4.0 AIR SURVEILLANCE ACTIVITIES

The air surveillance activities consist of monitoring and compliance programs for the Nevada Test Site (NTS), near offsite areas, and support facilities. These activities include radiological and nonradiological monitoring and environmental permit and operations compliance. There are both onsite and offsite radiological monitoring programs associated with the NTS. The onsite program is conducted by Bechtel Nevada (BN), the operations and maintenance contractor for the NTS. BN is responsible for NTS air surveillance, effluent monitoring, and ambient gamma radiation monitoring. Beginning July 1999, BN air sampling was expanded to six offsite locations to confirm compliance with National Emission Standards for Hazardous Air Pollutants (NESHAPs) regulations. The offsite air and ambient gamma radiation monitoring program is conducted by the U.S. Environmental Protection Agency's (EPA's) Center for Environmental Restoration, Monitoring and Emergency Response of the Radiation and Indoor Environments National Laboratory in Las Vegas, Nevada (R&IE-LV). Non-radiological air monitoring is primarily for permit compliance.

4.1 ONSITE RADIOLOGICAL MONITORING

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

Table 4.1 is a summary of the routine air surveillance program, as of the end of 1999. Air sampling was conducted for radioactive particulates and tritiated water (HTO) vapor. The air sampling locations are shown in Figure 4.1, and Figure 4.2 shows the locations where ambient gamma radiation monitoring is conducted on the NTS using thermoluminescent dosimeters (TLDs).

CRITERIA

Title 40, Code of Federal Regulations (CFR) Part 50, "National Primary and Secondary Ambient Air Quality Standards" (CFR 1971) and Title 40 CFR 61," NESHAPs," Subpart H, "Emission of Radionuclides Other Than Radon from Department of Energy Facilities" (CFR 1989) issued by the EPA are the primary drivers for air monitoring programs. In turn, the U.S. Department of Energy (DOE) published DOE Order 5400.1, "General Environmental Protection Program," (DOE 1990a), which establishes environmental protection program requirements, authorities, and responsibilities for DOE operations. These mandates require compliance with applicable federal, state, and local environmental protection regulations. Other DOE directives applicable to environmental monitoring include DOE Order O 231.1, "Environment, Safety, and Health Reporting" (DOE 1996d), DOE Order 5480.1B, "Environment, Safety, and Health Program for DOE Operations" (DOE 1990c); DOE Order 5484.1, "Environmental Protection, Safety, and Health Protection

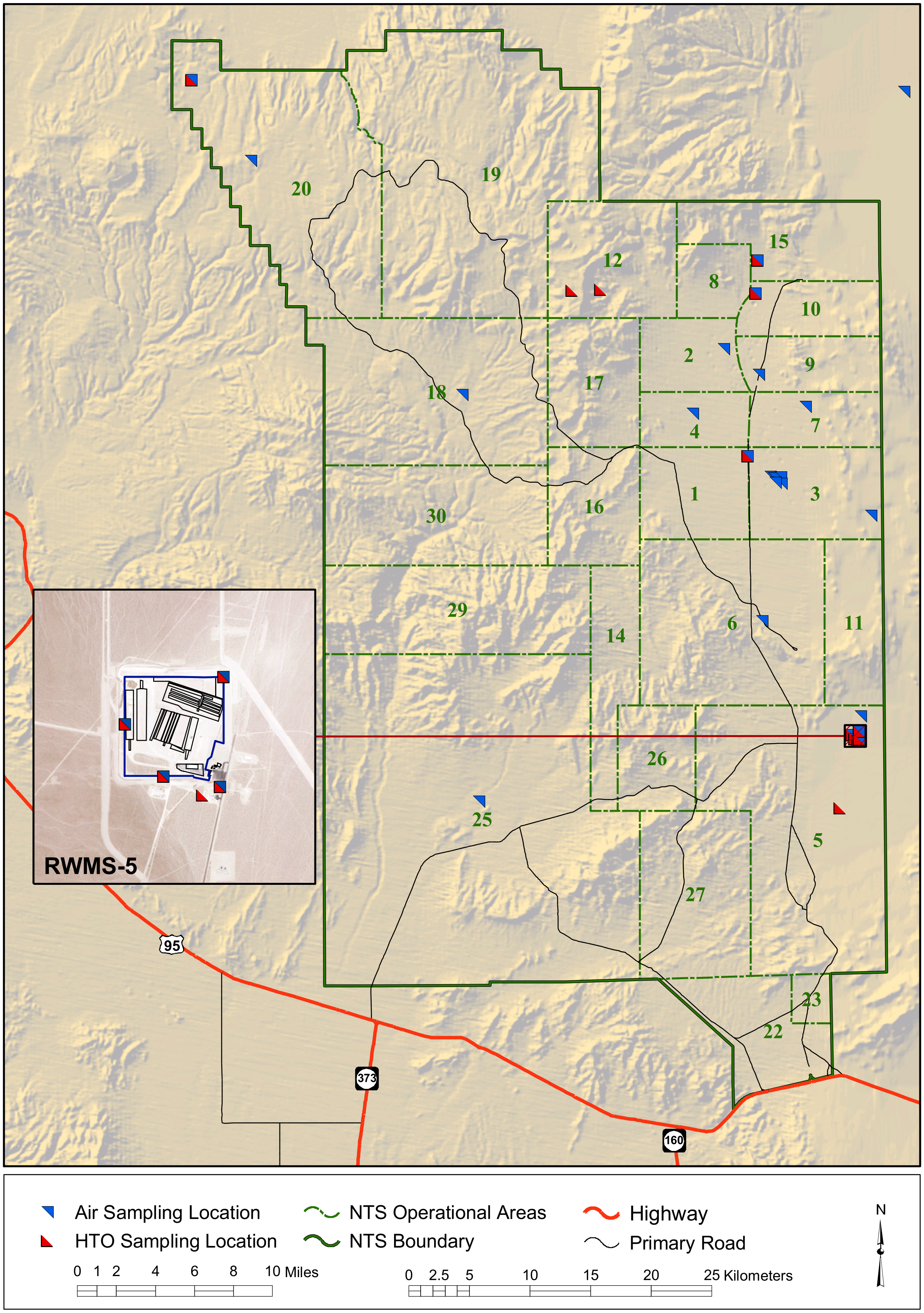


Figure 4.1 Air Sampling Stations on the NTS - 1999

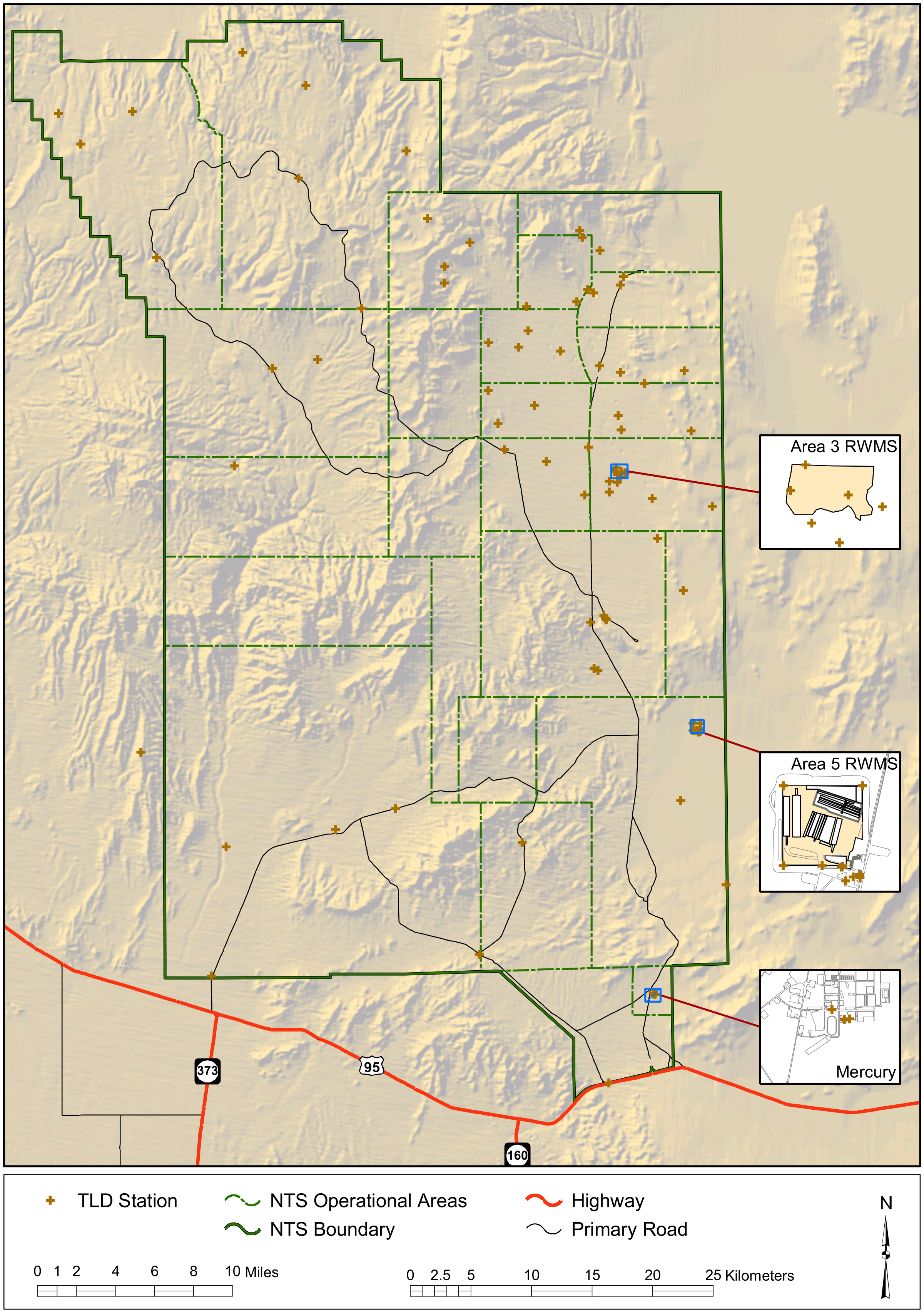


Figure 4.2 TLD Stations on the NTS - 1999

Information Reporting Requirements" (DOE 1990e); DOE Order 5400.5, "Radiation Protection of the Public and the Environment" (DOE 1990b); and DOE/EH-0173T, "Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance" (DOE 1991c).

AIRBORNE EFFLUENT MONITORING

Airborne radioactive effluents are the emissions on the NTS with the greatest potential for reaching members of the public. For all activities on the NTS, the estimated effective dose equivalent to any member of the public offsite from all airborne emissions continues to be much less than one mrem/yr (<10 percent of the guideline) (Grossman 2000). Compliance with the regulations listed above requires periodic measurements of effluents to confirm the low emission levels. The estimated effluents for 1999 are shown in Table 4.5 and include measured and calculated effluents, evaporated liquids, and resuspension of contaminated soils.

An increase in efforts to monitor radioactive air emissions at the NTS began in November 1988 as a result of requirements in DOE Order 5400.1. Known and potential effluent sources throughout the NTS were assessed for their potential to contribute to public dose and were considered in designing the “Site Effluent Monitoring Plan”, which forms part of the “Environmental Monitoring Plan, Nevada Test Site and Support Facilities” published in November 1991 (DOE 1991b). This plan was updated in 1992 and 1993, but has been superseded by a “Routine Radiological Environmental Monitoring Plan” (DOE 1998a).

ENVIRONMENTAL SURVEILLANCE

Air surveillance was conducted onsite throughout the NTS. Equipment at fixed locations continuously sampled the ambient air to monitor for radioactive material content. Ambient gamma exposures were measured with TLDs placed at fixed locations.

AIR MONITORING

The air surveillance program operated samplers that were designed to detect airborne radioactive particles and ^{3}H, as water vapor in the form of ^{3}H^{3}HO or ^{3}HHO. The low-volume air sampling units used to measure radioactive particulates were operated at 25 stations on the NTS (Figure 4.1) and 4 on the Nellis Air Force Range (NAFR) during 1999. These stations included 10 at radioactive waste management facilities. Access, worker population, geographical coverage, presence of radioactivity, and availability of electrical power were considerations in site selection for air samplers. During 1996, air samplers powered by solar photovoltaic/ battery systems were acquired for operation near contaminated areas where commercial power was not available and were in use at 14 locations in 1999.

