DOE/NV/11432-175
UC-600

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

Editors: Stuart C. Black, Wayne M. Glines and Yvonne E. Townsend

Graphic Artist: Angela L. McCurdy

September 1995

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

Prepared for the

U.S. Department of Energy
Nevada Operations Office

Prepared by:

Reynolds Electrical & Engineering Co., Inc.
Post Office Box 98521
Las Vegas, Nevada 89193-8521

9605290202 960514
PDR WASTE
WM-11 PDR

Rec'd w/LTR DTD 9605290190 960514 4pp
9605290197 960514

1.0 SUMMARY

Monitoring and surveillance on and around the Nevada Test Site (NTS) by DOE contractors and NTS user organizations during 1994 indicated that operations on the NTS were conducted in compliance with applicable federal and DOE regulations and guidelines. All discharges of radioactive liquids remained onsite in containment ponds, and there was no indication of potential migration of radioactivity to the offsite area through groundwater. Surveillance around the NTS indicated that airborne radioactivity from diffusion, evaporation of effluents, or resuspension was not detectable offsite, and no measurable net exposure to members of the offsite population was detected through the offsite dosimetry program. Using the Environmental Protection Agency's CAP88-PC model and NTS radionuclide emissions and environmental monitoring data, the calculated effective dose equivalent to the maximally exposed individual offsite would have been 0.15 mrem. This value is less than two percent of the federal dose limit due to radionuclide air emissions. Any person receiving this dose would also have received 124 mrem from natural background radiation. There were no nonradiological releases to the offsite area. Hazardous wastes were shipped offsite to approved disposal facilities. Compliance with the various regulations stemming from the National Environmental Policy Act is being achieved and, where mandated, permits for air and water discharges and waste management have been obtained from the appropriate agencies.

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

1.1 ENVIRONMENTAL MANAGEMENT

The DOE Nevada Operations Office (DOE/NV) is committed to increasing the quality of its management of NTS environmental resources. This has been promoted by the establishment of an Environmental Protection Division and a Health Protection Division within the Office of Environment, Safety, Security and Health and upgrading the Environmental Management activities to the Assistant Manager level to address those environmental issues that arise in the course of performing the primary mission of the DOE/NV, underground testing of nuclear explosive devices. An environmental survey in 1987 and a Tiger Team assessment in 1989 identified numerous issues that must be resolved before DOE/NV could be considered to be in full compliance with environmental laws and regulations. At the end of 1994, only one of the 149 Tiger Team findings remained open. Progress on corrective actions to bring operations into compliance is reported to DOE Headquarters Office of Environment, Safety and Health in a Quarterly Compliance Action Report.

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

Information System (EIS/ODIS) reports. In compliance with the National Emission Standards for Hazardous Air Pollutants (NESHAP), the accumulated annual data from these reports are used each year as input to the Environmental Protection Agency's (EPA) CAP88-PC software program to calculate potential effective dose equivalents to people living beyond the boundaries of the NTS and the surrounding exclusion areas.

1.2 RADIOLOGICAL ENVIRONMENT

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

Air emissions in 1994 consisted primarily of small amounts of tritium, radioactive noble gases, and plutonium released to the atmosphere that were attributed to:

- Diffusion of tritiated water vapor (HTO) in atmospheric moisture from evaporation of tritiated water from tunnel containment ponds.
- Continuing seepage of radioactive noble gases from higher yield (>20 kt) tests previously conducted on Pahute Mesa.
- Diffuse emissions calculated from the results of environmental surveillance activities.
- Resuspension of plutonium as measured with air sampling equipment.

Diffuse emissions included HTO, only slightly above detection limits, from the Radioactive Waste Management Site in Area 5 (RWMS-5), resuspended $^{239+240}Pu$ from areas on the NTS where it was deposited by atmospheric nuclear or device safety tests, and ^{85}Kr from Pahute Mesa. Table 1.1 shows the quantities of radionuclides released from all sources, including postulated loss of laboratory standards. None of the radioactive materials listed in this table were detected above ambient levels in the offsite area.

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

1.2.1 ONSITE ENVIRONMENTAL SURVEILLANCE

Environmental surveillance on the 3500 km^2 (1350 mi^2) NTS is designed to cover the entire area with some emphasis on areas of past nuclear testing and present operational activities. In 1994, there were 54 samplers for air particulates and reactive gases; 19 samplers collecting HTO in atmospheric moisture, and 10 samplers collecting air for analysis of noble gas content. Grab samples were collected frequently from water supply wells, springs, open reservoirs, containment ponds and sewage lagoons. Thermoluminescent dosimeters (TLDs) were placed at 201 locations on the NTS.

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

Approximately 2700 air samples were analyzed by gamma spectroscopy. All isotopes detected by gamma spectroscopy were naturally occurring in the environment (^{40}K, ^{7}Be, and members of the uranium and thorium series), except for six instances where very low levels of ^{137}Cs were detected. The gross beta annual average for the air sampling network was 2.1×10^{-14} µCi/mL. Plutonium analyses of monthly or quarterly composited air filters indicated an annual arithmetic average below 10^{-16} µCi/mL (4×10^{-6} Bq/m^3) of $^{239+240}Pu$ and below 10^{-18} µCi/mL (4×10^{-8} Bq/m^3) of ^{238}Pu for all locations during 1994, with the majority of results for both isotopes being on the order of 10^{-18} µCi/mL (4×10^{-8} Bq/m^3). A slightly higher average was found in samples in certain areas, but that level was calculated to be only 0.01 percent of the Derived Air Concentration for exposure to the public. Higher than background levels of plutonium are to be expected in some air samples because atmospheric testing in the 1950s and nuclear safety tests (where chemical explosives were used to blow apart nuclear devices) deposited plutonium on a small portion of the surface of the NTS.

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

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

Surface water sampling was conducted quarterly at 12 open reservoirs, eight springs, one containment pond, and nine sewage lagoons. A grab sample was taken from each of these surface water sites for analysis of gross beta, tritium, gamma-emitters, and plutonium isotopes. Strontium-90 was analyzed once per year for each location. Water samples from the springs, reservoirs, and lagoons contained background levels of gross beta, tritium, plutonium, and strontium. Samples collected from the containment pond contained detectable levels of radioactivity as would be expected.

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

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

1.2.2 OFFSITE ENVIRONMENTAL SURVEILLANCE

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

For the first three quarters of 1994, the Air Surveillance Network (ASN) was made up of 30 continuously operating sampling locations surrounding the NTS and 77 standby stations (operated one week each quarter) in all states west of the Mississippi River. The 30 ASN stations included 18 located at Community Radiation Monitoring Program (CRMP) stations, described below. During 1994 no airborne radioactivity related to current activities at the NTS was detected on any sample from the ASN. Other than naturally occurring ^{7}Be, the only specific radionuclide possibly detected by this network was ^{238}Pu or $^{239+240}Pu$ on a few air filter samples.

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

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

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

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

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

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

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

A network of 18 CRMP stations was operated by local residents. Each station was an integral part of the ASN, NGTSN, and TLD networks. In addition, they were equipped with a PIC connected to a gamma-rate recorder. Each station also had satellite telemetry transmitting equipment so that gamma exposure measurements acquired by the PICs are transmitted via the Geostationary Operational Environmental Satellite (GOES) to the NTS and from there to the EMSL-LV by dedicated telephone line. Samples and data from these CRMP stations were analyzed and reported by EMSL-LV and interpreted and reported by the Desert Research Institute, University of Nevada System. All measurements for 1994 were consistent with previous years and were within the normal background range for the U.S.

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

1.2.3 ECOLOGICAL STUDIES

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

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

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

1.2.4 LOW-LEVEL WASTE DISPOSAL

Environmental monitoring at and around RWMS-5 indicated that radioactivity was just detectable at, but not beyond, the waste site boundaries. This monitoring included air sampling, water sampling, tritium migration studies, and external gamma exposure measurement. Vadose zone monitoring for hazardous constituents has been installed in the mixed waste disposal pit (Pit 3) in RWMS-5 as a method of detecting any downward migration of mixed waste.

Elevated levels of plutonium were detected in several areas on the NTS, particularly in Areas 3 and 9 where operational activities and vehicular traffic resuspend plutonium for detection by air sampling. The presence of plutonium on the NTS is primarily due to atmospheric and safety tests conducted in the 1950s and 1960s. These tests spread plutonium in the eastern and northeastern areas of the NTS (see Chapter 2, Figure 2.3 for these locations).

1.2.5 RADIOLOGICAL MONITORING AT OFFSITE SUPPORT FACILITIES

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

1.3 NONRADIOLOGICAL MONITORING

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

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

As there are no liquid discharges to navigable waters, offsite surface water drainage systems, or publicly owned treatment works, no Clean Water Act National Pollution Discharge Elimination System permits were required for NTS operations. Under the conditions of state of Nevada operating permits, liquid discharges to 13 onsite sewage lagoons are regularly tested for biochemical oxygen demand, pH, and total suspended solids. In addition to the state-required monitoring, these influents were also tested for RCRA-related constituents as an internal initiative to further protect the NTS environment.

In compliance with the Safe Drinking Water Act and eight state of Nevada drinking water supply system permits for onsite distribution systems supplied by onsite wells, drinking water systems are sampled monthly for residual chlorine, pH, bacteria, and, less frequently, for other water quality parameters. Federal and state standards for fluorides and pH were slightly exceeded in the water system. In the case of fluorides, the state granted a variance to exceed Secondary fluoride standards as long as Primary standards were met. For the other exceedance, the state has been contacted to assist in developing a mitigation plan.

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

At the Liquified Gaseous Fuels Spill Test Facility, eight series of spill tests using 22 different chemicals were conducted during 1994. None of the tests generated enough airborne contaminants to be detected at the NTS boundary during or after the tests. Boundary monitoring was performed by EMSL-LV personnel.

1.4 COMPLIANCE ACTIVITIES

DOE/NV is required to comply with various environmental laws and regulations in the conduct of its operations. Monitoring activities required for compliance with the Clean Air Act, Clean Water Act, Safe Drinking Water Act, Toxic Substances Control Act, and RCRA are summarized above. Also, National Environmental Policy Act activities included action on 11 Environmental Impact Statements (EIS), 10 Environmental Assessments (EA) and 67 Categorical Exclusions. Of these, ten Environmental Impact Statements, three Environmental Assessments and all 67 Categorical Exclusions were initiated in 1994.

Wastewater discharges at the NTS are not regulated under National Pollutant Discharge Elimination System permits because all such discharges are to onsite sewage lagoons. Discharges to these lagoons are permitted under the Nevada Water Pollution Control Act. Wastewater discharges from the non-NTS support facilities of EG&G Energy Measurements, Inc. (EG&G/EM) were within the regulated levels established by city or county publicly owned treatment works.

