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

**Environmental Survey
Preliminary Report**

**Stanford Linear Accelerator Center
Stanford, California**

July 1988

MASTER

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PREFACE
TO
THE DEPARTMENT OF ENERGY
ENVIRONMENTAL SURVEY PRELIMINARY REPORT
FOR THE STANFORD LINEAR ACCELERATOR CENTER

This report contains the preliminary findings based on the first phase of a Survey at the U.S. Department of Energy (DOE) Stanford Linear Accelerator Center (SLAC) located in San Mateo County, California. The Survey is being conducted by DOE's Office of Environment, Safety and Health.

The SLAC Survey is a portion of the larger, comprehensive DOE Survey encompassing all major operating facilities of DOE. The DOE 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 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 preliminary findings are subject to modification based on comments from the San Francisco Operations Office concerning their technical accuracy. 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 Environmental Survey Summary Report.

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EXECUTIVE SUMMARY

Introduction

This report presents the preliminary findings from the first phase of the Survey of the U.S. Department of Energy (DOE) Stanford Linear Accelerator Center (SLAC) at Stanford, California, conducted February 29 through March 4, 1988.

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 the SLAC. The Survey covers all environmental media and all areas of environmental regulation and 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 at the SLAC, and interviews with site personnel.

The Survey team is developing a Sampling and Analysis Plan to assist in further assessing certain of the environmental problems identified during its on-site activities. The Sampling and Analysis Plan will be executed by a DOE National Laboratory or a support contractor. When completed, the results will be incorporated into the Environmental Survey Interim Report for the SLAC facility. The Interim Report will reflect the final determinations of the SLAC Survey.

Site Description

The SLAC facility occupies an area of 426 acres and is adjacent to the Stanford University campus in San Mateo County, California. The SLAC is 25 miles south of San Francisco and 15 miles northwest of San Jose. The SLAC facility is operated by Stanford University for the DOE. The structures of the SLAC are DOE-owned, while the land is University-owned and leased to the DOE.

The SLAC is dedicated to experimental and theoretical research in elementary particle physics and the development of new technology in high-energy

accelerators and elementary particle detectors. The major research facilities consist of:

- The 2-mile-long Linear Accelerator (LINAC), which generates the highest energy high-intensity electron beams available in the world;
- The Stanford Positron Electron Asymmetric Ring (SPEAR), an 8 giga electron volt (GeV) colliding-beam, storage-ring facility 260 feet in diameter;
- The Positron Electron Project (PEP), a 32 GeV colliding-beam, storage ring facility 2,600 feet in diameter; and
- Three magnetic spectrometers.

In addition to these facilities, the SLAC is constructing a new collider, which is nearing completion. Used in conjunction with the LINAC, the SLAC Linear Collider (SLC) will provide electron-positron collisions at 100 GeV.

The Environmental Survey of the SLAC included an assessment of the Stanford Synchrotron Radiation Laboratory (SSRL), which is a separate laboratory funded by DOE. All of the SSRL facilities are located within the SLAC boundaries. Activities at the SSRL involve experiments in the fields of biology, chemistry, and physics using synchrotron radiation.

As part of the Survey, representatives of the San Mateo County Office of Environmental Health, the Bay Area Air Quality Management District (BAAQMD), and Region IX of the U.S. Environmental Protection Agency (EPA) were contacted to solicit information on environmental concerns about the SLAC facility. There were no issues of concern raised by representatives of these agencies.

Summary of Findings

The major preliminary findings of the Survey at the SLAC facility are:

- Activated (i.e., containing induced radioactivity) equipment and parts are being released as salvage to the general public or for burial off-site in sanitary landfills without documentation to adequately assess the potential dose or environmental impact. Without proper documentation, material with higher-than-allowable levels of radioactivity could inadvertently be released off-site.
- Past and present spills, leaks or releases of hazardous and/or radioactive substances have resulted in actual and potential contamination of soil and groundwater at several areas on-site. The nature and extent of the contamination are either unknown or incompletely characterized.
- Five polychlorinated biphenyl (PCB) transformers (i.e., about 25 percent of all active PCB transformers on-site) were found to be leaking.
- There is the potential for storm sewer discharges to be contaminated from past and current spills of vacuum pump oil, compressor oil, diesel fuel, and oily sludges from operating equipment at several areas on the SLAC facility.

Overall Conclusions

The Survey found no environmental problems at the SLAC facility that represent an immediate threat to human life. The environmental problems identified at the SLAC by the Survey team do confirm that the facility is affected by several environmental problems which are the result of inadequate administrative (documentation) practices and inadequate chemical and waste management practices. These problems vary in terms of their magnitude and risk, as described in this report. 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. Site characterization activities currently underway and planned at the facility will contribute to meeting this requirement.

Transmittal and Follow-up of Findings

The preliminary findings of the Environmental Survey of the SLAC were shared with the San Francisco Operations Office (SAN) and the site contractor at the Survey closeout briefing held on March 4, 1988. By July 28, 1988, SAN had developed a draft action plan to address the Survey preliminary findings. The Operations Office plans to present this plan to the State of California Department of Health Services and the EPA Region IX Office. A final action plan addressing all the Survey findings cited herein will be prepared by SAN within 45 days after receiving this Preliminary Report. Those problems that involve extended studies and multiyear budget commitments will also be the subject of the Environmental Survey Summary Report and the DOE-wide prioritization.

Within the Office of the Assistant Secretary for Environment, Safety and Health, the Office of Environmental Guidance and Compliance (OEG) has immediate responsibility for monitoring environmental compliance and the status of the SLAC Survey findings. The Office of Environmental Audit will continue to assess the environmental problems through a program of systematic environmental audits that will be initiated toward the conclusion of the DOE Survey in 1989.

1.0 INTRODUCTION

The purpose of this report is to present the preliminary findings made during the Survey, February 29 - March 4, 1988, at the U.S. Department of Energy (DOE) Stanford Linear Accelerator Center (SLAC) in San Mateo County, California. Stanford University operates the SLAC for the DOE.

The SLAC Survey is part of the larger DOE-wide Survey 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 them. 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 means of identifying existing and potential environmental problems.

The SLAC Survey was conducted by a multidisciplinary team of technical specialists headed and managed by a Team Leader and Assistant Team Leader from DOE's Office of Environmental Audit. A complete list of the SLAC Survey participants and their affiliations is provided 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 of 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, in the form of existing and potential environmental problems, are presented in Sections 3.0 and 4.0. Section 3.0 includes those findings that pertain to a specific environmental medium (e.g., air or soil),

whereas Section 4.0 includes those that are non-media-specific (e.g., waste management, radiation, and quality assurance). The findings, being highly varied in magnitude, risk, and characterization, and consequently requiring different levels of management attention and response, are further subdivided into four categories within Sections 3.0 and 4.0.

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

- Category I includes only findings that, based on information available to the Team Leader, involve immediate threat to human life. Findings in this category shall be conveyed immediately to the Environment, Safety and Health personnel at the scene or in control of the facility or location in question for action. Category I findings are environmental problems with the highest potential risk, the strongest confidence in the finding based on the information available, and the most restrictive appropriate response 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 exposure, or a one-time exceedance where residual impacts pose an immediate potential for human exposure.
 - Evidence that a health-based environmental standard may be exceeded, as discussed in the preceding situation, within the time 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 environmental 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 environmental problems where the risk is high but where 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, most discretion is available to the Operations Offices and Program Offices as to appropriate response; however, the need for that response is such that management should not wait for the completion of the DOE-wide Survey to respond. Unlike Category I findings, a sufficient near-term response to Category II findings by the Operations Office may include further characterization before any action is 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 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 problems. Under this category, the range of alternatives available for response and the corresponding time limits for response are the greatest. Environmental problems included within this category will typically require lengthy investigation and remediation phases, as well as multiyear budget commitments. These problems will be included in the DOE-wide prioritization to ensure that DOE's limited resources are used effectively.

In general, levels of pollutants or materials that constitute a hazard or potential 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 concentration of some nonregulated material is sufficient to be included as an environmental problem. Likewise, concentrations of regulated materials, even though below limits 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 that are violations of regulations or requirements (e.g., improper storage of hazardous chemicals in unsafe tanks). Such conditions present a potential hazard 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 of management practices that are indirectly related to environmental risk but are not appropriate for inclusion in Categories I through III. Such findings can be based on 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 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 constitute only the first step in a multistep, iterative process to prioritize DOE's problems.

The next phase of the SLAC Survey is Sampling and Analysis (S&A). The Idaho National Engineering Laboratory (INEL), the S&A team for the SLAC, will collect samples over a 1-week period in fiscal year 1989. An S&A Plan is being prepared by DOE and INEL in accordance with the protocols in the DOE Environmental Survey Manual. The Survey S&A is designed to fill existing data gaps or weaknesses. Results generated by the S&A effort will be used to assist the Survey team in further defining the existence and extent of potential environmental problems identified during the Survey.

An Interim Report will be prepared 8 to 10 weeks after the completion of the S&A effort. The Interim Report will incorporate the results of the S&A effort, as well as any changes or comments resulting from review of the Preliminary Report. Based on the S&A results, 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 both as the site-specific repository for information generated by the Survey and, ultimately, as the site-specific source of information for the DOE-wide prioritization of environmental problems.

It is clear that certain of the findings and observations contained in this report, especially those in Category II, can and should be addressed in the near term (i.e., before the DOE-wide prioritization effort). It is also clear that the findings and observations in this report vary greatly in magnitude, risk, and characterization. Consequently, the priority, magnitude, and timeliness of near-term responses will require careful planning to ensure appropriate and effective application. The information in this Preliminary Report, albeit provisional, will assist the San Francisco Operations Office (SAN) in planning these near-term responses.

SAN has developed a draft action plan, dated July 28, 1988, in response to the preliminary findings presented at the conclusion of the on-site Survey activities and summarized in the SLAC Survey Status Report dated April 14, 1988. The draft action plan for the SLAC Survey has been reviewed by the Office of Environmental Guidance and Compliance (OEG), which has immediate responsibility for monitoring the status and overseeing the adequacy of corrective actions taken by the Operations Office in response to the Survey findings.

As required in the December 2, 1987, memorandum from the Assistant Secretary for Environment, Safety and Health to the Operations Office Managers entitled, Follow-up of Environmental Survey Findings, SAN will prepare and submit a final action plan to the Deputy Assistant Secretary (DAS) for Environment within 45 days after receiving this Preliminary Report. The final action plan for the SLAC Survey will address all of the preliminary findings cited herein and incorporate OEG's comments on the draft action plan.

2.0 GENERAL SITE INFORMATION

2.1 Site Setting

The Stanford Linear Accelerator Center (SLAC) is a national facility operated by Stanford University under contract with the U.S. Department of Energy (DOE). The SLAC is dedicated to theoretical and experimental research in high-energy particle physics and to the development of new techniques in high-energy accelerators and experimental apparatus. As it is operated as a national facility, scientists from universities and research centers throughout the United States and the world may participate in the high-energy research programs. The San Francisco Operations Office (SAN) is responsible for the oversight of SLAC operations.

The SLAC is located on 426 acres of Stanford University land in an unincorporated area in the extreme southern part of San Mateo County, California. As shown in Figure 2-1, it is on the San Francisco Peninsula, roughly midway between the metropolitan centers of San Francisco and San Jose. The Stanford University academic campus lies to the east of the SLAC across Alpine Road in neighboring Santa Clara County. The facility is near the intersection of the Junipero Serra Freeway (I-280) and Sand Hill Road. The Freeway is a major north-south artery connecting the metropolitan areas. Sand Hill Road, running east-west, joins the mid-Peninsula urban subregion of Palo Alto and Menlo Park with the outlying communities of Portola Valley, Woodside, and Ladera (SLAC, 1986b).

