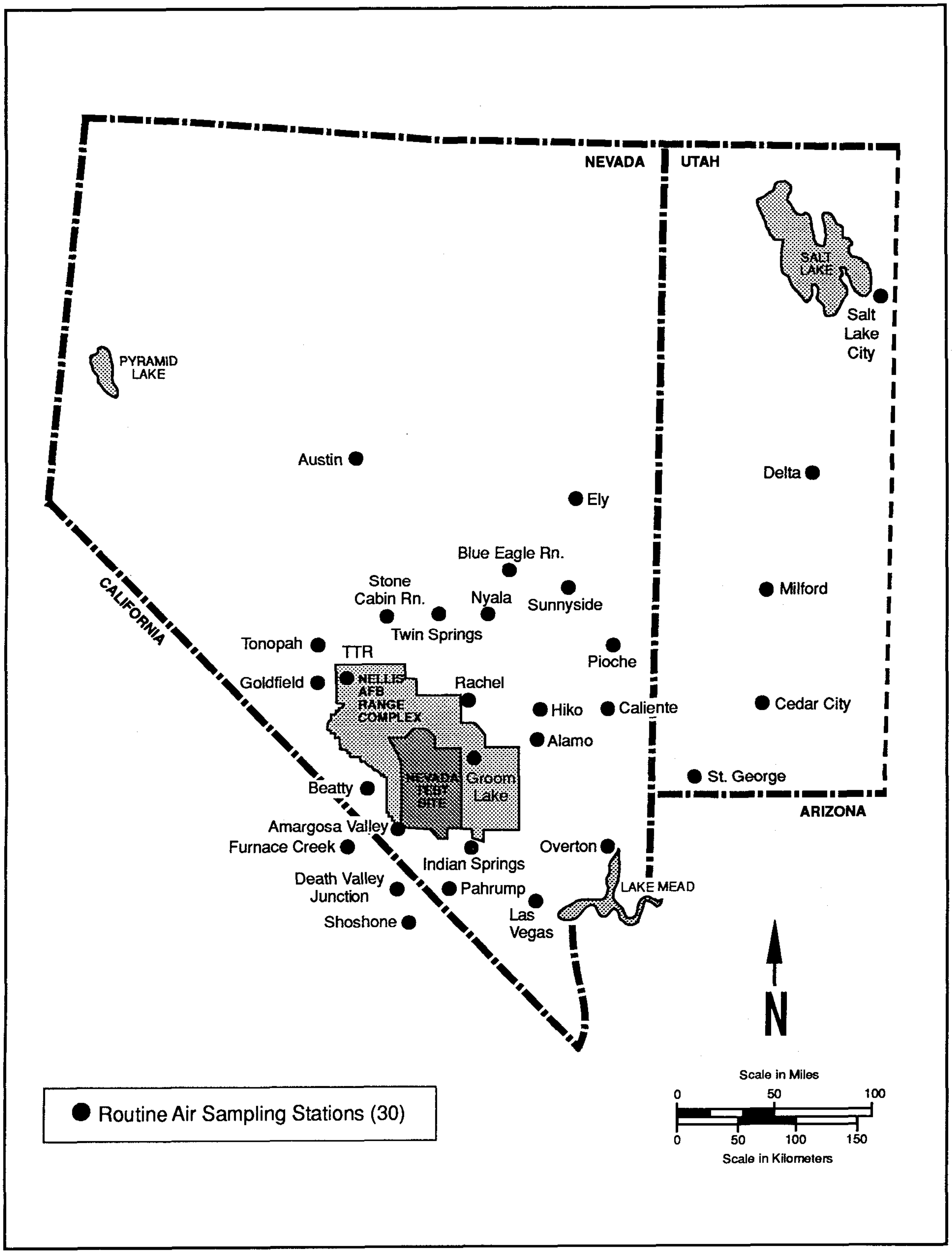


Figure 4.5 Air Surveillance Network Stations - 1992

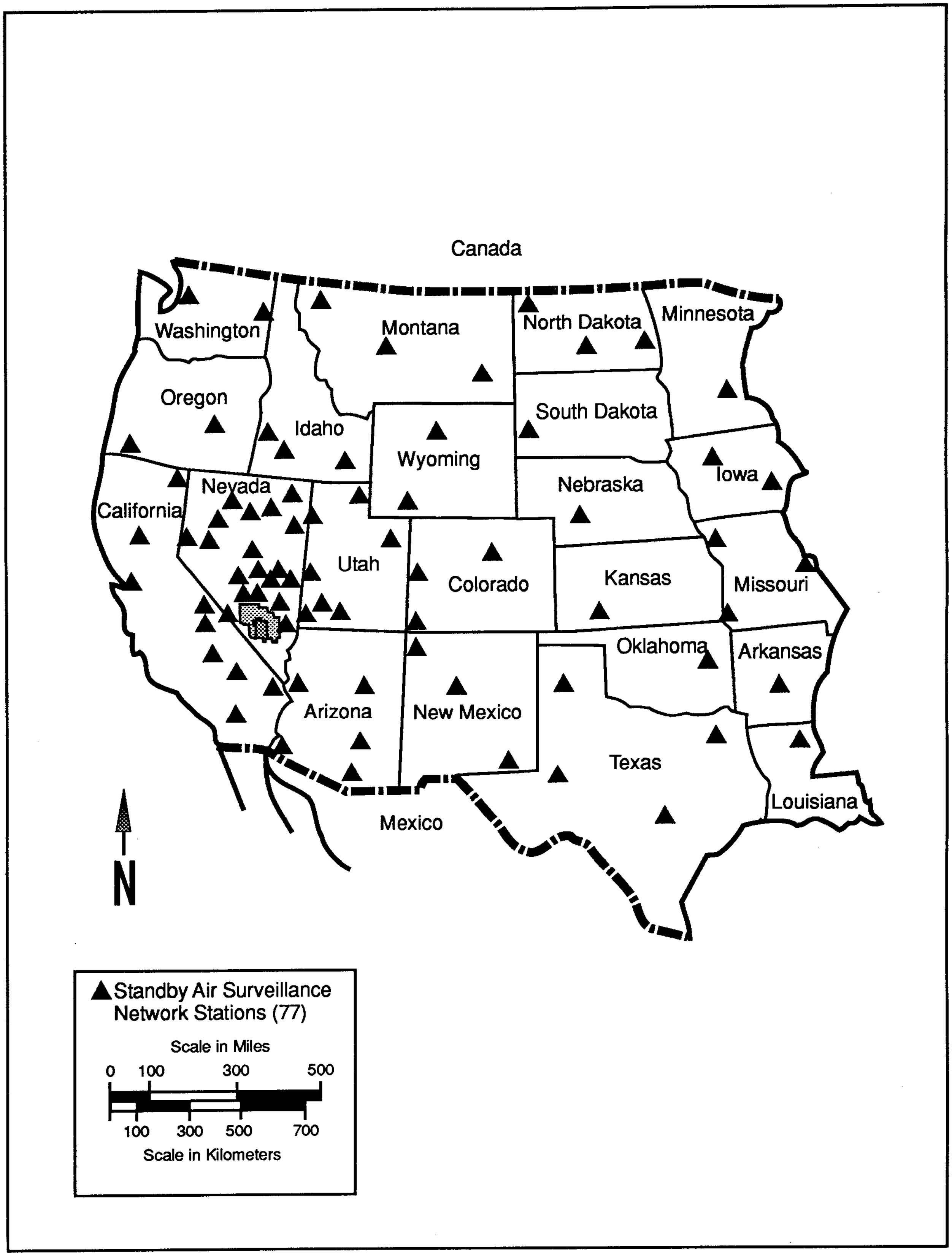


Figure 4.6 Standby Air Surveillance Network Stations - 1992

over the entire globe because of its half-life, 10.7 years, and the lack of significant sinks (NCRP, 1975). For these reasons, ^{85}Kr results are expected to be above the MDC. Tritium iscreated by natural forces in the upper atmosphere and is also emitted from nuclear reactors, reprocessing facilities (non-NTS facilities), and worldwide nuclear testing.

The locations of the NGTSN stations are shown in Figure 4.7. The NGTSN is designed to detect any increase in offsite levels of xenon, krypton, or atmospheric tritium due to possible NTS emissions. Routinely operated network samplers are typically located in populated areas surrounding the NTS and standby samplers are located in communities at some distance from the NTS. In 1992, this network consisted of 13 routine noble gas samplers, plus eight on standby, and 14 routine tritium-in-air samplers, plus another seven on standby, located in the states of Nevada, Utah, and California. In addition, a tritium sampler is routinely operated near a nuclear research reactor in Salt Lake City, Utah. Five stations which had previously been operated routinely were converted to standby status in November 1991: Shoshone, California; Cedar City, Utah; and Austin, Ely, and Caliente, Nevada. The stations remaining on routine sampling status ring the NTS to detect any emissions of noble gases or atmospheric tritium which reach the population centers in the immediate offsite area.

Noble gas samples are collected by compressing air into storage tanks. The equipment continuously samples air over a seven-day period and stores approximately 0.6 m^3 (21 ft^3) of air in the tanks. The noble gas samplers consist of a four-bottle system. One bottle is filled over the entire sampling period. The other three bottles are filled consecutively over the same sampling period in 56-hour increments. Only the bottle containing samples from the entire sampling period is routinely analyzed. If xenons or levels of ^{85}Kr greater than normal background were detected in this sample, then the other three samples would be analyzed. The tanks are exchanged weekly and returned to the EMSL-LV Radioanalysis Laboratory for analysis. For the analysis, samples are condensed at liquid nitrogen temperature. Gas chromatography is then used to separate the various radionuclides. The radioactive gases are dissolved in liquid scintillation "cocktails," then counted in a liquid scintillation counter to determine activity.

In tritium-in-air sample collection, a column filled with molecular sieve pellets is used to collect moisture from the air. Approximately 6 m^3 (212 ft^3) of air is drawn through the column during a typical 7-day sampling period. The water absorbed in the pellets is recovered and measured and the concentration of ^{3}H is determined by liquid scintillation counting. The volume of recovered water and the ^{3}H concentration is then used to calculate the concentration of HTO, the vapor form of tritium. HTO is the most common form of tritium encountered in the environment.

4.1.2.2 WATER MONITORING

As part of the LTHMP, EPA EMSL-LV scientists 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, "Groundwater Protection," Sections 9.5 and 9.6.

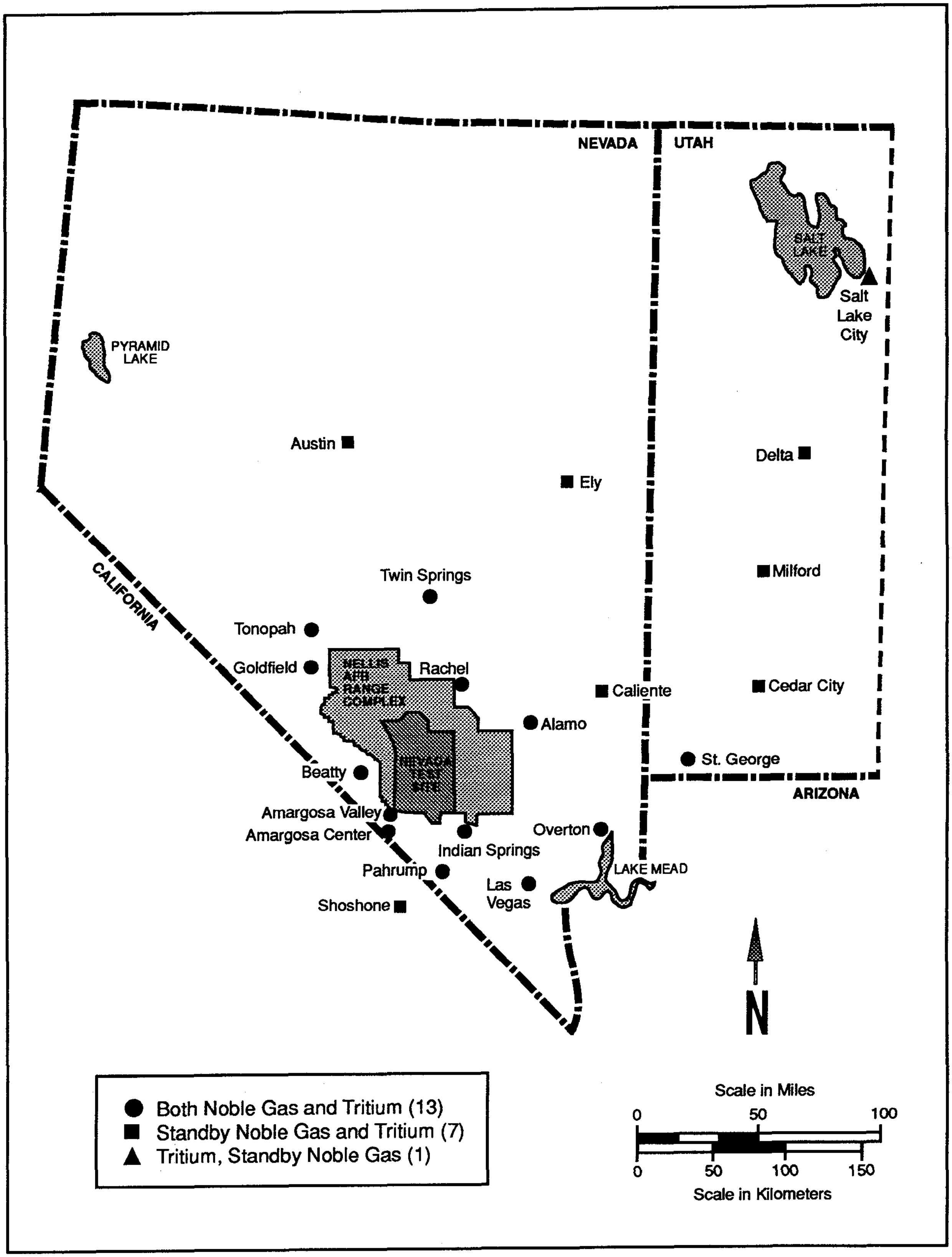


Figure 4.7 Offsite Noble Gas and Tritium Surveillance Network Stations - 1992

4.1.2.3 MILK SURVEILLANCE NETWORK

Milk is particularly important in assessing levels of radioactivity in a given area and, especially, the exposure of the population as a result of ingesting milk or milk products. 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 by children, can cause significant impairment of thyroid function. Because dairy animals consume vegetation representing a large area of ground cover and because many radionuclides are transferred to milk, analysis of milk samples may yield information on the deposition of small amounts of radionuclides over a relatively large area. Accordingly, milk is closely monitored by EPA EMSL-LV through the Milk Surveillance Network (MSN) and the Standby Milk Surveillance Network (SMSN). The third component of the monitoring network is a dairy animal and population census.

The MSN includes commercial dairies and family-owned milk cows and goats representing the major milksheds within 300 km (186 mi) of the NTS. At the beginning of 1992, there were 24 MSN collection sites. Two sites were discontinued in July 1992: Susie Scott's Ranch (Goldfield, Nevada) and Cedarsage Farm (Inyokern, California), which went out of business and moved to Idaho. McKay's Ranch (McGill, Nevada) was added to the MSN in February 1992. These locations are shown in Figure 4.8. No samples were collected in 1992 from Blue Eagle Ranch (Currant, Nevada) nor from Susie Scott's Ranch prior to its discontinuation.

The SMSN consists of dairies or processing plants representing all major milksheds west of the Mississippi River. The network is activated annually by contacting cooperating Food and Drug Administration (FDA) Regional Milk Specialists, who in turn contact State Dairy Regulators to enlist cooperating milk processors or producers. The annual activation permits trends to be monitored and ensures proper operation of the SMSN, should an emergency arise. The 115 locations sampled in 1992 appear in Figure 4.9. Changes in SMSN sampling locations are given in Table 4.2.

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. A partial census, including all California counties contiguous to Nevada, Box Elder and Tooele counties in Utah, and half of Nevada, was performed in 1992. The full census is scheduled to be completed by October 1993, including the northwestern and western counties of Nevada. 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 respective state governments.

Raw milk is collected in 3.8-L (1-gal) collapsible Cubitainers and preserved with formaldehyde. Samples from the SMSN are mailed to the EMSL-LV Radioanalysis Laboratory.

All milk samples are analyzed by high-resolution gamma spectrometry to detect gamma-emitting radionuclides. One sample per quarter from each MSN location and samples from two locations in each state in the SMSN are analyzed for ^{3}H by liquid scintillation counting and for ^{89}Sr and ^{90}Sr by radiochemical separation and beta counting.

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

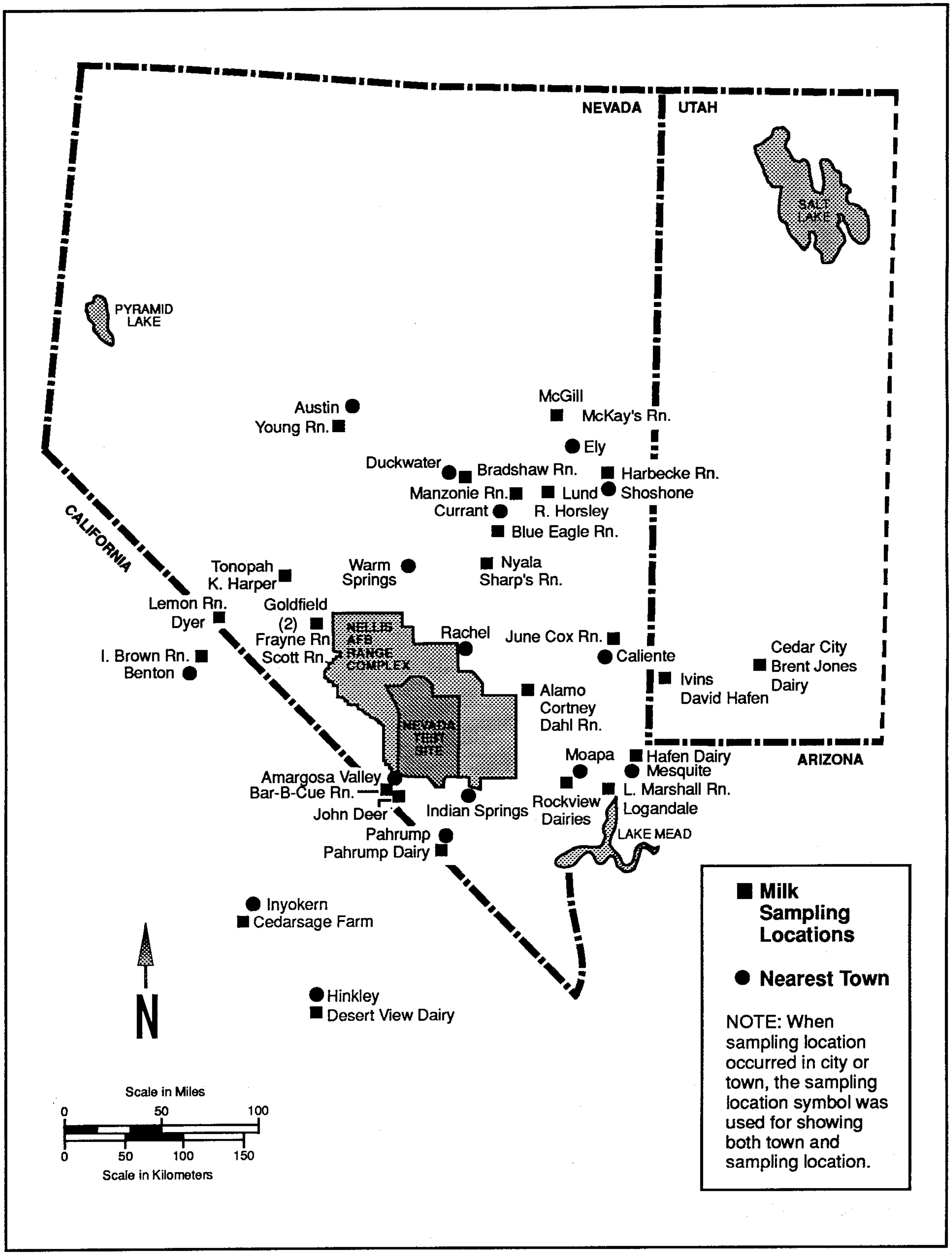


Figure 4.8 Milk Surveillance Network Stations - 1992

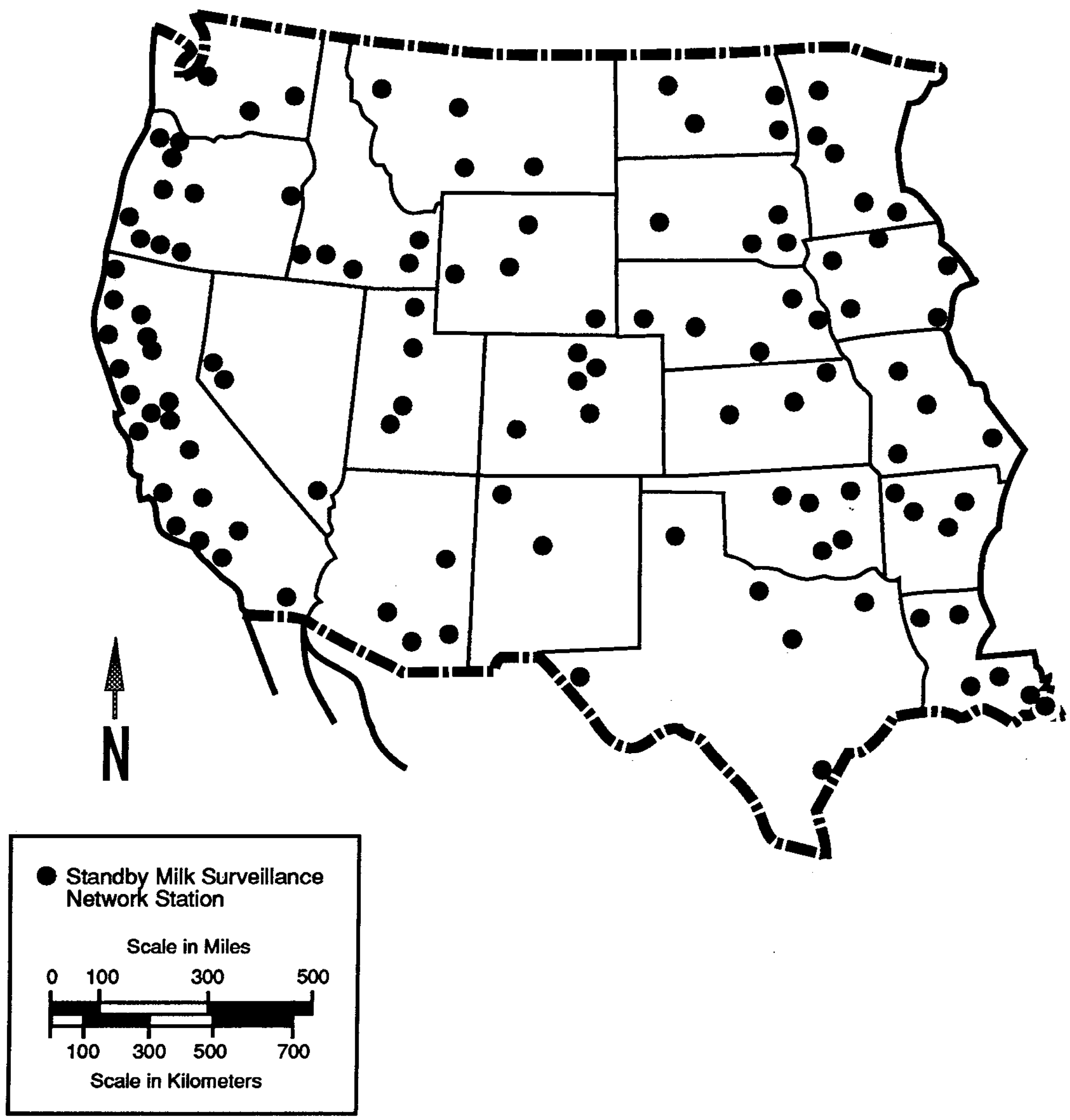


Figure 4.9 Standby Milk Surveillance Network Stations, 1992

Table 4.2 Standby Milk Surveillance Network Sampling Location Changes - 1992

City, State	Old Diary Name	City, State	New Dairy Name
Saugus, California	Wayside Honor Ranch	Long Beach, California	Paul's Dairy
North Powder, Oregon	Elmer Hill Dairy	Ontario, Oregon	Eastway Dairy
Logandale, Nevada	Nevada Dairy	Las Vegas, Nevada	Anderson Dairy
Corpus Christi, Texas	People's Baptist Church	Corpus Christi, Texas	Hygeia Milk Plant
Glen Rose, Texas	Daffan Family Dairy	Glen Rose, Texas	DeWayne Hankins Dairy
Ruston, Louisiana	Technical University Dairy		(no replacement)
		Coalgate, Oklahoma	Larry Krebs Dairy (new)
Manteca, California	A & J Foods, Inc.	Manteca, California	Supremo Foods (new name)
Aurora, Missouri	Mid-America Dairymen, Inc.	Monett, Missouri	Mid-America Dairymen, Inc. (relocation)

on the surface of fruits and vegetables from atmospheric deposition, resuspension, or in particles of soil adhering to vegetable surfaces. Weather patterns, especially precipitation, can affect soil inventories of radionuclides. Grazing animals ingest radionuclides which may have been deposited on forage grasses and, while grazing, ingest soil which may contain radionuclides. Radionuclides may accumulate in certain organs in the grazing animal, such as liver and muscle, and human uptake may occur by consumption of meat and meat products.

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. To that end, the program is based upon what is considered to be a worst-case scenario. Mule deer are migratory; the ranges of the herds which inhabit the NTS include lands outside the federal exclusionary area in which hunting is permitted. Therefore, it is theoretically possible for a resident to consume meat from a deer which had become contaminated with radionuclides during its inhabitation on 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 in the area. Some of these radionuclides may be ingested by animals residing in those areas. Cattle are purchased from ranches where atmospheric tests are known to have deposited radionuclides. The continued monitoring of bighorn sheep provides a long-term history for examination of radioactivity trends in large grazing animals. The biomonitoring network also includes special studies, such as collection and analysis of forage and grains. No such special studies were conducted in 1992. The locations where animals were collected in 1992 are shown in Figure 4.10.

During the bighorn sheep season in November and December, licensed hunters in Nevada are asked to donate one leg bone and one kidney from each bighorn sheep taken. The location where the sheep was taken and any other available information are recorded on the field data form. The bone and kidney samples are weighed, sealed in labeled sample bags, and stored in a controlled freezer until processing. Weights are recorded on the field data form. After completion of the hunting season, a subset of the samples is selected to

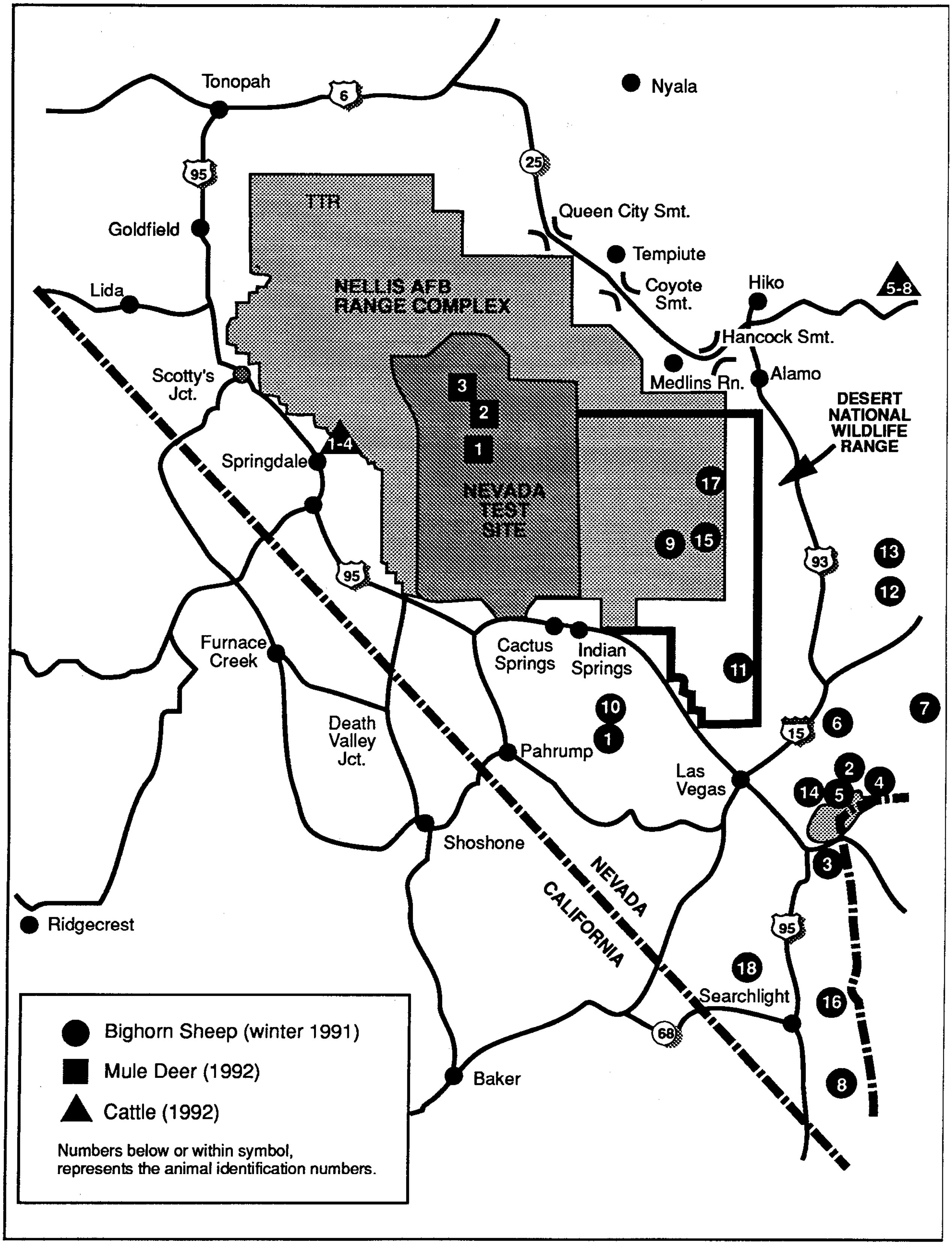


Figure 4.10 Collection Sites for Animals Sampled - 1992

represent areas around the NTS. The kidney is divided into two samples. One kidney sample is delivered to the EPA EMSL-LV Radioanalysis Laboratory for analysis of gamma-emitting radionuclides. The second kidney sample and all bone samples are shipped in a single batch to a contract laboratory for ashing. Upon completion of ashing, both the kidney and the bone samples are analyzed for plutonium isotopes and the bone samples are additionally analyzed for strontium. All results are reported in units of pCi/g of ash. The ash weight to wet weight ratios (percent ash) are also reported, to permit conversion of radionuclide activity to a wet weight basis for use in dose calculations.

Each year, attempts are made to collect four mule deer from the NTS, on a one per quarter schedule. If a deer is killed on the road, that animal is used. If road kills are not available, a deer is hunted by personnel with a special permit to carry weapons on the NTS. No deer was collected in the first quarter of 1992, although two hunting trips were conducted. 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, weighed, and sealed in labeled sample bags. Soft tissue organs, including lung, liver, muscle, and rumen contents are divided into two samples, one for analysis of gamma-emitting radionuclides and one which is ashed prior to analysis for 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 ashed and analyzed for plutonium isotopes and strontium. The samples requiring ashing are shipped in a single batch each quarter to a contract laboratory. Analyses are completed in the EPA EMSL-LV Radioanalysis Laboratory.

Four cattle are purchased each spring and fall from ranches in the offsite area around the NTS. In 1992, four cattle were purchased in the spring from G.L. Coffer's Fleur de Lis Ranch located north of Beatty, Nevada and another four were purchased in the fall from the Cortney Dahl Ranch in Delamar Valley (east of Alamo, Nevada). Generally, two adult cattle and two calves are acquired in each purchase. The facility at the old EPA farm on the NTS is used for the slaughter. This facility is designed to minimize risk of contamination. As with the bighorn sheep and 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. A second kidney sample and bone samples are sent to a contract laboratory for ashing. Ashed kidney samples are analyzed for plutonium isotopes; bone ash samples are analyzed for plutonium isotopes and 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 1992 by donation from residents of farms in LaVerkin, Utah (carrots with tops), Alamo, Nevada (carrots with tops, summer squash), Adaven, Nevada (apples), Twin Springs Ranch, Nevada, (apples), Rachel, Nevada (broccoli, cabbage, carrots with tops). The samples were analyzed by gamma spectrometry, then ashed and analyzed by radiochemistry for ^{90}Sr, ^{238}Pu, and $^{239+240}$Pu.

4.1.2.5 THERMOLUMINESCENT DOSIMETRY NETWORK

The TLD network is designed primarily to measure total ambient gamma exposures at fixed locations. A secondary function of the network is the measurement of exposures to specific individuals living within and outside estimated fallout zones from past atmospheric nuclear tests at the NTS (offsite residents). Measuring environmental ambient gamma exposures at fixed locations provides a reproducible index which can then easily be correlated to the maximum exposure an individual would have received were he continuously present at that location. Monitoring of individuals makes possible an estimate of individual exposures and helps to confirm the validity of using fixed-site ambient gamma measurements to project individual exposures.

A network of environmental stations and monitored personnel has been established by EMSL-LV in locations encircling the NTS. Fixed environmental station locations monitored in 1992 are shown in Figure 4.11 and locations of residents participating in the TLD program are shown in Figure 4.12. Personnel results are compared to the nearest fixed environmental station, as indicated on the figure. The broad array of the network design facilitates estimation of average background exposures as well as detection of any increase due to NTS activities.

Since 1987, environmental and personnel monitoring for ambient gamma exposures has been accomplished using the Panasonic TLD system. This system provides tissue equivalence for personnel TLDs which facilitates correlating individual measured exposures with the absorbed biological dose equivalent. Monitoring of offsite personnel is accomplished with the Panasonic UD-802 dosimeter. This dosimeter contains two elements of $Li_2B_4O_7$:Cu and two of $CaSO_4$:Tm phosphors. The four elements are behind 14, 300, 300, and 1000 mg/cm^2 filtration, respectively. Monitoring of offsite environmental stations is accomplished with the Panasonic UD-814 dosimeter. This dosimeter contains a single element of $Li_2B_4O_7$:Cu and three replicate $CaSO_4$:Tm elements. The first element is filtered by 14 mg/cm^2 of plastic, and the remaining three are filtered by 1000 mg/cm^2 of plastic and lead. The three replicate phosphors are used to provide improved statistics and extended response range.

During 1992 a total of 128 offsite stations were monitored to determine background ambient gamma radiation levels. The TLDs used to monitor fixed reference background locations are designed to be sensitive to beta, gamma, and high-energy X-radiations. Fixed environmental TLD stations are located in Arizona, California, Nevada, and Utah. Each station has a custom-designed holder that holds from one to four Panasonic TLDs. Normal operations involve packaging two TLDs in a heat-sealed bag to provide protection from the elements and placing the dosimeter packet into the fixed station holder. Fixed environmental monitoring TLDs are normally deployed for a period of approximately three months (one calendar quarter). To facilitate comparison of results obtained from varying deployment periods, an equivalent exposure rate is calculated by dividing integrated exposure by the number of days the dosimeter was deployed, resulting in an artificial unit of "equivalent mR/day". The average mR/day is then multiplied by 365.25 to determine the annual adjusted ambient gamma exposure. This presumes that exposures accumulate at an essentially uniform rate over the course of a year, a presumption that is valid in the absence of episodic releases of radioactivity.

During 1992 a total of 66 individuals living in 41 localities surrounding the NTS were provided with personnel TLDs. The TLDs used to monitor individuals are sensitive to beta, gamma, neutron, and low and high-energy X-radiations. Personnel dosimeters are cross-referenced to associated fixed reference background TLDs, and all personnel exposures are presumed to be due to gamma or high-energy X-radiation. Exposures of this type are numerically equivalent to absorbed dose. Thermoluminescent dosimeters used to monitor individuals are provided in holders which are designed to be worn on the front of an individual's body, between the neck and the waist. When worn in this manner, the TLD may be used to

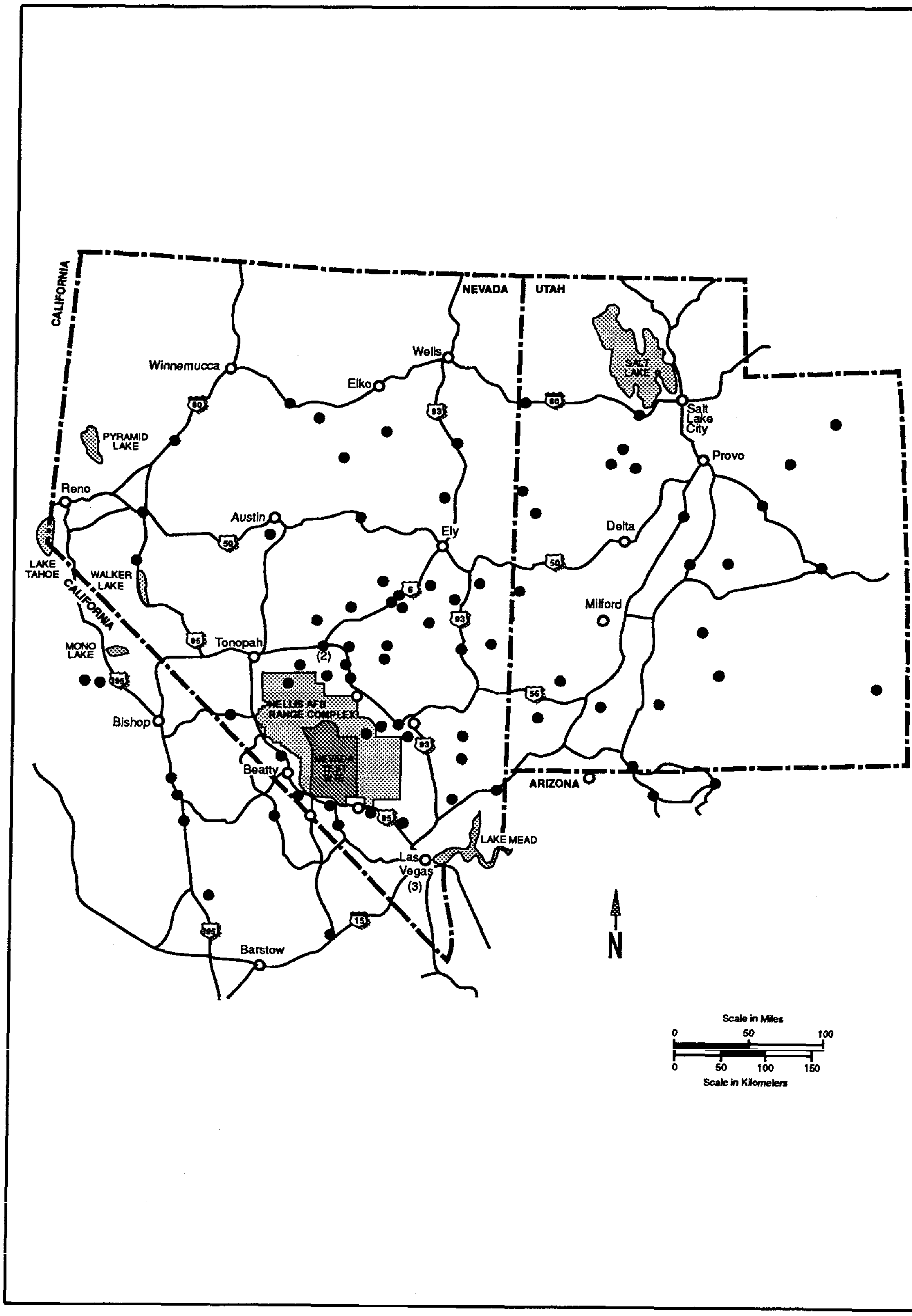


Figure 4.11 Thermoluminescent Dosimetry Fixed Environmental Stations - 1992

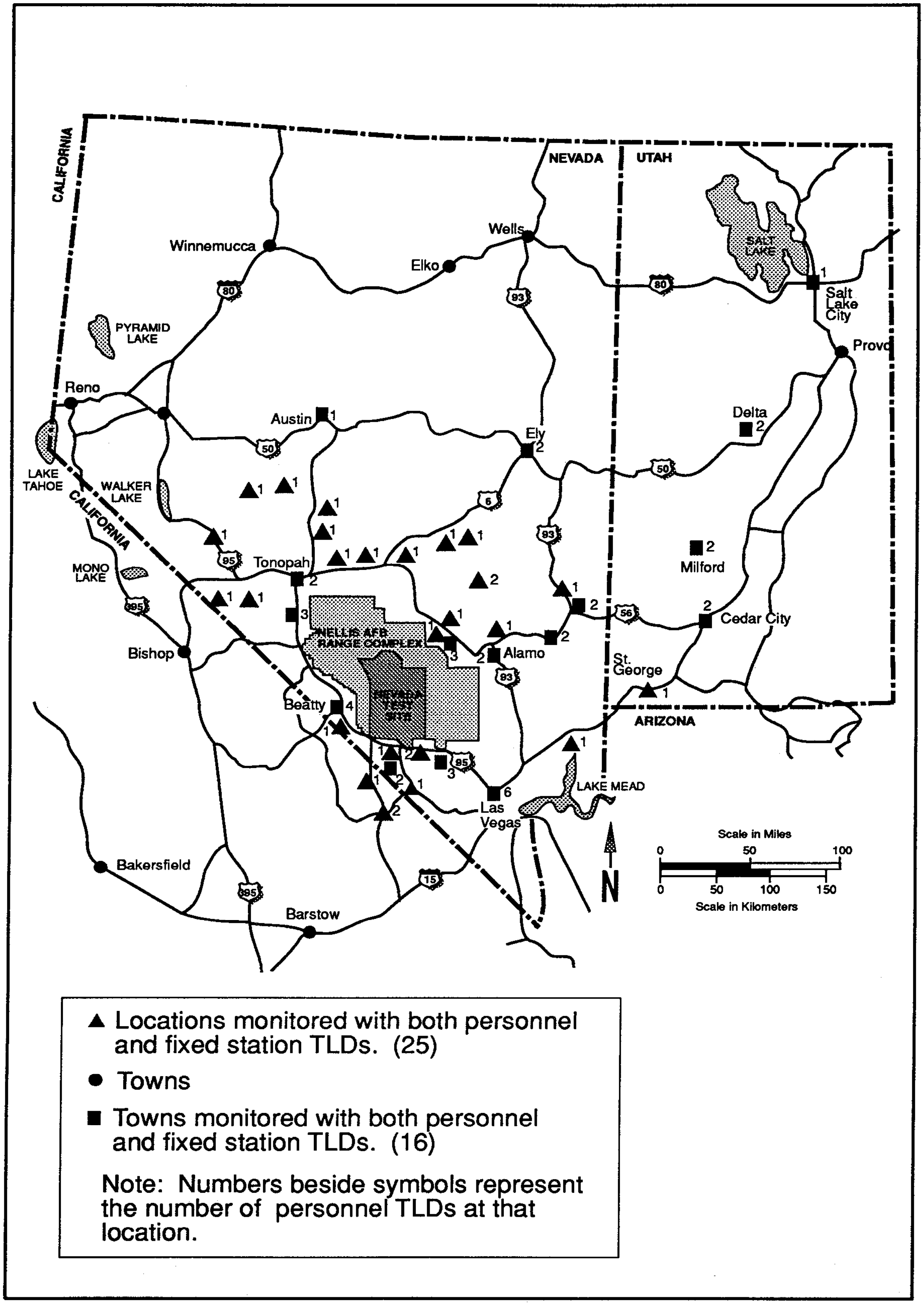


Figure 4.12 Thermoluminescent Dosimetry Personnel Monitoring Participants - 1992

estimate not only ambient gamma radiation exposure but to characterize the absorbed radiation dose an individual wearing the dosimeter may have received. These TLDs are exchanged on a nominal monthly schedule. The annual adjusted ambient gamma exposure (mrem in one year) is calculated by multiplying the mean daily rate for each individual by 365.25 following the same presumptions as detailed above.

Both fixed environmental station and personnel TLDs are processed by using a Panasonic automated system. Up to 500 TLDs may be loaded in 50-dosimeter magazines into the automatic sample changer attached to each reader. Each magazine is automatically advanced to admit dosimeters into the reading mechanism. In the mechanism, the dosimeter portion containing the four phosphors is withdrawn from the holder. Each element is then heated and its light output measured. When all four elements have been read, the card is re-inserted into its holder, the holder is returned to the magazine, and the process is repeated for the next dosimeter. The EMSL-LV TLD Laboratory is an accredited processor of personnel TLDs under the Department of Energy Laboratory Accreditation Program (DOELAP).

4.1.2.6 PRESSURIZED ION CHAMBER (PIC) NETWORK

The PIC network continuously measures ambient 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 anthropogenic activities. In the absence of anthropogenic activities, ambient gamma radiation rates naturally differ among locations as rates vary with altitude (cosmic radiation) and with radioactivity in the soil (terrestrial radiation). Ambient gamma radiation also varies slightly within a location due to weather patterns.

There are 27 PICs (excluding Terrell's Ranch and the Amargosa Valley Community Center) stationed in communities around the NTS which provide near real-time estimates of gamma exposure rates for the ORSP. The stations located at Terrell's Ranch and Amargosa Valley Community Center became part of the Yucca Mountain Project in December 1991 and, therefore, will not be included in this discussion. The locations of the PICs are shown in Figure 4.13. Eighteen of the PICs are located at CRMP stations. The CRMP is discussed in Section 4.1.2.8.

The PIC network utilizes Reuter-Stokes models 1011, 1012, and 1013 PICs. The PIC is a spherical shell filled with argon gas to a pressure 25 times that of atmospheric. 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 ions are collected by the center electrode. The electrical current generated is measured, and the intensity of the radiation field is determined from the magnitude of this current.

Data are retrieved from the PICs shortly after measurements are made. The near real-time telemetry-based data retrieval is achieved by the connection of each PIC to a data collection platform (DCP) which collects and transmits the data. Gamma exposure measurements are transmitted via the Geostationary Operational Environmental Satellite (GOES) directly to a receiver earth station at the NTS and from there to the EMSL-LV by dedicated telephone line. Each station routinely transmits data every four hours (i.e., 4-hour average, 1-minute maximum, and 1-minute minimum values) unless the gamma exposure rate exceeds the

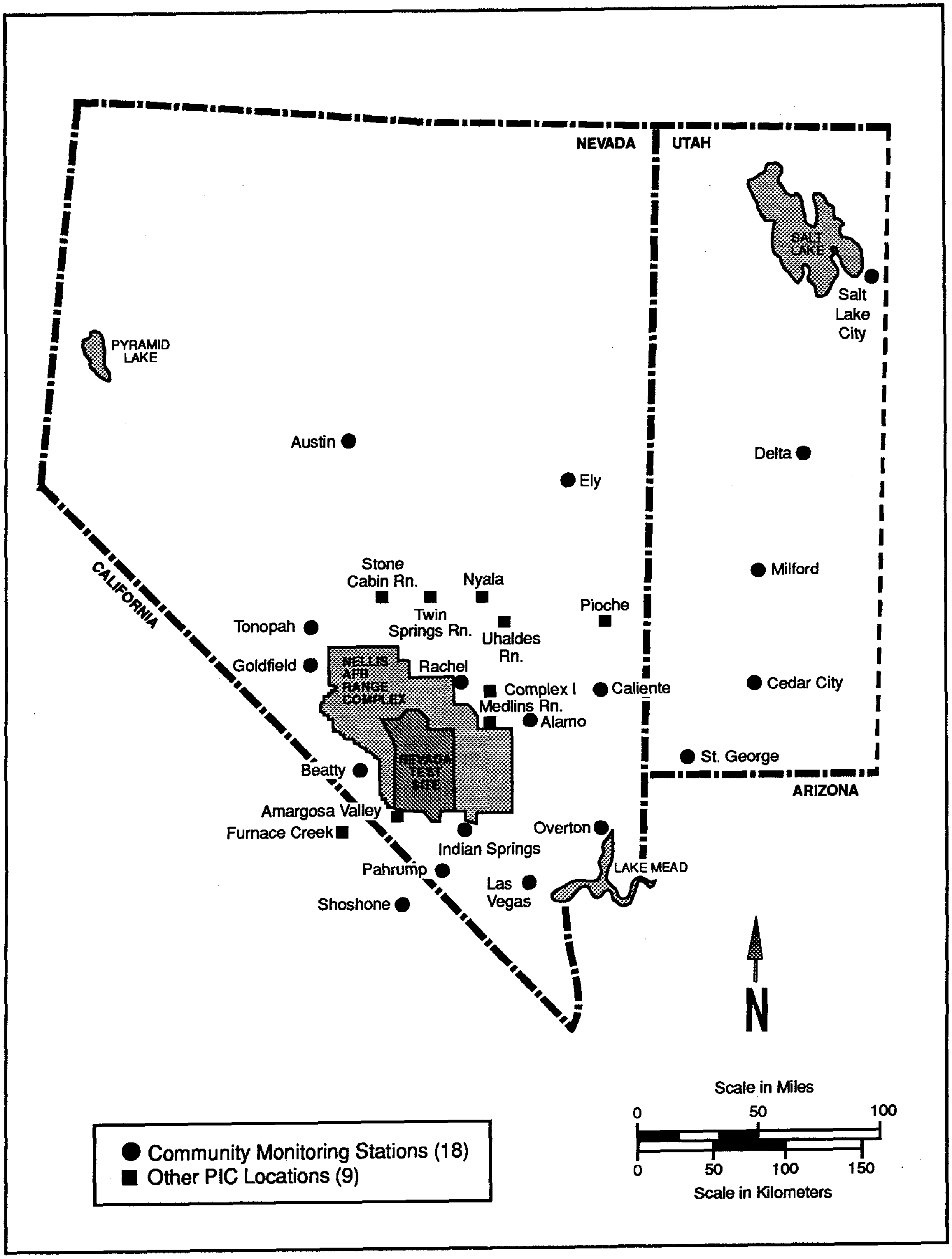


Figure 4.13 Pressurized Ion Chamber Network Station Locations - 1992

currently established alarm threshold. When the threshold is exceeded for two consecutive 1-minute samples, the system goes into the alarm mode and transmits a string of nine consecutive 1-minute values every 2 to 15 minutes. Additionally, the location and status (i.e.,routine or alarm mode) of each station are shown on a map display in the Control Point-One (CP-1) control room at the NTS and at EMSL-LV. Thus, the PIC network is able to provide immediate documentation of radioactive cloud passage in the event of an accidental release from the NTS. In previous years and at the beginning of 1992, the alarm threshold limit was 50 μR/h. During March and April 1992, new limits were established for each station by multiplying the normal background rate by two. The new threshold limits range from 12 μR/h for Las Vegas, Nevada to 35 μR/h for Milford, Utah and Stone Cabin Ranch, Nevada.

In addition to telemetry retrieval, PIC data are also recorded on both magnetic tapes and hard-copy strip charts at 25 of the 27 EPA stations and on magnetic cards for the other two EPA stations. The magnetic tapes and cards, which are collected weekly, provide a backup to the telemetry data and are also useful for investigating anomalies because the data are recorded in smaller increments of time (5-minute averages). The PICs also contain a liquid crystal display, permitting interested persons to monitor current readings.

The data are evaluated weekly by EMSL-LV personnel. Trends and anomalies are investigated and equipment problems are identified and referred to field personnel for correction. Weekly averages are stored in Lotus files on a personal computer. These weekly averages are compiled from the 4-hour averages from the telemetry data when available and from the 5-minute averages from the magnetic tapes or cards when the telemetry data are unavailable. Computer-generated reports of the PIC weekly average data are issued weekly for posting at each station. These reports indicate the current week's average gamma exposure rate, the previous week's and year's averages, and the maximum and minimum background levels in the U.S.

4.1.2.7 OFFSITE DOSIMETRY NETWORK

Internal exposure is caused by ingested, absorbed, or inhaled radionuclides that remain in the body either temporarily or for longer periods of time because of storage in tissues. At EMSL-LV, two methods are used to detect body burdens: whole-body counting and urinalysis. These two methods constitute the Internal Dosimetry Program. The Internal Dosimetry Program consists of two components, the Offsite Dosimetry Network and the Radiological Safety Program.

The Offsite Dosimetry Network was initiated in December 1970 to determine levels of radionuclides in some of the families residing in communities and ranches surrounding the NTS. The program consists of radionuclide uptake monitoring, external exposure monitoring, and physical examinations and was designed to estimate exposure to and effects from radioactive emissions from the NTS. The program began with 34 families (142 individuals) residing in general downwind areas from the NTS as well as in areas less subject to fallout. Currently there are 54 families (158 individuals) actively participating in the program. Locations of the 27 families monitored in 1992 are shown in Figure 4.14. The participants travel to EMSL-LV for a biannual whole-body count. A urine sample is also collected for ^{3}H analysis. At 18-month intervals a health history and physical examination, which includes a urinalysis, complete blood count, serology, chest x-ray (three-year intervals), sight screening, audiogram, vital capacity, EKG (if over 40 years old), and thyroid panel, are performed. The individual is then examined by a physician.

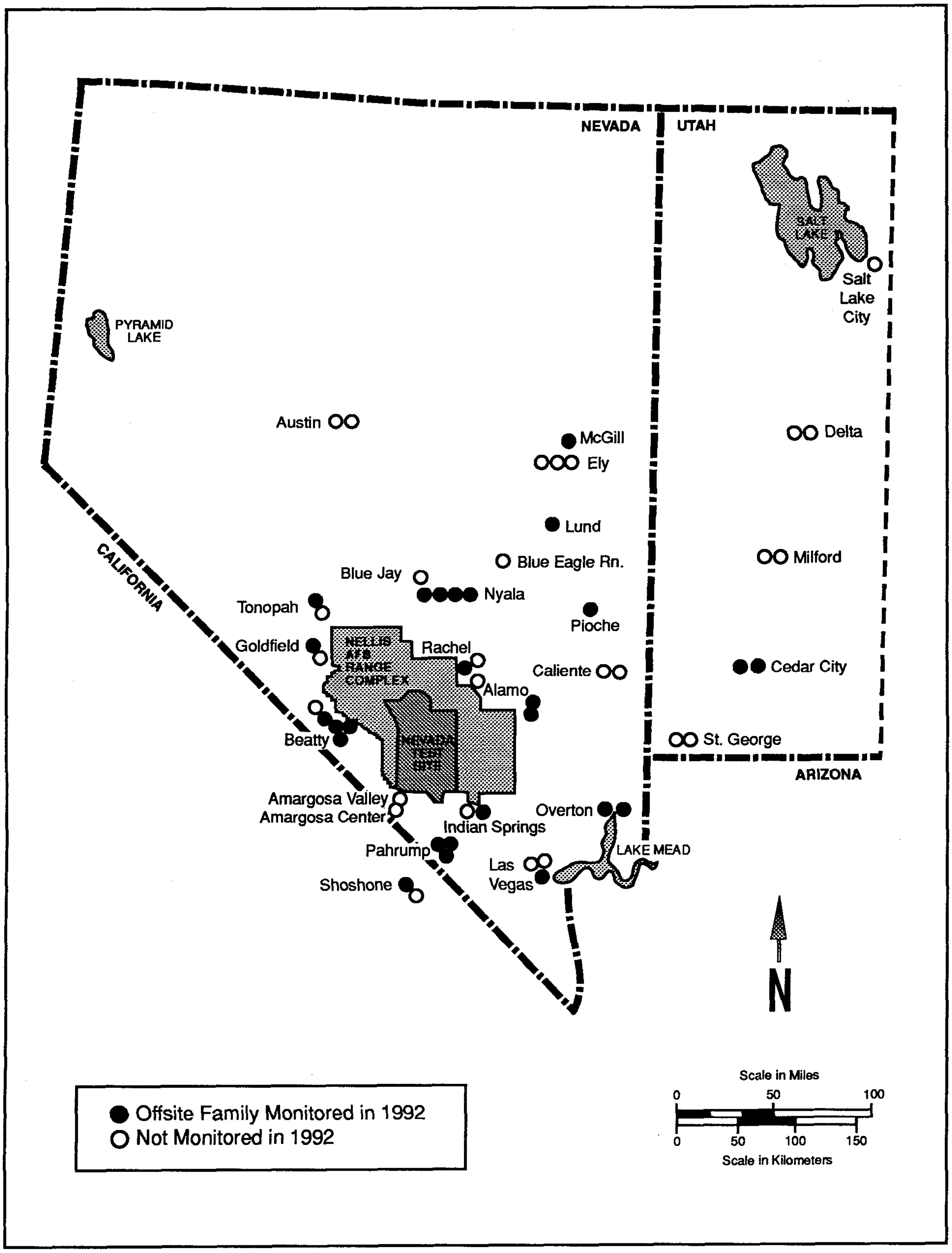


Figure 4.14 Location of Families in the Offsite Dosimetry Program - 1992

Radionuclide uptake monitoring was also performed under the Radiological Safety Program for EPA employees, DOE contractor employees, and other workers who might have been occupationally exposed. In 1992, by special request, internal dosimetry monitoring was completed for a member of the U.S. Army and for concerned members of the general public. Results of measurements on individuals from Las Vegas and other cities were compared. A special study of a group of Utah State University (USU) volunteers was conducted to determine uptake of ^{59}Fe ingested as part of a study to increase iron absorption from eating cheese.

The whole-body counting facility has been maintained at EMSL-LV since 1966. The facility is equipped to determine the identity and quantity of gamma-emitting radionuclides which might have been inhaled or ingested by offsite residents and others who may have been exposed to 1992 NTS radiation releases. Routine measurement of radionuclides in a person consisted of a 2000-second count with a sensitive radiation detector placed next to a person reclining in one of the two shielded counting rooms. In the other shielded room, a 2000-second count over the lung area is used to determine the presence of transuranic radionuclides, e.g., americium, plutonium, or uranium.

4.1.2.8 COMMUNITY RADIATION MONITORING PROGRAM

Because of the successful experience with the Citizen's Monitoring Program during the purging of the TMI containment in 1980, the Community Radiation Monitoring Program (CRMP) consisting of 15 monitoring stations located in the states of California, Nevada and Utah was begun. The program has continued to expand. Today there are 19 stations located in the same three states (See Figure 4.13). The CRMP is a cooperative project of the DOE, EPA, DRI, and University of Utah.

The DOE sponsors the program. The EPA provides technical and scientific direction, maintains the instrumentation and sampling equipment, analyzes the collected samples and interprets and reports the data. The DRI administers the program by hiring the local station managers and alternates, securing rights-of-way, providing utilities and performing quality assurance checks of the data. The University of Utah provides 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 is operated by a local resident, in most cases a science teacher. Samples are analyzed at the EMSL-LV Radioanalysis Laboratory. Data interpretation is provided by DRI to the communities involved. All of the 19 CRMP stations have one of the samplers for the ASN, NGTSN, and TLD networks and, in addition, a PIC and recorder for immediate readout of external gamma exposure, and a recording barograph. In December 1991 responsibility for the operation of the air sampler at the Amargosa Valley Community Center CRMP station was transferred from the ASN to the Yucca Mountain program. In late 1991 the noble gas sampler and the atmospheric moisture sampler for tritium analysis were placed on standby at the following communities:

Austin, Nevada	Ely, Nevada
Caliente, Nevada	Shoshone, California
Cedar City, Utah	

At Salt Lake City, Utah only the noble gas sampler is on standby as are both the noble gas and tritium-in-air samplers at the stations in Milford and Delta, Utah. These standby samplers are routinely activated for one week each quarter to assure proper operation. Sample collection can be initiated at any time by notifying the station manager or alternate or EMSL-LV personnel.

All of the equipment is mounted on a stand at a prominent location in each community so the residents are aware of the surveillance and, if interested, can have ready access to the data.

Computer-generated reports of the PIC data are issued weekly for each station. These reports display the current weekly average gamma exposure rate, the previous week's and the previous year's averages, and the maximum and minimum backgrounds in the U.S. In addition to being posted at each station, copies are sent to appropriate federal and state personnel in California, Nevada, and Utah.

4.1.2.9. COMMUNITY EDUCATION OUTREACH PROGRAM

DOE sponsors Public Information Presentations which are forums for increasing public awareness of NTS activities, disseminating radiation monitoring results, and addressing concerns of residents related to environmental radiation and possible health effects. These public information presentations were initiated in February of 1982 in the form of town hall meetings. Between 1982 and 1990, 95 town hall meetings were held in the communities surrounding the NTS. These communities are located in the states of Arizona, California, Nevada, and Utah.

In the fall of 1990 the focus of this outreach program was changed. Rather than a single subject presented at general town hall meetings, audiences from schools, service clubs and civic groups from the various communities were targeted and offered presentations on many different subjects. Table 4.3 lists the outreach presentations conducted in 1992. A list of presentation subjects is provided in Table 4.4. An annual report on the CRMP and outreach program is published by the Desert Research Institute under the name "Community Radiation Monitoring Program Annual Report for FY 19xx," with a report number such as DOE/NV-10845-xx, which may be obtained from either DRI or DOE/NV. All inquiries regarding the outreach program and presentations should be directed to DRI at (702) 895-0461.

4.1.3 NON-NTS FACILITY MONITORING

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; the Remote Sensing Laboratory at Nellis Air Force Base; and the Las Vegas Area Operation's North Las Vegas Facility A-1 Source Range. Sealed sources are tested periodically to assure there is no leakage of radioactive material.

Fence line radiation monitoring at these facilities was conducted during 1992. EG&G/EM uses Panasonic Type UD-814 TLDs. At least two TLDs are at the fence line on each side of the facility. TLDs are exchanged on a quarterly basis with an additional control TLD kept in a shielded safe. The monitoring data are in Table 4.5.

Table 4.3 Community Radiation Monitoring Program Outreach Presentations - 1992

Date	Location	Audience	Subject	Attendance
02/12	Adaven, NV	Uhalde Ranch County School	NTS Deer Migration Study	21
02/24	Tonopah, NV	Alpha Sigma Phi (women's college sorority)	Consumer Electronic Product Radiation	16
02/25	Tonopah, NV	Tonopah Junior High School	Downwind Radiation and Sheep Kill	104
04/07	Panaca, NV	Lincoln County Middle and High Schools	NTS Deer Migration Study	75
04/20	Tonopah, NV	Tonopah Rotary Club	NTS Archaeology	20
04/24	Tonopah, NV	Tonopah Elementary and High Schools	ABC's of Radiation	87
05/02	Beatty, NV	Beatty High School	NTS Archaeology; Archaeology in Egypt; Career opportunities in Archaeology, Geology and Hydrology; NASA's Astronaut Program	125
06/01	Coal Valley, NV	Complex I Residents	NTS Deer Migration Study	6
06/09	Tonopah, NV	Tonopah Rotary Club	Joint Verification Experiment	19
07/14	Tonopah, NV	Tonopah Rotary Club	NTS Deer Migration Study	16
09/16	Indian Springs, NV	Indian Springs High School Government Class	Current Events and the NTS	35
10/12	Cedar City, UT	American Legion and Auxiliary	Consumer Electronic Product Radiation	19
10/13	Cedar City, UT	Cedar City High School	Consumer Electronic Product Radiation	122
10/13	Cedar City, UT	Women in Business	Consumer Electronic Product Radiation	30
11/16	Tonopah, NV	Tonopah Rotary Club	NTS Hydrology	19
12/15	Parowan, UT	Parowan High School	NTS Deer Migration Study	96
12/16	Cedar City, UT	Cedar City High School	NTS Deer Migration Study	78
12/16	Cedar City, UT	Cedar City Exchange Club	NTS Deer Migration Study	16
			Attendance Total	904

Table 4.4 Community Radiation Monitoring Program Presentation Topics

- ABC's of Radiation. Radiation explained in understandable terms; when it is dangerous and when it is not.
- Testing Nuclear Weapons. How nuclear weapons are tested (safely) on the Nevada Test Site (NTS).
- Joint Verification Experiment. Interaction with the USSR during exchange of weapons tests at the NTS and the USSR.
- Downwind Radiation Exposures and Legislation. The different studies that have been done to calculate the radiation exposures to people who were living in the downwind area during atmospheric testing.
- Offsite Radiation Monitoring and the Community Monitoring Program. The offsite monitoring program which is performed by the Environmental Protection Agency in areas and communities surrounding the NTS. The Community Radiation Monitoring Program details how science teachers and local residents in Nevada, California, and Utah have been and are involved in understanding activities on the NTS.
- Hiroshima-Nagasaki Experience. Predicted radiation affects based on the Hiroshima-Nagasaki data.
- Environmental Restoration. Current environmental restoration programs on the NTS and those planned for the future.
- Onsite Environmental Monitoring. The NTS onsite environmental monitoring program.
- Consumer Electronic Product Radiation. Risks and benefits of safe usage of common household electronic products.
- NTS Archaeology. Prehistory and cultural resources of the southern great basin and NTS.
- NTS Hydrology. Groundwater flow studies and subsurface contamination on the NTS and surrounding areas.
- Surficial Radioactive Contamination. Occurrence of radioactive contamination on the NTS and surrounding area as a result of weapons testing.
- NTS Deer Migration Study. Seven year deer tagging study to understand migration patterns.
- Low Level Waste. A description of how low level waste is managed and controlled at the Low Level Waste Management Site on the NTS.
- Emergency Response Training. The training program for Nevada policemen and firemen who are first-on-the-scene accident responders.

Table 4.5 EG&G/EM Boundary Line Monitoring Data - 1992

LAVO ID#	1992 (mrem) 4th Qtr	3rd Qtr	2nd Qtr	1st Qtr	Location Description
LV-01	23	27	22	23	Northwest Corner of Fence/Gate C-6
LV-02	21	25	19	23	North Fence -- Across from C-3
LV-03	22	24	19	21	North Fence -- West End of A-12
LV-04	22	26	23	24	North Fence -- East End of A-12
LV-05	22	24	21	21	North Fence -- North of A-9
LV-06	23	27	21	22	North Fence -- North of substation
LV-07	23	25	19	24	North Fence -- West End of A-4
LV-08	20	23	18	20	Northeast Corner of Fence/Gate A-12
LV-09	20	23	18	19	East Fence -- North End of A-Complex
LV-10	20	22	19	18	East Fence -- Center of A-Complex
LV-11	22	25	20	20	East Fence -- South end of A-Complex
LV-12	22	23	20	19	East Fence -- North End of B-Complex
LV-13	21	23	19	19	East Fence -- Center of B-Complex
LV-14	20	19	17	19	East Fence -- South end of B-Complex
LV-15	21	20	19	22	South Fence -- East end of fence
LV-16	21	25	21	20	South Fence -- Center of fence/at substation
LV-17	21	23	19	21	Southwest Corner/Gate C-1
LV-18	22	25	19	20	West Fence -- Gate C-3
LV-19	23	25	20	21	West Fence -- Between Gate C-3 and NLV-01
LV-20	25	26	24	26	North Park Lot Fence -- South of C-3
LV-21	26	29	24	26	C-1 West End Guard Gate
LV-22	21	24	18	19	Main Parking Lot Guard Gate/Gate C-8
LV-23	22	24	18	20	Northwest End of A-13/Double Gates
LV-24	N/A	21	21	19	Atlas Guard Station/Gate A-11
LV-25	20	22	18	19	A-2 South Side/Loading Dock/Gate A-7
LV-26	19	22	17	18	NLV Badge Office (A-7)/Gate A-2
Control	14	19	18	19	
RSL ID#					
RSL-01	28	30	23	25	Southeast Fence -- Near Gate
RSL-02	23	22	20	21	South Fence -- Center of fence
RSL-03	20	25	17	20	Southwest Fence -- Near Gate
RSL-04	21	23	18	22	Northwest Fence -- Near Gate
RSL-05	28	27	21	24	North Fence -- Center of Fence
RSL-06	23	22	19	19	Northeast Fence -- Near Corner
Control	N/A	17	18	17	

Table 4.5 (EG&G/EM Boundary Line Monitoring Data - 1992, cont.)

	1992 (mrem)				
SBO ID#	4th Qtr	3rd Qtr	2nd Qtr	1st Qtr	Location Description
SBO-105	N/A	28	20	24	Building 130 -- Northwest Post
SBO-110	26	28	25	25	Building 130 -- Center Post
SB112	26	30	22	27	Building 130 -- Front Fence
SB116	26	29	23	25	Building 130 -- Northeast Corner of Fence
SB117	27	30	22	26	Building 130 -- Southeast Corner of Fence
SB118	27	29	24	26	Building 130 -- South fence
SB201	25	27	23	24	Building 226 -- Outside Window Sill
SB209	31	30	25	26	Building 227 -- North Fence
SB210	31	29	23	24	Building 2331 -- Rear Fence
SB215	26	28	21	24	Building 227 -- Northeast Corner of Fence
SB216	28	29	22	24	South Fence -- Behind Cf Shed
SB222	28	32	26	24	Building 227 -- East Fence
SB223	27	27	24	25	Building 227 -- Northeast Fence
SB224	25	28	21	24	Building 234 -- North Fence
SB225	24	38	20	24	Building 233 -- North Fence
SB226	25	28	21	22	Building 229-C -- Fence
SB228	29	29	23	27	Building 227 -- Southeast Corner of Fence
SB300	N/A	29	24	34	South Fence near Eyewash
SB314	25	28	23	25	North Fence -- Under cover
SB315	28	27	21	22	Driveway Gate
SB316	28	29	27	27	East Fence -- Near Corner
SB317	26	29	23	25	East Fence -- opposite X-ray rooms
SB318	32	33	25	31	East Fence -- Opposite Portal
SB319	26	27	21	24	Southeast Corner -- Near Steps
Control	22	20	19	23	
Control	23	22	18	25	

4.2 NONRADIOLOGICAL MONITORING

Scott A. Wade, H. Bruce Gillen and Scott E. Patton

The 1992 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 1992 that included wildlife surveys and vegetation trend assessments in disturbed and undisturbed areas of the Site. Nonradiological monitoring was conducted in 1992 for 54 tests conducted at the Liquified Gaseous Fuels Spill Test Facility (LGFSTF) on the NTS.

Nonradiological monitoring of non-NTS DOE/NV facilities was limited to wastewater discharges in publicly owned treatment works. This occurred at four EG&G/EM facilities.

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 Site 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 1992 there were 54 tests conducted at this facility, and 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 1992 was limited to:

- Sampling of drinking water distribution systems for Safe Drinking Water Act and state of Nevada compliance

- Sewage lagoon influent 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

Ecological studies conducted under the DOE/NV-sponsored BECAMP involved monitoring of the flora and fauna on the NTS to assess changes over time in the ecological condition of the NTS and to provide information needed for assessing NTS compliance with environmental laws, regulations, and orders. The monitoring effort (conducted by BECAMP Task 3 - Monitoring of the Flora and Fauna on the NTS) has been arranged into three interrelated phases of work: (1) a series of five non-disturbed control study plots in the test-impacted ecosystems that are monitored at one-, two-, three-, four-, or 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 the impact of disturbance, document site recovery, and investigate natural recovery processes; and (3) a series of wildlife observation plots centered around natural-spring and man-made water-source habitats on the NTS. The monitoring and survey work includes (1) vegetation sampling for the purpose of determining the health status, recovery, and utilization of vegetation in disturbed and undisturbed areas; (2) trapping of rodents to determine the condition of individual specimens and the continuity and stability of resident populations; (3) sampling of the 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 1992, the fifth full year of flora and fauna monitoring, 11 ecology monitoring sites and 43 plots were surveyed for plants, animals, and reptiles. The 43 plots monitored included (1) 17 for spring ephemeral plants, (2) 13 for perennial plants, (3) 8 for small mammals, and (4) 5 for lizards. Many of these sites contained paired disturbed/undisturbed plots. Monitoring sites surveyed included the control baseline plot in Southwestern Yucca Flat . Sites in disturbed areas of the NTS are monitored on a three year cycle. Three subsidence craters in northeastern Yucca Flat, first sampled in 1989, were resampled in 1992. To date, a total of 27 BECAMP ecology monitoring sites have been established on the NTS with many of the sites containing adjacent control plots.

Monitoring of feral horses continued in 1992 for the third consecutive year. Horse counts were made throughout the summer, one day a month, in regions around springs and well reservoirs, which resulted in a confident estimate of the feral horse population on the NTS. In addition, field observations were made of raptors, mule deer, and raven on the NTS. Desert tortoises in the Rock Valley/University of California, Los Angeles, study enclosures were surveyed twice in 1992.

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.

DOE/NV provides the facilities, security, and technical support, but all costs are borne by the organization conducting the tests. In 1992 54 tests were conducted involving chlorine, ammonia, chlorosulfonic acid, and oleum. 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. Based on wind direction and speed, the boundary monitor was instructed to collect samples at the time of projected maximum concentration. Samples were collected with a hand-operated Dräger pump and sampling tube appropriate for the chemical being tested. These results are reported in Section 7.1.6. 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 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 by use of two-way radio 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 31 air pollution, 8 wastewater, and 3 local hazardous waste generator permits, effluent monitoring was limited to wastewater discharges (see below) at 4 sites. Four other wastewater permits did not include effluent monitoring as a requirement. Reports on the quantities of hazardous materials used in production or disposed of were required by some of the various permits, but these quantities were gleaned from internal records on operating times or use rate, not from any specific routine monitoring effort. 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:

- EG&G/EM, LVAO, North Las Vegas Facility, was required to collect composite samples twice a year from the printed circuit board plating shop effluent and the anodizing shop effluent. Analysis for pH, cyanide, metals and total toxic organics was made on each sample. A biannual monitoring report was submitted to the City of North Las Vegas.

- EG&G/EM, WCO was required to collect grab samples semi-annually of the effluent from sinks used for cleaning parts. Analysis for pH was made on each sample and reported to the Massachusetts Water Resources Authority.

- EG&G/EM, LVAO, Remote Sensing Laboratory, was required to collect a composite sample twice a year from the photo laboratory effluent. Analysis for pH and silver was made on each sample. A biannual monitoring report was submitted to the Clark County Sanitation District.

- EG&G/EM, KO was required to collect a composite sample twice a year from the Alodining Shop effluent. Analysis for pH, chromium and cyanide was made on each sample. A biannual monitoring report was submitted to the City of Albuquerque.

4.3 ENVIRONMENTAL PERMITS

Elizabeth C. Calman, H. Bruce Gillen and Scott A. Wade

NTS environmental permits issued during 1992 by the state of Nevada included 41 active air quality permits involving emissions from construction operation facilities, boilers, storage tanks, and open burning; five active permits for onsite drinking water distribution systems; four permits for sewage discharges to lagoon collection systems; an N-Tunnel water pollution control permit; a temporary water pollution control permit for Area 12 steam cleaning operations; and endangered species and wildlife scientific collection permits. New revisions to the RCRA Part A and Part B permit applications were submitted to the state of Nevada in 1992.

Non-NTS EG&G/EM permits included 31 air pollution control permits and 8 sewage discharge permits. 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 4.6 is a listing of state of Nevada air quality operating permits renewed in 1992.

For OP 92-19, 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 1992 three open burns of explosives-contaminated debris in Area 27 were reported for this permit. As the Part A and B RCRA permit applications did not include burning of explosives in Area 27, to comply with a November 8, 1992 deadline for termination of interim status activities under 40 CFR 270, these burning activities were transferred to the Area 11 Explosive Ordnance Disposal (EOD) Area prior to November 8, 1992. The Area 11 EOD is included within the Part A and B application.

For OP 92-12, the Air Quality Officer must be notified by telephone at least two working days in advance of each training exercise for Class A flammables, and a written summary of each exercise must be submitted within 15 days following the exercise. This summary must include the date, time, duration, exact location, and amount of flammables burned. During 1992 twenty-eight burns were conducted for radiological emergency response training. No training burns were conducted by onsite fire protection services. Two controlled burns for Class A flammables were also held in 1992. A summary of all burns was included in an annual report submitted to the state in October 1992.

