SANDIA REPORT

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Site Environmental Report for 1996

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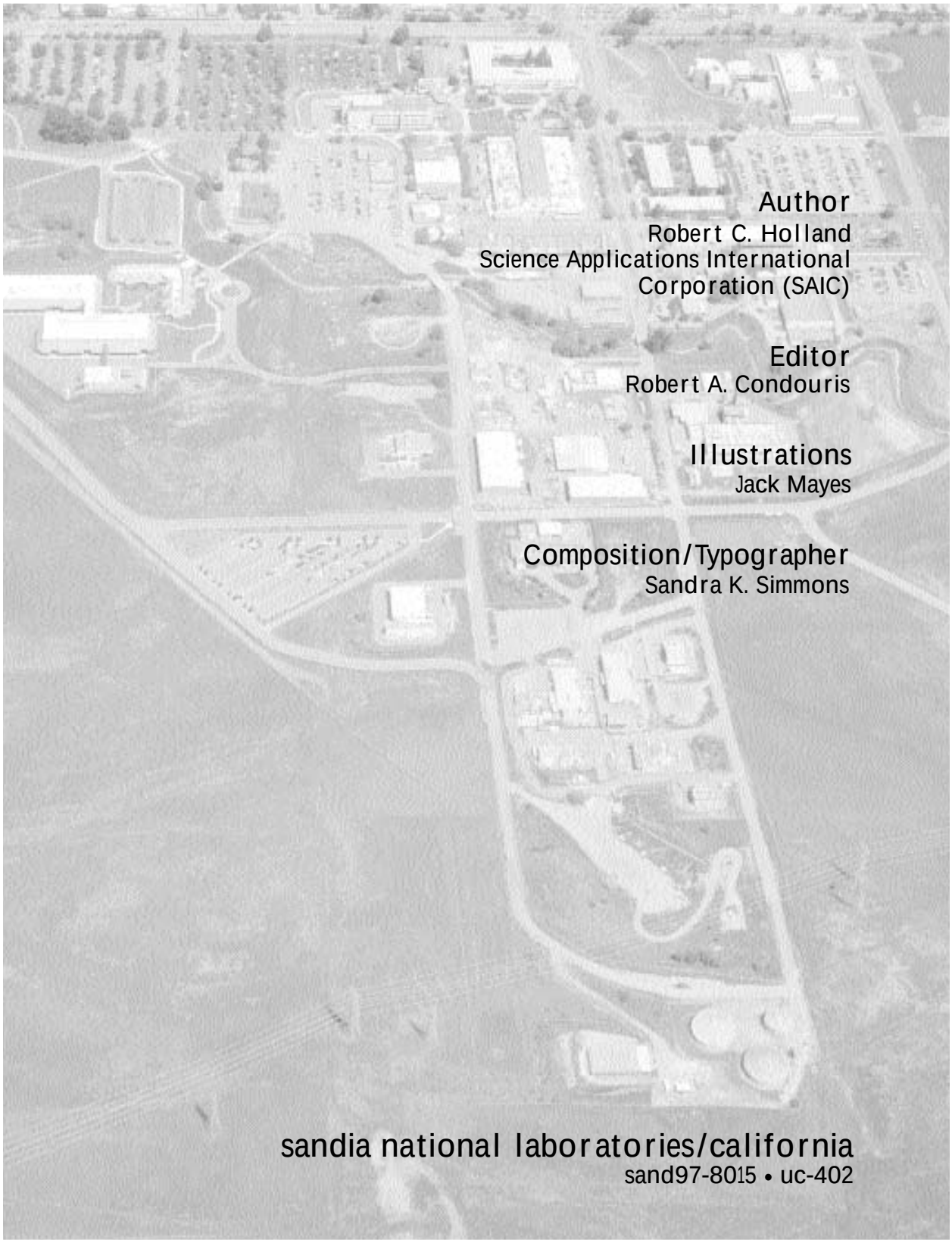

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Preface

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. 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.

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.1 To implement this program, SNL/California has developed a formal public participation program. This pro-

gram 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.

References

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

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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 1996 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 in the past 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/California is continuing to use this facility for nonnuclear laboratory operations.

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 1996, airborne contaminant concentrations measured at the Livermore site perimeter* and nearby

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

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 4.2 pCi/m^3 (1.6×10^{-1} Bq/m^3).** This level represents 0.004% 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 1.8 pCi/m^3 (6.7×10^2 Bq/m^3).

LLNL discharges small quantities of tritium to the atmosphere as a result of routine operations and clean-up activities. SNL/California no longer discharges tritium; consequently, the tritium measured in ambient air can be attributed to operations at LLNL 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 1996, 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 February 24, 1996, was above the discharge limit for zinc. A wastewater sample collected at the site outfall at various times in August and September 1996, showed a pH level below 5. 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 1996, all the liquid effluents from these processes complied with pretreatment discharge standards for metals and organic pollutants.

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 1996, no radionuclides were discharged to the sanitary sewer system in detectable amounts.

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 1996, 108 pCi/L (4.0 Bq/L), was 0.5% of the California Environmental Protection Agency's (Cal/EPA) drinking water standard for tritium in public drinking water (20,000 pCi/L).[3] Furthermore, all surface water samples collected in 1996 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.

** *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.*

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 1996 was 499 pCi/L (18.5 Bq/L) at the LLNL Salvage Yard. This value represents 2.5% 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 1996, 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.

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 1996 sampling. Analyses for the first two storms 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 1996, 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.

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 1996, the average annual dose , equivalent from external radiation measured at the Livermore site perimeter was 55 mrem (0.55 mSv). This level was essentially the same as the background radiation dose measured off-site: 54 mrem (0.54 mSv). These measurements demonstrate that no measurable external dose was due to direct radiation from Livermore site operations during 1996. That is, if a person had resided at the site fence line 24 hours a day, every day in 1996, 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 1996 was tritium. During clean-up operations at the former Tritium Research Laboratory 0.078 Ci (2.9×10^9 Bq) tritium was discharged to the atmosphere. The amount of tritium released from SNL/California in 1996 was the lowest on record since the Tritium Research Laboratory became fully operational. Figure 1-1 shows the total annual tritium discharges from SNL/California during 1987-96. The chart shows a general downward trend in tritium emissions over the past 10 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 1996. Tritium releases during this period were due solely to cleanup activities in the Tritium Research Laboratory.

The maximum potential radiation dose to a resident in an unrestricted (i.e., publicly accessible) area resulting from SNL/California operation in 1996 was 1.09×10^{-5} mrem (1.0×10^{-7} 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 1.09×10^{-5}% of the DOE allowable limit for protection of the public (100 mrem effective dose equivalent from all sources and all pathways) and 1.09×10^{-4}% of the allowable limit of 10 mrem from the air pathway.[2] 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

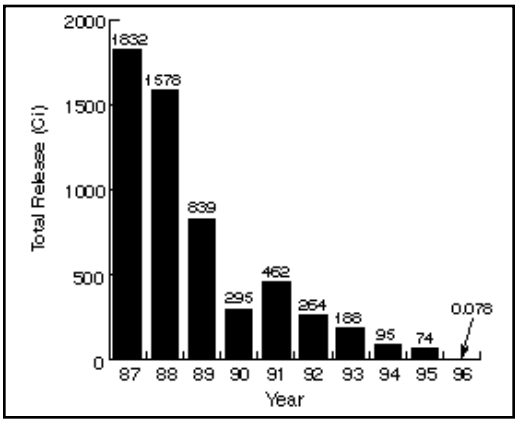


Figure 1-1. Annual airborne tritium discharges from SNL/California, 1987–96.

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 1.09×10^{-5} mrem in perspective, it is approximately 33,000,000 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.

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 1996 were well within regulatory standards (except for two wastewater discharge limit exceedances—see Chapter 4). For details of SNL/California's compliance record, see Chapter 3. It summarizes SNL/California's compliance with applicable environmental statutes and regulations for 1996 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).

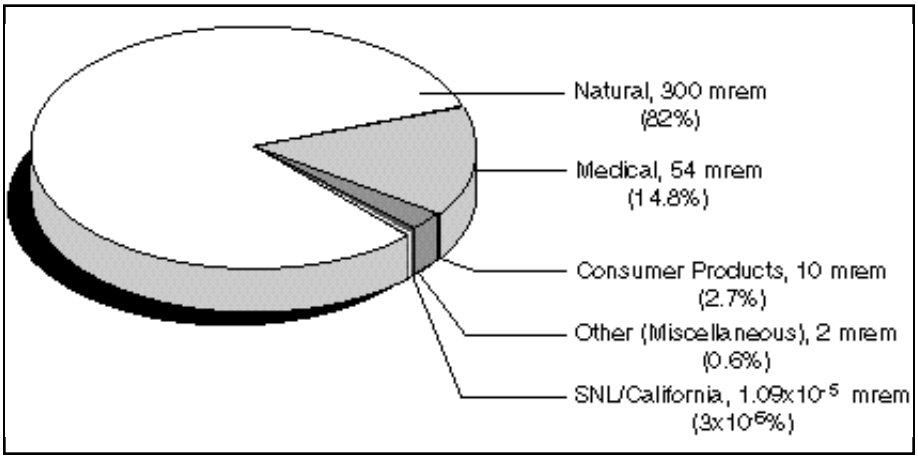
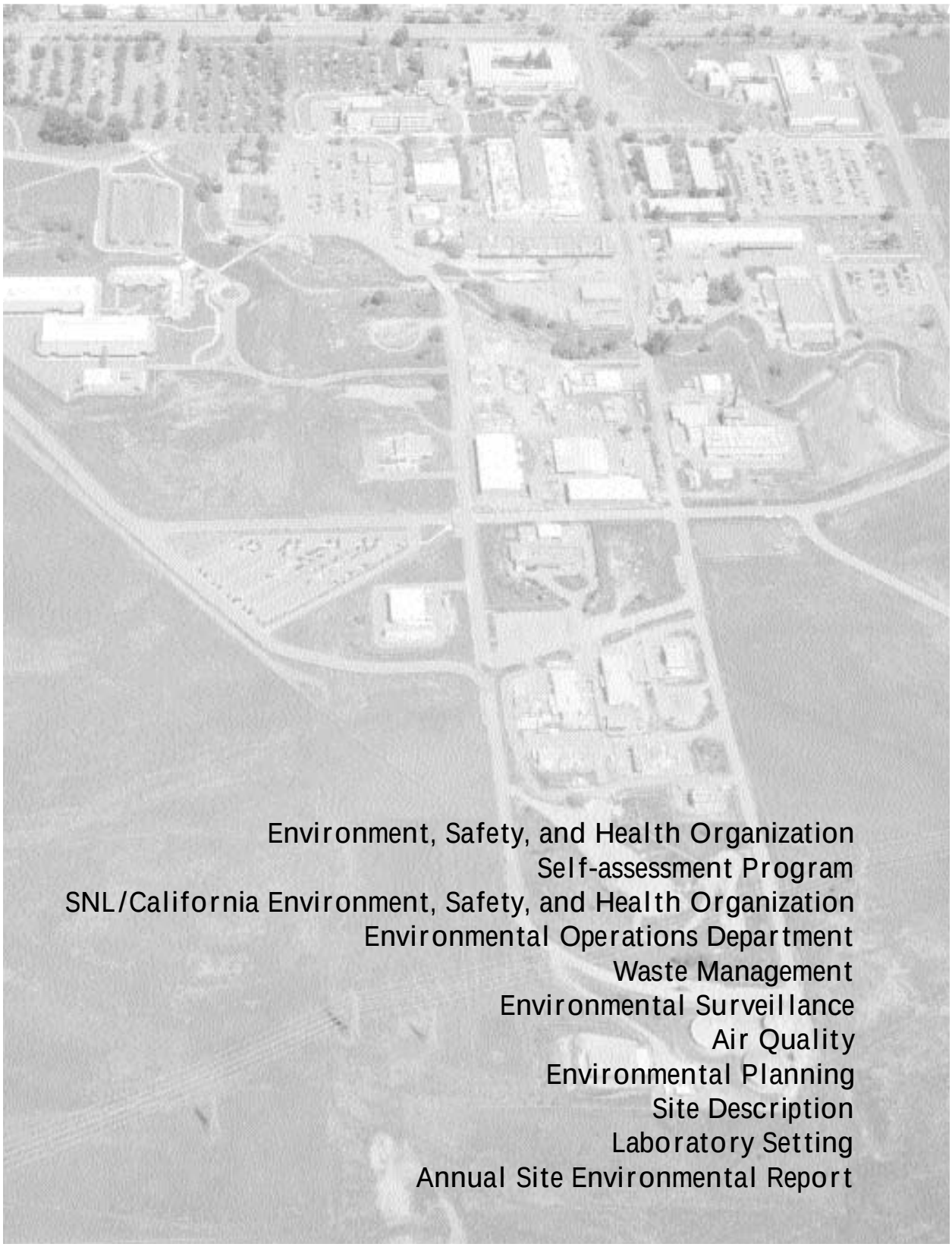


Figure 1-2. Typical radiation doses received by the general public and the maximum contribution from SNL/California.

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, SAND93-8011B (February 1997).



Environment, Safety, and Health Organization
Self-assessment Program
SNL/California Environment, Safety, and Health Organization
Environmental Operations Department
Waste Management
Environmental Surveillance
Air Quality
Environmental Planning
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 counter proliferation (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 Sandia/California ES&H Council (SCEC). The SCEC 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 SCEC 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 ES&H departments provide oversight of management-related ES&H activities and provides direct ES&H assurance information to the SNL/California vice president. The departments ensure uniform implementation of corporate ES&H management processes through the use of organizational ES&H coordinators. Additionally, the departments conduct 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 ES&H Performance Indicator Program establishes a set of quantitative measures for the DOE to use in evaluating and tracking SNL's ES&H performance at the corporate level.

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.

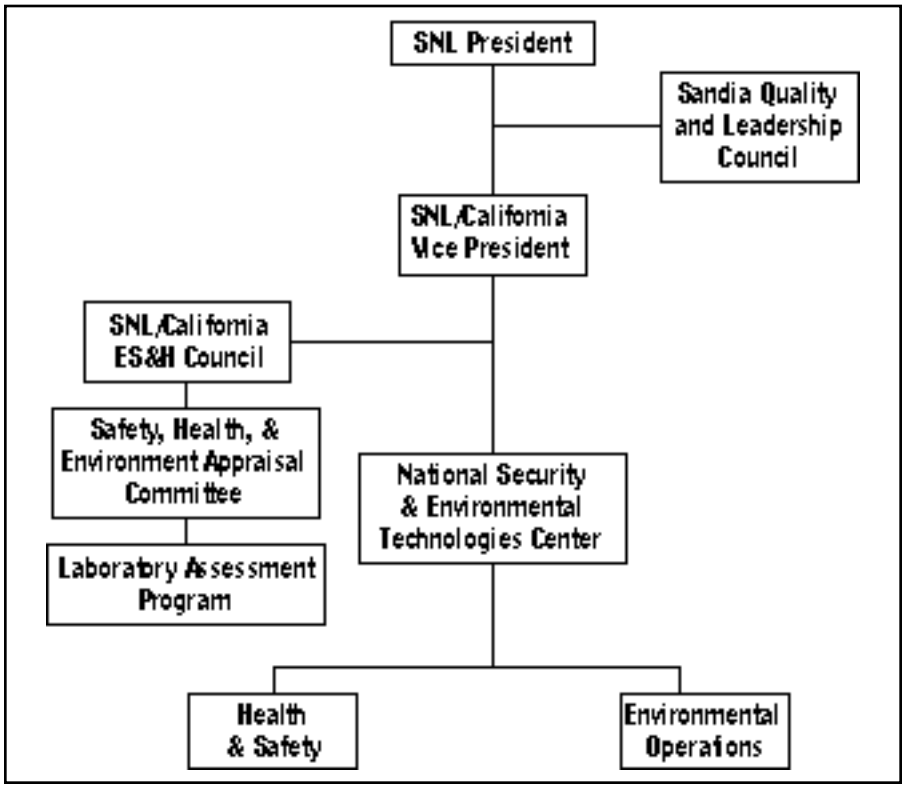


Figure 2-1. FY96 Organizational structure of environment, safety, and health at SNL/California.

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 Operations Department 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, 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, and the Radioactive and Mixed Waste Storage Facility. In addition, the group manages the permitting of three on-site netralization facilities that are regulated under "tiered permitting."

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,

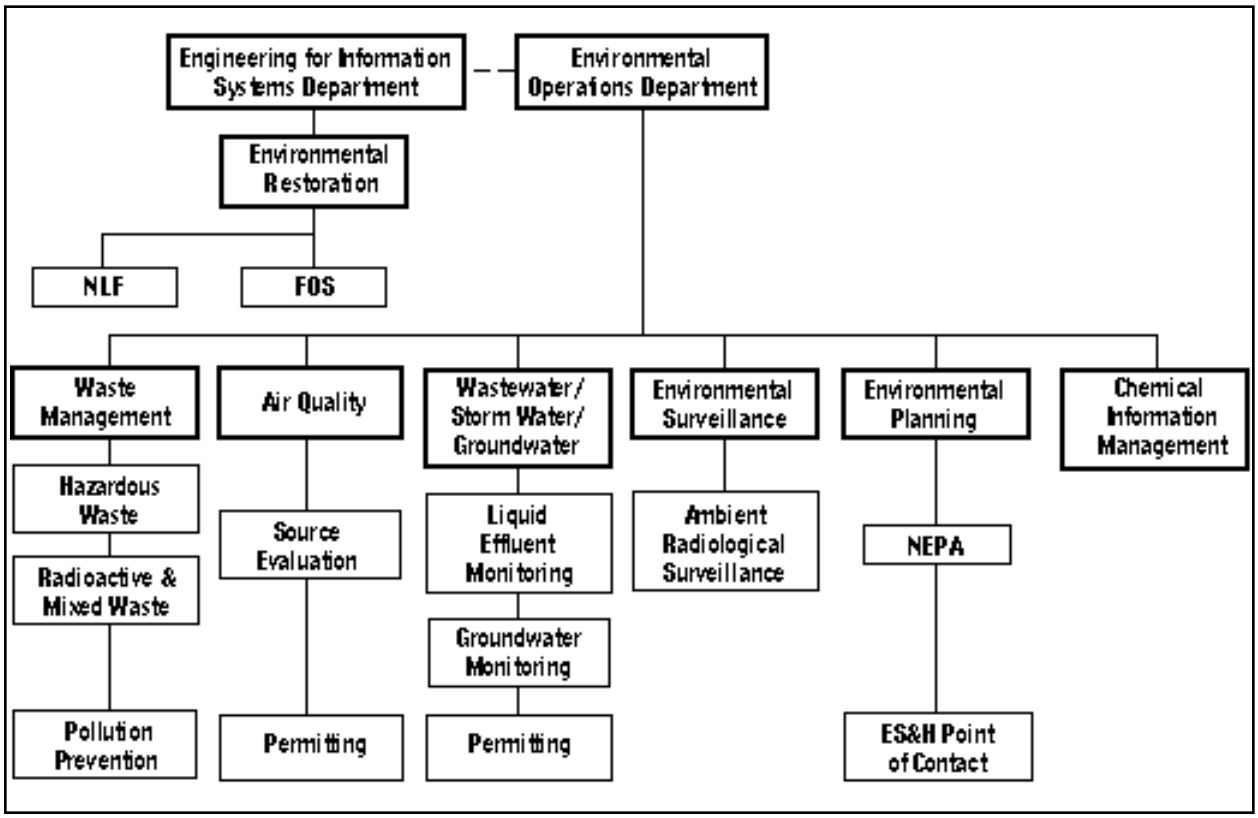


Figure 2-2. Organizational structure of the Environmental Operations Department.

- 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.

Environmental Surveillance

The Environmental Surveillance Group at SNL/California assesses potential impacts to the public and the environment from site operations. The group is responsible for ensuring that SNL/California complies with Federal, State, and local regulations and with DOE orders governing protection of the environment. Specifically, environmental surveillance personnel maintain a direct radiation monitoring system, and 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 also performs computer modeling of potential emissions to document compli-

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

ance with these regulations. 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

The Chemical Information Management 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 (MSDS). 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. The system includes 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, security, and communication 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 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.

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 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.

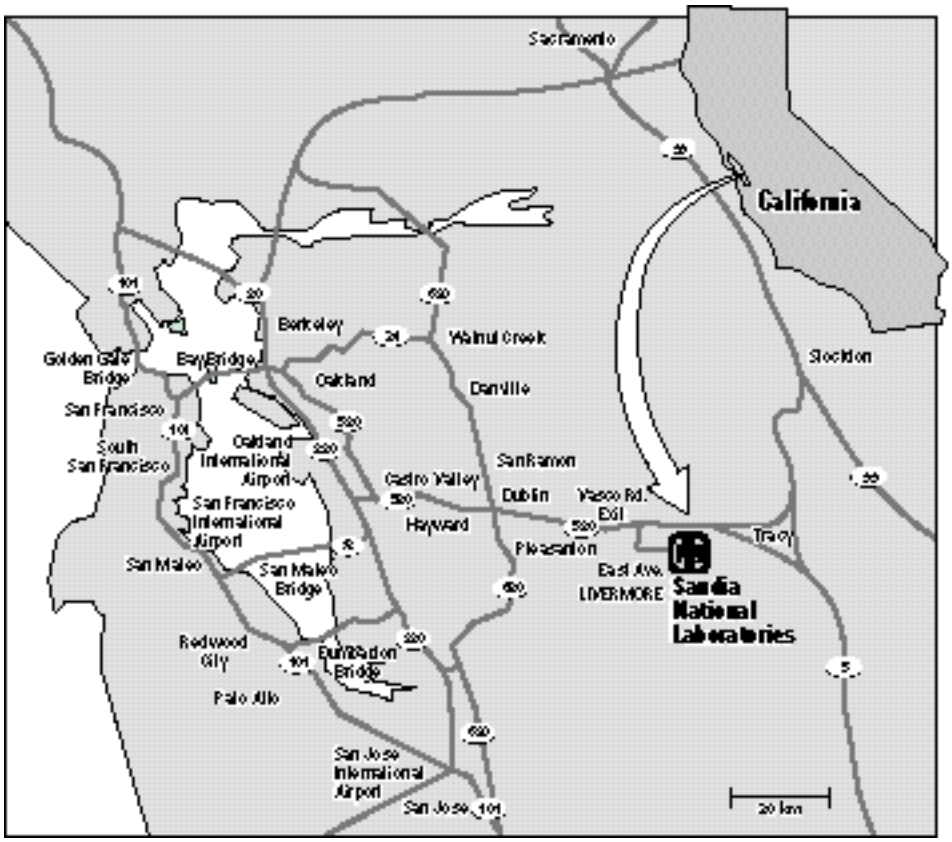


Figure 2-3. SNL/California in a regional setting.

