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SANDIA REPORT

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Site Environmental Report for 1995

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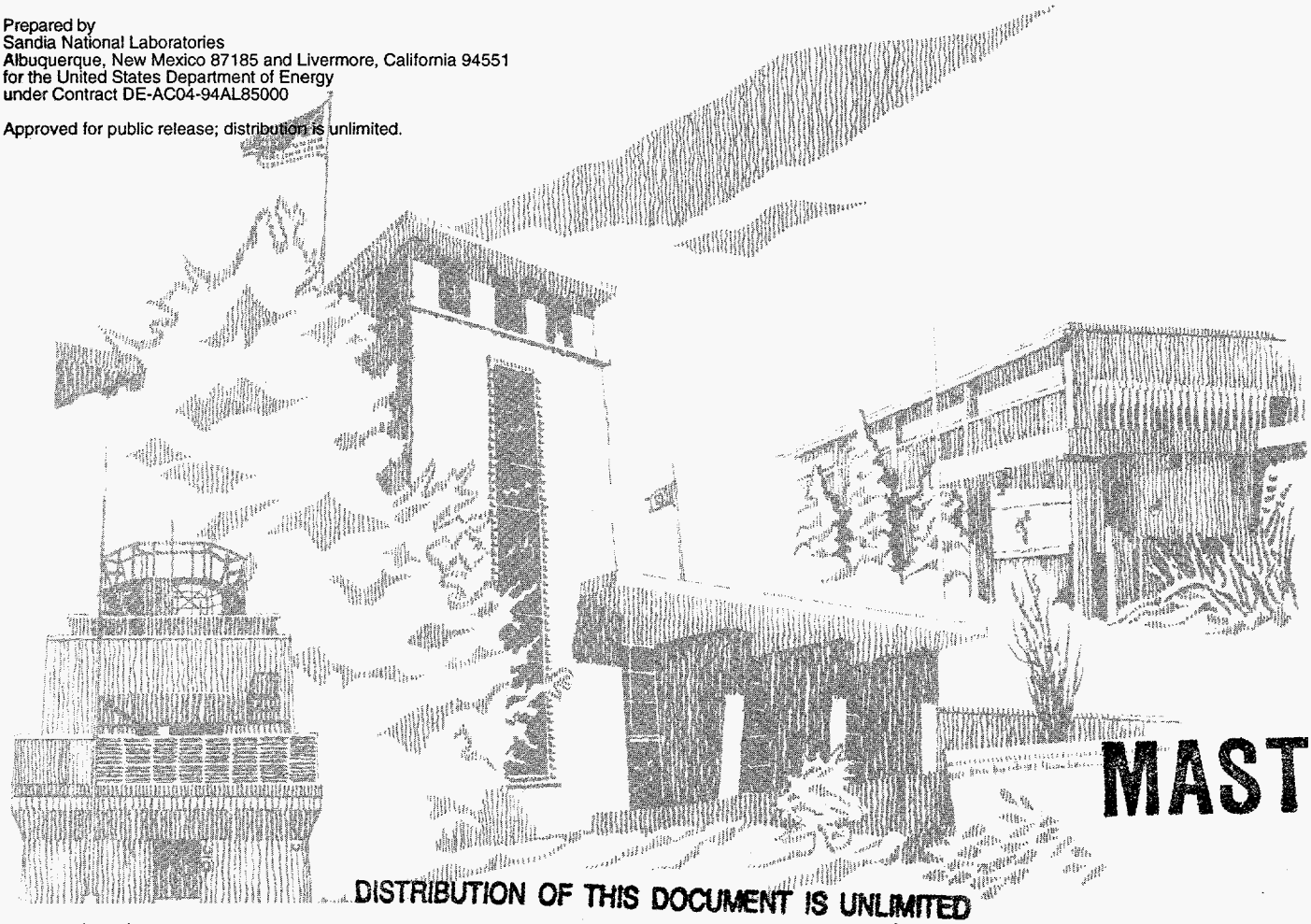

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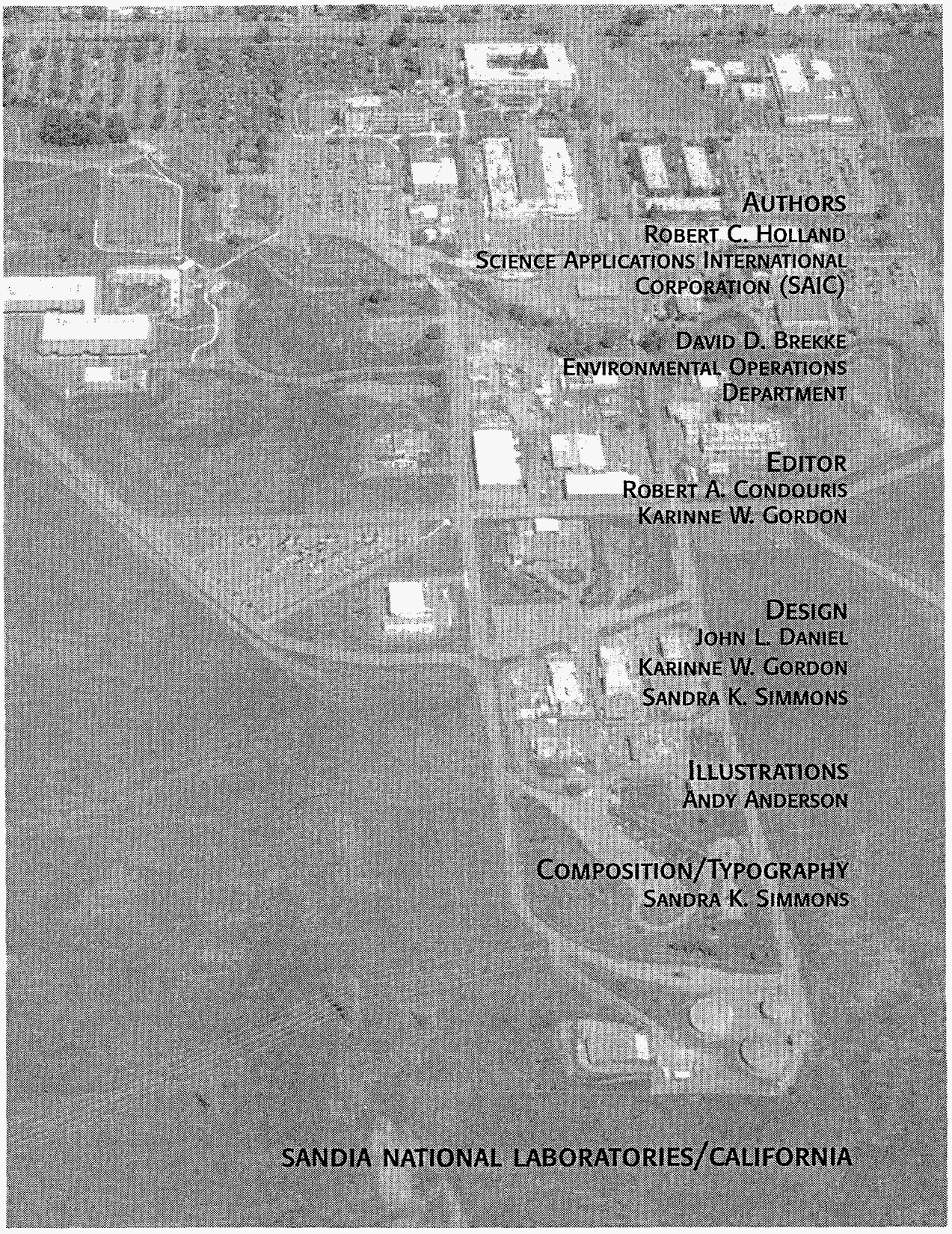

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PREFACE

The U.S. Department of Energy (DOE) Order 5400.1, *General Environmental Protection Programs*, establishes requirements for environmental protection programs at DOE sites, including Sandia National Laboratories (SNL). These programs ensure that DOE operations comply with Federal, State, and local environmental laws and regulations, as well as DOE orders and policies. To comply with DOE Order 5400.1, SNL/California has prepared the *Environmental Protection Implementation Plan*. This document provides the framework for SNL/California to implement the DOE's environmental protection goals and to comply with environmental regulations.

To verify effective protection of the environment, SNL/California maintains extensive effluent monitoring and environmental surveillance programs. These programs collect the information necessary to assess how effective pollution control measures are and to characterize the site's impact on the environment. The monitoring program routinely measures the levels of pollutants and radioactive material around the Sandia site and surrounding area. Much of the off-site environmental monitoring data in this report were collected by Lawrence Livermore National Laboratory (LLNL), which monitors outlying areas for both facilities. The SNL/California *Environmental Monitoring Plan* identifies the operations and emissions at the site and describes the effluent monitoring and environmental surveillance programs and activities. These programs and activities are in place to protect the public and the environment. The plan describes exposure pathways (potential routes of human exposure to pollutants), sampling and analysis procedures, radiation dose assessment methods, and quality assurance activities.

The SNL/California Environmental Operations Department is responsible for all environmental programs and activities, including reporting requirements. Environmental staff maintain various documents describing specific program areas. These documents are referenced in this report, as appropriate.

The SNL/California Environmental Operations Department prepares the *Site Environmental Report* annually, as required by the DOE and other regulatory agencies. It describes the results of SNL/California's environmental protection activities during the calendar year. It also summarizes environmental monitoring data and highlights major environmental programs. Overall, it evaluates SNL/California's environmental management performance and documents the site's regulatory compliance status.

Most importantly, the *Site Environmental Report* serves the needs of the public. It is a key element in our communication with the local community. For this reason, the report contains two summary chapters: Chapter 1, "Executive Summary," and Chapter 3, "Compliance Summary," which highlight and interpret environmental findings and regulatory compliance for the year. These summaries are written for the layperson and use a minimum of technical terminology. However, we have also included an extensive glossary in the back of the report. It defines acronyms, abbreviations, and technical terms. It also describes radiological nomenclature and conversion information for units used in the report.

The body of the report is a comprehensive description of environmental activities. It provides substantial background information and covers all major environmental programs at SNL/California.

From 1990 through 1995, SNL/California cooperated with the State of California to provide additional independent environmental surveillance around the DOE sites in Livermore. This effort (referred to as the "Agreement in Principle") allowed the State Department of Health Services to independently

monitor the environment around SNL/California and LLNL. The purpose of this agreement was to provide local citizens added assurance that their health and their environment are being protected adequately. In 1995, the State of California decided to end its participation in this program.

In October 1992, the DOE adopted a public participation policy, which commits to providing the public an opportunity to become involved in the decision-making process for environmental restoration and waste management activities. To implement this program, SNL/California has developed a formal public participation program. This program helps keep the local community members informed of matters that affect them. It also helps the DOE address public values and concerns. As a good corporate citizen, SNL/California has a long-standing policy of openness with the local community, which includes public meetings, site tours, and informational bulletins. Our formal public participation program is designed to further foster cooperation with our neighbors.

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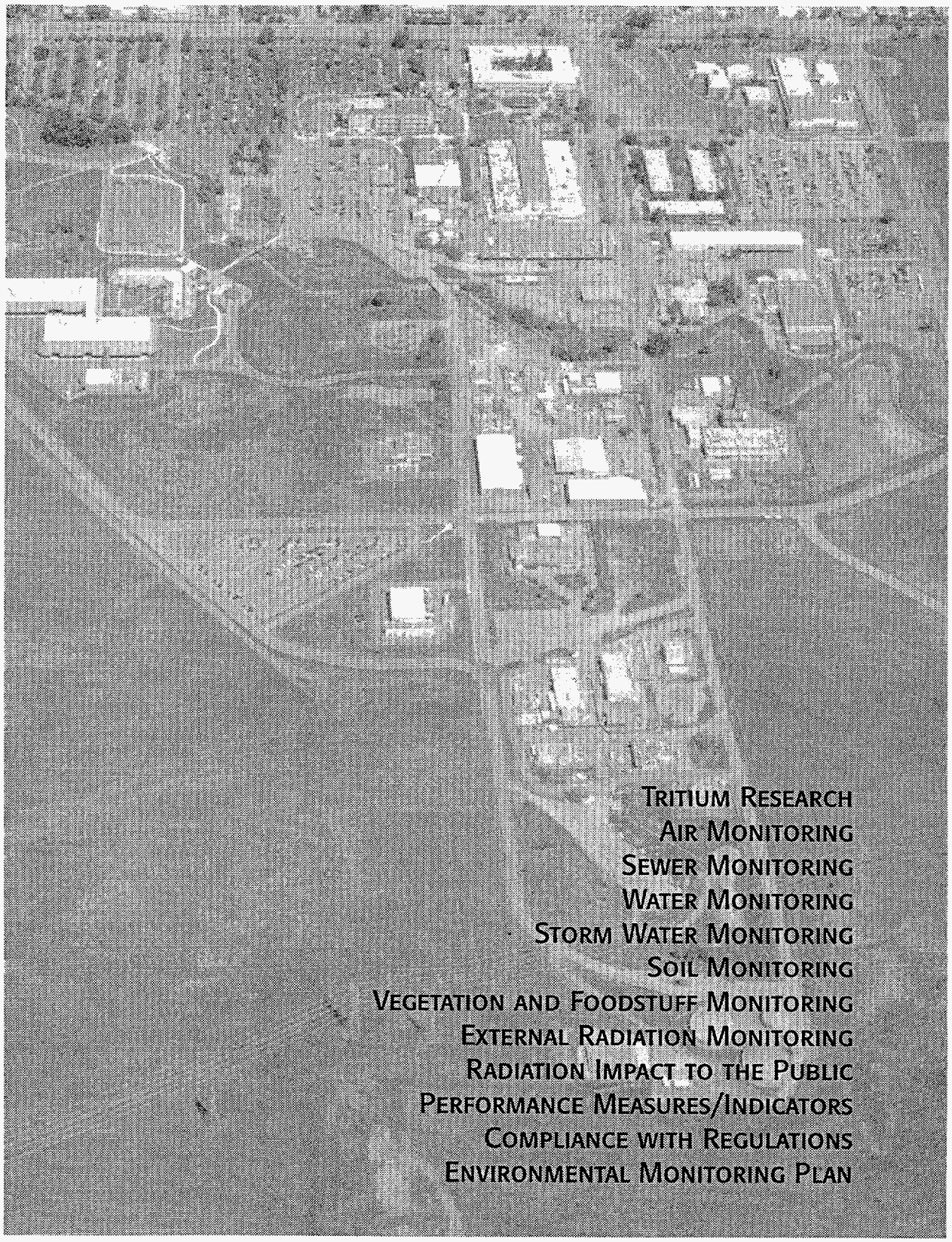

Tritium Research
Air Monitoring
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Vegetation and Foodstuff Monitoring
External Radiation Monitoring
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Environmental Monitoring Plan

Sandia National Laboratories (SNL) is committed to conducting its operations in an environmentally safe and sound manner. It is mandatory that activities at SNL/California comply with all applicable environmental statutes, regulations, and standards. Moreover, SNL/California continuously strives to reduce risks to employees, the public, and the environment to the lowest levels reasonably possible.

To help verify effective protection of public safety and preservation of the environment, SNL/California maintains an extensive, ongoing environmental monitoring program. This program monitors all significant airborne and liquid effluents and the environment at the SNL/California site perimeter. Lawrence Livermore National Laboratory (LLNL) performs off-site environmental monitoring for both sites. These monitoring efforts ensure that emission controls are effective in preventing contamination of the environment.

As part of SNL/California's Environmental Monitoring Program, an environmental surveillance system measures the possible presence of radioactive and hazardous materials in ambient air, surface water, groundwater, sewage, soil, vegetation, and locally produced foodstuffs. The program also includes an extensive environmental dosimetry program, which measures external radiation levels around the Livermore site and nearby vicinity.

Each year, the results of the Environmental Monitoring Program are published in this report, the *Site Environmental Report.* This executive summary focuses on impacts to the environment and estimated radiation doses to the public from site emissions. Chapter 3, "Compliance Summary," reviews the site's various environmental protection activities and compliance status with applicable environmental regulations.

The effluent monitoring and environmental surveillance results for 1995 show that SNL/California operations had no harmful effects on the environment or the public. A summary of the monitoring findings is provided below.

TRITIUM RESEARCH

SNL/California no longer has any nuclear facilities at its site. Furthermore, there are no appreciable radiological emissions to the environment. Tritium has been the only radionuclide discharged to the environment in measurable quantities from site operations for the past several years. Essentially all the tritium operations were conducted at the former Tritium Research Laboratory. In September 1993, the DOE approved SNL's plan to eliminate tritium activities at the Livermore, California, site; tritium experimentation concluded that same year.

SNL/California initiated an in-house cleanup and transition project for the Tritium Research Laboratory in 1993. The removal of available tritium was completed on October 18, 1994. Consequently, there is no accountable tritium remaining at the Tritium Research Laboratory. On November 10, 1994, the DOE reclassified it as a Non-Nuclear, Low-Hazard Facility. The final cleanup of the facility was completed in early 1996. SNL/CA is continuing to use this facility for non-nuclear laboratory operations, but its future mission has not yet been fully defined.

AIR MONITORING

Ambient air is the primary potential exposure pathway to the public from radionuclides emitted from SNL/California operations. Samples of ambient air are collected at the site perimeter and around the Livermore Valley.

During 1995, airborne contaminant concentrations measured at the Livermore site perimeter* and nearby vicinity complied with all applicable air quality standards. The only radionuclide that has been emitted to the atmosphere by SNL/California that requires routine air monitoring is tritium. The highest annual average tritium concentration in air measured at the Livermore site perimeter was approximately 19.2 pCi/m^3 (0.71 Bq/m^3).** This level represents 0.02% of the DOE derived concentration guide—the allowable radionuclide air concentration established by the DOE for protection of the public. The highest annual average tritium concentration measured in air off-site in the Livermore Valley was approximately 1.04 pCi/m^3 (3.8×10^{-2} Bq/m^3).

Both SNL/California and LLNL discharge small quantities of tritium to the atmosphere as a result of routine operations and clean-up activities. Consequently, the tritium measured in ambient air can be attributed to operations at both sites and to natural background sources.

SEWER MONITORING

The sanitary sewer effluent from the SNL/California site is monitored continuously and sampled weekly to ensure compliance with Federal, State, and local wastewater discharge limits. Moreover, SNL/California strives to minimize liquid effluents to the lowest levels possible.

In 1995, all liquid effluent from the Sandia sanitary sewer outfall complied with the site outfall discharge limits for regulated physical parameters, radionuclides, and Environmental Protection Agency (EPA) priority organic pollutants. A wastewater sample collected at the site outfall on June 26, 1995, was slightly above the discharge limit for silver. A wastewater sample collected at the site outfall on August 3, 1995, was slightly above the discharge limit for zinc. However, these concentrations did not adversely affect operations at the Livermore Water Reclamation Plant.

SNL/California also has a special monitoring program for "categorical processes" subject to EPA wastewater pretreatment standards (Title 40 CFR, Part 433).[1] In 1995, all the liquid effluents from these processes complied with pretreatment discharge standards for metals and organic pollutants. One of SNL/California's "categorical processes"—the Electroplating Laboratory—was relocated in 1995. It is now a closed-loop process and no longer discharges to the sanitary sewer.

The DOE and the State of California have established allowable limits for discharging radionuclides into a public sewer system (see Chapter 4).[2] These limits have been derived to protect the public and the environment. In 1995, the only radionuclide discharged to the sanitary sewer system in detectable amounts was tritium. A total of 0.024 Ci tritium was discharged as a result of routine operations. This level is only 0.5% of the State allowable limit. Moreover, the average tritium concentration in the SNL/California sewer effluent in 1995 was about 5 times below the DOE allowable limit for discharge to the sanitary sewer.

WATER MONITORING

All major surface-water bodies near the site (except the San Antonio Reservoir) are monitored routinely for tritium activity. The highest annual average tritium concentration observed off-site in water in 1995, 53.0 pCi/L (2.0 Bq/L), was 0.3% of the California Environmental Protection Agency's (Cal/EPA) drinking water standard for tritium in public

* *In this report, the "Livermore site perimeter" refers to both LLNL and SNL/California.*

** *The picocurie (pCi) is a commonly used English unit for measuring levels of environmental radiation. The becquerel (Bq) is a commonly used SI unit (International System of Units) for measuring radiation. These units are defined in the glossary.*

drinking water (20,000 pCi/L).[3] Furthermore, all surface water samples collected in 1995 had tritium levels much lower than the drinking water standard.

Groundwater samples are collected from monitoring wells at the Livermore Water Reclamation Plant. Tritium concentrations in wells downgradient of the plant were slightly higher than other groundwater samples. Even though these wells monitor an aquifer not used as a drinking water source, the tritium levels were still well below the State drinking water standard. The elevated values are due to the Livermore Water Reclamation Plant's past practice of discharging the plant effluent to the Arroyo Las Positas. This practice was discontinued several years ago, and the tritium concentrations have decreased since that time. Now, the tritium levels in the environment are primarily attributable to emissions from both SNL/California and LLNL, as well as to natural background.

Rainwater samples are collected at locations near the SNL/California site and in the Livermore Valley. The highest annual average tritium concentration measured in rainfall in 1995 was 252 pCi/L (9.3 Bq/L) at the LLNL Salvage Yard. This value represents 1.3% of the drinking water standard.

Storm Water Monitoring

A State-issued general industrial storm water National Pollutant Discharge Elimination System (NPDES) permit and a City of Livermore ordinance require SNL/California to eliminate non-storm water discharges and reduce pollutant discharge to the storm drain system to the maximum extent practicable. To comply with these requirements, SNL/California conducts a variety of sampling, monitoring, and inspection activities throughout the year. Storm water runoff is sampled and visually inspected during the wet months. Storm drain outfalls also are inspected during dry weather to make sure that no water is flowing in the storm drain system. The site is inspected annually to further ensure that on-site outdoor activities minimize the amount of pollutants left on the ground, which can be washed into storm water runoff.

In 1995, two grab samples were collected from all of the (eleven) sampling locations. Every effort was made to collect samples within the first thirty minutes of a storm, or as soon as possible thereafter. All required visual monitoring and sampling were done in 1995.

No regulatory limits have been set for pollutants in storm water runoff. No pollutants were detected at levels which would be a cause for concern during the 1995 sampling. Analyses included metals, toxic organics, and physical parameters.

Soil Monitoring

Surface soil and arroyo sediment samples are collected throughout the Livermore Valley and are analyzed for radionuclides.

In 1995, the concentration of ^{238}U in surface soils was within historical background levels and was consistent with levels observed in previous years. Tritium concentrations in arroyo samples collected near the Livermore site were much lower than the limits for tritium in drinking water, indicating that tritium in the arroyo sediments do not pose a risk to people or the environment.

During 1995, SNL/California conducted special soil sampling for tritium in support of clean-up activities at the Tritium Research Laboratory. The highest value of tritium in surface soil detected was 0.096 pCi/g, 0.009% of the allowable limit for unrestricted release of a site.

Vegetation and Foodstuff Monitoring

Samples of vegetation and locally produced agricultural products were collected in and around the Livermore Valley in 1995. Tritium is the only radionuclide of concern in the terrestrial food pathway

from operations at the Livermore site. Tritium is measured in local vegetation and wine.

Wine samples produced in the Livermore Valley showed tritium levels slightly above levels detected in samples from more distant areas. However, these levels of tritium do not represent a health concern. Although the government has not established safety standards for tritium in vegetation or wine, the levels of tritium observed in each of these media were below the concentration limits permissible for tritium in public drinking water.

EXTERNAL RADIATION MONITORING

SNL/California and LLNL conduct an extensive program to measure external radiation doses at the Livermore site perimeter and throughout the Livermore Valley.

In 1995, the average annual dose equivalent from external radiation measured at the Livermore site perimeter was 65.1 mrem (0.65 mSv). This level was lower than the background radiation dose measured off-site: 69.1 mrem (0.69 mSv). These measurements demonstrate that no measurable external dose was due to direct radiation from Livermore site operations during 1995. That is, if a person had resided at the site fence line 24 hours a day, every day in 1995, he or she would not have received any measurable dose of external radiation above the natural background level.

RADIATION IMPACT TO THE PUBLIC

Each year, the radiation impact from site operations is evaluated and presented to the public in this report. Potential radiation doses are calculated for a hypothetical individual who resides off site and receives the maximum exposure from all exposure routes. This comprehensive dose assessment includes all radiological emission sources and all significant environmental exposure pathways. The methods and models used to do this assessment are approved by the DOE and the EPA.

The only measurable radionuclide discharged to the atmosphere from SNL/California in 1995 was tritium. During clean-up operations at the former Tritium Research Laboratory 74 Ci (2.7×10^6 MBq) tritium was discharged to the atmosphere. The amount of tritium released from SNL/California in 1995 was the lowest on record since the Tritium Research Laboratory became fully operational. (Before Sandia operated the Tritium Research Laboratory, no tritium was emitted from site operations.) Figure 1-1 shows the total annual tritium discharges from SNL/California during 1987–95. The chart shows a general downward trend in tritium emissions over the past nine years. This performance clearly demonstrates SNL/California's conformance with the DOE's policy to keep emissions as low as reasonably achievable (ALARA). SNL/California conducted no tritium experiments in 1994 or 1995. Tritium releases during this period were due solely to cleanup activities in the Tritium Research Laboratory.

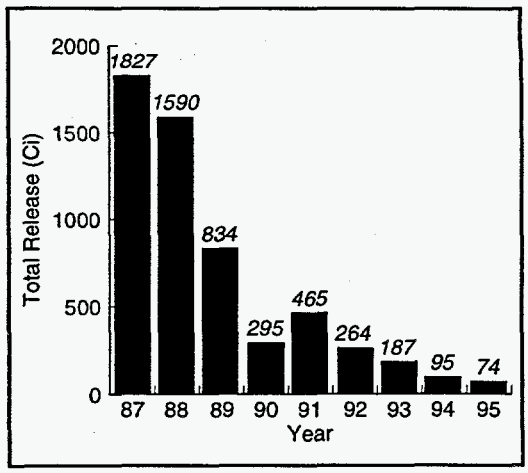


Figure 1-1. Annual airborne tritium discharges from SNL/California, 1987–95.

The maximum potential radiation dose to a resident in an unrestricted (i.e., publicly accessible) area resulting from SNL/California operation in 1995 was 0.01 mrem (1×10^{-4} mSv) effective dose equivalent. This dose was calculated for the point of maximum off-site exposure and represents the cumulative exposure from all significant exposure pathways (inhalation, air submersion, ingestion, and ground-surface irradiation). This level is 0.01% of the DOE allowable limit for protection of the public (100 mrem effective dose equivalent from all sources and all pathways) and 0.1% of the allowable limit of 10 mrem from the air pathway.[3] Furthermore, the methods and parameters used to calculate this dose were very conservative—the dose was calculated for the closest off-site resident, located approximately 1 km northeast of the Tritium Research Laboratory. A major portion of the food consumed by the hypothetical individual was assumed to have been grown locally. The individual was assumed to reside at this location continuously throughout the year. In addition, all the tritium released was assumed to be the most hazardous form, tritium oxide (HTO). Consequently, this dose is not a dose actually received by anyone, but an upper-bound estimate. To put this dose of 0.01 mrem in perspective, it is approximately 36,000 times less than the background radiation dose received in one year by a typical resident of the United States (see Fig. 1-2).

For more information about the methods used to assess these impacts and radiation protection regulations, see Appendix B.

PERFORMANCE MEASURES/INDICATORS

Environment, safety, and health (ES&H) performance has been measured using performance indicators at Sandia for many years. However, the program has had a limited scope and is being updated to meet the needs of the DOE's current performance-based oversight and assessment objectives. Sandia's effectiveness in managing ES&H issues now will be evaluated by the DOE through a mutually agreed upon set of performance indicators that will be designed to show trends before significant problems occur. See Chapter 5, "Environmental Program Information," for more information about performance indicators.

COMPLIANCE WITH REGULATIONS

SNL/California expends considerable effort to make sure that site operations comply with all applicable Federal, State, and local regulations. The environmental monitoring data demonstrate that all emissions to the environment from SNL/California in 1995 were well within regulatory standards (except for two wastewater discharge limit exceedances—see Chapter 4). For details

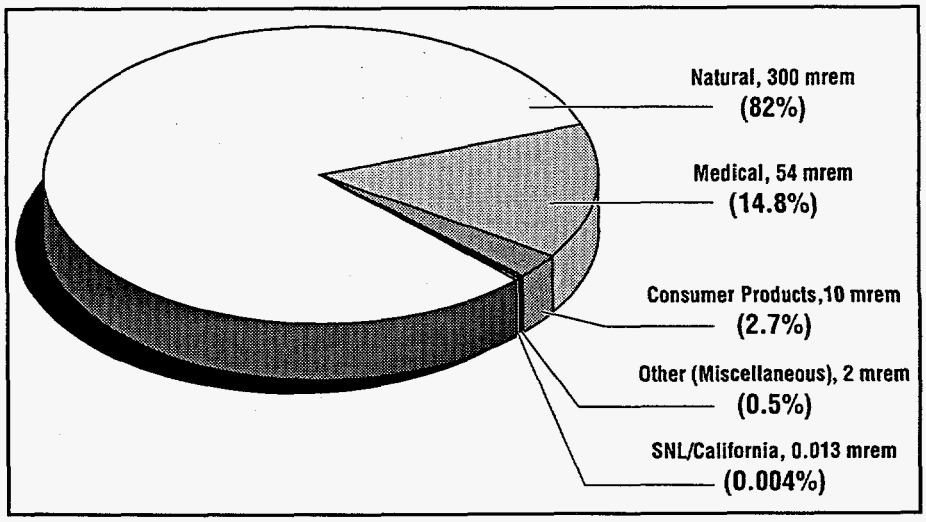


Figure 1-2. Typical radiation doses received by the general public and the maximum contribution from SNL/California.

of SNL/California's compliance record, see Chapter 3. It summarizes SNL/California's compliance with applicable environmental statutes and regulations for 1995 and discusses current issues related to environmental management.

ENVIRONMENTAL MONITORING PLAN

SNL/California prepared the *Environmental Monitoring Plan*, in accordance with DOE guidelines.[4] The plan serves as a guidance document for the Environmental Monitoring Program at SNL/California. When read in conjunction with the *Site Environmental Report* (which provides the results of the program for the current year), it provides a comprehensive overview of Sandia's Environmental Monitoring Program.

The *Environmental Monitoring Plan* contains a comprehensive review of environmental monitoring at SNL/California, including administrative structure, pathway analysis, effluent monitoring, sampling of environmental media, laboratory procedures, dose calculations, meteorological monitoring, and quality assurance. It details the operations of each of these areas and documents the rationale behind the diverse monitoring methods. In addition to documenting the monitoring system, the plan provides an in-depth review of the adequacy and scientific defensibility of SNL/California's monitoring program.

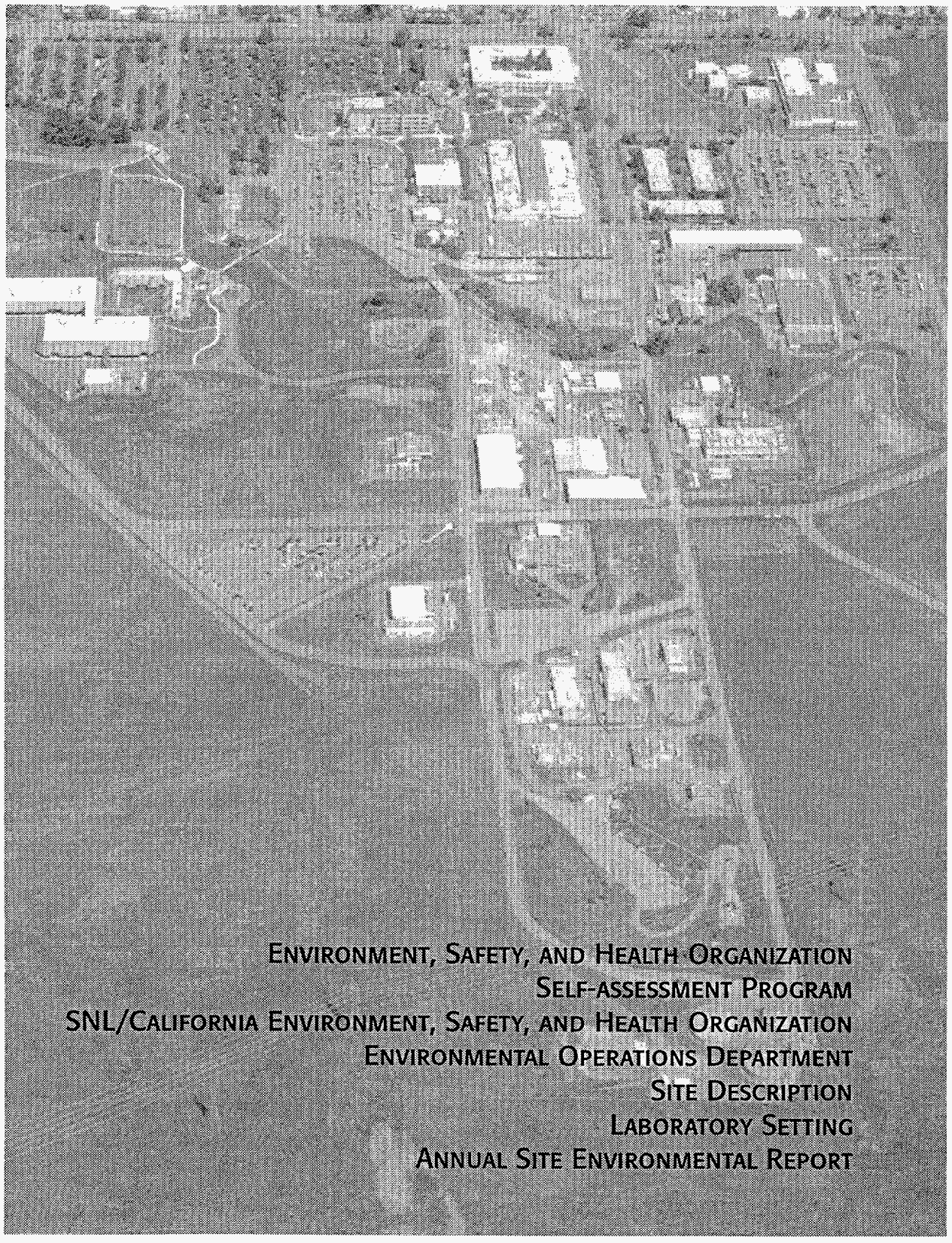
REFERENCES

1. U.S. EPA, Title 40 CFR, Part 433, *Metal Finishing Point Source Category* (July 1994).

2. U.S. DOE, Order 5400.5, *Radiation Protection of the Public and the Environment* (June 5, 1990).

3. State of California, *California Code of Regulations*, Title 22, Sections 64400 et seq., "California Domestic Water Quality and Monitoring" (1995).

4. R. C. Holland, *Environmental Monitoring Plan*, Sandia National Laboratories/California, SAND94-8011 (February 1994).



ENVIRONMENT, SAFETY, AND HEALTH ORGANIZATION
SELF-ASSESSMENT PROGRAM
SNL/CALIFORNIA ENVIRONMENT, SAFETY, AND HEALTH ORGANIZATION
ENVIRONMENTAL OPERATIONS DEPARTMENT
SITE DESCRIPTION
LABORATORY SETTING
ANNUAL SITE ENVIRONMENTAL REPORT

Sandia National Laboratories (SNL) is a prime contractor to the Department of Energy (DOE), engaged in research and development in the national interest. On October 1, 1993, Martin Marietta Corporation assumed the contract to manage and operate SNL, which had been managed by AT&T since 1949. On March 15, 1995, Martin Marietta Corporation merged with Lockheed Corporation to form Lockheed Martin Corporation.

SNL consists of facilities in New Mexico, California, Nevada, and Hawaii. As one of the United States' multipurpose national laboratories, SNL develops solutions to a wide range of problems facing the country. With the end of the Cold War, SNL's traditional national security mission has expanded to include advanced military technology, energy and environmental research, arms control/nonproliferation, and advanced manufacturing technologies. In addition, Sandia is involved in both technology transfer and educational outreach.

Operations at SNL's California facility comprise three broad programmatic areas:

National Security: National security programs involve both nuclear and nonnuclear work. National security activities encompass maintaining the safety, security, and reliability of the nuclear weapons stockpile as well as nonproliferation of weapons of mass destruction and counterproliferation (that is, response to proliferation).

Energy and Environmental Research: This research addresses a broad range of initiatives centered on combustion science and technology. Areas of emphasis include energy resources for a cleaner environment, minimization of the environmental impact of transportation, environmental remediation and pollution prevention, and renewable energy resources.

Integrated Manufacturing Technologies: This program uses the systems and technology at the site to develop advanced manufacturing techniques, including simulation-based design, concurrent engineering, rapid prototyping technologies, intelligent machines for hazardous and flexible operations, engineered processes and materials, environmental protection and control, and an infrastructure to support product realization. Our aim is to be an agile manufacturing test bed for low-cost prototypes and development.

SNL/California incorporates the highest regard for environment, safety, and health (ES&H) into every experiment and all site operations. SNL/California operates under the scope of Federal, State, and local regulatory authorities and has obtained all appropriate operating permits. Sandia is committed to operate in full compliance with the letter and spirit of applicable environmental laws, regulations, and standards. Furthermore, SNL/California strives to go beyond compliance with legal requirements by making every effort practical to reduce impacts to the environment to levels as low as reasonably achievable.

Environment, Safety, and Health Organization

SNL has established a corporate-level ES&H organization. The SNL President has overall responsibility for ES&H. He is advised by the SNL Quality and Leadership Council regarding ES&H issues. Together, they are ultimately responsible for establishing and communicating a corporate culture that considers the protection and preservation of the environment and the safety and health of its personnel, contractors, visitors, and the public, to be critical to Sandia's success.

SNL/California has an ES&H organization to carry out the corporate ES&H vision. Its structure is shown in Fig. 2-1. This organization implements ES&H programs and ensures compliance with regulations specific to the California site.

To help assure that ES&H commitments are fulfilled, SNL/California has established a site ES&H Council and a Management Assurance Department. The site ES&H Council ensures top-level management involvement in developing and monitoring ES&H goals. It establishes, promotes, and communicates a culture that recognizes ES&H as a top priority at the California site. The site ES&H Council also provides leadership and consistency of approach in the SNL/California ES&H program. It provides a mechanism for organizational communication—both horizontally and vertically.

The Management Assurance Department provides oversight of management-related ES&H activities and provides direct ES&H assurance information to the SNL/California vice president. The department ensures uniform implementation of corporate ES&H management processes through the use of organizational ES&H coordinators. Additionally, the department conducts internal audits and self-assessments of the SNL/California's ES&H management processes.

SELF-ASSESSMENT PROGRAM

SNL is developing a comprehensive system for assessing ES&H status and for tracking progress toward achieving ES&H goals. The SNL ES&H Self-Assessment Program consists of three key subprograms: Appraisal, Performance Indicators, and Operating Experience Evaluation.

The ES&H Appraisal Program establishes an internal appraisal hierarchy consisting of independent assessments, management surveillance, and organizational inspection activities. At SNL/California, senior management has established the Laboratory Assessment Program for conducting site-wide independent ES&H assessments. The Management Assurance Department coordinates training for SNL/California employees and managers involved in performing self-assessments.

The ES&H Performance Indicator Program establishes a set of quantitative measures for the

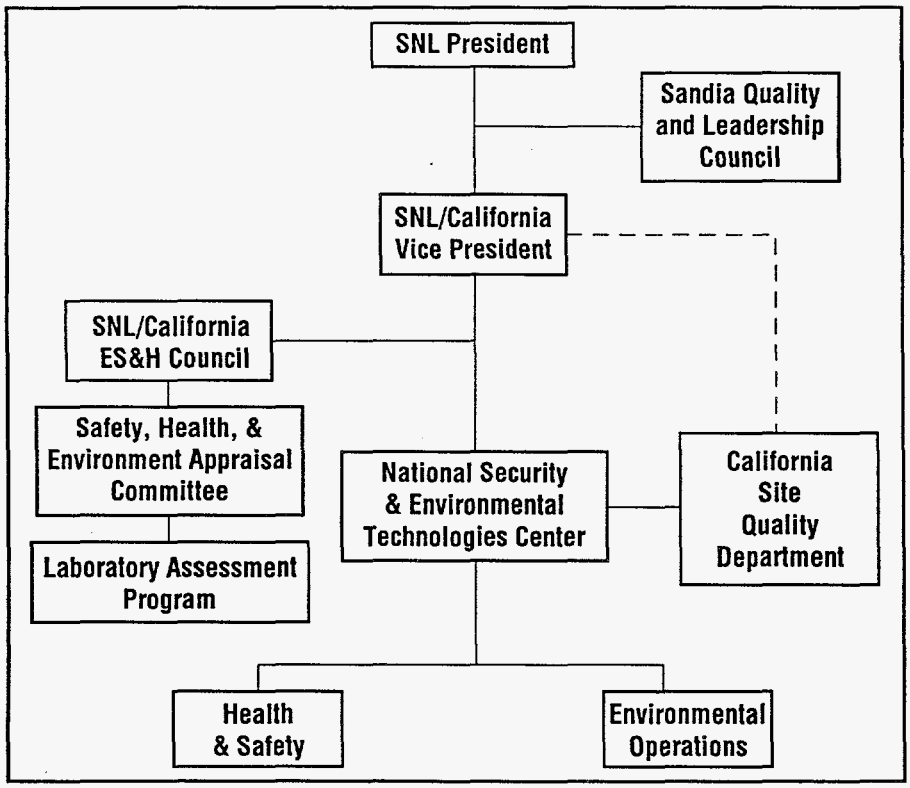


Figure 2-1. Organizational structure of environment, safety, and health at SNL/California.

DOE to use in evaluating and tracking SNL's ES&H performance.

The ES&H Operating Experience Evaluation Program documents incidents and lessons learned from these incidents. This information is distributed to employees to heighten their awareness of ES&H principles.

In addition, SNL/California's ES&H and Facilities Quality Assurance Group coordinates quality assurance/technical assessments within SNL/California's ES&H organization.

SNL/California Environment, Safety, and Health Organization

The organization responsible for ES&H at SNL/California is the National Security and Environmental Technologies Center. An important part of the center's mission is to ensure the health and safety of SNL/California employees and the general public, and to protect the environment. This mission is fulfilled by helping SNL/California employees understand and comply with DOE orders and their legal responsibilities under Federal, State, and local laws and regulations. The National Security and Environmental Technologies Center has two departments involved in ensuring workplace safety and protection of the environment: Health Protection and Environmental Operations. A quality assurance group reports directly to the center director and is functionally independent of the departments within the center.

The Environmental Protection and Operations Department were consolidated in 1995 to form the Environmental Operations Department, which is responsible for ensuring that operations at SNL/California are conducted in an environmentally responsible manner and in compliance with applicable laws and regulations. Department personnel contribute their expertise and services to guide and support other SNL/California departments in achieving their missions and goals. They are directly responsible for this report and the activities described herein. Therefore, their specific responsibilities are described below.

Environmental Operations Department

The Environmental Operations Department maintains a variety of programs to monitor the environmental impacts of site emissions, to preserve the quality of the environment, and to properly manage (minimize and dispose of) hazardous waste. To fulfill its mission, the department has groups responsible for public participation, waste management, pollution prevention, environmental surveillance, air quality, chemical information management (now in the Management Assurance Department, but still active in environmental protection responsibilities), environmental planning, and wastewater/storm water management (Fig. 2-2). The following sections briefly describe the activities of these groups.

Waste Management

The Waste Management Group is responsible for managing radioactive, mixed, medical, energetic, and hazardous wastes. Waste management activities include the collection, on-site transport, storage, treatment, packaging, and shipment of wastes in accordance with DOE-, EPA- and State-specified regulations and requirements. The group also manages the following Waste Management Program activities: training, permitting, reporting, interfacing with regulators through the DOE, program planning, recordkeeping, and budgeting.