New permits to construct were issue by the state of Nevada in 1992 for the Area 3 Two-Part Epoxy (TPE) Batch Plant, and for the mud plants located in Areas 3 and 20. Permits to construct were also issued due to modifications of permits for the Area 3 Stemming System and the Area 12 Batch Plant. Table 4.7 is a listing of all air quality permits active in 1992. The expiration date indicated in Table 4.7 for air quality permits to construct, identified with the

Table 4.6 Nevada Air Quality Operating Permits Renewed in 1992

Location	Permit	Replaces	Expiration Date
Area 1, Aggregate Plant	OP 2428	OP 1287	02/12/97
Area 27, Open Burning	OP 92-19	OP 91-20	11/08/92
Area 3, Portable Stemming	PC 3061	OP 2279	Varies
Area 12, Batch Plant	PC 3060	OP 1977	Varies
All Areas, NTS	OP 93-16	OP 91-12	02/25/94

Table 4.7 NTS Active Air Quality Permits - 1992

Permit No.	Facility or Operation	Expiration Date
OP 92-19[(a)]	Open burning, Area 27	11/08/92
OP 93-16[(a)]	Open burning fire rescue	02/25/94
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[(a)]	Aggregate Plant	02/12/97
OP 2625[(a)]	LGFSTF	11/02/97
OP 1583	Cafeteria boiler, Ajax boiler	03/23/93
OP 1584	Cafeteria boiler, Ajax boiler	03/23/93
OP 1585	Area 12 Cafeteria boiler, Ajax boiler	03/23/93
OP 1591	Surface area disturbances	03/23/93
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 2154	Incinerator	10/01/95
OP 2674[(b)]	Portable Ammonia Refrigeration System	12/14/97

(a) Permits reissued in 1992
(b) New permits issued in 1992

Table 4.7 (NTS Active Air Quality Permits - 1992, cont.)

Permit No.	Facility or Operation	Expiration Date
PC 2706	Portable Destemming System	Cancelled
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	Portable jaw crusher	Varies
PC 2824	Portable screen (C.R.)	Varies
PC 2825	Portable screen (Tel.)	Varies
PC 2826	Portable pugmill	Varies
PC 2894	Portable cement bins, Area 6	12/05/92
PC 2895	Temporary portable bins	Cancelled
PC 3060[(a)]	Concrete Batch Plant	Varies
PC 3061[(a)]	Portable stemming facility, Area 3	Varies
PC 3246	Area 3 Mud Plant	Varies
PC 3247	Area 20 Portable Mud Plant	Varies
PC 3248	Area 3 Portable Mud Plant	Varies
PC 2988	Area 3 Two-Part Epoxy Batch Plant	Varies

(a) Permits reissued in 1992
(b) New permits issued in 1992

prefix PC, is identified as "varies" as a permit to construct is generally valid until the time the state performs an inspection and an operating permit is issued.

4.3.1.2 NON-NTS AIR QUALITY PERMITS

Twenty-eight air pollution control permits have been issued for emission units at EG&G/EM Las Vegas Area Operations, one permit to operate for a vapor degreaser at the EG&G/EM Special Technologies Laboratory, one permit to operate for three solvent cleaning operations at the EG&G/EM Amador Valley Operations (AVO) and one Plans Approval for a vapor degreaser at Woburn Cathode Ray Tube Operations (WCO). No expiration dates have been issued for the LVAO ,STL and WCO permits. Annual renewal is contingent upon payment of permit fees. No renewal is required for the WCO permit. The AVO permit expires on February 1, 1993. Permits are amended and revised only if the situation changes under which the permit has been issued. For the other non-NTS, EG&G/EM operations, no other permits have been required or the facilities have been exempted. Table 4.8 lists each of the required permits.

4.3.2 DRINKING WATER SYSTEM PERMITS

NTS drinking water permits issued by the state of Nevada as shown in Table 4.9 were renewed with new expiration dates as shown. Permit number NY-4097-12NC was cancelled following direction from the state as water which is used in the associated distribution system

Table 4.8 Active Air Quality Permits, Non-NTS Facilities - 1992

Permit No.	Facility or Operation
Las Vegas Area Operation[(a)]	
A06501	Process Equipment, Metal Sanding - Cyclone, Losee Road, NLV
A06502	Process Equipment, Anodizing, Losee Road, NLV
A06504	Diesel Power Generator, Losee Road, NLV
A06506	Process Equipment, Welding, Losee Road, NLV
A06507	Process Equipment, Spray Painting, Losee Road, NLV
A06509	Process Equipment, PC Board Plating, Losee Road, NLV
A06510	Process Equipment, Material Processing, Losee Road, NLV
A06511	Process Equipment, Chemical Processing, Losee Road, NLV
A06512	Cyclone and Stack, Abrasive Blast Facility, Losee Road, NLV
A38701	Emergency Generator, C-1 Complex, Losee Road, NLV
A38702	Process Equipment, Surface Coating, Paint Spraying Facilities, NLV
A38703	Exhaust, Soldering, Building C-1, Losee Road, NLV
A38704	Exhausts, Photo Processing, Building C-1, Losee Road, NLV
A34801	Fuel Burning Equipment, Boiler, NAFB
A34802	Fuel Burning Equipment, Boiler, NAFB
A34803	Fuel Burning Equipment, Boiler, NAFB
A34804	Fuel Burning Equipment, Water Heater, NAFB
A34805	Fuel Burning Equipment, Water Heater, NAFB
A34806	Emergency Generator, NAFB
A34807	Fume Hood, Battery Charging Equipment, NAFB
A34808	Photochemical Mixing & Photo Processing w/Vents, NAFB
A34809	Process Equipment, Paint Spray Booths, NAFB
A06513	Time Saver Ferrous Sander with Torit Dust Cyclone
A06514	Time Saver Aluminum Sander with Torit Dust Cyclone
A06515	Katolight and Kohler Diesel Standby Generators
A06516	Emergency Fire Control Equipment, Cummins Diesel Engine
A06517	Trinco Dry Blast with Dust Filters
A34810	Emergency Fire Control Equipment, Cummins Diesel Engine
Special Technologies Laboratory[(a)]	
8477	Permit to Operate a 12 Gallon Capacity Vapor Degreaser
Amador Valley Operations	
7136	Permit to Operate three small solvent cleaning tanks
Woburn Cathode Ray Tube Operations[(a)]	
MBR-88-IND-188	Approval of plans to install a vapor degreaser

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

Table 4.9 NTS Drinking Water Supply System Permits - 1992

Permit No.	Area(s)	Expiration Date
NY-5024-12NC	Area 1	09/30/93
NY-4099-12C	Area 2 & 12	09/30/93
NY-360-12C	Area 23	09/30/93
NY-4098-12NC	Area 25	09/30/93
NY-5000-12NC	Area 6	09/30/93
NY-4097-12NC	Cancelled	

is provided by water haulage trucks instead of a water well. No drinking water systems were maintained by any non-NTS facility.

4.3.3 SEWAGE DISCHARGE PERMITS

Sewage discharge permits from the state of Nevada, Division of Environmental Protection (NDEP), are listed in Table 4.10 and require submission of quarterly discharge monitoring reports. Eight permits, listed in Table 4.11, were required for EG&G/EM non-NTS operations. Three of the eight permits required influent monitoring during 1992.

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, 1992 and are listed in Table 4.12.

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, one at the Amador Valley Operations facility, one at the Kirtland Operations, two at the Santa Barbara Operations facility, one at the Special Technologies Laboratory, and one at the Woburn Cathode Ray Tube Operations facility. These are listed in Table 4.11. 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 at the NTS. This permit became effective on November 12, 1992, and expires on the same date in 1994. The permit specifies pond monitoring and management requirements.

4.3.5 180-DAY TEMPORARY WATER POLLUTION CONTROL PERMIT FOR THE AREA 12 STEAM CLEANING FACILITY

On July 14, 1992, the NDEP issued 180-day temporary water pollution control permit for the discharge from the Area 12 Fleet Operations steam cleaning facility. The permit became effective on July 15, 1992, and expired on January 11, 1993. This permit allowed continued discharge from the facility under certain conditions and monitoring requirements. In August 1992 steam cleaning operations at this facility ceased. A closed loop steam cleaning replacement system was to be in place by the expiration date of the permit. However, the construction of the replacement system was indefinitely postponed at this facility as a result of programmatic changes at the NTS.

4.3.6 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. Monthly measurements of temperature, flow and pH will be required.

Table 4.10 NTS Sewage Discharge Permits - 1992

Permit No.	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)	03/31/93
NEV87059	Area 12	02/28/94

Table 4.11 Non-NTS Sewage Discharge Permits - 1992

Permit No./Location	Date Issued	Expiration Date
Las Vegas Area Operations		
CCSD-032/Remote Sensing Laboratory	10/26/89	12/23/93
CLV-9/North Las Vegas Facility[(a)]	10/01/92	10/01/93
Amador Valley Operations		
3672-101/Pleasanton, California	10/01/91	09/30/93
Santa Barbara Operations		
II-202/Goleta, California	01/01/92	12/31/92
III-330/Goleta, California	01/01/92	12/31/95
Special Technologies Laboratory		
II-225/Santa Barbara, California	01/01/92	12/31/95
Woburn Cathode Ray[(a)] Tube Operations		
43 005 732-0	11/20/92	12/15/96
Kirtland Operations		
2175A-R/Craddock Facility	10/15/91	09/01/94

(a) Effluent monitoring required by permittee

Table 4.12 NTS Septic Waste Hauling Trucks

Permit Number	Vehicle Identification Number	Expiration Date
NY-17-03310	Septic Tank Pumper E-104866	11/30/93
NY-17-03311	Septic Tank Pumper E-104573	11/30/93
NY-17-03312	Septic Tank Pumper E-104296	11/30/93
NY-17-03313	Septic Tank Pumper E-105293	11/30/93
NY-17-03314	Septic Tank Pumper E-105299	11/30/93
NY-17-03315	Septic Tank Pumper E-105919	11/30/93
NY-17-03317	Septic Tank Pumper E-105918	11/30/93
NY-17-03318	Septic Tank Pumping Subcontractor Vehicle	11/30/93

4.3.7 RCRA PERMITS

4.3.7.1 NTS OPERATIONS

Hazardous waste generation activities at the NTS continue to be performed under EPA ID Number NV3890090001. Part A and Part B RCRA permit applications have been submitted to the state of Nevada for the following NTS operations: Pit 3 in the Area 5 Radioactive Waste Management Site (RWMS), Mixed Waste Disposal Cells in Area 5 RWMS, the Area 5 Hazardous Waste Accumulation Site, the Transuranic Waste Storage pad in Area 5 RWMS, and the Area 11 Explosive Ordnance Disposal Area (see Section 3.5.1.1).

4.3.7.2 NON-NTS FACILITIES

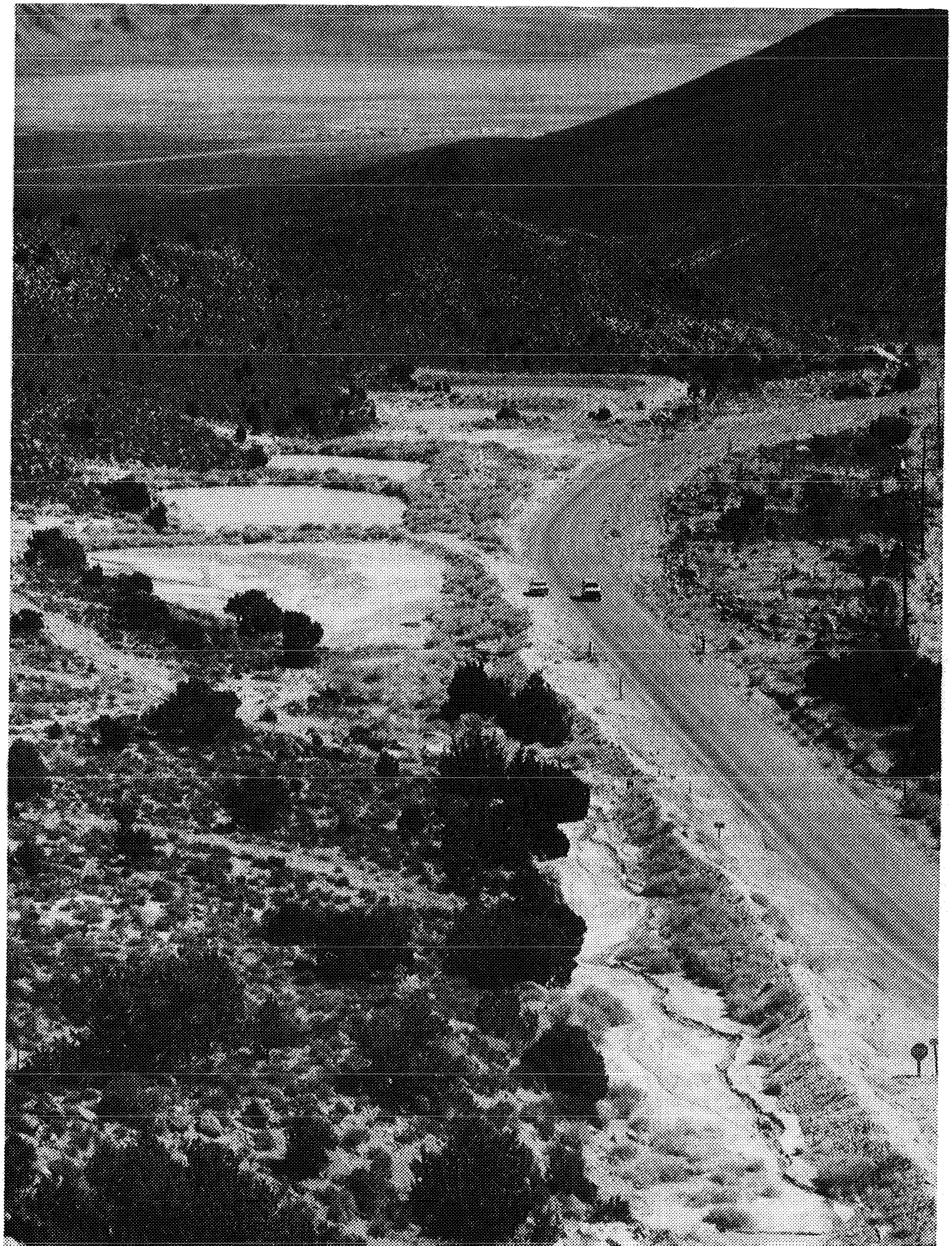
Nine EPA Generator ID numbers have been issued to seven EG&G/EM operations. In addition, three local permits were required at two EG&G/EM operations. Hazardous waste is managed at these locations using satellite accumulation areas and a 90-day or longer waste accumulation area. All hazardous and industrial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

4.3.8 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 number PRT-744522 issued by the U.S. Fish and Wildlife Service to REECo in 1990. This permit expires on December 31, 1994.

The state of Nevada Department of Wildlife issued a scientific collection permit, number S-6409, in 1992 for the collection and study of various species at the NTS. This permit expires on June 30, 1993.



5.0 RADIOLOGICAL MONITORING RESULTS

Radiological environmental monitoring results from onsite environmental programs included (1) effluent sampling results for airborne emissions and liquid discharges to containment ponds and (2) environmental sampling and study results for onsite surveillance conducted by Reynolds Electrical & Engineering Co., Inc., (REECo). Offsite surveillance was conducted by the EPA 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 short-term emissions over a period of hours or days, and radioactive liquid discharges to onsite containment ponds, produced concentrations that were only a small fraction of a percent 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

Fred D. Ferate

Monitoring efforts for potential airborne radioactive effluents at the NTS consisted primarily of intensive air sampling and radiation detection through instrumentation deployed in the vicinity of nuclear tests during and following the tests. This instrumentation showed no prompt release of radioactivity occurred after any of the six announced tests in 1992. Subsequent gas seepages occurred as a result of post-test operations. These occurred during three post-test operations, and resulted in releases of approximately 1.3 Ci of gaseous radioactivity. In addition, experiments performed in the chimney region of a tunnel test conducted in 1991 resulted in the release of approximately 3.4 Ci of gaseous radioactivity during 1992. Air samples collected in and around the Area 5 Radioactive Waste Management Site (RWMS) indicated that no measurable radioactivity was detectable away from the area, yet trace amounts of tritium were detected at its boundary. Samples near the Area 3 Bulk Waste Management Facility (BWMF), showed above-background levels of $^{239+240}Pu$. Measured ^{85}Kr levels on Pahute Mesa were found to be about 4 pCi/m^3 higher than the NTS average, due to atmospheric pumping 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 2.5×10^{-3} Ci of $^{239+240}Pu$, 0.6 Ci of ^3H and 280 Ci of ^{85}Kr were estimated for airborne emissions from

Area 3, from the Area 5 RWMS, and from Pahute Mesa, respectively. The primary liquid effluents were Rainier Mesa tunnel seepage water collected in containment ponds at the tunnel mouths. Influent to these ponds essentially contained only tritium (^{3}H), with a total tunnel discharge of 2200 Ci.

5.1.1 EFFLUENT MONITORING PLAN

As required by DOE Order 5400.1, the NTS Environmental Monitoring Plan (DOE/NV/10630-28,1991) was reviewed and updated in 1992. An important part of the Plan 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 0.1 mrem/year. In accordance with the National Emission Standards for Hazardous Air Pollutants (NESHAP) requirements set forth in 40 CFR 61.93(b)(4)(ii), and Regulatory Guide DOE/EH-0173T, compliance with these requirements will be 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 continued with changes to be introduced as conditions warrant.

To meet 40 CFR 61 requirements, an isokinetic sampling system was installed in September 1991 near the entrance to P Tunnel in Area 12, for the purpose of making periodic confirmatory measurements of airborne effluents from the P Tunnel ventilation duct. With occasional gaps because of repairs, equipment exchanges, and shutdowns of airflow in the ventilation duct, this system was in operation during 1992. More details are given in Section 5.1.2.2 of this report.

5.1.2 AIRBORNE EFFLUENTS

The majority of radioactive air effluents at the NTS in 1992 originated from underground nuclear explosive tests conducted by NTS user organizations; the Lawrence Livermore National Laboratory (LLNL), Los Alamos National Laboratory (LANL), and Defense Nuclear Agency (DNA) of the Department of Defense (DOD). (See Table 5.1 for a listing of all onsite effluent releases.) Each user organization performed effluent monitoring at the time of detonation that continued until all activities were completed. Upon request, REECo performed radioactive noble gas monitoring at Rainier and Pahute Mesas. This involved deployment of one or more noble gas samplers near surface ground zeros (SGZs) to monitor possible release of radioactive gases. Considering all radionuclides detected, approximately 6 curies were identifiable as airborne effluents released in 1992, from tests conducted during 1991 and 1992. In addition, based on environmental surveillance data, it was calculated that diffuse emissions contributed 0.0025 Ci of $^{239+240}Pu$ from Area 3, 0.6 Ci of ^{3}H from Area 5, and 280 Ci of ^{85}Kr from Pahute Mesa to the monitored effluents.

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

Table 5.1 NTS Radionuclide Emissions - 1992

Airborne Effluent Releases

Event or Facility Name (Airborne Releases)	Curies[a]									
	^{3}H[b]	^{37}Ar	^{39}Ar	^{85}Kr	^{127}Xe	^{129m}Xe	^{131m}Xe	^{133}Xe	^{131}I	$^{239+240}Pu$
Area 3, DIVIDER								1.1×10^{-1}		
Area 3[c]										2.5×10^{-3}
Area 5, RWMS[c]	6×10^{-1}									
Area 6[d]									1.3×10^{-5}	
Area 12, N Tunnel	4.9×10^{-2}	7.9×10^{-1}	8.1×10^{-5}	1.3×10^{-2}	5.7×10^{-6}	2.4×10^{-5}	1.5×10^{-2}	3.9×10^{-2}		
Area 12, P Tunnel	3.6×10^{-1}	2.1×10^{-0}		1.3×10^{-0}				2.4×10^{-1}	6.0×10^{-6}	
Areas 19 and 20, Pahute Mesa[c]				$2.8 \times 10^{+2}$						
TOTAL	1.0×10^{-0}	2.9×10^{-0}	8.1×10^{-5}	$2.8 \times 10^{+2}$	5.7×10^{-6}	2.4×10^{-5}	1.5×10^{-2}	3.9×10^{-1}	1.9×10^{-5}	2.5×10^{-3}

Liquid Effluent Releases

Containment Ponds	Curies[a]					
	Gross Beta	^{3}H	^{90}Sr	^{137}Cs	^{238}Pu	$^{239+240}Pu$
Area 6, Decontamination Pad Pond	9.9×10^{-5}	4.8×10^{-3}	3.2×10^{-6}			1.8×10^{-7}
Area 12, E Tunnel	2.1×10^{-3}	6.7×10^{1}	2.4×10^{-4}	1.7×10^{-4}	2.2×10^{-5}	2.1×10^{-4}
Area 12, N Tunnel	4.7×10^{-4}	2.6×10^{1}				1.2×10^{-6}
Area 12, T Tunnel	2.9×10^{-2}	2.2×10^{3}	4.0×10^{-4}	1.1×10^{-2}		6.7×10^{-5}
TOTAL	3.2×10^{-2}	2.2×10^{3}	6.4×10^{-4}	1.1×10^{-2}	2.2×10^{-5}	2.8×10^{-4}

(a) Multiply by 3.7×10^{10} to obtain Bq. Calculated releases of transuranics from laboratory losses are shown in Table 1.1.
(b) Total includes 4.9×10^{-2} Ci of molecular HT from Hunter's Trophy. Remainder is in the form of tritiated water vapor, primarily HTO.
(c) Calculated from air sampler data.
(d) Assumes all radioactivity on Anti-C clothing is ^{131}I and all becomes airborne during drying.

guide DOE/EH-0173T, as well as from EPA requirements in the National Emission Standards for Hazardous Air Pollutants, 40 CFR 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, and updated in October 1992.

5.1.2.1 NUCLEAR EVENT MONITORING

This section is a summary of the specific nuclear event monitoring conducted at the NTS prior to and after each event, as well as routine effluent monitoring on the NTS. The various events, by name, and the results of measurements taken at each event site are presented in Table 5.2. This section also discusses other NTS facilities which are monitored for effluents on a routine basis.

Air emissions from nuclear testing operations consisted primarily of radioactive noble gases and ^{3}H released during post-test drill-back, mine-back, or sampling operations following three 1992 underground nuclear tests, and from continued experiments in the chimney of a tunnel test conducted in 1991. None of the tests resulted in a prompt release or venting (i.e., a release of radioactive materials within 60 minutes of the nuclear test). Air emissions were monitored for source characterization and operational safety as well as environmental monitoring purposes.

Onsite radiological safety support, including monitoring for effluents (air emissions), was provided during the six announced nuclear tests conducted at the NTS in 1992 by NTS user organizations (LANL, LLNL, and DNA).

The test-associated services included detecting, recording, evaluating, and reporting of radiological conditions prior to, during, and for an extended period after each test and provision of aerial monitoring teams during each test to detect airborne releases. Personnel equipped with specialized collection and measurement instruments were prepared to respond rapidly should an accidental release of airborne radioactive materials have occurred from the underground test.

Complete radiological safety coverage was also provided during post-event drillback (for vertical shaft testing) and mineback (for tunnel testing) operations. These activities involved either drilling or mining into the vicinity of the nuclear detonation to acquire samples of test-associated material. These operations bore a potential for releasing radioactive gases to the atmosphere. Seepage of these gases to the surface might also have occurred. Methods of data accumulation included recording telemetered radiation measurements from the test area, air sampling, worker bioassays, and, if warranted, whole-body counting.

The radiation detection array surrounding a SGZ was positioned to provide the first telemetered data if venting were to have occurred following detonation of a nuclear device. A typical array for a vertical shaft event is shown in Figure 5.1. Each gamma-sensitive ion-chamber detector was linked by microwave and hard-wire communications to a console in one of two buildings at the NTS Control Point and/or the Control and Data Acquisition Center. The console also displayed information from each of the permanent telemetered remote area monitor (RAM) arrays. The levels were displayed on each console and the time of the measurement, in minutes after zero time (detonation), were recorded and displayed. Following each test, when control of the test area was released by the DOE Test Controller,

Table 5.2 Nuclear Event Release Summary - 1992

Announced 1992 Nuclear Events - Nevada Test Site

Event Name	Test Org.	Hole/ Area No.	Location	Date/ Time of Event	Prompt Release?	Telemetry Measurement Start	Telemetry Measurement Stop	Initial Radiation Survey Began	Initial Radiation Survey Ended	Maximum Exposure Rate	Release Information
JUNCTION	LANL	U19bg Area 19	Pahute Mesa	03/26/92 0830 hrs	No	03/26/92 0830 hrs	03/27/92 0830 hrs	03/26/92 1029 hrs	03/26/92 1108 hrs	0.05 mR/h	None detected
DIAMOND FORTUNE	DNA	U12p.05 Area 12	Rainier Mesa	04/30/92 0930 hrs	No	04/30/92 0930 hrs	05/11/92 1400 hrs	04/30/92 1109 hrs	04/30/92 1143 hrs	0.05 mR/h	Release included 0.242 Ci Xe-133 and 6.05 µCi ^{131}I (5/4/92 to 7/2/92) from low level seepage until cavity gases were transferred to DISTANT ZENITH chimney
VICTORIA	LANL	U3kv Area 3	Yucca Basin	06/19/92 0945 hrs	No	06/19/92 0945 hrs	06/24/92 1500 hrs	06/19/92 1014 hrs	06/19/92 1040 hrs	0.05 mR/h	None detected
GALENA	LLNL	U9cv Area 9	Yucca Basin	06/23/92 0800 hrs	No	06/23/92 0800 hrs	06/24/92 2200 hrs	06/23/92 0914 hrs	06/23/92 0923 hrs	0.05 mR/h	None detected
HUNTERS TROPHY	DNA	U12n.24 Area 12	Rainier Mesa	09/18/92 1000 hrs	No	09/18/92 1001 hrs	09/22/92 1300 hrs	09/18/92 1116 hrs	09/18/92 1151 hrs	3.0 mR/h	Release of 0.9 Ci of noble gases and tritium (11/18/92 to 1/5/93) from diagnostic studies
DIVIDER	LANL	U3ml Area 3	Yucca Basin	09/23/92 0804 hrs	No	09/23/92 0804 hrs	09/24/92 0941 hrs	09/23/92 0856 hrs	09/23/92 0915 hrs	0.05 mR/h	Release of 0.11 Ci ^{133}Xe on 10/14/92 during post shot operations
DISTANT ZENITH	DNA	U12p.04 Area 12	Rainier Mesa	09/19/91 0930 hrs	No	1992 releases associated with ventilation of LOS pipe and drilling in the Chimney region and included: 1.33 Ci ^{85}Kr, 2.07 Ci ^{37}Ar, and 0.1 µCi ^{39}Ar					

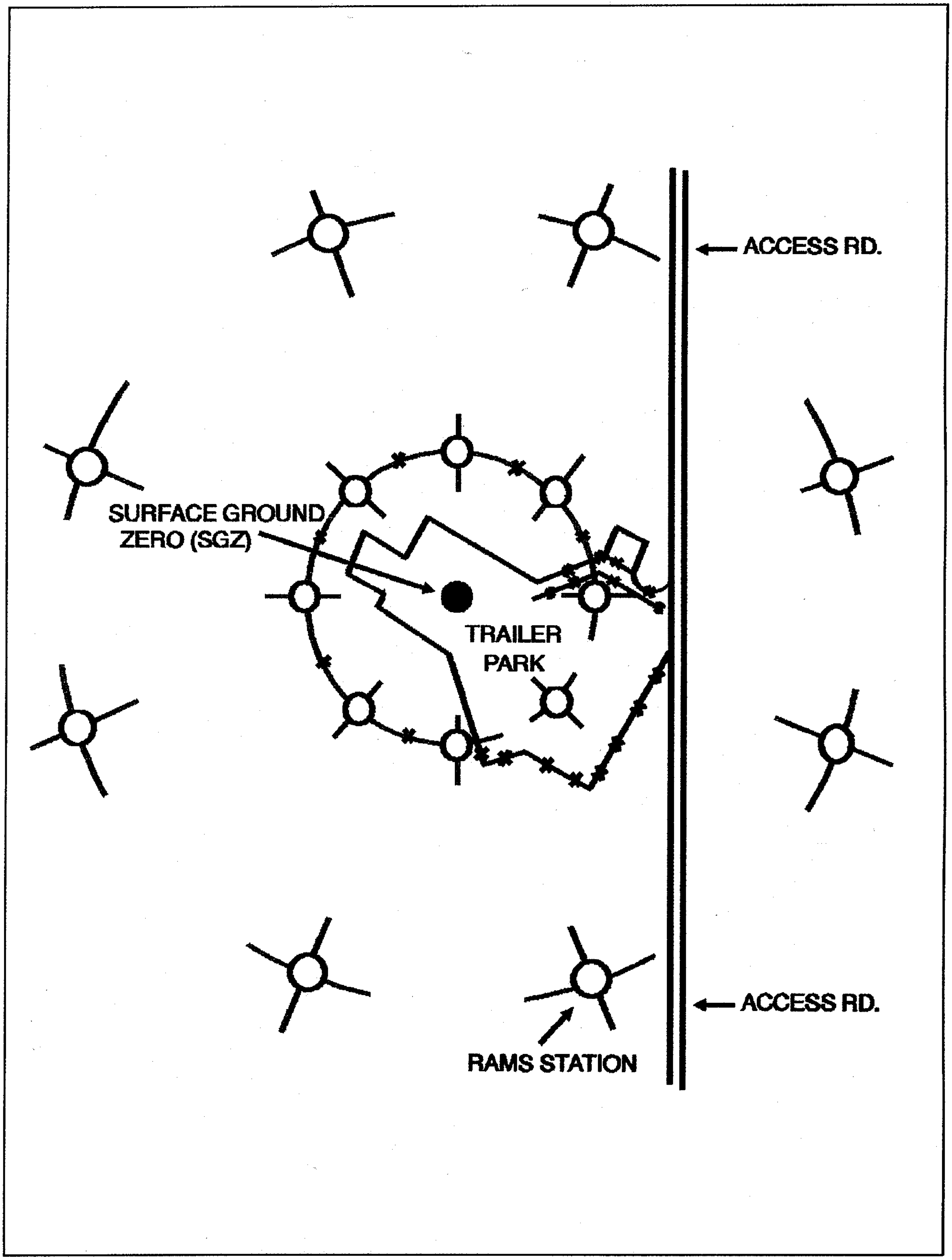


Figure 5.1 Typical RAM Array for a Nuclear Test. *The stations on the inner arc are at a radius of 320 feet from SGZ; the outer arc stations are at 1000 feet from SGZ*

REECo personnel accompanied the Test Group Director's inspection party entering the potential radiological exclusion area to perform initial surveys. Radiation measurements, obtained using portable detection instruments, plus measurements of time and location were recorded on survey forms and the information reported by radio. Survey locations were determined from roadside numbered reference stakes and road junctions. Maps showing the locations of these reference stakes in relation to roads and landmarks were provided to participating test groups. Radiation exposure rates obtained with portable instruments usually were made at waist-high level (approximately one meter above the ground). During the post-event drillback and mining activities, REECo personnel maintained continuous environmental surveillance in the work area. For drillback coverage, radiation detector probes were placed in strategic locations in the work areas and connected to recorders and alarms to warn of increases in radiation levels. Radiation monitoring personnel using portable instruments periodically checked work area radiation levels and issued protective equipment to, or evacuated, area personnel when necessary. For containment of radioactive material releases to the atmosphere during drillback, LANL utilized a pressurized recirculation system. LLNL used a ventline filter system designed to trap radioactive particulates released from the drill casing. In the ventline system, trapped radioactive material was allowed to decay under controlled conditions. For DNA tunnel operations, the effluent was passed through a charcoal/high-efficiency particulate aerosol (HEPA) filter system before release (with two exceptions, described below). This trapped radioactive material was also allowed to decay under controlled conditions.

In one event (Diamond Fortune) low level seepage started about 3 1/2 hours after zero time, and continued for approximately 2 months until the cavity gases were transferred through a closed pumping system to a chimney from a previous shot. Since the radioactivity had already passed through several hundred feet of rock before reaching the tunnel complex, it was believed that added filtration would not be effective.

In the other case, six probe holes were drilled into the chimney of a 1991 event (Distant Zenith) more than six months after test execution, and because of decay and physical settling of particulates, effluent from the probe holes was not filtered.

NOBLE GAS MONITORING

Portable air samplers were set up in the vicinity of the SGZ for the event in U-19bg conducted on Pahute Mesa during 1992. These air samplers were similar to the samplers used to monitor noble gases as part of the site-wide environmental surveillance program (see Section 5.2.1). The only modification to the sampler was that those sampling units deployed at the event sites could operate for several weeks on battery power. Otherwise the samples were taken and analyzed using the same methods described for the environmental surveillance noble gas samplers.

Two noble gas samplers were deployed, one near a RAM station in the prevailing upwind direction and the other in the prevailing downwind direction from ground zero. This deployment at RAM stations was performed to establish a common reference point with the RAM locations. Predominant wind direction and ease of access were the two main factors used when choosing the appropriate RAM station.

The resulting data for this event are presented in Appendix E, Table E.1. The maximum concentrations of ^{85}Kr and ^{133}Xe measured in samples collected at the locations indicated in this table were less than 6×10^{-5} percent and less than 3×10^{-4} percent, respectively, of the Derived Air Concentration (1×10^{-4} µCi/mL) for these radionuclides. Sampling at this location continued for 4 to 5 weeks following the event to assess any late-time, post-test seepage.

5.1.2.2 TUNNEL COMPLEX EFFLUENT

Despite multiple problems associated with the microprocessor-controlled isokinetic sampling unit which had been installed at P Tunnel Portal in September of 1991, samples were collected through this unit from the P Tunnel ventilation duct during all of 1992, except when the ventilation was turned off, when sampling equipment was being exchanged or tested, or when samples were lost because of sampling equipment malfunction.

Two sampling rakes with five probes each were situated along the diameter of the ventilation duct, perpendicular to the flow of air. Air from one rake was drawn through a particulate filter followed by an activated charcoal filter. Sampler air flow was controlled to assure that the linear air speed within the sampling tube was equal, within a specified tolerance, to the airspeed in the duct. Air from the other rake was drawn through another sampling tube, and some of the air from this tube was drawn through a silica gel column to extract moisture, while a separate portion was stored under pressure in an aluminum tank.

Because of excessive dust loading, the particulate filter was exchanged every eight hours, and a weekly composite was analyzed for gamma radiation and a monthly composite for ^{238}Pu and $^{239+240}Pu$. The charcoal filter was analyzed weekly for gamma radiation. The moisture from the silica gel column was analyzed every two weeks for tritium (HTO), and the compressed air was measured weekly for ^{85}Kr and ^{133}Xe.

Data from these measurements were reported to the Health Physics oversight for tunnel test operations, for use, along with operational monitoring data and process knowledge, in estimating radioactive releases from P Tunnel activities. The estimated releases from P Tunnel during 1992, as well as those for N Tunnel, are listed in Tables 5.1 and 5.2.

5.1.2.3 RADIOACTIVE WASTE MANAGEMENT SITES

Two permanent particulate/halogen samplers were located within the disposal pits at the RWMS in Area 5. The annual average concentration of samples taken within Pits 3 and 4 in Area 5 were 2.1 and 2.0 x 10^{-14} μCi/mL of gross beta activity. The NTS annual average gross beta concentration was 2.0 x 10^{-14} μCi/mL. These results indicate that, except for trace amounts of tritium, the operations in the RWMS are not contributing radiological effluents to the NTS environment. Average annual gross beta and plutonium results from all the samples collected at the RWMS facility are displayed in Figure 5.2.

Nine ^{3}H samplers were located surrounding the RWMS. These samplers are placed near the perimeter berm of the disposal site as seen in Figure 5.3. The annual average ^{3}H concentration for the nine stations was 6.5 x 10^{-6} pCi/mL. This value is less than 0.07 percent of the Derived Concentration Guide for tritiated water vapor in air. The results indicate the waste disposal operations at the RWMS did not contribute significant levels of tritiated water vapor to the NTS environment. The annual average ^{3}H concentrations from the samplers surrounding the RWMS facility are displayed in Figure 5.3.

The results from thermoluminescent dosimeters (TLDs) deployed surrounding the RWMS facility indicated that the gamma exposure rates measured in 1992 were not statistically different from the levels measured in 1991. A discussion of historical trends of environmental gamma exposure as measured by environmental TLDs is given in Volume II, Appendix G.

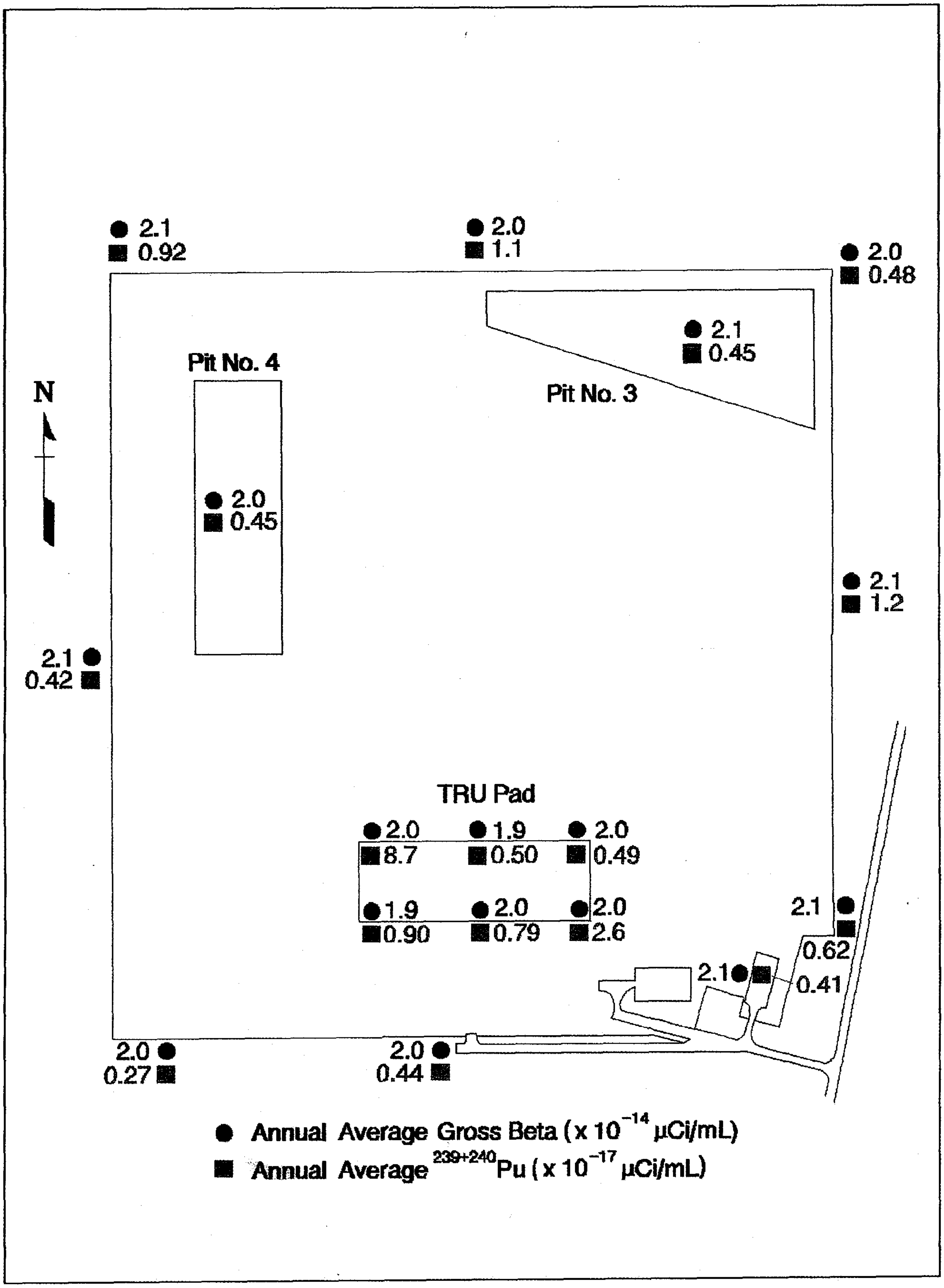


Figure 5.2 RWMS Air Sampling Annual Average Results - 1992

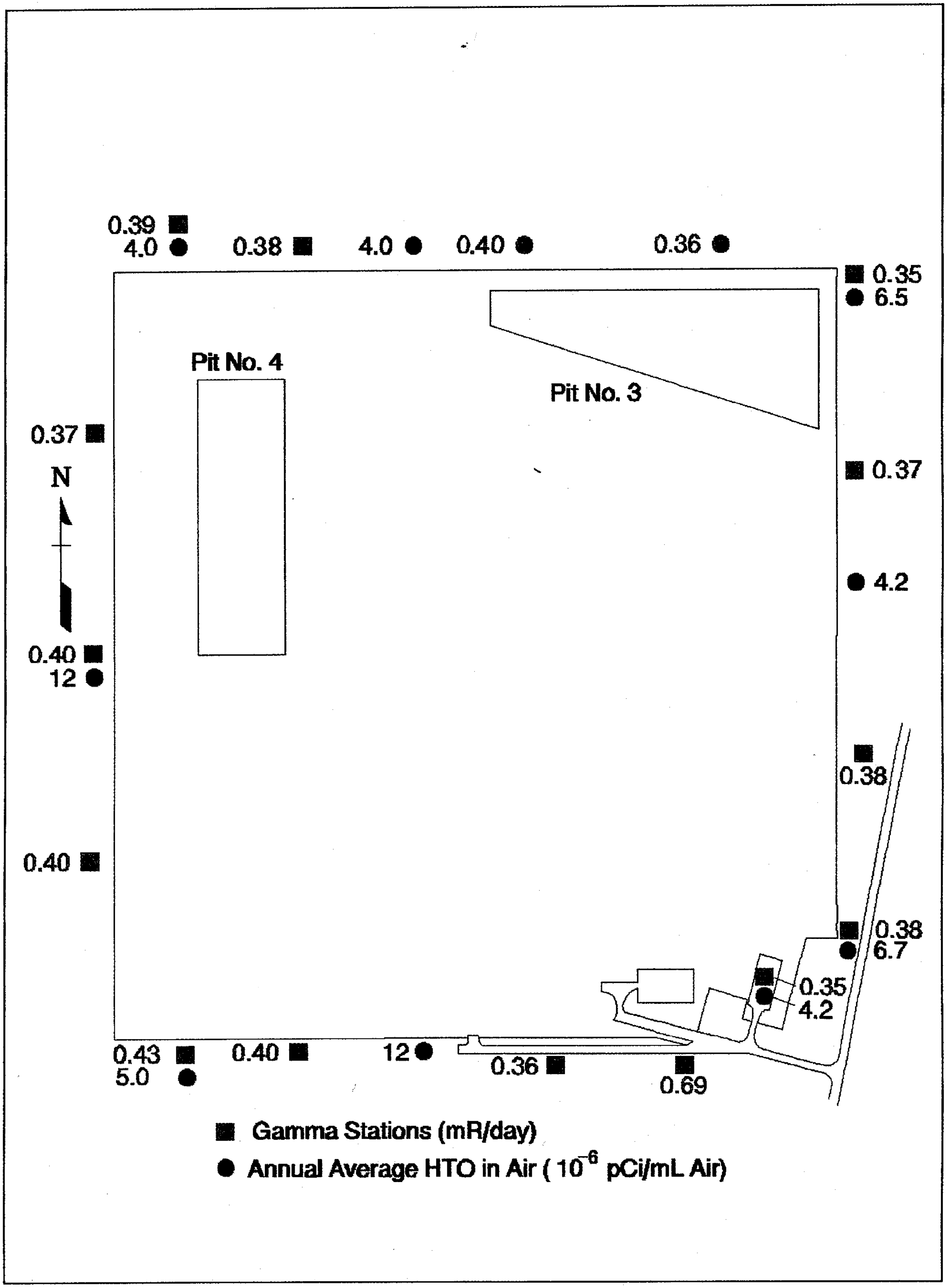


Figure 5.3 RWMS HTO & TLD Annual Average Results - 1992

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 (see Table F.4 in Volume II, Appendix F) shows that the gamma exposure rates detected at the RWMS perimeter are not atypical of gamma measurements taken at other locations on the NTS. The RWMS perimeter exposure rates in mR/day are shown in Figure 5.3. The statistical analysis is presented in Volume II, Appendix F.

The Area 3 Bulk Waste Management Facility (BWMF) is used for disposal of radiologically contaminated waste in packages that are unsuitable for waste disposal in the Area 5 facility. This waste is buried in subsidence craters much like waste is buried at the Area 5 RWMS. The BWMF 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 BWMF and surrounding areas. The gross beta annual average at the BWMF of 1.9×10^{-14} µCi/mL was similar to the 1991 average, and was not statistically different at the five percent significance level from the site-wide average of 2.0×10^{-14} µCi/mL. However, $^{239+240}Pu$ results indicated that levels of these radionuclides in the vicinity of the BWMF were consistently above the NTS average (see Appendix A of Volume II). Vehicular traffic and operational activities in Area 3 apparently resuspend plutonium that was deposited on the soil surface during the early days of nuclear explosives testing. As such, these elevated $^{239+240}Pu$ levels indicated that Area 3 was a diffuse source of effluents. Air sampling results are displayed in Section 5.2.1.2, Tables 5.5 and 5.6, and TLD results are listed and discussed in Appendix F of Volume II.

5.1.3 LIQUID EFFLUENTS

Liquid effluents at the NTS originated from tunnel drainage and cleanup of radiologically contaminated equipment. Typically, all liquid discharges within the NTS were held in containment ponds. Monthly grab samples were taken from each pond and, where possible, from the influent. Radioactive liquid effluents discharged to onsite ponds contained approximately 2200 Ci of ^{3}H during 1992. Radioactivity in liquid discharges released to onsite waste treatment or disposal systems (containment ponds) was monitored to assess the efficacy of treatment and control and provide a quantitative and qualitative annual summary of the radioactivity released onsite.

5.1.3.1 TUNNELS

Rainier Mesa in Area 12 is the location for nuclear tests that are conducted within tunnels by the DOD. As a result of drilling operations and seepage, water discharged from these tunnels was collected in containment ponds. This water was usually contaminated with radionuclides, mainly ^{3}H, generated during nuclear tests.

Liquid effluents were discharged during 1992 from three tunnels: N, T, and E. A monthly grab sample was taken from each containment pond and from the tunnel discharge. Monitoring results indicated that the water discharged from these tunnels contained measurable quantities of ^{3}H and fission products. Total quantities of ^{3}H, ^{238}Pu, $^{239+240}Pu$, and beta activity were determined for each liquid effluent source and are listed in Table 5.1.

The primary source of liquid discharges was from tunnel seepage. Onsite discharges to containment ponds contained about 2200 Ci of ^{3}H. No liquid effluents were discharged offsite. Discharges of other radionuclides totaled less than 20 mCi.

During 1992 an estimated 4.2 x 10^7 L of water were discharged into the T Tunnel containment ponds. Sampling results from the tunnel effluent pipe indicated an annual average of 5.5 x 10^4 pCi/mL (2 x 10^6 Bq/L) of ^{3}H. Therefore, the total quantity of ^{3}H discharged out of the T Tunnel complex was calculated to be 2150 Ci (uncertainty about 10%). Additional ^{3}H effluent data for T Tunnel and other sites discussed in Section 5.1.3 are found in Table 5.3.

At N Tunnel an estimated 7.2 x 10^7 L of water were discharged into the containment ponds. The 1992 average annual concentration of ^{3}H from samples taken at the N Tunnel effluent pipe was 360 pCi/mL (1.3 x 10^4 Bq/L). The gamma emitters were for the most part <MDC. The total ^{3}H discharge from N Tunnel activities for 1992 was calculated to be 26 Ci.

The E Tunnel complex has been inoperative for several years. However, water continued to discharge from the tunnel. The total flow during 1992 was estimated to be 3.3 x 10^7 L. Samples taken from this liquid discharge contained an annual average of 2.1 x 10^3 pCi/mL (7.8 x 10^4 Bq/L) of ^{3}H. The containment ponds for this tunnel were dry during 1992. The total ^{3}H activity discharged from E Tunnel effluents was calculated to be 67 Ci.

5.1.3.2 DECONTAMINATION FACILITY

The Decontamination Facility, located in Area 6, generated contaminated water during equipment decontamination processes which was discharged into a containment pond. Grab samples were taken from this pond on a monthly basis and analyzed for ^{3}H, beta, ^{238}Pu, $^{239+240}$Pu, and gamma activity. No nuclear tests were carried out during the last quarter of 1992 so no radioactivity entered the containment pond attributable to nuclear tests during the fourth quarter. On November 8, 1992, the containment pond was permanently isolated from the Decontamination Facility. Until a new lined containment pond is constructed, any effluent from that Facility will be captured in holding tanks and held for disposal.

During 1992 sampling results from influent to the containment pond at the Decontamination Facility were consistently near or below detection limits and less than DOE Order 5400.5 DCGs for all radionuclides except ^{3}H, as discussed under "Containment Ponds" in Section 5.2.1.5. The annual average of ^{3}H at the Decontamination Facility containment pond was 2.6 pCi/mL (96 Bq/L). The total volume of liquid discharged to the containment pond during 1992 was estimated to be 2.3 x 10^6 L. Therefore, the total discharge of ^{3}H for 1992 was estimated to be 6 x 10^{-3} Ci.

Table 5.3 Tritium in NTS Effluents - 1992

Location	Discharge Volume (L)	Average ^{3}H Concentration (pCi/mL)	Total ^{3}H Discharge (Ci)[a]
T Tunnel	4.2 x 10^7	5.5 x 10^4	2150
N Tunnel	7.3 x 10^7	3.6 x 10^2	26
E Tunnel	3.3 x 10^7	2.1 x 10^3	67
Area 6 Decontamination Facility Pond	2.3 x 10^6	2.6 x 10^0	6.0 x 10^{-3}

(a) Multiply by 3.7 x 10^{10} to obtain Bq.

5.2 RADIOLOGICAL ENVIRONMENTAL SURVEILLANCE

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Onsite surveillance of airborne particulates, noble gases, and tritiated water vapor indicated onsite 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 indicated that the gamma radiation environment within the NTS remained consistent with previous years. All gamma-ray monitoring stations displayed expected results, ranging from the background levels predominant throughout the NTS to the types of exposure rates associated with known contaminated zones and radiological material storage facilities. 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 indicated no NTS-related radioactivity was detected at measurable concentrations at any air sampling station, and there were no apparent net exposures detectable by the offsite internal dosimetry network. Radionuclides were detected in tissues from animals collected both onsite and offsite and in some vegetables collected offsite.

5.2.1 ONSITE ENVIRONMENTAL SURVEILLANCE

The onsite radiological surveillance networks consist of 52 air sampling stations; 10 radioactive noble gas sampling stations; 17 tritiated water vapor sampling stations; surface water samples from 15 open water supply reservoirs, 7 springs, 9 wastewater containment ponds, and 3 sewage lagoons; groundwater samples from 9 potable supply wells, 4 non-potable supply wells and 9 drinking water consumption points; and 187 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.

5.2.1.1 RADIOACTIVITY IN AIR

Fifty-two air sampling stations were operated continuously. 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 gross beta and gamma activity, combined at the end of the month, and then analyzed for ^{238}Pu and $^{239+240}$Pu. The charcoal cartridge was counted for gamma activity each week. The individual gross beta, ^{238}Pu, $^{239+240}$Pu, and gamma sampling results are listed in Volume II, Appendix A, Attachments A.1 through A.4.

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 components of the air, and the radioactive krypton and xenon in the sample were measured. Tritiated water vapor was monitored continuously at 17 locations. Samples were collected every two weeks and analyzed for ^{3}H.

For the purpose of comparing measured quantities of airborne radioactivity to the Derived Air Concentrations (DAC's, the guides for occupational exposures) found in DOE Order 5480.11 and to the Derived Concentration Guide (DCG, the guide 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 DCGs and DACs used herein are listed in Table 5.4.

- 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

During the year there was a change in air sampling locations. Due to the transfer of operations near the Area 3 3-300 Bunker to Area 6, sampling at the Area 3 3-300 Bunker was stopped, and the equipment moved to the Area 6 6-900 Building.

GROSS BETA

Figure 5.4 displays the average NTS gross beta results for 1992 sampling. Sampling results from the RWMS in Area 5 are shown in Figure 5.2. Air particulate samples were held for seven days prior to gross beta counting and gamma spectrum analysis to allow for the decay of radon and radon daughters. Samples collected at Gate 200 in Area 5 were not held for decay of radon daughters prior to gross beta analysis. The results from this station provided a useful indication of any site-wide anomalous concentrations. The statistical evaluation of this analysis is presented in Appendix A in Volume II. Table 5.5 presents the network arithmetic averages, minimums, and maximums for 1992 airborne gross beta sampling results.

The network (all locations excluding Gate 200) annual average gross beta concentration was 2.0×10^{-14} µCi/mL (7.4×10^{-4} Bq/m^3). This concentration is 0.001 percent of the ^{90}Sr DAC listed in DOE Order 5480.11 and 2.2 percent of the DCG noted in DOE Order 5400.5 adjusted to an annual Effective dose Equivalent (EDE) of 10 mrem. The standard deviation of these data was 8.8×10^{-15} µCi/mL (3.3×10^{-4} Bq/m^3). The statistical evaluation of the gross beta concentrations indicated that a lognormal distribution provides an adequate approximation to the true distribution. The network annual geometric mean and geometric standard deviation of the data were 1.8×10^{-14} µCi/mL and 1.6 (6.7×10^{-4} Bq/m^3 and 1.6). All results were above the MDC.

Table 5.4 Derived Limits for Radionuclides in Air and Water

Radionuclide	μCi/mL DAC (air)(a)	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	5×10^{-8}	3×10^{-11}	6×10^{-7}
^{90}Sr	2×10^{-9}	9×10^{-13}	4×10^{-8}
^{133}Xe	1×10^{-4}	5×10^{-8}	-
^{226}Ra	3×10^{-10}	1×10^{-13}	4×10^{-9}
^{238}Pu	7×10^{-12}	4×10^{-15}	2×10^{-9}
$^{239+240}Pu$	6×10^{-12}	4×10^{-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 for a year as required by 40CFR61.92 (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 using ICRP-30 annual limit of intake (ALI).

(d) Nonstochastic value.

PLUTONIUM

Monthly composite samples from each particulate sampling location were analyzed for ^{238}Pu and $^{239+240}Pu$. Figure 5.5 shows the airborne $^{239+240}Pu$ annual average results for each of the sampling locations. Tables 5.6 and 5.7 list the maximum, minimum, annual arithmetic mean, standard deviation, and the mean expressed as a percentage of the DCG for each sampling location, for $^{239+240}Pu$ and ^{238}Pu, respectively. The ranges in the annual mean concentrations for ^{238}Pu and $^{239+240}Pu$ for all stations were -0.084 to 3.3×10^{-17} μCi/mL and 0.17 to 240×10^{-17} μCi/mL (-3.1×10^{-8} to 1.2×10^{-6} and 6.3×10^{-8} to 8.9×10^{-5} Bq/m^3), respectively. The arithmetic mean and standard deviation of ^{238}Pu in air for all stations were -8.0×10^{-18} and 2.4×10^{-16} μCi/mL (-3.0×10^{-7} and 8.9×10^{-6} Bq/m^3), respectively. 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 1.2×10^{-16} and 2.3×10^{-15} μCi/mL (4.4×10^{-6} and 8.5×10^{-5} Bq/m^3), respectively. Because for both analyses many of the measured values were negative after background subtraction, the geometric means and standard deviations were not calculated.

As was the case in 1991, the 1992 maximum annual average (mean) $^{239+240}Pu$ concentration was found at the Area 3, U-3ah/at North sampling location. Results from samples taken at that location averaged 24.0×10^{-16} μCi/mL (9.0×10^{-5} Bq/m^3) during 1992. This quantity was

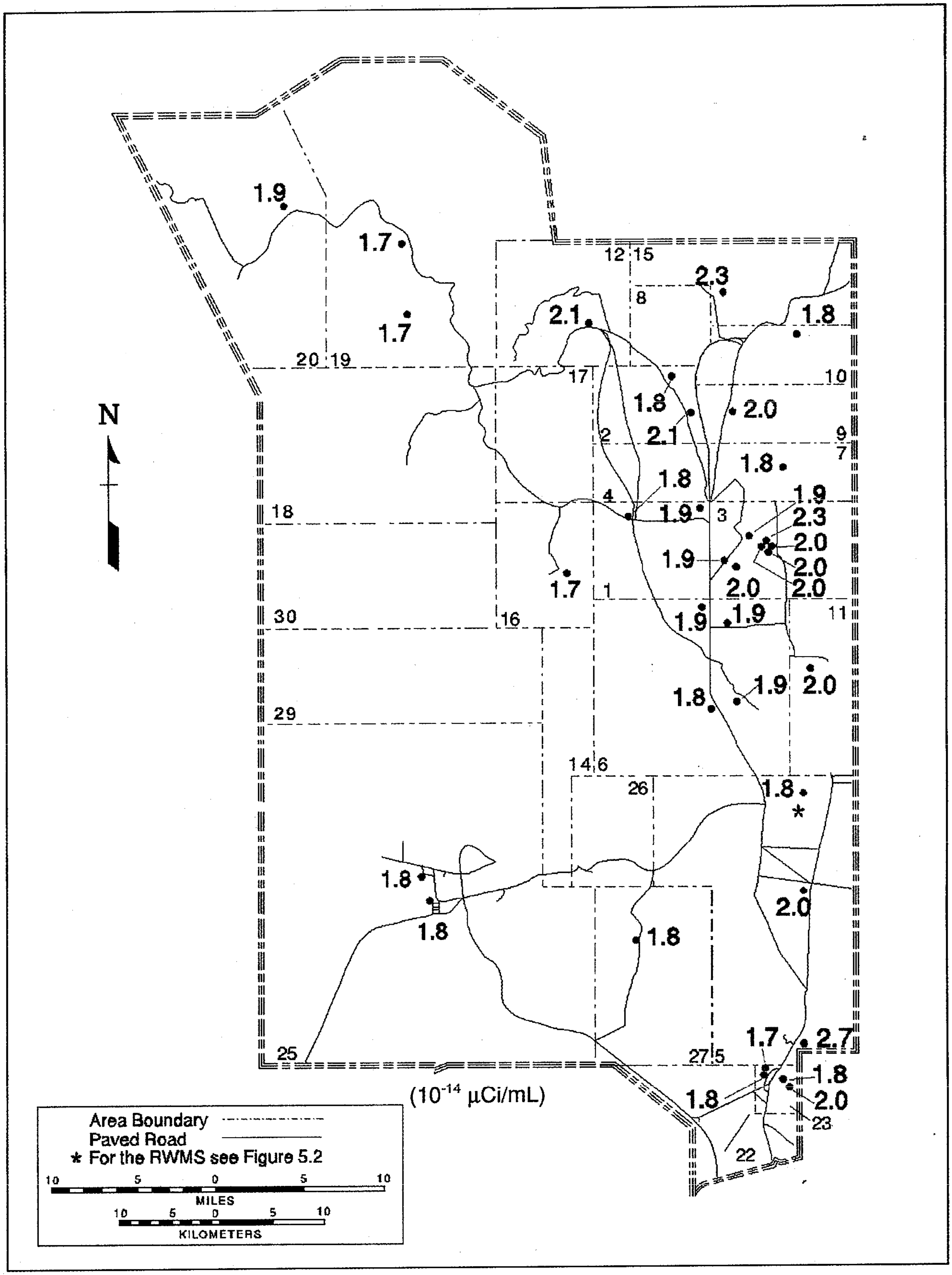

Figure 5.4 NTS Airborne Gross Beta Annual Average Concentrations - 1992

Table 5.5 Airborne Gross Beta Concentrations on the NTS - 1992

	Gross Beta Concentration (10^{-14} μCi/mL)					
Location	Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG
Area 1, BJY	51	4.4	0.11	1.9	0.82	2.1
Area 1, Gravel Pit	50	3.2	0.43	1.8	0.51	1.9
Area 2, 2-1 Substation	51	12	0.41	2.0	1.5	2.3
Area 2, Complex	52	3.6	0.30	1.8	0.51	2.0
Area 3, 3-300 Bunker	4	3.5	1.1	2.4	1.1	2.6
Area 3, Complex	51	4.2	0.55	1.9	0.66	2.1
Area 3, Complex No. 2	52	5.1	0.49	2.0	0.75	2.3
Area 3, Mud Plant	45	4.0	0.045	1.9	0.64	2.1
Area 3, U-3ah/at E	51	4.0	0.85	2.0	0.59	2.2
Area 3, U-3ah/at N	51	8.3	0.97	2.3	1.2	2.6
Area 3, U-3ah/at S	50	4.2	0.52	2.0	0.65	2.2
Area 3, U-3ah/at W	49	3.8	0.68	2.0	0.59	2.3
Area 5, DOD Yard	49	3.9	0.003	1.8	0.64	2.1
Area 5, Gate 200	51	7.6	0.098	2.7	1.7	3.0
Area 5, RWMS No. 1	52	4.0	0.97	2.1	0.65	2.3
Area 5, RWMS No. 2	51	4.2	0.43	2.1	0.75	2.4
Area 5, RWMS No. 3	51	4.1	0.34	2.1	0.71	2.3
Area 5, RWMS No. 4	51	4.0	0.10	2.0	0.78	2.3
Area 5, RWMS No. 5	51	4.1	0.70	2.0	0.65	2.2
Area 5, RWMS No. 6	51	3.7	0.15	2.1	0.63	2.3
Area 5, RWMS No. 7	52	4.2	0.90	2.1	0.63	2.4
Area 5, RWMS No. 8	52	3.9	0.88	2.0	0.66	2.2
Area 5, RWMS No. 9	51	4.0	0.39	2.0	0.63	2.2
Area 5, RWMS Pit No. 3	50	4.1	0.51	2.1	0.74	2.4
Area 5, RWMS Pit No. 4	51	3.8	0.58	2.0	0.61	2.2
Area 5, RWMS TP N	51	3.8	0.25	1.9	0.66	2.1
Area 5, RWMS TP NE	51	3.9	0.33	2.0	0.68	2.2
Area 5, RWMS TP NW	50	4.3	0.52	2.0	0.68	2.2
Area 5, RWMS TP S	52	3.9	0.97	2.0	0.59	2.2
Area 5, RWMS TP SE	51	3.7	0.60	2.0	0.70	2.2
Area 5, RWMS TP SW	52	4.0	0.47	1.9	0.66	2.2
Area 5, Well 5B	44	4.3	0.94	2.0	0.65	2.3
Area 6, Building 6-900	10	3.0	0.96	1.9	0.56	2.1
Area 6, CP-6	51	4.1	0.066	1.8	0.69	2.0
Area 6, Well 3 Complex	52	3.8	0.81	1.9	0.58	2.1
Area 6, Yucca Waste Pond	52	3.8	0.51	1.9	0.63	2.1
Area 7, Ue7ns	51	4.0	0.50	1.8	0.58	2.0
Area 9, 9-300 Bunker	48	4.6	0.60	2.0	0.79	2.2
Area 10, Gate 700	52	3.8	0.11	1.8	0.70	2.0
Area 11, Gate 293	52	3.8	0.91	2.0	0.62	2.2
Area 12, Complex	51	22	0.18	2.1	3.0	2.3
Area 15, EPA Farm	52	15	0.02	2.3	2.0	2.6
Area 16, 3545 Substation	45	3.4	0.60	1.7	0.54	1.9
Area 19, Echo Peak	43	3.4	0.68	1.7	0.47	1.9
Area 19, Pahute Substation	47	3.3	0.47	1.7	0.46	1.9
Area 20, Dispensary	47	3.6	0.47	1.9	0.56	2.1
Area 23, Building 790	51	3.5	0.56	1.8	0.59	2.0
Area 23, Building 790 No. 2	50	3.3	0.044	1.7	0.64	1.9
Area 23, East Boundary	48	4.0	0.60	2.0	0.66	2.2
Area 23, H&S Building	51	3.5	0.26	1.8	0.65	2.0
Area 25, E-MAD North	51	3.8	0.51	1.8	0.67	2.0
Area 25, NRDS Warehouse	51	4.0	0.53	1.8	0.63	2.0
Area 27, Cafeteria	50	3.8	0.026	1.8	0.66	2.0

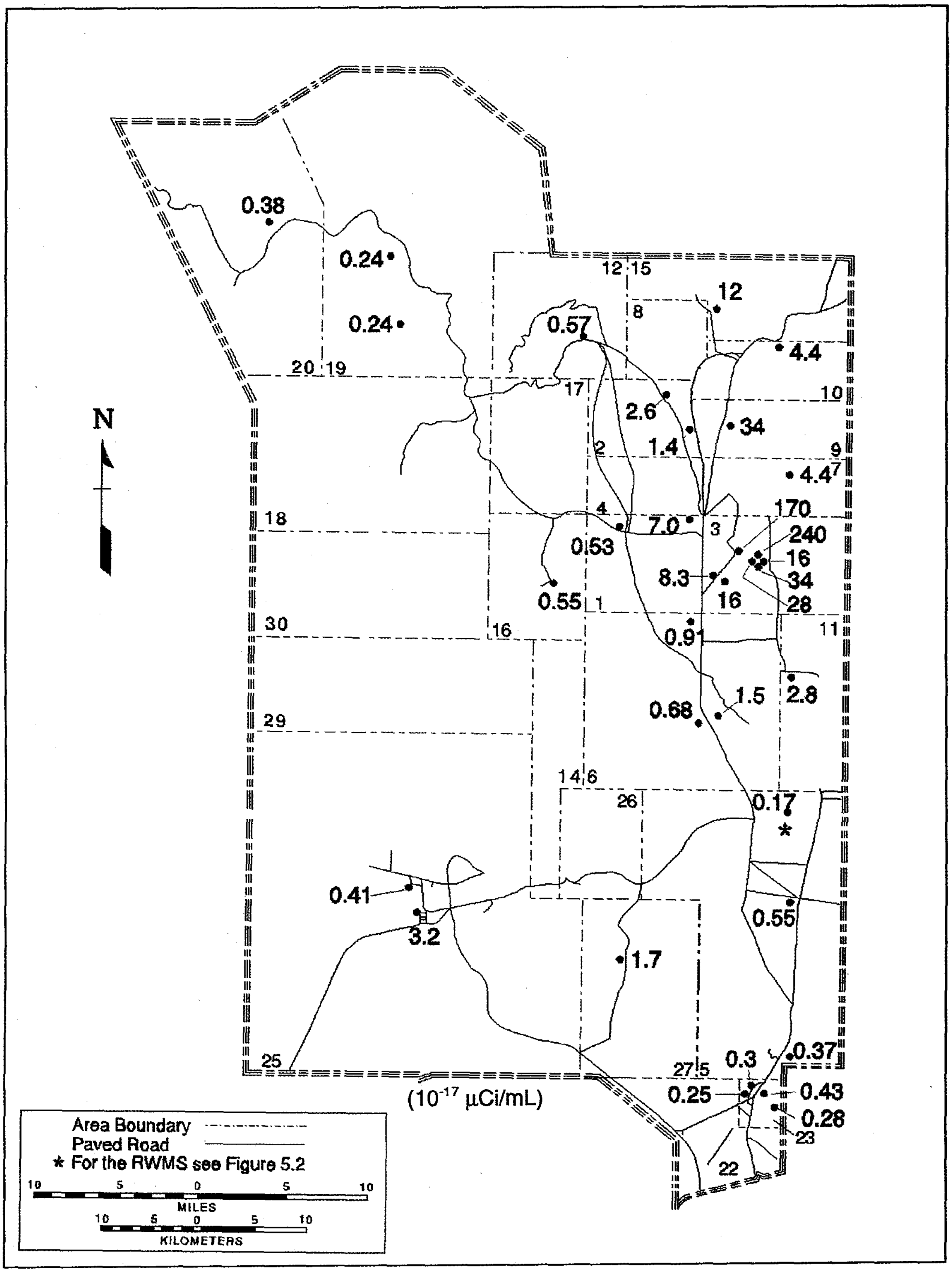

Figure 5.5 NTS Airborne $^{239+240}Pu$ Annual Average Results - 1992

Table 5.6 Airborne $^{239+240}Pu$ Concentrations on the NTS - 1992

		$^{239+240}Pu$ Concentration (10^{-17} µCi/mL)				
Location	Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG
Area 1, BJY	12	27	0.96	7.0	7.6	1.8
Area 1, Gravel	12	2.9	0.0	0.53	0.80	0.2
Area 2, 2-1 Substation	12	4.0	0.0	1.4	1.3	0.4
Area 2, Complex	12	11	0.18	2.6	4.0	0.6
Area 3, Complex	12	58	0.16	8.3	16	2.0
Area 3, Complex No. 2	12	86	1.4	16	23	3.9
Area 3, Mud Plant	11	490	0.0	170	190	42.0
Area 3, U-3ah/at E	11	42	1.6	16	16	4.0
Area 3, U-3ah/at N	11	660	6.1	240	270	60.0
Area 3, U-3ah/at S	11	130	2.4	34	44	8.6
Area 3, U-3ah/at W	11	97	4.8	28	32	7.0
Area 5, DOD Yard	12	0.78	-0.16	0.17	0.26	0.1
Area 5, Gate 200	12	2.2	0.0	0.37	0.61	0.1
Area 5, RWMS No. 1	12	1.1	-0.07	0.41	0.37	0.1
Area 5, RWMS No. 2	12	2.2	0.0	0.62	0.67	0.2
Area 5, RWMS No. 3	12	5.9	0.0	1.2	1.7	0.3
Area 5, RWMS No. 4	12	1.6	0.0	0.48	0.58	0.1
Area 5, RWMS No. 5	12	4.3	0.0	1.1	1.3	0.3
Area 5, RWMS No. 6	12	1.6	-0.13	0.92	1.2	0.2
Area 5, RWMS No. 7	12	2.1	-0.10	0.42	0.63	0.1
Area 5, RWMS No. 8	12	0.73	-0.065	0.27	0.25	0.1
Area 5, RWMS No. 9	12	1.0	0.0	0.44	0.32	0.1
Area 5, RWMS Pit No. 3	12	1.3	-0.12	0.45	0.5	0.1
Area 5, RWMS Pit No. 4	12	1.4	0.0	0.45	0.40	0.1
Area 5, RWMS TP N	12	1.8	-0.096	0.50	0.60	0.1
Area 5, RWMS TP NE	12	2.0	-0.098	0.49	0.64	0.1
Area 5, RWMS TP NW	12	93	0.0	8.7	26	2.2
Area 5, RWMS TP S	12	3.7	0.0	0.79	1.0	0.2
Area 5, RWMS TP SE	12	16	-0.092	2.6	4.7	0.6
Area 5, RWMS TP SW	12	4.4	0.0	0.9	1.2	0.2
Area 5, Well 5B	11	1.8	0.0	0.55	0.51	0.1
Area 6, CP-6	11	2.6	0.10	0.68	0.41	0.2
Area 6, Well 3	12	4.2	0.16	0.91	0.73	0.2
Area 6, Yucca Waste Pond	12	15	0.0	1.5	5.4	0.4
Area 7, Ue7ns	12	39	-0.004	4.4	11	1.1
Area 9, 9-300 Bunker	12	88	2.7	34	25	8.6
Area 10, Gate 700	11	24	0.0	4.4	7.6	1.1
Area 11, Gate 293	12	8.8	0.0	2.8	3.3	0.7
Area 12, Complex	12	3.8	-0.091	0.57	1.0	0.1
Area 15, EPA Farm	12	110	0.032	12	30	3.2
Area 16, 3545 Substation	11	1.9	0.023	0.55	0.55	0.1
Area 19, Echo Peak	11	1.2	0.0	0.24	0.34	0.1
Area 19, Pahute Substation	11	0.89	0.0	0.24	0.26	0.1
Area 20, Dispensary	11	1.9	0.0	0.38	0.51	0.1
Area 23, Building 790	12	0.6	0.0	0.25	0.26	0.1
Area 23, Building 790 No.2	12	0.88	0.0	0.30	0.28	0.1
Area 23, East Boundary	12	1.1	0.0	0.28	0.36	0.1
Area 23, H&S Building	12	2.5	-0.069	0.43	0.73	0.1
Area 25, E-MAD North	12	3.0	0.0	0.41	0.84	0.1
Area 25, NRDS Warehouse	12	35	0.0	3.2	10	0.8
Area 27, Cafeteria	12	16	0.0	1.7	4.4	0.4

Table 5.7 Airborne ^{238}Pu Concentrations on the NTS - 1992

Location	Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG
	^{238}Pu Concentration (10^{-17} µCi/mL)					
Area 1, BJY	12	2.30	-0.18	0.43	0.62	0.11
Area 1, Gravel Pit	12	0.15	-0.99	-0.084	0.30	0.0
Area 2, 2-1 Substation	11	0.16	-0.42	0.0096	0.16	0.002
Area 2, Complex	12	0.63	-0.44	0.086	0.28	0.022
Area 3, Complex	12	1.2	-0.42	0.17	0.41	0.042
Area 3, Complex No. 2	12	1.6	0.0	0.41	0.53	0.10
Area 3, Mud Plant	11	7.8	-3.4	2.0	3.3	0.50
Area 3, U-3ah/at E	11	0.79	-0.43	0.22	0.41	0.055
Area 3, U-3ah/at N	10	8.5	0.0	3.3	3.3	0.82
Area 3, U-3ah/at S	11	1.1	-0.77	0.38	0.47	0.095
Area 3, U-3ah/at W	11	1.5	-1.8	0.22	0.84	0.055
Area 5, DOD Yard	12	0.76	0.0	0.15	0.26	0.038
Area 5, Gate 200	11	0.48	-0.55	0.021	0.24	0.005
Area 5, RWMS No. 1	11	0.27	0.0	0.054	0.098	0.013
Area 5, RWMS No. 2	12	1.4	0.0	0.16	0.4	0.040
Area 5, RWMS No. 3	12	0.70	-1.5	-0.061	0.49	0.0
Area 5, RWMS No. 4	11	0.27	-0.93	-0.048	0.30	0.0
Area 5, RWMS No. 5	12	0.23	-0.73	0.066	0.31	0.016
Area 5, RWMS No. 6	12	1.6	-1.0	0.079	0.57	0.020
Area 5, RWMS No. 7	12	2.2	-0.51	0.21	0.68	0.052
Area 5, RWMS No. 8	12	1.4	-1.1	0.023	0.56	0.006
Area 5, RWMS No. 9	12	0.41	-0.86	0.0062	0.31	0.002
Area 5, RWMS Pit No. 3	11	0.23	-1.4	-0.072	0.46	0.0
Area 5, RWMS Pit No. 4	12	0.28	-0.083	0.019	0.085	0.005
Area 5, RWMS TP N	11	0.23	-1.3	-0.073	0.42	0.0
Area 5, RWMS TP NE	12	1.2	-0.57	0.13	0.46	0.032
Area 5, RWMS TP NW	12	2.5	-0.32	0.27	0.72	0.068
Area 5, RWMS TP S	11	0.95	0.0	0.12	0.29	0.03
Area 5, RWMS TP SE	12	0.58	0.0	0.067	0.16	0.017
Area 5, RWMS TP SW	11	0.17	-0.66	-0.032	0.22	0.0
Area 5, Well 5B	11	0.32	-1.2	-0.058	0.40	0.0
Area 6, Building 6-900	11	0.096	0.0	0.048	0.068	0.012
Area 6, CP-6	12	0.43	-0.035	0.069	0.14	0.017
Area 6, Well 3 Complex	12	1.4	-1.2	0.0087	0.58	0.002
Area 6, Yucca Waste Pond	11	0.48	0.0	0.086	0.14	0.022
Area 7, UE-7ns	12	0.35	-1.3	-0.032	0.42	0.0
Area 9, 9-300 Bunker	12	1.3	-1.5	0.34	0.67	0.085
Area 10, Gate 700	12	0.50	-0.025	0.17	0.19	0.042
Area 11, Gate 293	12	0.56	-0.53	0.10	0.25	0.025
Area 12, Complex	11	1.4	-0.57	0.095	0.46	0.024
Area 15, EPA Farm	12	1.5	-1.1	0.19	0.63	0.048
Area 16, 3545 Substation	9	0.0	-0.3	-0.045	0.102	0.0
Area 19, Echo Peak	11	0.0	-1.4	-0.15	0.42	0.0
Area 19, Pahute Substation	10	0.38	0.0	0.13	0.13	0.032
Area 20, Dispensary	12	0.68	-1.0	0.064	0.42	0.016
Area 23, Building 790	10	0.089	-1.4	-0.12	0.44	0.0
Area 23, Building 790 No.2	12	0.20	-0.56	-0.068	0.21	0.0
Area 23, East Boundary	10	0.16	-0.48	-0.011	0.18	0.0
Area 23, H&S Building	11	0.0	-0.74	-0.068	0.22	0.0
Area 25, E-MAD North	12	0.29	-0.83	-0.027	0.27	0.0
Area 25, NRDS Warehouse	12	0.3	-0.19	0.022	0.12	0.0055
Area 27, Cafeteria	11	0.96	0.0	0.16	0.28	0.040

0.04 percent of the DAC and 60 percent of the DCG adjusted to an annual EDE of 10 mrem. A statistical analysis (see Volume II, Appendix A) of the $^{239+240}$Pu results indicated that the concentrations of this radionuclide in Areas 3 and 9 were significantly higher than the concentrations in all other areas at the five percent significance level. This is not unexpected since, historically, this has been the case for these areas. The statistical analysis also showed that the annual average concentrations of $^{239+240}$Pu for all stations might have been higher from June through September; however, the standard deviations for the means were too great to be certain.