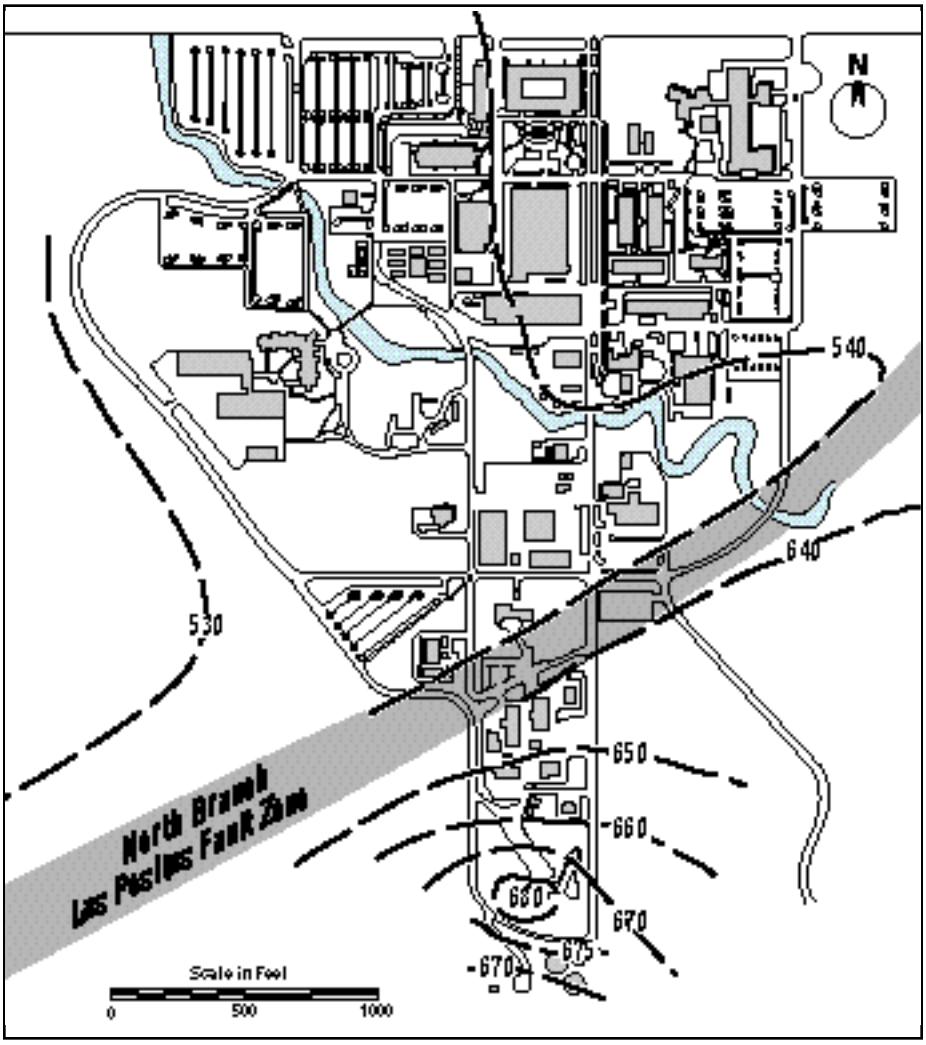


Figure 2-4. Ground contours at SNL/California.

Precipitation at the SNL/California site for calendar year 1996 was 45.6 cm (17.95 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 1996 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 non-native 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 applic-

able environmental requirements. It is prepared according to the requirements of DOE Order 5400.1.[1]

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.

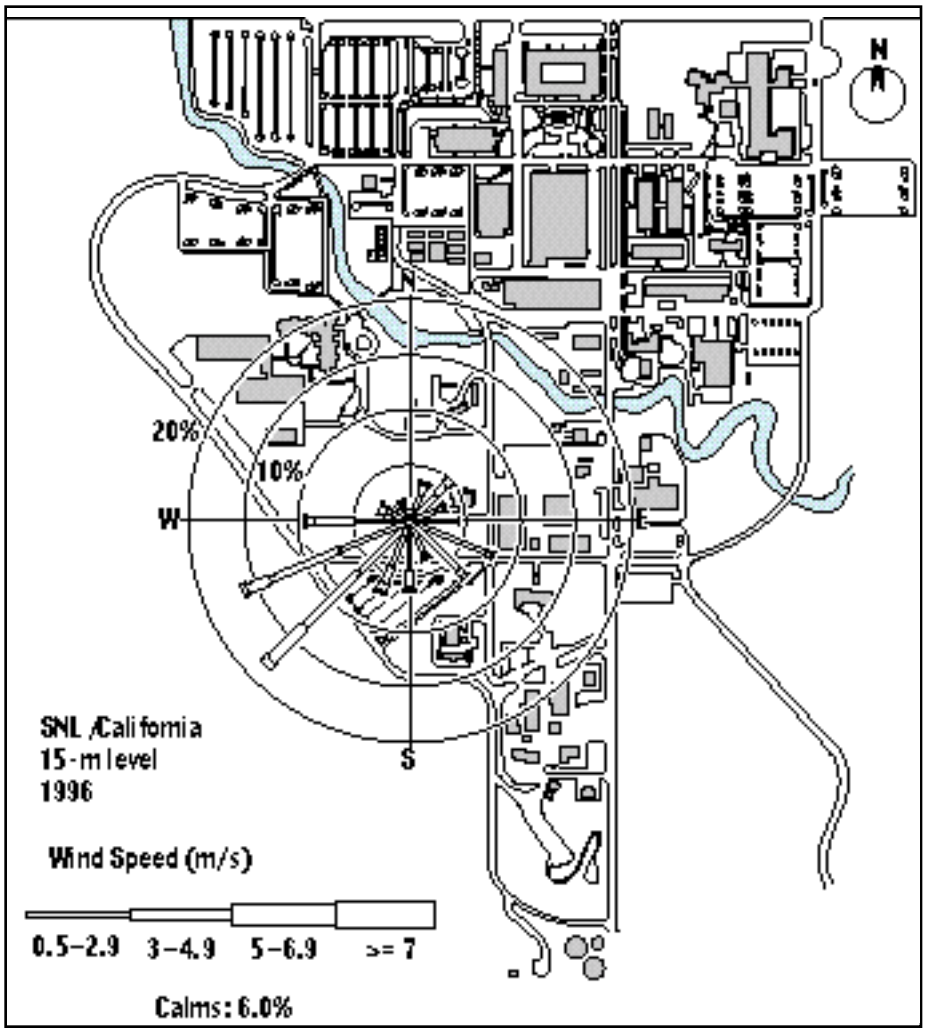
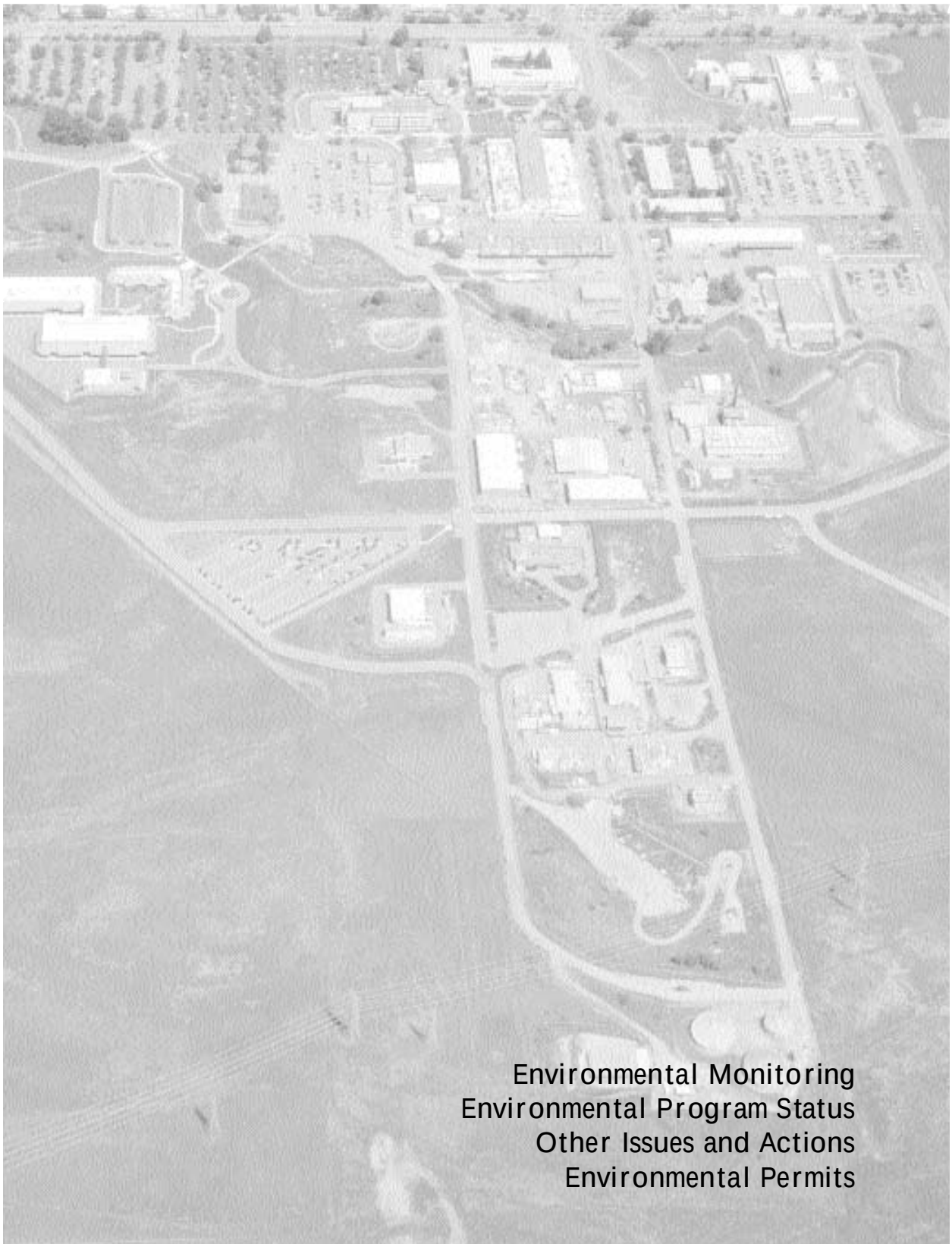


Figure 2-5. Wind rose showing the average annual wind direction and speed during 1996.

References

1. U.S. DOE, Order 5400.1, *General Environmental Protection Program* (November, 1988, Change 1, 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 1996. It also discusses current environmental management programs. The compliance activities at SNL/California are administered by the Environmental Operations Department.

Environmental Monitoring

The Environmental Operations Department at SNL/California maintains an environmental surveillance program to verify the effectiveness of emission control procedures and to measure directly 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 1996 demonstrate compliance with EPA and DOE standards.

The environmental monitoring data collected in 1996 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 1996 was the lowest amount since the Tritium Research Laboratory became fully operational. A total of 0.078 Ci (2.9×10^3 MBq) tritium was discharged to the atmosphere. Of this amount, virtually all was in the form of tritium oxide (HTO or T_2O). 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 1996, the maximum potential dose at a publicly accessible location was 1.09×10^{-5} mrem (1.09×10^{-7} mSv) effective dose equivalent. This small dose is 1.09×10^{-5} % of the DOE radiation protection standard, and about 33 million 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 1996, 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, storing, and shipping energetic, radioactive, mixed, and nonradioactive hazardous waste for offsite shipment. All SNL/California wastes are shipped offsite for treatment, storage, or disposal. No wastes are disposed at the SNL/California site premises.

Treatment performed onsite consists of: waste compaction to reduce volume, elementary neutralization, encapsulation of some low-level radioactive waste streams, and consolidation/commingling of various low-volume waste streams at the Hazardous Waste Storage Facility for offsite shipment.

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, independent from the waste management group.

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.

Low-Level Radioactive Waste Program

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

The majority of low-level waste management efforts in 1996 involved preparing for shipments of low-level radioactive waste to the Nevada Test Site. Much of this waste was generated during research and development projects over the last 4 years, including final transition of the Tritium Research Laboratory to other uses.

The DOE Nevada Operations Office audited the SNL/California low-level radioactive waste management program in July 1996 and September 1996. Based on the results of these reviews, SNL/California was granted provisional approval to ship additional low-level radioactive waste streams to the Nevada Test Site. Upon fulfillment of the remaining provisions, 1997 shipments should reduce the approximately 50 m^3 of low level waste currently stored onsite to a minimum.

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 onsite to the SNL/New Mexico site, with the exception of liquid scintillation counting wastes, which are shipped to a treatment facility. SNL/California successfully completed the shipment of all stored mixed waste by March 1995. Legacy sources of mixed-waste generation accounted for another shipment to SNL/New Mexico in 1996 of less than 0.1 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 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 1996: the Fuel Oil Spill, the Navy Landfill. 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) with-

drawal 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). During 1996, injection and wthdrawal cycles continued, ending with the third injection phase, which ran from September 24 through December 12, 1996. 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]

Currently, the Regional Water Quality Control Board, DOE, and SNL/California staff are investigating the possibility of declaring the Navy Landfill inert. In August 1996, the DOE submitted to the Regional Board a request for Inert Classification. The DOE and SNL/California are requesting that the Navy Landfill be categorized as containing only inert waste and, therefore, not subject to the closure requirements in CCR Title 23, Chapter 15, Article 8. The data presented in the request support the conclusions that 1) the Navy Landfill contains only inert waste, 2) the Navy Landfill waste is not degrading the quality of groundwater, and 3) the Navy Landfill in its current state does not pose a threat to the public health or environment.

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 1996, 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 1996, SNL/California had no reportable substances under Section 313, Toxic Release Inventory. During 1996, no incidents occurred at SNL/California, that required notification under Sections 302-303.

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 1996, 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 one occasion, the sanitary sewer effluent exceeded the site's discharge limits for zinc.

Wastewater samples collected at the site outfall on February 24, 1996, showed a zinc concentration of 21.0 mg/L. The discharge limit for zinc is 3.0 mg/L. The concentration of zinc in the site sewer effluent on this date was 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 at various times in August and September showed a pH level below 5. The Wastewater Discharge Permit prohibits discharges with pH less than 5 or greater than 10. SNL/California notified the City of Livermore, as required by the Wastewater Discharge Permit. However, investigations by SNL/California concluded that low flow conditions, which coincided with the low pH concentrations caused the probe to become dry resulting in inaccurate readings. The City of Livermore issued a memo stating that the Notice of Violation was not warranted for the reported August exceedance. The City of Livermore will document the violation in their reports to the Regional Water Quality Control Board with a footnote explaining that subsequent investigations by SNL/CALIFORNIA indicated an equipment problem rather than an actual violation.

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 one metal finishing categorical processes subject to the EPA's pretreatment standards for point sources (Title 40 CFR, parts 403 and 433).[7,8] This one process, is the Printed Wiring Facility located in Building 910. The Printed Wiring Facility requires special sampling of the wastewater it generates. In 1996, all the liquid effluents from the Printed Wiring Facility process complied with pretreatment discharge standards (for metals and organic pollutants).

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.[9] 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 (Regional 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 Alameda County Flood Control & Water Conservation District (Flood Control District) has adopted ordinances that control storm water discharges to the Flood Control District's storm drain system. However, under a Memorandum of Understanding with the Regional Board, the Regional Board is the lead regulatory agency for federal facilities such as SNL/California.

SNL/California's program ensures compliance with both the permit and the Flood Control District's ordinance by eliminating illicit discharges and connections to the storm drain system and by implementing a *Storm Water Pollution Prevention and Monitoring Plan*.[10]

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 1996, 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.[11] 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 1996, SNL/California complied with all the conditions specified in its air discharge permits. Therefore, it 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.

NESHAPs Compliance for Radionuclides

The EPA regulates airborne emissions of radionuclides through the Clean Air Act, National Emission Standards for Hazardous Air Pollutants (NESHAPs).[12] 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 1996, the maximum dose from SNL/California's air pathway was 1.09×10^{-5} mrem (1.09×10^{-7} mSv), or 1.09×10^{-4} % of the Clean Air Act limit.

Each year, SNL/California evaluates site air emissions for compliance with the NESHAPs Rule for Radionuclides.[12] 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 (TRL) (which is no longer operational) and the Radioactive Waste Management Facility. SNL/California monitors airborne emissions from both facilities.

In October 1996, SNL/California received permission from EPA to discontinue tritium monitoring (both stack and ambient air) because of the cleanup and reapplication of the TRL. The EPA also exempted SNL/California from future NESHAPS assessment and reporting requirements.

National Environmental Policy Act Compliance

During 1996, more than 100 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 1996.

Other Environmental Statutes

In 1996, 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 1996. 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*,[13] 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 1996. The system provides background information for each event reported, including date, type of occurrence, and a brief description.

Environmental Permits

Table 3-6 identifies the environmental permits held by SNL/California in 1996 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.[14] 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

Bay Area Air Quality Management District Permit-to-Operate is renewed annually. In 1996, SNL/California had Bay Area Air Quality Management District permits for 29 sources of air pollutants, such as boilers, vapor degreasers, a paint spray booth, and various abatement devices (see Table 3-2). SNL/California also operated 34 exempt sources (see Table 3-3). However, some of these sources are no longer operational due to changes in site operations during 1996.

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.[9] 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. EPA, Title 40 CFR, Part 403, *Federal Wastewater Pretreatment Standards* (July 1994).

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

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

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

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

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

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

14. 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 SARAestablish 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	12
Degreasers/cleaners	7
Paint spray booth	1
Gasoline dispensing facility	1
Miscellaneous	8
Total	29

Table 3-3. Bay Area Quality Management District Exemptions Held by SNL/California in 1996.

Source Type	Number of Exemptions Held
Laboratories	13
Diesel fuel dispensing tanks	2
Explosive test cells	2
Abrasive blasters	2
Miscellaneous	15
Total	34

Table 3-4. Environmental Audits of SNL/California in 1996.

Date	Regulatory Authority	Purpose
6/10–6/14, 9/17–9/19	DOE/Nevada	Waste acceptance
5/31, 6/13, 7/11, 7/30, 8/15	BAAQMD	Source inspections
11/20, 12/3	Livermore Water Reclamation Plant	Wastewater inspections
12/9–12/13	Lockheed Martin Corp.	Audit of ES&H programs

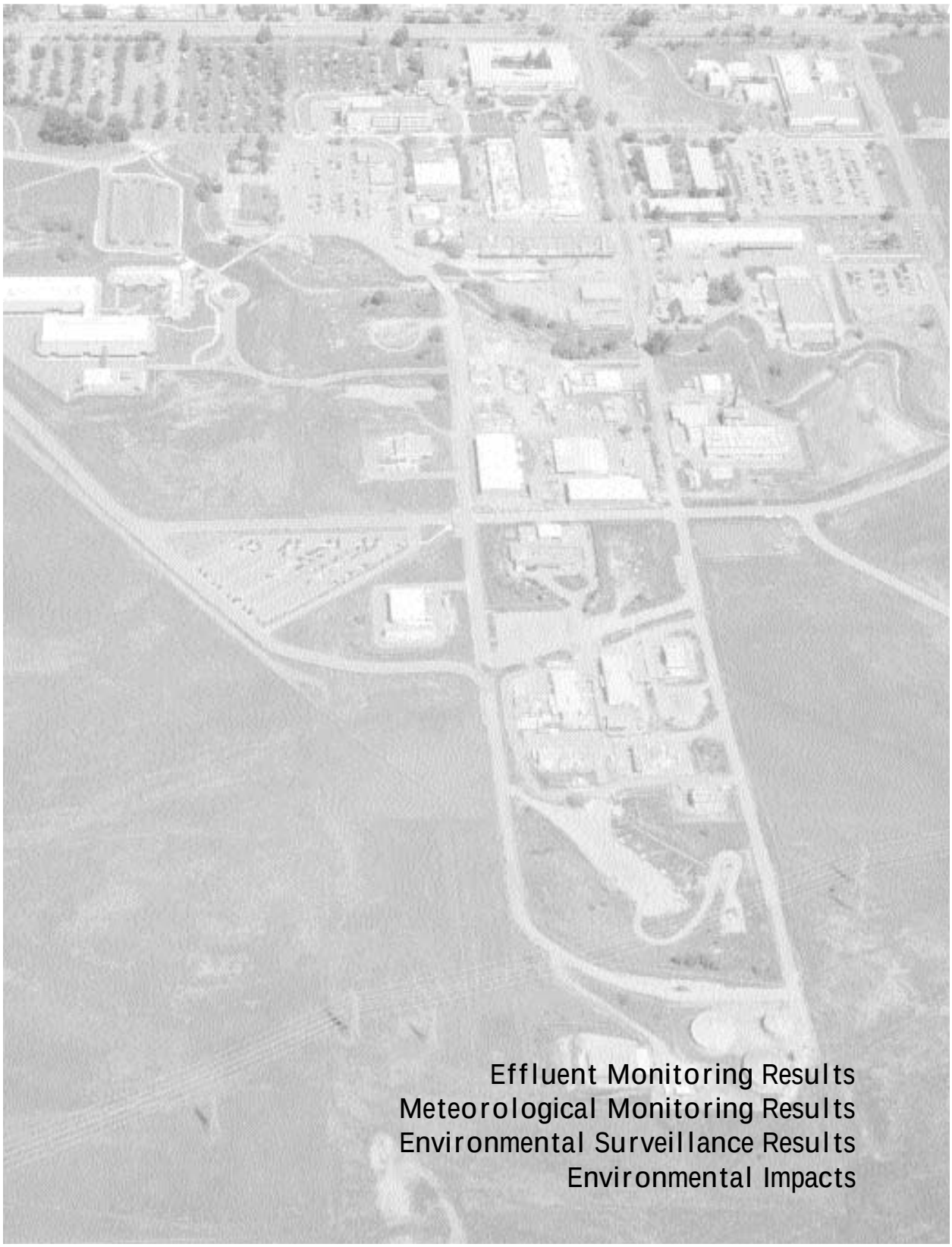
Table 3-5. Environment-related Occurrence Reports During 1996.