The Waste Management Group is responsible for operations conducted in the Hazardous Waste Storage Facility, the Tritiated Waste Storage Facility, and the Radioactive and Mixed Waste Storage Facility. In addition, the group manages the permitting of three on-site treatment facilities that are regulated under "per-

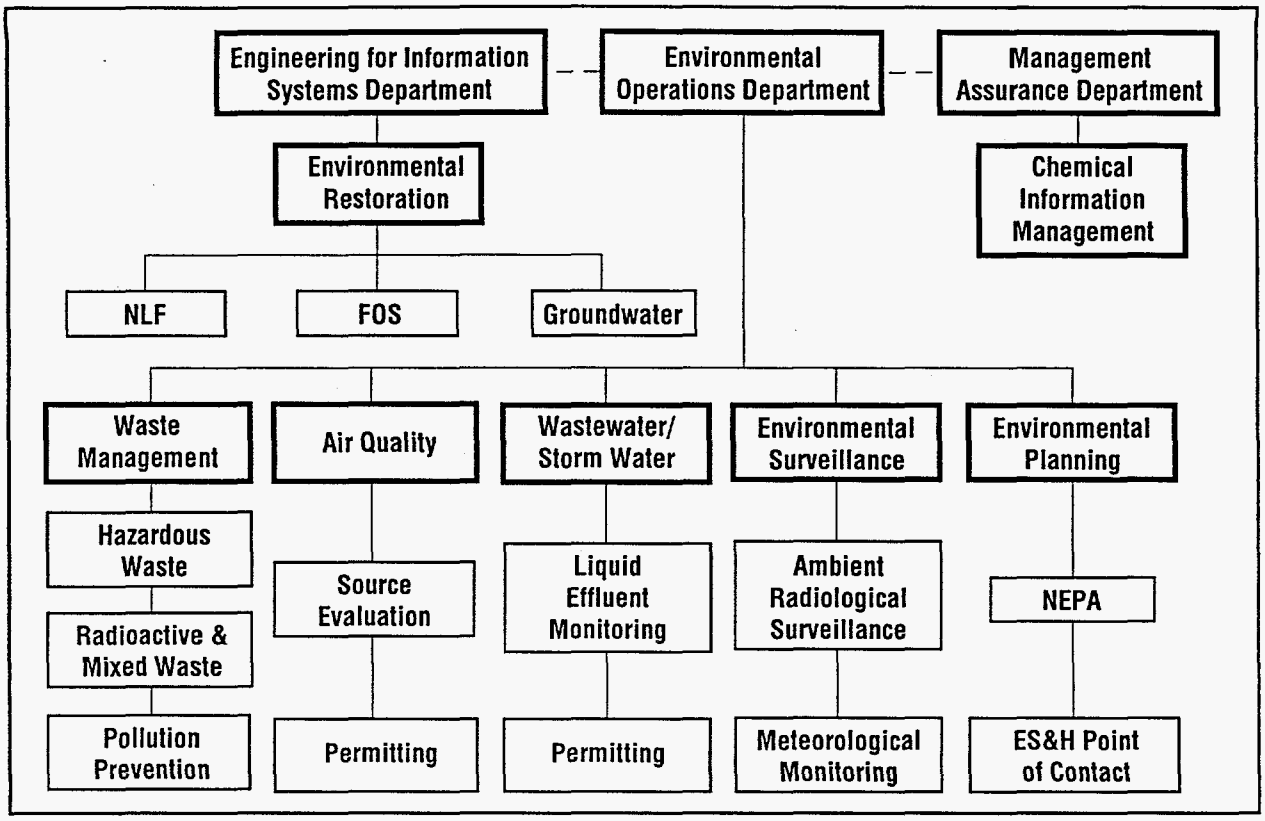


Figure 2-2. Organizational structure of the Environmental Operations Department.

mit-by-rule" (two waste compactors and a fluorescent light tube crusher).

Pollution Prevention

The Pollution Prevention Group is responsible for promoting pollution prevention and source reduction of all wastes in all site activities. Responsibilities include:

- gathering process information,
- evaluating processes and performing pollution prevention opportunity assessments,
- fostering employee awareness of pollution prevention and source reduction issues and technologies, and
- developing and maintaining site recycling programs.

The Pollution Prevention Group also is responsible for preparing reports to the DOE and to Federal, State, and local regulators. SNL/California has a waste minimization/pollution prevention coordinator to manage these efforts.

Environmental Restoration

Although housed in a different Department (Engineering for Information Systems),* the Environmental Restoration Group is responsible for assessing the extent of historical contamination of SNL/California sites and managing any necessary restoration efforts. This group also is responsible for characterizing groundwater flow.

Environmental Surveillance

The Environmental Surveillance Group at SNL/California assesses potential impacts to the public and the environment from site operations. The group is

* *The Environmental Restoration Group was placed in the Engineering for Information Systems Department in 1996.*

responsible for ensuring that SNL/California complies with Federal, State, and local regulations and DOE orders governing protection of the environment. Specifically, environmental surveillance personnel maintain a meteorological monitoring system, an air tritium monitoring system, and a direct radiation monitoring system, to ensure SNL/California's compliance with the National Emission Standards for Hazardous Air Pollutants (NESHAPs) Rule for Radionuclides, under the Federal Clean Air Act (CAA), and DOE orders. The group uses these systems to monitor the general environment of SNL/California and nearby vicinity to verify that emission controls are effective in preserving the local environs. The group also prepares numerous reports and other documents to demonstrate compliance.

Air Quality

The Air Quality Group manages a program to facilitate site compliance with regulations governing air emissions to the environment. The Air Quality Compliance Program maintains the site air emissions inventory and evaluates Sandia operations that are potential sources of air pollutants.

Chemical Information Management

Although housed in a different department (Management Assurance),* the Chemical Information Management Group aids in compliance with environmental laws, and so is discussed here. This Group is responsible for providing consultation for chemical analysis and data review and for maintaining the site-wide Chemical Information System/Material Safety Data Sheet system. This system is a UNIX-based relational database containing comprehensive information for tracking chemicals used at SNL/California. It includes a site-wide chemical inventory of more than 35,000 bar-coded chemical containers and potential personnel chemical exposure data. The system also manages more than 40,000 Material Safety Data Sheets, which are available to all site personnel on the SNL internal Web. In 1996, the system will include hazardous, radioactive and mixed waste tracking information.

Environmental Planning

The Environmental Planning Group is responsible for implementing the National Environmental Policy Act (NEPA) at the SNL/California site. This responsibility involves evaluating proposed projects, activities, and programs for potential environmental and human impacts. Key environmental concerns include potential air emissions (through vents or stacks on buildings), water effluents (storm water or sanitary sewer outfall), human exposure to hazardous substances, and waste generation and minimization.

In addition, the Environmental Planning Group acts as the point of contact for the ES&H Interdisciplinary Team, which comprises representatives from each of the primary disciplines within ES&H, and when appropriate, facilities and security programs. The Interdisciplinary Team is responsible for helping SNL/California's project teams consider ES&H, facility, and security issues as they plan and implement new projects or change ongoing projects. By reviewing proposed projects early in the planning stages, the Interdisciplinary Team helps make sure they begin on time.

Wastewater/Storm Water/Groundwater Management

The Wastewater/Storm Water Management Group is responsible for ensuring that SNL/California complies with all Federal, State, and local regulations and DOE orders regarding the quality of wastewater and storm water discharges. The group monitors these discharges

* *The Chemical Information Management Group was placed in the Management Assurance Department in 1996.*

both visually and through sampling and analysis. The group ensures that SNL/California site activities do not impact the quality of surface waters in the vicinity or in the San Francisco Bay (to which site storm water drains). The group verifies that wastewater and storm water discharges are in compliance with established standards and requirements. The group prepares numerous reports, permit applications, and other documents to demonstrate compliance with various environmental regulations and DOE orders. This group is responsible for the monitoring of groundwater in compliance with State regulations.

SITE DESCRIPTION

This section provides an overview of the SNL/California site, the physical environment, and the ecological characteristics of the area.

Laboratory Facility

The SNL/California site covers 1.7 km^2 (413 acres), which includes 213 acres of developed areas. In 1986 and 1987, the DOE acquired 228 acres to provide a security buffer zone between developed areas and the Laboratory.

The site facilities comprise approximately 74,400 m^2 (801,000 $ft.^2$) of building floor space. Of this, about 31% is office and drafting areas, 48% is light laboratories and shops, and 3% is heavy laboratories (e.g., high-pressure test facilities and explosives chambers). The remaining 18% is classified as miscellaneous usage, such as computer rooms and library space.

Because SNL/California is a multiprogrammatic laboratory involved in a broad range of research and development, facilities are designed for small-scale scientific and applied engineering research. The site has neither production nor large-scale manufacturing operations.

Emissions and Water Supply

In general, potential radiological emissions from normal operations at SNL/California comprise small amounts of tritium. However, tritium-related research ceased at SNL/California in 1993. SNL/California has sources of uranium, principally depleted uranium, but uranium materials have not been machined on site for several years. Therefore, site operations do not emit uranium isotopes. Nonradiological emissions include nitrogen oxides (NO_x), particulates, and precursor organic compounds.

The site's water supply normally comes from the Hetch Hetchy Aqueduct, which is supplemented occasionally by water from the Zone 7 Flood Control and Water Conservation District. Sandia's sanitary sewer effluent merges with the Lawrence Livermore National Laboratory (LLNL) sewer system, and the combined waste stream discharges to the City of Livermore sanitary sewer system at the northwest corner of the LLNL site. The sanitary sewer effluent from the SNL/California site (and from the rest of the Livermore area) is processed at the Livermore Water Reclamation Plant. After treatment, the wastewater is transported via pipeline to the San Francisco Bay. A portion of the treated effluent is reclaimed and used for local irrigation.

LABORATORY SETTING

SNL/California is located next to the City of Livermore (population approximately 58,000), in eastern Alameda County, 65 km (40 miles) east of San Francisco (see Fig. 2-3). The operating area is surrounded on all sides by DOE-owned land, which serves as a buffer zone. The site lies at the western base of the Altamont Hills. To the north is LLNL, and further north is an expanding business park and commercial development. The property to the south and east of the site comprises agricultural and low-density residential areas. Although principally residential, the area to the west encompasses a

wide range of uses, to include a business park, grazing lands, vineyards, and other small agricultural and industrial developments.

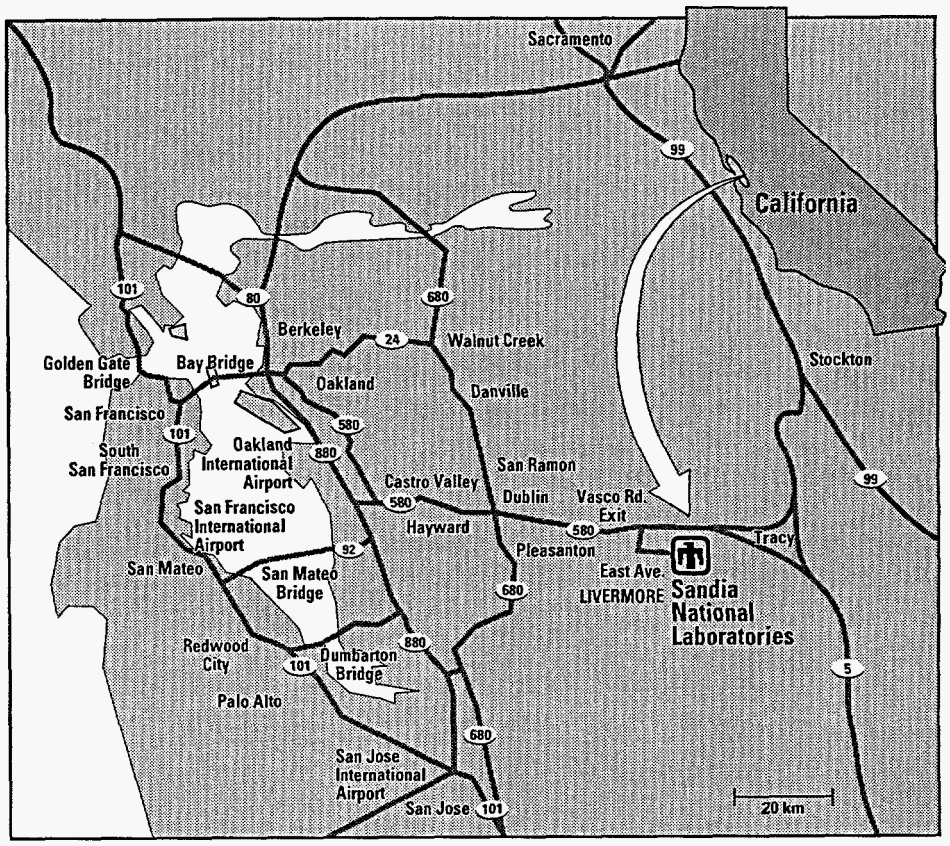


Figure 2-3. SNL/California in a regional setting.

Topography

The Livermore Valley is an irregularly shaped lowland in the Diablo Range of the California Coastal Mountain Range. The valley is approximately 26 km (16 miles) long (east to west) and averages about 11 km (7 miles) wide. The valley floor slopes gently downward to the west at about 10 m/km (50 ft./mile). The elevation is approximately 200 m (660 ft.) at the eastern boundary of the valley and 90 m (295 ft.) at the southwest corner.

The topography of the California site is generally characterized by relatively flat areas at the northern portion of the site, hills to the south, and steep banks along the Arroyo Seco.

Geology and Hydrology

The Livermore Valley overlies a complex geologic region where ancient arroyos have deposited a heterogeneous mixture of sand, silt, clay, and gravel. These alluvial deposits create layers of higher and lower permeability overlying the older Livermore formation. The groundwater of the Livermore Valley can be found in the more permeable layers, which lie between 5 and 33 m (17 and 110 ft.) below the surface (Fig. 2-4). Groundwater in the Livermore Valley generally flows in a westerly direction. The groundwater movement underlying the SNL/California site is strongly influenced by the Las Positas Fault Zone. North of the fault, movement is generally westerly. South of the fault, the movement is less distinct, but appears to be radial from a groundwater mound. Investigations of groundwater movement in this area are in progress.

Located in west-central California, the site is in a seismic region. The major faults are San Andreas, Hayward, Calaveras, and Greenville. The closest major faults are Calaveras—about 11 miles west of the site, and Greenville—about 2 miles east of the site. A small, locally active fault, the Las Positas Fault, runs through the southern portion of the site. Intermittent streams (arroyos) flowing northwest carry surface drainage into the Alameda Creek near Sunol, which continues west to the San Francisco Bay. The Arroyo Seco crosses the site from the southeast

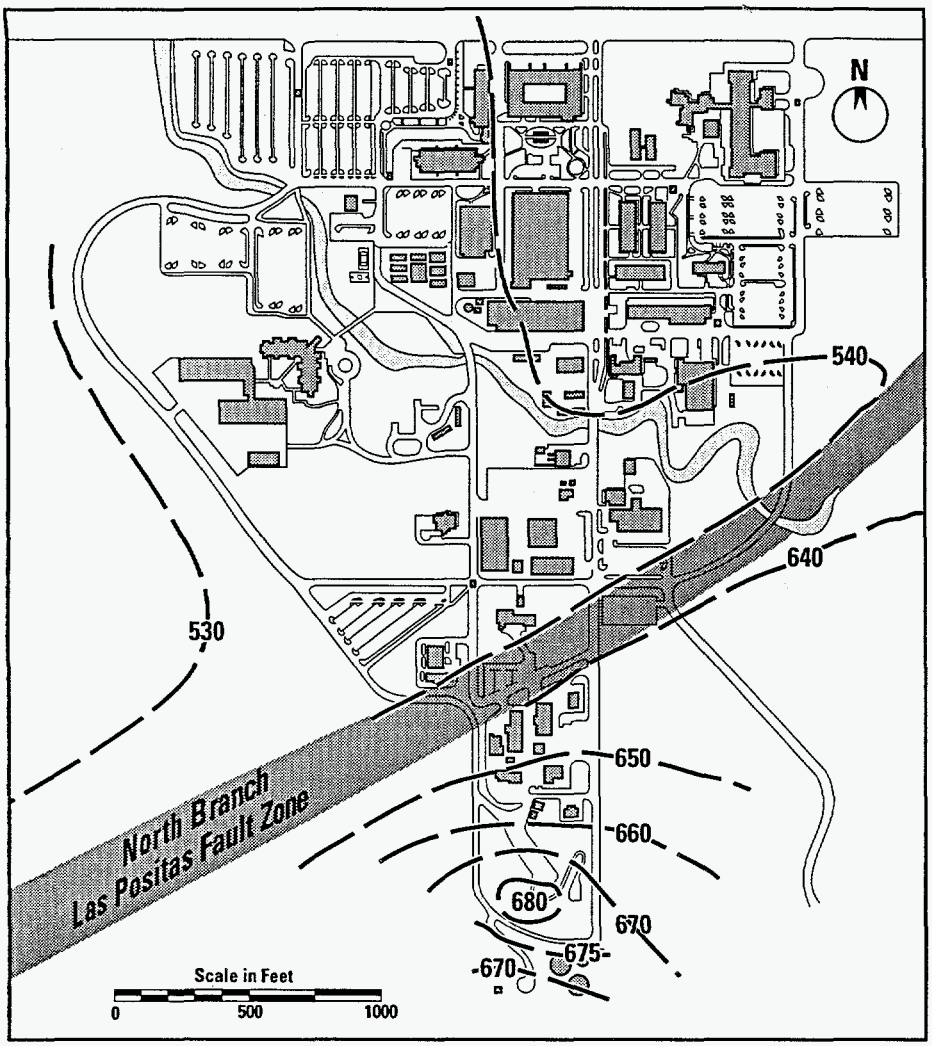


Figure 2-4. Ground contours at SNL/California.

to the northwest. Storm water runoff from the hills to the southeast flows into the arroyo during the rainy season. The arroyo is dry the rest of the year. The SNL/California site storm sewer system also channels storm water into the Arroyo Seco. This system is the main pathway for the site's surface drainage.

Climate and Meteorology

The climate of the Livermore Valley consists of mild, rainy winters and warm, dry summers. The mean annual temperature is 12.5°C (55°F), with extremes ranging from 0° to 38°C (32° to 100°F). Rain falls primarily between October and April. Precipitation at the SNL/California site for calendar year 1994 was 33.3 cm (13.1 in.). The prevailing winds blow from the west and southwest from April to September (Fig. 2-5). The winds are variable during the rest of the year. Specific meteorological measurements for 1994 are summarized in Chapter 4, "Environmental Monitoring Program."

Vegetation

Vegetation on the developed areas of the site consists of plants suitable for general landscaping. The undeveloped land, which mainly comprises the DOE security buffer zone, is dominated by nonnative grasses, such as slender oat and ripgut brome. Much of this zone is under cultivation to provide erosion control and fire protection.

The Arroyo Seco supports diverse vegetation. There are several large sycamore, valley oak, and red willow trees, as well as patches of cattail and rush at the eastern segment of the arroyo. The central portion of the arroyo hosts a few canyon live oak and almond trees, and annual grasses.

Wildlife

Wildlife is sparse on the SNL/California site. In 1991, a biological survey identified three species of amphibians and reptiles, 31 species of birds, and ten species of mammals. There are no perennial streams or permanent bodies of water at

SNL/California to support fish. Wildlife live in the undeveloped grassland and along the arroyo. Representative species include the fence lizard, black-tailed hare, California ground squirrel, red fox, and western meadowlark.

ANNUAL SITE ENVIRONMENTAL REPORT

This *Site Environmental Report* documents all SNL/California's significant environmental activities throughout the year. These include effluent and environmental monitoring, environmental restoration, and environmental protection activities. This report also evaluates SNL/California's compliance with applicable environmental requirements. It is prepared according to the requirements of DOE Orders 5484.1 and 5400.1.[2,3]

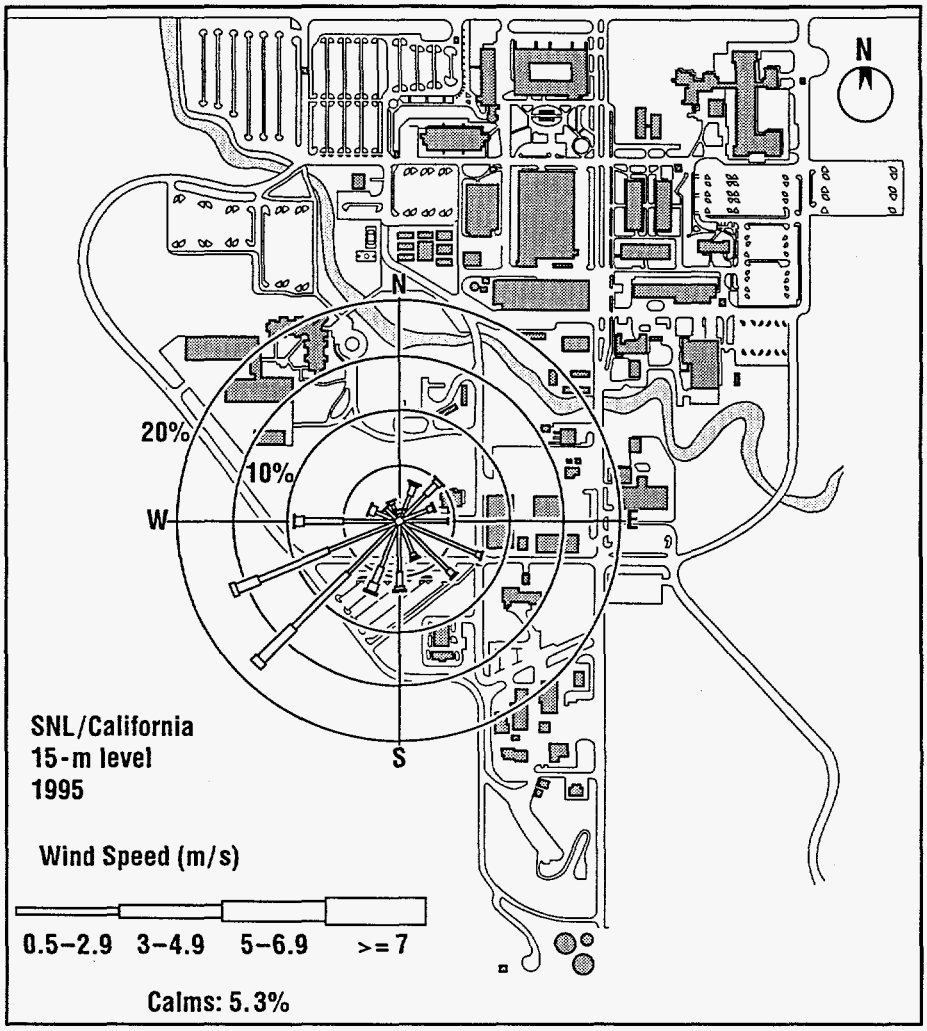


Figure 2-5. Wind rose showing the average annual wind direction and speed during 1995.

An extensive glossary at the end of this report defines commonly used acronyms and abbreviations, as well as other technical terms used in the body of the report. The International System of Units (SI) or metric system of measurements has been used, where feasible. A section on "Units of Measure" is included in the glossary as additional information about the system of units and quantities.

Appendix A contains laboratory procedures. Radiological doses are calculated at the point of maximum credible public exposure, according to EPA-approved methods and incorporating conservative model input and exposure parameters. Appendix B presents the methods, assumptions, and calculations used to assess the routine radiological impacts from SNL/California operations, and compares these measurements to DOE and Federal standards.

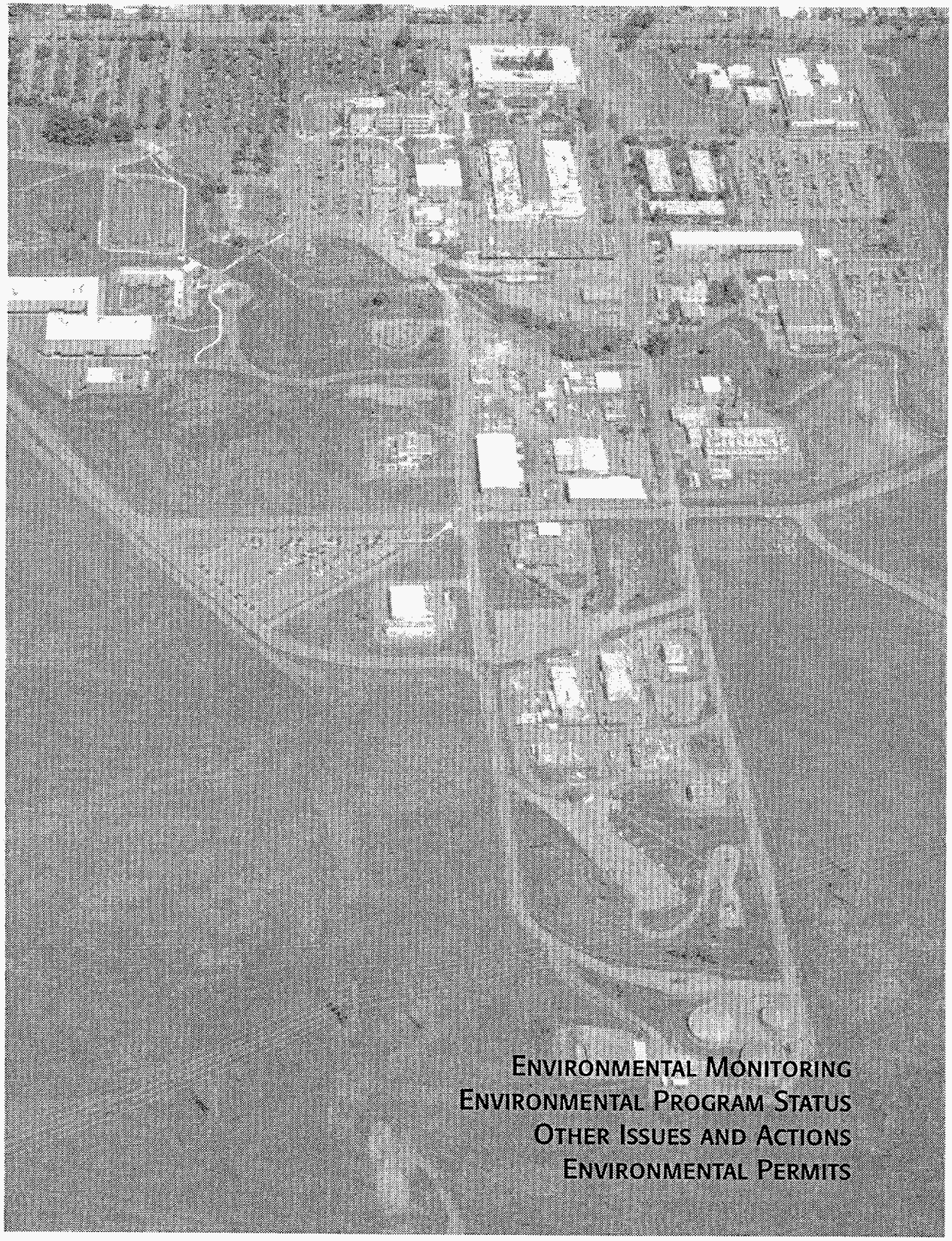
REFERENCES

1. U.S. DOE, SNL/California, *Public Participation Plan* (September 1994).

2. U.S. DOE, Order 5484.1, Chapter I, "Environmental Protection, Safety, and Health Protection Information Reporting Requirements" (June 29, 1990).

3. U.S. DOE, Order 5400.1, *General Environmental Protection Program* (June 29, 1990).

3 — Compliance Summary



Environmental Monitoring
Environmental Program Status
Other Issues and Actions
Environmental Permits

In accordance with DOE policy, SNL complies with all applicable Federal, State, and local environmental laws and requirements. In addition to meeting specific limits, SNL is obligated to keep emissions to the environment as low as reasonably achievable (ALARA). Several Federal, State, and local government agencies are responsible for enforcing and overseeing environmental regulations at SNL/California. The principal agencies include the U.S. EPA, the Cal/EPA, the Department of Health Services, the Department of Toxic Substances Control, the Regional Water Quality Control Board, the Bay Area Air Quality Management District, and the City of Livermore Water Reclamation Plant. Table 3-1 summarizes the major Federal environmental statutes that apply to SNL/California operations. State and local authorities also impose a variety of environmental regulations.

This chapter summarizes SNL/California's environmental management performance and documents the site's compliance with these environmental statutes and regulations in 1995. It also discusses current environmental management programs. The compliance activities at SNL/California are administered by the Environmental Operations Department.

ENVIRONMENTAL MONITORING

The DOE and the State of California have established allowable limits for discharging radionuclides to public sewer systems. Tritium is the only radionuclide discharged to the sewer in measurable amounts. During 1995, a total of 0.024 Ci (888 MBq) tritium was discharged as a part of routine operations. This is only 0.5% of the State allowable limit. Chapter 4 summarizes the regulations for wastewater discharge.

The Environmental Operations Department at SNL/California maintains an environmental surveillance program to verify the effectiveness of emission control procedures and to directly measure any effects on the environment. This surveillance program routinely examines environmental media at the site boundary and in the vicinity. Sampling includes ambient air, surface water, groundwater, sewage, soil, vegetation, and locally produced foodstuffs. An extensive network of environmental dosimeters is also used to measure external radiation levels. The environmental surveillance data collected during 1995 demonstrate compliance with EPA and DOE standards.

The environmental monitoring data collected in 1995 demonstrate that operations at SNL/California had no harmful effects on the environment or the public. SNL/California's emissions to the atmosphere during the year complied with all applicable Federal, State, and local environmental laws and standards.

The only detectable radionuclide discharged to the atmosphere was tritium from the Tritium Research Laboratory. Because tritium research has been phased out at SNL/California, the total amount of tritium released by SNL/California in 1995 was the lowest amount since the Tritium Research Laboratory became fully operational. A total of 74 Ci (2.7×10^6 MBq) tritium was discharged to the atmosphere. Of this amount, 72.9 Ci (2.7×10^6 MBq) was in the form of tritium oxide (HTO or T_2O) and the remaining 1.1 Ci (0.04×10^6 MBq) was in the form of elemental tritium gas (HT or T_2). Based on these emissions, the potential off-site radiological impact from SNL/California operations was assessed, incorporating all emission sources and all exposure pathways. The assessment was performed using EPA-approved methods and computer codes.

In 1995, the maximum potential dose at a publicly accessible location was 0.01 mrem (1×10^{-4} mSv) effective dose equivalent. This small dose is 0.01% of the DOE radiation protection standard, and about 36,000 times less than the background radiation dose received in one year by a typical resident of the

United States. Chapter 4 and Appendix B describe the radiological impact assessment in more detail.

ENVIRONMENTAL PROGRAMS STATUS

Table 3-1 briefly summarizes the major Federal environmental regulations that apply to SNL/California. They are described in detail below. Also discussed are activities related to compliance with California State regulations.

Resource Conservation and Recovery Act and California's Hazardous Waste Control Law

During 1995, SNL/California's waste programs complied with all DOE Orders and Federal and State Regulations. Hazardous waste management activities at SNL/California include handling, packaging, and storing energetic, radioactive, mixed, and nonradioactive hazardous waste. SNL/California incinerated small quantities of explosives on site until October 1989. No other form of hazardous waste disposal has been used at the SNL/California site.

The only treatment done on site is waste compaction to reduce volume, encapsulation of some low-level radioactive waste streams, and consolidation/commingling of various low-volume waste streams at the Hazardous Waste Storage Facility.

SNL/California does not generate transuranic or high-level radioactive wastes. Except for liquids generated from scintillation counting (which are sent off site for incineration), mixed waste is shipped to SNL/New Mexico for management, pursuant to SNL/New Mexico's Federal Facility Compliance Act *Site Treatment Plan.*

SNL/California has an active Waste Minimization and Pollution Prevention Awareness Program.

Chemical Waste Program

SNL/California holds a Cal/EPA Part B permit for the Hazardous Waste Storage Facility operations. It is effective from January 4, 1993, to January 4, 2003. The permit allows SNL/California to store hazardous waste and to conduct limited treatment activities.

In addition, DOE Headquarters lifted the shipping moratorium for hazardous waste generated in radioactive material areas because SNL/California's program proved adequate to ensure that hazardous wastes do not contain radioactivity above background levels.

Low-Level Radioactive Waste Program

The low-level radioactive waste management activities at SNL/California include handling, packaging, and storing radioactive waste.

The DOE Nevada Operations Office audited the SNL/California low-level radioactive waste management program in February 1993. Based on the results of this audit, SNL/California was granted permission to ship low-level radioactive waste to the Nevada Test Site.

In November 1994, the DOE Nevada Operations Office audited the SNL/California low-level radioactive waste management program for recertification. This audit included follow-up surveillance by the Nevada Operations Office in February 1995. The outcome of this audit was favorable; all corrective actions and approval to ship waste to the Nevada Test Site are being formalized.

Thus, the majority of work completed in 1995 involved preparing shipments of low-level radioactive waste to the Nevada Test Site. Much of this waste was generated during the cleanup and transition of the Tritium Research Laboratory.

Mixed Waste Program

SNL management decided to consolidate all cost, liability, and management activities associated with the management of mixed waste at the SNL/New Mexico facility. SNL/California now transfers all mixed waste generated on site to the SNL/New Mexico site. SNL/California successfully completed the shipment of all mixed waste that had been in storage

by March 1995, which totaled 6.37 m^3 mixed waste. Another shipment to SNL/New Mexico was completed in September 1995, which totaled 0.07 m^3 mixed waste.

Comprehensive Environmental Response, Compensation, and Liability Act

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) is Federal legislation. It establishes a program for cleaning up contaminated areas in the environment. Two SNL/California restoration sites are affected by the Act: the Fuel Oil Spill and the Navy Landfill. SNL/California is cleaning up or assessing these sites under the authority of the Regional Water Quality Control Board. This activity is funded by the DOE Environmental Restoration and Waste Management Program. Although assessment and remediation activities are formally regulated under RCRA and are being done under State direction, they conform to DOE methods specified in Order 5400.4.[1]

Pursuant to Regional Water Quality Control Board Orders 88-142 and 89-184,[2,3] SNL/California was involved in three assessments during 1995: the Fuel Oil Spill, the Navy Landfill, and Miscellaneous Sites. These are described below.

Fuel Oil Spill

As a result of an accidental puncture of an underground fuel transfer line in 1975, approximately 229,000 L (59,500 gallons) of #2 diesel fuel were released into the soil from a reserve fuel tank. Bench-scale tests of various remediation technologies were conducted in 1993. Analysis of the test results indicated *in situ* bioremediation (cleanup in place) to be the most effective and feasible cleanup method. Using a computer code developed at Los Alamos National Laboratory and monitoring well data, Los Alamos experts prepared a three-dimensional model characterizing the spill area. Argonne National Laboratory conducted additional bench-scale studies at the University of Notre Dame, to establish nutrient and oxygen levels and to identify degradation products. SNL/California completed three groundwater wells downgradient of the spill site to monitor and control the spread of the contaminated groundwater.

After heavy rainfall in the spring of 1993, the groundwater at the Fuel Oil Spill site rose about 3.6 m (12 ft.). Diesel and BTEX (benzene, toluene, ethylbenzene, and xylene) contamination were noted during the second-quarter groundwater sampling. As a result, the Regional Water Quality Control Board directed SNL/California to implement an interim remedial measure—a groundwater treatment system. SNL/California completed the work plan and system design in December 1993. Equipment installation, including carbon filtration beds and a free product separator, began in December 1993. The associated pumps, tanks, and piping were installed in January 1994, and the interim remedial measure commenced.

The interim remedial measure limits the flow of contaminated water away from the Fuel Oil Spill site. In so doing, SNL/California pumps and treats the groundwater and then discharges it to the sanitary sewer or uses it in landscape watering, pursuant to the Regional Water Quality Control Board's approval. All water discharged from the system is tested for BTEX and total petroleum hydrocarbons. No contaminants have been detected in the discharge stream.

From February to April 1994, SNL/California drilled 24 boreholes for a pilot study of *in situ* bioremediation. These boreholes are used for monitoring instrumentation, injection/withdrawal, and geophysical characterization. In September 1994, the Environmental Operations Department installed seven tensiometers and one down-hole barometer at the site. In addition, an infiltration gallery was constructed 1.2 m (4 ft.) below the surface. Environmental

Operations personnel set up a small land farm to bioremediate contaminated soil from the boreholes. They also installed additional equipment, including mixing tanks, compressors, and a data collection system.

SNL/California began operating the pilot study equipment in 1995. The study involves three steps: 1) injection of water containing nutrients to help stimulate bacterial activity (bacteria in the soil consume the fuel oil contaminants), 2) withdrawal of the water, and 3) ground aeration. The water used for step 1 is from the interim remedial measure wells, with city water added as necessary. Data from the monitoring boreholes and from analytical tests indicate that the bioremediation process has begun (the bacteria are consuming the fuel oil). This pilot study will likely continue through 1997.

Navy Landfill

An inactive landfill, used by the U.S. Navy and LLNL in the 1940s and 1950s, is located on the SNL/California site. Records show that no hazardous materials were disposed of at this site. SNL/California installed monitoring wells and implemented a sampling program for both water and soil to verify that no hazardous materials or contamination exist at the site. SNL/California completed and submitted to the Regional Water Quality Control Board a *Solid Waste Water Quality Assessment Test Report* (March 1990) and a follow-on *Final Additional Field Investigation Report* (March 1994).[4,5] In response, the Board issued a *Recommendation for Closure* in November 1994.[6] SNL/California completed a closure plan in 1995, which was submitted to the Board for review and approval.

Miscellaneous Sites

Under the direction of the Regional Water Quality Control Board, SNL/California assessed areas suspected of being contaminated from past operations. In 1993, SNL/California analyzed soil from sites identified during DOE's 1988 Environmental Survey. None of these sites were found to be contaminated. SNL/California sent a report documenting these findings to the Regional Water Quality Control Board.[7] One of the miscellaneous sites—the "burn pit"—was incorporated in the Navy Landfill closure. Neither cleanup nor further action is required at any of these sites. The Regional Water Quality Control Board approved the "no further action" closure on April 27, 1994.

Superfund Amendments and Reauthorization Act Title III; Emergency Planning and Community Right-to-Know Act

The Emergency Planning and Community Right-to-Know Act (EPCRA)—also known as the Superfund Amendments and Reauthorization Act (SARA) of 1986, Title III—requires reporting of toxic chemical usage and releases. The purpose of this provision is to make information about potential environmental releases of toxic chemicals available to the public. In accordance with the requirements of the Act, SNL/California submits reports annually to the EPA, the State of California, and the LLNL Fire Department. In 1995, SNL/California had two substances that were reportable under Sections 311 and 312: No. 2 fuel oil (fire hazard) and liquid nitrogen (asphyxiator, compressed gas, and cryogenic). In 1995, SNL/California had no reportable substances under Section 313, Toxic Release Inventory.

Hazardous Materials Release Response Plans and Inventory Law

The Hazardous Materials Release Response Plans and Inventory Law (California Law AB2185) covers the management of acutely hazardous materials in the State of California. Additional state laws—AB2187, AB3777, AB3205 AB2189—and other bills modifying the state hazardous materials program are codified in the California Health and Safety Code Division 20, Chapter 6.95 §25500, et seq.

SNL/California annually reviews and submits a *California Hazardous Material Management Plan* in accordance with the Hazardous Materials Release Response Plans and Inventory Law (and modifying laws) to the Alameda County Environmental Health Department, Hazardous Material Program.

Clean Water Act/Safe Drinking Water Act

Wastewater Discharge

SNL/California maintains one Wastewater Discharge Permit issued by the City of Livermore. This permit regulates SNL/California's sanitary and industrial effluent, which is discharged to the City's sewer system, and enforces the requirements of the Federal Clean Water Act. In 1995, all sanitary sewer effluent from the SNL/California site complied with the site outfall discharge limits for regulated physical parameters, radionuclides, and EPA priority organic pollutants. On two occasions, the sanitary sewer effluent slightly exceeded the site's discharge limits—once for silver and once for zinc.

Wastewater samples collected at the site outfall on June 23, 1995, showed a silver concentration of 0.27 mg/L. The discharge limit for silver is 0.20 mg/L. Therefore, the concentration of silver in the site sewer effluent on this date was slightly greater than the discharge limit. SNL/California notified the Livermore Water Reclamation Plant, as required by the Wastewater Discharge Permit. However, the plant staff indicated that this concentration did not adversely affect plant operations.

Wastewater samples collected at the site outfall on August 3, 1995, showed a zinc concentration of 4.50 mg/L. The discharge limit for zinc is 3.0 mg/L. Therefore, the concentration of zinc in the site sewer effluent on this date was slightly greater than the discharge limit. SNL/California notified the Livermore Water Reclamation Plant, as required by the Wastewater Discharge Permit. However, the plant staff indicated that this concentration did not adversely affect plant operations.

Details of all the wastewater monitoring and a summary of the sampling results are provided in the Sewer Outfall Monitoring section of Chapter 4, "Environmental Monitoring Program."

SNL/California operates two metal finishing categorical processes subject to the EPA's pretreatment standards for point sources (Title 40 CFR, parts 403 and 433).[8,9] These two processes, the Electroplating Laboratory and the Printed Wiring Facility, require special sampling of the wastewater they generate. In 1995, all the liquid effluents from the Printed Wiring Facility process complied with pretreatment discharge standards (for metals and organic pollutants).

In 1995, the Electroplating Laboratory was relocated from Bldg. 913 to Bldg. 943. The process is now a closed-looped system, and wastewater is not discharged to the sanitary sewer. The Electroplating Laboratory ceased discharging wastewater in May 1995. Livermore Water Reclamation Plant staff visited SNL/California on December 1, 1995, to verify that the Electroplating Laboratory had been shut down in its old location. In addition, they sent a letter stating that because the metal finishing processes have been shut down, Federal categorical pretreatment requirements no longer apply to discharges from Bldg. 913, and because the relocated process is a closed-loop system, categorical reporting requirements do not apply. However, the Reclamation Plant staff will periodically inspect the facility to verify existing information.

Industrial Storm Water Discharge

In 1995, SNL/California conducted all required elements of the storm water management program, which included extensive drain testing for sanitary connections to the storm drain system; training of all facilities and maintenance

personnel in storm water best management practices; and all monitoring required for storm water discharges.

SNL/California is covered under the California General Industrial Activities Storm Water National Pollutant Discharge Elimination System (NPDES) Permit.[10] This permit allows SNL/California to comply with Federal permitting requirements for storm water discharges associated with industrial activities. The permit requires SNL/California to implement a comprehensive storm water management program. SNL/California also must comply with the City of Livermore's municipal storm water ordinance. SNL/California's program ensures compliance with both the permit and the City's ordinance by eliminating illicit discharges and connections to the storm drain system and by implementing a *Storm Water Pollution Prevention and Monitoring Plan*.[11]

Drinking Water

The drinking water for the SNL/California site is supplied by the San Francisco Water District through the Hetch Hetchy Aqueduct. The San Francisco Water District is responsible for monitoring the quality of the incoming water. SNL/California neither treats nor samples the drinking water. LLNL maintains the drinking water distribution system for both sites. Maintenance includes water quality screening analyses.

Clean Air Act/Air Quality Regulations

In 1995, SNL/California complied with applicable laws, regulations, and guidelines governing radiological and nonradiological emissions to the atmosphere.

Several operations at SNL/California are subject to the rules and regulations administered by the Bay Area Air Quality Management District because they emit, or have the potential to emit, air contaminants.[12] The District and the California Air Resources Board are responsible for setting regulations and providing guidance to attain and maintain EPA and State of California air quality standards. In 1995, SNL/California received no violations for air emission exceedances.

Tables 3-2 and 3-3 list the type and number of permitted sources and exemptions granted to SNL/California. During 1995, SNL/California complied with all the conditions specified in its air discharge permits.

NESHAPs Compliance for Radionuclides

The EPA regulates airborne emissions of radionuclides through the Clean Air Act, National Emission Standards for Hazardous Air Pollutants (NESHAPs).[13] On December 15, 1989, the EPA revised its NESHAPs Rule for Radionuclides—Title 40 CFR, Part 61 (Subpart H applies to DOE facilities). It establishes radiation protection standards for protection of the public, monitoring requirements, and annual reporting of radionuclide air emissions. The EPA has established 10 mrem/yr. as the allowable limit of radiation dose received by the public from air emissions. In 1995, the maximum dose from SNL/California's air pathway was 0.01 mrem (1.0×10^{-4} mSv), or 0.1% of the Clean Air Act limit.