The facility is in a belt of low, rolling foothills, lying between the alluvial plain bordering San Francisco Bay on the east and the Santa Cruz Mountains on the west. The SLAC varies in elevation from about 175 to 375 feet above sea level, whereas the alluvial plain to the east around the Bay lies less than 150 feet above sea level; the mountains to the west rise abruptly to over 2,000 feet (SLAC, 1987a).

The land north of Sand Hill Road and east of the I-280 Freeway is within the City of Menlo Park; it is not a part of the SLAC facility nor of Stanford University lands. It encompasses a development called Sharon Heights, which includes a shopping center and townhouses. Other developments along Sand Hill Road include professional, administrative, and commercial buildings, condominium complexes, and a recreational area (i.e., a golf course). To the east and south are the low-

LOCATION OF THE SLAC FACILITY

FIGURE 2-1

density, single-family residential developments of Stanford Hills and Ladera, respectively. Although the SLAC is on unincorporated San Mateo County land, it is surrounded by the Menlo Park jurisdiction (SLAC, 1986b).

Figure 2-2 shows the principal buildings of the SLAC facility. These buildings are listed in Table 2-1. A complete listing of all the SLAC buildings and building numbers is provided in Appendix D.

Facility History

Stanford University has been a leader in the field of elementary particle physics since the early 1950s, when the 300-foot long, 1 billion electron volt (i.e., 1 giga electron volt [GeV]) accelerator was completed at the High Energy Physics Laboratory (HEPL) on the main Stanford University campus. In the late 1950s, it became clear that a continuation of the line of research begun at the HEPL would require much higher energies and a very large accelerator. Thus, the construction of the SLAC with its 2-mile-long electron Linear Accelerator (LINAC) began in the foothills behind the main campus in 1962. The LINAC was completed in 1966. The SLAC facility was leased for 50 years in 1962 to the Atomic Energy Commission. Construction of the SLAC Linear Collider (SLC), the SLAC's most recent matter-antimatter colliding beam facility, began in October 1983, and it is scheduled to begin operation in 1988 (SLAC, 1986b).

Population and Workforce

Figure 2-3 shows the Bay Area population in 10-mile increments from the SLAC facility. The six counties represented on the map (Alameda, Contra Costa, Marin, San Francisco, San Mateo, and Santa Clara) comprise a total population of 4,546,000. Population of the two counties immediately adjacent to the SLAC facility, San Mateo and Santa Clara Counties, is 1,882,000 (U.S. Bureau of the Census, 1983). Cities with populations greater than 100,000 within a 25-mile radius of the facility are listed below (U.S. Bureau of the Census, 1983):

Source: Adapted from SLAC, 1980b

PRINCIPAL BUILDINGS AT THE SLAC FACILITY

FIGURE 2-2

TABLE 2-1
PRINCIPAL SLAC BUILDINGS AND FACILITIES *

Building Name	Building Number
Administration/Engineering (A&E) Building	41
Auditorium	43
Auxiliary Control Building	3
Beam Switchyard	9
Cafeteria	42
Central Laboratory	40/84
Central Utility Building	23
Chemical Storage Building	36
Cleaning Facility Building	30
Collider Experimental Hall (CEH)	750
Computer Building	50
Cryogenics Laboratory	6
EFD Shops	104
Electronics Building	24
Electronics Building Annex	34
End Station A	61
End Station B	62
Fire Station	82
General Services Building	81
Heavy Fabrication Building	26
Klystron Gallery	2
Light Assembly Building	33
Light Fabrication Building	25
Main Control Center (MCC)	5
Metal Stores Shelter	29
New Warehouse/Magnet Factory	15

TABLE 2-1**PRINCIPAL SLAC BUILDINGS AND FACILITIES * (Continued)**

Building Name	Building Number
PEP Beam Facility/SSRL	650/730
PEP Control Room	685
PEP Interaction Region 2	620
PEP Interaction Region 4	640
PEP Interaction Region 6	660
PEP Interaction Region 8	680
PEP Interaction Region 12	720
Plant Maintenance and Utilities	35
SPEAR Control Building	117
Stanford Synchrotron Radiation Laboratory (SSRL)	120/131
SSRL Office and Shops	137/138
SLC Offices	214
SPEAR Experiment Assembly	101
Test Beam Facility (TBF)	121
Test Laboratory	44
Vacuum Assembly Building	31
Warehouse/User Offices	28

Source: Modified from SLAC, NDb

* These buildings are shown in Figure 2-2.

BAY AREA POPULATION DISTRIBUTION
IN 10-MILE INCREMENTS FROM THE SLAC

FIGURE 2-3

City	Approximate Distance from the SLAC in Miles	Direction from the SLAC	1980 Population
Oakland	20	Northeast	339,337
San Jose	15	Southeast	629,442
San Francisco	25	North	678,974
Sunnyvale	5	Southeast	106,681

Sources: American Automobile Association, 1987; U.S. Bureau of the Census, 1983

The employment population in the Sand Hill Road area and environs, including the SLAC, is estimated to be about 2,800. The residential population surrounding the east end of the accelerator, including Sharon Heights, Stanford Hills, and Ladera, is also estimated to be 2,800 (SLAC, 1986b).

The SLAC staff currently numbers roughly 1,550; there are about 1,200 full-time employees, 200 part-time employees, and 150 visiting scientists. Approximately one-quarter of the staff is professional, composed of physicists, engineers, programmers, and other scientific-related personnel. The balance of the staff is support personnel including technicians, crafts personnel, laboratory assistants, and clerical and administrative employees (SLAC, 1987a).

Geology and Seismology

The entire SLAC facility is underlain by sandstone and claystone. In general, the bedrock on which the western half of the accelerator rests is of Eocene age (over 50 million years old), and that under the eastern half is of Miocene age (over 10 million years old). On top of this bedrock at various places along the accelerator alignment are found alluvial deposits of sand and gravel generally of Pleistocene age (1 million years old). At the surface is a soil overburden of unconsolidated earth materials averaging from 3 to 5 feet in depth (SLAC, 1987a).

The western end of the LINAC is less than 1 mile from one of the most widely known structural geologic features in California, the San Andreas Fault Zone. This zone extends almost the entire length of the state and runs nearly perpendicular to the

LINAC. In 1906, movement on this fault zone, centered 30 miles north of San Francisco, caused the famous "San Francisco Earthquake" which, with a magnitude of 7.8 on the Richter Scale, was felt over a major portion of California (SLAC, 1982).

Climatology

The climate in the SLAC area is Mediterranean. Winters are warm and moist, and summers are mostly cool and dry. Long-term weather data describing conditions in the area are available from official and unofficial weather records at Palo Alto, 3 miles to the east. The SLAC facility is 200 to 400 feet higher than the Palo Alto station and is free of the moderating influence of the city; temperatures therefore average about 2°F lower than those of Palo Alto. The daily and annual range in temperature is small. A few frosty mornings occur during the winter, but the temperature seldom drops below freezing.

Rainfall averages about 22 inches/year. The distribution of precipitation is highly seasonal. About 75 percent of the precipitation, including most of the major storms, occurs during the 4-month period from December through March. Most winter storm periods are from 2 days to as much as a week in duration. The storm centers are usually characterized by relatively heavy rainfall and high winds. The combination of topography and air movement produces short fluctuations in intensity, which can be characterized as a series of storm cells following one another so as to produce heavy precipitation for periods of 5 to 15 minutes with lulls in between (SLAC, 1987a).

Ecology

The SLAC facility is distinguished by the presence of many mature oak trees, both standing singly and in groves. The land is further characterized by broad areas of open grassland. The facility is bordered in part on the south by San Francisquito Creek, the headwater area of which is dammed to form Searsville Lake at the west end of the LINAC.

Most of the plants now found in and around the existing SLAC research area were planted as landscaping after the SLAC's original construction was completed. These include Bishop pines, varieties of eucalyptus, coast live oaks, pyracantha, and a

number of low-growing ornamental shrubs. As the result of landscaping, far more trees now grow in the area than grew there naturally before development.

The area provides a habitat for various species of wild animals including deer, foxes, rabbits, and rodents (gophers, mice, and squirrels). Many types of birds inhabit the site; these include doves, finches, redwing blackbirds, hawks, quail, killdeer, and owls (SLAC, 1982).

2.2 Overview of Major Site Operations

The SLAC program in high-energy physics research is directed toward exploring and understanding the fundamental nature of matter and energy. Accelerators are the primary research tools that enable physicists to explore and understand the behavior of the subatomic environment.

An important component of the United States high-energy physics program is the 2-mile-long LINAC at the SLAC. The LINAC is the world's highest energy electron accelerator. The LINAC beams have been used to study electromagnetic, nuclear, and "weak" forces; to investigate the interactions of many of the short-lived subnuclear particles; and to provide the experimental evidence for the conjectured substructure of the proton and all other subatomic particles (SLAC, 1986b). Weak forces are fundamental interactions between elementary particles that are several orders of magnitude weaker than the electromagnetic force.

The LINAC is being upgraded to accelerate electrons and their antimatter equivalents, positrons, to 50 GeV. These particle beams are utilized by an array of experimental fixed target installations, two colliding beam storage rings, and the SLC. Besides positrons and electrons, other particle beams from the LINAC are available for physics research. Three magnetic spectrometers are also available for use with the LINAC.

In 1972, the world's then most powerful matter-antimatter colliding beam storage ring, the Stanford Positron Electron Asymmetric Ring (SPEAR), began operations. A storage ring is an experimental device used by physicists to store subatomic particle beams for the purpose of studying the results of particle collisions. Experiments with the SPEAR uncovered an entire family of previously unknown subnuclear

particles, changed the view of the substructure of the elementary particles, and contributed a great deal more information on the nature of electromagnetic and nuclear forces (SLAC, 1986b). The SPEAR currently serves as a strong source of synchrotron light for the Stanford Synchrotron Radiation Laboratory (SSRL) (Buildings 120/131)(SLAC, 1987a). Synchrotron light is electromagnetic radiation emitted by high-energy particles when accelerated to relativistic speeds (i.e., speeds that are large with respect to the speed of light). The SPEAR facility served as a prototype for the Positron Electron Project (PEP) storage ring.

The PEP storage ring is a special extension of the LINAC. The PEP facility, completed in 1980, is a large storage ring housed in an underground tunnel at depths varying from 20 to 100 feet, and in which beams of electrons and positrons circulate in opposite directions at energies up to 15 GeV. As shown in Figure 2-2, the underground ring has a diameter of about 2,300 feet and is located at the eastern extremity of the SLAC facility.

The SSRL is a separate DOE-funded laboratory operated by Stanford University. The SSRL is a national facility for the utilization of synchrotron radiation in biology, chemistry, and physics. The SSRL facilities are located around the SPEAR and PEP rings.

During 1984, a new medium-energy physics program in nuclear structure experiments was initiated at the SLAC. This program is based on the utilization of the spectrometers and associated equipment in End Station A (Building 61) with a lower energy beam produced by the Nuclear Physics Injector. Funding of the program is provided through the Nuclear Physics Program of DOE (SLAC, 1986b).

The SLC is a new type of electron-positron colliding beam facility housed in a 1.9-mile underground tunnel, which is in the final stages of construction. The SLC tunnel is also shown in Figure 2-2. The SLC operation is based on the acceleration of a single intense positron bunch and a single intense electron bunch to an energy of approximately 50 GeV each in one pulse of the LINAC. The Mark II particle detector will be used initially with the SLC, and a new SLAC Large Detector (SLD) will be installed in the future at the Collider Experimental Hall (CEH) (Building 750).