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

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

The American Indian Religious Freedom Act (AIRFA) directs federal agencies to consult with Native Americans to protect their right to exercise their traditional religions. In 1994, a technical report on this AIRFA Program was issued. This report includes recommendations of 17 tribal groups regarding the effects of DOE/NV's activities on Pahute and Rainier Mesas.

1.5 GROUNDWATER PROTECTION

DOE/NV instituted a Long-Term Hydrological Monitoring Program (LTHMP) in 1972 to be operated by the EPA under an Interagency Agreement. Groundwater was monitored on and around the NTS, at five sites in other states, and at two off-NTS locations in Nevada in 1994 to detect the presence of any radioactivity that may be related to nuclear testing activities. No radioactivity was detected above background levels in the groundwater sampling network surrounding the NTS. Low levels of tritium, in the form of HTO, were detected in onsite wells as has occurred previously. None exceeded 33 percent of the National Primary Drinking Water Regulation level.

HTO was detected in samples from wells at formerly utilized sites, such as DRIBBLE (MS), GNOME (NM), and GASBUGGY (NM) at levels consistent with previous experience. The tritium concentration in Well EPNG 10-36 at GASBUGGY began increasing about 1984, and ^{137}Cs was detected for the third year in a row.

Because wells that were drilled for water supply or exploratory purposes are used in the NTS monitoring program rather than wells drilled specifically for groundwater monitoring, an extensive program of well drilling for groundwater characterization has been started. The design of the program is for installation of approximately 60 wells at strategic locations on and near the NTS. Twelve of these wells have been completed, two existing wells recompleted and water quality parameters are being collected for future use in the characterization project. Other activities in this program included studies of groundwater transport of contaminants (radionuclide migration studies) and nonradiological monitoring for water quality assessment and RCRA requirements.

1.6 RADIOACTIVE AND MIXED WASTE STORAGE AND DISPOSAL

Two radioactive waste disposal facilities are operated on the NTS: the RWMS-5 and the Area 3 Radioactive Waste Management Site (RWMS-3). During 1994, the RWMSs received low-level waste generated at the NTS and other DOE facilities. Waste is disposed of in shallow pits, trenches, and selected craters. Transuranic (TRU) and TRU mixed wastes are stored on a curbed asphalt pad on pallets in overpacked 55 gallon drums and assorted steel boxes pending shipment to the Waste Isolation Pilot Plant (WIPP) in New Mexico. The RWMS-3 is used for disposal of bulk low-level waste and LLW that is contained in packages that are larger than the specified standard size used at the RWMS-5.

Environmental monitoring at both sites included air sampling for radioactive particulates and reactive gases and external exposure measurements using TLDs. Sampling for HTO in air,

water sampling, tritium migration studies, and vadose zone monitoring for moisture and hazardous constituents are conducted at the RWMS-5. Environmental monitoring results for 1994 indicated that measurable radioactivity from waste disposal operations was detectable only in the immediate vicinity of the facilities.

Because the NTS is not a RCRA permitted disposal facility, RCRA regulations require the shipment of nonradioactive hazardous materials to licensed disposal facilities offsite. No disposal of hazardous materials was performed at the NTS in 1994.

A Mixed Waste Management Unit (MWMU) is planned to be located immediately north of the existing pits within RWMS-5 and will be part of routine disposal operations. This area, designed to encompass 10 hectares (25 acres), will contain 8 landfill cells to be used for mixed waste disposal. Construction of the MWMU will commence upon completion of necessary National Environmental Policy Act (NEPA) documentation and issuance of a state of Nevada Part B Permit.

Mixed waste and low-level waste will only be accepted for disposal from generators (onsite and offsite) that have submitted a waste application as required by NVO-325, Nevada Test Site Defense Waste Acceptance Criteria, Certification, and Transfer Requirements; that have verified compliance to NVO-325; and that have received DOE/NV approval of the waste stream(s) for disposal at NTS.

1.7 QUALITY ASSURANCE

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

1.7.1 ONSITE NONRADIOLOGICAL QUALITY ASSURANCE

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

1.7.2 ONSITE RADIOLOGICAL QUALITY ASSURANCE

The onsite radiological QA program includes conformance to best laboratory practice and implementation of the provisions of DOE Order 5700.6C. The external QA intercomparison program for radiological data quality assurance consists of participation in the DOE Quality Assessment Program (QAP) administered by the DOE Environmental Measurements Laboratory (EML), the Environmental Radiation Performance Evaluation Studies Program (ERPESP) conducted by the EPA, and the quality assessment program sponsored by the International Reference Center for Radioactivity (IRCR) of the World Health Organization (WHO).

1.7.3 OFFSITE RADIOLOGICAL QUALITY ASSURANCE

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

1.8 ISSUES AND ACCOMPLISHMENTS

PRINCIPAL COMPLIANCE PROBLEMS FOR 1994

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

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

- On June 28, 1994, the state of Nevada filed a Complaint for Declaratory Judgement and Injunction in the U.S. District Court against DOE. Nevada claims that DOE has failed to comply with NEPA requirements at the NTS and must initiate a single, site-wide EIS for all major federal actions at the NTS. The state seeks to halt shipments of LLW from Fernald and all other transportation, receipt, storage, and disposal of mixed waste, hazardous waste, and defense waste. The state is also seeking to enjoin DOE from pursuing any "Weapons Complex" activities until publication of the EIS. The implications of this action for all ongoing and proposed NTS activities are of particular concern.

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

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

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

ACCOMPLISHMENTS FOR 1994

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

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

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

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

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

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

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

- At the state of Nevada's request, the Waste Management Program installed three pilot wells at RWMS-5. Underground conditions were carefully monitored, and the data have been used for site characterization. The uppermost groundwater table was found at approximately 244 m (800 ft). Only naturally occurring radioactivity was detected in the groundwater.

The environmental monitoring results presented in this report document that operational activities on the NTS in 1994 were conducted so that no radiological exposure occurred to the offsite public. Calculation of the highest individual dose that could have been received by an offsite resident (based on estimation of onsite worst-case radioactive releases obtained by measurement or engineering calculation and assuming the person remained outside all year) equated to 0.15 mrem to a person living in Amargosa Valley, Nevada. This may be compared to that individual's exposure to 124 mrem from natural background radiation as measured by the PIC at Amargosa Valley.

There were no major incidents of nonradiological contaminant releases to the environment, and intensive efforts to characterize and protect the NTS environment, implemented in 1990, were continued in 1994.

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

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

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

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

	Maximum EDE at NTS Boundary[a]	Maximum EDE to an Individual[b]	Collective EDE to Population within 80 km of the NTS Sources
Dose	0.157 mrem (1.6×10^{-3} mSv)	0.15 mrem (1.5×10^{-3} mSv)	0.52 person-rem (5.2×10^{-3} person-Sv)
Location	Site boundary 39 km SW of NTS CP-1	Amargosa Val., 42 km SW of NTS CP-1	33,740 people within 80 km of NTS Sources
NESHAP Standard	10 mrem per yr (0.1 mSv per yr)	10 mrem per yr (0.1 mSv per yr)	----
Percentage of NESHAP	1.6	1.5	----
Background	124 mrem (1.24 mSv)	124 mrem (1.24 mSv)	3210 person-rem (32.1 person Sv)
Percentage of Background	1.3×10^{-1}	1.2×10^{-1}	1.6×10^{-2}

(a) The maximum boundary dose is to a hypothetical individual who remains in the open continuously during the year at the NTS boundary located 39 km (24 mi) SW from the NTS Control Point 1.

(b) The maximum individual dose is to an individual outside the NTS boundary at a residence where the highest dose-rate occurs as calculated by CAP88-PC (Version 1.0) using NTS effluents listed in Table 5.1, assuming all tritiated water input to containment ponds was evaporated, assuming resuspended plutonium was carried offsite, and summing the contributions from each NTS source.

4.1.2 OFFSITE MONITORING

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

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

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

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

4.1.2.1 AIR MONITORING

The inhalation of radioactive airborne particles can be a major pathway for human exposure to radiation. The atmospheric monitoring networks are designed to detect environmental radioactivity from NTS and non-NTS activities. Data from atmospheric monitoring can determine the concentration and source of airborne radioactivity and can project the fallout patterns and durations of exposure to man. Atmospheric monitoring networks include the Air Surveillance, Noble Gas, and Atmospheric Moisture (Tritium-in-Air) Networks.

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

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

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

At EMSL-LV, both the glass-fiber filters and the charcoal cartridges were initially analyzed by high-resolution gamma spectrometry; charcoal cartridges from standby stations were analyzed only if there was some indication of radioiodine. Each of the glass-fiber filters was then analyzed for gross alpha and gross beta activity 7 to 14 days after sample collection to allow time for the decay of naturally occurring radon-thoron progeny. Glass-fiber filters from selected stations were composited and analyzed for plutonium isotopes.