In July 1999, high-volume air samplers for the collection of airborne particulates were installed at six offsite locations for the purpose of confirming compliance with NESHAPs regulations and to replace the R&IE-LV stations that were terminated at the end of FY 1999.

The low-volume air sampling unit consisted of a constant volume pump drawing approximately 85 L/min (3 cfm) of air through a 9-cm (3.5-in) diameter Whatman GF/A glass-fiber filter that trapped air particulates. Due to the moratorium on nuclear explosives testing, charcoal cartridges are no longer used in the air sampler. The particulate filter was mounted in a plastic, cone-shaped sample holder that faced downward at a height of 1.5 m (5 ft) above ground. A run-time clock measured the operating time. The time on the clock, multiplied by 85 L/min yields the volume of air sampled, which was about 860 m^3 (30,000 ft^3) during a typical seven-day sampling period.

A high-volume air sampler draws air at a constant rate of 68 m^3 per hour through a 20 x 25 cm (8 x 10 inch) glass-fiber filter, type FPAE-810. The filter is positioned upward and is covered to protect it from the wind and rain. The total volume sampled and the elapsed time is summed by a microprocessor, which also maintains a constant flow rate through the filter.

The 9-cm diameter filters were analyzed for gross alpha and gross beta radioactivity no sooner than 5 days after collection to allow for the decay of naturally-occurring radon and its progeny. The filters from four weeks of sampling were composited, analyzed by gamma spectroscopy, and then analyzed for plutonium isotopes.

The 20 x 25 cm filters were analyzed by gamma spectroscopy at least five days after collection, composited over an approximate one-month period, and analyzed for plutonium.

Airborne HTO vapor was monitored at 12 locations throughout the NTS. For this monitoring, a pump continuously drew air into the sampler at approximately 0.6 L/min, the total volume being measured with a dry-gas meter. The HTO vapor was removed from the air stream by two molecular sieve columns connected in series. These columns were exchanged biweekly. Beginning in July 1999, the samplers were replaced with constant flow units which were controlled by microprocessors, which summed the total volume sampled and the elapsed time.

The analytical procedures used on all these air samples are summarized in Table 4.2.

AMBIENT GAMMA MONITORING

Ambient gamma monitoring was conducted at 85 stations on the NTS (Figure 4.2) by use of TLDs. The dosimeter used was the Panasonic UD-814AS environmental dosimeter, consisting of four elements housed in an air-tight, water-tight, ultraviolet-light-protected case. One element, made of lithium borate, was only slightly shielded in order to measure low-energy radiation. The other three elements, made of calcium sulfate, were shielded by 1,000 mg/cm^2 of plastic and lead and were used to monitor penetrating gamma radiation. TLDs were deployed in a holder placed about one meter above the ground and were exchanged quarterly. Locations were chosen at the site boundary, at locations where historical monitoring has occurred, or where operations or ground contamination have occurred.

WASTE MANAGEMENT SITE MONITORING

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

During 1999, there were six air particulate sampling stations, four HTO vapor sampling stations, and 10 TLD stations placed around RWMS-5.

Monitoring at RWMS-3 during 1999 included four air particulate sampling stations and five TLD stations.

4.2 OFFSITE RADIOLOGICAL MONITORING

Under the terms of an Interagency Agreement between DOE and EPA's Office of Radiation and Indoor Air, the R&IE-LV conducted the Offsite Environmental Monitoring Program (OEMP) around the NTS. The primary activity of the OEMP is routine monitoring of potential human exposure pathways. Secondary activities include maintaining readiness to monitor during nuclear testing, emergency response, public information, and community assistance.

Maintaining readiness was exercised during three subcritical experiments conducted in 1999: CLARINET, OBOE I, and OBOE II. For each of the experiments, R&IE-LV senior personnel served on the Test Controller's Scientific Advisory Panel and on the EPA offsite radiological safety staff.

R&IE personnel continued to perform routine offsite environmental monitoring to assist the DOE in documenting compliance with NESHAPs and with DOE orders 5400.1 and 5400.5 throughout 1999.

Environmental monitoring networks, described in this and following Chapters, measure radioactivity in air (this chapter) and groundwater (Chapter 5). These networks monitor the major potential pathways for transfer of radionuclides to man. Ambient gamma radiation levels are monitored using Reuter-Stokes pressurized ion chambers (PICs) and Panasonic TLDs. Data from these networks are used to calculate an annual exposure to the offsite residents.

The Community Technical Liaison Program (CTLP) grew to 19 stations during 1999, operating in communities around the NTS and extending into southern Utah. The CTLP stations are managed by local residents and consist of air samplers, PICs, and TLDs. The Desert Research Institute (DRI) was a cooperator with R&IE-LV in the CTLP during calendar year (CY) 1999 and will assume full management of the DOE offsite program beginning with CY 2000. Transition of the program from R&IE-LV to DRI began during the third quarter of 1999.

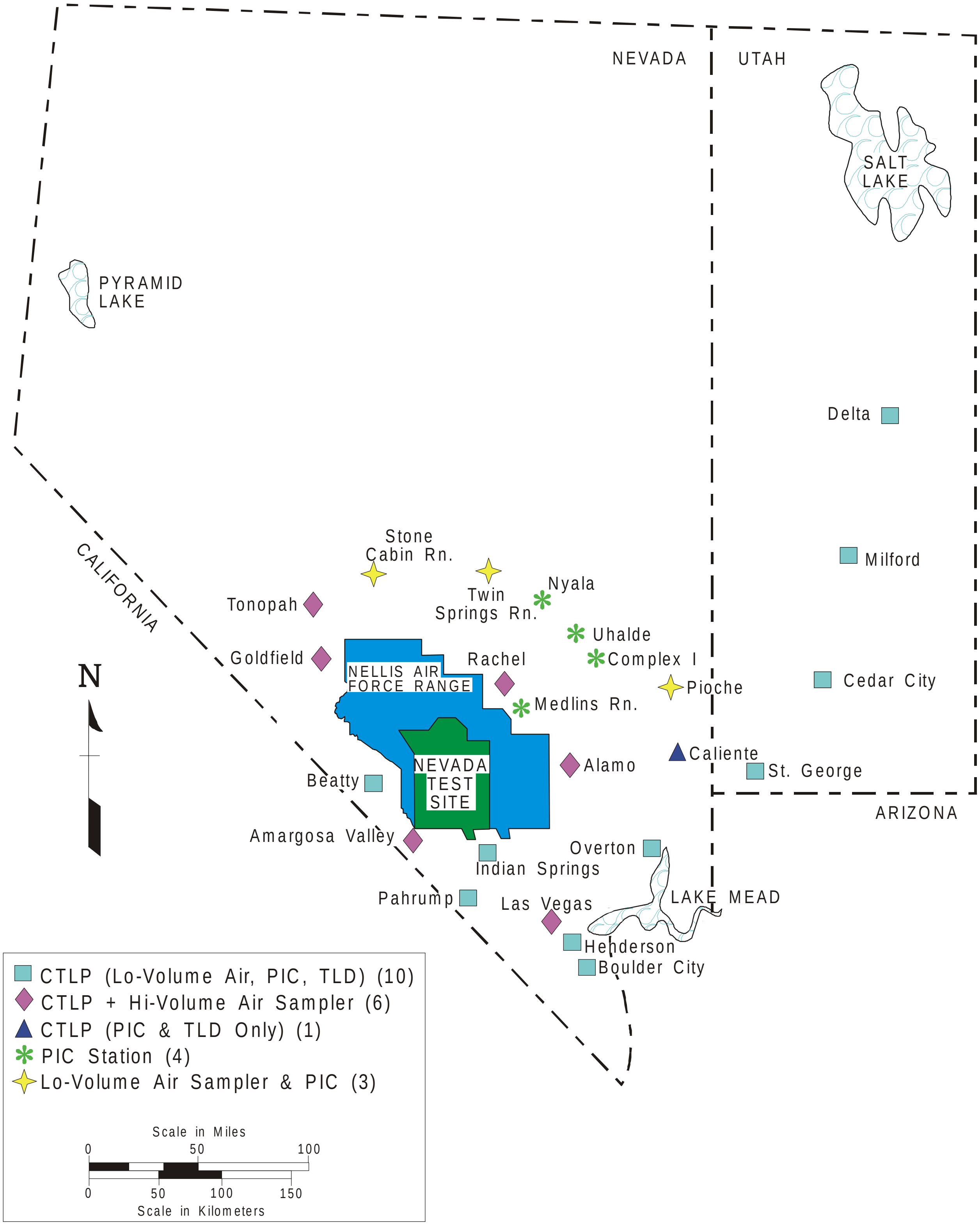
AIR SURVEILLANCE NETWORK (ASN)

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

The R&IE-LV ASN is currently designed to monitor the areas within approximately 130 km (80 mi) of the NTS. During CY 1999, the ASN consisted of 20 continuously operating sampling stations. High-volume air samplers were operational at six of the stations. The high-volume samplers were removed from the network after the December 1999 sample was collected. The current network is shown in Figure 4.3. Station location depends in part on the availability of electrical power and a resident willing to operate the equipment.

The low-volume air samplers at each station are equipped to collect particulate radionuclides on 5-cm (2.0-in) diameter glass-fiber filters at a flow rate of about 80 m^3 (2,800 ft^3) per day. Filters are changed weekly (approximately 560 m^3 or 20,000 ft^3 of air sampled). High-volume air samplers collect particulates on 20 x 25 cm (8 x 10 in) glass-fiber filters at a flow rate of approximately 1,600 m^3 (58,000 ft^3) per day. High-volume samples are collected monthly (approximately 48,000 m^3, or 1.7 million ft^3 of air sampled). Duplicate air samples are collected from two routine ASN stations each week. The duplicate samplers are operated at randomly selected stations for three months and then moved to new locations. One duplicate high-volume sampler is operated in the same manner as the duplicate low-volume samplers.

At the R&IE-LV, the glass-fiber filters are analyzed by high-resolution gamma spectrometry. Each of the glass-fiber filters is 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 progeny. Filters from high-volume air samplers are analyzed using high-resolution gamma spectrometry and are then analyzed for plutonium isotopes using wet chemistry methods.



Note: Real time data transmittal.

Figure 4.3 CTLP, PIC, and Air Sampling Locations Around the NTS - 1999

THERMOLUMINESCENT DOSIMETRY (TLD) NETWORK

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

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

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

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

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

In 1999, the TLD program consisted of 38 fixed environmental monitoring stations and 19 offsite personnel, as shown in Figure 4.4. At the end of the first quarter in 1999, Furnace Creek was discontinued as an environmental station and at the end of the third quarter the offsite personnel TLDs were discontinued due to funding.

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 shell is a spherical electrode with an electrical charge opposite to the shell. When gamma radiation penetrates the sphere, ionization of the gas occurs and the negative ions are collected by the center electrode. The current generated is proportional to the radiation exposure.

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

Seventeen PICs are located at the CTLP stations in communities around the NTS, and seven PICs are located at ranches and other non-CTLP locations. Meteorological data are collected from stations in Las Vegas, Boulder City, and Henderson. Additional stations are being updated with meteorological monitoring hardware during the final months of 1999. The locations of the PIC stations around the NTS are shown in Figure 4.3.