As shown in Figure 2-4, facilities and structures at the SLAC are grouped into six major areas based on functions and interrelationships:

- Main Campus
- Shops and Service Yards
- Accelerator Area
- Storage and Utility Yards
- North and South Research Facilities
- PEP, SSRL, and SLC Research Facilities

The Main Campus includes the Central Laboratory (Building 40), the Test Laboratory (Building 44), the Administration and Engineering Building (Building 41), the Cafeteria (Building 42), and the Auditorium (Building 43), built around a landscaped mall. The shops in the Shops and Service Yards are those facilities associated with the fabrication of devices and assemblies required to conduct the high-energy-particle physics research carried out at the LINAC, PEP, and SLC. Machine shops, electronics shops, the Computer Center (Building 50), the Plant Maintenance & Utilities Building (Building 35), the General Services Building (Building 81), and the Warehouse Building (Building 28) are in the Shops and Service Yards. The Accelerator Area consists of the Klystron Gallery (Building 2), which is the permanent structure housing ancillary equipment of the LINAC. The Storage and Utility Yards are an exterior storage area where materials are kept for reuse. These yards are located to be convenient to the shops and research facilities. The North and South Research Facilities are located in research yards where the SLAC conducts the basic scientific research activities associated with the LINAC. The PEP, SSRL, and SLC Research Facilities consist of the PEP storage ring, the SSRL, the SLC colliding beam facility, and associated structures (SLAC, 1986b).

2.3 State and Federal Concerns

Representatives of the Survey team met with representatives of the San Mateo County Office of Environmental Health and the Bay Area Air Quality Management District (BAAQMD), on January 14, 1988, as part of the pre-Survey visit to the SLAC. Region IX of the U.S. Environmental Protection Agency (EPA) was also contacted to solicit information on environmental concerns about the SLAC facility. There were no issues of concern raised by representatives of these agencies.

Source: Adapted from SLAC, 1986b

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 at the Stanford Linear Accelerator Center (SLAC). 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 as they relate to each medium.

3.1 Air

3.1.1 Background Environmental Information

The SLAC facility is located in San Mateo County, California, which is part of the San Francisco Bay Area Intrastate Air Quality Control Region (AQCR) 30. Radioactive and nonradioactive air emissions from the SLAC and other sources within this area are limited by the requirements of the Bay Area Air Quality Management District (BAAQMD), the California Air Resources Board (ARB), the California Department of Health Services (DOHS), and Region IX of the U.S. Environmental Protection Agency (EPA).

3.1.1.1 Airborne Radioactivity

Worldwide background atmospheric radioactivity is composed largely of fallout from past atmospheric nuclear weapons tests, natural radioactive constituents from the decay chains of thorium and uranium in soil, and materials resulting from interactions with cosmic radiation (e.g., natural tritiated water vapor produced by interactions of cosmic radiation and stable water). Atmospheric particulates result in part from soil particles that are blown by the wind. Consequently, changing meteorological conditions often cause large daily and seasonal fluctuations in airborne radioactivity levels. Windy, dry days can result in relatively high concentrations of airborne particulates, whereas precipitation can wash out many particles from the atmosphere.

The EPA measures airborne radiation levels at major cities throughout the United States to monitor fallout from nuclear devices and other forms of radioactive

contamination of the environment. The EPA monitoring station closest to the SLAC is in Berkeley, California, which is about 30 miles northeast of the facility. The most recent data from Berkeley and other U.S. cities available as of this writing are summarized below:

Radionuclide	Average Berkeley Concentration (10 ⁻⁶ pCi/m ³) ^a	Concentration Range for 62 U.S. Cities (10 ⁻⁶ pCi/m ³) ^a
gross Beta ^b	3 x 10 ⁴	Not available
plutonium-238 ^c	0.6	0 - 2.6
plutonium-239, 240 ^c	0.7	0 - 1.4
uranium-234 ^c	9.1	4.5 - 124.5
uranium-235 ^c	0	0 - 5.3
uranium-238 ^c	7.7	4.7 - 69.3

Source: EPA, Office of Radiation Programs, 1986, 1987a, b, c

a pCi/m³ = 10⁻¹² Ci/m³

b Data collected from April 1986 to March 1987

c Data collected from July 1986 to December 1986

Background airborne radioactivity at Berkeley falls within the range of values measured at other U.S. cities.

3.1.1.2 Ambient Air Quality

Table 3-1 lists the National Ambient Air Quality Standards (NAAQS), and the California ARB Air Quality Standards. Ambient air quality standards are established to protect the health and welfare of the general public. The air quality in San Mateo County in AQCR 30 has been designated by EPA as being (a) better than the NAAQS for total suspended particulates (TSP) and sulfur dioxide (SO₂); (b) cannot be classified or better than the NAAQS for nitrogen dioxide (NO₂); and (c) not meeting primary standards for ozone (O₃) and carbon monoxide (CO) (BNA, 1986). In July 1987 EPA replaced TSP as the indicator for particulate matter in the ambient standards with a new indicator that includes only those particles with an aerodynamic diameter less than or equal to a nominal 10 microns (PM₁₀). EPA has

TABLE 3-1

FEDERAL AND CALIFORNIA AMBIENT AIR QUALITY STANDARDS

Pollutant	Averaging Time	Federal Standards ^a		California Standards ^b
		Primary ^c	Secondary ^d	
Oxidant ^e	1-Hour	-	-	0.10 ppm
Ozone	1-Hour	0.12 ppm	0.12 ppm	-
Carbon Monoxide	8-Hour 1-Hour	9 ppm 35 ppm	9 ppm 35 ppm	9 ppm 20 ppm
Nitrogen Dioxide	Annual Average 1-Hour	0.05 ppm -	0.05 ppm -	0.25 ppm
Sulfur Dioxide	Annual Average 24-Hour 3-Hour 1-Hour	0.03 ppm 0.14 ppm - -	- - 0.5 ppm -	0.05 ppm 0.25 ppm
Particulate Matter (PM ₁₀)	Annual Arithmetic Mean Annual Geometric Mean 24-Hour	50 µg/m ³ - 150 µg/m ³	50 µg/m ³ - 150 µg/m ³	30 µg/m ³ 50 µg/m ³
Sulfates	24-Hour	-	-	25 µg/m ³
Lead	30-day Average Calendar Quarter	- 1.5 µg/m ³	- 1.5 µg/m ³	1.5 µg/m ³ -
Hydrogen Sulfide	1-Hour	-	-	0.03 ppm
Vinyl Chloride (chloroethene)	24-Hour	-	-	0.010 ppm
Visibility Reducing Particles	1 observation	-	-	In sufficient amount to reduce the prevailing visibility ^f to less than 10 miles when the relative humidity is less than 70%.

Source: California ARB, 1987.

- Federal standards, other than ozone, PM₁₀, and those based on annual averages, are not to be exceeded more than once a year. The ozone standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above the standard is equal to or less than one. For the PM₁₀ standard, no more than one expected exceedance per year is allowed. The annual averages are values that are not to be exceeded.
- California standards, other than carbon monoxide, sulfur dioxide (1 hour), nitrogen dioxide and PM₁₀, are values that are not to be equaled or exceeded. The carbon monoxide, sulfur dioxide (1 hour), nitrogen dioxide and PM₁₀ standards are not to be exceeded.
- Primary standards are the levels of air quality necessary, with an adequate margin of safety, to protect the public health.
- Secondary standards are the levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant.
- Measured as ozone.
- Prevailing visibility is defined as the greatest visibility that is attained or surpassed around at least half of the horizon circle, but not necessarily in continuous sectors.

not determined the PM₁₀ attainment status for the AQCRs because sufficient PM₁₀ ambient data are not yet available.

Table 3-2 presents 1986 background ambient air quality data measured in Redwood City, about 8 miles north of the SLAC facility. The Redwood City monitoring site is the locale nearest to the SLAC where ambient air quality measurements are taken. The table shows that the California O₃ and particulate matter standards were violated at Redwood City in 1986. Ozone is formed through the interaction of sunlight with volatile organic compounds (VOCs) and nitrogen oxides (NO_x). The SLAC is a small emitter of VOCs and NO_x, and it is a minor source of particulate matter. Other 1986 ambient measurements at the Redwood City monitoring station were in attainment with all Federal and California ARB air quality standards. During 1987, there were no measured exceedances of the O₃ and CO standards at this station (BAAQMD, 1987a).

3.1.1.3 Meteorology

The climate in the SLAC area is Mediterranean, with warm, moist winters and cool, dry summers. The SLAC facility averages about 22 inches/year of precipitation, the distribution of which is highly seasonal. About 75 percent of the precipitation, including most major storms, occurs during the 4-month period of December through March (SLAC, 1982). West-northwesterly winds prevail on an annual basis at the San Francisco International Airport, about 18 miles north of the facility. At the airport, summer weather is dominated by a sea breeze resulting in an average summer wind speed of nearly 15 miles per hour (mph) (NOAA, 1986). The frequency of occurrence of the sea breeze at the SLAC would be somewhat less because the facility is farther away from the Pacific coast.

The mixing height and the average wind speed within the mixing height are important parameters in a general appraisal of air pollution potential. Mixing height is defined as the height above the surface through which relatively vigorous vertical mixing occurs. Hence, much man-made air pollution is transported and dispersed within the mixing height. Based on Metropolitan Oakland International Airport upper air data, estimated afternoon mixing heights in the Stanford area range from a summer mean of about 2,100 feet to a spring mean of about 3,600 feet, which are less than mean afternoon mixing heights found in most other U.S.

TABLE 3-2
1986 BACKGROUND AMBIENT AIR QUALITY MEASUREMENTS

Pollutant	Averaging Time	Federal Standard ^a	2nd Highest Measured Concentration ^b	Annual Average Measured Concentration ^b	California Standard ^c	Highest Measured Concentration ^b
O ₃ ^d	1-Hour	0.12 ppm	0.08 ppm	-	0.10 ppm	0.10 ppm
CO	8-Hour 1-Hour	9.0 ppm 35 ppm	6.3 ppm 12.0 ppm	- -	9.0 ppm 20 ppm	6.4 ppm 12.0 ppm
PM ₁₀	Annual Arithmetic Mean Annual Geometric Mean 24-Hour	50 µg/m ³ 150 µg/m ³	- 78 µg/m ³	30 µg/m ³ -	- 30 µg/m ³ 50 µg/m ³	- 26 µg/m ³ 79 µg/m ³
NO ₂	Annual Average 1-Hour	0.05 ppm	-	0.024 ppm	- 0.25 ppm	- 0.13 ppm
SO ₂	Annual Average 24-Hour 3-Hour 1-Hour	0.03 ppm 0.14 ppm 0.50 ppm	0.008 ppm	0.001 ppm	- - - 0.25 ppm	- - - 0.05 ppm

Source: California ARB, 1987

- a. For the pollutants listed, the primary standard is equal to the secondary standard. Federal standards, other than those for ozone, particulate matter, and those based on annual averages, are not to be exceeded more than once a year. The ozone standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above the standard is equal to or less than one. For the PM₁₀ standard, no more than one expected exceedance per year is allowed. The annual averages are values that are not to be exceeded.
- b. As measured at Redwood City, about 8 miles north of the SLAC facility.
- c. California standards, other than those for carbon monoxide and PM₁₀, are values that are not to be equaled or exceeded. The carbon monoxide and PM₁₀ standards are not to be exceeded.
- d. The California standard regulates oxidant, measured as O₃.

locations. The intense elevated inversion that occurs on the eastern side of the quasi-stagnating high-pressure system in the Pacific Ocean during the summer months causes very shallow mixing heights along the California coast, including Stanford (Holzworth, 1969). Also, mean wind speeds within the mixing height are lower in California, Oregon, and Washington than in other areas of the country. The combination of shallow mixing heights and low transport wind speeds indicates that meteorological conditions conducive to the occurrence of air pollution episodes are frequent in the Stanford region and the rest of the state (Holzworth, 1972).