The presence of plutonium on the NTS is primarily due to atmospheric tests and tests in which nuclear devices were detonated with high explosives (called "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, higher than normal levels of plutonium in the air are still detected in several Areas on the Nevada Test Site. Because of operational activities and vehicular traffic in Area 3 some of the ^{238}Pu and $^{239+240}$Pu becomes airborne. As such, elevated levels of plutonium have been detected in Area 3 for several years.

Gamma

The charcoal cartridges used to collect halogen gases and the glass fiber filters used to collect particulates were analyzed by gamma spectroscopy. The results from the gamma spectroscopy analyses are provided in Appendix A, Attachment A.4. Except for one isolated case, all isotopes detected by gamma spectroscopy were naturally occurring in the environment (^{40}K, ^{7}Be, and members of the uranium and thorium series). A trace amount of ^{57}Co was detected in a sample collected at the Area 3 ah/at N station during the period July 13 to 20, 1992.

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 5.6 with the annual averages of the ^{85}Kr and ^{133}Xe analyses. All average concentrations were well below the DAC of 1 x 10^{-4} µCi/mL (3.7 x 10^{6} Bq/m^{3}) for each radionuclide. The samplers at the indicated locations were operated continuously throughout the year except for those at the Pahute Substation, Gate 400, and DDZ77 Transformer. These stations were added at different times during the year to provide more intensive sampling in the northwest area of the NTS where seepage of noble gases through the soil into the atmosphere has been noted previously. Summaries of the results are listed in Tables 5.8 and 5.9. All individual results are listed in Volume II, Appendix E. As shown in the list of individual sample results, five ^{133}Xe results and four ^{85}Kr results were considered invalid as the samples for these results were suspected of being contaminated by samples of high radioactivity that were previously analyzed in the same gas rig used for the cryogenic gas chromatographic separation. Also there was no corroboration of the results of these samples by the results of samples collected at the same location preceding or following these samples nor was there any corroboration by the results of samples collected at other locations during the same sampling periods.

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 some contribution of ^{85}Kr from underground nuclear tests at the NTS. Xenon-133 is not normally 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.

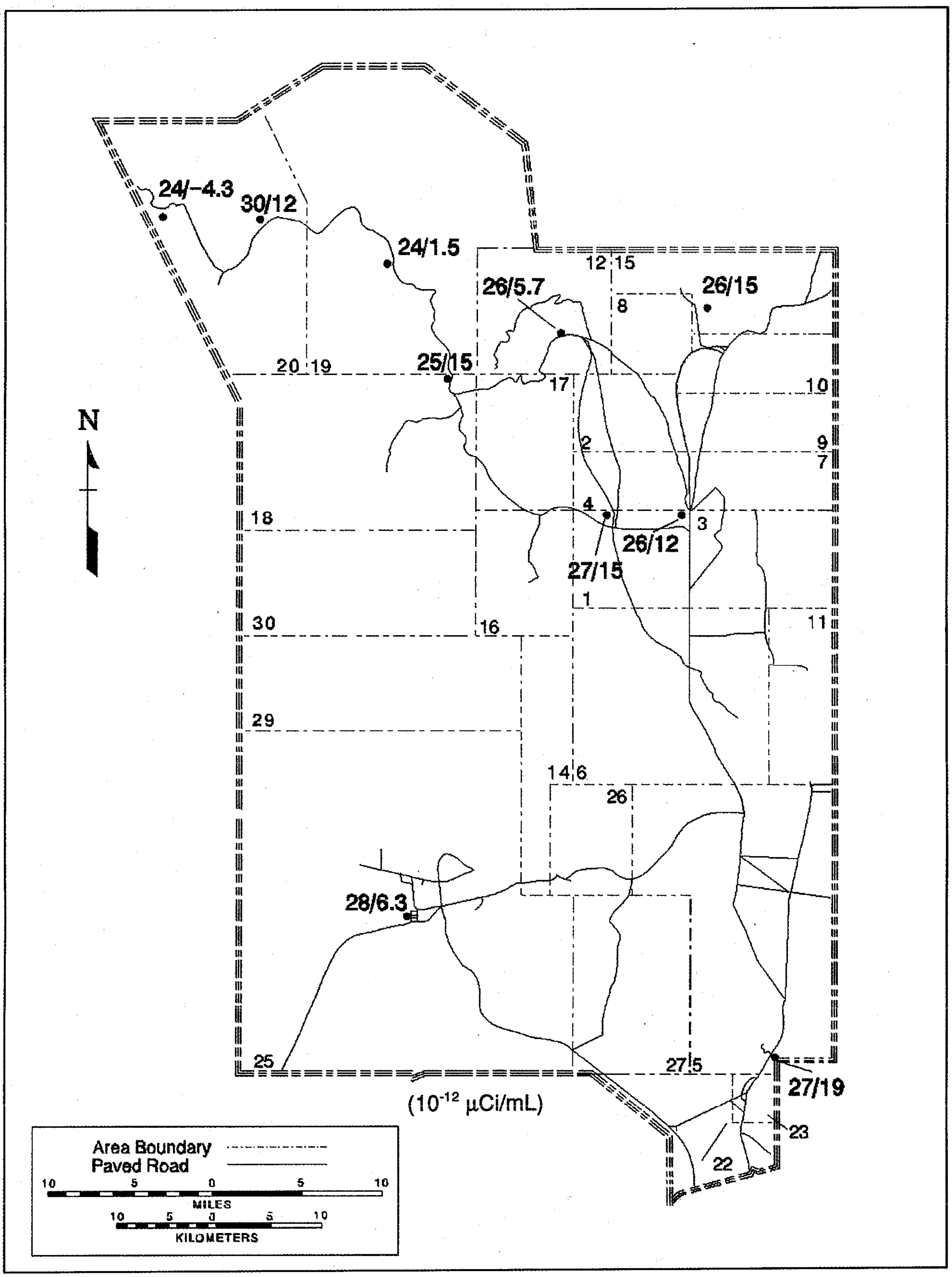

Figure 5.6 NTS $^{85}Kr/^{133}Xe$ Annual Average Concentrations - 1992

Table 5.8 Summary of All NTS ^{85}Kr Concentrations - 1992

Location	Number	^{85}Kr Concentration (10^{-12} µCi/mL) Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as % DCG
Area 1, BJY	45	37	13	26	5.1	0.009
Area 1, Gravel Pit	48	77	5.8	27	11	0.004
Area 5, Gate 200	45	49	14	27	6.5	0.009
Area 12, Camp	47	69	16	26	7.8	0.009
Area 15, EPA Farm	36	54	16	26	7.3	0.009
Area 18, Gate 400[a]	33	47	-4.9	25	9.4	0.008
Area 19, Pahute Substation[a]	30	40	7.4	24	5.6	0.008
Area 20, Dispensary	42	50	-5.0	30	8.7	0.01
Area 20, DDZ77 Trans.[a]	19	31	20	24	2.9	0.008
Area 25, E-MAD	45	140	9.7	28	19	0.009

(a) New sampling locations beginning, respectively, on April 7, March 31, and July 6.

Table 5.9 Summary of NTS ^{133}Xe Concentrations - 1992

Location	Number	^{133}Xe Concentrations (10^{-12} µCi/mL) Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as % DCG
Area 1, BJY	49	110	-70	12	30	0.02
Area 1, Gravel Pit	48	170	-59	15	40	0.03
Area 5, Gate 200	46	260	-30	19	50	0.04
Area 12, Camp	45	120	-200	5.7	46	0.01
Area 15, EPA Farm	40	190	-130	15	47	0.03
Area 18, Gate 400[a]	32	130	-62	15	39	0.03
Area 19, Pahute Substation[a]	31	79	-72	1.5	29	0.003
Area 20, Dispensary	38	120	-59	12	31	0.02
Area 20, DDZ77 Trans.[a]	20	8.8	-35	-4.3	9.3	0.0
Area 25, E-MAD	47	200	-200	6.3	57	0.01

(a) New sampling locations beginning, respectively, on April 7, March 31, and July 6.

Krypton-85

A summary of all ^{85}Kr results appears in Table 5.8. Again this year the highest annual average concentration of ^{85}Kr occurred at the Area 20 Dispensary, 30 x 10^{-12} µCi/mL (1.1 Bq/m^3), which is 0.01% of the DCG adjusted to an annual EDE of 10 mrem. The lowest, 24 x 10^{-12} µCi/mL (0.89 Bq/m^3), occurred at two different locations this year, the Area 19 Pahute Substation and the Area 20 DDZ77 Transformer. The higher average for the samples collected at the Area 20 Dispensary 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. The average concentrations in samples collected at the Area 19 Pahute Substation and the Area 20 DDZ77 Transformer station were expected to be similar to the Area 20 Dispensary. Why they were the lowest of all network stations, at 24 x 10^{-12} µCi/mL, is not clear.

Statistical evaluation of these data (Volume II, Appendix E) showed that the Area 20 Dispensary average concentration was not significantly higher than the other averages at the five percent significance level. This is a departure from the previous 2 years when concentrations at this location tested significantly higher than all other locations. Apparently the variances in the 1992 values were greater than those in 1991 resulting in this loss of significance (see Appendix E).

From the time series plots in Appendix E (Figures E.14 - E.24), no trend in concentrations was apparent. Each location had environmental levels of ^{85}Kr with occasional spikes attributed to seepage of noble gases from the Pahute Mesa area and to small releases of noble gases known to have occurred after current year nuclear tests and a nuclear test conducted in 1991. The time series plot of all samples, see Figure E.14, Appendix E, shows concentration spikes from March through October when releases of noble gases are known to have occurred (a delayed release during March through May, 1992, from the DISTANT ZENITH event of September 19, 1991; releases following the DIAMOND FORTUNE event of April 30; a release during drillback after the HUNTERS TROPHY event of September 18; and a release during drillback after the DIVIDER event of September 23, 1992).

Xenon-133

Table 5.9 summarizes the ^{133}Xe results for samples collected at each location. The highest average concentration was 19 x 10^{-12} µCi/mL (0.70 Bq/m^3) at Area 5 Gate 200, which is in the southern portion of the test site. The lowest annual average was -4.3 x 10^{-12} µCi/mL (-0.16 Bq/m^3) at the Area 20 DDZ77 Transformer. All average concentrations were below the minimum detectable concentration of about 24 x 10^{-12} µCi/mL (0.88 Bq/m$^{3)}$), which is 0.048 percent of the DCG adjusted to an annual 10 mrem EDE.

A statistical evaluation of the ^{133}Xe data is contained in Appendix E. This evaluation showed that the differences in the annual average concentrations were not significant at the 5 percent significance level.

The time series plots of the individual concentrations for each station showed no trend in concentrations. Most of the values varied around the minimum detectable concentration with a few high values, which were attributed to known releases of noble gases during the year. Similar to the ^{85}Kr plots, the time series plot for all ^{133}Xe values (Appendix E., Figure E.1) shows that most of the values above the minimum detectable concentration occurred between March and October when known releases of noble gases were reported (a delayed release during March through May, 1992, from the DISTANT ZENITH event of September 19, 1991; a release during drillback after the HUNTERS TROPHY event of September 18, 1992; and a release during drillback after the DIVIDER event of September 23, 1992).

5.2.1.4 TRITIATED WATER VAPOR SAMPLING RESULTS

The concentrations of tritiated water vapor determined from sampling conducted at 17 permanent sampling stations are summarized in Table 5.10. The individual results for each sample collected during the year are listed and plotted in Volume II, Appendix B, which also includes a statistical evaluation of the data. As shown in Table 5.10, the locations having the highest annual average tritium concentration were the Area 5 RWMS No. 7 and No. 9 Stations with an average of 12 x 10^{-6} pCi/mL (44 x 10^{-2} Bq/m^3). This average was only 0.1 percent of the DCG for tritium adjusted for an annual EDE of 10 mrem. The annual average concentration at each station is shown on the map in Figure 5.7.

From the statistical evaluation, the data were found to be lognormally distributed, therefore the natural logarithm of the individual concentrations were used in a one-way analysis of variance to test for differences between station means. The test concluded that there were differences between station means at the five percent significance level (see Appendix B). Further

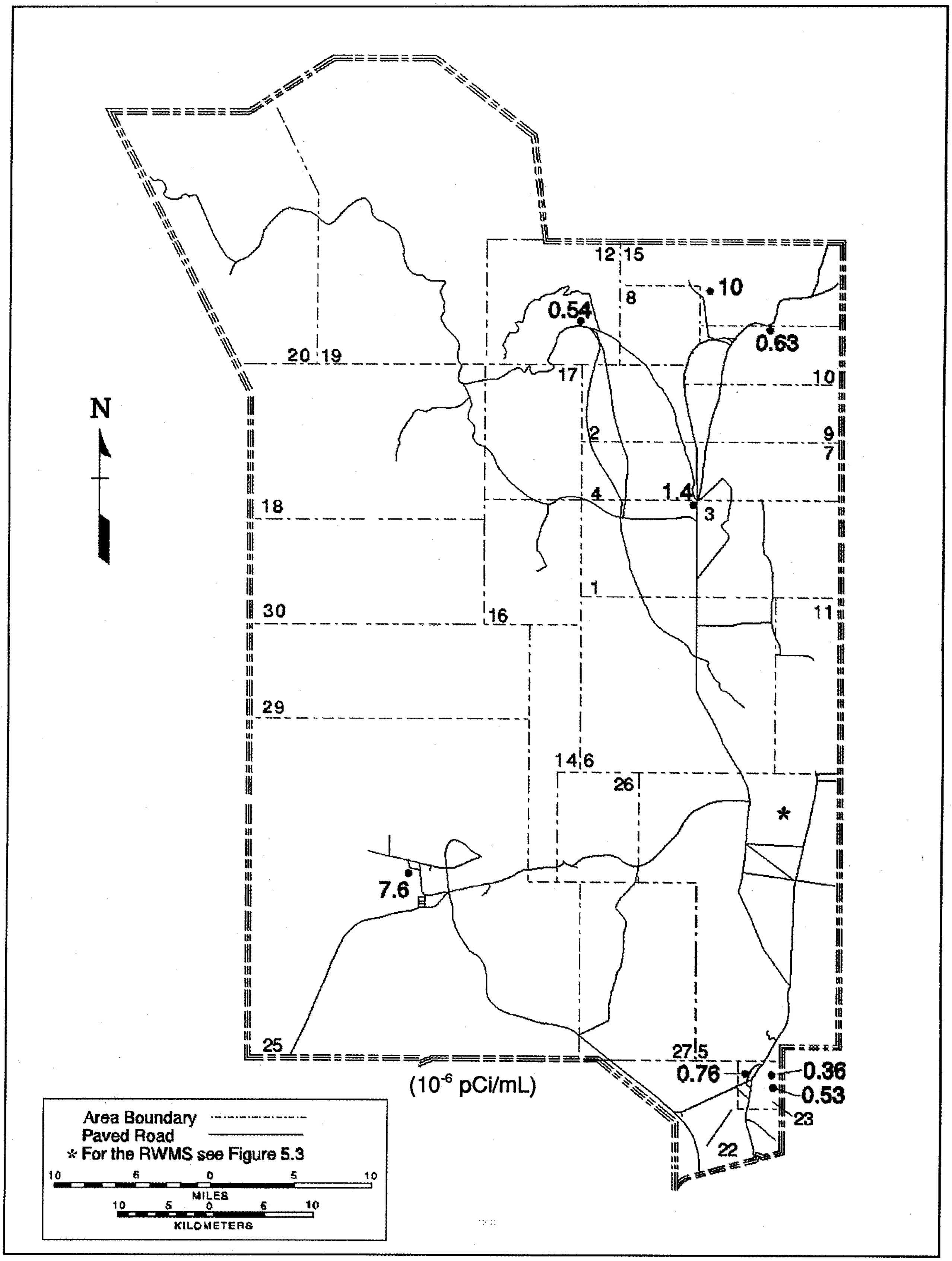

Figure 5.7 NTS Tritiated Water Vapor Annual Average Concentrations - 1992

Table 5.10 Airborne Tritium Concentrations on the NTS - 1992

	^3H Concentration (10^{-6} pCi/mL)					
Location	Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG
Area 1, BJY	23	10.	-1.1	1.4	2.1	0.01
Area 5, RWMS No. 1	20	18.	0.40	4.2	4.0	0.04
Area 5, RWMS No. 2	22	66.	0.34	6.7	13.	0.07
Area 5, RWMS No. 3	22	30.	0.31	4.2	6.0	0.04
Area 5, RWMS No. 4	21	17.	0.27	6.5	5.1	0.06
Area 5, RWMS No. 5	20	12.	0.19	4.0	3.0	0.04
Area 5, RWMS No. 6	20	8.5	0.38	4.0	2.4	0.04
Area 5, RWMS No. 7	20	49.	0.37	12.	13.	0.10
Area 5, RWMS No. 8	23	23.	0.60	5.0	4.6	0.05
Area 5, RWMS No. 9	22	110	0.29	12.	23.	0.10
Area 10, Gate 700 South	23	3.3	-0.30	0.63	0.88	0.006
Area 12, Complex	18	3.3	-0.69	0.54	0.83	0.005
Area 15, EPA Farm	16	62.	0.60	10.	14.	0.10
Area 23, Building 790 No.2	22	12.	-0.33	0.76	2.5	0.008
Area 23, East Boundary	22	2.0	-0.80	0.36	0.64	0.004
Area 23, H&S Roof	23	4.4	-0.32	0.53	1.1	0.005
Area 25, E-MAD North	23	88.	-0.24	7.6	20.	0.080

statistical testing also identified three overlapping groups. These groups are listed below in order of increasing median concentrations:

Lower Group	Middle Group	Higher Group
Area 23 East Boundary	Area 1 BJY	Area 5 RWMS No. 5
Area 23 H&S Building	Area 25 E-MAD	Area 5 RWMS No. 1
Area 23 Building 790	Area 5 RWMS No. 3	Area 5 RWMS No. 6
Area 10 Gate 700		Area 5 RWMS No. 8
Area 12 Complex		Area 5 RWMS No. 2
		Area 5 RWMS No. 4
		Area 5 RWMS No. 9
		Area 15 EPA Farm
		Area 5 RWMS No. 7

the lower group appears to include those locations where the majority of tritium concentrations were below the minimum detectable concentration (MDC); the middle group appears to represent those stations where concentrations were about evenly divided above and below the MDC; and the higher group includes those locations where the tritium concentrations were consistently over the MDC.

5.2.1.5 RADIOACTIVITY IN SURFACE WATER

Surface water sampling at the NTS was conducted at 15 open reservoirs, 7 natural springs, 9 containment ponds, and 3 sewage lagoons. The locations of these sources are shown in

Figures 5.8 and 5.9. Where water was available and the weather permitted, a grab sample was taken each month from each surface water location. 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. Gamma results for all sample locations indicated that radionuclide levels were consistently below the detection limit except for samples from the containment ponds. The data from the containment ponds are shown in Volume II, Appendix C, Attachments C.1 through C.7. Surface water at the NTS was scarce during 1992 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 is presented in Table 5.11 and compared to the DCG for ingested water. The one exception is the containment ponds, which are not compared to ingested water permissible concentrations. All sampling results are presented in tabular form beginning with Appendix C, Attachment C.1. In each appendix table, the result, the corresponding one standard deviation (1s) counting error, and the detection limit (minimum detectable concentration, MDC) are presented.

With the exception of containment ponds, no single annual average of any sampling location 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. The following sections report statistical summary data for all surface water sampling locations.

OPEN RESERVOIRS

Open reservoirs have been established at various locations on the NTS for industrial uses. Comparisons of the annual average concentrations of radioactivity were made to the DCGs for ingested water listed in DOE Order 5400.5, even though there was no known consumption of these waters. The annual average gross beta concentration for each reservoir is shown in Table 5.12 and compared to the DCG for ingested water; however, the water is not used for drinking.

NATURAL SPRINGS

Of the nine natural springs found onsite, (i.e. spring-supplied pools located within the NTS) seven were consistently sampled. These springs were a source of drinking water for wild animals on the NTS. The annual average gross beta results for each spring are shown in Table 5.13 and compared to the ^{90}Sr DCG for drinking water; however, the water is not used for drinking. The results for Reitman Seep were slightly above the DCG.

CONTAINMENT PONDS

Nine containment ponds were sampled on a monthly basis. These ponds contained impounded waters from tunnel test areas (including the effluent liquid as it is discharged from the tunnel) and a contaminated laundry release point. All active containment ponds were fenced, restricted access areas posted with radiological warning signs. The average gross beta concentration for each containment pond location is shown in Figure 5.9. At each tunnel complex, a grab sample was taken from all active containment ponds and at the effluent discharge point. A grab sample was also taken monthly from the Area 6 Decontamination Facility containment pond. All samples taken from these sources were analyzed for ^{3}H, ^{90}Sr, ^{238}Pu, $^{239+240}Pu$, gross beta, and gamma activity in accordance with the schedule of Table

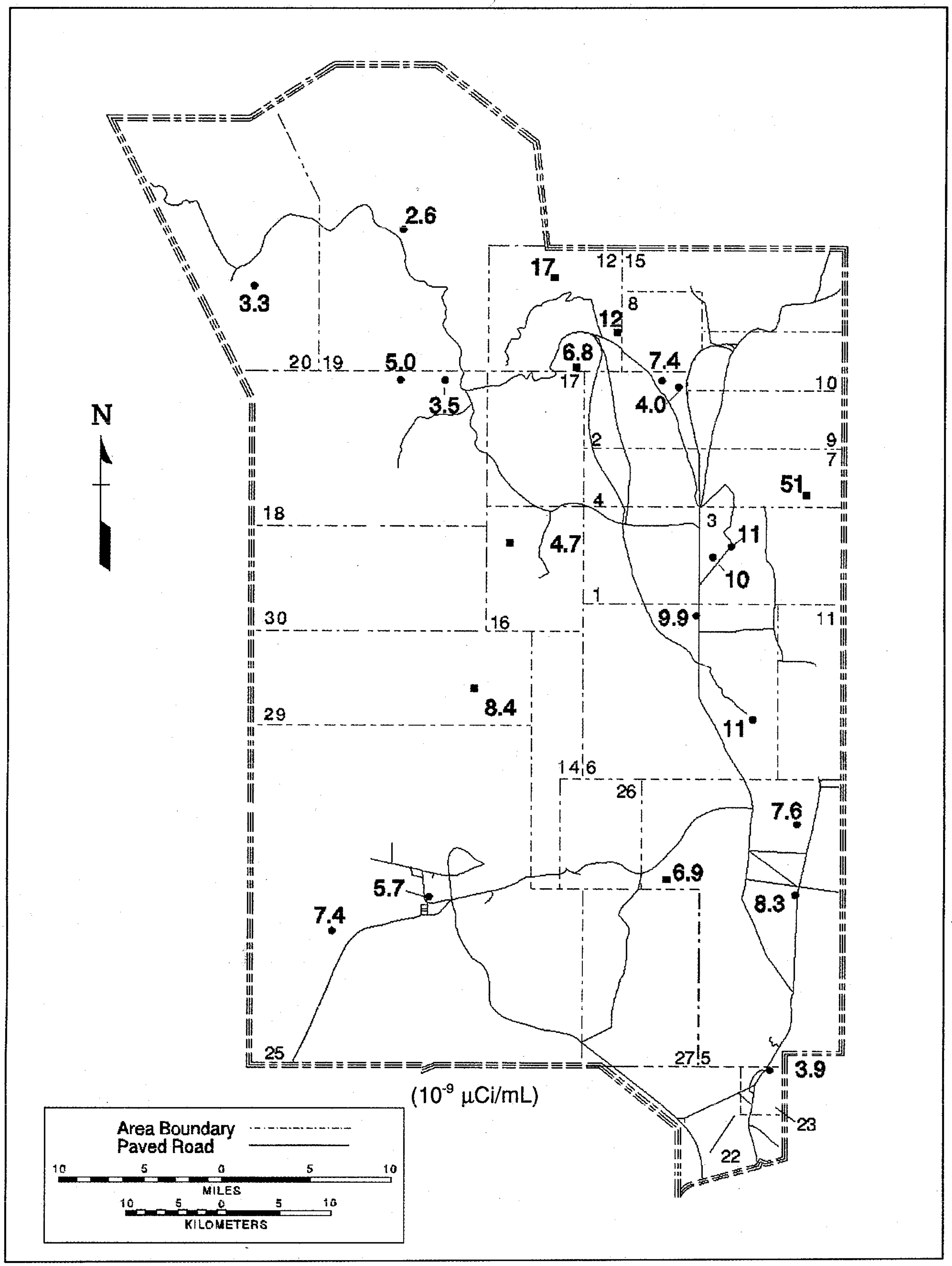

Figure 5.8 Annual Average Gross Beta in Open Reservoirs(•) and Natural Springs(■)- 1992

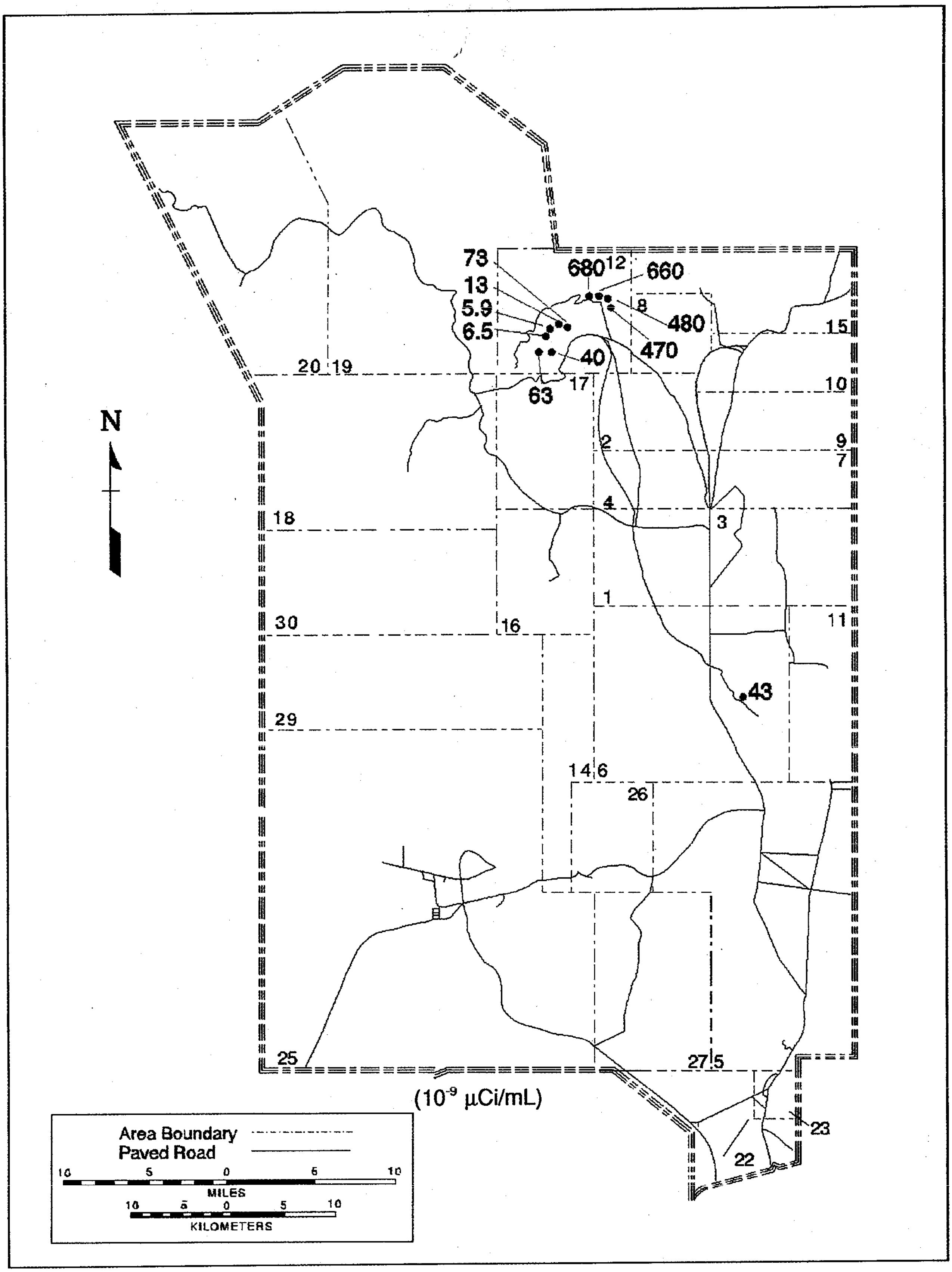

Figure 5.9 NTS Containment Pond Annual Average Gross Beta Concentrations - 1992

Table 5.11 Radioactivity in NTS Surface Waters - 1992

Source of water	No. of Locations	Gross ß	Tritium	^{238}Pu	$^{239+240}Pu$	^{90}Sr(a)	% of DCG Range(b)
	(Annual Average Concentrations in units of 10^{-9} μCi/mL)						
Open Reservoirs	14	6.7	24.	-0.014	0.016	0.36	0.04 - 17
Natural Springs	7	14	60.	-0.011	0.052	0.47	0.04 - 12
Containment Ponds							
T Tunnel	4	580.	4.1×10^7	0.088	2.4	14.	(c)
N Tunnel	4	26.	1.7×10^6	-0.018	0.10	0.10	(c)
E Tunnel	2	56.	2.0×10^6	0.646	6.0	6.8	(c)
Decon Facility	1	43.	2100.	-0.0034	0.079	1.4	(c)
Sewage Lagoons	3	25.	88.	-0.0085	.0065	0.27	(c)

(a) ^{90}Sr values are for one sample.
(b) DCG based on value for drinking water (4 mrem EDE).
(c) Not a potable water source.

Table 5.12 NTS Open Reservoir Gross Beta Analysis Results - 1992

Location	Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG(a)
	Gross Beta Concentration (10^{-9} μCi/mL)					
Area 2, Mud Plant Reservoir	12	6.8	3.1	4.0	0.94	10
Area 2, Well 2 Reservoir	12	13	4.3	7.4	2.2	18
Area 3, Mud Plant Reservoir	12	17	7.7	11	2.7	26
Area 3, Well A Reservoir	12	13	8.1	10	1.7	26
Area 5, UE-5c Reservoir	12	8.7	6.6	7.6	0.72	19
Area 5, Well 5B Reservoir	12	9.9	6.8	8.3	0.86	21
Area 6, Well 3 Reservoir	12	13	1.9	9.9	3.0	25
Area 6, Well C1 Reservoir	12	15	6.9	11	2.0	28
Area 18, Camp 17 Reservoir	11	4.9	2.3	3.5	0.75	8.7
Area 18, Well 8 Reservoir	9	8.4	2.2	5.0	2.0	13
Area 19, UE-19c Reservoir	10	4.5	1.3	2.6	1.0	6.4
Area 20, Well 20A Reservoir	11	12	1.3	3.3	3.1	8.3
Area 23, Swimming Pool	12	8.8	1.6	3.9	1.7	9.8
Area 25, Well J-11 Reservoir	11	7.0	4.0	5.7	0.99	14
Area 25, Well J-12 Reservoir	12	11	5.4	7.4	1.4	19

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

4.1. The annual average of gross beta analyses from each sampling location is listed in Table 5.14 and compared to the DCG for ingested water; however, the water is not used for drinking. All data and statistical analyses are listed in Appendix C, Attachments C.1 through C.7.

AREA 6 DECONTAMINATION FACILITY POND

During the decontamination of equipment at the Area 6 Decontamination Facility, the water used may become contaminated with various radionuclides. The water used during 1992 for

Table 5.13 NTS Natural Spring Gross Beta Analysis Results - 1992

	Gross Beta Concentration (10^{-9} µCi/mL)					
Location	Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG[(a)]
Area 5, Cane Spring	12	7.8	5.5	6.9	0.74	17
Area 7, Reitmann Seep	8	150.	31.	51.	41.	130
Area 12, Captain Jack	11	9.0	2.1	6.8	1.9	17
Area 12, Gold Meadows	5	28.	7.9	17.	9.5	42
Area 12, White Rock Spring	12	20.	8.5	12.	3.4	31
Area 16, Tippipah Spring	12	6.7	3.6	4.7	0.98	12
Area 29, Topopah Spring	5	11.	6.7	8.4	1.7	21

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

Table 5.14 NTS Containment Pond Gross Beta Analysis Results - 1992

	Gross Beta Concentration (10^{-9} µCi/mL)					
Location	Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG[(a)]
Area 6, Decontamination Facility Pond	12	62	12	43	17	100
Area 12, E Tunnel Effluent	12	93	41	63	16	160
Area 12, E Tunnel Pond No.1[(b)]	5	78	1.5	40	33	99
Area 12, N Tunnel Effluent	12	20	-5.3	6.5	6.9	16
Area 12, N Tunnel Pond No.1[(c)]	12	12	-0.37	5.9	5.6	15
Area 12, N Tunnel Pond No.2	11	85	-18	13	26	33
Area 12, N Tunnel Pond No.3	10	510	-3.1	73	160	180
Area 12, T Tunnel Effluent	12	1300	240	680	290	1700
Area 12, T Tunnel Pond No. 1[(b)]	5	890	490	660	200	1600
Area 12, T Tunnel Pond No. 2	11	930	120	480	220	1200
Area 12, T Tunnel Pond No. 3[(b)]	6	1100	-4.3	470	400	1200

(a) DCG based on ^{90}Sr value for drinking water (4 mrem EDE)
(b) Fewer samples because of lack of water
(c) Sampling resumed here because water became available

decontamination was discharged into a nearby fenced and posted containment pond until November 8, 1992, when all wastewater discharges were terminated and preparations begun to divert all liquid wastes from decontamination operations to storage tanks for monitoring, processing and eventual discharge to the Area 6 sewage lagoon if radioactivity concentrations meet appropriate discharge limits. A grab sample was taken and analyzed once per month.

RADIONUCLIDE MIGRATION STUDY POND

No samples were collected in 1992 from the Area 5 U-5eRNM2S migration research well or ditch because of the termination of this project in August 1991.

SEWAGE LAGOONS

Samples from three sewage lagoons were collected quarterly during 1992. These lagoons are part of a closed system used for evaporative treatment of sanitary waste. They are located in Areas 6, 12, and 23. There was no known contact by the working population during 1992. The annual gross beta concentration averages for these three lagoons ranged between 1.4 to 4.0 x 10^{-8} µCi/mL (0.52 to 1.5 Bq/L). No radioactivity was detected above the minimum detectable concentrations for tritium, ^{90}Sr, ^{238}Pu, and $^{239+240}$Pu. No event-related radioactivity was detected by gamma spectrometry analyses. The analytical results for individual samples may be found in Volume II, Appendix C.

5.2.1.6 RADIOACTIVITY IN GROUNDWATER

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. The NTS water system consists of 13 supply wells (Well UE-15d reported in 1991 is no longer operated), 9 of which supply potable water to onsite distribution systems. The drinking water is pumped from the wells to the points of consumption. The supply wells are sampled on a monthly basis. Occasionally, some operational problems interrupt the sampling schedule. All drinking water is sampled weekly to provide a constant check of the end-use activity and to allow frequent end-use activity comparisons to the radioactivity of the water in the supply wells. In this section are presented the analytical results from samples taken at the 13 supply wells which furnished the water for consumption and industrial use at the NTS during 1992. Each sample was analyzed in accordance with the schedule in Table 4.1.

SUPPLY WELLS

Water from 13 supply wells (9 potable and 4 non-potable) as shown in Figure 5.10 was used for a variety of purposes during 1992. 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 5.15 lists the potable and non-potable supply wells and their respective radioactivity averages; no event-related radionuclides were detected by gamma spectrometry. Included in the table is the average MDC for each of the measurements for comparison to the concentration averages for each location. Due to the limited operation of the Area 5 Well 5b, only two water samples were collected during the year. Individual sampling results are presented in Appendix C, Attachments C.1 through C.7, and statistical discussions of the samples may be found at the beginning of the appendix.

Gross Beta

As shown in Table 5.15, the gross beta concentration averages for all the supply wells were above the average MDC of the measurement. The highest average gross beta activity for potable supply wells, occurring at Well C and Well C-1, was 1.4 x 10^{-8} µCi/mL (0.52 Bq/L), which was 4.7 percent of the DCG for ^{40}K and 35 percent of the DCG for ^{90}Sr based upon 4 mrem EDE per year. In previous reports (Scoggins 1983 and Scoggins 1984), it was shown 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 5.10. All concentration averages were comparable to those reported last year.

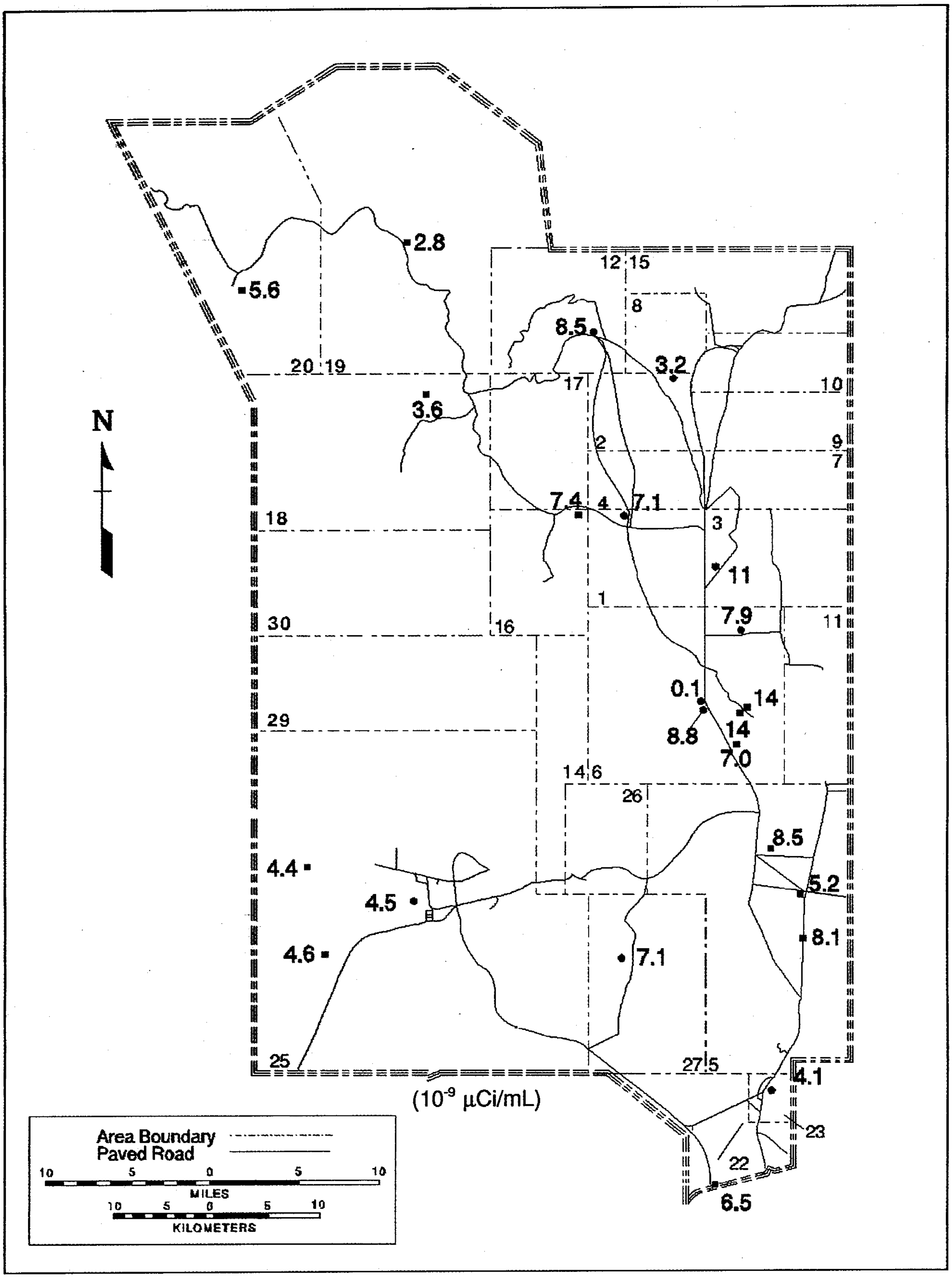

Figure 5.10 Annual Average Gross Beta in Supply Wells (■) and Potable Water (•) - 1992

Table 5.15 NTS Supply Well Radioactivity Averages - 1992

	μCi/mL					
Description	Gross Beta	$^{3}H^{(a)}$	$^{239+240}Pu$	^{238}Pu	Gross Alpha	$^{90}Sr^{(b)}$
Potable Water Supply Wells						
Area 5, Well 5C	8.1×10^{-9}	-7.5×10^{-9}	-7.5×10^{-15}	-9.9×10^{-12}	9.5×10^{-9}	5.9×10^{-10}
Area 6, Well No. 4	7.0×10^{-9}	-6.3×10^{-9}	1.1×10^{-12}	-2.3×10^{-11}	6.1×10^{-9}	8.6×10^{-11}
Area 6, Well C	1.4×10^{-8}	8.4×10^{-9}	-1.3×10^{-14}	4.3×10^{-12}	1.1×10^{-9}	1.1×10^{-10}
Area 6, Well C1	1.4×10^{-8}	-1.6×10^{-9}	-7.7×10^{-13}	-1.3×10^{-11}	9.3×10^{-9}	7.1×10^{-10}
Area 16, Well UE-16d	7.4×10^{-9}	-8.1×10^{-9}	1.3×10^{-11}	2.6×10^{-11}	9.4×10^{-9}	1.9×10^{-10}
Area 18, Well 8	3.6×10^{-9}	-8.6×10^{-9}	7.0×10^{-12}	-1.2×10^{-11}	5.8×10^{-9}	-1.5×10^{-11}
Area 22, Army Well No. 1	6.5×10^{-9}	-5.5×10^{-9}	-1.9×10^{-12}	-1.5×10^{-10}	4.4×10^{-9}	4.1×10^{-10}
Area 25, Well J-12	4.6×10^{-9}	-1.2×10^{-8}	-1.9×10^{-12}	-1.5×10^{-12}	1.7×10^{-9}	4.6×10^{-10}
Area 25, Well J-13	4.4×10^{-9}	-6.6×10^{-9}	1.3×10^{-11}	-5.0×10^{-12}	1.2×10^{-9}	4.4×10^{-10}
Non-Potable Water Supply Wells						
Area 5, Well 5B$^{(c)}$	5.4×10^{-9}	-2.9×10^{-8}	NA	NA	NA	NA
Area 5, Well UE-5c	8.5×10^{-9}	3.4×10^{-8}	-6.5×10^{-13}	-2.3×10^{-12}	NA	1.4×10^{-10}
Area 19, Well UE-19c	2.8×10^{-9}	4.4×10^{-8}	6.6×10^{-12}	-5.3×10^{-12}	NA	1.3×10^{-10}
Area 20, Well U-20	5.6×10^{-9}	-1.7×10^{-8}	6.1×10^{-13}	-1.9×10^{-11}	7.2×10^{-9}	3.0×10^{-10}
Average MDC	8.5×10^{-10}	1.0×10^{-8}	1.7×10^{-11}	3.8×10^{-11}	1.2×10^{-9}	1.3×10^{-10}

(a) Tritium results for potable wells obtained by enrichment analysis (MDC ≈ 1×10^{-8} μCi/mL); those for non-potable wells obtained by conventional analysis (MDC ≈ 3×10^{-7} μCi/mL)
(b) ^{90}Sr values are for one sample
(c) Only two samples collected, power unavailable
NA Not Analyzed

Tritium

Tritium, above the MDC of the measurement, was detected in only a few instances that are attributable to statistical variations and not to the presence of the tritium. This is supported by Table 5.15, which shows the average concentrations at all locations were below the average MDC of the measurement (note that the MDC was 1×10^{-8} μCi/mL for the tritium enrichment analyses performed on the potable supply wells samples but was 2.7×10^{-7} μCi/mL for the conventional analyses on the non-potable well samples). It should be noted that commercially available distilled water was used for the background matrix for both the conventional and enrichment analysis methods. Clearly the tritium concentration in the commercial product was frequently higher than in the samples themselves resulting in negative results. This was particularly pronounced in the results obtained from the enrichment method. Thus, except for possible statistical fluctuations, the negative values indicate that the water from the potable supply wells contained less tritium than the commercially available distilled water.

Plutonium

All supply water samples analyzed for ^{238}Pu and $^{239+240}Pu$ had concentrations below their respective MDCs of about 3.8 x 10^{-11} µCi/mL and 1.7 x 10^{-11} µCi/mL, which are 1.9 percent and 1.7 percent of the DCG adjusted to a 4 mrem EDE per year. This is shown in Table 5.15 where the concentration averages for these nuclides are less than the average MDCs of the measurements.

Gross Alpha

As shown in Table 5.15, the average gross alpha concentration for most of the supply wells was above the average MDC of 1.2 x 10^{-9} µCi/mL. The highest concentration occurred in samples from the Area 5 Well 5C, a source for potable water, and was 9.5 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. The combined concentration for this well was less than this at 5.8 x 10^{-10} µCi/mL.

Strontium

Only one sample was collected from each supply well in 1992 for analysis for ^{90}Sr. Concentrations of ^{90}Sr slightly above the MDC of the measurement were reported for samples collected from nine of the supply wells as shown in Table 5.15. The highest concentration, occurring in the sample from the Area 6 Well C1, was 7.1 x 10^{-10} µCi/mL (0.026 Bq/L), which is 1.8 percent of the DCG adjusted to a 4 mrem EDE per year and 8.9 percent of the EPA drinking water standard.

5.2.1.7 RADIOACTIVITY IN DRINKING WATER

As a check on any effect the water distribution system might have on water quality, ten end-points (labelled potable water in Figure 5.10) were sampled. Sampling was begun at Area 6, Building 6-900 when the Area 3 Camp operations were transferred to Area 6. In order to be certain that all of the water available for consumption was being considered, each drinking water system had in previous years been identified and sampled. 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 5.16. The five drinking water systems, fed by the nine potable supply wells on the NTS, are the source of the water for nine end-points; water from the tenth end-point, Area 6 Bottled Water, is provided by a commercial vendor. Due to the closing of the cafeterias in Areas 3, 12, and 27, samples could no longer be collected at these locations.

Table 5.17 lists the annual concentration averages for all the analyses performed on the samples collected from the end-use consumption points; note that the values for the ^{90}Sr analyses are for single samples and not an average. The individual results for these analyses and for the gamma spectrometry analyses are listed in Volume II, Appendix C. No event-related radionuclides were detected by gamma spectrometry.

Gross Beta

As in previous years, the gross beta concentration averages for all end-points were above the average MDC of the measurements. The highest annual average occurred in samples

Table 5.16 NTS Drinking Water Sources - 1992

Supply Well	End-point
Well C, C1, No. 4	Area 3, Cafeteria (Closed in February 1992)
	Area 27, Cafeteria (Closed in October 1992)
	Area 6, Cafeteria
	Area 6, Building 6-900 (Began sampling June 1992)
Well 8	Area 2, Rest Room
	Area 12, Cafeteria (Closed in December 1992)
Well UE-16d	Area 1, Building 101
Well 5C, Army No. 1	Area 23, Cafeteria
Well J-12, J-13	Area 25, Building 4221
None	Area 6, Bottled Water

Table 5.17 Radioactivity Averages for NTS End-Use Consumption Points - 1992

	μCi/mL					
Description	Gross Beta	$^{3}H^{(a)}$	$^{239+240}Pu$	^{238}Pu	Gross Alpha	$^{90}Sr^{(b)}$
Area 1, Building 101	7.1×10^{-9}	5.1×10^{-9}	-1.0×10^{-12}	8.8×10^{-12}	5.9×10^{-9}	8.9×10^{-11}
Area 2, Restroom	3.2×10^{-9}	1.4×10^{-8}	5.1×10^{-14}	-1.3×10^{-11}	7.7×10^{-10}	4.3×10^{-10}
Area 3, Cafeteria	1.1×10^{-8}	1.6×10^{-7}	.NA.	.NA.	.NA.	.NA.
Area 6, Bottled Water	1.4×10^{-10}	-6.9×10^{-8}	-2.6×10^{-12}	-7.2×10^{-12}	-5.8×10^{-11}	-3.9×10^{-11}
Area 6, Cafeteria	8.8×10^{-9}	1.8×10^{-8}	-8.7×10^{-13}	-2.3×10^{-12}	1.1×10^{-8}	5.2×10^{-10}
Area 6, Building 6-900	7.9×10^{-9}	-3.2×10^{-8}	1.7×10^{-12}	7.0×10^{-13}	8.7×10^{-9}	1.5×10^{-11}
Area 12, Cafeteria	8.5×10^{-9}	1.0×10^{-8}	-4.5×10^{-13}	-5.1×10^{-12}	2.4×10^{-9}	1.0×10^{-9}
Area 23, Cafeteria	4.1×10^{-9}	3.1×10^{-8}	5.8×10^{-14}	4.9×10^{-12}	6.9×10^{-9}	5.8×10^{-10}
Area 25, Building 4221	4.5×10^{-9}	2.5×10^{-8}	4.3×10^{-12}	2.2×10^{-11}	1.6×10^{-9}	2.8×10^{-10}
Area 27, Cafeteria	7.1×10^{-9}	3.1×10^{-8}	-1.7×10^{-12}	3.6×10^{-12}	6.9×10^{-9}	1.1×10^{-10}
Average MDC	8.9×10^{-10}	2.7×10^{-7}	1.5×10^{-11}	3.0×10^{-11}	1.0×10^{-9}	2.0×10^{-10}

(a) Analysis was by conventional method.
(b) ^{90}Sr values are for one sample.
NA Not analyzed, cafeteria was closed in February 1992.

collected at the Area 3 Cafeteria, 1.1×10^{-8} μCi/mL (0.41 Bq/L). This annual average was 3.7 percent of the DCG for ^{40}K adjusted to an annual 4 mrem EDE. The locations of all potable water stations are shown in Figure 5.10, along with their gross beta annual averages.

To determine whether the average gross beta concentration for each end-point sampling location was greater than the average gross beta concentration of the supply well(s) providing the water to the end-point, a statistical evaluation was performed using a form of the Student's t-statistic which ignored time dependency and assumed independence of the wells. As certain end-points draw water from more than one supply well, the supply wells were assumed to contribute equally to the end-points to which they contribute. The results of this evaluation concluded that all the end-point averages were not greater than the average of the supply well(s) at the 5 percent significance level.

Tritium

The tritium concentrations for all end-point water samples were less than the MDC of the measurement (3 x 10^{-7} μCi/mL), which was expected as the levels of tritium in the potable supply wells were below or near the tritium enrichment MDC of 1 x 10^{-8} μCi/mL. These MDCs are 0.33 percent and 0.011 percent, respectively, of the DCG adjusted to a 4 mrem EDE per year.

Plutonium

The annual averages of $^{239+240}Pu$ and ^{238}Pu for each end-point were below the average MDC's of the measurements, which were 1.5 percent and 3.0 percent of the respective DCG adjusted to an EDE of 4 mrem per year. Normally these radionuclides are not detected in groundwater.

Gross Alpha

In accordance with the National Primary Drinking Water Regulation, 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, gross alpha measurements are also made on quarterly samples from ten end-points. As shown in Table 5.17, the annual concentration averages for gross alpha radioactivity in samples collected at about half of the end-points exceeded the screening level at which ^{226}Ra analysis is required, 5 x 10^{-9} μCi/mL (5 pCi/L; 0.19 Bq/L). Samples from the nine supply wells were collected and analyzed for both ^{226}Ra and ^{228}Ra. As shown by the radium results in Table 5.18, the sum of the average concentrations for ^{226}Ra and ^{228}Ra were less than 5 pCi/L; therefore the onsite drinking water was in compliance with the drinking water regulations.

Table 5.18 Radium Analysis Results for NTS Drinking Water - 1992

		Concentrations (10^{-9} μCi/mL)			
Location	Number	^{226}Ra Arithmetic Mean	Standard Deviation	^{228}Ra Arithmetic Mean	Standard Deviation
Area 5, Well 5C	4	0.91	1.1	-0.41	0.58
Area 6, Well 4	4	0.51	0.65	0.43	0.34
Area 6, Well C	4	2.5	0.17	0.77	0.096
Area 6, Well C-1	4	1.6	0.80	0.60	0.90
Area 16, Well UE-16d	4	0.23	0.14	0.35	1.1
Area 18, Well 8	4	0.24	0.77	-0.10	0.47
Area 23, Army Well No. 1	4	1.5	0.98	0.30	0.24
Area 25, Well J-12	2	0.31	0.013	-0.11	0.47
Area 25, Well J-13	5	0.75	0.11	0.25	0.38

Strontium

As indicated by Table 5.17, several results for ^{90}Sr in samples from the different end-points were above the average MDC of the measurement. This is attributed to the uncertainty of the analysis, not the presence of ^{90}Sr, because the average 2 standard deviation counting error was about twice the counting result. The average MDC for ^{90}Sr, 2×10^{-10} µCi/mL, is 0.5 percent of the DCG adjusted to 4 mrem EDE per year, and no result was above the MDC.

5.2.1.8 EXTERNAL GAMMA EXPOSURES - ONSITE AREA

TLDs were deployed at 187 locations throughout the NTS to measure ambient gamma radiation levels. These dosimeters were manufactured by Panasonic and designed to measure the typical levels of gamma radiation present in the environment. The TLDs were deployed on the NTS at locations with radiological conditions ranging from background levels to areas with known contamination. This section presents the results from analysis of TLDs deployed during each quarter of 1992.

The average levels of environmental gamma exposures recorded during 1992 were statistically different within different NTS areas, as has been noted previously, but a pattern of differences within areas cannot be elucidated because of vastly different numbers of TLDs from the areas involved. Using only environmental data (i.e., excluding atypical readings and readings from the vicinity of known radiation sources), it also appears that the overall exposure rates for the first and second quarters are slightly lower than the overall rates for the third and fourth quarters. The reason for this difference is not apparent.

TLDs measured gamma exposures which ranged from 66 mR/year at the Area 23, Building 650 Roof, Building 650 Dosimetry and the Area 23, Gate 100 stations, to 4081 mR/year at the Area 5, RWMS MSM-2 East station. A plot of the data subsequent to removal of the obvious outlier data and the data from known radiation areas shows that the TLD results were normally distributed about a mean of 146 mR/year. The data that were removed range from 84 to 4081 mR/year.

Statistical analyses of the TLD data are presented in Appendix F. Table F.1 in that appendix contains a summary of the individual TLD results. Table 5.19 displays the results of gamma monitoring conducted at the NTS boundary. These locations were close to the boundary of the NTS and were reachable only via helicopter. The data collected at these locations were statistically not different from the data collected from the control locations. The boundary TLDs collected at the end of the first quarter had been in the field for six months; they had not been exchanged at the end of the fourth quarter of 1991 due to management concern over hazardous flying conditions. Consequently, the first quarter exposure rates listed in Table 5.19 are for the period October 1, 1991 to April 9, 1992.

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 5.20. The overall network exposure range for the control locations for 1992 was 0.18 to 0.39 mR/day, with an average exposure rate of 0.28 mR/day or 104 mR/year.

An investigation of historical trends in onsite environmental gamma levels as measured by the TLD network showed no significant differences between years, except for data from 1988 which

Table 5.19 NTS Boundary Gamma Monitoring Result Summary - 1992

Area	Location	First Quarter[a] (mR/day)	Second Quarter (mR/day)	Third Quarter (mR/day)	Fourth Quarter (mR/day)	Average[a] (mR/day)	1991 Annual Exposure (mR/yr)	1992 Annual Exposure (mR/yr)
3	Boundary TLD Station 358	0.22	0.19	0.28	0.26	0.24	79	88
15	Boundary TLD Station 356	0.43	0.45	0.50	0.49	0.47	167	172
10	Boundary TLD Station 357	0.32	0.23	0.29	0.27	0.28	89	102
11	Boundary TLD Station 359	0.41	0.45	0.52	0.51	0.47	165	172
5	Boundary TLD Station 360	0.17	0.18	0.25	0.23	0.21	71	77
12	Boundary TLD Station 355	0.30	0.33	[c]	0.34	0.32	116	117
20	Boundary TLD Station 352	0.27	[c]	0.35	0.34	0.32	101	117
19	Boundary TLD Station 353	[c]	[c]	[c]	0.41	0.41	169	150
19	Boundary TLD Station 354	(0.24)[b]	0.47	0.51	0.47	(0.42)	(137)	(154)
20	Boundary TLD Station 350	0.52	[c]	0.60	0.57	0.56	191	205
20	Boundary TLD Station 351	(0.45)[b]	0.50	0.58	0.50	(0.51)	(154)	(187)
22	Boundary TLD Station 346	0.21	0.19	0.24	0.23	0.22	75	81
25	Boundary TLD Station 347	0.32	0.29	0.34	0.34	0.32	107	117
30	Boundary TLD Station 349	0.51	0.46	0.52	0.46	0.49	154	179
25	Boundary TLD Station 348	0.49	0.39	0.53	0.46	0.47	142	172

(a) First quarter exposure rates are for the period October 1, 1991 to April 9, 1992. Some of these values differ from those reported in the 1991 report because the original values were found to have been calculated incorrectly.
(b) Low readings ascribed to heavy snow cover.
(c) Missing or Not Collected TLD.

Table 5.20 NTS TLD Control Station Comparison - 1986-1992

Area	Station	Exposure Rate (mR/day) 1986	1987	1988	1989	1990	1991	1992
5	Well 5B	0.22	0.32	0.43	0.36	0.34	0.37	0.31
6	CP-6	0.13	0.21	0.36	0.27	0.25	0.24	0.23
6	Yucca Oil Storage	0.22	0.30	0.29	0.32	0.32	0.33	0.31
23	Building 650 Dosimetry	0.31	0.14	0.26	0.19	0.20	0.19	0.18
23	Building 650 Roof	0.13	0.17	0.24	0.18	0.19	0.19	0.18
23	Post Office	0.16	0.24	0.29	0.23	0.23	0.24	0.23
25	HENRE Site	0.27	0.34	0.47	0.38	0.39	0.40	0.36
25	NRDS Warehouse	0.28	0.39	0.46	0.38	0.39	0.39	0.37
27	Cafeteria	0.27	0.38	0.49	0.32	0.40	0.42	0.39
Network Average		0.22	0.28	0.37	0.29	0.30	0.31	0.28

is considered less reliable than that for other years due to a calibration problem. The description of this analysis is found in Volume II, Appendix G.

5.2.1.9 SPECIAL ENVIRONMENTAL STUDIES

The Basic Environmental Compliance and Monitoring Program (BECAMP) conducts special environmental studies on the NTS that include (1) investigating the movement of radionuclides on and around the NTS through horizontal movement, water-driven erosion, vertical migration, and wind-driven erosional resuspension; (2) development of a human dose-assessment model specific to the environmental and radiological conditions of the NTS. The results of 1992 BECAMP investigations relative to onsite radiological monitoring are summarized in the following sections.

MOVEMENT OF RADIONUCLIDES ON AND AROUND THE NTS

Investigations into the movement of radionuclides on and around the NTS were concentrated on the water-driven migration of plutonium in a wash that passes through an area of NTS with plutonium-contaminated soil (Area 11). A methodology was developed to quantify, *in situ*, the amount of plutonium in sediments of the wash with the use of field instrumentation for the detection of low-energy radioactivity (FIDLER). Measurements were made of ^{241}Am activity along transects that were perpendicular to the wash. Knowing the Pu/Am ratio in soils of the area from earlier investigations, the amount of plutonium in the sediments then can be estimated. The study showed that after more than thirty years since the initial deposition of plutonium in the area, the transport distance down the wash was 32 m for an average velocity of 1 m/y. The methodology and results of the investigation were documented in a draft publication. This methodology was also used in another investigation of water-driven radionuclide migration, that in Area 20 of NTS. A preliminary *in situ* investigation was conducted in 1992. Additional work and documentation of the results are planned for 1993.

In 1992, work continued on the characterization of resuspension processes from the CLEAN SLATE III site on the Tonopah Test Range. This work was initiated due to the concern of potential airborne ^{241}Am and ^{239,240}Pu from contaminated soil. Air samples were collected biweekly for nine months in 1991 with several different types of samplers: (1) high-volume air samplers for the determination of air radionuclide concentrations and particle mass loading, (2) cascade impactors for determination of the aerosol particle-size distribution, and (3) array air samplers that are used to measure the vertical gradient of radioactivity in the air layer a few meters above the soil. Weather and micrometerological boundary-layer data were also collected from a station at the site. After collection of the air samples, a less costly method of analysis (gamma spectroscopy) was used on the first several series of samples. The analysis was not effective because of the unexpectedly low levels of americium in the air. There were not enough funds at the end of 1992 to conduct the more sensitive radiochemical analysis of the remaining samples. The preliminary results of the resuspension studies at CLEAN SLATE III were obtained by an indirect method, estimating a concentration of plutonium in the air by using the ratio of soil ^{241}Am /^{40}K and the more well-known ratio of ^{239,240}Pu/^{241}Am. This method was used because the ^{241}Am on the air filter media was below analytical detection limit while the ^{40}K was detectable. It was estimated that the air concentration of ^{239,240}Pu was 2.17 x 10^{-12} Ci/m^3 at CLEAN SLATE III, which was an order of magnitude lower than expected and only 5.5 times greater than the NTS annual background concentration. The low air concentration was probably due to a low enhancement factor, which describes the ground-surface effects on resuspension by taking the ratio of mass-specific activity in the air to that in the soil. The resuspension factor, the ratio of air radioactivity concentration to the total radioactivity deposition, was estimated to be two orders of magnitude lower than that observed for safety shot sites at Gadgets, Mechanics and Explosives (GMX) area and Plutonium Valley (Area 11) on NTS. The remaining air samples will be analyzed and the results of the investigation documented in a report in 1993.

HUMAN DOSE-ASSESSMENT MODEL

The BECAMP dose-assessment model is an extension of the Nevada Applied Ecology Group (NAEG)/NTS model that was used to estimate the internal dose to man from the inhalation and ingestion of $^{239+240}$Pu. The model has been modified to include (1) the external dose pathway for gamma-emitting radionuclides, (2) a multi-compartment gut model for calculating the dose to the gut, (3) the gamma-exposure pathway, (4) the radionuclides ^{60}Co, ^{90}Sr, ^{152}Eu, ^{155}Eu, ^{238}Pu, and ^{241}Am that are found in measurable quantities on the NTS, (5) codification of the internal and external doses in the model for all radionuclides, and (6) the radionuclides ^{101}Rh, ^{102}Rh, ^{125}Sb, ^{134}Cs, and ^{174}Lu that are found in small quantities on the NTS. A sensitivity and uncertainty analyses of the NAEG model showed the air pathways as the critical pathway for human exposure to plutonium, and the soil plutonium concentration and the factors controlling air concentration are the most important environmental parameters.

In 1992, work continued on the estimation of realistic uncertainties of model input parameters. This investigation involves the analyses of NTS soil-plutonium concentrations and resuspension data. The work has found the sensitivity of the BECAMP model to changes in all model parameters including the ten radionuclides found in soils of NTS. In particular, the sensitivity to the parameters defining the various exposure pathways has been found. Thus the analysis gives the relative importance of the inhalation and six ingestion pathways (accidental soil, washed vegetables, peeled vegetables, beef, liver, and milk) for each of the ten radionuclides. This work will be documented and the results published in 1993.

A related investigation, initiated in 1991, continued in 1992 and involved the development of analyses of uncertainties in predicted radionuclide body burdens and doses from discrete and continuous stochastic radionuclide source terms. Specifically, expressions for the uncertainty of body burdens were derived from a linear model of environmental transport and human metabolism in terms of uncertainty in soil radionuclide concentrations. The results of the theoretical analysis indicate that (1) the rate of metabolism has an effect on the uncertainty in body burdens of radionuclides for situations where the exposure to the radionuclide changes over time in a stochastic way, (2) successive random fluctuations produce a less uncertain result than random inputs determined at the outset of exposure and then fixed on the period of exposure, and (3) partially correlated random fluctuations produce 1/(1-a) greater uncertainties than purely random fluctuations, where "a" is the partial correlation coefficient. The results of the investigation will be presented in a report that should be completed early in 1993.

5.2.2 OFFSITE ENVIRONMENTAL SURVEILLANCE

The primary purpose of the offsite environmental surveillance program operated by EMSL-LV is to detect any radioactivity related to current NTS activities which could potentially result in human exposure. Therefore, monitoring is concentrated on possible human exposure pathways and monitoring locations are generally in inhabited areas around the NTS. Monitoring sites are not designed to provide full spatial characterization of the offsite area, nor is the monitoring designed to detect all types of radioactivity arising from all natural and manmade sources. Possible exposure pathways monitored include air, water, milk, domestic and game animals, and locally grown fruits and vegetables. Alpha, beta, and gamma radiation in air are monitored in the Air Surveillance Network (ASN), comprised of 30 continuously operating stations around the NTS and 77 standby samplers (SASN) in states west of the Mississippi River. Custom-designed noble gas samplers and atmospheric moisture samplers are continuously operated at 13 locations around the NTS and identical samplers are maintained on standby status at another seven locations. Additionally, in Salt Lake City, atmospheric moisture is continuously monitored while a noble gas sampler is maintained on standby status. Groundwater and some surface water supplies are sampled regularly in the Long-Term Hydrological Monitoring Program (LTHMP). Water sampling locations include 37 wells on the NTS or immediately outside its borders and 32 locations in the offsite area. The Milk Surveillance Network (MSN) consists of 25 locations sampled monthly, including family-owned cows and goats as well as commercial dairies in the immediate offsite area. In addition, most major milksheds west of the Mississippi River, represented by 115 locations in 1992, are sampled annually through the Standby Milk Surveillance Network (SMSN). Cattle from ranches in the offsite area, mule deer from the NTS, and bighorn sheep hunted in Nevada are all included in the Biomonitoring Network, as are locally grown fruits and vegetables obtained by donation from residents.

In addition to the networks described above, external gamma radiation is monitored by the Pressurized Ion Chamber (PIC) Network and the Thermoluminescent Dosimeter (TLD) Network. The PIC network includes 27 stations, excluding two reassigned to the Yucca Mountain Program, that are connected by satellite telemetry to the NTS for real-time data collection. Approximately 66 local residents voluntarily participate in the TLD network and another 128 TLDs are located at fixed environmental stations. In 1992, 107 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 occupationally exposed workers under the Radiological Safety Program.

The results of monitoring conducted in 1992 are discussed in the following subsections for each of the environmental surveillance networks mentioned above but specifically described in Chapter 4. No major accidental releases of radionuclides from the NTS were reported in 1992, as has been the case for many years. Some radionuclides were emitted (e.g., from tunnel purgings, drillbacks) even though operations were conducted under stringent safety criteria; however, none of these releases were large enough to be detected by the Offsite Radiological Safety Program (ORSP) monitoring networks.

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. 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 2.9×10^{-13} µCi/mL, was infrequently detected. Alpha and beta results for 64 samples were not included in data analysis. These results were excluded because they met one or more of the following criteria: sampling duration of greater than 14 days, total volume of less than 400 m^3, average flow rate less than 2.9 m^3/hr or greater than 4.0 m^3/hr, or power outage lasting more than one-third of sampling interval length. All remaining results were used in data analysis, including preparation of tables.

As in previous years, the gross beta results from both networks consistently exceeded the analysis minimum detectable activity concentration (MDC). The annual average gross beta activity was 1.6×10^{-14} µCi/mL for the ASN and 1.7×10^{-14} µCi/mL for the SASN. Summary gross beta results for the ASN are in Table 5.21 and for the SASN in Table D.1, Appendix D.

Beginning in the fall of 1991, a gross alpha analysis was completed on all samples. The average annual gross alpha activities were 9.2×10^{-16} µCi/mL for the ASN and 1.1×10^{-15} µCi/mL for the SASN. These results indicate a slight decrease in alpha activity as compared to the only other alpha data available, which are for 1989. The average annual gross alpha activities in 1989 were 1.3×10^{-15} µCi/mL for the 14 ASN stations and 1.5×10^{-15} µCi/mL for the 21 SASN stations. Summary gross alpha results for the ASN are presented in Table 5.22 and for the SASN in Table D.2, Appendix D.

Selected air prefilters were also analyzed for plutonium isotopes. This report contains results for samples collected over the period July 1991 through December 1992, presented in Table 5.23 for the ASN and in Table D.3, Appendix D, for the SASN. Prefilters are composited monthly for each of four ASN stations (Alamo, Amargosa Valley, Las Vegas and Rachel, Nevada) and are composited quarterly for two SASN stations in each of 13 states; the composites are submitted for plutonium analyses. Beginning January 1, 1992, plutonium analyses of prefilters from the ASN sampler at Salt Lake City, Utah, were discontinued. The May, August, and October 1992 composited samples from Rachel, Nevada, exceeded the MDC for ^{238}Pu. The fourth quarter 1992 composites for New Mexico and Wyoming exceeded the MDC of ^{238}Pu analysis. The only $^{239+240}$Pu result greater than the analysis MDC was for the fourth quarter 1992 New Mexico sample, comprised of a single sample collected in Carlsbad, New Mexico.

The October 1991 composite sample for Amargosa Valley, Nevada, was lost during analysis, as was the third quarter 1992 California composite sample. No samples were received from the California SASN stations for the first quarter 1992. Single SASN samples were analyzed for plutonium in instances when the second prefilter was not received and three prefilters were composited when a standby sampler was operated more than once in a given quarter.

TRITIUM IN ATMOSPHERIC MOISTURE (HTO)

Of the 716 routine and 15 standby samples collected in 1992, 15 samples were not analyzed: five because of broken sieves, three were lost, and seven contained insufficient sample (moisture). An additional seven samples were excluded from data analysis because of indications of operational malfunctions affecting data reliability. These included frozen lines, lack of pump flow, indications of leaks, and overextended sampling interval. Results exceeded the analysis MDC for two samples; these two samples, from Overton and Las Vegas, Nevada, were both collected June 16 through 24, 1992. The average HTO concentration for the Las Vegas station, located near the EPA Radioanalysis Laboratory, was 1.5×10^{-6} pCi/mL in 1992. The annual HTO network average was 6.6×10^{-7} pCi/mL. Summary data results are given in Table 5.24 for the routine stations and in Table D.4, Appendix D, for the standby stations.

Table 5.21 Gross Beta Results for the Offsite Air Surveillance Network - 1992

Sampling Location	Number	Gross Beta Concentration (10^{-14} μCi/mL) Maximum	Minimum	Arithmetic Mean	Standard Deviation
Death Valley Junction, CA	39	2.2	0.37	1.4	0.44
Furnace Creek, CA	49	3.8	0.56	1.8	0.62
Shoshone, CA	51	3.2	0.40	1.8	0.61
Alamo, NV	50	2.9	0.58	1.6	0.46
Amargosa Valley, NV	51	3.2	0.48	1.6	0.57
Austin, NV	43	5.7	0.21	1.7	0.84
Beatty, NV	52	3.1	0.31	1.7	0.53
Caliente, NV	48	2.9	0.21	1.6	0.65
Clark Station, NV					
Stone Cabin Ranch	51	2.5	0.29	1.4	0.43
Currant, NV					
Blue Eagle Ranch	51	5.8	0.28	1.7	0.92
Ely, NV	52	2.0	0.15	1.3	0.43
Goldfield, NV	52	3.4	0.32	1.7	0.53
Groom Lake, NV	43	3.7	0.73	1.8	0.60
Hiko, NV	51	2.9	0.17	1.6	0.53
Indian Springs, NV	51	3.5	0.38	1.8	0.62
Las Vegas, NV	51	3.8	0.43	1.8	0.65
Nyala, NV	52	4.0	0.16	1.4	0.63
Overton, NV	52	4.0	0.45	1.9	0.74
Pahrump, NV	52	3.0	0.04	1.3	0.56
Pioche, NV	52	2.9	0.09	1.6	0.53
Rachel, NV	50	4.7	0.11	1.7	0.80
Sunnyside, NV	45	2.9	0.28	1.6	0.60
Tonopah, NV	52	2.6	0.42	1.5	0.44
Tonopah Test Range, NV	51	2.7	0.19	1.5	0.44
Twin Springs, NV					
Fallini's Ranch	52	4.0	0.36	1.9	0.66
Cedar City, UT	52	2.7	0.32	1.4	0.47
Delta, UT	45	5.1	0.86	1.8	0.79
Milford, UT	48	5.0	0.61	1.9	0.82
Salt Lake City, UT	51	3.4	0.79	1.7	0.55
St. George, UT	52	4.1	0.36	1.8	0.70

Mean MDC: 2.5×10^{-15} μCi/mL   Standard Deviation of Mean MDC: 3.2×10^{-16} μCi/mL

Table 5.22 Gross Alpha Results for the Offsite Air Surveillance Network - 1992

		Gross Alpha Concentration (10^{-15} µCi/mL)			
Sampling Location	Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation
Death Valley Jct, CA	39	2.4	0.1	0.96	0.57
Furnace Creek, CA	49	2.4	0.1	0.95	0.57
Shoshone, CA	51	2.8	-0.3	0.81	0.61
Alamo, NV	50	2.8	0.1	1.1	0.58
Amargosa Valley, NV	51	2.7	-0.1	1.0	0.68
Austin, NV	43	2.6	0.0	1.1	0.59
Beatty, NV	52	2.5	0.0	0.91	0.60
Caliente, NV	48	2.4	-0.1	0.98	0.64
Clark Station, NV Stone Cabin Ranch	51	2.6	-0.2	1.1	0.58
Currant, NV Blue Eagle Ranch	51	8.9	-0.3	1.2	1.5
Ely, NV	52	1.9	-0.2	0.73	0.45
Goldfield, NV	52	2.5	0.1	0.80	0.50
Groom Lake, NV	43	5.2	0.0	1.4	1.0
Hiko, NV	51	2.5	-0.2	0.86	0.61
Indian Springs, NV	51	3.9	0.0	0.83	0.70
Las Vegas, NV	51	3.1	-0.2	0.89	0.75
Nyala, NV	52	2.5	-0.2	0.66	0.52
Overton, NV	52	4.6	-0.2	0.86	0.72
Pahrump, NV	52	2.2	-0.4	0.68	0.60
Pioche, NV	52	2.4	-0.2	0.60	0.48
Rachel, NV	50	2.5	0.0	0.97	0.69
Sunnyside, NV	45	4.8	0.0	1.2	0.85
Tonopah, NV	52	2.1	-0.6	0.67	0.50
Tonopah Test Range, NV	51	2.8	-0.1	1.0	0.72
Twin Springs, NV Fallini's Ranch	52	4.7	0.0	1.0	0.80
Cedar City, UT	52	2.3	0.0	0.98	0.55
Delta, UT	45	4.4	-0.1	0.84	0.75
Milford, UT	48	2.9	0.0	0.94	0.65
Salt Lake City, UT	51	1.5	-0.3	0.65	0.39
St. George, UT	52	2.5	0.0	0.77	0.55

Mean MDC: 8.1 x 10^{-16}µCi/mL   Standard Deviation of Mean MDC: 2.4 x 10^{-16} µCi/mL

Table 5.23 Offsite Airborne Plutonium Concentrations - 1992

Composite Sampling Location	Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG
		^{238}Pu Concentration (10^{-18} µCi/mL)				
Alamo, NV	18	6.8	-3.0	1.0	2.8	0.02
Amargosa Valley, NV	17	9.9	-8.8	-0.55	4.4	NA
Las Vegas, NV	18	7.4	-5.4	0.35	3.7	0.01
Rachel, NV	18	37.	-11.	3.4	11.	0.08
Salt Lake City, UT	6	8.4	-13.	-5.2	7.9	NA

Mean MDC: 16 x 10^{-18} µCi/mL Standard Deviation of Mean MDC: 9.9 x 10^{-18} µCi/mL

DCG Derived Concentration Guide; Established by DOE Order as 4 x 10^{-15} 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	18	5.0	-3.7	0.41	1.9	0.01
Amargosa Valley, NV	17	26.	-15.	-0.36	7.9	NA
Las Vegas, NV	18	5.7	-4.9	-0.64	2.8	NA
Rachel, NV	18	9.9	-7.4	2.2	4.4	0.06
Salt Lake City, UT	6	3.3	-2.2	0.32	2.2	0.01

Mean MDC: 12 x 10^{-18} µCi/mL Standard Deviation of Mean MDC: 8.8 x 10^{-18} µCi/mL

DCG Derived Concentration Guide; Established by DOE Order as 4 x 10^{-15} µCi/mL
NA Not applicable, result is <MDC

NOBLE GAS SAMPLING NETWORK

All samples were analyzed for ^{85}Kr and ^{133}Xe and the summary data results are given in Table 5.25 for the routine stations and in Table D.5 for the standby stations. Of the 699 samples collected in 1992, analyses were not performed on 74 samples (10.6 percent) due to insufficient volume collected or sampler malfunctions. Twelve quarterly samples were collected from standby samplers; none were collected from Milford and Salt Lake City, Utah. As expected, all ^{85}Kr results exceeded the MDC and all ^{133}Xe results were below the MDC. The annual averages for the continuously operated samplers were 2.6 x 10^{-11} µCi/mL for ^{85}Kr and -1.8 x 10^{-11} µCi/mL for ^{133}Xe and for the standby samplers, 2.6 x 10^{-11} µCi/mL for ^{85}Kr and -2.7 x 10^{-11} µCi/mL for ^{133}Xe.