Each year, SNL/California evaluates site air emissions for compliance with the NESHAPs Rule for Radionuclides.[13] This evaluation consists of a site-wide survey of all uses of radionuclides and the potential for airborne release. In 1995, the survey identified two facilities with the potential to emit airborne radioactive contaminants: the Tritium Research Laboratory (which is no longer operational) and the Radioactive Waste Management Facility. SNL/California monitors airborne emissions from both facilities.

The gaseous emissions from the Tritium Research Laboratory always have been carefully monitored. In 1991, the stack monitoring system was upgraded to ensure full compliance with the emission monitoring and testing procedures of Section 61.93(b) of the NESHAPs Rule.[13] Each year, as required by the Rule,

SNL/California calculates the radiological dose from these emissions, using the EPA-specified computer code (CAP-88). Although the Tritium Research Laboratory has ceased operations and has been cleaned in preparation for its transition to other uses, SNL/California continues to monitor any air ventilating through the building's stack. The input parameters and results of the calculation for 1995 are presented in Chapter 4, "Environmental Monitoring Program." Based on this calculation, SNL/California has determined that its operations involving radionuclides comply with the monitoring and radiological dose requirements of the NESHAPs.

National Environmental Policy Act Compliance

During 1995, more than 90 projects were evaluated, and NEPA classifications and/or determinations made.

The National Environmental Policy Act (NEPA) requires SNL/California to consider environmental issues in the review of every proposed project on-site. Because Sandia is a Federal government contractor and receives Federal funds, all proposed projects, programs, and activities must be reviewed for their potential environmental impacts. The DOE has implemented official regulations and orders to guide its facilities in the NEPA process. The DOE Albuquerque Operations Office directs SNL/California NEPA activities.

Chapter 5, "Environmental Program Information," provides more information about SNL/California's NEPA activities in 1995.

Other Environmental Statutes

In 1995, SNL/California had no significant activities governed by the following regulations:

- Toxic Substances Control Act,
- Federal Insecticide, Fungicide, and Rodenticide Act,
- Endangered Species Act,
- National Historic Preservation Act,
- Floodplain Management (Executive Order 11988), or
- Protection of Wetlands (Executive Order 11990).

SNL/California maintains compliance with the regulations listed above through internally generated procedures and review of DOE orders. No lawsuits pertaining to any environmental regulation are on file against SNL/California.

OTHER ISSUES AND ACTIONS

Audits and Inspections

Operations at SNL/California are routinely subjected to internal inspections as part of a self-assessment program. In addition to this internal scrutiny, external regulatory agencies audited or inspected SNL/California in 1995. Table 3-4 lists these audits and inspections by date. The table also cites the purpose and the regulatory agency performing the inspection or audit.

Occurrence Reports

DOE Order 5000.3B, *Occurrence Reporting and Processing of Operations Information*,[15] requires that occurrences be consistently reported to assure that both the DOE and SNL management are kept informed of all events that could:

- affect the health and safety of the public;
- seriously impact the intended purpose of DOE facilities;
- have a noticeable adverse effect on the environment; or
- endanger the health or safety of workers.

The SNL/California Occurrence Reporting System has established a formal process for investigating and notifying the DOE of unusual events at the site. The goals of SNL/California's Occurrence Reporting System are to ensure the following:

- timely identification, categorization, notification, and reporting to SNL and DOE management;
- timely evaluation and implementation of corrective actions, including root cause analyses to identify appropriate corrective actions; and
- dissemination of lessons learned to prevent occurrence of similar events.

Table 3-5 lists all the environment-related events reported through Sandia's Occurrence Reporting System in 1995. The system provides background information for each event reported, including date, type of occurrence, and a brief description.

State Oversight Program

On September 6, 1990, the DOE signed an Agreement in Principle with the State of California to provide California's citizens independent assurance that DOE sites are fulfilling their commitments to health, safety, and the environment. However, in 1995, the State Department of Toxic Substances Control decided to terminate participation in the Program. Oversight of SNL/California operations is still provided by the DOE, the EPA, and State agencies that have the authority to enforce regulations to which SNL/California is subject.

ENVIRONMENTAL PERMITS

Table 3-6 identifies the environmental permits held by SNL/California in 1995 and the regulatory agencies responsible for enforcing the respective regulations and permit conditions.

Hazardous Waste Permits

The Cal/EPA issued a final RCRA "Part B" permit on December 4, 1992, for SNL/California to operate the Hazardous Waste Storage Facility. The permit is effective from January 4, 1993, to January 4, 2003.

As provided by the 1984 Hazardous and Solid Waste Amendments to RCRA, the Cal/EPA conducted a RCRA Facility Assessment in April 1991. The assessment report was issued in September 1991. The Cal/EPA revised this report and reissued it in March 1992.[16] It identified three "solid waste management units" at SNL/California: the Fuel Oil Spill, the Navy Landfill, and Miscellaneous Sites. However, because these units were being assessed and remediated as part of the Regional Water Quality Control Board Order, no corrective action was required in 1995.

All waste handling operations at SNL/California are conducted according to the most recent State and Federal regulations. More information on SNL/California's Hazardous Waste Program is provided in Chapter 5, "Environmental Program Information."

Air Quality Permits

To comply with the NESHAPs Rule for Radionuclides,[13] SNL/California must obtain EPA approval before starting construction on new sources that may emit radionuclides to the air, or before modifying existing sources. SNL/California has a permit for operating the low-level tritium evaporator at the Tritium Research Laboratory, although it is no longer operational. When the permit expires, SNL/California will not renew it.

In 1995, SNL/California had Bay Area Air Quality Management District permits for 32 sources of air pollutants, such as boilers, the incinerator, vapor degreasers, a paint spray booth, and various abatement devices (see Table 3-2). However, several of these sources are no longer operational due to changes in site operations during 1995. Bay Area Air Quality Management District permits are renewed annually. SNL/California also operates 37 sources officially exempt from District permitting (see Table 3-3).

Wastewater Discharge Permit

SNL/California holds one Wastewater Discharge Permit issued by the Livermore

Water Reclamation Plant. This permit regulates SNL/California's sanitary and industrial liquid effluent, which is discharged into the City's sewer system. It is renewed annually. It contains discharge limits for the site sanitary sewer outfall and for processes subject to EPA pretreatment standards. The permit also contains liquid effluent monitoring and reporting requirements. For more details, see Chapter 4, "Environmental Monitoring Program," which has a summary of the conditions of SNL/California's Wastewater Discharge Permit.

Groundwater Discharge Permit

SNL/California holds one Groundwater Discharge Permit issued by the Livermore Water Reclamation Plant. This permit regulates the discharge to the sanitary sewer system of water captured by the aquifer protection wells at the Fuel Oil Spill site. SNL/California treats the water before discharging it to the sanitary sewer system. The permit is renewed annually. It contains discharge limits and monitoring and reporting requirements for the chemical constituents of concern. For more details, see Chapter 4, "Environmental Monitoring Program," which has a summary of the conditions of SNL/California's Groundwater Discharge Permit.

National Pollutant Discharge Elimination System Storm Water General Permit for Industrial Activities

SNL/California is covered under the California General Industrial Activities Storm Water National Pollutant Discharge Elimination System (NPDES) Permit.[10] This permit allows SNL/California to comply with Federal permitting requirements for storm water discharges associated with industrial activities.

The permit also requires SNL/California to implement a comprehensive storm water management program. Sandia's program is designed to identify and eliminate non-storm water discharges to the storm drain system, implement a storm water pollution prevention plan, and establish a storm water monitoring plan. Although the State Water Resources Control Board administers the storm water general permit, the San Francisco Bay Regional Water Quality Control Board enforces the general permit in Alameda County, for facilities such as SNL/California.

In response to Federal Clean Water Act permitting requirements for municipal storm water discharges, the City of Livermore has adopted ordinances that control storm water discharges to the City's storm drain system. The Livermore Water Reclamation Plant enforces the City's storm water management ordinance.

REFERENCES

1. U.S. DOE, Order 5400.4, CERCLA (October 6, 1989).

2. State of California, San Francisco Bay Region, Regional Water Quality Control Board, Order 88-142 (September 21, 1988).

3. State of California, San Francisco Bay Region, Regional Water Quality Control Board, Order 89-184 (December 13, 1989).

4. U.S. DOE, Sandia National Laboratories/California, *Solid Waste Water Quality Assessment Test Report* (March 1990).

5. U.S. DOE, Sandia National Laboratories/California, *Final Additional Field Investigation Report* (March 1994).

6. State of California, San Francisco Bay Region, Regional Water Quality Control Board, *Recommendation for Closure* (November 1994).

7. U.S. DOE, *Reconnaissance Investigation Report for Sandia National Laboratories, Livermore Miscellaneous*

Sites, DOE/AL Environmental Restoration Program (August 1992).

8. U.S. EPA, Title 40 CFR, Part 403, *Federal Wastewater Pretreatment Standards* (July 1994).

9. U.S. EPA, Title 40 CFR, Part 433, *Metal Finishing Point Source Category* (July 1994).

10. State of California, "NPDES General Permit for Storm Water Discharge Associated with Industrial Activities," State Water Resources Control Board (September 17, 1992).

11. EOA, Inc., *Storm Water Pollution Prevention and Monitoring Plan*, for Sandia National Laboratories/California (January 1994).

12. State of California, Bay Area Air Quality Management District, *Rules and Regulations* (issued January 1980; as revised).

13. U.S. EPA, Title 40 CFR, Part 61, NESHAPs (December 15, 1989).

14. U.S. DOE and University of California, *Environmental Impact Statement and Environmental Impact Report for Continued Operation of Lawrence Livermore National Laboratory and Sandia National Laboratories, Livermore*, DOE/EIS-0157 (August 1992).

15. U.S. DOE, Order 5000.3B, Occurrence Reporting and Processing of Operations Information (May 1990).

16. State of California, Environmental Protection Agency, RCRA *Facility Assessment Report* (March 1992).

Table 3-1. Major Federal Environmental Regulations Applicable to SNL/California.

Legislation	Description
Resource Conservation and Recovery Act **(RCRA)**	RCRA regulates hazardous, nonhazardous, and medical waste. It also regulates underground storage tanks containing hazardous substances and petroleum products.
Comprehensive Environmental Response, Compensation, and Liability Act **(CERCLA)** Superfund Amendments and Reauthorization Act **(SARA)**	CERCLA and SARA establish liability, compensation, cleanup, and emergency response for hazardous substances released to the environment.
Emergency Planning and Community Right-to-Know Act **(EPCRA)**	EPCRA (SARA Title III) requires that hazardous substances used on site be reported to State and local governments and to the general public.
Clean Water Act **(CWA)** National Pollutant Discharge Elimination System **(NPDES)**	Through the NPDES, the CWA regulates liquid discharges for both wastewater and storm water discharges from industrial activities.
Clean Air Act **(CAA)** National Emission Standards for Hazardous Air Pollutants **(NESHAPs)**	The CAA and NESHAPs set air quality standards for hazardous air emissions, such as radionuclides and benzene.
Toxic Substances Control Act **(TSCA)**	The TSCA controls the use and exposure of new industrial chemicals. It also regulates the use and disposal of polychlorinated biphenyls (PCBs).
National Environmental Policy Act **(NEPA)**	NEPA establishes criteria for evaluating potential environmental impacts of Federal activities and alternatives.

Table 3-2. SNL/California Bay Area Quality Management District Permitted Sources.

Source Type	Number of Permits Held
Boilers	7
Degreasers/cleaners	7
Paint spray booth	1
Gasoline dispensing facility	1
Miscellaneous	16
Total	32

Table 3-3. Bay Area Quality Management District Exemptions Held by SNL/California in 1995.

Source Type	Number of Exemptions Held
Laboratories	16
Diesel fuel dispensing tanks	2
Explosive test cells	2
Abrasive blasters	2
Miscellaneous	15
Total	37

Table 3-4. Environmental Audits of SNL/California in 1995.

Date	Regulatory Authority	Purpose
3/22–3/24	DOE/Albuquerque, Kirtland Area Office	ES&H oversight visit
3/24	Livermore Water Reclamation Plant	Wastewater inspection
5/19	Livermore Water Reclamation Plant	Wastewater inspection
6/27	California EPA and Livermore Water Reclamation Plant	Wastewater inspection
7/5	California EPA and Livermore Water Reclamation Plant	Wastewater inspection

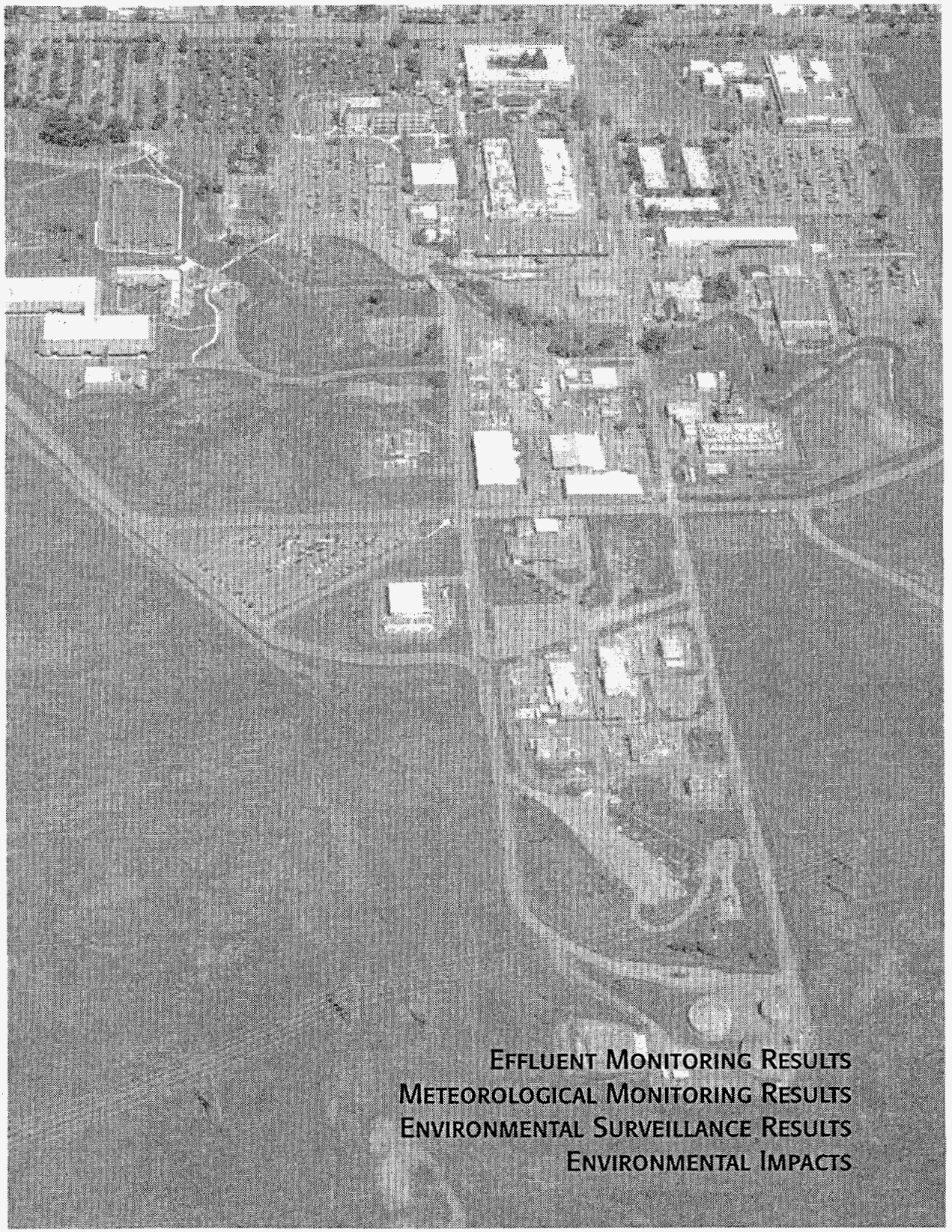
Table 3-5. Environment-related Occurrence Reports.

Report No.	Date	Subject	Occurrence Category	Description of Occurrence
ALO-KAO SNL-CASITE-1995-0006	7/12/95	Exceedance of wastewater discharge permit limit for silver	Off-normal	The SNL/California sanitary sewer outfall composite sample collected on June 19, 1995, showed a silver concentration of 0.27 mg/L, which is greater than the limit of 0.2 mg/L. A thorough investigation of the laboratories and facilities that use silver was conducted. The source of the silver could not be identified. SNL/California conducted a multi-faceted campaign to inform site personnel of wastewater discharge guidelines via presentations and brochures. The final occurrence report was issued in August 1995.
ALO-KAO SNL-CASITE-1995-0007	9/29/95	Exceedance of wastewater discharge permit limit for zinc	Off-normal	The SNL/California sanitary sewer outfall composite sample collected on August 3, 1995, showed a zinc concentration of 4.50 mg/L, which is greater than the limit of 3.0 mg/L. In the past, floor waxing products have been the source of high zinc levels. An investigation determined the areas that had been stripped and mopped during the period of the exceedance did not produce enough wastewater to elevate the zinc levels. The source of the zinc could not be identified. SNL/California conducted a multi-faceted campaign to inform site personnel of wastewater discharge guidelines via presentations and brochures. This included distributing wastewater guidance brochures to all SNL/California personnel and contractors. The final occurrence report was issued in November 1995.

Table 3-6. SNL/California Environmental Permits in 1995.

Category	Regulation/Authority	Permit Status
Waste Management	Title 40 CFR 264 (RCRA), EPA; Title 22 CCR, Division 4.5, Cal/EPA	Part B permit effective January 4, 2003.
Air Quality	Bay Area Air Quality Management District	Bay Area Air Quality Management District permits for 32 air emission sources. Permits renewed annually. (See Table 3-2.)
Air Quality	Title 40 CFR 61 (National Emission Standards for Hazardous Air Pollutants), EPA	Issued by the EPA (Title 40 CFR 61, Subpart H) to operate a low-level tritium evaporator at the Tritium Research Laboratory.
Wastewater Discharge	City Ordinance, City of Livermore	Permit for the site sanitary and industrial wastewater discharge. Permit renewed annually.
Storm Water Discharge	Clean Water Act (Title 40 CFR 122–124), EPA, National Pollutant Discharge Elimination System, State Water Resources Control Board	SNL/California has a Notice of Intent on file with the State Water Resources Control Board. As a result, Sandia is covered by the State's National Pollutant Discharge Elimination System General Permit for Discharge of Storm Water Associated with Industrial Activities. Permit renewed every five years.
Groundwater Discharge	City of Ordinance, City of Livermore	Permit for discharging treated groundwater to the sanitary sewer. Permit renewed annually.

4 – Environmental Monitoring Program



Effluent Monitoring Results
Meteorological Monitoring Results
Environmental Surveillance Results
Environmental Impacts

The Environmental Operations Department at SNL/California (in conjunction with LLNL) maintains effluent monitoring and environmental surveillance programs. The purpose of these programs is to assess and control potential impacts, if any, to the public and the environment from operations at SNL/California. The department monitors all significant liquid and airborne effluents, making sure SNL/California continually complies with environmental protection laws and standards. Monitoring activities verify the effectiveness of emission control measures by routinely examining environmental media, such as ambient air, surface water, groundwater, soil, arroyo sediments, storm water runoff, sewage, vegetation, and wine, for radionuclides and hazardous chemicals that may be emitted from site operations. An extensive environmental dosimeter network also measures external radiation levels. SNL/California's environmental monitoring activities (joint with LLNL) ensure that all significant exposure pathways are monitored. Table 4-1 shows the types and number of samples collected, the collection frequency, and the parameters measured.

This chapter discusses the results of SNL/California and LLNL's joint monitoring and surveillance activities. The data are interpreted and evaluated according to applicable standards. Appendix A describes the laboratory analyses done on the samples.

EFFLUENT MONITORING RESULTS

Airborne Effluents

The only detectable radionuclide discharged to the atmosphere from SNL/California is tritium from the Tritium Research Laboratory.[1] In 1995, a total of 74 Ci (2.7×10^6 MBq) tritium was discharged from clean-up operations at the former Tritium Research Laboratory. Of this amount, 72.9 Ci (2.7×10^6 MBq) was in the form of tritium oxide (HTO or T_2O), and the remaining 1.1 Ci (0.04×10^6 MBq) was in the form of elemental tritium gas (HT or T_2). Based on these stack emissions, SNL/California calculated potential off-site radiological doses to the public, including the maximum possible dose, using EPA-approved assessment models. The section "Environmental Impacts," presents the methods and results of this assessment. Figure 4-1 below, shows the tritium releases for both SNL/California and LLNL for the last 11 years.

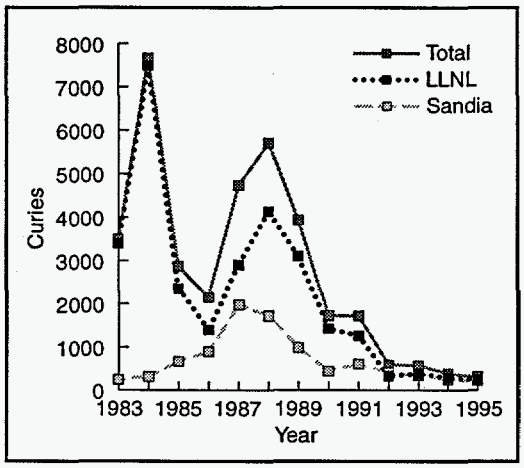


Figure 4-1. Tritium releases from both SNL/California and LLNL since 1984.

The Bay Area Air Quality Management District regulates air emissions of nonradiological pollutants by issuing operating permits. These permits set operating conditions or limitations on sources (equipment or operations) that may emit pollutants to the air. SNL/California has no sources that require routine emission monitoring for nonradiological pollutants. SNL/California's permits are discussed further in Chapter 3.

Liquid Effluents

SNL/California's Wastewater/Storm Water Program ensures that liquid effluents generated by SNL/California operations comply with applicable regulations.

Wastewater discharge limits are imposed by the DOE,[2] the City of Livermore, and other State and Federal agencies. Frequency, methods of sample collection, and parameters for which to analyze are specified in Federal regulations or by SNL/California's wastewater discharge permit. SNL/California continually strives to reduce pollutants in liquid effluents to the lowest levels possible.

In 1982, the EPA National Pretreatment Program provisions of the Clean Water Act (CWA) established liquid effluent monitoring requirements for specific pollutants.[3] Accordingly, SNL/California's Wastewater Control Program emphasizes controlling effluents at the source. SNL/California imposes strict administrative and engineering controls to prevent contaminated liquid discharge to the sanitary sewer system.

Wastewater from SNL/California operations is collected and analyzed before it is released to the sanitary sewer. This analysis allows SNL/California personnel to verify that contaminant levels are acceptable before they allow the water to be released to the sanitary sewer. Almost always, the contaminant concentrations are less than the discharge limits and often are less than detection limits. SNL/California is able to treat wastewater with contaminant concentrations greater than internal site limits, but less than hazardous waste limits. This capability allows SNL/California to further reduce the already low risk of contaminants entering the sanitary sewer. In addition to monitoring at the source, SNL/California extensively monitors the sanitary sewer effluent as it leaves the site (see pg. 4-4).

Liquid effluent discharges are analyzed according to applicable regulations governing discharges to a publicly-owned treatment works. These regulations include:

- Federal Regulations

  The Clean Water Act (CWA) provides the legislative framework for protecting the nation's waterways. Liquid discharges into surface waters and municipal sewer systems from industrial sources are regulated. In accordance with the objectives of the CWA, the EPA has established categorical pretreatment standards for specified classes of industrial dischargers. SNL/California is designated as a "Metal Finishing Point Source Category." Therefore, SNL/California is subject to the pretreatment standards in Title 40 CFR, Parts 403 and 433. These standards are based on available pollution control technology for specific industrial processes.

- State of California

  The EPA has delegated authority to the State of California to enforce the National Pollutant Discharge Elimination System (NPDES) and Federal Categorical Pretreatment Standards (Title 40 CFR, Part 403).[3] The San Francisco Bay Regional Water Quality Control Board has issued an NPDES permit to the City of Livermore Water Reclamation Plant. In addition, the Federal pretreatment program is administered through the Livermore Water Reclamation Plant (LWRP) with oversight by the Regional Water Quality Control Board. This arrangement ensures a viable pretreatment program and enforcement of all pertinent State and Federal regulations.

- City of Livermore

  Section 13.32 of the City of Livermore Municipal Code contains the discharge limits for Livermore's sanitary sewer system. These limits are stated in Sandia's Wastewater Discharge Permit, issued annually by the Livermore Water Reclamation Plant.

  In general, no facility may discharge any pollutant or wastewater that will interfere with the operation or performance of the publicly-owned treatment works.

- DOE Orders

  The principal DOE order governing discharges to public sewer systems is DOE Order 5400.5, Radiation Protection of the Public and the Environment. The purpose of this order is to establish standards and requirements for DOE operations to protect members of the public and the environment against undue risk from radiation. The DOE orders only address radiation protection, e.g., radionuclide discharges to public sewer systems.

  Tritium is the only radionuclide routinely discharged to the sanitary sewer from operations on the SNL/California site.

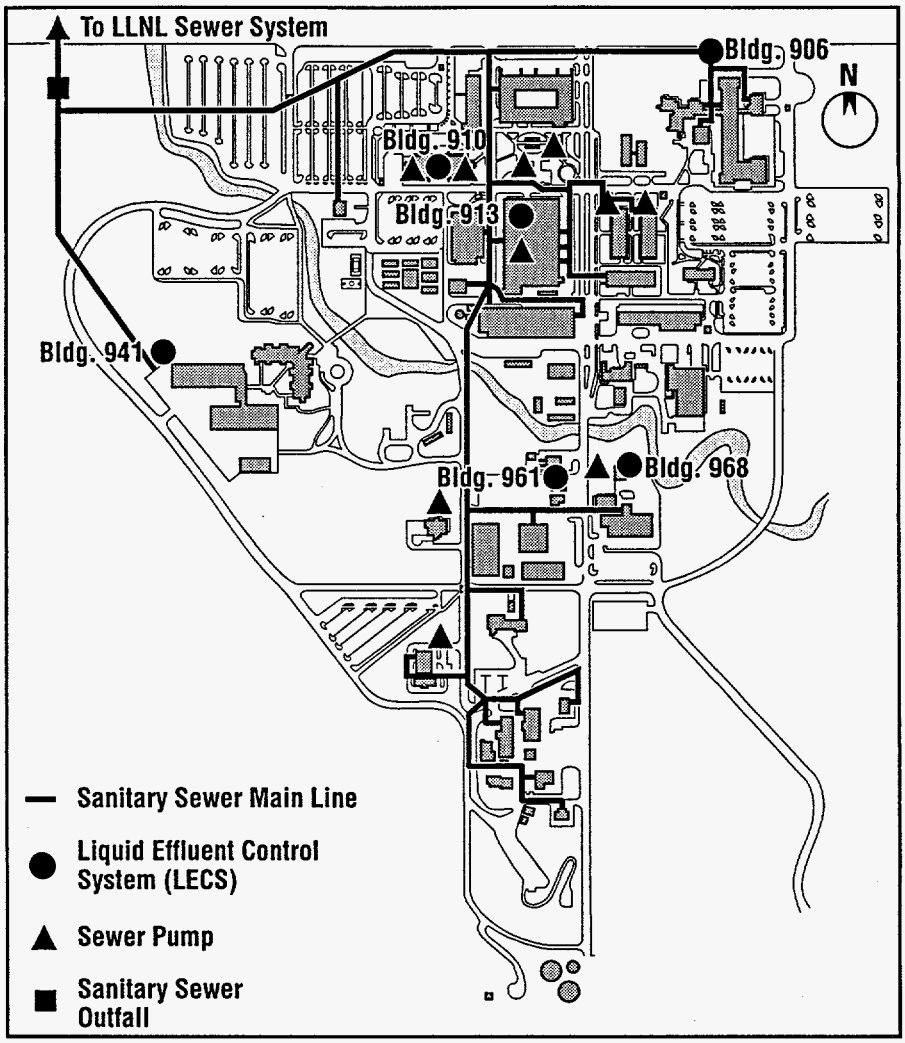


Figure 4-2. Sewer and LECS locations.

Liquid Effluent Control Systems Description

SNL/California controls at the generating source potentially contaminated liquid effluents. These effluents are routed to liquid effluent control systems (LECS). LECS consist of large, monitored holding tanks, which collect wastewater, allowing it to be analyzed before being released to the sanitary sewer. By retaining the wastewater at the point of generation, SNL/California can ensure it is within allowable limits before discharging it and can prevent accidental releases to the sanitary sewer system.

LECS Locations

Figure 4-2 shows the locations of all the LECS at the SNL/California site:

- Bldg. 968—all floor drains and laboratory sinks in Bldg. 968 are routed to two 2,500-gallon tanks.
- Bldg. 913—process wastewater from the central and southern portions of Bldg. 913 and from laboratories in Bldg. 916 is routed to a LECS consisting of three 5,000-gallon tanks.
- Bldg. 910—process wastewater is routed from the Printed Wiring Laboratory to a LECS consisting of one 5,000-gallon tank.
- Bldg. 961—water from decontamination operations is routed to a LECS consisting of one 2,000-gallon tank.

- Bldg. 906—process wastewater is routed to a LECS consisting of two 5,000-gallon tanks.
- Bldg. 941—process wastewater is routed to a LECS consisting of two 5,000-gallon tanks.

Methods

To assure that a representative sample is collected, the contents of the tanks are agitated by recirculation or air bubbling before they are sampled.

Analyses

To ensure compliance with the SNL/California wastewater permit requirements, a grab sample of the LECS contents is collected before the water is discharged to the sanitary sewer. A State-certified commercial laboratory analyzes the samples for parameters associated with the process generating the wastewater. The analyses typically include pH, arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, and zinc. As applicable, analyses for uranium and tritium are also performed.

Federal Categorical Processes

Locations

SNL/California operates two "categorical processes," which are subject to the Federal Pretreatment Standards (Title 40 CFR, Part 433): the Electroplating Laboratory in Bldg. 913 and the Printed Wiring Laboratory in Bldg. 910.[4] Semiannually, SNL/California conducts special sampling procedures for these facilities' wastewater.

In 1995, the Electroplating Laboratory relocated from Bldg. 913 to Bldg. 943. The process is now closed-loop, and does not discharge to the sanitary sewer. Discharges from the Bldg. 913 Electroplating Laboratory ceased in May, 1995. A site visit by LWRP on December 1, 1995 verified that the Electroplating Laboratory in Bldg. 913 was no longer operational. LWRP issued a letter stating that categorical pretreatment regulations no longer apply to Bldg. 913. The letter also stated that because of the closed-loop design of the Electroplating Laboratory in Bldg. 943, categorical monitoring requirements were not applicable to this laboratory. However, LWRP will conduct periodic inspections to verify existing information.

Analyses

To comply with the requirements of the Federal Pretreatment Standards, SNL/California collects grab samples of the wastewater from these processes semiannually. A State-certified commercial laboratory analyzes the samples for pH, arsenic, cyanide, cadmium, chromium, copper, lead, mercury, nickel, silver, zinc, and toxic organic compounds. The toxic organic compound analysis covers all EPA priority organic pollutants.

Results

The 1995 data for the semiannual monitoring showed that the wastewater met all of the pretreatment standards. The following parameters were consistently seen above their detection limits, but below their regulatory limits:

- Chromium—the regulatory limit for chromium is 1.71 mg/L. Chromium was seen at levels ranging from 0.06 to 0.07 mg/L.
- Copper— the regulatory limit for copper is 2.07 mg/L. Copper was seen at levels ranging from 0.21 to 0.58 mg/L.
- Nickel—the regulatory limit for nickel is 2.38 mg/L. Nickel was seen at levels ranging from 0.02 to 1.7 mg/L.

These data are also reported in the SNL/California *Categorical Process Report*, which is submitted to the LWRP semiannually.[5]

Sewer Outfall Monitoring

SNL/California monitors its sanitary sewer effluent before it exits the site and joins the sanitary sewer flow from LLNL. Monitoring is continuous and comprises

grab and flow-proportional daily and weekly composite sampling.

Locations

Samples are collected at the monitoring station at the site sewer outfall. Figure 4-2 shows the site's sanitary sewer system and the location of the sanitary sewer monitoring station at the SNL/California site.

Methods

SNL/California uses real-time instruments to continuously monitor the site sewer effluent for flow and pH. Grab samples are taken from the effluent stream before it reaches the real-time monitors. Flow-proportional samples are collected by two automatic, refrigerated, ISCO in-line samplers, one collecting a daily composite sample and the other a weekly composite. The daily composite sample is retained as an archive sample to use if confirmatory analyses are required.

Analyses

A flow-proportional composite sampler continuously samples the sewer effluent so that SNL/California can continuously monitor its compliance with the discharge limits contained in the site's Wastewater Discharge Permit. SNL/California conducts all sampling and analysis in accordance with the provisions of the permit.

SNL/California continuously monitors the liquid effluent at the site sewer outfall for pH and flow. SNL/California collects weekly composite and grab samples and sends them to a State-certified laboratory for analysis. The certified laboratory analyzes the composite samples for regulated metals, oxygen demand, total dissolved and suspended solids, and tritium. It analyzes the grab samples for cyanide, oil and grease. SNL/California collects a sewer outfall grab sample monthly. The State-certified laboratory analyzes the monthly sample for EPA priority organic pollutants (EPA Methods 624, 625, and 608). All the analytical results are tabulated in SNL/California's Wastewater Discharge Compliance Report, which is submitted to the Livermore Water Reclamation Plant monthly.[6]

Quality Assurance

SNL/California retains the daily composite sample as an archive sample. This archive sample is analyzed in case the weekly composite sample shows unusual concentrations of any parameter of concern. Data from the archive sample analysis are used to validate data from the weekly sample. SNL/California collects duplicate samples monthly for all parameters.

Results

In 1995, all liquid effluent from the Sandia/California sanitary sewer outfall complied with the site outfall discharge limits for regulated physical parameters, radionuclides, and EPA priority organic pollutants. On two occasions, the sanitary sewer effluent slightly exceeded the site's discharge limits for regulated metals, one for silver, and one for zinc.

Wastewater samples collected at the site outfall on June 23, 1995, showed a silver concentration of 0.27 mg/L. The discharge limit for silver is 0.20 mg/L. Therefore, the concentration of silver in the site sewer effluent on this date was slightly greater than the discharge limit. SNL/California notified the LWRP, as required by the Wastewater Discharge Permit. However, these concentrations did not adversely affect plant operations. Figure 4-3 shows silver concentrations in the sanitary sewer for 1995.

The wastewater samples collected on August 3, 1995, showed a zinc concentration of 4.50 mg/L. The discharge limit for zinc is 3.0 mg/L. Therefore, the concentration of zinc in the site sewer effluent on this date was slightly greater than the discharge limit. SNL/California notified the LWRP, as required by the Wastewater Discharge Permit. However, these concentrations did not adversely affect plant

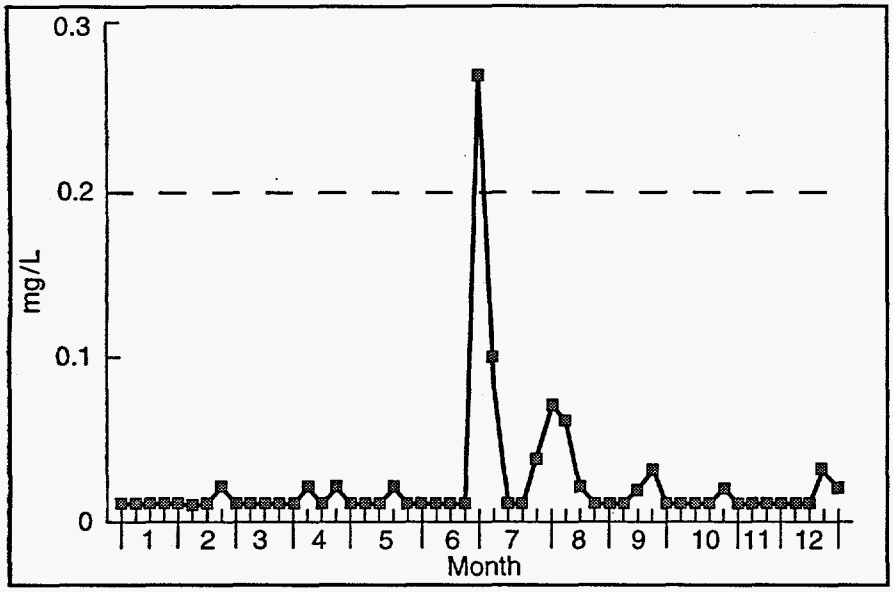


Figure 4-3. Silver concentrations in the sanitary sewer.

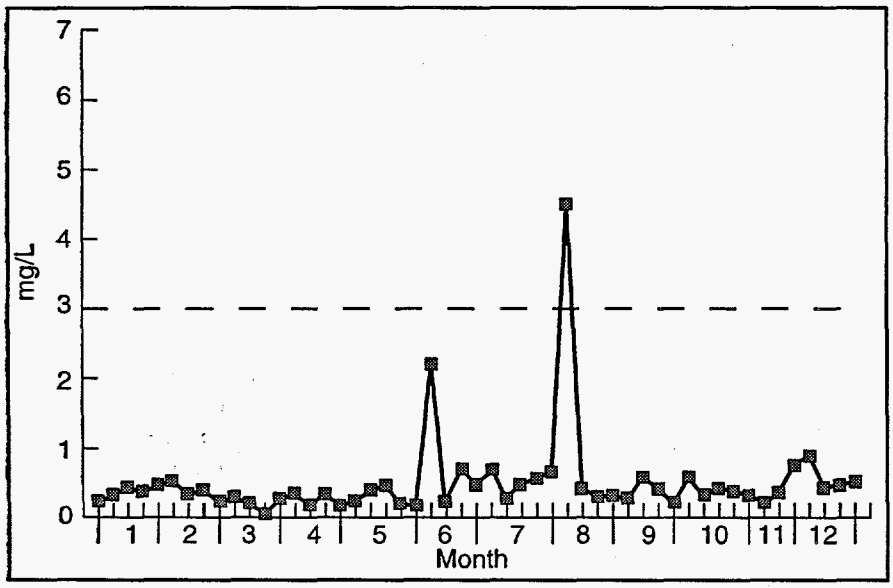


Figure 4-4. Zinc concentrations in the sanitary sewer.

operations. Figure 4-4 shows zinc concentrations in the sanitary sewer for 1995.

SNL/California performed a Mann-Kendall trend test on the 1995 metals and physical data. Copper, zinc, and Total Suspended Solids showed an upward trend. Total Dissolved Solids showed a downward trend. All other parameters showed no detectable trend. These trends are not a concern because none of the parameters exceed site discharge limits, except for zinc. Zinc levels have not shown any indication of consistently approaching site effluent limitations. SNL/California will continue to monitor trends.

The DOE and the State of California have established allowable limits for discharging radionuclides to public sewer systems, including a limit of 1×10^{-2} μCi/mL tritium as a monthly average. In 1995, tritium was the only radionuclide discharged to the sanitary sewer system from SNL/California. The average concentration of tritium in the sanitary sewer effluent was less than 3.0×10^{-6} μCi/mL, which was 0.03% of the DOE control limit. A total of 0.024 Ci tritium was discharged in 1995. No tritium samples exceeded the monthly average limit.

Storm Water Runoff

Description

As storm water runs off buildings, material-handling areas, parking lots, and other impervious areas on-site, it may pick up various pollutants, such as oil and grease, soil, litter, pesticides, and fertilizer. During dry weather, any non-storm-water discharge eventually evaporates; however, pollutants left on the ground still may be picked up and transported by runoff in a subsequent rainstorm. The SNL/California storm drain system conveys all runoff to the Arroyo Seco, which discharges into the Alameda

Creek and eventually to the San Francisco Bay. The arroyo is also a source for groundwater recharge.

To assess the contribution of site operations to pollutant loading in storm water, SNL/California collects samples of surface runoff at various points in the site's storm drain system.

Locations

Figure 4-5 shows the storm water sampling locations at SNL/California, as follows:

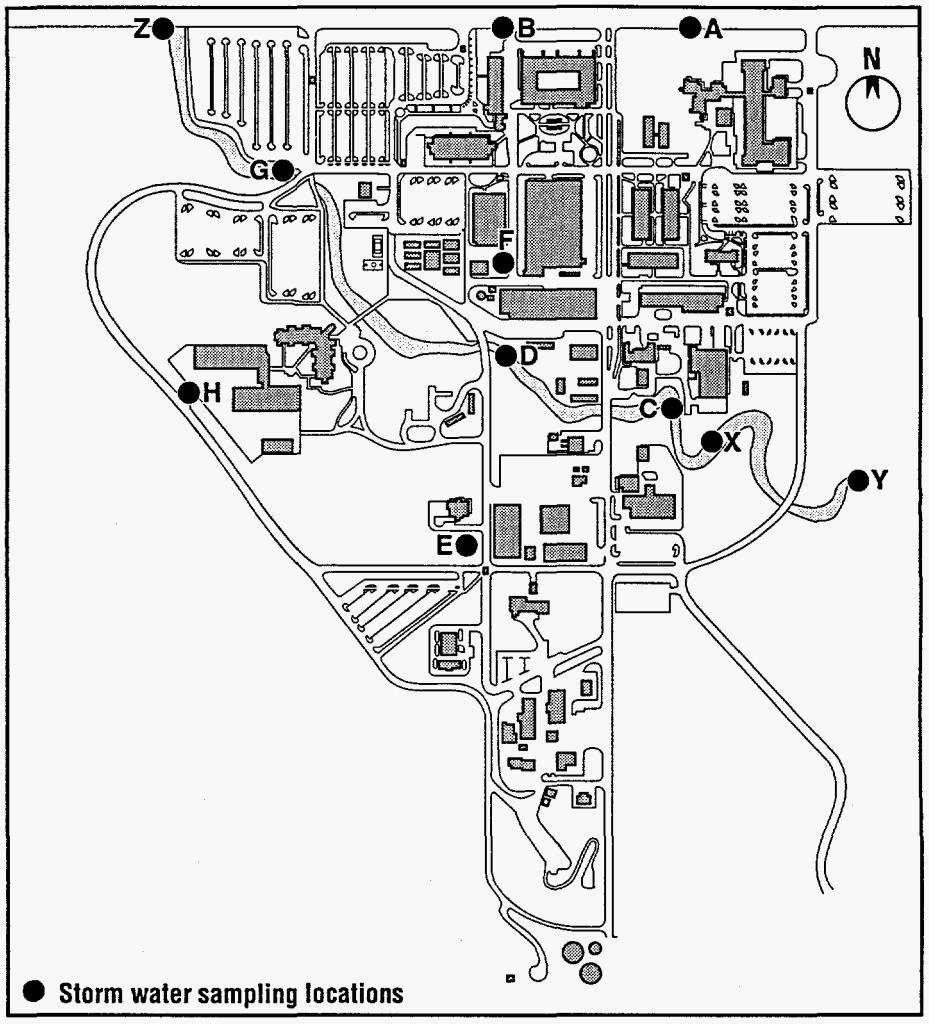


Figure 4-5. Storm water sampling locations on the SNL/California site.

- Location A—maintenance, materials handling and storage, and equipment storage on the west side of the Combustion Research Facility.
- Location B—material handling and equipment transfer for a maintenance area.
- Location C—handling of all incoming materials on site.
- Location D—material handling and storage; maintenance yard.
- Location E—primarily indoor research laboratories at the south end of Sandia Drive; outdoor activities include material and light equipment storage and a firing range.
- Location F—material handling area and storage sheds.
- Location G—material handling area and storage sheds; chemical storage shed and loading dock.
- Location H—maintenance, materials handling and storage, and equipment storage in areas surrounding the west side of the Integrated Manufacturing Technologies Laboratory.
- Location X—maintenance and equipment storage areas in the vicinity of building 968.
- Location Y—Arroyo Seco entering the site.
- Location Z—Arroyo Seco exiting the site.