Report No.	Date	Subject	Occurrence Category	Description of Occurrence
ALO-KO-SNL-CASITE-1996-0001	3/12/96	Exceedance of wastewater discharge permit No. 1251	Off-normal	The March 11 laboratory results from the SNL/California sanitary sewer outfall monitoring system showed a zinc concentration of 21 ppm for the 2/24/96 daily sample.
ALO-KO-SNL-CASITE-1996-0007	8/1/96	Fixed contamination	Off-normal	During a vacated space survey of B918, Health Physics personnel found three small areas of contamination, probably depleted uranium.
ALO-KO-SNL-CASITE-1996-0008	8/21/96	Exceedance of wastewater discharge permit No. 1251	Off-normal	Data from the SNL/California outfall monitoring system showed that the pH dropped below 5 in several separate instances between Aug. 14 and 15.

Table 3-6. SNL/California Environmental Permits in 1996.

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 until January 4, 2003.
Air Quality	Bay Area Air Quality Management District	Bay Area Air Quality Management District Permit-to-Operate for 63 air emission sources. Permit renewed annually. (See Tables 3-2 and 3-3).
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 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.

With the transition of the former Tritium Research Laboratory (TRL) to other uses, and the removal of SNL/California's reportable tritium inventory, tritium monitoring at SNL/California has been discontinued, with the exception of groundwater analyses, stormwater, and sanitary sewer effluent during heavy rain events. This Annual Site Environmental Report is the last to contain data from the SNL/California ambient air tritium monitoring, weekly sanitary sewer tritium monitoring, and the LLNL tritium monitoring data for ambient air, vegetation, groundwater, surface water, and soil/sediment.

Effluent Monitoring Results

Airborne Effluents

The only detectable radionuclide discharged to the atmosphere from SNL/California is tritium from the former TRL.[1] In 1996, a total of 0.078 Ci (2.9×10^9 Bq) tritium was discharged from clean-up operations at the former (TRL. The clean-up plan for the former TRL stated that stack monitoring would be discontinued once the calculated air pathway dose was less than 0.001 mrem. SNL/California used EPA approved computer codes to calculate that stack emissions of less than 7 Ci would attain this goal. Since the 1996 emissions of 0.078 Ci is much less than the calculated 7 Ci, monitoring of stack effluents ceased on October 10, 1996, with the permission of the EPA. Figure 4-1, shows the tritium releases for both SNL/California and LLNL for the last 11 years.

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

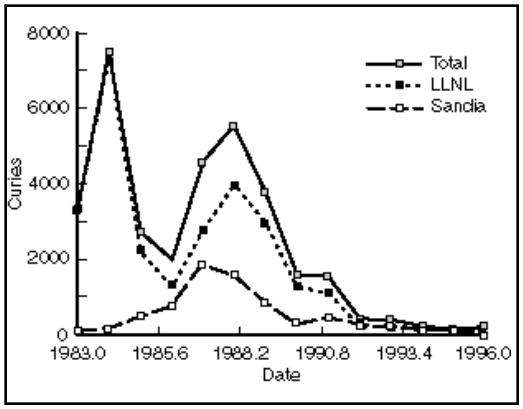


Figure 4-1. Tritium releases from both SNL/California and LLNL since 1983.

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 p. 4-8, Sewer Outfall Monitoring).

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.

  No radionuclides are routinely discharged to the sanitary sewer from operations at the SNL/California site.

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.

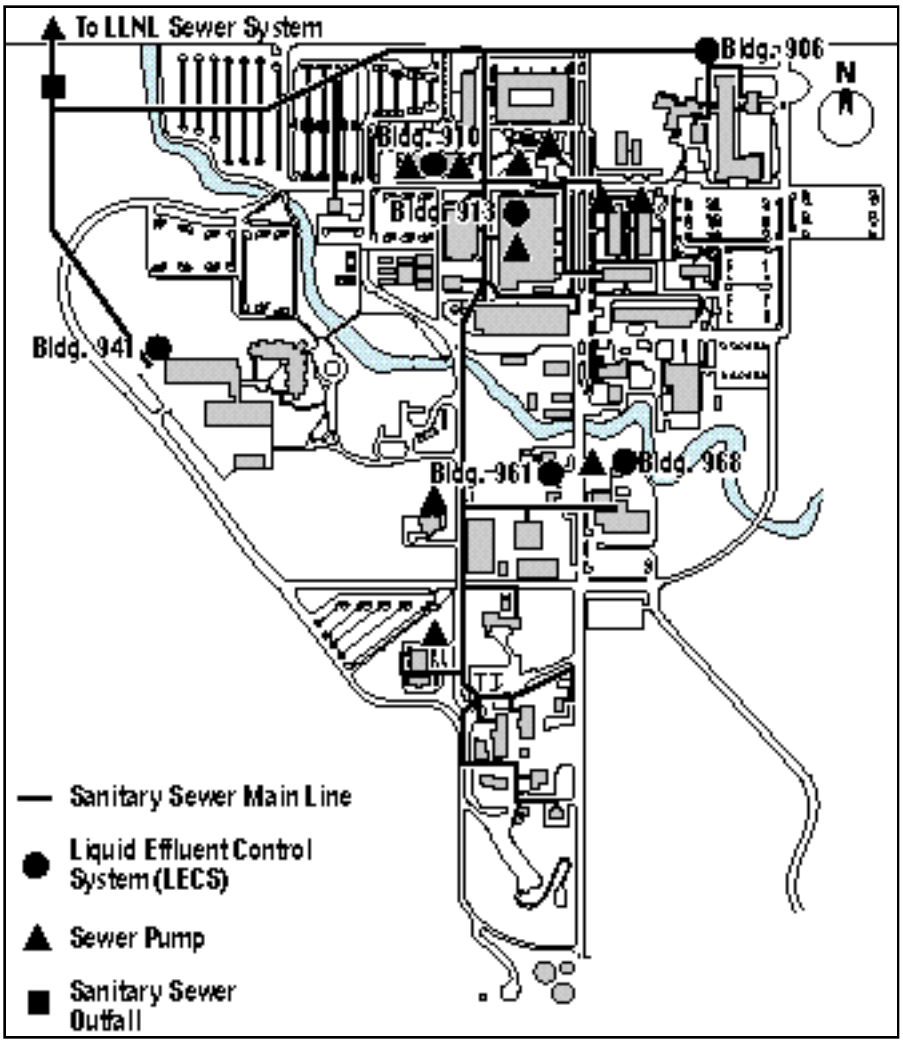


Figure 4-2. Sewer and LECS locations.

- 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 arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, and zinc. As applicable, analyses for uranium and tritium are performed by SNL/California personnel.

Federal Categorical Processes

Locations

SNL/California operates one "categorical process," which is subject to the Federal Pretreatment Standards (Title 40 CFR, Part 433): the Printed Wiring Laboratory in Bldg. 910.[4] Semiannually, SNL/California conducts special sampling procedures for this facilities' wastewater.

Analyses

To comply with the requirements of the Federal Pretreatment Standards, SNL/California collects grab samples of the wastewater from the Printed Wiring Laboratory 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 1996 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 0.02 to 0.12 mg/L.
- Copper— the regulatory limit for copper is 2.07 mg/L. Copper was seen at levels ranging from 0.15 to 1.3 mg/L.
- Zinc—the regulatory limit for zinc is 1.48 mg/L. Zinc was seen at levels ranging from 0.02 to 0.05 mg/L.

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

Groundwater Discharge to the Sanitary Sewer

Location

SNL/California operates a network of aquifer protection wells and a system of injection and withdrawal wells. The purpose of the groundwater extraction network is to capture any groundwater contaminated by the diesel fuel at the Fuel Oil Spill site. Treatment water from the *in*

situ bioremediation activities is captured from the soils by the withdrawal wells and is passed through an above ground treatment system. Effluent from the treatment system is discharged to the sanitary sewer system and subject to the discharge limits and monitoring and reporting requirements of the Groundwater Discharge Permit issued by the Livermore Water Reclamation Plant.

Analyses

To comply with the Groundwater Discharge Permit, SNL/California collects grab samples of effluent from the treatment system quarterly. A State-certified commercial laboratory analyzes the samples for benzene, ethylbenzene, toluene, xylenes, and total petroleum hydrocarbons for diesel.

Results

Groundwater discharge to the sanitary sewer in 1996 complied with all discharge permit requirements. Almost all of the parameters were analyzed below the detection limit except for diesel concentrations, which ranged from <50 to 130 µg/L. The permit limit is 250 µg/L cumulative for all the parameters (i.e., no single parameter or combination of parameters may add up to more than 250 µg/L). There was one sample in January that was initially analyzed above the permit limit; however, it was determined to be invalid because of discrepancies in the results. The City of Livermore issued a memo stating that no formal violation will be issued.

Details of the Environmental Restoration Program which the fuel oil spill site is a part of are provided in Chapter 6, "Groundwater."

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, and total dissolved and suspended solids. It analyzes the grab samples for cyanide, oil, and grease.

Beginning November 1996, SNL/CA reduced the sampling suite for the weekly composite samples. The weekly composite sample is now only analyzed for oxygin demand, and total and suspended solids. The grab sample is now collected once a month and is still analyzed for cyanide and, oil and grease.

SNL/California also 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]

Through December 23, 1996, tritium samples were collected from the weekly composite samples. The tritium analyses were performed by SNL/California personnel. In December 1996, SNL/California received permission from the City of Livermore to discontinue tritium sampling. (The City has requested that SNL/California continue to collect tritium samples during large rainfall events.)

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 1996, all liquid effluent from the SNL/California sanitary sewer outfall complied with the site outfall discharge limits for regulated physical parameters, radionuclides, and EPA-priority organic pollutants. On one occasion, the sanitary sewer effluent exceeded the site's discharge limits for zinc.

Wastewater samples collected at the site outfall on February 24, 1996, showed a zinc concentration of 21.0 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 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 zinc concentrations in the sanitary sewer for 1996.

The wastewater samples collected at the site outfall at various times in August and September showed a pH level below 5. The Wastewater Discharge Permit prohibits discharges with pH less than 5 or greater than 10. SNL/California notified the City of Livermore, as required by the Wastewater Discharge Permit. However, investigations by SNL/California concluded that low flow conditions that coincided with the low pH concentrations caused the probe to become dry, resulting in inaccurate readings. The City of Livermore issued a memo stating that the Notice of Violation was not warranted for the reported August exceedance. The City of Livermore will document the violation in their reports to the Regional Water Quality Control Board with a footnote

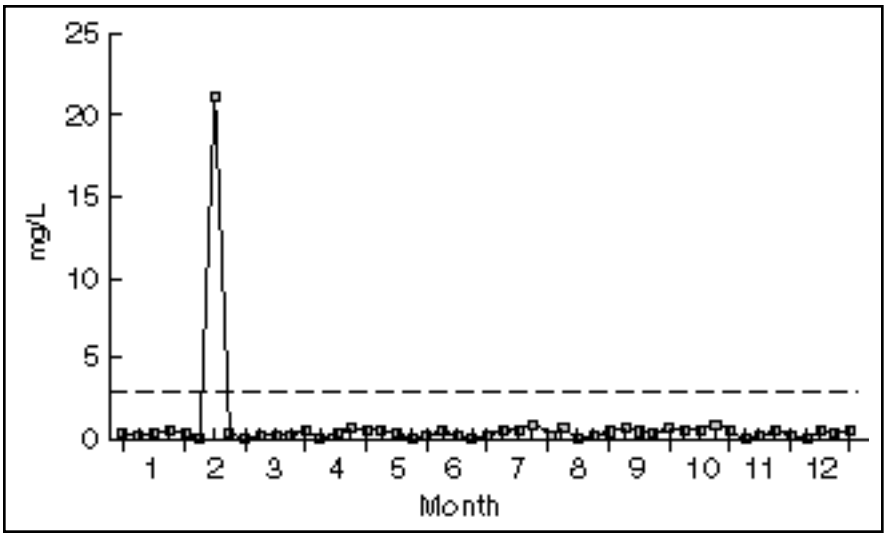


Figure 4-3. Zinc concentrations in the sanitary sewer.

explaining that subsequent investigations by SNL/California indicated an equipment problem rather than an actual violation.

SNL/California performed a Mann-Kendall trend test on the 1996 metals and physical data. Chemical oxygen demand showed an upward trend. Copper showed a downward trend. All other parameters showed no detectable trend. These trends are not a concern because none of the parameters exceeds site discharge limits. 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 1996, no tritium was discharged to the sanitary sewer system from SNL/California. This change is reflective of the fact that the cleanup of the wastewater system of the former TRL was completed in November 1995. The average concentration of tritium in the sanitary sewer effluent was less than 1.9×10^{-6} μCi/mL, which was 0.02% of the DOE control limit. Tritium samples were collected weekly at the sanitary sewer outfall through December 23, 1996, at which time permission was received from the LWRP to cease tritium monitoring at the outfall.

Storm Water Runoff

Description

As storm water flows 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 pollutants discharged in storm water, SNL/California collects samples of surface runoff at various points in the site's storm drain system.

Locations

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

- 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.

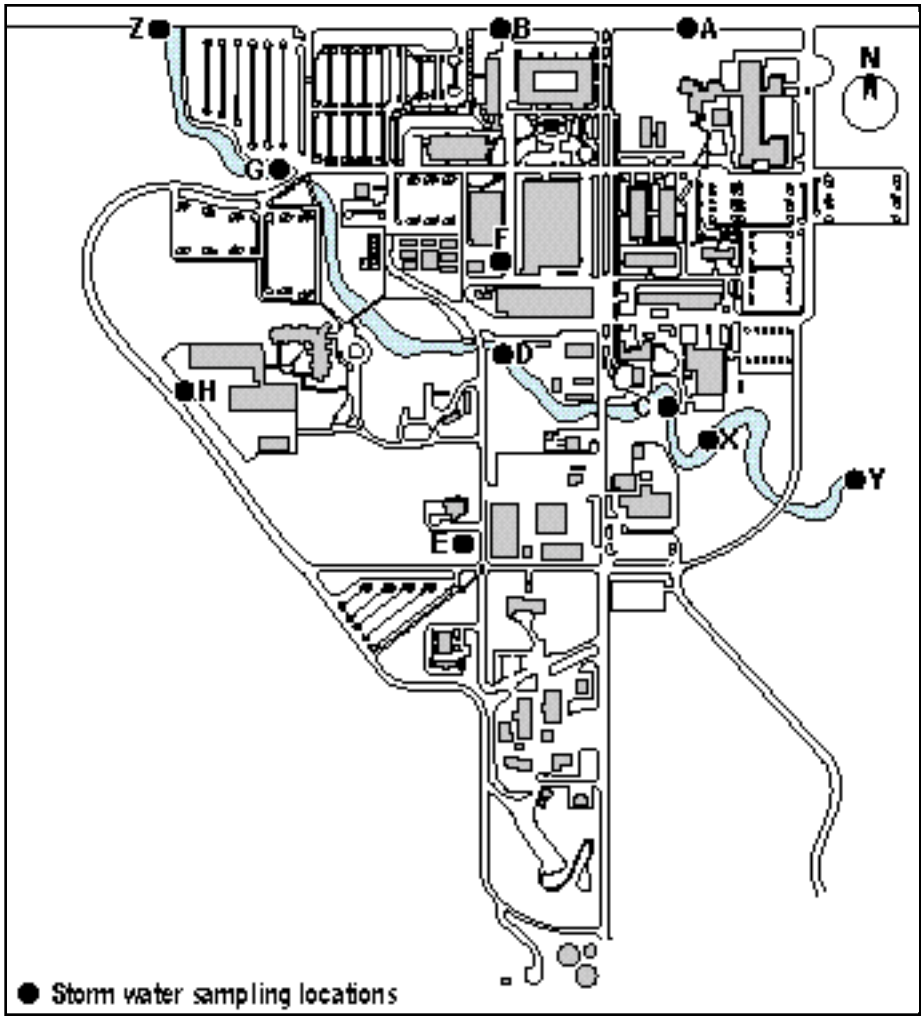


Figure 4-4. Storm water sampling locations on the SNL/California site.

Locations E and H are upstream discharge locations to the Arroyo Seco. These two locations represent flow from larger watersheds and were initially sampled to determine if there were significant pollutant contributions from the smaller area. Data from five and six sampling events for locations H and E, respectively, showed that there were no significant pollutant contributions from that area.[7] The two locations were eliminated for sampling beginning the 1996–97 wet season.

Methods

SNL/California collects samples during two storms that produce runoff sufficient to allow collection of storm water in sample bottles. The difference of the ground's permeability in different areas throughout the site often means there is surface runoff in some areas and none in other areas during the same storm event. SNL/California continues to sample until there are two samples for each location; therefore, there might be more than two storm events sampled throughout the year.

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.[8]

In 1996, samples were collected at all 11 locations during three storm-sampling events. Automatic samplers were installed at locations Y, Z, and D in 1995. A new automatic sampler was also installed at location G in 1996. Locations D, G, Y, and Z represent all the sampling locations in the Arroyo Seco. As slope conditions do not allow safe access to the arroyo during storm events, automatic samplers help ensure the safety of SNL/California personnel during storm water sampling.

Analyses

A State-certified laboratory analyzes storm water samples for specific conductivity, pH, total suspended solids, and oil and grease, as required by

SNL/California's storm water permit requirements. The laboratory also analyzed storm water samples for arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, zinc, pesticides, volatile organic compounds, and semivolatile organic compounds for the first two storms. SNL/California performed the tritium analyses. These analyses provide baseline information about pollutants that are discharged with storm water. Four years of storm water data have shown that there are no significant concentrations of the additional parameters. Beginning the 1996-97 wet season (October 1, 1996), SNL/California analyzed storm water samples only for the four parameters required by the storm water permit but continued to analyze for tritium.

Quality Assurance

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

Results

Regulatory agencies have not established numerical 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 4 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, 1995, and 1996 data will provide a baseline, to which future samples will be compared.

SNL/California's 1996 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 6.5 to 8.3, which is within the acceptable range published by the State Water Resources Control Board (State Board). Figure 4-5 shows pH levels in storm water runoff.
- Total suspended solids (TSS)—TSS concentrations ranged from below the detection limit of 10 mg/L to 5800 mg/L. The concentrations detected are within the range of those seen in previous years, with the exception of the samples collected at location Y during the second storm event (5800 mg/L). However, this location represents the storm water as it flows onto

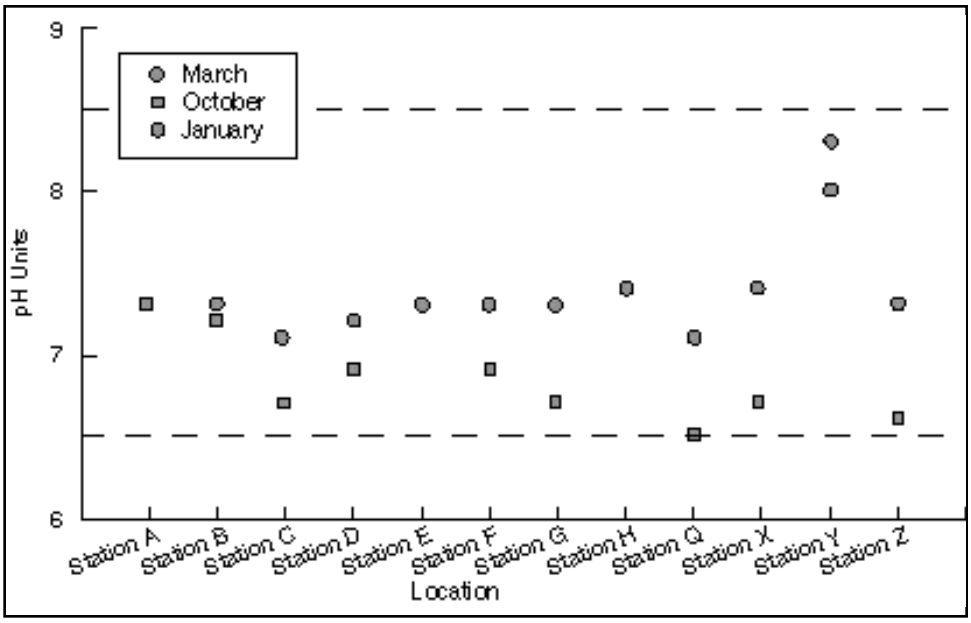


Figure 4-5. pH in storm water.

SNL/California property, which SNL/California activities have no impact on. Figure 4-6 shows concentrations of TSS in storm water.

- Specific conductivity—Specific conductivity measurements ranged from 20 to 1100 µmhos/cm. As with the TSS samples, these levels are within the range seen in previous years, with the exception of the sample collected at location Y during the second storm event (1100 µmhos/cm). This location represents the storm water as it flows onto SNL/California property. Figure 4-7 shows specific conductivity levels in storm water.
- Zinc—Zinc concentrations are consistently above the analytical detection limit. During the first two storm events, zinc concentrations ranged from 0.01 to 0.54 mg/L. These concentrations are within the range seen in previous years. Figure 4-8 shows concentrations of zinc in storm water.
- Other metals - In the samples from the first two storm events, the concentrations of other metals were generally very close to, or below their analytical detection limits.