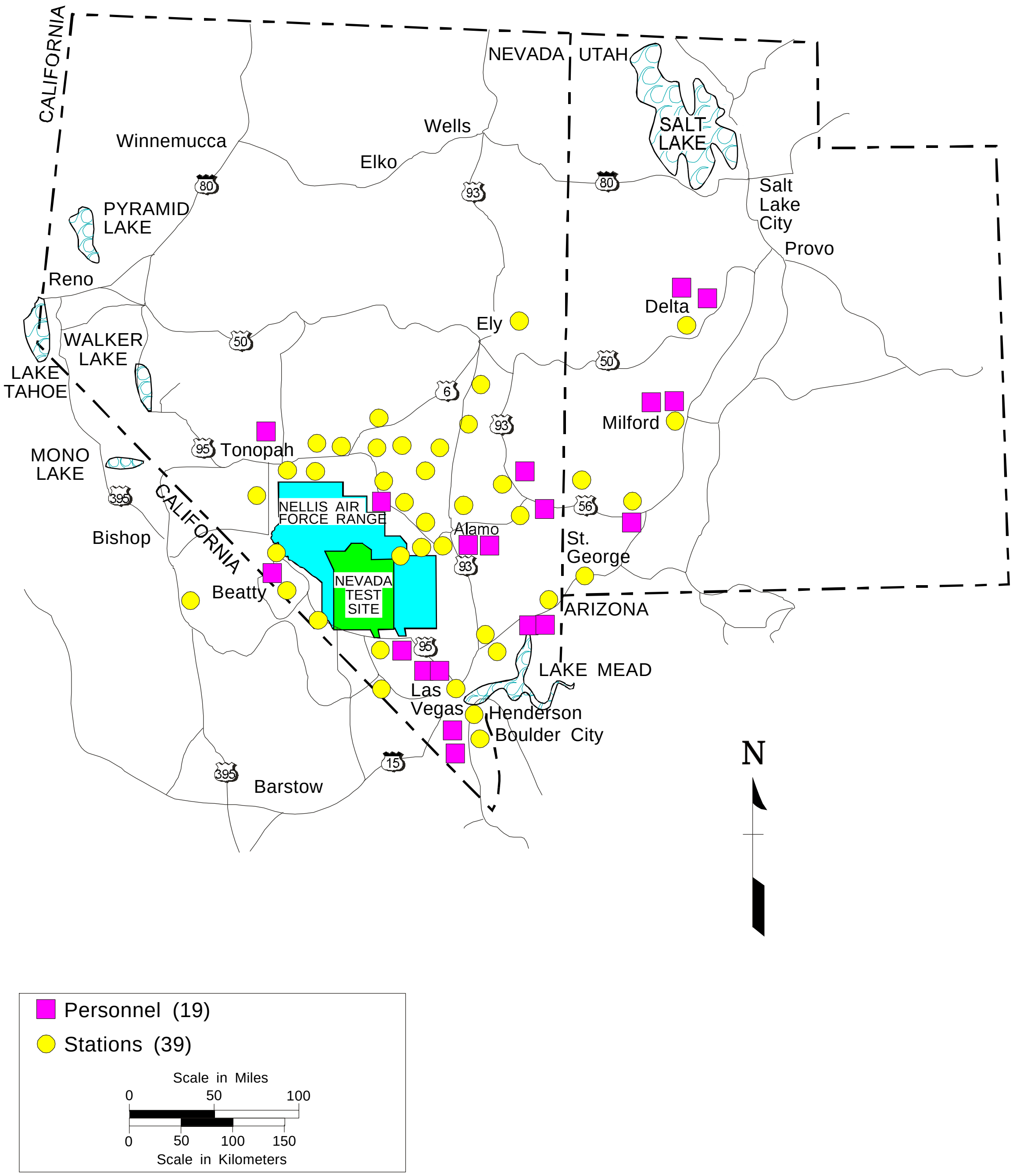


Figure 4.4 Locations of Offsite Station and Personnel TLDs - 1999

During the first two months of 1999, data from the PIC network were collected and displayed via satellite telemetry through the Los Alamos National Laboratory NEWNET system. Availability of the PIC telemetry data through this system was discontinued at the end of February 1999. During the remainder of CY 1999, PIC data were monitored by non-telemetry means, including magnetic media and chart recorders. Transition of the PIC network to the DRI began in July 1999 and was completed during December 1999. Data collection by way of telemetry resumed with equipment upgrades made to each station during the transition period. Current data were displayed on the DRI Western Regional Climate Center website as each station was upgraded. At the time of this writing, the PIC network data collected by DRI was unavailable in a format that could be summarized for reporting.

COMMUNITY TECHNICAL LIAISON PROGRAM (CTLP)

Because of the successful experience with the Citizen's Monitoring Program during the purging of the Three Mile Island containment in 1980, the Community Radiation Monitoring Program (CRMP) was begun. In 1999, there were 17 monitoring stations located in Nevada and Utah. The CTLP is a cooperative project of the DOE, EPA, and DRI. DOE/NV sponsors the program. DRI administers the program by hiring the local station managers and alternates, securing rights-of-way, providing utilities, distributing data reports, and performing additional quality assurance checks of the data. During the third and fourth quarter of 1999, the EPA began to transfer responsibility for technical and scientific direction, maintenance of the instrumentation and sampling equipment, sample analysis, data summary, and reporting, to DRI. The locations of the CTLP stations are shown in Figure 4.3.

Each station is operated by a local resident. In most cases, this resident is a high-school science teacher. Sixteen of the CTLP stations had one of the samplers for the ASN. In addition, some stations had a PIC and recorder for immediate readout of external gamma exposure and some had a TLD. A recording barograph was located at all stations. All of the equipment is mounted on a stand at a prominent location in each community so the residents can become aware of the surveillance and, if interested, can check the data. During 1999, standby noble gas and tritium monitoring equipment was removed from all stations.

4.3 NONRADIOLOGICAL MONITORING

The 1999 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 as discussed in Chapters 5 and 6. Air quality monitoring is not required for the NTS. The air permits issued by the state of Nevada do require opacity and material throughput measurements. Nonradiological monitoring was conducted for eight series of tests conducted at the Hazardous Materials Spill Center (HSC) on the NTS.

MONITORING OF NTS OPERATIONS

ROUTINE MONITORING

As there were no industrial-type production facility operations on the NTS, there was no significant production of nonradiological air emissions or liquid discharges to the environment. Sources of potential contaminants were limited to construction support and NTS operational activities. These included motor pool facilities; large equipment and drill rig maintenance areas; cleaning, warehousing, and supply facilities; and general worker support facilities (including lodging and administrative offices) in the Mercury Base Camp, Area 12 Camp, and to a lesser extent in Area 20 and the NTS Control Point (CP) Complex in Area 6.

The HSC in Area 5 is a source of potential release of nonradiological contaminants to the environment, depending on the individual tests conducted. In 1999, the eight test series conducted there, involved 23 different chemicals.

Routine nonradiological environmental monitoring on the NTS in 1999 was limited to Nevada operating permit requirements and asbestos sampling in conjunction with asbestos removal and renovation projects and in accordance with occupational safety and NESHAP compliance.

NTS AIR QUALITY PERMIT COMPLIANCE

Monthly visible emissions readings are a requirement of the NTS air quality operating permit, AP9711-0549. The permit limits particulate emissions to 20 percent opacity, except at the Area 1 Aggregate Plant, where the limit is 10 percent. Certification of personnel to perform valid visible emission opacity evaluations is required by the state, with recertification required every six months. During 1999, one employee of BN's Environmental Compliance Department and two Construction Department employees were recertified. In 1999, several visible emission evaluations of permitted air quality point sources were conducted. When visual evaluations determine that an emission exceeds the opacity requirement, corrective action is initiated. The opacity limit was not exceeded in 1999.

OFFSITE MONITORING

The HSC was established in Frenchman Flat in Area 5 as a basic research tool for studying the dynamics of accidental releases of various hazardous materials and the effectiveness of mitigation procedures. Prior to each HSC test series, and, at other tests in the series depending on projected need, the documentation describing the tests are reviewed by the EPA to determine whether appropriate air sampling equipment should be deployed downwind of the test at the NTS boundary to measure chemical concentrations that may have reached the offsite area. During 1999, no monitoring was required.

NON-NTS FACILITY MONITORING

Under normal conditions, the operations at the six non-NTS facilities operated by BN for DOE/NV do not produce radioactive effluents. The six are: (1) the North Las Vegas Facility (NLVF), (2) the Remote Sensing Laboratory (RSL), (3) the Special Technologies Laboratory (STL), (4) Livermore Operations (LO), (5) Los Alamos Operations (LAO), and (6) RSL-Andrews.

AIR QUALITY PERMITS

The permits required for 1999 are listed in Table 4.3. The permits required for the NTS in 1999 for non-NTS facilities that support the work of DOE/NV are listed in Table 4.4.

Thirteen air quality operating permits, issued by the Clark County Health District in Las Vegas, Nevada, were required for operations at the NLVF and the RSL during 1999. There were no effluent monitoring requirements associated with these permits.

No air permits were held or required for the LO, LAO, or RSL-Andrews facilities in 1999.

4.4 AIR SURVEILLANCE PROGRAM RESULTS

ONSITE RADIOLOGICAL MONITORING

AIRBORNE EFFLUENTS

During 1999, the monitoring of airborne radioactive emissions at the NTS involved several operational facilities and some inactive locations. Due to the continuation of the moratorium on nuclear testing throughout 1999, the monitoring of emissions from nuclear tests was not required. The results of other effluent monitoring, calculated or measured, are set forth in Table 4.5. The total curies of tritium emissions (338 Ci airborne) included in Table 4.5 are more than that reported in the 1998 Annual Site Environmental Report (192 Ci). The increase is attributed to an improvement in the air sampling collection efficiency for tritium. From field tests conducted in 1998, the tritium in air concentrations measured with the use of molecular sieve were found to be a factor of 2.3 times the concentrations measured with silica gel. Therefore beginning in July 1999, molecular sieve was used in place of silica gel, which resulted in the measurement of higher concentrations of tritium at all sampling locations during the last six months of 1999. As these concentrations were used with CAP88-PC software to estimate emissions, the higher concentrations resulted in higher estimated emissions.

AIR SAMPLING RESULTS

GROSS ALPHA

The annual average gross alpha results for each air sampling station are shown in Table 4.6. The annual average for the network was 2.5×10^{-15} µCi/mL (96 µBq/m^3), which was slightly higher than the median minimum detectable concentration (MDC). This average was slightly higher than the 1998 value. The samples from the NAFR were all about the same as the NTS average at 2.5×10^{-15} µCi/mL (93 µBq/m^3).

The samples collected from the air samplers at the low-level radioactive waste disposal facility in RWMS-3 and in RWMS-5 had gross alpha levels near the NTS average.

GROSS BETA

The annual average gross beta results for each air sampling station are shown in Figures 4.5 and 4.6 which also indicate the distribution of this radioactivity. The NTS average this year at 2.1×10^{-14} µCi/mL (0.78 mBq/m^3) was slightly higher than the 1998 value. The air samples from the NAFR had an average value slightly less at 1.7×10^{-14} µCi/mL (0.63 mBq/m^3). This is consistent with the results for the past few years. The basic data are in Table 4.6. Figure 4.7 depicts the trend in concentration for the past few years (a much longer trend is shown in Figure 1.1, Chapter 1), but expressed as percent Derived Concentration Guide (DCG), set by the EPA as 10 mrem per year for inhaled radioactivity. Note that the levels are only about 2 percent of the DCG. This guide is for public exposure and is based on ^{90}Sr, once a common beta-emitting isotope in the environment.

Air samples from both RWMS-3 and RWMS-5 had average gross beta levels that were near the NTS average.

PLUTONIUM

The annual average ^{238}Pu result of 1.4×10^{-18} µCi/mL (52 nBq/m^3) is less than the median MDC for this isotope and slightly greater than the 1998 average. The results from the NAFR were about half of the MDC. None of the stations had results greater than the MDC, except for Bunker 9-300. The annual averages for ^{238}Pu and for $^{239+240}$Pu are also included in Table 4.6.

The $^{239+240}$Pu network average of 1.0×10^{-16} µCi/mL (3.7 µBq/m^3) was about ten times the MDC and about twice the 1998 average value. To indicate the distribution of this nuclide over the NTS, the annual average concentration for each station is plotted in Figure 4.8 (see Figure 4.6 for RWMS-5). The highest annual average concentration was for Area 9 9-300, 1.3×10^{-15} µCi/mL. Of the NAFR samples, the set from Project 57 had the highest concentration of any station offsite. The trend of the NTS site-wide $^{239+240}$Pu concentration with time for the past few years is shown on Figure 4.9. There the data are plotted as a percent of the DCG for the general population as was done for the gross beta data above. The peak in the curve in 1992 was due to increased concentrations in Areas 3 and 9, probably related to increased vehicular travel and construction activities. The peak this year is mainly due to the Bunker 9-300 results.