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

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

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

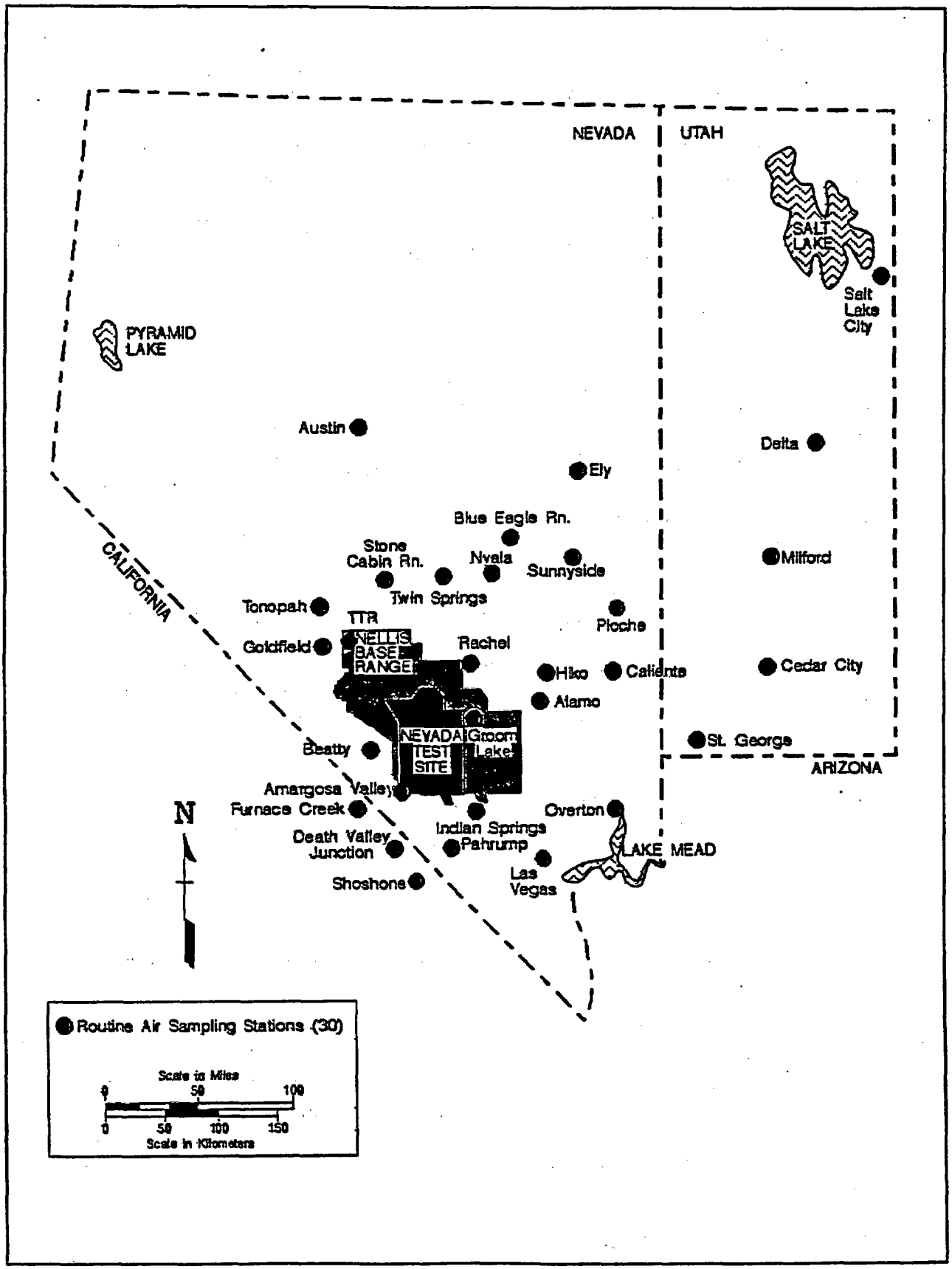

Figure 4.5 Air Surveillance Network Stations, January - September 1994

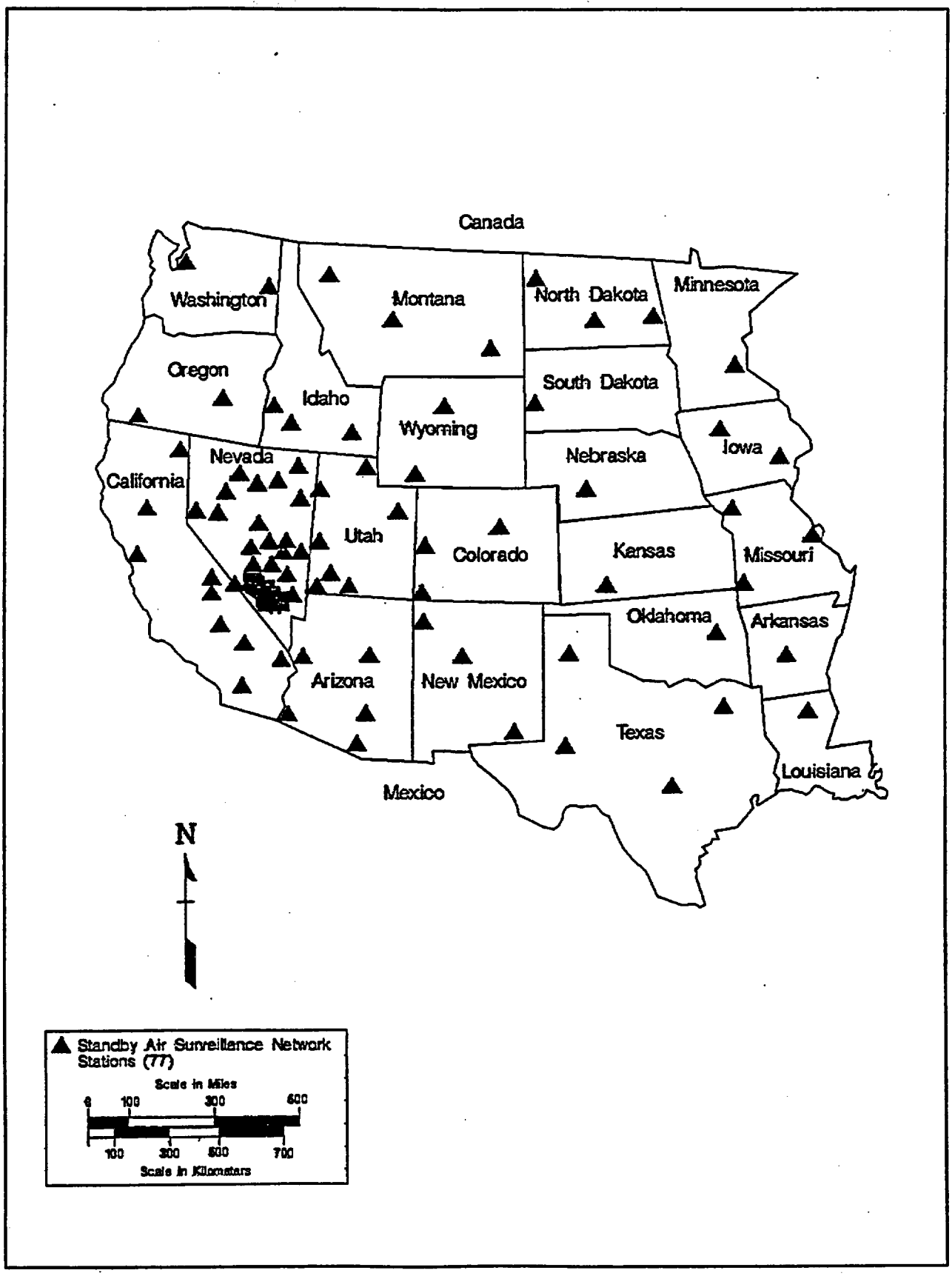

Figure 4.6 Standby Air Surveillance Network Stations, January - September 1994

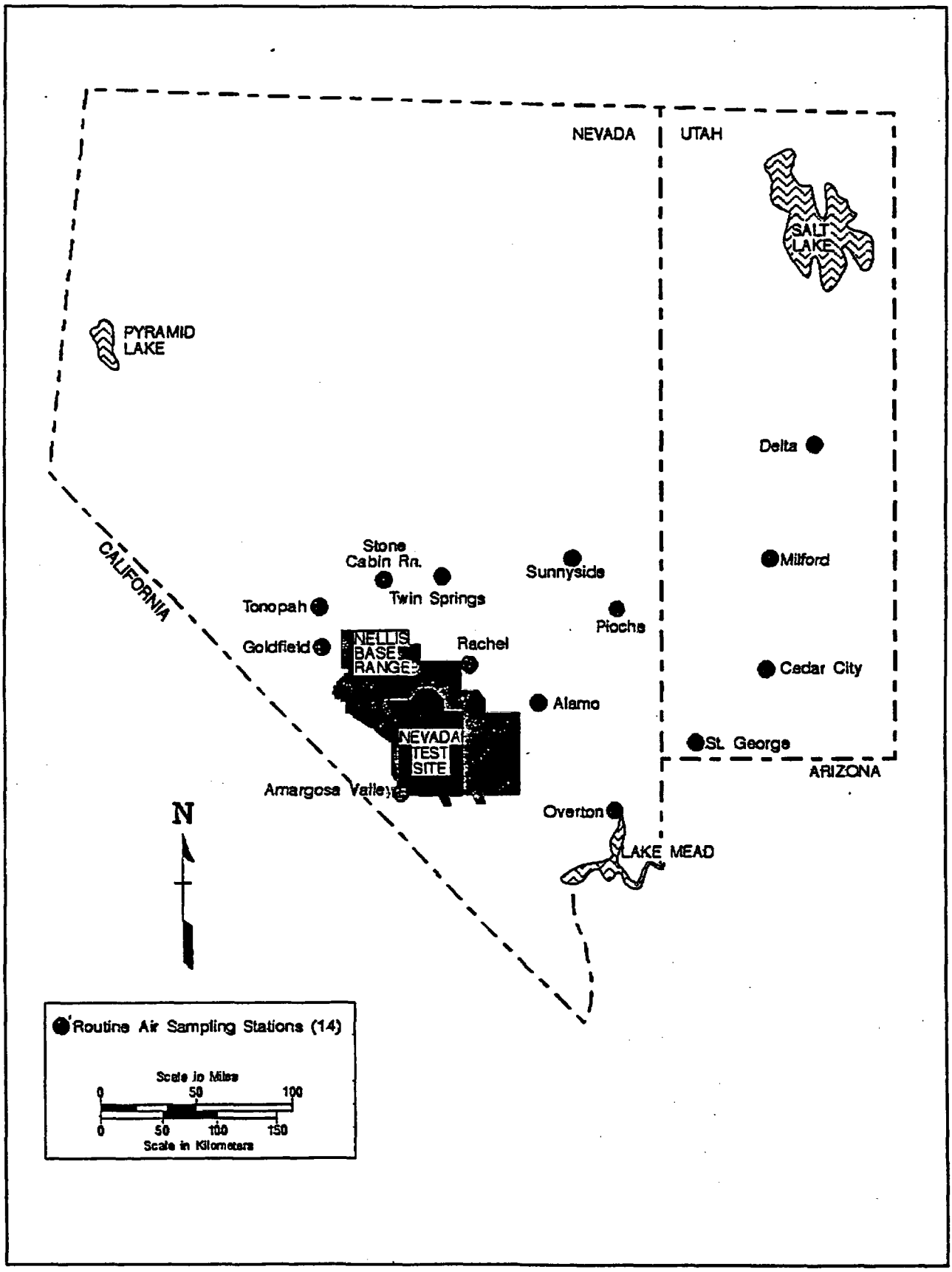

Figure 4.7 Air Surveillance Network Stations, Fourth Quarter - 1994

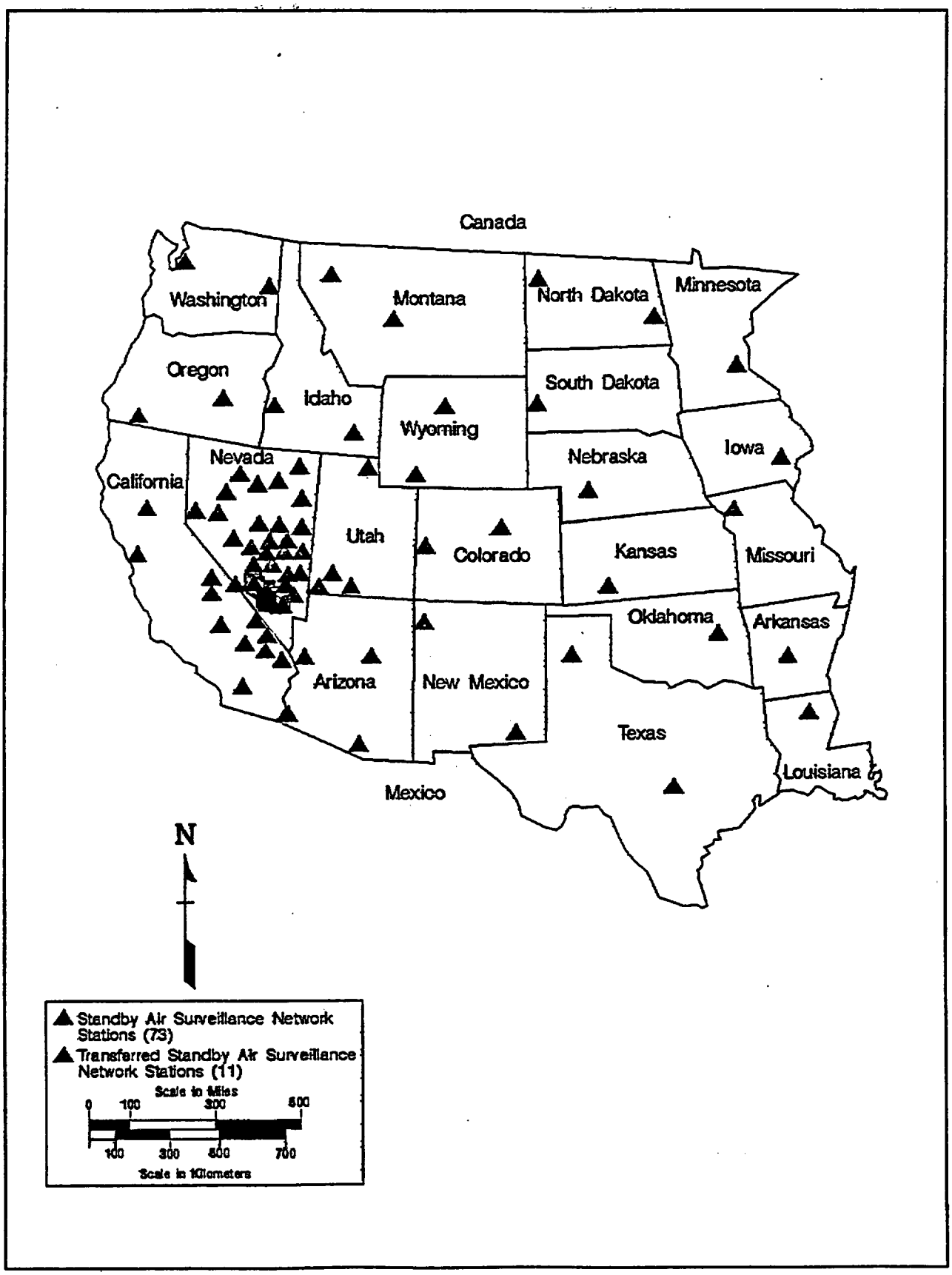

Figure 4.8 Standby Air Surveillance Network Stations, Fourth Quarter - 1994

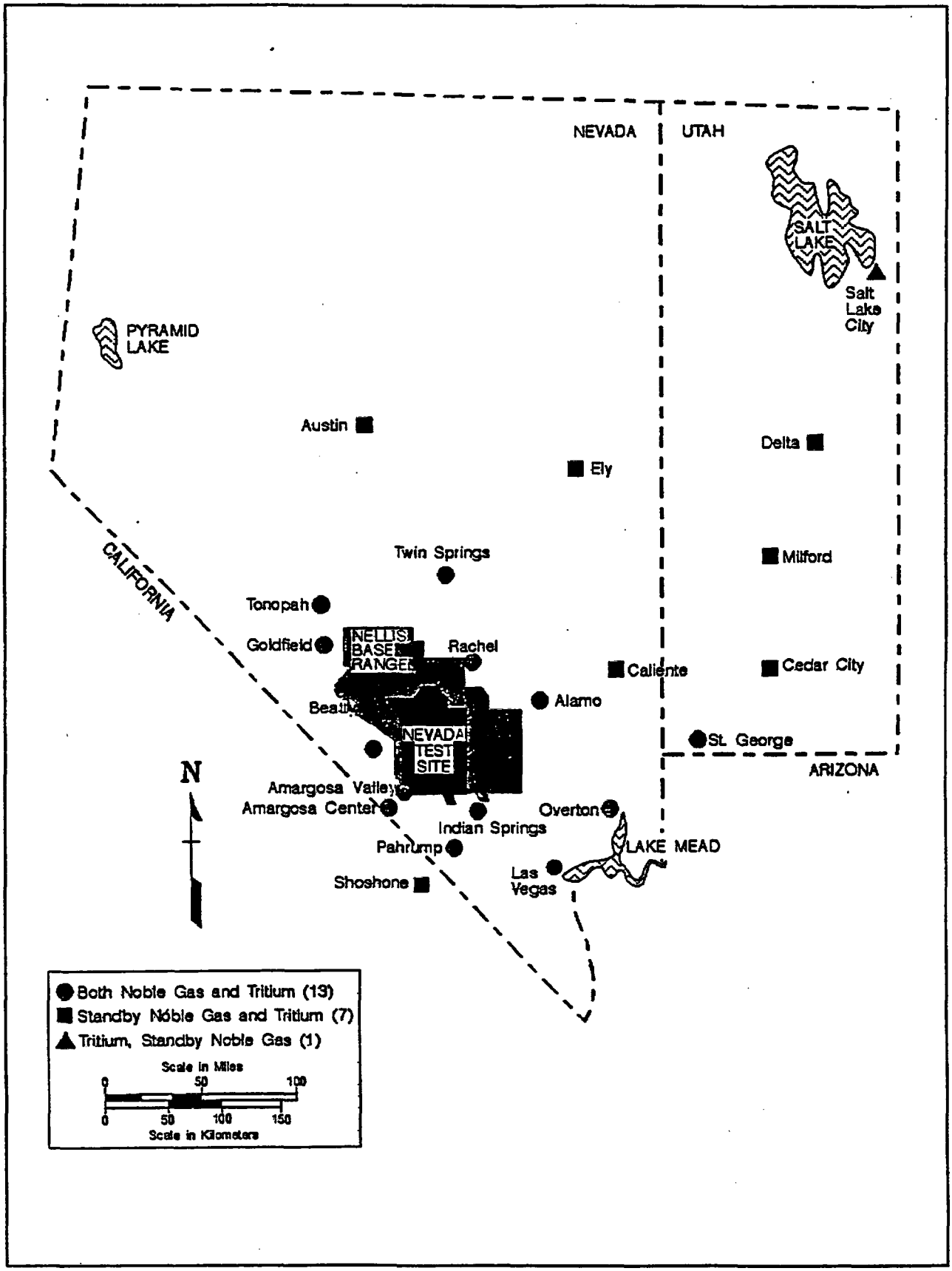

Figure 4.9 Offsite Noble Gas and Tritium Surveillance Network Stations - 1994

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

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

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

4.1.2.2 WATER MONITORING

As part of the LTHMP, EMSL-LV personnel routinely collect and analyze water samples from locations on the NTS and from sites in the surrounding offsite areas. Due to the scarcity of surface waters in the region, most of the samples are groundwater, collected from existing wells. Samples from specific locations are collected monthly, biannually, annually, or biennially in accordance with a preset schedule. Many of the drinking water supplies used by the offsite population are represented in the LTHMP samples. Results for the LTHMP samples are discussed in Chapter 9, Sections 9.5 and 9.6.

4.1.2.3 MILK SURVEILLANCE NETWORK (MSN)

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

The MSN includes commercial dairies and family-owned milk cows and goats representing the major milksheds within 300 km (186 mi) of the NTS. The 15 locations comprising the MSN at the beginning of 1994 are shown in Figure 4.10. Samples were collected from 14 of these locations in 1994. Changes in 1994 included five locations deleted and one added.

