**U.S. Department of Energy
Washington, DC 20585**

**Environment, Safety and Health
Office of Environmental Audit**

**Environmental Survey
Preliminary Report**

**Sandia National Laboratories
Livermore, California**

January 1988

MASTER *rd*

PREFACE
TO
THE DEPARTMENT OF ENERGY
SANDIA NATIONAL LABORATORIES LIVERMORE
ENVIRONMENTAL SURVEY PRELIMINARY REPORT

This report contains the preliminary findings based on the first phase of an Environmental Survey at the Department of Energy (DOE) Sandia National Laboratories Livermore (SNLL), located at Livermore, California. The Survey is being conducted by DOE's Office of Environment, Safety and Health.

The SNLL Survey is a portion of the larger, comprehensive DOE Environmental Survey encompassing all major operating facilities of DOE. The DOE Environmental Survey is one of a series of initiatives announced on September 18, 1985, by Secretary of Energy, John S. Herrington, to strengthen the environmental, safety, and health programs and activities within DOE. The purpose of the Environmental Survey is to identify, via a "no-fault" baseline Survey of all the Department's major operating facilities, environmental problems and areas of environmental risk. The identified problem areas will be prioritized on a Department-wide basis in order of importance in 1989.

The findings in this report are subject to modification based on the results from the Sampling and Analysis Phase of the Survey. The findings are also subject to modification based on comments from the Albuquerque Operations Office concerning the technical accuracy of the findings. The modified preliminary findings and any other appropriate changes will be incorporated into an Interim Report. The Interim Report will serve as the site-specific source for environmental information generated by the Survey, and ultimately as the primary source of information for the DOE-wide prioritization of environmental problems in the Survey Summary Report.

December 1987
Washington, D.C.

PRELIMINARY

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EXECUTIVE SUMMARY

Introduction

This report presents the preliminary findings from the first phase of the Environmental Survey of the United States Department of Energy (DOE) Sandia National Laboratories Livermore (SNLL), in Livermore, California, conducted January 19 through 23, 1987.

The Survey is being conducted by an interdisciplinary team of environmental specialists, led and managed by the Office of Environment, Safety and Health's Office of Environmental Audit. Individual team components are being supplied by a private contractor. The objective of the Survey is to identify environmental problems and areas of environmental risk associated with SNLL. The Survey covers all environmental media and all areas of environmental regulation. It is being performed in accordance with the DOE Environmental Survey Manual. This phase of the Survey involves the review of existing site environmental data, observations of the operations performed at SNLL, and interviews with site personnel.

The Survey team developed Sampling and Analysis requests to assist in further assessing certain of the environmental problems identified during its on-site activities. The Sampling and Analysis program will be executed by Oak Ridge National Laboratory. When completed, the results will be incorporated into the SNLL Environmental Survey Interim Report. The Interim Report will reflect the final determinations of the SNLL Survey.

Site Description

SNLL is located about 64 kilometers (40 miles) east of San Francisco, California, approximately 5 kilometers (3 miles) east of the City of Livermore. The facility is bounded on the north by Lawrence Livermore National Laboratory (LLNL). SNLL occupies more than 0.9 square kilometers (220 acres) of land and is undergoing an expansion program through acquisition of buffer zones along site boundaries. SNLL is operated by AT&T Technologies, Inc., and was established in 1956 to provide ordnance engineering services for LLNL. Current programs being carried out at SNLL include nuclear weapon systems development and combustion, solar, and fusion research.

On October 22, 1986, key members of the Survey team met with representatives of local and state regulatory agencies. No environmental issues were raised by the regulatory agencies during the meeting. Although not raised during the meeting, a known concern of the state is the potential for

groundwater contamination as a result of a 1975 diesel fuel leak. SNLL monitors this area in accordance with a 1985 California Regional Water Quality Control Board (CRWQCB) Order.

Summary of Findings

The major preliminary findings of the Environmental Survey conducted at SNLL are as follows:

- Diesel fuel, from a 1975 underground pipeline leak, has contaminated the unsaturated zone (soils) down to the water table. The contaminated soil is a potential source of groundwater contamination, especially if the water table rises. SNLL installed monitoring wells in 1984 and continues to monitor the nature and extent of contamination in accordance with a 1985 California Regional Water Quality Control Board Order. Analytical results for July 1986 indicate that the fuel in the unsaturated zone has reached the water table but does not appear to be migrating downgradient.
- Six areas on-site may have received hazardous substances. These areas, which have not been adequately characterized, constitute potential sources of groundwater contamination.

Overall Conclusions

The Survey found no environmental problems at SNLL that represent an immediate threat to human life. None of the environmental problems identified by the Survey were determined to require immediate management attention. At present, the most pressing problem facing the site is the potential for groundwater contamination as a result of the 1975 diesel fuel leak. SNLL has characterized the contaminated area and continues to monitor the groundwater in accordance with a State of California Order.

The environmental problems described in this report vary in terms of their magnitude and risk. Although the Survey-related sampling and analysis to be performed at SNLL will assist in further identifying environmental problems at the site, a complete understanding of the significance of some of the environmental problems identified requires a level of study and characterization that is beyond the scope of the Survey. Actions currently under way or planned at the site, particularly the groundwater investigation relating to the diesel fuel leak, will contribute toward meeting this requirement.

Transmittal of Results

The findings of the Environmental Survey of SNLL were shared with the DOE Albuquerque Operations Office and the site contractor at the Survey closeout briefing held January 23, 1987. Those findings that involve extended studies and multi-year budget commitments will be the subject of the Environmental Survey Summary Report and DOE-wide prioritization.

Within the Office of Environment, Safety and Health, the Office of Environmental Guidance and Compliance has immediate responsibility for monitoring environmental compliance and the status of SNLL findings. The Office of Environmental Audit will continue to assess the environmental problems through the program of systematic environmental audits that will be initiated toward the conclusion of the DOE Environmental Survey.

1.0 INTRODUCTION

The purpose of this report is to present the preliminary findings made during the Environmental Survey, January 19 through 23, 1987, at the Department of Energy's (DOE) Sandia National Laboratories Livermore (SNLL) in Livermore, California. SNLL is operated for DOE by AT&T Technologies, Inc. As a Preliminary Report, the contents are subject to revision. Revisions based on Albuquerque Operations Office review and comments concerning the technical accuracy, the results of the Sampling and Analysis phase of the Survey, and other information that may come to the Survey team's attention will be incorporated into the Interim Report.

The SNLL Survey is part of the larger, comprehensive DOE Environmental Survey effort announced by Secretary John S. Herrington on September 18, 1985. The purpose of the Environmental Survey is to identify, via a "no fault" baseline Survey of all the Department's major operating facilities, existing environmental problems and areas of environmental risk. The identified problem areas will be prioritized in 1989 on a Department-wide basis in order of importance. The prioritization will enable DOE to more effectively address environmental problems and allocate the resources necessary to correct these problems. Because the Survey is "no fault" and is not an "audit," it is not designed to identify specific, isolated incidents of noncompliance nor to analyze environmental management practices. Such incidents and/or management practices are, however, used in the Survey as a means of identifying existing and potential environmental problems and risk.

The SNLL Environmental Survey is being conducted by an interdisciplinary team of environmental specialists headed and managed by the Office of Environment, Safety and Health's Office of Environmental Audit. A complete list of Survey participants and their affiliations is included in Appendix A.

The Survey team focused on all environmental media, using Federal, state, and local environmental statutes and regulations, accepted industry practices, and professional judgment to make the preliminary findings included in this report. The team carried out its activities in accordance with the guidance and protocols in the DOE Environmental Survey Manual. Substantial use of existing information and of interviews with knowledgeable field office and site-contractor personnel accounted for a large part of the on-site effort. A summary of the site-specific Survey activities is presented in Appendix B, and the Survey Plan is presented in Appendix C.

The preliminary Survey findings are presented in Chapters 3 and 4 in the form of existing and potential environmental problems. Chapter 3 includes those findings that pertain to a specific

environmental medium, e.g., air or soil, while Chapter 4 includes those that are non-media-specific, e.g., waste management, radiation, and quality assurance. Because the findings vary greatly in terms of magnitude, risk, and characterization, and consequently require different levels of management attention and response, they are further divided into four categories within each of the sections in Chapters 3 and 4.

The criteria for placing a finding into one or more of the four categories are as follows:

Category I includes only those findings which, based upon the information available to the Team Leader, involve immediate threat to human life. Findings of this type shall be immediately conveyed to the responsible Environmental Safety and Health personnel at the scene or in control of the facility or location in question for action. Category I findings are those environmental problems where the potential risk is highest, the confidence in the finding, based on the information available, is the strongest, and the appropriate response to the finding is the most restrictive in terms of alternatives.

Category II findings encompass one or more of the following situations:

- Multiple or continuing exceedances, past or present, of a health-based environmental standard where there is immediate potential for human population exposure, or a one-time exceedance where residual impacts pose an immediate potential for human population exposure.
- Evidence that a health-based environmental standard may be exceeded, as discussed in the preceding situation, within the timeframe of the DOE-wide Survey.
- Evidence that the likelihood is high for an unplanned release due to, for example, the condition or design of pollution abatement or monitoring equipment or other management practices.
- Noncompliance with significant regulatory procedures, i.e., those substantive technical regulatory procedures designed to directly or indirectly minimize or prevent risks, such as inadequate monitoring or failure to obtain required permits.

Category II findings include those environmental problems where the risk is high but the definition of risk is broader than in Category I. The information available to the Team Leader is adequate to

identify the problem but may be insufficient to fully characterize it. Finally, in this category, more discretion is available to the Operations Offices and Program Offices as to the appropriate response; however, the need for that response is such that management should not wait for the completion of the entire DOE-wide Survey to respond. Unlike Category I findings, a sufficient, near-term response by the Operations Office may include further characterization prior to any action taken to rectify the situation.

Category III findings encompass one or both of the following criteria:

- The existence of pollutants or hazardous materials in the air, water, groundwater, or soil resulting from DOE operations that pose or may pose a hazard to human health or the environment.
- The existence of conditions at a DOE facility that pose or may pose a hazard to human health or the environment.

Category III findings are those environmental problems for which the broadest definition of risk is used. As in Category II, the information available to the Team Leader may not be sufficient to fully characterize the problem. Under this category, the range of alternatives available for response, and the corresponding timeframes for response, are the greatest. Environmental problems included within this category will typically require lengthy investigation and remediation phases, as well as multi-year budget commitments. These problems will be included in the DOE-wide prioritization effort to ensure that DOE's limited resources are used effectively.

In general, the levels of pollutants or materials that constitute a hazard or potential for hazard are those that exceed some Federal, state, or local regulations for release of, contamination by, or exposure to such pollutants or materials. However, in some cases, the Survey may determine that the presence of some nonregulated material is in a concentration that presents a concern for local populations or the environment that is sufficient to be included as an environmental problem. Likewise, the presence of regulated materials in concentrations, even though below those established by regulatory authorities, that nevertheless present a potential for hazard or concern may be classified as an environmental problem. In general, however, conditions that meet regulatory or other requirements, where such exist, should not present a potential hazard and will not be identified as an environmental problem.

Conditions that pose or may pose a hazard are generally those which are violations of regulations or requirements (e.g., improper storage of hazardous chemicals in unsafe tanks). Such conditions present a potential hazardous threat to human health and the environment and should be identified as an environmental problem. Additionally, potentially hazardous conditions are those where the likelihood of the occurrence of release is high.

The definition of the term environmental problem is broad and flexible to allow for the wide differences among the DOE sites and operations. Therefore, a good deal of professional judgment must be applied to the identification of environmental problems.

Category IV findings include instances of administrative noncompliance and management practices that are indirectly related to environmental risk, but are not appropriate for inclusion in Categories I-III. Such findings can be based upon any level of information available to the Team Leader, including direct observations by the team members. Findings in this category are generally expected to lend themselves to relatively simple, straightforward resolution without further evaluation or analysis. These findings, although not part of the DOE-wide prioritization effort, will be passed along to the Operations Offices and appropriate Program Office for appropriate action.

Based on the professional judgment of the Team Leader, the findings within categories are arranged in order of relative significance. Comparing the relative significance of one finding to another, either between categories within a section or within categories between sections, is neither appropriate nor valid. The categorization and listing of findings in order of significance within this report is only the first step in a multi-step iterative process to prioritize DOE's problems.

The next phase of the SNLL Survey was sampling and analysis (S&A). Oak Ridge National Laboratory (ORNL), the S&A team for SNLL, took samples in August 1987. Prior to sampling, an S&A Plan was prepared by DOE and ORNL in accordance with the protocols in the DOE Environmental Survey Manual. The S&A Plan was designed to fill existing data gaps or weaknesses. The results generated by the S&A effort are used to assist the Survey team in further defining the existence and extent of environmental problems and risk identified during the Survey.

An Interim Report is prepared 3 months after the S&A results are available. The Interim Report incorporates the results of the S&A effort as well as any changes or comments resulting from the review of the Preliminary Report. Based on the S&A results, the preliminary findings and observations made during the on-site Survey may be modified, deleted, or moved within or between categories. The Interim Report will serve as the site-specific source for information generated by the

Survey, and ultimately as the site-specific source of information for the DOE-wide prioritization of environmental problems in the final Survey report.

It is clear that the findings and observations in this report are highly varied in terms of magnitude, risk, and characterization. Consequently, the priority, magnitude, and timeliness of near-term responses requires careful planning to ensure appropriate and effective application. The information in this Preliminary Report, albeit preliminary, will assist the Albuquerque Operations Office in the planning of these near-term responses.

2.0 GENERAL SITE INFORMATION

2.1 Site Setting

The Sandia National Laboratories Livermore (SNLL), which occupies more than 0.9 square kilometers (220 acres) is located about 64 kilometers (40 miles) east of San Francisco at the southeast end of the Livermore Valley in southern Alameda County. The City of Livermore is located about 5 km (3 miles) to the west. DOE's Lawrence Livermore National Laboratory (LLNL) is situated immediately north.

SNLL overlies an area of low relief that slopes gently downward to the northwest. Two groups of low hills are situated approximately 1.0 km (0.6 miles) southeast and 3.2 km (2 miles) northwest of the site. The southernmost part of the site is the highest point, 250 meters (820 feet) above sea level, and is the location of three water-storage tanks which provide water for both DOE laboratories. The northern half of the site is relatively flat with an elevation ranging from 192 to 198 meters (630 to 650 feet) above sea level. Current plans are to purchase additional land to the south, east, and west to provide a buffer zone (SNL, 1984).

Figure 2-1 shows the regional setting. Land to the north of the two DOE laboratories is zoned industrial. To the west, land is rapidly becoming a high-density urban setting. To the south, land is zoned industrial, although its present use is mostly agricultural. To the east, land is zoned agricultural and is currently used as pasture. Figure 2-2 shows the site layout (DOE, 1982).

Prior to World War II, the land now occupied by the two DOE laboratories was used for light agriculture and cattle grazing. In March of 1942, the Navy purchased the property as a site for establishing a training base, subsequently known as the Livermore Naval Air Station. Part of the area now occupied by SNLL contained a Navy landfill disposal site.

Surface waters in the area generally drain toward the west by means of arroyos (creeks in arid regions) and intermittent streams. Also nearby are the South Bay Aqueduct and the Del Valle Reservoir.

The major water-bearing formations in this area are multi-layered systems of an upper, unconfined aquifer overlying a series of semiconfined aquifers. The two most important units containing aquifers are the surface valley-fill materials and the Livermore Formation. Groundwater occurs chiefly in an upper aquifer in unconsolidated sediments, and in a lower aquifer among deeper

FIGURE 2-1

REGIONAL SETTING OF SNLL
SNLL - LIVERMORE, CALIFORNIA

FIGURE 2-2

LAYOUT OF SNLL SITE SNLL - LIVERMORE, CALIFORNIA

sandstones. There are also several localized perched water-bearing zones underlying the site. Flow tends to be to the west or west-northwest (MARK Group, 1986).

The local climate is generally characterized as a Mediterranean type. Summers are typically warm and dry and winters are mild and moderately wet. Rainfall occurs mostly from October to April and averages about 37 cm (14.6 inches) per year.

Predominant winds in the summer are from the west and southwest, while in the winter, they are mixed with a high percentage coming from the northeast and north. Wind speeds are in the range of 5 to 7 meters per second (11 to 16 miles per hour).

2.2 Overview of Major Site Operations

Sandia National Laboratories Livermore (SNLL) is a prime contractor to the Department of Energy (DOE) operated under provision of a non-profit, no fee contract with AT&T Technologies, Inc. SNLL employs approximately 1,100 people.

SNLL's principal objective is research, development, and design of nuclear weapon systems. Major activities include tritium research, arming, fusing, and firing systems; and aerodynamic and structural elements used in nuclear bombs and warheads. Components in these systems include power supplies, timing mechanisms, radar, switches, and other classified elements that make up the intricate actuating and control mechanisms. Energy-related research activities are also conducted at the facility.

Current defense programs at SNLL include five major nuclear weapon systems in development or early production. Continued growth in defense programs is expected. The next generation of weapons that may be developed, such as high-technology space systems, directed-energy weapons, and advanced conventional weapons, is in preliminary design stages.

Energy programs include combustion, solar, and fusion research. Joint programs at the Combustion Research Facility will increase, and a need for studies in high-temperature science is developing. Solar research is likely to continue for the next 5 years and could extend beyond the year 2000. Fusion research will probably remain a small effort.

SNLL handles kilogram quantities of depleted uranium, a by-product of ^{235}U enrichment, (primarily ^{238}U with approximately 0.2 percent ^{235}U), gram quantities of tritium, and microcurie quantities of

other isotopes. The radionuclides released during normal operations at SNLL are small amounts of depleted uranium and tritium.

Arroyo Seco divides the SNLL site into two different work areas, as shown in Figure 2-2. The Office and Laboratory Area north of the arroyo is used to provide office, shop, laboratory, and support space. This area is the most heavily populated at SNLL.

The Office and Laboratory Area includes a vault for the storage of classified and unclassified radioactive materials. The laboratories in this area are: laboratories for electronics, telemetry, nucleonics, optical electronics, powder metallurgy, hydrogen effects, microelectronics, glass, and joining.

The Maintenance Shops and Storage Area are used for plant maintenance offices and shops, support facilities, raw stock storage, and a hold area for storing equipment. A small hold area used for the temporary storage of solid radioactive wastes is also located in this area. The carpentry and sheet metal shops were recently moved into this area from the Office and Laboratory Area.

Building 968, the SNLL Tritium Research Laboratory, is a 25-m x 55-m (82-ft x 180-ft) single-story, concrete laboratory building designed for tritium research experiments involving more than 0.1 gram of tritium. The maximum quantity of tritium allowed in an experiment is 120 g (1.2 megacuries). These experiments are performed in sealed gloveboxes. Automatic decontamination systems remove tritium from gloveboxes and vacuum pumps.

Dynamic and static environmental testing is carried out in 10 buildings on-site. Non-high-explosive testing and special testing are carried at LLNL's Site 300 whenever an isolation or special requirement situation is mandated.

2.3. State/Federal Concerns

Representatives of SNLL, the Albuquerque Operations Office, LLNL, the San Francisco Operations Office, and key members of the Survey team met with ten representatives of state and local environmental agencies on October 22, 1986, at the San Francisco Operations Office to discuss agency concerns at both laboratories. Attendees are listed in Appendix B. The U.S. Environmental Protection Agency was not able to send a representative.

During this meeting the Survey Team Leader described all aspects of the DOE Survey. Mr. T. Devlin presented status reports on environmental matters at SNLL and Messrs. Ragaini and Hoffman presented a similar status report on LLNL.

The questions from the attendees were general in nature; no major issues, environmental or otherwise, were raised. The attendees expressed interest in receiving a copy of the Environmental Survey Manual and Interim Survey Report, and there were a few questions about the prioritization system and the money available for corrective action. Although the state expressed interest in the sampling aspects of the Survey, there were no inquiries regarding the opportunity to participate in the Survey. The meeting lasted approximately 45 minutes.

PRELIMINARY

3.0 MEDIA-SPECIFIC SURVEY FINDINGS AND OBSERVATIONS

The discussions in this section pertain to existing or potential environmental problems in the air, soil, water, and groundwater media in relation to the Sandia National Laboratories Livermore, Livermore, California. The discussions include a summary of the available background environmental information related to each medium, a description of the sources of pollution and their control techniques, a review of the environmental monitoring program specific to each medium, and a categorization and explanation of the environmental problems found by the Survey team related to each medium.

3.1 Air

3.1.1 Background Environmental Information

SNLL is located in Alameda County, which is part of the Bay Area Air Quality Management District (BAAQMD) of the State of California. For many parameters, California has adopted air quality standards more stringent than Federal standards. Table 3-1 shows a comparison of the two standards. Nevertheless, the Bay Area has been successful in achieving compliance with most of these standards. Table 3-2 shows a summary of 1986 monitoring results for the monitoring stations operated by BAAQMD. As can be seen from this table, compliance with the standards for nitrogen oxides, sulfur dioxide, and total suspended particulates is excellent. San Francisco and San Jose are still considered nonattainment areas for carbon monoxide, but the Livermore Valley area has been designated as an attainment area for these four criteria pollutants (BAAQMD, 1985-1986; BAAQMD, 1987).

With respect to ozone, however, the Bay Area continues to have a nonattainment designation. In 1986, the Livermore station reported three days of noncompliance (down from four in 1985 and seven in 1984). In total, the Bay Area had only 5 days in 1986 on which one or more stations were above the Federal (1 hour) standard of 0.12 parts per million. The general trend in the Livermore Valley (and the Bay Area) is down. The State Implementation Plan for reaching attainment will continue to emphasize reductions in gasoline vapors and other components of automobile exhaust.

Attainment of the ozone standard in the Livermore Valley is partly dependent upon controlling releases in the urban areas to the west because of the general wind direction. Winds from the west, west-southwest, and southwest dominate, with these three compass points accounting for 48 percent of the winds. The wind rose for the SNLL area is shown in Figure 3-1, and a summary of wind frequencies by stability categories is shown in Table 3-3 (Devlin, 1986; DOE, 1982). It has been

TABLE 3-1

**COMPARISON OF FEDERAL AND CALIFORNIA AIR QUALITY STANDARDS
SANDIA NATIONAL LABORATORIES, LIVERMORE**

Pollutant Averaging Time	Federal Standards		California Standard	Objective
	Primary	Secondary		
Ozone 1-Hour	0.12 ppm 240 µg/m³	Same -	0.10 ppm 200 µg/m³	To prevent eye irritation, breathing difficulties.
Carbon Monoxide 8-Hour	9.3 ppm 10 mg/m³	Same	9.0 ppm 10 mg/m³	To prevent carboxyhemoglobin levels greater than 2%.
1-Hour	35 ppm 40 mg/m³	Same	20 ppm 23 mg/m³	
Nitrogen Dioxide Annual	0.05 ppm 100 µg/m³	Same	-	To prevent health risk and improve visibility.
1-Hour	-	-	0.25 ppm 470 µg/m³	
Sulfur Dioxide Annual	0.03 ppm 80 µg/m³	-	-	To prevent increase in respiratory disease, plant damage and odor.
24-Hour	0.14 ppm 365 µg/m³	-	0.05 ppm 131 µg/m³	
3-Hour	-	0.5 ppm 1,310 µg/m³	-	
1-Hour	-	-	0.25 ppm 655 µg/m³	
Sulfates 24-Hour	-	-	25 µg/m³	To improve visibility and prevent health effects.
Particulate Annual Geometric Mean	75 µg/m³	60 µg/m³	30 µg/m³ PM ₁₀ *	To improve visibility and prevent health effects.
24-Hour Average	260 µg/m³	150 µg/m³	50 µg/m³ PM ₁₀ *	
Visibility Reducing Particles	State Standard: One observation. Insufficient amount to reduce the prevailing visibility to less than 10 miles when the relative humidity is less than 70 percent			
Lead 30-Day	-	-	1.5 µg/m³	To prevent health problems.
Calendar Quarter	1.5 µg/m³	Same	-	
Hydrogen Sulfide 1-Hour	-	-	0.03 ppm 42 µg/m³	To prevent health problems.
Vinyl Chloride (Chloroethene) 24-Hour	-	-	0.010 ppm 26 µg/m³	To prevent health problems.

Source: BAAQMD, 1985-1986

*PM₁₀ = Particulate matter 10 microns or less in size.

ppm = parts per million

TABLE 3-2

AIR POLLUTION IN THE BAY AREA BY STATION AND CONTAMINANT: 1986
SANDIA NATIONAL LABORATORIES, LIVERMORE

Stations	Ozone			CO		NO ₂		SO ₂		TSP	
	Maximum	Days	3-Year Avg	Maximum	Days	Maximum	Days	Maximum	Days	Mean	Days
San Francisco	7	0	0.0	12.6*	2*	11	0	10	0	52	0
San Rafael	8	0	0.0	5.9	0	11	0	7	0	50	0
Richmond	7	0	0.0	5.0	9	13	0	8	0	38	0
Pittsburg	10	6	0.7	5.6	0	9	0	6	0	60	3
Concord	12	0	1.3	5.6	0	11	0	8	0	39	0
Oakland	9	0	0.0	7.5	0	-	-	-	-	-	-
San Leandro	8	0	1.1	-	-	-	-	-	-	-	-
Hayward	11	0	1.4	-	-	-	-	-	-	-	-
Fremont	14	2	3.7	5.6	0	14	0	7	0	48	0
Livermore	14	3	4.7	4.9	0	10	0	7	0	46	0
Alum Rock, S J	14	1	2.4	-	-	-	-	-	-	-	-
San Jose	14	1	3.3	11.0	4	16	0	7	0	**	**
Moorpark, S J	-	-	-	-	-	-	-	-	-	50	0
Gilroy	11	0	1.7	3.8	0	-	-	-	-	-	-
Los Gatos	12	0	5.7	-	-	-	-	-	-	-	-

TABLE 3-2
AIR POLLUTION IN THE BAY AREA BY STATION AND CONTAMINANT: 1986
SANDIA NATIONAL LABORATORIES, LIVERMORE
PAGE TWO

Stations	Ozone			CO		NO ₂		SO ₂		TSP	
	Maximum	Days	3-Year Avg	Maximum	Days	Maximum	Days	Maximum	Days	Mean	Days
Mountain View	13	1	0.3	-	-	-	-	-	-	-	-
Redwood City	10	0	0.3	6.4	0	13	0	3	0	44	0
Santa Rosa	8	0	0.0	5.3	0	14	0	3	0	38	0
Sonoma	10	0	0.0	-	-	-	-	-	-	-	-
Napa	9	0	0.0	6.8	0	9	0	2	0	46	1
Vallejo	9	0	1.0	10.8	4	10	0	9	0	36	0
Fairfield	9	0	0.3	-	-	-	-	-	-	-	-
DISTRICT		5			7		0		0		4

Source: BAAQMD, 1987

* Micro-scale site (Ellis Street) for street-level CO maxima

** Data invalid because of construction

S J San Jose

For ozone (O₃) and for nitrogen dioxide (NO₂), "maximum" is the highest hourly average value in parts per hundred million. For carbon monoxide (CO), "maximum" is highest 8-hour average value in parts per million. (The one-hour standard for CO was never exceeded during the year.) For sulfur dioxide (SO₂), "maximum" is highest 24-hour average value expressed in parts per billion. For total suspended particulates (TSP), "mean" is annual geometric mean in micrograms per cubic meter. "Days" columns give number of days per year on which an air quality standard was exceeded: Federal for O₃, CO, TSP, State for NO₂ and SO₂. For TSP, "Days" refers to Federal 150 µg/m³ secondary standard. The 3-year average for ozone, adjusted for instrument down-time, is the governing Federal standard (called Expected Annual Exceedance). Monitoring for O₃, CO and NO₂ is continuous. Monitoring for TSP is on the Federal systematic 6-day schedule; monitoring for SO₂ includes both time scales. Compiled by the staff of the BAAQMD Meteorology and Data Analysis Section.