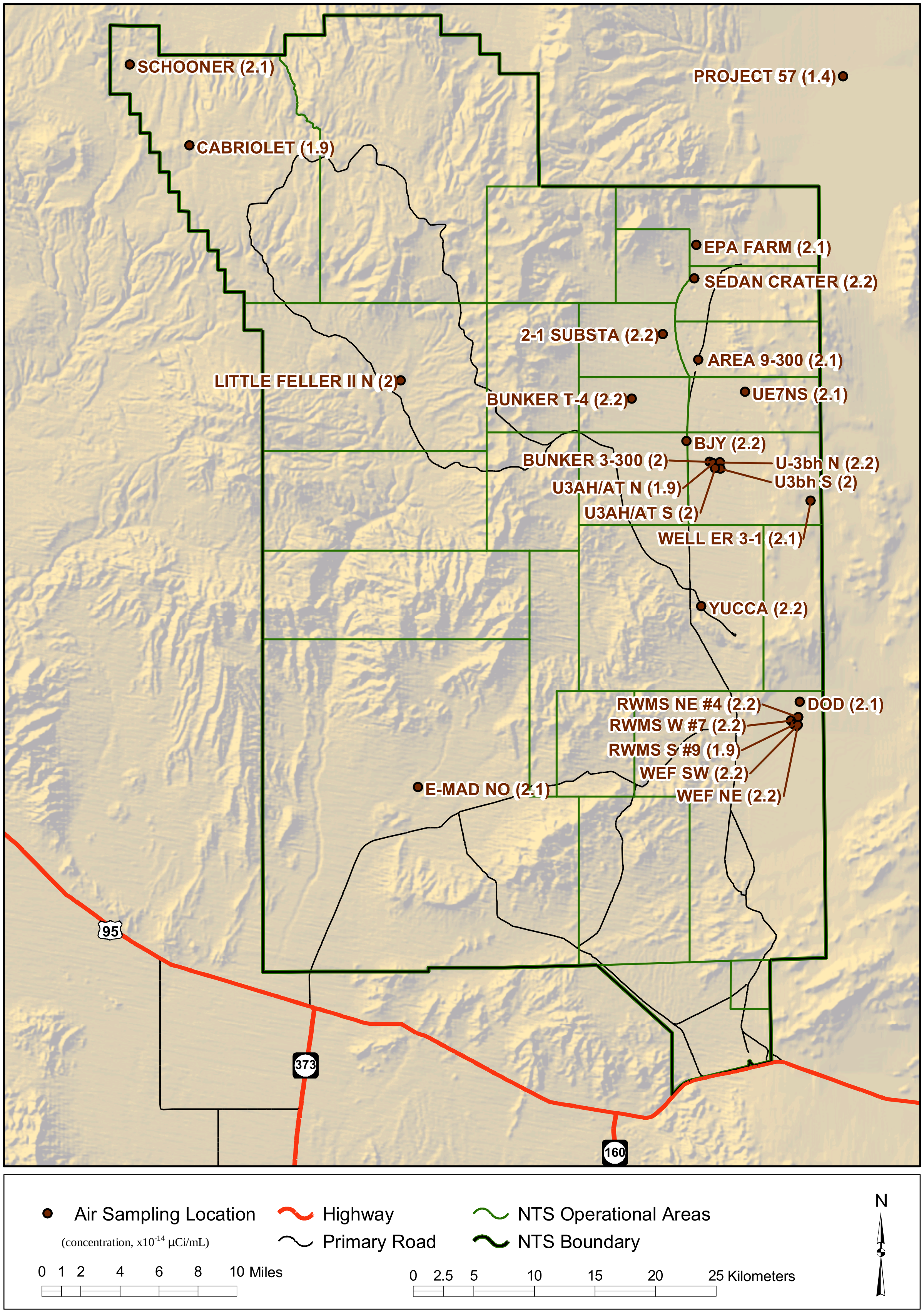


Figure 4.5 Annual Average Gross Beta from Air Sampling - 1999

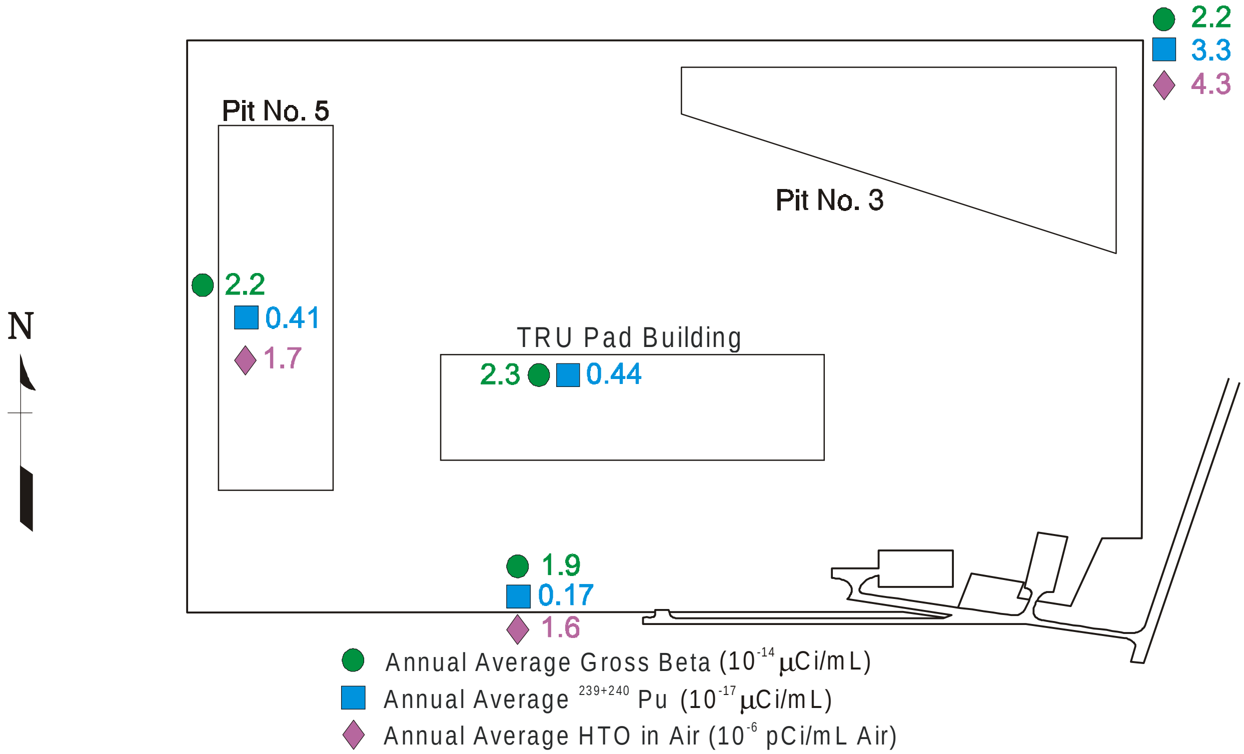


Figure 4.6 Air Monitoring Results for RWMS-5 - 1999

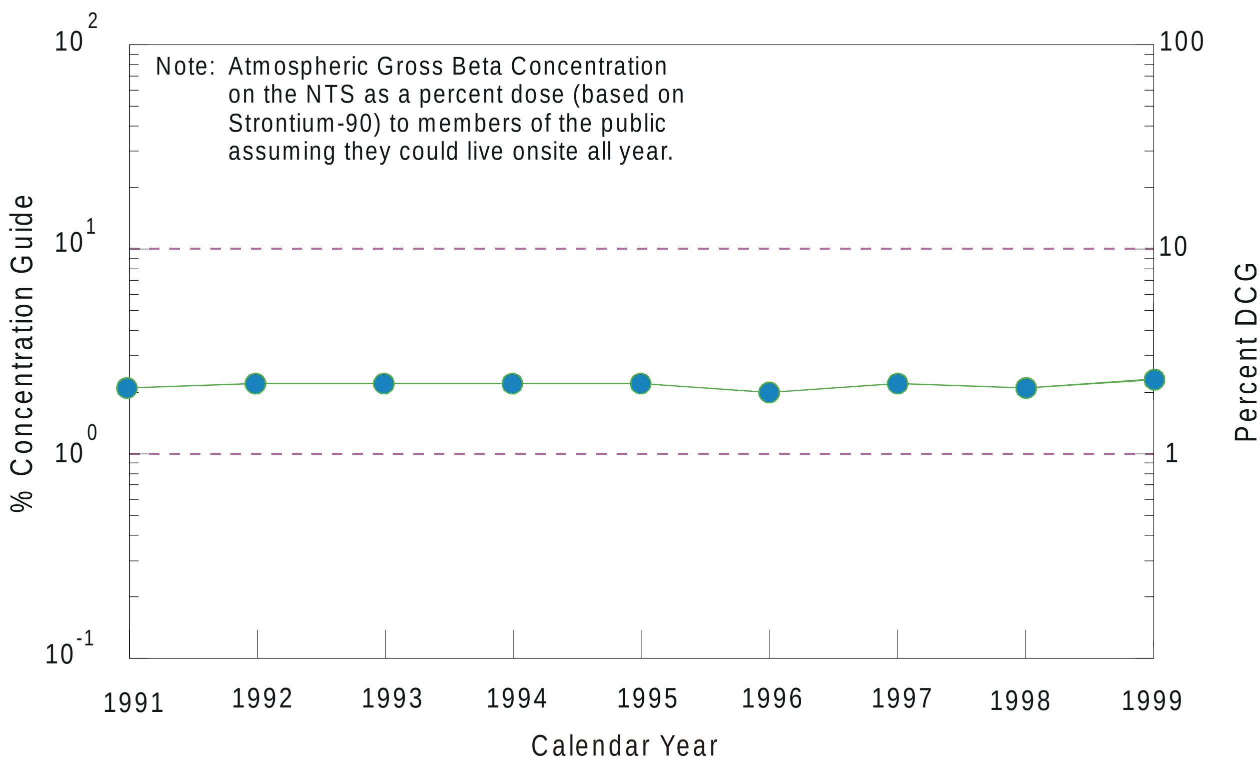


Figure 4.7 Trend in Annual Average Gross Beta Concentration in Air on the NTS

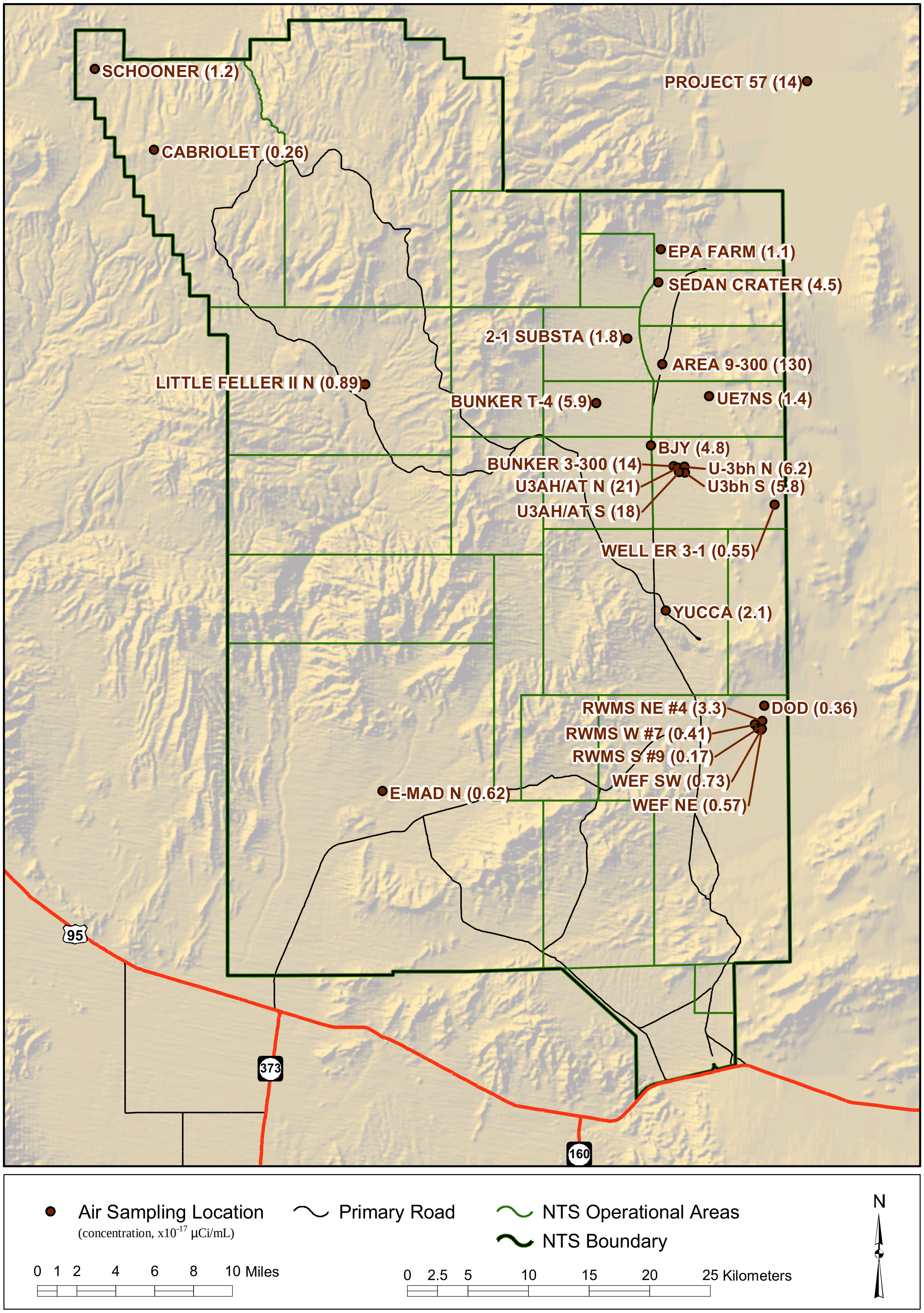


Figure 4.8 Annual Average $^{239+240}$Pu in Air on the NTS - 1999

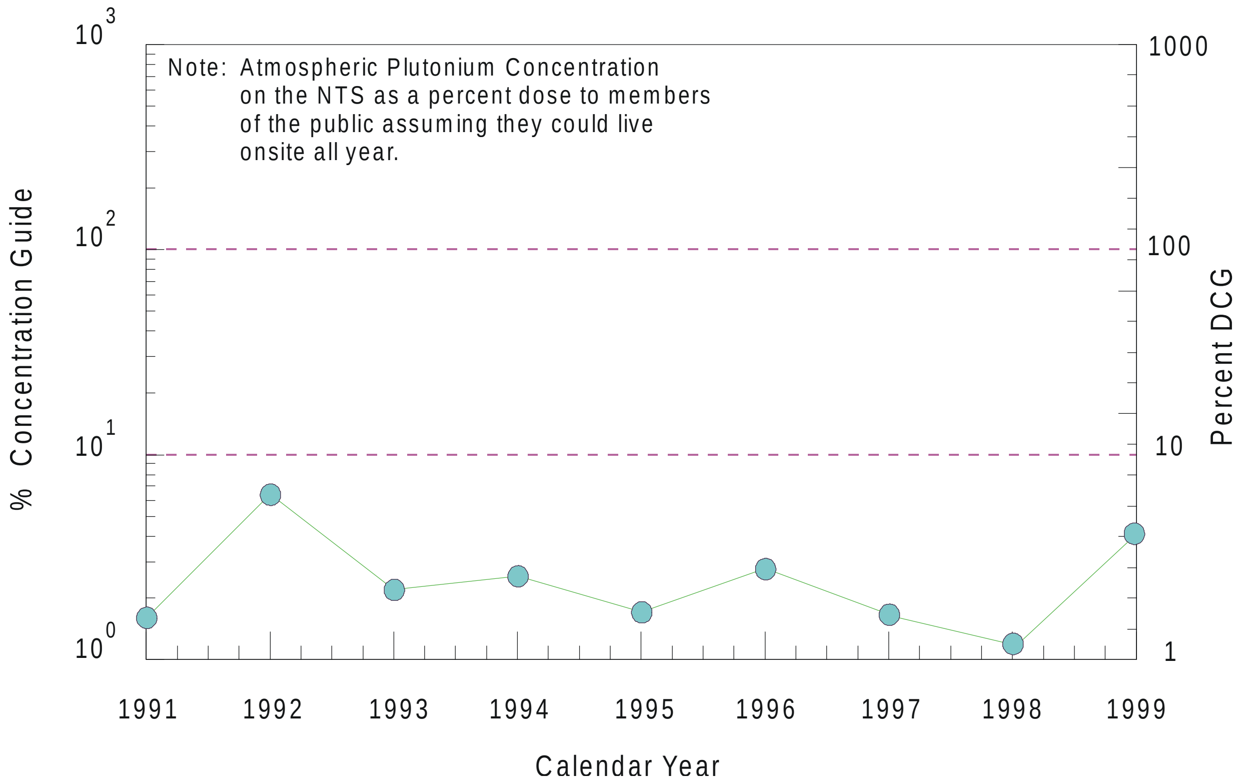


Figure 4.9 Trend in Annual Averages for Plutonium Concentration on the NTS

Air samples from RWMS-3 generally have concentrations of plutonium above the NTS average, while those from RWMS-5 are generally lower than the NTS average.

GAMMA

Gamma spectral analyses of the glass-fiber filters indicated only naturally occurring radioactive materials. The predominant one was ^{7}Be formed by cosmic ray interaction with nitrogen in the atmosphere. The annual average values for this isotope are shown in Table 4.6 and the NTS average of 2.1×10^{-13} µCi/mL (7.8 mBq/m^3) is similar to the value for 1998. The concentrations in samples from the NAFR were 24 percent lower, on the average, at 1.6×10^{-13} µCi/mL (5.9 mBq/m^3).

TRITIATED WATER VAPOR (HTO)

The annual average value for the 12 stations in this network was 25×10^{-6} pCi/mL (0.85 Bq/m^3). This concentration is 35 percent higher than it was in 1998 due to higher concentrations in 1999 at SCHOONER, which had an average concentration of 200×10^{-6} pCi/mL. The other locations which had annual averages above the median MDC were BJY, RWMS 4 NE, WEF NE, EPA Farm, SEDAN crater, Decon Pad, and E Tunnel Pond 2. All of the data are displayed in Table 4.7 and are plotted as a trend over the last several years in Figure 4.10. The data plotted in Figure 4.10 are the network average concentration of HTO in each year expressed as a percent of the DCG for the general offsite population. There has been a slight downward trend over the period plotted, until 1998; however, all values are less than 2 percent of the DCG. The increase in the network average is attributed to: (1) the elimination over the last two years of several sampling locations that previously measured tritium concentrations near and below the MDC; and (2) the use of a more efficient desiccant (molecular sieve instead of silica gel) in the tritiated atmospheric moisture samplers.