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

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

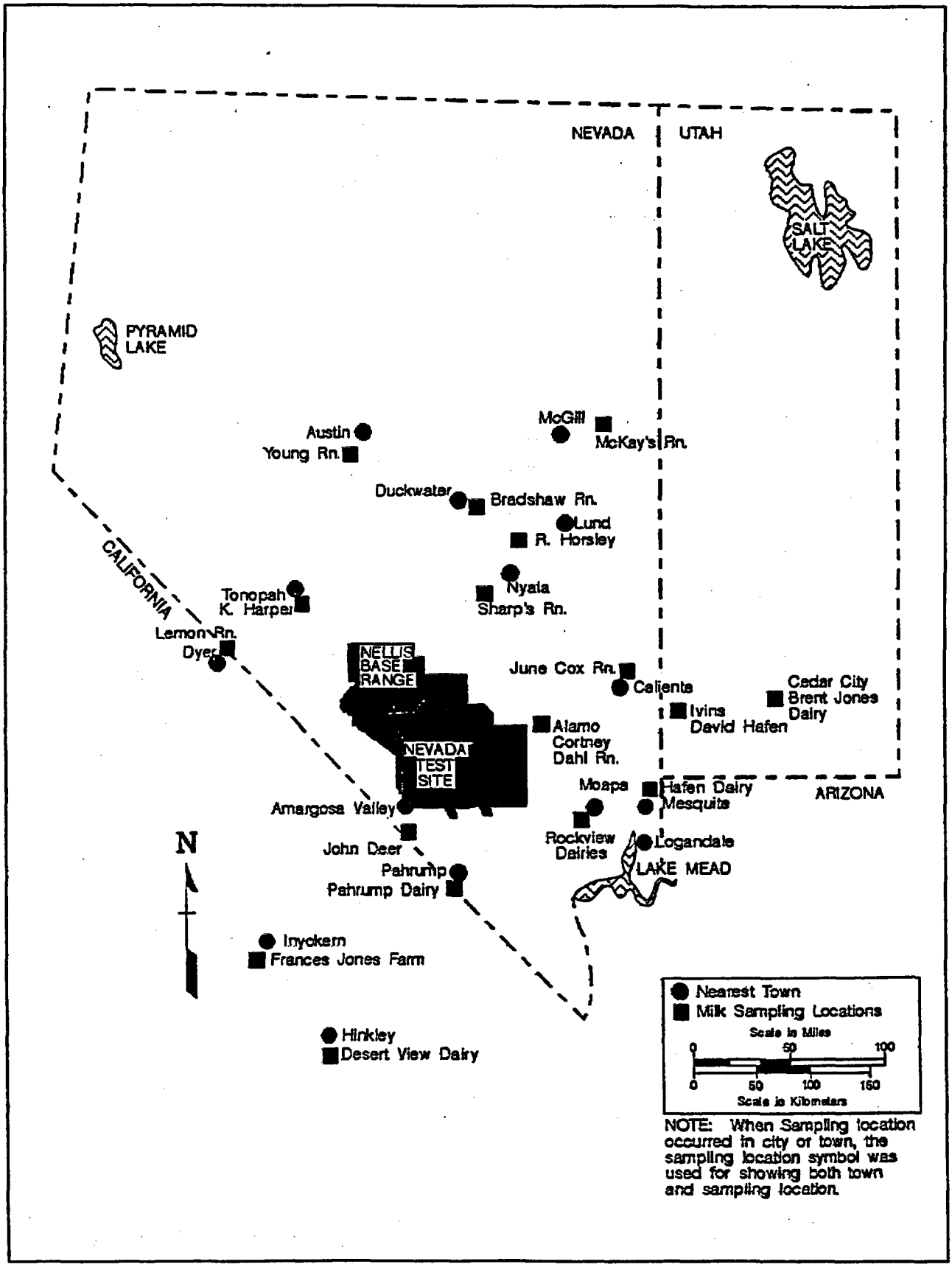

Figure 4.10 Milk Surveillance Network Stations - 1994

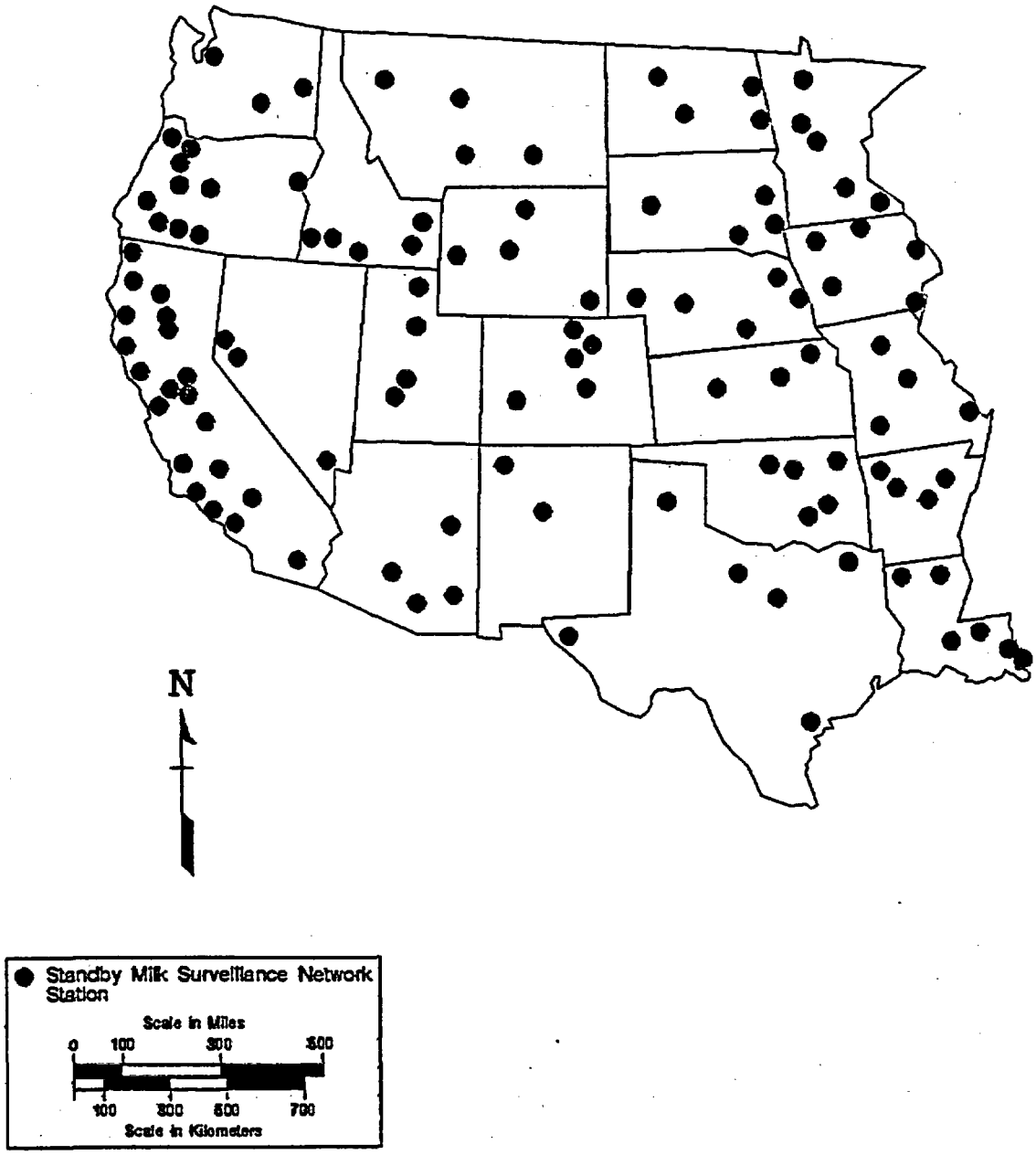

Figure 4.11 Standby Milk Surveillance Network Stations - 1994

scintillation counting and for ^{89}Sr and ^{90}Sr by radiochemical separation and beta counting. This network was designed to monitor areas adjacent to the NTS, which could be affected by a release of activity, as well as from areas unlikely to be so affected.