Methods

SNL/California collects samples during two storms that produce runoff sufficient to allow collection of storm water in sample bottles. Samples are collected at points in the storm water conveyance system that best represent certain drainage areas and activities. Storm water samples are collected and preserved in accordance with EPA standard methods, which are described in Title 40 CFR, Part 136.[7]

In 1995, samples were collected at all 11 locations during the first storm-sampling event. During the second storm sampling event, three automatic storm water samplers were installed at locations Y, Z, and D because of the normally difficult access to the arroyo at these points. For those sampling locations in the arroyo where automatic samplers have not yet been installed, if weather and slope conditions do not allow safe access to the arroyo, the water is collected from above the arroyo with a stainless steel bucket and then is transferred to the sample bottles. SNL/California intends to install another automatic sampler at location G to help ensure the safety of SNL/California personnel during storm water sampling.

Analyses

A State-certified laboratory analyzes storm water samples for conductivity, pH, total suspended solids, and oil and grease, as required by SNL/California's storm water permit requirements. The laboratory also analyzes storm water samples for arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, zinc, pesticides, volatile organic compounds, and semivolatile organic compounds. SNL/California performed the tritium analyses. These analyses provide baseline information about pollutants that are discharged with storm water.

Quality Assurance

SNL/California collects approximately 10% duplicate samples and soon will collect a field blank sample to assess potential contamination of future storm water samples. Duplicate and blank sample collection locations are randomly chosen and vary between storms.

Results

Regulatory agencies have not established effluent standards for storm water discharge. SNL/California uses sampling data to optimize storm water pollution prevention activities and to identify trends. Because the Storm Water Monitoring Program is only three years old, SNL/California does not have enough data at each sampling location to perform trend analyses or statistical comparisons between locations. The 1993, 1994, and 1995 data will provide a baseline, to which future samples will be compared.

SNL/California's 1995 storm water sampling results successfully identified site conditions and activities that impacted storm water quality. A critical review of the results show the following:

- Oil and Grease—No samples had levels above the analytical detection limit.
- pH - Sample pH ranged from 7.0 to 8.4, which is within the acceptable range published by the State Water Resources Control Board (SWRCB). Figure 4-6 shows pH levels in storm water runoff.
- Total suspended solids (TSS)—TSS concentrations ranged from below the detection limit of 10 mg/L to 4300 mg/L. The concentrations detected are within the range of those seen in previous years, with the exception of the samples collected at locations Y and Z during the first storm event (3800 and 4300 mg/L, respectively). These locations represent the storm water as it flows onto SNL/California property (location Y), and as it exits SNL/California property (location Z). The similarity at the two locations and the low levels

detected in runoff from other areas of the site indicate that SNL/California is not a major contributor to TSS in the storm water. These samples were collected before the automatic samplers were installed, and so the stainless steel bucket method was used (see above for discussion). Figure 4-7 shows concentrations of TSS in storm water.

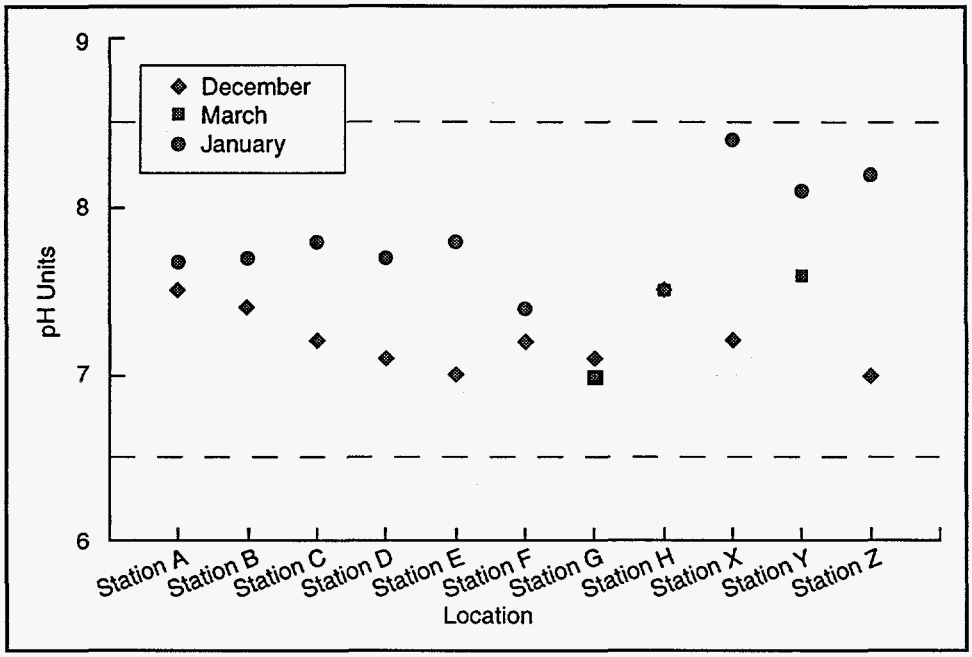


Figure 4-6. pH in storm water.

- Specific conductivity—Specific conductivity measurements ranged from 23 to 1100 µmhos/cm. As with the TSS samples, these levels are within the range seen in previous years, with the exception of the samples collected at locations Y and Z during the first storm event (530 and 1100 µmhos/cm respectively). These locations represent the storm water as it flows onto SNL/California property (location Y), and as it exits SNL/California property (location Z). The similarity at the two locations, and the low levels detected in runoff from other areas of the site indicate that SNL/California is not a major contributor conductivity of the storm water. Figure 4-8 shows specific conductivity levels in storm water.

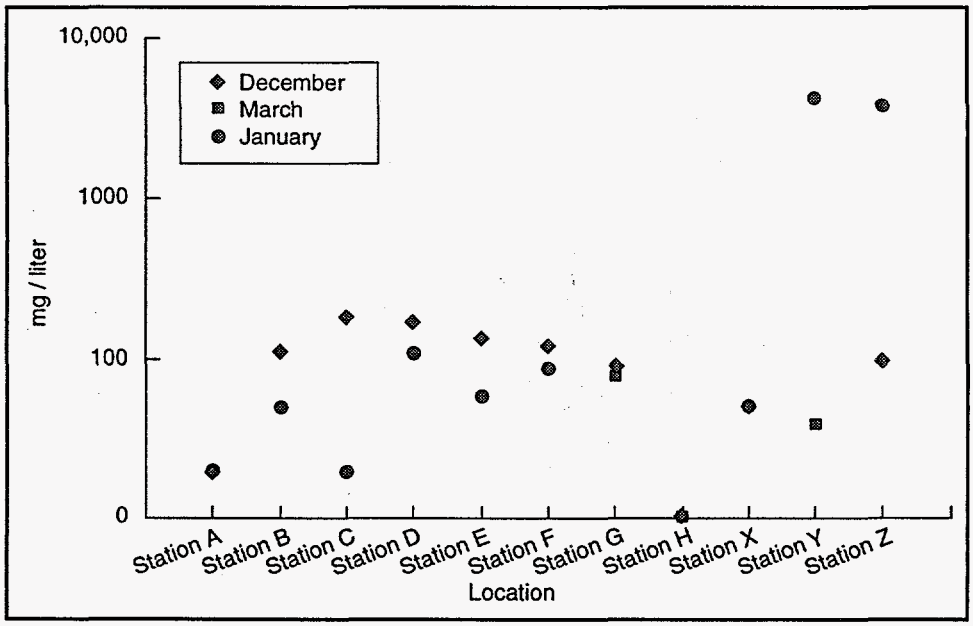


Figure 4-7. TSS in storm water.

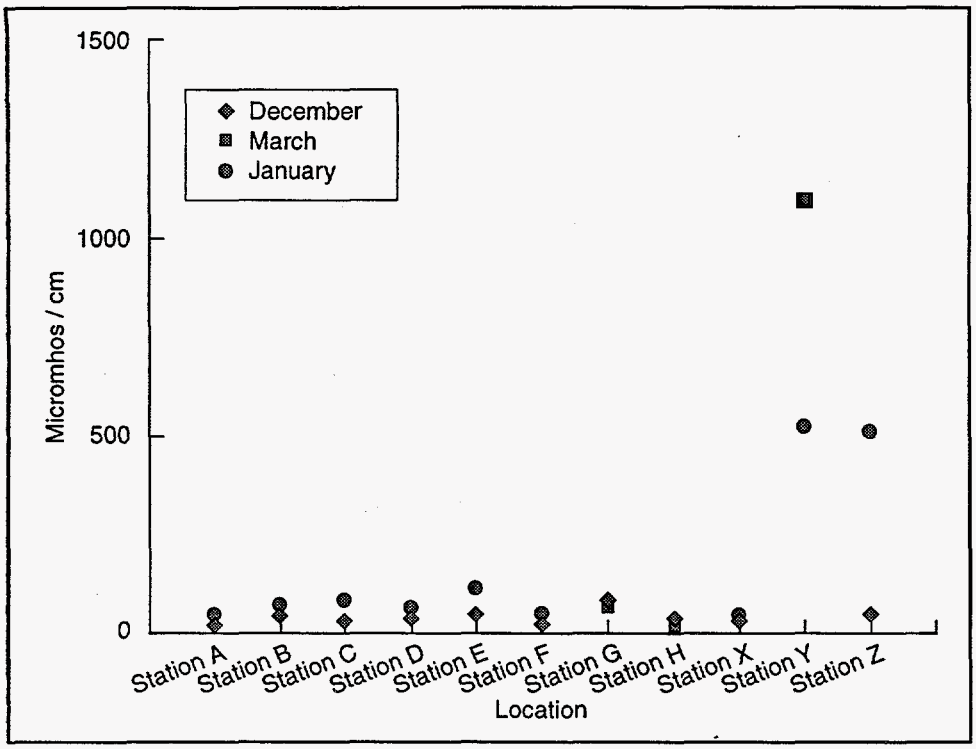


Figure 4-8. Specific conductivity in storm water.

- Diethylphthalate—Diethylphthalate was detected during the first storm event at five locations. The concentrations ranged from 14 to 39 µg/L. These concentrations are slightly higher than those seen last year, but not at a level that would cause concern. The data for these samples is in question, as the data from the duplicate samples collected at two of the locations do not agree closely with the routine sample data. See Chapter 7 for a further discussion of duplicate samples.
- Zinc—Zinc concentrations are consistently above the analytical detection limit. In 1995, zinc concentrations ranged from 0.01 to 0.71 mg/L. These concentrations are within the range seen in previous years. Figure 4-9 shows concentrations of zinc in storm water.
- Other metals - The concentrations of other metals were generally very close to, or below their analytical detection limits. Exceptions to this were copper and nickel at location Z, which were detected at 0.11 and 0.26 mg/L, respectively. Since this sample also had a very high TSS concentration (see above), it is believed that the nickel and copper were present in the suspended sediment. Zone 7 of the Alameda Flood Control District sources and other studiers have indicated that nickel and copper are naturally occurring elements in Livermore Valley soils.

METEOROLOGICAL MONITORING RESULTS

Meteorological data are continuously collected at a meteorological monitoring station on the SNL/California site. These data represent the atmospheric conditions at the site. SNL/California uses this information to assess the transport, diffusion, and deposition of materials released to the atmosphere. The 1995 data include wind speed, wind direction, rainfall, relative humidity, and ambient temperature.

Monitoring Methods

SNL/California maintains a meteorological tower on the western portion of the site (Fig. 4-10). This location represents the local terrain and is clear of any obstructions to wind-flow patterns. The meteorological monitoring system is part of the Atmospheric Release Advisory

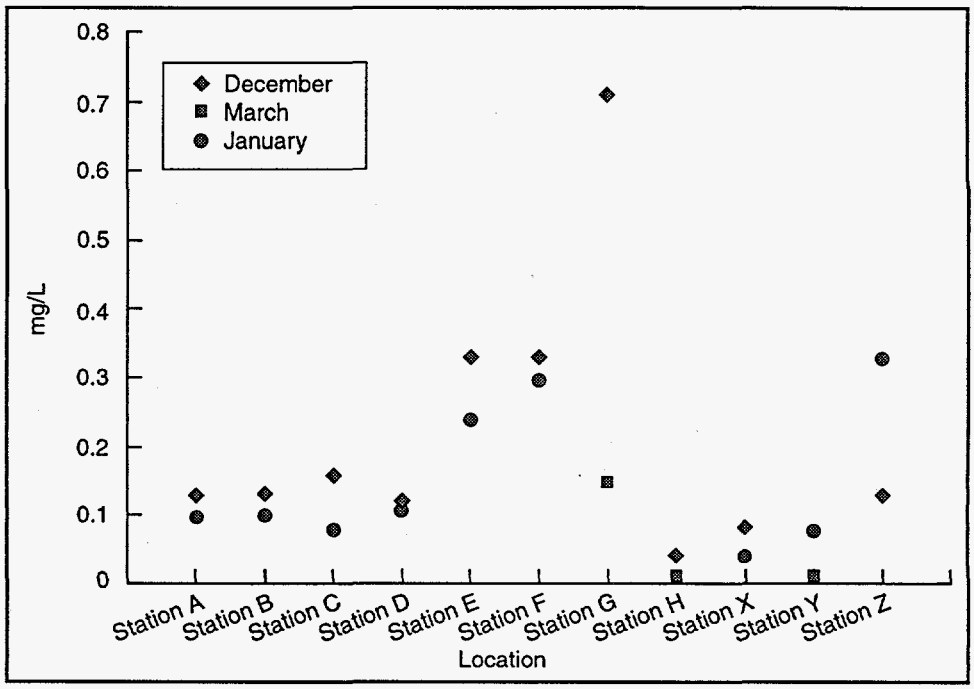


Figure 4-9. Zinc concentrations in storm water.

Capability, a DOE-operated network of monitoring stations designed to provide information to emergency response personnel. The Atmospheric Release Advisory Capability provides 24-hour access to trained assessors and computer models to evaluate atmospheric dispersion and calculate doses from accidental releases of radioactive or hazardous materials.

The SNL/California tower is equipped with HANDAR model 540 instruments (as required by the Atmospheric Release Advisory Capability system), which measure wind speed, wind direction, and temperature at heights of 10 m and 40 m, every 3 seconds. These data are compiled and stored as 15-minute averages. Rainfall is measured at ground level, and relative humidity is measured at the 10-meter level.

Results

The average 1995 surface wind speed and direction (10-meter tower level) measured at SNL/California are plotted in a wind rose (Fig. 4-11). The wind rose graphically illustrates annual average wind flow patterns. The lines extending from the center of the circle represent the direction from which the wind blows. The length of the lines is proportional to the frequency of the particular wind-speed interval. Each line represents one of the 16 primary compass directions (N, NNE, etc.) and is centered on a 22.5-degree-wide sector. The frequency of calm winds, defined as those less than 0.5 m/s (1.1 mph), was 4.8%, as indicated at the bottom of the figure. These measurements are based on 1-hour averages at the 10-meter tower level.

ENVIRONMENTAL SURVEILLANCE RESULTS

Ambient Air Monitoring

Air is a primary exposure pathway to humans from radionuclides released to the atmosphere. Therefore, environmental air sampling is conducted to evaluate potential doses from inhaled or ingested radionuclides. The inhalation of airborne radionuclides, either directly or from resuspension following deposition, may result in their being absorbed into the body from the lung or GI tract. Skin absorption can also be a significant route of uptake for tritium.

Description

The ambient air monitoring system consists of sampling stations at the site perimeter and throughout the Livermore Valley. This design enables discrimination between radionuclides from site

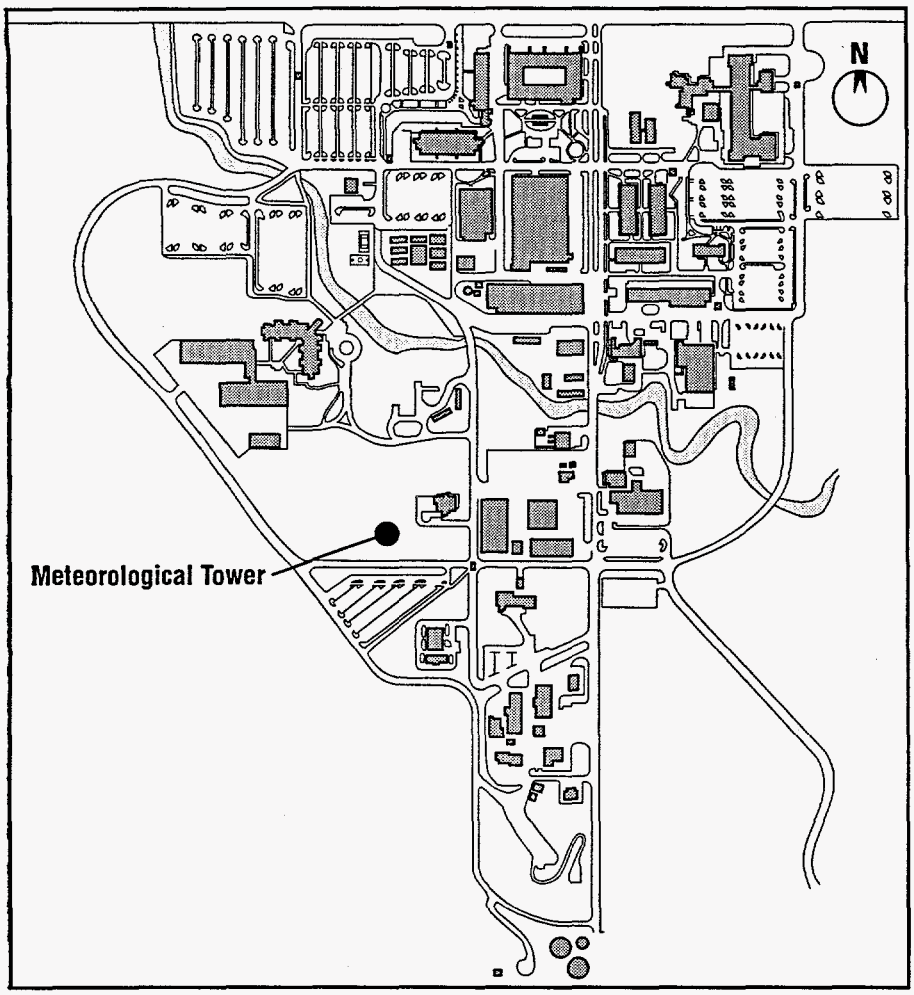


Figure 4-10. Location of the SNL/California meteorological monitoring station.

operations and from background sources. If radionuclide concentrations at the perimeter monitoring stations are higher than Valley stations, they are assumed to be the result of site emissions. The Valley locations also serve to monitor concentrations of radionuclides at local population centers.

Ambient air is the primary exposure pathway to the public from pollutants emitted from SNL/California operations. The potential emission of concern is tritium, which is collected as tritiated water vapor. More extensive analyses are performed on air filters in order to monitor the impacts of LLNL operations, which include a greater range of radionuclides.

Locations

The site perimeter (near-field) sampling locations are shown in Fig. 4-12. SNL/California maintains locations ATS-01 through ATS-05. LLNL maintains locations CAFE, SALV, and VET. The off-site (distant) locations, maintained by LLNL (except ATS-07, which is maintained by SNL/California), are shown in Fig. 4-13. LLNL locations XRDS, ZON7, ALTA, LCCY, and FIRE are the locations most pertinent to the SNL/California site. Other LLNL air monitoring locations (not shown) serve primarily to monitor LLNL operations.

In 1995, SNL/California continued operation of its air tritium sampling network with equipment essentially identical to that used by LLNL. Operation of this network is expected to continue until September 30, 1996. Since SNL/California no longer conducts any tritium operations on-site, the network will be decommissioned at this time.

Methods

LLNL collects air tritium samples at locations CAFE, SALV, VET, XRDS, MESQ, MET, VIS, COW, ZON7, ALTA, FIRE, and LCCY. SNL/California collects air tritium samples at all ATS locations. Sampling personnel collect these samples by pumping ambient air through a glass flask containing silica gel at a flow rate of 0.7 L/min. The flow is set to this rate when collection begins, the flow at the end of the 2-week collection period is noted, and the average of the two flow rates is used to calculate the total volume

of the sample. LLNL collects additional air tritium samples on the LLNL site to assess local impact from specific operations.

Quality Assurance

LLNL runs one air tritium sampler as a duplicate sampler at LLNL site perimeter locations. This sampler also is moved monthly. SNL/California runs a duplicate sampler at a Sandia-maintained sampling location. This sampler is moved biweekly. Duplicate samplers serve as the basis for determining the precision of the sampling and analytical system.

LLNL and SNL/California assess the accuracy of the analytical system by analyzing spiked pseudo samples, which have been prepared with standards traceable to the National Institute of Standards and Technology. Blank silica gel samples are created by bubbling tap water onto a silica gel sampler and then analyzing it for the required constituents. Chapter 7, "Quality Assurance," presents the results from the analysis of quality control samples.

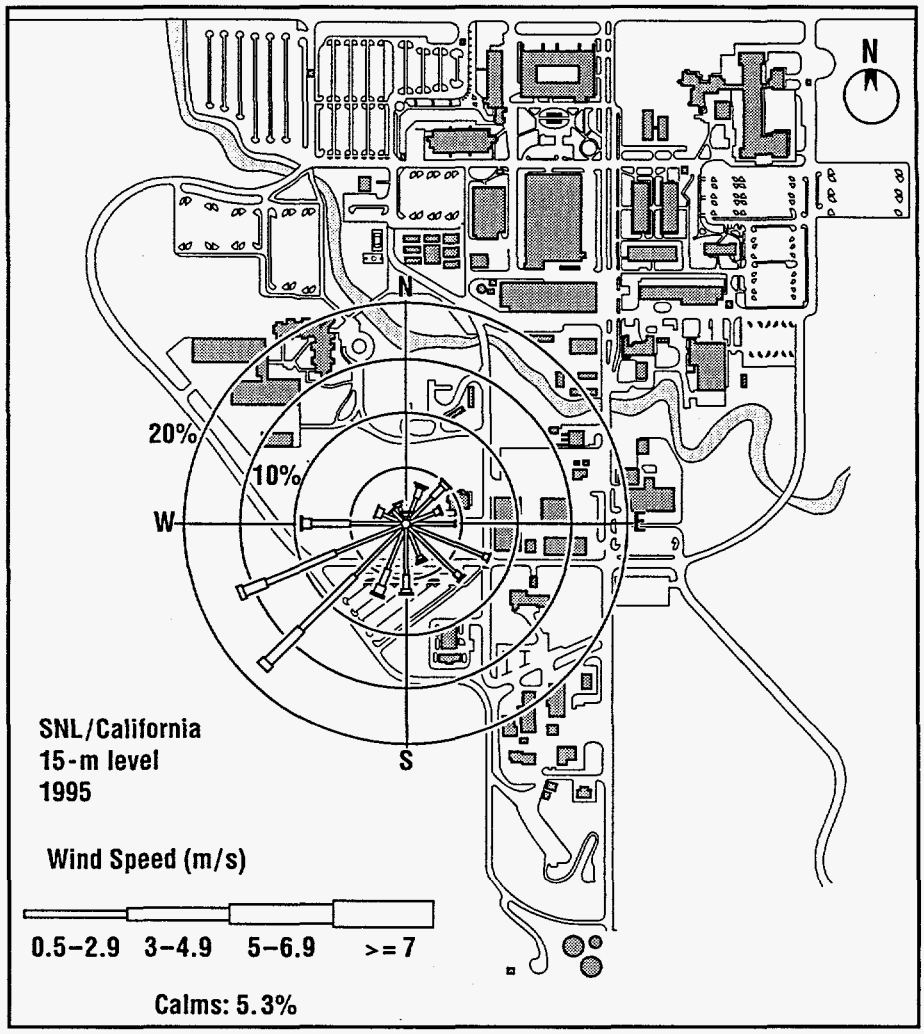


Figure 4-11. Wind rose showing the average annual wind direction and speed during 1995.

Results

The highest annual average tritium concentration observed in air in the Livermore Valley, by LLNL samplers was 1.04 pCi/m^3 (3.8×10^{-2} Bq/m^3).

The highest annual average tritium concentration measured at the SNL/California site perimeter by LLNL samplers was 3.49 pCi/m^3 (1.3×10^{-1} Bq/m^3). The DOE allowable limit for tritium in air for protection of the public is 1×10^5 pCi/m^3 (3.7×10^3 Bq/m^3). Figure 4-14 shows the highest annual average values for off-site and on-site tritium concentrations in air for 1987–95 (excluding the SNL/California samplers). The graph clearly shows a decrease in the average tritium concentration in air over the past 6 years. This corresponds well with the decreased amount of tritium released in recent years (see Fig. 4-1).

The highest annual average tritium concentration, as measured by SNL/California samplers, observed in air was 19.1 pCi/m3 (7.1×10^{-1} Bq/m^3), at

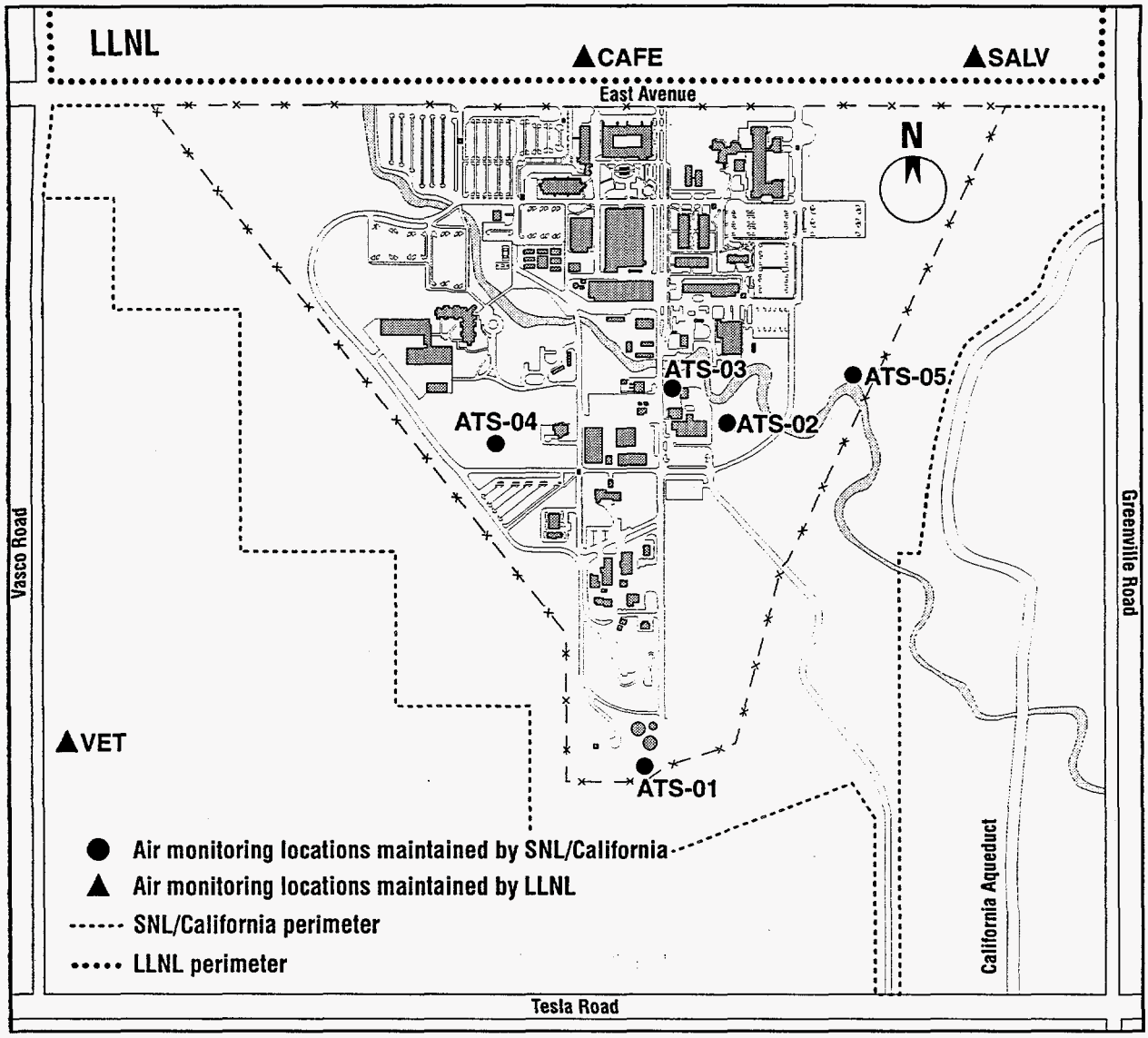


Figure 4-12. SNL/California site perimeter ambient air monitoring locations.

ATS-02 (see Fig. 4-12). This location is close to the Tritium Research Laboratory.

A statistical comparison of the tritium concentrations in air shows that the concentrations at locations SALV and CAFE, were significantly higher than the concentrations at the other locations at a 95% confidence level. Locations VET and ZON7 were significantly higher than the more distant locations with approximately 90% confidence. The SNL/California locations cannot be compared to the LLNL locations because of differences in the detection limits. However, a statistical comparison of the SNL/California locations shows that tritium concentrations at locations ATS-02 and ATS-03 were significantly higher at a 90% confidence level than those at other locations. In addition, tritium concentrations at location ATS-06 were higher than those at location ATS-04 at a 95% confidence level. The tritium concentrations at ATS-01, ATS-04, ATS-05, and ATS-06 were not statistically different than those at the background location (ATS-07). These

comparisons indicate that tritium concentrations are statistically higher at the perimeter of the SNL/California and LLNL sites and for a short distance downwind of the sites. However, more distant or upwind locations show no significant differences, and the tritium concentrations in air in these areas probably represent background values.

SNL/California performed a Mann-Kendall trend test for Sandia-maintained air sampling locations. Location ATS-03 showed a downward trend. Locations ATS-01, ATS-02, ATS-04, ATS-05, and ATS-07 showed no trend. Tritium concentrations probably will show a downward trend or will level off as tritium operations have ceased at SNL/California and have leveled off at LLNL. Continued trend tests will verify (or negate) this prediction.

The LLNL Environmental Report for 1995 contains additional air monitoring data.[8]

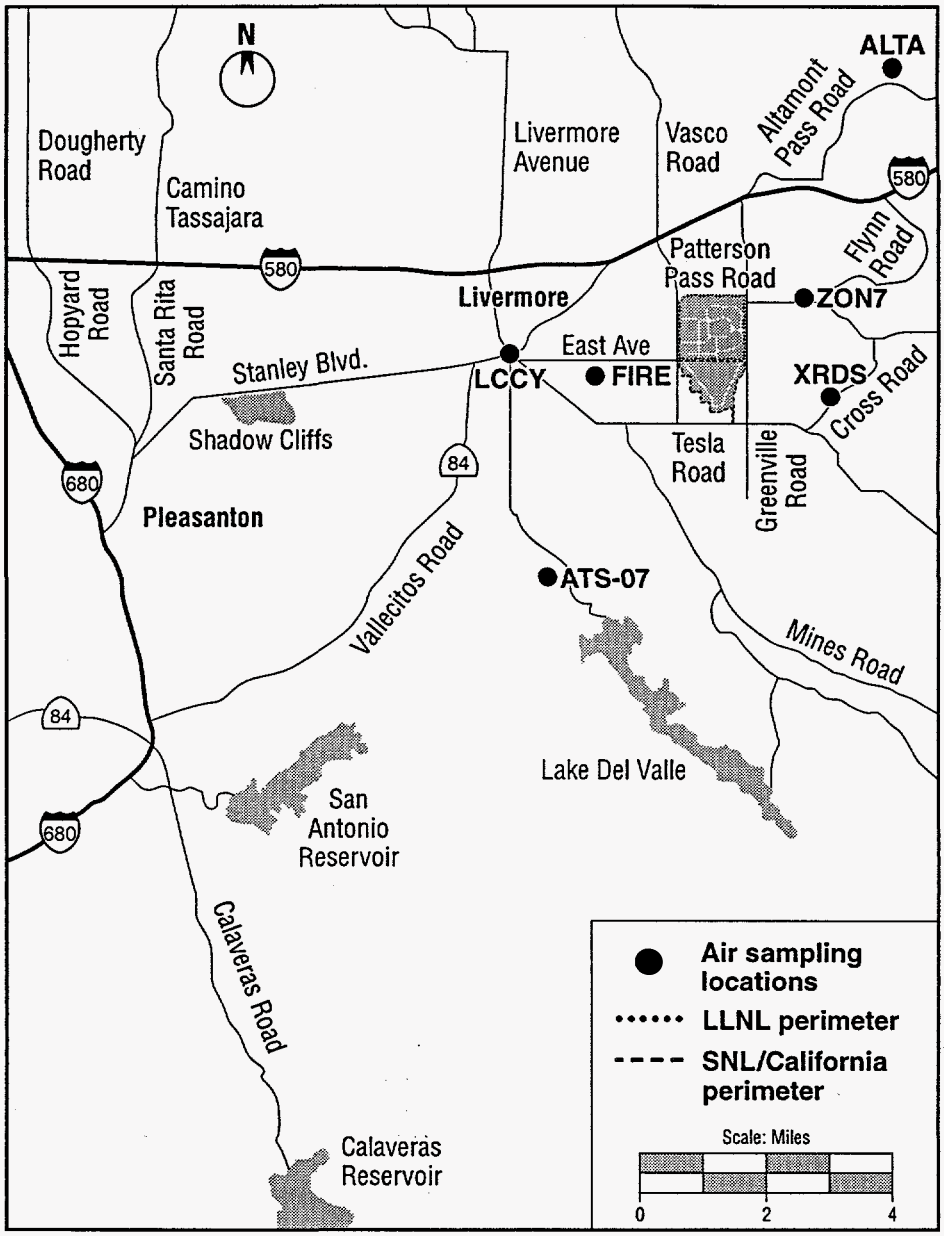


Figure 4-13. Air sampling locations in the Livermore Valley.

Water Sampling

Although there are no direct hydrologic connections between the SNL/California site and local surface bodies of water (except the Arroyo Seco), local surface water bodies could become contaminated due to exchange with pollutants in airborne effluents from site operations or rainout from effluent plumes. The effluent of primary concern in this case is tritium, due to its gaseous nature, and a corresponding high potential for dispersion.

Description

All major bodies of water near SNL/California, except the San Antonio Reservoir, are sampled and analyzed for

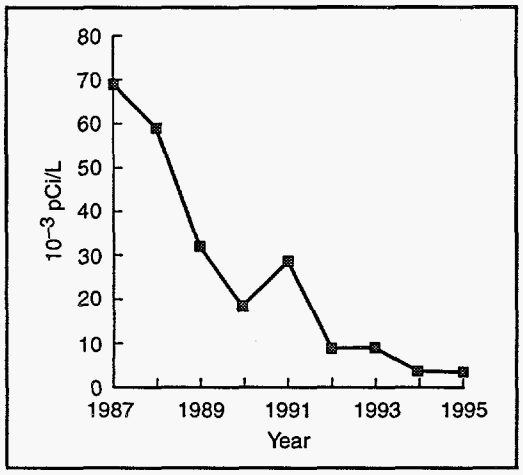


Figure 4-14. Highest annual average tritium concentration in air at the Livermore site perimeter (1987–95).

tritium. In addition, rainwater is collected and analyzed for tritium. Drinking water from the various companies serving the Livermore Valley are also sampled. Monitoring wells near the Livermore Water Reclamation Plant are sampled for tracking any contamination resulting from the plant's past practice of discharging the treated effluent to the arroyo. The sampling wells are used only to monitor groundwater quality near the Livermore Water Reclamation Plant; they are not used as drinking water sources.

In addition, rainwater is collected at several locations near the SNL/California site.

Locations

Figure 4-15 shows the surface water bodies near SNL/California that are sampled. Location ZON7 is the reservoir of the Patterson Pass water treatment facility (1.2 km east of LLNL). Location DUCK is the Springtown pond (an artificial decorative pond 2.6 km northwest of LLNL). Location DEL is Lake Del Valle (a water storage reservoir 8 km south of LLNL). Location SHAD is the Shadow Cliffs Regional Park Recreation Area (a reservoir produced by gravel excavation operations, 11 km west of LLNL). Location CAL is the Calaveras Reservoir (25 km southwest of LLNL). Location POOL is the LLNL swimming pool. Location ALAG is the Arroyo de la Laguna. Locations BELL, GAS, PALM, and TAP are tap water sources, which receive water from different water services. Location ORCH is an orchard on Mines Road.

Figure 4-16 shows the rainwater sampling locations. Figure 4-17 shows the Livermore Water Reclamation Plant groundwater sampling locations (wells).

Methods

Surface-water samples are collected quarterly by grab sampling. Samples are collected in argon-flushed glass bottles for tritium analysis.

Rainwater samples are collected in rain gages or open stainless steel buckets during every rainstorm. They are then transferred to argon-flushed glass bottles and delivered to LLNL's Nuclear Chemistry Division.

Quality Assurance

Approximately 10% randomly chosen duplicate samples are collected for the surface water bodies. Random duplicate samples also are collected for rainwater samples if there is enough water for two samples. Laboratory blanks, consisting of "dead" water, are created and processed by LLNL's Nuclear Chemistry Laboratory. The DOE Environmental Monitoring Laboratory and the EPA Environmental Measurements and Standards Laboratory both provide interlaboratory comparison samples for tritium in water. LLNL's Nuclear Chemistry Laboratory analyzes these samples routinely. Chapter 7, "Quality Assurance," presents results from the analysis of quality control samples.

Results

The highest measured tritium concentration in Livermore Valley surface waters was at the Shadow Cliffs Regional Park Recreation Area, at 53.05 pCi/L (1.96 Bq/L); higher concentrations were observed at the LLNL site, but are not

considered part of the SNL/California monitoring network. This level represents only 0.3% of the State Department of Health Services drinking water standard for tritium. All surface water samples collected in 1995 were below DOE and State drinking water standards.

The highest tritium concentration measured in rainwater was 252 pCi/L (9.3 Bq/L), at the LLNL salvage yard. This value represents 1.3% of the State drinking water standard for tritium. Figure 4-18 shows the highest annual average tritium concentrations in rainfall for 1987–95. The years 1990 and 1991 had higher concentrations than the earlier years, but levels dropped in 1992 and have remained low through 1995.

The highest tritium concentration measured in monitoring wells near the Livermore Water Reclamation Plant was 309 pCi/L (11.4 Bq/L). This value represents 1.5% of the State drinking water standard for tritium. Since the plant discontinued discharging wastewater to the Arroyo Seco several years ago, the tritium concentrations have been dropping.

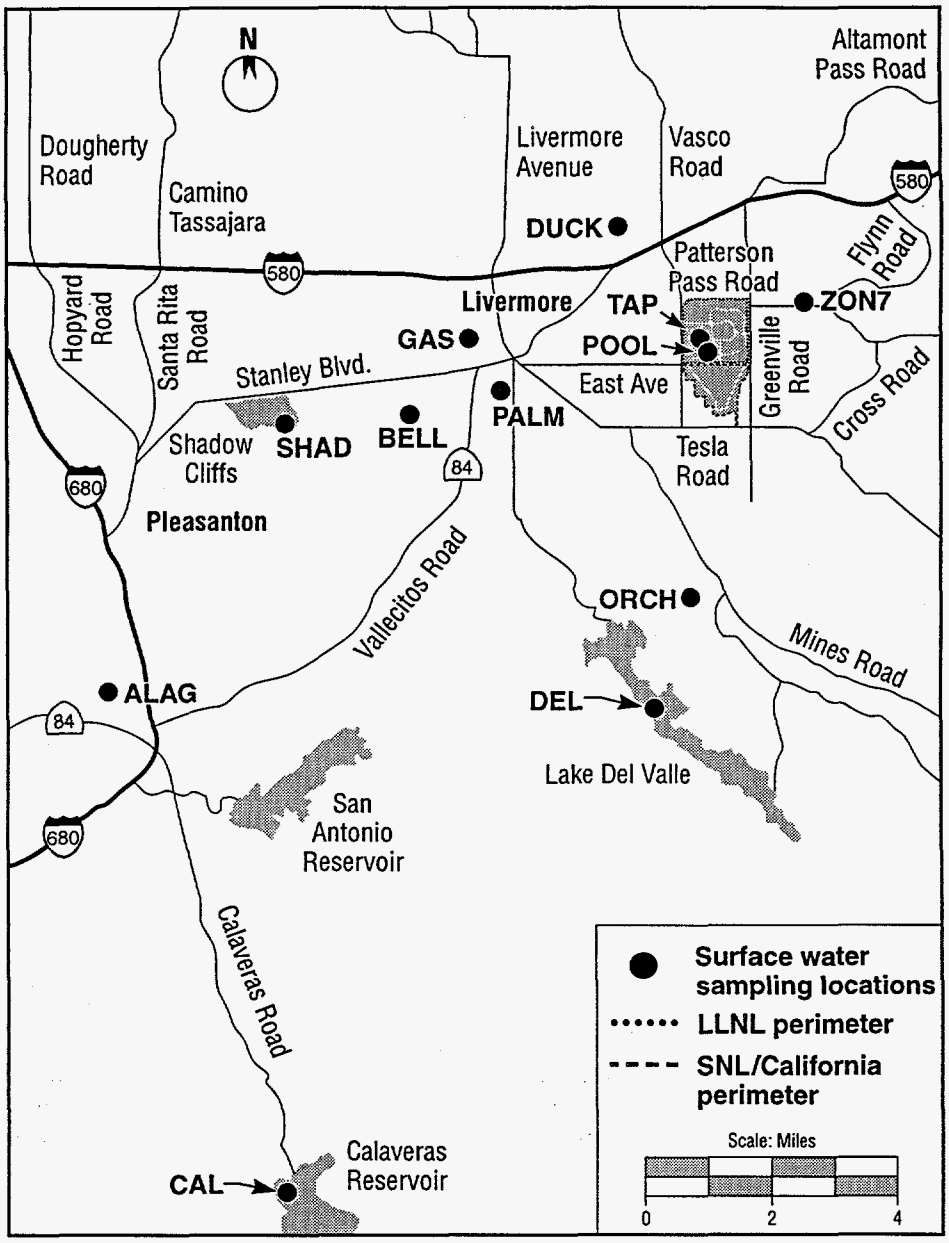


Figure 4-15. Surface water sampling locations in the Livermore Valley.

Soil/Sediment

Soil is an integrating medium, which can concentrate contaminants released to the atmosphere. Sedimentary material from the arroyos is also an integrating medium, which may concentrate pollutants transported by storm water runoff.

Description

Soil samples are collected from locations near the site perimeter and in the Livermore Valley. Any impacts due to site operations are assumed to be evident by greater concentrations in the near-field

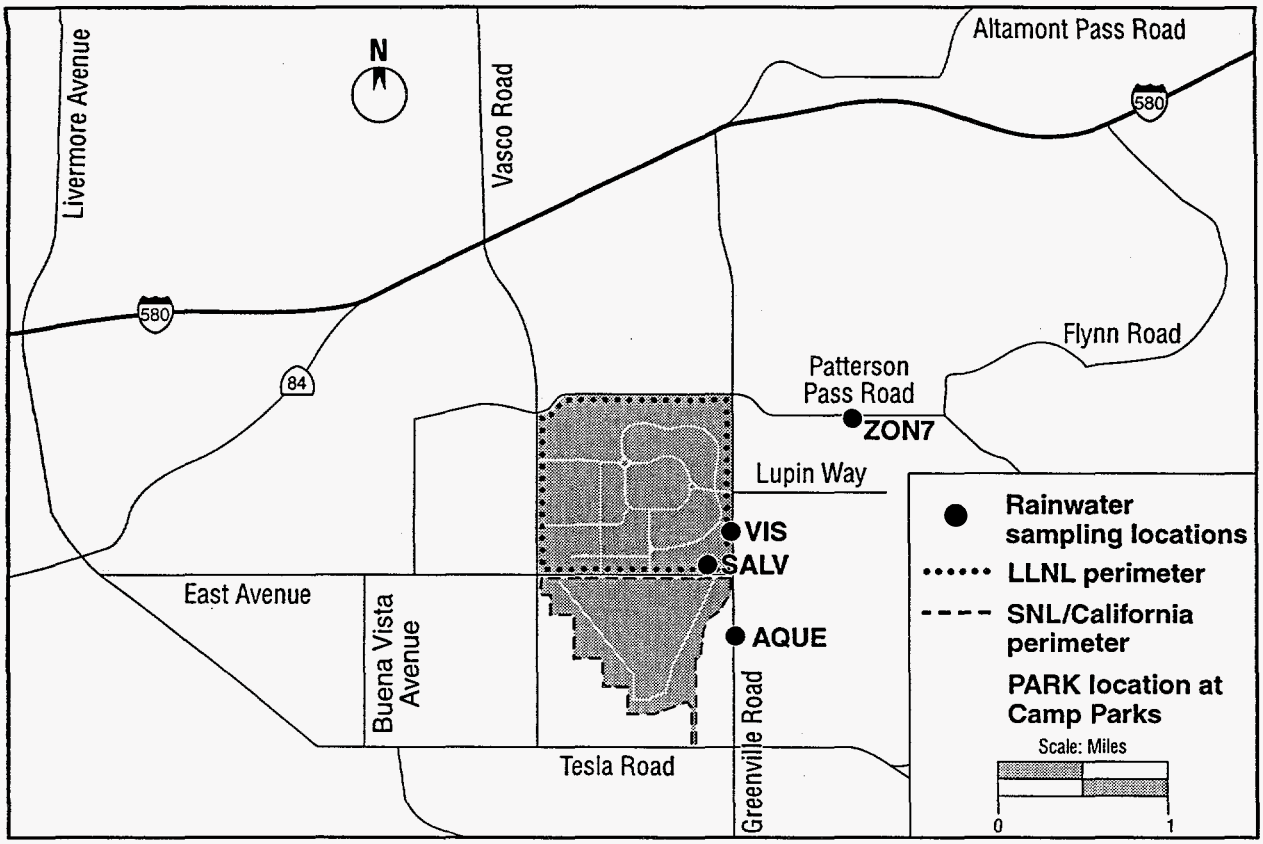


Figure 4-16. Rainwater sampling locations on the SNL/California site and in the Livermore Valley.

samples. Arroyo sediments are collected downstream of the site to assess any contamination by site operations.