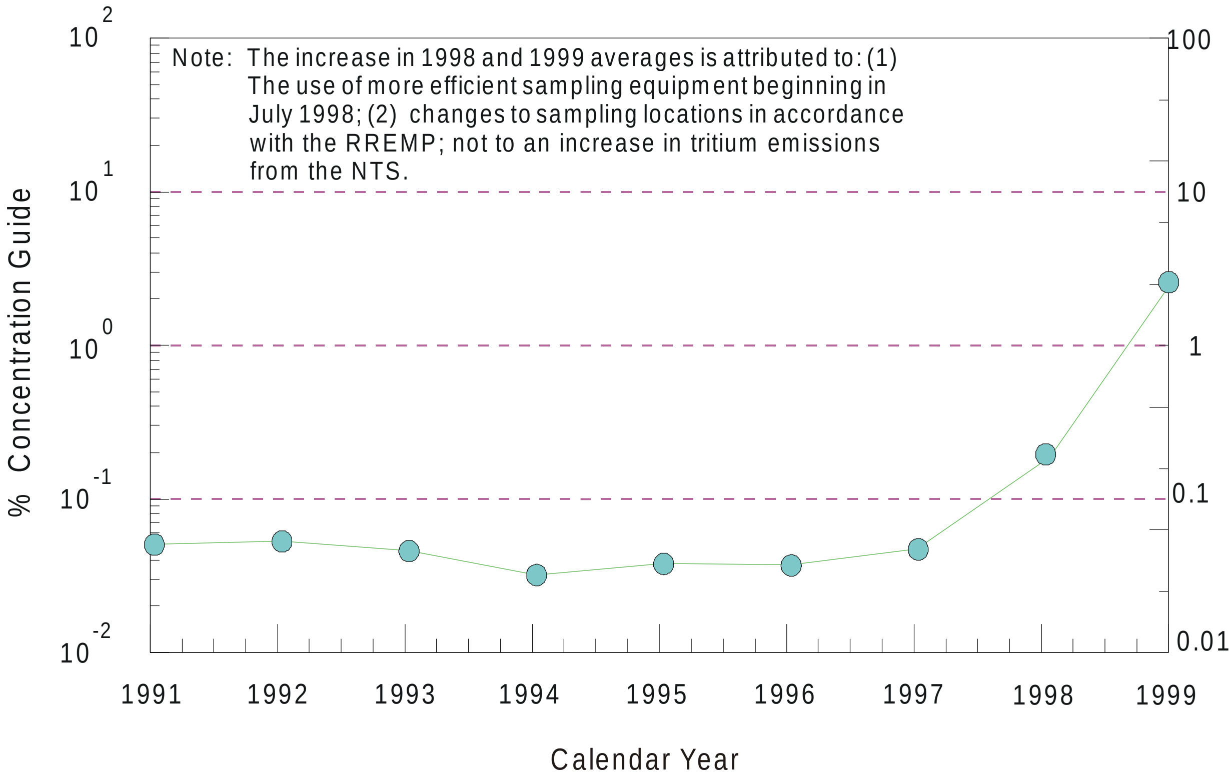


Figure 4.10 Trend in Annual Averages for HTO Concentration on the NTS

TREND AT THE WASTE MANAGEMENT SITES

The annual average air concentrations of plutonium and HTO as atmospheric moisture at RWMS-3 and RWMS-5 are set forth in Tables 4.8 and 4.9, respectively. No average for HTO is shown for RWMS-3, because that sampling was terminated at the beginning of 1998. The annual average HTO concentrations have been less than the median MDC for several years at RWMS-3.

ONSITE TLD RESULTS

The 1999 average exposure for the 13 boundary monitoring stations was 119 mR/year, the same as the average value for these stations in 1998 (see Table 4.10). Also, the 1999 average exposure for the nine historically monitored stations was 0.25 mR/day (91 mR/yr), as shown in Table 4.11. The results for these stations for the last six years have been almost identical. Both sets of results indicate that external radiation measured by TLDs has not changed to any measurable extent, at least for the last few years.

OFFSITE RADIOLOGICAL RESULTS

AIR SAMPLING RESULTS

The ASN measures the major radionuclides which could potentially be emitted from activities on the NTS, as well as naturally occurring radionuclides. The ASN results represent the possible inhalation exposure pathway for the general public.

Gamma spectrometry was performed on all samples from the ASN high and low volume air samplers. The majority of the samples were gamma-spectrum negligible (i.e., no gamma-emitting radionuclides detected). Naturally occurring ^{7}Be was detected occasionally by the low-volume network of samplers. It was detected consistently by the high-volume sample method with an average annual activity of 1.6 x 10^{-13} µCi/mL.

GROSS ALPHA

Gross alpha analysis was performed on all low-volume network samples. The average annual gross alpha activity was 2.1 x 10^{-15} µCi/mL (80 µBq/m^3). Summary results for the ASN are shown in Table 4.12.