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

4.1.2.4 BIOMONITORING

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

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

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

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

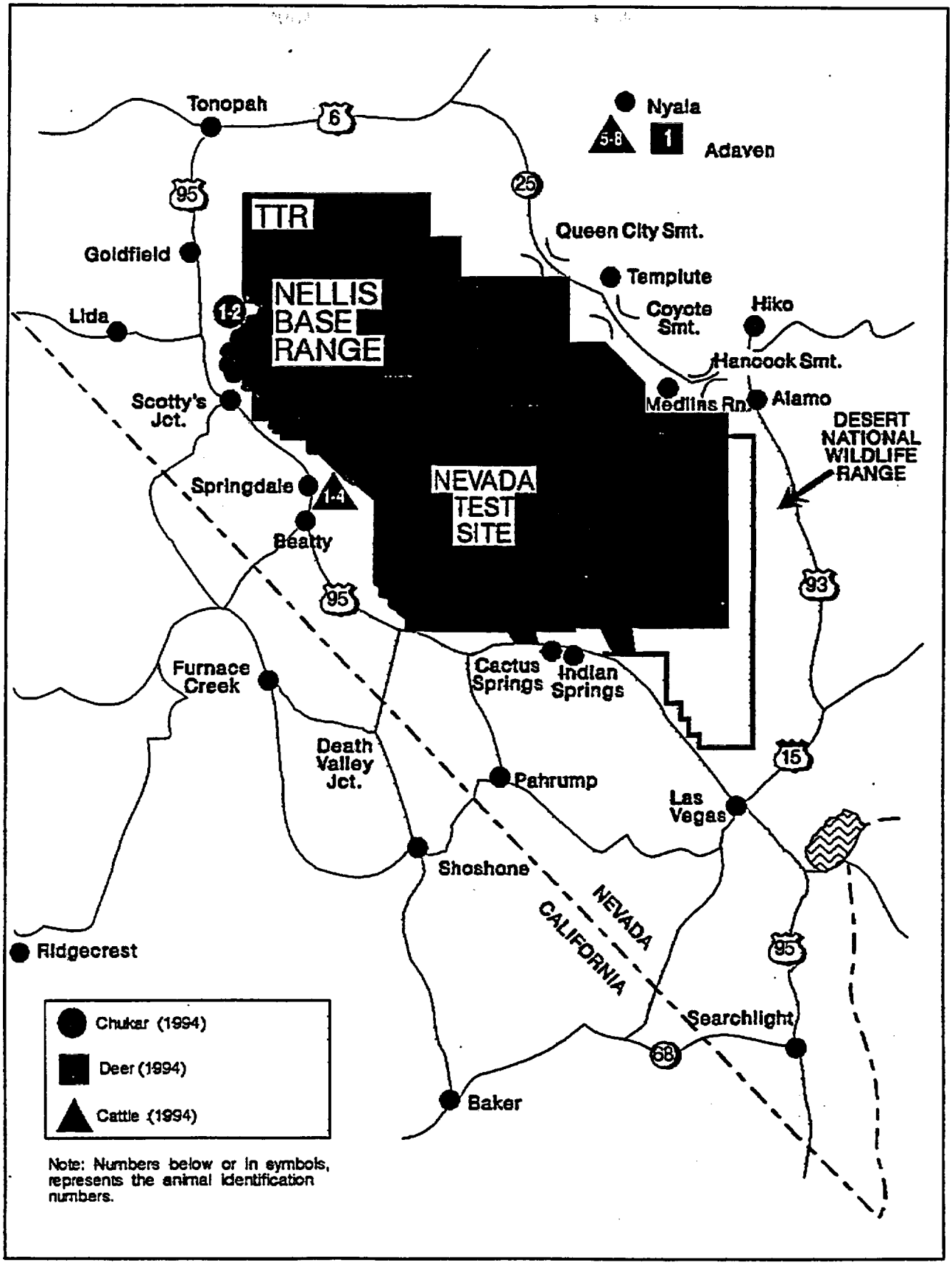

Figure 4.12 Offsite Collection Sites for Animals Sampled - 1994

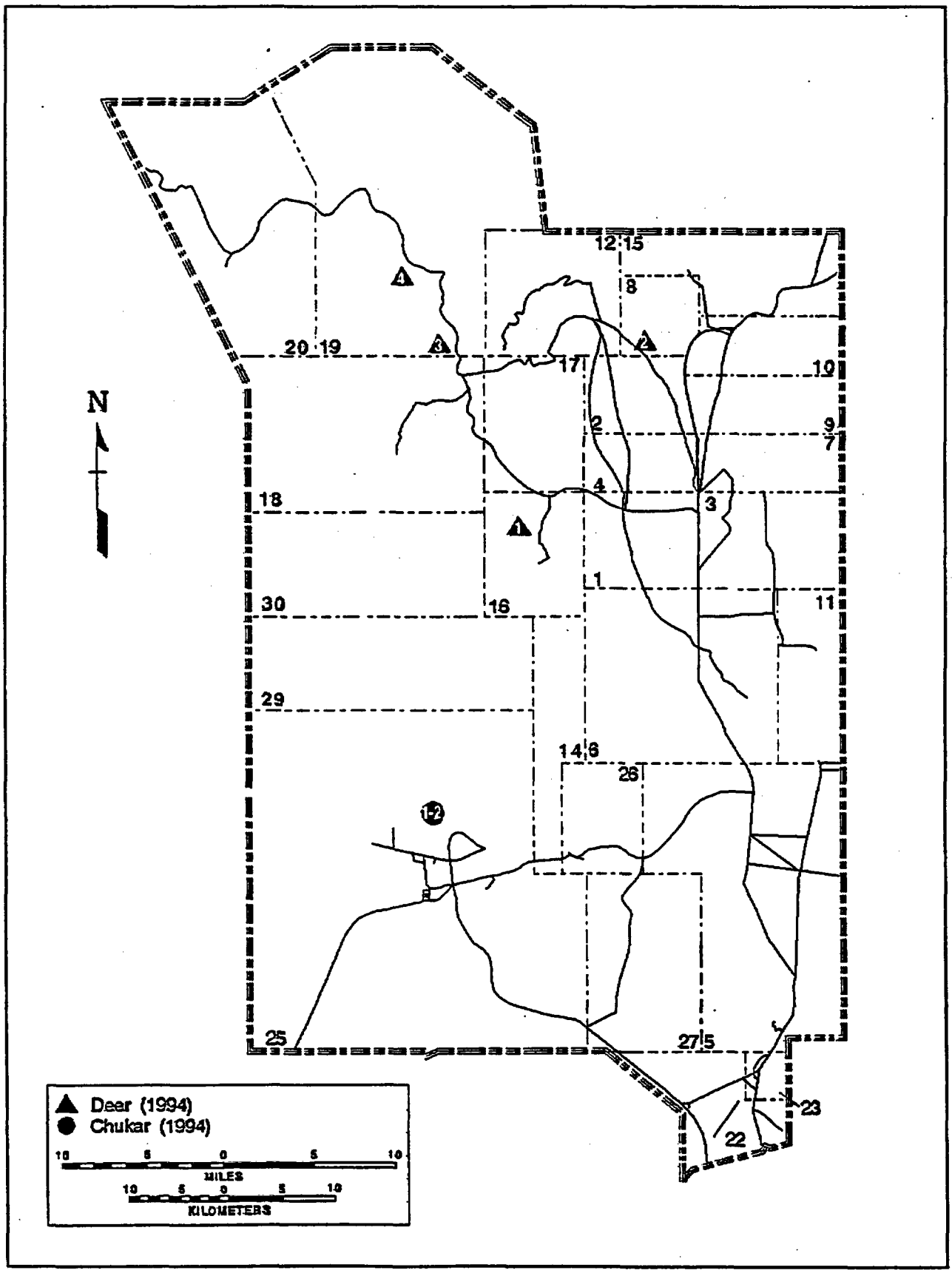

Figure 4.13 Onsite Collection Sites for Animal Sampled - 1994

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

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

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

4.1.2.5 THERMOLUMINESCENT DOSIMETRY NETWORK

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

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

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

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

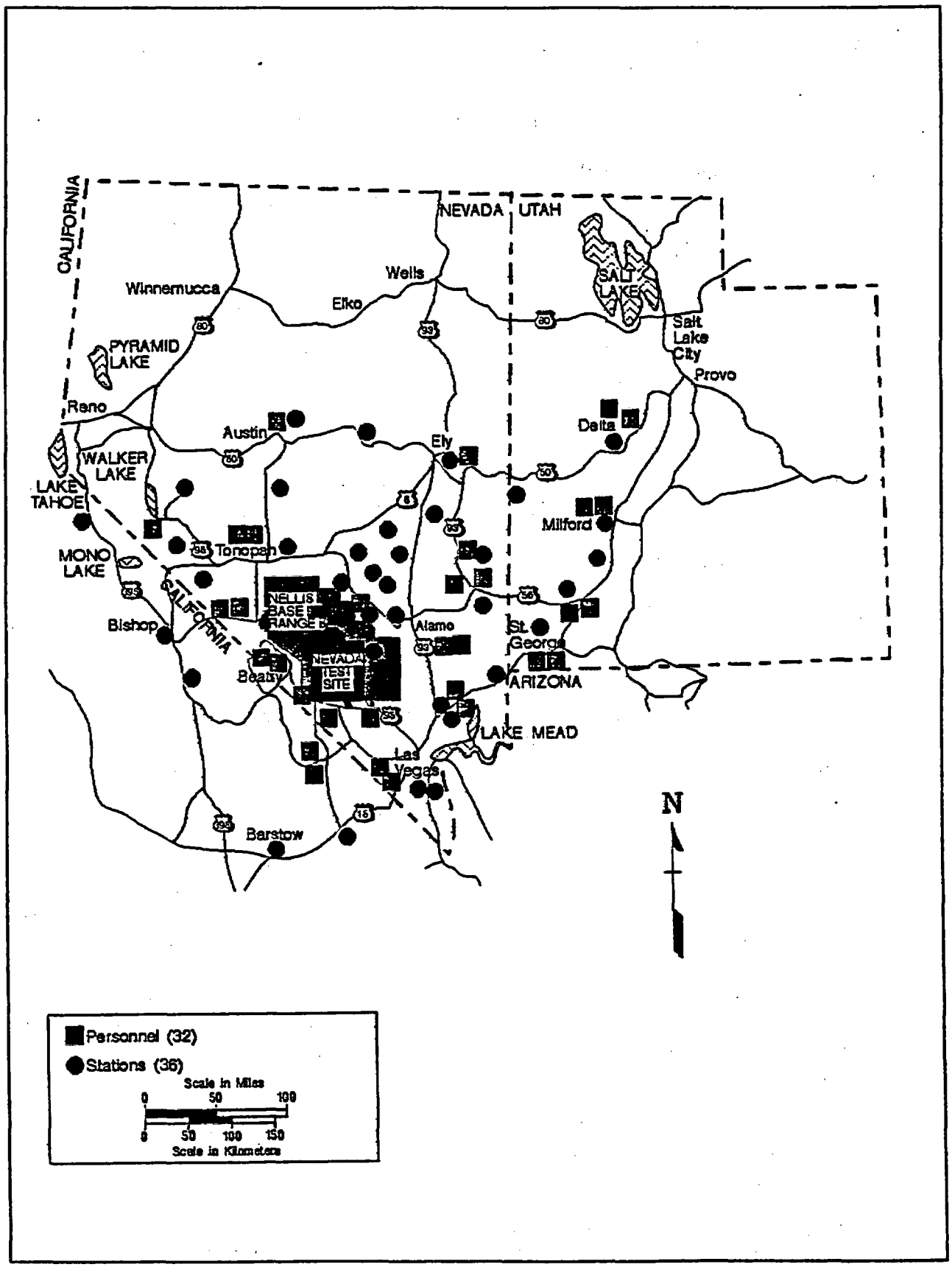

Figure 4.14 Thermoluminescent Dosimetry Fixed Environmental Stations and Personnel Monitoring Participants - 1994

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

4.1.2.6 PRESSURIZED ION CHAMBER (PIC) NETWORK

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

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

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

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

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

4.1.2.7 INTERNAL DOSIMETRY NETWORK

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

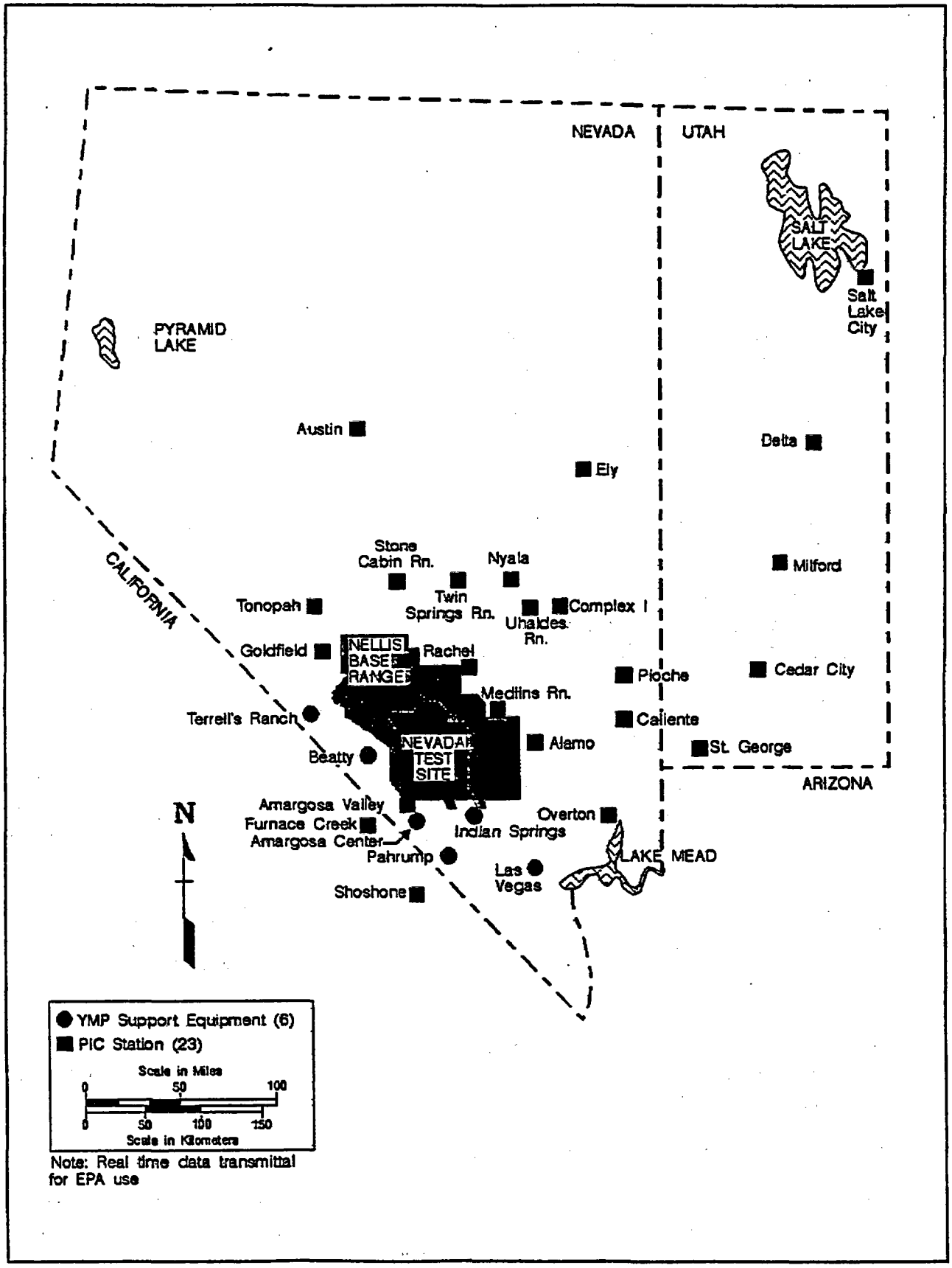

Figure 4.15 Pressurized Ion Chamber Network Station Locations - 1994

4.1.2.8 COMMUNITY RADIATION MONITORING PROGRAM

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

The DOE sponsored the program. The EPA provided technical and scientific direction, maintained the instrumentation and sampling equipment, analyzed the collected samples and interpreted and reported the data. The DRI administered the program by hiring the local station managers and alternates, securing rights-of-way, providing utilities and performing additional quality assurance checks of the data. The University of Utah provided detailed training twice a year for the station managers and alternates on all issues related to nuclear science, radiological health and radiation monitoring.

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

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

4.2 NONRADIOLOGICAL MONITORING

The 1994 nonradiological monitoring program for the NTS included onsite sampling of various environmental media and substances for compliance with federal and state regulations or permits and for ecological studies. BECAMP conducted studies in 1994 that included wildlife surveys and vegetation trend assessments in disturbed and undisturbed areas of the NTS. Nonradiological monitoring was conducted in 1994 for eight series of tests conducted at the Liquified Gaseous Fuels Spill Test Facility (LGFSTF) on the NTS.