SOURCE: Devlin, 1986

FIGURE 3-1

1985 WIND ROSE DIAGRAM
SNLL - LIVERMORE, CALIFORNIA

TABLE 3-3

SUMMARY OF WIND FREQUENCY TABLES BY STABILITY CATEGORIES^a
SANDIA NATIONAL LABORATORIES, LIVERMORE

DRY SEASON

	Category ^b					
	A	B	C	D	E	F
Most frequent direction	WSW, W	WSW, W	WSW, W	SW, WSW	SW, WSW	SW
Frequency (%)	~34	~48	~55	~62	~57	29
Speed (m/s)	3	3	4	5	5	5
Least frequent direction	ESE, SE, SSE	SE, SSE	ESE, SE	SE, NW	SE	SSE
Frequency (%)	5	~3	~2	~2	<1	0
Speed (m/s)	2	1-2	2	3-4	4	3
Highest average speed (m/s)	3	4	5	8	10	8
Direction	WNW, NW	WNW	N	NNW	NNW	NNW
Frequency	7-9	7	4	2	3	10
Lowest average speed (m/s)	2	2	2	2	2	0
Direction	S	SSE	SE	S	E	SSE
Frequency	7	2	1	1	1	0

WET SEASON

Most frequent direction	N	E	WSW, W	WSW, W	WSW, W	E
Frequency (%)	9	11	~25	~28	~32	15
Speed (m/s)	2	3	4	5	5-6	6
Least frequent direction	ESE	SSW	N	NNW	NNW	NW
Frequency (%)	3	4	2	2	1	<1
Speed (m/s)	2	3	4	3	4	2
Highest average speed (m/s)	3	~3	4	5	7	12
Direction	NW	WSW, W, WNW	WSW	WSW	NNE	NNE
Frequency (%)	5	~28	12	14	4	9
Lowest average speed (m/s)	2	2	3	3	3	2
Direction	ESE	SE, SSE	SSW, NNW	SSE	ESE, SE	NNW
Frequency (%)	3	~9	3-4	2	8	1

Source: DOE, 1982.

a Values rounded to nearest whole number.

b A = Extremely unstable conditions; B = Moderately unstable conditions; C = Slightly unstable conditions; D = Neutral conditions (applicable to heavy overcast, day or night); E = Slightly stable conditions; F = Moderately stable conditions.

m/s meters per second.

estimated that about one-third of the Livermore Valley smog precursors are imported from the upwind metropolitan bay areas (University of California, 1986).

Environmental plutonium and uranium radiation data reported by EPA for the Berkeley, California, sampling location are summarized below:

Location	10 ⁻¹⁸ ci/m ³ ± 2s				
	238Pu	239Pu	234U	235U	238U
Berkeley, California	1.9 ± 0.9	0.4 ± 0.4	7.5 ± 2.0	0.1 ± 0.2	7.2 ± 1.9

Source: EPA, 1987.

s = Sigma counting error

Pu = Plutonium

U = Uranium

Data described above was collected during the period from January-June 1986.

The Livermore Valley rarely experiences severe weather. The greatest recorded daily rainfall is about 90 mm (3.5 in). Thunderstorms occur less than 5 days per year and are not intense. Hail occurs even less frequently. Strong winds with gusts to about 30 m/s (67 mph) occur a few times each fall and winter, usually following the passage of a low-pressure system.

In one study, the tornado recurrence interval was estimated to be about 1 per 292,000 years or 3×10^{-6} per year. In a more recent study, it was indicated that extreme winds pose a more significant threat of structural damage in the central California area than to tornadoes.

SNL participates in LLNL's meteorological program for rapidly assessing critical meteorological parameters that may be used to estimate potential doses to individuals in the off-site environment in the event of an accidental release of hazardous materials into the atmosphere. This is known as the Atmospheric Release Advisory Capability (ARAC) service. It has three main functions: (1) to provide support to designated DOE facilities during an accidental release of radionuclides; (2) to support the DOE Emergency Response Team in the event of potential or actual release of radionuclides; and (3) to provide the Federal Aviation Administration (FAA) with dose assessments whenever aircraft could possibly intercept nuclear debris clouds from foreign atmospheric nuclear tests.

The ARAC central facility receives meteorological data from the Air Force Global Weather Central (AFGWC). In an accident situation, the meteorological data collected nearest the accident site are

used to predict cloud trajectories, concentrations, and population doses. At present, ARAC has two-way communications with AFGWC, the LLNL computer center, four DOE installations, the DOE Emergency Response Team, and the FAA.

3.1.2 General Description of Pollution Sources and Controls

The Bay Area Air Quality Management District (BAAQMD) has issued permits to operate 13 SNLL facilities. Nonradioactive airborne effluents from selected facilities are reported to the BAAQMD on an annual basis. The primary sources of nonradioactive airborne pollution are the SNLL steam plant and a small incinerator. The fuels used are natural gas or diesel No. 2, and the calculated releases are below applicable guide values (BAAQMD, 1986).

Five of the permits are for combustion sources: three for the steam plant and two for combustion research boilers. In addition, a small vapor degreaser is permitted. This degreaser uses an estimated 208 liters (55 gallons) per year of 1,1,1-trichloroethane. Other permitted sources include a stone saw that uses a cyclone to control dust (containing aluminum), a baghouse on machining operations at the machine shop, three paint-spray booths (one of which was closed in 1985), a drying booth at the Technical Art finish booth, and an incinerator.

Permitted emissions of volatile organic compounds are limited to 572 liters (151 gallons) per year (including the 1,1,1-trichloroethane). In 1986, estimates of actual usage reported to BAAQMD totaled about 530 liters (140 gallons) (Devlin, 1987a). Thus, SNLL is well below the criterion of 60 kg (133 pounds) per day of VOCs which BAAQMD uses to define a major stationary source.

Emissions of oxides of nitrogen from the combustion sources are estimated to be about 11 to 18 kg (25 to 40 pounds) per day, well below the 60 kg (133 pound) per day criterion. Emissions of total suspended particulates are insignificant.

SNLL handles kilogram quantities of depleted uranium, a by-product of ^{235}U enrichment, (primarily ^{238}U with about 0.2 percent ^{235}U), and gram quantities of tritium, but only microcuries of other isotopes. In 1986, it was estimated that 760 curies of tritium (mostly tritiated water) were released at the tritium research laboratory (TRL) stack. Releases of uranium were less than 10 curies from both airborne and liquid effluents.

High Efficiency Particulate Air (HEPA) filters are used at SNLL to control releases of depleted uranium particulates. A total of 28 HEPA filters were observed by the Survey team (6 in Building 913, 6 in Building 916, 4 in Building 961, and 12 in Building 979). Most are on machining or polishing

operations. Some of these control airborne metallic releases of other metals, such as beryllium or copper. Most filters had no differential pressure monitoring, and none had been tested during the past several years (see Finding 3.1.4.4.2).

All essential handling of tritium at SNLL occurs at the TRL (Building 968) because of the extensive controls in that building. (Tritium research conducted in Building 913 was transferred to the TRL in 1982.) A combination of practices to control tritium releases is in use at the TRL. Exhausting of areas of low contamination to areas of higher concentrations is practiced, and an elaborate system of alarms is in use. Waste streams from the sources (individual laboratories, hoods, and gloveboxes) are passed through either the gas purification system (GPS) or the vacuum effluent release system (VERS). The VERS operates continuously, but releases, indicated by alarms, can be processed in the GPS. The VERS system includes holding tanks to temporarily store additional volumes prior to treatment, if necessary. A total volume of 1,550 cubic meters (55,000 cubic feet) per minute of air is exhausted from the TRL through its 50-meter (164 ft) stack.

Annual releases of tritium from SNLL from 1982 through 1986 are shown in Table 3-4. The upward trend since 1983 is not expected to continue. Periodically, new techniques have been adopted. For example, on high-use gloveboxes, butyl gloves with low tritium permeability are being substituted for more conventional gloves. Similar improvements are being made to seals at the boxes.

3.1.3 Environmental Monitoring Program

Stack sampling at SNLL for airborne radionuclides is limited to tritium at the TRL, since quantities of other radionuclides on-site and subsequent potential releases are measured to be low. All rooms and gloveboxes inside the TRL are continuously monitored for tritium. These monitors are incorporated into an alarm system designed to both protect personnel and allow shutdown of experiments in the event of releases.

Continuous monitoring of the TRL main stack is accomplished by ion chambers that can alert personnel instantly to high levels. Continuous samples are also withdrawn from the stack and passed through a series of three ethylene glycol scrubbers for collection of tritiated water. Independently, a sample is passed over a heated palladium-sponge catalyst to convert tritium gas (H-T) to tritiated water (HTO). This sample is then passed through three ethylene glycol scrubbers in series for removal of the tritiated water formed in the catalytic oxidation stage. This procedure allows independent analysis for tritiated water and tritium gas. Most of the stack tritium is found in the form of tritiated water. Additional analyses are conducted for other tritium-containing compounds when experiments are in place utilizing (or possibly forming) such compounds.

TABLE 3-4

ANNUAL TRITIUM RELEASES (CURIES)
SANDIA NATIONAL LABORATORIES, LIVERMORE

1982	1983	1984	1985	1986
280	88	110	450	760

Source: Devlin, 1987b.

PRELIMINARY

Because LLNL maintains an extensive ambient air monitoring network, SNLL does not duplicate this effort. The LLNL programs will be described briefly, concentrating on the aspects which principally relate to SNLL releases.

The location of six LLNL perimeter monitoring stations is shown in Figure 3-2. Station 12 is actually on the north boundary of SNLL, whereas Stations 2 and 1 are close to the NNW and NNE boundaries of SNLL, respectively.

Other stations incorporated in the LLNL system are shown in Figure 3-3. Station 3 is actually on the southern SNLL boundary whereas Stations S-2 and S-1 are about 0.8 km (0.5 miles) to the west and east of SNLL, respectively.

Particulates are monitored at Stations 12, 2, 1, and 3, while tritium (in the form of tritiated water) is monitored at Stations S-2, S-1, 12, 2, and 1. Each of these particulate samples is obtained using $5.2 \times 10^{-2} \text{ m}^2$ (80-square inch) Whatman 41 cellulose filters from an average air flow rate of 400 to 700 liters/minute (14 to 25 cfm). The filters are changed weekly. Gross alpha, gross beta, uranium (both 235 and 238), and beryllium are determined on these samples.

In the tritium sampling program, concentrations of airborne HTO are determined at most of the above stations (Station 3 is a particulate station only) in addition to three other LLNL perimeter stations (Stations 13, 14, and 15 on Figure 3-2) and four remote stations in the Livermore Valley (Stations 4, 7, 9, and 17 in Figure 3-3).

The results of analysis of the particulate samples for gross alpha activity, gross beta activity, uranium-235, uranium-238, and beryllium are shown in Tables 3-5 through 3-9. The data indicate that levels of U-235 and U-238 are well below proposed derived concentration guidelines and that beryllium concentrations are less than 1 percent of the guide set by BAAQMD. No guidelines have been established by DOE orders for gross alpha or gross beta activity.

Comparison of the U-235 and U-238 data for 1984, 1985, and 1986 indicates that the ratios are nearly identical to that found for natural uranium. Thus, it is probable that the uranium in air samples is predominantly from natural sources.

The low levels for beryllium prompt SNLL to attribute the concentrations to resuspension of surface soil containing naturally occurring beryllium. Because the levels are below the regional mean, this appears to be a good assumption.

FIGURE 3-2

LLNL PERIMETER AIR-SAMPLING LOCATIONS
SNL LIVERMORE, CALIFORNIA

FIGURE 3-3

LIVERMORE VALLEY AIR-SAMPLING LOCATIONS
SNLL - LIVERMORE, CALIFORNIA

TABLE 3-5

GROSS ALPHA ACTIVITY IN AIR (10^{-15} $\mu\text{Ci}/\text{ml}$)
SANDIA NATIONAL LABORATORIES, LIVERMORE

Location	Average - Prior Years			1986 Results Average
	1983	1984	1985	
Livermore Site	0.6	0.5	0.5	0.5
Livermore Valley	0.6	0.5	0.5	0.5

Source: Devlin, 1987b

TABLE 3-6

GROSS BETA ACTIVITY IN AIR (10^{-14} $\mu\text{Ci}/\text{ml}$)
SANDIA NATIONAL LABORATORIES, LIVERMORE

Location	Average - Prior Years			1986 Results Average
	1983	1984	1985	
Livermore Site	1.0	1.1	1.4	1.4
Livermore Valley	1.4	1.5	1.9	1.9

Source: Devlin, 1987b

TABLE 3-7

URANIUM-235 CONCENTRATION IN AIR ($10^{-7} \mu\text{g}/\text{m}^3$)
SANDIA NATIONAL LABORATORIES, LIVERMORE

Location	1983	1984	1985	1986	% DCG*
Livermore Site	5.8	4.8	5.2	4.9	1×10^{-2}

Source: Devlin, 1987b

* The derived concentration guide (DCG) is $0.047 \mu\text{g}/\text{m}^3$

TABLE 3-8

URANIUM-238 CONCENTRATION IN AIR ($10^{-5} \mu\text{g}/\text{m}^3$)
SANDIA NATIONAL LABORATORIES, LIVERMORE

Location	1983	1984	1985	1986	% DCG*
Livermore Site	9.0	6.9	7.4	7.1	2×10^{-2}

Source: Devlin, 1987b

* The derived concentration guide (DCG) is $0.3 \mu\text{g}/\text{m}^3$

TABLE 3-9

BERYLLIUM CONCENTRATION IN AIR ($10^{-5} \mu\text{g}/\text{m}^3$)
SANDIA NATIONAL LABORATORIES, LIVERMORE

Location	1983	1984	1985	1986	% CG*
Livermore Site	2.4	2.5	6.8	4.2	0.4

Source: Devlin, 1987b

* Ambient concentration guide set by BAAQMD = $1 \times 10^{-2} \mu\text{g}/\text{m}^3$

Table 3-10 shows similar data for tritium (HTO) concentrations in ambient air. The information shown is taken directly from SNLL's annual monitoring report (Devlin, 1987b).

There were two occasions during 1986 when unusually high HTO concentrations were found at the perimeter monitors. These "outliers" were not included in the data in Table 3-10. Inclusion of the outliers raises the LLNL perimeter average from 2.4 to 12.3×10^{-11} $\mu\text{Ci/ml}$, the SNLL perimeter average from 1.8 to 3.8×10^{-11} $\mu\text{Ci/ml}$, and the Livermore Valley average from 1.0 to 4.6×10^{-11} $\mu\text{Ci/ml}$.

The high levels occurred during early September and again in late December. The first occurrence was noted at Stations 1 and 2 on the LLNL perimeter (Figure 3-2); Station S-2 west of SNLL; and Station 7, located about 8 km (5 miles) northeast of LLNL (Figure 3-3). The December occurrence was noted at Stations 13, 14, 15, and 7, with a slight elevation in concentrations at Station S-2. All averages were well below the derived concentration guides (DCGs). In fact, the highest single observation (at Station 14 in December), 448×10^{-11} $\mu\text{Ci/ml}$, is only 2.2 percent of the DCG.

Reviews of stack emissions and operating records at SNLL and LLNL have not identified any malfunction or other release that might have caused the unusually high concentrations. There is no explanation for the fact that Station 12 (located between Stations 1 and 2) and Station 4 (midway between LLNL and Station 7) did not report high values in September. Again, in December Station 4 reported low values, whereas Station 7 reported high values. Considering the erratic nature of the values, contamination of the samples in the laboratory appears to be a possible explanation.

Meteorological Tower

SNLL has a 40-meter (130-foot) telescoping tower originally installed to complement LLNL's tower. The LLNL tower is located near the north LLNL perimeter. The SNLL tower is near the southwest corner of the level portion of the SNLL site (at the west property line and approximately equidistant from East Avenue and the south boundary). Both towers are in locations where measurements accurately reflect meteorological conditions and are not influenced by buildings.

The SNLL tower has been out of service since late in 1986 because of the need for replacement of critical components. Considering the proximity of the LLNL tower to SNLL, SNLL does not regard fixing their tower as a high priority item.

TABLE 3-10

TRITIUM (HTO) ACTIVITY IN AIR (10^{-11} $\mu\text{Ci}/\text{ml}$)
SANDIA NATIONAL LABORATORIES, LIVERMORE

Location	Average - Prior Years			1986 Results
	1983	1984	1985	Average
LLNL perimeter	2.6	3.6	2.8	2.4
SNLL perimeter	2.1	1.6	1.6	1.8*
Livermore Valley			1.2	1.0

Source: Devlin, 1987c

* Derived concentration guide = 2×10^{-7} $\mu\text{Ci}/\text{ml}$ or 1×10^{-7} $\mu\text{Ci}/\text{ml}$ adjusted for skin absorption. SNLL perimeter average is 0.01 percent of the derived concentration guide.

3.1.4 Findings and Observations

3.1.4.1 Category I

None

3.1.4.2 Category II

None

3.1.4.3 Category III

None

3.1.4.4 Category IV

1. Dose Assessments. SNLL's dose assessment, as presented in the Annual Monitoring Report, is improperly calculated. In 1985 and 1986 SNLL estimated an "effective dose equivalent" of 0.01 millirem (mrem) based on the average perimeter airborne tritium concentrations.

The National Emission Standards for Hazardous Air Pollutants, 40 CFR 61, Subpart H, requires that the dose be calculated from radionuclide emissions data at the point of maximum concentration (as determined by dispersion modeling) in an unrestricted area where any member of the public resides. Although the health or environmental impact of the dose from SNLL is minimal, the method of calculation does not meet the requirements of 40 CFR 61, Subpart H.

Releases of radionuclides from both SNLL and LLNL are well controlled so that doses are low compared with DOE guidelines. For example, the LLNL collective dose to the population living within 80 km (50 mi) from the release of 774 Ci of tritium (as HTO) in 1986 was calculated to be 0.25 person-rem (compared to the dose from natural background radiation of 510,000 person-rem). LLNL does not include SNLL releases in its dose calculations. The dose from the 760 Ci released from SNLL in 1986 would be expected to be comparable. Doses at the property line and to the nearest resident would also be very low.

2. Testing of HEPA Filters. The HEPA filters at SNLL, if damaged while in use, would allow radionuclide particles to be discharged undetected, because there is no annual testing or

continuous monitoring of pressure drop across the filters. SNLL makes use of about 25 HEPA filters to control radioactive dust particles containing principally depleted uranium. A small number (two or three) are in use to contain other radionuclides and/or beryllium.

Standard operating procedures at most DOE locations require annual testing of HEPA filters to confirm the removal efficiency of 99.97 percent. In addition, many DOE locations utilize differential pressure monitors to warn of high loadings and/or damage. None of the SNLL filters use the differential pressure monitoring devices, and none have been tested since 1984.

3. Location of Perimeter Air Monitoring Stations: SNLL's perimeter monitoring stations for tritium are located so that concentrations at the property line are unmonitored. While this is not a regulatory or DOE requirement, standard procedures at most DOE facilities are to locate some ambient monitors at or near the property line in order to demonstrate that residents living near the perimeter are not exposed to high risks. SNLL's tritium perimeter monitors (Stations S-1 and S-2 in LLNL's network) are each located about 0.5 miles from the SNLL property line. SNLL's rationale for selecting these locations was that the height (50 meters) of the stack on the tritium research laboratory would tend to carry emissions over any monitors located on the property line.

3.2 Soils

3.2.1 Background Environmental Information

Section 3.2 presents soil-related environmental issues. This includes a description of the background soil conditions, the actual and potential soil contamination sources, the environmental monitoring system and results, and the findings and observations of the Survey team. The major focus of this section will be radionuclide contamination because it is only for those parameters that routine soil sampling occurs at SNLL. Special soil sampling for organic and inorganic contaminants is conducted in response to CERCLA- or RCRA-type investigations or activities, particularly groundwater studies. Descriptions of these types of investigations are presented in greater detail in Sections 3.4. and 4.5.

There are no regulations that limit the concentrations of uranium or thorium in soils. However, there is some guidance available from both the U.S. Nuclear Regulatory Commission (NRC) and the Department of Energy (DOE). The NRC, in a memorandum pertaining to a Branch Technical Position on the disposal or on-site storage of residual thorium or uranium, established derived concentration limits for various disposal options (NRC, 1981). One of these options applies to wastes with sufficiently low concentrations of uranium or thorium that they would present no health risk and

may be disposed of in any manner. The acceptable concentrations for this disposal option were derived by the NRC using radiation dose guidelines recommended by the Environmental Protection Agency (EPA, 1977) for protection against transuranium elements present in the environment. The derived concentration limits are natural thorium, 10 pCi/g; depleted uranium, 35 pCi/g; enriched uranium, 30 pCi/g; and natural uranium, 10 pCi/g. The concentration limits for natural thorium and natural uranium are based on the assumption that all the daughter products of these elements are present in secular equilibrium. The radium isotopes are the daughter products that are used to establish the limits.

DOE has established guidelines for residual radioactivity at Formerly Utilized Sites Remedial Action Program (FUSRAP) and Remote Surplus Facilities Management Program (SFMP) sites (DOE, 1985a; 1985b). The guidelines specify concentrations for thorium-232, thorium-230, radium-228, and radium-226 of 5 pCi/g averaged over the first 15 cm of soil below the surface and 15 pCi/g averaged over 15-cm-thick layers of soil more than 15 cm below the surface. These guidelines take into account the in-growth of the daughters and assume secular equilibrium. For other radionuclides or mixtures, the soil concentration guidelines must be derived, on a site-specific basis, from a basic dose limit of 100 mrem/yr to an individual, from all pathways.

There are no regulatory standards for nonradiological contaminant concentrations in soil as there are for drinking water supplies or for air. A determination of "safe" or "acceptable" levels in soils depends on contaminant migration pathways (e.g., wind or water erosion or leaching to the groundwater) and potential human exposure routes (e.g., ingestion of soils by children or farm animals, ingestion of contaminated groundwater, or inhalation of fugitive dust containing contaminants). Therefore, acceptable levels must be determined on a site-specific and chemical-specific basis.

Soils, by definition, consist of the upper 3 to 6 feet of unconsolidated bedrock debris, known as the regolith. Chemical, physical, and biological agents such as plants, animals, water, wind, and temperature act over time on the regolith and bedrock to form unique soils.

A soil usually consists of several horizons, including an uppermost zone of organic-matter accumulation, a zone of transition or leaching, and a zone of mineral accumulation. Below these horizons lies the regolith, which changes slowly with depth to unweathered bedrock. The point at which the regolith changes from soil to rock depends on whether it is being classified by soil scientists, engineers, or geologists. In many cases, these horizons are difficult to distinguish, but soil scientists have been able to map distinct soil units (or series) throughout the country.

The natural soils at SNLL are derived from the alluvial deposits of the Livermore Valley. SNLL is located within the boundaries of the Yolo-Pleasanton soil association (USDA, 1966). Weathering of the alluvial deposits has formed several distinct soil series that are recognized by the Soil Conservation Service. Soils of the Livermore and Positas series have formed near Arroyo Seco on the northern part of the site, whereas the Rincon, Zamora, and Livermore soils have formed on those alluvial materials near and within SNLL.

Background soil concentrations for U-238 and Th-232 are presented below:

Radionuclide	U.S. Average (Range) $\mu\text{g/g} \pm 2 \text{ STD. DEV.}$	California Average (Range) $\mu\text{g/g} \pm 2 \text{ STD. DEV.}$
U-238	3.0 ± 2.49 (0.36 - 11.4)	2.34 ± 3.3 (0.57 - 3.9)
Th-232	9.0 ± 4.22 (0.92 - 31.2)	4.95 ± 4.13 (2.75 - 6.97)

Source: Myrick et al., 1983

As can be seen from the data, California averages for both of these radionuclides are below U.S. averages

3.2.2 General Description of Pollution Sources and Controls

The actual and potential sources of soil contamination (with organic compounds) are generally the same actual or potential sources of groundwater contamination described in Sections 3.4 and 4.5, and are not repeated here. Radionuclides released from various processes at the SNLL may be deposited on the soil and taken up by vegetation. Analytical data from SNLL has not shown the presence of radionuclides in soil or vegetation samples to be above background. Tritium was found in Livermore Valley wines at slightly elevated levels (1.0 to $4.2 \times 10^{-7} \mu\text{Ci/ml}$), but within the range found in European wines (Devlin, 1985 and 1986).

3.2.3 Environmental Monitoring Program

SNLL has performed annual on-site soil sampling using radiochemical techniques. The five nuclides naturally occurring K-40. Results have shown only one of these nuclides handled at SNLL is U-238.

Analysis for radiological parameters since 1972 analyzed are Pu-239, Th-232, U-235, U-238, and is attributable to radioactive fallout. The only measurement of the remaining nuclides is part of

the fallout and natural radioactivity monitoring program. There is no routine monitoring of soil for organic or inorganic constituents. This type of monitoring is performed on a project-specific basis, and is discussed in Section 3.4.

Results for the average U-238 concentration from 1980-1986 are given in Table 3-11. There are no further details (standard deviation or individual results) available for these results. Concentration of U-238 has not varied significantly since 1972 when sampling and analysis began.

DOE uses a level of 35 pCi/g uranium (dry) in remedial action programs for acceptance of decontaminated areas. This concentration is equivalent to approximately 105 µg/g. The highest average sample result for U-238 (1982 in Table 3.11) is about 4 percent of this acceptance criteria.

3.2.4 Findings and Observations

3.2.4.1 Category I

None

3.2.4.2 Category II

None

3.2.4.3 Category III

None

3.2.4.4 Category IV

None

3.3 Surface Water

3.3.1 Background Environmental Information

The only surface water flow in the sequence at SNLL is Arroyo Seco, which crosses the site near its mid-point while flowing in a west to north west direction. The arroyo drains a 3,626 hectare (14 sq. mile) area in the foothills of the SNLL, and is typically dry from May through September.

TABLE 3-11

URANIUM-238 IN SOIL
SANDIA NATIONAL LABORATORIES, LIVERMORE

Year	Concentration ($\mu\text{g}/\text{dry g}$)	No. of Samples
1980	0.8	35
1981	3.4	6
1982	4.6	26
1983	2.7	21
1984	2.8	20
1985	4.2	20
1986	3.7	23

Source: Devlin, 1984, 1985, 1986, 1987b

All storm and surface water runoff from SNLL is channeled to Arroyo Seco through a storm drain system of culverts and open ditches. There are no facilities presently within the 100-year floodplain, and none are planned (DOE, 1986). In fact, the 1984 Site Development Plan contains the following statement in its analysis:

"No Sandia facilities have been built within the 100-year floodplain, and none should be allowed" (Emphasis added) (SNLL, 1984).

Arroyo Seco merges with Arroyo Las Pintas just east of the City of Livermore. They eventually connect with Alameda Creek and leave the Livermore Valley from its southwest corner at Sunol. Refer to Figure 3-4 for a sketch of the geographical setting. Arroyo Seco has been identified as a recharge site for the underlying water table in the SNLL area. Average annual rainfall at SNLL is reported to be 37 cm/year (14.6 inches per year), with 60 percent of the total precipitation occurring in the 3 months from December through February. During these periods, much of the surface flow in Arroyo Seco will infiltrate and recharge the water table. The depths to groundwater under SNLL vary from only 3 to 5 meters (10 to 15 feet) in the southern and eastern parts of the site to more than 30 meters (100 feet) in the north and west (DOE, 1986).

SNLL has endeavored to divert all operations-related wastewaters from normal site activity away from storm drains and Arroyo Seco. It has succeeded to the extent that there are no continuous releases of liquid effluents, except via the sanitary sewer system, which SNLL shares with LLNL. Currently, SNLL releases an average of 240,000 liters per working day (90,000 gallons per day [gpd]) to the LLNL sanitary sewer system. This effluent is transferred to the City of Livermore Water Reclamation Plant (LWRP) for treatment. Part of the LWRP-treated effluent (about 15 percent) is used locally to irrigate the airport, a golf course, lands along Interstate-580, and nearby agricultural land, but the great bulk of the flow is pumped out of the valley via a dedicated pipeline to San Francisco Bay.