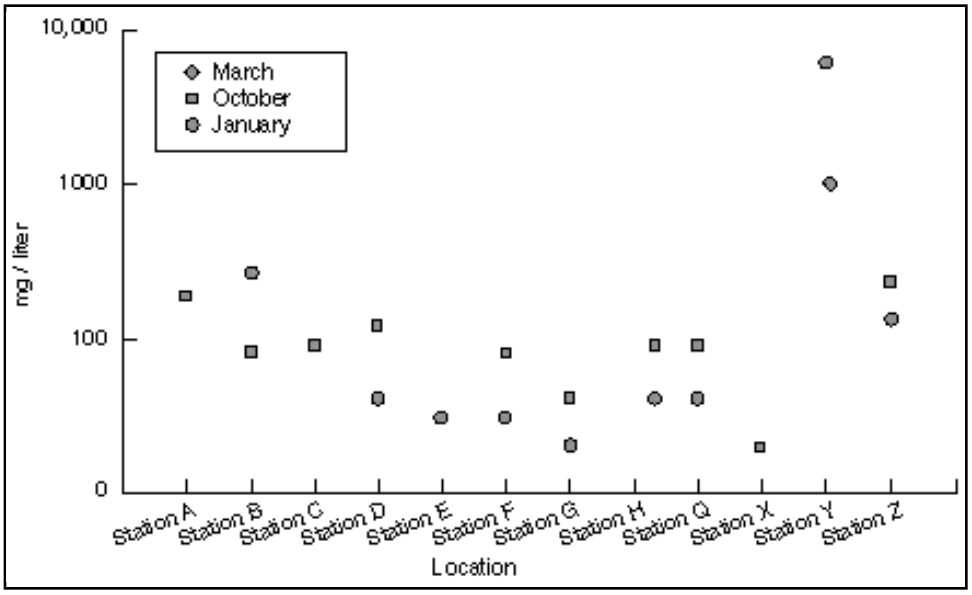


Figure 4-6. Total Suspended Solids in storm water.

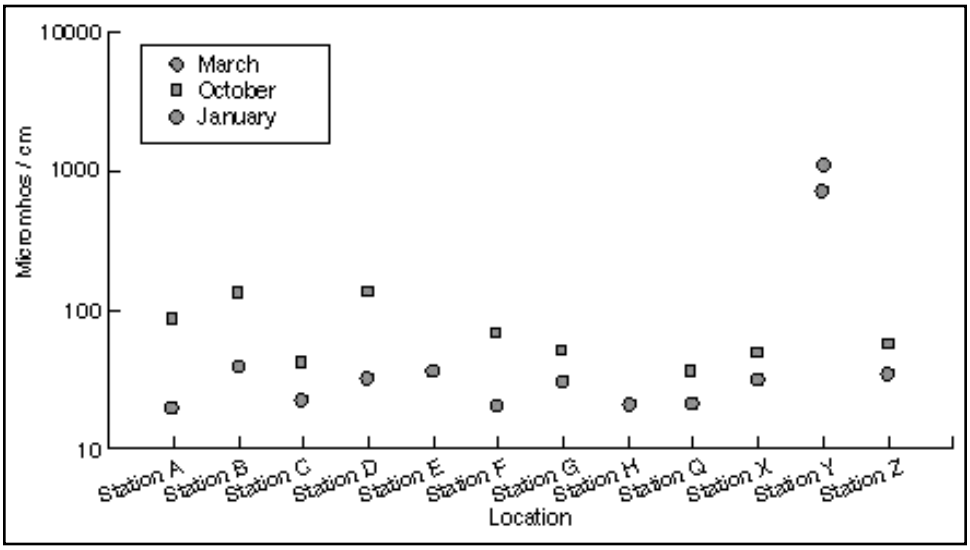


Figure 4-7. Specific conductivity in storm water.

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

1996 data include wind speed, wind direction, rainfall, relative humidity, and ambient temperature. During 1996, operation of the meteorological tower was turned over to the Emergency Preparedness Group, as the data will no longer be required for NESHAPs modeling.

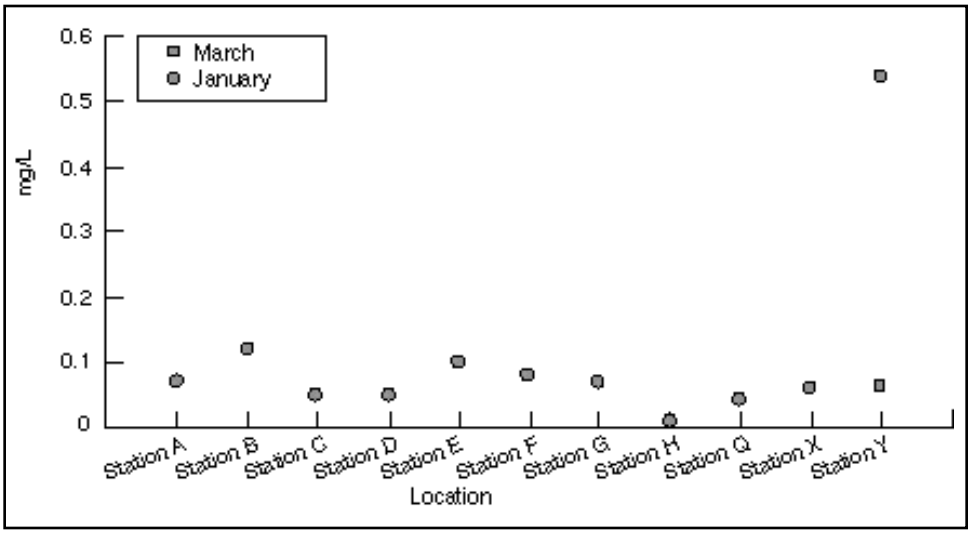


Figure 4-8. Zinc concentrations in storm water.

Monitoring Methods

SNL/California maintains a meteorological tower on the western portion of the site (Fig. 4-9). 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 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

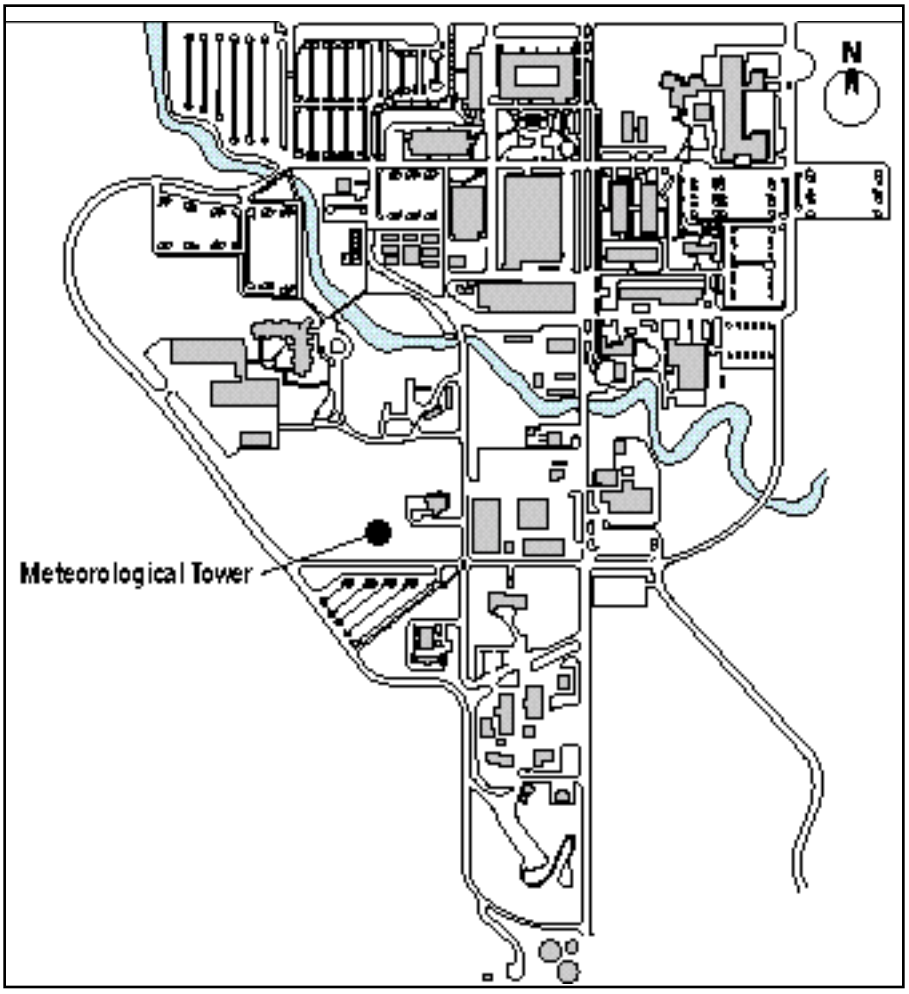


Figure 4-9. Location of the SNL/California meteorological monitoring station.

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 1996 surface wind speed and direction (10-meter tower level) measured at SNL/California are plotted in a wind rose (Fig. 4-10). 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.

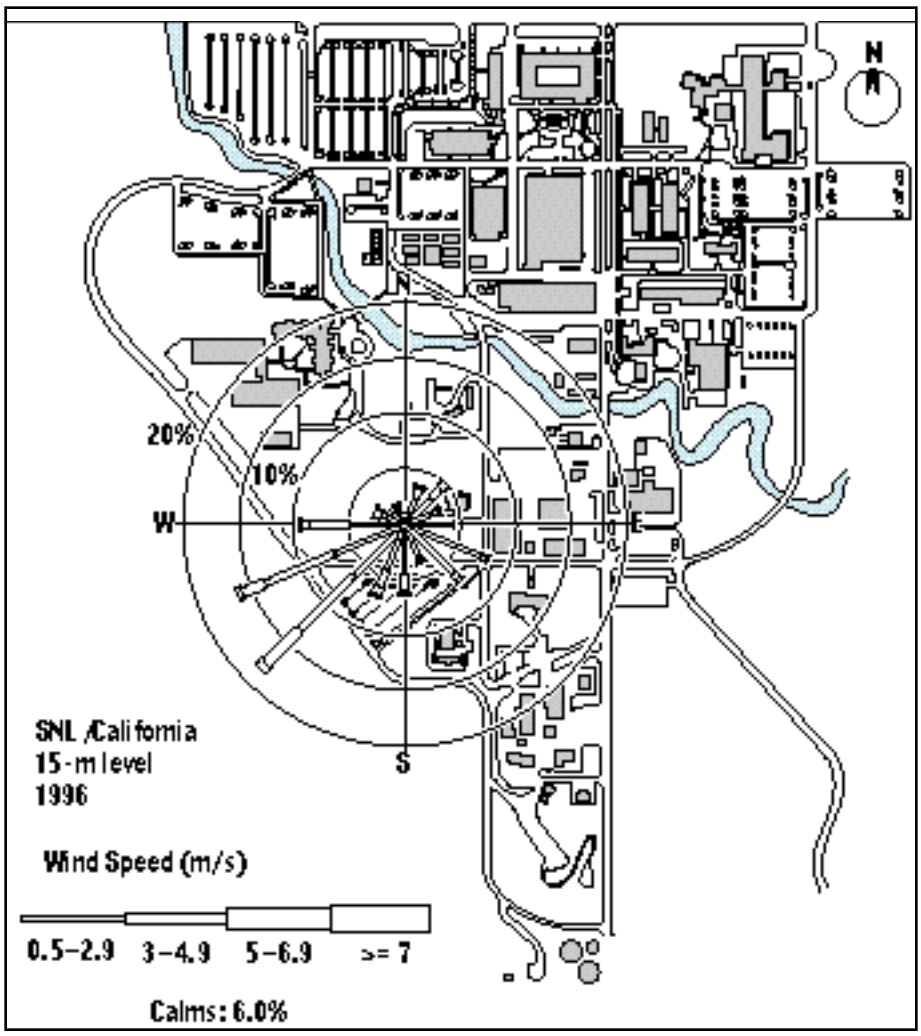


Figure 4-10. Wind rose showing the average annual wind direction and speed during 1996.

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

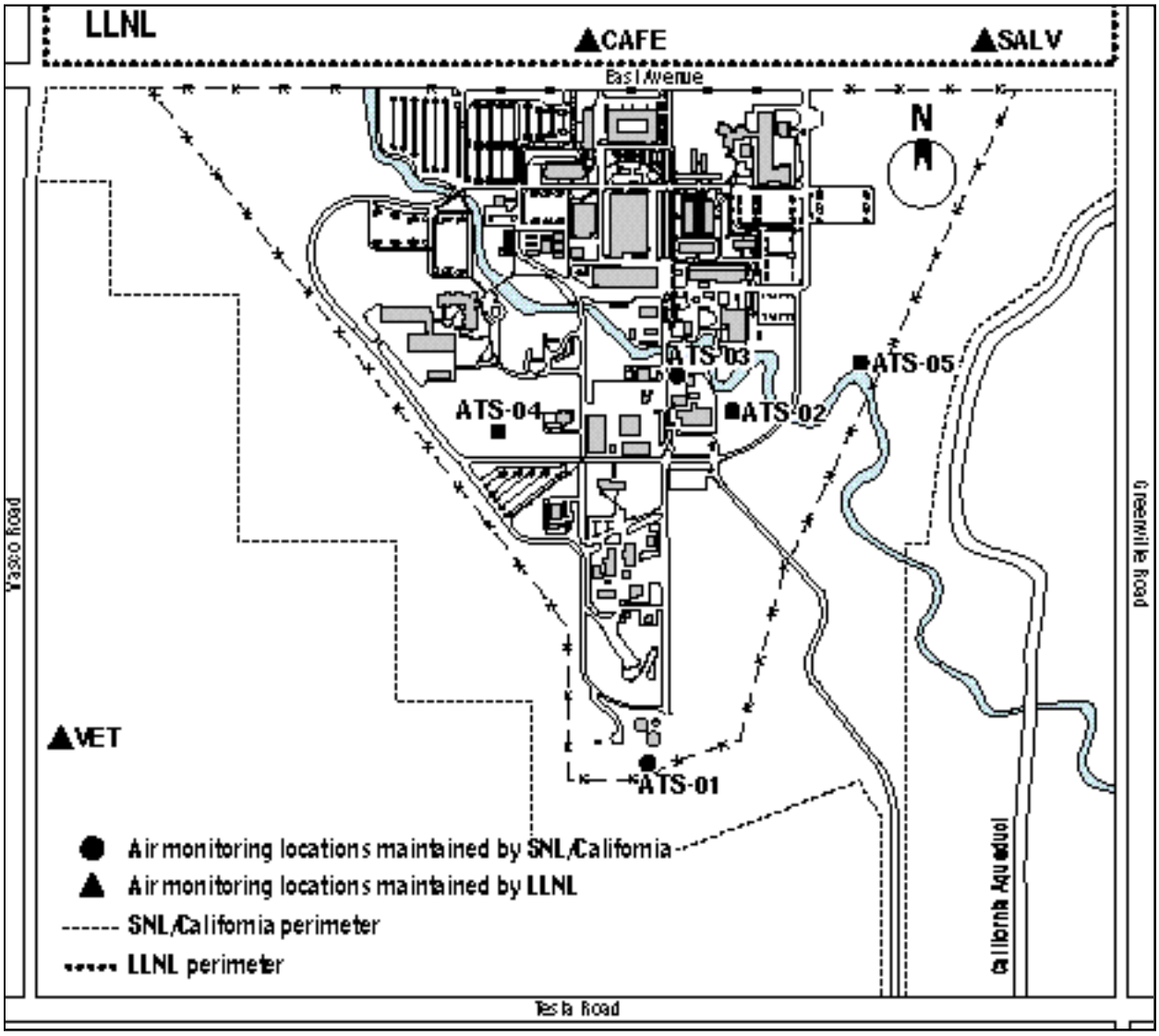


Figure 4-11. SNL/California site perimeter ambient air monitoring locations.

Livermore Valley. This design enables discrimination between radionuclides from site 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.

As of October 1996, the EPA gave SNL/California permission to cease ambient air tritium monitoring. This data will not appear in future Annual Site Environmental Reports.

Locations

The site perimeter (near-field) sampling locations are shown in Fig. 4-11 SNL/California maintained locations ATS-01 through ATS-07. 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. 4-12. 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 1996, SNL/California discontinued operation of its air tritium sampling network with equipment essentially identical to that used by LLNL. The LLNL air tritium sampling network will remain in operation.

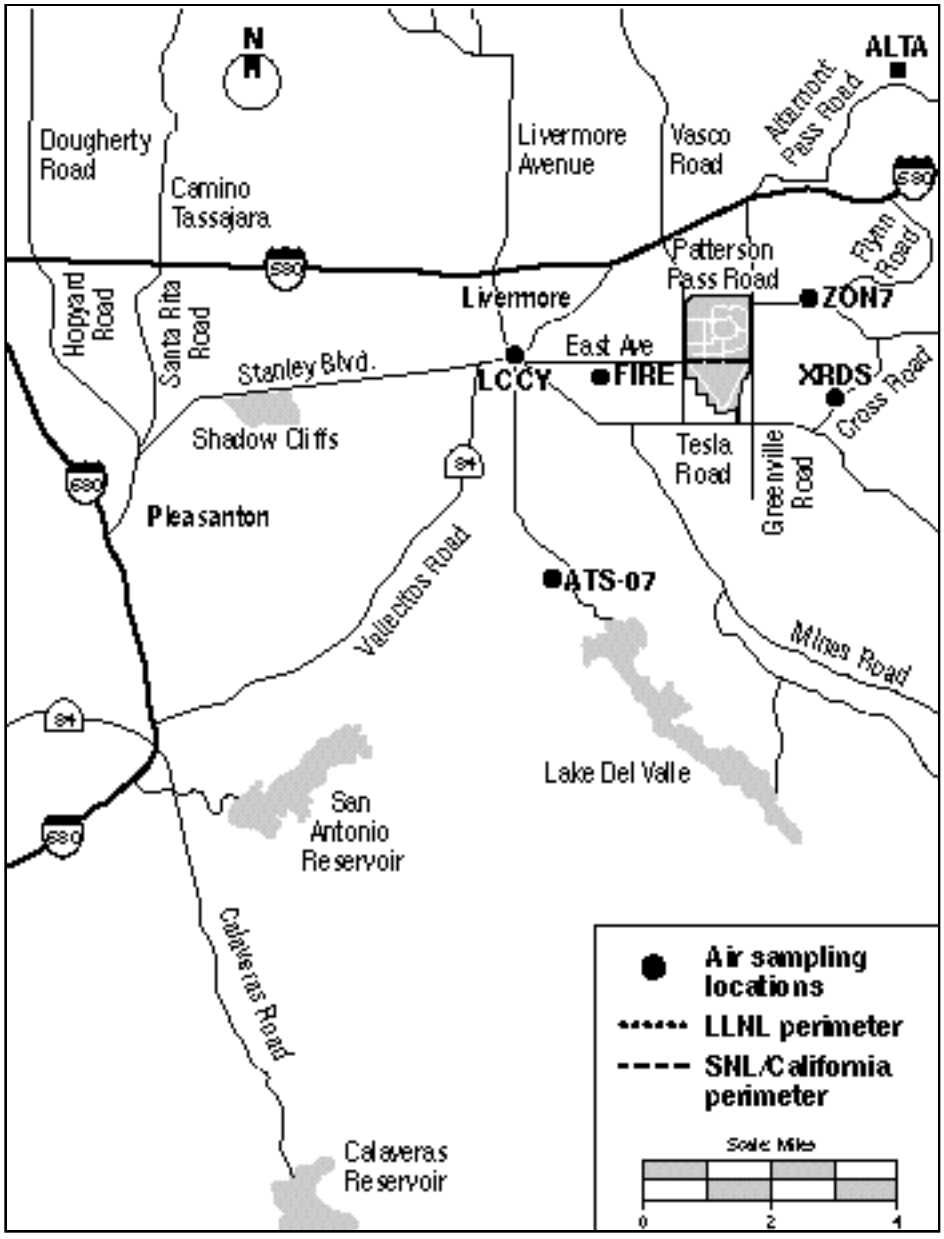


Figure 4-12. Air sampling locations in the Livermore Valley.

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.

Results

The highest annual average tritium concentration observed in air in the Livermore Valley, by LLNL samplers was 1.8 pCi/m^3 (6.7×10^{-2} Bq/m^3).

The highest annual average tritium concentration measured at the SNL/California site perimeter by LLNL samplers was 5.2 pCi/m^3 (1.9×10^{-2} 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 4-13 shows the highest annual average values for off-site and on-site tritium concentrations in air for 1987–96 (excluding the SNL/California samplers). The graph clearly shows a decrease in the average tritium concentration in air over the past 7 years with the exception of 1996. This corresponds well with the decreased amount of tritium released in recent years (see Fig. 4-1).

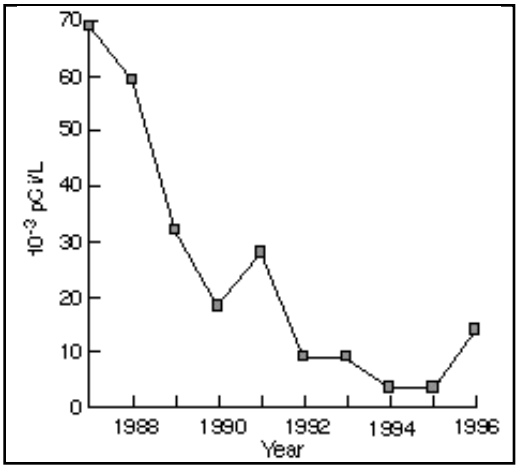


Figure 4-13. Highest annual average tritium concentration in air at the Livermore site perimeter (1988–96).