3.1.2 General Description of Pollution Sources and Controls

Air emission sources at the SLAC may be divided into radiological and nonradiological sources. Airborne radionuclides are produced in the air volume surrounding major electron beam absorbers such as beam dumps and targets. The degree of activation is dependent upon the beam power absorbed and the composition of the parent elements. Induced radioactivity produced at high energies are short-lived gases such as oxygen-15, carbon-11, and argon-41, having half-lives of 2 minutes, 20 minutes, and 1.8 hours, respectively. For the period from 1981 through 1986, annual radioactive gaseous releases from the SLAC have ranged from 0-1.6 curies. During 1986, no measurable quantities of radioactive gas were detected to be released from the facility. This occurred because there were few Linear Accelerator (LINAC) operating hours due to the upgrading of the LINAC in connection with the SLAC Linear Collider (SLC) construction (SLAC, 1987a).

Radionuclide releases should remain low in future years because of increasing emphasis on colliding beam physics and decreasing emphasis on fixed-target physics. In colliding beam storage rings such as the Positron Electron Project (PEP) and the SLC, beam particles are brought into collision over and over, with small quantities of radionuclides produced. Striking a fixed target only once produces radionuclides in the air volume surrounding the target (SLAC, 1987a).

In addition to radionuclide releases, there are nonradioactive air releases from boilers, paint spray booths, sandblasting booths, degreasers, and other miscellaneous point sources located at or near various maintenance, fabrication, assembly, and testing shops. Table 3-3 provides a summary of emission and control information for the SLAC air pollution sources registered with the BAAQMD. These sources emit VOCs, NO_x, CO, and particulate matter. Table 3-3 also indicates that a few permitted sources do not have air pollution control devices. The reason for this

TABLE 3-3

SOURCES OF AIR EMISSIONS AT THE SLAC THAT ARE REGISTERED WITH THE BAAQMD

Source No.	Source Name	Building	Control Device	Annual Average Emission Rates (lb/day)			
				Particulate	Organics	NO _x	CO
Permitted Sources							
1	Industrial Boiler	23	Not Required	1	1	26	7
2	Industrial Boiler	23	Not Required	1	1	26	7
3	Degreaser	25	Cover, Freeboard, Chillers, Safety Switches	-	40	-	-
4	Degreaser	25	Cover, Freeboard, Chillers, Safety Switches	-	60	-	-
5	Paint Spray Booth	35	Not Required	-	7	-	-
6	Boiler	37	Not Required	-	-	2	-
7	Sandblasting Booth	35	Simple Cyclone	-	-	-	-
8	Sandblast Room	35	Reverse Air Baghouse	-	-	-	-
9	Degreaser	44	Cover, Freeboard, Chillers, Safety Switches	-	7	-	-
14	Sandblasting Booth	123	Simple Baghouse	-	-	-	-
16	Sandblasting Booth	123	Simple Baghouse	-	-	-	-
18	Degreaser	44	Cover, Freeboard, Chillers, Safety Switches	-	3	-	-
19	Fume Hood	25	Preformed Spray Scrubber	-	-	-	-
20	Printed Circuit Board Etching	25	Preformed Spray Scrubber	-	-	-	-
21	Anodizing, Pickling, & Bright Dip Operation	25	Packed Bed Scrubber	-	-	-	-
22	Degreaser	44	Cover, Freeboard, Chillers, Safety Switches	-	-	-	-
Exempt Sources							
10	Woodworking Operations	35	Simple Cyclone	-	-	-	-
11	Metal Cutting Operations	25	Simple Cyclone	-	-	-	-
13	Metal Grinding	29	Simple Baghouse	-	-	-	-
17	Metal and Epoxy Glass Grinding	24	Simple Baghouse	-	-	-	-
	Total Emission Rates			2	119	54	14

Source: Adapted from BAAQMD, 1987b

^a As estimated by the BAAQMD

is that the BAAQMD regulations do not require controls for these small sources. During the Survey, it was discovered that there are no written maintenance procedures and records for the servicing of the air pollution control equipment listed in Table 3-3. It was also observed that the simple baghouse for the metal and epoxy glass-grinding operations, in the Electronics Building (Building 24) was not operating properly, allowing excessive particulate matter to escape into the air.

3.1.2.1 Beam Switchyard

The Beam Switchyard (BSY), Building 9, contains the equipment for distributing various types of particle beams from the LINAC to experimental setups in the research yard. It functions in a manner analogous to a railroad switchyard. The BSY is the only source of detectable gaseous radioactive emissions at the SLAC. The BSY areas are vented by five fans, with a total exhaust rate of 1,400 cubic feet per minute (ft³/min) (SLAC, 1987a). Rather than being vented continuously, the BSY is purged only for emergencies and only after a delay to allow the short-lived radioactive constituents in the air to decay. The venting takes place after each experimental cycle for brief periods of 1 hour or less. Administrative procedures for the BSY require the delay of venting until personnel entry is scheduled to occur, in order to minimize the release of radioactive gases to the environment (SLAC, 1980c).

3.1.2.2 Other Potential Radionuclide Sources

The LINAC, the PEP storage ring, and the SLC were designed to transport (not absorb) high-energy electrons and positrons. Hence, they produce only small quantities of radionuclides.

The LINAC is served by 15 fans. These exhausts are not currently monitored, because emission measurements in the past have shown that the accelerator is not a significant source of gaseous or particulate radioactivity due to low activating potential. The LINAC is vented only one or two times a year because of the need to maintain a nearly constant temperature in the accelerator housing.

The Beam Dump East (Building 3) has the same type of ventilation system as the BSY. It has not been used in some time.

The PEP facility is a large storage ring housed in an underground tunnel in which beams of electrons and positrons circulate in opposite directions at energies up to

15 billion electron volts [i.e., 15 giga electron volts (GeV)]. The facility includes six beam interaction regions (IRs) for simultaneous experimental studies. Only one of the IRs is currently operational. PEP and its IRs are vented continuously while the beam is on by 14 exhaust fans that vent just above grade level, with a total exhaust rate of about 1,800 ft³/min (SLAC, 1987a). No radionuclide releases have ever been detected from the PEP.

The SLC is a new electron-positron colliding beam facility housed in a 1.9-mile underground tunnel currently in the final stages of construction. The SLC operation is based on the acceleration of a single intense positron bunch and a single intense electron bunch to an energy of approximately 50 GeV each in one pulse of the LINAC, which projects the particles into the SLC. As with the PEP, residual radioactivity will be small, with somewhat greater amounts around the beam dumps (SLAC, 1982). There are two vent fans serving the SLC, one for each arc, with both removing a total of 30,000 ft³/min. Like the BSY, the SLC will be vented only after a waiting period to allow the short-lived radioactive products to decay. The vents will also remove smoke from the underground arcs in case of fire.

A positron source is being constructed in sector 20, two-thirds of the way from the west end of the LINAC, in connection with the SLC. A single exhaust will vent this area after a delay time to allow for the decay of gaseous radioactive species. This source will also emit about 1 part per million (ppm) of O₃.

3.1.2.3 Support Shops

There are a large number of support shops throughout the SLAC that provide a variety of repair, maintenance, assembly, testing, and fabrication services to SLAC research projects. The Light Fabrication Building (Building 25) is the main focus for in-house manufacturing for the SLAC in the areas of detector fabrication and klystron production. Klystrons are amplifier tubes and modulators used for driving electrons in accelerators. The Central Shops in the Light Fabrication Building consist of two machine shops, an electroplating shop, a structural and welding shop, a sheet metal shop, a coil winding shop, an assembly shop, and a machine repair shop. As shown in Table 3-3, there are five permitted air sources in this building consisting of two degreasers, a fume hood, a printed circuit board etching operation, and an anodizing, pickling, and bright dip operation.

The electroplating shop in the Light Fabrication Building carries out plating, anodizing, metal cleaning, electroless plating, and etching of printed circuit boards. There are a number of tanks of acid, alkaline, and cyanide solutions in the main shop area, all of which are vented into the main exhaust system that removes 65,000 ft³/min out of the area. Source tests carried out on the main exhaust vent about 5 years ago indicated that fume releases were low. A number of cyanide tanks were being gradually emptied during the Survey, permanently reducing the total quantity of cyanide solutions in use by about two-thirds.

As Table 3-3 indicates, there are five vapor degreasers at the SLAC used to clean metal parts. The two vapor degreasers in the electroplating shop in the Light Fabrication Building use trichloroethane as a solvent; these degreasers are the largest air emission sources at the SLAC. One vapor degreaser in the Test Laboratory (Building 44) also uses trichloroethane. The two refrigerated vapor degreasers in the Test Laboratory use Freon. In 1986, the SLAC received notices of violations on two vapor degreasers for violation of the BAAQMD solvent cleaning regulation concerning labeling and freeboard height. These violations were corrected (Lavagnino, ND). It was observed that the covers of the two degreasers in the electroplating shop and one of the refrigerated vapor degreasers were left open as an operational convenience when the degreasers were not being used, also in violation of a BAAQMD regulation.

Permitted sources at the Plant Maintenance and Utilities (PMU) Building (Building 35) consist of a sandblasting booth, a sandblast room vent, and a paint spray booth. In 1986, the SLAC received a notice of violation (NOV) from the BAAQMD concerning use of paints for coating metal parts containing VOCs over the BAAQMD limit in Regulation 8, Rule 19. Currently, only paints that comply with the VOC content regulation are being used.

There is a small lead melting and casting operation outside the Central Laboratory (Building 40) where lead blocks are made. The work is carried out for only several days each year. Ambient and worker breathing-zone lead samples taken during casting operations in 1987 indicated that concentrations in the vicinity of the source were low (Safety Office, 1987).

3.1.2.4 Fuel-Burning Sources

Two natural gas-fired boilers in the Central Utility Building (Building 23) are used for heating water. Each boiler is rated at 10×10^6 British thermal units per hour (Btu/hr) heat input. The standby fuel is No. 2 oil, which has never been used since the units were installed in 1963. In addition, there is a gas-fired boiler at the Light Fabrication Building Boiler Plant (Building 37) used as a standby source for the electroplating shop. This boiler is rated at 3.72×10^6 Btu/hr heat input. As shown in Table 3-3, these three permitted boilers are the only sources of NO_x at the SLAC.

3.1.3 Environmental Monitoring Program

The SLAC environmental monitoring program for air releases has two major components: stack emission monitoring for radionuclides, and meteorological monitoring. Stack emission and meteorological data are used as input to a model to estimate the off-site dose to the public on an annual basis, as required by the National Emission Standard for Radionuclide Emissions from DOE Facilities (40 CFR Part 61, Subpart H) (EPA, 1985). The dose modeling is discussed in Section 4.3.3. In addition, continuous physical radiation measurements of neutron and gamma doses are made near the site boundary. These radiation measurements are also discussed in Section 4.3.3. No routine ambient monitoring for radionuclides has been conducted.

Also, the SLAC does not carry out stack monitoring or ambient monitoring for nonradiological air pollutants because facility emissions are judged to be fairly low, and such monitoring is not required by air regulatory agencies. However, the BAAQMD does estimate annual average air emission rates for their permit program from annual updated emission inventory data provided by the SLAC (Wong, 1988b). The most current emission estimates are also listed in Table 3-3.

3.1.3.1 Emission Monitoring

The following radionuclide emission sources have monitors to measure gaseous radioactive releases: the BSY, Beam Dump East, the positron source, PEP, and SLC. Each fan providing ventilation for these sources is interlocked with monitoring instrumentation consisting of a Geiger-Mueller radiation detector, a power supply, a flow rate meter, a strip chart recorder of the number of counts, and an air pump. The electronics part of the system (i.e., the high-voltage power supply and the strip

chart recorder) is located at the Main Control Center (Building 5); the Geiger-Mueller detector is located at the exhaust. The electronics are in continuous operation, and the recorder and air pump are interlocked with the ventilation fan so that they operate only when the source is being vented (SLAC, 1982). These measurements give a gross indication of activity, but they do not provide an isotopic analysis. The Environment and Safety Office (ESO) plans to upgrade the system in the fall of 1988 by using a computer in the Main Control Center to record the data.