SNLL provides continuous monitoring of effluent flow rate and pH, and weekly measurements for heavy metals concentrations. Daily samples of SNLL sewage effluent are collected and analyzed quarterly to assess compliance with General Pretreatment Regulations for Existing and New Sources of Pollution (40 CFR 403). The combined SNLL/LLNL effluent is monitored also as it exits the northwest corner of the LLNL site. Radiation detectors measure radionuclides, an x-ray fluorescence monitor tracks soluble metals, a pH probe continuously measures pH, and flow rate is continuously recorded. The radiation, fluorescence, and pH detectors are designed to trigger an alarm in the LLNL firehouse (24 hours a day) if pre-set limits on radioactivity, metal content, or pH are exceeded. Thus, time is available for confirmatory analysis and diversion of contaminated effluents, if necessary. SNLL is located so close to the LLNL site so that its automatic monitoring station can be

FIGURE 3-4

SURFACE WATER FLOWS OF THE SNLL AREA
SNLL - LIVERMORE, CALIFORNIA

checked to determine whether the cause lies on its side of the combined sanitary sewer system. Cooperation between SNLL and LLNL has proven to be effective in minimizing environmental impacts due to inadvertent releases to the LWRP. However, SNLL is considering the acquisition of additional monitoring capability to provide earlier warning of any possible spills or accidental releases to the sanitary sewer system. Options considered include continuous monitoring of radioactivity, heavy metals, or both. An alarm system similar to the one in use at LLNL would ensure that releases could be detected at the earliest possible moment and would thus allow for quick response to the problem.

Another important entity shared by SNLL and LLNL is the domestic water supply system. Potable water is purchased from one of two public water sources:

- The Hetch Hetchy water system serving the City of San Francisco
- Zone 7 of the Alameda County's Flood Control and Water Conservation District

Three large receiving tanks whose total combined capacity is nearly 5 million liters (1.3 million gallons) are located at the south end of SNLL. Water for all domestic, laboratory, fire protection, and potable uses is then delivered by gravity and distributed to all SNLL and LLNL users via an underground piping grid system. Most of the time Hetch Hetchy water is used, but for 1 to 3 months a year, the system is switched over to Zone 7 water because of emergencies, necessary repairs, or contractual commitments involving water rights issues and the need to have more than one source available when needed.

3.3.2 General Description of Pollution Sources and Controls

All sources of polluted or contaminated wastewaters at SNLL have been identified, and appropriate controls are being applied. SNLL relies on several key principles to gain control of toxic, hazardous, or radioactive wastewaters:

- Emphasis on controlling effluents at the source. Concentrated waste liquids are segregated for separate handling.
- Retention of dilute wastewaters until sampling and analysis can guide proper disposal, either to the sanitary sewer system or to off-site contracted disposal sites. Tanks provide "hold-up" time only and are not intended for use as storage or accumulation tanks.

- Close liaison between program managers, experimenters, and hazardous waste/environmental specialists to identify potential problems unique to each project, building, or experiment. This team effort eliminates after-the-fact surprises.

The following paragraphs provide basic information on wastewater sources observed at SNLL. The major sources requiring aggressive control are illustrated in Figure 3-5. Four liquid effluent control systems (LECS) have been designed to handle wastewaters from the following operations:

1. Building 901 - printed wiring laboratory activities.
2. Building 913 and 916 - printed circuit, photography, plastics, electronics, analytical, and organic synthesis laboratories; plating shop and paint shop operations.
3. Building 961 - decontamination activities.
4. Building 968 - tritium research laboratory activities.

The first two systems above are under development and construction, with completion set for 1988. The latter two are currently in use (SNLL, 1987a). The wastewaters from these sources are principally dilute rinses from various cleaning or surface preparation operations, in addition to general laboratory wastes in small quantities. Care is taken to minimize possible loss of concentrated solutions to the LECS. For example, the printed wiring laboratory has a line of tanks with capacities of 38 to 76 liters (10 to 20 gallons). These tanks contain chromic/sulfuric etchant solutions, copperplating baths, and gold-cyanide and nickel sulfamate solutions. All spent solutions must be pumped into containers (there are no drains on these tanks) for off-site disposal. Spill cleanup kits are strategically located at transfer points, but in most cases, have never had to be used. All spent solvents (e.g., methylene chloride from stripping photo-resist material from printed circuit boards) are treated as hazardous material and are sent to off-site disposal.

Paint shop operations use a water curtain to trap overspray of paint droplets, which are removed by filtration. The water recirculates during operations, but must be drawn off and replaced 1-2 times per year. There is evidence that samples are not analyzed prior to disposal to make certain that the 280- to 380-liter (75- to 100-gallon) batch can be safely released to the sanitary sewers. Refer to Section 4.1.2.3.1 for additional information regarding this source.

Plating and etching operations are conducted in a new (1 year old) facility in Building 913. As in the case of the printed wiring laboratory, all solutions are retained in dedicated tanks and must be pumped out when spent. SNLL Hazards Control personnel handle the disposal by pumping solutions out of the tanks to a high sump, then to barrels for removal. During operations there is a steady flow of dilute rinses to the sanitary sewer, typically at 10 to 20 liters per minute (2.6 to 5.3 gpm).

FIGURE 3-5

LIQUID EFFLUENT MONITORING AND CONTROL SYSTEMS (LECS) SNLL - LIVERMORE, CALIFORNIA

Contamination of this rinsewater is minimized by use of high-pressure air jets to reduce drag-out of solutions from the tanks.

Photoprocessing wastes are carefully segregated and controlled to minimize release of wastewaters to the sewer. Solutions containing silver are collected for recycle and recovery of silver at LLNL. Other rinses, washwaters, and dilute spent chemicals are discharged to the sanitary sewers. SNLL has modified its processing so that all chemicals rinsed to the sewer are biodegradable and harmless to LWRP. Specifications are reviewed regularly to make certain all products used are compatible. Formerly SNLL had a chemical mixing room in the photography laboratory where concentrates were diluted and mixed to various formulations. Now, however, all chemicals are bought ready for use in pre-mixed cubetainers (cube-shaped containers). Thus the risk of spillage from handling and mixing is reduced.

Decontamination activities in Building 961 are performed on a washdown pad using a portable steam jenny and selected chemicals, depending on the material being decontaminated. All wastewaters are caught and drained to a 3,800-liter (1,000-gallon) hold-up tank, along with all sink drains and showers in the building. To date there have been very few large pieces of equipment to decontaminate. Solutions used include detergents, chelating compounds, and wetting agents. Sampling and analysis of the holding tank contents is performed prior to release, with the type of analyses dependent on the material used and contaminants anticipated (metals, organics, radioactivity). Thus far, all batches of wastewater collected from Building 961 have been acceptable for release to the sanitary sewer. None have required treatment or special off-site disposal.

The Tritium Research Laboratory (TRL), Building 968, uses a dual hold-up system consisting of two 9,500 liter (2,500 gallon) tanks for containing all liquid effluents except sanitary wastewaters. These tanks are located in a 30-foot-deep concrete vault for added safety. Wastewater accumulates at an average rate of 750 liters per week (200 gallons per week) unless leaks occur in the chilled water system. Such an event occurred on March 22, 1985, when tritium-contaminated wastewater was released to the liquid effluent hold tanks as a result of a contaminated chilled water leak during the previous night. Instead of the usual weekly volume of 750 liters (200 gallons), the two tanks accumulated over 17,000 liters (4,500 gallons). Analysis of the full tank indicated a tritium level of 0.1 $\mu\text{Ci/ml}$, which is the level of the DOE Order 5480.1 concentration guide for release to the sanitary sewer when averaged over a month. The full tank was drained to the sanitary sewer, thus releasing what was believed to be 1 curie of tritiated water. Further analysis of the flow-proportional samples collected at the LWRP by LLNL staff indicated that the total release received at the sewage treatment plant was 2 curies (SNLL, 1985). Either measurement grossly exceeded the State of California's

release limit guideline of 10 mCi/day. In addition, the release exceeded California's yearly limit of 1 curie for releases to sewage treatment plants.

To prevent a recurrence of such releases, SNLL has revised its procedures for handling radioactively contaminated liquid wastewaters at the TRL (Building 968) and the Rad Waste Facility (Building 961) (Wright, 1985). Requirements at the TRL now specify that, despite the large available capacity, tank contents are monitored as soon as 1,900 liter (500 gallon) are collected, to minimize the risk of contaminating a large volume in the event of a leak or other release of tritiated water to the hold-up tanks. If the HTO activity rate is less than 10 mCi, the contents are released to the sanitary sewer system. If activities are between 10 and 20 mCi, contents are released slowly over a 2-day period so that neither day exceeds the 10 mCi limit. If tank contents measure more than 20 mCi, a Hazards Control Health Physicist, together with TRL supervisory staff, determine appropriate measures for disposal. Available methods include off-site disposal at a state-licensed facility.

In addition to the wastewater sources cited above, other less aggressive (unlikely to be contaminated) sources exist at SNLL. There are 16 cooling tower installations, each releasing wastewater in the form of continuous or sporadic blowdown to the sanitary sewer system. Chemicals used in these towers include biocides, scale inhibitors, pH control chemicals, dispersants, and in one case (Building 913's largest tower), an antifoaming agent. All chemicals used are compatible with sewage treatment plant processes and have no adverse effect on LWRP operations (DOE, 1986).

Table 3-12 lists the cooling towers by location and summarizes makeup, blowdown and chemical addition practices. The Survey did observe that one tower (Building 916 West) was not blowing down to the sanitary sewer system. A newly installed tower (in-service less than a month), 916W, appeared to be designed to have its blowdown piped back inside the building to a sanitary drain, but the pipe was cut and the flow was allowed to reach the roof gutter. The gutter in turn drained to the storm drain system and then to Arroyo Seco. The only other deviation from the normal practice of discharging blowdown to the sanitary sewer occurs at Building 907. Although all normal blowdown is disposed of via the sanitary sewer, a quarterly clean-out of mud and salt from the tower basin is released to the storm drain along East Avenue, where it either percolates into the soil or flows west into Arroyo Seco.

The sanitary sewer system could become an inadvertent source of groundwater pollution from contaminated wastewaters in the event that seismic activity, age, or accidental damage caused the system to leak. The system is operated jointly with LLNL's, where there is evidence that exfiltration to groundwater does occur during the long, dry seasons (Ragaini et al., 1986). However, no evidence

TABLE 3-12
SNIL COOLING TOWER INSTALLATIONS
SANDIA NATIONAL LABORATORIES, LIVERMORE

Building No.	Description	No of Cooling Towers	Makeup Water	Blowdown	Chemical Addition	Remarks
907	Mechanical Building	1	Constant Trickle	Automatic	Automatic	-
912	Offices/Labs/Services/Computer Center	4	Constant Trickle	Manual	Manual	Due to be replaced with three new towers in 1987.
913	Machine Shop/Mockup Area	3	Automatic	Automatic	Automatic	Replaced with two towers in 08/86.
914	NDE/Environmental Testing	1	Automatic	Manual	Automatic	-
915	Steam Plant	1	Automatic	Manual	Manual	A chemical dispersant is added.
916	Shipping/Receiving/Stores Labs and Offices	3	Automatic	Manual	Manual	One out of service. West tower discharging to roof drain.
9163	Shipping and Receiving Annex	1	Automatic	Automatic	Automatic	-
968	Tritium Research Laboratory	1	Automatic	Automatic	Automatic	-
972	Hazardous Test Labs	2	Automatic	Manual	Manual	-

Source: Developed by DOE Survey team during site visit

of similar problems was noted for the SNLL portions of the system. In fact the Site Development Plan (SNL, 1984) states positively that "Underground sewer piping is 27 years old and in good condition. It should last another 13 years or more."

Storm water drainage is collected and routed to Arroyo Seco via a system of open ditches, pipes, and culverts. Samples are collected and analyzed by LLNL "during the period of active surface water flow following the first major storm system of the water year (October 1 to September 30)" (Holland, et al., 1987). The present system appears to be adequate for handling storm and surface water runoff effectively. There is an active silt removal and weed control program for maintaining free flow in the open ditches, although some evidence of silt build-up along the south side of East Avenue was noted during Survey activities.

3.3.3 Environmental Monitoring Program

SNLL's outfall is monitored continuously for pH and flow rate, and composite samples are collected weekly for analysis of metals, phenolics, cyanides, dissolved solids, and BOD₅ prior to entry into the LLNL sanitary sewer system. LLNL in turn continuously monitors pH, flow rate, and selected metals and radioactivity at their outfall and collects composites for analysis of all parameters listed in the discharge permit from LWRP. Refer to Table 3-13 for a summary of discharge limits.

Compliance with requirements is uniformly high, not only at the SNLL outfall but also for combined effluents from the LLNL monitoring station. Table 3-14 summarizes 1986 data from both locations. Note that with the sole exception of silver in the SNLL effluent, all annual averages are well within LWRP requirements. The LWRP limit for silver is 0.2 mg/l. The SNLL average includes an effluent sample (one of four) that had 1.2 mg/l of silver for the fourth quarter of 1986. The second highest concentration that year was 0.12 mg/l, and in prior years the highest concentration observed was 0.5 mg/l. The 1.2 mg/l value may be an outlier. In any case, the average silver content for LLNL's effluent (the wastewater actually released to LWRP) for the fourth quarter of 1986 was 0.02 mg/l, or 10 percent of the LWRP limit.

SNLL has submitted a Baseline Monitoring Report (BMR) for its printed wiring operations to the LWRP Superintendent in compliance with EPA requirements. BMRs were not submitted for electroplating and metal finishing operations because these operations were terminated in September 1984. SNLL reported in detail on the quantities of materials used in the production of printed circuit boards. The report described a sump and sewer sampling program designed to measure wastewater not only from the wiring laboratory, but also from selected other areas leading to the effluent release point. One round of sampling was conducted in October 1986, and all

TABLE 3-13

**SUMMARY OF DISCHARGE LIMITS
CITY OF LIVERMORE WATER RECLAMATION PLANT
SANDIA NATIONAL LABORATORIES, LIVERMORE**

Section 18.62 of the Code of the City of Livermore states the discharge limits for the sanitary sewer system. These limits are summarized:

<u>Contaminant</u>	<u>Permissible Limit</u>
(a) Flammables or explosives (gasoline, benzene, naptha, fuel oil, etc.)	None
(b) Solid or viscous substances	None
(c) pH outside following limits	6.8 to 8.5
(d) Toxic pollutants	None
(e) Noxious or malodorous substances affecting sludge use	None
(f) Fat, grease, or oil (freon extractable)	100 mg/l
(g) Materials causing NPDES violation	None
(h) Objectional color	None
(i) Temperature, maximum	40°C (104°F)
(j) Materials causing flow rate restrictions in sewer	None
(k) Radioactive wastes exceeding state or federal limits	None
(l) Hazards to human life or public nuisances	None
(m) TDS incremental addition no greater than	325 mg/l
(n) Chloride incremental addition no greater than	75 mg/l
(o) BOD ₅	300 mg/l
(p) Suspended solids	300 mg/l
(q) Specific Pollutant Limitations (Maximum Concentrations)	
arsenic	0.1 mg/l
cadmium	0.2 mg/l
copper	2.0 mg/l
cyanide	1.0 mg/l
lead	1.0 mg/l
mercury	0.01 mg/l
nickel	1.0 mg/l
silver	0.2 mg/l
total chromium	1.0 mg/l
zinc	3.0 mg/l
TICl	0.02 mg/l
phenolics	1.0 mg/l
PCBs	0.01 mg/l

Source: Devlin, 1987b

TABLE 3-14

**1986 AVERAGE CONCENTRATIONS
LIQUID EFFLUENTS FROM SNLL AND LLNL
(ALL CONCENTRATIONS IN MG/L EXCEPT WHEN NOTED)
SANDIA NATIONAL LABORATORIES, LIVERMORE**

Constituent	Discharge Limit	SNLL Effluent		LLNL Effluent	
		mg/l	% of DL	mg/l	% of DL
BOD ₅	300	75	25.0	79	26.3
Oil and Grease	100	12	12.0	< 11	< 11.0
PCBs	0.01	NA		< 0.003	< 3.0
Phenolics	1.0	< 0.05	< 5.0	< 0.11	< 11.0
TDS	325 Added	152	< 46.8	256	< 78.8
TICH	0.02	NA	--	ND	0.0
TOC	--	50*	--	51	--
TSS	300	5*	1.7	27	9.0
Chloride	75 Added	28*	< 37.3	36	< 48.0
Cyanide	1.0	0.13	13.0	< 0.02	< 2.0
Arsenic	0.1	< 0.03	< 30.0	< 0.003	< 3.0
Cadmium	0.2	< 0.05	< 25.0	0.0024	1.2
Chromium	1.0	0.3	30.0	0.04	4.0
Copper	2.0	< 0.2	10.0	0.07	3.5
Lead	1.0	< 0.04	< 4.0	0.015	1.5
Mercury	0.01	< 0.006	< 60.0	0.001	10.0
Nickel	1.0	< 0.12	< 12.0	< 0.04	< 4.0
Silver	0.2	0.35	175.0	0.02	10.0
Zinc	3.0	0.22	7.3	0.14	4.7
Tritiated Water (DCG)	2 μ Ci/l	NA	--	3.4 x 10 ⁻⁶ μ Ci/l	1.7 x 10 ⁻⁴

Sources: Devlin, 1987b; Holland et al., 1987
 * Average value for 1985. Not reported in 1986.
 NA Not analyzed
 ND None detected
 TICH Total identifiable chlorinated hydrocarbons
 DL Discharge Limit
 DCG Derived Concentration Guide

samples yielded analyses at very low concentrations, usually below instrument limits of detection. The results indicate that SNLL's strategy of controlling pollutants at their source is effective in preventing release of toxic/hazardous materials to the sewer system.

During the course of reviewing data, several analyses of hold-up tank contents were examined and compared with LWRP limits. The only constituent appearing to be outside the prescribed limits was an occasional pH reading. Metal concentrations tended to be about half of the permissible amount or less, while radioactivity (gross α , gross β , and tritium) was reported at pCi/liter levels. None of the analyses reviewed indicated that the LWRP would experience any difficulty in handling SNLL releases from hold-up tanks.

EPA has proposed that stormwater runoff be regulated under NPDES rules, so SNLL has begun acquiring data on water quality of stormwater runoff. Attempts have been made (by LLNL specialists) to collect runoff from the first major stormwater flow at the beginning of the wet season. Refer to Figure 3-6 to identify sampling locations. Analysis of one set of samples from 1986 indicated that most pollutants were not present at detectable levels in either the background samples entering SNLL or the runoff leaving the site. A measurable increase in 2,4-D concentration was apparently observed ($<0.5 \mu\text{g/l}$ to $11 \mu\text{g/l}$), but even this "gain" may not be real because of a misunderstanding between SNLL and LLNL staff on the identity of the stormwater runoff sampling points. Refer to Finding 3.3.4.2.1 for further discussion of this anomaly.

Even though SNLL purchases all its potable water from outside suppliers, its Hazardous Control Division has chosen to do limited monitoring and analysis of the potable water distribution system to protect on-site users and to guarantee the integrity of the system. Bacteria counts are made quarterly at selected locations. During the most recent investigation, samples were taken at 12 different buildings, and every coliform count was reported as <2 counts per 100 milliliters. SNLL has an ongoing program to prevent backflow of contaminated water into the potable water distribution system. The program involves training of all employees, installation of vacuum breakers or back-siphonage prevention valves, inspection of the entire system, and looking for possible cross connections. The program provides SNLL workers with a safe source of drinking water at all times.

3.3.4 Findings and Observations

3.3.4.1 Category I

None

SOURCE: Adapted from Holland et al., 1987.

FIGURE 3-6

STORMWATER RUN-OFF SAMPLING LOCATIONS
SNLL - LIVERMORE, CALIFORNIA

3.3.4.2 Category II

None

3.3.4.3 Category III

1. Contaminated Sediments in Arroyo Seco. Sediments in Arroyo Seco may be contaminated with hazardous or radioactive constituents as a result of past or ongoing discharges. SNLL has not adequately characterized either the arroyo sediments or the current stormwater discharges for the presence of contamination.

Past practices by the U.S. Navy may have resulted in release of contaminated runoff to Arroyo Seco. Records (DOE, 1986) indicate that an area immediately adjacent to the arroyo was used by the Navy as a paint and drum storage area. The chance of spillage or leaks existed at that time, prior to SNLL assuming control of operations. More recently, in 1984 the sump for the paint shop wastewaters from Building 913 was drained to the street, ultimately flowing into Arroyo Seco (DOE, 1986). Also, at times in the past, cooling tower blowdowns were released to the storm drain system (and thence to the Arroyo) rather than to sanitary sewers, which is the current mode of operations. The impact from such previous releases is not known.

The only ongoing permitted SNLL discharges to Arroyo Seco are stormwater discharges. The Survey identified two unpermitted discharges that were considered to be inconsequential from an environmental standpoint. These discharges are discussed in Findings 3.3.4.4.1 and 3.3.4.4.2. SNLL has no ongoing program for monitoring Arroyo Seco sediments, but instead relies on LLNL's stormwater runoff monitoring program as an indicator of contamination in the runoff. The results from this program are inconclusive because no data exist for runoff from the SNLL site. Refer to Figure 3-6 for a better understanding of the discussion which follows.

The 1986 Environmental Monitoring Report (EMR) for SNLL contains Table 14, which displays analytical data for stormwater runoff from Arroyo Seco (Devlin, 1987b). Two columns are offered for comparison: "SNLL Influent" and "SNLL Effluent." These columns are credited to Reference 1, the LLNL EMR (Holland et al., 1987), where the identical data (plus others) are found in Table A-27 of that reference. There the columns are headed "Influent SNLL" and "Influent LLNL." These data are presented here as Table 3-15. SNLL staff apparently presumed that both sets of data applied to Arroyo Seco, where LLNL's influent is SNLL's effluent. However, the Influent LLNL sample cited in Table A-27 is not for Arroyo Seco, but for

TABLE 3-15

**STORMWATER RUNOFF COMPARISON
SANDIA NATIONAL LABORATORIES, LIVERMORE
(All Data in mg/l Unless Otherwise Indicated)**

	SNLL 1986 EMR ⁽¹⁾ Table 14		LLNL 1986 EMR ⁽²⁾ Table A-2			
	SNLL Influent	SNLL Effluent	LLNL Influent	SNLL Influent	NW Effluent	Lake
Arsenic	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Beryllium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chromium	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Lead	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Mercury	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Selenium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Silver	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrate	1.2	0.1	0.10	1.2	1.4	0.68
Fluoride	0.24	0.19	0.19	0.24	0.26	<0.1
COD	110	85	85	110	88	31
TOC	18	31	31	18	21	6
Oil & Grease	13	8	8	13	9	<5
2,4-D, µg/l	<0.5	11	11	<0.5	3.2	<0.5
Chloroform, µg/l	5	<1	<1	5	<1	<1
Trichlorofluoro- methane, µg/l	3	3	3	3	3	3
Sample Point ⁽³⁾	4	See ⁽⁴⁾	1	4	3	2

(1) Source: Devlin, 1987b

(2) Source: Holland et al., 1987

(3) Identity of sampling point added by Survey team; not on original tables.

(4) There is no SNLL effluent sampling point. Data for Point 1 was listed erroneously by SNLL.

sampling point 1, the run-on along the eastern boundary of LLNL that eventually becomes part of the Arroyo Las Positas flow. The sampling points, shown in Figure 3-6, are defined more clearly on page 17 of Reference 1 and in the accompanying Figure 13. The text on page 17 goes on to describe exactly which samples were successfully collected following storms in 1985 and 1986, and it is evident that Station 6 (the Arroyo Seco channel effluent downstream of SNLL and LLNL) had not been sampled in either year. Thus no conclusion can be drawn regarding the impact from stormwater runoff from either facility on Arroyo Seco. Moreover, there is no planned sampling at the LLNL influent point in Arroyo Seco. The LLNL runoff sampling program accounts for Station 5 (an effluent discharge pipe draining into the arroyo from the southwest areas of LLNL) and for Station 6 (Arroyo Seco downstream of all SNLL and LLNL release points). For adequate assessment of SNLL's runoff impacts, an additional Arroyo Seco sampling point would be required upstream of Station 5 for comparison with Station 4, the SNLL influent sample. Otherwise, no conclusion can be drawn regarding the impact of stormwater runoff from SNLL on Arroyo Seco.

Neither SNLL nor LLNL have any ongoing program for characterizing soils or sediments in the arroyo. Even where other data is collected, the analytical emphasis has been on radionuclides only. As a result there is the possibility that residues remaining from past practices may be contributing to contamination of the groundwater beneath SNLL. Survey-related sampling is planned. Refer also to related Findings in Section 4.5.2.3.2, 4.5.2.3.3, 4.5.2.3.6 and 4.5.2.3.7.

3.3.4.4 Category IV

1. Cooling Tower Blowdown. The new cooling tower on the roof of Building 916 (the Baltimore Aircoil Tower at the west end of the building) releases blowdown to the roof gutters and then to the storm water drain. This water may eventually reach Arroyo Seco and would constitute an unauthorized discharge to the receiving stream. The issue of cooling tower blowdowns is discussed in Section V.C.8 of the Draft Comprehensive Environmental Assessment and Response Program (CEARP) (DOE, 1986). At the time when that report was compiled, SNLL obviously intended the blowdown to be disposed of as stated in the 1986 report: "All of the blowdown from the cooling towers goes into the sanitary sewers." This statement defined conditions as they existed in September 1986 when the draft report was released. The west cooling tower on the roof of Building 916 was installed in December 1986, after the CEARP Phase I assessment was completed. A pipe had been installed on the roof, apparently to convey the blowdown to a sanitary sewer drain within the building, but it had been recently cut. SNLL personnel were planning to investigate the problem and determine whether the present arrangement was temporary or permanent. In the meantime, the environmental

impact, if any, from this release is expected to be negligible because of the small discharge volume, estimated to be less than 150 liters (40 gallons) per day, and because of the absence of toxic or hazardous chemicals in the cooling tower blowdown. This problem is principally an administrative issue, since SNLL has repeatedly notified the regulatory agencies that there are no routine releases to the arroyo except for stormwater runoff, and that all cooling tower blowdowns are discharged to the sanitary sewer system.

2. Cleanout of Mud from Cooling Tower Sump. Accumulated sediment in the basin sump of the mechanical draft cooling tower serving Building 907 is cleaned out quarterly and pumped to the open storm drain running parallel to East Avenue. This material results in silt accumulation in the drainage ditch along East Avenue, which is one of the problems cited in the Site Development Plan's analysis of the storm and surface drainage system (SNL, 1984). Among the improvements proposed in the analysis is the replacement of open drainage ditches with underground pipelines. Listed among the benefits of this improvement were claims that "such a system along East Avenue will:

- Prevent sheet flooding that could occur across East Avenue.
- Reduce maintenance by eliminating silt removal and weed abatement in the ditches.
- Improve the appearance of East Avenue."

This analysis indicates that silt in the East Avenue storm drainage ditch has caused problems. The sediment released during cleanout of the B-907 cooling tower basin contributes to the silt load.

3. Inadequate Labeling of Laboratory Sinks. In most of SNLL's buildings, sinks are not properly identified as having sanitary sewer or hold-up tank connections. This is especially a problem in those laboratory rooms where both types of sink connections exist. Releases of hazardous wastes to the sanitary sewer could occur via these unlabeled drains. SNLL provides training in laboratory procedures for new staff members, but without written instructions on each sink, a release via an unlabeled drain could occur more easily.

3.4 Hydrogeology

3.4.1 Background Environmental Information

3.4.1.1 Physiographic Setting

The Livermore Valley is an east-west oriented topographic and structural depression that trends nearly normal to the strike of the central California Coast Range, within which it is located. The valley is 25 km (16 miles) long and an average of 11 km (7 miles) wide. The floor of the valley is relatively flat except for occasional small hills, which rise about 46 m (150 feet). Some of these hills may be the result of uplifts of older materials along faults.

The Livermore Valley is drained by westward-flowing intermittent streams. These streams join approximately 16 km (10 miles) southwest of the site to form Arroyo de Laguna, which is a tributary to Alameda Creek. Alameda Creek eventually flows into San Francisco Bay.

The SNLL site was constructed on the southeast part of the smooth valley floor, which slopes gently downward toward the northwest. Elevations on the site vary from a low of 174 m (570 feet) at the northwest corner to 206 m (675 feet) at the southeast corner. Slopes are generally less than 3 percent, except at the banks of Arroyo Seco and other drainage ditches.