5.2.2.2 WATER MONITORING

Environmental surveillance of water in the offsite areas around the NTS is conducted as part of the LTHMP. Results are discussed in Section 9.5.3 of Chapter 9, "Groundwater Monitoring."

Table 5.24 Offsite Atmospheric Tritium Results for Routine Samplers - 1992

		HTO Concentration (10^{-7} pCi/mL)				
Sampling Location	Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG
Alamo, NV	48	43.1	-35.3	6.52	17.4	0.01
Amargosa Valley, NV	51	50.3	-19.7	8.86	14.3	0.01
Amargosa Valley Community Center, NV	52	65.3	-44.7	5.48	19.1	0.01
Beatty, NV	51	18.7	-12.7	2.97	7.37	<0.01
Goldfield, NV	52	29.3	-27.0	4.93	11.7	<0.01
Indian Springs, NV	52	47.9	-43.2	7.41	17.6	0.01
Las Vegas, NV	52	94.9	-49.4	15.3	30.1	0.02
Overton, NV	51	57.0	-42.1	8.53	19.7	0.01
Pahrump, NV	51	64.9	-22.4	10.4	19.9	0.01
Rachel, NV	48	22.6	-22.7	3.8	9.82	<0.01
Tonopah, NV	52	49.4	-24.2	5.50	15.6	0.01
Twin Springs, NV Fallini's Ranch	51	56.5	-39.5	4.38	17.1	<0.01
Salt Lake City, UT	39	24.0	-35.3	1.93	13.3	<0.01
St. George, UT	51	88.2	-79.4	6.86	32.7	0.01

Mean MDC: 5.52 x 10^{-6} pCi/mL   Standard Deviation of Mean MDC: 2.75 x 10^{-6} pCi/mL

DCG Derived Concentration Guide; Established by DOE Order as 1 x 10^{-2} pCi/mL
MDC Minimum Detectable Concentration

5.2.2.3 MILK SURVEILLANCE NETWORK

The average total potassium concentration derived from ^{40}K activity was 1.6 g/L. Two SMSN samples indicated the presence of ^{137}Cs: the Tommy Rue Potts Dairy (Sulphur Springs, Texas) sample collected November 13, 1992 yielded 2.4 ± 0.9 pCi/L and the Brown's Velvet Dairy Products (New Orleans, Louisiana) sample collected April 9, 1992 yielded 3.5 ± 0.9 pCi/L of ^{137}Cs. These values were below the MDC of the analysis, which was approximately 5 pCi/L. No other manmade gamma-emitting radionuclides were detected.

Selected MSN and SMSN milk samples were also analyzed for ^{3}H, ^{89}Sr, and ^{90}Sr, and the results are similar to those obtained in previous years; neither increasing or decreasing trends are evident. Although there was a slight increase in the number of samples whose results exceeded the MDC for ^{3}H, ^{89}Sr, and ^{90}Sr in 1992, as listed in Table 5.26, the average annual concentrations have, in general, decreased slightly. A summary of the MSN results are in Tables 5.27 for ^{3}H, 5.28 for ^{89}Sr, and 5.29 for ^{90}Sr. The results for the annual SMSN samples analyzed for ^{3}H, ^{89}Sr, and ^{90}Sr are given in Table D.6, Appendix D. Samples analyzed by gamma spectrometry for the SMSN are listed in Table D.7, Appendix D.

5.2.2.4 BIOMONITORING

Sites where animals were collected in late 1991 and 1992 are shown in Chapter 4, Figure 4.10.

Table 5.25 Offsite Noble Gas Results for Routine Samplers - 1992

		^{85}Kr Concentration (10^{-11} μCi/mL)				
Sampling Location	Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG
Alamo, NV	48	3.0	2.2	2.6	0.21	0.01
Amargosa Valley, NV	44	3.0	2.2	2.6	0.20	0.01
Amargosa Valley Community Center, NV	35	3.0	2.1	2.6	0.23	0.01
Beatty, NV	50	3.1	2.1	2.6	0.24	0.01
Goldfield, NV	49	3.1	2.1	2.6	0.22	0.01
Indian Springs, NV	50	3.0	2.2	2.6	0.23	0.01
Las Vegas, NV	51	3.1	2.1	2.6	0.23	0.01
Overton, NV	52	3.1	2.1	2.6	0.22	0.01
Pahrump, NV	47	3.0	2.2	2.7	0.20	0.01
Rachel, NV	44	3.1	2.0	2.6	0.22	0.01
Tonopah, NV	45	3.1	2.0	2.6	0.19	0.01
Twin Springs, NV Fallini's Ranch	43	3.0	2.2	2.6	0.19	0.01
St. George, UT	49	3.1	2.0	2.6	0.26	0.01

Mean MDC: 0.56 x 10^{-11} μCi/mL   Standard Deviation of Mean MDC: 0.12 x 10^{-11} μCi/mL

DCG Derived Concentration Guide; Established by DOE Order as 3 x 10^{-7} μCi/mL

		^{133}Xe Concentration (10^{-12} μCi/mL)				
Sampling Location	Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG
Alamo, NV	49	4.2	-18.	-2.6	4.4	NA
Amargosa Valley, NV	44	7.2	-15.	-2.1	3.6	NA
Amargosa Valley Community Center, NV	36	21.	-17.	-2.1	7.1	NA
Beatty, NV	51	6.0	-15.	-2.1	4.6	NA
Goldfield, NV	48	13.	-16.	-1.4	5.0	NA
Indian Springs, NV	50	6.0	-12.	-1.8	3.4	NA
Las Vegas, NV	51	4.6	-18.	-1.5	4.7	NA
Overton, NV	52	8.2	-22.	-2.6	5.6	NA
Pahrump, NV	47	5.8	-15.	-1.1	3.5	NA
Rachel, NV	44	7.2	-15.	-2.6	5.2	NA
Tonopah, NV	46	8.8	-16.	-1.2	5.2	NA
Twin Springs, NV Fallini's Ranch	43	4.3	-13.	-0.94	3.8	NA
St. George, UT	49	7.7	-11.	-1.0	4.5	NA

Mean MDC: 1.4 x 10^{-11} μCi/mL   Standard Deviation of Mean MDC: 0.54 x 10^{-11} μCi/mL

DCG Derived Concentration Guide; Established by DOE Order as 5 x 10^{-8} μCi/mL

Table 5.26 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)		
	1992	1991	1990	1992	1991	1990
^{3}H	5 (150)	2 (150)	0 (130)	6 (160)	1 (150)	1 (160)
^{89}Sr	4 (-0.011)	1 (0.30)	0 (0.18)	4 (0.38)	3 (0.42)	0 (-0.16)
^{90}Sr	5 (0.65)	4 (0.55)	4 (0.58)	17 (0.99)	18 (1.2)	17 (1.3)

BIGHORN SHEEP

The sheep hunt takes place in November and December, hence, the data presented here are from animals hunted in late 1991. The kidney samples and one lung sample were analyzed for gamma-emitting radionuclides and for tritium. The bone samples were ashed prior to analysis of ^{90}Sr, ^{238}Pu, and $^{239+240}Pu$. A summary of results obtained from analysis of bighorn sheep bone and kidney are shown in Table 5.30 Other than naturally occurring ^{40}K, gamma-emitting radionuclides were not detected, nor was tritium detected, at activities greater than the MDC in any of the kidney or lung samples. All of the bone tissue samples, however, yielded ^{90}Sr activities greater than the MDC of the analysis. The range and median values for ^{90}Sr, shown in Table 5.30, were similar to those obtained last year (DOE, 1992). The average ^{90}Sr levels found in bighorn sheep bone ash since 1955 are shown in Figure 5.11. None of the bone samples yielded ^{238}Pu results greater than the MDC of the analysis and only one sample (Bighorn sheep No. 6) yielded a $^{239+240}Pu$ result greater than the MDC. This animal was collected in Area 268, near Buffington Pockets Spring south and west of Moapa, Nevada, near the Valley of Fire. Medians and ranges of plutonium isotopes, given in Table 5.30, were similar to those obtained previously (DOE, 1992).

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 are 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 second quarter of 1992 was a buck in good condition obtained by hunting in Area 18 of the NTS, near Buckboard Mesa road. No gamma-emitting radionuclides other than naturally occurring ^{40}K were detected in soft tissues, however, $^{239+240}Pu$ was detected in the lungs, liver, and muscle. The rumen contents contained ^{238}Pu and $^{239+240}Pu$. Values of $^{239+240}Pu$ were 0.031 ± 0.006 pCi/g ash in the lungs, 0.017 ± 0.004 pCi/g ash in the liver, 0.006 ±0.001 pCi/g ash in the muscle and 0.017 ± 0.003 pCi/g ash in the rumen. The bone sample contained 0.74 ± 0.13 pCi/g ash of ^{90}Sr. There was no detectable ^{3}H in the blood above the MDC of 1.8×10^{-7} µCi/mL.

Table 5.27 Offsite Milk Surveillance ^3H Results - 1992

Sampling Location	Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG
		^3H Concentration (10^{-7} µCi/mL)				
Benton, CA						
Irene Brown Ranch	1	2.5	2.5	2.5	--	0.32
Hinkley, CA						
Desert View Dairy	4	3.8	0.68	1.9	1.3	0.24
Inyokern, CA						
Cedarsage Farm	3	1.8	0.62	0.88	0.23	0.11
Alamo, NV						
Cortney Dahl Ranch	2	1.7	1.1	1.4	0.42	0.18
Amargosa Valley, NV						
Bar-B-Cue Ranch	4	1.6	-0.69	0.91	1.1	0.11
John Deer Ranch	2	2.3	1.5	1.9	0.56	0.23
Austin, NV						
Young's Ranch	4	2.6	0.52	1.3	0.94	0.17
Caliente, NV						
June Cox Ranch	4	1.0	0.43	0.82	0.29	0.10
Currant, NV						
Manzonie Ranch	4	2.6	1.4	1.8	0.57	0.22
Duckwater, NV						
Bradshaw's Ranch	4	1.2	0.29	0.85	0.42	0.11
Dyer, NV						
Ozel Lemon	3	4.0	0.24	1.9	1.9	0.24
Goldfield, NV						
Frayne Ranch	3	2.4	0.94	1.7	0.74	0.21
Logandale, NV						
Leonard Marshall	4	1.9	-0.02	0.86	0.91	0.11
Lund, NV						
Ronald Horsley Ranch	3	1.6	1.0	1.3	0.26	0.16
McGill, NV						
McKay's Ranch	4	2.4	-0.19	1.5	1.2	0.19
Mesquite, NV						
Hafen Dairy	4	4.2	0.09	1.9	2.0	0.24
Moapa, NV						
Rockview Dairies	4	2.5	0.38	1.8	1.0	0.23
Nyala, NV						
Sharp's Ranch	4	2.8	-0.20	1.1	1.5	0.14
Pahrump, NV						
Pahrump Dairy	4	2.6	1.0	1.9	0.66	0.24
Shoshone, NV						
Harbecke Ranch	4	2.6	0.46	1.6	0.87	0.19
Tonopah, NV						
Karen Harper Ranch	3	4.8	0.25	2.0	2.4	0.25
Cedar City, UT						
Brent Jones Dairy	4	3.0	0.87	2.1	0.92	0.26
Ivins, UT						
David Hafen Dairy	4	2.6	0.90	2.1	0.79	0.26

Mean MDC: 2.8 x 10^{-7} µCi/mL   Standard Deviation of Mean MDC: 0.57 x 10^{-7} µCi/mL

DCG Derived Concentration Guide; Established by DOE Order as 8 x 10^{-5} µCi/mL

Table 5.28 Offsite Milk Surveillance ^{89}Sr Results - 1992

		^{89}Sr Concentration (10^{-10} µCi/mL)				
Sampling Location	Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG
Benton, CA						
Irene Brown Ranch	1	5.1	5.1	5.1	--	0.06
Hinkley, CA						
Desert View Dairy	4	4.1	-7.6	-1.9	5.5	NA
Inyokern, CA						
Cedarsage Farm	3	4.6	-0.33	2.1	2.4	0.03
Alamo, NV						
Cortney Dahl Ranch	2	6.3	-15.	-4.2	15.	NA
Amargosa Valley, NV						
Bar-B-Cue Ranch	4	3.0	-19.	-6.3	9.9	NA
John Deer Ranch	1	4.4	4.4	4.4	--	0.06
Austin, NV						
Young's Ranch	3	5.6	-8.1	0.18	7.3	<0.01
Caliente, NV						
June Cox Ranch	3	1.5	-16.	-4.7	9.7	NA
Currant, NV						
Manzonie Ranch	4	6.8	-0.22	3.5	3.0	0.04
Duckwater, NV						
Bradshaw's Ranch	3	11.	-11.	-3.4	13.	NA
Dyer, NV						
Ozel Lemon	2	-3.2	-7.3	-5.3	2.8	NA
Goldfield, NV						
Frayne Ranch	2	3.5	-3.3	0.11	4.8	<0.01
Logandale, NV						
Leonard Marshall	4	4.4	-7.8	-1.6	5.4	NA
Lund, NV						
Ronald Horsley Ranch	3	1.1	-1.4	-0.31	1.3	NA
McGill, NV						
McKay's Ranch	4	-3.4	-9.1	-5.4	2.6	NA
Mesquite, NV						
Hafen Dairy	4	4.0	-7.7	-1.9	4.8	NA
Moapa, NV						
Rockview Dairies	3	11.	-3.6	2.5	7.6	0.03
Nyala, NV						
Sharp's Ranch	3	7.0	3.6	5.0	1.8	0.06
Pahrump, NV						
Pahrump Dairy	4	6.3	-2.4	1.8	3.7	0.02
Shoshone, NV						
Harbecke Ranch	4	8.2	0.77	4.7	3.5	0.06
Tonopah, NV						
Karen Harper Ranch	2	3.7	3.2	3.5	0.35	0.04
Cedar City, UT						
Brent Jones Dairy	4	9.7	-5.3	1.8	6.2	0.02
Ivins, UT						
David Hafen Dairy	4	11.	-4.9	2.8	7.3	0.03

Mean MDC: 12 x 10^{-10} µCi/mL   Standard Deviation of Mean MDC: 2.3 x 10^{-10} µCi/mL

DCG Derived Concentration Guide; Established by DOE Order as 8 x 10^{-7} µCi/mL

Table 5.29 Offsite Milk Surveillance ^{90}Sr Results - 1992

Sampling Location	Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG
		^{90}Sr Concentration (10^{-10} µCi/mL)				
Benton, CA						
Irene Brown Ranch	1	-1.2	-1.2	-1.2	--	NA
Hinkley, CA						
Desert View Dairy	4	5.6	1.1	3.6	2.1	0.89
Inyokern, CA						
Cedarsage Farm	3	3.7	1.0	2.3	1.4	0.57
Alamo, NV						
Cortney Dahl Ranch	2	6.9	-1.8	2.6	6.2	0.64
Amargosa Valley, NV						
Bar B Cue Ranch	4	14.	-0.87	5.0	6.6	1.2
John Deer Ranch	2	1.9	-0.094	0.89	1.3	0.22
Austin, NV						
Young's Ranch	4	13.	5.2	9.6	3.3	2.4
Caliente, NV						
June Cox Ranch	3	8.6	2.6	5.0	3.2	1.2
Currant, NV						
Manzonie Ranch	4	16.	3.2	7.7	5.8	1.9
Duckwater, NV						
Bradshaw's Ranch	4	14.	1.2	8.3	5.2	2.1
Dyer, NV						
Ozel Lemon	3	11.	5.5	8.6	2.7	2.1
Goldfield, NV						
Frayne Ranch	3	9.3	7.6	8.1	0.99	2.0
Logandale, NV						
Leonard Marshall	4	6.9	1.8	4.4	2.7	1.1
Lund, NV						
Ronald Horsley Ranch	3	7.5	2.2	4.0	3.0	1.0
McGill, NV						
McKay's Ranch	4	8.7	5.1	7.2	1.7	1.8
Mesquite, NV						
Hafen Dairy	4	10.	3.5	6.4	3.0	1.6
Moapa, NV						
Rockview Dairies	3	6.8	-0.82	3.5	3.9	0.88
Nyala, NV						
Sharp's Ranch	4	9.3	4.3	6.8	2.2	1.7
Pahrump, NV						
Pahrump Dairy	4	8.6	1.1	4.9	4.2	1.2
Shoshone, NV						
Harbecke Ranch	4	20.	6.8	14.	5.5	3.5
Tonopah, NV						
Karen Harper Ranch	3	22.	12.	17.	5.7	4.2
Cedar City, UT						
Brent Jones Dairy	4	7.8	2.6	5.5	2.2	2.7
Ivins, UT						
David Hafen Dairy	4	11.	2.3	5.8	3.9	2.9

Mean MDC: 14×10^{-10} µCi/mL   Standard Deviation of Mean MDC: 1.5×10^{-10} µCi/mL

DCG Derived Concentration Guide; Established by DOE Order as 4×10^{-8} µCi/mL

Table 5.30 Radiochemical Results for Animal Samples - 1992

Sample Type	Parameter	Number	Maximum	Minimum	Median[(a)]	Standard Deviation	Median MDC ± std. dev.
Cattle Blood	$^{3}H^{(b)}$	8	2.6	-0.62	0.99	1.0	3.2 ± 1.0
Cattle Liver	% Ash	8	1.4	1.1	1.3		
	$^{238}Pu^{(c)}$		7.6	-1.1	0.59	2.8	4.8 ± 3.1
	$^{239+240}Pu^{(c)}$		15.	-0.95	10.	5.8	2.6 ± 2.6
Cattle Bone	% Ash	8	34.	14.	25.		
	$^{89}Sr^{(d)}$		0.72	-0.46	-0.08	0.54	0.36 ± 0.03
	$^{90}Sr^{(d)}$		0.88	0.27	0.45	0.22	0.20 ± 0.08
	$^{238}Pu^{(c)}$		2.2	-0.85	0.24	0.96	1.8 ± 1.1
	$^{239+240}Pu^{(c)}$		18.	-0.28	0.42	6.3	1.7 ± 1.1
Cattle Fetus	% Ash	2	10.4	2.1	6.2		
	$^{90}Sr^{(d)}$		0.22	0.079	0.15	0.10	0.47 ± 0.32
	$^{238}Pu^{(c)}$		-1.2	-1.5	-1.4	0.23	4.35 ± 0.04
	$^{239+240}Pu^{(c)}$		5.0	1.1	3.1	2.8	2.2 ± 1.2
Deer Blood	$^{3}H^{(b)}$	3	1.8	-0.17	1.7	1.1	4.8 ± 18
Deer Liver	% Ash	3	1.3	1.2	1.3		
	$^{238}Pu^{(c)}$		0.00022	-2.6	0.000030	1.5	7.1 ± 3.6
	$^{239+240}Pu^{(c)}$		52.	1.8	17.	26.	3.3 ± 1.8
Deer Lung	% Ash	3	1.2	0.92	1.1		
	$^{238}Pu^{(c)}$		2.7	-3.5	1.6	3.8	1.5 ± 4.8
	$^{239+240}Pu^{(c)}$		31.	8.1	11.	12.	1.5 ± 4.8
Deer Muscle	% Ash	3	1.2	0.90	0.99		
	$^{238}Pu^{(c)}$		0.72	-0.000032	0.54	0.38	1.5 ± 1.8
	$^{239+240}Pu^{(c)}$		96.	5.9	12.	51.	1.5 ± 0.73
Deer Rumen Content	% Ash	3	2.0	1.5	1.8		
	$^{238}Pu^{(c)}$		2.4	1.3	1.8	0.60	1.9 ± 2.4
	$^{239+240}Pu^{(c)}$		37.	17.	28.	10.	1.9 ± 0.67
Deer Bone	% Ash	3	32.	32.	32.		
	$^{89}Sr^{(d)}$		0.39	--	--	--	0.31 ± --
	$^{90}Sr^{(d)}$		1.4	0.68	0.74	0.40	0.36 ± 0.13
	$^{238}Pu^{(c)}$		0.83	-0.52	-0.39	0.74	2.4 ± 0.89
	$^{239+240}Pu^{(c)}$		7.8	0.39	1.0	4.1	2.4 ± 1.3
Bighorn Sheep Bone	% Ash	16	39.	19.	33.		
	$^{90}Sr^{(d)}$		2.7	0.37	1.0	0.68	0.17 ± 0.05
	$^{238}Pu^{(c)}$		0.85	-4.1	-0.000026	0.37	2.2 ± 1.5
	$^{239+240}Pu^{(c)}$		6.2	-0.57	0.14	1.6	1.5 ± 1.4
Bighorn Sheep Kidney	$^{3}H^{(b)}$	17	3.0	-1.3	0.75	1.1	3.5 ± 0.01

(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.

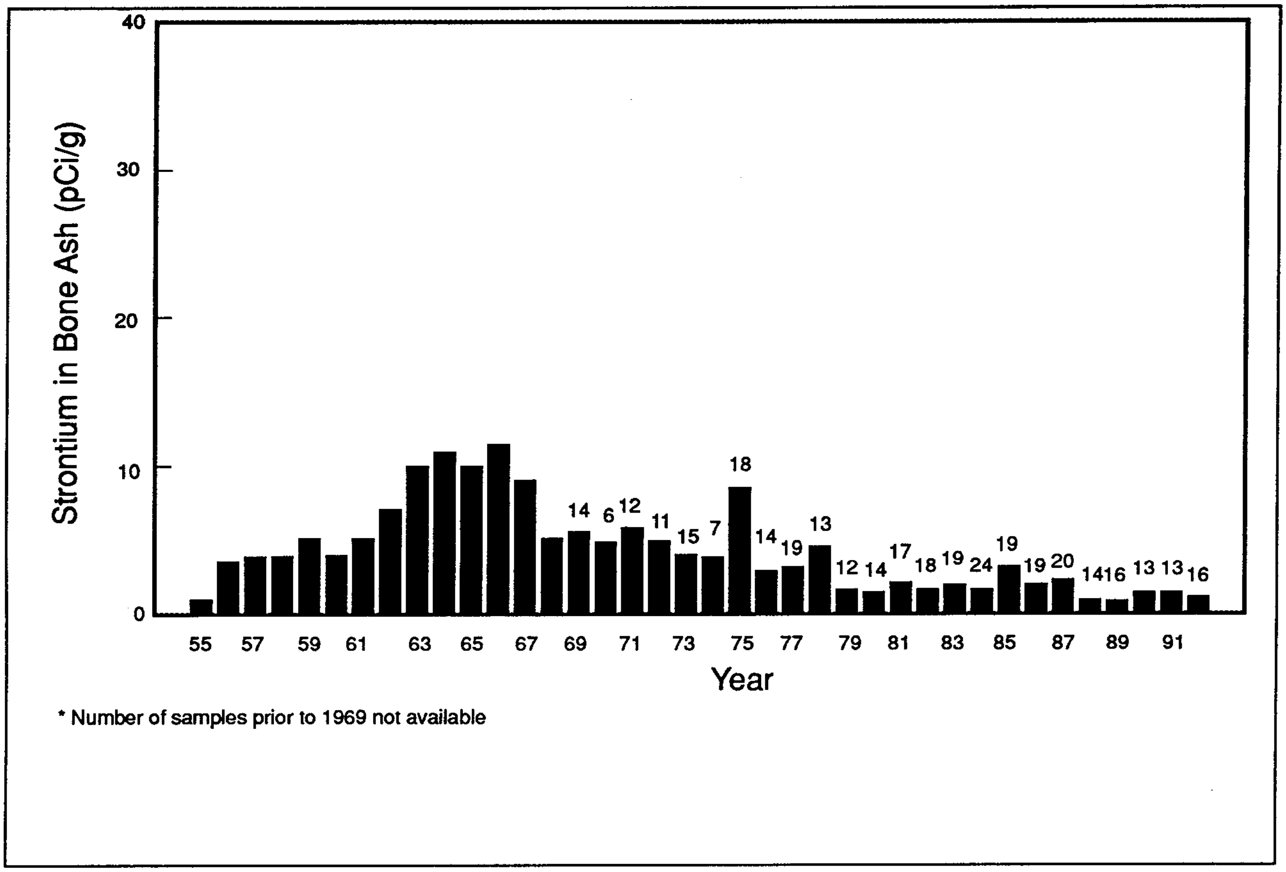

Figure 5.11 Average Strontium levels in bighorn sheep, 1955 - 1992

The mule deer collected in the third quarter was a young buck in fair condition obtained by hunting in Area 19 of the NTS. The blood sample did not contain ^{3}H above the MDC of 4.8 x 10^{-7} µCi/mL and there were no gamma-emitting radionuclides other than ^{40}K in the soft tissues. Plutonium-238 was found in the lung and rumen content. Bone contained only ^{90}Sr, 1.4 ± 0.2 pCi/g ash. All soft tissue samples contained $^{239+240}Pu$; the lungs contained 0.011 ± 0.002 pCi/g ash, the liver 0.002 ± 0.0001 pCi/g ash, and the muscle 0.012 ± 0.002 pCi/g ash.

The final hunter kill in the fall was a nonlactating doe in good condition located in Area 19 of the NTS on Pahute Mesa road. There was no ^{3}H found in the blood above the MDC of 5.2 x 10^{-7} µCi/mL and no gamma emitting radionuclides other than ^{40}K were detected in soft tissue or rumen contents. Liver, muscle, and rumen contained $^{239+240}Pu$: 0.052 ± 0.008 (liver), 0.097 ± 0.008 (muscle), and 0.037 ± 0.005 (rumen) pCi/g ash, respectively. Bone contained 0.008 ± 0.001 pCi/g ash $^{239+240}Pu$ and 0.39 ± 0.32 pCi/g ash of ^{89}Sr and 0.68 ± 0.07 pCi/g ash of ^{90}Sr.

The medians and ranges of the 1992 mule deer analyses, presented in Table 5.30, are similar to those reported for mule deer collected in 1991 for bone tissue analyses and ^{238}Pu analyses in all tissues (DOE, 1992). The average ^{90}Sr levels found in mule deer bone ash since 1955 are shown in Figure 5.12. Marked differences between years are observed in the medians of tritium activity in blood and $^{239+240}Pu$ in ashed soft tissues. These differences are due to the fact that two contaminated animals were collected in 1991. In past years, none or, at most, one of the mule deer have shown evidence of radioactive contamination and, thus, a contaminated sample had no impact on the median.

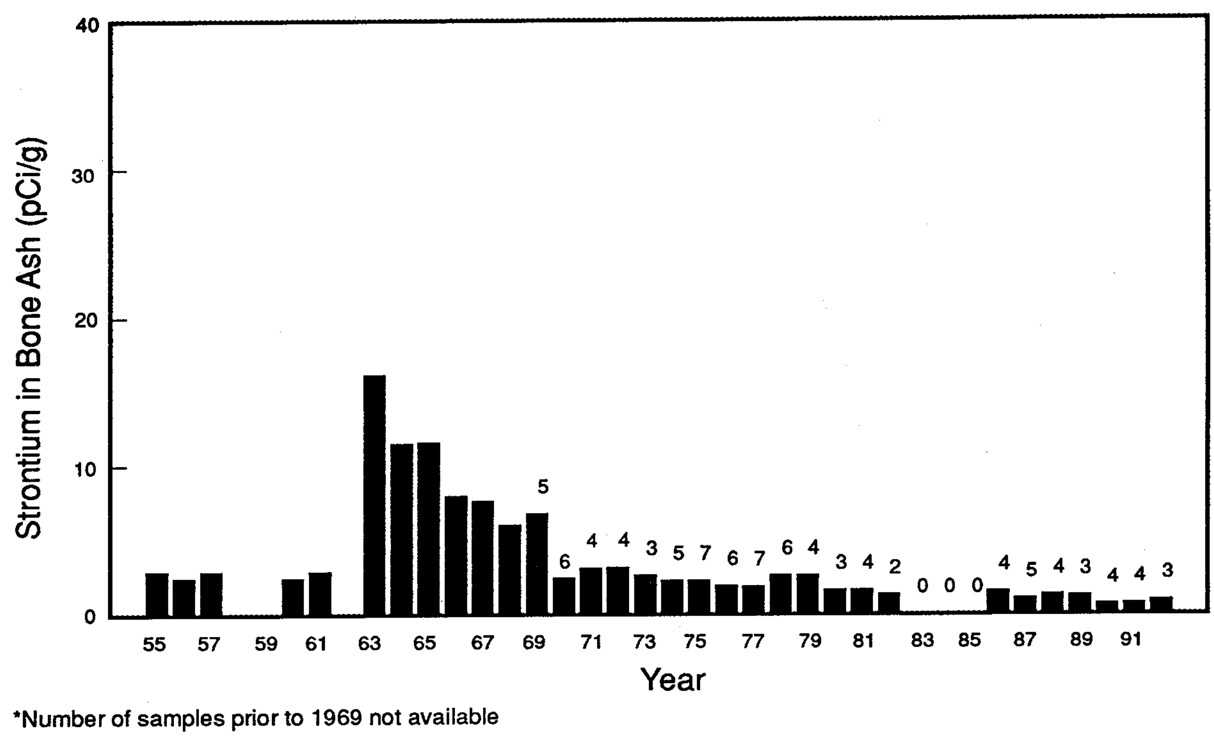

Figure 5.12 Average Strontium levels in mule deer, 1955 - 1992

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 1992, from the G.L. Coffer Fleur de Lis Ranch of Beatty, Nevada had detectable concentrations of ^{90}Sr in bone ash samples, ranging from 0.27 ± 0.08 pCi/g ash to 0.75 ± 0.13 pCi/g ash. One bone sample contained, 0.001 ± 0.001 pCi/g ash of ^{238}Pu and 0.003 ± 0.001 pCi/g ash of $^{239+240}Pu$. One of the cows was pregnant. The fetal bone contained no ^{90}Sr above the detectable concentration of 0.70 pCi/g ash. The average ^{90}Sr found in cattle bone ash since 1955 are shown in Figure 5.13. All liver samples from the adult cattle contained $^{239+240}Pu$, ranging from 0.004 ± 0.001 pCi/g ash to 0.015 ± 0.004 pCi/g ash. No ^{3}H was detected above the MDC. These animals had ranged from Beatty into the NTS in the Beatty Wash area.

Four cattle were purchased in September 1992, from the Cortney Dahl ranch in Delamar Valley (near Alamo, NV). The livers of three of the animals contained $^{239+240}Pu$ ranging from 0.010 ± 0.004 pCi/g ash to 0.014 ± 0.002 pCi/g ash and one liver contained 0.008 ± 0.003 pCi/g ash of ^{238}Pu. Only one bone sample contained $^{239+240}Pu$, 0.018 ± 0.002 pCi/g ash, but all four contained ^{90}Sr ranging from 0.34 ± 0.06 to 0.88 ± 0.07 pCi/g ash. One bone sample also

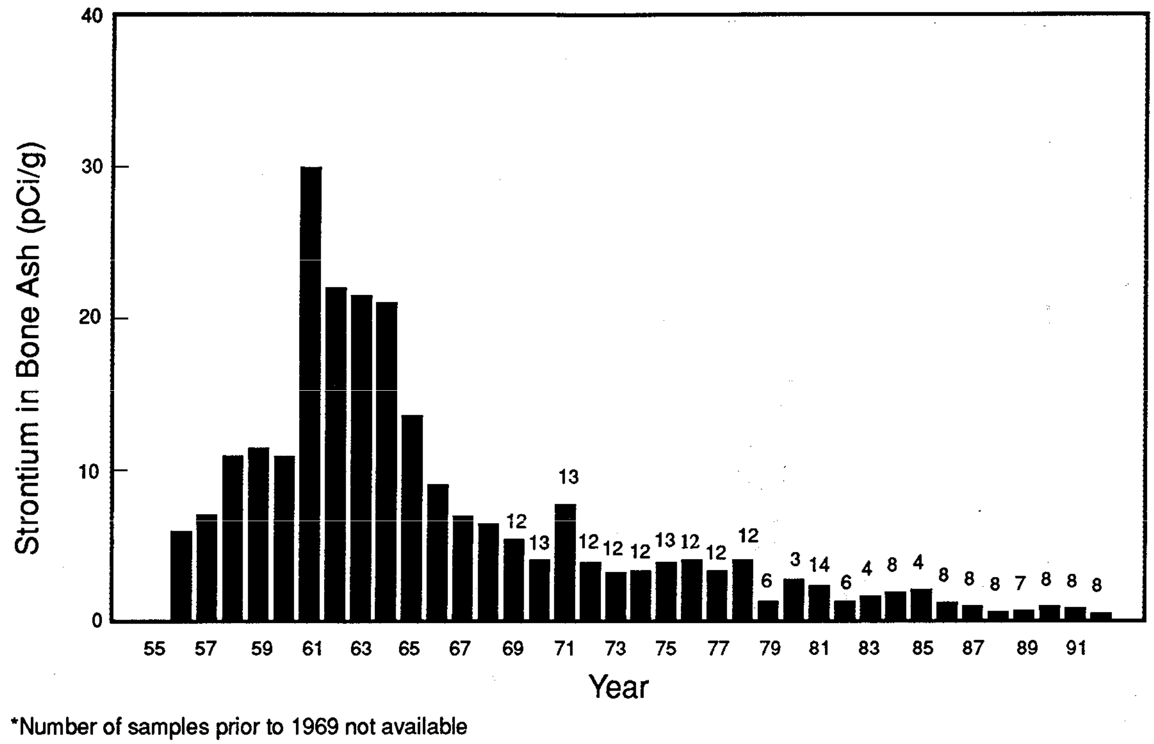

Figure 5.13 Average Strontium levels in cattle, 1955 - 1992

contained ^{89}Sr, 0.72 ± 0.36 pCi/g ash. One cow was pregnant and the fetus contained 0.005 ± 0.001 pCi/g ash of $^{239+240}Pu$. No ^{3}H was detected above the MDC. Medians and ranges, given in Table 5.30, are similar to those reported for animals collected in 1991 (DOE, 1992).

FRUITS AND VEGETABLES

In the fall of 1992, eight samples of locally grown fruits and vegetables were donated by offsite residents in Utah and Nevada. Fruits and vegetables sampled included apples, broccoli, cabbage, carrots, and summer squash. All samples were analyzed for gamma-emitting radionuclides and only naturally occurring ^{40}K was detected. All samples were analyzed for tritium; no results greater than the MDC of the analysis were obtained. Samples were then ashed and analyzed for ^{90}Sr, ^{238}Pu, and $^{239+240}Pu$. Results which were greater than the MDC of the analysis are listed in Table 5.31. Four vegetable samples from Nevada, (cabbage, broccoli, and two samples of carrots with tops), contained ^{90}Sr greater than the MDC of the analysis. The source of the ^{90}Sr may have been soil particles adhered to the vegetable. No ^{238}Pu was found in any of the samples. Concentrations of $^{239+240}Pu$ greater than the analysis MDC were found in all carrots with tops samples. None of the smooth-skinned surface crops contained these radionuclides.

5.2.2.5 THERMOLUMINESCENT DOSIMETRY NETWORK

As part of EPA's ongoing process of continual quality improvement, a management systems review (MSR) was conducted in September and October 1992. The MSR is a type of internal

Table 5.31 Detectable ^{90}Sr and $^{239+240}Pu$ Concentrations in Vegetables

Vegetable	Collection Location	% Ash	$^{90}Sr \pm 1\sigma$ pCi/g ash (MDC)	$^{239+240}Pu \pm 1\sigma$ 10^{-3} pCi/g ash (MDC)
Broccoli	Rachel, NV	0.45	2.0 ± 0.49 (1.4)	
Cabbage	Rachel, NV	0.31	0.78 ± 0.18 (0.62)	
Carrots with tops	Alamo, NV	1.61	0.34 ± 0.05 (0.12)	1.3 ± 0.5 (0.83)
Carrots with tops	Rachel, NV	1.03	0.82 ± 0.22 (0.68)	3.4 ± 1.5 (2.3)
Carrots with tops	LaVerkin, UT	1.21		0.77 ± 0.41 (0.72)

audit, with the focus on the appropriateness of processes and the adequacy of meeting program objectives. It is meant to be a cooperative assessment, involving quality assurance staff, program personnel, experts in related fields, and primary data users.

The MSR found that the offsite environmental TLD program has been modeled on programs used for occupational exposure monitoring. The objective in occupational exposure monitoring is to isolate exposure due to work-related radiation. As the objectives in the offsite external dosimetry program are to monitor ambient environmental levels of radiation, to detect and identify any trends, and to establish a baseline against which any measurable releases of radioactivity from the NTS can be compared, many of the processes commonly used in occupational exposure monitoring are inappropriate. In particular, the use of control dosimeters to measure exposure due to background and transit time were identified as concerns and were intensively investigated. The investigation revealed that adjustments made to results by using these controls yielded values that were not representative of total ambient environmental radiation levels. The error in the results was determined to be 30 to greater than 100 percent, although the absolute magnitude of the error, in units of mR, is small. In the absence of a significant release of radioactivity from the NTS or elsewhere, all samples are representative of background radiation.

No data are available at this time. All data from 1991 and 1992 are currently being reviewed and corrected to be fully representative of ambient radiation levels. New procedures are being implemented so that all future data, including all results obtained for 1993, will be correct. Final valid data for 1991 and 1992 will be released when available.

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. Weekly averages were compiled for every station, for every week during 1992 with the exception of the weeks listed in Table 5.32. Data were unavailable during these weeks due to equipment failure.

Table 5.33 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 6.0 μR/hr at Las Vegas, Nevada to 19.3 μR/hr at Austin, Nevada. For each station, this table also shows the total mR/yr (calculated based on mean of the weekly averages) and the average gamma exposure rate from 1991. Total mR/yr measured by this network ranged from 53 mR/yr at Las Vegas, Nevada, to 169 mR/yr at Austin, Nevada. 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 (Committee on the Biological Effects of Ionizing Radiation, 1980). The annual exposure levels observed at each PIC station are well within these U.S. background levels. Figure 5.14 shows the distribution of the weekly averages from each station arranged by ascending means (represented by filled circles). The left and right edges of the box on the graph represent the 25th and 75th percentiles of the distribution of the weekly averages (i.e., 50 percent of the data falls within this region). The vertical line drawn inside the box represents the 50th percentile or median value. The horizontal lines extend from the box to the minimum and maximum values.

The data from Goldfield, Nevada show the greatest range. From October 1990 until the sensor unit was exchanged in February 1992, the PIC unit at this location had been underestimating the gamma exposure rate. The gamma exposure rates measured from February to December 1992 closely resemble those seen prior to October 1990.

5.2.2.7 OFFSITE DOSIMETRY NETWORK

During 1992, whole-body and lung counting were performed on 281 individuals, of whom 107 were participants in the Offsite Internal Dosimetry Network (see Chapter 4, Figure 4.14 for the location of the participating families). An additional 118 gamma spectra were obtained for radiation workers, including EPA, DOE, and contractor personnel. Special study whole-body counts were performed for Utah State University (USU) volunteers participating in an ^{59}Fe uptake study, the U.S. Army, the U.S. Navy, and concerned citizens. No transuranic radionuclides were detected in any lung-counting data. All of the whole-body gamma spectra for the Offsite Dosimetry Network and Radiological Safety Program participants were representative of normal background and showed only naturally occurring ^{40}K. The USU volunteers, as expected, showed uptake of ^{59}Fe. The U.S Army specialist, wounded during Operation Desert Storm, was found to have depleted uranium shrapnel imbedded in his legs and in one hand. An attempt was made to determine the amount of ^{235}U and ^{238}U present in the embedded shrapnel, but the depth of most of the shrapnel was unknown as was the self absorption by the metal itself, so an accurate determination was impossible.

Bioassay results for single urine samples collected at random periods of time from participants in the Offsite Dosimetry Network showed only five samples, from random locations and times, with tritium concentrations greater than the MDC. The greatest tritium concentration detected in a sample was $3.4 \times 10^{-7} \pm 3.0 \times 10^{-7}$ μCi/mL, which is only 0.4 percent of the annual limit of intake for the general public. Table 5.34 provides a summary of bioassay results. Two participants from McGill, Nevada, did not participate in the bioassay portion of the program this year.

As reported in previous years, medical examinations of the offsite families revealed a generally healthy population. The blood examinations and thyroid profiles showed no symptoms which could be attributed to past or present NTS testing operations.

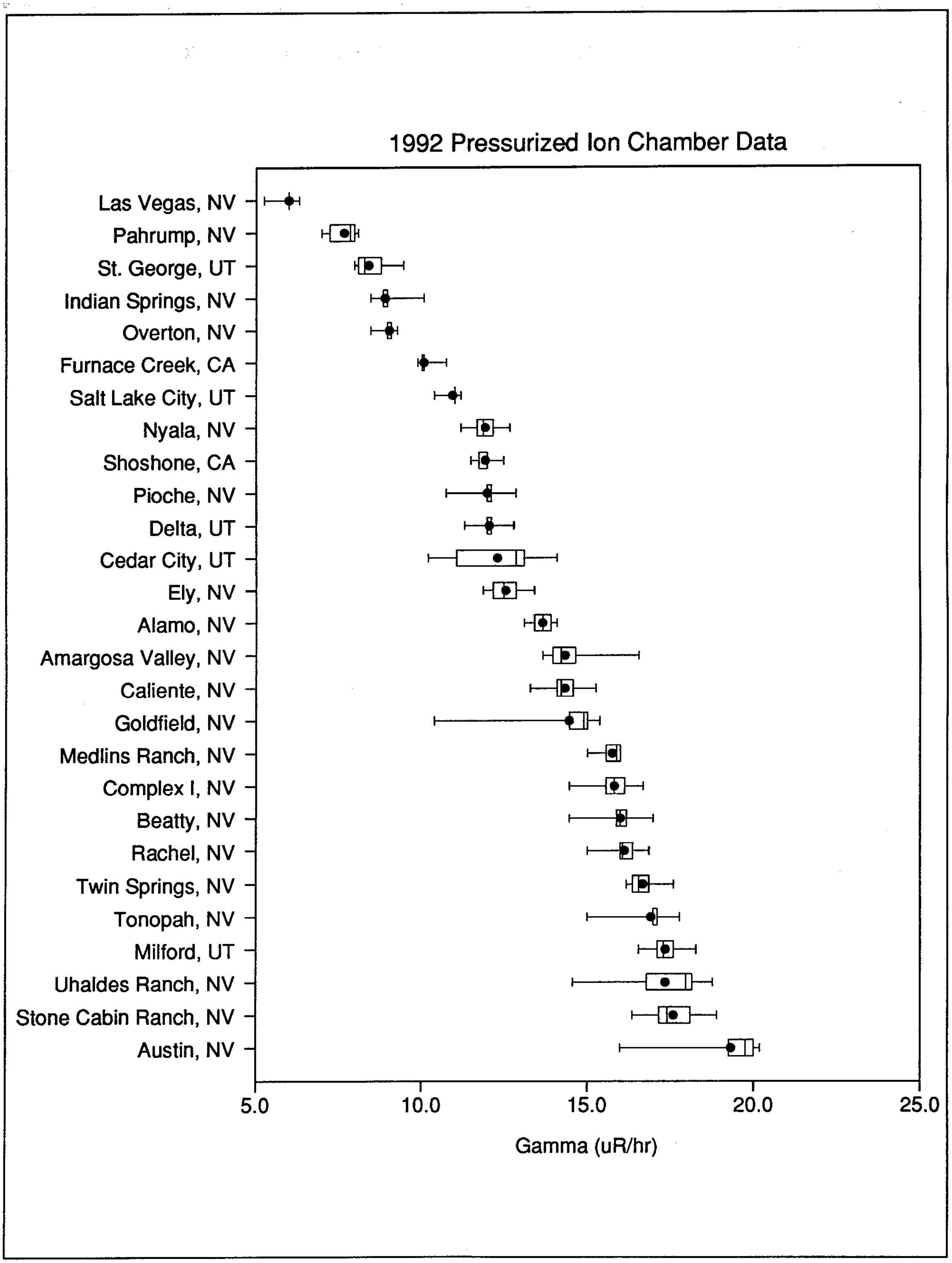

Figure 5.14. Distribution of the weekly averages from each Pressurized Ion Chamber network station - 1992

Table 5.32 Weeks for which Pressurized Ion Chamber Data were Unavailable

Station	Week Ending	Station	Week Ending
Alamo, Nevada	July 15 July 22 July 28	Nyala, Nevada	February 25 March 11 November 17 November 24
Austin, Nevada	January 14	Pahrump, Nevada	June 16 November 11 November 24
Cedar City, Utah	May 12		
Delta, Utah	May 26	Salt Lake City, Utah	February 4 February 18
Furnace Creek, California	June 2	St. George, Utah	February 25 May 12 June 16
Las Vegas, Nevada	January 21 January 28	Twin Springs, Nevada	December 30
Medlin's Ranch, Nevada	March 11		

Table 5.33 Summary of Weekly Gamma Exposure Rates as Measured by Pressurized Ion Chamber - 1992

		Gamma Exposure Rate (μR/hr)						
Station	Number of Weekly Averages	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Median	mR/yr	1991 Mean (μR/hr)
Furnace Creek, CA	51	10.8	9.9	10.1	0.18	10.0	88	10.1
Shoshone, CA	52	12.5	11.5	11.9	0.24	12.0	105	11.8
Alamo, NV	49	14.1	13.1	13.7	0.30	13.7	120	13.4
Amargosa Valley, NV	52	16.6	13.7	14.4	0.54	14.2	126	14.0
Austin, NV	51	20.2	16.0	19.3	1.05	19.8	169	17.4
Beatty, NV	52	17.0	14.5	16.0	0.50	16.0	140	16.3
Caliente, NV	52	15.3	13.3	14.4	0.42	14.2	126	14.3
Complex I, NV	52	16.7	14.5	15.8	0.41	15.9	139	15.9
Ely, NV	52	13.4	11.9	12.6	0.41	12.5	110	12.3
Goldfield, NV	52	15.4	10.4	14.5	1.03	14.9	127	12.8
Indian Springs, NV	52	10.1	8.5	8.9	0.27	9.0	78	8.7
Las Vegas, NV	50	6.3	5.3	6.0	0.12	6.0	53	5.9
Medlin's Ranch, NV	51	16.0	15.0	15.8	0.28	15.9	138	15.8
Nyala, NV	48	12.7	11.2	11.9	0.36	11.9	104	12.4
Overton, NV	52	9.3	8.5	9.0	0.16	9.0	79	8.9
Pahrump, NV	48	8.1	7.0	7.7	0.39	7.9	67	7.9
Pioche, NV	52	12.9	10.8	12.0	0.35	12.0	105	11.8
Rachel, NV	52	16.9	15.0	16.2	0.37	16.1	142	15.9
Stone Cabin Ranch, NV	52	18.9	16.4	17.6	0.59	17.5	154	17.6
Tonopah, NV	52	17.8	15.0	16.9	0.51	17.0	148	16.7
Twin Springs, NV	51	17.6	16.2	16.7	0.37	16.6	146	16.7
Uhalde's Ranch, NV	52	18.8	14.6	17.4	1.15	18.0	152	17.0
Cedar City, UT	51	14.1	10.2	12.3	1.12	12.9	108	10.6
Delta, UT	51	12.8	11.3	12.1	0.24	12.0	106	11.9
Milford, UT	52	18.3	16.6	17.4	0.37	17.3	152	17.4
Salt Lake City, UT	50	11.2	10.4	11.0	0.15	11.0	96	10.9
St. George, UT	49	9.5	8.0	8.4	0.42	8.3	74	8.9

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

Table 5.34 Tritium in Urine, Offsite Internal Dosimetry Program - 1992

		^{3}H Concentration (10^{-7} µCi/mL)				
Location	Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as % DCG
Shoshone, CA	3	-0.014	-1.1	-0.42	0.57	NA
Alamo, NV	10	1.8	-0.59	0.94	0.73	0.10
Beatty, NV	10	3.1	-0.57	0.97	1.2	0.11
Goldfield, NV	2	2.7	1.6	2.2	0.76	0.24
Henderson, NV	2	1.3	0.76	1.0	0.38	0.11
Indian Springs, NV	2	1.3	0.74	1.0	0.41	0.11
Las Vegas, NV	2	2.3	1.4	1.8	0.67	0.21
Lund, NV	2	1.5	1.4	1.4	0.055	0.16
Nyala, NV	9	3.4	0.043	1.4	1.0	0.16
Overton, NV	11	2.0	0.84	1.4	0.42	0.15
Pahrump, NV	23	2.5	0.0	1.0	0.77	0.11
Pioche, NV	10	1.7	0.31	0.80	0.55	0.09
Rachel, NV	4	2.1	1.2	1.7	0.37	0.19
Tonopah, NV	4	3.0	-0.64	1.7	1.6	0.18
Cedar City, UT	11	1.6	-0.79	0.91	0.71	0.10

Mean MDC: 2.5 x 10^{-7} µCi/mL   Standard Deviation of Mean MDC: 0.53 x 10^{-7} µCi/mL

DCG Derived Concentration Guide; Established by DOE Order as 9 x 10^{-5} µCi/mL
NA Not Applicable

6.0 DOSE ASSESSMENT

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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, based on onsite source emission measurements and estimates provided by DOE and calculated by EPA's CAP88-PC model, resulted in a maximum dose of 0.012 mrem (1.2 x 10^{-4} mSv) to a hypothetical resident of Indian Springs, NV, 54 km (32 mi) SE of the NTS Control Point. Monitoring network data indicated a 1992 dose of 78 mrem (0.78 mSv) from normal background radiation occurring in Indian Springs. The calculated dose to this individual from world-wide distributions of radioactivity as measured from surveillance networks was 0.088 mrem. The calculated population dose (collective effective dose equivalent) to the approximately 21,750 residents living within 80 km (50 mi) from each of the NTS airborne emission sources was 0.029 person-rem (2.9 x 10^{-4} person-Sv). An additional EDE of 2 x 10^{-3} mrem would be received if all of the 45 kg (100 lb) of meat from a contaminated deer collected on the NTS were consumed. All of these maximum dose estimates are about 1% 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 a resident of 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. 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 sum of these methods provides an estimate of the EDE to a hypothetical, single individual who would have to have been continuously present in one location and outdoors. In addition, a Collective EDE is calculated by the first method for the total offsite population residing within 80 km (50 mi) of the NTS. 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 1992. These four pathways were:

- Background radiation due to natural sources such as cosmic radiation, natural radioactivity in soil, and ^{7}Be in air
- Worldwide distributions of 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 drillback and purging activities

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

Operational releases and other 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 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 Weather Service Nuclear Support Office (WSNSO) were used to construct wind roses, indicating the prevailing winds for the following areas: Mercury, Area 12, Area 20, Yucca Flat, and 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 have been continuously present at Indian Springs, Nevada, 54 km (32 mi) SE of CP-1. The maximum dose to that individual was 0.012 mrem (1.2×10^{-4} mSv). For comparison, data from the PIC monitoring network indicated a 1992 dose of 78 mrem from background gamma radiation occurring in Indian Springs. In addition, a collective population dose was calculated. The population living within a radius of 80 km (50 mi) from each of the sources on the NTS was estimated to be 21,750 individuals, based on 1991 data. The collective population dose within 80 km (50 mi) from the airborne emission sources was calculated to be 0.029 person-rem (2.9×10^{-4} 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, the maximum EDE of 0.012 mrem is due almost entirely to tritium. The annual average HTO in air concentration that would cause this EDE is 40 times that actually measured in Indian Springs. Table 6.1 summarizes the annual contributions to the EDEs due to 1992 NTS operations as calculated by use of CAP88-PC and the released radionuclides listed in Table 5.1.

Input data for the CAP88-PC model include meteorological data from WSNSO 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. Results obtained by using the CAP88-PC model are considered over-estimates of the dose to offsite residents since these results are much less than exposures estimated with offsite monitoring results.

6.1.2 ESTIMATED DOSE USING MONITORING NETWORK DATA

Potential CEDEs to individuals may be estimated from the concentrations measured by the EPA monitoring networks during 1992. Actual results obtained in analysis are used; the majority of which are less than the reported MDC. Precision and accuracy DQOs 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.

Table 6.1 Summary of Effective Dose Equivalents from NTS Operations during 1992

	Maximum EDE at NTS Boundary[(a)]	Maximum EDE to an Individual[(b)]	Collective EDE to Population within 80 km of the NTS Sources
Dose	1.7×10^{-2} mrem (1.7×10^{-4} mSv)	$1.2 \pm 0.1 \times 10^{-2}$ mrem (1.2×10^{-4} mSv)	2.9×10^{-2} person-rem (2.9×10^{-4} person-Sv)
Location	Site boundary 60 km SSE of NTS Area 12	Indian Springs, 80 km SSE of NTS Area 12	21,700 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	0.17	0.12	-----
Background	78 mrem (0.78 mSv)	78 mrem (0.78 mSv)	1660 person-rem (16.6 person Sv)
Percentage of Background	2.2×10^{-2}	1.5×10^{-2}	1.6×10^{-3}

(a) The maximum boundary dose is to a hypothetical individual who remains in the open continuously during the year at the NTS boundary located 60 km SSE from the Area 12 tunnel ponds.

(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.

The concentrations given in Table 6.2 are expressed in terms of activity per unit volume, weight, or time. 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 for a 10 year old child = 164 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).

Table 6.2 Monitoring Networks Data used in Dose Calculations

Medium	Radionuclide	Concentration	Comment
Animals			
Beef Liver	$^{239+240}Pu$	1.97×10^{-4} pCi/g (7.3×10^{-6} Bq/g)	Concentrations are the maximum concentrations observed for each animal tissue type
Deer Muscle	$^{239+240}Pu$	8.69×10^{-4} pCi/g (3.2×10^{-5} Bq/g)	
Deer Liver	$^{239+240}Pu$	6.73×10^{-4} pCi/g (2.5×10^{-5} Bq/g)	
Milk	^{90}Sr	0.65 pCi/L (0.024 Bq/L)	Concentration is the average of all network strontium results
	^{3}H	153 pCi/L (5.7 Bq/L)	Concentration is the average of all network tritium results
Drinking Water	^{3}H	1.3 pCi/L (0.05 Bq/L)	Concentration is the average of results from the two wells in Indian Springs, Nevada
Vegetables			
Broccoli	^{90}Sr	9.00×10^{-3} pCi/g (3.3×10^{-4} Bq/g)	Concentrations are maximum observed for each sample type
Carrots	$^{239+240}Pu$	3.50×10^{-5} pCi/g (1.3×10^{-6} Bq/g)	
Air	^{3}H	0.66 pCi/m^3 (0.024 Bq/m^3)	Concentration is the average of all tritium results from network
	^{85}Kr	26.7 pCi/m^3 (0.99 Bq/m^3)	Concentration is the highest annual average at any location
	$^{239+240}Pu$	2.2×10^{-6} pCi/m^3 (8.1×10^{-8} Bq/m^3)	Concentration is the network highest annual average

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)
- ^{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:

- (0.66 pCi/m^3) x (8400 m^3/yr) x (6.4×10^{-8} mrem/pCi) = 3.5×10^{-4} mrem/yr.

However, in calculating the inhalation CEDE from ^{3}H, the value is increased by 50% to account for absorption through the skin. The total dose in one year, therefore, is $1.5 \times 3.5 \times 10^{-4} = 5.3 \times 10^{-4}$ mrem. Dose calculations from ORSP data are given in Table 6.3.

The dose from consumption of a mule deer collected on the NTS is not included in Table 6.3. The individual CEDEs from the various pathways added together give a total of 0.088 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:

$$\{[(8.69 \times 10^{-4} \text{ pCi/g}) \times (4.5 \times 10^{4} \text{ g})] + [(6.73 \times 10^{-4} \text{ pCi/g}) \times (280 \text{ g})]\} \times (3.7 \times 10^{-4} \text{ mrem/pCi}) = 1.4 \times 10^{-2} \text{ mrem}$$

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 1992.

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 equation.

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 3.2×10^{-7} mrem/pCi, this equates to a dose of 7.8×10^{-4} mrem. This is a negligible quantity when compared with the PIC network measurements that vary from 53 to 169 mR/year, depending on location.

Table 6.3 Dose Calculations from Monitoring Network Data

Medium	Route of Exposure	Radionuclide	Calculation	Dose (EDE) (mrem/yr)
Milk				
	Ingestion	^{90}Sr	(0.65 pCi/L) x (164 L/year) x (1.4 x 10^{-4} mrem/pCi)	1.5 x 10^{-2}
		^{3}H	(153 pCi/L) x (164 L/year) x (6.4 x 10^{-8} mrem/pCi)	1.6 x 10^{-3}
Total from Milk Consumption				1.66 x 10^{-2}
Foodstuffs				
Beef Liver	Ingestion	^{238}Pu	(1.01 x 10^{-4} pCi/g) x (11.5 x 10^{3} g/yr) x (3.7 x 10^{-4} mrem/pCi)	4.2 x 10^{-4}
		$^{239+240}Pu$	(1.97 x 10^{-4} pCi/g) x (11.5 x 10^{3} g/yr) x (3.7 x 10^{-4} mrem/pCi)	8.4 x 10^{-4}
Broccoli[(a)]	Ingestion	^{90}Sr	(9.00 x 10^{-3} pCi/g) x (258 g/day) x (125 days/yr) x (1.4 x 10^{-4} mrem/pCi)	4.1 x 10^{-2}
Carrots[(a)]	Ingestion	$^{239+240}Pu$	(3.50 x 10^{-5} pCi/g) x (258 g/day) x (125 days/yr) x (3.7 x 10^{-4} mrem/pCi)	1.3 x 10^{-3}
Total from Foodstuff Consumption				4.4 x 10^{-2}
Air				
	Submersion/ Inhalation	^{3}H	(0.66 pCi/m^3 x 8400 m^3/y x 1.5 x 6.4 x 10^{-8} mrem/pCi)	5.3 x 10^{-4}
	Submersion	^{85}Kr	(26.7 pCi/m^3 x 1.5 x 10^{-5} mrem/yr per pCi/m^3)	4.0 x 10^{-4}
	Inhalation	$^{239+240}Pu$	2.2 x 10^{-6} pCi/m^3 x 8400 m^3 x 0.31 mrem/pCi	5.7 x 10^{-3}
Total from Air				6.6 x 10^{-3}
Total from Ingestion, Inhalation, Absorption and Submersion				6.7 x 10^{-2}

(a) The vegetable intake of 516 g/d was split between broccoli and carrots and the number of days used for consumption were 125, slightly more than 4 months.

6.3 SUMMARY

The extensive offsite environmental surveillance system operated around the NTS by EPA EMSL-LV measured no radiological exposures that could be attributed to recent NTS operations. Calculation with the CAP88-PC model resulted in a maximum inhalation dose of 0.012 mrem (1.2×10^{-4} mSv) to a hypothetical resident of Indian Springs, NV, 54 km (32 miles) SE of the NTS CP-I. If this individual were also to collect and consume an NTS deer such as the one discussed above, the estimated EDE would increase by another 1.4×10^{-2} mrem to a total possible EDE of about 0.026 mrem. This maximum dose estimate is less than 0.1% 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 21,750 residents living within 80 km (50 mi) of each of the NTS airborne emission sources was 0.029 person-rem (2.9×10^{-4} person-Sievert).

Data from the PIC gamma monitoring indicated a 1992 dose of 78 mrem from background gamma radiation measured in Indian Springs. This gamma background value is derived from an average PIC field measurement of 8.7 μR/hr. The 0.067 mrem CEDE calculated from the monitoring networks discussed above is a negligible amount by comparison.

The uncertainty (2σ) for the PIC measurement at the 78 mrem exposure level is approximately 3 percent. Extrapolating to the calculated annual exposure at Indian Springs, Nevada, yields a total uncertainty of approximately 2.3 mrem. Because the estimated dose from NTS activities is much less than 1 mrem (the lowest level for which DQOs are defined, as given in Chapter 11) no conclusions can be made regarding the achieved data quality as compared to the DQO for this insignificant dose.

7.0 NONRADIOLOGICAL MONITORING RESULTS

R. B. Hunter and S. A. Wade

Environmental nonradiological monitoring of NTS operations involved only onsite monitoring as there were no nonradiological discharges to the offsite environment. Onsite drinking water distribution systems were monitored for Safe Drinking Water Act compliance; sewage influents to onsite lagoons were monitored for state of Nevada permit requirements; monitoring for polychlorinated biphenyls (PCBs) was conducted as part of Toxic Substance Control Act compliance; asbestos monitoring was conducted for asbestos removal and renovation projects; and environmental media were sampled for hazardous characteristics and constituents. Flora, fauna, and special environmental conditions were also monitored for 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. All samples were collected according to accepted practices and sent to state approved laboratories for analysis.

7.1.1.1 BACTERIOLOGICAL SAMPLING

All drinking water distribution systems on the NTS were sampled by Reynolds Electrical & Engineering Co., Inc. (REECo). Common sampling points were rest-room and cafeteria sinks. The samples were submitted for analysis of coliform bacteria to the state-approved Associated Pathologists Laboratories in Las Vegas, Nevada. Bacteriological testing was conducted according to Nevada Administrative Code (NAC) 445.247 and 40 CFR Part 141. These require that all water systems servicing fewer than 1000 nontransient persons be tested once a month. Systems serving more persons must be tested more frequently.

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.

Using the "most probable number" technique, if the coliform bacteria colony count exceeded 2.2 colonies per 100-mL sample, or, using the "membrane filter" technique, if the coliform bacteria colony count exceeded zero, the system would have been declared unsafe and closed. In order to reopen the system, three consecutive samples had to have a coliform count below the state standard.

Sample results for 1992 for the distribution systems water quality parameters are listed in Table 7.1, along with applicable state of Nevada permit numbers. The samples were taken

Table 7.1 Monthly Monitoring Results for NTS Potable Water Systems - 1992[a]

Area/ Building	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
						PERMIT NY-360-12C						
Area 22												
RC	1.0	0.5	5.0[e]	0.6	1.0	0.5	1.0	0.3	0.3	1.0	0.5	0.5
Coliform	0	0	0	0	0	0	0	0	0	0	0	0
RC	--	--	0.5	--	--	0.5	--	--	--	--	--	--
Coliform	--	--	0	--	--	0	--	--	--	--	--	--
Area 23												
RC	1.0	0.5	0.5	0.5	0.5	2.3	0.9	0.1	0.6	0.5	0.9	0.7
Coliform	0	0	Yes[d]	0	0	0	0	0	0	0	0	0
RC	1.0	0.5	0.5	0.5	0.5	0.5	1.0	0.9	0.8	0.8	0.9	0.7
Coliform	0	0	0	0	0	0	0	0	0	0	0	0
RC	1.0	0.5	0.5	0.5	0.5	0.5	1.0	0.9	0.5	0.8	0.9	0.7
Coliform	0	--	0	0	0	0	0	0	0	0	0	0
RC	--	--	0.4	2.5	--	0.5	--	0.9	--	--	--	--
Coliform	--	--	0	0	--	0	--	0	--	--	--	--
RC	--	--	0.5	--	--	--	--	--	--	--	--	--
Coliform	--	--	0	--	--	--	--	--	--	--	--	--
RC	--	--	0.5	--	--	--	--	--	--	--	--	--
Coliform	--	--	0	--	--	--	--	--	--	--	--	--
RC	--	--	0.4	--	--	--	--	--	--	--	--	--
Coliform	--	--	0	--	--	--	--	--	--	--	--	--
RC	--	--	0.8	--	--	--	--	--	--	--	--	--
Coliform	--	--	0	--	--	--	--	--	--	--	--	--
RC	--	--	0.8	--	--	--	--	--	--	--	--	--
Coliform	--	--	0	--	--	--	--	--	--	--	--	--
RC	--	--	0.8	--	--	--	--	--	--	--	--	--
Coliform	--	--	0	--	--	--	--	--	--	--	--	--
RC	--	--	0.5	--	--	--	--	--	--	--	--	--
Coliform	--	--	0	--	--	--	--	--	--	--	--	--
RC	--	--	0.4	--	--	--	--	--	--	--	--	--
Coliform	--	--	0	--	--	--	--	--	--	--	--	--
RC	--	--	0.5	--	--	--	--	--	--	--	--	--
Coliform	--	--	0	--	--	--	--	--	--	--	--	--
Area 23 Fill Stand												
RC	--	--	0.5	0.8	--	--	--	--	--	--	--	--
Coliform	--	--	0	0	--	--	--	--	--	--	--	--
						PERMIT NY-4098-12NC						
Area 25												
RC	0.6	0.8	0.5	0.1	0.2	0.5	0.7	0.9	0.3	0.5	0.5	0.6
Coliform	0	0	0	0	0	0	0	0	0	0	0	0
						PERMIT NY-4099 12NC						
Area 2												
RC	0.4	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.8	0.5	0.6	0.2
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) Total coliforms present on samples taken on Feb. 7 and 20, 1992 at the Area 3 Cafeteria. Three follow-up tests on Feb. 24, 1992, indicated the absence of coliforms. Water was posted during the interim.

(c) Total coliforms present on sample taken on March 17, 1992 at the Area 6 Fill Stand. Three follow up tests on March 24, 1992, indicated the absence of coliforms. This fill stand was not used during the interim.

(d) Total coliforms present on sample taken on March 13, 1992 in Area 23 Building 790. Multiple follow up samples taken on March 18, 1992, indicated the absence of coliforms.

(e) This sample was taken at the well head and indicates elevated chlorine level following superchlorination of the water column after installation of a new pump.

Table 7.1 (Monthly Monitoring Results for NTS Potable Water Systems - 1992[a], cont.)

Area/ Building	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Area 12												
RC	0.4	0.5	0.5	0.5	0.5	0.3	0.6	0.5	0.8	0.5	0.5	0.5
Coliform	0	0	0	0	0	0	0	0	0	0	0	0
RC	0.4	0.4	0.5	0.5	0.5	0.3	0.4	0.5	0.5	0.8	0.5	0.8
Coliform	0	0	0	0	0	0	0	0	0	0	0	0
RC	--	0.5	0.5	--	--	0.3	0.6	0.5	0.5	0.5	0.5	0.6
Coliform	--	0	0	--	--	0	0	0	0	0	0	0
RC	--	--	--	--	--	1.0	--	--	--	--	--	--
Coliform	--	--	--	--	--	0	--	--	--	--	--	--
RC	--	--	--	--	--	--	--	--	--	--	--	--
Coliform	--	--	--	--	--	--	--	--	--	--	--	--
					PERMIT NY-5000-12NC							
Area 6												
RC	1.0	1.0	1.0	0.6	1.0	1.0	0.6	0.6	0.8	0.8	0.8	0.5
Coliform	--	0	0	0	0	0	0	0	0	0	0	0
RC	1.0	1.0	1.0	0.6	1.0	1.0	0.6	0.6	0.8	0.7	0.8	0.9
Coliform	--	--	0	0	0	0	0	0	0	0	0	0
RC	--	--	0.2	0.5	--	--	0.6	0.5	0.8	0.7	0.8	0.6
Coliform	--	--	0	0	--	--	0	0	0	0	0	0
RC	--	--	--	--	--	--	--	--	--	--	--	--
Coliform	--	--	--	--	--	--	--	--	--	--	--	--
RC	--	--	--	--	--	--	--	--	--	--	--	--
Coliform	--	--	--	--	--	--	--	--	--	--	--	--
Area 6	Fill Stand											
RC	--	--	0.8	0.8	--	--	--	--	--	--	--	--
Coliform	--	--	Yes[c]	0	--	--	--	--	--	--	--	--
RC	--	--	1.0	--	--	--	--	--	--	--	--	--
Coliform	--	--	0	--	--	--	--	--	--	--	--	--
RC	--	--	1.0	--	--	--	--	--	--	--	--	--
Coliform	--	--	0	--	--	--	--	--	--	--	--	--
RC	--	--	1.0	--	--	--	--	--	--	--	--	--
Coliform	--	--	0	--	--	--	--	--	--	--	--	--
Area 6	Sample of Water at Area 27											
RC	1.0	2.0	0.4	0.5	0.5	1.5	1.0	0.1	0.8	0.6	1.0	1.8
Coliform	0	0	0	0	0	0	0	0	0	0	0	0
RC	--	--	1.0	--	--	1.5	--	--	--	--	--	--
Coliform	--	--	0	--	--	0	--	--	--	--	--	--
RC	--	--	1.0	--	--	--	--	--	--	--	--	--
Coliform	--	--	0	--	--	--	--	--	--	--	--	--
RC	--	--	1.0	--	--	--	--	--	--	--	--	--
Coliform	--	--	0	--	--	--	--	--	--	--	--	--
RC	--	--	0.5	--	--	--	--	--	--	--	--	--
Coliform	--	--	0	--	--	--	--	--	--	--	--	--
RC	--	--	1.0	--	--	--	--	--	--	--	--	--
Coliform	--	--	0	--	--	--	--	--	--	--	--	--

(a) RC - residual chlorine in parts per million (ppm); coliform colony count is in number/100 mL.
(b) Total coliforms present on samples taken on Feb. 7 and 20, 1992 at the Area 3 Cafeteria. Three follow-up tests on Feb. 24, 1992, indicated the absence of coliforms. Water was posted during the interim.
(c) Total coliforms present on sample taken on March 17, 1992 at the Area 6 Fill Stand. Three follow up tests on March 24, 1992, indicated the absence of coliforms. This fill stand was not used during the interim.
(d) Total coliforms present on sample taken on March 13, 1992 in Area 23 Building 790. Multiple follow up samples taken on March 18, 1992, indicated the absence of coliforms.
(e) This sample was taken at the well head and indicates elevated chlorine level following superchlorination of the water column after installation of a new pump.

Table 7.1 (Monthly Monitoring Results for NTS Potable Water Systems - 1992[(a)], cont.)

Area/ Building	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
					PERMIT NY-5000-12NC							
Area 6												
RC	--	--	0.5	--	--	--	--	--	--	--	--	--
Coliform	--	--	0	--	--	--	--	--	--	--	--	--
Area 5	Sample of Water at Area 5											
RC	--	--	--	2.0	1.5	1.5	--	--	--	--	--	--
Coliform	--	--	--	0	0	0	--	--	--	--	--	--
RC	--	--	--	2.0	1.5	1.5	--	--	--	--	--	--
Coliform	--	--	--	0	0	0	--	--	--	--	--	--
					PERMIT NY-5024-12NC							
Area 1												
RC	0.1	0.5	1.5	0.1	0.5	0.1	0.7	0.5	0.3	0.4	0.5	0.1
Coliform	0	0	0	0	0	0	0	0	0	0	0	0
RC	--	--	0.1	--	--	--	--	--	--	--	--	--
Coliform	--	--	0	--	--	--	--	--	--	--	--	
					PERMIT NY-4097-12NC							
Area 3												
RC	1.5	0.8	1.0	0.4	1.0	1.1	0.9	1.0	0.3	0.5	1.0	1.0
Coliform	0	Yes[b]	0	0	0	0	0	0	0	0	0	0
RC	1.0	0.8	1.0	0.2	1.0	1.1	0.9	1.0	0.3	0.5	1.3	0.8
Coliform	0	0	0	0	0	0	0	0	0	0	0	0
RC	1.5	0.8	1.0	0.5	1.0	1.1	0.5	0.8	0.4	1.0	1.1	0.9
Coliform	0	0	0	0	0	0	0	0	0	0	0	0
RC	1.0	0.8	0.5	0.5	1.0	1.1	0.5	0.8	0.4	0.5	0.8	--
Coliform	0	0	0	0	0	0	0	0	0	0	0	--
RC	1.5	1.0	0.5	0.6	1.0	1.1	1.1	1.0	1.0	0.5	--	--
Coliform	0	0	0	0	0	0	0	0	0	0	--	--
RC	1.5	0.5	1.0	0.4	0.5	1.1	1.1	1.0	1.0	--	--	--
Coliform	0	0	0	0	0	0	0	0	0	--	--	--
RC	1.0	1.0	1.0	--	--	0.2	0.5	1.0	0.6	--	--	--
Coliform	0	Yes[b]	0	--	--	0	0	0	0	--	--	--
RC	1.0	1.0	0.2	--	--	0.2	0.5	1.0	0.5	--	--	--
Coliform	0	0	0	--	--	0	0	0	0	--	--	--
RC	1.0	0.5	1.0	--	--	1.5	0.5	--	0.5	--	--	--
Coliform	0	0	0	--	--	0	0	--	0	--	--	--
RC	1.0	0.8	1.5	--	--	1.5	1.0	--	0.5	--	--	--
Coliform	0	0	0	--	--	0	0	--	0	--	--	--
RC	1.0	0.8	2.0	--	--	--	--	--	0.5	--	--	--
Coliform	0	0	0	--	--	--	--	--	0	--	--	--
RC	1.0	0.8	1.0	--	--	--	--	--	--	--	--	--
Coliform	0	0	0	--	--	--	--	--	--	--	--	--

(a) RC - residual chlorine in parts per million (ppm); coliform colony count is in number/100 mL.

(b) Total coliforms present on samples taken on Feb. 7 and 20, 1992 at the Area 3 Cafeteria. Three follow-up tests on Feb. 24, 1992, indicated the absence of coliforms. Water was posted during the interim.

(c) Total coliforms present on sample taken on March 17, 1992 at the Area 6 Fill Stand. Three follow up tests on March 24, 1992, indicated the absence of coliforms. This fill stand was not used during the interim.

(d) Total coliforms present on sample taken on March 13, 1992 in Area 23 Building 790. Multiple follow up samples taken on March 18, 1992, indicated the absence of coliforms.

(e) This sample was taken at the well head and indicates elevated chlorine level following superchlorination of the water column after installation of a new pump.

various locations within the distribution systems. The RC results are paired with the coliform results from that specific sample. RC results (0.1 to 2.3 parts per million [ppm]) were all within state regulatory requirements with the exception of the well head sample taken in March at the Area 22 Army well. The elevated chlorine level expressed in this sample was a result of superchlorination of the well following replacement of the pump. The pH for the distribution systems is indicated in Table 7.2. Systems for which analyses indicated the presence of coliform bacteria are indicated.

Each truck which hauled potable water from NTS wells to work areas was sampled and analyzed for the presence of coliform bacteria.

7.1.1.2 Chemical Analysis

Chemical analysis for organic and inorganic compounds was conducted in accordance with NAC 445 and 40 CFR 141. The sample collection points were at each of the permitted water distribution systems on the NTS shown in Chapter 4, Figure 4.3.

7.1.1.3 Volatile Organic Compound Analysis

Samples for VOCs were collected in October 1992 from all NTS potable water wells. The samples were analyzed by Westech Laboratory Services, of Phoenix Arizona. These analyses did not indicate the presence of any VOCs above quantitation limits. Samples for analysis from Well 4a were taken in May 1992 and analyzed by Sierra Technical Services, of North Las Vegas, Nevada, for VOCs. These analyses did not indicate the presence of any VOCs.