Each air monitor also has a sample filter to collect radioactive particulates. Particulate radionuclides, however, have never been detected in the airborne effluent exhausted from the SLAC facility (SLAC, 1987a). In view of these past results, the ESO no longer analyzes the sample filters.

The radioactive gas monitors for each ventilation fan are inspected and calibrated at the beginning of each accelerator cycle. They are calibrated with a National Bureau of Standards krypton-85 source. In addition, they are checked prior to each run with a cobalt-60 source.

3.1.3.2 Meteorological Monitoring

A tower located about 1,700 feet due east of the eastern end of the Klystron Gallery (Building 2) has been instrumented with meteorological sensors to obtain meteorological data for input to the annual radiation dose model. Wind speed and wind direction instruments are located 40 feet above the ground; the tower also has temperature sensors. Current plans call for the recorded data to be processed by a microcomputer. The ESO plans to have the system operational by the summer of 1988. The tower is located within about 200 feet of 3 trees that are about the same height as the tower.

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. Malfunction of particulate air pollution control device. The baghouse for the metal and epoxy glass-grinding operations, source 17 in Table 3-3, in the Electronics Building does not operate properly, leading to the discharge of excessive particulate emissions.

A number of operations in the printed circuit room of the Electronics Building, such as a wheel buffer, a grinder, a belt, and a band saw, are vented into a cyclone and baghouse. After passing through the cyclone and baghouse, the effluent from these operations is discharged. The baghouse is a small emitter of nonhazardous particulates that does not require an air permit. It was observed that the baghouse was open at one end near the ground, allowing particulate matter to escape into the air. The SLAC has indicated that a work order is in preparation to repair the baghouse.

2. Improper usage of vapor degreaser pollution control device. The release of VOCs from a number of vapor degreasers at the SLAC is increased because the covers are left open when the degreasers are not in operation. This is also in violation of a BAAQMD regulation.

The cover on a degreaser is designed to reduce solvent evaporation when work is not being processed in the degreaser. During the Survey, it was observed that the covers of certain degreasers at the SLAC were left open as an operational convenience when the degreasers were not being used. These degreasers were the two degreasers in the plating shop in the Light Fabrication Building, and one of the degreasers using Freon in the Test Laboratory. The BAAQMD regulation on solvent cleaning operations also specifies the use of a closed cover as an equipment requirement when work is not being processed. In addition, posted instructions on at least one of these degreasers indicated that the cover should be closed when not in use. According to SLAC personnel, there are plans to issue a directive on the proper operations of the degreasers.

3. Lack of written maintenance procedures and records for the servicing of air pollution control equipment. There are neither written standard operating procedures nor maintenance records for the maintenance of air pollution control equipment for various shop sources at the SLAC, which could lead to excessive air pollution emissions.

There are 16 air emission sources at the SLAC registered with the BAAQMD with control equipment to reduce emissions (Table 3-3). This control equipment consists of cyclones, baghouses, spray scrubbers, vapor degreaser control devices, and a packed bed scrubber, all of which require maintenance to ensure that the equipment is functioning properly. Although some maintenance is carried out for much of this equipment, no systematic maintenance program has been established. For instance, a SLAC worker familiar with the sandblasting operations in Building 126 indicated that, to his knowledge, the filter bags in the baghouse have never been changed out or checked.

Aside from the manufacturers' literature, there are no written instructions on the operation of the controls, no written procedures to ensure that the control equipment is functioning properly, nor instructions specifying the frequency of servicing. Also, there are no maintenance logs indicating when the control devices were serviced. In the absence of a systematic maintenance program, control efficiencies may be reduced and excessive air emissions could occur.

4. Unfavorable meteorological tower location. The on-site meteorological tower at the SLAC facility is sited too close to a number of trees, which will affect the validity of collected wind data if used as input to the model for predicting the annual radiation dose.

The convention for siting wind instruments is to locate the sensors in a level, open-terrain setting to make measurements that are representative of the state of the atmosphere in the area. Open terrain is defined as an area where the distance between the wind sensors and any obstruction is at least 10 times the height of that obstruction. This practice has been in use for siting meteorological towers for quite a number of years and is widely accepted. There are at least 3 trees in the vicinity of the SLAC meteorological tower that are well within the "10 times" criterion. These trees are about as high as the

wind sensors (40 feet). The trees will have an aerodynamic influence on measured winds such that unrepresentative wind data (i.e., lowered wind speeds, enhanced horizontal turbulence) will be obtained when the trees are upwind of the tower. The SLAC intends to use these data as input to the AIRDOS-EPA model to predict the annual radiation dose. The use of unrepresentative meteorological data will affect the validity of the model predictions.

PRELIMINARY

3.2 Soils

3.2.1 Background Environmental Information

In general, soils at the Stanford Linear Accelerator Center (SLAC) have formed as a result of alluvial deposition from the San Francisquito Creek over rocks of mainly marine sedimentary and volcanic origin. The marine sedimentary rocks include sandstones, siltstones, shales, and claystones. The volcanic rocks include volcanic breccia, flow basalt, tuff, and agglomerate. At the surface is a soil overburden of unconsolidated earth materials. The dominant upper subsoil texture is sandy and the dominant lower subsoil texture is very fine sand and silt (SLAC, 1987a).

Background soil concentrations of radionuclides and chemicals in the vicinity of the SLAC are not routinely analyzed by the SLAC, nor are most available in literature. However, Myrick, Berven, and Haywood (1983) have compiled background soil concentrations of naturally occurring members of the uranium and thorium decay series. Table 3-4 presents radium-226, thorium-232, and uranium-238 concentration data in soil for California, the United States, and the world. Vegetation and certain foodstuffs are indicators of radionuclide contamination in soil and therefore would be collected and analyzed as part of a comprehensive environmental monitoring program. The SLAC has never routinely sampled for these parameters, and no comparison with background values could be presented.

The U.S. Department of Energy (DOE) has established guidelines for residual radioactivity in soil at Formerly Utilized Sites Remedial Action Program (FUSRAP) and remote Surplus Facilities Management Program (SFMP) sites (DOE, 1985; Gilbert et al., 1985). These guidelines are commonly used at operating facilities to determine acceptable levels of radioactivity in soil. In contrast, 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 and potential human exposure routes. Therefore, acceptable levels must be determined on a site-specific and chemical-specific basis.

TABLE 3-4
BACKGROUND SURFACE SOIL CONCENTRATIONS
(pCi/g^a ± 2 STD Dev)

Location	Ra-226		Th-232		U-238	
	Range	Mean	Range	Mean	Range	Mean
California	0.24-1.3	0.77 ± 1.0	0.30-0.76	0.54 ± 0.45	0.19-1.3	0.78 ± 1.1
U.S.	0.23-4.2	1.1 ± 0.48	0.10-3.4	0.98 ± 0.46	0.12-3.8	1.0 ± 0.83
World	0.49-1.98	0.79	0.22-1.31	0.65	0.33-1.32	0.66

Source: Myrick, Berven, and Haywood, 1983

^a pCi/g = 10⁻¹² Ci/g

3.2.2 General Description of Pollution Sources and Controls

The major pathways for potential contamination of soil at the SLAC are operation of the Linear Accelerator (LINAC) and storage rings, routine and accidental airborne releases, routine and accidental liquid releases, and activities associated with waste disposal practices. To avoid soil contamination, the site has established controls on handling radioactive and hazardous materials. The controls include packaging, handling, storage, and disposal requirements; air filtration; and water treatment systems.

The SLAC also contains localized on-site areas of possible soil contamination by hazardous materials, resulting from active leaks, pesticide use, past spills, releases of liquid wastes, and waste disposal practices. Actively leaking polychlorinated biphenyl (PCB)-contaminated transformers were observed during the on-site portion of the Survey. Also, one document indicated that chlordane had been used to control ants and earwigs in and around on-site buildings (McHugh, 1971). A 150-gallon solution of 0.5 percent chlordane in water was applied monthly by a hand sprayer on a 12-foot-wide band exterior to buildings. Information regarding the total quantity of chlordane used or the duration of this practice is not available. With the exception of operation of the LINAC and storage rings and the activities at the Casting Pad, these sources and controls are discussed in Sections 3.1.2 (Air), 3.3.2 (Surface Water), 4.1.1 (Waste Management), 4.2.1 (Toxic and Chemical Materials), and 4.5.1 (Inactive Waste Sites and Releases).

3.2.2.1 Operation of the LINAC and Storage Rings

Operation of the LINAC and storage rings may either contaminate or activate soils. Soil contamination could occur through leakage of the cooling water or through the release of airborne emissions from ventilation stacks. Soil activation could result from particle scattering when the LINAC beam strikes targets or beam dumps, or from beam loss during particle acceleration.

Controls of soil activation consist of shielding the LINAC, storage rings, target areas, and beam dumps with concrete. Cooling water is passed through an ion exchange column and discharged to the sanitary sewer. Section 3.3.2 provides a more detailed discussion of the disposal of this cooling water. Other than retention of the air to allow short-lived radionuclides to decay before venting and

monitoring, there are no controls on airborne emissions from the LINAC. For a more detailed discussion, see Section 3.1.2.

3.2.2.2 Activities at the Casting Pad

The Casting Pad is located along the south boundary of the SLAC, south of Sector 28 of the Klystron Gallery as shown on Figure 3-1. The area was originally used for casting concrete shielding blocks used at the SLAC. The area now houses several small maintenance shops and is also used for storage. There is a small parts cleaner next to Building 439. SLAC staff at the area reported that diesel oil is used as the cleaning solvent. The plywood base that the cleaner is mounted on was observed to be saturated with diesel oil, and the soil surrounding the base was stained.

Located near the parts cleaner is a portable steam cleaner that is apparently used for cleaning vehicles and equipment. The cleaning is performed on a graveled area, and wastewaters generated either infiltrate into the soil or run off to the south into a drainage ditch. The gravel surface where the cleaning is conducted was stained with oil.

Outside one of the shops at the Casting Pad is a drum storage rack containing a 30-gallon drum labeled "form oil". At the time of the Survey, this drum was observed to be leaking and the soil beneath the drum was stained.

Also observed at the Casting Pad area was the storage of hazardous materials, and potentially hazardous wastes, directly on the ground and without secondary containment. Items observed to be stored without secondary containment included several lead-acid storage batteries, a leaking 1-gallon unmarked can, an empty 5-gallon can of 1,1,1-trichloroethane, and an empty 5-gallon can labeled "potassium cyanide".

3.2.3 Environmental Monitoring Program

The SLAC has not had in the past nor does it currently have a soil monitoring program. Interviews with site personnel indicated that occasionally soil sampling and analysis was performed on an informal basis, in association with a specific spill incident or localized area. However, no site-wide documentation was available.

Source: SLAC, 1980b

FIGURE 3-1
LOCATION OF THE CASTING PAD AND BUILDING 439
AT THE SLAC

3.2.4 Findings and Observations

3.2.4.1 Category I

None

3.2.4.2 Category II

1. Soil contamination at the Casting Pad. Current operations at the Casting Pad are resulting in the release of contaminants to the soil and potentially to groundwater. The Survey team observed a spill of diesel oil from a parts cleaner, a spill from a drum of "form oil", and evidence of oil contamination from steam cleaning. In addition, other chemicals and solvents are stored in the area, in the open, and on unpaved surfaces.

The Casting Pad is located along the south boundary of the SLAC, south of Sector 28 of the Klystron Gallery. The area, originally used for casting concrete shielding blocks used at the SLAC, now houses several small maintenance shops and is also used for storage. There is a small-parts cleaner next to Building 439. SLAC staff at the area reported that diesel oil is used as the cleaning solvent. The plywood base that the cleaner is mounted on was observed to be saturated with diesel oil, and the soil surrounding the base was stained. The total volume of spilled diesel oil, as indicated by the observed staining, is estimated to be less than 5 gallons.