In 1995, Sandia/California performed a special soil sampling in support of the TRL clean-up. Samples were collected at the SNL/California site, as well as background locations in the Livermore Valley.

Locations

Figure 4-19 shows the surface soil sampling locations. Locations VIS and TANK are considered near-field sampling locations. The rest are distant locations. Figure 4-20 shows the arroyo sediment near-field sampling location, ASS2. If air samplers are present, the surface soil samples are taken as closely as possible to these locations. Soil samples are taken from areas not shaded by trees or brush or areas that indicate evidence of human activity, such as construction or agriculture.

Professional judgement was used to choose sampling locations that were most likely to show tritium contamination for Sandia's TRL soil characterization. Samples were collected downwind of the TRL and in surface drainage pathways. Additional samples were collected from the SNL/California site for completeness, and distant locations were chosen for background measurements.

Methods

The annual soil and sediment samples are collected by taking cores approximately 10 cm in diameter and 5 cm deep. Five cores are collected from a 1 m^2 area and are composited to make a total sample of approximately 1 kg. The soil then is delivered to LLNL's Nuclear Chemistry Laboratory, where it is ground and blended. Aliquots are taken for gamma spectroscopy and plutonium analysis. (SNL/California does not use plutonium;

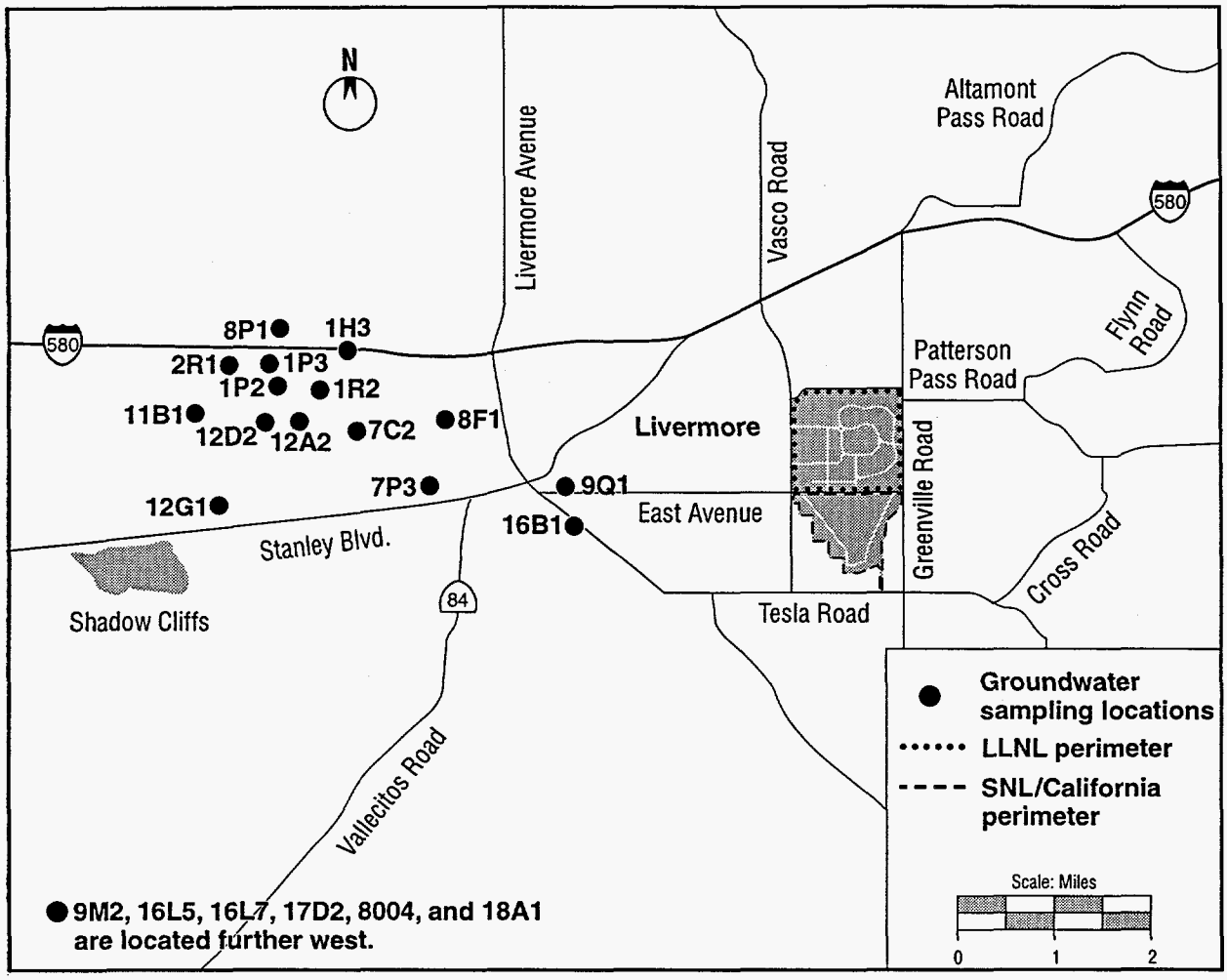


Figure 4-17. Groundwater sampling locations in the Livermore Valley.

therefore, plutonium analyses are not included in this report.) Sediments for tritium analysis are transferred to glass jars, which are then kept in an ice chest until they are delivered to the Nuclear Chemistry Laboratory, where they are frozen until analyzed.

Surface soils for Sandia's TRL soil characterization were collected after removal of surface vegetation. Only the top few centimeters of soil were collected. The samples were then frozen until analyses could be performed by a commercial laboratory.

Quality Assurance

Duplicate soil and sediment samples are taken at 10% of the soil sampling sites, chosen at random. These locations are chosen from all the locations sampled by LLNL, and thus may not include duplicates taken from a location near SNL/California.

The DOE Environmental Monitoring Laboratory's interlaboratory comparison soil samples are analyzed twice a year for uranium by LLNL's Nuclear Chemistry Division. The Nuclear Chemistry Division also analyzes reagent-grade sand as blank samples. Results from the analysis of quality control samples are presented and discussed in Chapter 7, "Quality Assurance."

Duplicate and blank samples were submitted to the laboratory in order to

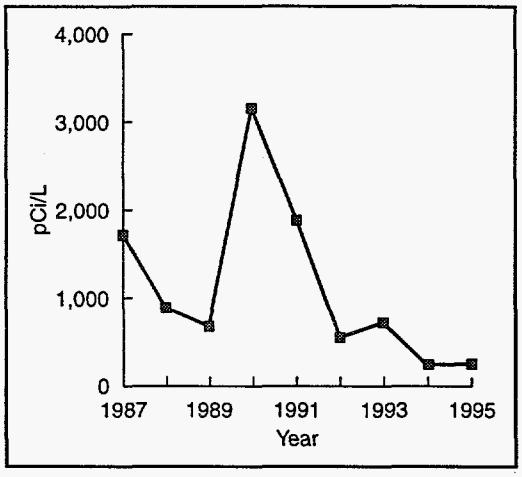


Figure 4-18. Highest annual average tritium concentration in rainfall (1987–95).

assess the quality of the TRL soil characterization sampling and analysis.

Results

Radionuclide concentrations in perimeter soil and arroyo sediment samples in are similar to those found in off-site samples, with the exception of tritium in arroyo sediments which are sightly elevated at the SNL/California perimeter, and on the LLNL site. The concentration of tritium found in water recovered from the Arroyo Seco at its outfall from the SNL/California site was 232 pCi/L. This level represents 1.2% of the State drinking water standard for tritium.

Only 2 of the 21 samples collected for Sandia's TRL soil characterization contained tritium above the analytical detection limit. The highest concentration measured was 0.096 pCi/g, which represents 0.009% of the allowable limit for unrestricted release of the site (as derived using DOE prescribed methodology).

Vegetation and Foodstuff

Agricultural products can accumulate radionuclides and provide a transport pathway for human ingestion. Vegetation may become tainted with pollutants by direct deposition from the air onto the plants, or by uptake through the roots. The public may also be exposed to pollutants through the consumption of meat from animals fed on contaminated vegetation.

Description

The only agricultural products produced in appreciable quantities near SNL/California are wine and beef. SNL/California samples wine, rather than grapes, to assess the dose to the public at the time of consumption. Wines from nearby vineyards and those in other parts of California are sampled to assess the impact of site operations. Grasses and weeds are sampled due to the lack of production in the area of significant quantities of grains or vegetables. Very little beef is raised in the Livermore Valley and most cattle are fed with imported feed. Thus, SNL/California does not sample beef because it is difficult to obtain and not a good indicator medium.

Locations

Figure 4-21 shows the sampling locations for vegetation. Locations AQUE, ZON7, VIS, MET, RAIL, MESQ, and TESW are near-field. Locations FCC, I580, MOD, DAN, PARK, CAL, and PATT are distant. All the Livermore Valley wine locations are considered near-field.

Methods

Vegetation samples consist of grasses or weeds that are green at the time of sampling. They are intended to represent forage for animals in the region. Vegetation samples are collected quarterly. They are put in plastic bags and kept in an ice chest until they are delivered to LLNL's Nuclear Chemistry Laboratory, where they are kept frozen until analyzed.

Wine samples are collected annually from local producers. They represent the most recent vintage available for any particular variety; therefore, each year's collection represents a number of vintage years. All samples are analyzed for tritium content. To prevent contamination, wine samples are stored in an argon atmosphere after the original sample containers have been opened.

Quality Assurance

Duplicate samples are collected for approximately 10% of the sampling locations, chosen at random. Wine samples are collected from a number of other California wine producers for comparison. No reference-standard samples for tritium in vegetation or foodstuffs are currently available. Results from the analysis of quality control samples are presented and discussed in Chapter 7, "Quality Assurance."

Results

The highest annual average tritium concentration for vegetation collected in 1995 was 824 pCi/L (30.5 Bq/L) at the location AQUE. This is slightly higher than the highest annual average value seen last year. However, this high average is due to one sample collected at this location. The tritium concentrations generally remained low, following an initial drop in 1992 from historically higher values. Historical data are shown in Fig. 4-22, which plots the highest annual average tritium concentration in vegetation.

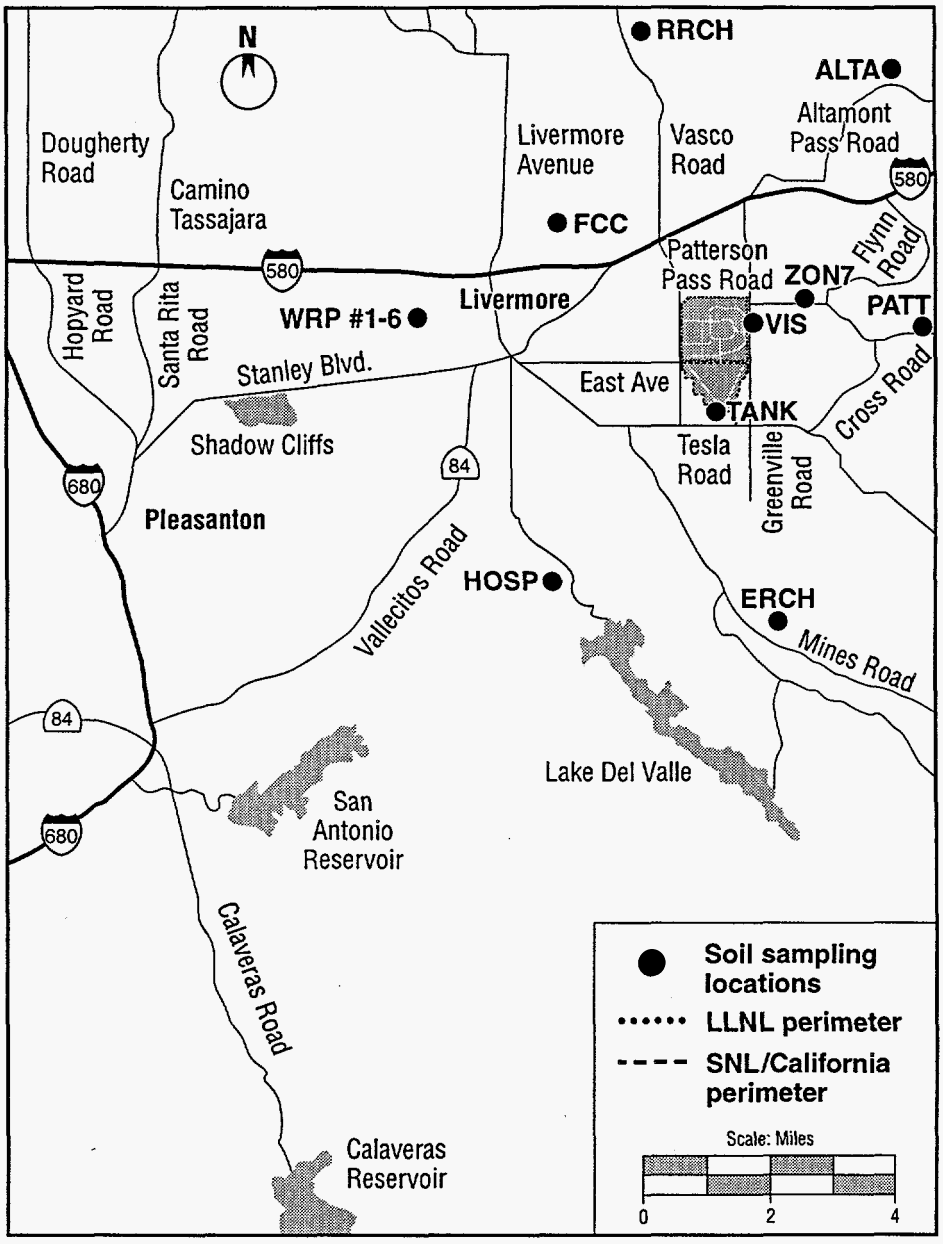


Figure 4-19. Soil sampling locations on the SNL/California site and in the Livermore Valley.

Locations AQUE and VIS show the highest concentrations of tritium. A statistical comparison shows that these locations are significantly higher than the distant locations at a 95% confidence level. Statistical comparisons also show that the perimeter locations were significantly higher than the distant locations (with the exceptions of locations PATT and I580) at a 90% confidence level. These comparisons indicate that tritium concentrations at or near the SNL/California and LLNL site perimeters are statistically higher than locations more representative of the Livermore Valley; however, the

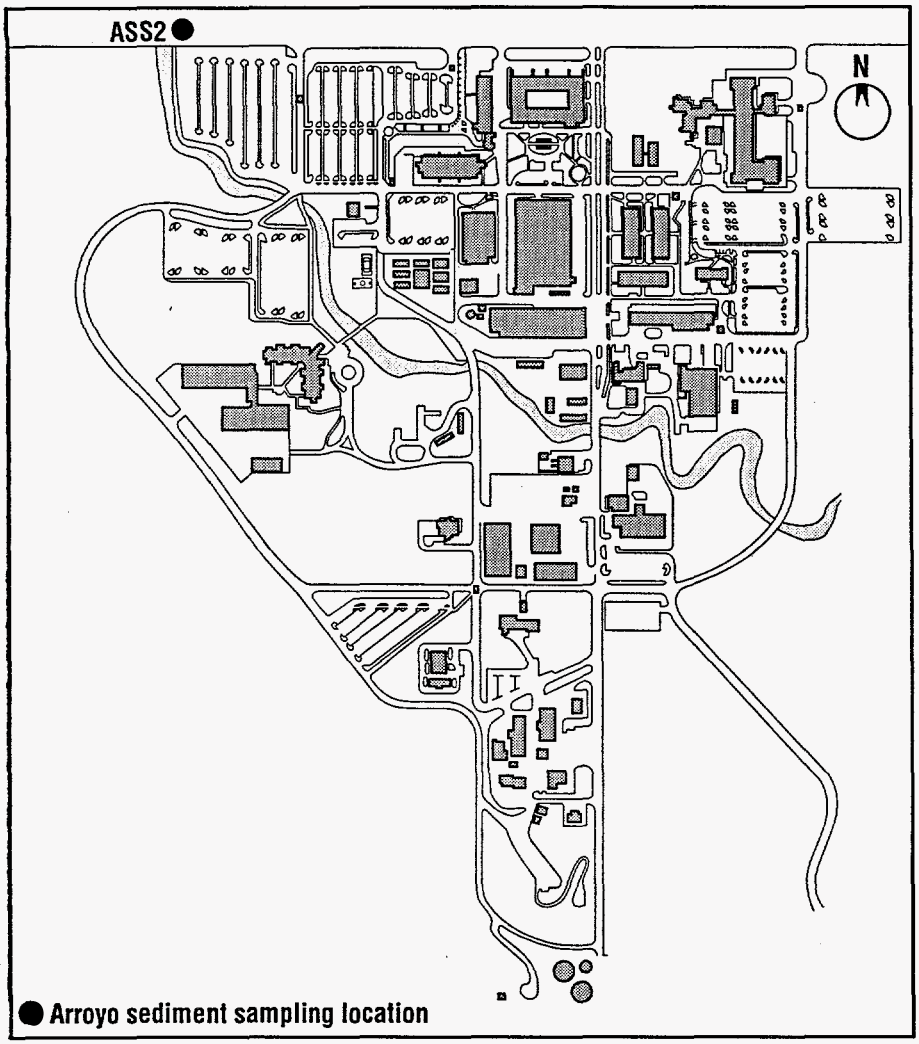


Figure 4-20. Arroyo sediment sampling location on the SNL/California site perimeter.

measured values still are quite low. The higher concentrations can be attributed to site operations. The highest concentrations seen in 1995 are slightly higher than those seen in 1994.

Average tritium concentrations in wine were 97.0 pCi/L for Livermore Valley wines, and 18.1 pCi/L for other California wines. The wines represent several vintage years, and thus are not intended to represent the tritium releases in 1995, but rather to provide an index of public exposure. The Livermore Valley wines analyzed showed a decrease in tritium content compared to 1994 analyses. The other California wines showed a slight increase compared to a 1994 analyses. Because these wines represent several vintages, the change in tritium content may be a statistical fluctuation or may be due to the wines chosen for sampling.

A statistical comparison of the tritium concentrations in the two types of wines sampled shows that the tritium concentrations in Livermore Valley wines are statistically higher than in the other California wines (at a 95% confidence level).

The levels of tritium observed in foodstuffs produced in the Livermore Valley do not pose a health concern at any consumption rate. No specific safety standards exist for tritium in vegetation or wine. However, the effective dose equivalent was calculated for vegetation (the medium for which a consumption estimate is available). The highest dose calculated was 3.8×10^{-2} mrem, which is 0.038% of the DOE maximum permissible dose to a member of the public.

External Radiation

One of the exposure pathways for population groups living near DOE facilities is external radiation. The only source of external radiation at the SNL/California site is large isotopic radiation sources used for industrial radiography.

Description

Thermoluminescent dosimeters are used to measure the dose rates near

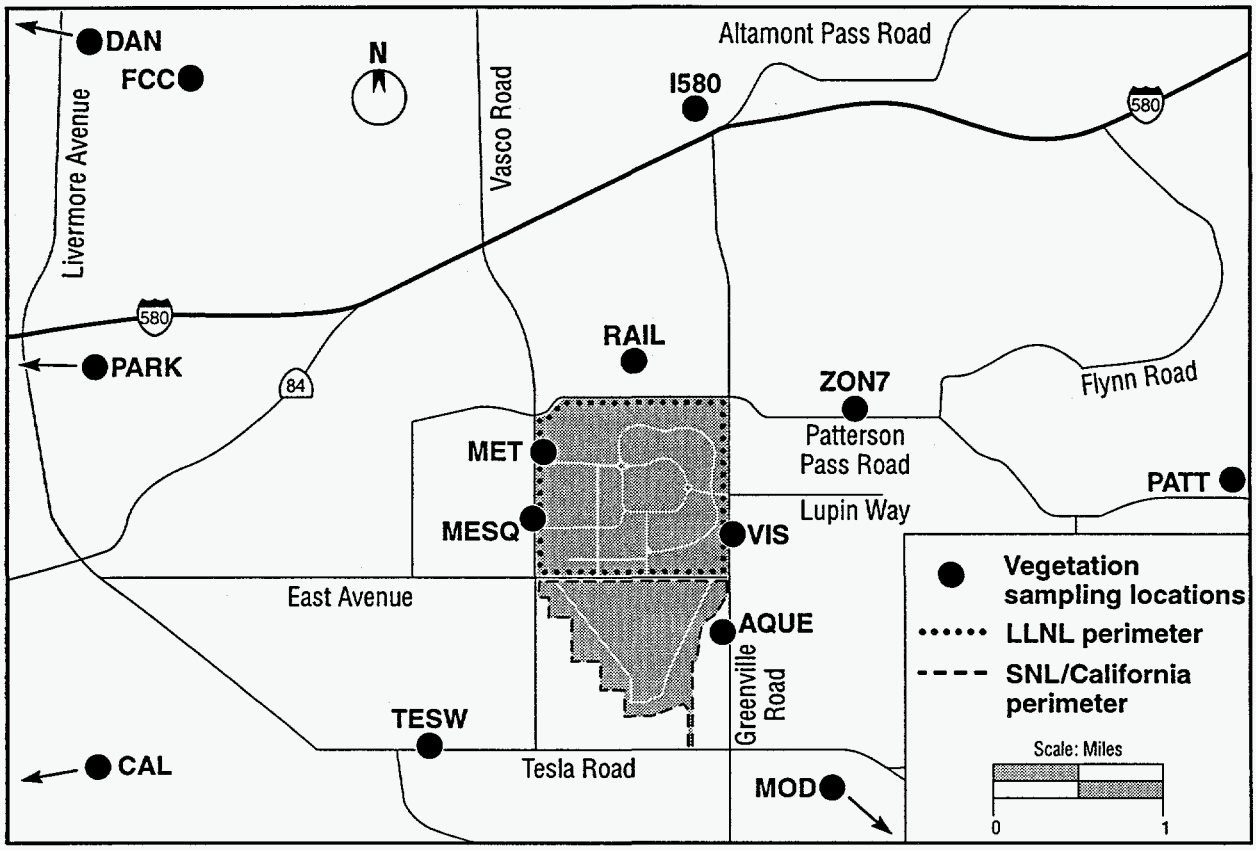


Figure 4-21. Vegetation sampling locations on the SNL/California site perimeter and in the Livermore Valley.

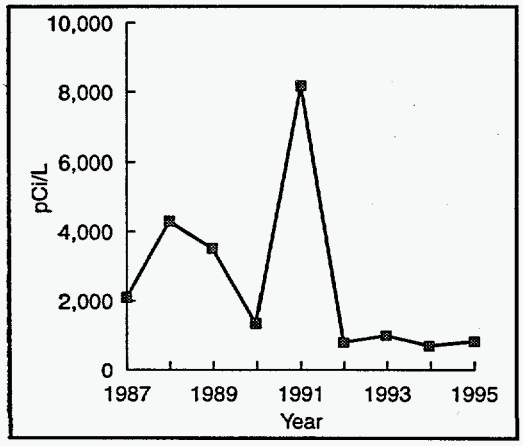


Figure 4-22. Highest annual average tritium concentrations in vegetation (1987–95).

SNL/California. Dosimeters are placed at the site perimeter and at more distant locations near the Livermore site. If site operations were contributing significantly to the external radiation dose, the dosimeters at the site perimeter would show a higher dose than those at more distant locations.

Locations

Figure 4-23 shows the locations of the dosimeters at the SNL/California site (near-field). Figure 4-24 shows off-site dosimeter locations (distant). LLNL significantly reduced the number of sampling locations during 1995.

Methods

LLNL's Environmental Monitoring Group collects the site perimeter and off-site dosimeters quarterly. LLNL's Hazards Control Department processes them. The dosimeters are contained in mylar bags while in the field.

The sampling locations have been chosen (per U.S. Nuclear Regulatory Commission)[9] to avoid interference from

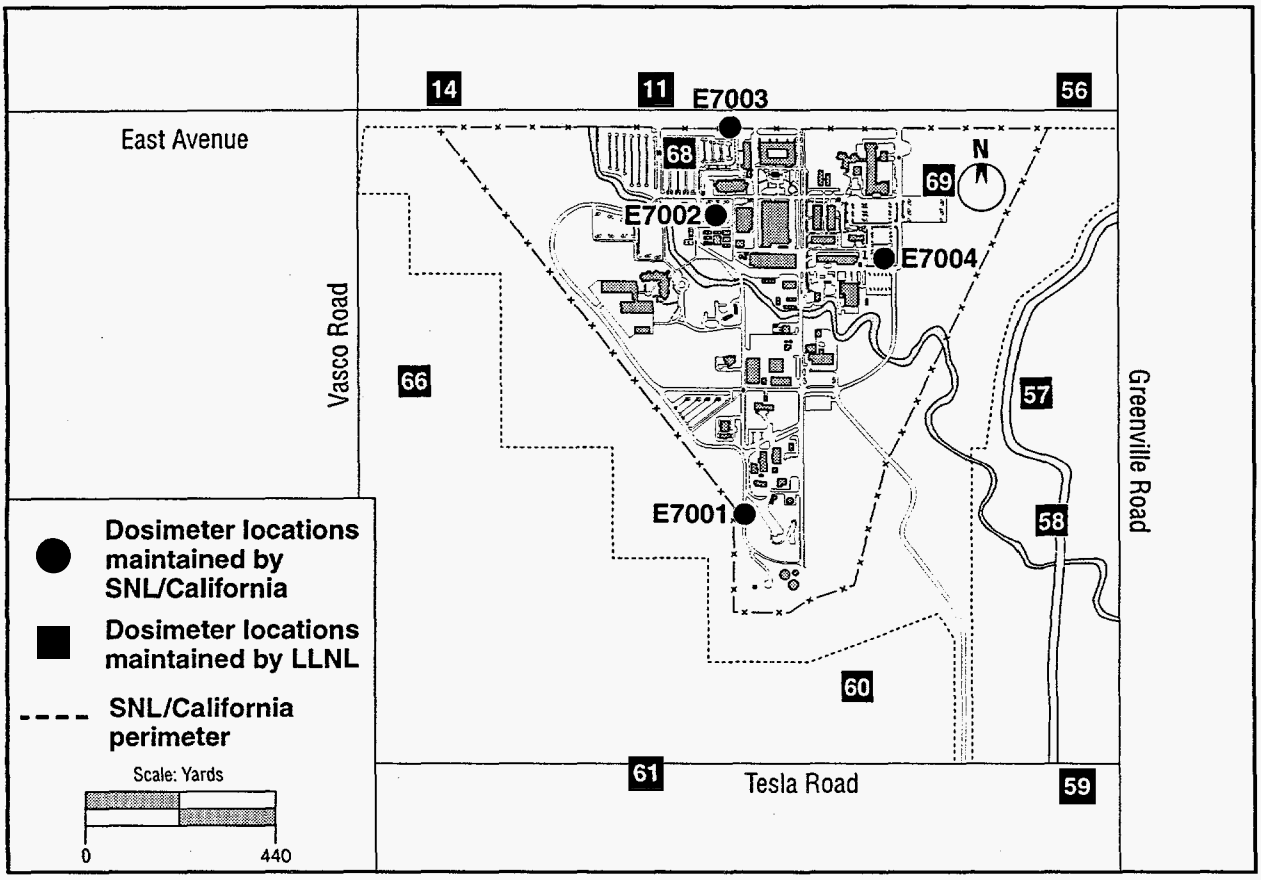


Figure 4-23. Dosimeter locations on the SNL/California site and around the site perimeter.

large objects in the vicinity. LLNL uses Panasonic UD814 dosimeters. Each one contains three elements of thallium-activated calcium sulfate and one element of lithium borate. SNL/California uses Harshaw lithium-fluoride, high sensitivity ribbon dosimeters. SNL/California Environmental Protection Department personnel collect the four on-site dosimeters and send them to SNL/New Mexico for analysis.

Quality Assurance

To be acceptable for placement in the field, all phosphors of the dosimeters must be accurate to ±5% upon calibration. Dosimeters with a known exposure are introduced as blind samples in the processing of the field dosimeters. These are equivalent to spiked pseudo samples for the purposes of establishing the accuracy of the system. Duplicate dosimeter packets are placed at random locations and analyzed along with the routine dosimeters. The dosimeters are calibrated by using a source that is traceable to the National Institute of Standards and Technology. The California Department of Health Services also co-locates dosimeters at some of the monitoring stations to serve as an independent cross check. Exposures to the dosimeters during collection and transit are determined by the use of unexposed dosimeters (referred to as "transit controls"). These are taken on the collection route, carried with field dosimeters during transit to the laboratory, and then read for accumulated dose.

Results

The annual average external dose at the SNL/California perimeter was 65.1 mrem (0.65 mSv). The annual average external

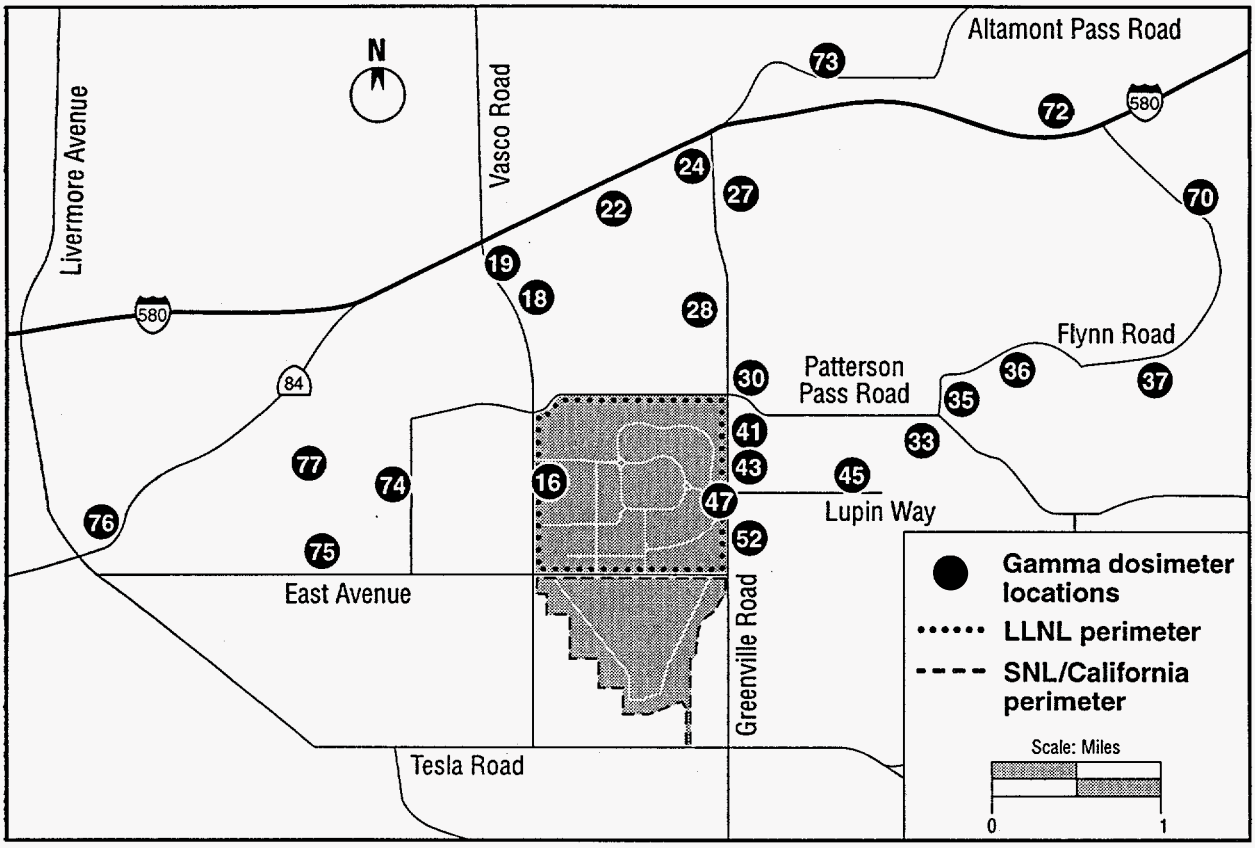


Figure 4-24. Dosimeter locations in the Livermore Valley.

dose measured for the Livermore Valley locations was 69.1 mrem (0.69 mSv). If operations at SNL/California were producing excess external radiation, the perimeter (near-field) monitoring would show a higher dose than the more distant Livermore Valley monitoring. A Student's t-test comparing the dose at the SNL/California site perimeter and the Livermore Valley showed the dose at the site perimeter to be lower than the dose in the Livermore Valley for the second and third quarters at a 90% confidence interval. Data for the first and fourth quarters showed no significant difference. Any differences are probably due to variations in the local geology.

SNL/California performed a Mann-Kendall trend test on annual average perimeter doses and valley doses for the years 1989 through 1995. The test showed no significant trends at the 90% confidence level for the perimeter samples, and a slight positive trend for the valley samples at a 95% confidence level.

ENVIRONMENTAL IMPACTS

Radiological impacts from SNL/California's operations are diminishing rapidly. As elaborated on earlier in this report, tritium research has ceased and emissions to the environment have dropped dramatically. Furthermore, there have been no uranium emissions for the past several years. In the past, very small amounts of tritium have been released to the surrounding environment.

However low, each calendar year, the impacts from site emissions are assessed and reported to the public in this *Site Environmental Report.* The radiological impacts are determined by calculating the radiation dose to a maximally exposed individual and for the total pop-

ulation living within 80 km (50 miles) of the site.

All the significant exposure pathways are sampled as a part of SNL/California's Environmental Monitoring Program. However, most of the pollutants released are at very low concentrations once dispersed in the environment. As a result, levels often are too low to determine dose to humans directly from environmental measurements.

Furthermore, the origin or source of tritium (the only radionuclide released from SNL/California) found in the environment is difficult to trace. It may be released from SNL/California operations, LLNL operations, world-wide fallout, or produced naturally. Consequently, the public's exposure to tritium directly resulting from SNL/California releases is difficult to measure. Therefore, potential radiation doses are calculated based on facility emissions, i.e., stack monitoring data. This information is entered into EPA-approved environmental transport and exposure pathway computer models to calculate off-site doses. In this report, the *effective dose equivalent* is used to express radiation dose in terms of potential health risk. Appendix B explains radiation dose terminology and the methods and assumptions used in calculating these doses.

The major pathways of radiation exposure from atmospheric releases are inhalation and consumption of locally grown foods.

Tritium

Because tritium is the only radionuclide discharged to the environment in measurable amounts, much of the monitoring program is devoted to assessing and controlling its impact.

Tritium (^3H, commonly designated by T), a radioactive isotope of hydrogen, is a naturally occurring and ubiquitous component of the environment. Tritium is produced in relatively large amounts by interactions of cosmic rays and gases of the upper atmosphere. The world-wide inventory of tritium has been substantially increased by nuclear weapons testing. Tritium has a physical half-life of 12.3 years and decays by emission of a beta particle of very low energy (maximum energy 18 keV and an average energy of 5.7 keV).

Modeling the Dispersion of Atmospheric Releases

Tritium discharged to the atmosphere is mixed and dispersed as it is transported by prevailing winds. This dispersal can result in internal exposure to people via inhalation and ingestion. Radionuclides are removed from air by radioactive decay and deposition onto the ground or vegetation. The deposited radionuclides can then move through various pathways to humans.

Computer models developed by the EPA simulate the movement, decay, and deposition of radionuclides to predict the air concentrations at downwind locations. These models also calculate the uptake and transfer of radionuclides through the food chain. This information can be used to estimate radiation doses to individuals residing in specific areas.

SNL/California assesses the radiological impacts of site operations by determining four potential doses to the public:

- external (direct) dose at the site boundary,
- maximally exposed individual dose (all pathways),
- air pathway dose, and
- collective (population) dose.

Figure 4-25 simplistically represents the important exposure pathways.

External Radiation Dose

The external dose is a measure of the radiation field at the site boundary from direct penetrating sources of radiation (primary gamma rays). TLDs are used to measure the external dose at locations around the SNL/California site that permit uncontrolled public access (e.g.,

fence lines and open areas). TLDs also are placed at distant locations to serve as background or *control measurements.* The near-field and far-field dosimeters can be compared to determine if site operations contribute to the external dose rate. That is, the difference in the dose rates between the site perimeter and the background locations represents the external dose due to SNL/California operations.

In 1995, the annual average external dose at the site boundary was 65.1 mrem (0.65 mSv), compared to 69.1 mrem (0.69 mSv) for the Livermore Valley monitoring stations. These results are virtually identical within the statistical confidence level of the method, indicating that no external dose was measured as a direct result of SNL/California operations in 1995.

Maximally Exposed Individual Dose

The *maximally exposed individual* is a hypothetical person who lives at an off-site location and has a presumed lifestyle that produces the highest credible radiation dose. The following exposure pathways were included in this calculation:

- inhalation of air downwind,
- submersion in the airborne plume, and
- consumption of food and water contaminated by fallout.

The characteristics and assumptions used to calculate this individual's dose were selected to maximize the contributions of all realistic environmental pathways of exposure to radionuclides. In reality, these assumptions overestimate the dose (because no one actually lives under the presumed conditions). Thus, this is not an actual dose received by anyone, but an upper-limit estimate.

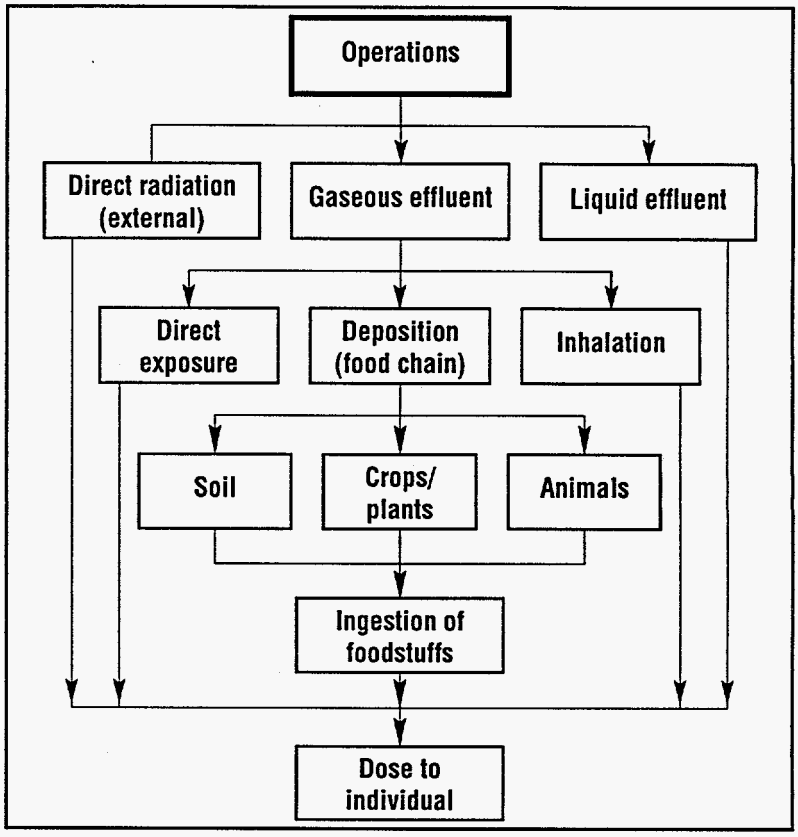


Figure 4-25. Major radiation exposure pathways to humans.

The dose to the maximally exposed individual from SNL/California operations in 1995 was 0.01 mrem (1×10^{-4} mSv) effective dose equivalent (see Table 4-2). This dose represents the total exposure from all emission sources and all exposure pathways (i.e., inhalation, air submersion, and ingestion).

The current DOE radiation protection limit for the public is 100 mrem/yr. (1 mSv/yr.), which is consistent with the recommendations of the International Commission on Radiological Protection. Thus, the maximum calculated dose was 0.01% of the allowable standard.

Air Pathway Dose (Clean Air Act Standards)

The EPA has established radiation dose limits for protection of the public in Title 40 CFR, Part 61, Subpart H, of the Clean Air Act. Under the NESHAPS Radionuclide Rule,10 no member of the

public shall receive a radiation dose of more then 10 mrem/yr. from emissions to the atmosphere. To demonstrate compliance with the Clean Air Act, SNL/California must calculate the air pathway dose using the Clean Air Act Assessment Package, 1988 (CAP88) computer codes. This software contains exposure characteristics and dose factors specified by the EPA.

Because only the air pathway contributes to off-site doses at SNL/California, this dose is the same as the maximally exposed individual dose. Therefore, the 1995 air pathway dose was 0.01 mrem, which is 0.1% of the EPA Clean Air Act limit.

Population Dose

The regional population dose from SNL/California operations was estimated by calculating the radiation dose to the total population residing within an 80-km (50-mile) radius of the SNL/California site. Exposure to regional populations can include the following pathways: inhalation, air submersion, and ingestion. The population dose is referred to as the *collective effective dose* equivalent. It is expressed in units of person-rem or person-Sv.

The collective dose for 1995 was 0.58 person-rem (5.8×10^{-3} person-Sv). There are no regulatory limits for collective dose. DOE Order 5400.5 requires an estimate of the collective dose as an additional evaluation of public impact of site operations. This population dose is 3×10^{-5}% of the estimated 1.9×10^{6} person-rem collective effective dose equivalent from natural background radiation (assuming 300 mrem/yr. as a conservative average dose).[11]

Perspectives on Radiation Exposures

This section provides basic information about the sources of radiation exposure and compares various levels of radiation doses. Thus, it is intended to more clearly explain the radiation doses resulting from SNL/California operations. The calculated *maximum* dose from SNL/California operations in 1995 was 0.013 mrem. This dose is extremely small compared to Federal standards and natural background levels of radiation. To compare, note that the national average radiation dose received by the general public from both natural and man-made sources of radiation is approximately 365 mrem/yr. (see Fig. 4-26).

The major source of radiation exposure to the public is attributed to radiation from naturally occurring radioactive materials in the environment, or *background* radiation. This exposure occurs from both external and internal sources, including cosmic radiation from the sun. Recent evidence suggests that as much as two-thirds of a person's background dose come from naturally occurring radon gas, which accumulates in buildings. Radioactive materials also are in the environment as a result of former nuclear weapons testing.