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

4.2.1 NTS OPERATIONS MONITORING

4.2.1.1 ROUTINE MONITORING

As there were no industrial-type production facility operations on the NTS, there was no significant production of nonradiological air emissions or liquid discharges to the environment. Sources of potential contaminants were limited to construction support and NTS operation activities. This included motor pool facilities; large equipment and drilling rig maintenance areas; cleaning, warehousing, and supply facilities; and general worker support facilities (including lodging and administrative offices) in the Mercury Base Camp, Area 12 Camp, and to a lesser extent in Area 20 and the NTS Control Point Complex in Area 6. The LGFSTF in Area 5 is a source of potential release of nonradiological contaminants to the environment, depending on the individual tests conducted. In 1994 there were eight series of tests involving 22 different chemicals conducted at this facility. Monitoring was performed to assure these contaminants did not move to offsite areas. Since these monitoring functions are performed by the EMSL-LV at the NTS boundary, monitoring functions for the LGFSTF are described below in Section 4.2.2, "Offsite Monitoring." Routine nonradiological environmental monitoring on the NTS in 1994 was limited to:

- Sampling of drinking water distribution systems and water haulage trucks for Safe Drinking Water Act and state of Nevada compliance;
- Sewage lagoon influent and N-tunnel discharge sampling for compliance with state of Nevada operating permit requirements;
- Sampling of electrical equipment oil, soil, water, surfaces, and waste oil for the presence of polychlorinated biphenyls (PCB) as part of Toxic Substance Control Act compliance;
- Asbestos sampling in conjunction with asbestos removal and renovation projects and in accordance with occupational safety and National Emission Standards for Hazardous Air Pollutants (NESHAP) compliance;
- Sampling of soil, water, sediment, waste oil, and other media for RCRA constituents.

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

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

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

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

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

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

Table 5.21 Offsite Airborne Plutonium Concentrations - 1994

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

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

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

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

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

Table 5.22 Offsite Atmospheric Tritium Results for Routine Samplers - 1994

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

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

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

Table 5.23 Offsite Noble Gas Results for Routine Samplers - 1994

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

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

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

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

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

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

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

Table 5.24 Summary of Radionuclides Detected in Milk Samples

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

Table 5.25 Radiochemical Results for Animal Samples - 1994

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

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

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

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

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

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

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

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

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

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

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

Facility: EG&G - Remote Sensing Laboratory/Nellis

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

Facility: EG&G - Atlas/Las Vegas

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

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

Facility: EG&G - Santa Barbara

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

* Not available, missing data

6.0 DOSE ASSESSMENT

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

6.1 ESTIMATED DOSE FROM NEVADA TEST SITE ACTIVITIES

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

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

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

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

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

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

Operational releases and calculated sources of radioactive emissions from the NTS are used as input data for CAP88-PC to provide estimates of exposures to offsite populations. The other three sources of exposure listed above are treated in Section 6.1.2 below.

6.1.1 ESTIMATED DOSE USING REPORTED NTS EMISSIONS

Onsite source emission measurements, as provided by DOE, are listed in Chapter 5, Table 5.1, and include tritium, radioactive noble gases, and radioiodine. These are estimates of releases made at the point of origin. Meteorological data collected by the Special Operations and Research Division, Air Resources Laboratory (ARL/SORD) were used to construct wind roses and stability arrays for the following areas: Mercury, Area 12, Area 20, Yucca Flat, and the Radioactive Waste Management Site (RWMS) in Area 5. A calculation of estimated dose from NTS effluents was performed using EPA's CAP88-PC model (EPA 1992). The results of the model indicated that the hypothetical individual with the maximum calculated dose from airborne NTS radioactivity would reside at Amargosa Valley, Nevada, 42 km (26 mi) SE of CP-1. The maximum dose to that individual would be 0.15 mrem (1.5×10^{-3} mSv). For comparison, data from the PIC monitoring network indicated a 1994 dose of 124 mrem (1.24 mSv) from background gamma radiation occurring in Amargosa Valley. The population living within a radius of 80 km (50 mi) from the airborne sources on the NTS was estimated to be 33,740 individuals, based on 1994 data. The collective population dose within 80 km (50 mi) from each of these sources was calculated to be 0.52 person-rem (5.2×10^{-3} person-Sv). Activity concentrations in air that would cause these calculated doses are much higher than actually detected by the offsite monitoring network. For example, 0.15 mrem of the calculated EDE to the MEI is due to plutonium. The annual average plutonium concentration in air that would cause this EDE is 32 times the annual average measured plutonium in air in Amargosa Valley. Table 6.1 summarizes the annual contributions to the EDEs due to 1994 NTS operations as calculated by use of CAP88-PC and the radionuclides listed in Chapter 5, Table 5.1.

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

6.1.2 ESTIMATED DOSE USING MONITORING NETWORK DATA

Potential CEDEs to individuals may be estimated from the concentrations of radioactivity as measured by the EPA monitoring networks during 1994. Actual results obtained in analysis are used; the majority of which are less than the reported Minimum Detectable Concentration (MDC).

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

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

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

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

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

The algorithm for the internal dose calculation is:

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

As an example calculation, the following is the result of breathing tritium in air:

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

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

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

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

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

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

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

6.2 DOSE (EDE) FROM BACKGROUND RADIATION

In addition to external radiation exposure due to cosmic rays and gamma radiation from naturally occurring radionuclides in soil (e.g., ^{40}K, uranium and thorium daughters), there is a contribution from ^{7}Be that is formed in the atmosphere by cosmic ray interactions with oxygen and nitrogen. The annual average ^{7}Be concentration measured by the offsite surveillance network was 0.29 pCi/m^3. With a dose conversion factor for inhalation of 2.6×10^{-7} mrem/pCi, and an annual breathing volume of 8400 m^3/yr, this equates to a dose of 6.3×10^{-4} mrem as calculated in Table 6.2. This is a negligible quantity when compared with the PIC network measurements that vary from 73 to 164 mR/year, depending on location.

6.3 SUMMARY

The extensive offsite environmental surveillance system operated around the NTS by EPA's EMSL-LV detected no radiological exposures that could be attributed to recent NTS operations, but a calculated EDE of 0.015 mrem can be obtained if certain assumptions are made. Calculation with the CAP88-PC model, using estimated or calculated effluents from the NTS during 1994, resulted in a maximum dose of 0.15 mrem (1.5×10^{-3} mSv) to a hypothetical resident of Amargosa Valley, NV, 3 km (1.9 mi) SE of the NTS boundary. Based on monitoring network data, this dose is calculated to be 0.015 mrem. This latter EDE is about 10% of the dose obtained from CAP88-PC calculation. This maximum dose estimate is less than 1 percent of the International Commission on Radiological Protection (ICRP) recommendation that an annual effective dose equivalent for the general public not exceed 100 mrem/yr (ICRP 1985). The calculated population dose (collective effective dose equivalent) to the approximately 33,740 residents living within 80 km (50 mi) of each of the NTS airborne emission sources was 0.52 person-rem (5.2×10^{-3} person-Sv). Background radiation would yield a CEDE of 3210 person-rem (32.1 person-Sv).

Data from the PIC gamma monitoring indicated a 1994 dose of 124 mrem from background gamma radiation measured in Amargosa Valley. The CEDE calculated from the monitoring networks or the model as discussed above is a negligible amount by comparison. The uncertainty (2σ) for the PIC measurement at the 124 mrem exposure level is approximately 5 percent. Extrapolating to the calculated annual exposure at Amargosa Valley, Nevada, yields a total uncertainty of approximately 6 mrem which is greater than either of the calculated EDEs. Because the estimated dose from NTS activities is less than 1 mrem (the lowest level for which Data Quality Objectives (DQOs) are defined, as given in Chapter 10) no conclusions can be made regarding the achieved data quality as compared to the DQOs for this insignificant dose.

Table 6.1 Summary of Effective Dose Equivalents from NTS Operations during 1994

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

(a) The maximum boundary dose is to a hypothetical individual who remains in the open continuously during the year at the NTS boundary located 39 km (24 mi) from CP-1.

(b) The maximum individual dose is to a person outside the NTS boundary at a residence where the highest dose-rate occurs as calculated by CAP88-PC (Version 1.0) using NTS effluents listed in Table 5.1 and assuming all tritiated water input to the Area 12 containment ponds was evaporated.

(c) National Emission Standards for Hazardous Air Pollutants.