Near the parts cleaner is a portable steam cleaner that is apparently used for cleaning vehicles and equipment. The cleaning is performed on a graveled area, and wastewaters generated either infiltrate into the soil or run off to the south into a drainage ditch. The gravel surface where the cleaning is conducted was stained with oil. The area of soil staining is estimated to be 100 square feet.

Outside one of the shops at the Casting Pad is a drum storage rack containing a 30-gallon drum labeled "form oil". At the time of the Survey, this drum was observed to be leaking, and the soil beneath the drum was stained. The total

volume of oil leaked, based on the observed staining, is estimated to be less than 5 gallons.

Also observed at the Casting Pad area was the storage of hazardous materials, and potentially hazardous wastes, directly on the ground and without secondary containment. Items observed to be stored in such a fashion included several lead-acid storage batteries, a leaking 1-gallon unmarked can, an empty 5-gallon can of 1,1,1-trichloroethane, and an empty 5-gallon can labeled "potassium cyanide".

3.2.4.3 Category III

1. Possible soil contamination. There is evidence of contamination of the soil from PCBs, chlordane, and other hazardous constituents. This possible contamination has not been adequately assessed via a comprehensive soil monitoring program.

Numerous areas of localized contamination and evidence of past contamination were observed at the time of the Survey. This contamination is available for further distribution via air, surface water, and groundwater transport. Since other media such as surface water and groundwater are not sampled, the lack of a soil monitoring program may have resulted or could result in an undetected release of hazardous material to the off-site environment.

Survey-related sampling and analysis of on-site soils is planned to determine whether past and/or current practices have resulted in environmental contamination.

3.2.4.4 Category IV

None

3.3 Surface Water

3.3.1 Background Environmental Information

This section describes the background environmental information for the Stanford Linear Accelerator Center (SLAC). Included are discussions of the facility's geography and topography; hydrology (i.e., San Francisquito Creek and surface drainage); and water supplies, uses, and distribution.

3.3.1.1 Geography and Topography

The SLAC is located on the San Francisco Peninsula about halfway between San Francisco and San Jose, California. The site lies in a belt of low, rolling foothills between the alluvial plain bordering San Francisco Bay on the east and the Santa Cruz Mountains on the west (SLAC, 1987a). The whole accelerator site varies in elevation from 200 to 375 feet above sea level whereas the alluvial plain to the east around the Bay lies less than 150 feet above sea level; the mountains to the west rise abruptly to over 2,000 feet (Ecology & Environment, Inc., 1985). The SLAC site occupies 426 acres of land (SLAC, 1986b) located 2 miles west of Stanford University and west of the City of Palo Alto, and is located in an unincorporated portion of San Mateo County. It is bordered on the north by Sand Hill Road, and on the south and east by San Francisquito Creek. The topography and the location of the SLAC with respect to San Francisquito Creek and the surrounding area are shown on Figure 3-2.

3.3.1.2 Hydrology

San Francisquito Creek

The SLAC is located approximately 6.5 miles southwest of San Francisco Bay. The closest drainage to the site is San Francisquito Creek located slightly less than a mile to the south (Millan, Higgins, and Pera, 1987), which roughly parallels the southern 2-mile border of the SLAC site. The creek begins at the dammed Searsville Lake at the western extremity of the SLAC, which has a capacity of 925 acre-feet. The creek then winds for 3.1 miles to the eastern SLAC extremity where it joins the Los Trancos tributary near the Stanford golf course. The creek serves as a border between

Source: United States Geological Survey, 1973

FIGURE 3-2

TOPOGRAPHY OF THE SLAC AND MAJOR SURFACE-WATER FEATURES

Menlo Park and Palo Alto, and hence San Mateo and Santa Clara Counties, respectively, from this point downstream to the bay. It travels 2.9 miles from the golf course to El Camino Real and another 4.5 miles to the bay, for a total length of 10.5 miles (SLAC, 1982).

The San Francisquito Creek has a drainage basin of 37.5 square miles (SLAC, 1982). A significant portion of the natural runoff is caught in Searsville and Felt Lakes. As much as 700 acre-feet of water from Searsville and Felt Lakes is diverted annually via pipeline to the Stanford University campus for irrigation and to fill Lake Lagunita, a recreation area near the campus. There is also a flume upstream from the golf course which can divert water from the creek to Lake Lagunita. Until the SLAC facility was built, the only water which flowed in the first 3 miles of the creek was that which spilled over the Searsville Dam during the rainy winter months. The average annual discharge for the creek is 12,500 acre-feet (SLAC, 1982). Although the SLAC facility discharges only about 95 acre-feet of water into the San Francisquito Creek per year, this contribution is significant because it has changed the summer dry creek into an all-year flow. When the SLAC Linear Collider (SLC) begins operation, the SLAC discharge to the creek is expected to be about 160 acre-feet of water per year (SLAC, 1982).

The major flow of San Francisquito Creek is during the 5-month period from December through April, with a maximum flow of over 650 gallons per second (gal/sec) in February (SLAC, 1982). This is contrasted against a 1 gal/sec average continuous discharge from the SLAC from all sources, including blowdown. This continuous flow allows fish to exist downstream which are trapped in pools during the dry months of the year. The flow also allows a large number of birds, reptiles, amphibians, insects, and small mammals to live in the vicinity of the creek.

During the dry months, May through November, there is little flow in the stream other than that provided by the SLAC. Dry years affect campus irrigation and recreation. The Searsville Lake water used for campus irrigation must be supplemented with well water and a sufficient volume of water may not be available to fill Lake Lagunita.

Between July and the first significant rainfall in the late fall or early winter, there is usually no flow at the gaging station east of the SLAC facility. The highest recorded

flow in the creek is 5,560 cubic feet per second (cfs); the average flow for 21 years is 18.8 cfs (Ecology & Environment, Inc., 1985). During periods of surface runoff, San Francisquito Creek discharges to the north to San Francisco Bay and probably contributes to temporary bank storage and underflow south and west of the gaging station (Ecology & Environment, Inc., 1985).

Surface Drainage

Three major natural drainage channels drain surface water from the SLAC facility, as shown in Figure 3-3. Channel 1 drains the research area on the eastern portion of the SLAC, and consists of 2 sub-drainage channels which originate at Positron Electron Project (PEP) Interaction Region (IR)-6 (Building 660) and PEP IR-8 (Building 680). These join at a horsetrack located off-site south of PEP to form a single channel which then flows into San Francisquito Creek east of Interstate 280 (I-280).

Channel 2 is a small channel located north of the Klystron Gallery (Building 2) near Sector 19 and south of I-280. The Linear Accelerator (LINAC) was constructed so that this natural drainage channel would still flow south underneath it. The portion of the channel where it emerges south of the LINAC is shown as Channel 3 on Figure 3-3. This channel then flows off-site past the Stanford University primate center and eventually enters San Francisquito Creek (SLAC, 1982).

A seepage channel is also present north of PEP IR-12 (Building 720), which drains to the northeast (ERDA, 1976). This channel seeps into the ground in a large field northeast of a eucalyptus grove in the area. Prior to the construction of the SLAC, the seepage basin and the three channels described above were dry during the summer. Presently, however, the seepage basin is damp year-round due to runoff from irrigated lawn areas, and the streams flow perennially due to irrigation runoff and discharge from the SLAC cooling towers (ERDA, 1976).

3.3.1.3 Water Supplies, Uses, and Distribution

The SLAC domestic water is furnished via the Menlo Park Municipal Water Department (MPMWD). The source of the MPMWD water is the City of San Francisco-owned and operated Hetch-Hetchy Aqueduct System which touches the northeastern boundary of the SLAC, and is transmitted across the San Joaquin

Source: SLAC, 1982

NATURAL DRAINAGE CHANNELS AT THE SLAC

FIGURE 3-3

Valley from reservoirs in the Sierra Nevada. A 16-inch main and metering station near the Sand Hill Road entrance of the SLAC serves the entire site. The SLAC and its neighboring Sharon Heights development receive water service from "Zone 3," a separate independent system within the MPMWD. This separate system taps the Hetch-Hetchy aqueduct, and pumps water up to a 2-million-gallon reservoir located on the north side of Sand Hill Road approximately opposite Sector 7 of the accelerator. One million gallons of this reservoir is reserved for SLAC emergencies (SLAC, 1986b). This reservoir is situated to provide gravity flow to SLAC's distribution loop piping systems through a metered connection at Sector 7 of the LINAC. The Hetch-Hetchy system can deliver 300 million gallons per day (mgd) of water to its customers; it is projected that the SLAC, with SLC, would use less than 2/10 of 1 percent (0.002) of this capacity (SLAC, 1982). The Zone 3 system was constructed in 1962 under special agreements among the City of Menlo Park, the developer of Sharon Heights, Stanford University, and DOE. The cost of construction was shared among the various parties, and each party has a vested interest in, and is entitled to, certain capacity rights in accordance with these agreements (SLAC, 1987a).

The "pre-SLC" water demand in 1981 amounted to about 122 million gallons per year (mgy). This was comprised of the following (SLAC, 1986b):

Water Use	Volume (mgy)	Percent
LINAC cooling (including blowdown)	77	63
Equipment cooling	11	9
Irrigation	13	11
Domestic	21	17
Total	122	100

It is projected that with the addition of the SLC, the annual water use rate could increase by over 60 percent (SLAC, 1982). Available chemical analyses for the SLAC domestic water system are shown in Table 3-5.

Since over half of the water is necessary for machine cooling, the daily consumption of this component varies directly with the LINAC operating schedule. The domestic water usage however, is relatively constant. The SLAC now utilizes four cooling

TABLE 3-5
SLAC DOMESTIC WATER ANALYSES^a

Constituent	SLAC Domestic Water Analysis ^b	Public Health Service Drinking Water Standards
Hardness	24	-
Calcium	16	-
Magnesium	8	-
Alkalinity (Phenolphthalein)	2	-
Alkalinity (Methyl Orange)	20	-
Sulfate	8	250
Chloride	4.0	250
Silica	3.3	-
Inorganic Phosphate	0.7	-
Ortho Phosphate	0.7	-
pH (standard units)	8.6	-
Specific Conductance:		-
micro mhos at 18°C	60	-
micro mhos at 25°C	70	-
Chromium	0.005	0.05

Source: SLAC, 1982

a Date of analyses unknown.

b Figures are in milligrams per liter (mg/L), unless otherwise indicated.

c Standards are equivalent to U.S. Environmental Protection Agency Drinking Water Standards

water towers comprising a total cooling capacity of 73 megawatts (MW) to dissipate the heat generated by the LINAC and other experimental apparatus (SLAC, 1987a).

Power consuming devices are directly cooled by a recycling closed-loop system of low-conductivity water (LCW). The LCW is piped from the accelerator or other devices to be cooled, to the cooling tower, through heat exchangers where the heat is exchanged from the closed system to the domestic water in the towers. A portion of the tower water is ultimately evaporated into the atmosphere.

During current operations, roughly 45 percent of the water consumed by the laboratory is lost by evaporation from the four cooling towers (SLAC, 1987a). The remaining 55 percent is disposed of as follows:

- 26 percent is blowdown, equipment cooling, and runoff from irrigation entering San Francisquito Creek via the storm drains (ERDA, 1976);
- 20 percent is domestic and process wastewater discharged via the sanitary sewers connected to the Menlo Park Sanitary District; and
- 9 percent is absorbed into the ground from irrigation (SLAC, 1987a).