7.1.1.4 Inorganic Compound Analysis and Water Quality

Samples for inorganic compounds and water quality were collected in October 1992, in accordance with 40 CFR 141.11 and NAC 445. These samples were sent to Westech Laboratory Services, of Phoenix Arizona. Sample results, along with state standards, are listed in Table 7.2. Well 4a was sampled by state of Nevada personnel on April 30, 1992. The results of the analyses from this sampling are included in Table 7.3.

The sample from the distribution system in Area 25 had a fluoride level of 2.0 ppm which is at the threshold limit of the state of Nevada Secondary Standard of 2.0 ppm. Following 1990 sampling results which indicated elevated fluoride concentrations, the DOE petitioned the state of Nevada for a variance to fluoride requirements for wells J-12 and J-13. In January 1991 the state of Nevada approved a variance request with the caveat that the wells be sampled on an annual basis to ensure that the fluoride level does not exceed the Primary Standard of 4.0 mg/L, and that the user population would be notified of the elevated fluoride levels. The user population was initially notified in November, 1990.

The sample from the distribution system in Area 6 had a total dissolved solids (TDS) level of 690 ppm which exceeded the state of Nevada Secondary Standard of 500 ppm. Well 5C which supplies the Mercury (Area 23) distribution continues to exhibit an elevated pH at the well head. However, mixing of water with Army well in Area 22, which also supplies the Mercury distribution system, lowers the pH to within state requirements, as indicated in Table 7.2.

Notices for posting entitled "Elevated pH in Mercury Water Supply," "Elevated TDS Concentration in Area 6 Water Supply," and "Elevated Fluoride Concentration in Area 25 Water Supply" have been previously provided to the appropriate potable water user population. These notices identified the (1) violations, (2) areas affected, and (3) potential health effects.

Table 7.2 Water Chemistry Analysis for the NTS Potable Water Distribution Systems - 1992

Constituents	WELLS						STANDARDS	
	A-23	A-25	A-12	A-6	A-6 DAF	A-1	SWDA	State Limits[b]
T.D.S.[a]	350	220	160	690	300	400	--	500
Hardness	19	47	22	32	87	250	--	--
Calcium	3.7	16	7.3	7.2	22	66	--	--
Magnesium	<0.05	1.7	1.0	3.5	7.7	21	--	--
Sodium	110	38	28	240	45	27	--	--
Potassium	1.1	4.0	2.6	9.4	5.0	5.5	--	--
Sulfate	71	14	15	66	35	83	--	250
Chloride	17	4.9	8.1	45	8.3	4.4	--	250
Nitrate	<0.50	<0.50	2.8	<0.5	1.5	<0.50	10	--
Alkalinity	230	110	62	470	130	290	--	--
Bicarbonate	230	94	62	470	130	290	--	--
Carbonate	<2.0	15	<2.0	<2.0	<2.0	<2.0	--	--
Fluoride	0.94	2.0	0.82	1.3	0.80	0.49	4.0	2.0
Arsenic	0.013	<0.010	<0.010	<0.010	<0.010	<0.010	0.05	--
Iron	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	--	0.6
Manganese	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	--	0.05
Copper	<0.05	<0.05	<0.05	0.11	<0.05	<0.05	--	1
Zinc	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	--	5
Barium	<0.05	<0.05	<0.05	<0.05	<0.05	0.13	--	1
Boron	<0.50	<0.50	<0.50	0.50	<0.50	<0.50	--	--
Silica	8.0	24	19	12	27	12	--	--
Color	<1	<1	<1	<1	<1	<1	--	15
Turbidity	0.22	0.27	0.24	0.16	0.24	0.12	N/A	N/A
pH	7.59	8.36	7.13	7.24	8.05	7.35	6.5/8.5	6.5/8.5
Elect. Conduct.	480	250	170	1100	350	560	--	--
Cadmium	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.01	--
Chromium	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.05	--
Lead	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.05	--
Mercury	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	--
Selenium	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.01	--
Silver	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.05	--
MBASs	---	---	---	<0.1	<0.1	<0.1	--	0.5

(a) Analysis for T.D.S. through Silica, and Cadmium through MBASs are measured in parts per million. Color through Electrical Conductivity are measured in standard units for each individual constituent.

(b) State primary standards are adopted directly from the SDWA standards. All standards listed are state established secondary standards.

Table 7.3 Water Chemistry Analysis of Well 4a

Parameter	Result	Units
Total Dissolved Solids	283	ppm
Hardness	80	ppm
Calcium	22	ppm
Magnesium	6	ppm
Sodium	55	ppm
Potassium	6	ppm
Sulfate	35	ppm
Chloride	9	ppm
Nitrate (Total)	14.3	ppm
Alkalinity	138	ppm
Bicarbonate	159	ppm
Carbonate	5	ppm
Fluoride	0.81	ppm
Arsenic	0.004	ppm
Iron	0.42	ppm
Manganese	0.04	ppm
Copper	0.00	ppm
Zinc	0.01	ppm
Barium	0.01	ppm
Boron	0.2	ppm
Silica	65	ppm
Color	3	S.U.
Turbidity	0.2	S.U.
pH	8.22	S.U.
Elect. Conductivity	385	S.U.
Cadmium	<0.001	ppm
Chromium	<0.005	ppm
Lead	<0.005	ppm
Mercury	<0.0005	ppm
Selenium	0.001	ppm
Silver	<0.005	ppm
MBAS	<0.1	ppm

7.1.2 CLEAN WATER ACT

7.1.2.1 NTS OPERATIONS

In accordance with the state of Nevada operating permits (OPs) for the sewage lagoon systems on the NTS (OPs Nos. NV87059, NV87060, NV87069, and NV87076), regular influent sampling schedules have been established.

State-required monitoring was conducted at sewage lagoons for flow rate, pH, biochemical oxygen demand (BOD), and total suspended solids (TSS). The flow rate and pH were estimated or measured onsite, and the BOD and TSS were determined by the Atlas Chemical Testing, in Las Vegas, Nevada, a state approved laboratory (see Table 7.4).

Table 7.4 pH, BOD, Flow Rate and TSS in NTS Sewage Lagoon Influents - 1992

	1st Quarter			2nd Quarter			3rd Quarter			4th Quarter			State
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Limits
pH													
Yucca Lake	---	---	8.2	---	---	8.2	---	---	8.2	7.9	---	---	6.0 to 9.0
Area 6, CP-6	---	---	7.5	---	---	8.1	---	---	8.0	---	---	7.6	6.0 to 9.0
Area 6, CP-72	---	---	7.9	---	---	8.6	---	---	8.8	---	---	8.4	6.0 to 9.0
Area 6 LANL	---	---	8.3	---	---	8.8	---	---	8.9	---	---	8.4	6.0 to 9.0
Area 6 DAF	---	---	Dry	---	---	Dry	---	---	7.4	---	---	7.5	6.0 to 9.0
Area 2	---	---	7.8	---	---	9.2	---	---	9.0	---	---	8.4	6.0 to 9.0
Area 12	---	---	7.7	---	---	7.9	---	---	8.1	---	---	8.2	6.0 to 9.0
Area 22, Gate	8.5	8.0	7.8	7.9	7.7	8.8	8.1	8.4	8.9	8.2	8.4	8.9	6.0 to 9.0
Area 23	8.6	7.8	8.1	8.0	7.5	8.1	7.8	7.8	8.3	8.3	8.1	7.9	6.0 to 9.0
Area 25, Reactor Control	---	---	6.8	---	---	Dry	---	---	8.5	---	---	Dry	6.0 to 9.0
Area 25, Central Support	---	---	6.9	---	---	8.2	---	---	8.5	---	---	8.1	6.0 to 9.0
Area 25, Engine Test Stand	---	---	Dry	---	---	Dry	---	---	Dry	---	---	Dry	6.0 to 9.0
Area 25, Test Cell "C"	---	---	Dry	---	---	Dry	---	---	Dry	---	---	Dry	6.0 to 9.0
FLOW RATE (in millions of gallons per day)													
Area 6, Yucca Lake	0.0019	0.0015	0.0036	0.0103	0.0049	0.0053	0.0060	0.0041	0.0050	0.008	0.0054	0.0058	0.01
Area 6, CP-6	0.0016	0.0016	0.0016	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015	0.0078
Area 6, CP-72	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0006
Area 6 DAF	Dry	Dry	Dry	Dry	Dry	Dry	0.0003	0.0003	0.0003	0.0002	0.0002	0.0002	0.0055
Area 6 LANL	Dry	0.0029	0.0028	0.0008	0.0008	0.0076	0.0008	0.0008	0.0008	0.0010	0.0010	0.0010	0.0066
Area 2	0.0002	0.0002	0.0002	0.0003	0.0003	0.0003	0.0004	0.0004	0.0005	0.0005	0.0005	0.0005	0.0009
Area 12	0.058	0.050	0.047	0.058	0.038	0.017	0.023	0.034	0.031	0.037	0.013	0.023	0.072
Area 22, Gate	0.0013	0.0013	0.0013	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0015
Area 23	0.101	0.112	0.163	0.133	0.138	0.153	0.161	0.149	0.151	0.108	0.103	0.070	0.227
Area 25, Reactor Control	0.0005	0.0005	0.0005	0.0004	0.0003	Dry	0.0004	Dry	0.0006	Dry	Dry	Dry	0.0015
Area 25, Central Support	0.0005	0.0005	0.0005	0.0006	0.0006	0.0006	0.0009	0.0009	0.0009	0.0010	0.0010	0.0010	0.0036
Area 25, Engine Test Stand	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	0.0012
Area 25, Test Cell "C"	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	0.0008
BOD (mg/L)													
Area 6, Yucca Lake	---	---	462	1344	---	303	---	---	---	260	---	---	No Standard
Area 12	---	---	456	---	725	---	---	---	491	---	---	918	No Standard
Area 23	359	322	192	220	178	409	196	280	500	247	401	828	No Standard
Area 25, Reactor Control	---	---	---	Dry	---	---	---	---	---	Dry	---	---	No Standard
TSS (mg/L)													
Area 6, Yucca Lake	---	---	272	590	---	288	---	---	---	282	---	---	No Standard
Area 12	---	---	389	---	472	---	---	---	289	---	---	420	No Standard
Area 23	260	284	215	224	348	248	216	296	264	175	166	404	No Standard
Area 25, Reactor Control	---	---	---	Dry	---	---	---	---	---	Dry	---	---	No Standard

--- = No sampling required

Dry = No flow

Continuous monitoring of flow rates was conducted at the Areas 6 (Yucca Lake), 12, and 23 lagoon systems. Flow rates for all other lagoon systems were determined by visual estimation which is permissible under current permit requirements.

The pH was determined for the Areas 22 and 23 lagoon systems every month and for all other systems every quarter. The pH is determined through use of a pH meter. For BOD and TSS, the sewage lagoon system permits require biannual sampling at the Area 6 Yucca Lake and Area 25 Reactor Control lagoon system, quarterly sampling at the Area 12 lagoon system, and monthly sampling at the Area 23 lagoon system. An automatic sampler to collect BOD and TSS samples was installed in the Area 6 Yucca Lake system during 1991.

A water pollution control permit was issued for the U-12n Tunnel discharge in November 2, 1992. This permit became effective on November 12, 1992. This permit requires quarterly monitoring and reporting. The first quarterly report was provided to the DOE/NV in mid January 1993. The results of this monitoring are indicated on Tables 7.5, 7.6, 7.7 and 7.8.

7.1.2.2 NON-NTS SAMPLING RESULTS

EG&G/EM operations which were required by permit to sample and analyze wastewater effluent and submit monitoring reports were LVAO,KO, and WCO. The effluent monitoring demonstrated that the operations were in compliance with the limits specified in the permits.

7.1.3 NON-HAZARDOUS SOLID WASTE DISPOSAL

All operation and maintenance manuals for the sanitary landfills at the NTS have been approved by the state of Nevada. (Permits are not issued for sanitary landfills by the state.) Monitoring of these landfills was limited to recording daily refuse amounts by weight. All waste disposed of in the Area 23 landfill was weighed at the Gate 100 weighing station. Weights indicated for the Area 9 landfill are estimations. Table 7.9 contains the amount of waste disposed of in the Area 9 and 23 sanitary landfills.

7.1.4 TOXIC SUBSTANCES CONTROL ACT (TSCA)

During 1992, a total of 170 samples were submitted for PCB analyses. All PCB samples were analyzed at the REECo Analytical Services Department's (ASD) analytical chemistry laboratory. Of the total number of samples, 96 were oil, 21 were wipes, 38 were water, 7 were soil, and 8 were miscellaneous matrices.

The sample results are as follows: 68 oil samples did not contain detectable PCBs, 5 oil samples were detectable but less than the limit of quantitation, 5 ppm, 20 samples were between 5 and 500 ppm, and 3 samples were greater than 500 ppm. Four of the wipe samples were less than the limit of quantitation, 0.87 $\mu g/100\ cm^2$, and the other 17 wipe samples ranged from <2.88 to 2560 $\mu g/100\ cm^2$. Thirty-seven water samples did not contain detectable PCBs, and one water sample contained PCBs at 3 ppm. Six soil samples did not contain detectable PCBs, and 1 soil sample contained PCBs at 0.21 ppm. The other eight miscellaneous matrices did not contain detectable PCBs.

The laboratory also analyzed 143 (84 percent) blank and spike samples as part of the laboratory quality control program (46 percent of the total samples analyzed).

Table 7.5 N-Tunnel Drainage Monitoring Station Continuous Sampling Results

November 12 to 30, 1992

Parameter	Units	Mean	Range of Average Daily Values
Hydrogen Ion Activity (pH)	Standard Units	8.9	8.8 - 9.0
Temperature	Degrees Celsius	10	8.5 - 12.8
Specific Conductance	Microsiemens	460	390 - 560
Turbidity	N.T.U.'s	23	18 - 63
Flow Rate	Liters/Minute	150	110 - 320
Total Flow	Liters	3.9×10^6	---

December 1992

Parameter	Units	Mean	Range of Average Daily Values
Hydrogen Ion Activity (pH)	Standard Units	8.9	8.7 - 9.0
Temperature	Degrees Celsius	6.73	5.6 - 11
Specific Conductance	Microsiemens	426.20	390 - 560
Turbidity	N.T.U.'s	55.39	18 - 240
Flow Rate	Liters/Minute	123.23	33 - 190
Total Flow	Liters	3.62×10^6	---

Table 7.6 Fourth Quarter Chemical Analysis of N-Tunnel Effluents[a]

Chemical	Permit Limit mg/L	Sample Concentrations mg/L
Arsenic	0.05	0.010
Cadmium	0.01	<0.005
Chromium	0.05	<0.01
Lead	0.05	<0.05
Selenium	0.01	<0.002
Silver	0.05	<0.005
Copper	1.0	0.014
Zinc	5.0	<0.005

(a) Individual samples were taken from Ponds 3, 4, and 5 and composited into one sample. Ponds 1 and 2 did not contain 30 cm of liquid depth and were not sampled in accordance with Part I.C.I of the Permit.

Table 7.7 Fourth Quarter Radionuclide Analysis of N-Tunnel Effluents

Constituent	Permit Limit pCi/L	Sample Concentrations pCi/L
Gross Alpha	15	9.3
Gross Beta	50	9.0
Tritium	20,000	1.3×10^6

Table 7.8 Fourth Quarter Organic Analysis of N-Tunnel Effluents

Chemical	Concentration ug/L	Detection Limit ug/L
Chloromethane	J	2.0
Chloroethane	8.0	2.0
Methyl Chloride	J	1.0
Acetone	B,J	2.0
Tetrachloroethane	B	2.0
Bis(2-ethylhexyl)phthalate	J	10

(J) Indicates an estimated value. There is a compound present which meets identification criteria, but the result is less than the sample quantification limit and greater than zero.

(B) This flag is used when the analyte is found in the associated blank as well as in the sample. It indicates possible/probable contamination of the blank.

Table 7.9 Quantity of Waste Disposed of in Sanitary Landfills - 1992

	Quantity (in pounds)	
Month	Area 9	Area 23
January	2,688,297	598,688
February	1,682,411	988,748
March	1,403,591	248,070
April	604,175	383,000
May	754,904	333,539
June	528,600	1,384,790
July	1,212,885	933,077
August	1,102,700	577,975
September	918,125	440,450
October	1,142,200	1,110,236
November	783,824	308,352
December	200,050	726,620
Total	13,021,762	8,033,545

7.1.5 NATIONAL EMISSION STANDARDS FOR HAZARDOUS AIR POLLUTANTS

During 1992, 826 bulk and air samples were collected and analyzed in conjunction with asbestos removal and renovation projects at the NTS. Of the 629 bulk samples collected, 166 were positive for asbestos and 463 were negative. One hundred twenty-five (17 percent) bulk quality assurance samples were also analyzed. A total of 197 general area air samples were collected and analyzed, along with 47 (19 percent) quality assurance samples.

7.1.6 RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)

Table 7.10 provides the number of samples analyzed during 1992 for waste management and environmental compliance activities at the NTS. Four hundred fifty-six (85 percent) of the volatile organic analyses were done by REECo ASD and the other 78 (15 percent) were performed by outside commercial laboratories. Two hundred (99 percent) of the semi-volatile organic analyses were done by REECo ASD and the other three (1 percent) were performed by outside commercial laboratories. Five hundred forty-four (94 percent) of the ICP(a) metals analyses were done by REECo ASD and the other 37 (6 percent) were performed by outside commercial laboratories. Two hundred nine (83 percent) of the TCLP(b) metals analyses were done by REECo ASD and the other 44 (17 percent) were performed by outside commercial laboratories. All of the pH, flashpoint, TPH, and analyses indicated as "other" were performed by REECo ASD.

A total of 1982 (33 percent) blank and spike samples were analyzed by the REECO ASD in addition to the analyses reported in the table as part of the laboratory quality control program.

Table 7.10 Number of RCRA Samples Analyzed - 1992

Sample Type Analysis	Soil	Water	Sediment	Oil	Other	Total
Volatile Organic	106	265	15	72	76	534
Semi-volatile Organic	77	82	7	12	25	203
ICP Metals[(a)]	51	218		312		581
TCLP Metals[(b)]	137	28	23	46	19	253
pH	80	398		270	48	796
Flashpoint	19	13		60	11	103
TPH[(c)]	574	45		19	7	645
Other	30	82	10	577	22	721
Total	1,074	1,131	55	1,368	208	3,836

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

7.1.7 SPECIAL STUDIES

A total of 54 tests were conducted at the Liquified Gaseous Fuels Spill Test Facility (LGFSTF) in 1992. These tests involved spill evaluations of chlorosulfonic acid (CSA), 65% oleum, a mixture of sulfur trioxide in sulfuric acid, chlorine and ammonia. Ten chlorine spill tests were conducted in June 1992. Fourteen ammonia spill tests were conducted in July 1992. Fifteen (total) CSA spill tests were conducted during April and May 1992. Fifteen (total) oleum spill tests were conducted during April and May 1992. Pursuant to 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 Nevada Test Site (NTS) was continued by the DOE/NV-sponsored Basic Environmental Compliance and Monitoring Program (BECAMP). The program included long-term monitoring of relatively undisturbed sites and intermittent monitoring of sites disturbed by DOE activities (e.g., roadsides, subsidence craters). Sampling activities in 1992 included measurements on annual and perennial plants, reptiles, birds, rodents, deer, and feral horses. Total rainfall for 1992 was higher than any year since 1984, following three years of severe drought. Both animal and plant populations began to recover, generally in complex ways that were not predicted. To follow long-term trends in ecological conditions at the NTS, 1987 to 1992 monitoring results of a baseline plot in southwestern Yucca Flat are presented. Results are also presented from monitoring of flora and fauna on three subsidence craters and monitoring of feral horses, deer, ravens, and tortoises on the NTS.

Precipitation measured at Yucca Flat during 1992 totaled 220 mm (8.7 in), more than twice the totals from 1989 through 1991 (Table 7.11). Precipitation in 1992 was heaviest during winter, but included several widespread thunder showers in summer.

7.2.1 FLORA

Results of plant monitoring on the Yucca Flat baseline plot from 1987 through 1992 revealed marked declines in several shrub and bunchgrass species through 1991, but modest recovery by some in 1992. On this plot, as for most of the NTS, there was little germination of dominant shrub species. *Atriplex canescens* was an exception in that small numbers of seedlings were found on many plots. Numbers of woody shrubs generally continued to decrease, as severely damaged individuals died. In contrast, herbaceous perennials like the bunchgrasses and *Sphaeralcea ambigua*, and rhizomatous perennials like *Mirabilis pudica* and *Hilaria jamesii* increased considerably in density following germination in the cool wet spring (Table 7.12).

Several shrub species, largely in the family Chenopodiaceae (saltbushes), grew well in 1992 as they recovered from drought damage. *Atriplex canescens* and *Ceratoides lanata* more than tripled in live volume, *Grayia spinosa* doubled, and five of eleven *Hymenoclea salsola* (family Asteraceae) which survived the drought increased more than five-fold (Table 7.13). This represented opportunistic growth of some sub-dominant species with rapid growth potentials. Several other species continued to shrink, generally resprouting from the center and shedding peripheral branches. Timing of rainfall probably limited overall shrub regrowth in 1992, as 120 mm fell between December 1991 and March 1992, when most shrubs are dormant, while only 71 mm fell from April through October, when woody shrubs are most active.

Table 7.11 Precipitation at BJY in Central Yucca Flat, 1983 - 1992

Year	Precipitation Total (mm)
1983	350
1984	276
1985	106
1986	154
1987	194
1988	114
1989	63
1990	54
1991	105
1992	220

The NTS desert supports many ephemeral plant species, which germinate from seed and quickly reproduce during short periods of favorable weather. Winter ephemerals germinated in December 1991 and again in February 1992, and persisted into early May. They were

Table 7.12 Counts of Live Perennial Plants Species, and Dead Shrubs and Grasses on a 100 m^2 Baseline Plot in Southwestern Yucca Flat, 1987 - 1992

Species	1987	1988	1989	1990	1991	1992
Acamptopappus shockleyi	44	34	26	13	11	9
Arabis pulchra	0	1	0	0	0	0
Artemisia spinescens	49	47	38	21	6	2
Atriplex canescens	36	38	38	41	31	32
Ceratoides lanata	65	58	53	54	42	35
Ephedra nevadensis	22	18	21	21	21	18
Erioneuron pulchellum[(a)]	28	17	0	2	0	27
Grayia spinosa	40	35	34	44	33	35
Hymenoclea salsola	11	9	8	10	8	5
Lycium andersonii	20	15	18	20	14	13
Menodora spinescens	1	1	1	1	1	0
Mirabilis pudica	7	4	0	0	1	11
Oryzopsis hymenoides[(a)]	8	6	5	0	0	4
Sitanian jubatum[(a)]	28	8	0	0	0	4
Sphaeralcea ambigua	71	26	2	0	1	60
Stipa speciosa[(a)]	6	10	5	8	3	3
Tetradymia axillaris	2	2	2	2	2	0
Totals	438	329	251	237	174	258
Dead grasses	-	-	8	32	44	33
Dead shrubs	-	-	55	167	449	230

(a) These species are grasses; the remainder are shrubs

Table 7.13 Estimated Live Volumes (Liters per 100 m^2) of Perennial Plants on a Baseline Plot in Southwestern Yucca Flat, 1987 - 1992

Species	1987	1988	1989	1990	1991	1992
Acamptopappus shockleyi	592	344	381	16	41	93
Arabis pulchra	0	1	0	0	0	0
Artemisia spinescens	732	537	575	47	32	5
Atriplex canescens	2085	1535	1264	921	893	3802
Ceratoides lanata	798	461	611	378	265	780
Ephedra nevadensis	5007	5320	5015	4482	4130	3599
Erioneuron pulchellum[(a)]	1	2	0	0	0	0
Grayia spinosa	2948	3195	3015	1598	1392	2612
Hymenoclea salsola	420	196	188	44	41	238
Lycium andersonii	4073	3511	2681	2521	2630	677
Menodora spinescens	1	1	1	0	1	0
Mirabilis pudica	5	1	0	0	1	89
Oryzopsis hymenoides[(a)]	41	10	2	0	0	3
Sitanian jubatum[(a)]	11	2	0	0	0	0
Sphaeralcea ambigua	34	20	0	0	0	11
Stipa speciosa[(a)]	2	3	3	2	1	1
Tetradymia axillaris	1732	1583	1869	1636	1514	0
Totals	18,482	16,722	15,605	11,645	10,941	11,910
Dead grasses	-	-	4	21	57	13
Dead shrubs	-	-	2429	3487	5184	5057

(a) These species are grasses; the remainder are shrubs

sampled each year in April and early May. On the Yucca Flat baseline plot their biomass in late April (26 ± 13 g/m^2) was greater than in any year monitored, (1964-66 by Beatley, 1988-1992 by BECAMP). Beatley (1967) reported 5.1, 0.4, and 13.1 g/m^2, for 1964, 1965 and 1966 respectively.

Winter ephemeral densities on the Yucca Flat baseline plot were 172 ± 67/m^2, up 120% from 1991, but only 9% of 1988 values (Table 7.14). Considering the relatively abundant rainfall and its favorable seasonal distribution, this density was quite low. A primary reason appeared to be that *Bromus rubens*, a regionally dominant introduced species, declined dramatically during the two drought years when germination was negligible. Seeds of the annual *Bromus* apparently do not persist long enough to weather extended drought, as it declined from 97% of the ephemeral population in 1988 to 62% in 1992 (Table 7.14). *Bromus rubens* declined severely in quadrants that were not under shrubs. Densities (n/m^2) in quadrants with some shade fell from 3160 to 224 (-93%), while unshaded quadrants declined from 1052 to 11 (-99%) (Table 7.15). In 1988 67% of the *Bromus* population was under shrubs, but in 1992 95% was under shrubs. There are several plausible explanations, including that seed predation was more intense in the open, surface temperatures were too high in the open, or that 1992 germination conditions were less favorable in the open.

The decline in numbers of the introduced *Bromus* species is significant. After a series of relatively wet years during the 1980's their numbers were so great as to seriously compete with the native species. Although information to prove this is not available, six years of BECAMP data and six years of data collected in 1970-1976 at the US. International Biological

Table 7.14 Species Richness, Densities and Total Above-Ground Biomasses of Spring Ephemerals ($\bar{X} \pm$ 2sem) in Southwestern Yucca Flat, Sampled 1988-1992

	1988	1989	1990	1991	1992
Species (n/1000 m^2)	21	0	0	22	35
Density (n/m^2)	1956 ± 1114	0	0	78 ± 69	172 ± 133
Biomass (g/m^2)	21 ± 9	0	0	0.5 ± 0.5	26 ± 26
% *Bromus* (n/m^2)	97	-	-	82	62
% *Bromus* (g/m^2)	86	-	-	86	61

Table 7.15 Densities (n/m^2 ± 2sem) of *Bromus* Plants in Quadrants (+) Compared to those in the Open (-)

Year	Cover	Density
1988	+	79 ± 59
1988	-	26 ± 18
1991	+	2.8 ± 3.0
1991	-	0.0 ± 0.0
1992	+	5.6 ± 5.8

Programme Validation Site in Rock Valley suggest the high *Bromus* densities were detrimental to the native ephemeral plants. In the 1970's there was a significant linear correlation between native ephemeral biomass and precipitation ($r = 0.948$, 4 d.f., $p = 0.005$), while from 1987 through 1992 there was not ($r = 0.532$,4 d.f., $p > 0.50$). Furthermore, in 1988, *Bromus* was very dense, and 202 mm of rain produced only 0.9 g/m^2 of native biomass, while in 1992 200 mm produced 10.1 g/m^2. This circumstantial evidence that *Bromus* competes with native ephemerals should be strengthened by further monitoring and experimentation, because *Bromus* species threaten significant changes in native populations.

7.2.2 FAUNA

The side-blotched lizard, *Uta stansburiana*, reproduced well in 1992, apparently in response to the adequate rainfall and plant production in Yucca Flat. The lizard population continued to increase in density, building on 1991 gains, and surpassed pre-drought densities of both adult and juvenile lizards (Table 7.16). The most common small mammals captured in the desert of the NTS were kangaroo rats and pocket mice (Table 7.17, 7.18). The most ubiquitous rodent,

Table 7.16 Estimated Densities (n/ha ± 2sem) of the Lizard *Uta stansburiana* in Summer on a Baseline Plot in Yucca Flat, NTS

	1987	1988	1989	1990	1991	1992
Adults	33 ± 6	42 ± 13	55 ± 11	20 ± 6	32 ± 12	70 ± 16
Hatchlings	123 ± 18	101 ± 34	11 ± 5	53 ± 25	121 ± 25	268 ± 53

Table 7.17 Spring Densities (n/ha) of Small Mammals Estimated by Mark Recapture Techniques on the Yucca Flat Baseline Plot. The Error Terms are Estimated 2sem Following Seber (1982)

Species	1988	1989	1990	1991	1992
Dipodomys merriami	5.0 ± 0.2	3.4 ± 0.0	5.0 ± 1.3	7.4 ± 0.0	15.1 ± 1.7
Dipodomys microps	5.2 ± 0.8	2.7 ± 0.7	2.3 ± 1.0	1.2 ± 0.0	5.4 ± 0.7
Perognathus longimembris	19.0 ± 1.8	9.0 ± 1.6	8.2 ± 4.7	13.2 ± 3.5	3.4 ± 1.9

Table 7.18 Distribution of Ssmall Mammal Species on BECAMP Monitoring Plots, 1987 - 1992

	Number of Plots Occupied					
Species	1987	1988	1989	1990	1991	1992
Number of plots sampled	5	21	17	12	16	14
Peromyscus crinitus	0	0	1	2	0	1
P. eremicus	0	0	0	0	0	7
P. maniculatus	2	9	14	4	2	10
P. truei	0	1	2	1	0	1
Percentage of plots occupied by *Peromyscus* species	40	43	82	42	12	79
Perognathus longimembris	5	15	10	9	11	2
P. parvus	0	4	4	1	1	6
Chaetodipus formosus	1	10	1	3	6	4
Percentage of plots occupied by pocket mice	100	90	76	92	81	50
Dipodomys deserti	1	1	0	1	0	0
D. merriami	5	19	15	12	16	12
D. microps	3	15	12	6	12	12
D. ordii	0	1	2	1	0	4
Percentage of plots occupied by kangaroo rats	100	95	100	100	100	100

Merriam's kangaroo rat (*Dipodomys merriami*), doubled in density, while the chisel-toothed kangaroo rat (*Dipodomys microps*), finally rebounded from a 1991 low to pre-drought densities at the baseline site in Yucca Flat. Reproduction of *D. merriami* during the summer of 1992 appeared to be excellent. Sampling in a burned area near the Yucca Flat baseline plot revealed large numbers of juveniles and pregnant or lactating females.

In contrast to the kangaroo rats (*Dipodomys* spp.), the little pocket mouse (*Perognathus longimembris*) decreased to a five-year low spring-density-estimate for 1992, after increasing in 1991 (Table 7.17). A decrease in *P. longimembris* was evident in all other areas studied in 1992 - its densities were the lowest recorded since monitoring began in 1987. The Great Basin pocket mouse (*P. parvus*) was also present in lower numbers at several sites in 1992.

On the other hand, 1992 appeared to be a good year for *Peromyscus* which had been absent from most plots for three years. Four species of *Peromyscus* were captured on the Pahute Mesa baseline site. *Peromyscus maniculatus*, the most common, replaced *Perognathus parvus* as the most abundant species on this plot. *Peromyscus eremicus* was captured for the first time on BECAMP plots in 1992, and was present at seven plots (Table 7.18).

Monitoring of feral horses continued for the third consecutive year. During 1992 four of six yearlings survived, bringing the population to 65 animals by year-end. One yearling was killed in a vehicle collision and another disappeared in spring and was presumed dead. During 1992 17 foals were observed, none of which survived past August. One foal with an open wound was later found dead. All others were presumably killed by mountain lions, though remains were not found.

Mule deer were surveyed with spotlights in September for the fourth consecutive year. The sighting rate for 1992 increased over the two previous years (Table 7.19), suggesting a moderate increase in numbers possibly associated with easing of the drought conditions.

NTS raptors were monitored by recording opportunistic sightings over successive years (Table 7.20). Search effort varied a maximum of 27% among years. Relative numbers of most raptor species increased during 1992, probably reflecting increased numbers of migrants through the NTS region. A Peregrine falcon and Northern Goshawks were observed for the first time since 1987. The low number of Accipiters (Cooper's Hawk and Sharp-shinned Hawk) sightings was because proportionately little time was spent in piñon-juniper habitat.

Monitoring of raven nests suggested an increase in reproduction, as sixteen active nests were observed in 1992, compared to eight in 1991. The range of nestlings per nest also increased to 1 to 6, compared to 1 to 3 in 1991. As in 1991, most raven nests (13 of 16) were on manmade structures.

Table 7.19 Mean (± 2sem) Number of Deer Seen per Kilometer of Road Travelled on Three Nights at Sites on Pahute and Rainier Mesas, 1989 - 1992

Year	n/km
1989	0.56 ± 0.10
1990	0.35 ± 0.02
1991	0.24 ± 0.04
1992	0.54 ± 0.20

Table 7.20 Opportunistic Raptor Sightings on the NTS, 1989 - 1992

Species	1989	1990	1991	1992
Turkey vulture	48	24	70	90
Golden eagle	37	14	22	28
Red-tailed hawk	69	35	44	70
Rough-legged hawk	9	0	2	7
Northern harrier	3	2	1	15
Osprey	1	1	2	3
Prairie falcon	18	6	7	14
Peregrine falcon	0	0	0	1
American kestrel	18	25	19	36
Goshawk	0	0	0	2
Accipiters	3	21	2	13
Long-eared owl	0	2	2	4
Burrowing owl	7	7	9	38
Great horned owl	1	1	1	5
Barn owl	0	0	0	1
Totals	214	138	181	327

During 1992, 7 free-roaming tortoises were captured, weighed, marked, and released on the NTS by BECAMP, bringing the total marked since 1987 to 82 individuals. In addition, all 17 tortoises inhabiting fenced areas in Rock Valley were recaptured and measured in 1992. These animals have been recaptured twice a year, when possible, for the last 29 years. Two juvenile tortoises in one fenced plot were captured in 1992. The plot had one adult female and two adult males, and the fence was intact, indicating in situ reproduction. No symptoms of disease were seen on any tortoises captured in 1992. The tortoise work was done under U. S. Fish and Wildlife Service and state of Nevada permits.

7.2.3 MONITORING OF DISTURBED AREAS

BECAMP monitors disturbed areas on the NTS on a three year cycle. Three subsidence craters in northeastern Yucca Flat, first sampled in 1989, were resampled in 1992. The craters were formed in 1963 (U-3cn), 1967 (U-10af), and 1978 (U-7au) by underground nuclear explosions. They are shallow bowl-shaped depressions with slopes generally less than 45°. Runoff has created a silty playa-like deposit in the center of each, and the slopes are eroded. The surrounding areas slope gently towards the south. North slopes in each crater (south-facing slopes) are eroded significantly more than the south slopes, partially due to runoff into the craters (the erosion of Sedan crater, surrounded by a throwout berm, is slight in comparison). The insides of the craters have areas where the surface was scraped, graveled, or ponds constructed prior to collapse. Vegetation was studied on the north and south slopes, and animal studies were performed with one plot covering the bottom and extending up one slope.

Ephemeral plant populations in the craters in 1989 were almost absent (<2/m^2), but in 1992 there were averages of 162 to 460 plants per square meter inside the craters and 122 to 454 on the control plots (Table 7.21). Crater U-3cn was sampled April 13-15, before full growth and reproduction. Craters U-10af and U-7au were sampled May 4 and May 6, respectively, just before the ephemerals dried up. Mean plant sizes in the latter two craters were significantly higher than in U-3cn ($F = 7.80$, $df = 2,142$, $p = 0.001$), which we tentatively

Table 7.21 Characteristics of Ephemeral Plant Populations on Three Subsidence Craters and Adjacent Control Plots in Spring 1992; Error Terms are ± 2sem

Date	Crater	n/m^2	g/m^2	mg/plant
		North Facing		
14 Apr	U-3cn	206 ± 98	6 ± 3	30 ± 10
4 May	U-10af	398 ± 250	29 ± 11	200 ± 139
6 May	U-7au	460 ± 206	25 ± 14	76 ± 34
		South Facing		
14 Apr	U-3cn	162 ± 117	4 ± 4	22 ± 13
4 May	U-10af	328 ± 191	80 ± 45	380 ± 249
6 May	U-7au	266 ± 180	73 ± 52	325 ± 100
		Controls		
14 Apr	U-3cn	124 ± 59	5 ± 3	47 ± 22
4 May	U-10af	454 ± 200	47 ± 23	102 ± 24
6 May	U-7au	122 ± 93	38 ± 32	395 ± 247

attribute to the longer period of growth. There was a tendency ($F = 1.30$, d.f. = 2,117, $p = 0.275$) for numbers of ephemerals to be higher on north-facing slopes, but individual plant sizes were greater on south-facing ones ($F = 4.90$, d.f. = 2,117, $p = 0.009$). Total ephemeral biomass in quadrats was higher on the south-facing slopes ($F = 4.69$, d.f. = 2,117, $p = 0.011$). Four to fourteen species were found in 20, 0.025 m^2 quadrats sampled on each of nine plots. In all three craters the number of species was slightly higher on north-facing slopes, but the difference was not statistically significant. Although generalizations are difficult because of the interacting factors of species, slope, aspect, disturbance regime, and perennial population parameters, it appeared germination was largely independent of aspect, but that growth of ephemerals was enhanced late in the season on the south-facing (warmer) slopes.

Most subsidence craters, including the three studied by BECAMP, are in the northeastern portions of Yucca Flat. Disturbed sites in this area have been dominated by the introduced weed *Salsola australis* (Russian thistle) since at least 1957 (Shields and Rickard 1957). The subsidence craters interact in several ways with *Salsola.* First, they are collection sites for wind-blown dead remains, which are deposited in erosion channels on the sides of the craters. Second, seeds germinate and grow well inside craters, favored by various disturbances and runoff water which collects in the bottoms.

Mid-summer (June-July) biomass of *Salsola* was estimated in the three craters and their controls (Table 7.22). These values were noticeably higher than the zero to five g/m^2 observed in summer 1989, and are significant production values for NTS desert vegetation.

Shrub and perennial grasses on subsidence crater slopes, like ephemerals, reflect the various factors of prior disturbance, aspect, erosion, and silting. Live volumes of perennials tend to be higher on north-facing slopes (Table 7.23). Shrubs in craters and on controls appeared to be severely affected by the 1989-91 drought, but many *Oryzopsis hymenoides* seedlings and a

Table 7.22 Production (g/m^2 ± 2sem) of *Salsola australis* in Three Subsidence Craters in Northeastern Yucca Flat

Crater	Dates	North Facing	Center	South Facing	Control
U-3cn	June 11-24	66 ± 34	88 ± 66	83 ± 68	72 ± 22
U-7au	July 13-16	9 ± 8	0	109 ± 35	399 ± 312
U-10af	July 9	197 ± 118	26 ± 16	68 ± 47	122 ± 116

Table 7.23 Volumes (L/100m^2) of Live Shrub and Bunchgrass Canopies in Three Subsidence Craters

Crater		South Facing	Center	North Facing	Control
U-3cn	shrubs	478	349	2068	905[a]
	grasses	11	0	13	56
U-7au	shrubs	463	0	819	1901
	grasses	0	0	3	2
U-10af	shrubs	502	2	833	449[b]
	grasses	0	2	47	5[b]

(a) Excluding *Polygala subspinosa*
(b) In a scraped area

few *Atriplex canescens* seedlings were found, small enough to have germinated in 1992. Grass seedlings were more abundant on north-facing slopes of U-3cn and U-10af. In U-7au the north-facing slope was scraped, and the south-facing was not, and grass numbers were accordingly greater on the south-facing slope. Across craters, the number of grass seedlings differed significantly between north- and south-facing slopes ($F = 10.7$, 1,294 d.f., $p<0.001$). There also was a significant difference in numbers of grass seedlings among craters ($F = 167$, 2,294 d.f., $p < 0.0001$).

It is reasonable to presume that shrub growth in both crater and control areas was inhibited by use of summer water resources by *Salsola*, and that recovery of the shrub populations from drought was delayed by the presence of this introduced species. Because *Salsola* dies every fall, it will eventually again be restricted to the disturbed sites (lacking shrubs) in this area.

Reproduction of lizards in 1992 in the subsidence craters and their corresponding controls was excellent (Table 7.24). With respect to 1989, adult summer densities in 1992 were lower at U-3cn crater, with little or no change observed at the U-7au and U-10af sites. The U-3cn crater has an active raven's nest located in the crater, and predation by ravens probably

Table 7.24 Estimated Summer Densities (n/ha ± 2sem) of the Lizard *Uta stansburiana* at Three Craters in Eastern Yucca Flat, NTS; (Error Estimates According to Seber 1982)

Site	Crater 1989	Crater 1992	Control 1989	Control 1992
U-3cn				
Adults	44 ± 8	13 ± 6	41 ± 19	20 ± 12
Hatchlings	12 ± 12	42 ± 9	20 ± 12	48 ± 25
U-7au				
Adults	21 ± 0	20 ± 14	64 ± 4	16 ± 5
Hatchlings	5 ± 5	36 ± 16	5 ± 0	52 ± 25
U-10af				
Adults	5 ± 5	5 ± 5	NONE	2 ± 0
Hatchlings	5 ± 0	30 ± 15	2 ± 0	41 ± 9

contributed to lower survivorship of adult *Uta* at this site. Juvenile predatory lizards (*Gambelia wislizenii*) were also present at high densities in the U-7au crater and control (17 ± 6 and 11 ± 0 per hectare respectively) and on the control for U-10af (11 ± 0).

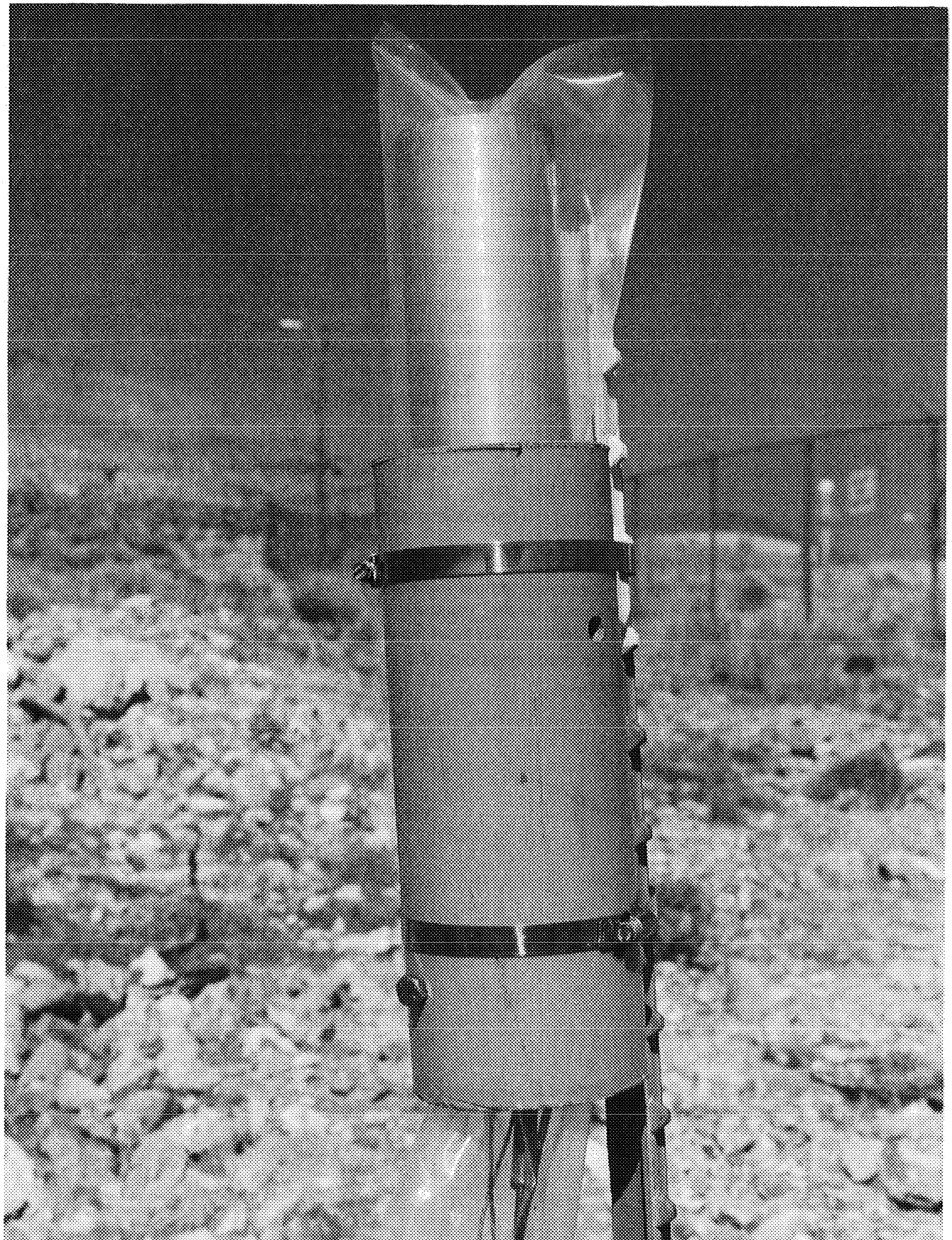
Small mammal populations increased in two of three craters (U-7au and U-10af) in 1992 from 1989 levels (Table 7.25). Most rodents captured at the three craters and corresponding controls were kangaroo rats. The little pocket mouse, *P. longimembris*, decreased or

Table 7.25 Estimated Spring Densities (n/ha ± 2sem) of Small Mammals Determined by Mark Recapture Techniques at Three Crater Sites in Yucca Flat in 1989 and 1992; Standard Errors were Estimated Following Seber (1982)

	$\bar{X}$ ± 2sem			
	Crater		Control	
Site/Species	1989	1992	1989	1992
U-3cn				
Dipodomys merriami	12.0 ± 0.8	9.7 ± 1.8	9.3 ± 1.0	13.9 ± 2.7
Dipodomys microps	(4)[a]	---	---	(1)
Perognathus longimembris	---	---	6.0 ± 1.4	(3)
Other[b]	(2)	(1)	(1)	---
U-7au				
Dipodomys merriami	(3)	12.0 ± 2.0	(3)	8.7 ± 0.9
Dipodomys microps	---	---	(1)	(1)
Other[b]	(2)	(4)	(3)	(3)
U-10af				
Dipodomys merriami	11.8 ± 0	21.3 ± 1.3	24.3 ± 5.0	25.2 ± 0.8
Dipodomys microps	(4)	(2)	7.1 ± 0.8	7.1 ± 0.8
Perognathus longimembris	(1)	---	(1)	---
Other[b]	(5)	(2)	(4)	(3)

(a) Number in parentheses are number captured; - too few for estimate
(b) *Neotoma lepida, Onychomys torridus, Peromyscus eremicus, P. maniculatus*, or *Ammospermophilus leucurus*
---None Captured

disappeared at these sites (Table 7.25), as at most sites in 1992. Rodents on the U-3cn crater and control plot appeared to be heavily preyed on by a pair of ravens which nested in the crater for at least the last three years. Analysis of raven pellets under this nest in 1991 revealed 39% of the material was mammalian or unidentifiable bone fragments, indicating heavy use of the surrounding vertebrate species as a food source.




CAUTION
RADIOACTIVE
CONTAMINATION AREA

8.0 RADIOACTIVE AND MIXED WASTE STORAGE AND DISPOSAL

Gregory J. Shott

Low level radioactive wastes are disposed of at two locations on the NTS. The Area 5 Radioactive Waste Management Site (RWMS) receives packaged defense related low level wastes (LLW) from DOE and Department of Defense (DOD) facilities. LLW is disposed of at the Area 5 RWMS in shallow pits and trenches. In past years high specific activity wastes have been disposed of in deep augured shafts known as greater confinement disposal (GCD). The Area 3 RWMS is used for the disposal of packaged radioactive wastes, low specific activity LLW packaged in large bulk waste containers and unpackaged bulk wastes from the NTS. Subsidence craters are used for waste disposal in Area 3.

Hazardous waste and transuranic (TRU) wastes are stored above ground in Area 5. Transuranic wastes are stored in Area 5 on a specially constructed pad pending final certification and shipment to the Waste Isolation Pilot Plant (WIPP) in New Mexico. Uranium ore residues designated as strategic materials are stored north of the Area 5 RWMS. Hazardous wastes generated on the NTS are accumulated at the Hazardous Waste Accumulation Site in Area 5 pending shipment to an offsite treatment, storage and disposal facility.

During 1992, air samples were collected at the Area 3 and Area 5 RWMS for analysis of gross beta activity, photon emitting radionuclides, radioiodines, plutonium and tritium. The only airborne radionuclide detected that is attributed to disposal activities was tritium at the Area 5 RWMS. All concentrations were well below the derived concentration guides. Gamma radiation fields are monitored by TLDs. Gamma exposures greater than background were detected at the Area 5 RWMS gate and in areas where waste is stored above ground. Neutron radiation fields at the perimeter of the TRU waste storage area were monitored by proton recoil dosimeters and were well below occupational limits. Mixed waste cells were monitored for infiltration of rain water.

8.1 WASTE DISPOSAL OPERATIONS

Radioactive waste disposal was established at Area 5 on the NTS in 1961. By July 1, 1976 six of nine developed trenches had been filled with low level radioactive waste. In 1978 waste disposal operations were expanded when the DOE established the Radioactive Waste Management Project for the disposal of defense related low level radioactive waste from the NTS, offsite DOE generators and DOD facilities. The state of Nevada granted the NTS interim status for the disposal of low level mixed wastes in 1987. Mixed waste disposal was curtailed in 1990 following EPA regulation by the DOE due to concerns about the presence of Land Disposal Restricted constituents in mixed waste. The state of Nevada later curtailed mixed waste disposal until such time as DOE can provide National Environmental Policy Act documentation and implement a state approved Waste Analysis Plan. The Area 3 RWMS has been used for the disposal of atmospheric test debris and low specific activity DOE and DOD wastes.

Wastes generated on the NTS that are regulated by the state of Nevada under the Resource Conservation and Recovery Act (RCRA) are disposed of at an offsite treatment, storage and disposal facility. Hazardous chemical waste are not accepted from offsite generators. No mixed wastes have been received or disposed of at the Area 5 and Area 3 RWMS since 1991.

8.1.1 AREA 5 RADIOACTIVE WASTE MANAGEMENT SITE

The Area 5 RWMS is located on Frenchman Flat, approximately 26 km (16 mi) north of the NTS main gate. The Area 5 RWMS occupies approximately 296 ha (732 acres) in Area 5. Currently, 37 ha (92 acres) are posted radiological areas used for the disposal of low level radioactive and mixed wastes. Prior to 1968, Area 5 had been used for the testing of conventional weapons and the above ground and below ground testing of nuclear weapons.

The Frenchman Flat basin is bounded by the Massachusetts Mountains on the north, Black Ridge and Mt. Salyer to the west, the Buried Hills and Ranger Mountains to the east, and Mercury Ridge to the south. The general surface geology of the area is alluvial sediment. 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 in the vicinity of the disposal site. To the west, the slope increases to about three percent. Two shallow dry washes cross the site from the northwest. An earthen dike has been constructed along the western, northern and eastern border of the Area 5 RWMS to prevent water flow into the disposal area.

There are no permanent surface water impoundments or drinking water wells at the Area 5 RWMS. All potable water is transported by truck from another site. During 1992 three pilot wells were developed at the perimeter of the Area 5 RWMS for the purpose of obtaining geological and hydrological site characterization data. Results from this investigation will be the subject of a separate report. Preliminary data from the pilot wells confirms that the water content of vadose zone soils is extremely low and that water potential and flow is upward. Using data developed prior to 1992 from eight wells in Area 5, the water table elevation beneath the Area 5 RWMS has been estimated by a Dupuit-Forchiemer approximation to be approximately 244 m (800 ft) below the surface. The computed water table elevation is also consistent with resistivity measurements and preliminary measurements from the 1992 pilot wells. Preliminary modeling studies have shown the travel time from the surface to the water table to be thousands of years. This modeling is based on Appendix C, "Technical Guidance Manual for Calculating Time of Travel in the Unsaturated Zone," to the report "Guidance Criteria for Identifying Areas of Vulnerable Hydrology" that was produced for the U.S. EPA by the Battelle Project Management Division in 1986. Preliminary results from the pilot wells indicate that the upper most aquifer under the Area 5 RWMS has not been contaminated by waste disposal operations.

In the past low level radioactive waste and mixed wastes have been managed by shallow land burial in trenches and pits at depths ranging from 6 m (20 ft) to 7.6 m (25 ft). Burial cells are temporarily covered by 2.8 m (9 ft) soil caps pending final design of a permanent closure cap.

High specific activity wastes have been managed by deep burial in augured shafts 36 m (120 ft) deep. The shafts have been backfilled with soil from a depth of 21 m (70 ft) to the surface. Wastes received at the Area 5 RWMS are transported and disposed of in approved Department of Transportation containers. Most wastes received at the Area 5 RWMS are shipped in 55-gal steel drums or 4 ft X 4 ft X 7 ft steel and wooden boxes.

Low-level radioactive wastes are accepted for disposal from generators that have received DOE/HQ and DOE/NV approval. Prior to receiving approval, generators must submit an application detailing a waste characterization and certification program that meets the requirements of NVO-325(Rev. 1), Nevada Test Site Defense Waste Acceptance Criteria, Certification, and Transfer Requirements. Approval may be granted if an audit indicates that the waste characterization and certification plan has been satisfactorily implemented. Approved generator programs are reviewed and audited annually.

In 1992 7,265 m^3 (2.6 X 10^5 ft^3) of low level radioactive wastes containing a total of 80 Ci (3.0 TBq) were received from eight approved DOE and DOD generators. At the end of 1992 the Area 5 RWMS had disposed of 1.6 X 10^5 m^3 (5.7 X 10^6 ft^3) of waste containing 9.8 MCi (3.6 X 10^5 Tbq) of undecayed activity. Tritium accounts for over 98% of the undecayed activity. ^{137}Cs, ^{90}Sr, ^{60}Co and depleted uranium account for the majority of the remaining activity.

Mixed wastes were not received or disposed of at the NTS in 1992. LLW disposed of prior to 1986 are suspected of containing low levels of constituents that would be regulated as hazardous waste under RCRA. Mixed wastes have been disposed of in Pit 3 under RCRA Interim Status. In May 1990 mixed waste disposal operations in Pit 3 ceased due to EPA issuance of the Land Disposal Restrictions of RCRA. A Mixed Waste Management Unit (MWMU) is planned to be cited in the northeastern area of the Area 5 RWMS. The MWMU will cover approximately 10 ha (25 acres) and contain 8 landfill cells to be used for mixed waste disposal. Mixed waste disposal operations at the NTS will commence under interim status in Pit 3 upon completion of National Environmental Policy Act (NEPA) documentation and an approved Waste Analysis Plan and at the MWMU upon issuance of a State of Nevada Part B Permit.

8.1.2 AREA 3 RADIOACTIVE WASTE MANAGEMENT SITE

The Area 3 RWMS is located within Area 3 in the center of Yucca Flat approximately 8 miles north of the Yucca Playa Dry Lake Bed. The Area 3 RWMS lies at an elevation of 1230 m (4050 ft) and covers approximately 20 ha (50 acres). The site is located on approximately 450 m (1500 ft) of alluvial sediments. Its climate and topography is similar to that of the site in Area 5. Further details regarding the Area 3 RWMS are available in DOE report DOE/NV/10630-8 (Gonzalez 1989).

Atmospheric and underground nuclear tests have been conducted in several areas in Yucca Flat including Area 3. Safety tests that have resulted in the dispersion of plutonium in surface soils also have been conducted in Area 3.

The Area 3 RWMS is used for the management of bulk debris from above ground nuclear tests and bulk low specific activity wastes generated offsite. Subsidence craters formed by underground nuclear tests are used for LLW disposal at this site. The subsidence craters range in depth from 15 m (49 ft) to 24 m (78 ft). The craters are filled by alternating layers of stacked waste packages and clean fill. A 2.5-m (8 ft) thick cap of clean soil extending 1.2 m

(4 ft) above the grade has been used for temporary closure of the craters. Two craters, U-3ax and U-3bl, have been filled to date. U-3ah/at is currently open and contains almost 47,464 m^3 (1,676,000 ft^3) of atmospheric testing debris. Between 1974 and 1988 almost 218,915 m^3 (7,730,900 ft^3) of contaminated material were consolidated at this location. In 1992 the Area 3 RWMS received 16,964 m^3 (6.0 X 10^5 ft^3) of waste containing 1.2 Ci (44 GBq) of activity. A total volume of 282,208 m^3 (1.0 X 10^7 ft^3) originally containing 1528 Ci (56 Tbq) have been disposed of at the Area 3 RWMS. Tritium accounts for approximately 87% of the waste activity. Fission products and depleted uranium account for the majority of the remainder.

8.1.3 STRATEGIC MATERIALS STORAGE AREA

The strategic materials storage area is used for storage of residues from the processing of uranium ores that were received from Mound Laboratory, Miamisburg, Ohio. On a mass basis this material consist primarily of ^{238}U and iron. On an activity basis the residues are highly enriched in ^{230}Th and ^{231}Pa and contain approximately 290 Ci (10.7 TBq) of total activity. The residues are presently considered strategic materials and are stored in a controlled area pending a decision on their final disposition. The materials are packaged in steel drums in wooden boxes which are in turn stored in 28 steel cargo containers. The containers are stored on concrete pads inside a fenced area that is a posted radiological area. The cargo containers are not routinely opened to minimize personnel exposure to external gamma radiation fields and potential internal radiation hazards. Periodic container integrity inspections are performed. Gamma radiation fields are monitored by TLDs placed at 18 locations on the fence surrounding the cargo containers and are exchanged quarterly as stated in Section 8.2.2, below.

8.1.4 TRANSURANIC WASTE STORAGE

The TRU waste storage cell is located in the southeast corner of the Area 5 RWMS. The cell is used for interim storage of TRU waste materials previously received from Lawrence Livermore National Laboratory (LLNL) that are suspected of being TRU mixed waste. TRU mixed waste is not currently accepted for storage or disposal at the NTS. The TRU inventory is awaiting permanent disposal in a deep geologic repository at the Waste Isolation Pilot Plant (WIPP). This waste does not currently meet WIPP waste acceptance criteria and will require characterization and certification before final disposal. The waste is stored in a curbed asphalt pad and surrounded by a security fence. A liner is embedded in the asphalt pad. The storage cell is a controlled radiological area.

Waste management personnel perform inspections of all TRU waste containers on a weekly basis. Rain water that accumulates on top of drums is removed after each rain fall event. The drums are stored on wooden pallets to prevent contact with rain water that may accumulate on the pad. During 1992 all of the TRU waste in 55-gal drums were overpacked into steel drums with HEPA filter vents. Construction of a cover for the TRU waste storage cell is planned for 1993.

External gamma and neutron radiation fields are monitored at the perimeter of the TRU waste storage cell at six stations with TLD's and proton recoil dosimeters. Six air sampling stations are located at the perimeter of the storage cell. Samples are analyzed for gross beta activity, photon emitting radionuclides and plutonium. Water that accumulates on the pad after rain fall events is sampled and analyzed for gross alpha activity. Neutron dosimeters are placed on the fence near each air sampler.

8.2 ENVIRONMENTAL MONITORING AT WASTE STORAGE AND DISPOSAL SITES

The Reynolds Electrical & Engineering Co., Inc., (REECo) Environmental Surveillance Section is responsible for collection of samples and verifying sample results. Standard operating procedures are maintained by the REECo Environmental Management Division, Analytical Services Department (ASD). The REECo ASD Radioanalytical Section is responsible for the analysis of the samples.

8.2.1 AIR MONITORING

Air sampling is conducted at nine sites along the perimeter of the Area 5 RWMS fence and at six sites along the perimeter of the TRU waste storage cell. At the Area 3 RWMS, four samplers are located along the perimeter of the U-3ah/at craters. These air samplers operate at an air flow rate of 100 L (3.5 ft^3) per minute and are changed weekly. The sampling media is a 10 cm (4 in) glass-fiber filter and a charcoal cartridge that are analyzed for gross beta, photon emitting radionuclides, ^{238}Pu and ^{239,240}Pu. Samplers for HTO are located with the particulate samplers. The tritium samplers consisted of a column of silica gel, a pump for drawing air through the desiccant, and a dry-gas meter to measure the sample volume. Samples are collected every two weeks and represent approximately 10 m^3 (350 ft^3) of air.

Only tritium and naturally occurring particulate radionuclides were detected in air at the Area 5 RWMS in 1992. The progeny of the primordial radionuclides ^{232}Th and ^{238}U, the naturally occurring primordial radionuclide ^{40}K and the cosmogenic radionuclide ^{7}Be were the only nuclides detected. No radioiodines, ^{238}Pu or ^{239,240}Pu were detected. Tritium oxide is routinely detected at the Area 5 RWMS at activity concentrations slightly greater than mean activity concentration for the NTS. Activity concentrations have been increasing slightly in recent years and are probably attributable to waste operations. The highest activity concentration detected 2.7 X 10^{-10} µCi/mL (9.9 Bq/m^3) is less than 0.3% of the derived concentration guide.

Naturally occurring radionuclides and traces of plutonium were detected in air at all of the Area 3 samplers in 1992. Plutonium occurs at elevated levels in Area 3 soils due to atmospheric weapons tests performed more than 30 years ago. Airborne plutonium in the Area 3 air samples is most likely due to resuspension of contaminated soils and is not attributable to waste disposal activities. The highest concentration of ^{239,240}Pu detected, 2.4 x 10^{-15} µCi/ml, was approximately 60% of the derived concentration guide. Most concentrations were much less. No radioiodines were detected in the Area 3 samples. The only other radionuclides detected were naturally occurring primordial and cosmogenic radionuclides.

8.2.2 EXTERNAL GAMMA EXPOSURES

Thermoluminescent dosimeters (TLDs) were deployed at 44 locations around the Area 5 RWMS. Ten TLDs were placed within the perimeter including six TLDs around the TRU waste storage pad and two each in Pit Nos. 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 are located around the Strategic Materials Storage Area (SMSA). All TLDs were collected and analyzed quarterly.

TLDs placed at the perimeter of the Area 5 RWMS recorded annual exposures ranging from 128 mR to 157 mR. These values are generally in the range of exposures expected from naturally occurring primordial radionuclides in Area 5 soils. The annual exposure at the East Gate which is the main entrance to the disposal area was 252 mR. The higher exposure at this site is attributable to the passage of trucks delivering waste to the site. Exposures measured within Pits 3 and 4 fell within the range of values recorded for the facility perimeter. Annual exposures at the perimeter of the TRU waste storage cell were elevated and ranged from 190 mR to 661 mR. The TRU waste storage cell is located within a locked and fenced area that is controlled radiological area. The TRU waste storage cell is not a continuously occupied area. Annual exposures at the perimeter of the strategic materials storage area ranged from 602 mR to 4.07×10^3 mR. The strategic materials storage area is a fenced and posted area , located in a remote infrequently occupied area.

Exposure was monitored at the Area 3 RWMS at 19 sites located at the perimeter of craters used for disposal. Annual exposures ranged from 142 mR to 978 mR. As noted earlier, areas surrounding the Area 3 RWMS are contaminated with fallout from atmospheric weapon testing. Much of the exposure measured at the Area 3 RWMS is attributable to fallout.

8.2.3 NEUTRON DOSE EQUIVALENTS

Neutron dose equivalents were measured at six locations at the perimeter of the TRU waste storage cell. Annual dose equivalents for 1992 ranged from 85 mrem to 255 mrem. The perimeter of the TRU waste storage cell is not a routinely occupied area.

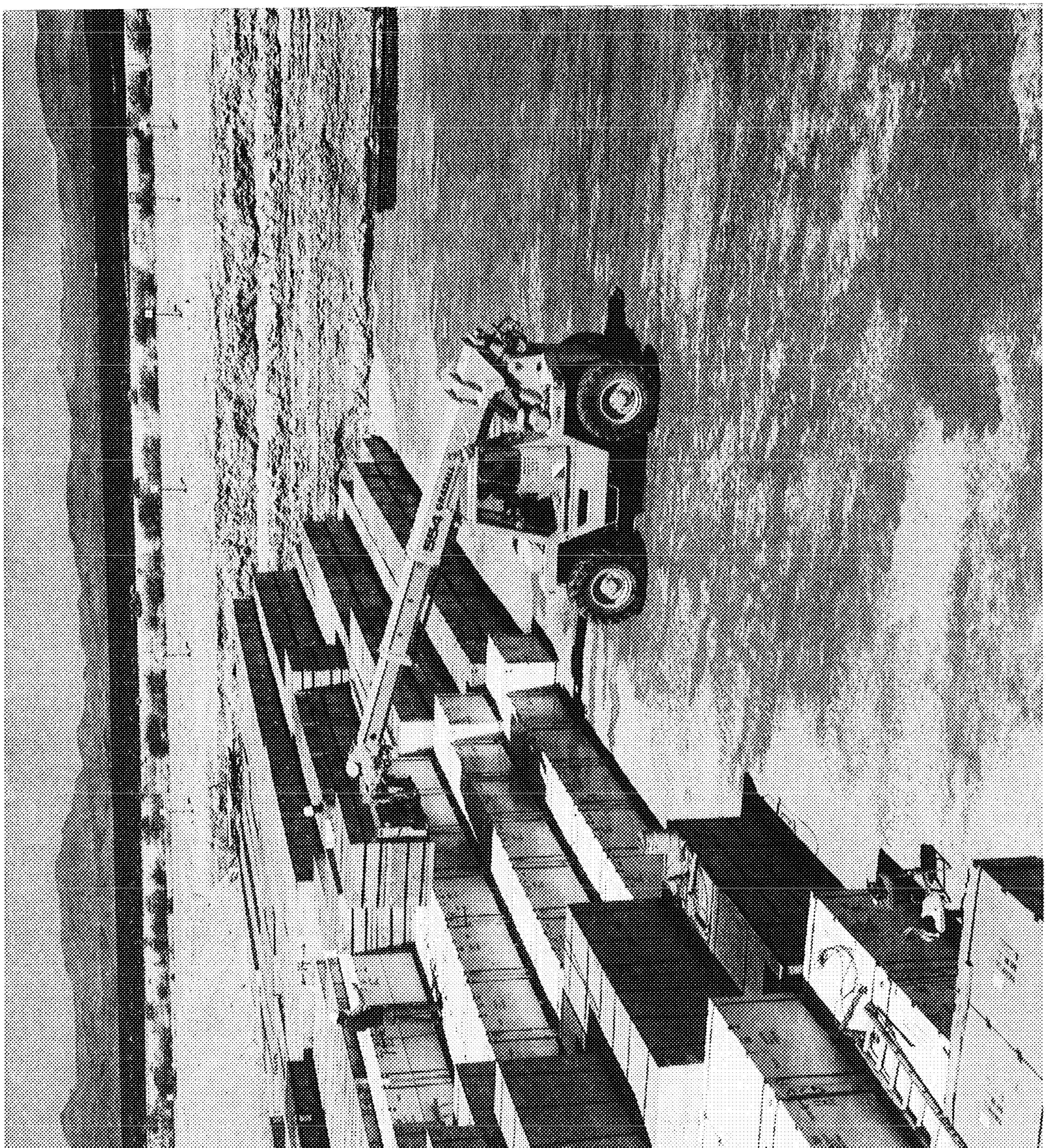
8.2.4 VADOSE ZONE MONITORING FOR MIXED WASTE DISPOSAL

Travel times of contaminants from waste disposal cells to the groundwater is expected to be tens of thousands of years because groundwater recharge and infiltration is believed to be nearly zero at the Area 5 RWMS. Therefore conventional groundwater monitoring is not an effective and timely method to detect the migration of contamination. A vadose zone monitoring program is being implemented to allow earlier detection of contaminant migration from the mixed waste disposal cell (Pit 3) at the Area 5 RWMS. Gas sampling and in situ monitoring will be conducted in access tubes placed in a 24-ft grid. Each tube extends 4 m (13 ft) beneath the floor of the pit and has gas sampling ports at the top, middle and bottom of the waste stack and a sealed port 4 m (13 ft) beneath the floor. Parameters to be monitored include soil moisture content, photon emitting radionuclides and volatile organic compounds in soil pore gas. Because water movement through the waste is a potential mechanism for the transport of waste components, soil moisture content will provide an early assessment of disposal unit performance. Because of the low water content of the vadose zone, vapor transport of volatile organic compounds is the most likely migration mechanism. Analysis of vadose zone soil air samples will provide early detection of the presence and concentration of volatile organic compounds. Gamma spectrum logging will be used to identify migrating radionuclides in the soil.

Baseline soil moisture data are currently being obtained by fast neutron scattering at 24 stations in Pit No. 3, the interim status mixed waste cell. Data collected to date indicates that rain fall does not infiltrate beyond 1.5 m (5 ft) and does not contact waste packages. Gas chromatography and gamma spectroscopy data collection will begin at these same locations in 1993. This area is providing data for use in computer model studies for the design of future vadose zone monitoring systems.

8.2.5 TRITIUM MIGRATION STUDIES AT THE AREA 5 RWMS

Subsurface tritium migration studies of four sites at the Area 5 RWMS have been conducted by personnel from the University of California, Berkeley (UCB). Soil pore gas samples and vegetation samples are routinely collected by UCB personnel at the Area 5 RWMS. Sampling was suspended during most of 1992 due to the unavailability of laboratory facilities. Sampling was resumed in August of 1992. Tritium migration study results are the subject of separate reports prepared by UCB.



9.0 GROUNDWATER PROTECTION

Ronald L. Hershey and Deb J. Chaloud

The extensive program of well drilling at the NTS for groundwater characterization continued in 1992. The program will continue until the location, quantity, and movement of groundwater and contaminants are understood well enough to support a Remedial Investigation and Feasibility Study (RI/FS). The RI/FS will evaluate potential groundwater contaminant transport pathways, the risks associated with those pathways, and possible remedial actions. Approximately 100 new characterization wells are planned and a number of existing wells will be recompleted to obtain characterization data. Current wells being drilled are positioned to maximize the geologic and hydrologic information available at each major underground testing area.

Other activities in this program include studies of several aspects of the groundwater transport of contaminants (radionuclide migration studies), including monitoring and evaluating the effect of underground nuclear tests on the hydrogeologic environment, investigating the availability of contaminants to leach into groundwater, and monitoring of radiological and nonradiological contaminants in water.

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 1991 to detect the presence of any radioactivity that may be related to nuclear testing activities. No radioactivity was detected in the groundwater sampling network around the NTS. 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 these wells at both these sites are decreasing and were well below the National Primary Drinking Water Regulation levels during 1991. NTS supply wells were monitored for gross alpha and beta activity as well as tritium levels.

9.1 HYDROGEOLOGY OF THE TESTING SITES

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 in the following paragraph.

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

(Chapman and Hokett 1991)

9.1.2.1 FALLON, NEVADA

The 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. Calculated groundwater flow velocities through the granite to the alluvial aquifers of Fairview Valley are very slow.

9.1.2.2 BLUE JAY, NEVADA

The 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 cavity to the Bering Sea.

9.1.2.4 RIO BLANCO, COLORADO

Project RIO BLANCO is located 1,779 m (5,838 ft) below the ground surface 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 2,568 m (8,426 ft) below the ground surface 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 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 including 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.

9.2 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 EPA'S 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 the locations on the NTS and at off-NTS sites where groundwater samples obtained from the sampling network contain levels of man-made radioactivity greater than 0.2% of the Drinking Water Regulation. Potential contamination sites are discussed below.

The majority of underground tests have occurred in Yucca Flat, Frenchmen Flat, Pahute Mesa, Rainier Mesa, and Shoshone Mountain. To date, approximately 620 underground nuclear tests have been announced. The principal by-products from these tests are 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 the secondary missions of the NTS, including disposal of defense-related low-level radioactive and mixed wastes, spill testing of hazardous liquified gaseous fuels, testing of radioactive materials, and other activities, 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 injection wells, leach fields, sumps, waste storage facilities, tunnel ponds and muck piles, and storage tanks, may have contaminated local soil and the shallow unsaturated zone of the NTS.

Because of the great depths to groundwater and the arid climate, it is assumed that 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, and wastes disposed into subsidence craters have the potential to reach the regional water table.

9.3 GROUNDWATER PROTECTION PROGRAMS

A variety of DOE/NV programs contain some aspect of groundwater protection in their overall objectives. Descriptions of these groundwater protection activities follow.

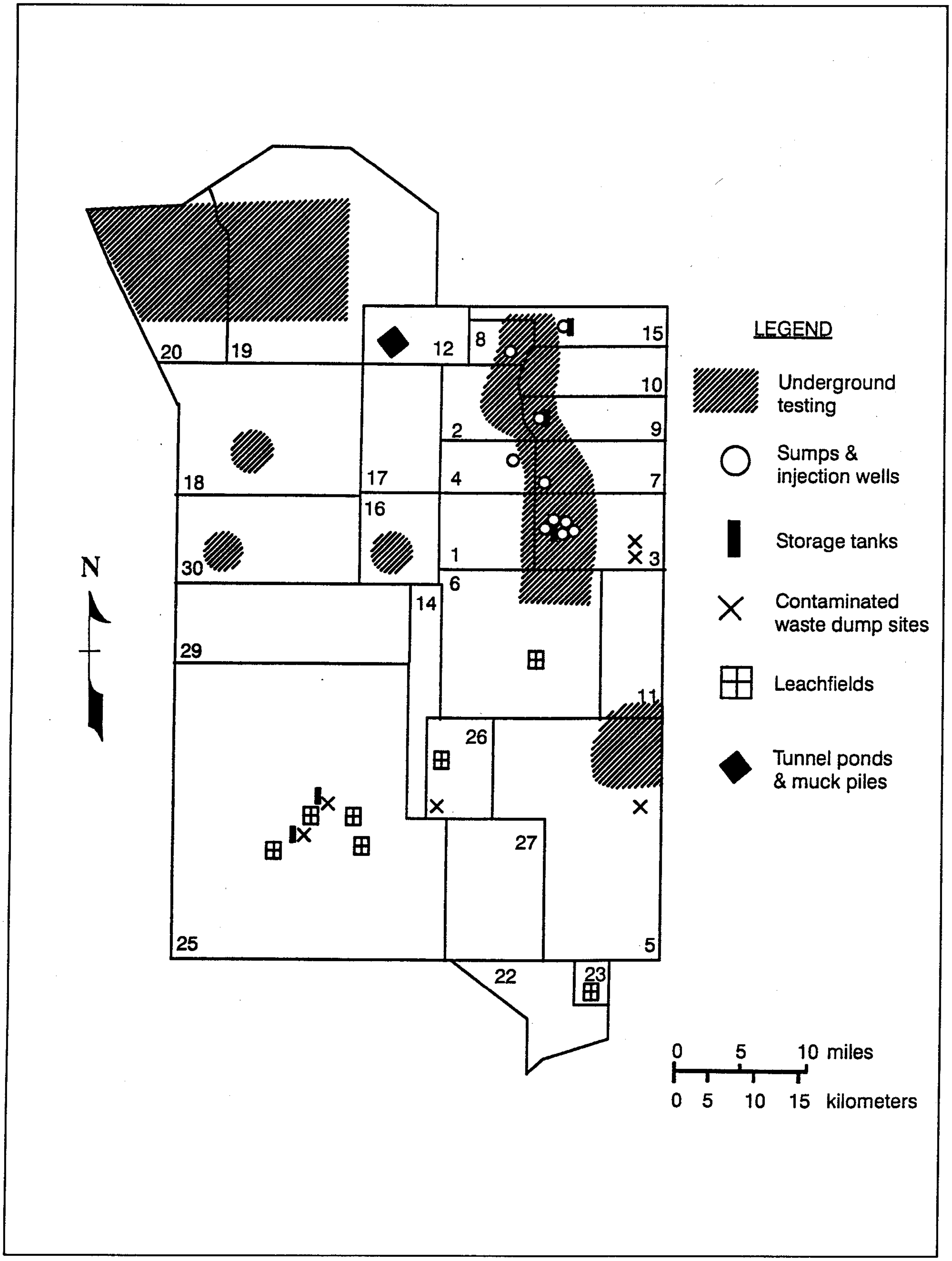


Figure 9.1 Areas of Potential Groundwater Contamination on the NTS

Table 9.1 Water Samples Containing Man-Made Radioactivity[a]

Sampling Location	Radionuclide	Concentration x 10^{-9} µCi/mL
NTS Onsite Network		
Well PM-1	^{3}H	210
Well UE-7ns	^{3}H	410
Project DRIBBLE, Mississippi		
Well HMH-1	^{3}H	1.4×10^{4}
Well HMH-2	^{3}H	1.3×10^{4}
Well HMH-5	^{3}H	2.1×10^{3}
Well HMH-10	^{3}H	300
Well HM-L	^{3}H	1.3×10^{3}
Well HM-S	^{3}H	7.1×10^{3}
Half Moon Creek Overflow	^{3}H	700
REECo Drainage Pit B	^{3}H	1.3×10^{3}
REECo Drainage Pit C	^{3}H	560
Project GASBUGGY, New Mexico		
Well EPNG 10-36	^{3}H	360
	^{137}Cs	6
Project GNOME, New Mexico		
Well DD-1	^{3}H	6.5×10^{7}
	^{90}Sr	1.3×10^{4}
	^{137}Cs	5.5×10^{5}
Well LRL-7	^{3}H	1.2×10^{4}
	^{137}Cs	200
Well USGS-4	^{3}H	1.2×10^{5}
	^{90}Sr	6.2×10^{3}
Well USGS-8	^{3}H	9.1×10^{4}
	^{90}Sr	5.1×10^{3}
	^{137}Cs	69

(a) Only ^{3}H concentrations greater than 0.2% of the National Primary Drinking Water Regulation (4 mrem) using DCGs from ICRP-30 are shown (greater than 1.8×10^{-7} µCi/mL).