Table 6.2 Monitoring Networks Data used in Dose Calculations

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

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

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

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

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

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

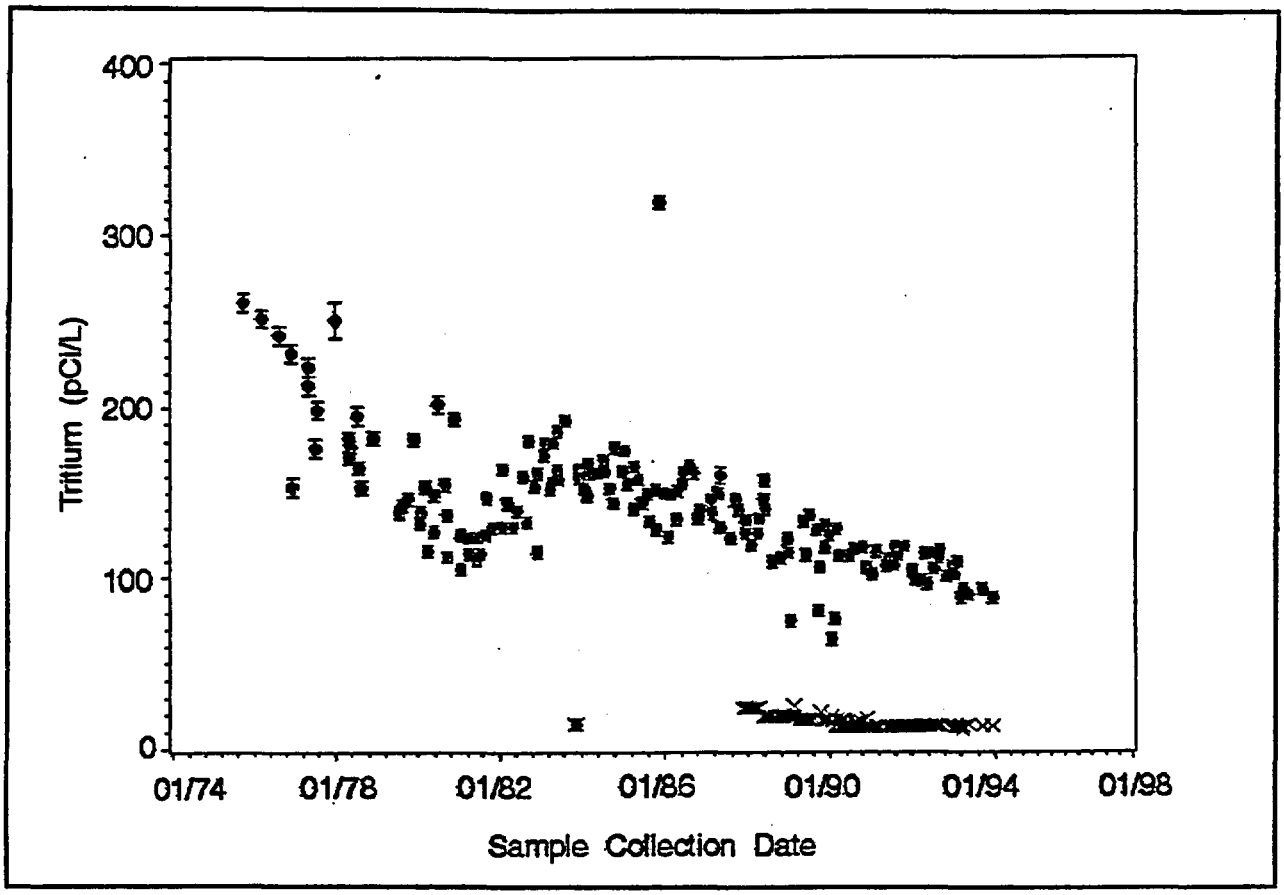

Figure 9.3 Tritium Concentration Trends in Test Well B on the NTS

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

9.5.2.2 OFFSITE MONITORING IN THE VICINITY OF THE NEVADA TEST SITE

The monitoring sites in the area around the NTS are shown in Figure 9.4. Most of the sampling locations represent drinking water sources for rural residents or public drinking water supplies for the communities in the area. The sampling locations include 23 wells, seven springs, and a surface water site. All of the locations are sampled monthly except for Penoyer Well 13 and Penoyer Wells 7 and 8 which are in operation only part of the year.

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

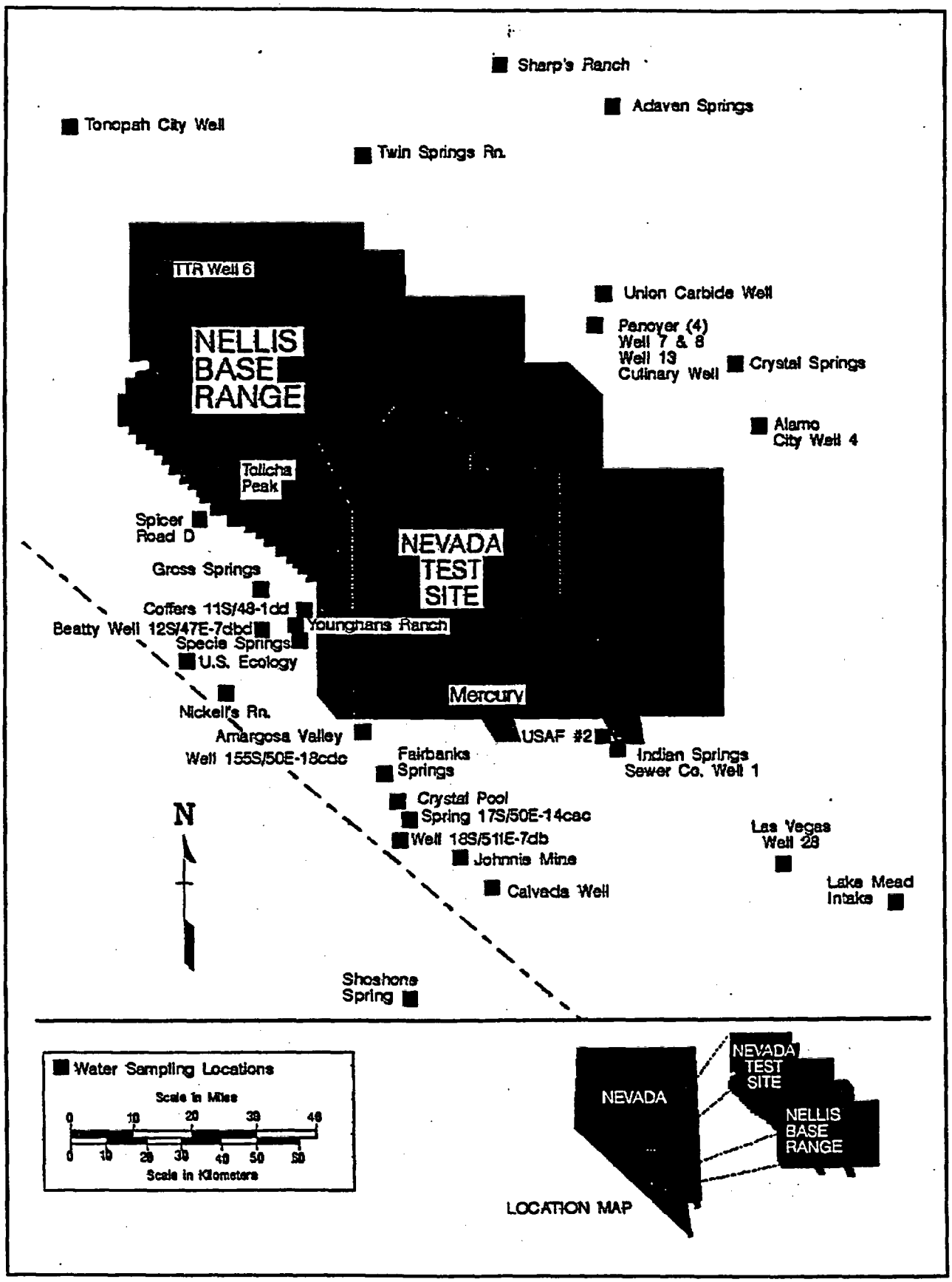

Figure 9.4 Wells Outside the NTS Included in the LTHMP

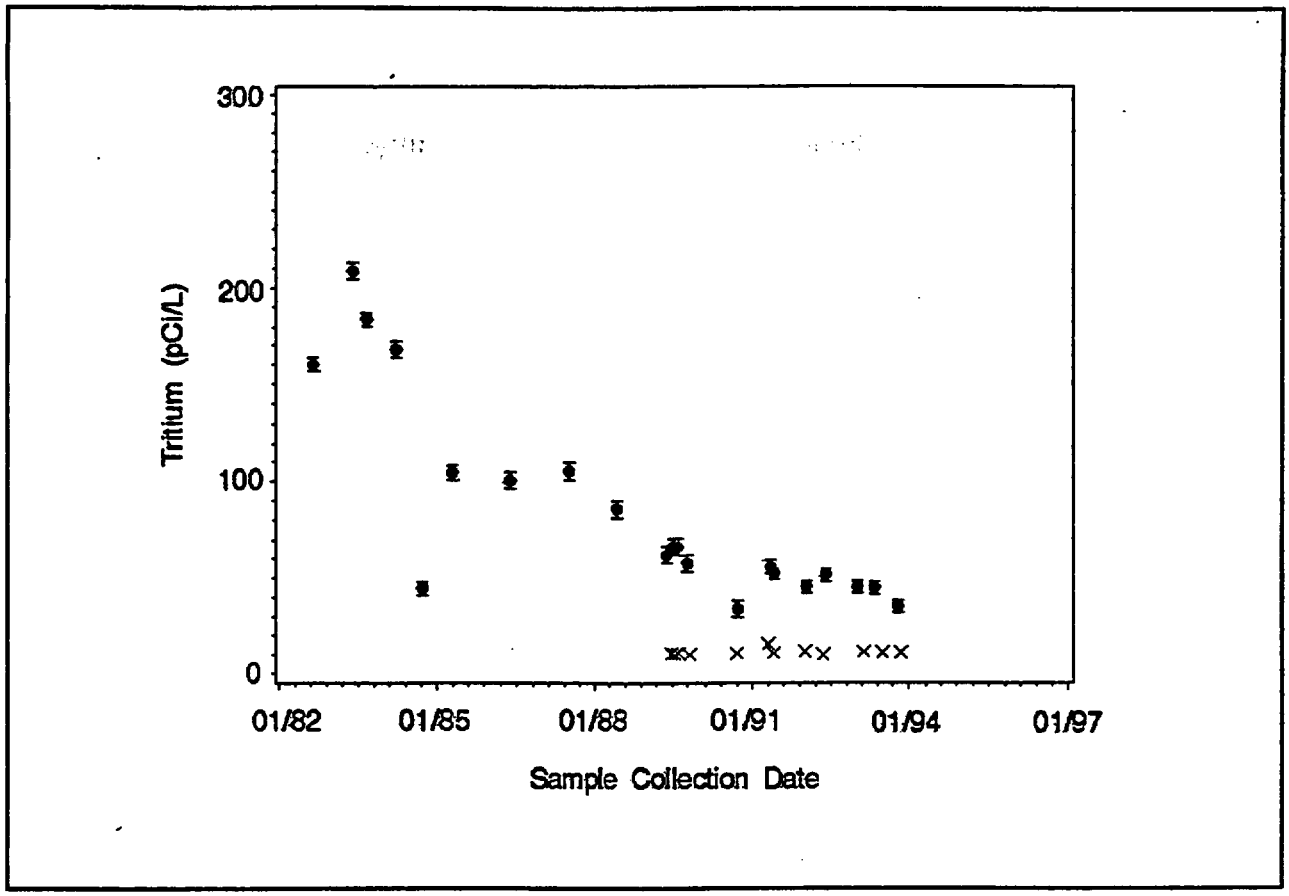

Figure 9.5 Tritium Results in Water from Lake Mead, Nevada

9.6 LTHMP AT OFF-NTS NUCLEAR DEVICE TEST LOCATIONS

The LTHMP conducts sampling at sites of past nuclear device testing in other parts of the U.S. to ensure the safety of public drinking water supplies and, where suitable sampling points are available, to monitor any migration of radionuclides from the test cavity. Annual sampling of surface and ground waters is conducted at the Projects SHOAL and FAULTLESS sites in Nevada, the Projects GASBUGGY and GNOME sites in New Mexico, the Projects RULISON and RIO BLANCO sites in Colorado, and the Project DRIBBLE site in Mississippi. Sampling was conducted in both the spring and fall to determine rainfall dilution of ^{3}H concentration at the Mississippi site. Sampling is conducted in odd numbered years, on Amchitka Island, Alaska, site of Projects CANNIKIN, LONG SHOT, and MILROW.

The sampling procedure is the same as that used for sites on the NTS and offsite areas (described in Section 9.5.1), with the exception that two 3.8-L samples are collected in Cubitainers. The second sample serves as a backup or as a duplicate sample.

Because of the variability noted in past years in samples from the shallow monitoring wells near Project DRIBBLE ground zero (GZ), the sampling procedure was modified several years ago. A second sample is taken after pumping for a specified period of time or after the well has been pumped dry and permitted to refill with water. These second samples may be representative of formation water, whereas the first samples may be more indicative of recent rainfall.