The highest annual average tritium concentration, as measured by SNL/California samplers, observed in air was 4.2 pCi/m3 (1.6×10^{-1} Bq/m^3), at ATS-03 (see Fig. 4-11). This location is close to the former 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. Location CAFE was sgnificantly higher than location SALV at 95% confidense level. Location ZON7 was significantly higher than the more distant locations (except location VET) with approximately 95% 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 location ATS-03 were significantly higher at a 95% confidence level than those at other locations. In addition, tritium concentrations at location ATS-02 were higher than those at locations ATS-04 at a 90% confidence level. The tritium concentrations at ATS-01, were not significantly different than those at locations ATS-02, ATS-04, ATS-05, and ATS-06. All locations showed significantly higher concentrations 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 con-

centrations 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-05 showed an upward trend. All other locations showed no trends. The upward trend at location ATS-05 is not believed to be due to operations at SNL/California, since there were no emissions from the site during 1996.

The LLNL Environmental Report for 1996 contains additional air monitoring data.[9]

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 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 4-14 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 4-15 shows the rainwater sampling locations. Figure 4-16 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 Lake Del Valle at 108 pCi/L (4.0 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 0.5% of the State Department of Health Services drinking water standard for tritium. All surface water samples collected in 1996 were below DOE and State drinking water standards.

The highest tritium concentration measured in rainwater was 499 pCi/L (18.5 Bq/L), at the LLNL salvage yard. This value represents 2.5% of the State drinking water standard for tritium. Figure 4-17 shows the highest annual average tritium concentrations in rainfall for 1987–96. The years 1990 and 1991 had higher concentrations than the earlier years, but levels dropped in 1992 and have remained low through 1996.

The highest tritium concentration measured in monitoring wells near the Livermore Water Reclamation Plant was 377 pCi/L (13.9 Bq/L). This value represents 1.9% 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.

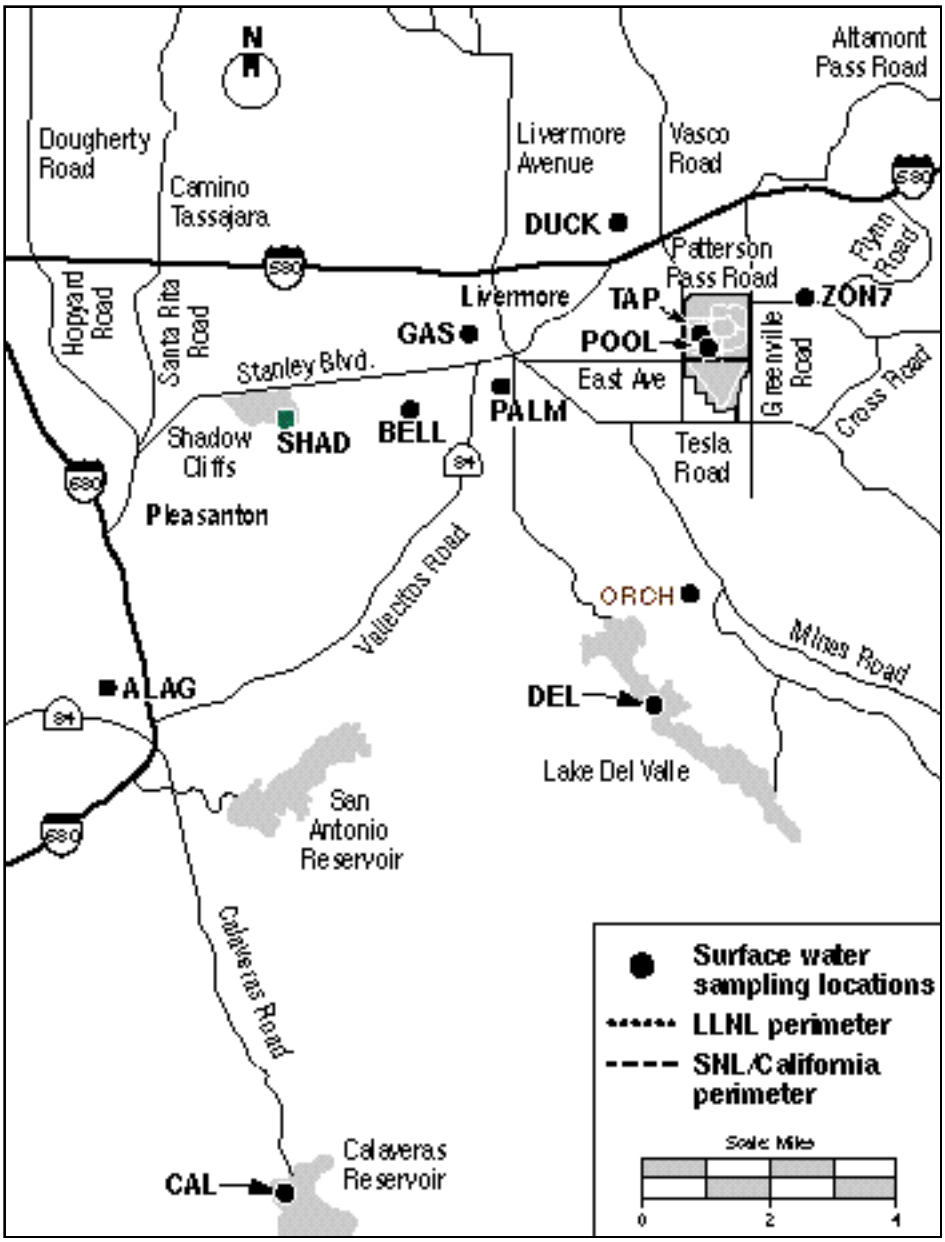


Figure 4-14. Surface water sampling locations in the Livermore Valley.

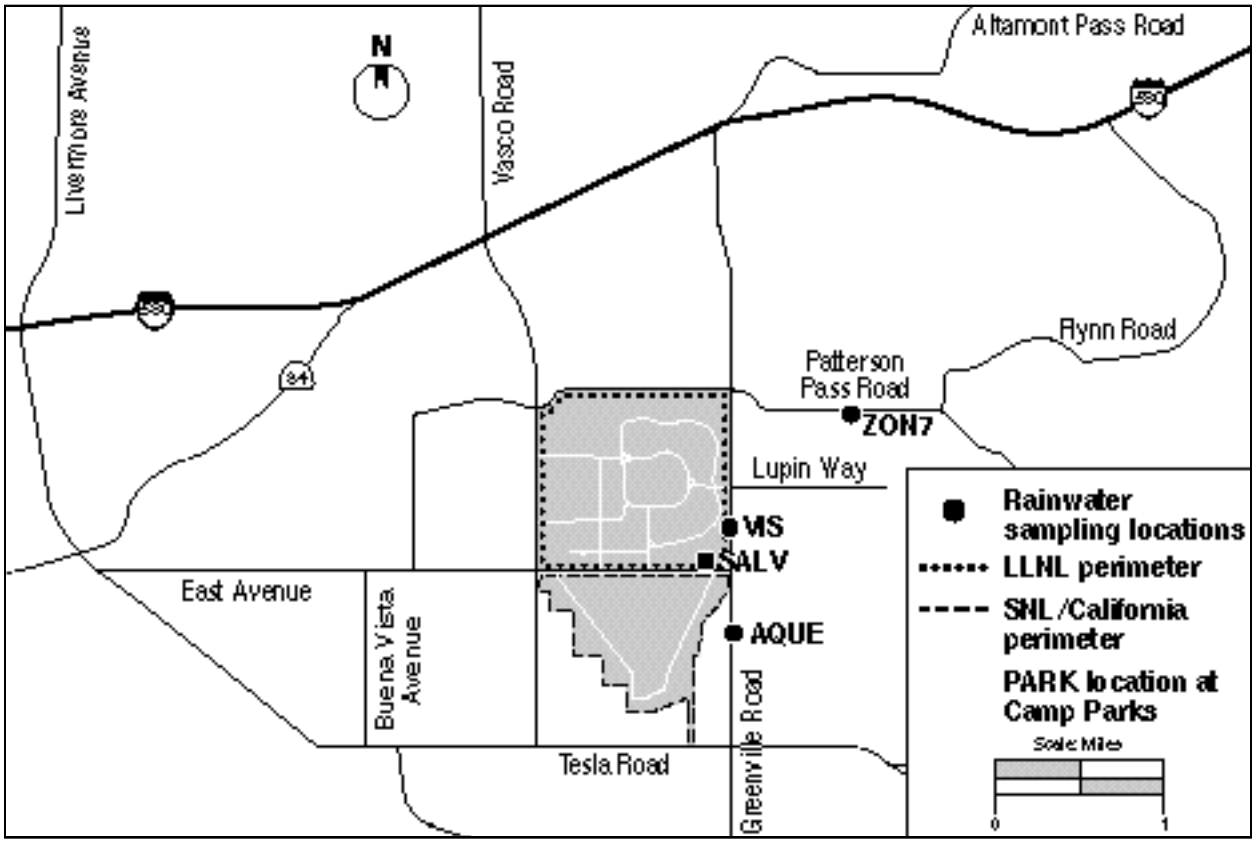


Figure 4-15. Rainwater sampling locations on the SNL/California site and in the Livermore Valley.

Soil/Sediment

Soil is an integrating medium, which can concentrate contaminants released to the atmosphere. Arroyo sediments is usually sampled by LLNL at a location downstream of SNL/CA. However, no sample was collected at this location during 1996.

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 samples.

Locations

Figure 4-18 shows the surface soil sampling locations. Locations VIS and TANK are considered near-field sampling locations. The rest are distant locations. 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.

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; therefore, plutonium analyses are not included in this report.)

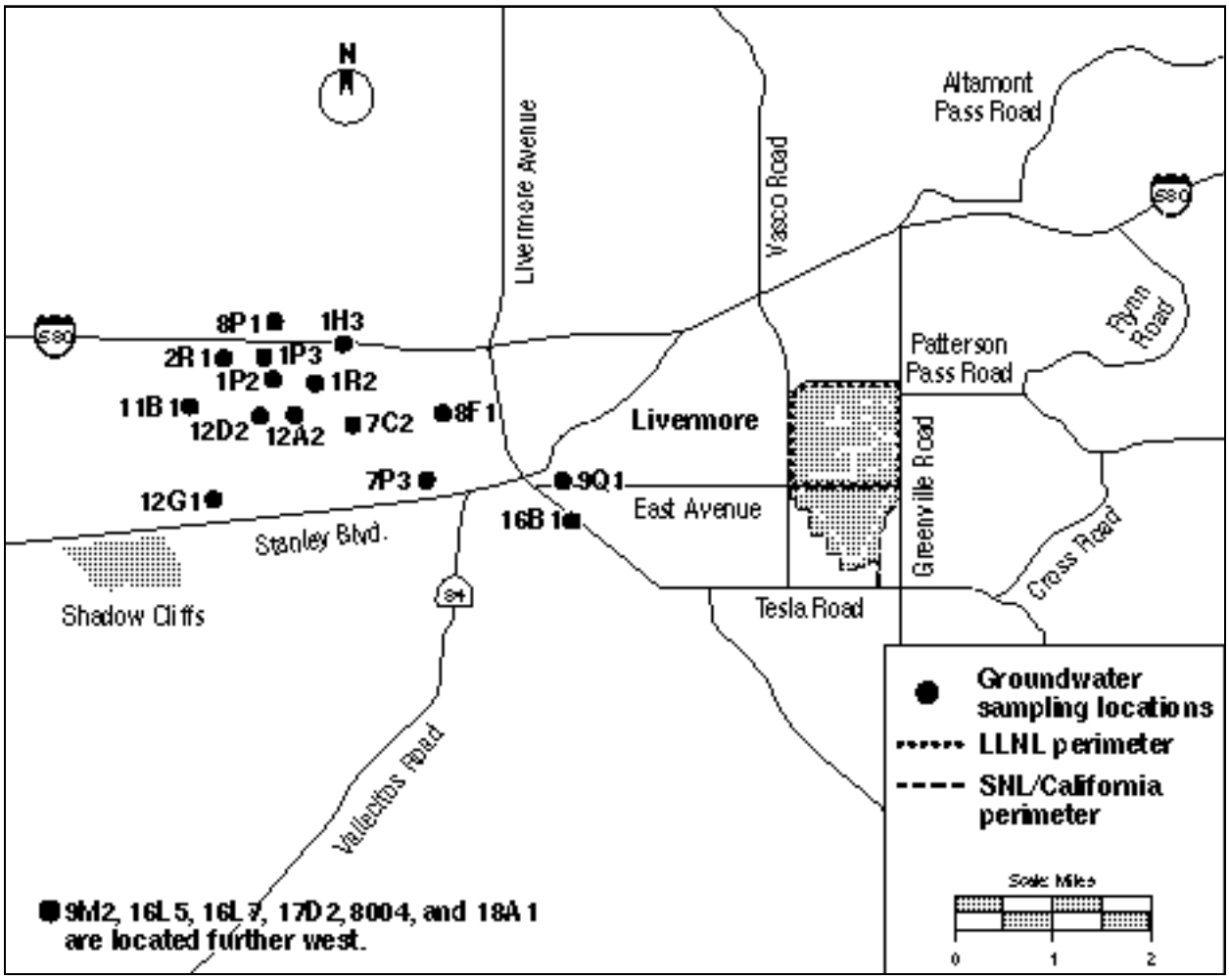


Figure 4-16. Groundwater sampling locations in the Livermore Valley.

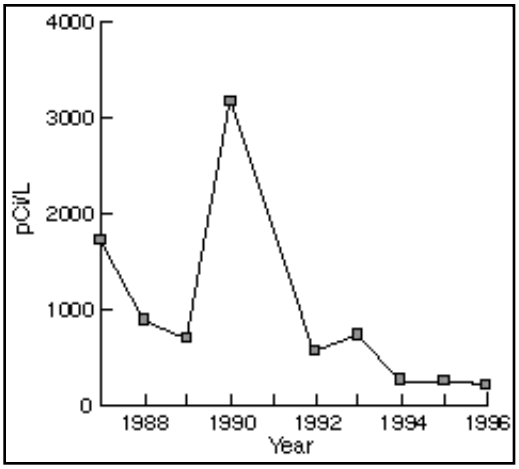


Figure 4-17. Highest annual average tritium concentration in rainfall (1988–96).

Quality Assurance

Duplicate soil 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."

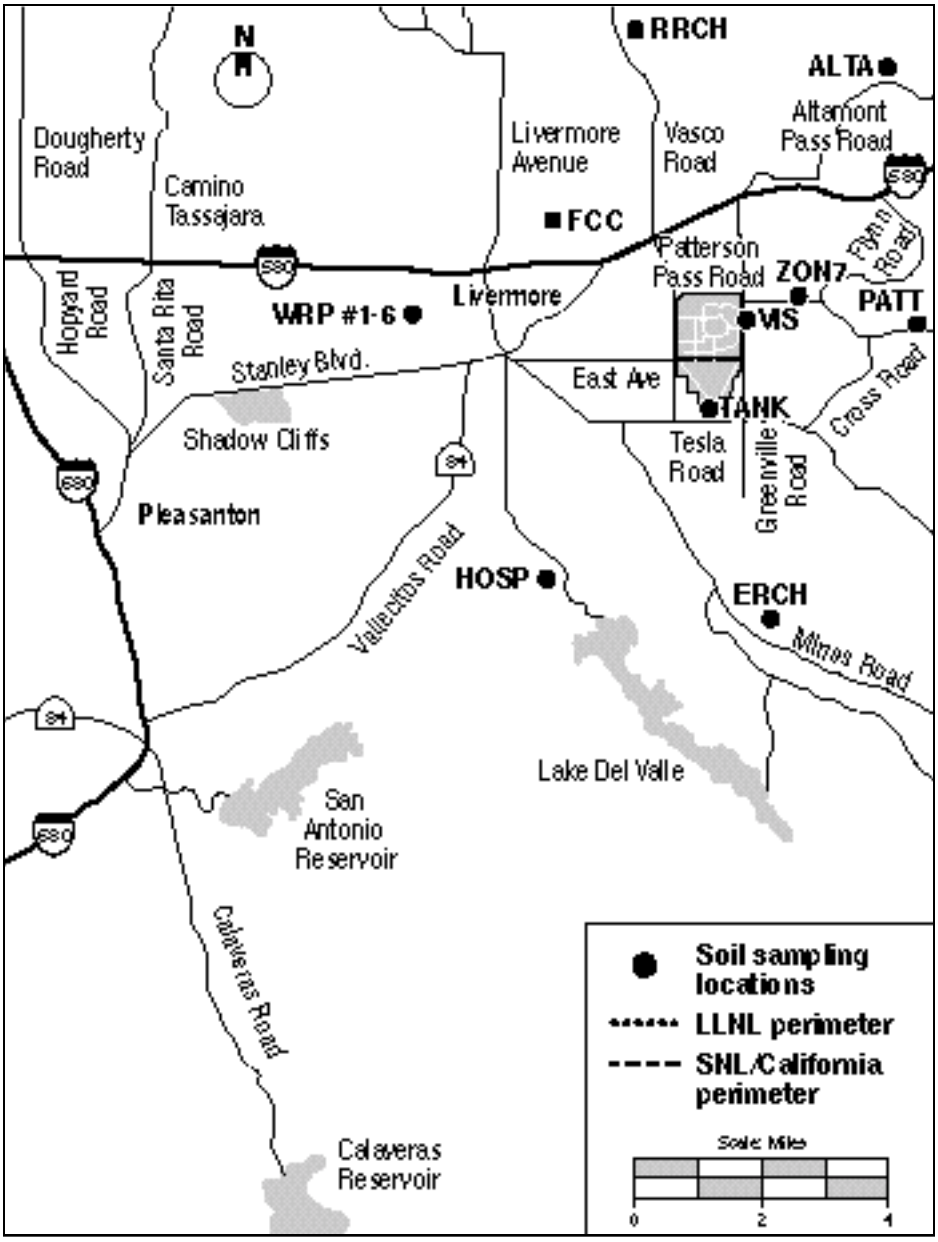


Figure 4-18. Soil sampling locations on the SNL/California site and in the Livermore Valley.

Results

Radionuclide concentrations in perimeter soil samples are similar to those found in off-site samples.

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 4-19 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.

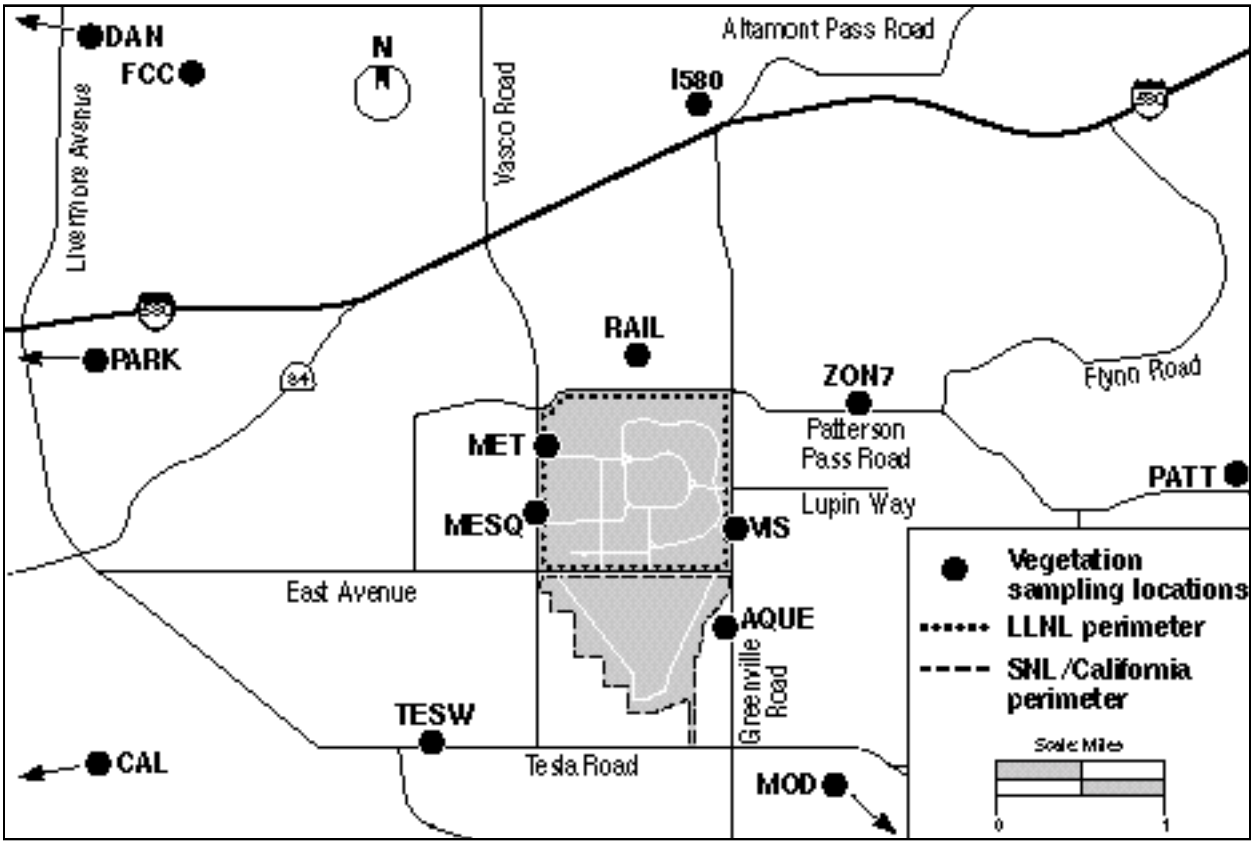


Figure 4-19. Vegetation sampling locations on the SNL/California site perimeter and in the Livermore Valley.