3.4.1.2 Geology

The Livermore Valley is located within the California Coast Range Province, which consists of a system of nearly mountain ranges and valleys that trend north-northwest. Livermore Valley lies wholly within the Diablo Range as an east-west trending structural basin but dominated by northwest-southeast trending geologic structures. To the west, the valley is bounded by the Calaveras-Sunol Fault, while to the east, it is bounded by the Greenville Fault. Both faults exhibit right-lateral movement. Figure 3-7 presents the general site location in relation to the major structural features of the California Coast. The Coast Range is aligned with a number of active faults, three of which are considered to be major--the San Andreas, the Sur-Nacimiento, and the Coast Range thrust. These faults have juxtaposed three distinct lithologic blocks in a complex structural and chronological history.

The stratigraphy within and underlying the Livermore Valley is composed of rocks and sediments from the Jurassic through the Pliocene and Holocene.

FIGURE 3-7

MAJOR FAULT ZONES OF THE SAN FRANCISCO BAY REGION
SNIL - LIVERMORE, CALIFORNIA

The Franciscan Assemblage (Jurassic and Cretaceous age) is the bedrock formation at SNLL. It is composed of a weakly-metamorphosed, greenish-gray sandstone that weathers to a greenish-brown. The rock is massively bedded and highly jointed and has been extensively deformed. It is exposed at the ground surface in Mt. Diablo and in the Diablo Range.

Overlying the Franciscan Assemblage in the Livermore Valley are marine sedimentary rocks (Cretaceous to late Tertiary age) and alluvial deposits (late Tertiary to Holocene age). A generalized stratigraphic section for the Livermore Valley is presented in Figure 3-8.

Unmetamorphosed marine sediments, known collectively as the Great Valley Sequence (Cretaceous age: Horsetown, Panoche, and Moreno Grande Formations), lie in fault contact with the Franciscan Assemblage throughout the valley. These rocks are variably cemented, greenish-gray to brown, concretionary sandstones that are interbedded with dark gray shale and conglomerate.

Stratigraphically overlying the Great Valley Sequence is a series of marine sediments of Eocene to Upper Miocene ages. The Tesla Formation (map unit Tts) is of late Paleocene to Eocene age. Its thickness is highly variable because it was deposited on an erosion surface of the Great Valley Sequence. The Miocene Cierbo Formation unconformably overlies the Tesla Formation. It is lithologically similar to the Tesla Formation, but contains resistant conglomerate beds and distinctive fossils. The Neroly Formation, consisting mainly of bluish sandstone with lenses of andesite-bearing conglomerate, tuff, and shale, overlies the Cierbo. The Neroly Formation is of Upper Miocene Age. It is easily mapped by distinctive purple float.

In the vicinity of SNLL, the Livermore Valley is filled with up to 1.2 km (0.7 miles) of fluvial and lacustrine sediments of Pliocene to Holocene age. This thick sequence has been subdivided into the Plio-Pliocene Livermore Formation and several alluvial deposits. Like many sedimentary deposits, these units vary laterally and vertically in composition. A geologic map of the site area is shown on Figure 3-9.

The Lower Livermore Formation (Pliocene age) consists primarily of greenish or bluish gravels, which may be interbedded with fine-grained sediments (map unit Tps). The Upper Livermore Formation (Pliocene age) consists of interbedded brown to reddish-brown silt, clays, sands, and gravels (map unit Qtl). The Upper Livermore Formation is also known as the Tulare Formation. The Livermore Formation ranges in thickness from about 30 to 1,220 meters (100 to 4,000 feet).

There are four recognized post-Livermore units in the Livermore Valley. The oldest are terrace deposits 3 to 10 m (10 to 33 feet) above the present-day bed of the Arroyo Seco (map unit Qal₂).

FIGURE 3-8

GENERALIZED STRATIGRAPHIC SECTION TESLA QUADRANGLE
SNLL - LIVERMORE, CALIFORNIA

SOURCE: Dresen and Nichols, 1986.

GEOLOGIC MAP OF S
SNLL - LIVERM

FIGURE 3-9

LL, LLNL AND VICINITY
RE, CALIFORNIA

These deposits are silty clay and silty gravel of Franciscan origin. There is also a slightly younger unit of valley fill and terrace deposits found in exposure along Arroyo Seco (map unit Qal₁). They consist of silty gravels capped by yellow and light-brown sandy clays and silts. The older alluvial deposits are typically dense, oxidized, and have a prominent soil profile development.

Two younger units occur in the vicinity of SNLL--low terrace and correlative alluvial deposits of late Pleistocene to Holocene age (map unit Hpal), and local accumulations of floodplain and stream channel deposits (map unit Hs). The floodplain deposits are typically dense, oxidized, and have a prominent soil profile. The channel deposits consist of dark-brown, organic-rich silty-clay, sand clay, and sandy silt with occasional lenses of sand and gravel. These channel deposits range in thickness from 60 cm (2 feet) in the southeastern portion of the laboratory to 3 to 5 m (10 to 17 feet) near Arroyo Seco and the natural course of Arroyo Las Positas.

3.4.1.3 Structural Geology

The Coast Range has a complex history of folding and faulting along the continental margin. Several episodes of folding have occurred in the past and may be continuing into the present time. Most of the faults in the area are northwest-trending strike-slip faults where the dominant motion is horizontal with a smaller vertical component. The Livermore Valley is bounded on the west by the Calaveras Fault and on the east by the Greenville Fault, which are both considered to be active faults. North and south of the valley, the Diablo Range is formed by large, doubly-plunging antiforms with cores of Franciscan rocks. The valley is a complex synclinal structure, with beds that generally thicken toward the center of the valley.

The Calaveras Fault is a right-lateral strike-slip fault that branches from the San Andreas Fault near Hollister and trends northwestward to the San Ramon Valley. It is located about 17 km (11 miles) west of SNLL at its closest approach. This fault has been active, and was the site of a major earthquake in 1861 (magnitude 6+). The fault acts as a groundwater barrier in the Dublin area, with higher water levels on the west side of the fault zone. Up to 15 mm/yr creep has been observed on this fault, with an average annual slip rate of 7 mm/yr. A maximum probable earthquake of magnitude 7.3 has been predicted for this fault.

The Greenville Fault Zone is a set of northwest-trending right-lateral strike-slip faults that extends southeast from Mt. Diablo to San Antonio Valley. A recently-active strand of the Greenville Fault lies about 1.1 km (3,500 feet) northeast of SNLL. The fault is a young tectonic feature that truncates or offsets all other faults and folds that cross it, with the exception of the Las Positas Fault Zone. The current slip rate has been estimated at 0.5 to 0.7 mm/yr. The maximum credible earthquake has been

estimated at magnitude 6.6 ± 0.2 . In January 1980, two earthquakes of magnitude 5.8 and 5.3 on the Greenville Fault caused structural damage to several buildings at the adjacent Lawrence Livermore National Laboratory.

In addition to the Calaveras Fault and the Greenville Fault, two other active faults have been identified in the area -- the Las Positas Fault and the Tesla Fault. Figure 3-7 presents the locations of the identified faults in this portion of the valley. The Las Positas Fault trends northeastward and creates a groundwater barrier. The northern branch of this fault crosses the southern portion of SNLL and coincides with a break in slope between the valley floor and hills to the south. It is a left-lateral strike-slip fault, with an average slip rate calculated to be 0.4 mm/yr. The maximum credible earthquake on this fault is estimated to magnitude 6.0 ± 0.5 .

The Tesla No. 2 Fault appears to dip to the southwest and has lateral and reverse components, with the southwest side up. On June 21, 1977, an earthquake magnitude of 3.6 apparently occurred along the Tesla Fault. Topography suggests that the Tesla Fault has captured the drainage of Arroyo Seco and has directed it towards the northwest. The Tesla No. 1 Fault has apparently been inactive since pre-Tertiary times.

In addition to these four active faults, 20 other faults have been mapped or postulated in the Livermore Valley. Studies of these faults indicate either that these faults do not disturb late Quaternary sediments (and are therefore considered to be inactive) or that their existence is doubtful. Based upon these considerations, none of these faults are considered to have the potential to affect the laboratory.

The major geologic hazard associated with the presence of the active faults is strong ground shaking as a result of a major earthquake on either a regional or local fault. Surface rupture as a result of sympathetic displacement on a nearby inactive strand of the Greenville Fault is a remote possibility. Secondary seismic hazards such as soil liquefaction are unlikely at this site.

3.4.1.4 Groundwater

SNLL is located within the Livermore Valley Groundwater Basin. The Livermore Valley Groundwater Basin has been subdivided by the California Department of Water Resources (DWR) into 12 subbasins (State of California, 1974). The SNLL facility straddles both the Spring and Mocho Subbasins. The division between the two subbasins is the Tesla Fault system. Most of SNLL is located in the Mocho subbasin. Figure 3-10 shows the locations of the subbasin in the site area.

FIGURE 3-10

GROUNDWATER SUBBASINS IN THE SNLL AREA
SNLL - LIVERMORE, CALIFORNIA

The Mocho subbasin is bounded by the Spring subbasin on the northeast, the Livermore Fault on the west, the Livermore Uplands on the south, and the Tassajara Formation to the north (MARK Group, 1986). In 1974, groundwater was reported by DWR to occur under a variety of conditions on the Mocho subbasin from shallow unconfined groundwater within 7.5 meters (25 feet) of the ground surface to deeper confined zones with potentiometric surfaces lying 23 to 46 meters (75 to 150 feet) below grade. Artesian and flowing artesian conditions are reported from deep wells (MARK Group, 1986).

The Spring subbasin is drained by Altamont Creek and is bounded on the southwest by the Tesla Fault, on the northeast by the Carnegie Fault and a third, unnamed fault. The southeast side of the basin is formed by the groundwater divide in the Livermore uplands and by non-water-bearing rocks.

DWR reported in 1974 that groundwater in this subbasin occurs primarily under unconfined or semi-confined conditions. Depth to water ranges from 4.6 to 24 meters (15 to 80 feet) below grade. The potentiometric surface of the deeper Livermore Formation is about 53 meters (175 feet) below grade and slopes toward the north at about 10 meters per kilometer (50 feet per mile).

Recent measurements indicate groundwater occurs under SNLL from a depth of 7 to 10 meters (20 to 30 feet) below grade to the south and east to more than 30 meters (100 feet) below grade in the northern and western part of the facility (SNLL, 1987b). Water-bearing zones underlying SNLL may be either unconfined or confined, depending upon the local geology and hydrogeologic conditions. The hydraulic gradient appears to be downward. A typical subsurface cross-section is shown on Figure 3-11.

The location of water-bearing strata under the SNLL facility appears to be highly dependent upon the location of permeable sand and gravels in the subsurface. The extent of the more permeable sand and gravel deposits does not appear to be laterally extensive in all directions. In certain areas, coarser materials may contain significant quantities of fine-grained materials resulting in lower hydraulic conductivity values. This condition is probably due to the environment in which deposition of these materials took place. The stream channels associated with alluvial fans are known to frequently change channel locations. The resultant effect is discrete sand bodies that may only be continuous along the axis of the channel. Hydraulic conductivities measured during well testing in the shallow waterbearing zone range from 2 to 15 feet squared per day (HydroGeoChem, 1985; Mark Group, 1986). No testing of the lower waterbearing zones has been performed on-site.

SOURCE: MARK Group, 1986.

SUBSURFACE CROSS
SNLL - LIVERM

SE
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- ☐ Fine-grained facies. Predominantly silts and clays with occasional thin sand and gravel interbeds.
- ☒ Coarse-grained facies. Predominantly fine to coarse sands and gravels.

FIGURE 3-11

SECTION AT ARROYO SECO
MORE, CALIFORNIA

Water levels measured in these wells indicate three water table potentiometric surfaces have been encountered. The highest levels, measured in Wells AS4 and NLF, range from approximate elevation 196 to 209 meters (645 to 685 feet) and occur south and east of the Las Positas Fault. No deeper monitoring wells have been installed in the area southeast of the fault. The intermediate potentiometric water surface occurs at approximately elevation 166 meters (545 feet) in wells screened above elevation 152 meters (500 feet) near the location of the 1975 fuel spill. The third potentiometric surface was observed in only one well, AS-3C, at approximately elevation 163 meters (535 feet). This potentiometric surface appears to be confined in that area by the presence of a 7.6 meter (25 foot) thick clay layer. The well seal for AS-3C is at elevation 152 meters (500 feet) at the base of the clay layer. No deeper monitoring wells have been installed in that area. The general locations of groundwater monitoring wells installed for monitoring quality and water levels are shown in Figure 3-12.

Although the data from these wells are generally consistent with the trends reported for the LLNL Main Site (Dresen and Nichols, 1988), the lack of an overall site monitoring system precludes definitive evaluation of the hydraulic gradients and flow directions of the principal water-bearing zones in the vicinity of known contamination, or the site in general. As a consequence, the effect of the Las Positas Fault on the groundwater regime is not well understood, but is postulated to behave as a barrier because of the drop in potentiometric levels on the northwest side of the fault. The fact that water levels in Wells AS4 and NLF are higher than those measured in the wells near the 1975 fuel spill may tend to support this. However, these levels may also represent the general regional gradient.

Conversely, the water level data from LLNL indicates a "ridge" on the potentiometric surface of the shallow groundwater table may occur in the 1975 fuel spill area with resulting gradients being downward toward the northwest and to the southeast toward the fault (Dresen and Nichols, 1986). Because of the lack of strategically located monitoring wells there is not enough data available to definitively resolve this apparent conflict. The potentiometric surface changes are likely to be further confounded by a continuous rise in groundwater levels of as much as 1.5 meters (5 feet) per year since the 1976-1977 drought (Kennedy/Jenks Engineers, 1985). This regional water table rise may affect gradients and flow directions beneath the site that could not be properly characterized with the existing monitoring system. Consequently, direction and velocity of known contaminants off-site could not be adequately defined to predict their potential arrival at receptors.

Groundwater recharge occurs primarily from losing streams, secondarily from precipitation, and only slightly from subsurface inflow (MARK Group, 1986). Precipitation averages 38 centimeters (15 inches) per year. Recharge from Arroyo Seco would be expected to occur during periods of flow,

FIGURE 3-12

GROUNDWATER MONITORING LOCATIONS SNLL - LIVERMORE, CALIFORNIA

normally in the rainy season early in the year. Stream flow was reported in January and February 1986 during installation of some of the monitoring wells at the 1985 fuel spill site (MARK Group, 1986), but the creek bed was observed to be dry during the site visit for this Survey in January 1987. This seasonal precipitation may have caused a slight rise in the water table near the monitoring wells with the highest levels being measured in the April and May 1986 readings, and then dropping through the drier summer months until the most recent reported reading in December 1986 (SNLL, 1987b). The fluctuations of the potentiometric surface during that time appeared to be on the order of 1 to 1-1/2 meters (3 to 5 feet). Because of the lack of an adequate areal distribution of monitoring wells, it is not known if the water table on the entire site experiences this seasonal fluctuation, or if recharge concentrated by the channel of Arroyo Seco created a groundwater mound near its channel.

3.4.1.5 Groundwater Quality and Use

The most prevalent use of groundwater in this area is for irrigation of cropland. In many cases the depth and construction of irrigation wells is not known. At present, irrigation wells have not been found to have an effect on groundwater flow at the site (i.e., groundwater is not being drawn off-site in response to pumping wells, probably because these wells are screened in deeper aquifers to ensure a steady water supply). Historically, groundwater in the Mocho subbasin has generally been fair to excellent quality sodium bicarbonate and magnesium bicarbonate water. Groundwater underlying SNLL is generally classified as being predominantly sodium bicarbonate. Groundwater in the Spring subbasin is of sodium chloride character and classified as irrigation Class II and III.

A residential development is situated less than 0.6 km (1 mile) northwest of the SNLL. Some of the residents are using wells for their water supply, but most are using the public (surface water) supply from the City of Livermore. A contaminant plume is moving toward the homes of these residents, and wells that have been identified as in danger of contamination have been replaced with bottled water provided by LLNL. This plume appears to be emanating from historical release on the LLNL site, not from SNLL.

3.4.2 General Description of Pollution Sources and Controls

The following seven locations at SNLL are potential sources of groundwater contamination.

- Diesel Fuel Oil Tank - Location of a 1975 diesel fuel pipeline leak that resulted in the subsurface release of almost 60,000 gallons of diesel fuel oil. SNLL has characterized the nature and extent of contamination, and continues to perform monitoring.
- "Navy" Landfill - Former municipal waste landfill; may have received some hazardous wastes; soil and groundwater monitoring results by SNLL are inconclusive.
- Navy Paint and Drum Storage Area - Former storage yard for paints, solvents, and aircraft dope. SNLL has not characterized this area.
- High Explosive (HE) Burn Pit - Pit where sodium, lithium, and potassium were burned. According to SNLL, no HE was ever disposed or burned in this pit. SNLL has not characterized this area.
- Fire Extinguisher Training Area - A total of less than 1,000 gallons of gasoline was poured onto ground and in trays, then ignited for demonstrations. SNLL has not characterized this area.
- Building 913 Paint Shop - Overspray sump was drained into Arroyo Seco on at least one occasion. SNLL has not characterized this area.
- Debris Area on North Side of Arroyo Seco - Paint sludge and oil-stained soil on bank of Arroyo. SNLL has not characterized this area.

Of these sites, the diesel fuel leak and the Navy Landfill are probably the only potentially significant sources of groundwater contamination. The other five potential contamination sources do not appear to present a risk of significant groundwater contamination because of the relatively low volume of wastes believed to have been disposed at each location, and the depth to groundwater. These five sites are considered to be potential sources of groundwater contamination because wastes were disposed of at these locations, and insufficient analytical data exist to demonstrate that no contamination exists.

Of the two potentially significant sources of groundwater contamination, only the diesel fuel leak has been characterized. Based on existing information, the diesel fuel leak has already contaminated the groundwater. (See Finding 3.4.4.3.1). The other potential source, the Navy landfill, has not been adequately characterized. SNLL has not detected significant (i.e., not attributable to laboratory artifacts) groundwater contamination at the Navy landfill. Only one well exists in the vicinity of this landfill, however, and the hydrogeology of the area is not clearly understood. Also, the records on the operation of the landfill from the 1940s have not been completely researched. The diesel fuel leak and the Navy landfill are discussed further in Findings 3.4.4.3.1, 3.4.4.3.2, 4.5.2.3.1, and 4.5.2.3.2.

3.4.3 Environmental Monitoring Program

Groundwater monitoring at SNLL has primarily been tied to specific facility investigations. Prior to September 1986, SNLL had no routine groundwater monitoring, except for the monitoring provided by LLNL for wells MW 253 and MW 202 immediately south of East Avenue. The data from this monitoring are included in the LLNL Environmental Monitoring Reports. These wells on SNLL property and north (downgradient) of SNLL on LLNL property provide adequate perimeter and off-site groundwater monitoring. To the extent that SNLL relies on off-site and perimeter monitoring by LLNL, the quality of data for the SNLL site will be influenced partially by the quality of LLNL's program. Because there were some minor shortcomings found in the LLNL Survey, (see LLNL Preliminary Survey Report, August 1987, page 4-97, Finding 4.4.2.4), results for the wells monitored by LLNL may be suspect. The potential uncertainty about these wells is not significant for two reasons. First, the shortcomings in the QA/QC program are relatively minor. Second, the sources of contamination from SNLL are limited and already well-defined. Off-site migration from these sources is very unlikely in the near future. SNLL's current monitoring plans include quarterly sampling for fuel hydrocarbons and selected VOCs.

Two site-specific groundwater investigations have been performed at SNLL: (1) Diesel Fuel Oil Leak; and (2) Navy Landfill. Of these two only the Diesel Fuel Oil Leak has been a reasonably extensive and complete characterization. Eight wells are available there for monitoring purposes (See Figure 3-12). At the Navy Landfill, one well has been drilled. Results of this monitoring are discussed in Finding 3.4.4.3.2.

In addition to the groundwater monitoring activities, associated with these investigations, SNLL drilled a series of soil borings along the Arroyo Seco (5 borings) and at the Navy Landfill (10 borings). The investigations at those two areas consisted of collecting soil samples at intervals on the order of every 10 feet in depth in either hollow stem auger or rotary wash borings. Samples were collected in

driven samplers containing inner liners of either brass or aluminum. The samples were sealed, and refrigerated for shipment to an analytical laboratory. The laboratories, analyzed for hydrocarbons (diesel), volatile organics, metals, and benzene, toluene, and xylene (BTX). Results of the borings and analyses were provided in consultant reports or status reports required by the State of California relative to the 1975 fuel spill. These borings revealed no significant contamination. Results of the analyses are discussed in Section 4.5.

3.4.4 Findings and Observations

3.4.4.1 Category I

None

3.4.4.2 Category II

None

3.4.4.3 Category III

1. Diesel Fuel Tank Area - A leak of approximately 59,500 gallons of number 2 diesel fuel oil has contaminated about 7,650 to 15,300 cubic meters (10,000 to 20,000 cubic yards) of soil and created a plume of contaminated groundwater extending about 14 meters (45 feet) northwest from the leak. The leak occurred in January 1975 when a grounding rod was accidentally driven through a fiberglass transfer pipe leading from a 660,000-liter (175,000-gallon) oil storage tank. The transfer line puncture was located within 30 yards of the tank, which is located on the west-central side of SNLL. In addition, fuel flowed into a utility trench which was open at the time.

In 1984, SNLL began an exploratory investigation to determine the extent of the subsurface fuel oil migration. Essentially, SNLL's investigations indicated that the fuel is primarily adsorbed to soil in the unsaturated zone to a depth of 30 meters (100 feet), where it intercepts a saturated gravel and sand zone. SNLL also found that the fuel oil constituents had spread laterally to a radius of about 14 meters (45 feet) from the original puncture point. One report indicates that the groundwater is moving approximately 12 meters (40 feet) per year, or 3 centimeters per day (0.1 feet per day) to the northwest (HydroGeoChem, Inc., 1985). A later report by the Mark Group in 1986, however, estimated that groundwater was moving southwest (243 degrees) at 33 meters (109 feet)

per year, or 9 centimeters per day (0.3 feet per day), and east (90 degrees) at 67 meters (219 feet) per year, or 18 centimeters per day (0.6 feet per day). These divergent results were believed by SNLL to be the result of seasonal mounding under the Arroyo Seco. The Arroyo Seco serves as a focus of recharge in the area of SNLL. Previous studies by LNLL and SNLL on the general site area have found a generalized northwest flow pattern at about 56 meters (183 feet) per year, or 15 centimeters per day (0.5 feet per day).

The nearest water supply well is located about 760 meters (2,500 feet) west of the fuel oil tank leak site and is used for irrigation and livestock. At a rate of 56 meters (183 feet) per year or 15 centimeters per day (0.5 feet per day), the fuel oil contaminants would reach this well in about 14 years. This period could be longer if the contaminants are degraded in the ground. If the contaminants follow a less resistant path, however, this well could be contaminated sooner. DOE is in the process of acquiring the land upon which this well is located as part of a larger land acquisition (buffer zone) program.

This irrigation well is one of two wells on the Pestana property on the west side of SNLL. It is a 30 centimeter (12-inch) diameter well drilled 65 meters (212) feet deep, and screened between 56 and 58 meters (185 and 190 feet), but is not used.

The other well is a domestic supply well used by the house located about 150 meters (500 feet) west of the irrigation well. It is 18 centimeters (7 inches) in diameter, and screened between 40 meters (130 feet) and its bottom at 45 meters (147 feet). Five well volumes were pumped from both wells during a pump test. The water in both of these wells was very black. The irrigation well water smelled of hydrogen sulfide but was not contaminated with PCE or TCE. The house well water was slightly oily, but was not contaminated with PCE or TCE. Other contaminants were not analyzed because the goal of the investigation was to assess PCE and TCE contamination from LLNL. Following purchase of this land, SNLL planned to seal these wells.

In June 1986, SNLL found oil-saturated soil below the oil tank perimeter where a utility trench had been opened at the time of the fuel leak. The implication of this new finding is that a slightly larger area is contaminated with oil than had previously been believed. SNLL officials believe that oil filled the opened trench and seeped into an arc-shaped area of soil. Eight monitoring wells and several soil borings have been used to delineate this area.

As of February 1987, only one well (4-C) exhibits contamination with organic compounds. This well shows elevated TOC (55 mg/l) and low levels of benzene (about 3 ug/l) and xylene (2 ug/l). Other wells in the downgradient direction showed no organic compounds. The soil column is known to be contaminated from the surface to the water table. The presence of about 100 feet of unsaturated sediments has attenuated much of the contamination and retarded its migration. The water table has been rising for at least five years. Should the water table continue to rise, the area of groundwater contamination would increase because of the solubility of many of the fuel oil constituents. The contaminated soil, in this scenario, would constitute a continuing source of contamination.

The groundwater is being monitored downgradient northwest of the spill site. SNLL, in accordance with a California Regional Water Quality Control Board Administrative Order, has agreed to continue monitoring of the spill and to take appropriate remedial action if warranted by a change from the current slow spread of the oil and its constituents. Refer also to Finding 4.5.2.3.1 for further discussion on the physical characteristics of this source of groundwater contamination.

2. Navy Landfill (NLF) - The groundwater monitoring system at the NLF is inadequate to characterize the groundwater quality or potential receptors. The "Navy" Landfill (NLF) which is located on the south side of the property, is a potential source of groundwater contamination. According to the SNLL CEARP report, the Navy used the landfill from 1942 to 1947, and LLNL site contractors used the landfill from 1947 to 1961, when it was closed. It is located in an area that was originally a ravine cut into the hillside. In 1961, the NLF area was reconfigured and regraded to accommodate bunkers arranged in a semi-circle at the base of the landfill embankment. The NLF originally occupied about 3.5 acres (400 feet by 400 feet), with a 20- to 30-foot depth of fill (approximately 148,000 cubic yards).

The NLF primarily received mixed municipal refuse and construction debris, according to SNLL interviews performed by LANL during the CEARP report preparation. The nature and amount of material disposed of is not known precisely. Some information was obtained from several borings into the landfill and one monitoring well downhill. (Refer to Figure 3-12.) A total of ten borings were made around, and in some cases, through the landfill. Fill materials such as wire, wood, and concrete were observed in some of these borings, but no groundwater was encountered. The results of the soil borings indicate the presence of low levels of organics in the soil and fill. The maximum organic contaminant

concentration in the soil was 380 ppb of methylene chloride. In addition, two soil samples revealed freon-113 concentrations above 5 ppb. These contaminants may actually be artifacts of laboratory cross-contamination. Historic photographs have shown the presence of drums in the landfill. These facts lend to the conclusion that groundwater contamination may be present but has not been detected by the current monitoring scheme. Refer also to Finding 4.5.2.3.2 for further discussion of this problem. SNLL has made no remedial plans for the NLF.

The single well (NLF-1) in the magazine area adjacent to the landfill has not revealed any groundwater contamination. However, a single well cannot be used to define the direction and rate of groundwater movement. It is not known whether well NLF-1 is downgradient of the landfill. Groundwater was encountered in this well approximately 9 meters (30 feet) below the ground surface at the NLF monitoring well. Because of the steep slope of the NLF hillside (referred to as a "canyon" by the MARK Group in 1986) and the nearby Las Positas Fault, approximately 0.4 kilometers (1/4 mile) to the north of the NLF, the location and direction of groundwater movement is unclear. Survey-related sampling is planned.

3.4.4.4 Category IV

None

4.0 NON-MEDIA-SPECIFIC SURVEY FINDINGS

This section discusses findings and observations pertaining to waste management, toxic and chemical materials, radiation, quality assurance, and inactive waste sites and releases. These discussions do not include a background environmental information section because the areas addressed are not necessarily tied to the medium, as was the case with the discussions in Section 3.0. These discussions include an environmental monitoring program section, where appropriate and where information was available. The findings for hazardous, radioactive, mixed, and solid waste management are summarized in the section addressing waste management.

4.1 Waste Management

4.1.1 General Description of Pollution Sources and Controls

4.1.1.1 Hazardous Waste Management

DOE Orders 5480.2 titled Hazardous and Radioactive Waste Management, issued December 13, 1982, and 5820.2 titled Radioactive Waste Management, issued December 6, 1984, are the principal DOE orders regulating waste management at DOE sites. The Resource Conservation and Recovery Act (RCRA) of 1976, and the 1984 RCRA amendments and associated regulations issued by the EPA define hazardous wastes as those wastes that either fail one of the four characterization tests (EP Toxicity, corrosivity, ignitability, reactivity) or are listed as hazardous wastes due to toxicity. The Act and regulations establish the standards used during the Survey as the basis for evaluating hazardous and mixed waste handling procedures and facilities.