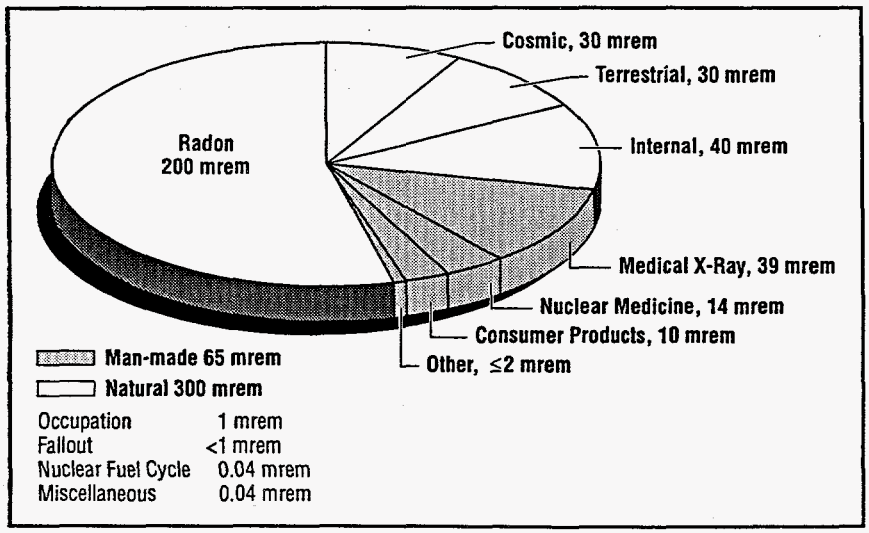


Figure 4-26. Sources of radiation received by a U.S. resident.

The amount of radiation exposure an individual receives varies according to location and lifestyle. In the Livermore area, background radiation dose is about 200–300 mrem/yr.

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7. R. J. Harrach et al., *Environmental Report for 1994*, Lawrence Livermore National Laboratory, UCRL50027-94 (1995).

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11. U.S. DOE, Order 5400.5, *Radiation Protection of the Public and the Environment* (March 1988).

Table 4-1. Environmental Sampling Program Overview.

Medium	No. of Locations[a]	Parameters	Frequency	Requiring Authority	Authority Reported to
Air tritium	17	tritium	biweekly	DOE Order 5400.1	DOE
Soil	15	uranium, tritium, metals, solvents, pesticides	annually	DOE Order 5400.1	DOE
Groundwater	22	volatile and semivolatile organics, metals, general minerals, diesel, tritium, radium, and uranium	quarterly	RWQCB[b]	RWQCB
Surface water	12	gross alpha, gross beta, tritium	quarterly	DOE Order 5400.1	DOE
Sewer outfall	1	metals, cyanide, BOD, COD, oil and grease, TDS, TSS, pH, tritium, conductivity, pesticides, volatile and semi-volatile organics[c]	sampled continuously or grab; analyzed weekly or monthly	City of Livermore DOE Order 5400.1	City of Livermore, DOE
Stacks	1	tritium	sampled continuously, analyzed weekly	DOE Order 5400.1 Clean Air Act NESHAPs	DOE, EPA
Vegetation and foodstuff	32	tritium	quarterly, monthly	DOE Order 5400.1	DOE
Storm water	11	conductivity, pH, TSS, oil and grease, metals, pesticides, volatile and semivolatile organics, tritium	two storms per sampling location	City of Livermore Municipal Code Ch. 13.45, DOE Order 5400.1	SWRCB[d] RWQCB, City of Livermore, DOE
External radiation	39	radiation dose	quarterly	DOE Order 5400.1	DOE

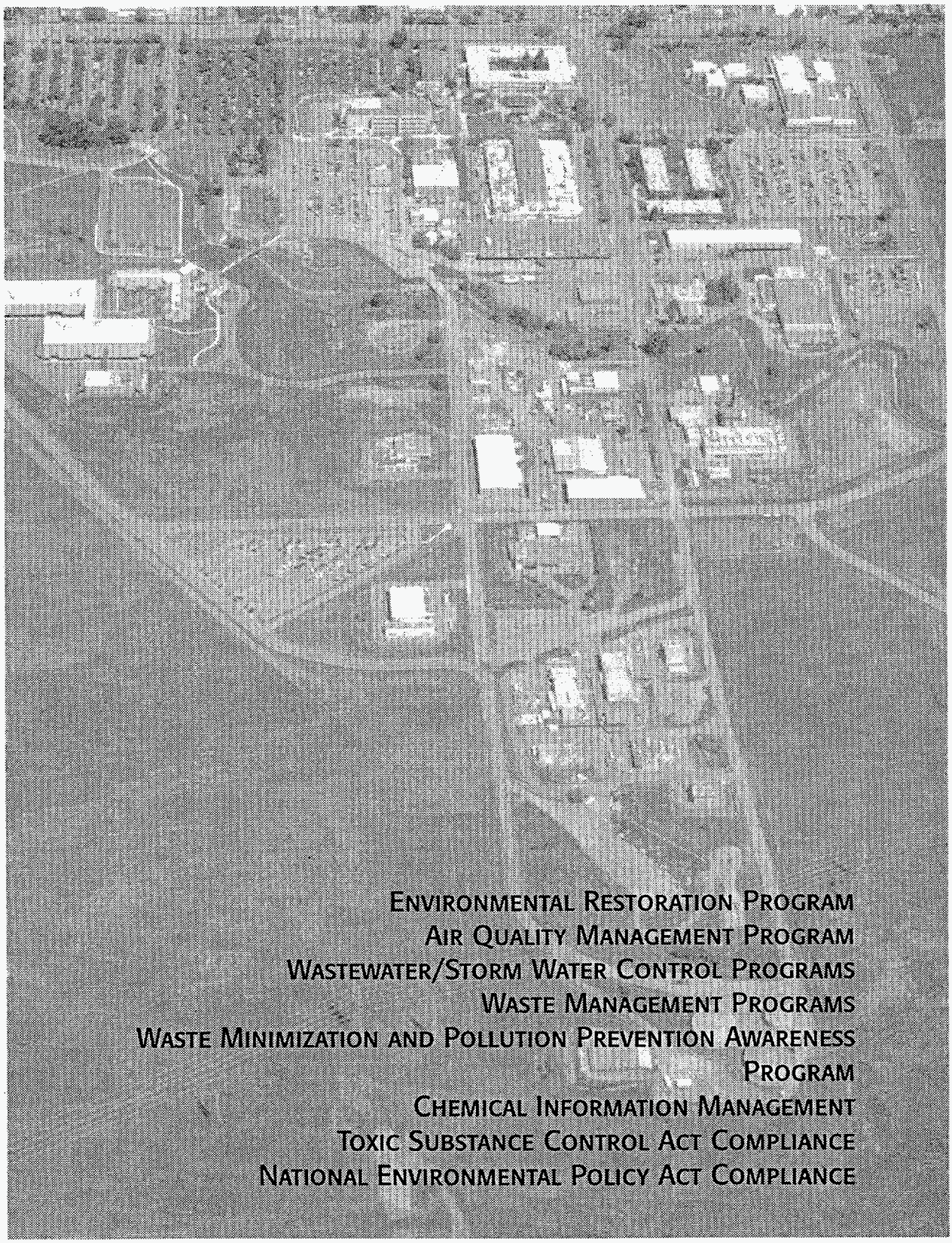
[a]These numbers represent all the samples collected by LLNL and SNL/California. Not all the LLNL samples are pertinent to SNL/California; therefore, the number of locations listed in the following tables may differ from these values.

[b]Regional Water Quality Control Board.

[c]BOD = biological oxygen demand, COD = chemical oxygen demand, TDS = total dissolved solids, TSS = total suspended solids.

[d]State Water Resources Control Board.

5 — Environmental Program Information



Environmental Restoration Program
Air Quality Management Program
Wastewater/Storm Water Control Programs
Waste Management Programs
Waste Minimization and Pollution Prevention Awareness Program
Chemical Information Management
Toxic Substance Control Act Compliance
National Environmental Policy Act Compliance

ENVIRONMENTAL RESTORATION PROGRAM

CERCLA and SARA mandate cleanup of toxic and hazardous contaminants at closed or inactive waste sites. SNL/California activities related to these laws are being addressed under the DOE Environmental Restoration Program and are directed by the State Regional Water Quality Control Board.

Currently, SNL/California is remediating two sites (Fig. 5-1): the Fuel Oil Spill and the Navy Landfill. A third previously listed site, the Trudell Auto Repair Shop, was cleaned up and officially closed in 1990. In addition, investigations were completed in 1993 at five sites with suspected contamination (Miscellaneous Sites). The Regional Water Quality Control Board closed these sites, with no further action required, in 1994. The Regional Water Quality Control Board Site Cleanup Order 88-142,[1] issued in September 1988, directs cleanup activities at SNL/California. This Order was modified in 1989 for the Fuel Oil Spill (Order 89-184).[2] The Engineering for Information Systems Department is conducting these restoration activities, as described below.

Fuel Oil Spill

In 1975, as the result of an accidental puncture of an underground transfer line, 59,500 gallons of #2 diesel fuel spilled into the vadose zone from an above-ground reserve fuel tank. SNL/California has monitored the groundwater in this area since 1985. It shows occasional low-level contamination with fuel oil components. Neighboring farmers sometimes use this aquifer as a source of drinking or agricultural water.

SNL/California completed a remedial investigation of the spill site in November 1988. In 1990, SNL/California, Argonne National Laboratory, and the University of Notre Dame performed several bench-scale tests to determine the most effective means of cleanup. The resulting treatability report indicated that bioremediation would be the most effective of the technologies tested in reducing fuel oil contamination. In 1991, *in situ* bioremediation tests were done. Bioremediation was proven effective, but in the field, it proceeds at a slower rate than laboratory tests done in slurry reactors.

In December 1990, Argonne began groundwater flow and contaminant transport modeling to support the pilot bioremediation system design. Using a computer code developed at Los Alamos National Laboratory and monitoring well data, experts at Los Alamos prepared a three-dimensional model characterizing the spill area. Argonne conducted additional bench-scale studies at Notre Dame to establish required nutrient and oxygen levels and to identify degradation products. SNL/California completed three groundwater wells downgradient of the spill site to control and monitor the spread of the contaminated groundwater.

After heavy rainfall in the spring of 1993, the groundwater at the Fuel Oil Spill site rose about 3.6 m (12 ft.). Diesel and BTEX contamination were noted during the second-quarter groundwater sampling. As a result, the Regional Water Quality Control Board directed SNL/California to implement an Interim Remedial Measure, a groundwater treatment system. Because SNL/California is planning to move the system to a permanent location (to serve as the water treatment system for the Fuel Oil Spill pilot study nutrient injection and withdrawal systems), it has been termed the "Temporary Interim Remedial Measure."

In the fall of 1993, the Regional Water Quality Control Board approved SNL/California's work plans for the Fuel Oil Spill pilot study and the Temporary Interim Remedial Measure. SNL/California completed the Fuel Oil Spill site plan in October 1993 and the Temporary Interim Remedial Measure

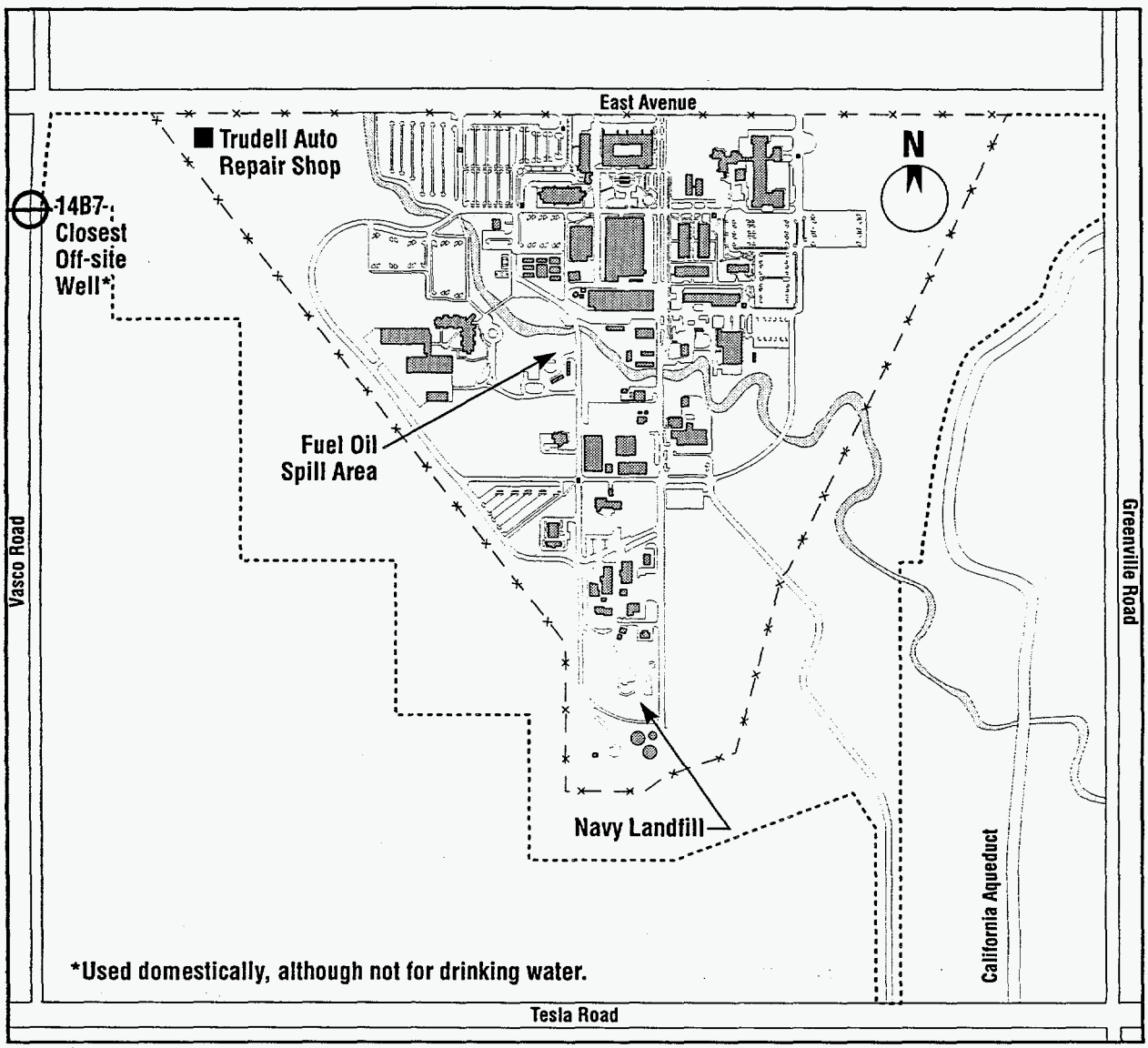


Figure 5-1. SNL/California remediation sites.

work plan and system design in December 1993.

SNL/California completed site preparation—including fencing, gates, site grading, gravel, and paving—in December 1993. Using the conceptual design from Argonne National Laboratory, SNL/California installed a free product separator and carbon filtration beds in January 1994. The Temporary Interim Remedial Measure went on line in early February 1994.

In March and April 1994, SNL/California drilled ten monitoring boreholes and installed downhole instrumentation, five injection/withdrawal wells, four Zone 1 withdrawal wells, and five geophysical logging boreholes. SNL/California set up a small land farm (*ex situ* bioremediation) to treat the drill cuttings from the wells and boreholes. The land farm reduced the contamination in the withdrawn soil to less than 50 ppm, and in 1995, it was closed.

During the summer of 1994, utility hookups were completed, and the data acquisition software was finished and installed. Following these activities, SNL/California installed a subsurface infiltration gallery, seven tensiometers, and a remote barometer at the pilot study site. Multiplexers and data loggers were installed and connected to the computers. The data collection computer system began baseline monitoring for temperature, pressure, and soil moisture. This system comprised 158 information channels collecting data once every minute, 24 hours per day.

In late November 1994, SNL/California completed the construction of the pilot study system. The components of the Temporary Interim Remedial Measure were moved into the pilot study system and were tested. The Final Interim Remedial Measure now is continuously operating.

SNL/California conducted a small-scale, flow-through test in April 1995. The bioremediation pilot study began in June 1995, with the first phase of the process: injection of water into the ground. The water contained the necessary nutrients for *in situ* bacterial growth: nitrogen and phosphorus, with calcium and magnesium salts added to modify the soil properties. Using low to moderate flow rates of 1.5 to 6.0 gallons per minute, SNL/California technicians injected nearly 2,000,000 gallons of water into the contaminated soil.

In October 1995, the injection system was shut down, and the second, withdrawal phase began. About 60,000 gallons of water were removed and treated; the rest remains in the pores of the soil to facilitate the bioremediation.

In November 1995, the third phase—aeration—began. Air was forced into the soil and then pulled from the soil at a low rate (about 5 $ft.^3$ per minute). This phase continued through the end of 1995.

In 1996, the three phases (nutrient injection, withdrawal, and aeration) will be repeated two or three times. Ongoing data collection and chemical analyses will help SNL/California monitor the progress of the bioremediation. Late in 1996, SNL/California will test the soil for fuel oil contaminants to determine the extent of cleanup through *in situ* bioremediation.

Navy Landfill

An inactive landfill is located at the southern end of the SNL/California site. It was used by the Navy during and shortly after World War II, and again by LLNL in the 1950s and early 1960s. A survey of historical records and landfill contents indicated that only general construction debris and machine turnings were disposed of at the site. There is no indication of any hazardous materials being buried at this landfill. The landfill measures approximately 11,300 m^2 in area and 68,800 m^3 in volume.

The landfill appeared on the State of California's Solid Waste Water Quality Assessment Test Program list in December 1987. Consequently, the State required a wastewater quality assessment test proposal (equivalent to a remedial investigation plan). SNL/California submitted the proposal in March 1993 and a report in 1994.[3,4]

To characterize the site, SNL/California installed an upgradient well, three downgradient wells, a piezometer, and two lysimeters. Two additional wells were installed in 1993, under the direction of the Regional Water Quality Control Board, to provide additional information about the groundwater at the site. The wells and the lysimeters are sampled quarterly.

SNL/California has received approval from the State for closure of the landfill. Grading of the land surface, installation of a cap, and revegetation are planned for 1996.

Miscellaneous Sites

As directed by the Regional Water Quality Control Board, SNL/California assessed

areas suspected of being contaminated by past operations. In 1993, SNL/California analyzed soil from sites identified during the DOE's *1988 Environmental Survey*. The results of the analysis showed no contamination above RCRA action levels. SNL/California submitted a report on the sampling and analyses to the Regional Water Quality Control Board.[5] One of the Miscellaneous Sites (the "burn pit") was incorporated in the Navy Landfill closure. On April 27, 1994, the Regional Water Quality Control Board approved closure of the Miscellaneous Sites, with no further action required.

Underground Storage Tank Management

SNL/California complies with Federal and State requirements for underground storage tanks.[6] SNL/California has two regulated underground storage tanks.

One 500-gallon tank was installed in a vault behind Bldg. 964 in 1986 to store diesel fuel for emergency power generators. It is constructed of double-walled fiberglass and is equipped with a Leak Alert™ system (Universal Sensors & Devices), which meets all tank monitoring requirements.[6] The Leak Alert™ system has two sensors—metal-oxide semiconductors—which detect organic vapors. These sensors are connected to a signal panel, which emits both audio and visual alarms.

The second underground storage tank is a 950-gallon steel tank in a containment vault located below grade, north of the former Tritium Research Laboratory. This tank stores diesel fuel for the building's emergency generator.

Spill Prevention Control and Countermeasure Plan

The *Spill Prevention Control and Countermeasure Plan* establishes procedures for controlling, and if necessary, remediating oil spills at SNL/California.[7] The plan was prepared in accordance with Title 40 CFR, Part 112.[8] It was approved in December 1992. Site personnel have been trained in spill response procedures.

AIR QUALITY MANAGEMENT PROGRAM

In 1995, SNL/California continued activities to assure site-wide compliance with air quality regulations. These activities are directed toward assuring adequate evaluation of air permit requirements and other applicable regulations. Operations at SNL/California are subject to the rules and regulations of the Bay Area Air Quality Management District, the State Air Resources Board, and the EPA, which have jurisdiction over facilities that emit air contaminants.

SNL/California's Air Quality Management Program identifies and evaluates potential sources of air pollutants, and documents compliance requirements. The Air Quality Group (Environmental Operations Department) maintains the site-wide air emissions source inventory, which provides data on materials, equipment, and operations that are subject to air quality regulations. The Air Quality Group also prepares applications for air permits or exemption requests as needed in conjunction with this inventory.

In 1995, SNL/California operated 32 permitted sources and 37 exempt sources (see Chapter 3, "Compliance Summary"). SNL/California annually reports air emissions from these sources to the Bay Area Air Quality Management District, at the time of permit renewal.

In 1995, SNL/California also participated in the Bay Area Air Quality Management District's *Spare the Air Campaign*, which is designed to inform the public and employers of days when air pollution is approaching unhealthful levels. On these "spare the air days," the District and participating employers request individuals to curtail or postpone pollution-causing activities. The District recognized SNL/California as one of the

top 14 employers out of 420 participating companies in the Bay Area and awarded SNL/California for outstanding efforts in the *Spare the Air Campaign.*

WASTEWATER/STORM WATER CONTROL PROGRAMS

Wastewater Management Program

The primary goal of the Federal Clean Water Act is to protect and restore the integrity of the nation's waterways. The Clean Water Act establishes the National Pollutant Discharge Elimination System (NPDES), which requires permitting of all point-source liquid effluent discharges. These permits contain specific criteria for discharging liquids to waterways. The State of California has authority to enforce the requirements of the Clean Water Act. The Livermore Water Reclamation Plant is responsible for issuing and enforcing SNL/California's wastewater permit. The permit contains specific pollutant limitations and monitoring requirements for discharging wastewater to the municipal sewer system.

During the last few years, the government has implemented more stringent regulations governing industrial wastewater discharges to public sewer systems. SNL/California always has maintained a program to control liquid effluents. This program incorporates administrative and engineering controls to prevent contaminated wastewater from being discharged to the municipal sewer system.

In 1994, SNL/California developed the Wastewater Waste Minimization Program to reduce pollutants in wastewater discharge, protect the environment, and ensure compliance with Federal, State, and local regulations. This program involves several steps. The first step was a wastewater survey designed to collect the information needed to identify wastewater sources on site; it was completed in 1995. The next step, which is in progress, is to develop and implement a drain registration program. This program will track and maintain the information collected during the site survey and will update it. The final step will be to identify and select wastewater minimization opportunities.

In 1995, SNL/California also developed an informational brochure, which is distributed to site personnel. The brochure provides general guidelines to SNL/California personnel about what can and cannot be discharged into the sanitary sewer system.

Liquid Effluent Control Systems

The Liquid Effluent Control Systems (LECS) are key elements of SNL/California's wastewater management. The LECS comprise large, monitored, holding tanks, which collect and retain wastewater generated at key facilities. These systems allow SNL/California to analyze the wastewater and verify that its constituents are within acceptable limits before discharging it to the sanitary sewer system. SNL/California has six LECS in operation, at the following locations (see Fig. 4-2 in Chapter 4): Bldg. 913 (miscellaneous laboratories), Bldg. 910 (Printed Wiring Laboratory), Bldg. 961 (Hazardous Waste Facility), Bldg. 968 (Tritium Research Laboratory), Bldg. 906 (Combustion Research Facility), and Bldg. 941 (Integrated Manufacturing Technologies Laboratory).

Sewer Diversion Facility at LLNL

The combined SNL/California and LLNL sewer effluent is discharged to the City of Livermore municipal sewer system at the northwest corner of the LLNL site. To better control effluents and increase protection of the Livermore Water Reclamation Plant, LLNL and SNL/California constructed a sewer diversion facility at LLNL. This system can retain approximately 200,000 gallons of contaminated sewage on site, if necessary, for further evaluation.

Storm Water Management Program

Amendments to the Clean Water Act in 1987 require permits for storm water discharges from municipal storm drain systems and storm water discharges associated with industrial activities. In 1990, the EPA published specific permit requirements. With permitting authority, California's Water Resources Control Board adopted the General Industrial Activities NPDES Storm Water permit (for storm water discharge) in 1991, which was later amended in 1992. It allows industrial facilities in California* to be in compliance with the Federal storm water permitting requirements by filing a Notice of Intent with the Board. SNL/California has filed a Notice of Intent and must comply with the requirements of the permit. Although the State Water Resources Control Board administers the storm water permit, SNL/California is regulated by the Regional Water Quality Control Board.[9]

In response to the permitting requirement of the Federal Clean Water Act for municipal storm water discharges, the City of Livermore adopted ordinances that also require SNL/California to manage storm water discharges to the City's storm drain system. The Livermore Water Reclamation Plant enforces the City's storm water ordinances.

SNL/California complies with Federal, State, and local storm water requirements through a comprehensive Storm Water Management Program. This program includes the Storm Water Pollution Prevention Program and the Storm Water Monitoring Program.

Storm Water Pollution Prevention Plan

The *Storm Water Pollution Prevention Plan* identifies activities that result in non-storm water discharges to the storm drain system and describes how these discharges are eliminated.[10] It identifies sources and activities that could allow pollutants to be deposited on impervious surfaces and picked up by storm water runoff. It also describes how SNL/California minimizes these pollutant sources discharged with storm water runoff by implementing best management practices.

Because the SNL/California site continually changes, the *Storm Water Pollution Prevention Plan* is a living document. It is updated regularly to reflect these changes.

Storm Water Monitoring Program

The purpose of the Storm Water Monitoring Program is to optimize SNL/California storm water pollution prevention activities. It consists of extensive visual inspection and sampling activities, which include:

- *Dry Weather Visual Inspection*—During dry weather, no water should be flowing in the storm drain system. At least twice from May through September, SNL/California inspects all storm drain outfalls that discharge into the site's two main storm water conveyances (the Arroyo Seco and the drainage channel along East Avenue) for any flow or evidence of past flow (such as sludge or stains).
- *Wet Weather Visual Inspection*—SNL/California also inspects all storm drain outfalls discharging into the site's two main storm water conveyances during storms to see if storm water runoff is picking up pollutants from the site. These inspections are conducted once per month from October through April, during a storm that produces runoff.
- *Storm Water Sampling*—When it has rained enough to produce runoff, SNL/California collects storm water samples from up to eleven sampling locations, during at least two

* *The California General Industrial Activities NPDES Storm Water Permit applies to regulated facilities throughout California, except facilities located in Santa Clara County. The San Francisco Bay Regional Water Quality Control Board has adopted a separate NPDES permit for facilities in Santa Clara County.*

separate storms. Chapter 4 describes each sampling location and the results of Sandia's storm water sampling activities in 1995.

- *Annual Site Inspection*—The annual site inspection ensures that best management practices are effectively implemented. Findings from the site inspection are used to update the *Storm Water Pollution Prevention Plan.*

Storm water monitoring information is used to identify potential sources of pollutants and non-storm water discharges.

In 1995, SNL/California completed all dry season, wet season, and annual site inspections required by the storm water general permit. Two storm water samples were collected from all storm water sampling locations.

Because collecting samples in the Arroyo Seco is often dangerous under storm conditions, SNL/California installed three automatic samplers at locations D, Y, and Z in November 1995. These samplers were used to collect samples during the second storm. Sandia plans to install another automatic sampler at location G to help ensure the safety of sampling personnel during storm water sampling.

To increase storm water pollution prevention awareness on site, the Environmental Operations Department conducted storm water best management practices training for all facilities and maintenance personnel. During the training, participants learned how to minimize the impact of their daily activities on storm water quality. Topics covered include general "housekeeping," construction activities, vehicle and heavy equipment maintenance, material handling, and building maintenance.

WASTE MANAGEMENT PROGRAMS

RCRA, as amended by the Hazardous and Solid Waste Amendments of 1984, requires a comprehensive program for managing hazardous wastes from generation to ultimate disposal. The primary goals of RCRA are to reduce the volume and toxicity of wastes and to minimize the amount of waste requiring land disposal. The California Hazardous Waste Control Law is similar to, but more restrictive than, RCRA. The EPA authorized the State to assume RCRA authority in August 1992. This authority is enforced by the Cal/EPA's Department of Toxic Substances Control.

Hazardous waste activities at SNL/California include collection, on-site transportation, consolidation, treatment, and storage of energetic, radioactive, mixed, and nonradioactive hazardous wastes. SNL/California has not and does not plan to dispose of hazardous wastes at the site. SNL/California was granted a RCRA Part B Permit for the storage of hazardous waste in January 1993. The permit is effective until January 2003.

In 1989, SNL/California implemented a computerized tracking system for all hazardous, mixed, and radioactive wastes. This system tracks wastes from the point of generation to final disposal.

Hazardous Waste Program

Hazardous waste is defined as a material with no further end use, which is not radioactive, but contains constituents that may be harmful to human health or the environment. RCRA wastes are regulated by the U.S. EPA and the Cal/EPA. Non-RCRA wastes are regulated by the Cal/EPA.

SNL/California sends all nonradioactive wastes generated on site to permitted commercial facilities for treatment or disposal. SNL/California shipped an average of approximately 4,500 kg/month chemical waste off site for disposal in 1995.

Low-Level Radioactive Waste Program

The low-level radioactive waste management activities at SNL/California include handling, packaging, and storing of

radioactive waste. Most of the program work completed this year was shipment of low-level radioactive waste to the Nevada Test Site from the cleanup and transition activities at the Tritium Research Laboratory. SNL/California shipped approximately 15,692 kg low-level radioactive waste to the Nevada Test Site in 1995. Small volumes (less than 7 m^3) of waste from other research and development activities are in storage. No transuranic or high level radioactive waste are generated at the SNL/California site.

Mixed Waste Program

Mixed waste is a hazardous waste that also contains radionuclides regulated by the Atomic Energy Act. SNL/California's Mixed Waste Program has taken major steps to meet compliance objectives of the Federal Facilities Compliance Act. SNL (both the California and the New Mexico sites) has consolidated all cost and compliance liability associated with the storage, treatment, and disposal of mixed waste. As of March 30, 1995, SNL/California met all compliance requirements for the Federal Facilities Compliance Act. Mixed waste generated at SNL/California (less than 0.5 m^3) is now shipped to SNL/New Mexico for management, and no mixed waste is stored at SNL/California.

WASTE MINIMIZATION AND POLLUTION PREVENTION AWARENESS PROGRAM

SNL/California has supported various waste minimization activities since 1985. These efforts have evolved into the Waste Minimization and Pollution Prevention Awareness Program. The program's principal objective is to maximize all opportunities for eliminating or minimizing waste through source reduction, reuse, and recycling. Waste that cannot be reduced, reused, or recycled is treated through available treatment technology. The program reflects ongoing efforts to integrate pollution prevention and waste minimization into the site's operating philosophy. The increases in waste management costs and the public's interest in environmental issues provide added incentives for an effective program.

SNL/California has implemented a variety of waste minimization techniques. These are supported by employee training programs aimed at reducing waste while meeting the company's requirements for quality, productivity, safety, and environmental compliance.

A key element of the Waste Minimization and Pollution Prevention Awareness Program is the development of baseline information on waste generation. Sandia has established a corporate Pollution Prevention Team to assist in the ongoing evaluation and evolution of the waste minimization program. Its primary functions are to make all SNL employees aware of the program, identify tasks to implement the program, and provide a mechanism for communicating waste minimization issues within the SNL community and to the public. The Pollution Prevention Team is responsible for developing, designing, creating, and overseeing implementation of waste minimization projects. Waste generators are responsible for implementing the program.

SNL/California's waste minimization and pollution prevention efforts demonstrate both the commitment and involvement of SNL/California's management and staff. These efforts include the following:

- Waste Minimization and Pollution Prevention Awareness Program awareness has been incorporated into several required ES&H training courses and is provided at monthly new-hire orientations.
- SNL/California hosts an Earth Day exhibit annually, which includes internal programmatic activities, external regulatory agencies, and commercial representatives.

- The corporate Solvent Substitution Technical Advisory Committee and Chlorofluorocarbon Elimination Working Groups help users find less hazardous or nonhazardous solvents and cleaning agents.
- SNL/California employees substitute safe alternatives for hazardous chemicals whenever possible.
- SNL/California developed and implemented a trip reduction program to reduce air pollution by reducing vehicle trips to the site.
- Waste minimization personnel conduct site-wide waste minimization activities surveys to determine the usage of waste minimization practices around the site.
- Mulching mowers are used to reduce yard waste. In addition, SNL/California is studying a composting process to use yard waste generated on site.
- SNL/California recycles toner cartridges; 896 toner cartridges were recycled in 1995, which saved 450 $ft.^3$ of landfill space.
- The SNL/California Materials Management Department, General Stores, stocks environmentally safe products and products containing post-consumer recycled material.
- SNL/California has a metal recycling program; the metal recycled in 1995 netted $28,140 in revenue.
- The Property Reapplication and Reclamation Department reassigns excess equipment to other SNL organizations or to organizations outside of Sandia.
- Paper and aluminum cans throughout the SNL/California site are recycled. In 1995, more than 44,770 kg (98,700 lb.) paper and more than 302 kg (666 lb.) cans were collected for recycling.
- Tires from the Maintenance Department are recycled as a part of LLNL's tire recycling program.
- The Waste Management Group recycles hazardous wastes whenever possible. Some examples are batteries, mercury, coolants, petroleum oil, empty drums, and lead. Silver from photochemicals (fixers and developers) is reclaimed whenever possible. The Waste Management Group also recycles nonhazardous laboratory glass.
- The wastes generated by laboratory processes are assessed (through pollution prevention opportunity assessments) to determine if they can be eliminated or reduced.

The Waste Management Group tracks all regulated waste generation information. The Facilities Operations and Property Management departments track and maintain all nonhazardous waste information. The quantities listed in Table 5-1, except for sanitary waste, are based on the manifested shipment database for calendar years 1994 and 1995, respectively. Table 5-2 shows the results of SNL/California's recycling efforts in 1995.

Pollution Prevention Opportunity Assessments

SNL/California conducts Pollution Prevention Opportunity Assessments (PPOAs) under the direction of the DOE. The goal of a PPOA is to identify ways to minimize the waste generated by site activities through evaluation of material management and on-site processes. Reassessments are conducted on processes every 18 to 24 months after the initial assessment. Waste generation is tracked biannually to evaluate waste minimization progress.

SNL/California conducted five PPOAs and seven reassessments in 1995. PPOAs were completed for the following facilities: the Supercritical Water Oxidation Flow Reactor, the Network Operations' Digital Photo Imaging Laboratory, the Engineering Evaluation Reactor

Laboratory, Technical Art, and Protective Services. Reassessments were completed for the following facilities: the Printed Circuit Board Laboratory, the Photography Laboratory, the Machine Shop, the Mechanics Shop, the Paint Shop, Inorganic Solid Waste and Empty Containers, and the Diana Laser Project. The results of these PPOAs and reassessments are summarized as below.

Supercritical Water Oxidation Flow Reactor

The Supercritical Water Oxidation Flow Reactor is used to conduct fundamental research and development on the characteristics of the oxidation process in supercritical water. Studies are conducted to determine the kinetics of the oxidation of various aqueous organic mixtures. The ultimate goal is to develop processes to treat various hazardous aqueous wastes that contain small amounts of organics and to reduce them to nonhazardous wastes.

To determine the outcome of an experiment, an analysis is conducted to evaluate the concentrations and types of constituents. This analytical data also can be used by the Environmental Operations Department to determine whether the effluent from the experiment is nonhazardous and can be disposed of in the sanitary sewer or is hazardous and must be disposed of accordingly.

Network Operations' Digital Photo Imaging Laboratory

The Network Operations' Digital Photo Imaging Laboratory provides slides, prints, and transparencies produced directly from computer files as a service to various site organizations. However, this facility is going to be shut down because it is no longer considered necessary for current SNL/California operations. Therefore, the systems will be sent to reclamation or transferred to another organization. Shutting down the operation will eliminate the waste stream entirely and will result in a significant cost savings on disposal and chemical procurement.

Engineering Evaluation Reactor Laboratory

The Engineering Evaluation Reactor Laboratory conducts evaluations on the characteristics of the oxidation process in supercritical water. In 1994, the laboratory personnel evaluated the reactor's ability to destroy ammonium picrate without producing unacceptable byproducts. The results showed that with proper design of the equipment, ammonium picrate can be destroyed without producing unacceptable byproducts.

During the first six months of 1995, the lab primarily studied the characteristics of salt corrosion and acid attack on the reactor components. In one study, the analysis of a <1% solution of sodium sulfate waste showed it to be nonhazardous. After the effluent from various analyses has been reanalyzed and confirmed to be nonhazardous, it is collected in a sump and released to the sanitary sewer. As long as the effluent proves to be nonhazardous, it is not part of the hazardous waste stream.

Technical Art

The Technical Art group in the Technical Communications Department provides the following services: computer-generated two-dimensional and three-dimensional imagery, graphic design, viewgraphs, figures and graphs for reports, and desktop publishing. The major waste streams—spent fixer and developer—have been reduced to a minimum by the purchase and use of an Agfa Rapiline 43 processor. In December 1992, Technical Art personnel inventoried all chemicals, as required by the Chemical Information System. All chemicals were evaluated and disposed of based on their usefulness in existing processes. The result was a large reduction in the amount of chemicals in storage. The storage and inventory of chemicals subsequently have been kept to a minimum.

Protective Services

Protective Services personnel provide guard and protection services for the materials, facilities, property, and personnel at SNL/California. The major hazardous waste streams are lead-contaminated water and contaminated wipes. Protective Services has taken the following steps to minimize hazardous waste:

- the DOE is researching different types of ammunition; some ammunition does not contain lead.
- spent casings from the Firing Range are sent off site for recycling as scrap brass.
- officers are required to wear gloves while cleaning weapons to reduce the risk of skin exposure to solvents.
- after October 1995, Security personnel will no longer carry an auxiliary firearm.

Printed Circuit Board Laboratory Reassessment (1/95)

Based on the results and recommendations of the initial assessment in October 1992, the Printed Circuit Board Laboratory has done or is doing the following:

- started using the Chemical Information System to minimize the amount of chemicals kept in inventory.
- monitoring chemical baths and adjusting them if possible; the baths are sampled, and the samples are analyzed by a contract laboratory.
- after receiving a treatment permit, began treating spent chemicals.
- evaluating neutralization of baths in the tanks before draining them; if the process works, the tanks will be drained into the ion exchange system and then sent out as wastewater.
- discharging spent developer solution and rinsate from the treatment system to the LECS, from which the effluent is sampled and verified for acceptability to be released to the sanitary sewer.

Photography Laboratory Reassessment (1/95)

Based on the results and recommendations of the initial assessment, the Photography Laboratory has done or is doing the following:

- installed a new, smaller Hope/Kodak C-41 Processor, which requires approximately 50% fewer chemicals than the old processor.
- kept records of the chemicals that were put into the processes until the Chemical Information System was placed on line; now, the Chemical Information System tracks the chemicals purchased and used by the Photography Laboratory.
- shut down two of the four Royal Print processors and uses them for parts for the two that remain in use.

To further reduced waste generation, the use of digitized processor units is recommended for future implementation.

Machine Shop Reassessment (3/95)

Based on the results and recommendations of the initial assessment in March 1993, the Machine Shop has done or is doing the following:

- replaced a parts washing unit that used solvent (1,1,1-trichloroethane); the replacement unit used a biodegradable, noncaustic solution. After a test period, Machine Shop personnel found that this unit did not clean as well as the solvent-based unit. A new, solvent-based unit—the Branson Vapor Degreaser—maintains the cleaning standards necessary, but is smaller than the original unit (it holds 8 gal. solvent vs. 100 gal.). Therefore, less 1,1,1-trichloroethane is used annually. The Branson Vapor Degreaser releases approximately 18 gal. spent solvent per year in vapor form, in accordance with the degreasers Bay Area Air

Quality Management District permit.

- segregates hazardous waste by type.
- replaced Aqua-Syn, the coolant originally used by the shop, with Syntilo 9154, which is a more efficient coolant and is projected to reduce this waste stream by 30%.
- contracted with Unitog Laundry Service to provide laundry service to the Machine Shop; as a result, the use of disposable rags has diminished by 80%. Due to the type of work done in the Machine Shop, use of some disposable rags is necessary.
- management is investigating various coolant reclaiming units for on-site use; however, a unit satisfactory for the Machine Shop has not been found.

Mechanics Shop Reassessment (5/95)

Based on the results and recommendations of the initial assessment in May 1993, the Mechanics Shop has done or is doing the following:

- continued to follow up on the waste reduction activities in place in 1993, such as recycling waste oil, worn batteries, and used cart parts, and reduction of aerosol cans by using bulk chemicals in air-powered cans.
- continued the program to eliminate asbestos from the brake shoes of all vehicles on site; approximately one-half of the vehicles have been so serviced.
- service all vehicles on a six-month schedule.
- reduced generation of contaminated gasoline by keeping the diesel fuel pump locked so that the user must unlock the pump to dispense diesel fuel; unlock the gasoline pump each day for normal use; and selected a new fuel vendor and a better quality of fuels.
- weigh tires that are sent to LLNL for recycling.

Paint Shop Reassessment (7/95)

Based on the results and recommendations of the initial assessment in June 1993, the Paint Shop has done or is doing the following:

- added a dryer system to the air compressor to reduces the amount of oil and moisture in the air; however, this dryer system is not considered abatement for volatile organic compounds.
- uses latex paint instead of oil-based paint, whenever possible; because latex paint is water-soluble, this practice reduces the use of solvent during cleanup.
- evaluating a variety of degreasers in order to reduce the use of solvents; the goal is a 25% reduction in solvent use.
- allowing paint to dry on latex paint waste (paper pails, stir sticks, and disposable rags) before disposal, as allowed by the California Code of Regulations, Title 22, 66261.7.
- where practical, uses disposable brushes, rollers, cups, and tubs to avoid generation of waste cleaning solvents.
- reuses wooden stir sticks as many times as possible before discarding them.

Inorganic Solid Waste and Empty Containers <30 Gallons Reassessment (7/95)

Based on the results and recommendations of the initial assessment in 1993, the following has been done or is being done:

- fluorescent light tubes are recycled, resulting in a large reduction of waste.
- a glass bottle recycling program was implemented; now, all empty bottles that contained a hazardous chemical that can be rinsed out with water and/or dried are cleaned and recycled.

- hazardous chemicals are replaced with nonhazardous chemicals whenever possible.
- the chemical exchange program was implemented.
- the Chemical Inventory System was implemented and helps control the quantity of chemicals kept in inventory.

Diana Laser Laboratory (12/95)

Based on the results and recommendations of the initial assessment in 1993, the Diana Laser Laboratory has done or is doing the following:

- converted to the use of only the Coumarin 440 dye in the Diana laser operation; which has significantly reduced the amount of waste generated by the process.

CHEMICAL INFORMATION MANAGEMENT

The Environmental Operations Department implemented a site-wide Chemical Information System/Material Safety Data Sheet management system in April 1992. This system is designed to help SNL/California more effectively comply with Federal, State and local regulations and DOE orders, and to improve the operating efficiency in chemical work areas. It is a computer database, which tracks chemical containers in facilities by bar-code labels. It has several unique features, including flexible software, which permits SNL/California to customize it for the inventory's special needs. The system provides detailed information on chemical inventory and usage on site, thus supporting numerous ES&H programs and activities. These major programs and activities include:

- Chemical Information Management—Emergency Planning and Community Right-to-Know Act (EPCRA) and the California Hazardous Material Management Plan reporting;
- Industrial Hygiene—Chemical Information for Personnel Hazards Communication Information (Employee Right-to-Know/Material Safety Data Sheets,);
- Health Physics—radioactive material tracking;
- Waste Management—waste container tracking and hazardous material and spill information;
- Pollution Prevention—chemical inventory and usage on site;
- Air Quality—chemical inventory and usage on site;
- Storm Water/Wastewater—chemical inventory and usage on site;
- Emergency Preparedness—chemical inventory, hazardous material information, and spills;
- Fire Protection—chemical inventory and hazardous material information;
- Explosives—chemical inventory and hazardous material information;
- General resource for ES&H and Laboratory-wide audits, surveys, and information requests.

In 1992, SNL/California began to tie the waste management tracking system into the site-wide chemical inventory system to form a "cradle-to-grave" process (chemical procurement through waste management). Due to funding and other program constraints, the activity was delayed until 1994. Work on the activity resumed in 1994, and anticipated implementation is in 1996.

TOXIC SUBSTANCE CONTROL ACT COMPLIANCE

The Toxic Substance Control Act (TSCA) establishes regulations to control the use of and exposure to new industrial chemicals. It identifies toxic substances and regulates their manufacture, use, storage, handling, and disposal. TSCA requires premanufacturing notification and evaluation of new chemicals to assess the

health and environmental risks. It also regulates the use, inspection, and disposal of polychlorinated biphenyls (PCBs).