9.3.1 GROUNDWATER PROTECTION POLICY AND PROCEDURES

It is the policy of DOE/NV to conduct its operations safely and to minimize the impact on the environment. The Environmental Protection Policy Statement issued by DOE/NV outlines a general policy of preventing pollutants from reaching groundwater, but it also recognizes that some options for groundwater protection from underground testing of nuclear devices 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. With reference to groundwater, the policy is as follows: "A principal objective of the DOE/NV policy is to assure the minimization of potential impacts on the environment, including groundwater, from underground testing. To ensure minimization of impacts, while fulfilling the requirements of the testing program, the location and construction of tests will be optimized in order to maximize environmental protection while minimizing adverse impacts on the testing mission of DOE/NV. 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."

Procedures and controls implemented for protection of groundwater from the potential impacts of underground testing include:

- Utilizing areas previously used for testing
- Minimizing tests at or below the water table
- Restricting tests to two or more cavity radii from any regional carbonate aquifer
- Citing tests 1,500 meters or more from any NTS boundary where groundwater leaves the NTS
- Plugging of emplacement holes that extend more than two cavity radii or 30 meters beneath the working point to prevent the open borehole from becoming a preferential pathway for groundwater contamination

The Hydrology Program Manager of DOE/NV will coordinate a review of each emplacement-hole location for compliance with procedures and controls, and may make recommendations regarding acceptability of the location. Review of the emplacement-hole location documentation for technical content will include representatives of the TOD, the HRMP, and the Environmental Protection Division (EPD) of DOE/NV. The EPD will review the documentation for environmental compliance. Based on recommendations by the previously mentioned groups, additional boreholes may be required to be drilled for hydrologic monitoring. Also, 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.

9.3.2 HYDROLOGY/RADIONUCLIDE MIGRATION PROGRAM

The Hydrology/Radionuclide Migration Program (HRMP) was originally chartered to characterize the hydrologic system including the hydrogeology, groundwater chemistry, and radiochemistry beneath and around the NTS. With the initiation of the Environmental Restoration Program, the HRMP's mission and objectives are being redefined to include groundwater protection activities; development, demonstration, and transfer of new technology; hydrologic and radiologic support of operations; and long-range hydrologic research.

HRMP activities are conducted by agencies with expertise in the various sciences required to examine the subsurface effects of the weapons testing program. These agencies include the

Lawrence Livermore National Laboratory, Los Alamos National Laboratory, U. S. Geological Survey, and the Desert Research Institute. A wide variety of studies, presently being conducted by the program participants are listed below.

Program organization has changed since last year as part of an ongoing consolidation of projects under broad research themes. The 1992 HRMP work can be grouped under five broad categories: Operational Support, Groundwater Protection, Groundwater Monitoring, Long-Range Studies, and Program Management. Program management includes planning, developing, managing, budgeting, and coordination of the various HRMP elements. Work under the other categories is described in more detail below.

9.3.2.1 OPERATIONAL SUPPORT

The purpose of this task is to provide operational support in regard to hydrology and radionuclides for the NTS mission. The following studies were part of this task.

YUCCA FLAT HYDROLOGY

Unusually high hydraulic pressures are observed in Yucca Flat that present problems with respect to nuclear testing by increasing engineering and material costs and causing concern for radionuclide migration. A Yucca Flat hydrology map (groundwater altitude) is being prepared. It is to be based on historic and current groundwater levels. This long-term project is designed to collect hydraulic information necessary to understand and to mitigate problems caused by the high pressure zone in Yucca Flat. Presently, fluid levels in existing holes and exploratory holes are being monitored, and water samples collected for analysis of tritium, krypton, and gamma-emitting fission products. Water levels were measured in UE-3e#4, UE-4t, U-4ups2a, U-7cd, U-7cd1 and U-3mi, and samples were collected from UE-3e#4, U-4ups2a, and UE-4t. U-7cd, a new emplacement hole, encountered high pressures in 1992. Water levels were monitored and a sample was collected from this hole, with no tritium detected. Research into mathematical modeling approaches to determine the origin of Yucca Flat overpressure was begun and a finite-difference model of the fluid pressure effects of radial compaction around underground tests identified. Monitoring and mapping of the overpressures will continue in 1993, as will evaluation of gravitational and radial-compression theories for the origin of the overpressures.

PAHUTE MESA GROUNDWATER LEVELS

On Pahute Mesa, water is often encountered in emplacement holes during drilling that is well above the predicted elevation of the local groundwater table. These waters may be perched groundwater or fluids that are introduced during drilling. Drillers often find it impossible to maintain the desired water level above the bit in the Timber Mountain tuffs. It is possible that massive injection during drilling in this formation leads to standing water in Pahute Mesa emplacement holes. Water levels are monitored in emplacement holes, other boreholes, and wells to help determine the origin of these high water levels and to produce a groundwater altitude map for the Mesa. Chemical labeling of drilling fluids is conducted in emplacement holes to further evaluate the origin of anomalous groundwater at the Mesa. Water level measurements, chemical labelling of drilling fluids, and sampling for tracers are expected to continue in 1993.

NEAR-FIELD HYDROLOGIC STUDY

The near-field hydrologic system controls the transfer of water and radionuclides from the shot cavity to the regional hydrologic system; therefore, it can strongly affect the environmental impact of underground testing. Theoretical studies have been made on the near-field hydrologic environment of below water-table tests. These studies have included algebraic solutions describing groundwater flow in collapse-chimney/aquifer systems, and have provided first-order estimates of potential radionuclide transport in such systems. The solutions demonstrate that the maximum potential for transport occurs when a permeable collapse chimney connects two aquifers. This year, development began on an analytical element computer program for estimating near-field migration from below water-table tests. Modifications were also made to the 3-D compressible fluid flow code HST3D for use in calculations and data visualization. Next year, these models will be applied to estimating tritium plumes for Pahute Mesa and the fate of tritium at the USGS Amargosa Valley Research Site.

WELL VALIDATION PROGRAM

To quantify the movement of groundwater beneath the NTS and help develop a monitoring strategy to detect the possible migration of hazardous and radioactive substances, detailed testing of existing wells and boreholes is being conducted. Wells presently used for groundwater sampling are poorly characterized with regard to lithology, aquifer penetrated, vertical hydraulic gradients, and vertical variations in water quality. Additional site investigation is necessary to properly interpret hydrologic data from these wells. For example, in many wells evaluated so far, natural vertical flow, induced by vertical hydraulic gradients, was detected. The presence of vertical flow suggests that depth-to-water measurements in open holes do not represent the actual hydraulic head present in any one open interval. The presence of vertical flow also invalidates the assumption that only horizontal flow occurs, which is traditionally used in estimating groundwater flow and contaminant transport potential. A thermal-pulse flowmeter was built and tested this year, and a pump and packer were added for use in wells with greater than six-inch diameters. A new hydrochemical logging tool was also built to measure temperature, electrical conductivity, pH, dissolved oxygen, and bromide ion concentration. Geophysical logs and water samples were collected at ER-12-1, UE-1q, U-7cd satellite well, and three wells at the Central Nevada Test Area. Validation activities will continue at existing NTS wells in 1993 under the Groundwater Characterization Project. Testing of the new logging tool will be conducted.

9.3.2.2 GROUNDWATER PROTECTION

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. Groundwater chemistry data including pH, total dissolved solids, and inorganic dissolved constituents are being assembled and interpreted. Hydrochemical facies maps are being constructed from the database.

To define the source term of radionuclides available for transport, a water sample was collected from U-4ups2a, a postshot hole into the cavity/chimney region of a nuclear test conducted in 1989. A number of fission products at concentrations expected for chimney material were identified in the water and filtrate. These concentrations were compared to data collected in 1990 and recalculated using a new counting system calibration. The results suggest that the water level had reestablished itself above the region sampled, and the tritium distribution in the chimney retained some measure of the concentration gradients that were present shortly after the explosion. Sampling at locations where migration has occurred (e.g., at UE-3e#4) continued for evaluation of transport mechanisms. Current results suggest that a volatile cesium precursor migrated by dynamic gaseous injection, while tritium likely moved with groundwater. The risk associated with the potential migration of radionuclides at the NTS was evaluated this year using a travel-time distribution approach. These analyses will be refined in the upcoming year by developing a closed form solution for different radionuclides and predicting the spatial distribution of the plume at any given time.

NEW TECHNOLOGIES

Technology development to aid in characterizing and remediating potential environmental contaminants in the subsurface of the NTS has proceeded along four fronts this year. The suitability of pressure transducer systems in measuring water-level fluctuations in deep boreholes and wells under non-stressed conditions is being evaluated. Second, as discussed in the "Well Validation" section of Operational Support, a thermal-pulse flowmeter has been developed for measuring the direction and magnitude of flow between hydrologic horizons connected by a borehole. A new logging tool for pH, electrical conductivity, temperature, dissolved oxygen, and bromide was designed. Third, the use of infrared spectroscopy to quantitatively determine the amount of free and bound water was investigated and a preliminary downhole infrared instrument was designed. Fourth, a project to develop a method to remove tritium from water without evaporation was begun. The basis for this method is the process of isotopic equilibration between liquid water and water in the atmosphere. In the equilibration process, molecular exchange redistributes isotopes according to their fractionation factor, resulting in an isotopic flux without requiring an associated volume flux of water. The tritium concentrations of some NTS waters are in extreme isotopic disequilibrium with ambient vapor, so the isotopic compositions of these waters will be driven toward equilibrium with respect to tritium. Laboratory experiments were conducted this year to determine the effect of volume and surface area on isotopic exchange and to quantify tritium exchange. Next year, experiments will be directed at determining how to facilitate the exchange process.

9.3.2.3 GROUNDWATER MONITORING

An ongoing program to accurately determine the rate and direction of groundwater flow is being conducted. Historic water-level measurements are being evaluated and new water-level measurements are being made that describe the conditions in the water-bearing zones of the subsurface environment at and around the NTS. Water use data on and around the NTS are being collected and evaluated. Naturally occurring isotopes of strontium, uranium, neodymium, hydrogen, and helium in groundwater at the NTS are being examined to identify and trace groundwater through individual aquifers. The noble gases (helium, neon, argon, krypton, and xenon) dissolved in groundwaters are also being identified to fingerprint water from different aquifers.

9.3.2.4 LONG-RANGE STUDIES

CAMBRIC STUDIES

In 1965 the CAMBRIC nuclear test was conducted in Frenchman Flat, Area 5. A reentry borehole (RNM-1) was drilled into the cavity in 1974 along with a satellite well (RNM-2S) 91 meters away. Water was continually pumped from the satellite well to induce a hydraulic gradient from the cavity to the satellite well. Groundwater samples were collected from these wells to evaluate radionuclide migration away from the cavity. Effluent from RNM-2S was discharged into a ditch near the pumped well until pumping was discontinued in August 1991 in accordance with Department of Energy and state of Nevada environmental regulations. To determine how the site responded to the cessation of pumping and return to the naturally small hydraulic gradient in the area, water samples were collected from RNM-1 and RNM-2S in 1992. At RNM-1, both ^{3}H and ^{137}Cs are present in slightly greater concentrations than those in the last samples collected in August 1991. No ^{85}Kr was detected in this well. At RNM-2S, ^{3}H, ^{85}Kr and possibly ^{137}Cs were detected, but the concentrations could not be compared to 1991 because steady state concentrations were not reached before the holding tank had filled and the pump had to be turned off. Additional sampling may be conducted in 1993.

GROUNDWATER RECHARGE STUDIES

One of the fundamental questions concerning the groundwater system at the NTS is where and under what conditions does groundwater recharge occur. Previous studies have suggested that infiltration may occur along washes, through exposed bedrock, or through coarse fan deposits. In this study, recharge associated with wash environments and high elevation is investigated by monitoring meteorological data (precipitation, temperature, relative humidity) and soil data (soil temperature, relative soil moisture, volumetric water content). This year, the number of study sites was doubled to eight: four on Pahute and Rainier Mesas, and four at lower and upper Fortymile Wash, Whiterock Spring, and U3fd crater. Data were collected via phone modem and by onsite transfer with a lap-top computer, while site maintenance was also conducted (e.g., one site was damaged by a nearby lighting strike). The data are routinely evaluated and will be used to construct and calibrate a groundwater recharge model.

9.3.3 OTHER GROUNDWATER PROTECTION PROGRAMS

Because of the large distance from the surface to groundwater, there is a minimal risk of groundwater contamination from surface activities. Nonetheless, there are several programs established to provide groundwater protection from surface activities at the NTS. Most of these are described elsewhere in this report with waste minimization, treatment, storage, and disposal described below. For information on the protection programs, sampling, and analyses related to the Safe Drinking Water Act, Clean Water Act, and Resource Conservation and Recovery Act, please see Chapters 5 and 7.

9.3.3.1 WASTE MINIMIZATION AND POLLUTION PREVENTION AWARENESS PROGRAM

The DOE Nevada Operations Office has developed a Waste Minimization and Pollution Prevention Awareness Program (WM&PPAP) that states goals and policies for waste minimization and represents an ongoing effort to make pollution prevention and waste minimization part of NTS operating philosophy. The plan is designed to reduce waste generation and possible pollutant releases to the environment and thus increase the protection of employees and the public. All DOE/NV contractors and NTS users that exceed the EPA criteria for small-quantity generators are establishing their own waste minimization and pollution prevention awareness programs. The DOE/NV WM&PPAP provides guidance to contractors and users in preparing their individual plans. Contractor programs will ensure that waste minimization activities are in accordance with federal, state, and local environmental laws and regulations, and DOE Orders. The objectives of the waste minimization and pollution program are:

- Identifyiny processes generating waste streams
- Characterizing and tracking each waste stream
- Identifying, evaluating, and implementing applicable waste minimization technologies
- Setting numerical goals and schedules after the initial assessment of technological and economic feasibility
- Establishing an employee pollution prevention awareness and training program

Additional goals include the promotion and use of nonhazardous materials, establishment of a baseline of waste generation data, calculations of annual reductions of wastes generated, implementation of recycling programs, and incorporation of waste minimization concepts and technologies in planning and design of new processes and facilities, and in upgrades of existing facilities. A waste minimization task force composed of representatives from each contractor and NTS user has been established to coordinate DOE/NV waste minimization and pollution prevention awareness activities.

9.3.3.2 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 generated by DOE defense facilities (see Chapter 8). The Area 5 Radioactive Waste Management Site also serves as a temporary storage area for Lawrence Livermore National Laboratory transuranic wastes which will be shipped to the Waste Isolation Pilot Plant in New Mexico for final disposal. The Area 5 facility also has mixed waste disposal capability. All hazardous wastes generated at the NTS are disposed offsite at commercial facilities approved and permitted by the EPA. Hazardous wastes are temporarily stored at the NTS in full compliance with federal, state, and local requirements.

Waste disposal facilities are presently operating under interim status pending completion of the RCRA permitting process or under DOE Orders. Operation of the low-level radioactive waste and mixed waste disposal sites, and the temporary transuranic waste storage site are supported by an environmental monitoring program that indicates waste is being safely contained in the near surface environment in which it is emplaced. The radioactive and mixed-waste disposal facilities are mainly shallow land burial areas. No free liquid wastes are accepted, extensive flood protection is provided, and closure designs strongly emphasize limiting deep soil infiltration. These sites will most likely remain too dry for significant migration and consequent groundwater contamination to occur. Three pilot wells were installed at the Radioactive Waste Management Site in Area 5 and will be sampled and analyzed in compliance with RCRA requirements in support of a RCRA Part B permit application. Data collected during and after drilling these wells will also be integrated into the CERCLA RI/FS for the underground test areas. Vadose zone monitoring is conducted under the waste disposal pits to obtain more timely information on any possible movement of waste constituents toward the groundwater table.

9.4 ENVIRONMENTAL RESTORATION PROGRAM

The objectives of the Environmental Restoration Program (ERP) are to assess past hazardous and radioactive waste contamination that may have occurred as a result of operations at DOE facilities, and to develop remedial actions consistent with the National Oil and Hazardous Substances Pollution Contingency Plan for those sites that pose a threat to human health, welfare, and/or the environment. Since it's inception, requirements of the ERP have been developed so that DOE compliance with federal laws such as the Resource Conservation and Recovery Act (RCRA); Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); and the Superfund Amendments and Reauthorization Act (SARA) could be met. CERCLA and SARA are the primary legislative acts governing remedial action at former hazardous waste disposal sites and 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. As a result, the ERP was modified to include a RI/FS program for all former DOE hazardous waste disposal sites and expended nuclear tests. An initial step of the RI/FS is to conduct site characterization to determine the type of contamination present, the extent and concentration of contaminants, and to identify and delineate potential contaminant transport pathways. Various aspects of the ERP and RI/FS relating to groundwater are discussed below.

9.4.1 GROUNDWATER CHARACTERIZATION PROJECT

The hydrogeologic regime in the vicinity of the NTS is not understood well enough to meet DOE's regulatory compliance objectives. As part of the ERP, the Groundwater Characterization Project (GCP) is being conducted to better understand the location, quantity, and movement of groundwater and contaminants at the NTS. Information gained from the GCP will be used in the RI/FS to evaluate potential groundwater contaminant transport pathways, the risks associated with those pathways, and possible remedial actions. Approximately 100 new characterization wells will be constructed and a number of existing wells recompleted to obtain characterization data. Presently, the wells being drilled for the GCP are being positioned to maximize the geologic and hydrologic information available at 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.

9.4.2 TUNNEL EFFLUENT CHARACTERIZATION PROJECT

Nuclear devices are tested in horizontal tunnels mined into Rainier Mesa at the NTS. The tests are 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 contain radionuclides from underground nuclear tests, and are drained out of the tunnels into evaporation ponds or washes. Mining and related operations also may have released organic compounds and heavy metals to the tunnel effluent. U12n tunnel effluent is covered under a temporary discharge permit and U12n, U12t, and U12e tunnel effluent are the subject of a list of options submitted to the state of Nevada in 1992. The objective of the options is to eliminate the discharge to the soil column. In the interim, liquid effluent is analyzed for radionuclides as part of the Environmental Surveillance Program, reported in Chapter 5. In addition, samples are collected to identify metals and organic compounds, and to observe temporal variations in discharge volumes and chemical constituents. The data are expected to support the design of treatment or remediation measures. An RI/FS for the tunnel evaporation ponds will define the extent of contamination, associated risks, and appropriate remedial actions.

9.4.3 DECONTAMINATION AND DECOMMISSIONING AND REMEDIAL ACTION PROGRAMS

Groundwater protection is related to some of the decontamination and decommissioning (D&D) programs for surplus, contaminated facilities and remedial action programs for inactive, contaminated facilities and sites at the NTS. Remedial action programs identify sites, assess the extent of contamination, minimize the spread of contamination, clean up sites according to negotiated agreements, and provide long term monitoring. D&D programs have similar objectives, as well as ensuring that facilities are maintained in a safe manner pending determination of final facility disposition. Facilities that will be closed or modified under these programs include operational support facilities such as sumps, injection wells, and leach fields.

Because of the arid climate and the great depths to groundwater from the land surface, any contaminants found in the near-surface environment will probably not reach the water table. However, injection of liquid wastes into wells greatly increases the potential for contamination of groundwater by shortening the pathway to the water table and supplying the medium to transport contaminants. Pumping liquid wastes into leach fields and unlined surface structures such as ponds and lagoons introduces contaminants into the unsaturated zone and supplies the mechanisms necessary to transport contaminants to the local groundwater table.

As part of the RCRA site closure process, discharges of liquid wastes to injection wells and leach fields are being eliminated. Lagoons, ponds, and sumps are being lined with impermeable materials that will allow liquid wastes to evaporate, rather than seep into the ground. Residual contaminants are being periodically removed from these surface structures. Dumping of liquid radioactive and hazardous wastes into subsidence craters has been eliminated. Long-term measures will be instituted to remediate contaminated areas, control migration of wastes, and/or isolate wastes from the accessible environment. A list of NTS facilities with RCRA closure plans is shown in Table 9.2.

Hazardous wastes found in the soils will be remediated as required by state of Nevada and federal regulations. Most radioactive materials produced from nuclear testing, including tritium, cannot be treated. Thus, mixed wastes and radioactive wastes presently located in the near surface will either be isolated from the accessible environment by *in situ* stabilization using engineered barriers to restrict migration or removed and placed in properly designed and permitted waste repositories. Extensive monitoring systems surrounding isolated wastes will be designed and constructed to provide early warning of contaminant migration. Dry wastes isolated in the unsaturated zone will be monitored with instruments that detect waste transport in the liquid and gaseous phases. Monitoring systems for liquid-waste storage areas, lagoons, and ponds will also use soil-moisture and soil-gas monitoring instruments as well as monitoring wells.

9.4.4 OTHER ENVIRONMENTAL RESTORATION PROGRAMS

To properly assess the potential risks associated with contamination resulting from underground nuclear testing and to evaluate possible remedial actions, it is necessary to

Table 9.2 NTS Facilities with RCRA Closure Plans

Area	Designation
Area 2	Bitcutter Shop & LLNL Postshot 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

understand how radionuclides produced by a test move through the underground hydrogeologic environment in the days and years following a test. One factor that may be important to the migration process is the spatial distribution of the radioactive material in the cavity and chimney following a test. For example, if the working point of a test is in the vadose zone just above the water table, the bottom of the resulting cavity may be below the water table. If there is separation of volatile and refractory materials, the source terms in the cavity bottom and in the chimney could differ significantly from one another and they would be subject to different probabilities of leaching by groundwater. To investigate the extent to which volatile and refractory elements are separated in postshot deposits and differences in leachability, samples are obtained from expended nuclear cavities and chimneys. Samples collected in 1992 from a test conducted in alluvial material above the water table revealed the specific activity of the chimney sample to be much lower than that of the cavity sample, and the relative distributions of refractory elements (e.g., molybdenum, zirconium, neodynium) and volatile elements (e.g., iodine, cesium, barium) differed somewhat. For example, ^{137}Cs was found only in the chimney sample. This isotope has volatile and gaseous precursors with half-lives up to several minutes and was probably not present as the melt glass condensed from the vapor phase. After the samples were counted, they were placed in deionized water in a constant temperature shaker bath for 15 days and the resulting leachate was then filtered and counted. The only radionuclides detectable in the leachate were ^{124}Sb and ^{131}I. As observed in earlier samples, the ^{131}I in the chimney sample was much more leachable than that in the cavity sample. Presumably this occurs because the iodine in the chimney is primarily surface condensate, whereas that in the cavity is incorporated within the melt glass. Additional samples from another test will be analyzed next year and more leaching experiments will be performed. The potential source term for contaminant migration will be further evaluated next year by analyzing large-volume water samples collected from NTS wells to measure their tritium and fission product content.

9.5 LONG-TERM HYDROLOGICAL MONITORING PROGRAM ACTIVITIES ON AND AROUND THE NEVADA TEST SITE

The Long-Term Hydrological Monitoring Program (LTHMP) was established in 1972 by the Nevada Operations Office of the AEC, the predecessor agency to DOE/NV. The U.S. EPA's Environmental Monitoring Systems Laboratory in Las Vegas, Nevada (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 was instituted because the AEC (and later affirmed by DOE/NV) acknowledged its responsibility for obtaining and for disseminating data acquired from all locations where nuclear devices have been tested. Those data must be appropriate and adequate to:

- Assure public safety
- Inform the public, news media, and scientific community about any radiological contamination
- Document compliance with existing federal, state, and local antipollution requirements

The LTHMP conducts routine monitoring of specific wells on the NTS and of wells, springs, and surface waters in the offsite area around the NTS. In addition, sampling for the LTHMP is conducted at other locations in the U.S. where nuclear weapons tests have been conducted. These locations include sites in Nevada, Colorado, New Mexico, Mississippi, and Alaska. Sites outside of the NTS and vicinity are discussed in Section 9.6.

9.5.1 SAMPLING AND ANALYSIS PROCEDURES

At nearly all LTHMP locations, the standard operating procedure is to collect three samples from each source. Two samples are collected in 500-mL glass bottles to be analyzed for tritium. The results from analysis of one of these samples are reported while the other sample serves as a backup in case of loss or as a duplicate sample. The remaining 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 rig is used. With this rig it is possible to collect three-liter samples from wells as deep as 1800 meters. At the normal sample collection sites, the pH, conductivity, water temperature, and sampling depth are measured 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. Prior to 1979, the first samples from a new location were analyzed for 15 stable elements; anions, nitrates, ammonia, silica; uranium, plutonium, and strontium isotopes; and ^{226}Ra. Most of these analyses can still be completed by special request. At least one of the Cubitainer samples from each site is analyzed by gamma spectrometry, using a 100-minute counting time. One of the 500-mL samples from each site is analyzed for tritium. When sample results are close to or less than the MDC for the conventional tritium analysis (approximately 400 to 700 pCi/L), the sample is concentrated by electrolysis. The MDC for this method (referred to as the enrichment method in the following text) is approximately 5 to 7 pCi/L.

9.5.2 NEVADA TEST SITE MONITORING

The present makeup of the LTHMP for the NTS onsite network, which includes sample locations on the NTS or immediately outside its borders on federally owned land, is displayed in Figure 9.2. All sampling locations are selected by DOE and primarily represent drinking water supplies. All samples are analyzed by gamma spectrometry and for tritium by the enrichment method. Sixteen wells are sampled monthly and twenty-one wells are sampled twice per year, at approximately six month intervals. No gamma-emitting radionuclides were detected in any of the samples collected in 1992 and analyzed by gamma spectrometry. The greatest tritium activity measured in the LTHMP NTS network in 1992 was 448 ± 4 pCi/L in a sample from Well UE-7ns. This activity is 0.5 percent of the derived concentration guide (DCG).[1]

Of the 37 sampling locations assigned to the LTHMP, six could not be sampled at any time in 1992 as noted in Table 9.3. One new sampling location was added, Well P.M. Exploratory #1, and sampling was resumed at two locations in 1992: Well 5B, which was last sampled in July 1988, and Well UE-7ns, which had last been sampled in September 1987. Additional analyses were performed on the first samples collected from the new location and from the two wells with a long break in sampling. The May 1992 sample from Well P.M. Exploratory #1 and the August 1992 sample from Well 5B yielded no detectable activity for ^{137}Cs, ^{238}Pu, $^{239+240}$Pu, ^{89}Sr, or ^{90}Sr. The Well 5B sample was also negative for tritium, while the sample from Well P.M. Exploratory #1 yielded a tritium activity of 207 ± 3 pCi/L. The March 1992 sample from Well UE-7ns yielded no detectable alpha or gamma emitters; a gross beta activity of 7.87 ± 0.96 (MDC of 2.51) pCi/L was obtained and tritium results were 380 ± 4 pCi/L.

In the fall of 1992, DOE elected to restrict access and reduce maintenance to certain portions of the NTS. As part of this cost-saving measure, water Well U-20 and Well UE-19c have been temporarily shut down; i.e., power to the pump disconnected and the lines drained. The last samples collected from these two wells were taken in October 1992. In addition, Well UE-16f is located in an area with restricted access which precluded collection of the semiannual sample scheduled to be taken in October. It is expected that access restrictions will be removed and power restored in the spring of 1993.

Summary results of tritium analyses are presented in Table 9.3. Five of the monthly sampled wells and seven of the wells sampled semiannually yielded tritium results greater than the MDC of the enrichment analysis (approximately 5 to 7 pCi/L) in one or more samples. Of these, 6 involved only a single sample, with tritium activities less than 30 pCi/L (less than 0.03 percent of the DCG). Two of the monthly sampled wells, Test Well B and water Well C, have consistently shown detectable tritium over their sampling history. The 1992 average for Test Well B was 105 pCi/L (range 94 to 119 pCi/L, 0.10 to 0.13 percent of the DCG) and for water Well C was 16.1 pCi/L (range 10.9 to 23.7 pCi/L, 0.01 to 0.03 percent of the DCG). A decreasing trend is evident in Test Well B, as shown in Figure 9.3[2].

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[1] The derived concentration guide (DCG) used in this report is 90,000 pCi/L of tritium in water. This DCG is taken from the ALI for ^{3}H in ICRP-30 modified for a maximum dose of 4 mrem/year for ingestion of beta/gamma emitters in water, assuming consumption of two liters of water per day and assuming tritium to be the only radioactive contaminant. The current U.S. standard given in the National Primary Drinking Water Regulations (40 CFR 141), although based on the same maximum dose and assumptions, specifically limits tritium to 20,000 pCi/L in drinking water. A revision of standard has been proposed which will, when enacted, raise the permissible tritium concentration to 63,000 pCi/L in U.S. drinking water.

[2] In the time series plots used as figures in this section and the one that follows, the filled circles represent the result value, the error bars indicate ± one standard deviation of the analysis, and the (x) represents the MDC value.

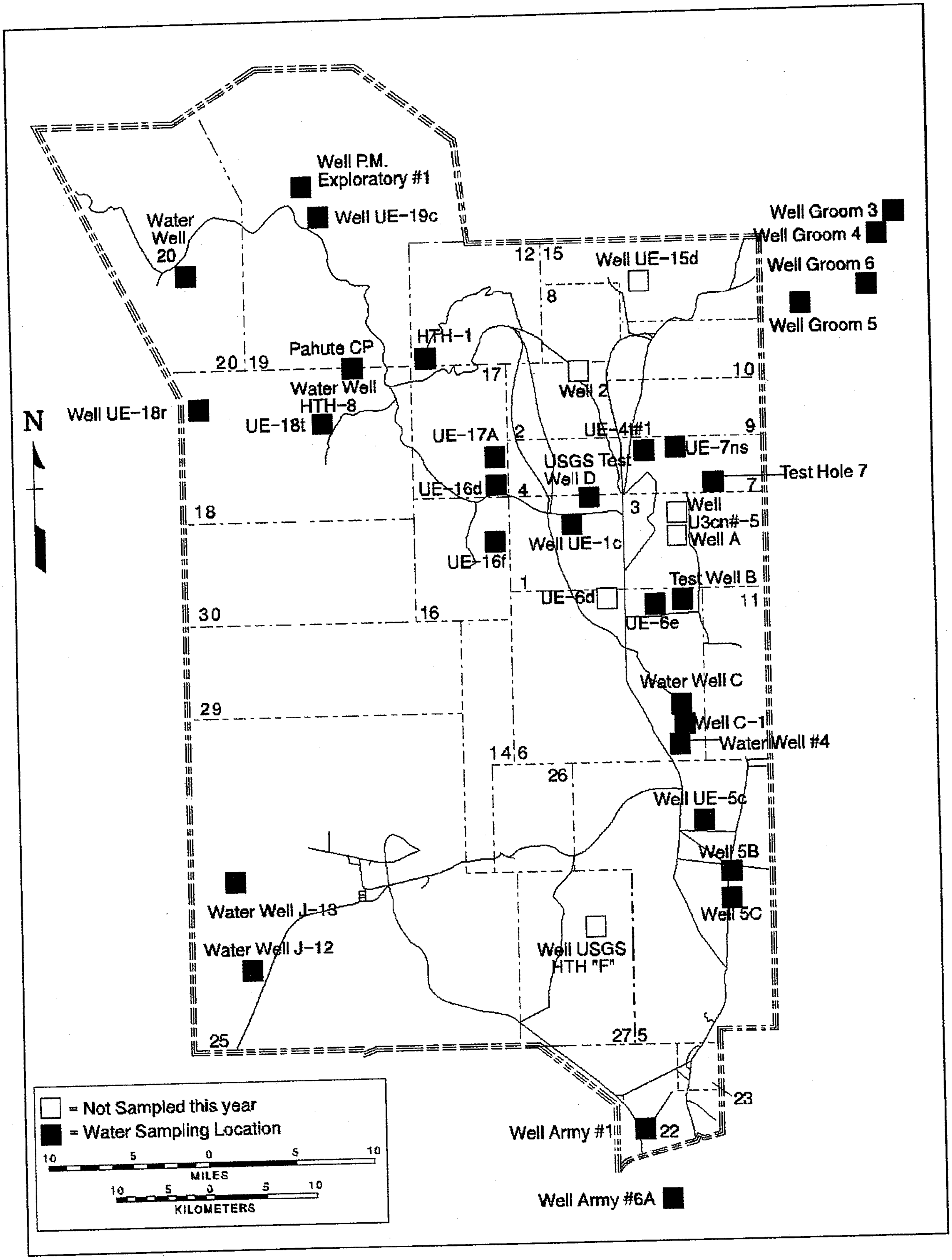

Figure 9.2 Wells on the NTS Included in the LTHMP

Table 9.3 Long-Term Hydrological Monitoring Program Summary of Tritium Results for Nevada Test Site Network, 1992

Location	Tritium Concentration (pCi/L) Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG
Test Well B	11	120.	94.	100.	7.5	0.12
Test Well D	2	5.6	3.1	4.3	1.8	NA
Test Well #7	2	3.3	2.8	3.0	0.4	NA
Well Army #1	12	3.2	-2.5	0.2	1.8	NA
Well Army #6A	2	3.2	1.7	2.4	1.1	NA
Well A	Well inactivated by DOE, last sampled October 1988					
Well C	11	24.	11.	16.	4.4	0.02
Well C-1	2	17	4.7	11.	8.7	0.01
Well Groom 3	12	6.2	-2.0	2.0	2.6	NA
Well Groom 4	12	3.4	-1.9	-0.1	1.6	NA
Well Groom 5	12	3.2	-3.0	0.0	1.9	NA
Well Groom 6	11	1.2	-1.9	-0.2	1.0	NA
Well USGS HTH "F"	Not sampled in 1992, last sampled February 1980					
Well HTH #1	1	–2.1	–2.1	–2.1	0	NA
Well HTH #8	12	10.3	-5.1	0.3	3.6	NA
Well J-12	8	2.2	-3.9	-0.2	2.2	NA
Well J-13	12	3.7	-2.6	0.4	2.0	NA
Well P.M. Expl. #1	2	210.	210.	210.	0.2	0.23
Well U-3cn #5	Well shut down throughout 1992, last sampled December 1981					
Well U-20	8	4.9	-3.0	1.0	2.7	NA
Well UE-1c	2	2.5	0.0	1.2	1.7	NA
Well UE-4t #1	2	47	30	38	12	0.04
Well UE-5c	2	–1.1	–2.9	–2.0	1.3	NA
Well UE-6d	Inaccessible throughout 1992, never been successfully sampled					
Well UE-6e	1	26	26	26	0	0.03
Well UE-7ns	2	450.	380.	410.	48.	0.46
Well UE-15d	Pump inoperative, well shut down by DOE					
Well UE-16d	2	2.3	–4.5	–1.1	4.8	NA
Well UE-16f	1	7.2	7.2	7.2	0	0.01
Well UE-17a	2	2.3	–2.3	0.0	3.3	NA
Well UE-18r	1	1.3	1.3	1.3	0	NA
Well UE-18t	1	100.	100.	100.	0	0.11
Well UE-19c	11	5.3	-2.1	0.5	2.5	NA
Water Well 2	Well shut down throughout 1992, last sampled December 1990					
Well #4	12	2.9	-4.8	-0.6	2.1	NA
Well 5B	1	3.2	3.2	3.2	0	NA
Well 5C	12	3.7	-2.7	0.1	2.0	NA

NA Not applicable; Percent of concentration guide is not applicable: the tritium result is less than the MDC or the water is know to be nonpotable

DCG Derived Concentration Guide; Established by DOE Order as 90,000 pCi/L

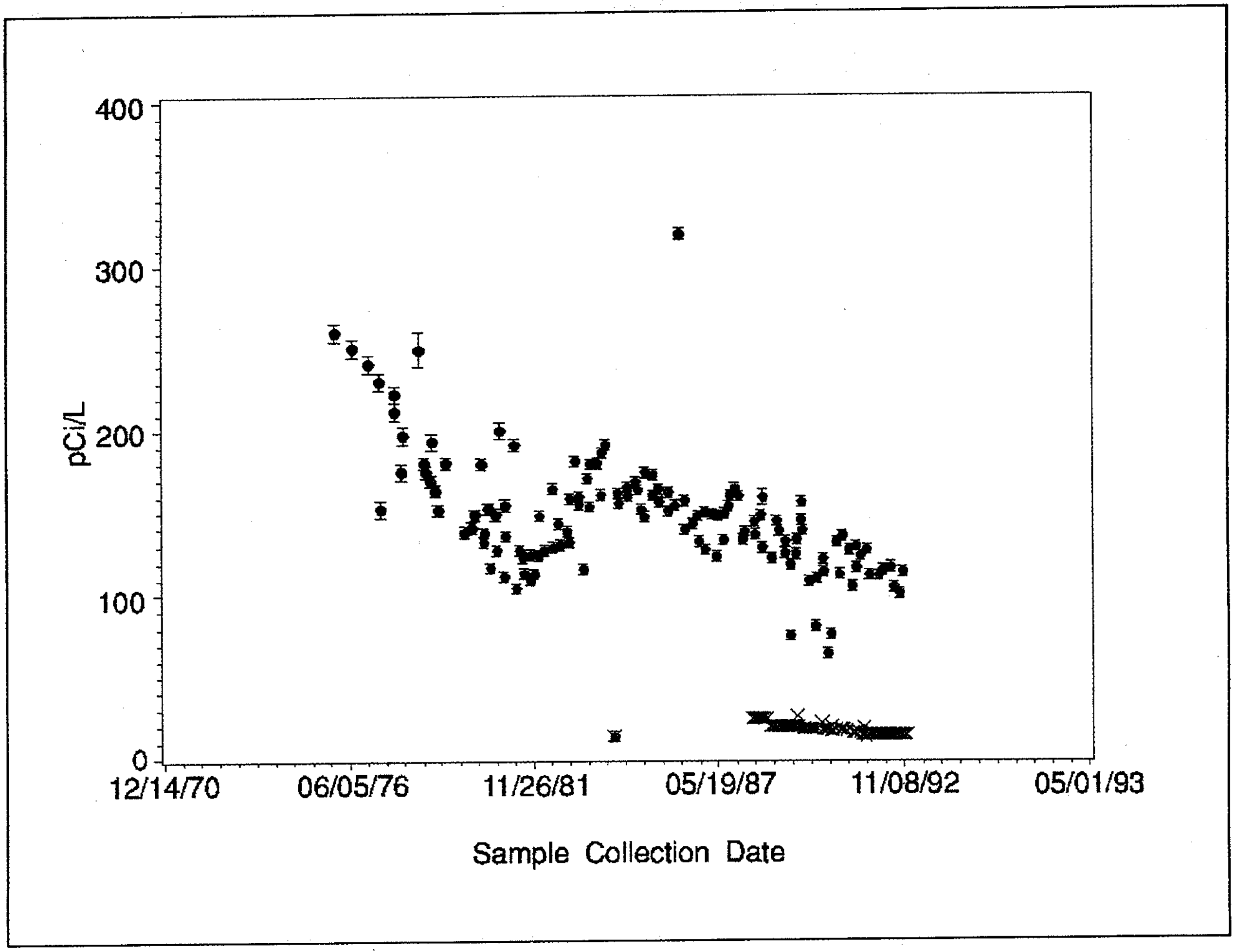

Figure 9.3 Tritium Concentration Trends in Test Well B on the NTS

Both of the semiannual samples collected from Wells UE-4t #1, P.M. Exploratory #1, and UE-7ns contained detectable tritium, as did the single sample obtained from Well UE-18t. Average concentrations for these wells were less than 40 pCi/L (0.04 percent of the DCG) in Well UE-4t #1, 207 pCi/L (0.23 percent of the DCG) in Well P.M. Exploratory #1, and 414 pCi/L (0.46 percent of the DCG) in Well UE-7ns. The single sample obtained from Well UE-18t yielded a tritium result of 102 ± 2 pCi/L (0.11 percent of the DCG). Three of these sampling locations do not have sufficient data to discern any trends, as they have been added to the sampling network in recent years. Well UE-7ns was routinely sampled between 1976 and 1987; an increasing trend was evident, with tritium concentrations in excess of 2500 pCi/L at the time sampling ceased in September 1987.

9.5.3 OFFSITE MONITORING IN THE VICINITY OF THE NEVADA TEST SITE

The monitoring sites located in the offsite area around the NTS are shown in Figure 9.4. Most of the sampling locations represent drinking water sources for rural residents in the offsite area and public drinking water supplies in most of the communities in the area. The sampling sites include 23 wells, seven springs, and two surface water sites. Thirty of the locations are

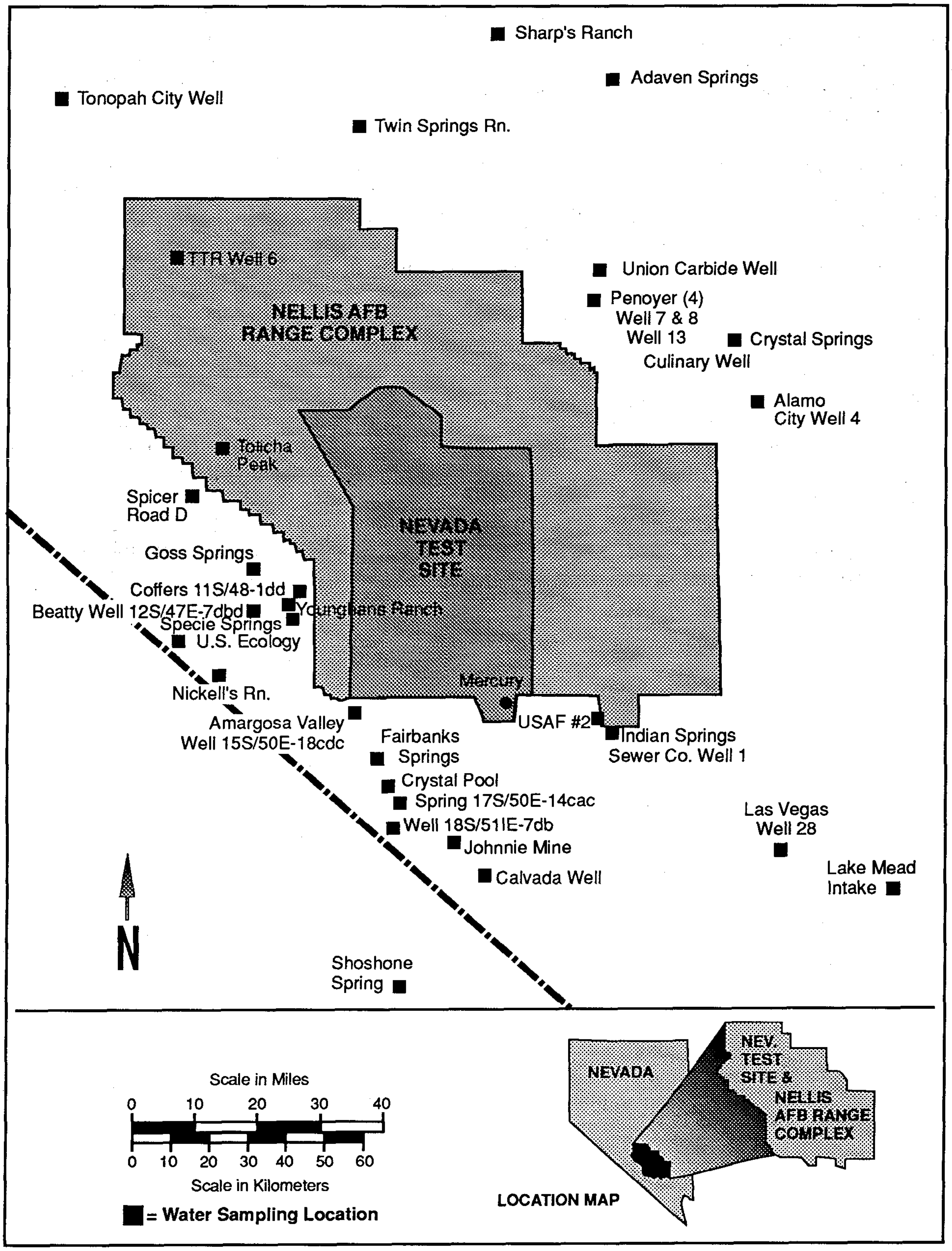

Figure 9.4 Wells Outside the NTS Included in the LTHMP

routinely sampled every month. The remaining two sites, Penoyer Well 13 and Penoyer Wells 7 and 8, are in operation only part of the year; samples are collected whenever the wells are in operation. Water samples are collected each month for gamma spectrometric analysis. Samples for tritium analysis are collected on a semiannual basis. One of these semiannual tritium analyses is done by the conventional analysis method; the other analysis is done by the enrichment method.

Over the last decade, only three sites have evidenced detectable tritium activity on a consistent basis. These three sites are in Nevada, namely Lake Mead Intake (Boulder City), Adaven Spring (Adaven), and Specie Springs (Beatty). In all three cases, the tritium activity represents environmental levels that have been generally decreasing over time. The last time tritium concentrations for Specie Springs were greater than the MDC was in 1990.

In 1992, four of the samples analyzed for tritium by the enrichment method yielded detectable tritium activities. The January result for Adaven Spring of 32.4 ± 1.8 pCi/L was consistent with tritium levels noted in recent years as shown in Figure 9.5. The May and September results for Lake Mead Intake were 57.5 ± 2.2 pCi/L and 62.2 ± 2.3 pCi/L as indicated in Figure 9.6. These results were similar to results obtained in 1991. This surface water site may be impacted by rainfall containing scavenged atmospheric tritium to a greater extent than the well and spring sites in the offsite network. The tritium result of 6.0 ± 1.7 pCi/L for the September sample from Johnnie Mine was only slightly higher than the MDC of 5.5 pCi/L and was the first detectable tritium activity obtained for that site since sampling was initiated in 1989. Tritium results for all samples are shown in Table D.6, Appendix D. No gamma-emitting radionuclides were detected in any sample taken in 1992 from the network shown on Figure 9.4.

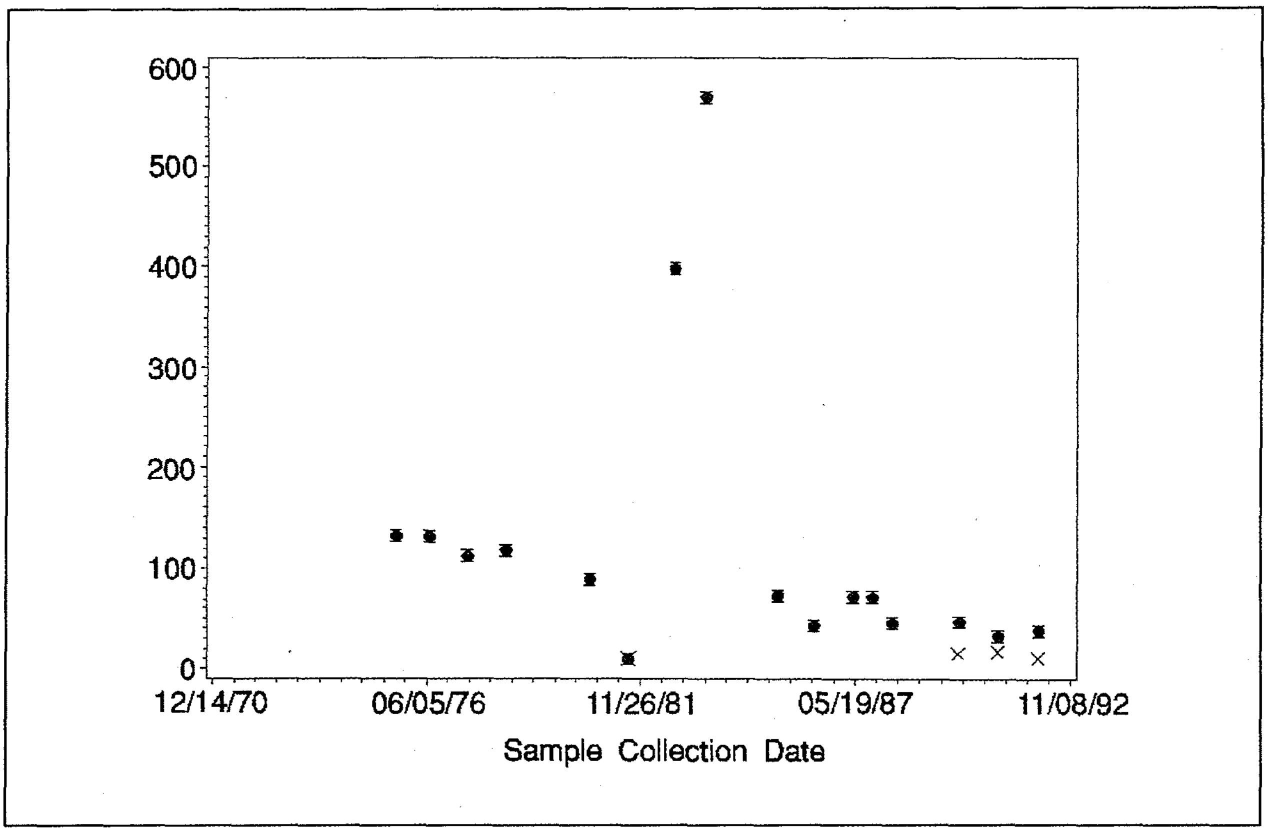

Figure 9.5 Tritium Results in Water from Adaven Springs, Nevada

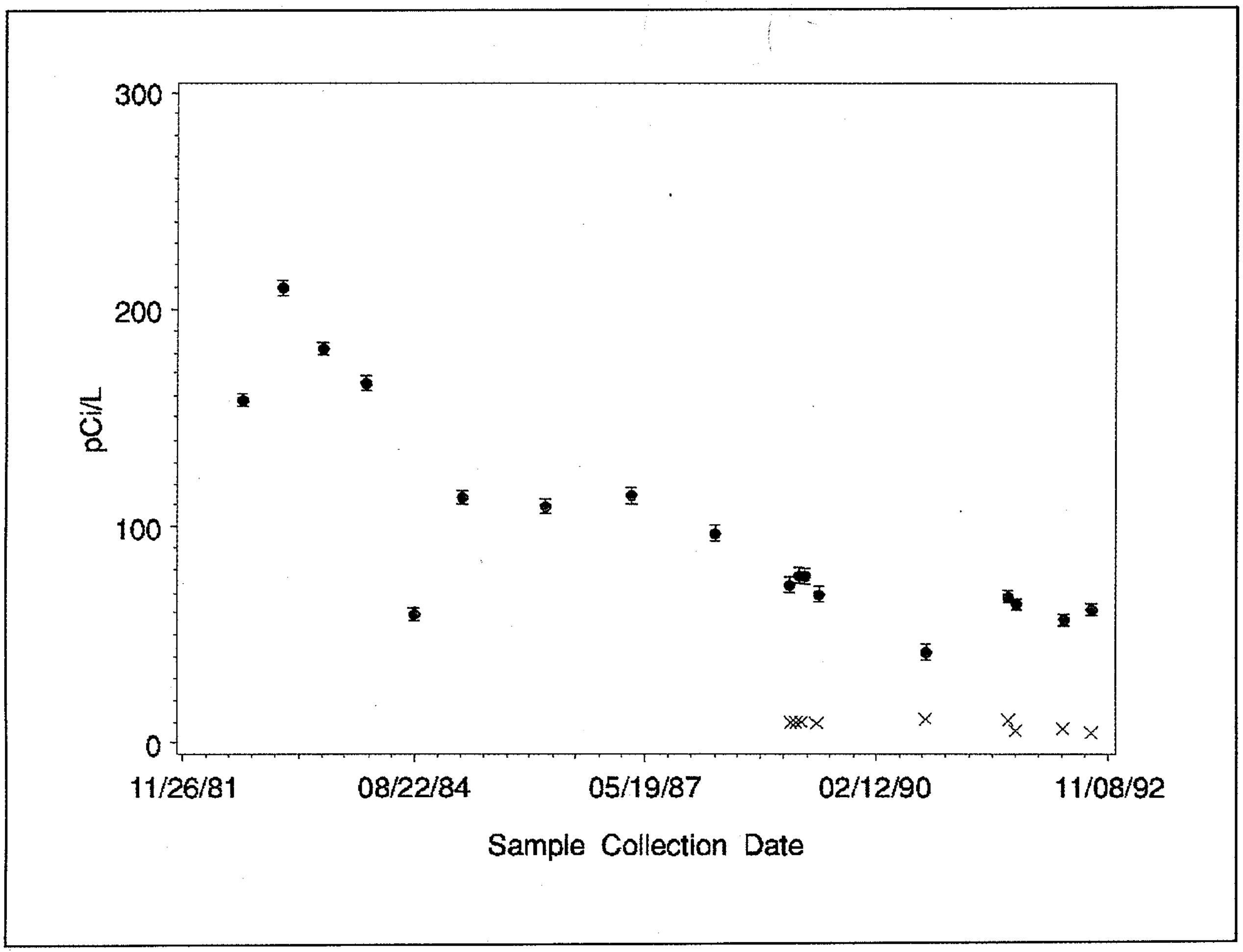

Figure 9.6 Trend of Tritium Results in Water from Lake Mead, Nevada

9.6 HYDROLOGICAL MONITORING AT OTHER UNITED STATES NUCLEAR DEVICE TESTING LOCATIONS

In addition to the groundwater monitoring conducted on and in the vicinity of the NTS, monitoring is conducted under the LTHMP at sites of past nuclear device testing in other parts of the U.S. 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. Additionally, sampling is conducted every two years on Amchitka Island, Alaska, site of Projects CANNIKIN, LONG SHOT, and MILROW; sampling was last conducted in 1991. The primary purposes of this portion of the LTHMP are 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. The following subsections summarize results of sampling conducted in 1992; analytical results for all samples are provided in Appendix D.

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 obtained 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 more representative of formation water, whereas the first samples may be more indicative of recent area 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 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 (3200 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 February 24 and 25, 1992. Sampling locations are shown in Figure 9.7. Routine sampling locations include one spring and five wells of varying depths. Hot Creek Ranch spring was not sampled this year because it was dry. All of the sampling 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 migration from the test cavity, should it occur (Chapman and Hokett, 1991). All samples yielded negligible gamma activity and tritium activities were less than the MDC and less than 0.01 percent of the DCG (Table D.9, Appendix D). These results are consistent with results obtained in previous years. The consistently below-MDC results for tritium indicate that, to date, migration of radioactivity into the sampled wells, and into the area drinking water supplies, has not occurred.

9.6.2 PROJECT SHOAL

Project SHOAL, a 12-kt test emplaced at 365 m (1200 ft), was conducted on October 26, 1963, in a sparsely populated area near Frenchman Station, Nevada. The test, a 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 on February 11, 1992. Four of the six routine sampling locations shown in Figure 9.8 were sampled at that time. No sample was collected from Spring Windmill because the well was dry and no sample was collected from Well H-3 because the pump was not operational. The pump was replaced and a sample from Well H-3 was collected on October 21, 1992. The routine sampling locations include one spring, one windmill, and four wells of varying depths. At least one location, Well HS-1, should intercept radioactivity migration from the test cavity, should it occur (Chapman and Hokett, 1991).

No gamma activity was detected in any of the samples. A tritium result of 56 $\pm$ 2 pCi/L was detected in the water sample from Smith/James Spring, equivalent to 0.06 percent of the DCG (see Table D.10, Appendix D). All of the 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 9.9. It is unlikely that the tritium source is the Project SHOAL cavity; the most probable source is assumed to be rainwater infiltration.

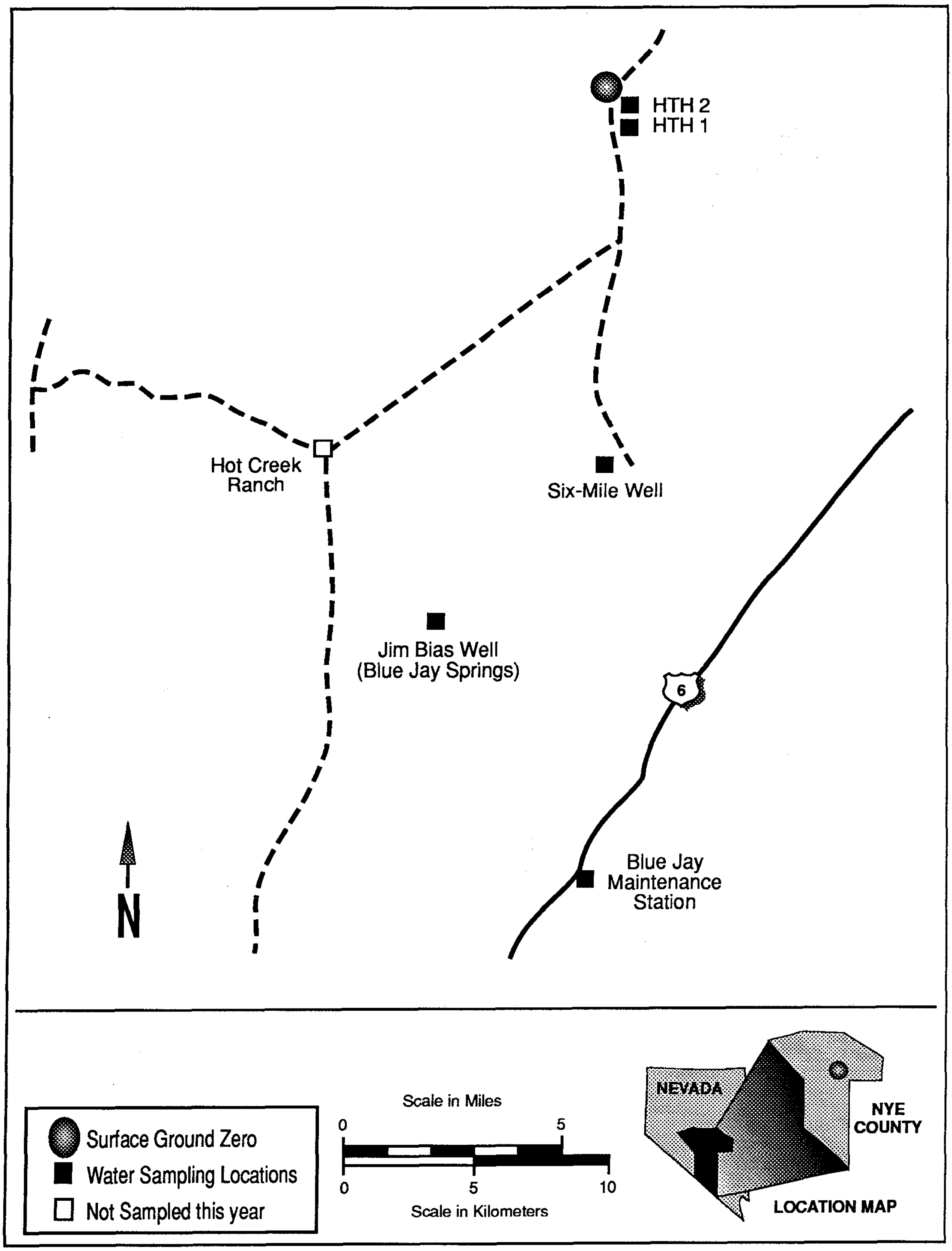

Figure 9.7 LTHMP Sampling Locations for Project FAULTLESS - 1992

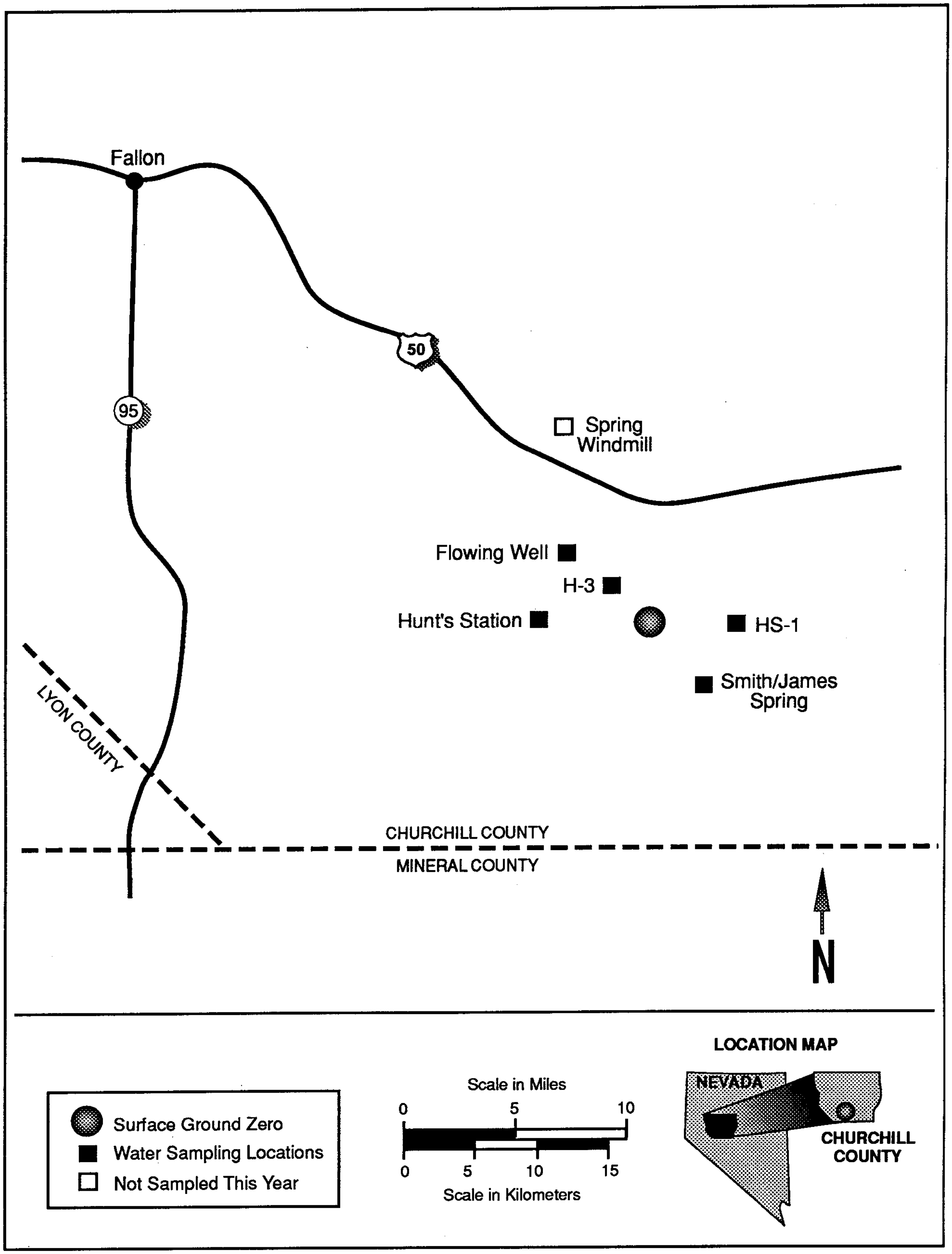

Figure 9.8 LTHMP Sampling Locations for Project SHOAL - 1992

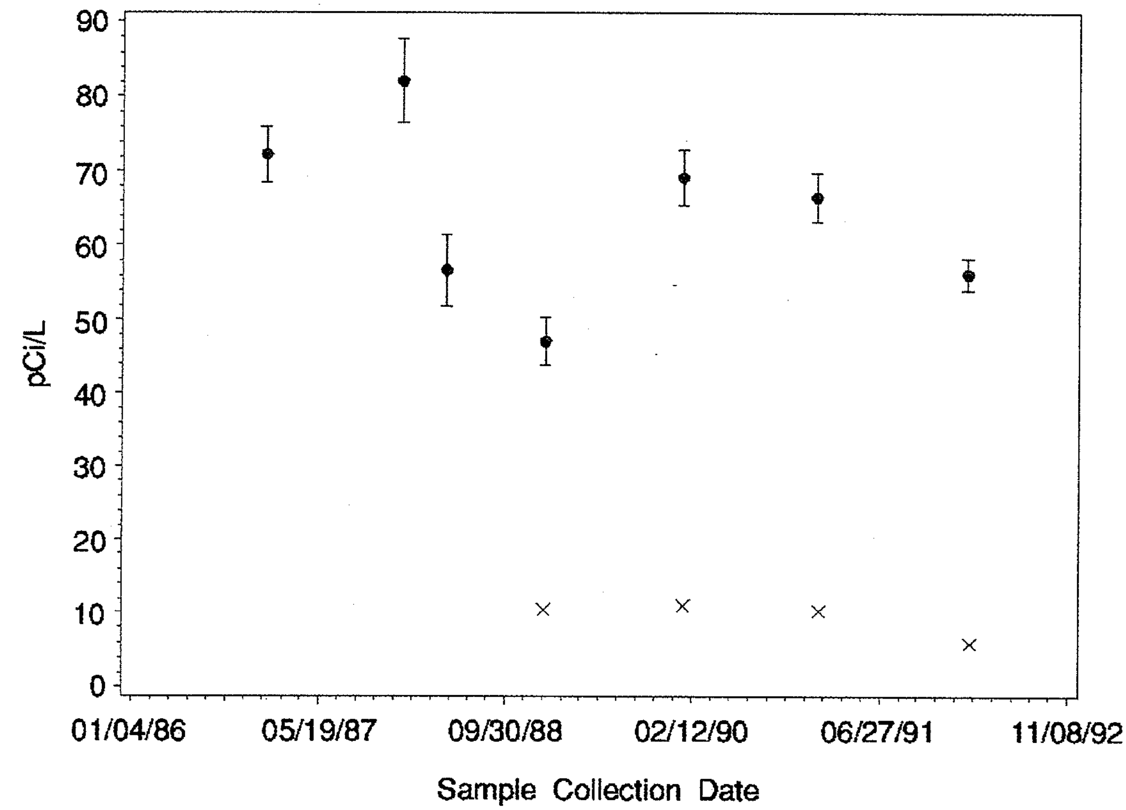

Figure 9.9 Tritium Results for Water from Smith/James Spring, Nevada

Because Well H-3 had not been sampled since 1986, analyses of $^{89,90}Sr$ and Pu and U isotopes were completed in addition to tritium analysis. Results were less than the MDC of the analysis for strontium, plutonium, and ^{235}U. Uranium-234 and ^{238}U were detected at low levels (0.14 ± 0.02 pCi/L of ^{234}U and 0.042 ± 0.011 pCi/L of ^{238}U) and are probably of natural origin.

9.6.3 PROJECT RULISON

Cosponsored by AEC and Austral Oil Co. under the Plowshare Program, Project RULISON was designed to stimulate natural gas recovery in the Mesa Verde formation. The test, conducted near Rifle, Colorado on September 10, 1969, consisted of a 40-kt nuclear explosive emplaced at a depth of 2568 m (8426 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. Soil was removed during the cleanup operations.

Sampling was completed on June 9, 1992, with collection of nine samples in the area of Grand Valley and Rulison, Colorado. Routine sampling locations, depicted in Figure 9.10, include the Grand Valley municipal drinking water supply springs, water supply wells for five

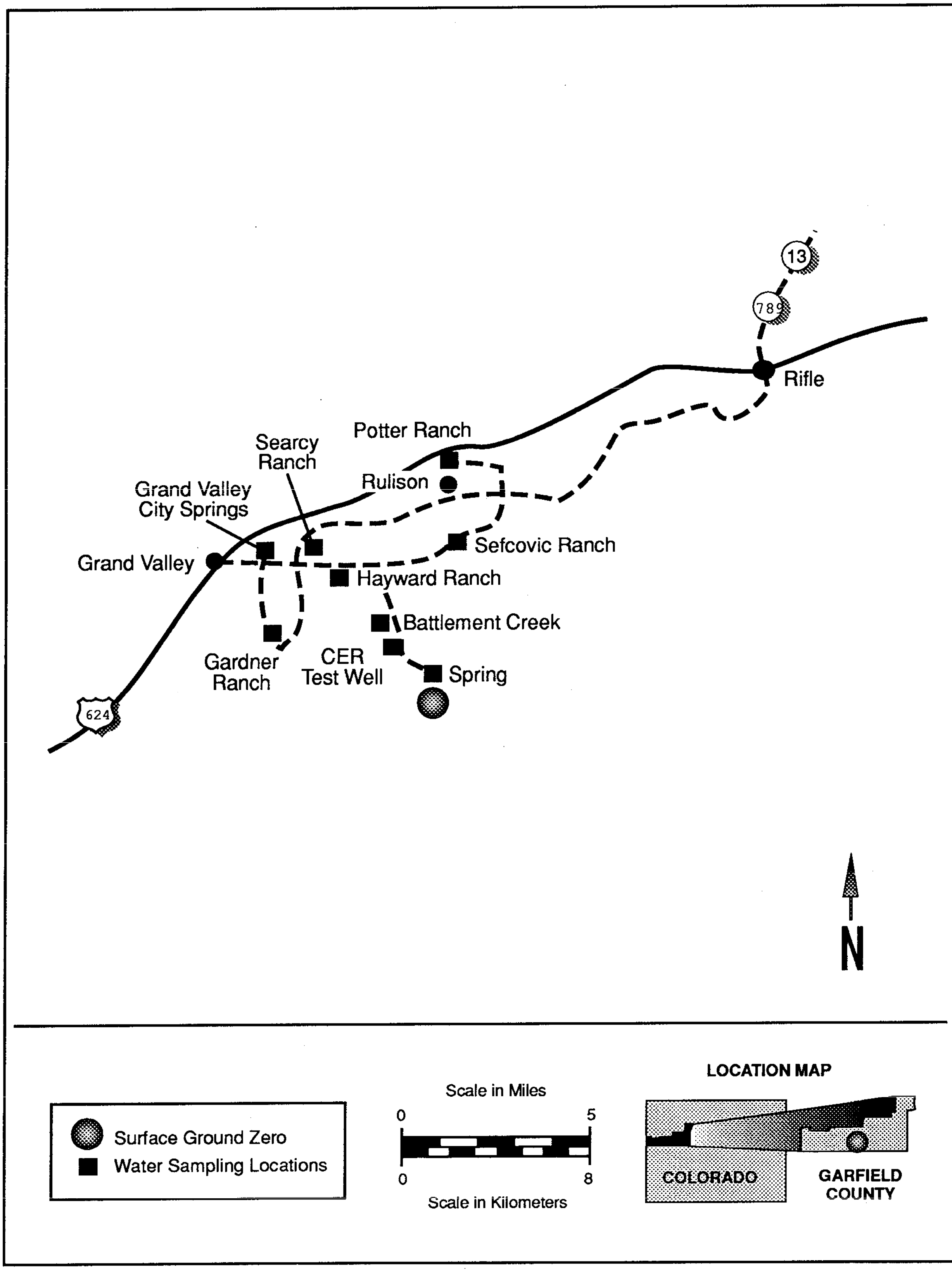

Figure 9.10 LTHMP Sampling Locations for Project RULISON - 1992

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 locations performed by Desert Research Institute (DRI) indicated that none of the sampling locations 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 decreasing to stable trend over the last two decades. The range of tritium activity in the 1992 samples was 48 ± 2 pCi/L at CER Test to 160 ± 3 pCi/L at Lee Hayward Ranch (see Table D.11, Appendix D). These values are less than one percent of the DCG. The detectable tritium activities are probably a result of the natural high 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). Figure 9.11 displays data for the last 20 years for Lee Hayward Ranch. The low value obtained in 1990 was attributed to analytical bias and was observed consistently for all Project RULISON sampling locations.

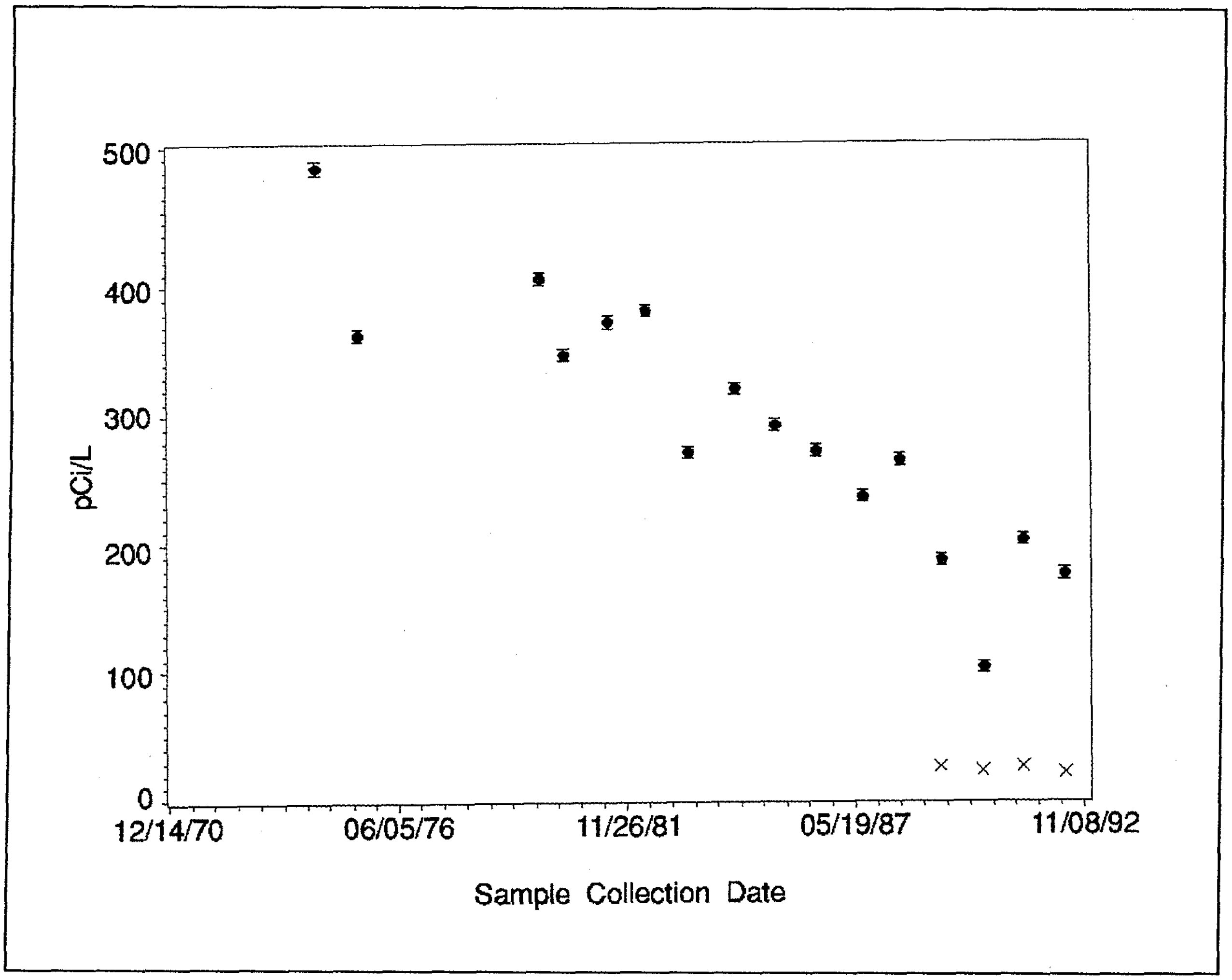

Figure 9.11 Tritium Trends in Groundwater, Hayward Ranch, Colorado

9.6.4 PROJECT RIO BLANCO

Like Project RULISON, 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 (5838-, 6229-, and 6689-ft) depths in the Ft. Union and Mesa Verde formations. Production testing continued to 1976; tritiated water produced during testing was injected to 1710 m (5600 ft) in a nearby gas well. Cleanup and restoration activities were completed by November 1976.