GROSS BETA

As in previous years, the gross beta results from the low-volume sampling network consistently exceeded the analytical MDC. The annual average gross beta activity was 1.6 ± 0.6 x 10^{-14} µCi/mL (5.9 ± 2.2 x 10^{-4} Bq/m^3). Summary gross beta results for the ASN are in Table 4.13.

PLUTONIUM

High-volume samples were collected monthly and analyzed for plutonium isotopes. Due to a low limit of detection for high-volume sampling and analysis methods, environmental levels of $^{239+240}$Pu were consistently detected at all six of the sampling sites. Sixty-eight samples were analyzed during CY 1999. The overall average annual activity was 0.13 x 10^{-18} µCi/mL (4.8 nBq/m^3) for ^{238}Pu. Only 7 of the 68 samples analyzed for ^{238}Pu had result values greater than the analysis MDC. The average activity for these seven samples was 0.51 x 10^{-18} µCi/mL (18 nBq/m^3). Six of these samples were from the Rachel, Nevada sampling location, and the other sample was collected in Alamo, Nevada. Fifty-four of the 68 samples were above the detection limit for $^{239+240}$Pu. The average activity for this group of samples was 2.9 x 10^{-18} µCi/mL (107 nBq/m^3) for $^{239+240}$Pu. If you exclude the one high sample of 52 x 10^{-18} from Rachel, Nevada, the group average activity drops to 2.0 x 10^{-18} µCi/mL (74 nBq/m^3) for the remaining 53 samples. Summary results of the high-volume data are shown in Table 4.14.

TLD RESULTS FOR STATIONS

Total annual exposure for 1999 ranged from 46 mR (0.46 mSv) per year at Las Vegas, Nevada, to 147 mR (1.47 mSv) per year at Queen City Summit, Nevada, with a mean annual exposure of 28 mR (0.28 mSv) per year for all operating locations. All results are shown in Table 4.15 and are consistent with previous years results.

TLD RESULTS FOR PERSONNEL

Annual whole body dose equivalents ranged from a low of 51 mrem (0.51 mSv) to a high of 175 mrem (1.8 mSv) with a mean of 108 mrem (1.8 mSv) for all monitored personnel during 1999. A summary of the results is shown in Table 4.16. These results are consistent with previous years results. The result for Furnace Creek was not used because it was for one quarter only.

PRESSURIZED ION CHAMBER (PIC) NETWORK

The PIC data presented in this section are based on daily averages of gamma exposure rates from each station. Table 4.17 contains the maximum, minimum, mean, standard deviation, and median of the daily averages for the periods where telemetry data was available during 1999. The table shows the total mR/yr and the average gamma exposure rate for each station during the year. The mean ranged from 72 to 152 mR/yr. Background levels of environmental gamma exposure rates in the United States (from the combined effects of terrestrial and cosmic sources) vary between 49 and 247 mR/yr (BEIR III 1980). The annual exposure levels observed at each PIC station are well within these United States background levels. Data for the remainder of 1999 when telemetry information was unavailable, were collected using chart media. Charts for each station were reviewed weekly for irregularities or increases above normal background levels. No trends or anomalous data were observed in the chart data. Magnetic tape and electronic cartridge data quality have seriously deteriorated during the last several years and do not meet data quality requirements for this report.

NON-NTS BN FACILITY MONITORING

BN facilities that use radioactive sources or radiation-producing equipment with the potential to expose the general population outside the property line to direct radiation are the STL, during operation of the Sealed Tube Neutron Generator and operation of the Febetron; RSL-Andrews, during storage of sealed sources; and Atlas NLVF A-1 Source Range. Sealed sources are tested every six months to ensure there is no leakage of radioactive material. The data from sealed source testing are kept in the BN Radiation Protection Records. Operation of radiation generating devices is controlled by BN procedures. Fence-line radiation monitoring at STL and NLV was conducted during 1999 using Panasonic Type UD-814 TLDs. At least two TLDs were placed at the fence line at a location which would be the closest to radiation sources at these facilities. At RSL-Andrews, all the boundary TLD stations were terminated during fourth quarter 1998. TLDs were exchanged on a quarterly basis with additional control TLDs kept in a shielded safe. The TLD results are given in Table 4.18. The range of results, 45 to 65 mR/yr, is within the background range in the continental United States.

Table 4.1 Summary of the NTS Air and Direct Radiation Surveillance Program - 1999

Sample Type	Description	Collection Frequency	Number of Locations	Type of Analysis
Onsite Monitoring				
Air	Sampling through Whatman GF/A glass fiber filter, 85 L/min .	Weekly	29	Gross alpha and beta, (Gamma spectroscopy, $^{238,239+240}Pu$, monthly composite).
	High-volume sampling	Weekly	6	Gamma spectroscopy, $^{238,239+240}Pu$, monthly composite.
	Low-volume sampling through molecular sieve	Biweekly	12	HTO (tritiated water)
External Gamma Radiation Levels	UD-814AS thermoluminescent dosimeters	Quarterly	85	Total quarterly exposure
Offsite Monitoring				
Air	Sampling through 5-cm glass-fiber filter	Weekly	20	Gamma spectroscopy, gross α & ß
	Sampling through 500-cm^2 glass-fiber filter at 1,100 L/min	Monthly	6	Gamma spectroscopy $^{238,239+240}Pu$
External Gamma Radiation Levels	UD-814AS thermoluminescent dosimeters	Quarterly	38	Quarterly exposure at deployed location
	UD-802 thermoluminescent dosimeters	Quarterly	19	Quarterly exposure of offsite personnel
External Gamma Radiation Rate	Reuter-Stokes Pressurized Ion Chambers	Continuous	17	Continuous rate recording summarized hourly

Table 4.2 Analytical Procedures, Air and TLD - 1999

Analysis	Sample Type Nominal Size	Analytical Procedure	Equipment	Count Time (min)	Estimated MDC
BN Analytical Procedures					
Gross α	Air, 860 m^3	After 5 - 7 days, place in planchet	Gas-flow proportional counter	20	74 µBq/m^3 (2 x 10^{-3} pCi/m^3)
Gross β	Air, 860 m^3	Continue count.	Gas-flow proportional counter	20	150 µBq/m^3 (4 x 10^{-3} pCi/m^3)
Gamma spectrometry composite	Air, 3,400 m^3	Filters placed on planchet, that is placed on crystal	HpGe, calibrated 1 keV per channel,	20	370 µBq/m^3 (1 x 10^{-2} pCi/m^3) for ^{137}Cs
$^{238,239+240}$Pu Monthly Composite	Air, 3,400 m^3	Acid dissolution, ion-exchange, ppt with ^{242}Pu tracer, collect on filter	Alpha spectrometer with solid-state PIP detector	333	0.41 µBq/m^3 (11 x 10^{-6} pCi/m^3)
Tritium	Air, 8 m^3	Moisture trapped on molecular sieve, heat to remove	5 mL in cocktail counted in liquid scintillation counter	70	0.11 Bq/m^3 (3 pCi/m^3)
Ambient gamma	TLD, UD-814AS	Expose in field, 3 months	Automatic TL reader		10 mR per quarter
EPA Analytical Procedures					
Gross α	Air, 560 m^3	After 7-14 days place in planchet	Gas-flow proportional counter	30	30 µBq/m^3 (8 x 10^{-4} pCi/m^3)
Gross β	Air, 560 m^3	After 7-14 days place in planchet	Gas-flow proportional counter	30	90 µBq/m^3 (2.5 x 10^{-3} pCi/m^3)
Gamma spectrometry	Air, 560 m^3 Low-vol 10,000 m^3 High-vol	Place on detector, has online analytical program	HpGe detector, calibrated 0.5 keV/channel from 40 to 2,000 keV	30	2 mBq (0.05 pCi)/m^3 20 µBq (5 x 10^{-4} pCi) per m^3 (Hi-vol), ^{137}Cs
$^{238,239+240}$Pu Monthly Composite	Air, 40,000 m^3	Acid dissolution, ion-exchange, electrodeposition on stainless steel disc with ^{242}Pu tracer	Alpha spectrometer with solid-state PIP detector	1,000	0.02 µBq/m^3 (5.0 x 10^{-7} pCi/m^3)

Table 4.3 NTS Active Air Quality Permits - 1999

Permit	Description	Expiration Date	Annual Reporting
AP9711-0549		02/07/2002	February 1
Area 1 Facilities	Shaker Plant Circuit Rotary Dryer Circuit Wet Aggregate Plant Concrete Batch Plant Sandbag Facility Cedar Rapids Screen Shotcrete Hopper/Conveyor Cambilt Conveyor Commander Crusher Kolberg Screen Plant		
Area 3 Facilities	Mud Plant		
Area 5 Facilities	Navy Thermal Treatment Unit		
Area 6 Facilities	Cementing Equip. (Silos) Decontamination Facility Boiler Diesel Fuel Tank Gasoline Fuel Tank Portable Field Bins Portable Stemming Systems 1 & 2 Diesel Engines (11) Two-Part Epoxy Batch Plant		
Area 12 Facilities	Concrete Batch Plant		
Area 23 Facilities	Building 753 Boiler Diesel Fuel Tank Gasoline Fuel Tank NTS Surface Disturbances Incinerator (Wackenhut)		
AP9711-0556	Area 5 HSC	10/20/2002	February 1
AP9711-0814	Area 11 TaDD Facility	07/21/2003	February 1
AP9711-0785	UGTA Surface Disturbance Permit	03/20/2003	February 1
00-24	Burn Variance, NTS (Training Fires)	03/09/2001	None
00-26	Burn Variance, NTS (EM Drill)	03/21/2001	None
	Non-BN Operated NTS Air Permits		
00-10	Burn Variance Area 27 (LLNL)	02/05/2001	None
	BN Operated Off-NTS Air Permits (TTR and NAFR)		
AP9711-0785	UGTA Class II Air Quality Permit	04/16/04	February 1

Table 4.4 Active Air Quality Permits for Non-NTS Facilities - 1999

Permit	Description	Expiration Date	Annual Reporting
	Remote Sensing Laboratory		
A0034811	Excimer Laser, Lumonics, EX-700	None	June 1
A34801	Boiler, Columbia, W1-180	None	March 1
A34802	Boiler, Columbia, WL-90	None	March 1
A34803	Water Heater, No. 2 Natl. BD	None	March 1
A34804(a)	Emergency Fire Control Pump Engine	None	June 1
A34804(b)	Emergency Generator, Cummins	None	June 1
A34805	Spray Paint Booth	None	June 1
	North Las Vegas Facility		
A38701	Spray Paint Booth (A-16)	None	June 1
A38702	Hamada Offset Press (C-1)	None	June 1
A38703	Emergency Generators (C-1)	None	June 1
A06503	Emergency Generator (A-1/A-5/B-2)	None	June 1
A06505	Aluminum Sander (A-16)	None	June 1
A06507	Trinco Dry Blaster (A-1)	None	June 1

Table 4.5 NTS Radionuclide Emissions - 1999

Onsite Liquid Discharges

Containment Ponds	Curies[(a)] ^{3}H	^{90}Sr	^{137}Cs	^{238}Pu	$^{239+240}Pu$
Area 12, E Tunnel	1.53×10^{1}	3.2×10^{-5}	4.1×10^{-3}	5.5×10^{-6}	4.8×10^{-5}
Area 20, U-20n PS No.1	9.43×10^{0}				
TOTAL	2.47×10^{1}	3.2×10^{-5}	4.1×10^{-3}	5.5×10^{-6}	4.8×10^{-5}

Airborne Effluent Releases - Curies[(a)]

Facility Name	^{3}H[(b)]	$^{239+240}Pu$
Laboratories	5.7×10^{0}	
SCHOONER	6.5×10^{1}	
Area 5, RWMS[(d)]	7.1×10^{0}	
SEDAN Crater [(d)]	2.6×10^{2}	
Areas 3 and 9[(c)]		4.0×10^{-2}
Other Areas[(c)]		2.0×10^{-1}
TOTAL	3.38×10^{2}	2.4×10^{-1}