The State of California has the authority from EPA to carry out the EPA RCRA regulatory program in addition to its own regulatory program. The main body of California regulations are identical to those of EPA. However, California has a broader listing and one additional characterization test for defining hazardous waste than does the EPA. California lists waste oil as a hazardous waste and has created a Toxic Threshold Limit Concentration (TTLC) for certain hazardous constituents. Wastes exceeding the TTLC for any of a list of constituents is a hazardous waste. Thus, wastes in California can test hazardous either by waste composition or by failing one of the four characteristic tests. California also includes PCBs as a hazardous constituent which, if exceeded in either the leaching procedure or the TTLC at levels of 5 ppm and 50 ppm, respectively, make the waste subject to hazardous waste regulations. This increases the number and quantity of wastes which must be handled as hazardous or mixed wastes by SNLL. California also regulates underground storage tanks more strictly than EPA.

SNLL is a multiprogram laboratory involved in multidisciplinary research and development activities over a broad range of scientific and technical fields. The primary mission of the laboratory is designing, testing, and evaluating non-nuclear portions of nuclear weapons. The secondary mission of SNLL involves energy research with programs in combustion, solar, and fusion research. The large number of programs with continually changing activities and levels of effort, results in the generation of a wide variety of waste. The waste at SNLL is generated in relatively small volumes and usually contains toxic or hazardous constituents.

The bulk of SNLL hazardous wastes are generated in the electroplating, printed circuits, and organic development laboratories, with small quantities of hazardous waste generated in other SNLL facilities. Approximately 130 to 170 drums of hazardous waste are shipped off-site annually to commercial hazardous waste facilities. Table 4-1, which is derived from the SNLL hazardous waste shipment data base, gives information on the types, quantities, and off-site commercial facilities used for treatment and disposal of the 4,000 kilograms of hazardous waste generated monthly at SNLL.

Hazardous wastes are collected in containers, such as 5-gallon carboys or drums, at generating facilities. The generator of the waste is responsible for collecting the waste in an approved container, identifying the contents, initiating the paperwork required for storage, and also for requesting disposal. SNLL Hazards Control personnel are responsible for transportation of the hazardous waste from the generating facility to the waste storage facility.

The Hazardous Waste Storage Facility (B-9622) is a RCRA Part B permitted storage facility. It is located within the fenced security exclusion area of the laboratory. The facility consists of one building, B-9622, in which wastes are received and processed, and five outdoor, roofed storage shelters used for storage of containerized liquid wastes in drums and carboys. The floor of each shelter has a 4-inch depressed cavity to contain any spilled liquids. Containers stored within the shelter are placed on wooden skids. Two shelters are designed for acid wastes (64 drums), while one shelter (32 drums) each is used for alkaline, flammable, and poisonous wastes. The open sides of the shelters are protected from precipitation and sun by curtains. Water run-off is prevented by berms. EPA inspection of the hazardous waste storage area in 1986 found no problems (Schneider, 1986). SNLL prepared a hazardous waste management plan in 1983 (SNLL, 1983). This plan was used by SNLL in obtaining the RCRA Part B permit for the container storage facility (State of California, 1983).

TABLE 4-1

**HAZARDOUS WASTE OFF-SITE SHIPMENTS (07/15/85-10/17/86)
SANDIA NATIONAL LABORATORIES, LIVERMORE**

Treatment/Disposal Facility	Date	Shipping Name	DOT Cl	Total Volume or Weight	Total Weight Pounds	Comment
California Solvent Recycling	10/17/86	Methyl Alcohol	Flammable	220 Gal	—	Waste for recycle. Also drum #85099, 86045
IT Vine Hill	09/29/86	Corrosive Liquid	Corrosive	200 Gal	—	Acid wastes from Printed Circuit Board Shop
Chem Waste - Kettleman	09/29/86	Flammable Liquid	Flammable	55 Gal	—	Solvent mixture containing chlorinated cmpds
Chem Waste - Kettleman	09/29/86	Hazardous Waste Liquid	ORM-E	110 Gal	—	Oil w/ 10 ppm CN, ethylacetate Also Drum 85110
Enscn	07/13/86	Polychlorinated Biphenyl	ORM-E	—	1,535	
Evans Drum	07/23/86	Hazardous Waste Liquid	NA9189	—	2,300	
Casmalia	07/23/86	Hazardous Waste Solid	ORM-E	—	—	
California Oil Recyclers	07/17/86	Oil, NOS	Combustible	1,425 Gal	—	
IT Vine Hill	06/02/86	Corrosive Liquid, NOS	Corrosive	908 Gal	—	
California Oil Recyclers	05/14/86	Oil, NOS	Combustible	950 Gal	—	
H&H Ship Service	04/12/86	Hazardous Waste Solid	ORM-E	5 Yd ³	—	
H&H Ship Service	04/12/86	Hazardous Waste Solid	ORM-E	5 Yd ³	—	
Safety Specialists	04/18/86	Hazardous Waste Liquid	ORM-E	—	120	Labpack
Safety Specialists	04/18/86	Hazardous Waste Liquid	ORM-E	—	120	Labpack
Safety Specialists	04/18/86	Hazardous Waste Liquid	ORM-E	—	100	Labpack
Safety Specialists	04/18/86	Hazardous Waste Liquid	ORM-E	—	126	Labpack
Safety Specialists	04/18/86	Hazardous Waste Liquid	ORM-E	—	171	Labpack
Safety Specialists	04/18/86	Hazardous Waste Solid	ORM-E	—	44	Labpack
Safety Specialists	04/18/86	Hazardous Waste Liquid	ORM-E	—	47	Labpack
Safety Specialists	04/18/86	Hazardous Waste Liquid	ORM-E	—	177	Labpack

**TABLE 4-1
HAZARDOUS WASTE OFF-SITE SHIPMENTS (07/15/85-10/17/86)
SANDIA NATIONAL LABORATORIES, LIVERMORE
PAGE TWO**

Treatment/Disposal Facility	Date	Shipping Name	DOT CL	Total Volume or Weight	Total Weight Pounds	Comment
Safety Specialists	04/18/86	Hazardous Waste Liquid	ORM-E	--	59	Labpack
Safety Specialists	04/18/86	Hazardous Waste Solid	ORM-E	--	75	Labpack
Safety Specialists	04/18/86	Sulfur Solid, NOS	ORM-C	--	5	Labpack
Safety Specialists	04/18/86	Flammable Liquid	Flammable	--	12	Labpack
Safety Specialists	04/18/86	Hazardous Waste Liquid	ORM-E	--	160	Labpack
Safety Specialists	04/18/86	Mercury, Metallic	ORM-B	--	16	Labpack
Safety Specialists	04/18/86	Sodium Nitrate, NOS	Oxidizer	--	2	Labpack
Safety Specialists	04/18/86	Perchloric Acid, NOS	Oxidizer	--	2	Labpack
Safety Specialists	04/18/86	Poison B Solid, NOS	Poison B	--	3	Labpack
Safety Specialists	04/18/86	Corrosive Solid, NOS	Corrosive	--	125	Labpack
Safety Specialists	04/18/86	Corrosive Liquid, NOS	Corrosive	--	9	Labpack
Safety Specialists	04/18/86	Hazardous Waste Solid	ORM-E	--	46	Labpack
Safety Specialists	04/18/86	Corrosive Liquid	Corrosive	--	68	Labpack
Safety Specialists	04/18/86	Hazardous Waste Liquid	ORM-E	--	131	Labpack
Safety Specialists	04/18/86	Hazardous Waste Solid	ORM-T	--	200	Non Labpack
Safety Specialists	04/18/86	Hazardous Waste Solid	ORM-E	--	100	Non-Labpack
Safety Specialists	04/18/86	Asbestos	ORM-C	--	75	Non Labpack
Safety Specialists	04/18/86	Poison B Solid, NOS	Poison B	--	200	Non Labpack
Safety Specialists	04/18/86	Poison B, NOS	Poison B	--	200	Non Labpack
Safety Specialists	04/18/86	Flammable Liquid	Flammable	--	183	Labpack

TABLE 4-1
HAZARDOUS WASTE OFF-SITE SHIPMENTS (07/15/85-10/17/86)
SANDIA NATIONAL LABORATORIES, LIVERMORE
PAGE THREE

Treatment/Disposal Facility	Date	Shipping Name	DOT CL	Total Volume or Weight	Total Weight Pounds	Comment
Safety Specialists	04/18/86	Hazardous Waste Solid	ORM-E	--	45	Labpack
Safety Specialists	04/18/86	Flammable Liquid	Flammable	--	110	Labpack
Safety Specialists	04/18/86	Hazardous Waste Solid	ORM-E	--	173	Labpack
Safety Specialists	04/18/86	Corrosive Solid, NOS	Corrosive	--	58	Labpack
Safety Specialists	04/18/86	Poison B, NOS	Poison B	--	75	Non-Labpack
Safety Specialists	04/18/86	Flammable Liquid	Flammable	--	16	Labpack
Safety Specialists	04/18/86	Corrosive Solid, NOS	Corrosive	--	189	Labpack
Safety Specialists	04/18/86	Hazardous Waste Solid	ORM-E	--	25	Non-Labpack
Safety Specialists	04/18/86	ORM A, NOS	ORM-A	--	26	Labpack
Safety Specialists	04/18/86	Hazardous Waste Solid	ORM-E	47 Yd3	--	
Safety Specialists	04/18/86	Hazardous Waste Solid	ORM-E	--	491	Non-Labpack
Safety Specialists	04/18/86	Hazardous Waste Solid	ORM-E	--	495	Non-Labpack
Safety Specialists	04/18/86	Hazardous Waste Solid	ORM-E	--	360	Non-Labpack
Safety Specialists	04/18/86	Hazardous Waste Solid	ORM-E	--	300	Non-Labpack
EnSCO	04/17/86	Polychlorinated Biphenyl	ORM-E	55 Gal	--	Oil w/54 ppm of CB
EnSCO	04/17/86	Polychlorinated Biphenyl	ORM-E	275 Gal	--	Kerosene w/PCB
EnSCO	04/17/86	Polychlorinated Biphenyl	ORM-E	275 Gal	--	PCB Oil
EnSCO	04/17/86	Polychlorinated Biphenyl	ORM-E	--	100	Capacitors
IT Vine Hill	02/14/86	Corrosive Liquid, NOS	Corrosive	2,056 Gal	--	Acid mixture containing metals
IT Vine Hill	02/14/86	Flammable Liquid, NOS	Flammable	450 Gal	--	Oil containing organic liquids

TABLE 4-1
HAZARDOUS WASTE OFF-SITE SHIPMENTS (07/15/85-10/17/86)
SANDIA NATIONAL LABORATORIES, LIVERMORE
PAGE FOUR

Treatment/Disposal Facility	Date	Shipping Name	DOT CL	Total Volume or Weight	Total Weight Pounds	Comment
Safety Specialists	02/03/86	Hazardous Waste Solid	ORM-E		1,500	
Safety Specialists	02/03/86	Hazardous Waste Solid	ORM-E		800	
Safety Specialists	02/03/86	Corrosive Solid, NOS	Corrosive		800	
Casmalia	01/31/86	Polychlorinated Biphenyl	ORM-E		5,100	Transformer, emptied & rinsed Had contained pure PCBs
Casmalia	01/31/86	Polychlorinated Biphenyl	ORM-E		200	Paper waste & equipment contaminated & w/PCBs
Safety Specialists	01/20/86	Corrosive Solid, NOS	Corrosive		1,500	
Casmalia	01/08/86	Corrosive Solid, NOS	Corrosive		2,750	
Safety Specialists	12/23/85	Polychlorinated Biphenyl	ORM-E	6 Yd ³		
Safety Specialists	12/23/85	Polychlorinated Biphenyl	ORM-E	825 Gal		
Safety Specialists	12/23/85	Polychlorinated Biphenyl	ORM-E		350	
Safety Specialists	12/23/85	Hazardous Waste Solid	ORM-E		500	
Casmalia	12/16/85	Hazardous Waste Solid	ORM-E		2,250	
Casmalia	12/16/85	Hazardous Waste Solid	ORM-E		600	
Casmalia	12/16/85	Hazardous Waste Solid	ORM-E		600	
Casmalia	12/16/85	Hazardous Waste Solid	ORM-E		4	
Casmalia	12/16/85	Corrosive Solid, NOS	Corrosive		2,750	
Casmalia	12/16/85	Hazardous Waste Solid	ORM-E	5 Yd ³		
Casmalia	12/16/85	Hazardous Waste Solid	ORM-E	4 Yd ³		
Casmalia	12/16/85	Hazardous Waste Solid	ORM-E	6 Yd ³		

TABLE 4-1
HAZARDOUS WASTE OFF-SITE SHIPMENTS (07/15/85-10/17/86)
SANDIA NATIONAL LABORATORIES, LIVERMORE
PAGE FIVE

Treatment/Disposal Facility	Date	Shipping Name	DOT CL	Total Volume or Weight	Total Weight Pounds	Comment
Safety Specialists	08/20/85	Flammable Liquid, NOS	Flammable	--	131	Labpack
Safety Specialists	08/20/85	Flammable Liquid, NOS	Flammable	--	130	Labpack
Safety Specialists	08/20/85	Acid Liquid, NOS	Corrosive	--	190	Labpack
Safety Specialists	08/20/85	Corrosive Liquid	Corrosive	--	179	Labpack
Safety Specialists	08/20/85	Corrosive Liquid	Corrosive	--	170	Labpack
Safety Specialists	08/20/85	ORM-A, NOS	ORM-A	--	55	Labpack
Safety Specialists	08/20/85	Asbestos	ORM-C	--	4	Labpack
Safety Specialists	08/20/85	Oxidizer, NOS	Oxidizer	--	104	Labpack
Safety Specialists	08/20/85	Magnesium Powder	Flammable	--	55	Labpack
Safety Specialists	08/20/85	Magnesium Powder	Flammable	--	55	Labpack
Safety Specialists	08/20/85	Water Reactive Solid	Flammable	--	6	Labpack
Safety Specialists	08/20/85	Water Reactive Solid	Flammable	--	8	Labpack
Safety Specialists	08/20/85	Flammable Liquid, NOS	Flammable	--	138	Labpack
Safety Specialists	08/20/85	Hazardous Waste Solid	ORM-E	--	135	Labpack
Safety Specialists	08/20/85	Flammable Liquid, NOS	Flammable	--	3	Labpack
Safety Specialists	08/20/85	Poison B, NOS	Poison B	--	3	Labpack
Safety Specialists	08/20/85	Hazardous Waste Solid	ORM-E	--	192	Labpack
Safety Specialists	08/20/85	Corrosive Liquid, NOS	Corrosive	--	217	Labpack
Safety Specialists	08/20/85	ORM-B, NOS	ORM-B	--	75	Labpack
Safety Specialists	08/20/85	Hazardous Waste Solid	ORM-E	--	135	Labpack

TABLE 4-1
HAZARDOUS WASTE OFF-SITE SHIPMENTS (07/15/85-10/17/86)
SANDIA NATIONAL LABORATORIES, LIVERMORE
PAGE SIX

Treatment/Disposal Facility	Date	Shipping Name	DOT Cl	Total Volume or Weight	Total Weight Pounds	Comment
Safety Specialists	08/20/85	Hazardous Waste Solid	ORM-E	--	80	Labpack
Safety Specialists	08/20/85	Sodium Hydroxide Solid	Corrosive	--	60	Labpack
Safety Specialists	08/20/85	Oxidizer, Corrosive	Oxidizer	--	35	Labpack
Safety Specialists	08/20/85	Poison B, NOS	Poison B	--	70	Labpack
Safety Specialists	08/20/85	Hazardous Waste Solid	ORM-E	--	50	Labpack
Safety Specialists	08/20/85	Cyanide Solution, NOS	Poison B	--	385	Labpack
Safety Specialists	08/20/85	Poison B, NOS	Poison B	--	1	Labpack
Safety Specialists	08/20/85	Hazardous Waste Solid	ORM-E	--	63	Labpack
Safety Specialists	08/20/85	Poison B Solid, NOS	Poison B	--	2	Labpack
Safety Specialists	08/20/85	Hazardous Waste Solid	ORM-E	--	450	Non-Labpack
Safety Specialists	08/20/85	Hazardous Waste Solid	ORM-E	--	100	Non-Labpack
Evans Drum Company	08/16/85	Hazardous Waste Liquid	ORM-E	--	1,080	Empty Drums
Evans Drum Company	08/16/85	Acetone	Flammable	--	40	Empty Drum
Evans Drum Company	08/16/85	1,1,1-Trichloroethane	UN2831	--	40	Empty Drum
Evans Drum Company	08/16/85	Paint-Related Material	Combustible	--	40	Empty Drum
California Oil Recyclers	07/15/85	Oil, NOS	Combustible	1,050 Gal	--	92.8% Waste Oil - 7.2% Water
Chem Waste Kettleman	07/15/85	Phosphoric Acid	Corrosive	55 Gal	--	
Chem Waste Kettleman	07/15/85	Corrosive Liquid, NOS	Corrosive	220 Gal	--	
Chem Waste Kettleman	07/15/85	Sulfuric Acid	Corrosive	165 Gal	--	
Chem Waste Kettleman	07/15/85	Hydrochloric Acid	Corrosive	275 Gal	--	

TABLE 4-1
HAZARDOUS WASTE OFF-SITE SHIPMENTS (07/15/85-10/17/86)
SANDIA NATIONAL LABORATORIES, LIVERMORE
PAGE SEVEN

Treatment/Disposal Facility	Date	Shipping Name	DOT CL	Total Volume or Weight	Total Weight	Comment
Chem Waste Kettleman	07/15/85	Oxidizer, Corrosive	Oxidizer	55 Gal	--	
Chem Waste Kettleman	07/15/85	Chromic Acid Solution	Corrosive	330 Gal	--	
Chem Waste Kettleman	07/15/85	Nitric Acid, 40%	Corrosive	110 Gal	--	
Chem Waste Kettleman	07/15/85	Ferric Chloride Solution	Corrosive	165 Gal	--	
Chem Waste Kettleman	07/15/85	Sodium Hydroxide Sol	Corrosive	495 Gal	--	
Chem Waste Kettleman	07/15/85	Sodium Hydroxide Sol	Corrosive	110 Gal	--	
Chem Waste Kettleman	07/15/85	Zinc Chloride Sol	Corrosive	165 Gal	--	
Chem Waste Kettleman	07/15/85	Sodium Hydroxide Sol	Corrosive	55 Gal	--	
Chem Waste Kettleman	07/15/85	Hazardous Waste Liquid	ORM-E	110 Gal	--	
Chem Waste Kettleman	07/15/85	Asbestos	ORM-C	360 Gal	--	
Chem Waste Kettleman	07/15/85	Corrosive Solid NOS	Corrosive	30 Gal	--	
Chem Waste Kettleman	07/15/85	Trichloroethylene	ORM-A	110 Gal	--	
Chem Waste Kettleman	07/15/85	1,1,1-Trichloroethane	ORM-A	55 Gal	--	
Chem Waste Kettleman	07/15/85	Xylene	Flammable	55 Gal	--	
Chem Waste Kettleman	07/15/85	Nickel Ammonium Sulfate	ORM-E	715 Gal	--	
Chem Waste Kettleman	07/15/85	Hazardous Waste Liquid	ORM-f	110 Gal	--	

Source: SNLL, 1986a
Gal Gallon(s)
Yd³ Cubic Yards
NOS Not otherwise specified
DOT CL Department of Transportation Classification

ORM-A Other regulated material (irritant)
ORM-B Other regulated material (corrosive)
ORM-C Other regulated material (49 CFR 177.101 Listing)
ORM-E Other regulated material (hazardous wastes)

Small quantities of laboratory wastes are accumulated (up to 300 pounds) in B-9622. An outside contractor is called in to package these wastes into labpacks for shipment off-site.

SNLL produces a small quantity of High Explosive (HE) contaminated waste consisting of wrapping boxes, packaging materials that may become contaminated with HE during shipping, small misfired explosive devices, and miscellaneous materials such as wood and electrical cables remaining in a firing chamber after a charge has been fired. This waste is burned in an on-site incinerator to "guarantee that all explosive material has been destroyed." The maximum quantities of high explosive that may be incinerated at one time is either a maximum of 0.51 grams of loose uncontained explosive powder or 3 grams explosive equivalent of squibbs, which are self-contained explosives in a metal shell set off electrically to give a charge that would ignite a propellant. In response to a request from the California Department of Health Services, SNLL filed a revised RCRA Part A Application to include the on-site incinerator (SNLL, 1986b). SNLL stated in the cover letter accompanying the application that SNLL intended to seek a variance from RCRA permitting for the incinerator, since "it is not used as a vehicle to fire explosives, only to guarantee that all explosive material has been destroyed." SNLL has not yet heard from the state.

4.1.1.2 Mixed Waste

Mixed wastes are hazardous wastes with radioactive constituents. Currently, mixed wastes are not regulated since California has not yet obtained authority to regulate mixed wastes. SNLL generates small quantities (e.g., grams, pints) of mixed wastes. Waste acids contaminated with tritium are generated in the analytical lab, materials laboratories, and in the autoradiographic etch process. The Tritium Research Laboratory (TRL) generates 1 drum/year of scintillation cocktail wastes, which consists of small vials containing milliliter quantities of radioactively contaminated solvents. These scintillation wastes are treated as a hazardous waste. The scintillation vials are crushed, filtered, and residual liquid transferred to Lawrence Livermore National Laboratory for incineration. Other mixed wastes include U-238 and tritium-contaminated laboratory chemicals such as nitrites, nitrates, sulfates, sulfides, and U-238-contaminated chromium, zinc, mercury, copper, silver, beryllium, and lithium hydride, all generated in small quantities.

Until 1986, SNLL shipped its mixed wastes, after solidification of liquids, to the Nevada Test Site (NTS). Mixed wastes will now be stored on-site since NTS will no longer accept mixed wastes until RCRA permits are obtained. Depleted U-238 turnings produced in B-913 and solidified in B-961 as discussed in the section on radioactive wastes, are also considered a mixed waste because the turnings are pyrophoric, (i.e., a reactive mixed waste). NTS has declined to accept similar solidified uranium turnings from other DOE facilities.

4.1.1.3 Radioactive Waste

SNLL generates 28,700 kilograms of radioactive waste per year, none of which is high level or transuranic waste. All radioactive waste at SNLL is low-level waste. Table 4-2 contains compositions, volumes, and masses of radioactive wastes as described in the Waste Management Site Plan. Over 66 percent of the waste is tritium-contaminated materials, including tritium-contaminated water (8,000 gallons generated during 1985) shipped to General Electric (GE) Vallecitos Nuclear Center for evaporation. The remainder is mostly depleted uranium-contaminated wastes, classified weapon components, and small quantities of mixed wastes, which (with the exception of the mixed wastes) are sent to NTS for disposal.

The generators of radioactive waste are the Tritium Research Laboratory, Machine Shop, and the Test Assembly Group. SNLL has also assumed responsibility for storage and disposal of Sandia W-70 and W-82 test vehicle debris from the Yuma Proving Ground (YPG). Personnel at YPG package the material for shipment to SNLL to be included in SNLL radioactive waste shipments to NTS.

The majority of the tritium waste is generated at the Tritium Research Laboratory (TRL). The wastes include low-level and high-specific-activity liquids, contaminated compactibles, and experimental hardware, and incidental gaseous tritium. Liquid wastes from the TRL consist of high-specific-activity water from the Vacuum Effluent Recovery System and from the Recirculating Gas Purification System; very low-specific-activity water from the hood sinks and chilled water supply; and solvents and liquids from decontamination operations and vacuum and gas transfer pumps. The Machine Shop (B-913) generates depleted uranium in the form of turnings. The Test Assembly Group (TAG) in B-913 generates damaged or surplus components. Classified components and subassemblies are disposed of as radioactive waste. W-70 and W-82 test vehicle debris from YPG includes classified U-238-contaminated and beryllium-contaminated wastes.

Health Physics Technicians are responsible for picking up radioactive wastes when a full container has been accumulated. The wastes are transferred to Building 961, which is the radioactive waste handling facility. Material decontamination, radioactive waste storage, waste compaction, and radioactive waste treatment such as neutralization and solidification of nonclassified radioactive wastes, take place at this facility. Secret Restricted Data (SRD) wastes are stored at the B-927 Classified Material Vault.

TABLE 4-2

RADIOACTIVE WASTE INVENTORY
SANDIA NATIONAL LABORATORIES, LIVERMORE

Category	Activity (Ci)	Volume/Year(1) (M ³)	Mass/Year(2) (Kg)	Treatment/ Disposal
U-238, Tritiated Solids	9,500	21	16,000	NTS
Tritiated Water Absorbed on Clay	High Activity 90,000	1	2,500	Mound
Tritiated Water - Low Activity	3	10	10,000	Evaporated GE

Source: SNLL Site Waste Management Plan (Siegfried, 1986).

(1) Volume given is gross volume, including contaminated equipment, laboratory trash, air space, cushioning material, etc.

(2) Mass given is gross weight, including containers and packing material.

Ci - Curies

NTS - Nevada Test Site

M³ - Cubic Meter

Kg - Kilogram

Radioactively contaminated items are steam cleaned on a washdown pad located outside of B-961. The washdown pad drains to a 1,000-gallon hold tank. Chemically contaminated equipment may also, on occasion, be cleaned on the pad. The washdown pad is used very infrequently. Wastewaters are handled as a radioactive wastewater and either sent to GE Vallecitos Nuclear Center or discharged to the sanitary sewer if below applicable limits.

Low Specific Activity (LSA) tritium-contaminated oils and solvents with tritium quantities less than 1,000 curies are absorbed on clay in 15-gallon steel "beer kegs" which are then packed with sorbent at the TRL. The keg is then overpacked into a steel drum or steel box for off-site shipment to NTS. Neutralized acids and bases are absorbed on clay in 15-gallon polyethylene kegs. All kegs are limited to 20 curies of tritium and 20 liters of liquid. The polyethylene kegs are also overpacked and placed in steel boxes for off-site shipment. Tritium-contaminated laboratory trash is compacted in steel drums in B-961 or used as cushioning around contaminated hardware in steel boxes.

High-specific-activity tritium wastes generated by the TRL's Vacuum Effluent Recovery System (VERS) and the glove box Gas Purifying System (GPS) are temporarily stored on molecular sieves after tritium gas is oxidized to form tritiated water. The sieves are regenerated at 1- to 2-year intervals and the 24 to 36 liters of tritiated water produced is sent to Mound Laboratory for disposal.

U-238 turnings from the B-913 Machine Shop are immersed in oil and stored in B-961. The turnings are solidified with concrete after filtering to remove the oil at B-961. SRD classified U-238 waste are bagged, labeled, weighed, and stored in steel boxes in the B-927 vault. All solid radioactive wastes are shipped to NTS for disposal.

Low-specific-activity water generated from laboratories or equipment cleaning at the TRL drains to newly built 2,500-gallon hold tanks. If the hold tank contains greater than 20 mCi in activity, the contents are shipped to GE Vallecitos for disposal by evaporation. Otherwise, the hold tank contents are released to the sanitary sewer.

Small quantities (1 to 2 kilograms/year) of uranium powders are oxidized in a laboratory hood in B-979 and B-916 prior to shipment to NTS. Larger items of equipment which may contain uranium powders are also oxidized prior to shipment. (See Section 4.1.1.2 for additional details.)

4.1.1.4 Solid Waste

Solid wastes are defined as waste materials without hazardous, radioactive or toxic constituents. All solid waste generated at SNLL is disposed at the Livermore town landfill. Classified burnable wastes without hazardous or radioactive constituents are burned at the SNLL incinerator.

4.1.2 Findings and Observations

4.1.2.1 Category I

None

4.1.2.2 Category II

None

4.1.2.3 Category III

1. Wastewater Analysis. Hazardous constituents used in laboratory and maintenance operations may be discharged to the sanitary sewer because wastewater from the B-913 retention tank is not analyzed prior to discharge, and wastewater from the B-913 paint spray booth is not analyzed for the presence of hazardous constituents prior to discharge.

The B-913 wastewater retention tank receives waste machine coolant and wastewaters from certain laboratory areas in B-913, which may contain hazardous constituents. The retention tank is only analyzed for beryllium and uranium prior to release of the contents to the sanitary system. The presence of hazardous constituents would be undetected by the current analytical scheme. Survey-related sampling and analysis is planned.