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 1996 was 656 pCi/L (243 Bq/L) at the location AQUE. This is slightly lower than the highest annual average value seen last year. This high average is due to one sample collected at this location. The tritium concentrations generally remained

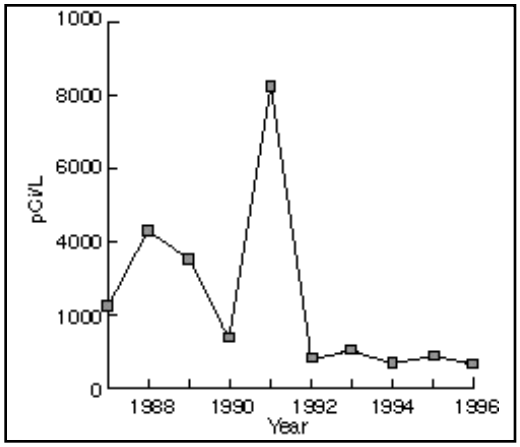


Figure 4-20. Highest annual average tritium concentrations in vegetation (1988–96).

low, following an initial drop in 1992 from historically higher values. Historical data are shown in Fig. 4-20, which plots the highest annual average tritium concentration in vegetation.

Locations MET and VIS show the highest concentrations of tritium. A statistical comparison shows that location ZON7 is significantly higher than locations PATT, FCC, CAL, and PARK at a 90% confidence level. Location I580 is significantly higher than location CAL at a 90% confidence level, and location VIS is significantly higher than location MET 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 measured values still are quite low. The higher concentrations can be attributed to site operations. The highest concentrations seen in 1996 are slightly lower than those seen in 1995.

Average tritium concentrations in wine were 86.6 pCi/L for Livermore Valley wines, and 17.2 pCi/L for other California wines. The wines represent several vintage years, and thus are not intended to represent the tritium releases in 1996, but rather to provide an index of public exposure. The Livermore Valley wines analyzed showed a decrease in tritium content compared to 1995 analyses. The other California wines showed a slight decrease compared to 1995 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 9.0×10^{-6} mrem, which is 9×10^{-6} % 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 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 4-21 shows the locations of the dosimeters at the SNL/California site (near-field). Figure 4-22 shows off-site dosimeter locations (distant).

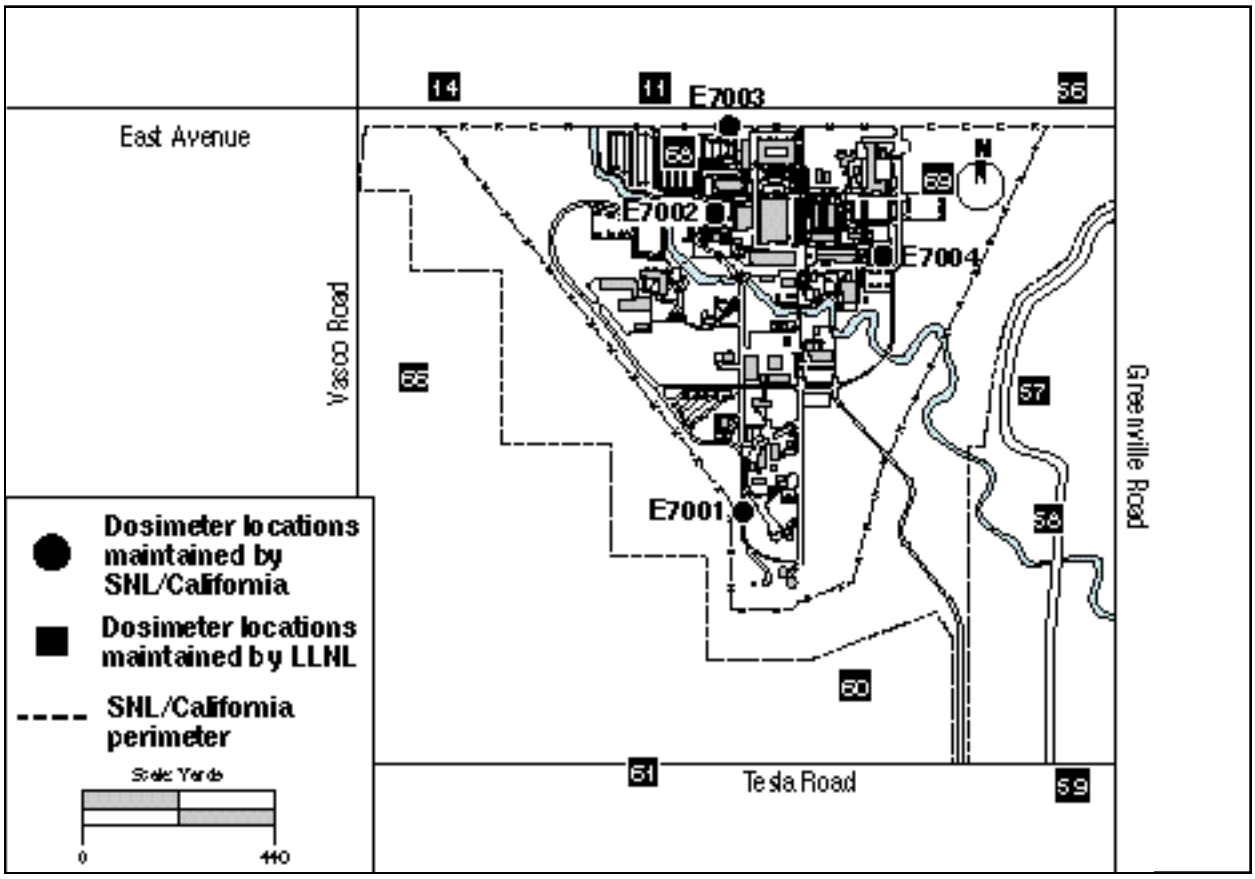


Figure 4-21. Dosimeter locations on the SNL/California site and around the site perimeter.

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)[10] to avoid interference from 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

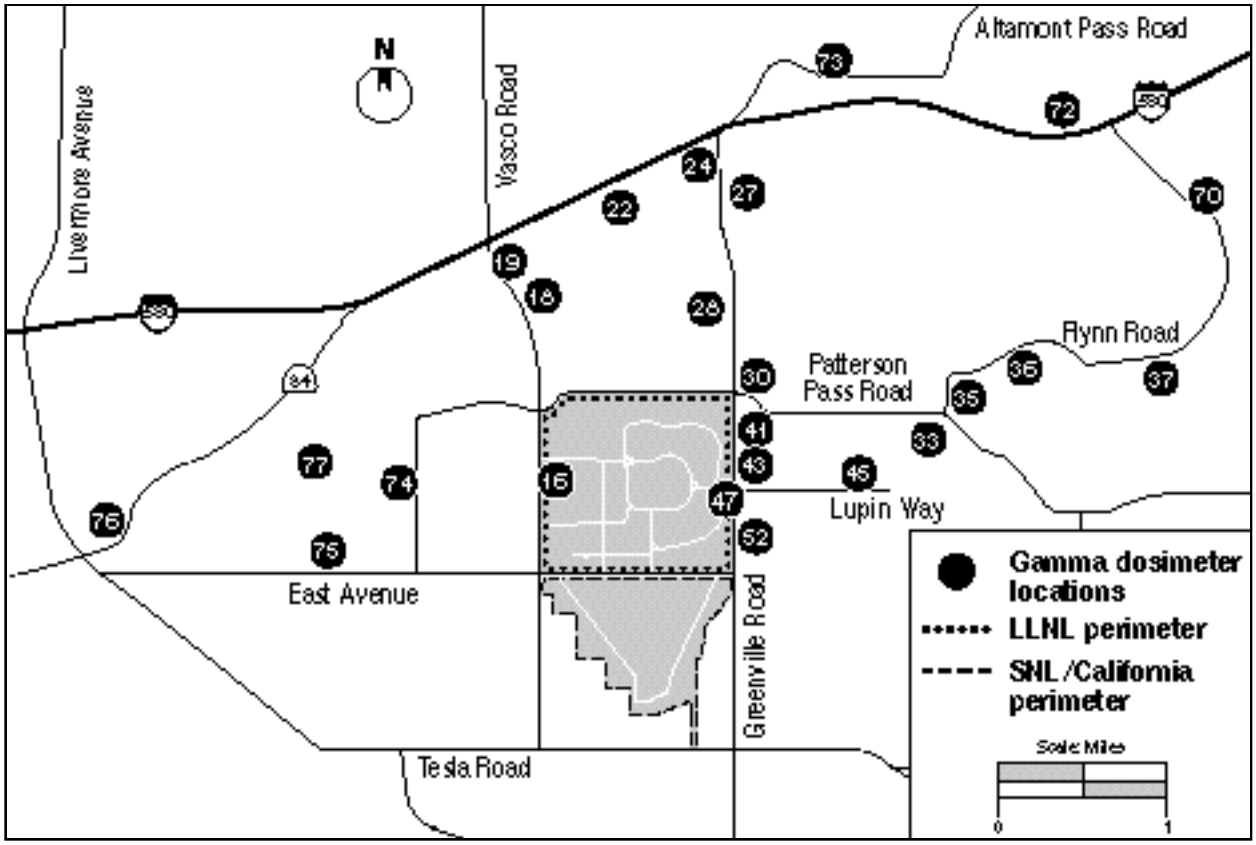


Figure 4-22. Dosimeter locations in the Livermore Valley.

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 56 mrem (0.56 mSv). The annual average external dose measured for the Livermore Valley locations was 55 mrem (0.55 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 no significant difference.

SNL/California performed a Mann-Kendall trend test on annual average perimeter doses and valley doses for the years 1989 through 1996. The test showed no significant trends at the 95% confidence level for the perimeter and valley samples.

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.

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 population 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 (^{3}H, 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 4-23 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

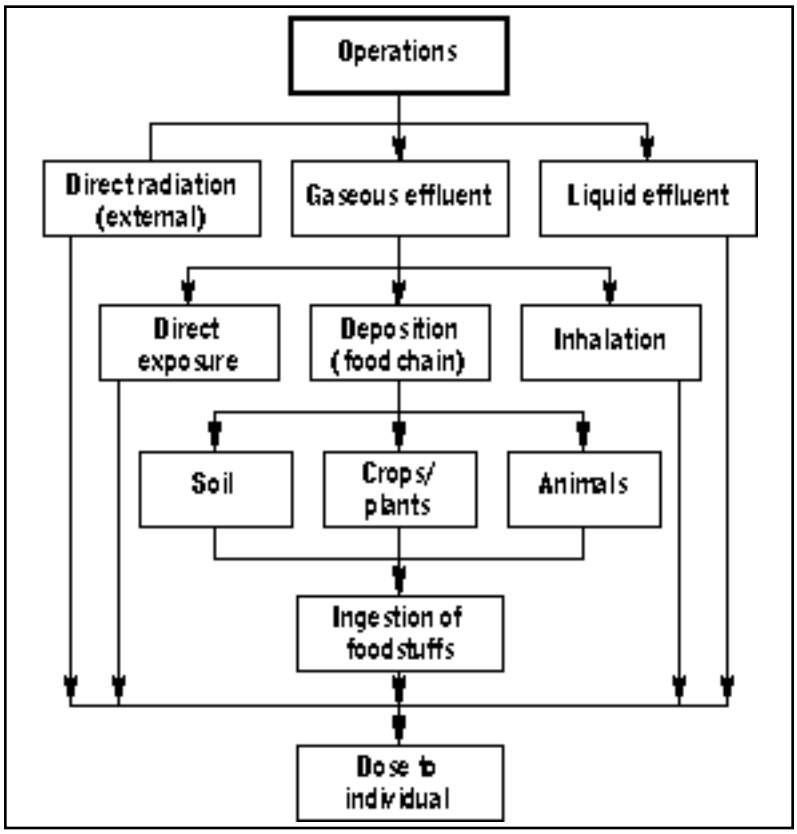


Figure 4-23. Major radiation exposure pathways to humans.

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 1996, the annual average external dose at the site boundary was 55 mrem (0.55 mSv), compared to 54 mrem (0.54 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 1996.

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.

The dose to the maximally exposed individual from SNL/California operations in 1996 was 1.09×10^{-5} mrem (1.09×10^{-7} 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 only route of tritium exposure at SNL/California is through airborne release. The calculated doses include immersion, inhalation, and ingestion doses based upon this airborne release.

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 1.09×10^{-5} % 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, 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 1996 air pathway dose was 1.09×10^{-5} mrem, which is 1.09×10^{-4} % 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 1996 was 5.31×10^{-4} person-rem (5.31×10^{-6} person-Sv). There are no regulatory limits for collective dose. DOE Order 5400.2 requires an estimate of the collective dose as an additional evaluation of public impact of site operations. This population dose is 3×10^{-8}% 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).[2]

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 1996 was 1.9×10^{-5} 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. 4-24).

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

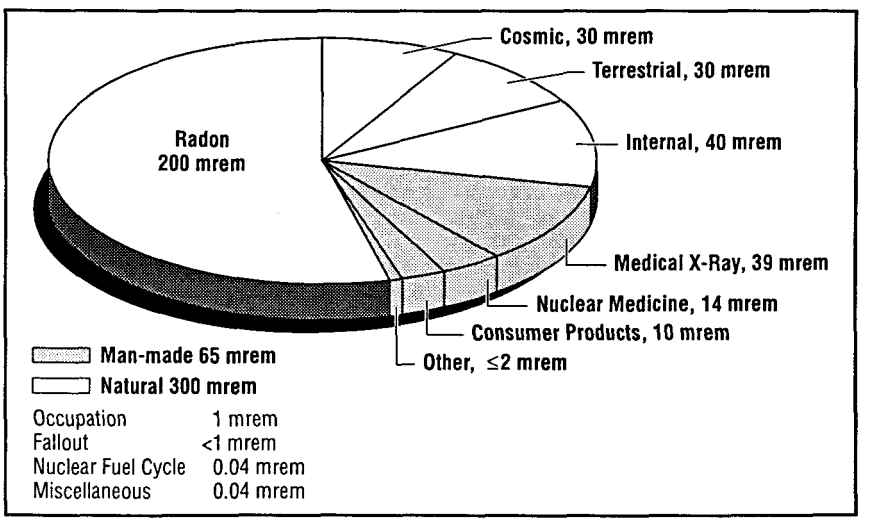


Figure 4-24. Sources of radiation received by a U.S. resident.

two-thirds of a person's background dose comes from naturally occurring radon gas, which accumulates in buildings. Radioactive materials also are in the environment as a result of former nuclear weapons testing.

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.

References

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5. U.S. DOE, Sandia National Laboratories/California, *Categorical Process Report* (January 1995).

6. U.S. DOE, Sandia National Laboratories/California, *Wastewater Discharge Compliance Report* (monthly).

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9. U.S. EPA, Title 40 CFR, Part 136, *Guidelines Establishing Test Procedures for the Analysis of Pollutants* (1992, latest revision).

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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	29	volatile and semivolatile organics, metals, general minerals, diesel, tritium, radium, and uranium. One well monitored for water level only.	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	34	radiation dose	quarterly	DOE Order 5400.1	DOE

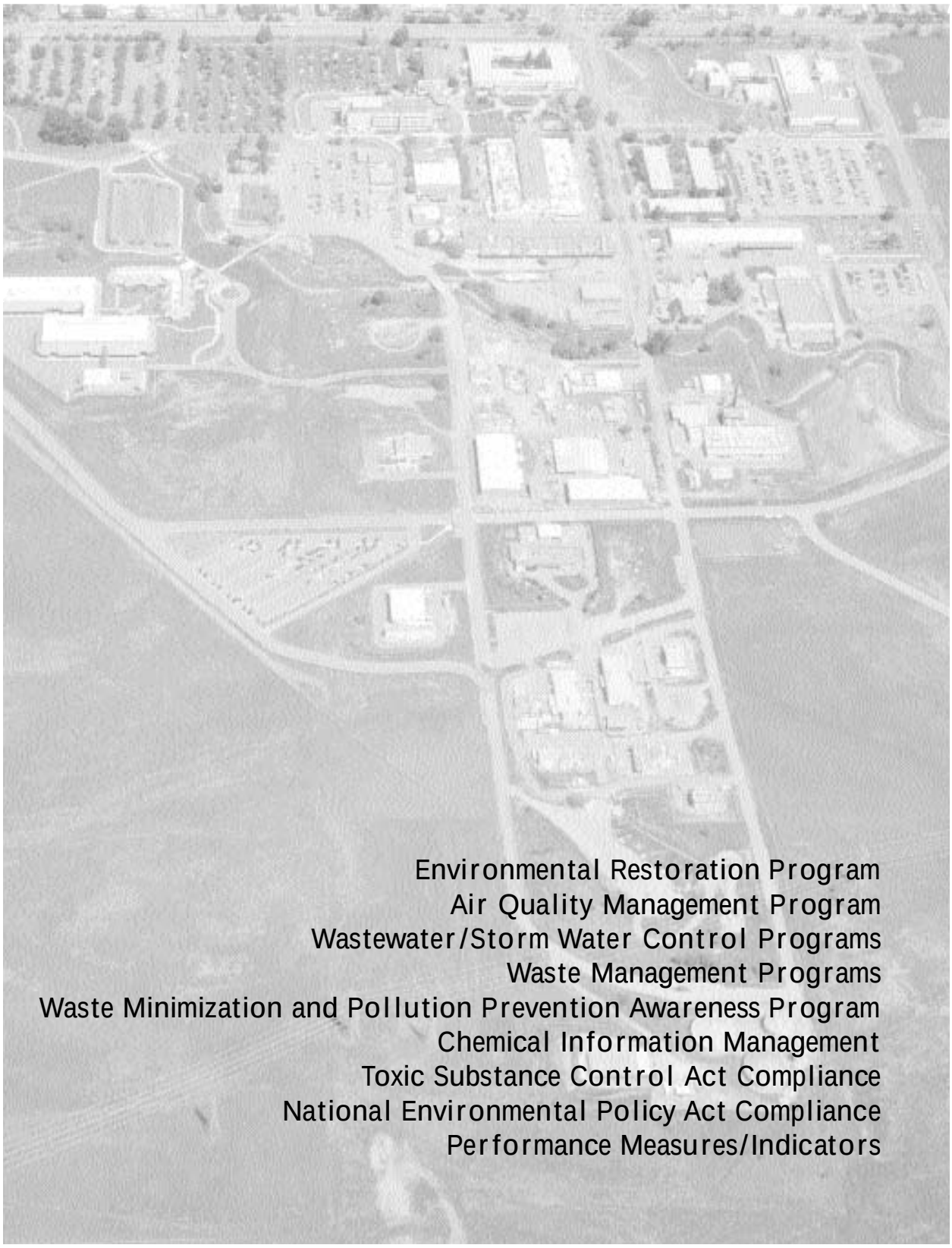
[a]These numbers represent all the samples collected by LLNL and SNL/California. Not all the LLNL samples are pertinent to SNL/California; therefore, the number of locations listed in the following tables may differ from these values.

[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
Performance Measures/Indicators

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 was 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

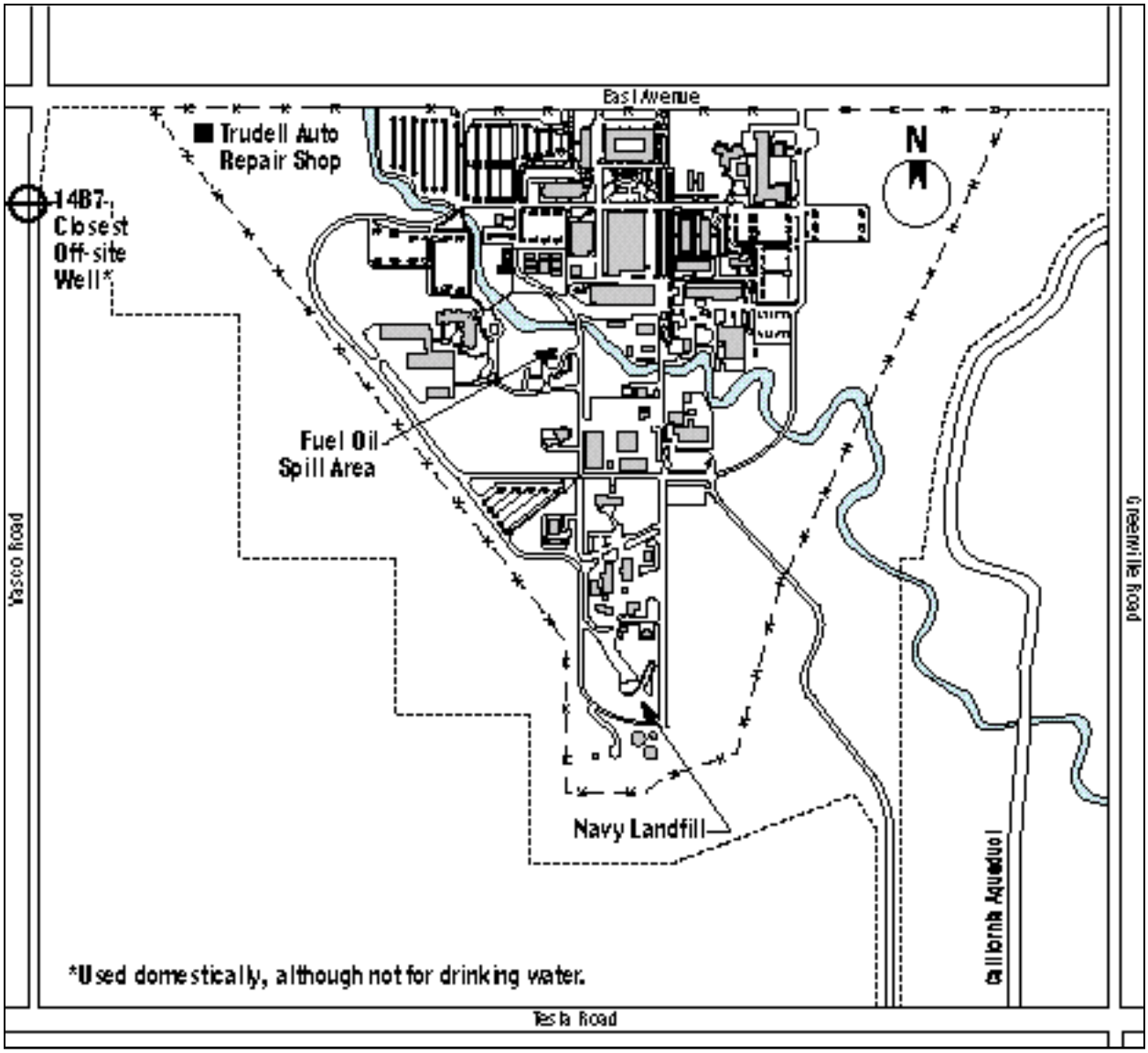


Figure 5-1. SNL/California remediation sites.