SNL/California removed all PCB transformers in response to a major site-wide electrical upgrade, conducted over the last few years. Most remaining PCB-contaminated electrical equipment (concentrations of 50 to 500 ppm) was removed or retrofitted with non-PCB-contaminated mineral oil. Only a few PCB-contaminated ballast switches and capacitors now remain on-site.

NATIONAL ENVIRONMENTAL POLICY ACT COMPLIANCE

The National Environmental Policy Act (NEPA) is the basic national charter for the protection of the environment. This law requires that SNL/California protect the environment by reviewing each new or changing project for potential environmental impacts. Environmental issues considered include air emissions, water and wastewater issues, waste generation and minimization, and the human environment (workers and the surrounding community). NEPA documents are available to the public and serve as a vehicle for the public to participate in the DOE's decision-making process.

A major SNL/California NEPA document, the site-wide *Environmental Impact Statement*, was published in August 1992.[11] The Secretary of Energy signed the Record of Decision in January 1993, which formally allows the DOE to continue operations at SNL/California. From an environmental perspective, this document discusses the existing and proposed mission and projects of SNL/California for the subsequent five to ten years.

The *Environmental Impact Statement* provides a baseline of environmental information by which Sandia evaluates the potential impacts of each proposed project, activity, and program. It discusses SNL/California's continuing operations to provide routine services to the entire site. Such routine operations include maintenance activities, administrative duties, and temporary office space and support activities.

Each proposed SNL/California project must be evaluated according to the DOE's *NEPA Implementing Procedures* (Title 10 CFR 1021).[12] The DOE Albuquerque Operations Office provides guidance to SNL/California regarding these implementing procedures. Part of the required NEPA documentation for every project is an Environmental Checklist, which is designed for Sandia staff members to describe their projects and identify potential environmental issues.

After an internal review process is complete, the checklist is submitted to the DOE Kirtland Area Office for review and a NEPA determination. The DOE determines that the project (1) falls under a categorical exclusion, as defined in the implementing procedures, (2) is covered under the site's *Environmental Impact Statement*, or (3) requires further NEPA review and documentation. SNL/California does not make determinations on its own proposed projects.

Because the SNL/California site has a site-wide *Environmental Impact Statement*, most of the NEPA evaluations result in either coverage under existing documentation or a request to the DOE for categorical exclusion.

In 1995, more than 90 projects were evaluated, and NEPA classifications and/or determinations were made. Most of these projects fell into the following general categories of continuing actions and operations: projects relating to environmental cleanup and technology; global warming; energy and environment; materials research and development; computer modeling and analysis, project management, research, and development; and microelectronics.

SNL/California requested categorical exclusions for support structures, asbestos management, and routine maintenance activities.

In past years, the NEPA Program staff provided NEPA training to 97% of SNL/California's employees. As a continuing effort, a NEPA training module has been incorporated into the ES&H training class for new employees. The goal of the training is to familiarize staff members with NEPA and to show them how using the DOE environmental checklist can help them integrate environmental mitigation into their projects. If a staff member needs additional NEPA training, one- and three-day courses are available for detailed, comprehensive methodology and process training.

PERFORMANCE MEASURES/INDICATORS

Environment, safety, and health (ES&H) performance has been measured using performance indicators at Sandia for many years. However, the program has had a limited scope. Currently, SNL has a defined hierarchy of performance indicators, with a comprehensive set of labs-wide indicators at the top and more detailed, organization-specific indicators at the bottom. For reporting to the DOE, the top-level indicators are categorized into four general areas: protection of people, protection of the environment, compliance, and management practices; and two types: outcomes and precursors. The top-level precursor indicators are derived from lower level indicators, which have been developed and used by organizations to safely manage their workplaces to achieve the desired overall ES&H outcomes. The outcomes indicators measure and trend the overall ES&H performance at SNL, whereas the precursor indicators may show trends in the performance of ES&H processes intended to achieve those outcomes. The correlation of process performance to outcomes performance is used to pinpoint key performance indicators to monitor ES&H.

An ES&H Oversight Pilot team, which consists of both SNL and DOE representatives, is developing an updated set of corporate ES&H performance indicators for SNL to meet the needs of the DOE's current performance-based oversight and assessment objectives. The SNL organization responsible for this effort is the Emergency Management and Operations Evaluation Department. These new performance indicators will be designed to show trends before significant problems occur and will become a key part of the ES&H portion of the annual DOE/SNL laboratory appraisal. The top-level indicators will evolve to include proven key indicators. Each SNL division will be responsible for developing its own set of performance indicators that can be used to measure performance. These also will be evaluated during the annual DOE/SNL laboratory appraisal.

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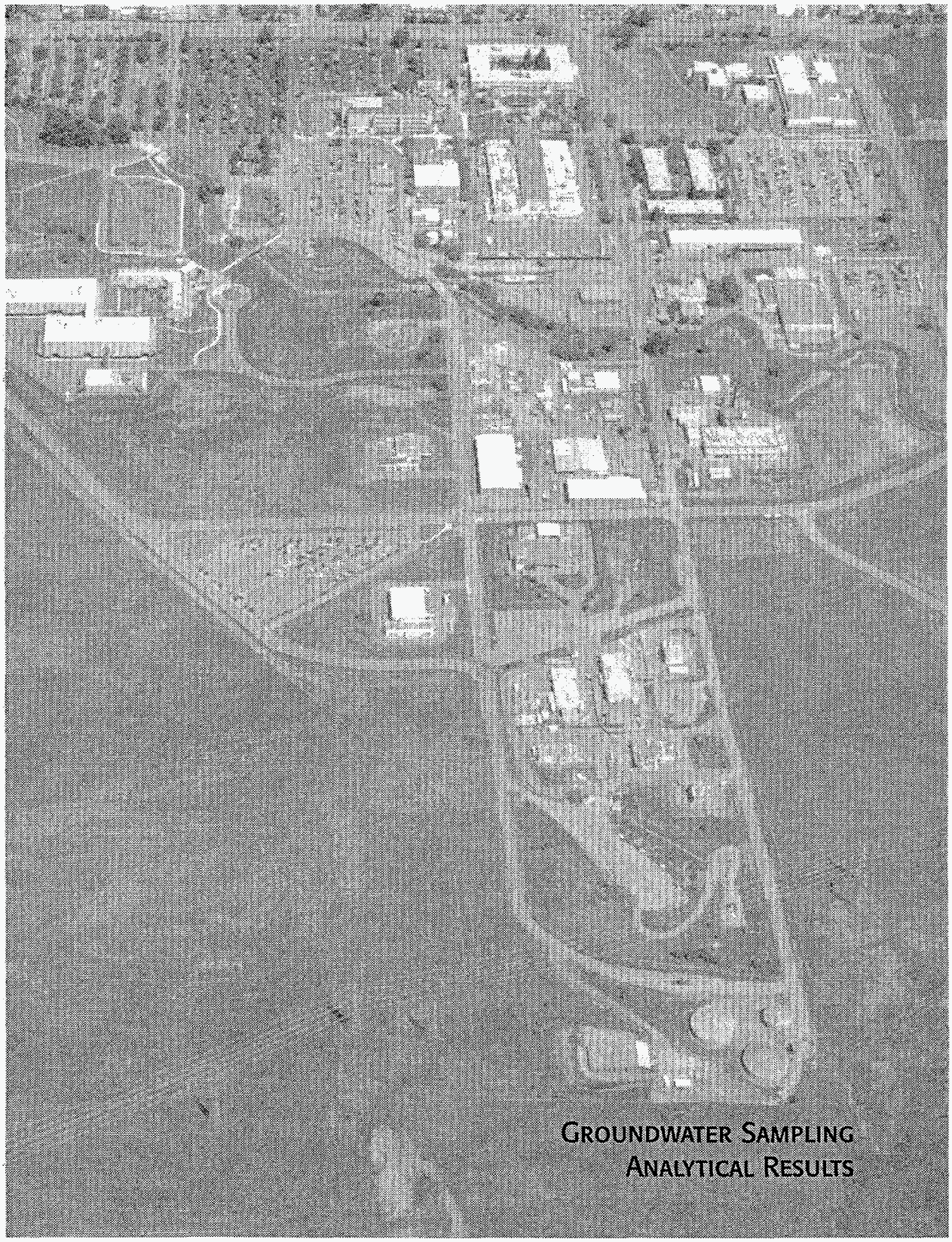
Table 5-1. SNL/California Site Waste Reduction Summary.

Waste Type	Waste Shipped in 1994 (kg)	Waste Shipped in 1995 (kg)	Change
RCRA hazardous waste	22,069	34,444	+56%
California-regulated (non-RCRA) hazardous waste	14,965	24,780	+66%
Low-level mixed waste	346	475	+37%
Low-level radioactive waste	17,920	15,692	−12%
TSCA (PCBs/asbestos)	18,156	26,431	+46%
Biohazardous	133	134	+0.8%
Sanitary waste	880,740	597,508	−32%

Table 5-2. SNL/California Site Recycling Activities (Estimated Values).

Material	1991	1992	1993	1994	1995
Office Paper (tons)	3.0	22.47	27.0	29.0	49.4
Aluminum (lbs)	340	1000	880	1000	665



GROUNDWATER SAMPLING
ANALYTICAL RESULTS

SNL/California issued the *Groundwater Protection Management Program Plan* on September 14, 1990,[1] to assure compliance with applicable Federal, State, and local environmental protection laws and regulations, Executive Orders, and internal department policies. The plan's objective is to document a management program for groundwater protection and remediation. Specifically, it addresses CERCLA, SARA, RCRA, and the Safe Drinking Water Act. The plan includes the following elements, as required by DOE Order 5400.1:[2]

- documentation of the quantity and quality of the groundwater,
- identification of sites that may be contaminated with hazardous substances, and
- a remedial action program, which is directed by the Regional Water Quality Control Board and contained in DOE directives.

SNL/California designed the Groundwater Monitoring Program as a part of the Environmental Restoration Program to monitor the effectiveness of the site's pollution control measures and to make sure that contaminants are not entering domestic water supplies. The groundwater sampling schedule calls for the 29 site-wide monitoring wells to be sampled each quarter, as indicated in Table 6-1. However, persistent drought conditions have generally reduced the number of wells that can be sampled to 12 or 13. Parameters for analysis are selected in accordance with Regional Water Quality Control Board requirements. Selection is based on the history of the area and the need for obtaining data for site-wide groundwater characterization. The location of the wells are shown in Figure 6-1.

The Environmental Restoration Program evaluates SNL/California's inactive waste disposal sites, spill locations, and waste management practices to determine if there is an adverse impact on the environment, and to develop any necessary remedial actions. This program also will support the remediation of groundwater that might become contaminated in the future. The uppermost water-bearing unit, which may be considered a water table aquifer, and the deeper confined/semiconfined aquifers at SNL/California are connected hydrologically to aquifers used for human and livestock drinking water, and for agricultural purposes. However, they are not a water source for these purposes.

SNL/California is conducting a Remedial Investigation/Feasibility Study to fully assess the nature and extent of the release of hazardous substances. This investigation encompasses four tasks:

- Fuel Oil Spill—Assessment and Remediation
- SNL/California Miscellaneous Sites [Arroyo Seco (AS-3, AS-4)]
- Navy Landfill—Assessment and Remediation
- Trudell Auto Repair Station—Assessment and Remediation

SNL/California is conducting the remediation activities according to orders issued by the Regional Water Quality Control Board.[3,4]

GROUNDWATER SAMPLING

SNL/CA has been experiencing drought conditions since 1986. Drought conditions were relieved somewhat in 1993, but water levels were similar or slightly decreased in 1994. In 1995, water level returned to 1993 levels because of heavy precipitation during the first three months of the year. By the end of the year, only one well could not be sampled because the water level was too low. A hydrogeologist determined the wells' suitability to be sampled by checking water levels and conditions. If sampling was possible, the water was checked for pH, temperature, and specific conductivity before samples were taken. Three purge volumes were removed, when

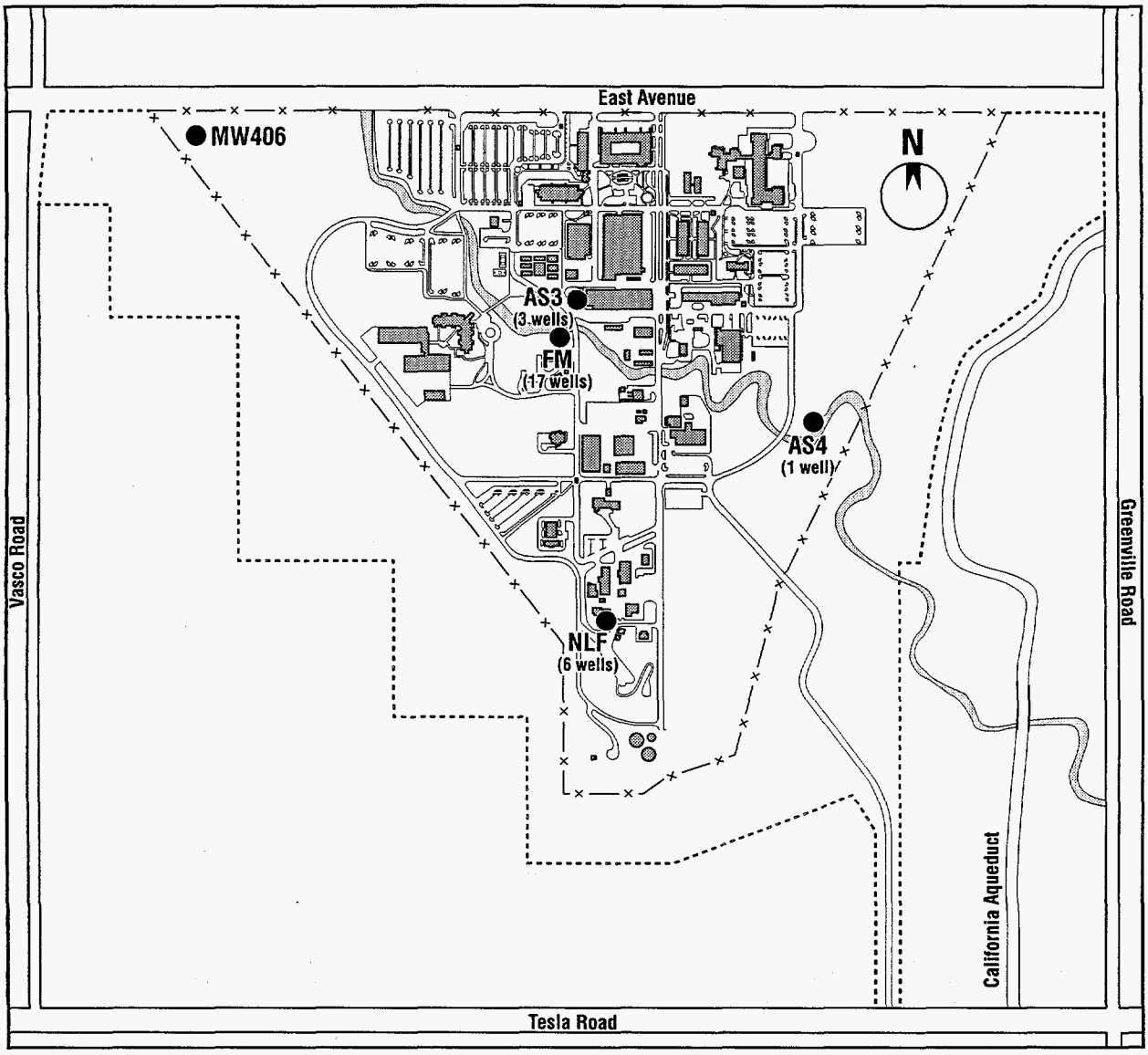


Figure 6-1. Groundwater monitoring well locations on the SNL/California site.

possible. Established quality assurance and quality control procedures were followed. These included chain of custody reporting and analyzing trip and equipment blanks to ensure the validity of the data.

LLNL reports data from groundwater monitoring wells installed on SNL/California property as part of the LLNL groundwater investigation project. Results are reported in LLNL's *Monthly Progress Report*. The Regional Water Quality Control Board requires quarterly reports to summarize groundwater-related project activities at SNL/California. Groundwater monitoring requirements have been upgraded and are defined in Board Orders 88-142 and 89-184 and in memoranda from the Board to the DOE.[3,4]

Fuel Oil Spill Site

The Fuel Oil Spill site has 17 monitoring wells. Seven wells (FM-1–FM-7) were

installed in 1984 to assess the impact of a 59,000-gallon diesel fuel spill on the subsurface environment. However, persistent drought conditions lowered the water table, requiring the installation of ten deeper wells (FM-8–FM-14, and FDG-1–FDG-3) between 1986 and 1988.

During the first quarter of 1995, 14 of the 17 Fuel Oil Spill monitoring wells had enough water for SNL/California to obtain a sample according to established procedures. All 17 wells were sampled during the second and third quarter. By the fourth quarter, sixteen of the wells had enough water to obtain a sample.

Arroyo Seco

In January 1986, four wells were installed at locations along the Arroyo Seco (AS-3 and AS-4 in Fig. 6-1), which traverses the site. Locations of three of the wells (AS-3A, B, and C) were based on primary recharge areas and expected surface runoff points at the SNL/California site. Well AS-3C was installed at a much greater depth to monitor the third aquifer. (Water-bearing zones are numbered consecutively downward from the ground surface.) A fourth well, AS-4, installed upgradient of SNL/California, was intended to function as a background well.

During the first quarter of 1995, groundwater samples were obtained from AS-4 only. As water levels continued to rise, AS-3A, AS-3B, AS-3C, and AS-4 were sampled during the second quarter. By the third and fourth quarter, there was enough water in all four Arroyo Seco wells to collect a sample.

Navy Landfill

In January 1986, SNL/California installed one well (NLF-1) at the Navy Landfill site, an abandoned landfill used in the 1940s and 1950s for construction debris. SNL/California installed three additional wells (NLF-2–NLF-4) in June 1988 (Fig. 6-1). In an effort to assess the elevated levels of chromium and nitrate observed in groundwater at the Navy Landfill site, SNL/California installed two additional monitoring wells (NLF-5 and NLF-6) in August 1993.

All six Navy Landfill wells contained enough water for sampling during all four quarters of 1995.

Buffer Zone

As part of the expansion of the DOE security buffer zone in 1987, SNL/California acquired property that had been used as a gasoline service station and an auto repair shop. This land, known as the Trudell Auto Repair site, had subsurface contamination from previous activities. Restoration of the Trudell site was completed in August 1990, and the Regional Water Quality Control Board approved site closure in November 1990. Although cleanup of the site is officially complete, SNL/California continues to monitor the area through quarterly sampling of well MW-406 (see Fig. 6-1).

MW-406 did not contain enough water for sampling during 1995.

ANALYTICAL RESULTS

In 1995, well NLF-6 was the only location in which carbon tetrachloride was detected. Carbon tetrachloride was detected during all four quarters at levels greater than the State maximum contaminant level (MCL) (0.5 µg/L) ranging from 1.0 to 2.1 µg/L. SNL/CA will continue to monitor for carbon tetrachloride.

Throughout 1995, diesel was found in wells around the site. At the Navy Landfill, diesel was found in NLF-1 during all four quarters ranging from 220 to 580 µg/L and in NLF-6 during the second quarter at 150 µg/L. Diesel was found in 13 of the 14 wells at the Fuel Oil Spill site. As SNL/California anticipated, diesel concentrations increased during the third quarter when the bioremediation study began injecting water into the ground, displacing the diesel into the groundwater. Groundwater concentrations at the Fuel Oil Spill site ranged from 80 µg/L to

770 mg/L and are graphed in Figure 6-2. More than half of the diesel concentrations were "qualified" diesel. "Qualified" diesel means that the detected chromatographic pattern does not match the standard diesel pattern; however, the analytical method used by SNL/California specifies that the detected compound be reported as diesel. Benzene concentrations above the state MCL (1 µg/L) were found in six of the Fuel Oil Spill site wells in the third quarter and two wells in the fourth quarter. Benzene concentrations ranged from 1.3 to 8.3 µg/L. The wells where benzene was found also had the highest levels of diesel. Since benzene is a component of #2 diesel fuel oil, benzene can also be expected in these wells.

Groundwater from all but two monitoring wells showed high concentrations of total dissolved solids. All but two of the wells sampled were above the state secondary drinking water standard (500 mg/L) in at least one quarter. This is a measure of water quality only, and is indicative for the area.

Groundwater from several of the monitoring wells in the Fuel Oil Spill site showed levels of aluminum, chromium, and nickel greater than the MCL. Throughout the Fuel Oil Spill site, groundwater showed a wide range of aluminum concentrations. Thirteen wells exceeded the State MCL (1 mg/L), with concentrations of 1.1 to 750 mg/L. Chromium was detected for three quarters in wells FM-6 and FM-7 at concentrations up to 1.1 mg/L, which is greater than the federal MCL (0.1 mg/L). Nickel was detected in the Fuel Oil Spill site wells FM-6, FM-7, FM-8, and FM-10 above the federal MCL (0.1 mg/L). Nickel concentrations ranged from 0.14 mg/L to 1.4 mg/L. Figure 6-3 shows historical trends of these parameters in groundwater at the Fuel Oil Spill Site.

Nickel was also detected above the federal MCL (0.1 mg/L) in all four quarters in the Navy Landfill well NLF-3. Nickel concentrations ranged from 0.16 to 0.36 mg/L. Figure 6-4 shows historical trends of these parameters in groundwater at the Navy Landfill Site.

Nitrates (as nitrogen) were detected above the federal MCL (10 mg/L)in the wells NLF-1 and NLF-6 at the Navy Landfill all four quarters. Nitrates were detected above the federal MCL in NLF-3 during three quarters. Nitrate concentrations above the federal MCL ranged from 13 to 68 mg/L. Figure 6-4 shows historical trends of these parameters in groundwater at the Navy Landfill Site.

Samples were analyzed in 1995 for total radium-226, radium-228, tritium, and natural uranium. The combined concentration of radium-226 and

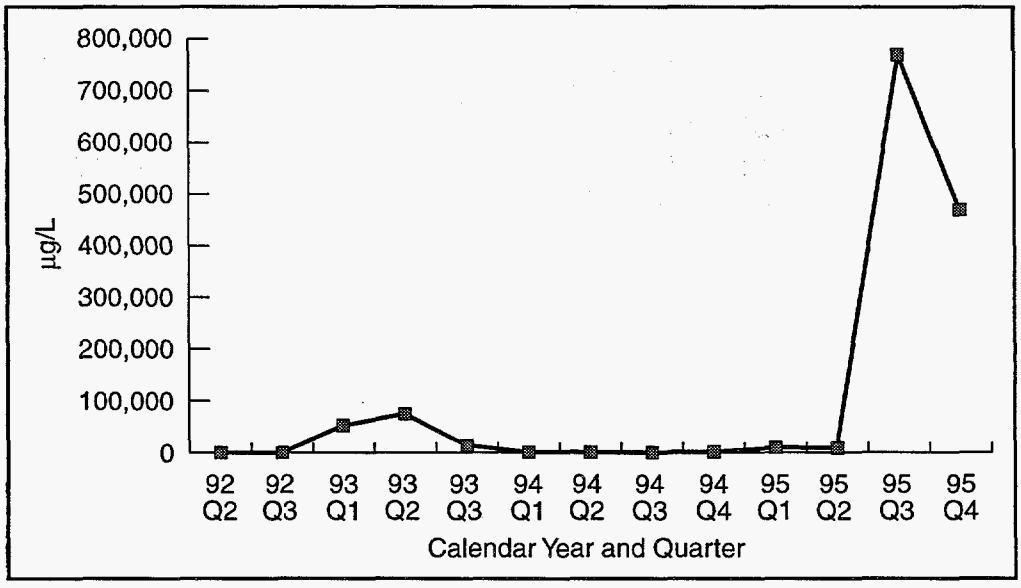


Figure 6-2. Highest positively detected diesel concentration in groundwater from any Fuel Oil Spill monitoring well.

radium-228 was above the state MCL (5 pCi/L) in one of the wells in the Fuel Oil Spill during the first quarter. Figure 6-5 shows historical tritium monitoring data at the Navy Landfill site, Fuel Oil Spill site, and Arroyo Seco wells.

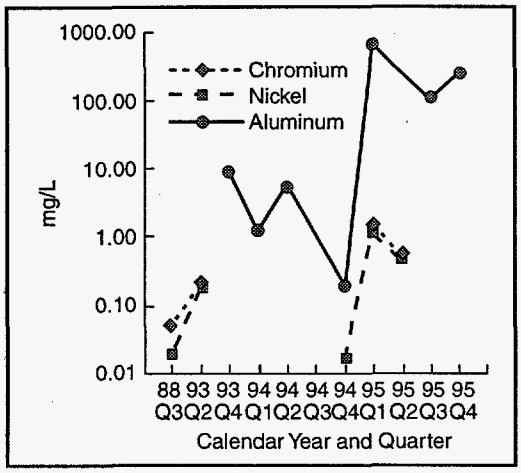


Figure 6-3. Highest detected analyte concentration in groundwater from any fuel oil spill monitoring well.

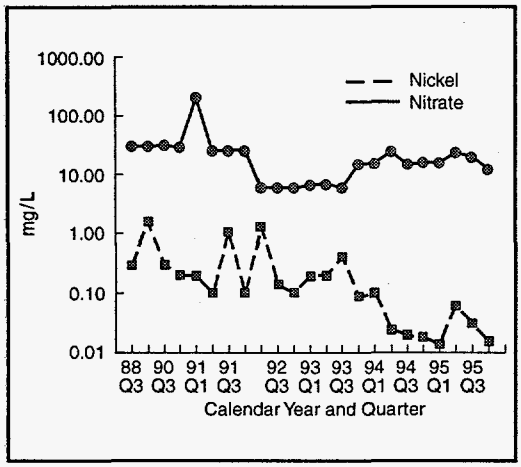


Figure 6-4. Highest analyte concentration observed in any Navy Landfill monitoring wells.

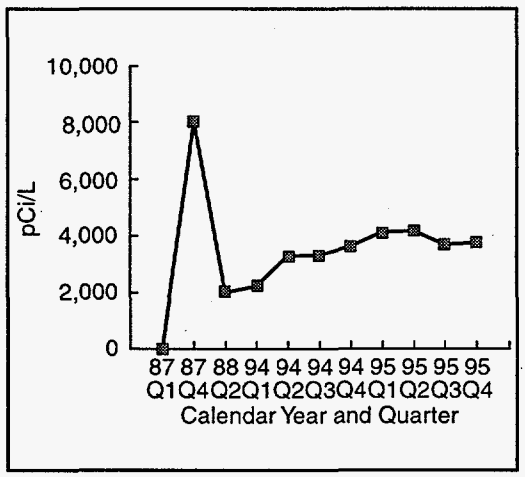


Figure 6-5. Highest tritium activity observed in SNL/California monitoring wells.

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1. U.S. DOE, Sandia National Laboratories, Livermore, *Groundwater Protection Management Program Plan* (September 1990).

2. U.S. DOE, Order 5400.1, *General Environmental Protection Program* (November 1988).

3. State of California, San Francisco Bay Region, Regional Water Quality Control Board, Order 88-142 (September 21, 1988).

4. State of California, San Francisco Bay Region, Regional Water Quality Control Board, Order 89-184 (December 13, 1989).

Table 6-1. Sample Analysis Schedule.

Area	Well ID	EPA 601[a]	EPA 602 (BTEX)[b]	EPA 8015 (TPHD)[c]	CCR General Minerals[d]	CCR Metals[e]	RAD[f]	Water Elevation
Fuel Oil Spill	FM-1	X	X	X	X	Y	Y	X
	FM-2	X	X	X	X	Y	Y	X
	FM-3	X	X	X	X	Y	Y	X
	FM-4	X	X	X	X	Y	Y	X
	FM-5	X	X	X	X	Y	Y	X
	FM-6	X	X	X	X	Y	Y	X
	FM-7	X	X	X	X	Y	Y	X
	FM-8	X	X	X	X	Y	Y	X
	FM-9	X	X	X	X	Y	Y	X
	FM-10	X	X	X	X	Y	Y	X
	FM-11	X	X	X	X	Y	Y	X
	FM-12	X	X	X	X	Y	Y	X
	FM-13	X	X	X	X	Y	Y	X
	FM-14	X	X	X	X	Y	Y	X
	FDG-1	X	X	X	X	Y	Y	X
	FDG-2	X	X	X	X	Y	Y	X
	FDG-3	X	X	X	X	Y	Y	X
Arroyo Seco	AS-3A	X	X	X	X	Y	Y	X
	AS-3B	X	X	X	X	Y	Y	X
	AS-3C	X	X	X	X	Y	Y	X
	AS-4	X	X	X	X	Y	Y	X
Navy Landfill	NLF-1	X	X	X	X	X	X	X
	NLF-2	X	X	X	X	X	X	X
	NLF-3	X	X	X	X	X	X	X
	NLF-4	X	X	X	X	X	X	X
	NLF-5	X	X	X	X	X	X	X
	NLF-6	X	X	X	X	X	X	X
Buffer Zone	MW-406	X	X	X	Y			X
	MW-11							X

X indicates analysis done every quarter.
Y indicates analysis done every year.
Z indicates analysis done every other quarter.

[a]EPA Method 601 applies to halogenated volatile organic compounds.

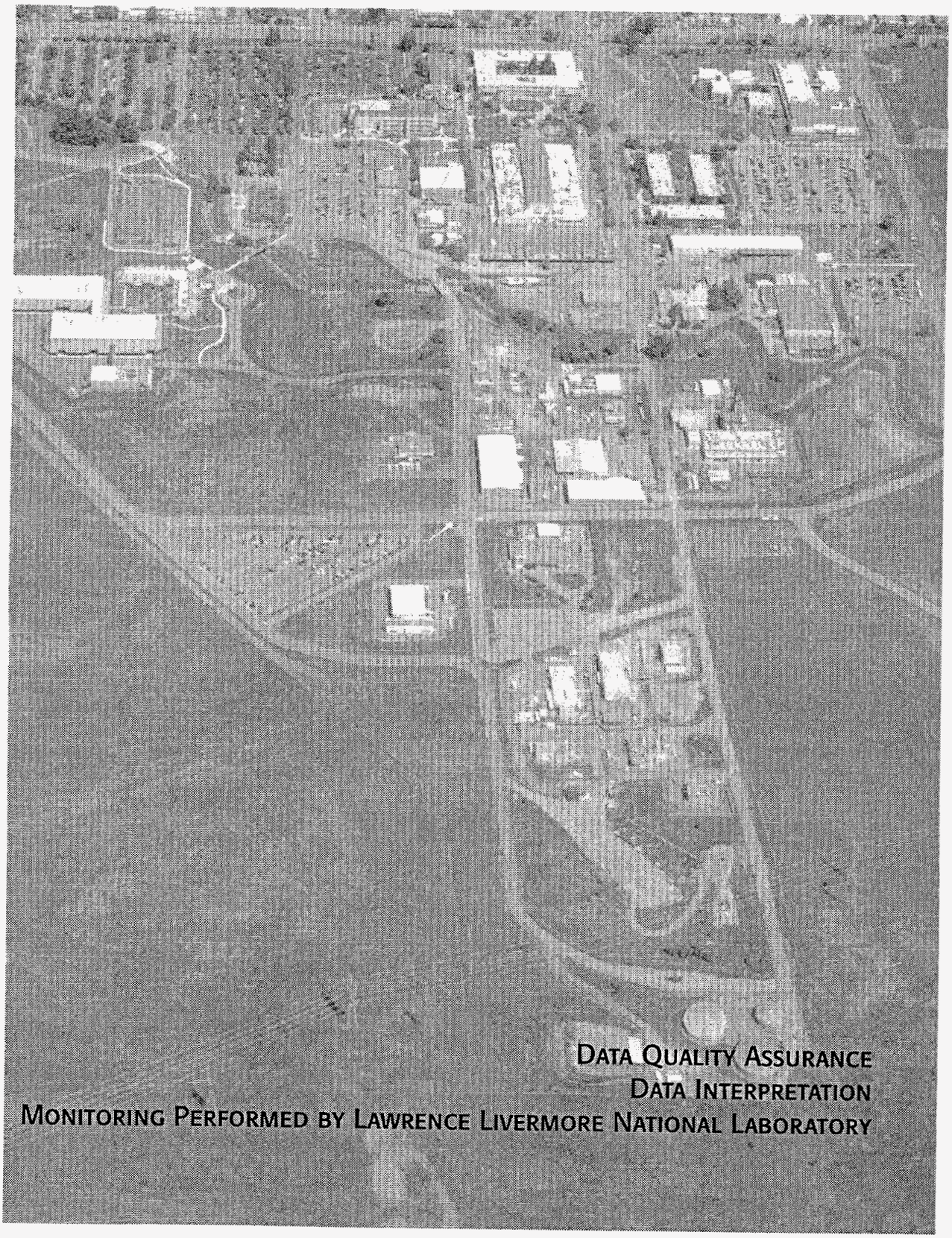
[b]EPA Method 602 applies to BTEX (benzene, toluene, ethylbenzene, xylenes), which are aromatic volatile organic compounds.

[c]TPHD is diesel, which is analyzed according to EPA Method 8015.

[d]CCR general minerals include bicarbonate, carbonate and hydroxide alkalinity, calcium, chloride, copper, magnesium, nitrate (as NO_3), pH, sodium, sulfate, specific conductivity, sulfate, total dissolved solids, total hardness, and zinc (Title 22 CCR 64433). Potassium is also included in the analyses.

[e]CCR metals include antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, fluoride salts, lead, mercury, nickel, selenium, silver, thallium, vanadium, and zinc. These are listed as Inorganic Persistent and Bioaccumulative Toxic Substances in Title 22 CCR 66261.24(a)(2)(A).

[f]RAD (radioactivity) analyses include tritium, radium, and uranium.



Data Quality Assurance
Data Interpretation
Monitoring Performed by Lawrence Livermore National Laboratory

SNL/California maintains an effluent monitoring and environmental surveillance program, as required by DOE Orders 5400.1 and 5400.5.[1,2] These Orders specify quality assurance requirements consistent with DOE Order 5700.6B.[3] The DOE has issued DOE Order 5700.6C,[4] which supersedes DOE Order 5700.6B. The ES&H, Facilities, and Security Center at SNL/California has developed and is implementing a Quality Assurance Management Plan consistent with the provisions of DOE requirements.[5] Additional procedures for implementing the plan include the following:

- qualifications and training;
- procedure development and control;
- control of measuring and test equipment, including monitoring and data collection equipment;
- identification and control of samples;
- identification and control of technical data;
- procurement control;
- records management; and
- independent assessment.

Consistent with the requirements of the *Quality Assurance Management Plan*, the Environmental Surveillance Group has developed a Quality Assurance Project Plan, which describes how the Quality Assurance Management Plan will be implemented.[6] The *Quality Assurance Project Plan* includes quality assurance guidance from other documents, such as Title 40 CFR, Part 58, *Ambient Air Quality Surveillance*,[7] and the *EPA's Quality Assurance Handbook for Air Pollution Measurement Systems*.[8] To meet the most current guidance on quality assurance for environmental projects, the *Quality Assurance Project Plan* follows the guidance and format of the draft *Quality Assurance Requirements for Environmental Programs*.[9] Operating procedures supplement the *Quality Assurance Project Plan* and implementing provisions of the *Quality Assurance Management Plan*. Operating procedures specify requirements for environmental monitoring, LECS monitoring, and process wastewater sampling for compliance with Federal categorical pretreatment regulations.

The Environmental Operations Department incorporates normal data and supervisory reviews into routine operations. SNL/California's upper management performs management assessments, as required in the *Quality Assurance Management Plan*. Assessments identify problems that may keep an organization from achieving required goals or conforming to requirements. Finally, the *Quality Assurance Management Plan* provides for independent technical assessments to verify quality.

DATA QUALITY ASSURANCE

SNL/California assesses the quality of the data collected for the Environmental Operations Department by estimating the precision and accuracy of the data. SNL/California estimates precision by collecting duplicate samples. The data obtained from the duplicate samples is compared to the data obtained from the routine samples. A confidence interval thereby can be calculated. The confidence interval represents the variability that exists in the monitoring system and the range of values around a reported data point, within which the actual value can be expected to lie.

Accuracy is estimated through analysis of samples containing a known amount of the constituent of interest. The result is compared to the known amount, and once again, a confidence interval is calculated. This confidence interval indicates the range of values within which the actual value can be expected to lie. In general, smaller confidence intervals represent more accurate and precise analyses.

The Environmental Operations Department has standardized methods for calculating confidence intervals and has established acceptance criteria for them. These methods and acceptance criteria are described in the procedure, *Data Validation and Verification for the Environmental Monitoring Program.*[10] The acceptance criteria account for the confidence interval enlarging (i.e., the error associated with the analysis becomes greater) as the concentration of a constituent in a sample approaches the detection limit. For this reason, acceptance criteria that may be achievable at relatively high concentrations may not be achievable at very low concentrations. At very low levels, the presence of the constituent of interest may be detected, but not the quantity. To address this phenomenon, the EPA recommends that "practical quantitation limits" be established. The Environmental Operations Department has established practical quantitation limits at ten times the detection limit for each constituent of interest. Therefore, the acceptance limits for precision and accuracy are progressive—the confidence interval can be larger near the detection limit and smaller as the practical quantitation limit is approached.

To facilitate the calculation of confidence intervals for accuracy and precision, the procedures for collecting environmental samples specify three types of quality control samples:

- *Duplicate Samples.* Duplicate samples are collected according to the same methods as the routine samples, and at the same time and location. These samples are used to assess the precision (repeatability) of the sample collection and analysis system.
- *Interlaboratory Comparison Samples.* These are samples prepared by the EPA or the DOE. The participating laboratory analyzes them as normal samples and reports the data to the initiating agency. The agency then informs the laboratory of how close the results were to the known amount in the sample. Thus, the participating laboratory uses these data to assess the accuracy of its measurements.
- *Blank Samples.* Blank samples resemble the routine samples as closely as possible, but lack the constituent of interest. These samples are not used to assess accuracy or precision, but are important for assessing possible contamination of the samples during collection, transportation, and analysis.

Table 7-1 shows the results of the EPA Environmental Radioactivity Laboratory's Intercomparison Studies Program for SNL/California. One of the SNL/California tritium-in-water results lies outside of the acceptable range of ±3 standard deviations. This problem was addressed by changing the counting procedure to subtract an average background value, rather than the background immediately preceding any sample count. This provides a more stable background number, and has led to improved accuracy and precision for tritium analyses.

Table 7-2 presents data from SNL/California's duplicate sampling. These data represent the precision of the combined sampling and analytical processes. All t-tests between routine and duplicate samples showed no significant difference. However, the 95% confidence intervals for TSS, BOD, COD, and Oil and Grease in wastewater do not meet the acceptance criteria of having a width of less than 50% of the routine sample average.An investigation into these phenomenon indicates that the most probable reason for the discrepancies is the extraordinary heterogeneity of the wastewater samples. Care is taken when collecting duplicate samples, so the differences noted are taken to reflect the true variable nature of the wastewater. The ratio of duplicate to routine samples for

diethylphthalate and benzylbutylphthalate in wastewater does not meet the acceptance criteria. This is also an indication of the variability of the wastewater.

DATA INTERPRETATION

Once the precision and accuracy of the data have been established, and the acceptance criteria have been met, the data must be interpreted. Data Analysis for the Environmental Monitoring Program describes SNL/California's methods for interpreting data.11 These methods fall into several categories:

- *Determining averages and standard deviations.* Averages and standard deviations are useful as summaries of data collected during the year. The usual methods for calculating averages and standard deviations assume that the data have a "normal" (bell curve) distribution. However, many environmental data do not follow a normal distribution, and the usual methods of calculating averages and standard deviations would be misleading for these data sets. Therefore, all data sets are tested for normality. If the data are found to be not normally distributed, then the average and standard deviation appropriate for a data set with a lognormal distribution are calculated. (Most environmental data follow a lognormal distribution if they are not distributed normally.) Data sets with ten or fewer data points are treated as normally distributed, with no checks of the distribution, because more data points are needed to describe the distribution accurately.
- *Testing for outliers.* SNL/California includes outlying data in the data sets, unless they can be attributed to a specific cause (such as laboratory contamination of the sample). SNL/California personnel use box plots (a statistical method) to determine outliers.
- *Comparing data.* If possible, SNL/California personnel compare data collected on or near the SNL/California site and data collected at "background"—or distant—locations. If concentrations on or near the site are observed at a higher concentration than at distant locations, the site may be assumed to be the source of observed hazardous or radioactive materials in the environment. Conversely, if concentrations on or near the site are similar to (or lower than) concentrations at distant locations, the site may be assumed not to be the source of hazardous or radioactive materials in the environment. SNL/California personnel compare concentrations by using t-tests (statistical tests) or by analysis of variance techniques to determine if any observed differences are statistically significant.
- *Determining compliance with standards.* If regulatory standards have been established for hazardous or radioactive material concentrations in an environmental medium, SNL/California compares monitoring results to the standard. Because a single data point is associated with high uncertainty, SNL/California personnel use the confidence interval for precision, as calculated above, for comparison. If the 95% confidence interval around the observed value includes values at or above the regulatory standard, then the standard may have been exceeded. The data are investigated further to confirm, if possible, whether or not the standard was indeed exceeded. If the entire confidence interval is above the regulatory limit, then we assume the standard was exceeded.
- *Determining values below the analytical detection limit.* Most analytical methods cannot state definitively that the concentration of a hazardous or radioactive material is zero. Most

analytical methods have a "lower limit of detection," below which material presence cannot be ascertained. This lower detection limit usually is defined as the concentration at which the presence of the material can be detected with 99% statistical certainty. These values are shown with a "less than" symbol (<) preceding the value. They cannot be used in the normal statistical calculations described above because they represent ranges instead of discrete values. To perform statistical calculations on data sets containing these values, SNL/California personnel use the following methods:

- If more than one-third of the data set consists of detection limit values, SNL/California reports the median and median absolute deviation of the data set, instead of the average and standard deviation.
- If less than one-third of the data set consists of detection limit values, SNL/California calculates averages and standard deviations using the detection limit as a normal result. (This method is conservative because it really represents the highest possible value for the data.)

Monitoring Performed by Lawrence Livermore National Laboratory

LLNL conducts much of the off-site environmental monitoring and transmits the results to SNL/California. LLNL has a quality assurance program and procedures for environmental monitoring, documented in the *Environmental Monitoring Section Quality Assurance Plan.*[12] Samples processed outside of LLNL are sent to laboratories that have been State-certified to do the analyses required. Many of the radiological analyses are done by the Nuclear Chemistry Division at LLNL. The Nuclear Chemistry Division has established a quality assurance plan for environmental measurement and has applied to the State for certification.

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6. R. C. Holland, *Environmental Monitoring Program Quality Assurance Project Plan*, Sandia National Laboratories/California, SAND93-8010 (June 1993).

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11. U.S. DOE, Sandia National Laboratories/California, *Data Analysis for the Environmental Monitoring Program* (January 1994).

12. L. M. Garcia and R. A. Failor, *Environmental Monitoring Section Quality Assurance Plan*, Lawrence Livermore National Laboratory, UCRL-AR-114318 (1993).

Table 7-1. Quality Assurance Analyses for the Environmental Protection Agency's Environmental Radioactivity Laboratory Intercomparison Studies Program.[a]

			Value Reported (pCi/L ± 1σ)		
Medium	Analysis	Analyzed by	Analytical Result	Known	Normalized deviation from the known value[b]
Water	tritium	SNL/California	6129 ± 181	7435 ± 744	–3.04
		SNL/California	4988 ± 348	4872 ± 487	–0.41

[a]All data were provided by LLNL's Nuclear Chemistry Division.
[b]Acceptable deviations are between –2 and 2 ($-2 < x < 2$).

Table 7-2. Quality Assurance—Duplicate Sampling, Selected Parameters on SNL/California Collected Samples.