Scrubbing waters from the paint spray booth, which are periodically released to the sanitary system, are not analyzed for potential hazardous constituents prior to their release. The paint spray booth scrubbing waters may contain components of solvents and paints.

4.1.2.4 Category IV

1. Waste Accumulation Areas (WAAs). Lack of proper secondary containment and adherence to labeling procedures in waste accumulation areas used for the temporary storage of

hazardous/radioactive wastes could result in the release of hazardous and/or radioactive constituents to the environment.

The existence of numerous individual hazardous/radioactive waste-generating sources at SNLL has resulted in the need for areas where wastes can be accumulated. Wastes are transported in solid or liquid form from individual laboratories or facilities to a WAA, where the wastes are temporarily stored prior to transport to the B-9622 Hazardous Waste Storage Facility.

California and EPA regulations allow the temporary (less than 90 days) accumulation of hazardous wastes in WAAs. Standards for accumulation of wastes in these areas call for the labeling of containers as hazardous waste containers, noting accumulation start dates and storage for less than 90 days. Requirements for secondary containment, impermeable surfaces, and run-on/run-off controls which apply to permitted storage areas do not technically apply to WAAs. Given that the wastes in the WAAs typically pose the same hazards as wastes in permitted storage areas, not implementing the above requirements increases the potential for a release of hazardous or radioactive constituents from WAAs.

WAAs lacking adequate secondary containment, and proper labeling include the following:

- B-913: South end shed WAA, lack of secondary containment, containers not labeled.
- B-963: Waste oil collected in drum with partial secondary containment, containers not labeled.
- B-906: Containers not labeled.

4.2 Toxic and Chemical Materials

4.2.1 General Description of Pollution Sources and Controls

The toxic and chemical materials portion of the Survey covered PCBs, asbestos, fully halogenated chlorofluoroalkanes, and pesticides/herbicides. In addition, chemical storage or handling at the stores area and an off-site warehouse were also examined.

PCB Sources

PCBs are only present in capacitors at SNLL. Records indicate that there are no PCB transformers or other PCB-containing equipment or material on-site, but the exact amounts of PCBs at SNLL are not accurately known because of the manner in which the PCB reports are completed. However, it is

estimated that only a few hundred pounds are present. The current PCB capacitors are all labeled according to Toxic Substances Control Act (TSCA) regulations. For disposal purposes, an outside contractor, who has been screened by SNLL personnel, is used to remove and dispose of any remaining PCB equipment. There are no PCB wastes stored on-site at SNLL. Current plans are to phase out all PCB-containing equipment (DOE, 1986).

Asbestos Sources

A program is in place to locate and label all asbestos-containing material. Whenever a removal project is anticipated, an outside contractor is selected to conduct the removal according to the National Emission Standards for Hazardous Air Pollutants (NESHAPS) regulations. All outside contractors are screened by SNLL personnel to ensure that all asbestos handling and removal practices conform with NESHAPS requirements. Asbestos wastes are removed to state-approved landfills. No estimates are available on the amounts of asbestos present at SNLL, although site personnel have indicated that the total amount is small (DOE, 1986).

Pesticide Sources

Pesticide usage at SNLL began in the mid-1960s. About 638 pounds of pesticides are used per year by SNLL personnel. These include Carmex, Princep, Atrazine, and Ronstar G. The SNLL applicators are licensed and are inspected by a county agricultural agent. Pesticides, such as Atrazine and 2,4-D, are stored in the Maintenance Storage Building. The Survey team's inspection found that the storage and mixing areas are well maintained and ventilated. Mixing is done in Building 962. Labeling of the containers is in accordance with the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) and contains such information as formulation, toxicity, target organisms, breakdown properties, and environmental effects. Empty containers are triple-rinsed and given to Hazards Control for disposal. Any unused or excess pesticide materials are disposed of by Hazards Control according to specified requirements.

Other Sources

The purchase and storage of all chemicals is under the scrutiny of Hazards Control Division (HCD). A computer tracking system is in place that utilizes information on the material safety data sheets (MSDS) and purchase orders to track the location, purchase, and shelf-life of chemicals used at SNLL. Chemicals used at this facility are received and initially stored at Building 916 before distribution to the users throughout SNLL. Building 918 is used for storage of gas cylinders and some bulk chemicals. It is a divided area that neatly segregates the various gas cylinders according to types.

The Research Drive Warehouse, which is basically a furniture/equipment store house, was found to contain pallets of petroleum-based products and several drums of tellurium. See Finding 4.2.2.4.2 for more details.

4.2.2 Findings and Observations

4.2.2.1 Category I

None

4.2.2.2 Category II

None

4.2.2.3 Category III

None

4.2.2.4 Category IV

1. PCB Annual Reports. A review of SNLL's PCB annual report revealed the following deficiencies:

- It is not possible to confirm that PCB transformers have been eliminated from the site, because PCB transformer information is not segregated from other PCB information in the annual report.
- The number of capacitors in/out of service is not shown on an annual basis.
- Quantities of PCB capacitors in storage and dates are not shown.
- Disposal information such as dates, transporter, and facility are not shown.

Although these deficiencies do not constitute environmental problems, they do constitute administrative noncompliance with TSCA regulations and could result in fines.

2. Improper Storage of Chemicals. The storage of chemicals in the furniture/equipment warehouse on Research Drive could lead to potential environmental problems during emergencies, such as fires. One pallet (twelve 5-gallon cans) of MagnaFlux (a flammable petroleum-based product) and three 55-gallon drums of tellurium were found stored there at

the time of the Survey. When heated, tellurium can emit toxic fumes which would endanger personnel in the event of a fire.

3. Uncontained Chemical Storage. The lack of a contained area for the storage of trichloroethylene (TCE) near the B-913 solvent recovery still could result in the release of a hazardous chemical to the environment. This storage area contained about 5 drums of TCE, which is used throughout SNLL as a general solvent. In the event of a spill or accidental rupture of one of the drums, TCE would contaminate soil and possibly groundwater.

4.3 Radiation

4.3.1 Background Environmental Information.

The SNLL radiation site setting can be described as a subset of each of the previous media settings (i.e., air, soils, surface water, and hydrogeology). Each of these primary pathways is responsible for radionuclide transport and potential contamination of ambient air, soils, drinking water, groundwater, vegetation, and food.

Background radiation in the vicinity of SNLL is a consequence of both natural and man-made sources. These sources include cosmic radiation; natural radioactive materials in the soils and building materials; fallout from past atmospheric weapons detonations; releases of radioactive materials from nuclear power plants and other facilities handling radioactive materials worldwide; and the intake of radioactive materials in air, drinking water, and food. The most significant exposure is that to the lungs from background levels of radon. The annual average effective dose equivalent for natural background in the United States is approximately 189 millirem/year (mrem/yr) (United Nations, 1982). This dose is detailed in Table 4-3. About one-half of the dose equivalent is attributable to the inhalation of radon-222 and its decay products. Previously accepted estimates of background doses did not include the radon contribution and were set at about 100 mrem/year.

The data in Table 4-3 were derived in accordance with the approach recommended by the International Commission for Radiation Protection (ICRP) in ICRP Reports 26 and 30. This approach allows direct comparison of the effective dose for different organs by reflecting the distribution of and organ sensitivity to various radionuclides. This is accomplished by applying "weighting factors"

TABLE 4-3

AVERAGE ANNUAL EFFECTIVE DOSE EQUIVALENT TO
HUMANS FROM NATURAL BACKGROUND RADIATION

SANDIA NATIONAL LABORATORIES, LIVERMORE

Organ	Annual Effective Dose Equivalent (mrem)
Gonads	24
Breast	14
Lung (Total)	100
Red Bone Marrow	13
Bone Surfaces	6
Thyroid	3
Other	29
Total(1)	189

Source: United Nations, 1982

(1) Total represents the product of the appropriate weighting factor times the annual dose equivalent for pulmonary, tracheal/bronchial, and mean doses.

to the doses received by individual organs. The weighting factors are expressed as the fraction of the total risk for the entire body attributable to the organ. The sum of the dose equivalents for the individual organs provides an estimate of the total effect of the radiation on the whole body.

The EPA reports gamma radiation dose rates on a quarterly basis for select locations throughout the United States in Environmental Radiation Data (EPA, 1987). During the most recent reporting period of July-September 1986, measured dose rates equivalent to an annual dose of approximately $59.6 \text{ mrem} \pm 6.2 \text{ mrem}$ were reported for the Berkeley, California, monitoring location. Although SNLL does not have an environmental Thermoluminescent Dosimeter (TLD) program of its own (see Finding 4.3.4.4.1), data collected at 55 Livermore Valley locations (Figure 4-1) by Lawrence Livermore National Laboratory (LLNL) and used by SNLL indicate annual dose rates of approximately $60 \text{ mrem} \pm 11 \text{ mrem}$ (Griggs and Buddemeier, 1986).

As required by DOE Order 5484.1 Chapter III, 4d2d1-3, SNLL makes an annual "assessment and reporting of potential dose to the public," using data collected and calculated by LLNL. Deficiencies associated with calculation methodology are discussed in Finding 4.3.4.4.2. In 1985 DOE adopted an interim radiation protection standard for environmental activities to be implemented in calendar year 1985 (DOE, 1985c). It is DOE policy to follow the guidance of the National Council on Radiation Protection and Measurements (NCRP) to the extent practicable with respect to radiation protection standards. A comprehensive revision of previous NCRP recommendations on a basic radiation protection system is still under development. However, current NCRP guidance is available regarding protection of the public in its September 18, 1984, advice to the Environmental Protection Agency published under the title "Control of Air Emissions of Radionuclides." In this document, the NCRP endorses the recommendation of the International Commission on Radiological Protection (ICRP) to limit the continuous exposure to any member of the public from other than medical sources and natural background to 100 mrem per year whole body dose-equivalent. The previously recommended limit of 500 mrem per year is retained for non-continuous exposures. This recommendation is now adopted as an interim standard for DOE environmental activities for the sum of all exposure pathways.

SOURCE: Adapted from Griggs and Buddemeier, 1986

FIGURE 4-1

OFF-SITE GAMMA DOSIMETER LOCATIONS SNLL - LIVERMORE, CALIFORNIA

Immersion, or external penetrating radiation exposure from radionuclides in air and external penetrating radiation exposure from radionuclide land-surface contamination, also known as ground-plane irradiation, are direct radiation issues. Environmental TLD monitoring programs, in conjunction with soil radionuclide monitoring of the Livermore Valley, demonstrate public exposure is well below permissible limits and is essentially indistinguishable from background levels.

Radiation exposures are received from external sources and from radionuclides taken into the body by inhalation of air and ingestion of water and foodstuffs. Radionuclides taken into the body will continuously irradiate the body until they are removed through either radioactive decay or metabolic processes. Consequently, internal dose estimates are calculated as "50-year dose commitments." These are obtained by integrating the total dose received by an individual's body over an assumed remaining lifetime of 50 years. Principal pathways for exposure of humans from radionuclides released from SNLL are shown in Figure 4-2. The dose to the various major organs are considered for various exposure pathways. The radiation doses received by a specific organ are weighted and summed to determine the total dose.

4.3.2 General Description of Pollution Sources and Controls

Penetrating radiation sources, including sealed gauge and check sources as well as larger diagnostic radiation sources, are used on-site as part of research efforts. The source with the greatest potential for public exposure is the Radiography Operation in Building 923. This is located about 75 yards from SNLL's fence-line and is a well-shielded operation. Health physics assessments are conducted periodically for employee exposure evaluations. However, because of the lack of a perimeter fencing TLD program, no documentation exists on a continuing basis measuring fence-line dose rates (see Finding 4.3.4.4.1).

The major source of radionuclide emissions and subsequent non-direct radiation pathway exposure is the Tritium Research Laboratory. This facility contributes the majority of airborne and water releases of radioactive material consisting primarily of tritiated water (HTO) in vapor and liquid forms. Control technologies include trapping, retention tanks, and building design. The latter control technology relies on air flowing from areas of least potential contamination to areas of greatest potential contamination. Details on the environmental impacts of these releases are discussed in Section 4.3.3.

FIGURE 4-2

PATHWAYS FOR EXPOSURE OF MAN FROM
ATMOSPHERIC AND AQUATIC RELEASES OF RADIOACTIVE EFFLUENTS
SNLL - LIVERMORE, CALIFORNIA

4.3.3 Environmental Monitoring Program

SNLL's environmental radiation monitoring program consists largely of using data collected by LLNL in the area surrounding the site. Figure 4-1 shows LLNL's TLD locations for off-site measurement of penetrating radiation. LLNL positions 55 and 57 through 69 represent the closest approximation SNLL has to perimeter TLD monitoring. Table 4-4 summarizes these data for CY-1985 resulting in a 57.1 mrem average "perimeter approximation," as discussed above, not fence-line dose (refer to Figure 4-1). Because SNLL does not have a fence-line TLD monitoring program, documentation of penetrating radiation doses at a location where "uncontrolled public access" is possible, (even though the doses are not likely to be excessive), is not available (see Finding 4.3.4.4.1).

As mentioned in the air section (3.1) SNLL reports an airborne radionuclide dose assessment for tritium using "perimeter" average tritium concentrations. A discussion regarding data handling of these perimeter tritium results is provided in Section 3.1.3, and details concerning deficiencies in dose assessment methodologies are described in Findings 3.1.4.4.1 and 4.3.4.4.2.

The remaining environmental monitoring data discussed in this section has been collected, analyzed, and reported by LLNL as part of its environmental monitoring program. Because both LLNL and SNLL release tritium to the environment and are geographically very close to each other, it is difficult to determine whether observed tritium concentrations in various media are specifically the result of one laboratory or the other. Nevertheless, the overall effect of the combined activities of both sites will be observed in "measured" data rather than "calculated" data used in AIRDOS modeling. Dose assessment for other monitored media are discussed in the following paragraphs.

As mentioned in Section 3.3.1, all of SNLL's sanitary discharges flow into LLNL's sanitary system and ultimately to the permitted outfall located at the northwest corner of the LLNL Main Site. Adult whole-body dose assessments calculated for surface water data are listed in Table 4-5 for locations shown in Figure 4-3. These calculations assume that a person would consume 2 liters/day and use dose conversion factors for tritium contained in ICRP 30 from that sampling location. The highest dose is 0.05 mrem, which represents 0.03 percent of the U.S. average background radiation dose shown in Table 4-3.

TABLE 4-4

PERIMETER DIRECT-RADIATION APPROXIMATION
SANDIA NATIONAL LABORATORIES, LIVERMORE

LLNL TLD Monitoring Position	Annual Average (mrem)
55	62.0
57	52.0
58	57.0
59	55.0
60	73.0
61	47.0
62	50.0
63	55.0
64	56.0
65	54.0
66	62.0
67	64.0
68	60.0
69	52.0
Average	57.1

Source: Adapted by DOE Survey team from Griggs and Buddemeier, 1986
TLD = Thermoluminescent Dosimeter

TABLE 4-5

TRITIUM (HTO) IN WATER - LIVERMORE VALLEY
SANDIA NATIONAL LABORATORIES, LIVERMORE

Location ^a	No. of Samples	[10 ⁻⁷ μ Ci/ml $\pm$ 2 σ (%)]			%SDM ^b	%CG ^c	Calculated Adult Whole-Body Dose (mrem)
		Maximum	Minimum	Average			
11	4	0.8	0.4	0.6	22	3 x 10 ⁻¹	3 x 10 ⁻³
15	4	0.8	0.5	0.7	16	3 x 10 ⁻¹	3 x 10 ⁻³
16	4	2.3	1.3	1.8	27	9 x 10 ⁻¹	8 x 10 ⁻³
19	4	0.7	0.5	0.6	18	3 x 10 ⁻¹	3 x 10 ⁻³
20	10	34.5	0.7	9.9	107	5	5 x 10 ⁻²
23	4	0.7	0.4	0.5	27	3 x 10 ⁻¹	3 x 10 ⁻³
24	4	1.5	0.5	0.9	51	4 x 10 ⁻¹	4 x 10 ⁻³
26	4	1.7	1.4	1.5	9	8 x 10 ⁻¹	7 x 10 ⁻³
29	4	0.7	0.3	0.4	37	2 x 10 ⁻¹	2 x 10 ⁻³
30	4	1.0	0.4	0.6	44	3 x 10 ⁻¹	3 x 10 ⁻³
31	4	0.9	0.3	0.6	44	3 x 10 ⁻¹	3 x 10 ⁻³
33	4	0.8	0.1	0.5	52	3 x 10 ⁻¹	3 x 10 ⁻³
37	4	1.2	0.4	0.8	47	4 x 10 ⁻¹	4 x 10 ⁻³

Source: Adapted from Griggs and Buddemeier, 1986

a See Figure 4-3 for sample locations.

b SDM = Standard deviation of the mean

c CG = Concentration Guide = 2 x 10⁻⁵ μ Ci/ml.

FIGURE 4-3

LIVERMORE VALLEY WATER SAMPLING LOCATIONS
SNLL — LIVERMORE, CALIFORNIA

Table 4-6 lists the calculated adult whole-body dose for vegetation samples collected at locations shown in Figure 4-4. Conservative vegetation pathway public dose calculations yield exposures of 0.3 mrem/year for Livermore Valley locations representing 0.16 percent of the U.S. average background radiation dose shown in Table 4-3.

Table 4-7 shows measured tritium concentration in milk obtained from farms within 5 kilometers of SNLL (Livermore Valley) and the associated adult whole-body dose. Milk dose calculations assume intake of 30 liters/year and use the ICRP 30 tritium dose conversion factor.

Tables 4-8 and 4-9 show tritium concentrations in wine and honey, which are two locally produced agricultural products. No dose assessment calculations have been made because accurate data on consumption of these specific products would be difficult to obtain and probably not contribute significantly to public dose. Inclusion of this information is provided as another relative indicator of off-site impacts due to SNLL activities.

4.3.4 Findings and Observations

4.3.4.1 Category I

None

4.3.4.2 Category II

None

4.3.4.3 Category III

None

4.3.4.4 Category IV

1. Direct Radiation - Fence-Line "Uncontrolled Public Access" Radiation Dose Monitoring. Lack of a fence-line environmental penetrating radiation monitoring program prevents documentation and evaluation of potential present or past environmental impacts. Current LLNL TLD locations surrounding the SNLL site were not located to discriminate between

TABLE 4-6

TRITIUM (HTO) IN VEGETATION - LIVERMORE VALLEY
SANDIA NATIONAL LABORATORIES, LIVERMORE

Location ^a	No. of Samples	[10 ⁻⁷ μ Ci/ml $\pm$ 2 σ (%)] In Water Recovered			%SDM ^b	Calculated Adult Whole-Body Dose (mrem)
		Maximum	Minimum	Average		
4	4	4.2 $\pm$ 24	2.8 $\pm$ 40	3.6	17	6 $\times$ 10 ⁻³
15	4	326.0 $\pm$ 1	8.1 $\pm$ 14	91.4	171	2 $\times$ 10 ⁻¹
20	4	17.2 $\pm$ 8	4.5 $\pm$ 24	9.9	55	2 $\times$ 10 ⁻²
23	4	440.0 $\pm$ 1	26.4 $\pm$ 5	144.3	137	3 $\times$ 10 ⁻¹
29	4	20.7 $\pm$ 6	4.9 $\pm$ 23	11.6	58	2 $\times$ 10 ⁻²
31	4	17.5 $\pm$ 7	5.2 $\pm$ 22	9.7	57	2 $\times$ 10 ⁻²
32	4	14.4 $\pm$ 8	2.5 $\pm$ 44	8.8	64	2 $\times$ 10 ⁻²
33	4	4.4 $\pm$ 23	1.0 $\pm$ 100	1.9	88	3 $\times$ 10 ⁻³

Source: Adapted from Griggs and Buddemeier, 1986

a See Figure 4-4 for sample locations

b SDM = Standard deviation of the mean

FIGURE 4-4

LIVERMORE VALLEY VEGETATION SAMPLING LOCATIONS
 ● SNLL - LIVERMORE, CALIFORNIA

TABLE 4-7

TRITIUM IN MILK - LIVERMORE VALLEY
SANDIA NATIONAL LABORATORIES, LIVERMORE

	HTO [10.7 μ Ci/ml $\pm$ 2 σ (%)]
Number of samples	29
Maximum	5.2 $\pm$ 20
Minimum	1.0 $\pm$ 100
Average	1.5
% SDM ^a	55.9
Calculated adult whole-body dose (mrem)	3 x 10 ⁻³

Source: Adapted from Griggs and Buddemeier, 1986

a SDM = Standard deviation of the mean

TABLE 4-8

**TRITIUM (HTO) IN WINE
SANDIA NATIONAL LABORATORIES, LIVERMORE**

Location	No. of Samples	[10 ⁻⁷ μ Ci/ml $\pm$ 2 σ (%)] In Water Recovered			%SDM ^a
		Maximum	Minimum	Average	
California	2	1.8 $\pm$ 12	1.2 $\pm$ 14	1.5	27
Europe	4	13.9 $\pm$ 3	2.3 $\pm$ 10	5.5	102
Livermore	3	3.9 $\pm$ 6	3.0 $\pm$ 8	3.4	15

Source: Adapted from Griggs and Buddemeier, 1986

a SDM = Standard deviation of the mean

TABLE 4-9

**TRITIUM (HTO) IN HONEY - LIVERMORE VALLEY
SANDIA NATIONAL LABORATORIES, LIVERMORE**

Location	No. of Samples	[10 ⁻⁷ μ Ci/ml $\pm$ 2 σ (%)] In Water Recovered			%SDM ^a
		Maximum	Minimum	Average	
California	2	7.3 $\pm$ 4	2.6 $\pm$ 7	5.0	67
Livermore	2	4.6 $\pm$ 6	3.9 $\pm$ 6	4.2	11

Source: Adapted from Griggs and Buddemeier, 1986

a SDM = Standard deviation of the mean

controlled and uncontrolled access areas. Even though it is unlikely that members of the public could be overexposed (≥ 100 mrem continuous or ≥ 500 mrem noncontinuous) lack of continuous monitoring of penetrating radiation levels prevents long-term documentation of compliance.

2. Dose Assessment - Calculation Methodology. Effective dose equivalent air doses reported in the 1986 SNLL Environmental Monitoring Report are based on monitored average perimeter airborne concentrations of tritium. Use of alternative methodologies other than AIRDOS modeling is not permitted for determining compliance with NESHAPS radionuclide requirements unless formal approval of such strategies is requested of and granted by EPA. "Perimeter" monitoring for purposes of calculating dose consists of two locations as described in Section 3.1.3, and no submission to EPA has been made by SNLL.

4.4 Quality Assurance/Quality Control

4.4.1 General Description of Data Handling and Sampling Procedures

Because there is no on-site environmental laboratory at SNLL, QA/QC functions are centered around the sampling aspect of samples sent to outside laboratories. At present EAL Corporation has been supplying most of the analytical results for this site. The Hazards Control Division (HCD) is responsible for ensuring that proper quality assurance measures are taken during sampling rounds and by the contract laboratory. These measures include sampling procedures and training, chain-of-custody, corrective action, QA coordination, and corresponding with the contract laboratory. The QA portion of the Survey concentrated on a review of documentation from these areas. The absence of a central QA coordinator was evident, as shown by the fact that some QA data received from EAL is outside established EPA guidelines (e.g., standard recoveries greater than 120 percent of known values). As a result, some of the data used by SNLL Hazards Control personnel may be of limited value. In addition, there are no assurances that a proper chain-of-custody is always maintained. This was evident because chain-of-custody forms are not always completed, and samples are left in unlocked refrigerators for several hours before pick-up for transfer to the analytical laboratory.

4.4.2 Findings and Observations

4.4.2.1 Category I

None

4.4.2.2 Category II

None.

4.4.2.3 Category III

None.

4.4.2.4 Category IV

1. On-Site Environmental Sampling Data Quality. Results from the environmental monitoring program may be suspect due to one or more of the following items:
 - Written procedures are not in place for environmental sampling, hence, there is no way to document that sampling is being conducted according to procedures. Using word-of-mouth procedures could result in sampling errors, especially by inexperienced personnel, or when performing non-routine sampling.
 - The chain-of-custody is not always completed for environmental samples. In addition, samples are stored in unlocked and unattended refrigerators until taken to EAL Corporation for analyses. Both items may affect the integrity of samples sent to the outside laboratory.
2. Off-Site Laboratory Data Quality. The quality of data being submitted by the present outside laboratory may be suspect. QA results supplied by the EAL Corporation are not always within guidelines suggested by EPA (e.g., standard recoveries for spiked samples within ± 20 percent of the known amounts added). There currently is no mechanism for alerting the SNLL data user that data may be of limited use. The present practice is for individual Hazards Control staff members to review the data as it comes in and report it accordingly.

4.5 Inactive Waste Sites and Releases

4.5.1 General Description of Pollution Sources and Controls

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 established (1) notification requirements, (2) liability standards, and (3) response authority for dealing with releases of hazardous substances to the environment. Also known as "Superfund," CERCLA's scope is expansive. The EPA and state agencies can undertake or order study or cleanup when there is a release or the substantial threat of a release of a hazardous substance to the environment.

Superfund was significantly expanded by the Superfund Amendments and Reauthorization Act of 1986 (SARA). In addition to increasing the size of the fund to finance cleanups from \$1.6 billion to \$9 billion, SARA creates a response authority for petroleum underground storage tank releases (technically an amendment to RCRA) and mandates community right-to-know and emergency preparedness programs (Title III). SARA also obligates Federal facilities to comply with the same regulations and policies as other entities. Hence, except for certain limited national security waivers, federal facility cleanup plans for sites on the National Priorities List must undergo EPA review and concurrence.

This section describes seven actual and potential hazardous substance release sources from Sandia National Laboratory, Livermore (SNLL). All of these areas except the small debris area were addressed in the September 1986 "CEARP/Phase I Installation Assessment" report prepared by Los Alamos National Laboratories (LANL) and SNLL (DOE, 1986). All seven of these areas are described in greater detail in Section 4.5. The following areas at SNLL are shown on Figure 4-5:

- Diesel Fuel Oil Tank - Location of a 1975 diesel fuel pipeline leak that resulted in the subsurface release of almost 60,000 gallons of diesel fuel oil. SNLL has characterized the nature and extent of contamination at this area, and continues to perform groundwater monitoring.
- "Navy" Landfill - Former municipal waste landfill; may have received some hazardous wastes; soil and groundwater monitoring results by SNLL are inconclusive.
- Paint and Drum Storage Area - Former Navy storage yard for paints, solvents, and aircraft dope. SNLL has not characterized this area.

- High Explosives (HE) Burn Pit - Pit where sodium, lithium and potassium were burned. According to SNLL, no HE was ever disposed or burned in this pit. SNLL has not characterized this area.
- Fire Extinguisher Training Area - A total of less than 1,000 gallons of gasoline was poured onto ground and ignited for demonstrations. SNLL has not characterized this area.
- Building 913 Paint Shop - Overspray sump was drained into Arroyo Seco on at least one occasion. SNLL has not characterized this area.
- Debris Area on North Side of Arroyo Seco - Paint sludge and oil-stained soil on bank of Arroyo. SNLL has not characterized this area.

4.5.2 Findings and Observations

4.5.2.1 Category I

None

4.5.2.2 Category II

None

4.5.2.3 Category III

1. Diesel Fuel Oil Leak. A leak of approximately 59,500 gallons of number 2 diesel fuel oil has contaminated about 10,000 to 20,000 cubic yards of soil and created a plume of contaminated groundwater extending about 45 feet from the leak. The leak occurred in January 1975 when a grounding rod was accidentally driven through a fiberglass transfer pipe leading from a 175,000-gallon oil storage tank. The leak was discovered by SNLL 4 weeks after the incident. The transfer line puncture occurred within 30 yards of the tank, which is located on the west-central side of the SNLL site (see Figure 4-6). In addition, fuel flowed into a utility trench that was open at the time.