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 ft3 per minute). This phase continued through the end of 1995.

In 1996, the cycles (nutrient injection, withdrawal, and aeration) continued. The year ended with the third injection phase which began on September 24. The nutrient mix for the third injection phased consisted of 25 mg/L of ammonium nitrate and 1 mg/L of phosphoric acid. Nutrients are being injected through all eight pilot study injection points along with the infiltration gallery at a flow rate of 1.5 gallons/minute at each location. The third-cycle, nutrient injection was completed on December 12. Approximately 842,000 gallons of water and nutrient were injected through the injection wells and 199,000 gallons through the infiltration gallery. Ongoing data collection and chemical analyses help SNL/California monitor the progress of the bioremediation.

During the second half of the 1996, SNL/California began performing carbon dioxide (CO_2) measurements in the monitoring wells within the pilot study area. The CO_2 concentrations have been extremely high, which indicate that significant biodegradation is occurring. Later, monitoring wells outside of the pilot study area were sampled, and significant CO_2 levels were found in the wells where contamination is located. This suggests that the pilot study injections are affecting an area substantially larger than the pilot study area. Work is continuing with the CO_2 measurements to determine the level of biological activity and the area being impacted by the pilot study bioremediation.

In January of 1997, total petroleum hydrocarbon (TPH) samples will be taken to determine the level of contamination in the monitoring wells. This data will be compared to the original TPH baseline data to help determine how much bioremediation has taken place and to establish the effectiveness of the pilot study operation.

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 are sampled quarterly.

In November 1994, SNL/California received a recommendation for closure of the landfill from the SWRCB.

After further review of the site data in early 1996, SNL/California and DOE suggested that an enlarged cover over the Navy Landfill may not be necessary to protect human health and the environment. Currently, the Regional Water Quality Control Board, DOE, and SNL/California are investigating the possibility of declaring the Navy Landfill inert. In August 1996, the DOE submitted to the Regional Board a request for Inert Classification. The DOE and SNL/California are requesting that the Navy Landfill be categorized as containing only inert waste and, therefore, not subject to the closure requirements in CCR Title 23, Chapter 15, Article 8. The data presented in the request support the conclusions that 1) the Navy Landfill contains only inert waste, 2) the Navy Landfill waste is not degrading the quality of groundwater, and 3) the Navy Landfill in its current state does not pose a threat to the public health or environment.

Underground Storage Tank Management

SNL/California complies with Federal and State requirements for underground storage tanks.[5] 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.[5] 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.

In 1996 both underground storage tanks were upgraded to meet the requirements of the 1997 UST regulations.

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.[6] The plan was prepared in accordance with Title 40 CFR, Part 112.[7] It was approved in December 1992. Site personnel have been trained in spill response procedures.

Air Quality Management Program

In 1996, 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 1996, SNL/California operated 29 permitted sources and 34 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 1996, 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 ask individuals to voluntarily curtail or postpone pollution-causing activities. The District recognized SNL/California for its participation 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 (the former 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 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 (SWRCB) administers the storm water permit, SNL/California is regulated by the Regional Water Quality Control Board (Regional Board).[8] A new storm water permit has been drafted that modifies frequency of some monitoring activities. The SWRCB staff anticipates the new permit will be issued in the beginning of 1997. However, the first permit remains effective until the second permit is adopted by the SWRCB.

In response to the permitting requirement of the Federal Clean Water Act for municipal storm water discharges, the Alameda County Flood Control & Water Conservation District (Flood Control District) adopted ordinances that also require SNL/California to manage storm water discharges to the Flood Control District's storm drainage system. However, under a memorandum of understanding with the Regional Board, the Regional Board is the lead regulatory agency for federal facilities such as SNL/California.

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

* *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.*

discharges are eliminated.[9] 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 recent 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 visible 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 separate storms. Chapter 4 describes each sampling location and the results of Sandia's storm water sampling activities in 1996.
- *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 1996, 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 a fourth automatic sampler at location G (see Fig. 4-5). Automatic samplers help ensure the safety of sampling personnel during storm water sampling.

Waste Management Programs

The Resource Conservation and Recovery Act (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.

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 1996.

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 2,000kg low-level radioactive waste to the Nevada Test Site in 1996. Less than 50 m^3 of waste from other research and development activities are in the storage facility, packaged in DOT-specification containers. 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 from point-of-generation to SNL/New Mexico or to other permitted treatment facilities for management; no mixed waste is currently stored at SNL/California waste management facilities.

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 or disposed. 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 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. In 1996 SNL/California emphasized products that contain recycled material. Nineteen vendors displayed products ranging from rerefined oil to office accessories made from recycled plastic.
- 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's a trip reduction program continues to reduce air pollution by reducing vehicle trips to the site.
- Waste minimization personnel conduct site-wide pollution prevention activities surveys to determine the usage of pollution prevention practices around the site.
- Green waste is collected and disked into the fields. Branches and shrub cuttings are processed through a shipper/shredder and used in weed control and ground covering.
- SNL/California recycled 483 toner cartridges in 1996, which saved 130 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 1996 netted $26,117 in revenue and avoided 90.78 metric tons of waste.
- 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 1996, more than 35.21 metric tons of paper and 0.27 metric ton of cans were collected for recycling.
- Cardboard was added to the recycling program in 1996. More than 8.92 metric tons of cardboard were recycled.
- Over 0.50 metric ton of tires from Sandia/California's Maintenance Department were recycled in 1996 as a part of LLNL's tire recycling program.
- The Waste Management Group recycles hazardous wastes whenever possible. Some examples are batteries, mercury, fluorescent light tubes, 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 1995 and 1996, 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 under the direction of the DOE. The goal of a PPOA is to identify opportunities to prevent the generation of waste through the evaluation of material management and on-site processes and activities. Approximately 18 to 24 months after the initial assessment, a reassessment (PPOR) is conducted. Waste generation is tracked annually to evaluate pollution prevention progress.

SNL/California conducted the following two PPOAs and three PPORs in 1996: PPOA for Propellants, Explosives, and Pyrotechnics; PPOA for Landscape Waste; PPOR for the Radiography Laboratory; PPOR for the Plotting and Digitizing Support/Electronic Prototype Laboratory; and PPOR for Network Operations' Digital Photo Imagers. The results of these PPOAs and PPORs are summarized below.

Propellants, Explosives, and Pyrotechnics (April, 1996)

This PPOA documents the activities at SNL/California that have involved propellants, explosives, and pyrotechnics, and outlines options for disposal of energetic waste. In 1992 Sandia formed the Propellants, Explosives, and Pyrotechnics Evaluation and Reapplication Task Force (PEPER) to develop the tools to implement cradle-to-grave management of energetic materials. PEPER met the following objectives: 1) create an accurate inventory of all energetic materials owned by Sandia; 2) evaluate the stability of the inventory, and identify and destroy all imminent hazards; 3) reduce the inventory to be consistent with post-Cold War business needs; and 4) create a cradle-to-grave ownership process.

SNL/California's primary goal is the reapplication or recycling of surplus energetic materials. Rocket motors have been donated to other government organizations and bulk explosives, gun propellants, and rocket motor propellants have been converted into a variety of new products. Most of the obsolete components that contain explosives are being dismantled with the metal and explosives going to recycling. There are limited disposal options, and they include transferring energetic materials to Kirtland Air Force Base for open burn or detonation, or to a facilities that destroys the explosives in a contained thermal treatment system. Future disposal methods may include plasma arc technology that thermally destroys the material so that the end result is a stable and non-leaching glassy slag, or cryocycling or cryofracture that reclaims encapsulated explosives for recycling or reuse.

Facilities that use a contained thermal treatment system to destroy explosives are being evaluated by SNL/CAs waste management department. Research on the feasibility of using plasma arc technology and cryocycling and cryofracturing continue.

Landscape Waste (August, 1996)

SNL/California landscaping covers approximately 5.3 acres of lawn area and 3.9 acres identified as ground cover and

shrub areas. The two most economical and environmentally friendly options for recycling landscape identified by the PPOA process are: 1) grasscycling, which leaves the grass clippings on the lawn where they are naturally recycled, and 2) using a chipper/shredder to turn tree and shrub trimmings into wood chips and mulch for weed control and garden decoration.

Other less cost effective options include: using a disposal service to send landscape waste to a recycling/compost facility; Sandia hauling the waste to a recycling/compost facility; composting on site; and increase low maintenance landscaping where appropriate (e.g., more native and drought tolerant plants).

As a result of the findings of the PPOA, grass clippings are disked into the ground, and tree and shrub cuttings are put through a chipper shredder and used as mulch.

Plotting and Digitizing Support Laboratory/Electronic Prototype Laboratory Reassessment (April 1996)

The initial PPOA was performed in 1994. Based on the results of the reassessment, the following pollution prevention activity has taken place:

Two new products, Kodak Ektaline 2000 Film and Rapid Access Developer, are being used in conjunction. The Rapid Access Developer has a longer life or period of use than the previous developer used.

Radiography Laboratory Reassessment (May 1996)

The initial PPOA was performed in 1994. Based on the results of the reassessment, the following pollution prevention activities have taken place:

- The laboratory was moved and upgraded.
- The Agfa-Geavert DD 3700 print processor was eliminated from the process.
- The lab has the capability to do real time Radiography thereby eliminating much of the wet photo chemical process.
- Photographic waste had decreased by controlling the amount of time the DuPont NDT 100 processor is turned on and by lessening the frequency of bath changes.
- The developer is no longer considered hazardous waste and is sent to the sewer thus avoiding from 225 to 260 kg of hazardous waste going to disposal annually.

Network Operations' Digital Photo Imagers Reassessment (August 28, 1996)

The initial PPOA was performed in 1994. Based on the results of the reassessment, the following pollution prevention activity took place:

The two Ilford Digital Photo Imager processors were decommissioned and shipped to LLNL for reapplication. Approximately $25,000 is saved annually in new material and waste disposal costs, and the generation of approximately 1,000 kg of waste is avoided annually by with the shutdown of the DPI operation.

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. A Waste Management System (WMS) software module was completed and successfully put into production early 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). 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.[10] 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).[11] The DOE Kirtland Area Office (KAO) provides guidance to SNL/California regarding these implementing procedures. Part of the required NEPA documentation for every project is either 1) an SNL/ California Project Information List (PIL), used for documenting projects that are clearly covered under existing documentation (the EIS or Umbrella Categorical Exclusions), or 2) a DOE Environmental Checklist (ECL), used for documenting projects that are not clearly covered under existing documentation. The PIL undergoes an SNL/CA internal review and classification, while the ECL is forwarded to DOE/KAO for a NEPA determination. SNL/California does not make determinations on its own proposed projects. Both the PIL and ECL provide a description of the proposed project and identify potential environmental, safety or health issues. 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.

Another type of document, an Umbrella ECL, is prepared for groups of activities which are conducted on a routine or continuing basis. SNL/California requested Umbrella categorical exclusions for the following groups of activities: siting and construction of support structures; asbestos management; routine maintenance activities; safety and health enhancements; chemical detection/sensor research; and decontamination and decommissioning of buildings and support structures.

In 1996, more than 100 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.

In past years, the NEPA Program staff provided NEPA training to 97% of SNL/California's employees. Efforts aimed at increasing NEPA awareness in 1996 included: increased use of the ES&H Interdisciplinary Team (IDT); periodic announcements on the daily news bulletin (TNT); and placing NEPA triggering mechanisms into the LDRD, ICO, and CRADA funding processes.

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

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4. U.S. DOE, Albuquerque Operations Office, *Navy Landfill Solid Waste Water Assessment Test Report* (June 1994).

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8. State of California, California Administrative Code, Title 22, "California Domestic Water Quality and Monitoring Regulations" (1977).

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

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

Waste Type	Waste Shipped in 1995 (kg)	Waste Shipped in 1996 (kg)	Change (%)
RCRA hazardous waste	34,444	14,700	-57%
California-regulated (non-RCRA) hazardous waste	24,780	9,500	-62%
Low-level mixed waste	475	225	-53%
Low-level radioactive waste	15,692	1,980	–87%
TSCA (PCBs/asbestos)	26,431	14,630	-45%
Biohazardous	134	215	+60%
Sanitary waste	880,740	276,646	–69%

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

	Amount Recycled Per Year (in metric tons unless otherwise specified)					
Recycled Item	**1991**	**1992**	**1993**	**1994**	**1995**	**1996[a]**
Office Paper	2.93	20.40	26.00	26.50	44.79[d]	35.21[e]
Cardboard						8.92
Toner Cartridges		0.09	0.48	0.72	1.22	0.66
Aluminum Cans	NA	0.45	0.40	0.46	0.30	0.27
Tires					0.53	0.53
Scrap Metal[b]	NA	NA	340.00	91.00	68.04	90.78
Waste Management						
- lead	0.77	NA		[c]	[c]	[c]
- batteries	0.92	NA	1.47	3.64	2.99	0.42
- engine oils	750 gal	NA	2.79	2.90	3.18	2.62
- fluorescent light tubes	1.82	NA	0.20	6.54	4.54	0.40
- coolant	1320 gal	NA	9.54	5.44	4.26	4.98
- photo related items containing silver (gross)	18,000 gal	NA	5.56	5.91	1.59	1.68
- laboratory glass					20 yr[c]	0.55
Yard Waste						NA

Note: NA = data not available

[a]Totals as of December 2, 1996.

[b]Scrap metals are not segregated or weighed, but are sold to contractors by lot. The weight indicated is an estimation.

[c]Included in scrap metal.

[d]Increase due to the additional types of paper that can be recycled.

[e]Decrease due to use of double sided copying capabilities, TNT, electronic bulletin boards and other electronic memos, forms, etc.

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 (see Chapter 5 for description of this 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. 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.

Groundwater Sampling

Before sampling, 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 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 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.

All 17 of the Fuel Oil Spill monitoring wells had enough water for SNL/California to obtain a sample according to established procedures during all four quarters of 1996.

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

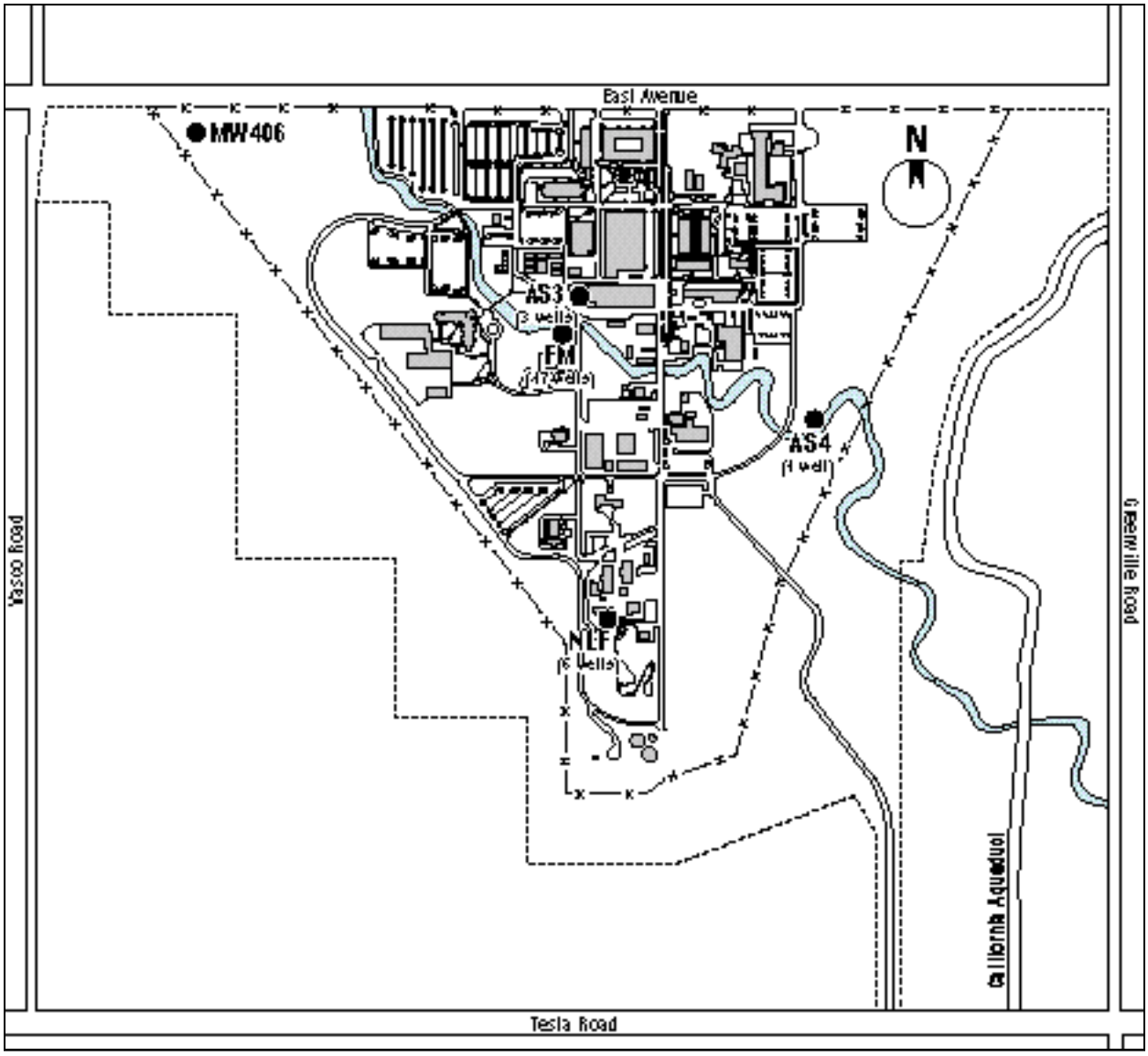

Figure 6-1. Groundwater monitoring well locations on the SNL/California site.

ground surface.) A fourth well, AS-4, installed upgradient of SNL/California, was intended to function as a background well.

During 1996, groundwater samples were only obtained from AS-4, as wells AS-3A, B, and C were purged dry or did not have sufficient water to collect a sample according to established procedures.

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 1996.

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 was sampled during the second, third, and fourth quarters of 1996.

Analytical Results

In 1996, well NLF-6 was the only location in which carbon tetrachloride was detected. Carbon tetrachloride was detected during three quarters at levels greater than the State maximum contaminant level (MCL) (0.5 µg/L) ranging from 1.1 to 2.3 µg/L. SNL/CA will continue to monitor for carbon tetrachloride.

Throughout 1996, diesel was found in wells around the site. At the Navy Landfill, diesel was found in NLF-1 during three quarters ranging from 360 to 620 µg/L, in NLF-3 during the third quarter at 100 µg/L, and in NLF-6 during the second and third quarters at 80 and 100 µg/L respectively. Diesel was found in 16 of the 17 wells at the Fuel Oil Spill site during at least one quarter. Groundwater concentrations at the Fuel Oil Spill site ranged from 70 µg/L to 620,00 µg/L and are graphed in Figure 6-2. During the first three quarters, 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. Beginning in the fourth quarter, the analytical laboratory initiated a new reporting format. If the detected chromatographic pattern does not match the standard diesel pattern, the concentration is reported as "TPH-extractables" rather than diesel. Benzene concentrations above the state MCL (1 µg/L) were found in three of the Fuel Oil Spill site wells in the second quarter, in two wells in the first and fourth quarters, and in one well in the third quarter. Benzene concentrations ranged from 1.6 to 11 µg/L. The wells where benzene was

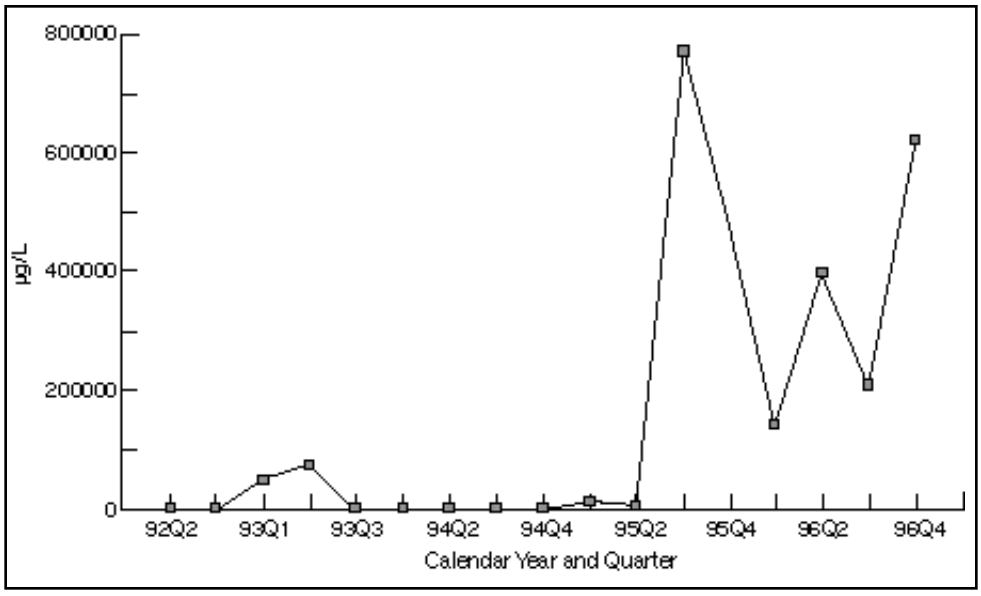

Figure 6-2. Highest positively detected diesel concentration in groundwater from any Fuel Oil Spill monitoring well.

found had the highest levels of diesel. Since benzene is a component of #2 diesel fuel oil, benzene can also be expected in these wells. Diesel was also found in the Buffer Area well (MW-406) in the second and third quarters at 330 and 100 µg/L respectively.