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

Table 4.6 Summary Data (µCi/mL) for Gross Alpha/Beta, ^{7}Be, and Plutonium in Air - 1999

Location	Gross α (x 10^{-15})	Gross β (x 10^{-14})	^{7}Be (x 10^{-13})	^{238}Pu (x 10^{-18})	$^{239+240}Pu$ (x 10^{-18})
Onsite Air Sampling					
Area 1, BJY	2.4	2.2	2.1	0.27	48
Area 2, 2-1 Substation	2.3	2.2	2.1	0.26	18
Area 3, Bunker 3-300	2.5	2.0	2.0	1.9	140
Area 3, U-3AH/AT N	2.4	1.9	1.9	2.4	210
Area 3, U-3AH/AT S	2.4	2.0	2.1	1.6	180
Area 3, U-3BH N	2.8	2.2	2.1	-0.51	62
Area 3, U-3BH S	2.3	2.0	2.0	0.04	58
Area 3, Well ER 3-1	2.3	2.1	2.1	-0.66	5.5
Area 4, Bunker T-4	2.4	2.2	2.2	8.3	59
Area 5, DOD	2.1	2.1	2.0	0.22	3.6
Area 5, RWMS 4 Northeast	2.5	2.2	2.1	0.07	33
Area 5, RWMS 7 West	2.8	2.2	2.0	-0.43	4.1
Area 5, RWMS 9 South	1.8	1.9	2.1	-0.68	1.7
Area 5, RWMS TRU Bldg N	2.5	2.3	1.9	-0.65	4.4
Area 5, WEF Northeast	2.3	2.2	2.1	-0.09	5.7
Area 5, WEF Southwest	2.3	2.2	2.1	0.10	7.3
Area 6, Yucca	2.2	2.2	2.2	0.23	21
Area 7, UE7NS	2.0	2.1	2.1	-0.40	14
Area 9, Bunker 9-300	4.6	2.1	2.2	14.00	1300
Area 10, SEDAN Crater	2.4	2.2	2.2	3.50	45
Area 15, EPA Farm	2.5	2.1	2.1	-0.12	11
Area 18, LITTLE FELLER 2 N	2.1	2.0	2.0	-0.37	8.9
Area 20, CABRIOLET	2.1	1.9	2.0	0.99	2.6
Area 20, SCHOONER	2.1	2.1	2.0	2.10	12
Area 25, E-MAD N	2.3	2.1	2.1	-0.37	6.2
Average	2.5	2.1	2.1	1.4	100
Near Offsite Air Sampling					
Area 13, PROJECT 57	2.1	1.4	1.4	1.93	140
Area 52, CLEAN SLATE II	2.8	1.8	1.5	0.75	120
Area 52, CLEAN SLATE III	3.3	2.2	1.7	-0.52	7.2
Area 52, DOUBLE TRACKS	2.1	1.7	1.7	0.31	1.5
Average	2.5	1.7	1.6	0.82	84
Median MDC	1.8	0.40	0.22	11.	11
Offsite Air Sampling					
Alamo	--	--	1.6	0.40	2.5
Amargosa Center	--	--	1.7	0.02	1.3
Beatty	--	--	1.7	0.04	2.7
Goldfield	--	--	1.6	0.08	0.96
Indian Springs	--	--	1.5	0.03	2.3
Rachel	--	--	1.6	0.41	28
Average	--	--	1.6	0.16	6.2
Median MDC	--	--	0.035	0.92	0.92

Table 4.7 Airborne Tritium Concentrations on the NTS - 1999

		^{3}H Concentration (10^{-6} pCi/mL)				
		Onsite				
Location	Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG
Area 1, BJY	30	20	-1.3	3.0	4.5	0.030
Area 5, RWMS NE (4)	25	15	0.66	4.3	3.7	0.043
Area 5, RWMS S (9)	31	10	-0.92	1.6	2.5	0.016
Area 5, RWMS W (7)	32	12	-1.8	1.7	3.0	0.017
Area 5, WEF NE	30	52	-0.61	3.2	9.5	0.032
Area 5, Well 5B	31	1.9	-2.3	0.12	0.89	<0.01
Area 6, Decon Pad	3	4.2	2.2	3.4	1.0	0.034
Area 10, SEDAN Crater	31	41	1.5	16	12	0.16
Area 12, E Tunnel Pond No. 2	21	54	2.6	20	15	0.20
Area 12, Stake T-18	20	2.3	-2.1	0.28	0.88	<0.01
Area 15, EPA Farm	32	27	3.8	11	4.2	0.11
Area 20, Schooner	31	750	12	200	233	2.0
All Stations	322	750	-2.3	25	88	0.25
		Offsite				
Amargosa Valley	8	29	-0.58	3.8	10	0.038
Indian Springs	8	11	-0.53	3.9	5.3	0.039

Median MDC was 2.5×10^{-6} pCi/mL

Table 4.8 Mean Air Monitoring Results for Various Radionuclides at the RWMS-3, 1995 - 1999

Year	$^{239+240}$Pu ($\times 10^{-17}$ µCi/mL)	^{238}Pu ($\times 10^{-17}$ µCi/mL)	Tritium ($\times 10^{-12}$ µCi/mL)
Arithmetic Mean 1999	13	0.09	(a)
Arithmetic Mean 1998	4.2	0.08	(a)
Arithmetic Mean 1997	3.8	0.06	1.2
Arithmetic Mean 1996	16	0.25	0.5
Arithmetic Mean 1995	8.8	0.16	(a)
Mean MDC	1.1	0.99	2.8
Derived Concentration Guide	200	300	10,000

(a) Sampling for tritium was stopped at the end of 1997 due to concentrations less than the MDC.

Table 4.9 Mean Air Monitoring Results for Various Radionuclides at the RWMS-5, 1995 - 1999

Year	$^{239+240}$Pu ($\times 10^{-17}$ µCi/mL)	^{238}Pu ($\times 10^{-17}$ µCi/mL)	Tritium ($\times 10^{-12}$ µCi/mL)
Arithmetic Mean 1999	1.0	-0.02	2.7
Arithmetic Mean 1998	1.3	0.03	4.0
Arithmetic Mean 1997	0.23	0.03	3.7
Arithmetic Mean 1996	0.51	0.02	3.2
Arithmetic Mean 1995	0.6	0.01	5.7
Mean MDC	1.1	0.99	2.9
Derived Concentration Guide	200	300	10,000

Table 4.10 NTS Boundary Gamma Monitoring Results - 1999

Location	First Quarter (mR/day)	Second Quarter (mR/day)	Third Quarter (mR/day)	Fourth Quarter (mR/day)	Annual Average (mR/d)	Annual Average (mR/yr)
U-15E Substation	0.24	0.25	0.25	0.24	0.25	90
Stake J-41	0.34	0.35	0.36	0.35	0.35	130
Stake LC-4	0.42	0.44	0.44	0.41	0.43	160
Stake A-118	0.37	0.40	0.40	0.39	0.39	140
Papoose Lake Road	0.21	0.21	0.21	0.21	0.21	76
Gate 19-3P	0.43	0.41	0.42	0.40	0.42	150
Army Well No. 1	0.21	(a)	0.20	0.20	0.20	75
3.3 Miles SE of Aggregate Pit	0.16	0.15	0.15	0.15	0.15	57
Guard Station 510	0.33	(a)	0.32	0.31	0.32	120
Yucca Mountain	0.37	(a)	0.35	0.33	0.35	130
Cat Canyon/Buggy Rd	0.47	0.45	0.47	0.47	0.47	170
Gold Meadows	0.34	0.35	0.37	0.34	0.35	130
Well ER 3-1	0.32	0.34	0.33	0.31	0.33	120

(a) Results lost due to human error.

Table 4.11 NTS Historical TLD Station Comparisons, 1992-1999

Area	Station	Exposure Rate (mR/day) 1993	1994	1995	1996	1997	1998	1999
5	Well 5B	0.39	0.34	0.30	0.30	0.30	0.29	0.29
6	CP-6	0.30	0.19	0.19	0.21	0.20	0.19	0.25
6	Yucca Oil Storage	0.37	0.27	0.26	0.28	0.28	0.26	0.31
23	Building 650 Dosimetry	0.26	0.15	0.15	0.14	0.16	0.15	0.15
23	Building 650 Roof	0.25	0.14	0.15	0.14	0.16	0.14	0.14
23	Post Office	0.30	0.21	0.20	0.18	0.20	0.18	0.18
25	HENRE Site	0.45	0.32	0.33	0.34	0.32	0.32	0.31
25	NRDS Warehouse	0.46	0.33	0.36	0.32	0.33	0.32	0.31
27	Cafeteria	0.46	0.33	0.33	0.34	0.37	0.34	0.35
Network Average		0.36	0.25	0.25	0.25	0.26	0.24	0.25

Table 4.12 Gross Alpha Results for the Offsite Air Surveillance Network - 1999

Sampling Location	Number	Concentration (10^{-15} µCi/mL [37 µBq/m^3]) Maximum	Minimum	Mean	Standard Deviation
Alamo	52	7.6	0.1	2.6	1.7
Amargosa Center	52	4.7	0.2	1.5	0.9
Beatty	51	7.6	0.9	2.5	1.6
Boulder City	52	5.5	0.0	1.8	1.1
Caliente	49	5.2	0.3	1.9	1.0
Cedar City	49	7.6	0.9	3.4	1.5

Mean MDC = 7.6 x 10^{-16} µCi/mL Standard Deviation of Mean MDC = 2.3 x 10^{-16} µCi/mL

Table 4.12 (Gross Alpha Results for the Offsite Air Surveillance Network - 1999, cont.)

Sampling Location	Concentration (10^{-15} µCi/mL [37 µBq/m^3]) Number	Maximum	Minimum	Mean	Standard Deviation
Delta	51	6.4	0.5	1.8	1.1
Goldfield	52	6.6	0.2	2.3	1.9
Henderson	50	9.5	0.8	2.8	1.7
Indian Springs	51	5.4	-0.1	1.4	0.9
Las Vegas	51	4.9	0.4	1.7	1.0
Milford	51	7.0	0.6	2.3	1.3
Overton	52	5.3	0.2	2.6	1.3
Pahrump	51	3.2	0.3	1.3	0.6
Pioche	45	3.0	-0.2	1.3	0.8
Rachel	52	5.3	-0.4	2.0	1.2
St. George	51	10.5	0.6	3.2	2.2
Stone Cabin	51	7.6	0.2	2.4	1.2
Tonopah	52	8.2	0.4	2.2	1.7
Twin Springs	52	5.5	0.3	1.9	1.2

Mean MDC = 7.6 x 10^{-16} µCi/mL   Standard Deviation of Mean MDC = 2.3 x 10^{-16} µCi/mL

Table 4.13 Gross Beta Results for the Offsite Air Surveillance Network - 1999

Sampling Location	Concentration (10^{-14} µCi/mL [0.37 mBq/m^3]) Number	Maximum	Minimum	Mean	Standard Deviation
Alamo	52	2.8	0.5	1.4	0.4
Amargosa Center	52	3.5	0.3	1.5	0.6
Beatty	51	3.4	0.5	1.7	0.6
Boulder City	52	4.3	0.7	1.6	0.7
Caliente	49	5.2	0.1	1.9	0.8
Cedar City	49	2.7	0.4	1.5	0.4
Clark Station	51	3.0	0.4	1.6	0.5
Delta	51	3.9	0.2	1.7	0.7
Goldfield	52	2.8	0.3	1.4	0.5
Henderson	50	3.0	0.8	1.6	0.4
Indian Springs	51	2.6	-0.2	1.5	0.5
Las Vegas	51	2.6	0.5	1.5	0.5
Milford	51	4.1	0.3	1.8	0.8
Overton	52	3.4	0.5	1.7	0.6
Pahrump	51	2.5	0.6	1.5	0.3
Pioche	45	3.1	0.6	1.6	0.5
Rachel	52	3.2	-0.1	1.6	0.6
St. George	51	3.8	0.2	1.7	0.7
Tonopah	52	2.4	0.5	1.3	0.4
Warm Springs	52	3.5	0.2	1.7	0.7

Mean MDC = 2.41 x 10^{-15} µCi/mL   Standard Deviation of Mean MDC = 0.31 x 10^{-15} µCi/mL

Table 4.14 Plutonium Results for the Offsite Hi-Volume Air Surveillance Network - 1999

^{238}Pu Concentration (10^{-18} µCi/mL)

Sampling Location	Number	Maximum	Minimum	Mean	Standard Deviation	%DCG[(a)]
Alamo	12	0.40	-0.06	0.15	0.16	(b)
Amargosa Center	9	0.18	0.00	0.07	0.07	(b)
Goldfield	11	0.38	-0.11	0.11	0.17	(b)
Las Vegas	11	0.19	-0.07	0.06	0.08	(b)
Rachel	12	1.1	0.01	0.33	0.30	(b)
Tonopah	12	0.21	-0.07	0.06	0.09	(b)

Mean MDC = 0.40 x 10^{-18} µCi/mL Standard Deviation of Mean MDC = 0.17 x 10^{-18} µCi/mL

(a) Derived Concentration Guide; Established by DOE Order as 2 x 10^{-15} µCi/mL.
(b) Not applicable, result less than MDC.
Note: To convert µCi/mL to Bq/m^3 multiply by 3.7 x 10^{10} (e.g., [0.43 x 10^{-18}] x [3.7 x 10^{10}] = 52 nBq/m^3).