Samples were collected on June 10 and 11, 1992. The sampling sites, shown in Figure 9.12, include two shallow domestic water supply wells, six surface water sites along Fawn Creek, three springs, and three monitoring wells located near the cavity. At least two of the monitoring wells (Wells RB-D-01 and RB-D-03) are suitable for monitoring possible migration of radioactivity from the cavity. Tritium activity in the three springs ranged from 49 to 57 pCi/L. These values are <0.1 percent of the DCG (see Table D.12, Appendix D). A generally decreasing trend in tritium activity is evident in the three springs; Figure 9.13 depicts one of the three springs. Neither of the two shallow domestic wells located near the Project RIO BLANCO site yielded detectable tritium activity. All of the sampling sites along Fawn Creek yielded tritium activities of approximately 25 pCi/L (range 21 to 29 pCi/L), less than 0.04 percent of the DCG. There is no statistically significant difference between sites located upstream and downstream of the cavity area. The three monitoring wells all yielded no detectable tritium activity, indicating that migration from the test cavity has not yet 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 (1216 ft) depth in the Salado salt formation. Radioactive gases were unexpectedly vented during the test. The U.S. Geological Survey (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 remediation 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.

Annual sampling at Project GNOME was completed between June 15 and 18, 1992. The routine sampling sites, depicted in Figure 9.14, include nine monitoring wells in the vicinity of surface GZ, the municipal supplies at Loving and Carlsbad, New Mexico, and the Pecos River Pumping Station well. No detectable tritium activity was detected in the Carlsbad municipal supply or the Pecos River Pumping Station well. A tritium activity of 8 ± 2 pCi/L was detected in the Loving municipal supply. An analysis by DRI (Chapman and Hokett, 1991) indicates these three sampling locations, located on the opposite side of the Pecos River from the Project GNOME site, are not connected hydrologically to the site and, therefore, cannot become contaminated by Project GNOME radionuclides except via surface pathways.

Tritium results greater than the MDC were detected in water samples from six 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 12,000 ± 200 pCi/L in Well LRL-7 to $6.5 \times 10^{7} \pm 3.2 \times 10^{5}$ pCi/L in Well DD-1, which are 13 to 720 percent of the DCG. Well DD-1 collects water from

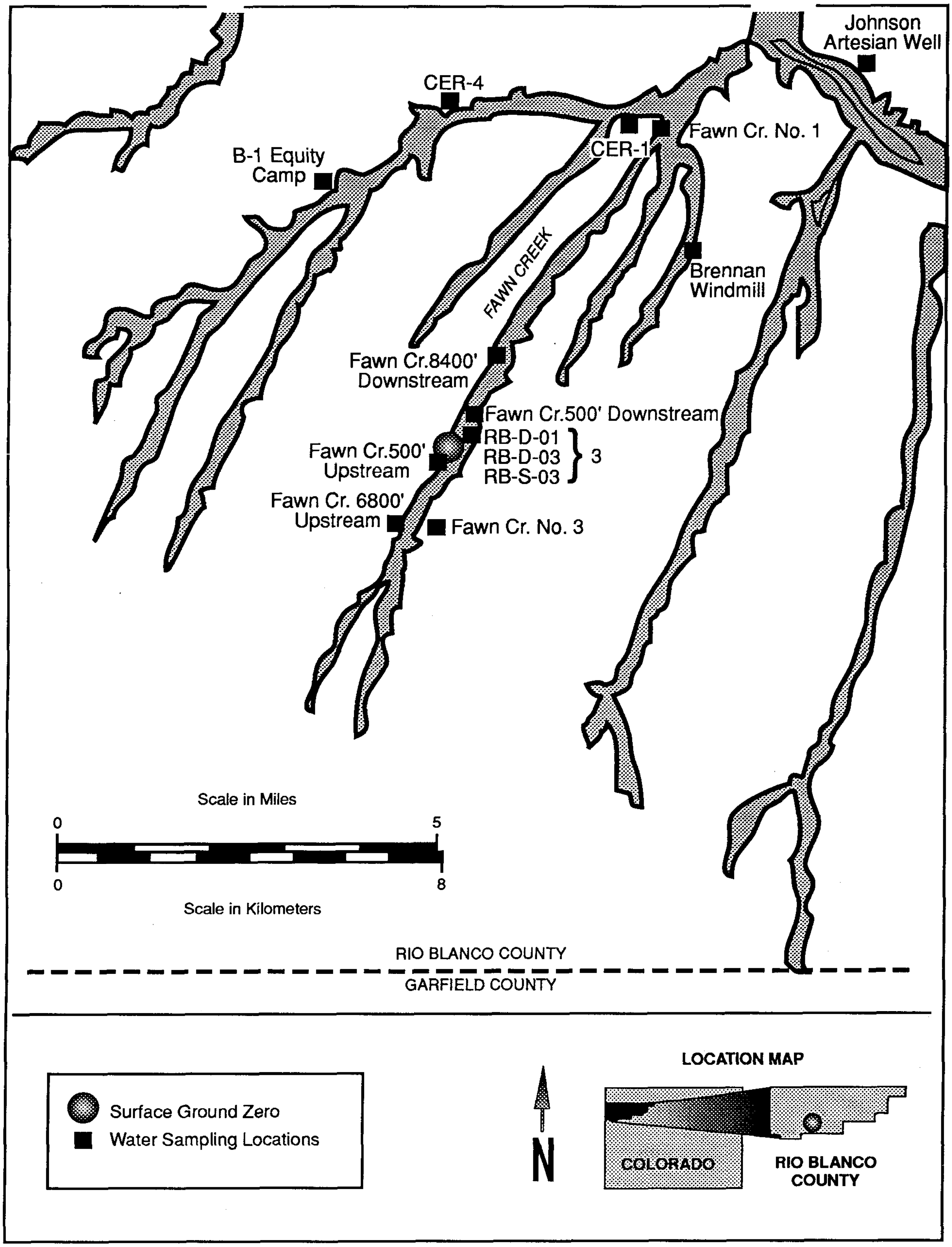

Figure 9.12 LTHMP Sampling Locations for Project RIO BLANCO, Colorado

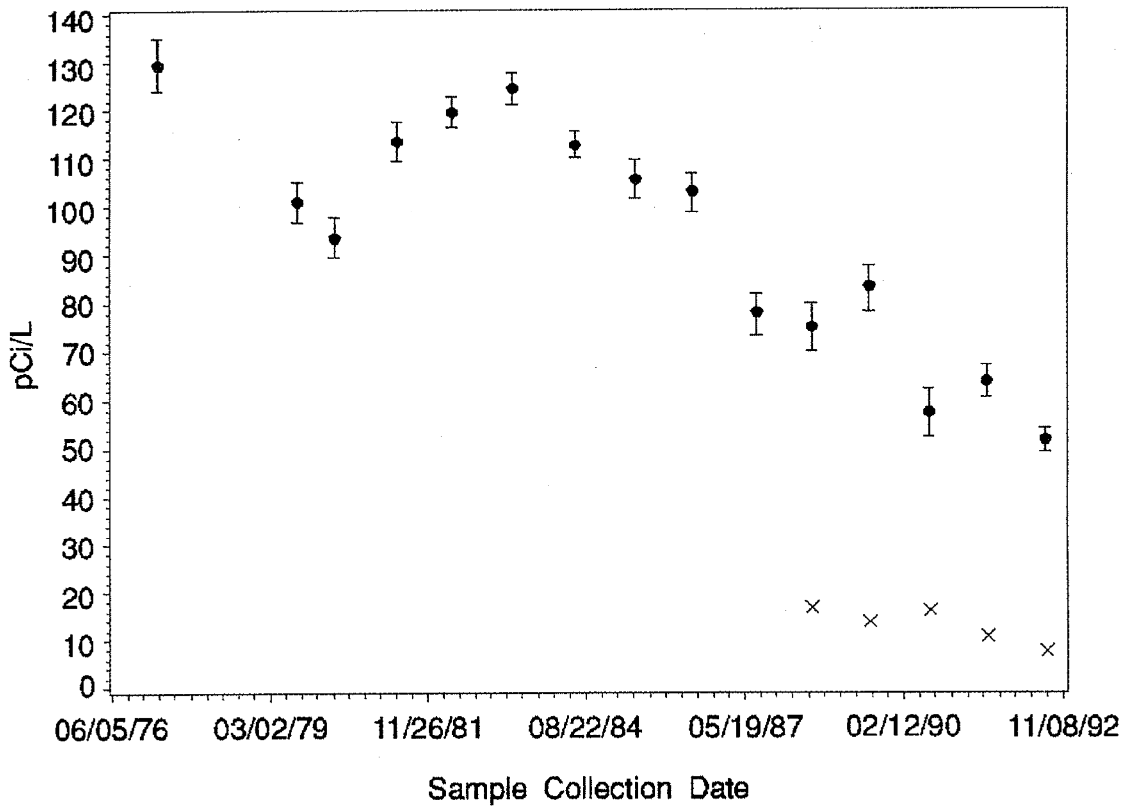

Figure 9.13 Tritium Results in Water from CER No. 4, RIO BLANCO, Colorado

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. In addition to tritium, ^{137}Cs concentrations ranging from 69 ± 1 pCi/L to 550,000 ± 26.000 pCi/L were observed in samples from wells DD-1, LRL-7, and USGS-8, while ^{90}Sr activity ranging from 5100 ± 16 pCi/L to 13,000 ± 1,200 pCi/L was detected in wells DD-1, USGS-4 and USGS-8. Samples from these four wells were also analyzed for plutonium isotopes; results were less than the MDC in all cases. The samples from wells DD-1, LRL-7, and USGS-4 indicate decreasing trends for all analyzed radionuclides. Although ^{137}Cs was not detected in the USGS-4 sample. The tritium activity in the 1992 sample from Well LRL-7 was greater than that observed in 1991, but the overall historical trend is decreasing, as shown in Figure 9.15. An increase was observed in ^{137}Cs and ^{90}Sr concentrations in USGS-8; however, a decrease was observed in the tritium concentration in this well.

The remaining two wells with detectable tritium concentrations were PHS wells 6 and 8, with results of 37 ± 2 pCi/L and 15 ± 2 pCi/L, respectively (see Table D.13 Appendix D). These values are less than 0.05 percent of the DCG. No tritium was detected in the remaining Project GNOME samples, including Well USGS-1, which the DRI analysis (Chapman and

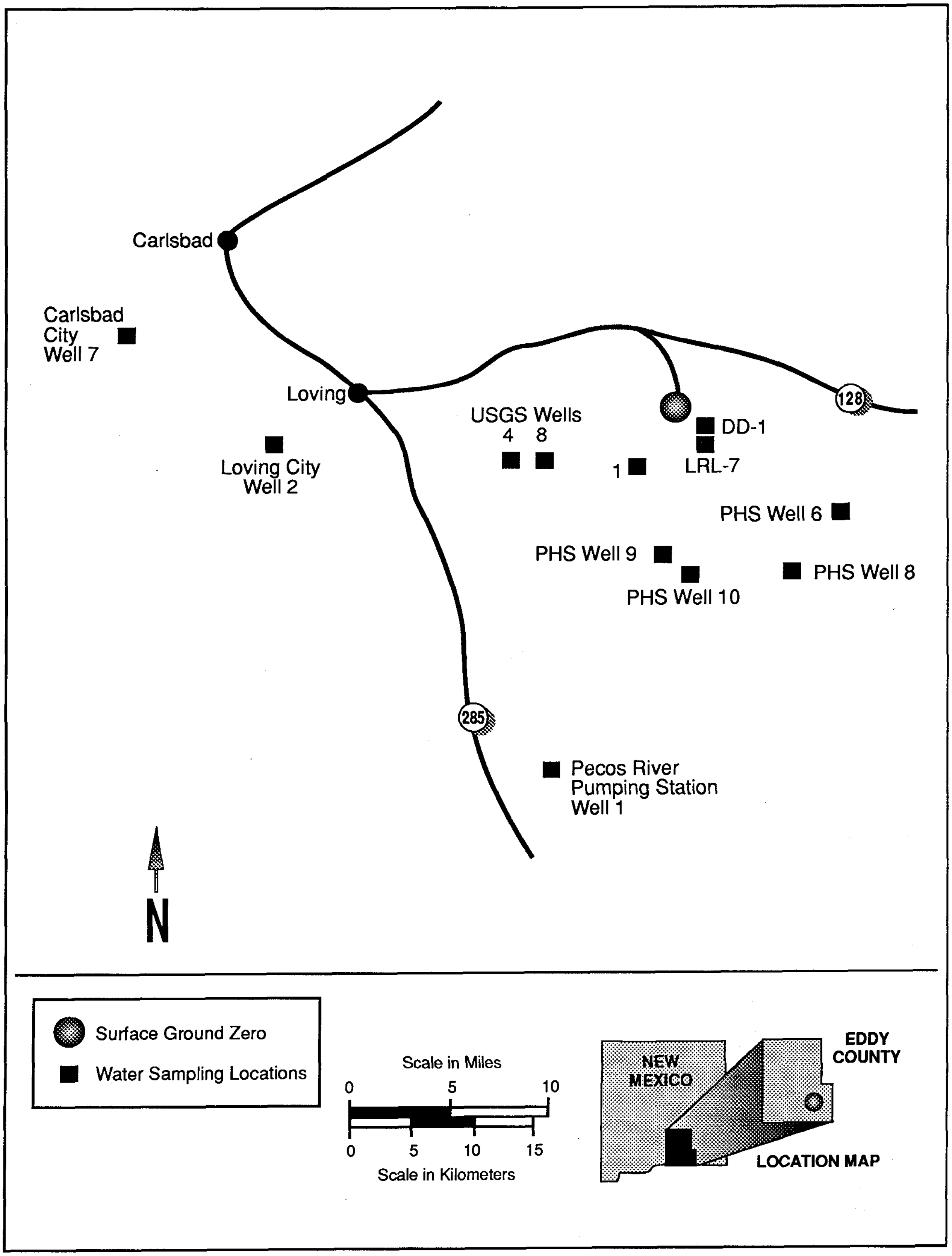

Figure 9.14 LTHMP Sampling Locations for Project GNOME - 1992

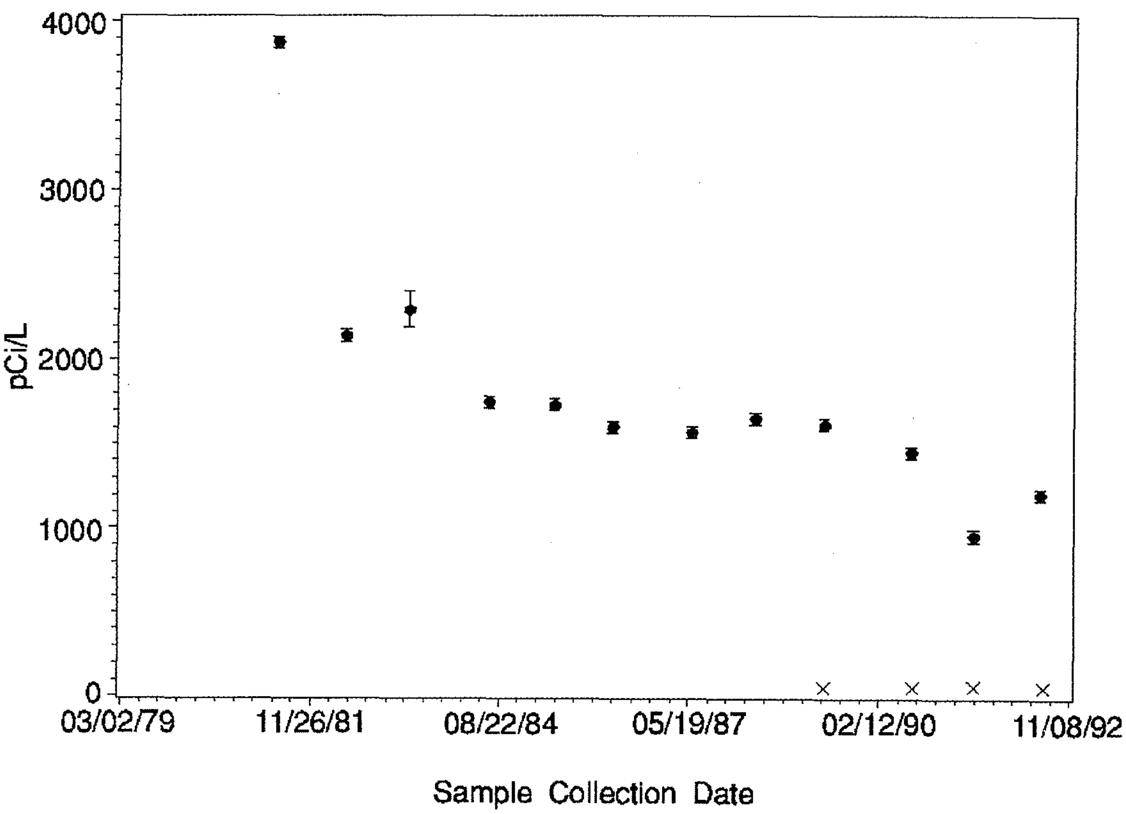

Figure 9.15 Tritium Results in Water from Well LRL-7 near Project GNOME, New Mexico

Hokett, 1991) indicated is positioned possibly to detect migration of radioactivity from the cavity, should it occur.

9.6.6 PROJECT GASBUGGY

Project GASBUGGY was a Plowshare Program test cosponsored by the U.S. Government and El Paso Natural Gas. Conducted near Gobernador, 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.

Sampling was conducted April 14 through 16, 1992. In prior years, samples were collected in June; an earlier trip was scheduled this year because of the tritium increase seen in Well EPNG 10-36 and discussed in last year's ASER (DOE 1992). Ten samples were collected. Samples were not collected from Arnold Ranch due to a road washout nor from Well 28.3.33.233 (South) because the windmill was not operational. The Old School House Well, first sampled in 1991, was sealed by the state of New Mexico, thus ending plans to add this station to the routine sampling directory. The routine sampling locations include six wells, one windmill, three springs, and two surface water sites, depicted in Figure 9.16. The two

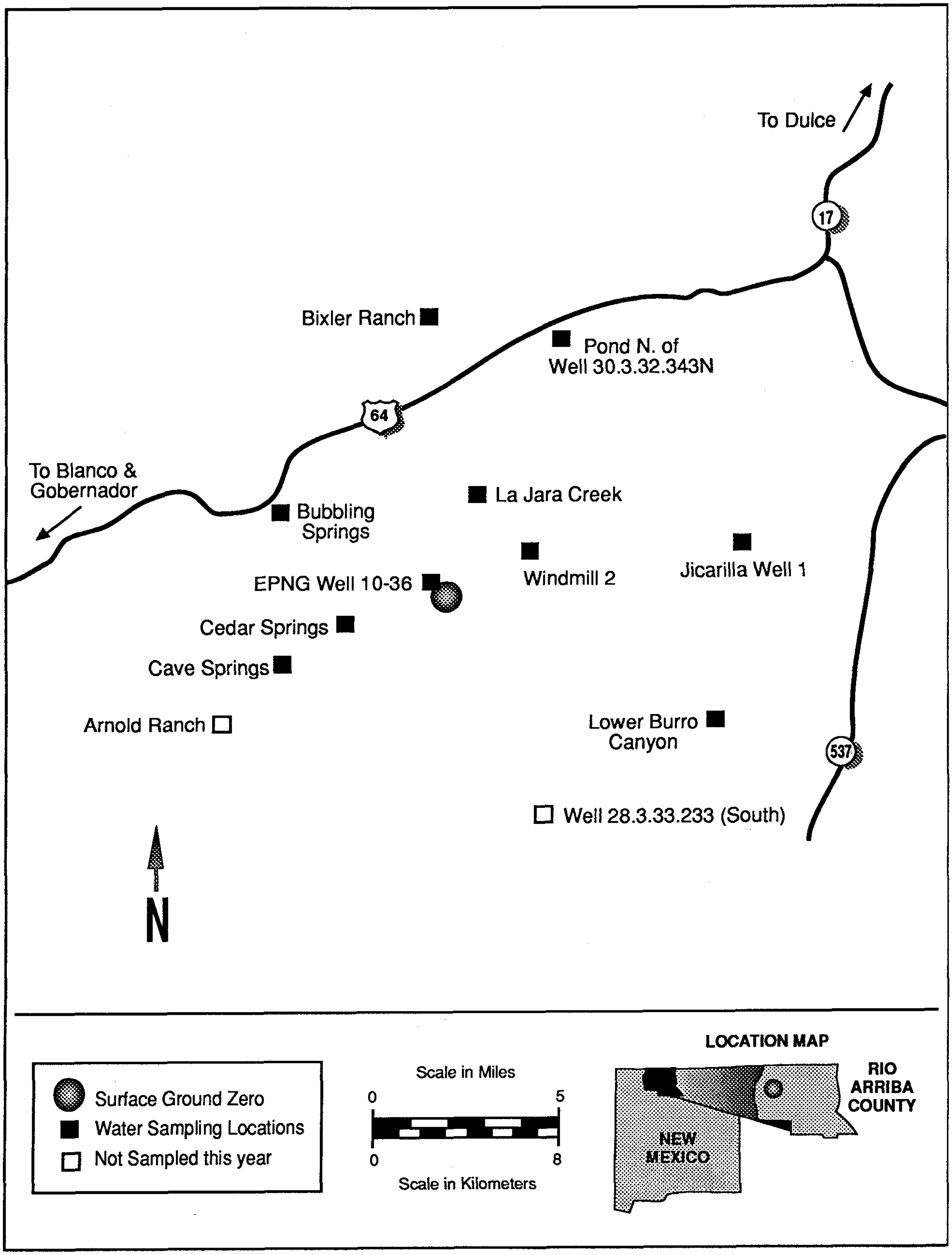

Figure 9.16 LTHMP Sampling Locations for Project GASBUGGY - 1992

surface water sampling sites yielded tritium activities of 34 ± 3 pCi/L and 70 ± 3 pCi/L; a comment by the sampling technician indicated the first-listed sample was primarily rainwater. These values are 0.04 and 0.08 percent of the DCG, respectively. The three springs yielded tritium activities ranging from 42 ± 2 pCi/L to 75 ± 3 pCi/L, which are less than 0.1 percent of the DCG and similar to the range seen in previous years. Tritium activities in three shallow wells which were sampled this year varied from less than the MDC to 19 ± 2 pCi/L, which is 0.02 percent of the DCG. Analytical results are presented in Table D.14 Appendix D.

Well EPNG 10-36, a gas 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 each year since 1984, except 1987. The proximity of the well to the test cavity suggests the possibility that the activity increases noted may be indicative of migration from the test cavity. The sample collected in April yielded a tritium activity of 33 ± 2 pCi/L. The area had been experiencing heavy rainfall in the weeks prior to and during sampling. The sampling technician had noted that one of the surface sampling sites, a pond, was comprised primarily of rainwater. The tritium concentration in that sample and in Well EPNG 10-36 are identical. Further, the pH and conductivity measured in Well EPNG 10-36 were similar to the values obtained at the surface sampling site and markedly different than measurements of pH and conductivity taken in Well EPNG 10-36 in previous years. Consequently it is suspected that the sample may not be representative of formation water.

A second sample was collected from Well EPNG 10-36 on September 16, 1992. Initial results for this sample indicated a concentration of 10.3 ± 2.6 pCi/L (MDC of approximately 7 pCi/L) of ^{137}Cs based on a 100-minute counting interval. Presence of ^{137}Cs was confirmed by a 1000-minute count which yielded results of 5.97 ± 0.85 pCi/L (MDC of 0.83 pCi/L) and a longer, 5-day counting interval which confirmed this concentration (with an MDC of 0.1 pCi/L). The tritium activity in this sample was 364 ± 4 pCi/L. No $^{238,\ 239+240}$Pu or ^{90}Sr was detected at activities greater than the MDC.

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, 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 four explosive tests, two nuclear and two gas, conducted in the Tatum Salt Dome 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 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, conducted on February 2, 1969, and HUMID WATER, conducted on April 19, 1970. The ground surface and shallow groundwater aquifers were contaminated by disposal of drilling muds and fluids in surface pits. The radioactive contamination was primarily limited to the unsaturated zone and upper, nonpotable aquifers. Shallow wells, labeled HMH wells on Figure 9.17, have been added to the area near surface GZ to monitor this contamination. In addition to the monitoring

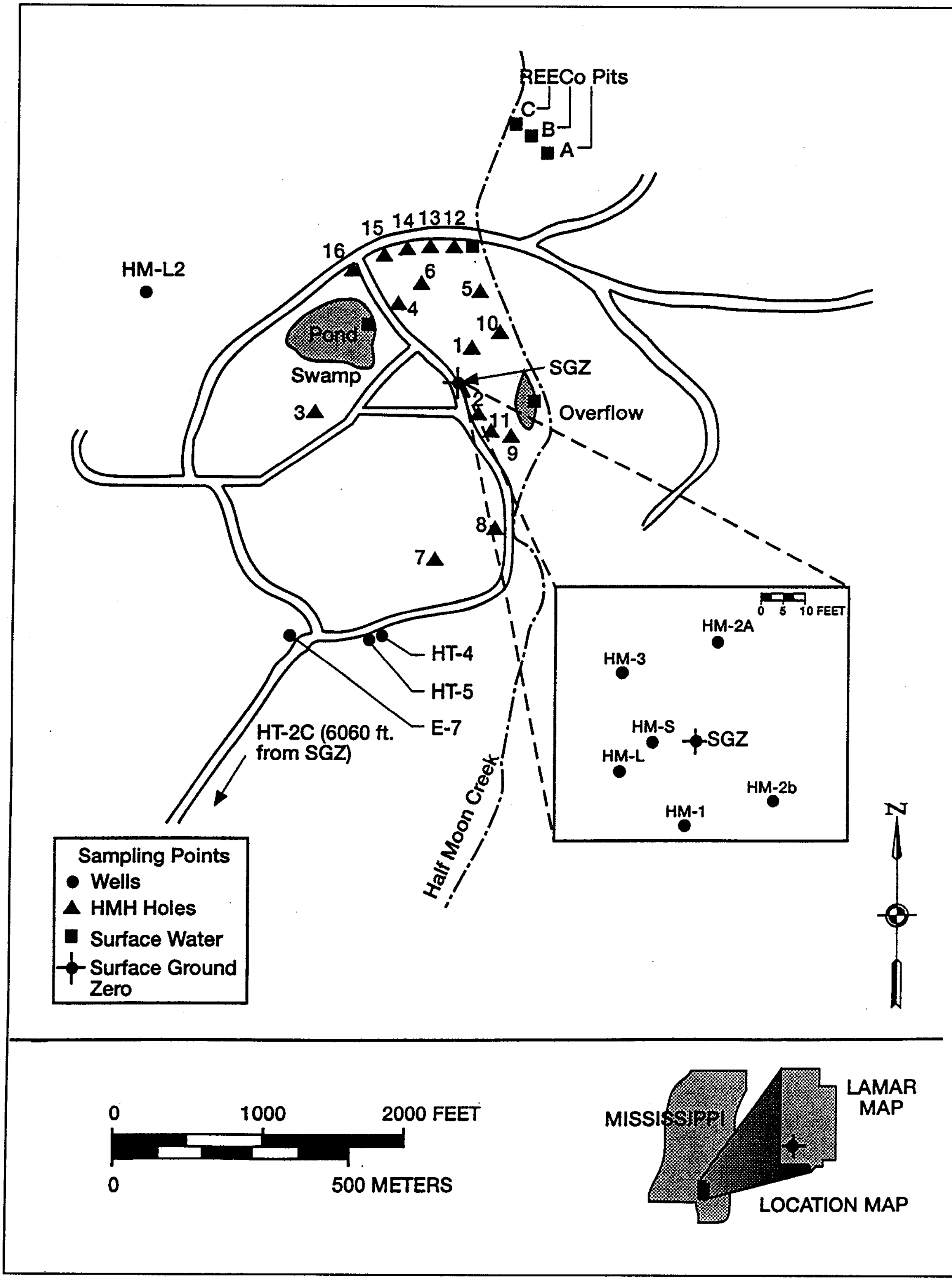

Figure 9.17 LTHMP Sampling Locations for Project DRIBBLE, Near Ground Zero - 1992

Wells surrounding GZ, extensive sampling is conducted in the nearby offsite area. Most private drinking water supply wells are included, as shown in Figure 9.18.

Sampling on and in the vicinity of the Tatum Salt Dome was conducted between April 26 and 29, 1992. A total of 109 samples were collected; five of these were from new sampling locations in Lumberton, Mississippi. Six routine sampling locations were not sampled. One resident had moved and the well is no longer in operation; another resident was connected to city water and no longer uses the well for drinking water supplies. These sampling locations have been eliminated from the routine sampling directory. The remaining samples not taken this year were unobtainable due to inaccessibility of the sampling location because of local flooding, because the resident was not home, or because the well was dry.

In the 50 samples collected from offsite sampling locations, tritium activities ranged from less than the MDC to 59 ± 5 pCi/L, equivalent to 0.07 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 9.19. Low levels of uranium isotopes were detected in four of the five new sampling locations, ranging from 0.038 to 0.14 pCi/L of ^{234}U and 0.018 to 0.12 pCi/L of ^{238}U. These low levels are probably of natural origin.

Due to the high rainfall in the area, the normal sampling procedure is modified for the shallow onsite wells. Following collection of a first sample, the well is pumped for a set period of time or until dry and a second sample is collected the next day. The second samples are thought to be more representative of the formation water. Twenty-four locations in the vicinity of GZ were sampled using this procedure; 19 of these yielded tritium activities greater than the MDC in either the first or second sample. In addition, seven locations were sampled once; five of these samples yielded tritium concentrations greater than the MDC. Overall, tritium activities ranged from less than the MDC to $1.44 \times 10^4 \pm 200$ pCi/L, as shown in Table D.15, Appendix D. The locations where the highest tritium activities were measured generally correspond to areas of known contamination. Increases in tritium activity over previous years were noted in REECO pits B and C, and Well HMH-10. However, decreasing trends were noted for the wells where high tritium activities have historically been noted, such as Well HM-S depicted in Figure 9.20. Results of sampling related to Project DRIBBLE are discussed in greater detail in *Onsite and Offsite Environmental Monitoring Report: Radiation Monitoring around Tatum Salt Dome, Lamar County, Mississippi, April 1992* (Thomé and Chaloud, in press).

9.6.8 AMCHITKA ISLAND, ALASKA

Three nuclear weapons tests were conducted on Amchitka Island in the Aleutian Island chain of Alaska. Project LONG SHOT, conducted on October 29, 1965, was an 80-kt test under the Vela Uniform Program, designed to investigate seismic phenomena. Project MILROW, conducted on October 2, 1969, was an approximately 1-Mt "calibration test" of the seismic and environmental responses to the detonation of large-yield nuclear explosives. Project CANNIKIN, conducted on November 6, 1971, was a proof test of the Spartan antiballistic missile warhead with less than a 5-Mt yield. Project LONG SHOT resulted in some surface contamination, even though the chimney did not extend to the surface. Sampling on Amchitka Island, Alaska, is conducted every other year. No samples were collected in 1992. The next sampling trip is scheduled for September 1993.

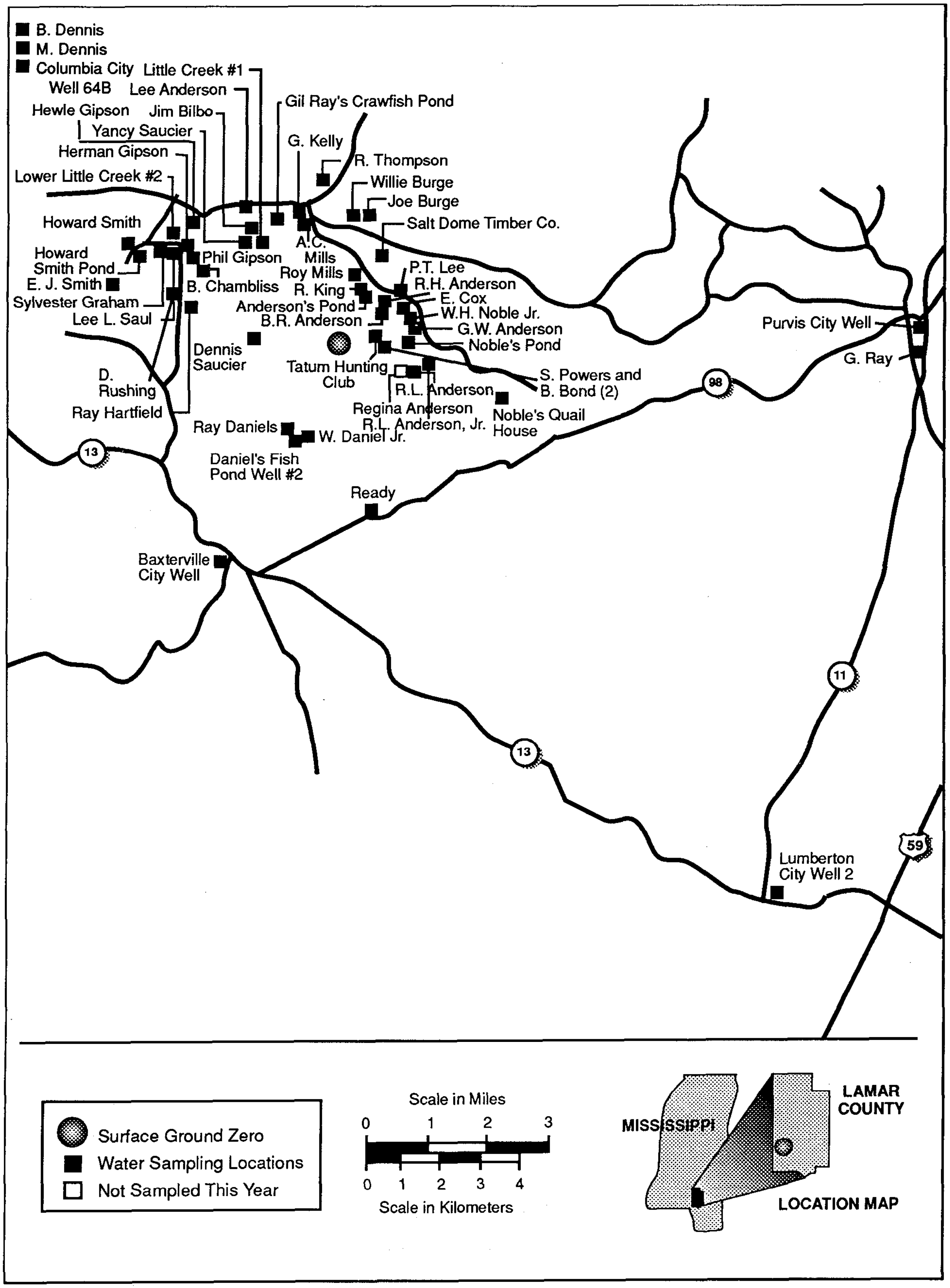

Figure 9.18 LTHMP Sampling Locations for Project DRIBBLE, Towns and Residences - 1992

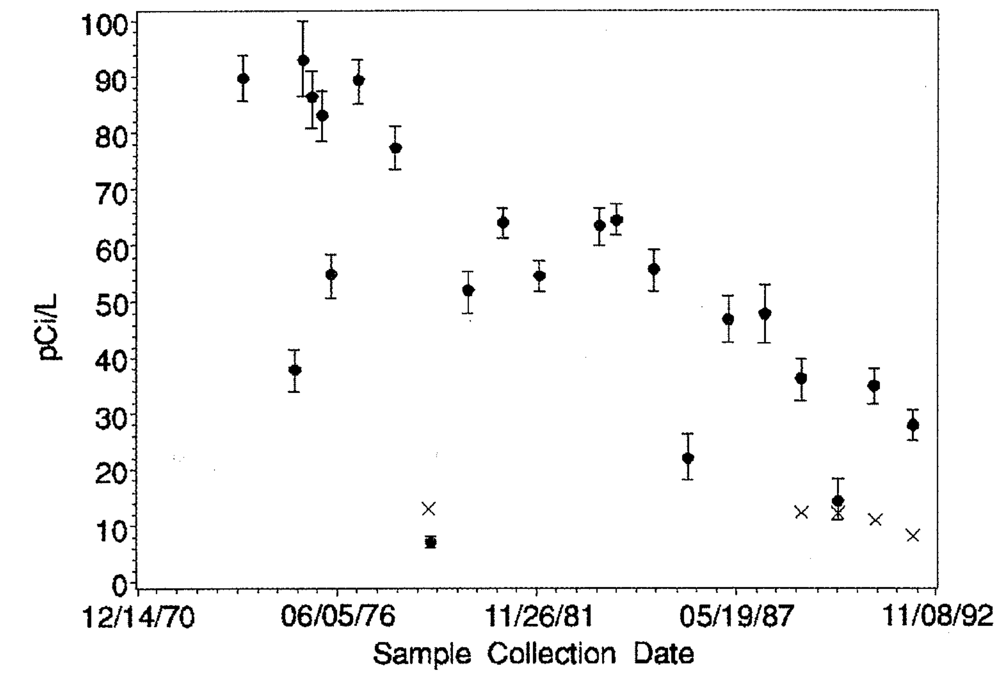

Figure 9.19 Tritium Result Trends in Baxterville, MS Public Drinking Water Supply - 1992

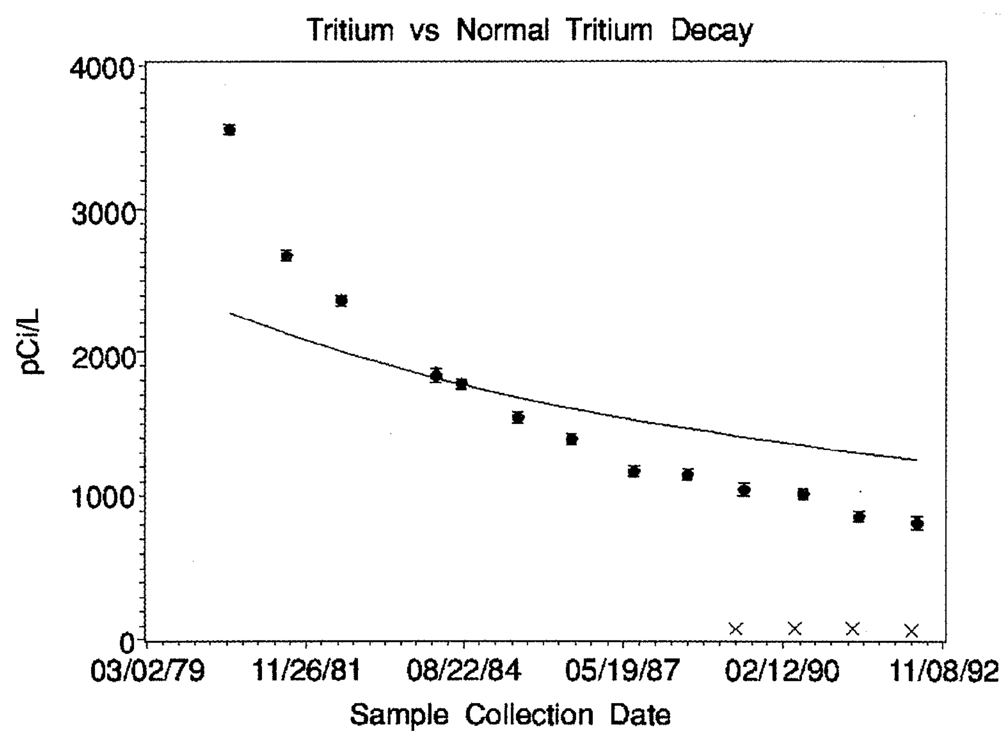

Figure 9.20 Tritium Results in Well HM-S, Tatum Salt Dome, Project DRIBBLE

10.0 ONSITE LABORATORY QUALITY ASSURANCE

Yvonne Booker, Fred Ferate and Kevin R. Krenzien

The quality assurance program for radiological and nonradiological analyses ensures that data produced by the Analytical Services Department meets customer and regulatory defined requirements. Data quality is assured through process-based quality assurance, procedure-specific quality assurance, data quality objectives, and performance evaluation programs. The external quality assurance 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); and the Nuclear Radiation Assessment and Cross Check Program (NRACC) conducted by the EPA's Environmental Monitoring Systems Laboratory in Las Vegas (EMSL-LV). The external quality assurance intercomparison program for nonradiological data quality assurance consists 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, and the College of American Pathologists (CAP) Analysis of Lead in Blood Program.

10.1 OVERVIEW OF LABORATORY QUALITY ASSURANCE PROGRAM

The Reynolds Electrical & Engineering Co., Inc. (REECo) Analytical Services Department (ASD) implements the requirements of DOE Order 5700.6C, "Quality Assurance" through integrated quality procedures. Table 10.1 defines the ASD quality procedures and the DOE Order 5700.6C criteria they implement.

The ASD uses a two-level approach to the quality assurance of analytical data. The quality of data and results is assured through both procedure-based and process-specific quality assurance.

Procedure-based quality assurance begins with the development and distribution of standard operating procedures (SOPs). These SOPs contain the method of analysis and the required quality control samples for a given analysis. Personnel performing an analysis are trained and are qualified for that analysis. Qualification includes indoctrination to that procedure and the successful analysis of a quality control sample. Calibration standards and checks specific to each procedure are used. These standards must be traceable to either the National Institute of Standards and Technology (NIST) or the Environmental Protection Agency (EPA). Quality control samples, e.g. spikes, blanks, and replicates, are included for each procedure. Values of QC samples may be either known by the analyst or blind to the analyst. Finally,

Table 10.1 Matrix of DOE Order 5700.6C, "Quality Assurance" Criteria vs Analytical Services Department Quality Procedures

DOE Order 5700.6C Criterion	ASD Quality Procedure Number(s)	ASD Quality Procedures
1. Program	AAHzz.B.01.00	ASD Operations Implementing Procedure
	AAHzz.B.02.00	Organization
2. Personnel Training Qualifications	AAHzz.B.03.00	Personnel Training and Qualifications
3. Quality Improvement		REECo Company Quality Improvement Procedures
4. Documents and Records	AAHzz.B.06.00	Documents and Records
5. Work Processes	AAHzz.B.07.00	Verification of Computer Software
	AAHzz.B.08.01	QC Samples and Control Charts
	AAHzz.B.08.02	Data Discrepancies and Corrective Actions
	AAHzz.B.12.01	Sample Traceability
	AAHzz.B.12.02	Standards Traceability
	AAHzz.B.12.03	Operational Check Requirements
	AAHzz.B.12.04	Calibration Requirements
	AAHzz.B.12.05	Reagents Verification
	AAHzz.B.12.06	ASD Analytical Logbooks
	AAHzz.B.12.07	Verification of Pipettes
6. Design	AAHzz.B.10.00	Planning and Scoping
	AAHzz.B.11.00	Design of Data Collection Operations
7. Procurement	AAHzz.B.05.00	Procurement of Services and Items
8. Data Acceptance and Review	AAHzz.B.13.00	Assessment of Data Usability
9. Management Assessment	AAHzz.B.04.00	Management Assessment
10. Independent Assessment	AAHzz.B.14.00	Independent Assessment

compliance to analytical procedures is measured through procedure specific assessments or surveillances.

Process-specific quality assurance begins with the implementation of quality assurance procedures. The quality assurance program includes the performance of periodic operational checks of analytical balances, reagent water quality, and storage temperatures. Periodic calibration is required for all measuring equipment such as analytical balances, analytical weights, and thermometers.

An essential component to process-specific quality assurance is assessment of data usability. Assessment of data involves data review and data verification. Data provided by trained analysts or Health Physicists using approved methods and instrument systems is subjected to data review. Data review is a systematic procedure of reviewing a body of data against preestablished criteria to verify its validity prior to its intended use. It is applied to a body of data after the fact, systematically and uniformly. It is applied close to the origin of the data by an independent and objective reviewer.

Data processing is done by the analyst who obtained the data or another analyst. The analyst who obtains the data, reviews the raw analytical results. Independent data review starts with a peer analyst who did acquire or process the data. The peer analyst reviews data to ensure that data processing has been correctly performed and that the reported analytical results correspond to the data acquired and processed. 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 is the procedure taken to ensure that the reported results correctly represent the sampling and/or analyses performed. Data verification includes the processing of quality control sample results. Sample management personnel process data to demonstrate that results meet the requirements of a project.

Data discrepancies identified during the data review and verification process are documented on data discrepancy reports (DDRs). DDRs are reviewed and tended quarterly as a tool to highlight systematic problems which may appear as discrete points over time. 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.

10.2 DATA AND MEASUREMENT QUALITY OBJECTIVES

10.2.1 DATA QUALITY OBJECTIVES

The statement of data quality objectives is a means of delineating the circumstances under which measurements are made, and of defining what ranges of variability in the measured data are acceptable. Data quality objectives describe the decision to be made, how the measurements will be used, the range of sampling possibilities, what measurements will be made, where the samples will be taken, and what calculations will be performed on the measurement data to arrive at the final desired result.

The validity of the final result will depend critically on the quality of the measurements. This is determined by defining acceptable ranges of variability in the measured data through the formulation of associated measurement quality objectives.

This section defines those data quality objectives identified for onsite radiological and nonradiological environmental measurements.

10.2.1.1 DECISION TO BE MADE

The primary decision to be made on the basis of radiological environmental surveillance measurements is to verify that members of the general public outside the site boundaries have not received effective dose equivalents above DOE and regulatory limits that can be attributed to activities occurring on the site. Such doses, in exceptional cases, could be due to direct exposure to external radiation. However, if such doses occur, they are 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). A pathway may be quite complex; for example, the food pathway could be due to airborne radioactivity falling on soil, being absorbed by plants which are then eaten by some animal which is then eaten by the person exposed.

The circumstances at the Nevada Test Site, where aquifers are deep, with negligible horizontal or vertical transport, where there are no surface flows of water and little rain, very little vegetation, sparse animal population, no food grown for human consumption, and large distances to the nearest member of the general public, lead to the hypothesis that the airborne pathway is by far the most important for possible dose to a member of the general public.

Decisions made with nonradiological data are related to waste characterization, extent and characterization of spills, compliance to regulatory thresholds for environmental contaminants, or possible worker exposure.

10.2.1.2 USE OF THE MEASUREMENTS

There are many ways to estimate the magnitude of such a personnel exposure. One way is to measure the radionuclide concentrations in the air at the location of the person and use documented methods to estimate the dose received. To do this for all persons nearest the site would require inordinate numbers of sampling stations and would be prohibitively expensive.

Another way is to measure the radionuclide concentrations at points within the site and to use models to calculate the concentration at the location of the person and to estimate that person's dose. This is the way most of the environmental surveillance data measured at the Nevada Test Site are used.

10.2.1.3 RANGE OF SAMPLING POSSIBILITIES

The numbers, types and locations of radiological sampling stations are determined in terms of where the possible sources are located and what isotopes are 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, financial constraints, and so on.

The numbers, types and location of nonradiological samples are typically defined by regulatory actions on the NTS and are identified 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.

10.2.1.4 MEASUREMENTS TO BE MADE

The air and water samples are brought to the laboratory, where the types and amounts of radioactivity in them (if measurable) are determined. These are then converted to radioactivity concentrations by dividing by the sample volume, which is measured separately.

Nonradiological inorganic or organic constituents in air, water, soil, and sludge samples are analyzed for and reported using Environmental Protection Agency (EPA) approved methods, such as, EPA Method No. 1311, Toxicity Characteristic Leaching Procedure; EPA Method No. 6010, Inductively Coupled Plasma Analysis for Inorganic Analytes; and EPA Method No. 8270, Analysis of Semivolatile Organic Compounds.

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 for, are asbestos, solvents, welding metals, and radioisotopes. Samples which are analyzed include urine, blood, air filters, charcoal tubes, and bulk asbestos.

10.2.1.5 SAMPLING LOCATIONS

The locations where radiological environmental surveillance samples are taken on the Nevada Test Site are described in Chapters 4 and 5 of this Report. Methods for taking the samples, and the portion of the physical system to be sampled are described in detailed standard operating procedures of REECo's Environmental Section.

The locations of nonradiological environmental samples are determined through site remediation and characterization activities.

10.2.1.6 CALCULATIONS TO BE PERFORMED

The measured radioactivity concentrations determined as described above are used in a calculational model to predict the radioactivity concentration in the air at various locations off-site where a member of the public might be found, and the dose that person would receive from breathing that concentration during an entire year is calculated.

The dose of greatest interest is the dose to the maximally exposed individual; i.e., for all the different locations where members of the general public might be found, the dose is calculated for a person at the location where the predicted radioactivity concentration is the highest. The predicted concentration is calculated by summing the contribution at that location from all NTS sources.

The assumptions used in the calculational model are conservative, so that the calculated dose to the maximally exposed individual is an estimated upper bound to the dose that person would actually have received.

10.2.2 MEASUREMENT QUALITY OBJECTIVES

Measurement quality objectives (sometimes also referred to as data quality objectives) 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.

10.2.2.1 REPRESENTATIVENESS

Representativeness is the degree to which a sample extracted from some medium is truly representative of that medium, i.e., the degree to which the measured analytical concentrations represent the concentrations in the medium being sampled.

In a broader sense, it also refers to whether the spatial locations of the sampling stations and the frequency of sampling are such that, when the measured radioactivity concentrations are input into the model, they will lead to the correct estimated maximum annual dose to an offsite member of the public.

To strive for representativeness of the input data, a carefully designed environmental monitoring plan (DOE/NV/10630-28, "Environmental Monitoring Plan, Nevada Test Site and Support Facilities") has been established. Factors which were taken into account in formulating the monitoring plan include the locations of known and potential sources, historical and operational knowledge of the types of nuclides and the pathways of concern, the effects of wind and weather, extensive historical meteorological data, geological, hydrological, and topographical data, and locations of human populations.

10.2.2.2 COMPARABILITY

Comparability refers to the degree of confidence we have in our analytical results.

Internally, every attempt is made to strive for comparability of measurement data by performing the sample collection and subsequent measurements in a consistent manner. To this end, standard operating procedures are used for sample collection, handling, and laboratory analyses. Standard reporting units and a consistent number of significant digits are used. Confidence in the results is maintained through extensive quality assurance measures, and the use of standardized procedures for data analysis and validation.

To additionally insure that the measured data are essentially the same as those which would be obtained by other competent investigators using the same or other reliable methods, the instruments used 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, and the laboratory participates in several intercomparison programs where its results can be compared with those of the sponsor laboratory and with those of other participating laboratories.

10.2.2.3 COMPLETENESS

Completeness is simply defined as the percentage of samples collected versus those which had been planned 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 planned. Also data entry or transcription errors can be made. Consequently, the REECo Environmental Section completeness objectives for all samples and analyses have been set at 90 % for sample collection and 85 % for analyses.

Completeness for inorganic and organic analyses is the comparison to hold time. A component of 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.

10.2.2.4 PRECISION

Precision refers to the uncertainty that occurs if the same analysis were performed again on the same sample with no change in conditions, or the degree to which repeated measurements on the same sample agree. Practical ways to determine precision are to compare 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 conditions as nearly identical as possible. Precision for Environmental Section samples is determined by comparing results for duplicate samples of particulates in air, radiohalogens, 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., as the ratio of the standard deviation of the measurements being compared divided by their mean, expressed as a percent.

The REECo Environmental Section precision objectives are shown in Table 10.2. They depend on the relation between the radioactivity concentration (Conc.) and the minimum detectable concentration (MDC).

Table 10.2 Precision Objectives Expressed as Percents

Analysis	Conc. > 10 MDC	4 MDC ≤ Conc. ≤ 10 MDC
Gross Alpha	±30	±60
Gross Beta	±30	±60
Gamma Spectrometry	±30	±60
Scintillation Counting	±30	±60
Alpha Spectrometry	±20	±50

Note: The precision objective for TLDs at environmental levels is 10 percent.

10.2.2.5 ACCURACY

Accuracy in the measurement of a quantity refers to how well we can measure the true value of that quantity. For practical purposes, assessments of accuracy for analyses performed in the REECo Analytical Services Department 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, as determined by the sponsoring laboratory, are not known by ASD staff until several months after the measurements are made and the results sent back to the quality assurance laboratory. The true values are defined operationally as the values measured by these laboratories before the samples were sent out. Additionally, quality control samples with known values are submitted to the Radioanalyticl and Analyticl Chemistry Laboratories by the ASD Quality Support Group. These sample values are blind 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 quantitatively 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). Table 10.3 shows the REECo Environmental Section accuracy objectives.

The REECo analytical laboratory participates in several interlaboratory performance evaluation (PE) programs. The ASD Radioanalytical Section participates in the DOE/EML, EMSL-LV, World Health Organization (WHO), and the Oak Ridge Bioassay performance evaluation programs. The ASD Analytical Chemistry Section participates in the EPA/Contract Laboratory Program, NIST/Proficiency Analytical Testing, College of American Pathologists Blood Lead, American Industrial Hygiene Association (AIHA) Asbestos Analyst Registry, AIHA Bulk Asbestos, and National Voluntary Laboratory Accreditation Program Bulk Asbestos performance evaluation programs.

Table 10.3 Accuracy Objectives Expressed as Percent Bias

Analysis	Conc. > 10 MDC	4 MDC ≤ Conc. ≤ 10 MDC
Gross Alpha	±20	±50
Gross Beta	±20	±50
Gamma Spectrometry	±20	±50
Scintillation Counting	±20	±50
X-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.

10.3 RESULTS FOR COMPLETENESS, PRECISION, AND ACCURACY

10.3.1 COMPLETENESS

The analysis completeness data for calendar year 1992 are shown in Table 10.4. 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 noy beenmet for some nalyses, other factors would be used to assess aacceptability. Figure 10.1 shows hold time compliance within the REECo Analytical Chemistry Section.

10.3.2 PRECISION

Using standard deviations for the differences among the three $CaSO_4$ elements of individual environmental TLDs for the second quarter of 1992, the network precision expressed as a relative standard deviation is calculated to be 8.0%.

For ^{85}Kr analysis of duplicate noble gas samples during 1992, when outliers are removed, 15 of 138 analyses were above 4 times and the remainder were below 4 times the nominal MDC of 8 pCi/m^3. The precision of this analysis (%RSD) due to variations between duplicate sample analyses was 38 percent while the %RSD due strictly to counting error was 33 percent. The overall precision was an acceptable 51 percent as a result of combining the two uncertainties.

10.3.3 ACCURACY

The ASD accuracy objective was measured through participation in interlaboratory comparison and quality assessment programs in 1992.

10.3.3.1 RADIOLOGICAL PERFORMANCE EVALUATION RESULTS

The external radiological performance evaluation program consisted of participation in the QAP conducted by DOE/EML and NRACC conducted by EMSL-LV. These programs served as a means of evaluating the performance of the radiological laboratory and identifying problems requiring corrective actions.

Summaries of the 1992 results of the interlaboratory comparison and quality assessment programs conducted by the EMSL-LV and DOE/EML are provided in Tables 10.5 and 10.6. The last column in each table (Ratio of REECo/other organization) is the accuracy of analysis and can be expressed as percent accuracy by multiplying by 100.

10.3.3.2 NONRADIOLOGICAL PERFORMANCE EVALUATION RESULTS

The external nonradiological performance evaluation program consisted of participation in the NIOSH PAT program, CAP Lead in Blood Program, and AIHA AAR program. These programs served as a means of evaluating the performance of the nonradiological laboratory and identifying problems requiring corrective actions.

Table 10.4 Analysis Completeness Data for Calendar Year 1992

Analysis	Medium	Completeness
Gross Beta	Particulate Air Filter	95.4 %
Plutonium	Particulate Air Filter	90.7
Gamma Spectrometry	Particulate Air Filter	95.4
Gamma Spectrometry	Charcoal Air Filter	95.4
Tritiated Water	Air	82.2
Krypton-85	Air	91.1
Xenon-133	Air	94.9
Gross Beta	Potable Water Endpoints	90.2
Gamma Spectrometry	Potable Water Endpoints	90.2
Tritiated Water	Potable Water Endpoints	90.2
Gross Beta	Wells, Reservoirs, Springs, Ponds	87.1
Plutonium	Wells, Reservoirs, Springs, Ponds	97.8
Gamma Spectrometry	Wells, Reservoirs, Springs, Ponds	88.9
Tritiated Water	Wells, Reservoirs, Springs, Ponds	88.9
Strontium-90	Wells, Reservoirs, Springs, Ponds	100.0
Gross Alpha	Potable Wells and Endpoints	93.5

Note: These percentages represent all analyses which were carried to completion, and some analyses for which the results were found to be invalid for other reasons.

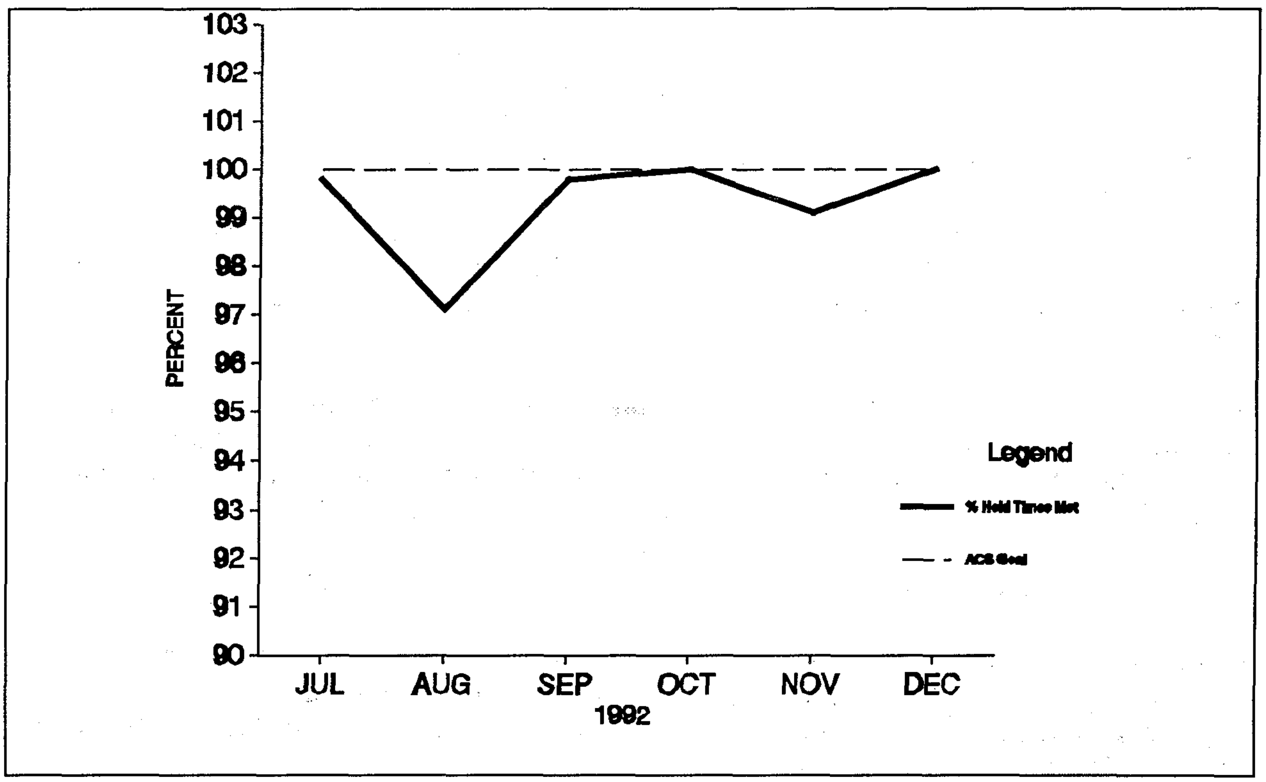

Figure 10.1 REECo Analytical Chemistry Section Hold Time Compliance

Table 10.5 Results of EMSL-LV Nuclear Radiation Assessment and Cross Checks - 1992

Analysis/ Date	Water Samples, pCi/L REECo[a]	EMSL-LV-[b]	Control Limits[c]	Ratio of REECo/ EMSL-LV
Gross Alpha				
04/14/92	39. ± 1.7	40. ± 10.	23. - 57.	0.98
10/20/92	29. ± 0.58	29. ± 7.0	17. - 41.	0.99
Gross Beta				
04/14/92	200. + 13.[f]	140. ± 21.	100. - 180.	1.4
10/20/92	42. ± 1.7	53. ± 10.	36. - 70.	0.79
^{3}H				
02/21/92	7700. ± 130.	7900. ± 790.	6500. - 9300.	0.98
06/19/92	2100. ± 130.	2100. ± 350.	1500. - 2700.	1.0
10/23/92	6300. ± 170.	6000. ± 600.	4900. - 7000.	1.1
^{60}Co				
02/14/92	No Data [d]	40. ± 5.0	31. - 49.	----
04/14/92	59. ± 0.58	56. ± 5.0	47. - 65.	1.1
06/05/92	21. ± 1.2	20. ± 5.0	11. - 29.	1.1
10/09/92	11. ± 1.0	10. ± 5.0	1.3 - 19.	1.1
10/20/92	17. ± 2.5	15. ± 5.0	6.3 - 24.	1.2
^{65}Zn				
02/14/92	No Data [d]	150. ± 15.	120. - 170.	----
06/05/92	120. ± 10.[e]	99. ± 10.	82. - 120.	1.2
10/09/92	170. ± 6.8	150. ± 15.0	120. - 170.	1.2
^{89}Sr				
01/17/92	32. ± 11.[e]	51. ± 5.0	42. - 60.	0.62
04/14/92	37. ± 4.2[f]	15. ± 5.0	6.3 - 24.	2.5
05/08/92	29. ± 1.5	29. ± 5.0	20. - 38.	1.0
09/11/92	21. ± 4.2	20. ± 5.0	11. - 29.	1.0
10/20/92	8.3 ± 3.5	8.0 ± 5.0	0.0 - 17.	1.0
^{90}Sr				
01/17/92	19. ± 4.2	20. ± 5.0	11. - 29.	0.97
04/14/92	42. ± 3.0[f]	17. ± 5.0	8.3 - 26.	2.5
05/08/92	7.3 ± 1.2	8.0 ± 5.0	0.0 - 17.	0.92
09/11/92	12. ± 0.58	15. ± 5.0	6.3 - 24.	0.82
10/20/92	8.7 ± 1.5	10. ± 5.0	1.3 - 19.	0.87
^{106}Ru				
02/14/92	No Data [d]	200. ± 20.	170. - 240.	----
06/05/92	170. ± 27.[e]	140 ± 14.	120 - 170	1.2
10/09/92	170. ± 18.	180. ± 18.	140. - 210.	0.98

(a) Average value [± 1 standard deviation] reported by REECo
(b) The known value (± 1s) reported by EMSL-LV
(c) The control limits determined by EMSL-LV
(d) No data provided
(e) The value is outside the control limits determined by EMSL-LV
(f) Outliers

Table 10.5 (Results of EPA/EMSL Nuclear Radiation Assessment and Cross Checks - 1992, cont.)

Analysis/ Date	Water Samples, pCi/L *(cont.)* REECo[(a)]	EMSL-LV[(b)]	Control Limits[(c)]	Ratio of REECo/ EMSL-LV
^{133}Ba				
02/14/92	No Data [(d)]	76. ± 8.0	62. - 90.	----
06/05/92	95. ± 5.5	98. ± 10.	81. - 120.	0.97
10/09/92	70. ± 2.3	74. ± 7.0	62. - 86.	0.94
^{134}Cs				
02/14/92	No Data [(d)]	31. ± 5.0	22. - 40.	----
04/14/92	24. ± 3.0	24. ± 5.0	15. - 33.	1.0
06/05/92	15. ± 2.1	15. ± 5.0	6.3 - 24.	1.0
10/09/92	9.7 ± 0.58	8.0 ± 5.0	0.0 - 17.	1.2
10/20/92	4.0 ± 0.0	5.0 ± 5.0	0.0 - 14.	0.80
^{137}Cs				
02/14/92	No Data [(d)]	49. ± 5.0	40. - 58.	----
04/14/92	24. ± 1.5	22. ± 5.0	13. - 31.	1.1
06/05/92	16. ± 1.0	15. ± 5.0	6.3 - 24.	1.1
10/09/92	11. ± 1.2	8.0 ± 5.0	0.0 - 17.	1.3
10/20/92	12. ± 1.5	8.0 ± 5.0	0.0 - 17.	1.5
^{226}Ra				
03/06/92	10. ± 1.2	10. ± 1.5	7.5 - 13.	1.0
04/14/92	17. ± 2.4	15. ± 2.2	11. - 19.	1.2
07/17/92	40. ± 2.6[(f)]	25. ± 3.7	18. - 31.	1.6
10/20/92	4.9 ± 0.25[(e)]	7.4 ± 1.1	5.5 - 9.3	0.66
11/06/92	5.3 ± 1.3[(e)]	7.5 ± 1.1	5.6 - 9.4	0.71
^{228}Ra				
03/06/92	12. ± 0.7	16. + 3.9	8.7 - 22.	0.81
04/14/92	17. ± 3.4	14. ± 3.5	7.9 - 20.	1.2
07/17/92	19. ± 2.4	17. ± 4.2	9.4 - 24.	1.1
10/20/92	7.5 + 1.1	10. ± 2.5	5.7 - 14.	0.75
11/06/92	4.0 ± 0.31	5.0 ± 1.3	2.7 - 7.3	0.79
^{239}Pu				
01/24/92	16. ± 0.29	17. ± 1.7	14. - 20.	0.93
08/21/92	8.4 ± 0.06	9.0 ± 0.9	7.4 - 11.	0.93
^{Nat}U				
03/13/92	20. ± 3.3	25. ± 3.0	20. - 30.	0.79
04/14/92	2.3 ± 0.2	4.0 ± 3.0	0.0 - 9.2	0.58
07/24/92	2.4 ± 0.38	4.0 ± 3.0	0.0 - 9.2	0.60
10/20/92	11. ± 0.58	10. ± 3.0	5.0 - 15.	1.1
11/13/92	14. ± 1.4	15. ± 3.0	10. - 20.	0.92

(a) Average value (± 1s) reported by REECo
(b) The known value (± 1s) reported by EPA/EMSL-LV
(c) The control limits determined by EPA/EMSL-LV
(d) No data provided
(e) The value is outside the control limits determined by EPA/EMSL-LV
(f) Outliers

Table 10.5 (Results of EPA/EMSL Nuclear Radiation Assessment and Cross Checks - 1992, cont.)

Analysis/ Date	Air Filters, pCi/Filter			Ratio of REECo/ EMSL-LV
	REECo[(a)]	EMSL-LV[(b)]	Control Limits[(c)]	
Gross Alpha				
03/27/92	10. ± 0.0	7.0 ± 5.0	0.0 - 16.	1.4
08/28/92	32. ± 1.5	30. ± 8.0	16. - 44.	1.18
Gross Beta				
03/27/92	44. ± 1.0	41. ± 5.0	32. - 50.	1.1
08/28/92	76. ± 0.58	69. ± 10.	52. - 86.	1.1
^{90}Sr				
03/27/92	14. ± 1.0	15. ± 5.0	6.3 - 24.	0.93
08/28/92	22. ± 1.2	25. ± 5.0	16. - 34.	0.87
^{137}Cs				
03/27/92	14. ± 1.2	10. ± 5.0	1.3 - 19.	1.4
08/28/92	17. ± 1.2	18. ± 5.0	9.3 - 27.	0.96

(a) Average value (± 1s) reported by REECo
(b) The known value (± 1s) reported by EMSL-LV
(c) The control limits determined by EMSL-LV
(d) No data provided
(e) The value is outside the control limits determined by EMSL-LV
(f) Outliers

Table 10.6 Results of the DOE/EML Quality Assessment Program - 1992

Analysis/ Date	Air Filters, Bq/Filter			Ratio of REECo/ EML
	REECo[(a)]	DOE/EML[(b)]	Mean[(c)]	
^{7}Be				
03/92	37. ± 7.0%	29. ± 6.0%	29.	1.3 ± 0.13
09/92	390 ± 1.0%	310. ± 2.0%	300	1.3 ± 0.04
^{54}Mn				
03/92	8.5 ± 7.0%	6.0 ± 5.0%	5.8	1.4 ± 0.13
09/92	3.4 ± 20.%[(d)]	26. ± 3.0%	25.	0.13 ± 0.03
^{57}Co				
03/92	11. ± 4.0%	7.9 ± 3.0%	7.0	1.3 ± 0.08
09/92	8.2 ± 0.0%	6.4 ± 4.0%	5.5	1.3 ± 0.06

(a) Average value (± 1s) reported by REECo
(b) The known value (± 1 standard error of the mean [sem]) reported by DOE/EML
(c) The mean value was computed from all reported results, which are in the range of 0.5 to 2.0 times of the DOE/EML known value
(d) The 99% confidence limits of the REECo value (REECo value ± 3s) does not include the EML-DOE known value and the ratio of REECo/EML is outside the 0.5-1.5 range
(e) In units of µg/filter, g, or mL

Table 10.6 (Results of the DOE/EML Quality Assessment Program - 1992, cont.)

Analysis/ Date	Air Filters, Bq/Filter *(cont.)* REECo[a]			DOE/EML[b]			Mean[c]	Ratio of REECo/ EML		
^{60}Co										
03/92	7.5	±	4.0%	5.8	±	4.0%	5.5	1.3	±	0.080
09/92	4.5	±	5.0%	3.1	±	6.0%	3.1	1.5	±	0.13
^{90}Sr										
03/92	0.23	±	20.%	0.21	±	3.0%	0.22	1.1	±	0.23
09/92	0.15	±	4.0%	0.14	±	8.0%	0.15	1.1	±	0.10
^{134}Cs										
03/92	5.6	±	3.0%	4.4	±	4.0%	4.4	1.3	±	0.07
09/92	4.1	±	0.0%	3.7	±	2.0%	3.4	1.1	±	0.03
^{137}Cs										
03/92	8.2	±	8.0%	5.8	±	4.0%	5.8	1.4	±	0.13
09/92	8.0	±	2.0%	5.8	±	5.0%	5.7	1.4	±	0.08
^{144}Ce										
03/92	100.[d]	±	4.0%	64.	±	5.0%	65.	1.6	±	0.11
09/92	55.	±	7.0%	43.	±	3.0%	36.	1.3	±	0.11
^{238}Pu										
03/92	0.25	±	12.%	0.27	±	4.0%	0.26	0.94	±	0.12
09/92	0.027	±	23.%	0.042	±	9.0%	0.034	0.63	±	0.16
^{239}Pu										
03/92	0.27	±	11.%	0.29	±	10.%	0.27	0.95	±	0.15
09/92	0.040	±	0.0%	0.045	±	6.0%	0.041	0.90	±	0.06
^{Nat}U										
09/92	1.9[e]	±	20.%	1.3	±	14.%	1.4	1.5	±	0.36
	Soil Samples, Bq/kg									
^{40}K										
03/92	760.	±	3.0%	720.	±	2.0%	770.	1.1	±	0.05
09/92	330.	±	2.0%	380	±	3.0%	410.	0.86	±	0.04
^{90}Sr										
03/92	3.0	±	29.%	4.5	±	8.0%	4.8	0.67	±	0.20
09/92	5.5	±	20.%	9.6	±	10.%	9.7	0.57	±	0.13

(a) Average value (± 1s) reported by REECo
(b) The known value (± 1 standard error of the mean [sem]) reported by DOE/EML
(c) The mean value was computed from all reported results, which are in the range of 0.5 to 2.0 times of the DOE/EML known value
(d) The 99% confidence limits of the REECo value (REECo value ± 3s) does not include the EML-DOE known value and the ratio of REECo/EML is outside the 0.5-1.5 range
(e) In units of µg/filter, g, or mL

Table 10.6 (Results of the DOE/EML Quality Assessment Program - 1992, cont.)

Analysis/ Date	REECo[a]			DOE/EML[b]			Mean[c]	Ratio of REECo/ EML		
	Soil Samples, Bq/kg *(cont.)*									
^{137}Cs										
03/92	6.0	±	10.%	5.2	±	7.0%	5.7	1.2	±	0.16
09/92	240.	±	0.0%	290.	±	2.0%	320.	0.84	±	0.02
^{238}Pu										
09/92	22.	±	33.%	22.	±	3.0%	20.	0.99	±	0.33
^{239}Pu										
03/92	25.	±	3.0%	26.	±	7.0%	28.	0.99	±	0.08
09/92	8.6	±	37.%	7.8	±	6.0%	7.4	1.1	±	0.43
^{Nat}U										
09/92	0.87[d][e]	±	26.%	2.3	±	8.0%	2.0	0.38	±	0.10
	Vegetation Samples, Bq/kg									
^{40}K										
09/92	1000.	±	2.0%	1000.	±	2.0%	1000.	1.0	±	0.04
^{90}Sr										
03/92	300.	±	9.0%	380.	±	7.0%	340.	0.80	±	0.10
09/92	142.[d]	±	4.0%	489.	±	8.0%	411.	0.29	±	0.03
^{137}Cs										
03/92	25.	±	1.0%	25.	±	5.0%	27.	1.0	±	0.05
09/92	30.	±	23.%	29.	±	4.0%	32.	1.0	±	0.24
^{238}Pu										
03/92	1.3	±	7.0%	1.1	±	4.0%	1.2	1.2	±	0.10
09/92	1.1	±	13.%	1.2	±	6.0%	1.2	0.85	±	0.12
^{239}Pu										
03/92	0.30	±	19.%	0.31	±	1.0%	0.35	0.98	±	0.19
09/92	0.36	±	12.%	0.38	±	10.%	0.38	0.95	±	0.15
	Water Samples, Bq/kg									
^{3}H										
03/92	240.	±	3.0%	230.	±	3.0%	240.	1.1	±	0.06
09/92	120.	±	2.0%	120.	±	2.0%	130.	1.0	±	0.03
^{54}Mn										
03/92	61.	±	0.0%	57.	±	1.0%	55.	1.1	±	0.02
09/92	37.	±	7.0%	33.	±	2.0%	36.	1.1	±	0.08

(a) Average value (± 1s) reported by REECo
(b) The known value (± 1 standard error of the mean [sem]) reported by DOE/EML
(c) The mean value was computed from all reported results, which are in the range of 0.5 to 2.0 times of the DOE/EML known value
(d) The 99% confidence limits of the REECo value (REECo value ± 3s) does not include the EML-DOE known value and the ratio of REECo/EML is outside the 0.5-1.5 range
(e) In units of µg/filter, g, or mL

Table 10.6 (Results of the DOE/EML Quality Assessment Program - 1992, cont.)

Analysis/ Date	Water Samples, Bq/kg *(cont.)* REECo[a]			DOE/EML[b]			Mean[c]	Ratio of REECo/ EML		
^{60}Co										
03/92	100.	±	1.0%	94.	±	1.0%	93.	1.1	±	0.02
09/92	31.	±	4.0%	28.	±	3.0%	29.	1.1	±	0.06
^{90}Sr										
03/92	1.8	±	4.0%	2.1	±	2.0%	2.0	0.83	±	0.05
09/92	2.1	±	7.0%	2.2	±	8.0%	2.4	0.97	±	0.10
^{134}Cs										
03/92	77.	±	0.0%	72.	±	2.0%	74.	1.1	±	0.02
09/92	48.	±	5.0%	44.	±	4.0%	50.	1.1	±	0.08
^{137}Cs										
03/92	96.	±	0.0%	85.	±	2.0%	86.	1.1	±	0.03
09/92	33.	±	2.0%	29.	±	3.0%	33.	1.1	±	0.05
^{144}Ce										
03/92	210.	±	3.0%	190.	±	1.0%	180.	1.1	±	0.04
09/92	64.	±	5.0%	51.	±	3.0%	55.	1.2	±	0.09
^{238}Pu										
03/92	0.50	±	1.0%	0.45	±	7.0%	0.47	1.1	±	0.09
09/92	1.7	±	10.%	2.0	±	4.0%	1.9	0.86	±	0.09
^{239}Pu										
03/92	0.56	±	3.0%	0.58	±	6.0%	0.56	0.97	±	0.07
09/92	0.23	±	3.0%	0.24	±	8.0%	0.25	0.98	±	0.09
^{Nat}U										
9/92	0.008[e]	±	25.%	0.0091	±	4.0%	0.0087	0.88	±	0.22

(a) Average value (± 1s) reported by REECo
(b) The known value (± 1 standard error of the mean [sem]) reported by DOE/EML
(c) The mean value was computed from all reported results, which are in the range of 0.5 to 2.0 times of the DOE/EML known value
(d) The 99% confidence limits of the REECo value (REECo value ± 3s) does not include the EML-DOE known value and the ratio of REECo/EML is outside the 0.5-1.5 range
(e) In units of µg/filter, g, or mL

Summaries of the 1992 results of the interlaboratory comparison and quality assessment programs conducted by the NIOSH PAT, CAP, and AIHA are provided in Tables 10.7, 10.8, and 10.9.