In 1984, SNLL began an exploratory investigation to determine the extent of the subsurface fuel oil migration. Essentially, SNLL's investigations indicated that the fuel is primarily adsorbed to soil in the unsaturated zone to a depth of 100 feet, where it intercepts a saturated

FIGURE 4-6

FUEL OIL PIPELINE LEAK SNLL - LIVERMORE, CALIFORNIA

gravel and sand zone. SNLL also found that the fuel-oil constituents had spread laterally to a radius of about 30 to 45 feet centered asymmetrically on the original puncture point. The groundwater is moving approximately 40 feet per year (0.1 feet per day) to the northwest (HydroGeoChem, Inc., 1985). A later report by the MARK Group in 1986, however, estimated that groundwater was moving southwest (243 degrees) at 109 feet per year (0.3 feet per day), and east (90 degrees) at 219 feet per year (0.6 feet per day). These divergent results were believed by SNLL to be the result of groundwater mounding under the Arroyo Seco. Previous studies (Carpenter et al., 1984) by LLNL and SNLL on the general site area have found a generalized northwest flow pattern at about 183 feet per year (0.5 feet per day). The nearest water supply well is located about 2,500 feet west of the fuel-oil tank leak site, and is used for irrigation and livestock. At a rate of 183 feet per year (0.5 feet per day), the fuel oil contaminants would reach this well in about 14 years. This period could be longer if the contaminants are degraded in the ground. If the contaminants follow a less resistant path, however, this well could be contaminated sooner. DOE is in the process of acquiring the land upon which this well is located as part of a larger land acquisition (buffer zone) program.

In June 1986, SNLL found oil-saturated soil below the oil tank perimeter, where a utility trench had been opened at the time of the fuel leak (SNLL, 1987b). The implication of this new finding is that a slightly larger area is contaminated with oil than had previously been believed. SNLL officials believe that oil filled the opened trench and seeped into an arc-shaped area of soil.

Additional details about the groundwater contamination resulting from the diesel fuel leak are provided in Section 3.4 on hydrogeology. The groundwater is being monitored downgradient, northwest of the spill site. SNLL, in accordance with a California Regional Water Quality Control Board Administrative Order, has agreed to continue monitoring of the spill and to take appropriate remedial action if warranted by a change from the current slow spread of the oil and its constituents.

2. "Navy" Landfill. The "Navy" Landfill (NLF), located on the south side of the property, is a potential source of groundwater contamination (See Figure 4-7). According to the SNLL CEARP report, the Navy used the landfill from 1942 to 1947, and LLNL site contractors used the landfill from 1947 to 1961, when it was closed. In 1961, the NLF area was reconfigured and regraded to accommodate bunkers arranged in a semi-circle at the base of the landfill embankment. The NLF originally occupied about 3.5 acres (400 feet by 400 feet), with a 20- to 30-foot depth to fill (approximately 148,000 cubic yards).

The NLF primarily received mixed municipal refuse and construction debris, according to SNLL interviews performed by LANL during the CEARP report preparation (DOE, 1986). The nature and amount of material disposed of is not known precisely. Some information was obtained from several borings into the landfill and one monitoring well downhill on the north side. It is uncertain whether this well is downgradient. Details of these borings are given in Section 3.4 on hydrogeology. The results of the soil borings indicate the presence of low levels of organics in the soil and fill. The maximum organic contaminant concentration in the soil was 380 ppb of methylene chloride. In addition, two soil samples showed freon-113 concentrations above 5 ppb. SNLL has no remedial plans for the NLF. Survey-related sampling is planned.

3. "Navy" Supply Department Paint and Drum Storage Area. The Navy Paint and Drum Storage Area is a potential source of soil and groundwater contamination. The "Navy" Storage Yard was used from approximately 1942 until 1954, according to aerial photographs, for storing a variety of drummed materials, including paint, dope, solvents, and thinners. This yard was about an acre area (200 feet by 200 feet), located immediately south of the Arroyo Seco on the east side of Sandia Drive in the central section of the site.

No analytical information is available on whether waste was spilled or discharged in this area. One employee interviewed by LANL, who was in the area during the early 1950s, indicated that the area appeared clean at that time (DOE, 1986). Survey-related sampling is planned.

4. HE Burn Pit. The High Explosives (HE) Burn Pit may be a source of groundwater and soil contamination. Located on the south side of SNLL adjacent to the incinerator between the explosives test area and the old "Navy" Landfill, the burn pit was used for about 15 years for burning reactive metals. The 6-foot-diameter concrete burn pit was built in approximately 1960 for burning waste HE after test firings. The pit was not used for this purpose, according to SNLL personnel, but was used instead for burning lithium, sodium, and potassium. It has not been used since the mid-1970s. No information is available on the quantity of waste disposed of in the pit.

No analytical information is available on the presence of residual contaminants in, under, or around the pit. The pit is essentially a buried concrete cylinder with no top or bottom. Contaminants could leach through the bottom of the pit from infiltrating rainwater into the groundwater. Vertical migration may not be that extensive, given the low precipitation rate of 33 cm/year (13 in/year). Survey-related sampling is planned.

5. Fire Extinguisher Training Area. The fire extinguisher training area may be a source of groundwater and soil contamination.

The fire extinguisher training area is located northeast of Building 962, west of A Street, and south of the Arroyo Seco. This area was used for almost 20 years from 1959 to 1978. Since 1978, the fire extinguisher training area has moved twice. Originally, 3 to 4 gallons of gasoline or waste solvents were poured onto the ground and ignited for each demonstration. These demonstrations were held approximately ten times per year. At subsequent training sessions, the gas was poured into metal pans, not onto the ground. Assuming a worst-case situation (i.e., that all of the gasoline was poured directly onto the ground, not into a pan, and that none of the gas or solvents evaporated or burned), then a maximum of 760 gallons was disposed of in this area (4 gallons per session x 10 sessions per year x 19 years).

The gas or solvents may have migrated to groundwater because the training area was not lined. It is unlikely that this area presents a significant threat to groundwater, however, because of the relatively small amount of material released, the low precipitation rate of 33 cm/yr (13 in/year), and the depth to groundwater of 30 meters (100 feet). Survey-related sampling is planned.

6. Debris Area on North Side of Arroyo. Debris and spills on the north bank of the Arroyo Seco, east of Sandia Drive, may be a potential source of groundwater and surface-water contamination. The Survey team observed an area south of Fifth Street, inside the security fence on the north side of the Arroyo Seco, stained with oily patches and dried paint sludge. This area was approximately 30 by 10 feet. According to SNLL personnel, this disposal probably occurred within the past year when the area was used by construction contractors working on Building 916. Assuming that the oily patches were only superficial stains, the total amount of wastes disposed in this area was probably less than 100 gallons, based on the Survey team's visual estimate. Survey-related sampling of the area is planned.

4.5.2.4 Category IV

1. CERCLA Section 103(c) Notification. SNLL has not submitted a notification to EPA pursuant to the June 1981 regulatory requirement and may therefore be in violation of the law. The SNLL Phase I Report (DOE 1986) included descriptions of two types of sites: "Potential CERCLA Sites" and "Sites/Situations Not Requiring Action." Sites from both of these categories of sites should have been included in a compliant CERCLA Notification. Because of the petroleum exemption in CERCLA, sites where only petroleum products were known or suspected of being released (e.g., Diesel Fuel or the Gasoline Storage Facility) would not necessarily be required to be included in the notification. Sites such as the Navy Land-fill and the Navy Paint and Drum Storage Yard probably should have been included. In general, a compliant CERCLA notification would likely include information on all sites included in the Phase I Installation Assessment Report (DOE Order 5480.14), as well as the Solid Waste Management Units (SWMUs) listed in the Part B permit application, but not including sites submitted pursuant to RCRA Section 3014. These two facilities are not covered by the limited exemptions and exclusions to the CERCLA notification requirement (46 FR, April 15, 1981). The purpose of this CERCLA notification requirement is to provide information on potential environmental and health problems associated with facilities that treated, stored, or disposed of hazardous substances. Inclusion in this notification does not constitute an implicit judgment that a problem exists but rather that the potential for a problem exists. The notification is the first step in a process that sorts out which sites pose a threat and determines the relative degree of that threat.

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APPENDIX A

SURVEY PARTICIPANTS

Larry Weiner	DOE Headquarters	DOE Team Leader
Susan Barlsas	DOE Headquarters	DOE Assistant Team Leader
Ronald Peterson	DOE, ALO	ALO Survey Representative
John Cochran	DOE, ALO	ALO Survey Representative
Joseph Crist*	NUS Corporation	Air
Joseph Boros	NUS Corporation	Surface Water
Amy Hubbard and James Werner	NUS Corporation	Groundwater/Soil
Ralph Basinski	NUS Corporation	Waste Management
Arthur Olszewski	NUS Corporation	Toxic and Chemical Materials/ Quality Assurance
Mark Francis	NUS Corporation	Radiation
James Werner	JCF Corporation	Inactive Waste Sites and Releases

* NUS Coordinator
ALO - Albuquerque Operations Office

APPENDIX B

SITE-SPECIFIC SURVEY ACTIVITIES

B.1 Pre-Survey Preparation

The U.S. Department of Energy (DOE) Office of Environmental Audit, Assistant Secretary for Environment, Safety and Health, selected a Survey team for the Sandia National Laboratories, Livermore (SNLL) in June 1986. Mr. Lawrence A. Weiner was designated the DOE Team Leader, with Ms. Susan Barisas serving as the Assistant Team Leader. Messrs. Ronald L. Peterson and John Cochran were contacts in all Survey efforts for the Albuquerque Operations Office. The remainder of the team was composed of contractor specialists from the NUS Corporation and its subcontractor, ICF Corporation. These individuals and their areas of expertise are listed below.

Specialty	Name
Air	Joseph Crist*
Surface Water	Joseph Boros
Waste Management	Ralph Basinski
Inactive Waste Sites	James Werner
Hydrogeology	Amy Hubbard
Radiation	Mark Francis
QA/Toxics	Arthur Olszewski

* NUS Coordinator

Survey team members began reviewing SNLL general environmental documents and reports in July 1986. Messrs. Weiner, Basinski, Crist, and Ms. Barisas conducted a pre-Survey site visit on October 23-24, 1986, to gain familiarity with key DOE and site personnel. They toured the facility and completed a cursory review of the data generated in response to an information request of September 26, 1986. The request listed environmental information of interest to the Survey team for Survey planning purposes.

Representatives of SNLL, the Albuquerque Operations Office, Lawrence Livermore National Laboratory (LLNL), the San Francisco Operations Office, the members of the Survey team, and ten representatives from state and local environmental agencies attended a meeting at the

San Francisco Operations Office. A list of attendees is provided in Table B-1. Agencies represented included the Bay Area Air Quality Management District, the Regional Water Control Board-San Francisco Region, the Alameda County Environmental Health Department, the Zone 7 Water Agency, the California Department of Health Services, the City of Livermore, and the City of Tracy. The Environmental Protection Agency was not able to send a representative. The Survey team leader described all aspects of the DOE Survey. Mr. T. Devlin presented a status report on environmental matters at SNLL, and Messrs. Hoffman and Ragalini reported on LLNL's status. The questions from the attendees were general in nature and no major issues, environmental or otherwise, were raised. The attendees expressed interest in receiving a copy of the Environmental Survey Manual and Interim Survey report, and there were a few questions about the prioritization system and the money available for corrective action. Although the state expressed interest in the sampling aspects of the Survey, there were no inquiries regarding the opportunity to split samples or participate in the Survey in any other way. The meeting lasted approximately 45 minutes.

The Survey team intensively reviewed the information generated during the pre-Survey visit and prepared a Survey Plan (see Appendix C) for the SNLL site. This plan described the specific approach to the Survey for each of the technical disciplines and included a proposed schedule for the on-site activities.

B.2 On-Site Activities

The on-site portion of the Survey was conducted during the period of January 19-23, 1987. The opening meeting was held on January 19, 1987, at the site and was attended by representatives from DOE Headquarters, the Albuquerque Operations Office, SNLL, NUS Corporation, and ICF Corporation. Discussions during this meeting centered on the purpose of the Survey, logistics at SNLL, and an introduction of the key personnel involved.

During the Survey, team members reviewed file materials, permits and applications, background studies, engineering drawings, accident reports, and operating logbooks. The site operations were thoroughly analyzed to identify existing and potential pollutants. Site operations and monitoring procedures were observed. Extensive interviews were conducted with laboratory personnel regarding environmental controls, operations, monitoring and analysis, past operations, regulatory permits, and waste management.

TABLE B-1

DOE ENVIRONMENTAL SURVEY MEETING WITH AGENCY REPRESENTATIVES
OCTOBER 22, 1986

Name	Organization
Gerald Katz	DOE/San Francisco
J. G. Crist	NUS Corporation
Larry Weiner	DOE/Headquarters
Susan Barisas	DOE/Headquarters
Richard Ragaini	Lawrence Livermore National Laboratory
Perry K. Lovell	Sandia National Laboratories, Livermore
Ronald L. Peterson	DOE/Albuquerque
John Cochran	DOE/Albuquerque
Jim Davis	DOE/San Francisco
Theresa Rumjahn	Regional Water Quality Control Board - San Francisco Region
Chris Smith	City of Livermore
Thomas K. Devlin	Sandia National Laboratories, Livermore
Fred Hoffman	Lawrence Livermore National Laboratory
Irene Nishimura	City of Tracy, Community Development Department
Joe Slamovich	Bay Area AQMD
Susan Brechtel	DOE/San Francisco
Jack Bean	Bay Area AQMD
R. Roth	Bay Area AQMD
Gerald H. Winn	Alameda County Environmental Health
J. Killingstad	Zone 7 Water Agency
Denise Tsuji	Department of Health Services
Rafat A. Shahid	Alameda County Environmental Health
Roger Ferenbaugh	Los Alamos National Laboratory

Periodic meetings of the Survey team members were held to report observations and compare findings. The DOE Team Leader, Assistant Team Leader, the NUS Coordinator, and Survey team members met daily to discuss findings and progress and to arrange for specific site personnel and facilities to be available, as needed, on the following day.

The Survey team members identified further sampling and analysis requirements necessary to complete the Survey effort. The sampling and analysis requirements were discussed with Oak Ridge National Laboratory (ORNL) representatives on January 22, 1987. ORNL had been designated by DOE to provide the sampling team for the SNLL site and to perform the laboratory analytical services.

A site close-out briefing was held on January 23, 1987, wherein the DOE Assistant Team Leader presented the preliminary observations of the Survey team. These observations were classified as preliminary, because additional research and, in some cases, additional field sampling were required to positively confirm the observations.

B.3 Sampling and Analysis

ORNL will perform the sampling and analysis portion of the Survey. ORNL evaluated the Sampling and Analysis Requests made by the Survey team and determined sampling and analysis logistics, costs, and schedules. The Sampling and Analysis Plan prepared by ORNL includes a quality assurance plan and a health and safety plan. The Sampling and Analysis team completed sampling at the site during August 1987.

B.4 Report Preparation

A Survey Preliminary Report for the SNLL will be prepared for DOE review. Comments from this review and the results of the sampling and analysis efforts will be incorporated and the report will be reissued as an Interim Report. The timing of the Interim Report is dependent upon the completion of the sampling and the reporting of the analytical results to the Survey team.

APPENDIX C
ENVIRONMENTAL SURVEY PLAN

ENVIRONMENTAL SURVEY PLAN
SANDIA NATIONAL LABORATORIES/LIVERMORE
JANUARY 19-23, 1987
LIVERMORE, CALIFORNIA

1.0 INTRODUCTION

The Sandia National Laboratories/Livermore (SNLL) survey is part of the larger Department of Energy (DOE)-wide Environmental Survey effort announced by Secretary John S. Herrington on September 18, 1985. The purpose of this effort is to identify, via "no-fault" baseline surveys, existing environmental problems and areas of environmental risk at DOE facilities, and to rank them on a DOE-wide basis. This ranking will enable DOE to more effectively establish priorities for addressing environmental problems and allocate the resources necessary to correct these problems. Because the survey is "no fault" and is not an "audit," it is not designed to identify specific isolated incidents of noncompliance, or to analyze environmental management practices. Such incidents and/or management practices will, however, be used in the survey as a means of identifying existing and potential environmental problems.

The SNLL survey will be conducted in accordance with the protocols and procedures contained in the May 16, 1986, draft Environmental Survey Manual.

2.0 SURVEY IMPLEMENTATION

The Environmental Survey of Sandia National Laboratories at Livermore (SNLL) will be managed by the Team Leader, Larry Weiner and the Assistant Team Leader, Susan Barisas. Ron Peterson and John Cochran will serve as the Albuquerque Operations Office (ALO) representatives on the Environmental Survey team. Sampling activities will be managed by Oak Ridge National Laboratory. Technical support is provided by NUS Corporation and ICF Technology, Inc. personnel as follows:

Joseph G. Crist	NUS Coordinator/Air
Joseph Boros	Surface Water/Underground Tanks
Arthur Olszewski	QA/ISCA (Toxic Materials)
Mark Francis	Radiation
Ralph Basinski	RCRA (Solid, Hazardous, and Radioactive Wastes)
James Werner	CERCLA (Inactive Sites)
Amy Hubbard	Hydrogeology/Soil

2.1 Pre-Survey Activities

Pre-Survey activities began in early September, 1986, when Survey team members began reviewing SNLL environmental documents that were available at the DOE Office of Environmental Audit (OEA). This review was followed by a September 26, 1986 memorandum from Lawrence A. Weiner (OEA) to Raymond L. Miller (ALO) and SNLL (via ALO), announcing the pre-survey site visit and requesting additional survey-related information.

The pre-survey site visit, October 24-25, 1986, was conducted by Mr. Weiner, Ms. Barisas, Mr. Crist, Mr. Basinski, and Mr. E. Burd (NUS Health and Safety Advisor). The purpose of the visit was to become familiar with the site, identify potential areas of concern for purposes of the survey, collect the documents requested in the September 26 memorandum, and coordinate plans for the upcoming survey with ALO and SNLL personnel. During this pre-survey visit, the team met with representatives of ALO and SNLL, and officials of the various state, regional, county, and city environmental agencies. Team representatives toured the facility and collected the documents assembled by site personnel in response to the information request memorandum. These documents were transferred to NUS Pittsburgh offices in November for use by team members during the planning stage of the survey. Additional information was subsequently requested by the team and has been received and reviewed. This survey plan is based upon the information received by the survey team as of January 6, 1987.

2.2 On-Site Activities and Survey Reports

The Environmental Survey will be conducted from January 19, 1987 through January 23, 1987. A tentative agenda is as shown in Table 1. It is expected that modifications to the agenda will be made as appropriate to minimize disruption of site activities, and to enhance survey efficiency and effectiveness. All modifications to the agenda will be coordinated with the site officials designated as survey contacts.

The on-site activities of the survey team will consist of discussions with, among others, environmental, safety, operations, waste management, purchasing, and warehousing personnel; a review of files and documents (including classified documents) unavailable prior to the on-site portion of the survey; and process-specific and area-specific tours of the facility.

A closeout briefing will be conducted on Friday, January 23, to describe the preliminary findings of the survey team. A copy of the close-out notes will be left with ALO and SNLL. A preliminary report of the SNLL survey will be prepared within 6 to 8 weeks from the conclusion of the survey. The preliminary report will be sent to ALO and SNLL for review and comment.

Upon completion of the sampling and analyses (S&A) portion of the survey (discussed below) an interim report will be prepared by the survey team. The interim report will incorporate comments to the preliminary report and the data from the S&A results. The interim report will be made available to the public, upon request.

Upon completion of the Environmental Survey effort a final report will be prepared and will contain a DOE-wide list of environmental problems. The report will be used as an information base for the ranking of DOE's environmental problems.

2.3 Sampling and Analysis

Based on available site environmental information and the results of the on-site survey activities, the SNLL survey team will identify survey-related sampling needs. Implementation of the S&A phase of the SNLL survey will begin approximately four months after the completion of the on-site survey activities. This effort is expected to have a two to four week duration and will be conducted by ORNL. Mr. Tom Kitchens will be the ORNL Team Leader for the S&A phase of the SNLL survey. The ORNL sampling team will draft a sampling plan based upon the sampling needs identified by the survey team. The Assistant Team Leader (Ms. Susan Barasis) will coordinate the review of this sampling plan with ALO, SNLL, and EPA's Environmental Monitoring Systems Laboratory (EMSL) in Las Vegas. EMSL has quality assurance and data validation responsibility for the S&A phase of the Environmental Survey.

Analysis of survey-related samples will be performed by ORNL following the protocols specified in the SNLL sampling plan. Results of the sampling and analysis will be transmitted to the survey team leader for incorporation into the Interim Report.

3.0 QUALITY ASSURANCE

3.1 Issue Identification

The quality assurance (QA) area of the survey will focus on evaluating current sampling and analysis procedures performed at SNLL or at any off-site laboratories conducting environmental analyses on samples from SNLL. The intent will be to review the quality assurance procedures for collecting process effluent and environmental samples, for performing the laboratory analytical work to identify and to quantify pollutants and for evaluating and reporting the data. Aspects of the quality assurance program relating to environmental management of SNLL which will be examined, if available, include: analyst training; equipment/instrument calibration and maintenance; sample collection, handling and chain-of-custody procedures; blank, replicate and spiked sample results; data reduction and reporting; and data documentation, including logbook and calculation reviews and archival data storage.

Sampling and analysis procedures will be reviewed to ensure that they conform to accepted requirements and are being appropriately implemented by SNLL. An overall survey of the SNLL environmental monitoring quality assurance program will be performed.

Primary contacts at SNLL are expected to be personnel from the analytical facilities at SNLL.

3.2 Records Required

Files will be reviewed as part of the survey, including documents not yet reviewed or received (e.g., classified documents, individual files, documents not yet identified). Specific documents and files to be reviewed as part of the survey include, but will not be limited to, the following:

- QA plans for SNLL and any supporting analytical laboratories.
- SNLL environmental sampling and analysis procedures manuals.
- QA audits of environmental sampling and analysis at SNLL (1981-present).
- Periodic or annual QA summary reports for SNLL.
- Summaries of results of QA sample analyses of external performance evaluation samples (e.g., from DOE's Environmental Measurements Laboratory and from the EPA).
- Training records for sample collection personnel and SNLL laboratory staff.
- Laboratory notebooks, standard data reporting forms and sampling logbooks.
- Instrument maintenance, repair and calibration records for laboratory and field equipment.
- Results of internal precision and accuracy studies of environmental analyses.
- Results of interlaboratory analyses of standard samples, if any (e.g., studies between LLNL and SNLL).

4.0 SURFACE WATER/DRINKING WATER

4.1 Issue Identification

The focus of the surface water/drinking water portion of the SNLL survey will be on the potential for release of polluted or contaminated wastewaters to surface waters, the combined SNLL/LNLL sanitary sewer system, the Livermore Waste Reclamation Plant or groundwater aquifers underlying SNLL. Pathways for off-site migration of pollutant may include:

- Releases (accidental or planned) to the sanitary sewers prior to or following chemical or radiological analysis.
- Spills or leaks into permeable soil areas.
- Exfiltration of sanitary wastewaters into soils or groundwater during the dry season.
- Contaminated surface run-offs into storm drains and the Arroyo Seco basin.

A review of available information indicates that considerable attention has been paid to control of radiological releases and minimization of toxic metal pollutants. However, less documentation exists on the fate of trace levels of toxic organics in wastewaters. The survey will assess the potential for organic contamination of wastewaters, as well as review present conditions of wastewater control and collection. Liquid waste sources, processes, collection and handling equipment will be examined and records of operation will be reviewed.

The survey will include identification of potential discharges to surface waters, or the local sanitary authority, which may not be addressed in operating permits or other documents from SNLL. The site will be investigated for evidence of possible breaks or obstructions in the sewer systems which could result in releases of wastewater to the environment. The survey will also address the possibility of cross-contamination of the potable water piping system by either the sanitary or storm drainage systems. Measures taken at SNLL to prevent back-flow of process wastewater or sanitary sewer flows into the drinking water piping systems will be reviewed.

With respect to wastewater monitoring and treatment systems, copies of standard operating procedures will be reviewed. Operating logbooks and maintenance records will also be checked. Actual procedures put in normal practice by SNLL personnel will be observed to determine how closely SOP's are being followed. Interviews with managers and operators of monitoring systems will be conducted in order to understand modifications or significant deviations, if any, from written SOP's.

A walk-through of selected buildings will be made to observe normal routines, including maintenance activities which generate wastewaters. Various discharge and monitoring points will be reviewed, and sampling and analytical procedures in use will be observed in action. Emphasis will be placed on the major contributors to wastewater generation, for example, plating operations in Building 913 (if these operations have ever been resumed since their shut-down for modifications in 1982), printed circuit laboratories in the same

building, decontamination procedures in Building 961, and laboratory practices in Building 968, the TRL. In addition to decontamination procedures at Building 961, other toxic waste handling and storage procedures as practiced at Building 9622 and the adjacent storage shelters will be observed.

The wastewater collection, holding and transfer system will be evaluated under normal operating conditions, as will the effluent monitoring station at the edge of the SNLL property prior to entering the LLNL sewer system. Site surface drainage characteristics, such as culverts, arroyos and ravines will also be examined, along with the man-made efforts to control surface run-on and run-off. The impact of changes resulting from construction of new facilities will also be evaluated.

4.2 Records Required

Files will be reviewed as part of the survey including documents not yet reviewed or received (e.g., classified documents, individual files, documents not yet identified). Specific documents and files to be reviewed as part of the survey include, but will not be limited to, the following:

- Recent analytical data on wastewater releases to the local POTW.
- Notices of violations relating to wastewater releases.
- Operators logbooks and monitoring reports.
- Standard operating procedures for wastewater collection, holding and transfer.

- Sampling protocols and logbooks.
- Monitoring equipment maintenance records.
- Detailed drawings of the domestic water supply, storage and distribution system.
- Records of drinking water quality.
- Internal memos or correspondence relating to surface water/drinking water problems, e.g., back-flow prevention measures.
- Memos and correspondence relating to minimizing infiltration of rainwater/groundwater into sanitary sewers during wet seasons, and exfiltration of sanitary wastewaters into soil or groundwater during dry seasons. Include data on comparison of flow monitoring with precipitation readings.
- Other records as determined on-site.

PRELIMINARY

5.0 AIR

5.1 Issue Identification

The air-related survey activities will involve an assessment of the air emissions at the site, the administrative and emission controls applied to the sources, and the ambient air monitoring systems. The emphasis of the survey will be on operational and procedural practices associated with the emission sources and the emission control equipment, fugitive emission sources, both within and outside the buildings, and mitigative procedures applied to fugitive emission sources. Close liaison will be maintained with the radiation team member because of the importance of air-rad issues.

The general approach to the survey will include a review of existing air permits, pending applications, and standard operating procedures. Processes and control equipment will be inspected for compliance with DOE ALARA requirements for radionuclide emissions. The survey will also review the nonradiological air contaminants from the different buildings at the site, evaluate any existing controls applied to the air emissions, and assess the need for additional monitoring or emission controls to characterize or reduce the environmental consequences of the emissions.

The ambient air monitoring system will be evaluated to assess the adequacy of the existing monitoring program to characterize environmental impacts of the air emissions from the facility. The activities involved in this part of the survey will include the inspection of the ambient air quality samplers, a

review of documentation applicable to the ambient air data acquisition, and an evaluation of the processing procedures used to assure the accuracy of the data.

Areas of particular interest will include emissions of the criteria pollutants (e.g., sulfur oxides, nitrogen oxides, hydrocarbons, carbon monoxide and lead) as well as regulated hazardous air pollutants (e.g., radioactive-bearing particulates, and asbestos). Although not currently listed as hazardous air pollutants, fluorides, and freons will be included in this review.

In addition, the use of organic solvents will be assessed as a potential or actual source of emissions to determine if they are adequately characterized, monitored, and controlled. The organic emissions assessment will focus on those substances that the EPA intends to list as hazardous or toxic air pollutants.

Fugitive emissions from the resuspension of contaminated soils will be evaluated as a potential means of the airborne release of radionuclides and hazardous materials from the facility. Consideration will be given to historical and current operations to determine the potential for soil contamination and windborne releases.

Several areas of specific interest have been identified during a review of available documentation:

- Completeness of permitting for degreasers and parts cleaners and use of environmentally acceptable solvents. SNLL has one vapor degreaser and numerous parts cleaners differing in size and choice of solvent.
- Control and monitoring of radionuclides, freon, and fluoride emissions.
- Emission potential of fugitive dust sources such as roads, and landfill activities.
- Potential for asbestos emissions during building decontamination or demolition.
- Effluent sampling and monitoring operations.