$^{239+240}$Pu Concentration (10^{-18} µCi/mL)

Sampling Location	Number	Maximum	Minimum	Mean	Standard Deviation	%DCG[(a)]
Alamo	6	7.0	0.28	1.6	1.8	0.05
Amargosa Center	9	3.2	0.54	1.7	0.92	0.06
Goldfield	11	2.6	0.44	1.1	0.75	0.04
Las Vegas	11	9.1	0.17	1.5	2.6	0.05
Rachel	12	52	0.12	7.7	14	0.26
Tonopah	12	1.5	-0.05	0.64	0.51	0.02

Mean MDC = 0.44 x 10^{-18} µCi/mL Standard Deviation of Mean MDC = 0.20 x 10^{-18} µCi/mL

(a) Derived Concentration Guide; Established by DOE Order as 3 x 10^{-15} µCi/mL.
Note: To convert µCi/mL to Bq/m^3 multiply by 3.7 x 10^{10} (e.g., [1.4 x 10^{-18}] x [3.7 x 10^{10}] = 52 nBq/m^3).

Table 4.15 TLD Monitoring Results for Offsite Stations - 1999

Station Name	Daily Exposure (mR) Min	Max	Mean	Total (mR) Exposure
Alamo, NV	0.20	0.42	0.29	106
Amargosa Center, NV	0.18	0.35	0.26	95
Beatty, NV	0.23	0.44	0.33	119
Blue Jay, NV	0.26	0.54	0.36	113
Boulder City, NV	0.17	0.38	0.24	88
Caliente, NV	0.19	0.43	0.30	109
Cedar City, UT	0.15	0.34	0.24	87
Complex I, NV	0.22	0.52	0.30	109
Coyote Summit, NV	0.28	0.58	0.38	137
Delta, UT	0.17	0.38	0.27	100
Furnace Creek, CA	0.16	0.28	0.05	18
Goldfield, NV	0.20	0.42	0.29	107
Groom Lake, NV	0.18	0.44	0.27	97
Henderson (CCSN), NV	0.20	0.36	0.27	99
Hiko, NV	0.15	0.35	0.23	84
Indian Springs, NV	0.16	0.35	0.23	84

Table 4.15 (TLD Monitoring Results for Offsite Stations - 1999, cont.)

Station Name	Daily Exposure (mR) Min	Max	Mean	Total (mR) Exposure
Las Vegas, NV (UNLV)	0.13	0.26	0.13	46
Lund, NV	0.21	0.52	0.30	110
Lund, UT	0.22	0.46	0.34	125
Medlins Ranch, NV	0.23	0.52	0.35	127
Mesquite, NV	0.15	1.82	0.22	80
Milford, UT	0.24	0.50	0.35	129
Moapa, NV	0.19	0.37	0.28	102
Nyala, NV	0.17	0.42	0.27	99
Overton, NV	0.15	0.34	0.22	79
Pahrump, NV	0.12	0.25	0.18	65
Pioche, NV	0.18	0.44	0.27	97
Queen City Summit, NV	0.29	0.66	0.40	147
Rachel, NV	0.23	0.49	0.35	127
Sacorbatus Flats, NV	0.23	0.49	0.35	128
St. George, UT	0.13	0.28	0.20	72
Stone Cabin, NV	0.03	0.54	0.33	120
Sunnyside, NV	0.16	0.37	0.24	87
Tonopah Test Range, NV	0.25	0.55	0.37	135
Tonopah, NV	0.24	0.58	0.36	131
Twin Springs, NV	0.24	0.43	0.34	125
Uhaldes Ranch, NV	0.11	0.51	0.17	62
Warm Springs No. 1, NV	0.20	0.43	0.24	86

Table 4.16 TLD Monitoring Results for Offsite Personnel - 1999

Personnel ID No.	Associated Station Name	Number of Days	Daily Deep Dose Exposure (mrem) Min	Max	Mean	Total Annual Exposure
022	Alamo, NV	274	0.20	0.35	0.28	102
038	Beatty, NV	274	0.40	0.56	0.48	175
293	Pioche, NV	274	0.18	0.26	0.22	80
344	Delta, UT	274	0.28	0.29	0.28	102
345	Delta, UT	274	0.27	0.47	0.36	132
346	Milford, UT	274	0.25	0.46	0.35	128
347	Milford, UT	274	0.21	0.46	0.35	128
348	Overton, NV	274	0.20	0.36	0.27	99
427	Alamo, NV	274	0.21	0.36	0.29	106
592	Rachel, NV	183	0.14	0.14	0.14	51
593	Cedar City, UT	274	0.21	0.33	0.26	95
595	Las Vegas, NV	274	0.14	0.30	0.23	84
596	Las Vegas, NV	274	0.11	0.28	0.22	80
607	Tonopah, NV	274	0.37	0.50	0.43	157
608	Logandale, NV	274	0.18	0.33	0.25	91
610	Caliente, NV	274	0.34	0.41	0.37	135
621	Indian Springs, NV	274	0.17	0.31	0.24	88
655	Boulder City, NV	274	0.25	0.33	0.28	102
656	Henderson, NV	274	0.23	0.42	0.30	110

Table 4.17 Summary of Gamma Exposure Rates as Measured by PIC - 1999

Station	Gamma Exposure Rate (µR/hr) Max	Min	Standard Deviation	Average	mR/yr
Alamo	14.5	10.4	0.51	12.5	110
Amargosa	14.7	6.5	0.58	10.7	94
Beatty	19.6	15.3	0.35	16.3	143
Boulder City	15.0	10.7	0.26	11.4	100
Caliente	16.9	13.4	0.45	14.5	127
Cedar City	14.0	8.6	0.34	9.7	85
Complex I	No data - discontinued in fall of 1998				
Delta	14.3	10.0	0.57	11.6	102
Furnace Creek	No data - discontinued in fall of 1998				
Henderson	16.1	12.2	0.31	13.2	116
Goldfield	21.6	13.5	0.54	15.2	133
Indian Springs	14.9	9.9	0.48	11.1	97
Las Vegas	10.8	8.9	0.22	9.6	84
Medlin's	No data - discontinued in fall of 1998				
Milford	19.8	14.6	0.62	17.2	151
Nyala	No data - discontinued in fall of 1998				
Overton	11.3	6.5	0.56	9.0	79
Pahrump	14.5	5.5	0.35	8.2	72
Pioche	No data - discontinued in fall of 1998				
Rachel	22.8	14.5	0.63	16.6	146
St. George	10.4	7.5	0.37	8.3	73
Stone Cabin	No data - discontinued in fall of 1998				
Terrel's	No data - discontinued in fall of 1998				
Tonopah	19.4	15	0.80	17.3	152
Twin Springs	No data - discontinued in fall of 1998				
Uhalde's	No data - discontinued in fall of 1998				

Table 4.18 BN Offsite Boundary Monitoring Data - 1999

Station ID No.	Description	1st Qtr (mR)	2nd Qtr (mR)	3rd Qtr (mR)	4th Qtr (mR)	1999 (mR)
	North Las Vegas Facility					
LV-100	North Fence of Bldg. A-1	12.4	14.4	15.3	19.5	61.6
LV-101	North Fence of Bldg. A-1	12.4	14.9	14.8	19.8	61.9
LV-C1	Control	7.95	9.79	11.6	15.8	45.1
LV-C2	Control	8.25	10.4	11.0	16.0	45.7
	Special Technologies Laboratory					
ST-122	Bldg. 5540, Room 117, CF Well	17.0	[(b)]	[(b)]	[(b)]	[(c)]
ST-123	Bldg. 5540, Room 114, North Wall	16.7	[(b)]	[(b)]	[(b)]	[(c)]

Table 4.18 (BN Offsite Boundary Monitoring Data - 1999, cont.)

Station ID No.	Description	1st Qtr (mR)	2nd Qtr (mR)	3rd Qtr (mR)	4th Qtr (mR)	1999 (mR)
			Special Technologies Laboratory (cont.)			
ST-124	Bldg. 5540, Room 114, North Wall	16.4	(b)	(b))	(b)	(c)
ST-125	Bldg. 5540, Room 114, East Wall	17.8	(b)	(b)	(b)	(c)
ST-126	Bldg. 5540, Room 114, East Wall	19.0	(b)	(b)	(b)	(c)
ST-127	Bldg. 5540, Room 114, East Wall	19.0	(b)	(b)	(b)	(c)
ST-128	Bldg. 5540, Corridor Ceiling, Room 110	16.7	(b)	(b)	(b)	(c)
ST-129	Bldg. 5540, Corridor Ceiling, Room 110	16.4	(b)	(b)	(b)	(c)
ST-130	Bldg. 5540, Corridor Ceiling, Room 110	16.7	(b)	(b)	(b)	(c)
ST-131	Bldg. 5540, Room 117, East Wall	18.4	(b)	(b)	(b)	(c)
ST-132	Bldg. 5540, Room 117, East Wall	18.7	(b)	(b)	(b)	(c)
ST-133	Bldg. 5540, Room 117, East Wall	18.4	(b)	(b)	(b)	(c)
ST-134	Bldg. 5540, Room 114, Overhead	17.0	(b)	(b)	(b)	(c)
ST-135	Bldg. 5540, Room 114, Overhead	17.5	(b)	(b)	(b)	(c)
ST-136	Bldg. 5540, Room 114 Overhead	17.5	(b)	(b)	(b)	(c)
ST-137	Bldg. 5540, Room 114, CF Well&Vaults	21.1	20.2	(a)	19.2	60.5(d)
ST-141	Bldg. 227, Rear on Fence	21.4	18.7	(a)	24.8	64.9(d)
ST-199	Bldg. 229-C, Left Side of Sliding Gate	18.4	17.8	(a)	24.0	60.2(d)
ST-200	Bldg. 229-C, Left Side of Sliding Gate	18.4	18.6	(a)	23.6	60.6(d)
ST-209	Bldg. 227, Behind CF Shed	17.0	16.9	(a)	22.2	56.1(d)
ST-210	Bldg. 227, Behind CF Shed	17.8	16.9	(a)	22.0	56.7(d)
ST-215	Bldg. 228, Crime Lab Window Sill	15.8	15.4	(a)	22.0	53.2(d)
ST-216	Bldg. 228, Crime Lab Window Sill	17.3	16.0	(A)	22.0	55.3(d)
ST-C1	Control 1	13.4	13.6	(a)	17.5	44.5(d)
ST-C2	Control 2	12.8	14.2	(a)	16.3	43.3(d)

(a) Results lost due to procedural error.
(b) Station terminated.
(c) Annual sum not possible due to missing quarterly results.
(d) Sum of only three quarters.