Almost all of the monitoring wells showed high concentrations of total dissolved solids. Groundwater from all but one well 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.

Nickel was 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 0.28 mg/L. Figure 6-3 shows historical trends of these parameters in groundwater at the Navy Landfill Site. One of the wells at the Fuel Oil Spill site (FM-3) also showed concentrations above the state or federal MCL for Barium (1 mg/L), Cadmium (0.005 mg/L), Lead (0.05 mg/L), and Nickel (0.1 mg/L). The metal concentrations were 1.8, 0.006, 0.55, and 0.29 mg/L respectively.

Groundwater from several monitoring wells in the Fuel Oil Spill site showed levels of aluminum greater that the state MCL (1 mg/L). Seven wells exceeded the State MCL with concentrations ranging from 1.1 to 200 mg/L. Aluminum was also detected in the Buffer Zone well ranging from 1.4 to 7.9 mg/L.

Nitrates (as nitrogen) were detected above the federal MCL (10 mg/L) in the wells NLF-1 and NLF-6 at the Navy Landfill in all four of the quarters. Nitrates were detected above the federal MCL in NLF-3 during the first and fourth quarters. Nitrate concentrations above the federal MCL ranged from 17 to 63 mg/L. Figure 6-3 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. Figure 6-4 shows historical tritium monitoring data at the Navy Landfill site, Fuel Oil Spill site, and Arroyo Seco wells.

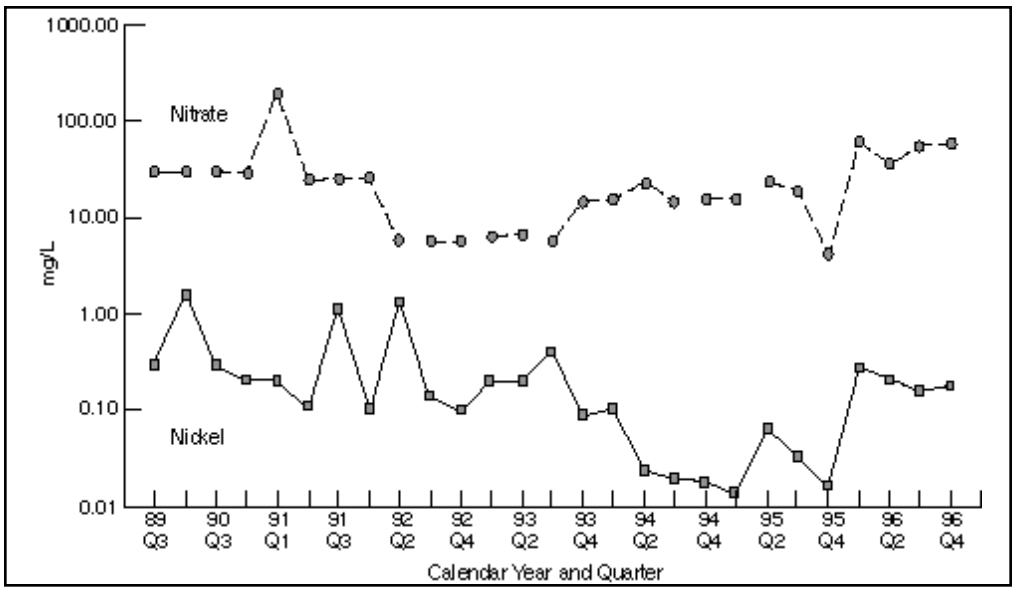

Figure 6-3. Highest analyte concentration observed in any Navy Landfill monitoring wells.

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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).

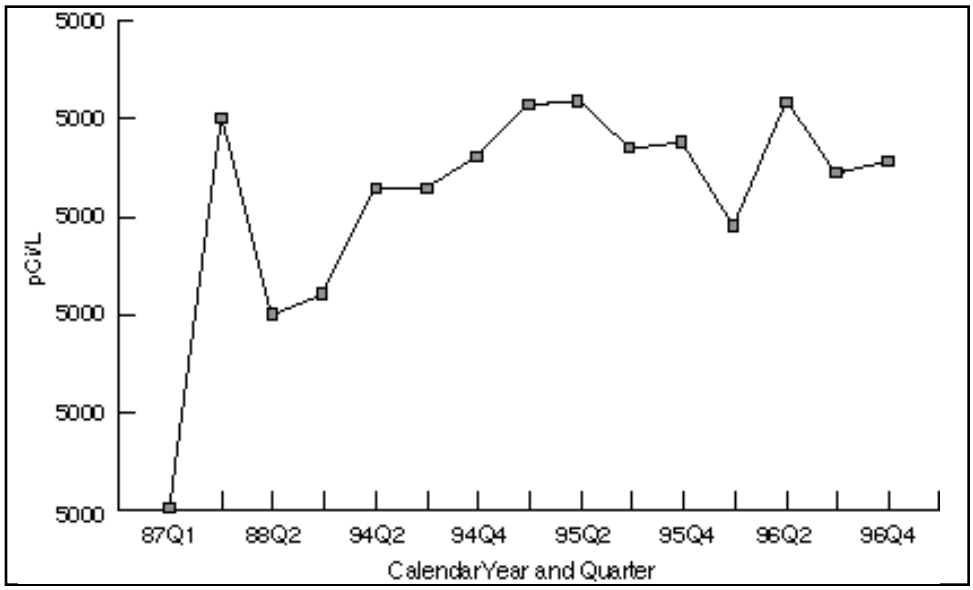


Figure 6-4. Highest tritium activity observed in SNL/California monitoring wells.

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.

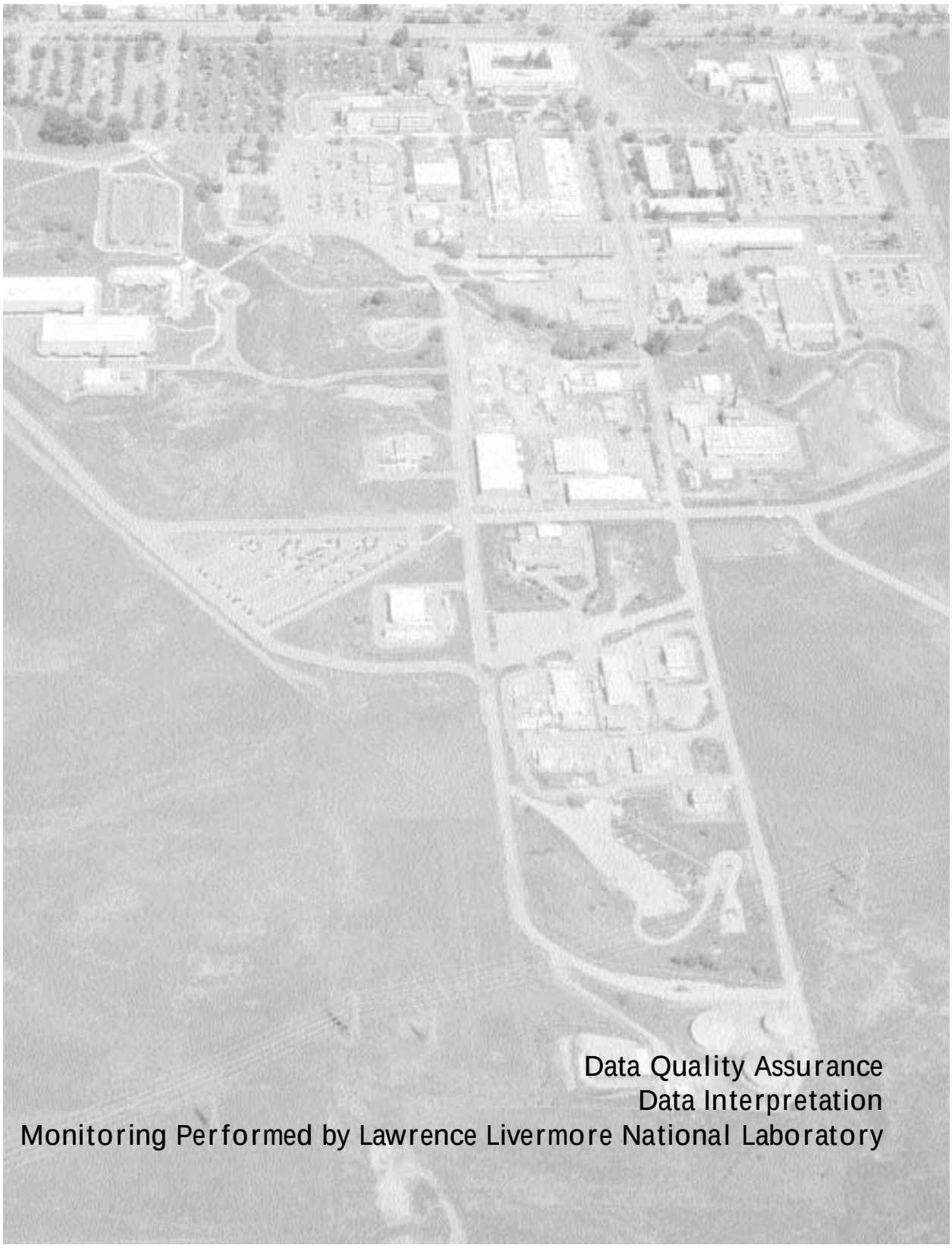
[b]EPA Method 602 applies to BTEX (benzene, toluene, ethylbenzene, xylenes), which are aromatic volatile organic compounds.

[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 National Security and Environmental Technologies 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.

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, 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 phenol 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.

References

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

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

3. U.S. DOE, Order 5700.6B, *Quality Assurance* (March 1989).

4. U.S. DOE, Order 5700.6C, *Quality Assurance* (August 1992).

5. U.S. DOE, Sandia National Laboratories/California, *Quality Assurance Management Plan* (1991).

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

7. U.S. EPA, Title 40 CFR, Part 58, *Ambient Air Quality Surveillance* (1987).

8. U.S. EPA, *Quality Assurance Handbook for Air Pollution Measurement Systems*, EPA600/9-76-005 (1976).

9. American Society for Quality Control, *Quality Assurance Requirements for Environmental Programs*, ANSI/ASQC E4 (September 1992).

10. U.S. DOE, Sandia National Laboratories/California, *Data Validation and Verification for the Environmental Monitoring Program* (January 1994).

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.

			Value Reported (pCi/L ± 1σ)		
Medium	**Analysis**	**Analyzed by**	**Analytical Result**	**Known**	**Normalized deviation from the known value[b]**
Water	tritium	SNL/California	21,273 ± 361	22,002 ± 2200	–0.57

[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	52.12/–10.98	—[d]
	Chemical oxygen demand	14.50/–18.26	—[d]
	Total suspended solids	88.14/–45.93	—[d]
	Total dissolved solids	1.18/–14.67	—[d]
	Specific conductivity	3.07/–1.85	—[d]
	Oil and grease	34.98/–18.61	—[d]
	Chromium	—[c]	0.75
	Copper	15.65/–20.49	—[d]
	Mercury	—[c]	1.37
	Nickel	—[c]	0.50
	Silver	—[c]	0.92
	Zinc	9.95/–23.62	—[d]
	Chloroform	4.17/–7.49	—[d]
	Phenol	—[c]	2.79
Storm Water Runoff			
	pH	—[c]	0.98
	Specific conductivity	—[c]	0.92
	Total suspended solids	—[c]	1.00
Air			
	Tritium[e]		

[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.

[e]detection limit were collected during 1996.

Glossary

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
NEPA	National Enviornmental 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
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. (Theunit 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).

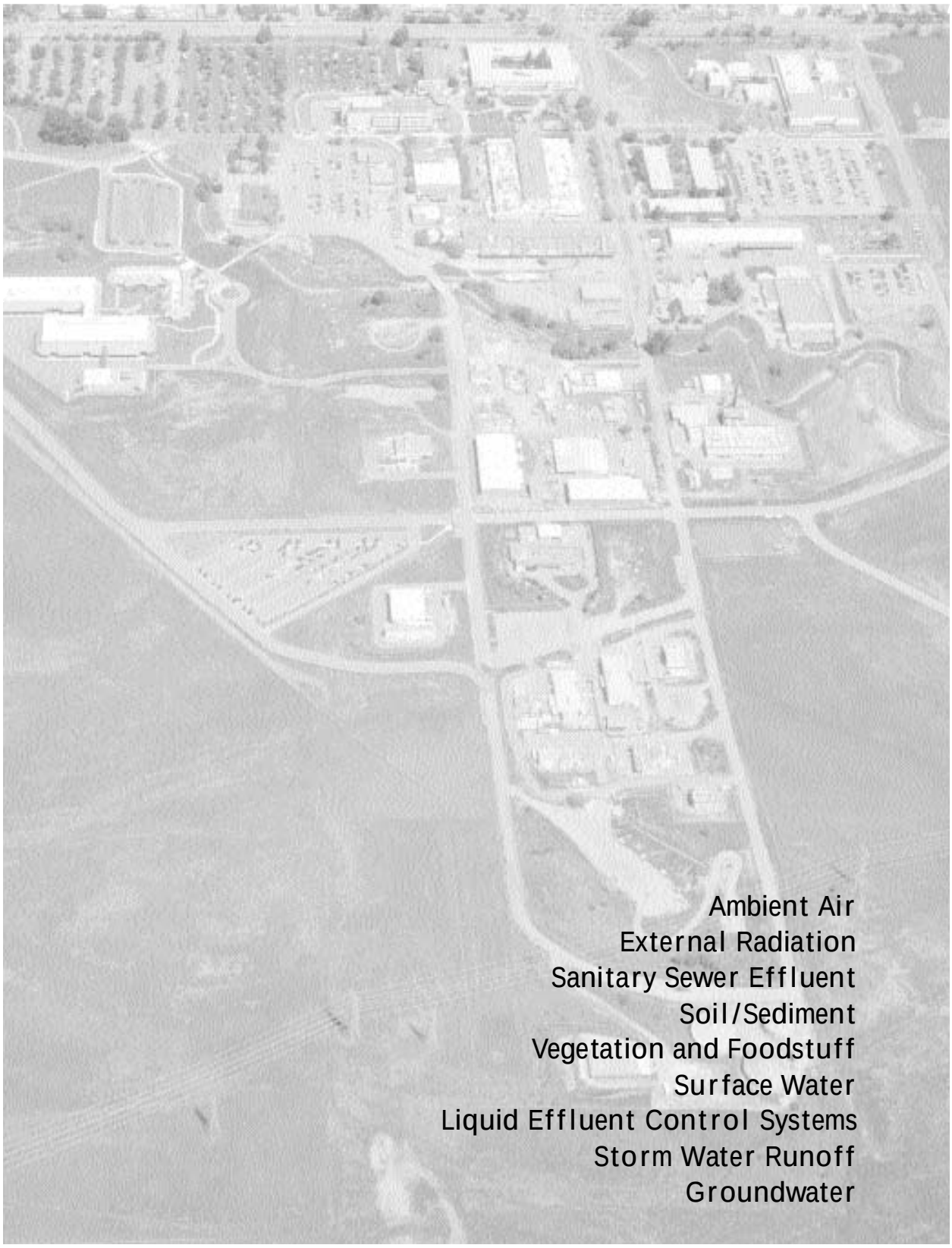
rem Stands for roentgen equivalent man; a unit of ionizing radiation, equal to the amount of radiation needed to produce the same biological effect to humans as 1 rad of high-voltage x-rays. It is the product of the absorbed dose (rad), quality factor (Q), distribution factor, and other necessary modifying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

gray (GY) A unit of absorbed dose from ionizing radiation; 1 Gy = 100 rad.

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

Chemical and physical analyses on LECS and groundwatersamples 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 LLNL 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, and total suspended solids.

Soil/Sediment

Tritium in Arroyo Sediment

A portion of the sediment is sent to the LLNL 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 LLNL 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 LLNL 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 LLNL 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.

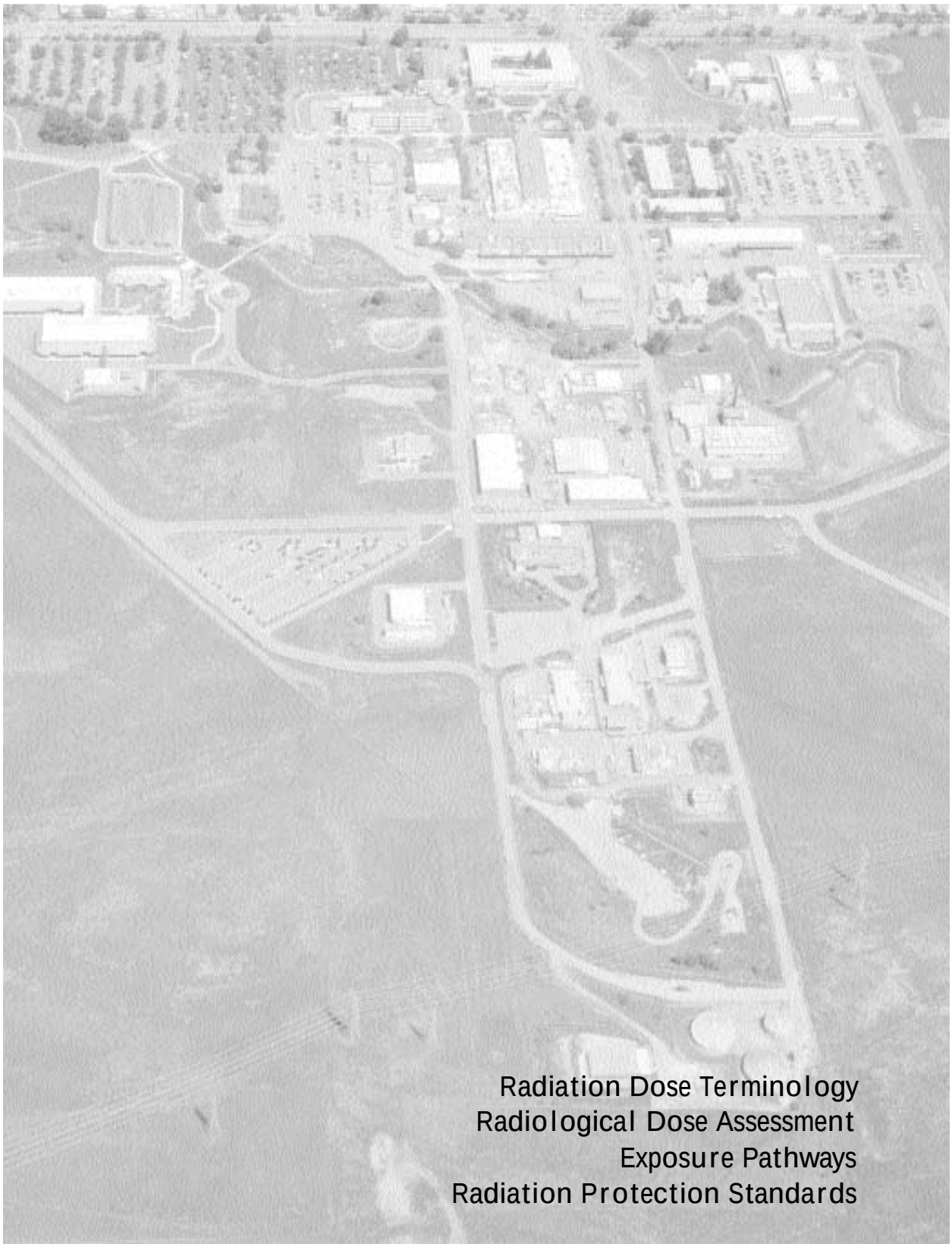
Storm Water Runoff

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 1996 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 take in 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,

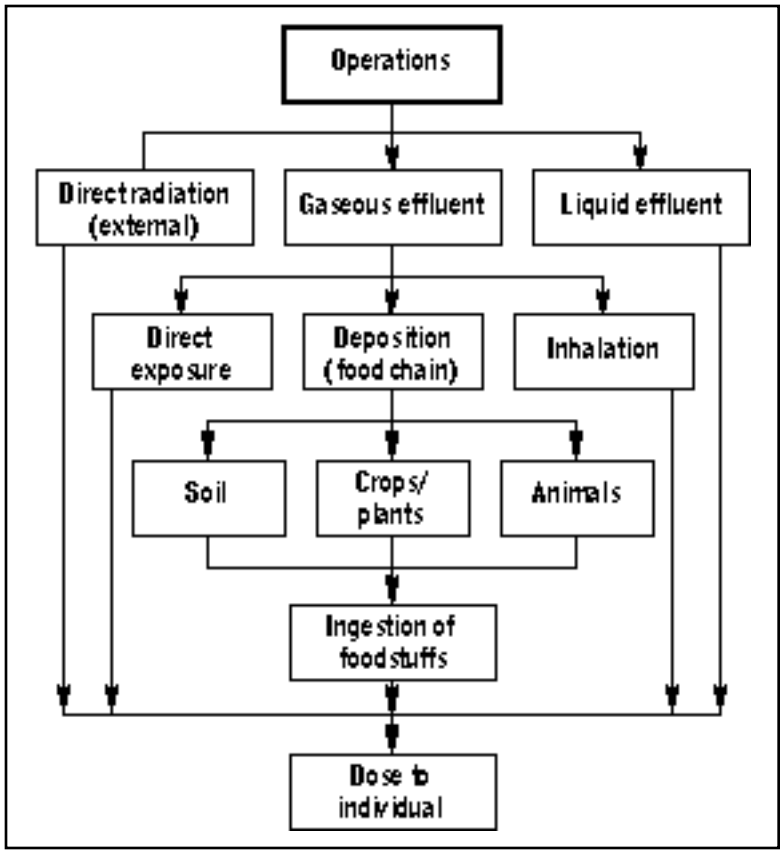


Figure B-1. Major radiation exposure pathways to humans.

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 maintained 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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