Throughout the survey, emphasis will be placed on assessing the available data to characterize the overall environmental impact of site operations.

5.2 Records Required

Files will be reviewed as part of the survey, including documents not yet reviewed or received (e.g., classified documents, individual files, documents not yet identified). Specific documents and files to be reviewed as part of the survey include, but will not be limited to, the following:

- PSD ledger
- Air effluent sampling and QA procedures
- Ambient air sampling and QA procedures
- Stack test results
- Laboratory records on TSP analyses (ambient)
- Any other documents pertinent to air emissions from SNLL buildings

6.0 RADIATION

6.1 Issue Identification

Radiological issues to be addressed during the environmental survey will center around air, soil, surface water, and groundwater media. Each of the above mentioned media will be evaluated for radiation concerns by collecting background information and data (including ambient data), identifying existing and decommissioned radiation pollution sources and associated controls, and finally by reviewing environmental monitoring programs designed to gather data on identified pollution sources.

The survey will also evaluate rad-waste management practices, direct radiation exposure issues, dose assessment methodologies, and radiochemistry quality assurance programs for environmental monitoring data. Review of rad-waste programs including management practices for low-level, transuranic, rad-hazardous (mixed), and adherence to Sandia procedures will be a major focus of the radiation portion of the survey. A more detailed discussion of this subject is provided in Section 8.0 (Solid/Hazardous/Radioactive Waste) of the work plan. The radiological evaluations will be closely coordinated with the other specialists on the survey team.

Radiological survey issues will be evaluated on a media-by-media basis with coordination through Mr. Thomas K. Devlin. Non-media specific radiation issues will be addressed on an individual basis as indicated in the suggested schedule. To accomplish this, the assistance of persons knowledgeable in

prioritizing radiation related issues will be invaluable for accomplishing survey objectives. Each operation will be assessed based upon observations of processes, effluent sources, controls and monitoring equipment. Discussions with operating and supervisory personnel will also be utilized to provide needed information critical for complete evaluation. Reports, records, and other data associated with continuous, intermittent and any accidental or unscheduled releases should be readily accessible for review.

6.2 Records Required

Files will be reviewed as part of the survey, including documents not yet reviewed or received (e.g., classified documents, individual files, documents not yet identified). Specific documents and files to be reviewed as part of the survey include, but will not be limited to, the following:

- Radiation-related ambient air quality information.
- Background radiation data for soil, surface water, and groundwater.
- Inventories of air, soil, surface water, and groundwater radionuclide release points and quantities.
- Vegetation radionuclide monitoring data.
- Unscheduled or accidental release reports.
- Radioanalytical quality assurance programs and procedures.
- Dose assessment methodologies, including assumptions, calculations, reporting, etc.
- Building plot plans with process and equipment locations.
- Description of radiation monitoring equipment practices and procedures (e.g., calibration, maintenance, etc.)

- Reports or recommendations for upgrading radiation monitoring systems.
- Reports prioritizing new radiation monitoring installations.
- Off-site and on-site radionuclide sampling point criteria.
- Rad-waste management practices, policies, procedures, and communication mechanisms.
- NESHAPS/DOE Subpart H 61.90-61.98 reports.
- Information regarding employee radiation exposure data.
- Aerial radiation surveys (historical and recent).

PRELIMINARY

7.0 TOXIC/HAZARDOUS SUBSTANCES

7.1 Issue Identification

The toxic substances survey will address raw materials and process-related chemicals used at SNLL as well as the usage, handling, storage and disposal of polychlorinated biphenyls (PCBs), asbestos, pesticides (including herbicides and biocides) and other hazardous substances. The condition and environmental monitoring of underground storage tanks used for storage of substances other than wastes will also be examined. Through interviews with key SNLL personnel and tours of plant facilities, the tracking, control and management of toxic/hazardous substances will be reviewed. This information and records of usage, will be evaluated to determine the potential for environmental contamination.

The survey will address inventory control of PCB-containing and PCB-contaminated electrical equipment, hydraulic equipment and heat transfer equipment. The condition of equipment containing PCBs and the potential for environmental contamination will also be assessed by examining a subset of this equipment. Obsolete, stored or used PCB equipment will be checked for proper containment and protection. Plant storage records for PCBs will be reviewed. Disposal practices for non-radioactive PCB materials will also be addressed.

SNLL projects involving the demolition/disposal of asbestos and asbestos-containing materials will be reviewed to identify pathways of contamination. Asbestos removal and disposal practices will be evaluated, and asbestos disposal areas will be visited.

Pesticide purchase, usage, and application records will be reviewed. The applicator training program will be reviewed. Pesticide storage areas and disposal practices will be examined to assess risk for environmental contamination.

Toxic and hazardous materials purchase and usage records will be reviewed. Areas where these materials are stored and used will be visited and handling procedures will be evaluated.

Management, inventory, and control of chlorofluorocarbons ("freons") will be examined.

Discussions will be held with those individuals knowledgeable of toxic/hazardous substances practices in order to develop an understanding of current and past practices. Discussions will be held with personnel from at least the following groups:

- Hazards Control Division
- SNLL Stores

7.2 Records Required

Files will be reviewed as part of the survey, including documents not yet reviewed or received (e.g., classified documents, individual files, documents not yet identified). Specific documents and files to be reviewed as part of the survey include, but will not be limited to, the following:

- Comprehensive Environmental Assessment and Response Program
- Toxic/hazardous substances inventory and chemical purchase records.
- Toxic substances labeling and tracking system overview.
- Procedures for purchasing, handling, storing, using and disposing of toxic substances.
- PCB transformer/capacitor inspection records (1981-present).
- Storage and inspection records for PCB contaminated equipment (1981-present) including radioactivity contaminated and non-radioactive items.
- Disposal records for non-radioactive PCB items (1979-present).
- Procedures for storage, handling, and disposal of PCB fluids.
- Correspondence with SNLL Fire Department regarding PCB electrical equipment, especially any records of fires involving PCB equipment.
- Locations of all SNLL buildings and areas containing asbestos.
- Procedures for asbestos removal, handling, and disposal as well as environmental monitoring information.
- Records of asbestos use in plant equipment and support facilities.
- Identification of active and inactive asbestos disposal areas at SNLL.
- Pesticide/herbicide training, handling, storage, and disposal records and standard operating procedures.
- Pesticide annual reports (1981-1985).
- Special procedures involving handling, storage, use and disposal of chlorofluoroalkanes (e.g., freons).
- Inventory and environmental monitoring reports and procedures for underground storage tanks (1981-present).
- Other records as determined on site.

8.0 SOLID/HAZARDOUS/RADIOACTIVE WASTE

8.1 Issue Identification

The solid/hazardous/radioactive waste survey will be carried out by reviewing and evaluating all activities generating solid wastes, and the treatment, storage, recycling and disposal practices involved in the handling of solid wastes including handling of wastes by commercial off-site facilities.

Management of all solid waste streams including mixed wastes, hazardous wastes, radioactive wastes and non-hazardous wastes will be reviewed. The review will generally consist of several activities. 1) Physical facilities where wastes are generated, accumulated, stored, treated, recycled or disposed will be visited; 2) Personnel involved in these activities will be interviewed; 3) Files will be reviewed; 4) The potential for contamination of environmental media as defined by waste regulations will be evaluated.

At SNLL a variety of wastes are generated in small volumes. These wastes generally contain toxic, radioactive and/or hazardous constituents. Many waste generating activities are short term or sporadic, depending on the program. Consequently, existing records may not accurately reflect the waste streams currently being generated. Emphasis will be placed on reviewing general waste characterization management practices, training practices and inspecting facilities which can potentially generate solid wastes.

Off-site commercial facilities receiving wastes from SNLL will also be evaluated. The purpose is to evaluate potential problems at the off-site facilities which may involve SNLL wastes. This will include an evaluation of any classified or radioactive wastes that may have been sent to NTS.

Initial emphasis will be placed on those SNLL facilities shown by past records to have generated significant quantities of waste. Emphasis will also be placed on potential mixed wastes, including classified wastes which may not have been adequately characterized due to the regulatory uncertainties regarding mixed wastes.

Waste handling practices that will be reviewed include the following:

- Waste minimization and recycling.
- Waste characterization, segregation and manifesting.
- Treatment and decontamination.
- Waste accumulation, packaging, and storage procedures.
- Waste management practices, including training, inventory control, record keeping, inspection protocols, and contingency planning.

Waste handling operations and practices will be compared with existing descriptions and written procedures. Information gathered on waste generation points and waste streams will be used to find any sources of waste not previously identified or properly characterized, which may have potential to affect the environment.

Discussions will be held with those individuals knowledgeable of waste management practices in order to develop an understanding of past and existing waste management practices. Discussion will be held with waste generators and personnel from the Hazards Control Division.

The review of solid/hazardous/radioactive waste practices will be co-ordinated with the CERCLA and hydrogeologic surveys to identify past and present releases that may pose a threat to the environment; the radiological survey to define problems with wastes containing radioactive constituents; and the surface water/drinking water survey since all aqueous process wastes are handled as solid wastes at SNLL.

8.2 Records Required

Files will be reviewed as part of the survey, including documents, not yet reviewed or received (e.g., classified documents, individual files, documents not yet identified). Specific documents and files to be reviewed as part of the survey include, but will not be limited to, the following:

- RCRA Part A Permit Application.
- RCRA Part B Permit Application.
- 3016 Inventory.
- Underground tank storage notification and associated records.
- Inspection records (state, local and federal).
- Groundwater monitoring, sampling, and analytical documentation.

- Release notification or occurrence records.
- Waste inventory documentation.
- Enforcement action documents.
- Internal facility inspection documentation.
- Correspondence with regulatory agencies on solid waste.
- Records dealing with the reuse/recycling of wastes.
- Training records.
- Correspondence with off-site commercial waste handling facilities.

PRELIMINARY

9.0 INACTIVE WASTE SITES/RELEASES (CERCLA)

9.1 Issue Identification

The survey will attempt to identify environmental problems and potential risks associated with the historical handling, storage and disposal of hazardous substances at SNLL. This aspect of the survey will be coordinated with the RCRA and hydrogeology team members. The survey will focus on current and future risks related to the following:

- Past land disposal practices (on and off-site);
- Past spills/releases from tanks, pipes, pits, trenches;
- Potential for future spills/releases; and
- On-going remedial action program

Facilities that have handled or are currently handling hazardous, mixed, and low-level radioactive substances at SNLL will be evaluated.

The following nine areas identified in the SNLL Status Report as "Hazardous Materials Usage and Spills" will be evaluated:

- 1) Fuel reserve storage tank
- 2) Navy landfill
- 3) Building 913 - Machining, plating, etc. shop
- 4) Building 916 - Labs
- 5) Building 918 - Raw stacks storage
- 6) Building 968 - Tritium research lab

- 7) Building 973 - Explosives test areas
- 8) Fire extinguisher training
- 9) Chemical control

The status of activities undertaken pursuant to DOE Order 5480.14 will be assessed. Any available material on the Phase I report will be reviewed. In addition to those areas identified in the 1985 Status report, several other areas at the SNLL site will be evaluated.

These areas include the combustion research lab (Building 906), decontamination and waste storage facility (Building 961), maintenance (Building 962), explosives shipping and receiving (Building 981), Area 8 incinerator, and a planned property acquisition that includes a former gas station. In addition, records of past off-site disposal from SNLL will be reviewed.

Sites that have undergone or are undergoing remediation will be addressed. Records and analytical data in support of the site cleanup will be reviewed. Also, inactive tanks or containers that may have held hazardous substances will be identified and their status assessed. Former storage areas and staging locations will be included in this effort.

The survey team will want to review additional material pertaining to the Phase I Installation Assessment report (i.e., map locations of all burial, spill, and release sites, aerial and surface photographs, personnel interview

files and reconnaissance field data pertaining to HRS/mHRS evaluations). The team will also want to review the environmental records pertaining to the past management, disposal (on-site and off-site), clean-up, and regulatory compliance.

Contacts for this portion of the survey will include personnel from the Hazards Control Division.

9.2 Records Required

Files will be reviewed as part of the survey, including documents not yet reviewed or received (e.g., classified documents, individual files, documents not yet identified). Specific documents and files to be reviewed as part of the survey include, but will not be limited to, the following:

- Past waste management plans
- SOPs regarding management of hazardous substances, disposal area and storage areas
- Hazardous substances inventories
- Listing of areas used for hazardous substances storage, receiving and shipping, and disposal
- Historical files on past operations and processes, substances used, and methods of handling and disposal
- Files on past off-site waste handling and disposal
- Records of facility expansion and building rubble disposal

- Descriptions and Notifications of inactive waste sites and potential areas of contamination
- Description of all waste management facilities, including buried tanks and structures (existing and removed)
- Historical aerial and surface photographs of the facility
- "Interview files" for the draft Phase I Installation Assessment report
- Files pertaining to any radiometric surveys of the site grounds
- Documents pertaining to past, current, and proposed remedial actions at SNLL
- Environmental records pertaining to past facility responses to hazardous substance spills and releases
- Draft Phase II and III materials, including working copies, internal memoranda, correspondence, and calculation sheets

10.0 HYDROGEOLOGY/SOILS

10.1 Issue Identification

The survey effort will involve the evaluation of recent studies of site hydrogeology, determination of the status of on-going studies, and the review of plans for further investigations and remedial actions. Each potential or known source of groundwater contamination will be visited, and sampling activities will be observed, if possible. Many of these visits to sources will be conducted jointly with the RCRA, CERCLA, and/or surface water personnel. Well construction will be reviewed both on "as built" diagrams, and in the field. Potential groundwater recharge areas will be investigated.

Known or suspected areas of soil contamination will also be visited. Observations of soil staining, surface drainage pathways, and nearby monitoring wells will be made. Soil sampling activities will also be observed, if possible.

Several areas of specific interest have been identified through review of the documents received thus far. These include:

- Diesel fuel spill area, where several monitoring wells (9) indicate that the fuel has not reached the water table in appreciable amounts. Boring logs will be evaluated in more detail to determine whether there are preferred migration pathways above the first water bearing zone.
- Arroyo Seco area, which was known to receive wastes in the past, although several wells (4) have shown no contamination.

- Navy Landfill, at the southern end of the property, has only one monitoring well. This area has not been completely characterized, and even though the well shows elevated levels of TOC, other contaminants have not been identified.
- Navy Storage Yard/Public Works Area, where soil sample and wells show little or not contamination, but where groundwater has not been well-characterized.

Personnel involved in the groundwater and soil investigations will be contacted for this portion of the survey.

10.2 Records Required

Files to be reviewed as part of this survey include documents and data not yet received or reviewed (e.g., classified documents, individual files, or documents not yet identified). Specific documents include, but will not be limited to, the following:

- Detailed groundwater monitoring plan, if available.
- Sampling procedures and analytical protocol.
- Earthquake damage reports.
- Well construction (as built) diagrams and current well/boring locations.
- Chemical analytical data for soils and groundwater.
- Additional geologic and/or hydrogeologic investigations, as available.

QA/TSCA - A. OLSZENSKI

MONDAY, JAN. 19	TUESDAY, JAN. 20	WEDNESDAY, JAN. 21	THURSDAY, JAN. 22	FRIDAY, JAN. 23
<p>Introductory Briefing</p> <p>PCB File Review</p>	<p>PCB/Asbestos Inspections</p> <p>Visit Bldg. 9622</p> <p>Bldg. 979 - PCB Storage Tank</p> <p>E-2 - Stock Storage Maintenance Yard</p>	<p>Pesticide & Toxic Chemical Reviews & Inspections</p> <p>Visit Bldg. 961, 962, 918 Maintenance Shop & 916 & 982 Stores</p>	<p>QA Review</p> <p>Visit Bldgs. 912, 913, 969, 914, Warehouse 927 and Off-Site, M-24-Lab</p>	<p>Close-out</p>

SURFACE WATER/DRINKING WATER/UNDERGROUND TANKS - J. BOROS

MONDAY, JAN. 19	TUESDAY, JAN. 20	WEDNESDAY, JAN. 21	THURSDAY, JAN. 22	FRIDAY, JAN. 23
<p>SNLL Introductory Briefings</p> <p>Review SOP's</p> <p>Interview Haz. Control Personnel regarding Permit Status</p>	<p>Tour Bldgs. 913 and Adjacent Areas (907, 911, 915, 916, 917 and 918), incl. Monitoring Station to observe sampling & recording set-up</p> <p>Check Cooling Towers at Bldgs. 912 to 916 and 922</p>	<p>Tour Bldgs. 961, 962, 963 and 968 (TRL)</p> <p>Check Cooling Towers at Bldgs. 968 and 972</p> <p>Interview persons responsible for potable water system</p> <p>Fuel Reserve Tank</p> <p>Incinerator Fuel Tank</p> <p>Water Towers (3)</p> <p>All Storm Drains to Arroyo Seco</p>	<p>Coordinate Sampling Program with Asst. Team Leader and Sampling Lab Personnel</p> <p>Review files and monitoring records</p> <p>Preliminary debriefing</p>	<p>Catch-up</p> <p>Close-out debriefing</p>

AIR - J. CRIST

MONDAY, JAN. 19	TUESDAY, JAN. 20	WEDNESDAY, JAN. 21	THURSDAY, JAN. 22	FRIDAY, JAN. 23
Site Orientation Permits Review 951, 914	Review Air-Rad Sources with M. Francis 968 969 906 962 963 Incinerator	Review Non-Rad Air Sources Buildings 907, 913, 915, 918, 970-983	Review Ambient Air Monitoring Stations Complete Permits Review	Team Debriefing Close-out Meeting

IRADIATION - M. FRANCIS

MONDAY, JAN. 19	TUESDAY, JAN. 20	WEDNESDAY, JAN. 21	THURSDAY, JAN. 22	FRIDAY, JAN. 23
<p>SNLL Introductory Briefings</p> <p>Review/Visit On-Site Radiation Lab QA & Analytical Programs</p> <p>Visit Decontamination Facility (Bldg. 961)</p> <p>914</p>	<p>Review/Visit Radiation Air Sources with J. Crist (Bldgs. 968, 969 and 906), 976</p> <p>Review/Visit Radiation Waste Management Policies/Procedures & Accumulation & Storage Areas (Bldgs. 962 and 963)</p> <p>927</p> <p>Incinerator</p> <p>9622</p>	<p>Review/Visit Radiation Soil Pollution Sources & Monitoring Program</p> <p>Review/Visit Radiation Surface Water Pollution Sources & Monitoring Program 913</p> <p>Review/Visit Radiation Groundwater Pollution Sources & Monitoring Program</p> <p>Bldgs. 970, 972, 978 and 979</p> <p>Monitoring Station</p>	<p>Ambient Air Monitoring Stations with J. Crist</p> <p>Review/Visit Direct Radiation Sources (Bldg. 923)</p> <p>Review Dose Assessment Procedures</p> <p>Review TLD Program</p> <p>Coordinate Sampling & Analysis Program</p>	<p>Team Debriefing</p> <p>Close-out Meeting(s)</p> <p>Follow-up Visits</p>

SOLID/HAZARDOUS/RADIOACTIVE WASTES - R. BASINSKI

MONDAY, JAN. 19	TUESDAY, JAN. 20	WEDNESDAY, JAN. 21	THURSDAY, JAN. 22	FRIDAY, JAN. 23
<p>Introductory Briefing</p> <p>Tour 913</p>	<p>Tour 906 Combustion Research</p> <p>914 NDE/Env. Labs</p> <p>915 Steam Plant</p> <p>918 Metal Storage Cutting</p> <p>Off-site Warehouse Storage</p> <p>Stock Storage, Maintenance Yard</p>	<p>923, 924, 927, 961, 962, 963, 966, 968 (Tritium Research Lab)</p> <p>969</p>	<p>970, 971, 972, 973, 974, 976, 977, 978, 979, 981, 982, 983</p> <p>Incinerator</p> <p>Hazardous Waste Storage</p>	<p>Revisits</p> <p>Close-out</p>

CERCLA - J. J. WERNER

MONDAY, JAN. 19	TUESDAY, JAN. 20	WEDNESDAY, JAN. 21	THURSDAY, JAN. 22	FRIDAY, JAN. 23
<p>SWILL Orientation</p> <p>Fuel Reserve Storage Tank</p> <p>Navy Public Work Yard</p> <p>Navy Supply Department Paint and Drum Yard</p> <p>Navy Landfill</p> <p>B963 Garage</p> <p>B962 Maintenance</p> <p>Arroyo Seco</p>	<p>B913 Machine Shop (Paint Shop Spill, Ditch)</p> <p>B916 Labs</p> <p>B915 Steam Plant (1985 Spill)</p> <p>B918 Raw Stocks Storage</p> <p>B968 Tritium Lab</p> <p>B973 Expl. Test Area</p> <p>B979 PCB Storage</p> <p>Former Fire Ext. Training Area</p>	<p>B906 Combustion Research Lab</p> <p>B961 Decon. Waste Storage</p> <p>Fire Extinguisher Training Area (near 961).</p> <p>B981 Explosives Shipping & Receiving</p> <p>Area 8 Incinerator</p> <p>Burn Pit</p>	<p>Planned Property Acquisition/Gas Station</p> <p>File Review</p> <p>Sampling & Analysis Plan Preparation</p> <p>Revisits</p>	<p>Team Debriefing</p> <p>Revisits/File Review</p> <p>Close-out Meeting</p>

HYDROGEOLOGY/SOILS - A. HUBBARD

MONDAY, JAN. 19	TUESDAY, JAN. 20	WEDNESDAY, JAN. 21	THURSDAY, JAN. 22	FRIDAY, JAN. 23
<p>Introductory Briefings</p> <p>Visit Diesel Fuel Spill/Arroyo Seco area</p> <p>Visit Navy Storage Yard/Public Works Area</p>	<p>Visit Navy Landfill, Monitoring Well-11 and Gas Station</p> <p>File Review</p>	<p>File Review</p> <p>Coordinate S&A Plan</p>	<p>Debriefings with DOE Team Leaders & Team Members</p>	<p>Close-out Debriefing</p>

APPENDIX D

CHEMICAL SYMBOLS, ABBREVIATIONS, AND ACRONYMS

AEC	Atomic Energy Commission
AFGWC	Air Force Global Weather Control
AIRDOS	Estimation of radiation dose caused by airborne radionuclides in areas surrounding nuclear facilities
ALARA	As Low As Reasonably Achievable
ARAC	Atmospheric Release Advisory Capability
AT&T	American Telephone and Telegraph
Avg.	Average
BAAQCD	Bay Area Air Quality Control District
BAAQMD	Bay Area Air Quality Management District
BMR	Beryllium Monitoring Report
BOD ₅	Biochemical Oxygen Demand (5-day)
BTX	Benzene, toluene, and xylene
°C	Degrees Celsius (or Centigrade)
CAC	California Administrative Code
CEARP	Comprehensive Environmental Assessment and Response Program
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CG	Concentration Guide
Ci	Curie(s)
cm	Centimeter(s)
CN	Cyanide
CO	Carbon Monoxide
CRWQCB	California Regional Water Quality Control Board
CY	Calendar Year
D-38	Uranium containing higher concentrations of ²³⁸ U than found in nature
DCG	Derived Concentration Guide
DL	Discharge Limit

APPENDIX D
CHEMICAL SYMBOLS, ABBREVIATIONS, AND ACRONYMS
PAGE TWO

DOE	Department of Energy
DOT CL	Department of Transportation Classification
E	East
EDTA	Ethylenediamine tetra-acetic acid (or its salts)
e.g.	(exempli gratia) for example
EPA	Environmental Protection Agency
ESE	East-southeast
et al.	(et alii, alioe, or alia) and others
°F	Degrees Fahrenheit
FAA	Federal Aviation Administration
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
Gal	Gallon(s)
GE	General Electric
GLP	Good Laboratory Practice(s)
GMP	Good Management Practice(s)
gpd	Gallons Per Day
GPS	Gas Purification System
H-3	Tritium
ha.	Hectare(s)
HE	High Explosive(s)
HEPA	High Efficiency Particulate Air
HGC	HydroGeoChem, Inc.
H-T	Tritiated Hydrogen Gas
HTO	Tritiated Water
I	Interstate
ICRP	International Commission on Radiological Protection
i.e.	(id est) that is
Inc.	Incorporated

APPENDIX D
CHEMICAL SYMBOLS, ABBREVIATIONS, AND ACRONYMS
PAGE THREE

kg	Kilogram(s)
km	Kilometer(s)
l	Liter(s)
LANL	Los Alamos National Laboratory
LECS	Liquid Effluent Control System
LLNL	Lawrence Livermore National Laboratory
LSA	Low Specific Activity
LWRP	City of Livermore Water Reclamation Plant
m	Meter(s)
Max.	Maximum
μCi	Microcurie(s)
mCi	Millicurie(s)
μg	Microgram(s)
mg	Milligram(s)
ml	Milliliter(s)
mm	Millimeter(s)
mrem	Millirem(s)
mrem/yr	Millirem(s) per year (10^{-3} roentgen equivalent man/year)
MSDS	Material Safety Data Sheets
N	North
NA	Not analyzed
NCRP	National Council on Radiation Protection and Measurements
ND	None Detected
NOS	Not Otherwise Specified
NE	Northeast
NESHAPS	National Emission Standards for Hazardous Air Pollutants
NLF	"Navy" Landfill
NNE	North-northeast
NNW	North-northwest

APPENDIX D
CHEMICAL SYMBOLS, ABBREVIATIONS, AND ACRONYMS
PAGE FOUR

No.	Number(s)
NO ₂	Nitrogen Dioxide
NPDES	National Pollutant Discharge Elimination System
NTS	Nevada Test Site
NW	Northwest
O ₃	Ozone
ORM-A	Other Regulated Material (e.g., irritant)
ORM-B	Other Regulated Material (e.g., corrosive)
ORM-C	Other Regulated Material (e.g., 49 CFR 177.101 Listing)
ORM-E	Other Regulated Material (e.g., hazardous wastes)
ORNL	Oak Ridge National Laboratory
PCC	Polybrominated biphenyl
PCB	Polychlorinated biphenyl
pCi	Picocurie(s)
pH	Negative logarithm of the hydrogen ion concentration
PM ₁₀	Particulate matter 10 microns or less in diameter
ppb	Parts Per Billion
ppm	Parts Per Million
PSP	Protocols for Specific Purposes
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
s	Second(s)
S	South
S&A	Sampling and Analysis
SARA	Superfund Amendments and Reauthorization Act of 1986

APPENDIX D
CHEMICAL SYMBOLS, ABBREVIATIONS, AND ACRONYMS
PAGE FIVE

SDM	Standard Deviation of the Mean
SE	Southeast
S.J.	San Jose
SNL	Sandia National Laboratories
SNLL	Sandia National Laboratories Livermore
SO ₂	Sulfur Dioxide
SOP	Standard Operating Procedure(s)
sq. mi.	Square Mile(s)
SRD	Secret Restricted Data
SSE	South-southeast
SSW	South-southwest
SW	Southwest
SWMU	Solid Waste Management Unit(s)
TAG	Test Assembly Group
TCDD	Tetrachlorodibenzo-p-dioxin
TDS	Total Dissolved Solids
TICH	Total Identifiable Chlorinated Hydrocarbons
TLD	Thermoluminescent Dosimetry
TOC	Total Organic Carbon
TRL	Tritium Research Laboratory
TSCA	Toxic Substances Control Act
TSP	Total Suspended Particulates
TSS	Total Suspended Solids
TTLC	Toxic Threshold Limit Concentration
²³⁵ U	Uranium-235
²³⁸ U	Uranium-238
U-238	Uranium-238
U.S	United States

APPENDIX D
CHEMICAL SYMBOLS, ABBREVIATIONS, AND ACRONYMS
PAGE SIX

VERS	Vacuum Effluent Release System
VOC	Volatile Toxic Organic Compounds
W	West
WAA	Waste Accumulation Area(s)
WNW	West-northwest
WSW	West-southwest
Y ³	Cubic Yards
YPG	Yuma Proving Grounds
Yr	Year(s)
α	Alpha
β	Beta
σ	Sigma
%	Percent
'	Minute(s)
"	Second(s)
2,4-D	2,4-Dichlorophenoxyacetic acid
~	Approximately
≥	Greater than or equal to

END

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