The SLAC storm drainage system is a combination of natural and paved channels. Some surface flow is directed to natural drainage channels. Other flow pathways consist of paved curb and gutter flow to drop inlets, which then proceed to a closed underground pipe system. A small amount drains north to Sand Hill Road, while all other areas drain south and eventually into San Francisquito Creek (SLAC, 1986b).

The sanitary sewer system is annexed to the West Bay Sanitary District (WBSD), which owns the sewer lines and pumping stations. The main sewer outfall is located in a natural swale running northeast from the main SLAC campus area toward Sand Hill Road. A smaller line runs along Alpine Road east of the facility and serves the New Warehouse/Magnet Factory (Building 15), PEP IR-4, IR-6, IR-7, and IR-8 (SLAC, 1988d). The primate center and Addison-Wesley lease-hold also join this sewer main (SLAC, 1986b). Both lines run to the South Bayside System Authority (SBSA) treatment plant.

The landscaping irrigation system is comprised of aboveground pipe with quick couplers for open trees or plants and buried lines with automatic pop-up sprinkler heads for lawn and special areas. All lawn area sprinklers are controlled by valves remotely operated by automatic clocks (SLAC, 1986b).

3.3.2 General Description of Pollution Sources and Controls

Wastewaters produced at the SLAC include sanitary and industrial sources, as well as some sources that enter the storm sewer system and discharge to San Francisquito Creek. The sanitary and industrial wastewaters, which contain both chemical and radiological contaminants, are either disposed of via the sanitary sewer, or are collected and disposed of by the Environment and Safety Office (ESO). This latter category of wastes is discussed in Section 4.1.1.

At the SLAC, the ultimate responsibility for the disposal of hazardous substances lies with the generator, although there are no written procedures to govern what is acceptable for disposal via the sanitary sewer drains. Disposal of hazardous substances via the sanitary sewer is, however, considered undesirable, and SLAC personnel interviewed during the Survey seemed cognizant of this. Furthermore, signs are posted above sinks in some areas to restrict disposal via the drains leading to the sanitary sewer. Nevertheless, some hazardous substances are disposed of via the sanitary sewer. Likewise, there are no written procedures which prohibit the discharge of hazardous substances to the storm drain system. Some hazardous substances are discharged to the storm drain system and may therefore impact surface waters.

All wastes disposed of via the sanitary sewer at the SLAC flow to the SBSA treatment plant via lines owned by the WBSD. Two sanitary sewer outfalls exist from the SLAC; the main outfall lies north of PEP IR-12, while a smaller outfall is located along Alpine Road east of the facility. Monitoring of the sanitary sewer effluent is discussed in Section 3.3.3.4.

Some of the SLAC wastewaters which are disposed of via the sanitary sewer receive pretreatment prior to disposal, while others do not. This section therefore describes wastewater sources in three categories: pretreated wastewaters, direct discharges to the sanitary sewer, and discharges to surface waters.

3.3.2.1 Pretreated Wastewaters

Electronics Building (Building 24)

This building is used for printed circuit board fabrication, electronics assembly and installation. A copper polishing machine which operates using a rotary brush and water is used daily for about 2 hours at 5 gallons per minute (gpm) of water. The copper shavings are filtered from the machine effluent and collected in a sump tank while the filtrate goes to the sanitary sewer. Other wastewaters produced in this building are discussed in Section 3.3.2.2.

Light Fabrication Building (Building 25) and Wastewater Treatment Plant - Plating (Building 38)

Room 115 of the Light Fabrication Building contains the electroplating shop, which began operation in 1963. The electroplating facility performs plating, anodizing, metal cleaning, electroless plating, chromate conversion coating, and printed circuit board fabrication (ESO, ND). The shop has a wooden floor which is occasionally hosed down. The plating shop rinses, which primarily contain copper, are routed to a gutter which leads to the wastewater treatment plant (WWTP) after passing through a screen and into a 6-inch pipe. Cracks in the subsurface floor were sealed about 3 years ago. There is no overflow of rinses onto the floor. The plating shop uses a cyanide dip which it is planning to eliminate.

Adjacent to the electroplating shop is a parts cleaning/metal finishing area with a wet floor. The wet floor has been deteriorating due to bath discharges, and is planned to be replaced by a trough to feed into the WWTP.

Prior to 1978, any discharges (i.e., rinses and spills) to the shop floor drained to a sump below the floor and were routed untreated to the sanitary sewer. In 1978, a neutralization system was constructed to assist in meeting pH limits on wastewater imposed by the sewer district (ESO, ND). In 1984, this system was upgraded to meet the electroplating pretreatment standards.

In the WWTP, cyanide destruction is accomplished using sodium hypochlorite. Cyanide-containing wastewaters are added at a rate of 4 to 6 ounces per gallon (oz/gal) of influent to the 11,000-gallon treatment tank consisting of three compartments. Wastewaters are pH-adjusted for metals precipitation using sodium hydroxide and sulfuric acid, and ferric chloride and polymer are added to aid settling. Some plating solutions and acid cleaning/stripping solutions are also metered into the system for treatment, although since 1978 most have been disposed of off-site (ESO, ND). Only the more dilute solutions (i.e., the rinsewaters rather than the concentrated plating baths) are treated at the WWTP. Cyanide and chromic acid baths reportedly have never been released to the sanitary sewer (ESO, ND). The metal hydroxides are settled out in a clarifier, and the overflow is directed to the sanitary sewer. The clarifier solids are dewatered with a 1- or 2-cubic-foot filter press. A sludge dryer which reduces the sludge to about 25 percent of its original volume will reportedly be placed into service in the near future. The resulting sludge containing 2 to 3 percent water (after the sludge dryer) is disposed of off-site as hazardous waste. The amount of sludge generated is 1/2-1 drum/day at a treatment rate of 8,000 to 15,000 gallons per day (gal/day), operating on an 8-hour shift per day. The design capacity of the WWTP is 40 gpm (19,200 gal/day) for up to 200 parts per million (ppm) copper in the influent. The plating shop also contains 2 vapor degreasers containing 1,1,1-trichloroethane. Solvent use includes toluene, acetone, methyl ethyl ketone (MEK), isopropyl alcohol, 1,1,1-trichloroethane, Fluorocarbon-TF, and gel paint stripper. The solvents are used on rags in small quantities and do not enter the WWTP.

The WWTP is now required to meet the metal finishing pretreatment standards given in Table 3-6 for both the daily maximum and average limits. Results of analyses for samples obtained by the SBSA from the WWTP for 1986-1987 are given in the table. All results for these last four sampling events available to the Survey team are in compliance.

Sampling and analysis for process control is performed 3 to 4 times daily at 4 locations: the WWTP influent, after pH adjustment and flocculation treatment, clarifier influent, and clarifier effluent. Samples are analyzed for copper and occasionally cyanide and chromates. The SBSA also monitors the WWTP for compliance with the pretreatment standards. In 1983/1984, numerous exceedances were noted at the WWTP due mainly to copper and total metals. A Notice of

TABLE 3-6

METAL FINISHING PRETREATMENT STANDARDS AND RESULTS FOR BUILDING 25 WWTP EFFLUENT

Species	Daily Maximum (mg/L)	Average(a) (mg/L)	Results (mg/L)			
			11/11/86	3/5/87	5/12/87	8/25/87
Cadmium	0.69	0.26	0.014	0.008	0.008	0.006
Chromium (total)	2.77	1.71	1.53	0.92	1.06	0.86
Copper	3.38	2.07	0.89	0.23	0.09	0.22
Cyanide (total)	1.20	0.65	0.37	0.03	0.02	<0.02
Lead	0.69	0.43	0.07	0.21	0.05	<0.05
Nickel	3.98	2.38	0.26	0.15	0.04	<0.04
Silver	0.43	0.24	NA	NA	NA	NA
Zinc	2.61	1.48	0.909	0.050	0.030	0.027
Total Toxic Organics (TTO)	2.13		NA	NA	NA	NA
pH	6.0 - 13.0(b)		8.5	8.7	8.1	9.2

Sources: SLAC, 1987a, c

(a) Limit for average of previous four samples.

(b) Upper pH limit is SBSA standard.

NA Not analyzed

Violation (NOV) was issued by SBSA due to a daily copper concentration of 17.3 milligrams per liter (mg/L) (limit 4.5 mg/L at that time) and a 4-day average of 5.42 mg/L (limit 2.7 mg/L) for sampling on July 30, 1986. This was the only violation noted since the WWTP was upgraded in 1984.

The SLAC currently does not monitor its effluent for total toxic organics (TTOs) as per the electroplating and metal finishing pretreatment regulations, and has applied for an exemption from this requirement to SBSA. The facility has sent a list to SBSA containing the 6 organics which are used at the plating shop or the adjacent analytical laboratory, and plans to submit a Solvent Management Plan to SBSA when requested in lieu of sampling for TTOs. Personnel from the SLAC stated that SBSA plans to monitor for these 6 organics during the next round of sampling. These organics include benzene, 1,1,1-trichloroethane, chloroform, methylene chloride, nitrobenzene, and toluene (Wong, 1987).

Outside the Light Fabrication Building is a pad used for steam-cleaning large equipment of aluminum, steel, etc. A sodium lauryl sulfonate detergent is used at up to 300 gallons per hour (gal/hr). A 210-gallon caustic tank for use with the large aluminum assembly area rests on a guttered pad. Phosphoric acid, a caustic solution and a cutting agent are routed to a trough for automatic pH measurement, neutralization as required, and then discharge to the sanitary sewer. A pH meter and recorder are located inside the building. No defoamants are used in this operation. Other operations that occur in the Light Fabrication Building are discussed in Section 3.3.2.2.

Cleaning Facility (Building 30)

This building is used to clean large aluminum parts and contains sulfuric acid and sodium hydroxide baths. Four to five years ago, wastewaters were directed to the electroplating shop WWTP. Currently, the overflow of tapwater rinses containing carryover from the baths is routed to the sanitary sewer via a sump and drain beneath the wooden floor. This operation was closed for 2 to 3 years and became operational just about 1 week prior to the on-site Survey. The pH adjustment system was not operating during the on-site Survey. Discharges from the operation would tend to be alkaline, according to SLAC personnel.

Central Laboratory (Building 40)

This building houses the physical electronics laboratory, which performs small-scale tests on metallurgical samples. Approximately 1 pint of acid is used per day in this area. Currently, acids, alcohols, and solvents are collected and disposed of by the ESO. Adjacent to this area, however, is a 24-cubic-foot plastic tank containing calcium carbonate and marble chips. This tank is connected to the sink and is used to neutralize any acids in the effluent as they pass through the tank. The tank is not monitored prior to discharge via a floor drain leading to the sanitary sewer.

A second sink in this area is also connected to a 24-cubic-foot tank, which drains to the sanitary sewer. This sink has not been used for water for 10 years. It lies within a hooded enclosure and is now used for sandblasting and paint spraying.

This area contained a cardboard box on the floor with vacuum pump wastes, including 5 containers of gear oil and mineral spirits. This box was about 5 feet from a sanitary sewer drain. The laboratory also contained acids, alcohols, trichloroethylene (TCE), and acetone in 5-gallon metal cans about 10 feet from a floor drain. Additional wastewaters generated in this building are discussed in Section 3.3.2.2.

General Services Building (Building 81)

A motor pool area outside this building is used for steam cleaning of vehicles, parts, etc. A drain leading to a sump is located in this area which contains an oil/water separator. The oil is held up while the water passes through to the sanitary sewer. The sludge and oil are pumped out of the sump by ESO as needed, although no routine inspections are conducted nor do written procedures exist for performing this operation. The sludge and oil were analyzed to establish the waste stream type; they are disposed of as "other regulated materials - hazardous waste, not otherwise specified" (ORM-E) wastes. No analyses of the water effluent have ever been performed.

This building also generates solvent and other oil wastes from vehicle maintenance, as described in Section 4.1.1. A parts washer and an old hydraulic lift are present but no longer used. No sinks are present inside the building.