10.3.3.3 CORRECTIVE ACTIONS IMPLEMENTED IN RESPONSE TO PERFORMANCE EVALUATION PROGRAMS

REECo results were generally within the control limits determined by the program sponsors. Causes of results which were not within acceptable performance limits were investigated, and corrective actions were taken to prevent reoccurrence. Corrective actions include 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 performance evaluation samples.

Table 10.7 NIOSH PAT Program Interlaboratory Comparison - 1992

Analysis and Date	REECo Result	Reference Value[(a)]	Ratio[(b)]	Performance Limits[(a)]
Cd (in mg)				
02/21/92	0.0107	0.0099	1.08	0.0084-0.0113
	0.0146	0.0147	0.99	0.0126-0.0169
	0.0196	0.0190	1.03	0.0165-0.0215
	0.0073	0.0069	1.06	0.0059-0.0079
05/19/92	0.0235	0.0218	1.08	0.0190-0.0245
	0.0190	0.0178	1.07	0.0154-0.0201
	0.0083	0.0079	1.05	0.0069-0.0090
	0.0126	0.0118	1.07	0.0103-0.0134
08/19/92	0.0045	0.0050	0.90	0.0043-0.0056
	0.0107	0.0117	0.91	0.0103-0.0131
	0.0154	0.0158	0.97	0.0141-0.0174
	0.0087	0.0089	0.98	0.0077-0.0101
11/18/92	0.0171	0.0175	0.98	0.0152-0.0197
	0.0093	0.0098	0.95	0.0085-0.0111
	0.0056	0.0059	0.95	0.0050-0.0067
	0.0131	0.0136	0.96	0.0120-0.0152
Cr (in mg)				
02/21/92	0.0777	0.0744	1.04	0.0619-0.0868
	0.1685	0.1713	0.98	0.1392-0.2034
	0.1017	0.1010	1.01	0.0839-0.1181
	0.1531	0.1470	1.04	0.1209-0.1730
08/19/93	0.2120	0.2177	0.97	0.1648-0.2706
	0.1730	0.1780	0.97	0.1411-0.2149
	0.0750	0.0748	1.00	0.0605-0.0892
	0.1252	0.1223	1.02	0.0950-0.1497
Pb (in mg)				
02/21/92	0.0529	0.0494	1.07	0.0431-0.0556
	0.0768	0.0783	0.98	0.0676-0.0889
	0.0305	0.0304	1.00	0.0266-0.0342
	0.0623	0.0592	1.05	0.0523-0.0662
05/19/92	0.0221	0.0220	1.00	0.0194-0.0246
	0.0381	0.0376	1.01	0.0326-0.0425
	0.0753	0.0743	1.01	0.0651-0.0835
	0.0482	0.0474	1.02	0.0416-0.0532
08/19/92	0.0463	0.0489	0.95	0.0423-0.0555
	0.0258	0.0275	0.94	0.0235-0.0315
	0.0645	0.0650	0.99	0.0555-0.0744
	0.0783	0.0785	1.00	0.0694-0.0876
11/18/92	0.0280	0.0291	0.96	0.0249-0.0333
	0.0701	0.0734	0.96	0.0650-0.0819
	0.0398	0.0414	0.96	0.0375-0.0454
	0.0600	0.0627	0.96	0.0552-0.0701

(a) Value provided by the NIOSH PAT Program
(b) Ratio = REECo Result/Reference Value
(c) Solvent abbreviations: CTC=Carbon Tetrachloride, DCE=1,2 Dichloroethane, MCM=1,1,1-Trichloroethane, PCE=Tetrachloroethylene, OXY=o-Xylene, TCE=Trichloroethylene, CFM=Chloroform, BNZ=Benzene, TOL=Toluene
(d) Outliers

Table 10.7 (NIOSH PAT Program Interlaboratory Comparison - 1992, cont.)

Analysis and Date	REECo Result	Reference Value[a]	Ratio[b]	Performance Limits[a]
Zn (in mg)				
02/19/92	0.0839	0.0809	1.04	0.0671-0.0946
	0.1198	0.1142	1.05	0.0987-0.1297
	0.2024	0.1944	1.04	0.1708-0.2180
	0.1623	0.1536	1.06	0.1330-0.1743
11/19/92	0.0715	0.0745	0.96	0.0617-0.0873
	0.1341	0.1434	0.94	0.1202-0.1665
	0.1993	0.2067	0.96	0.1724-0.2410
	0.1678	0.1782	0.94	0.1506-0.2058
Silica (in mg)				
02/21/92	0.0955	0.0901	1.06	0.0346-0.1455
	0.1460	0.1500	0.97	0.0766-0.2234
	0.1350	0.1203	1.12	0.0400-0.2006
	0.1400	0.1316	1.06	0.0497-0.2134
05/19/92	0.0862	0.0801	1.08	0.0026-0.1577
	0.0635	0.0533	1.19	0.0119-0.0947
	0.1221	0.1278	0.96	0.0385-0.2171
	0.1455	0.1141	1.28	0.0219-0.2062
08/19/92	0.1007	0.1022	0.99	0.0284-0.1759
	0.1324	0.1081	1.22	0.0336-0.1825
	0.0344	0.0778	0.44	0.0186-0.1370
	0.0936	0.0765	1.22	0.0207-0.1324
11/18/92	0.1158	0.1259	0.92	0.0530-0.1987
	0.0893	0.0862	1.04	0.0239-0.1485
	0.1412	0.1579	0.89	0.0721-0.2436
	0.0620	0.0579	1.07	0.0049-0.1110
Asbestos (in fibers/mm^2)				
02/21/92	916	798.2	1.15	471.4 - 1210.6
	536	495.8	1.08	282 - 769.6
	283	232.8	1.22	116.3 - 389.3
	415	356.9	1.16	197.6 - 562.8
05/19/92	313.3	245	1.28	67.5 - 533.2
	704.7	721.2	0.98	256.5 - 1420.8
	567.3	490.1	1.16	173.9 - 966.4
	414.3	279.4	1.48	85.7 - 584.3
08/19/92	530	383.3	1.38	205.8 - 615.6
	1064	863.1	1.23	477.9 - 1361.2
	408	383.4	1.06	216.1 - 598.5
	679	572.2	1.19	296.4 - 938
11/18/92	814	645.9	1.26	256.2 - 1212.6
	390	382.1	1.02	138.3 - 747
	199	163.5	1.22	43.3 - 361
	512	412.9	1.24	168.1 - 765.9
		Solvents[c]		
MCM (in mg)				
02/21/92	1.3086	1.2040	1.09	1.0431-1.3649
	1.1563	1.0383	1.11	0.9050-1.1717
	0.8370	0.7410	1.13	0.6171-0.8649
	0.6256	0.5531	1.13	0.4760-0.6301

(a) Value provided by the NIOSH PAT Program
(b) Ratio = REECo Result/Reference Value
(c) Solvent abbreviations: CTC=Carbon Tetrachloride, DCE=1,2 Dichloroethane, MCM=1,1,1-Trichloroethane, PCE=Tetrachloroethylene, OXY=o-Xylene, TCE=Trichloroethylene, CFM=Chloroform, BNZ=Benzene, TOL=Toluene
(d) Outliers

Table 10.7 (NIOSH PAT Program Interlaboratory Comparison - 1992, cont.)

Analysis and Date	REECo Result	Reference Value[a]	Ratio[b]	Performance Limits[a]
		Solvents[c]		
PCE (in mg)				
02/21/92	1.0204	1.0194	1.00	0.9271-1.1117
	0.5281	0.5089	1.04	0.4474-0.5704
	0.7143	0.6936	1.03	0.6088-0.7785
	1.2305	1.1944	1.03	1.0593-1.3295
TCE (in mg)				
02/21/92	0.5819	0.5640	1.03	0.5064-0.6217
	0.9130	0.8668	1.05	0.7836-0.9499
	1.1542	1.0966	1.05	0.9851-1.2081
	0.8656	0.8223	1.05	0.7439-0.9007
11/18/92	1.3435	1.3639	0.99	1.2166-1.5112
	0.6930	0.7089	0.98	0.6220-0.7959
	1.2492	1.2642	0.99	1.1189-1.4095
	0.4740	0.4651	1.02	0.4104-0.5198
CFM (in mg)				
05/19/92	1.0928	1.0810	1.01	0.9607-1.2013
	1.2841	1.3012	0.99	1.1538-1.4485
	0.8959	0.8733	1.03	0.7723-0.9744
	0.5935	0.5675	1.05	0.4989-0.6362
CTC (in mg)				
05/19/92	1.1538	1.1665	0.99	1.0430-1.2899
	0.9186	0.9414	0.98	0.8224-1.0603
	0.5715	0.5328	1.07	0.4693-0.5963
	1.4423	1.4562	0.99	1.2728-1.6396
11/18/92	0.8216	0.8184	1.00	0.7038-0.9330
	1.1048	1.1169	0.99	0.9583-1.2755
	0.5496	0.5043	1.09	0.4144-0.5941
	1.4667	1.4787	0.99	1.3242-1.6332
DCE (in mg)				
05/19/92	0.6920	0.6677	1.04	0.5845-0.7509
	0.9490	0.9456	1.00	0.8224-1.0689
	1.3728	1.3341	1.03	1.1725-1.4958
	0.8484	0.8177	1.04	0.7201-0.9153
11/18/92	0.9064	0.9175	0.99	0.8186-1.0163
	1.2206	1.2509	0.98	1.0993-1.4025
	0.7536	0.7604	0.99	0.6758-0.8451
	0.5532	0.5450	1.02	0.4856-0.6044
BNZ (in mg)				
08/19/92	0.0865	0.0712	1.21[d]	0.0567-0.0856
	0.1381	0.1218	1.13	0.0992-0.1443
	0.2980	0.2833	1.05	0.2478-0.3188
	0.3658	0.3492	1.05	0.3022-0.3963
OXY (in mg)				
08/19/92	1.2314	1.2442	0.99	1.0554-1.4330
	1.5301	1.5174	1.01	1.3099-1.7250
	0.9325	0.9121	1.02	0.7732-1.0510
	0.6783	0.6600	1.03	0.5658-0.7541
TOL (in mg)				
08/19/92	1.1137	1.1285	0.99	0.9752-1.2817
	0.8854	0.8681	1.02	0.7474-0.9888
	1.3508	1.3345	1.01	1.1827-1.4863
	0.5046	0.4901	1.03	0.4304-0.5499

(a) Value provided by the NIOSH PAT Program
(b) Ratio = REECo Result/Reference Value
(c) Solvent abbreviations: CTC=Carbon Tetrachloride, DCE=1,2 Dichloroethane, MCM=1,1,1-Trichloroethane, PCE=Tetrachloroethylene, OXY=o-Xylene, TCE=Trichloroethylene, CFM=Chloroform, BNZ=Benzene, TOL=Toluene
(d) Outliers

Table 10.8 CAP Program Interlaboratory Comparison - 1992

Analysis and Date	REECo Result	Reference Value[a]	Ratio[b]	Performance Limits[a]
Blood Pb (in µg/dL)				
04/18/92	9.3	5.42	1.72	0.0 - 11.5
	34.3	37.91	0.90	31.9 - 44.0
	18.8	18.44	1.02	12.4 - 24.5
	23.5	26.59	0.88	20.5 - 32.6
	37.3	38.20	0.98	32.2 - 44.2
07/18/92	8.6	9.37	0.92	3.3 - 15.4
	20.8	20.60	1.01	14.6 - 26.6
	28.6	28.11	1.02	22.1 - 34.2
	43.6	42.72	1.02	36.3 - 49.2
	32.8	34.10	0.96	28.1 - 40.1
10/10/92	41.0	40.67	1.01	Not Reported
	16.2	12.47	1.30	8.4 - 16.5
	29.2	27.89	1.05	Not Reported
	28.2	28.33	1.00	Not Reported
	18.2	15.22	1.20	11.2 - 19.3
01/22/93	33.6	30.53	1.10	Not Reported
	21.4	19.34	1.11	15.3 - 23.4
	14.4	9.78	1.47[c]	5.7 - 13.8
	25.4	19.35	1.31	Not Reported
	12.2	9.53	1.28	5.5 - 13.6

(a) Value provided by the CAP Blood Lead Survey Program
(b) Ratio = REECo Result/Reference value
(c) Outlier

Table 10.9 AAR Program Interlaboratory Comparison - 1992

Analysis and Date	REECo Result[a]	Reference Value[b]	Ratio[c]	Performance Limits[b]
Quantitative Asbestos (in fibers/mm^2)				
04/21/92	157	284	0.55	142 - 567
	216	284	0.76	142 - 567
	234	284	0.82	142 - 567
	554	552	1.00	276 - 1105
	604	552	1.09	276 - 1105
	666	552	1.21	276 - 1105
	117	187	0.63	93 - 374
	125	187	0.67	93 - 374
	124	187	0.66	93 - 374
	232	354	0.66	177 - 707
	286	354	0.81	177 - 707
	298	354	0.84	177 - 707
10/19/92	482	442	1.09	221 - 885
	502	442	1.14	221 - 885
	673	570	1.18	285 - 1141
	637	570	1.12	285 - 1141
	322	288	1.12	144 - 575
	242	288	0.84	144 - 575
	302	285	1.06	143 - 570
	244	285	0.86	143 - 570

(a) Individual analyst results reported by REECo
(b) Value(s) provided by AAR
(c) Ratio = REECo Result/Reference Value

11.0 OFFSITE LABORATORY QUALITY ASSURANCE

Deb J. Chaloud

The policy of the U.S. Environmental Protection Agency (EPA) requires participation in a centrally managed quality assurance (QA) program by all EPA organizational units involved in environmental data collection. The QA program developed by the Nuclear Radiation Assessment Division (NRD) of the Environmental Monitoring Systems Laboratory, Las Vegas (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 (DOE) 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 that data is defensible. Achieved data quality may then be evaluated against these DQOs. This chapter describes the DQOs and the achieved data quality for the ORSP in 1992.

11.1 POLICY

One of the major goals of the U.S. Environmental Protection Agency (EPA) is to ensure that all EPA decisions which are dependent on environmental data, are supported by data of known quality. Agency policy initiated by the Administrator in memoranda of May 30, 1979, and June 14, 1979, requires participation in a centrally managed Quality Assurance (QA) Program by all EPA Laboratories, Program Offices, Regional Offices, and those monitoring and measurement efforts supported or mandated through contracts, regulations, or other formalized agreements. Further, by EPA Order 5360.1, Agency policy requires participation in a QA Program by all EPA organizational units involved in environmental data collection.

The QA policies and requirements of EPA's Environmental Monitoring Systems Laboratory in Las Vegas (EMSL-LV) are summarized in the *Quality Assurance Program Plan* (EPA, 1987). 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, 1992a). 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). It is NRD policy that achievement of quality measurements is of the highest priority in the conduct of the ORSP and that quality is the responsibility of all personnel. All personnel are required to adhere to the requirements of the QA Plan and of all SOPs applicable to their duties to ensure that all environmental radiation monitoring data collected by EPA EMSL-LV in support of the ORSP are of adequate quality and properly documented for use by DOE, EPA, and other interested parties.

11.2 DATA QUALITY OBJECTIVES

Data quality objectives (DQOs) are statements of the quality of data a decision maker needs to ensure that a decision based on that data is defensible. Data quality objectives are defined in terms of representativeness, comparability, completeness, precision, and accuracy. Representativeness and comparability are generally qualitative assessments while completeness, precision, and accuracy may be quantitatively assessed. In the ORSP, representativeness, comparability, and completeness objectives are defined for each monitoring network. Precision and accuracy are defined for each analysis type or radionuclide.

Achieved data quality is monitored continuously through internal QC checks and procedures. In addition to the internal quality control procedures, NRD participates in external intercomparison programs. One such intercomparison program is managed and operated by a group within EPA EMSL-LV. These external performance audits are conducted as described in and according to the schedule contained in "Environmental Radioactivity Laboratory Intercomparison Studies Program" (EPA, 1992b). The analytical laboratory also participates in the DOE Environmental Measurements Laboratory (EML) Quality Assurance Program in which real or synthetic environmental samples that have been prepared and thoroughly analyzed are distributed to participating laboratories. Periodically (every two or three years) external systems and performance audits are conducted for the TLD network as part of the certification requirements for DOE's Laboratory Accreditation Program (DOELAP). A Management System Review this year indicated an error in use of TLD transit blanks that required complete re-analysis of all TLD data.

11.2.1 REPRESENTATIVENESS, COMPARABILITY, AND COMPLETENESS OBJECTIVES

Representativeness is defined as "the degree to which the data accurately and precisely represent a characteristic of a parameter, variation of a property, a process characteristic, or an operation condition" (Stanley and Verner, 1985). In the ORSP, representativeness may be considered to be the degree to which the collected samples represent the radionuclide activity concentrations in the offsite environment. Collection of samples from all media which are possible pathways to human exposure as well as direct measurement of offsite resident exposure through the TLD and internal dosimetry monitoring programs provides assurance of the representativeness of the calculated exposures.

Comparability is defined as "the confidence with which one data set can be compared to another" (Stanley and Verner, 1985). Comparability of data is assured by use of SOPs for sample collection, handling, and analysis; use of standard reporting units; and use of standardized procedures for data analysis and interpretation. In addition, another aspect of comparability is examined through comparison of external performance audit results to those achieved by other participating laboratories. Use of SOPs, maintained under a document control system, is an important component of comparability, ensuring that all personnel conform to a unified set of procedures.

Completeness is defined as "a measure of the amount of data collected from a measurement process compared to the amount that was expected to be obtained under the conditions of measurement" (Stanley and Verner, 1985). Data may be lost due to instrument malfunction, sample destruction, loss in shipping or analysis, analytical error, or unavailability of samples. Additional data values may be deleted due to unacceptable precision, accuracy, or detection limit or as the result of application of statistical outlier tests. The completeness objective for all networks except the LTHMP is 90%. The completeness objective for the LTHMP is 80%.

11.2.2 PRECISION AND ACCURACY OBJECTIVES OF RADIOANALYTICAL ANALYSES

Precision is defined as "the degree of mutual agreement characteristic of independent measurements as the result of repeated application of the process under specified conditions" (Taylor, 1987). In the ORSP, total system precision is estimated from analytical results for field duplicates or, where collection of field duplicates is impractical, from sample splits. Results of repeated analyses of QC samples provide an estimate of laboratory or instrument precision.

Accuracy is defined as "the degree of agreement of a measured value with the true or expected value of the quantity of concern" (Taylor, 1987). Intercomparison study performance audit samples and matrix spike samples are used to estimate accuracy in the ORSP. Objectives for both precision and accuracy are given below.

Measurements of sample volumes should be accurate to ± 5% for aqueous samples (water and milk) and to ± 10% 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. Precision to a 95% confidence interval, monitored through analysis of duplicate samples, must be within ± 10% for activities greater than ten times the minimum detectable concentration (MDC) and ± 30% for activities greater than the MDC but less than ten times the MDC. There are no precision requirements for activity concentrations below the MDC, which by definition, cannot be distinguished from background at the 95% confidence interval. Control limits for accuracy, monitored with matrix spike samples, is required to be no greater than ± 20% for all gross alpha, gross beta, and gamma spectrometric analyses.

At concentrations greater than ten times the MDC, precision is required to be within ± 10% for:

- Conventional Tritium Analyses
- Uranium
- Thorium (all media)
- Strontium (in milk)

and within ± 20% for:

- Enriched Tritium Analyses
- Strontium (except in milk)
- Noble Gases
- Plutonium

At concentrations less than ten times the MDC, both precision and accuracy are expressed in absolute units, not to exceed 30% of the MDC for all analyses and all media types.

11.2.3 QUALITY OF EXPOSURE ESTIMATES

The allowable uncertainty of the effective dose equivalent to any human receptor is ± 0.1 mrem annually. This uncertainty objective is based solely upon the precision and accuracy of the data produced from the surveillance networks and does not apply to uncertainties in the model used, effluent release data received from DOE, or dose conversion factors. Generally, effective dose equivalents must have an accuracy (bias) of no greater than 50% for annual exposures greater than or equal to 1 mrem but less than 5 mrem and no greater than 10% for annual exposures greater than or equal to 5 mrem.

11.3 DATA VALIDATION

Data validation is defined as "A systematic process for reviewing a body of data against a set of criteria to provide assurance that the data are adequate for their intended use. Data validation consists of data editing, screening, checking, auditing, verification, certification, and review" (Stanley et al, 1983). Data validation procedures are documented in SOPs. All data are reviewed and checked at various steps in the collection, analysis, and reporting processes.

The first level of data review consists of sample tracking; e.g., that all samples planned to be collected are collected or reasons for non-collection are documented, that all collected samples are delivered to Sample Control and are entered into the appropriate data base management system, and that all entered information is accurate. Next, analytical data are reviewed by the analyst and by the laboratory supervisor. Checks at this stage include verifying that all samples received from Sample Control have been analyzed or reasons for non-analysis have been documented, that data are "reasonable" (e.g., within expected range), and that instrumentation operational checks indicate the analysis instrument is within permissible tolerances. Discrepancies indicating collection instrument malfunction are reported to the Field Operations Branch. Analytical discrepancies are resolved; individual samples or sample batches may be reanalyzed if required.

Raw data are reviewed by a designated media expert. A number of checks are made at this level, including:

- Completeness--all samples scheduled to be collected have, in fact, been collected and analyzed or the data base contains documentation explaining the reasons for non-collection or non-analysis

- Transcription errors--checks are made of all manually entered information to ensure that the information contained in the data base is accurate

- Quality control data--field and analytical duplicate, audit sample, and matrix blank data are checked to ensure the collection and analytical processes are within specified QC tolerances

- Analysis schedules--lists of samples awaiting analysis are generated and checked against normal analysis schedules to identify backlogs in analysis or data entry

- Anomalous results - sample results and diagnostic graphics of sample results are reviewed for reasonableness. Conditions indicative of instrument malfunction are reported to Field and/or Laboratory Operations

Once the data have been finalized, they are compared to the DQOs. Completeness, accuracy, and precision statistics are calculated. The achieved quality of the data is reported annually, at a minimum. If data fail to meet one or more of the established DQOs, 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. Only specified personnel have change access; others have read access only.

All sample results exceeding the traditional natural background activity range are investigated. If data are found to be associated with a non-environmental condition, such as 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 (for example, higher-than-normal activities were observed for several radionuclides following the Chernobyl accident). When activities exceeding the expected range are observed for one network, the data for the other networks at the same location are checked. For example, higher-than-normal-range PIC values are compared to data obtained by the air, noble gas, TLD, and tritium-in-air samplers at the same location.

Data are also compared to previous years' data for the same location using trend analysis techniques. Other statistical procedures may be employed as warranted to permit interpretation of current data as compared to past data. Future trends may also be predicted. Trend analysis is made possible due to the length of the sampling history which, in some cases, is 30 years or longer.

Data from the offsite networks are used, along with NTS source emission estimates prepared by DOE, to calculate or estimate annual committed effective dose equivalents to offsite residents. Surveillance network data are the primary tools for the dose calculations. Additionally, CAP88-PC is used with local meteorological data to predict doses to offsite residents from NTS source term estimates. An assessment of the uncertainty of the dose estimate is made, based on analytical uncertainty, and reported with the estimate.

11.4 QUALITY ASSESSMENT OF 1992 DATA

Data quality assessment is associated with the regular QA and QC practices within the radioanalytical laboratory. The analytical quality control plan, documented in SOPs, describes specific procedures used to demonstrate that data are within prescribed requirements for accuracy and precision. Duplicate samples are collected or prepared and analyzed in the exact manner as the regular samples for that particular type of analysis. Data obtained from duplicate analyses are used for determining the degree of precision for each individual analysis. Accuracy is assessed by comparison of data from spiked samples with the "true" or accepted values. Spiked samples are either in-house laboratory blanks spiked with known amounts of radionuclides or performance audit samples prepared by other organizations in which data are compared among multiple laboratories.

On an annual basis, achieved data quality statistics are compiled. This data quality assessment is performed as part of the process of data validation, described in Section 11.3. The following subsections describe the achieved data quality for 1992.

11.4.1 COMPLETENESS

Completeness is calculated as:

$$\%C = \left(\frac{V}{n}\right)100$$

where
%C = percent completeness
V = number of measurements judged valid
n = total number of measurements

The percent completeness of the 1992 data is given in Table 11.1. Reasons for sample loss include instrument malfunction, inability to gain site access, monitoring technician error, or laboratory error. Completeness is not applicable to the Internal Dosimetry Network, as all individuals who request a whole body or lung count receive a valid one, resulting in a completeness of 100 percent, by definition.

The achieved completeness of over 96 percent for the LTHMP exceeds the DQO of 80 percent. If the wells shut down by DOE were to be included in the completeness calculation, the achieved completeness becomes 86 percent for the LTHMP overall, but only 78 percent for sites sampled on the NTS.

Overall completeness for the routine air surveillance network was greater than 98 percent, exceeding the DQO of 90 percent. Individually, all stations exceeded 95 percent data recovery and four stations achieved completeness of 100 percent. Plutonium analyses, conducted on composited filters from selected routine and standby air stations, were over 93 percent complete, exceeding the DQO of 90 percent.

Overall, the noble gas network met the DQO of 90 percent completeness. On an individual station basis, data recovery was over 90 percent for seven routine sampling locations, and greater than 80 percent for another five routine sampling locations. Completeness was less than 70 percent for one routine sampling location (Amargosa Center) and for all of the standby station locations. Generally, recovery of less than 75 percent of the sampling period indicate the data cannot be considered to be representative of that period; consequently, an annual average for Amargosa Center cannot be considered representative of the year.

The achieved completeness for the atmospheric moisture network was greater than 95 percent, exceeding the DQO of 90 percent. On an individual station basis, all of the routine sampling locations achieved data recoveries greater than 80 percent; all but one were greater than 90 percent. Data recoveries were lower for the standby stations; however, the issue of annual representation does not apply to the standby locations which are operated only one week per quarter as a means of testing operational reliability.

Overall data recovery for the routine milk network was less than the DQO of 90 percent. Many of the milk sampling locations consist of family-owned cows or goats and can provide milk only when the animal is lactating. Less than 75 percent of the total possible number of

Table 11.1 Data Completeness of Offsite Radiological Safety Program Networks

Network	No. of Sampling Locations	Total Samples Possible	Valid Samples Collected	Percent Completeness
LTHMP	243	423[(a)]	408	96.5[(a)]
Air Surveillance	30	10,950 days[(b)]	10,824	98.8
	18 ($^{238, 239+240}Pu$)	196[(c)]	184	93.9
Noble Gas	21[(d)]	4969 days[(b)]	4519 (^{85}Kr)	90.9 (^{85}Kr)
			4545 (^{133}Xe)	91.5 (^{133}Xe)
Atmospheric Moisture	21[(e)]	5306 days[(b)]	5054	95.3
Milk Surveillance	25	288	225	78.1
Animal Investigation	3	12[(f)]	11	91.7
PIC	27	1404 weeks[(g)]	1379	98.2

(a) Does not include wells which were shut down by DOE for part or all of the year (see Section 9.5.2), nor unoccupied residences in Mississippi (see Section 9.6.7).

(b) Continuous samplers with samples collected at intervals of approximately one week. Days used as units to account for differences in sample interval length

(c) Includes five quarters (July 1991 through September 1992) of data for 13 standby network locations and five routine sampling locations. Analyses of plutonium isotopes for one routine sampling location (Salt Lake City, Utah) were discontinued at the beginning of 1992

(d) Thirteen stations are operated on a routine basis and another eight are operated one week per quarter.

(e) Fourteen stations are operated on a routine basis and another seven are operated one week per quarter.

(f) Includes four mule deer from the Nevada Test Site and four cows from each of two locations; Does not include bighorn sheep, fruits and vegetables, and other animals which are "samples of opportunity"

(g) Continuous samplers with data summarized on a weekly basis samples were collected from seven ranches: Dahl (Alamo, Nevada), Lemon (Dyer, Nevada), John Deer (Amargosa Valley, Nevada), Frayne (Goldfield, Nevada), Brown (Benton, California), Blue Eagle (Currant, Nevada), and Scott (Goldfield, Nevada). Annual means for these locations individually cannot be considered to be representative of the year. However, the milkshed may be adequately represented if an alternate location in the area was sampled when the primary station could not supply milk.

All of the animals scheduled for collection in the Animal Investigation Program (AIP) were collected, with the exception that no mule deer was collected from the NTS in the first quarter of 1992. There were no road kills in that quarter and no deer were found on two hunting trips conducted during the quarter. Overall completeness exceeded the DQO of 90 percent.

The achieved completeness of over 98 percent for the PIC network exceeds the DQO of 90 percent. The redundant data systems used in the PIC network (i.e., satellite telemetry, magnetic tape or card data acquisition systems, and strip charts) are responsible for the high rates of recovery. Gaps in the satellite transmissions are filled by data from the magnetic tape or card media. If necessary, strip charts would be digitized to fill gaps if data were not available from either of the other two sources; however, no digitized data were needed in 1992.

11.4.2 PRECISION

Precision is monitored through analysis of duplicate samples. Field duplicates (e.g., a second sample collected at the same place and time and under the same conditions as the routine sample) are collected in the ASN, LTHMP, and Milk Surveillance networks. For the ASN, a duplicate sampler is collocated with the routine sampler at randomly selected sites for a period of one to three months to provide the field duplicate. A total of four samplers are used; these second samplers are moved to various site locations throughout the year. Noble gas and atmospheric moisture samples are split to provide duplicate samples for analysis; the number of duplicates is limited by the number of routine samples which contain sufficient volume to permit division into two samples. Animal tissue, vegetable, and bioassay (urine) samples are also split after processing, if the volume of material is sufficient. Two TLDs, each with three identical phosphors, are deployed to each fixed station, providing a total of six replicates. In lieu of field duplicates, precision for the PICs is determined by the variance of measurements over a specific time interval when only background activities are being measured. Precision may also be determined from repeated analyses of routine or laboratory spiked samples. The spiked QC samples are generally not blind to the analyst; e.g., the analyst both recognizes the sample as a QC sample and knows the expected (theoretical) activity of the sample.

Precision is expressed as percent relative standard deviation (%RSD), calculated by:

$$\%RSD = \left(\frac{std.\ dev.}{mean}\right)100$$

The precision or %RSD is not reported for duplicate pairs in which one or both results are less than the MDC of the analysis. For most analyses, the DQOs for precision are defined for two ranges: values greater than or equal to the MDC but less than ten times the MDC and values equal to or greater than ten times the MDC. The %RSD is partially dependent on statistical counting uncertainty so it is expected to be more variable for duplicate analyses of samples with low activities.
Figure 11.1 displays %RSDs for LTHMP field and spiked sample duplicate pairs analyzed by

the conventional tritium method. This figure includes 48 pairs of matrix spike samples and one field duplicate pair with means equal to or greater than the MDC but less than ten times the MDC. All pairs yielded %RSDs of less than 12 percent; the DQO for precision of samples in this activity range is 30 percent. Two field duplicate pairs with means equal to or greater than ten times the MDC are not included in the figure; these two pairs had means of 118,000 and 91,800 pCi/L and %RSDs of 0.02 and 1.1 percent, respectively. These results are well within the DQO of ten percent for values equal to or greater than ten times the MDC. Figure 11.2 displays %RSDs for duplicate pairs analyzed by the enriched tritium method. Of 26 field and two matrix spike sample duplicate pairs with means equal to or greater than the MDC but less than ten times the MDC, only one pair exceeded the DQO of 30 %RSD. The mean for this pair was approximately two times the MDC and the %RSD was 31.4%. The %RSD for all matrix spike and field duplicate sample pairs with means equal to or greater than ten times the MDC were within the DQO of 20 percent. Six of the field duplicate pairs are not included on the figure because the means were much higher than the remaining values. The means of these six pairs range from 373 to 721 pCi/L and the %RSDs range from 1.3 to 12.6 percent.

The single matrix spike duplicate pairs analyzed for gross alpha and for gross beta in water had means equal to or greater than ten times the MDC and yielded %RSDs of less than ten percent which met the DQO of 30 percent. Duplicate analyses were performed for ^{137}Cs, however, all results were less than the MDC.

In the ASN, field duplicate pairs are analyzed for gross alpha, gross beta, and gamma-emitting radionuclides. Figure 11.3 shows the %RSD distribution for gross alpha field duplicate analyses. Of 55 field duplicate pairs with means greater than or equal to the MDC but less than ten times the MDC, 36 pairs were within the DQO of 30 %RSD. Another seven pairs yielded %RSDs between 30 and 40 percent. As shown in Figure 11.4, gross beta field duplicate analyses yielded %RSDs ranging from less than one percent to greater than 100 percent for the 117 field duplicate pairs greater than or equal to the MDC but less than ten times the MDC. Of the 117 pairs, 94 yielded %RSDs within the DQO of 30 %RSD and another eight pairs yielded %RSDs less than 40 %RSD. There were only three duplicate pairs with means equal to or greater than ten times the MDC; the %RSD for these pairs were all within the DQO of 20 percent. These results indicate that the true achieved precision for these gross spectrometric analyses, at concentrations less than ten times the MDC, is closer to 40 percent. The data users are currently reevaluating the data quality required to achieve program objectives; the DQO may be modified if it is determined that the achieved data quality is adequate for program needs. Of the five field duplicate pairs with ^{7}Be activities equal to or greater than ten times the MDC, all yielded %RSDs less than 20 percent and, of these, all but one were less than 10 %RSD.

In addition to analysis of field duplicate pairs, selected routine sample filters are analyzed twice for gross alpha, gross beta, and gamma-emitting radionuclides. Of 74 duplicate analyses for gross alpha with results equal to or greater than the MDC but less than ten times the MDC, 63 yielded %RSDs within the DQO of 30 percent and another three pairs yielded %RSDs of less than 40 percent. Of 174 duplicate analyses for gross beta with means equal to or greater than the MDC but less than ten times the MDC, all but one yielded %RSDs of less than 20 percent. In addition, 13 duplicate analyses for gross beta yielded means of equal to or greater than ten times the MDC; the %RSDs for these pairs were all less than ten percent. Four duplicate gamma spectrometry analyses yielded ^{7}Be results with means equal to or greater than ten times the MDC and %RSDs for the pairs were all less than four percent.

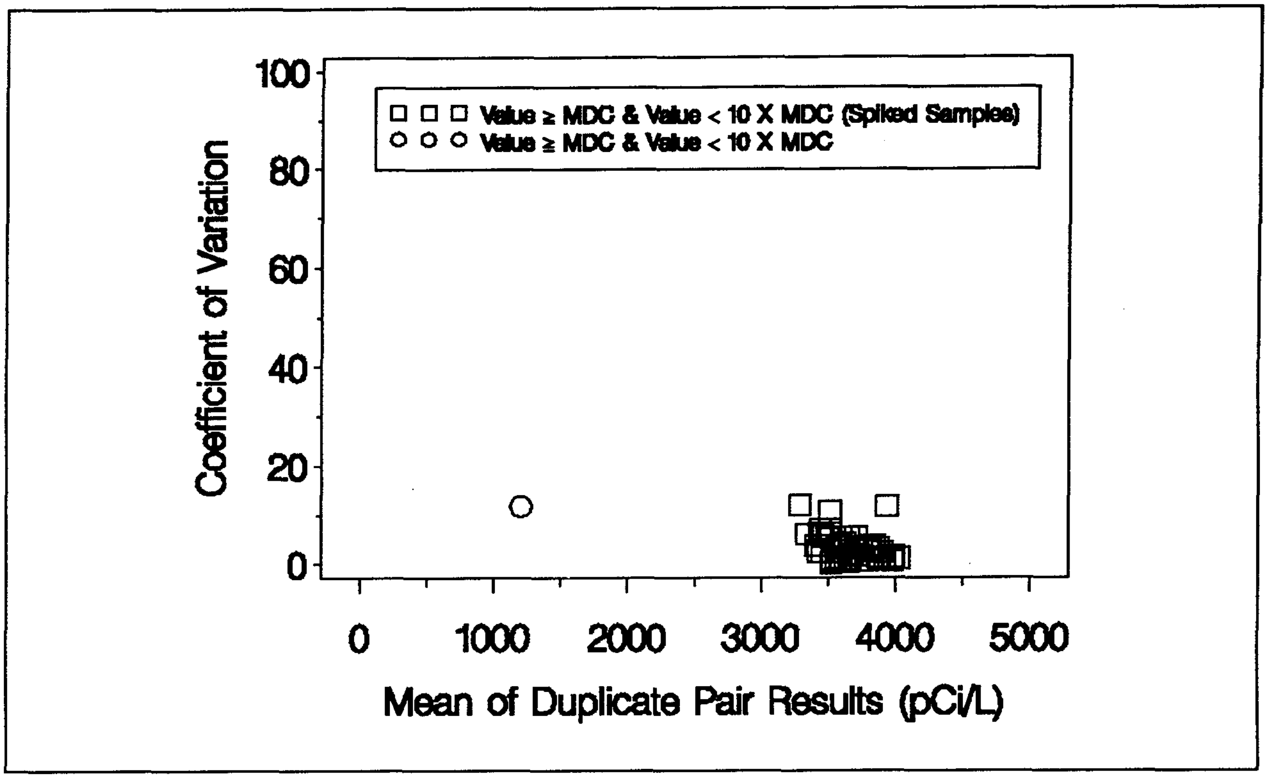

Figure 11.1 Field and Spiked Sample Pair Precision for LTHMP Conventional Tritium Analyses

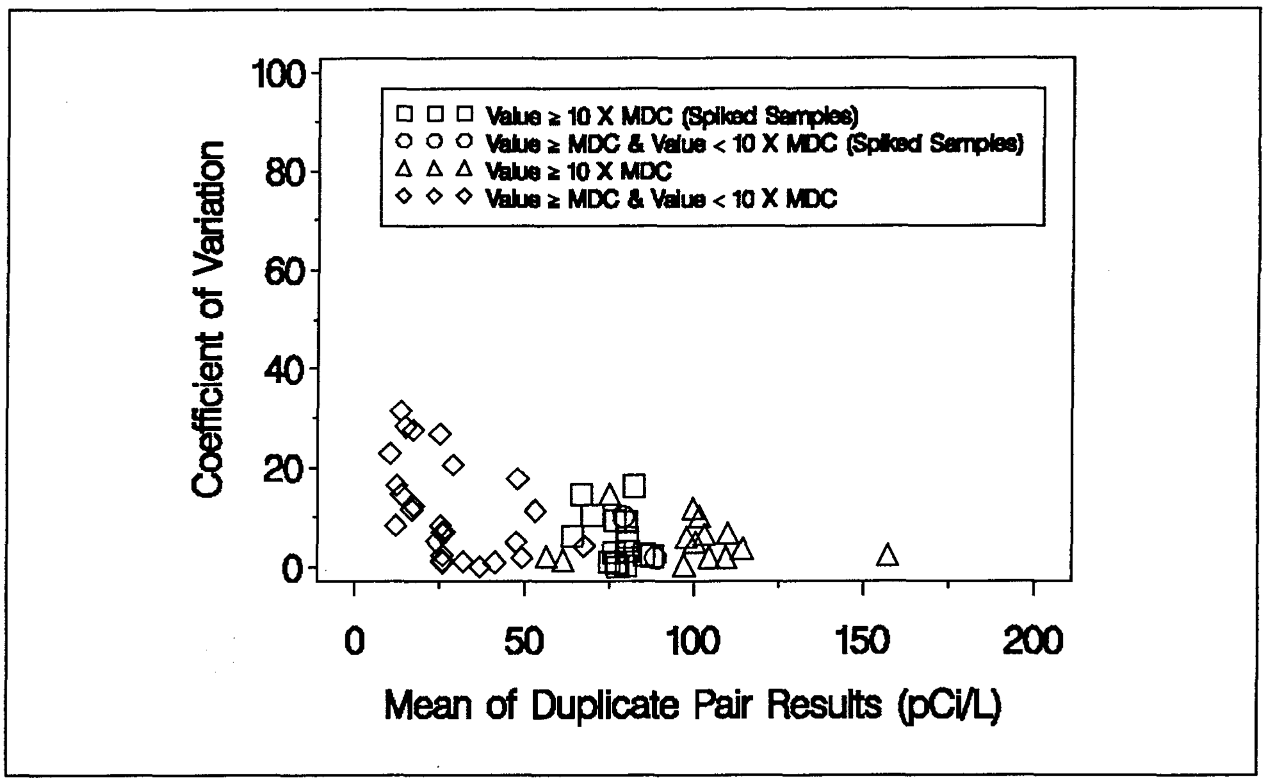

Figure 11.2 Field and Spiked Sample Duplicate Pair Precision for LTHMP Enriched Tritium Analyses

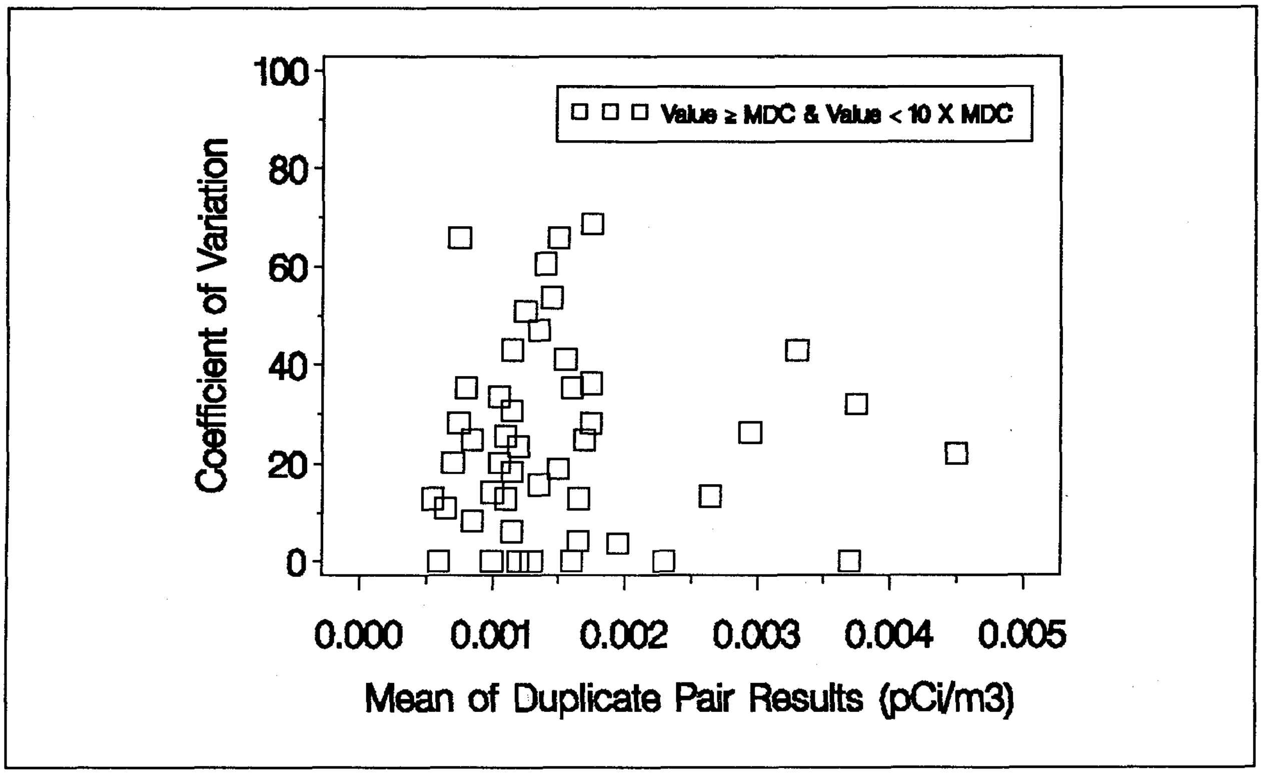

Figure 11.3 Field Duplicate Pair Precision for Air Surveillance Network Gross Alpha Analyses

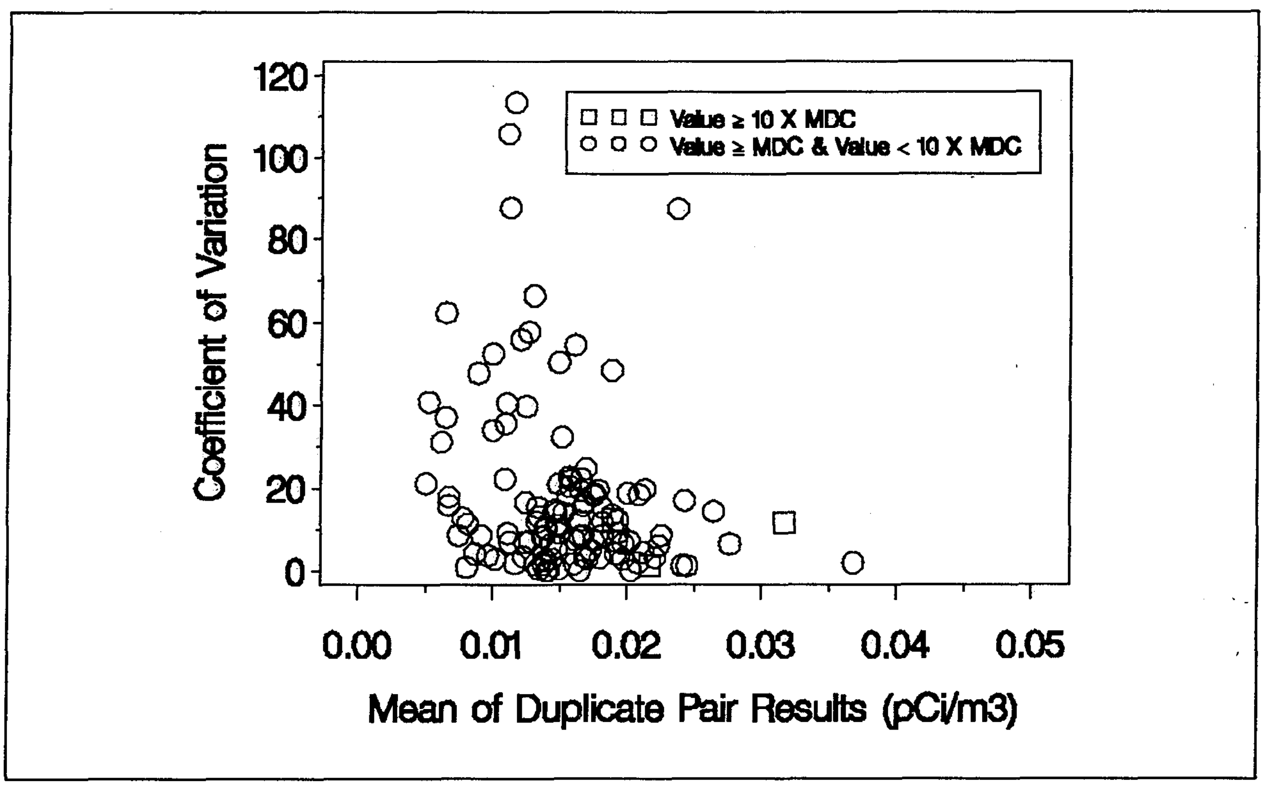

Figure 11.4 Field Duplicate Pair Precision for Air Surveillance Network Gross Beta Analyses

All of the 48 noble gas sample splits analyzed for ^{85}Kr had activities greater than or equal to the MDC but less than ten times the MDC. All but two %RSDs were less than 20 percent, better than the DQO of 30 percent for sample pairs in this activity range. The %RSDs for ^{85}Kr are shown in Figure 11.5. Of 104 analyses of split sample pairs analyzed in the atmospheric moisture network, only nine pairs yielded results equal to or greater than the MDC but less than ten times the MDC. With one exception, the %RSDs for these were all less than 22 percent, but the average was still less than 30 percent.

Only one of the 31 field duplicate pairs from the MSN analyzed for tritium yielded results equal to or greater than the MDC but less than ten times the MDC. The %RSD for this sample pair was 5.8 percent. Total potassium was measured at concentrations equal to or greater than ten times the MDC in 74 field duplicate pairs and in 36 duplicate analyses. In all but two cases, the %RSDs for the pairs was less than 20 percent and the remaining two pairs were within 25 percent. The %RSD results for the field duplicate pairs are shown in Figure 11.6. Four spiked sample duplicate pairs yielded means of ^{90}Sr equal to or greater than the MDC but less than ten times the MDC; the %RSDs for these pairs were all less than 12 percent.

In the AIP, matrix (bone ash) spike sample duplicates were analyzed for ^{90}Sr and $^{239+240}Pu$. The single pair analyzed for ^{90}Sr yielded a mean equal to or greater than the MDC but less than ten times the MDC and a %RSD of 12.9 percent. The single pair analyzed for $^{239+240}Pu$ yielded a mean equal to or greater than ten times the MDC and a %RSD of 2.2 percent. Vegetable sample splits were analyzed for ^{90}Sr, but all results were less than the MDC. Similarly, all 14 split bioassay sample pairs yielded results less than the MDC.

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. Table 11.2 presents the pooled data and estimates of overall precision. The pooled standard deviations and %RSD indicate that, with the exception of gross alpha analyses, the achieved precision is better than the DQO for the analysis and activity range. The pooled %RSD for tritium in air is based on a limited number of sample pairs, with the result influenced by one outlier with the %RSD of over 40 percent.

11.4.3 ACCURACY

The accuracy of all analyses is controlled through the use of approved or NIST-traceable standards in instrument calibrations. Internal checks of instrument accuracy may be periodically performed, using spiked matrix samples. These internal QC procedures are the only control of accuracy for whole body and lung counts and PICs. For spectroscopic and radiochemical analyses, an independent measurement of accuracy is provided by participation in intercomparison studies using samples of known activities. The EPA EMSL-LV Radioanalysis Laboratory participates in two such intercomparison studies. An independent verification of the accuracy of the TLDs is performed every two or three years by DOELAP, with a "pass/fail" report given.

In the EPA EMSL-LV Intercomparison Study program, samples of known activities of selected radionuclides are sent to participating laboratories on a set schedule throughout the year. Water, milk, and air filters are used as the matrices for these samples. Results from all participating laboratories are compiled and statistics computed comparing each laboratory's

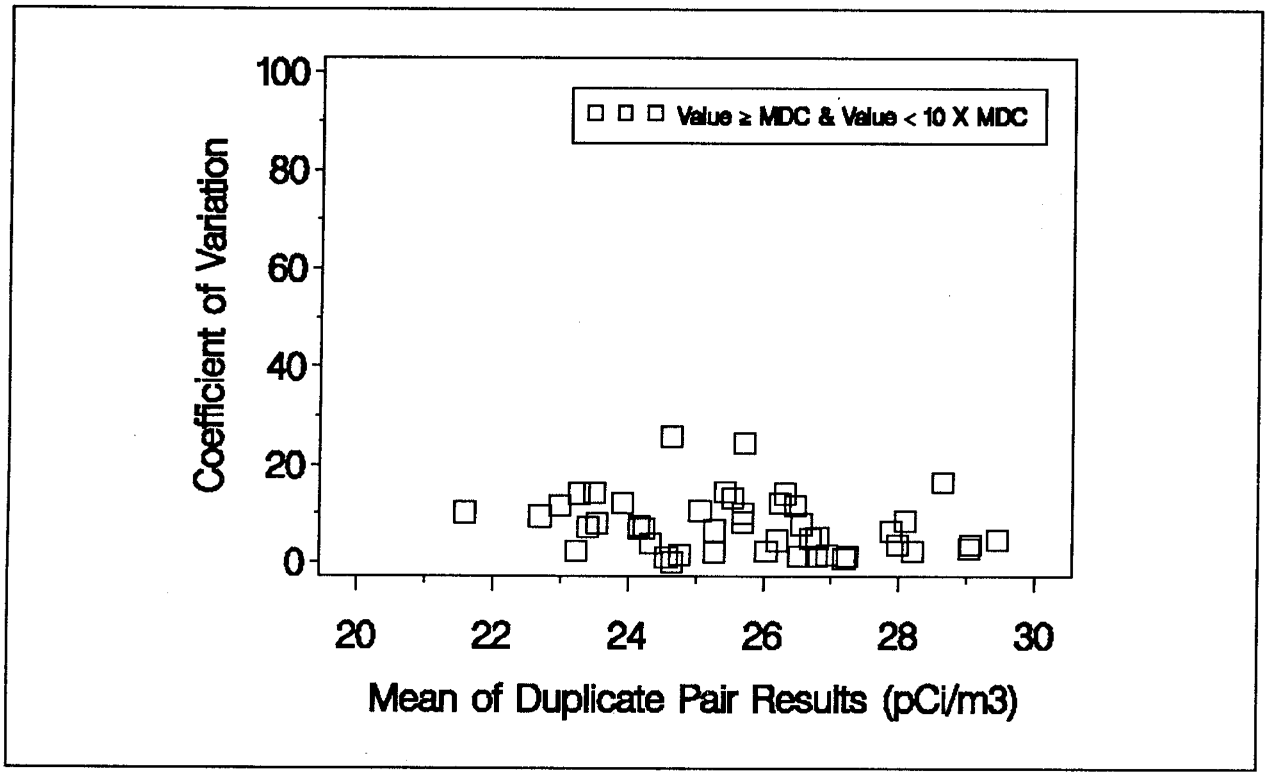

Figure 11.5 Split Sample Precision for Noble Gas Network ^{85}Kr Analyses

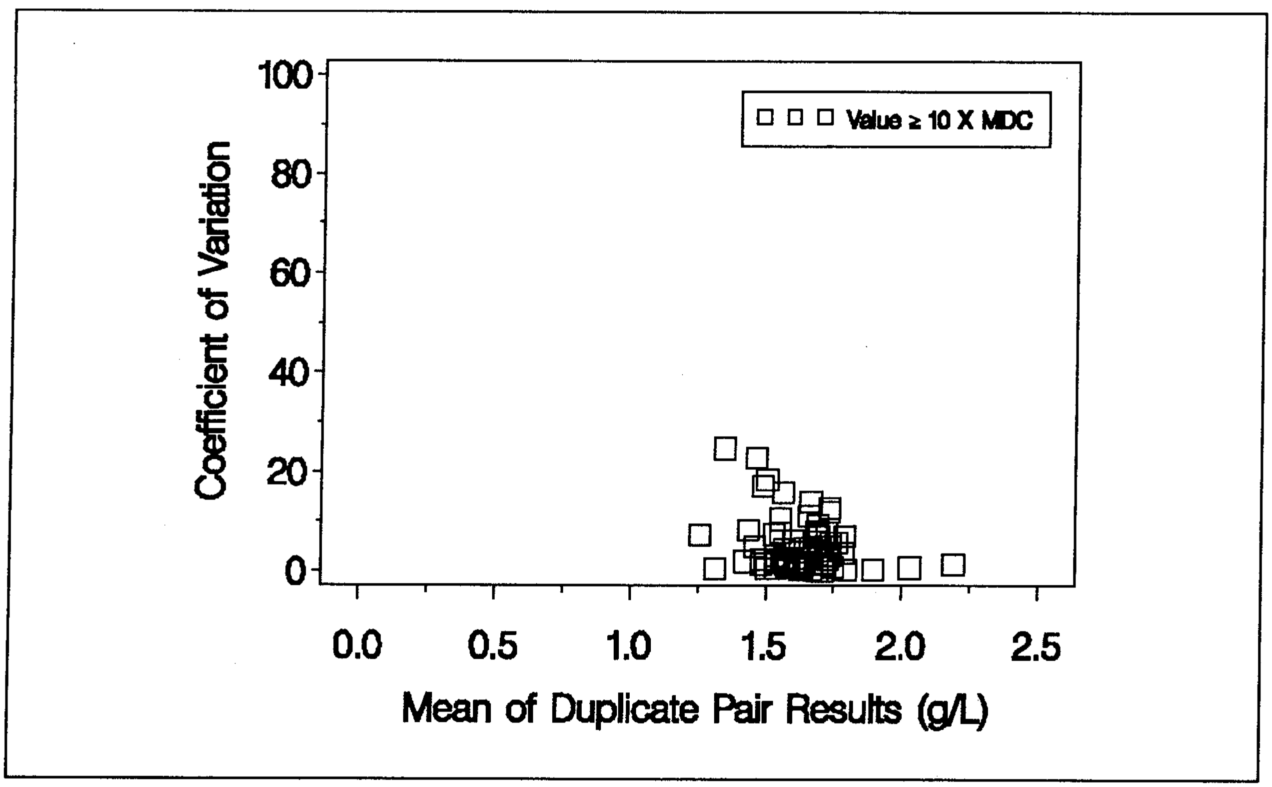

Figure 11.6 Field Duplicate Pair Precision for Milk Surveillance Network Total Potassium Analyses

Table 11.2 Overall Precision of Analysis

Network	Analysis	Sample Type	Range	n	Pooled Standard Deviation	%RSD
LTHMP	Gross Alpha	Spiked	≥10x MDC	1	1.4	5.8
	Gross Beta	Spiked	≥10x MDC	1	2.8	8.7
	Conv. Tritium	Spiked	≥MDC,<10x MDC	48	160.	4.3
	Conv. Tritium	Field	≥MDC,<10x MDC	1	140.	11.8
	Conv. Tritium	Field	≥10x MDC	2	720.	0.7
	Enrich. Tritium	Spiked	≥MDC,<10x MDC	2	5.8	6.8
	Enrich. Tritium	Field	≥MDC,<10x MDC	26	3.4	11.9
	Enrich. Tritium	Spiked	≥10x MDC	16	5.6	7.2
	Enrich. Tritium	Field	≥10x MDC	20	20.	8.6
Air Surveillance	Gross Alpha	Field	≥MDC,<10x MDC	55	0.000	33.8
	Gross Alpha	Lab Dup	≥MDC,<10x MDC	74	0.000	23.6
	Gross Beta	Field	≥MDC,<10x MDC	117	0.004	27.6
	Gross Beta	Lab Dup	≥MDC,<10x MDC	174	0.001	8.3
	Gross Beta	Field	≥10x MDC	3	0.003	10.4
	Gross Beta	Lab Dup	≥10x MDC	13	0.001	3.8
	^{7}Be	Field	≥10x MDC	5	0.025	8.8
	^{7}Be	Lab Dup	≥10x MDC	4	0.006	2.4
Noble Gas	^{85}Kr	Split	≥MDC,<10x MDC	46	2.4	9.5
Tritium in Air	HTO	Split	≥MDC,<10x MDC	9	1.5	20.9
Milk	Conv. Tritium	Field	≥MDC,<10x MDC	1	25.	5.8
	Potassium (total)	Field	≥10x MDC	74	0.11	6.8
	Potassium (total)	Lab Dup	≥10x MDC	36	0.076	4.7
	^{90}Sr	Spiked	≥MDC,<10x MDC	4	1.6	7.5
Animal Investigation Program	^{90}Sr (ash)	Spiked	≥MDC,<10x MDC	1	2.7	12.9
	$^{239+240}Pu$ (ash)	Spiked	≥10x MDC	1	0.09	2.2

results to the known value and to the mean of all laboratories. The comparison to the known value provides an independent assessment of accuracy for each participating laboratory.

Table 11.3 presents accuracy (referred to therein as Percent Bias) results for these intercomparison studies. Comparison of results among all participating laboratories provides a measure of comparability, discussed in Section 11.4.4. Approximately 70 to 250 laboratories participate in any given intercomparison study.

Table 11.3 Accuracy of Analysis from EPA Intercomparison Studies

Nuclide	Month	Known Value (pCi/L)[(a)]	EPA Average (pCi/L)[(a)]	Percent Bias
		Water Intercomparison Studies		
Alpha	January	30.	23.	–24.
Alpha	April [(b)]	40.	50.	24.
Alpha	May	15.	18.	22.
Alpha	September	45.	57.	26.
Alpha	October [(b)]	29.	40.	38.
Beta	January	30.	31.	4.4
Beta	April [(b)]	140.	130.	–6.7
Beta	May	44.0	47.	6.8
Beta	September	50.0	59.	18.
Beta	October [(b)]	53.0	48.	–8.8
^{3}H	February	8000.	8000.	0.77
^{3}H	June	2100.	2100.	–2.6
^{3}H	October	6000.	5900.	–1.1
^{60}Co	February	40.	42.	5.0
^{60}Co	April [(b)]	56.	55.	–1.2
^{60}Co	May	20.	19.	–3.4
^{60}Co	October	10.	10.	0.0
^{60}Co	October [(b)]	15.	15.	–2.2
^{65}Zn	February	150.	160.	11.
^{65}Zn	May	99.	100.	3.7
^{65}Zn	October	150.	150.	3.4
^{89}Sr	January	51.	44.	–13.
^{89}Sr	April [(b)]	15.	13.	–16.
^{89}Sr	May	29.	26.	–9.2
^{89}Sr	September	20.	19.	–6.6
^{89}Sr	October [(b)]	8.0	8.	4.1
^{90}Sr	January	20.	20.	1.6
^{90}Sr	April [(b)]	17.	16.	–3.9
^{90}Sr	May	8.0	8.0	0.0
^{90}Sr	September	15.	14.	–6.6
^{90}Sr	October [(b)]	10.	11.	10.
^{106}Ru	February	200.	180.	–10.
^{106}Ru	May	140.	130.	–8.7
^{106}Ru	October	180.	140.	–23.
^{131}I	February	59.	60.	2.2
^{131}I	August	45.	45.	0.0
^{133}Ba	February	76.	67.	–12.
^{133}Ba	May	98.	92.	–6.5
^{133}Ba	October	74.	74.	–0.45
^{134}Cs	February	31.	30.	–4.3
^{134}Cs	April [(b)]	24.	23.	–4.2
^{134}Cs	May	15.	13.	–11.

(a) Values were obtained from the individual intercomparison study reports and are reported with the units included in those reports. All values have been rounded to two significant figures.

(b) Performance Evaluation (PE) samples. These have more than one constituent

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

With the exception of gross alpha in water and ^{106}Ru in the October gamma in water intercomparison study sample, the achieved accuracy was better than ± 20 percent. For most analyses, the DQOs are ± 20 percent for values greater than ten times the MDC and ± 30 percent for results greater than the MDC but less than ten times the MDC. The achieved %Bias for the alpha activity in water samples was approximately 25 to 35 percent. The other intercomparison study in which the EPA EMSL-LV Radioanalysis Laboratory participates is the semiannual DOE QA Program conducted by EML in New York, NY.

Approximately 20 laboratories participate in this intercomparison study program. Sample matrices include water, air filters, vegetation, and soil. The EML result is assumed to represent the known or true activity for calculation of %Bias. Results for these performance audit samples are given in Table 11.4. The DQOs for accuracy were exceeded for a number of analyses, primarily for gamma-emitter results in the September air and water samples. The cause of the evident bias is under investigation. Routine sample data were not affected and internal QC checks indicated the systems were in control. Gamma spectroscopy results for the March water and air filter samples were all well within the DQO of ± 20 percent. The DQO was also exceeded for ^{239}Pu in the March soil and vegetation samples and for ^{90}Sr in the September vegetation sample. Routine and internal QC check samples processed in the same time frame on the same systems are being checked to determine if results may be affected, requiring flagging or invalidation.

In addition to use of irradiated control samples in the processing of TLDs, DOELAP monitors accuracy as part of the accreditation program. As with the intercomparison studies, samples of known activity are submitted as single blind samples. The designation "single blind" indicates the analyst recognizes the sample as being other than a routine sample, but does not know the concentration or activity contained in the sample. Individual results are not provided to the participant laboratories by DOELAP; issuance of the accreditation certificate indicates acceptable accuracy has been achieved as one of the accreditation criteria. No DOELAP samples were received in 1992.

11.4.4 COMPARABILITY

The EPA Intercomparison Study reports (EPA, 1981) provide results for all laboratories participating in each intercomparison study. A grand average is computed 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. Table 11.5 displays data from the 1992 intercomparison studies for all variables measured. There were two instances in which the EPA EMSL-LV Radioanalysis Laboratory results deviated from the grand average by more than three

Table 11.4 Accuracy of Analysis from DOE Intercomparison Study

Nuclide	Month	EML Value[(a)]	EPA Value	Percent Bias
		Air Intercomparison Studies		
^{7}Be	March	29.	29.	2.8
^{7}Be	September	310.	390.	26.
^{54}Mn	March	6.0	6.4	7.0
^{54}Mn	September	26.0	36.	39.
^{57}Co	March	7.9	7.3	–7.6
^{57}Co	September	6.4	8.1	26.
^{60}Co	March	5.8	6.1	4.8
^{60}Co	September	3.1	4.3	40.
^{90}Sr	March	0.21	0.17	–17.
^{134}Cs	March	4.4	5.2	17.
^{134}Cs	September	3.7	4.8	29.
^{137}Cs	March	5.8	6.4	12.
^{137}Cs	September	5.8	8.3	43.
^{144}Ce	March	64.	70.	9.2
^{144}Ce	September	43.	51.	19.
^{238}Pu	March	0.27	0.26	–3.3
^{238}Pu	September	0.042	0.035	–18.
^{239}Pu	March	0.28	0.25	–11.
^{239}Pu	September	0.045	0.039	–13.
		Soil Intercomparison Studies		
^{238}Pu	September	22.	20.	–8.7
^{239}Pu	March	26.	32.	24.
^{239}Pu	September	7.8	7.0	–10.
		Vegetation Intercomparison Studies		
^{90}Sr	March	380.	350.	–6.9
^{90}Sr	September	490.	620.	26.
^{238}Pu	March	1.1	1.1	4.6
^{238}Pu	September	1.2	1.3	7.2
^{239}Pu	March	0.31	0.37	20.
^{239}Pu	September	0.38	0.34	–9.8

(a) Values were obtained from the Environmental Measurements Laboratory (EML) with all values rounded to two significant figures. Units are Bq/filter for air, Bq/L for water, and Bq/Kg for the remaining matrices.

Table 11.5 Comparability of Analysis from EPA Intercomparison Studies[a]

Nuclide	Month	EPA Laboratory Average pCi/L	Grand Average pCi/L	Known Value pCi/L	Normalized Deviation from Grand Average	Normalized Deviation from Known Value
			Water Intercomparison Studies			
Alpha	January	23	24	30	-0.30	-1.6
Alpha	April [b]	50	40	40	1.7	1.7
Alpha	May	18	14	15	1.4	1.2
Alpha	September	57	36	45	3.2	1.8
Alpha	October[b]	40	28	29	2.9	2.7
Beta	January	31	30	30	0.50	0.46
Beta	April [b]	130	118	140	1.0	-0.77
Beta	May	47	43	44	1.5	1.0
Beta	September	59	49	50	3.6	3.1
Beta	October [b]	48	46	53	0.31	-0.81
^{3}H	February	8000	7900	7900	0.05	0.13
^{3}H	June	2100	2100	2120	-0.16	-0.27
^{3}H	October	5900	6000	5960	-0.29	-0.19
^{60}Co	February	42	40	40	0.67	0.69
^{60}Co	April [b]	55	56	56	-0.38	-0.23
^{60}Co	June	19	21	20	-0.44	-0.23
^{60}Co	October	10	11	10	-0.33	0
^{60}Co	October [b]	15	15	15	-0.22	-0.12
^{65}Zn	February	160	150	148	1.9	2.0
^{65}Zn	June	100	100	98	-0.34	0.64
^{65}Zn	October	160	160	148	0.33	1.4
^{89}Sr	January	44	47	51	-0.97	-2.3
^{89}Sr	April [b]	13	16	15	-0.99	-0.81
^{89}Sr	May	26	28	29	-0.59	-0.29
^{89}Sr	September	19	20	20	-0.47	-0.46
^{89}Sr	October [b]	8.3	8.6	8	-0.09	0.12
^{90}Sr	January	20	19	20	0.36	0.12
^{90}Sr	April [b]	16	16	17	0.17	-0.23
^{90}Sr	May	8	7.7	8	0.09	0
^{90}Sr	September	14	14	15	-0.17	-0.35
^{90}Sr	October [b]	11	10	10	0.17	0.35
^{106}Ru	February	180	190	203	-1.1	-1.8
^{106}Ru	June	130	140	141	-1.2	-1.5
^{106}Ru	October	140	160	175	-2.4	-3.8
^{131}I	February	60	60	59	0.05	0.38
^{131}I	August	45	46	45	-0.26	0
^{133}Ba	February	67	75	76	-1.8	-2.0
^{133}Ba	June	92	96	98	-0.78	-1.1
^{133}Ba	October	74	73	74	0.15	-0.08
^{134}Cs	February	30	29	31	0.08	0.46
^{134}Cs	April [b]	23	23	24	-0.15	-0.35
^{134}Cs	June	15	15	15	-0.49	-0.58
^{134}Cs	October	7	8.1	8	-0.39	-0.35
^{134}Cs	October [b]	5	5.3	5	-0.11	0

(a) Values were obtained from the individual intercomparison study reports and are reported with all values rounded to two significant figures.

(b) Performance Evaluation (PE) samples

Table 11.5 (Comparability of Analysis from EPA Intercomparison Studies, cont.)[a]

Nuclide	Month	EPA Laboratory Average pCi/L	Grand Average pCi/L	Known Value pCi/L	Normalized Deviation from Grand Average	Normalized Deviation from Known Value
			Water Intercomparison Studies *(cont.)*			
^{134}Cs	October [b]	5	5.3	5	-0.11	0
^{137}Cs	February	51	51	49	0.11	0.69
^{137}Cs	April [b]	23	23	22	-0.07	0.35
^{137}Cs	June	15	16	15	-0.5	-0.12
^{137}Cs	October [b]	8.3	8.9	8	-0.18	0.12
^{137}Cs	October	8.7	8.7	8	-0.02	0.23
			Air Filter Intercomparison Studies			
Alpha	March	8	8.3	7	-0.12	0.35
Alpha	August	30	31	30	-0.19	0
Beta	March	39	42	41	-1.0	-0.58
Beta	August	71	72	69	-0.17	0.35
^{90}Sr	March	15	15	15	0.02	-0.12
^{90}Sr	August	22	24	25	-0.8	-1.0
^{137}Cs	March	11	11	10	-0.12	0.23
^{137}Cs	August	20	20	18	0.11	0.69
U (Nat)	March	26	24	25	1.1	0.21
U (Nat)	April [b]	4.2	4.3	4.2	1.7	1.7
U (Nat)	October [b]	10	10	10	2.9	2.7
U (Nat)	November	15	14	15	0.17	-0.27
U (Nat)	July	4	4	4	0.03	0.02
^{239}Pu	January	16	16	17	0.35	-0.85
^{239}Pu	August	8.7	8.6	9	0.23	-0.58
			Milk Intercomparison Studies			
^{89}Sr	April	32	31	38	0.22	-2.2
^{89}Sr	September	12	14	15	-0.48	-0.92
^{90}Sr	April	26	25	29	0.35	-1.2
^{90}Sr	September	14	13	15	0.41	-0.35
^{131}I	April	78	78	78	-0.1	0
^{131}I	September	96	101	100	-0.92	-0.75
^{137}Cs	April	40	40	39	-0.23	0.23
^{137}Cs	September	15	16	15	-0.27	0.12
K (Total)	April	1760	1700	1710	1.1	0.94
K (Total)	September	1820	1710	1750	2.2	1.4

(a) Values were obtained from the individual intercomparison study reports and are reported with all values rounded to two significant figures.

(b) Performance Evaluation (PE) samples

standard normal deviate units. These were the gross alpha and gross beta results for the September water intercomparison sample. Both results were within the DQO for accuracy. All other analyses were within three standard normal deviate units of the grand mean. This indicates acceptable comparability of the Radioanalysis Laboratory with the 85 to 233 laboratories participating in the EPA Intercomparison Study Program.

11.4.5 REPRESENTATIVENESS

Representativeness cannot be evaluated quantitatively. Rather, it is a qualitative assessment of the ability of the sample to model the objectives of the program. The primary objective of the ORSP is to protect the health and safety of the offsite residents. Therefore, the DQO of representativeness is met if the samples are representative of the radiation exposure of the resident population. Monitoring stations are located in resident population centers. Citing criteria specific to radiation sensors are not available for many of the instruments used. Existing citing criteria developed for other pollutants are applied to the ORSP sensors as available. For example, citing criteria for the placement of air sampler inlets are contained in Prevention of Significant Deterioration guidance documents (EPA, 1976). Inlets for the air samplers at the ORSP stations have been evaluated against these criteria and, in most cases, meet the citing requirements. In the few instances in which air sampler inlet citing criteria are not met, plans have been made to relocate the stations. Guidance or requirements for handling, shipping, and storage of radioactivity samples are followed in program operations and documented in SOPs. Standard analytical methodology is used and guidance on the holding times for samples, sample processing, and results calculations are followed and documented in SOPs.

In the LTHMP, the primary objectives are protection of drinking water supplies and monitoring of any potential cavity migration. Sampling locations are primarily "targets of opportunity", i.e., the sampling locations are primarily wells developed for other purposes than radioactivity monitoring. Guidance or requirements developed for CERCLA and RCRA regarding the number and location of monitoring wells has not been applied to the LTHMP sampling sites. In spite of these limitations, the samples are representative of the first objective, protection of drinking water supplies. At all of the LTHMP monitoring areas, including on and around the NTS, most potentially impacted drinking water supplies are monitored, as are many supply sources with virtually no potential to be impacted by radioactivity resulting from past or future nuclear weapons testing. The sampling network at some locations is not optimal for achieving the second objective, monitoring of any migration of radionuclides from the test cavities. An evaluation conducted by DRI describes, in detail, the monitoring locations for each LTHMP location and the strengths and weaknesses of each monitoring network (Chapman and Hokett, 1991). This evaluation is cited in the discussion of the LTHMP data in Sections 9.5 and 9.6.

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ANNUAL SITE ENVIRONMENTAL REPORT FOR CALENDAR YEAR (CY) 1992 AND ENVIRONMENTAL COMPLIANCE SELF-ASSESSMENT

Each year the U.S. Department of Energy (DOE) examines all environmental monitoring programs associated with the Nevada Test Site (NTS) and publishes the DOE Nevada Operations Office Annual Site Environmental Report. The document for CY 1992 is enclosed. The report includes results of on-site and off-site monitoring activities, actions required to comply with environmental regulations, and explanations of the long-term studies that assess the environmental conditions at nuclear test sites. Quality assurance programs that ensure validity and the accuracy of monitoring data are described in the report.

The primary mission of the NTS is the testing of our nation's nuclear weapons, and as such, there are no major industrial-type facilities located within the boundaries of the 3,500 square kilometer (1,350 square miles) expanse. Radioactive materials associated with the recent nuclear weapons testing program are contained underground in the vicinity of each test. Controlled radioactive wastes, such as laboratory samples and contaminated equipment, are disposed of at the on-site Radioactive Waste Management Facility. Nonradioactive hazardous materials are shipped to a U.S. Environmental Protection Agency (EPA)-approved disposal facility.

It is the policy of the DOE to protect human health and safety in all activities. Analyses of the CY 1992 environmental monitoring show that NTS operations met the radiation protection standards established by both the DOE and the EPA, and there has been no radiation exposure above natural background levels to anyone living off-site. No employees have received exposures greater than the international standards set for radiation workers, and most are far below the allowable level.

All NTS activities comply with the regulation mandated in the National Environmental Policy Act. Permits or authorizations from the appropriate regulatory agencies have been obtained for air and water discharges and for waste management issues.

Questions about the NTS environmental program should be addressed to Darwin J. Morgan, Office of External Affairs, at (702) 295-3521.

Nick C. Aquilina
Manager

EPD:CTO-102

Enclosure:
As stated