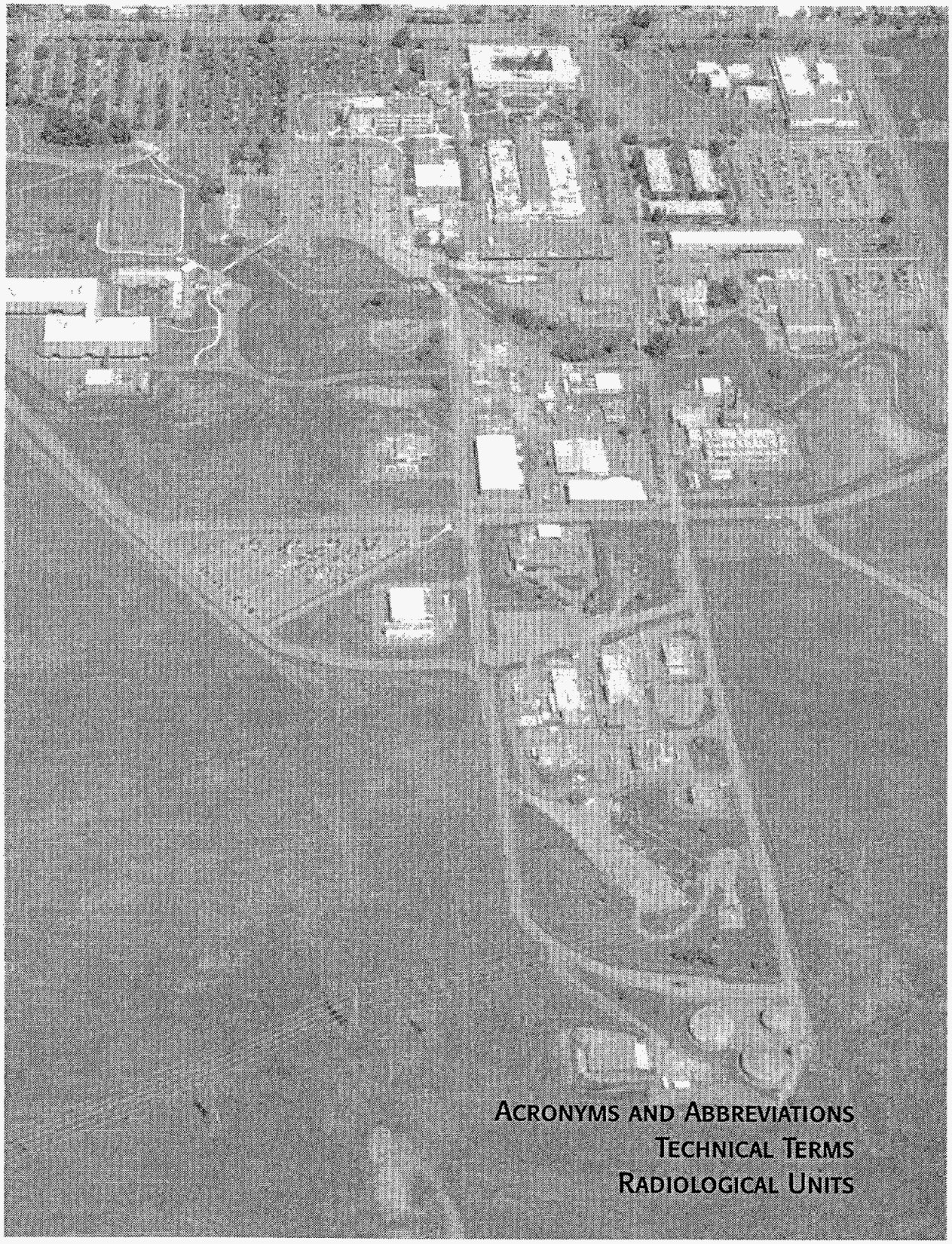
Medium	Analysis	Confidence Interval (85%)[a]	Ratio[b]
Wastewater			
	Biological oxygen demand	76.55/–12.48	—[d]
	Chemical oxygen demand	42.87/–10.12	—[d]
	Total suspended solids	259.27/–69.44	—[d]
	Total dissolved solids	7.26/–5.09	—[d]
	Specific conductivity	1.15/–0.77	—[d]
	Oil and grease	54.86/–14.61	—[d]
	Cadmium	—[c]	1.17
	Chromium	—[c]	0.61
	Copper	36.23/–10.10	—[d]
	Lead	—[c]	0.52
	Mercury	—[c]	1.00
	Nickel	—[c]	0.50
	Silver	—[c]	1.12
	Zinc	31.53/–24.32	—[d]
	Bis(2-ethylhexyl)phthalate	—[c]	3.0
	Chloroform	8.96/–7.0	—[d]
	di -n-	—[c]	1.12
	Diethylphthalate	—[c]	6.1
	Phenol	—[c]	0.64
Storm Water Runoff			
	pH	—[c]	0.99
	Specific conductivity	—[c]	1.02
	Chromium	—[c]	1.00
	Copper	—[c]	0.75
	Nickel	—[c]	1.00
	Zinc	—[c]	0.98
	Total suspended solids	—[c]	1.43
Air			
	Tritium	21.44/–29.01	—[d]

[a]Only calculated for data sets with more than eight valid data pairs.

[b]Only calculated for data sets with less than eight valid data pairs. The value is the ratio of quality assurance sample/routine sample.

[c]Not calculated—less than eight valid data pairs available.

[d]Not calculated—more than eight valid data pairs available.



ACRONYMS AND ABBREVIATIONS
TECHNICAL TERMS
RADIOLOGICAL UNITS

ACRONYMS AND ABBREVIATIONS

ALARA	as low as reasonably achievable
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
BOD	biological oxygen demand
BTEX	benzene, toluene, ethylbenzene, xylenes
CAA	Clean Air Act (Federal)
Cal/EPA	California Environmental Protection Agency
CCR	California Code of Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CN	cyanide
COD	chemical oxygen demand
CWA	Clean Water Act (Federal)
DCG	Derived Concentration Guide (DOE)
DOE	Department of Energy
DWS	drinking water standard
EDE	effective dose equivalent
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
ES&H	environment, safety, and health
HT or T_2	elemental tritium
HTO or T_2O	tritium oxide (tritiated water)
LECS	Liquid Effluent Control System
LLNL	Lawrence Livermore National Laboratory
LWRP	Livermore Water Reclamation Plant
MAD	median absolute deviation
NEPA	National Environmental Policy Act
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System
O&G	oil and grease
PCB	polychlorinated biphenyl
RCRA	Resource Conservation and Recovery Act
SDM	standard deviation of the mean
SI	International System of Units
SNL	Sandia National Laboratories
SWRCB	State Water Resources Control Board
TDS	total dissolved solids

TSCA	Toxic Substance Control Act
TSS	total suspended solids

TECHNICAL TERMS

accuracy	The closeness of the result of a measurement to the true value of the quantity measured.
air particulates	Airborne particles. These may include dust, dirt, and pollutants that occur as particles, and any pollutants that may be associated with or carried on the dust or dirt.
aliquot	A portion of a sample taken for analysis.
alpha particle	A charged particle (identical to the helium nucleus) comprising two protons and two neutrons that are emitted during decay of certain radioactive atoms. Alpha particles are stopped by several centimeters of air or a sheet of paper.
ambient air	The surrounding atmosphere, usually the outside air, as it exists around people, plants, and structures. It does not include the air next to emission sources.
aquifer	A saturated layer of rock or soil below the ground surface that can supply usable quantities of ground water to wells and springs. Aquifers can be a source of water for domestic, agricultural, and industrial uses.
arroyo	An intermittent or seasonal stream.
background radiation	Ionizing radiation from natural sources. It may include cosmic radiation; external radiation from naturally occurring radioactivity in the earth (terrestrial radiation), air, and water; internal radiation from naturally occurring radioactive elements in the human body; and radiation from medical diagnostic procedures.
best management practice	Any method, process, or procedure developed to prevent and/or reduce pollutants discharged to the environment.
beta particle	A charged particle (identical to the electron), which is emitted during decay of certain radioactive atoms. Most beta particles are stopped by ≤0.6 cm of aluminum.
categorical process	An industrial process, which discharges wastewater and is regulated under Title 40 CFR, Part 403.
collective effective dose equivalent	The sum of the effective dose equivalents of all individuals in an exposed population within a certain radius; expressed in units of person-rem (or person-sievert).
contaminant	Any hazardous or radioactive material present in an environmental medium, such as water or vegetation.
controlled area	Any Laboratory area to which access is controlled to protect individuals from exposure to radiation and radioactive materials.

cosmic radiation	High-energy particulate and electromagnetic radiation that originates outside the earth's atmosphere. Cosmic radiation is part of natural background radiation.
discharge	A release into an area not controlled by SNL/California.
dose	A term denoting the quantity of radiation energy absorbed.
dose, absorbed	The energy imparted to matter by ionizing radiation per unit mass of irradiated material. (The unit of absorbed dose is the rad.)
dose, effective	The hypothetical whole-body dose that would give the same risk of cancer mortality and/or serious genetic disorder as a given exposure and that may be limited to just a few organs. The effective dose equivalent is equal to the sum of individual organ doses, each weighted by the degree of risk that the organ dose carries. For example, a 100-mrem dose to the lung, which has a weighting factor of 0.12, gives an effective dose that is equivalent to 12 mrem (100×0.12).
dose, equivalent	A term used in radiation protection that expresses all types of radiation (alpha, beta, and so on) on a common scale for calculating the effective absorbed dose. It is the product of the absorbed dose in rads and certain modifying factors. (The unit of dose equivalent is the rem.)
dose, maximum boundary	The greatest dose commitment, considering all potential routes of exposure from a facility's operation, to a hypothetical individual who is in an uncontrolled area where the highest dose rate occurs. It assumes that the hypothetical individual is present 100% of the time (full occupancy), and it does not take into account shielding (for example, by buildings).
dose, maximum individual	The greatest dose commitment, considering all potential routes of exposure from a facility's operation, to an individual at or outside the Laboratory boundary where the highest dose rate occurs. It takes into account shielding and occupancy factors that would apply to a real individual.
dose, population	The sum of the radiation doses to individuals of a population. It is expressed in units of person-rem. For example, if 1,000 people each received a radiation dose of 1 rem, their population dose would be 1,000 person-rem.
dosimeter	A portable detection device for measuring the total accumulated exposure to ionizing radiation. See also *thermoluminescent dosimeter.*
downgradient	In the direction of groundwater flow from a designated area of interest; analogous to downstream.
effective dose equivalent	Abbreviated EDE; the summation of the products of the dose equivalent received by specified tissues of the body and a tissue-specificweighting factor. This sum is a risk-equivalent value and can be used to estimate the health risk of the exposed individual. The tissue-specific weighting factor represents the fraction of the total health risk resulting from uniform whole-body irradiation that would be contributed by that particular tissue. The EDE includes the

	committed EDE from internal deposition of radionuclides and the EDE due to penetrating radiation from sources external to the body; it is expressed in units of rem (or sievert).
effluent	A liquid or gaseous waste discharged to the environment.
emission	A gaseous or liquid stream containing one or more contaminants. The verb form, emit, means the act of discharging a contaminant or pollutant into the environment.
environmental remediation	The process of restoring a contaminated area to a noncontaminated or safe condition.
exposure	A measure of the ionization produced in air by x or gamma radiation. (The unit of exposure is the roentgen.)
external radiation	Radiation originating from a source outside the body.
extractable pollutants	Pollutants that can be removed from a contaminated sample by passing water through the sample.
gamma radiation	Short-wavelength electromagnetic radiation of nuclear origin that has no mass or charge. Because of its short wavelength (high energy), gamma radiation can cause ionization. Other electromagnetic radiation (such as microwaves, visible light, and radio waves) have longer wavelengths (lower energy) and cannot cause ionization.
groundwater	A subsurface body of water in the zone of saturation (where soil sediments have become saturated with water).
half-life, radioactive	The time required for the activity of a radioactive substance to decrease to half its value by inherent radioactive decay. After two half-lives, one-fourth of the original activity remains ($1/2 \times 1/2$); after three half-lives, one-eighth ($1/2 \times 1/2 \times 1/2$); and so on.
hazardous waste	Waste exhibiting any of the following characteristics: ignitability, corrosivity, reactivity, or EP-toxicity (yielding toxic constituents in a leaching test). Because of its concentration, quantity, physical, or chemical characteristics, it may: 1) cause or significantly contribute to an increase in mortality rates or cases of serious irreversible illness; or 2) pose a substantial present or potential threat to human health or the environment when improperly treated, stored, transported, disposed of, or handled.
internal radiation	Radiation from a source within the body as a result of deposition of radionuclides in body tissues by processes such as ingestion, inhalation, or implantation. Potassium (^{40}K), a naturally occurring radionuclide, is a major source of internal radiation in living organisms.
lysimeter	A device for sampling soil moisture in the unsaturated zone. See *vadose zone.*
nonattainment area	An area that does not meet the National Ambient Air Quality Standards.

non-storm water	Any water flow that is not entirely composed of rain.
nuclide	A species of atom characterized by what constitutes the nucleus, which is specified by the number of protons, number of neutrons, and energy content; or, alternatively, by the atomic number, mass number, and atomic mass. To be regarded as a distinct nuclide, the atom must be able to exist for a measurable length of time.
organic compound	A chemical whose primary constituents are carbon and hydrogen.
organochloride	An organic compound in which one or more of the hydrogen atoms have been replaced with a chlorine atom.
Part B permit	The second, narrative section submitted by hazardous waste generators in the RCRA permitting process. It details the procedures followed at a facility to protect human health and the environment.
pH	A measure of hydrogen ion concentration in an aqueous solution. Acidic solutions have a pH less than 7, basic solutions have a pH greater than 7, and neutral solutions have a pH of 7.
piezometer	Generally, a small-diameter, nonpumping well used to measure the elevation of the water table or potentiometric surface (an imaginary surface that represents the static head of groundwater and is defined by the level to which water will rise).
pollutant	Any hazardous or radioactive material present in an environmental medium, such as water or vegetation. For storm water, a pollutant is a material that can be mobilized in water, including (but not limited to) litter, soil, oil and grease, pesticides, and fertilizer.
pretreatment	Any process used to reduce a pollutant load before wastewater enters the sewer system.
pretreatment regulations	National wastewater pretreatment regulations (Title 40 CFR, Part 403) adopted by the EPA in compliance with the 1977 amendments to the Clean Water Act, which required that the EPA establish pretreatment standards for existing and new industrial sources.
priority pollutants	A set of organic and inorganic chemicals identified by the EPA as indicators of environmental contamination.
purgeable pollutants	Pollutants that can be removed from a sample by passing nitrogen gas through the sample.
radiation protection standard	Limits on radiation exposure regarded as necessary for protection of public health. These standards are derived based on acceptable levels of risk to individuals.
radiation	Energy emitted from the nucleus of an atom in the form of waves or particles.
radioactivity	The property or characteristic of a nucleus of an atom to spontaneously disintegrate accompanied by the emission of energy in the form of radiation.

radiological	Arising from radiation or radioactive materials.
radionuclide	An unstable nuclide. See nuclide and radioactivity.
recharge zone	An area of the ground in which surface water migrates to the groundwater.
remediation	See *environmental remediation.*
sanitary sewer system	A system that collects or conveys domestic and industrial wastewater off site. The SNL/California system connects to the LLNL sanitary sewer system, and the combined effluent then connects to the City of Livermore municipal sewer system. The effluent is treated at the Livermore Water Reclamation Plant.
scintillation cocktail	A solution of organic compounds that emits light upon interacting with radiation. For the purposes of this report, it is used primarily for the tritium analysis.
source	Any operation or equipment that produces and/or emits pollutants (e.g., pipe, ditch, well, or stack).
storm drain system	A collection of inlets, catch basins, channels, and trenches, which transport rain from paved areas on the SNL/California site to the Arroyo Seco.
storm water runoff	Rainfall on paved areas that flows over the ground surface.
terrestrial	Pertaining to or deriving from the earth.
terrestrial radiation	Radiation emitted by naturally occurring radionuclides, such as ^{40}K; the natural decay chains ^{235}U, ^{238}U, or ^{232}Th; or cosmic-ray-induced radionuclides in the soil.
thermoluminescent dosimeter	A type of dosimeter. After being exposed to radiation, the material in the dosimeter (lithium fluoride) luminesces upon being heated. The amount of light the material emits is proportional to the amount of radiation (dose) to which it was exposed. See also dosimeter.
tritium	A radionuclide of hydrogen with a half-life of 12.3 years. The very low energy of its radioactivity decay makes it one of the least hazardous radionuclides.
uncontrolled area	An area beyond the boundaries of a controlled area. See *controlled area.*
upgradient	Opposite of the direction of groundwater flow from a designated area of interest. Analogous to upstream.
uranium	A metallic element that is highly toxic and radioactive.
uranium, depleted	Uranium consisting primarily of ^{238}U and having less than 0.72 wt% ^{235}U. Except in rare cases occurring in nature, depleted uranium is man-made.
uranium, total	The amount of uranium in a sample, assuming that the uranium has the isotopic content of uranium in nature (99.27 wt% ^{238}U, 0.72 wt% ^{235}U, and 0.0057 wt% ^{234}U).

vadose zone The partially saturated or unsaturated region of the ground above the water table that does not yield water to wells.

wind rose A diagram that shows the frequency and intensity of wind from different directions at a particular place.

Zone 7 The common name for the Alameda County Flood Control and Water Conservation District. Zone 7 is the water management agency for the Livermore-Amador Valley with responsibility for water treatment and distribution. Zone 7 is also responsible for management of agricultural and surface water and the groundwater basin.

RADIOLOGICAL UNITS

becquerel (Bq) Unit of radioactive decay equal to one disintegration per second. (SI unit)

curie (Ci) Unit of radioactive decay equal to 2.22×10^{12} disintegrations per minute. (conventional unit)

millirem (mrem) Unit equal to 10^{-3} rem. See *rem.*

person-rem The unit of population dose, which expresses the sum of radiation exposures received by a population. For example, two persons, each with a 0.5-rem exposure, receive 1 person-rem, and 500 people, each with an exposure of 0.002 rem, also receive 1 person-rem.

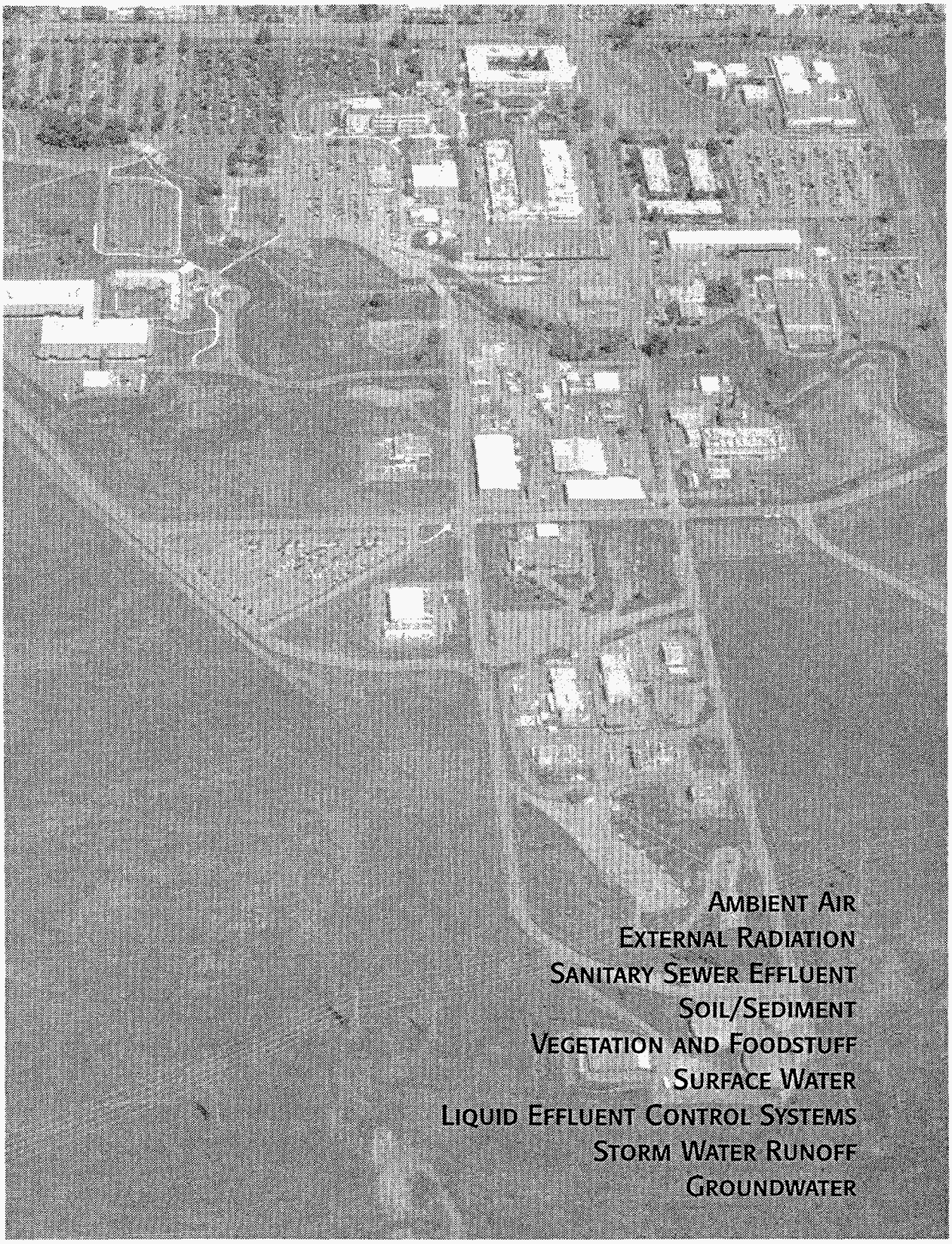
rad A unit of absorbed dose from ionizing radiation (0.877 rad/R).

rem Stands for roentgen equivalent man; a unit of ionizing radiation, equal to the amount of radiation needed to produce the same biological effect to humans as 1 rad of high-voltage x-rays. It is the product of the absorbed dose (rad), quality factor (Q), distribution factor, and other necessary modifying factors. It describes the effectiveness of various types of radiation in producing biological effects.

roentgen (R) A unit of radiation exposure that expresses exposure in terms of the amount of ionization produced by x or gamma rays in a volume of air. One roentgen (R) is 2.58×10^{-4} coulombs per kilogram of air.

sievert (Sv) A unit of radiation dose equivalent. The Sv is the SI unit equivalent to the rem. It is the product of the absorbed dose (gray), quality factor (Q), distribution factor, and other necessary modifying factors. It describes the effectiveness of various types of radiation to produce biological effects; $1\ Sv = Gy \times Q \times N = 100$ rem.

Appendix A — Laboratory Procedures



Ambient Air
External Radiation
Sanitary Sewer Effluent
Soil/Sediment
Vegetation and Foodstuff
Surface Water
Liquid Effluent Control Systems
Storm Water Runoff
Groundwater

SNL/California uses the Environmental Monitoring Laboratory of LLNL's Nuclear Chemistry Division for the analysis of radionuclides in environmental media (except which analysis is done by a commercial laboratory). The Environmental Monitoring Laboratory issued a quality assurance plan in April 1991. Submittal of the application for accreditation is planned for 1995, pending complete implementation of the quality assurance and quality control programs.

Chemical and physical analyses on LECS samples are done by a state-certified commercial laboratory.

For a commercial laboratory to be considered for use by SNL/California, it must be accredited by the State Department of Health Services.

Following is a brief synopsis of the analyses done on samples from each of the environmental media.

AMBIENT AIR

Tritium

LLNL samples—The silica gel is sent to the Environmental Monitoring Laboratory, where it is transferred from the collection flask to a plastic bag. It is thoroughly mixed, and an aliquot is taken for processing. The sample is then freeze-dried. The water removed is counted by liquid scintillation to determine the tritium concentration.

SNL/California samples—The silica gel is sent to a contract laboratory, where it is thoroughly mixed and an aliquot is taken for processing. The moisture on the silica gel is removed by azeotropic distillation with toluene. An aliquot of the distillate is then counted by liquid scintillation to determine the tritium concentration.

EXTERNAL RADIATION

The dosimeters collected by LLNL are processed by LLNL's Hazards Control Department, using automated equipment. The dosimeters are received from the Monitoring Group and stored in a lead shield until they are processed.

The dosimeters collected by SNL/California personnel are processed by the Health Instrumentation Department at SNL/New Mexico. These dosimeters are also stored in a lead shield before processing.

SANITARY SEWER EFFLUENT

Tritium

Sewer samples are distilled in preparation for tritium counting. SNL/California's Health Physics organization does the counting by liquid scintillation.

Other Analyses

The metals and organics samples are sent to a State-certified, commercial laboratory, where they are processed in accordance with EPA protocols. The analyses performed on sanitary sewer effluent samples are EPA method 624 (volatile organics), EPA method 625 (semivolatile organics), EPA method 608 (pesticides), metals (As, Cd, Cr, Cu, Pb, Hg, Ni, Ag, Zn), oil and grease, chemical oxygen demand, biological oxygen demand, cyanide, total dissolved solids, total suspended solids, and pH.

SOIL/SEDIMENT

Tritium in Arroyo Sediment

A portion of the sediment is sent to the Environmental Monitoring Laboratory, where it is freeze-dried. The water removed is then analyzed for tritium activity by liquid scintillation counting.

Surface Soils

The surface soil samples are sent to the Environmental Monitoring Laboratory, where they are analyzed for various radioactive constituents. The only parameter of concern to SNL/California is

uranium, which is determined by gamma spectrometry.

VEGETATION AND FOODSTUFF

All vegetation and foodstuff samples are processed by the Environmental Monitoring Laboratory.

Tritium in Vegetation

An aliquot of the vegetation is freeze-dried, and the water removed is analyzed for tritium activity by liquid scintillation counting.

Tritium in Wine

An aliquot of wine is passed through a Peterson furnace to oxidize all the organic matter in the wine to water. This water is then passed through a gas conversion furnace, which converts the water to hydrogen gas. The hydrogen gas is then analyzed for tritium activity by introducing it into an internal gas proportional counter. Alternatively, the wine may be purged with an inert gas and allowed to decay for a period of time. Then the ^{3}He (the decay product of tritium) is measured by mass spectrometry and used to calculate the tritium concentration.

SURFACE WATER

These samples are processed by the Environmental Monitoring Laboratory.

Low-tritium Water

Water that is expected to have very low tritium content (such as certain surface water and well water) is processed by electrolytically concentration the tritium content of the water (enriching). The water is then analyzed for tritium activity by liquid scintillation counting.

High-tritium Water

Because this water contains higher levels of tritium, electrolytic enrichment is not necessary. This water is distilled under an argon atmosphere and then is analyzed for tritium content by liquid scintillation.

LIQUID EFFLUENT CONTROL SYSTEMS

Metals

Samples are sent to a state-certified commercial laboratory.

Metals analyses are performed by Inductively Coupled Plasma-Atomic Emission Spectra (ICP-AES) in accordance with internal Environmental Protection Department procedures, which are compatible with applicable EPA procedures.

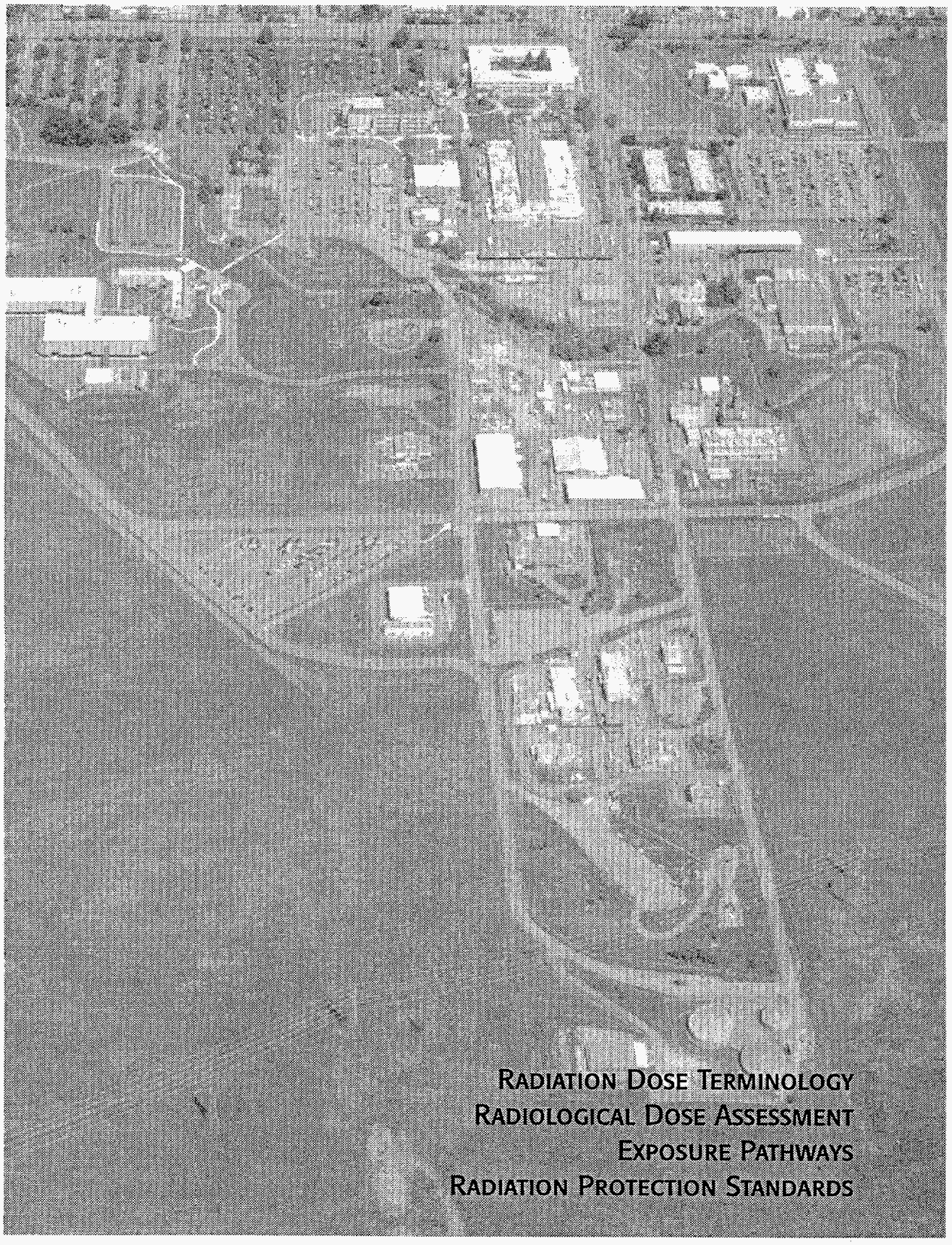
STORM WATER RUNOFF

Samples are sent to a State-certified, commercial laboratory, where they are processed in accordance with EPA protocols. The analyses performed on storm water runoff samples are EPA method 608 (pesticides), EPA method 624 (volatile organics), EPA method 625 (semivolatile organics), metals (As, Cd, Cr, Cu, Pb, Ni, Ag, Zn), pH , total suspended solids, specific conductivity, oil and grease. SNL/California performed the tritium analyses.

GROUNDWATER

Groundwater samples are analyzed by a State-certified commercial laboratory. The samples are processed in accordance with EPA protocols. The analyses performed on groundwater samples are EPA method 624 (volatile organics), EPA method 625 (semivolatile organics), CCR Title 22 organics, metals (As, Ba, Be, Cd, Cr, Pb, Se, Ag), gross alpha, gross beta, and tritium.

APPENDIX B – RADIOLOGICAL DOSE ASSESSMENT



RADIATION DOSE TERMINOLOGY
RADIOLOGICAL DOSE ASSESSMENT
EXPOSURE PATHWAYS
RADIATION PROTECTION STANDARDS

This appendix explains radiation dose terminology, describes the methods used to calculate radiation doses to the public, and provides the specific models used in the 1995 dose assessment.

RADIATION DOSE TERMINOLOGY

Internal and External Radiation Doses

A person's radiation dose from an external (penetrating) radiation source is received only while the individual is exposed to the source. However, if radioactive material is taken into the body, the dose will continue even after the intake has ceased. The body can intake radioactive materials primarily three ways:

- ingestion of the radioactive material in food or drinking water,
- inhalation of airborne radioactive particulates or vapors, and
- absorption of the radionuclide through the skin.

Following an intake, radioactive material is distributed throughout the body according to how it is metabolized. Consequently, organs will continue to absorb energy emitted by the radionuclides remaining in the body.

The dose rate to organs will diminish over time because of radioactive decay and biological elimination. Because the body rapidly eliminates some materials, like tritium, exposure to radioactivity following intake is brief. Also, some radionuclides decay rapidly (have short half-lives), thereby minimizing exposure.

Absorbed Dose and Dose Equivalent

The absorbed radiation dose is defined as the quantity of radiation energy absorbed by an organ, divided by the organ's mass. The SI unit for absorbed dose is the gray (Gy). An organ receives an absorbed dose of 1 Gy when it absorbs 1 joule (J) of radiation energy per kilogram (kg) of its mass (1 Gy = 1 J/kg). The conventional unit of absorbed dose is the rad (100 rad = 1 Gy).

The measure of absorbed dose is independent of the type of radiation (alpha particles, beta particles, gamma rays, or neutrons). Different types of radiation cause different levels of damage to human tissue, based on the rate of energy deposition.

The dose equivalent takes into account the type of radiation involved in the exposure. The dose equivalent is calculated by multiplying the absorbed dose by a quality factor specific to the type of radiation.

The International Commission on Radiological Protection (ICRP) has recommended specific quality factors for the radiation types most relevant to this report. DOE has adopted these quality factors, which are listed below, in DOE Order 5400.5:

- Gamma rays: 1
- Beta particles, other electrons: 1
- Alpha particles: 20

The committed dose equivalent is the predicted total dose equivalent to a tissue or organ over a 50-year period after a known intake of a radionuclide into the body. Fifty years is the approximate residual life expectancy of a young adult.

The SI unit of dose equivalent and committed dose equivalent is the sievert (Sv). The conventional unit, used in this report, is the rem (100 rem = 1 Sv).

Effective Dose Equivalent

The effective dose equivalent (EDE) combines the dose equivalents received by all organs or tissues into a single weighted sum. The EDE is defined as the sum of all organ dose equivalents after each one has been multiplied by an appropriate weighting factor. The weighting factors were developed by the ICRP. They express the fractional risk of a stochastic health effect associated with the dose equivalent to that organ. DOE adopted the ICRP weighting factors (Wt) in DOE

Order 5400.5. The EPA has accepted these factors for calculating radiation dose for determining compliance with the Clean Air Act (Title 40 CFR, Part 61, Subpart H).

The EDE combines the individual organ or tissue dose equivalents into a single risk-weighted sum. EDEs can be added to determine the total risk from exposure to several radionuclides. When external radiation sources, such as an airborne plume, expose the whole body uniformly, the external EDE is added to the EDE from internal exposures.

The committed effective dose equivalent refers to the total EDE that is accumulated over a 50-year period following a single intake.

Collective Effective Dose Equivalent

Collective dose is the sum of individual doses received by all members of a population. In this report, the average individual EDE is used to calculate the collective dose for the population within a 50-mile radius. The unit of collective EDE is the person-rem or person-sievert (person-Sv).

RADIOLOGICAL DOSE ASSESSMENT

This section presents the methods, assumptions, and calculations used to assess routine radiological exposures from each significant environmental pathway. It covers routine operations involving uniform releases to the environment and is not intended for assessing consequences from accidents.

SNL/California annually assesses radiologic impacts of site operations on the public. This assessment is done in accordance with DOE- and EPA-approved methods. The results are published and made available to the general public each year in the SNL/California *Site Environmental Report.*

The radiological impacts from SNL/California operations are assessed by determining the radiologic dose to members of the public who would receive maximum credible exposures. This assessment involves the following:

- measuring radioactive emissions from SNL/California,
- identifying all relevant exposure pathways,
- evaluating environmental transport and fate of contaminants, and
- estimating human intake and resulting dose.

In most cases, the amount of radioactive material emitted by SNL/California is too small for radiologic doses to be determined from direct measurements of radionuclide concentrations in environmental media. That is, it is not always possible to discriminate between Sandia's contribution to radiation in the environment and natural background sources of radiation. Also, because Sandia is located adjacent to LLNL, the monitoring system cannot always differentiate the emissions from the two sites. Therefore, off-site doses are calculated based on radioactive effluent measurements at the point of discharge from the facility. Environmental transport and exposure pathway computer models are used to estimate radionuclide concentrations in various environmental media at locations accessible to the public. Dosimetric models then are applied to determine human intake and to convert intake to dose.

Radiological doses are expressed in terms of EDE. The method used to calculate EDEs applies the dosimetric parameters recommended by the ICRP in Publications 26 (1977) and 30 (1980).

Doses from the air pathway also are calculated and reported to demonstrate compliance with the Federal Clean Air Act NESHAPs Rule for Radionuclides (Title 40 CFR, Part 61). These doses are calculated using the Clean Air Act Code, which contains models (AIRDOS-EPA and RADRISK) approved by the EPA for calculating atmospheric transport and exposure. Under the Clean Air Act, the

EPA assumes jurisdiction over radionuclides emitted to the atmosphere, i.e., the air pathway. The air pathway dose includes radiological dose from immersion, inhalation, and ingestion, resulting from radionuclides emitted to the atmosphere. Population exposure is converted to radiation dose using the dose conversion factors and weighting factors specified by the EPA.

EXPOSURE PATHWAYS

Figure B-1 simplistically represents the important pathways of radioactivity released to the environment. Based on the environmental pathway analysis for SNL/California and the land use characteristics on and around the site, the following doses are calculated:

- external (direct) dose at the site boundary;
- inhalation from the air pathway and submersion from plume passage; and
- ingestion from consumption of locally produced foodstuffs and drinking water.

SNL/California has no operations that discharge liquid effluents to surface water or to the ground. These doses are determined at the point of maximum exposure in uncontrolled areas, i.e., publicly accessible locations. The doses are compared to DOE and EPA radiation protection standards. Each of the doses used to evaluate the radiological impact from SNL/California operations is described briefly below.

External "Fence-Line" Dose

The fence-line dose rate is a measure of the maximum external radiation dose at locations of nearest uncontrolled public access.

The dosimeters measure dose rates from all external radiation sources, including cosmic radiation, radioactivity that occurs naturally in the environment, fallout from nuclear weapons testing, and any contributing from SNL operations. In most cases, the dose rates are a measure of regional background, as shown by comparing the perimeter measurements to those made at off-site locations (in the Livermore Valley). Moreover, these measurements are made at points of maximum exposure and assume an occupancy of 24 hours a day, 365 days a year. No member of the public actually resides at these locations for extended periods of time; therefore, these estimates are conservative.

Inhalation/Submersion Dose

Air pathway doses are calculated for each airborne radioactive discharge to the atmosphere. Inhalation/submersion doses are calculated at the site perimeter, at the location of the nearest resident,

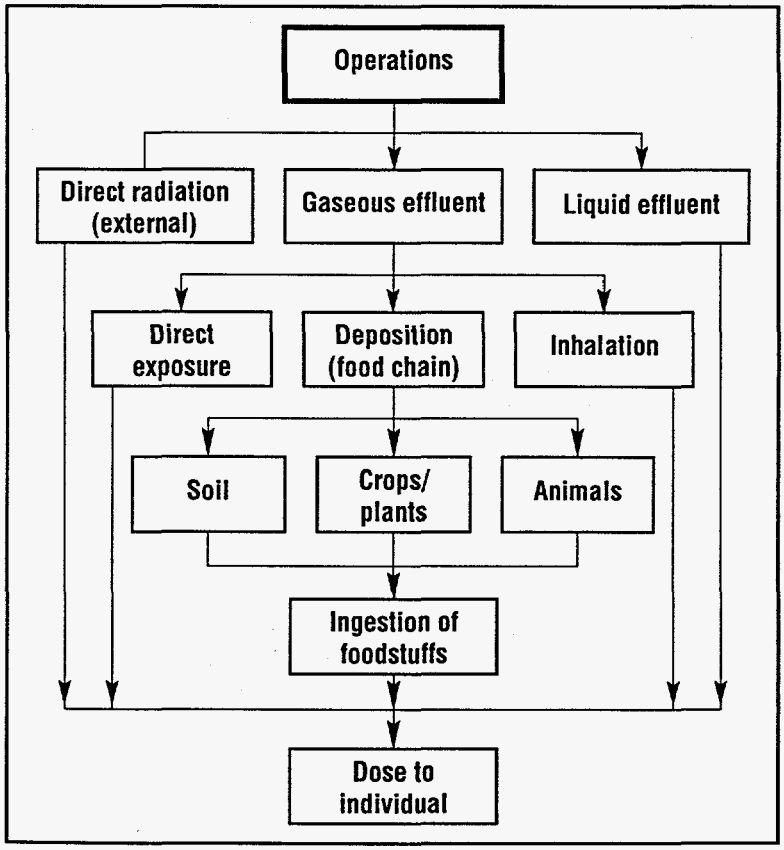


Figure B-1. Major radiation exposure pathways to humans.

and at the point of maximum off-site exposure. The amount of radioactivity released by SNL/California is usually too low for radionuclide concentrations in ambient air to be measured accurately and for dose to be determined. Therefore, environmental transport and exposure pathway models are used to calculate potential dose resulting from effluent emissions (measured at the Tritium Research Laboratory stack). The two methods used comply with both DOE standards and NESHAPs.

The atmospheric transport of radioactive materials from SNL/California is calculated based on source term and meteorological conditions. Meteorological factors (wind speed, direction, and atmospheric stability) are measured continuously at a monitoring station on the SNL/California site. Atmospheric observations are collected at two tower levels (10 m and 40 m). Because the 30-m Tritium Research Laboratory stack is being modeled, the corresponding 40-m tower data are used.

Ingestion Dose

Potential doses from ingestion of locally produced foodstuff and surface water are based on actual measurements of radionuclide concentrations in the various media (determined by sample analysis). Conservative exposure data and current ICRP dosimetric factors are used to estimate doses to the individual. Field measurements are used to assess tritium in water, milk, and vegetation (which includes the forage-cow-milk pathways).

RADIATION PROTECTION STANDARDS

SNL/California conducts its operations in accordance with applicable Federal, State, and local environmental laws and regulations. In addition, the DOE has established radiation protection standards for the public and the environment, which are contained in DOE Orders pursuant to the Atomic Energy Act.

Radiation protection standards for the public have been established by the DOE to protect public health. Protection of the public is accomplished by limiting radiation doses received by individuals residing in uncontrolled areas (i.e., areas accessible to the public) resulting from DOE operations. In other words, these standards are based on acceptable risk to members of the public.

All Pathways (DOE Order 5400.5)

Environmental protection program requirements for DOE operations are established in DOE Order 5400.1, *General Environmental Protection Program.* Radiation protection standards are provided in DOE Order 5400.5, *Radiation Protection of the Public and the Environment.* Order 5400.5 limits the annual EDE to any member of the public to 100 mrem/year (1 mSv/yr.). This limit is based on the dose to the maximally exposed individual in an uncontrolled area from all emission sources and all exposure pathways. It is consistent with the recommendations of the International Commission on Radiological Protection and the National Council on Radiation Protection and Measurements. The DOE derived concentration guide lists concentrations of radionuclides in water and air that could be continuously consumed or inhaled (365 days/yr.) and not exceed the DOE primary radiation protection standard to the public (100 mrem/yr. effective dose equivalent).

In addition to these quantitative standards, the overriding DOE policy is that exposures to the public and emissions to the environment shall be main-

tained as low as reasonably achievable (ALARA).

Air Pathway Only (Clean Air Act, Title 40 CFR, Part 61)

DOE facilities are also required to comply with EPA standards for radiation protection. On December 15, 1989, the EPA issued its final NESHAPs Rule for Radionuclides. This Rule mandates that air emissions from DOE facilities shall not cause any individual in the public to receive in any year an EDE of greater than 10 mrem (0.1 mSv).

Drinking Water Pathway Only (Title 40 CFR, Part 141, DOE Order 5400.5)

Radionuclide concentrations in DOE-operated public drinking water supplies shall not cause persons consuming the water to receive an effective dose equivalent greater than 4 mrem (0.04 mSv) in a year. DOE activities shall not cause private or public drinking water systems downstream of the facility discharge to exceed the radiological drinking water limits in Title 40 CFR, Part 141.

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