LINAC Beam Absorbers and Cooling Water Systems

There are various areas at the SLAC where accelerator-induced radioactive wastewaters may be produced. These areas are where the energy of the electron/positron beams is partially or totally absorbed by water. In water, this absorption produces four radioisotopes: oxygen-15, carbon-11, beryllium-7, and tritium. The half-lives of oxygen-15 and carbon-11 are 2 minutes and 20 minutes, respectively. Due to their relatively short half-lives, these two constituents do not present a concern. The beryllium-7, with a half-life of 54 days, is removed by the ion exchange resin beds required to maintain the conductivity of the water at a low level. Therefore, tritium, with a half-life of 12.3 years, is the only remaining constituent of potential concern.

The locations of these areas are as follows:

- The Beam Switchyard's (BSY) Primary Cooling Water Systems
- The Beam Dump Areas
- The LINAC's Cooling Water Systems

Each of these systems contains a heat exchanger and an ion exchange column to maintain the low conductivity of the water. A SLAC surveillance crew reportedly measures the conductivity of this water regularly and changes the ion exchange resin (1.5 cubic feet in each bed) annually. The ion exchange resins contain radioactive material. In addition, these resins also contain metal contamination, such as copper, chrome, nickel, and iron, from the piping systems. In 1966, the resins were shipped to Beatty, Nevada, for disposal. None have been shipped since that time. Currently, there are about 30 drums of resin stored at the radioactive waste storage yard at the SLAC awaiting approval for shipment to an off-site DOE disposal facility.

The Beam Dump (absorbing) Areas are where the energy from the LINAC beam particles is safely terminated. This is accomplished by dissipating the energy of the beam particles in a mass of material. Beam dumps at the SLAC use concrete, copper, iron, and water. The water is contained in a closed system, which contains a heat

exchanger and an ion exchange column to maintain the necessary low conductivity of the water.

Wastewaters from the BSY's Primary Cooling Water Systems and from the Beam Dump Areas are only released by leaks or during maintenance on the systems. Wastewaters from these systems are collected in stainless steel-lined-sumps sized to contain the entire water volume, then pumped to a 4,000-gallon mobile holding tank and disposed of in the sanitary sewer. In the past, samples of these radioactive wastewaters were obtained prior to disposal via the sanitary sewer. Although the volume of these radioactive wastewaters released to the sewer is not known, data available for the 1971-1978 time period indicate a range of radioactivity as follows.

Analyses	Concentration
Gross beta activity	5 - 55,000 pCi/L
Gross beta-gamma activity	7 - 1,250 pCi/L
Tritium	6,000 - 120,000,000 pCi/L

Sources: Hughes, 1977; ERDA, 1976

These data represent the higher levels of radioactivity released in the SLAC wastewaters during the facility's period of operation. Since dilution of this water with other SLAC wastewaters has been sufficient to result in an overall concentration of radioactivity which is less than DOE derived concentration guidelines (DCGs) for release, the SLAC no longer samples and analyzes its wastewaters from these systems prior to disposal in the sanitary sewer. It does, however, maintain a monitoring station for the sanitary sewer. During 1984, 0.063 curie of tritium believed to be from leaks in the primary cooling water system was discharged via the sanitary sewer (SLAC, 1985a). This value represents only 0.075 percent of the DCG for release. Further information on the monitoring of the sanitary sewer is given in Section 3.3.3.4.

The LINAC's Cooling Water Systems are as follows. Each of the LINAC's 30 sectors contains three water cooling systems: one each for the klystron, the magnet, and the wave guide. Each of these 90 systems contains an ion exchange resin bed,

referred to as a Permutit (the brand name) by SLAC personnel, to produce LCW. In addition, every two sectors of the LINAC contain a water-cooled heat exchanger, for an additional 15 systems along the LINAC. In the past, none of the water in any of these systems has reportedly contained any detectable radioactivity. These ion exchange resin beds are changed out during regular maintenance of the equipment, according to SLAC personnel, and are regenerated at the deionized water plant near the WWTP. Since the cooling lines within the accelerator are copper, copper is picked up on the resin beds as the lines are cleaned, as discussed later.

Deionized Water Plant

The Deionized Water (DI) Plant produces LCW for cooling within the LINAC and associated equipment, as well as for use in the plating shop and various laboratories (ESO, ND). The DI Plant also regenerates the 90 nonradioactive ion exchange beds used in the LINAC as well as nonradioactive resins from about 10 other locations at the SLAC.

LCW is produced by passing SLAC domestic water through first a sand filter followed by a carbon filter. The media from these filters are disposed of by the subcontractor who replaces the spent media. The water then passes through a 5-micron filter and a polymer resin bed for organic removal. Effluent is directed to a cationic bed and an anionic bed, followed by a mixed bed for polishing. The water is then directed to a 12,000-gallon stainless steel storage tank, to ultraviolet light treatment, and through more filtration (10 microns and 0.2 micron) before being distributed. The regenerant solutions from the cation and anion beds are piped directly to the sanitary sewer.

The Permutits from the LINAC contain a mixed bed resin. During regeneration, the resin cleaner and backwash are directed to an 8,000-gallon mobile tank. The regenerant is directed to a 4,000-gallon mobile tank. As a result of the copper picked up from the LINAC cooling lines, a low pH/high copper waste stream is produced. The mobile tanks are sampled for copper and pH; if the copper concentration is high (1,000 ppm) and the pH less than 4, the tanker contents are disposed of by a subcontractor. If acceptable, the wastewater is sent to the WWTP and neutralized to pH 5 to 10, as are the mixed bed regenerant solutions for the

other 10 SLAC ion exchangers. Approximately 2 tankers are filled for every 30 cubic feet of Permutit bed regenerated. This wastewater must be disposed of off-site on a monthly basis.

3.3.2.2 Direct Discharges to the Sanitary Sewer

Plant Maintenance and Utilities (PMU) Building (Building 35)

The paint shop uses epoxy-based and water-based paints. Paint brushes from latex paint are cleaned with water in a sink leading to the sanitary sewer. In the past, a sink led to an underground storage tank for solvents. This sink has since been capped off and the solvent tank was removed about 4 years ago. This tank removal is discussed further in Sections 3.4.2 and 4.5.1. Other wastes generated in this area are discussed in Section 4.1.1.

Fabrication, Assembly, and Testing Shops

- New Warehouse/Magnet Factory (Building 15)

In the past, this building was used for the manufacture of magnets for the SLC, and used to perform some assembly involving small quantities of solvents and oils. It is now used for testing, storage, and some manufacturing for the SLC Large Detector (SLD). Some 5-gallon cans of gear oil were present. The only wastewater discharge is to the sanitary sewer from a lavatory.

- Electronics Building (Building 24)

In addition to the activities discussed in Section 3.3.2.1, this building also contains photographic processing equipment. An aqueous film developer using sodium carbonate (6 lb/80 gal water) and potassium hydroxide (diluted 25:1 with water) for stripping discharges to the sanitary sewer. Film development also occurs in a darkroom. The solutions go into the drain with water. No silver recovery is performed. A photographic silk screening process uses solvents for cleaning and paint thinning, which get washed off into the sink to the sanitary sewer. Other cleaning solutions are drummed for disposal by the ESO.

- Light Fabrication Building (Building 25)

In addition to the activities discussed in Section 3.3.2.1, this building contains a central shop area that performs long-term work on equipment. Most machine coolants were eliminated from use within the last 5 years, except for Trimsol® and Simperial® cutting fluid. A coolant recovery system is planned, but currently coolants are drummed for disposal as hazardous waste. Alcohol and acetone are used in the assembly area. Small quantities of oils and 1,1,1-trichloroethane are also used and collected for disposal by the ESO.

- Heavy Fabrication Building (Building 26) and Annex

Coolants, oils, and solvents in this area are disposed of as hazardous waste. The floor is concrete and has a drain to the sanitary sewer, but there is no evidence of past spills in the area.

An 18-cubic-foot stainless-steel container marked "trichloroethane" and about half full of liquid was present in another area of the building. The tank was on wooden blocks without containment, and reportedly was being used by a customer using the area for work for the SLC. Limited work on radioactive parts is performed, as is the grinding of copper, stainless steel, plastics, and titanium.

- PEP Vacuum Assembly Building (Building 31)

Components in the clean room are wiped with acetone, Freon, and alcohol. An ultrasonic bath containing about 12 cubic feet of water and possibly some solvent is drained twice monthly and disposed of by the ESO, as are the other solvents and pump oils. Although floor drains are present, there is no evidence that past spills have occurred.

- Light Assembly Building (Building 33)

This building is used by the SLD group and the University of California at Riverside. Hexane, benzene, and alcohol in small quantities were present in a room off the main assembly area; these have not been used for over 1 year. Eight drums of Freon

TF and some alcohol were present and used for cleaning with rags. This is disposed of by the ESO. No sinks were in the area.

- Test Laboratory (Building 44)

Wastewaters produced in the machine shop, bake station, and the hydrogen furnace in the tube assembly area are collected by the ESO. Some Freon and acetone and three degreasers were noted in the machine shop.

- Test Laboratory Substation (Building 45)

The quality control (QC) inspection area contains a few sinks which are used for sanitary purposes only. One sink in the print shop was capped off, which was formerly the electronics area.

The mechanical area uses Freon as a degreaser. A Freon recycling unit is planned. A klystron oil treatment unit is also present, which processes about 2,000 gal/month. Oil containing more than 50 ppm of polychlorinated biphenyls (PCBs) is drummed for disposal. Oil containing less than 50 ppm of PCBs is processed for reuse. A small amount of water and solids is separated from the oil in a centrifuge. This water (i.e., 1 pint/4 months) is left in a pan to evaporate. The processed oil is then reused in new or rebuilt klystrons.

- Stanford Positron Electron Asymmetric Ring (SPEAR) Assembly Building (Building 101)

This building contains sinks that are used for domestic purposes. Some Freon is used in this building, and a spill of 2 pounds of mercury occurred in the past. Three metal plates are in the floor of two adjacent rooms where machinery was bolted in place. The soil under these plates appeared to be dry, and no chemicals were stored in the area.

- EFD Shops (Building 104)

The power supply group and some shops are housed in this building, which contains a cabinet with small quantities of chemicals. The area is on bottled water, and no water sources or sinks are present.

Research Laboratories and Support Shops

- Central Laboratory (Building 40)

In addition to the activities discussed in Section 3.3.2.1, this area has a machine shop. This shop uses 1,1,1-trichloroethane, which is disposed of by the ESO. Chemical cleaning, if needed, is performed at the plating shop. No solvents reportedly have been disposed of in the drain, at least for the past 10 years. Three floor drains are present in the shop but no evidence of past spills was apparent. When the floor is steam-cleaned, the detergent solution is washed into the drains. Outside, cutting fluid from a diamond stone cutter is drummed for disposal, and fluids from the lathes are recycled.

- Central Laboratory Annex (Building 84)

This area is used for electrical and mechanical assembly. Most laboratories are dry; however, a few use small quantities of solvents. Laser dyes are stored in Room G215, but the laser was removed and the room is no longer in use. Epoxy casting is performed in Room B231, and small quantities of methanol and MEK are used.

Experimental Areas and Support Shops

- End Station A (ESA) (Building 61)

No chemicals were in use in this area. An isolated drum containing radioactive materials was stored in a back corner (see Section 4.1.1). Cooling water is piped to this area.

- Stanford Synchrotron Radiation Laboratory (SSRL) (Building 120)

This building contains 24 stations that use the particle beam from the SPEAR storage ring for experiments. It houses a biolaboratory and has a self-contained, water-cooled, closed-loop LCW system. No activation of the water occurs from activities in this area since there is no acceleration of the LINAC beam; energy is actually being dissipated, not injected. About 8 years ago, there was a laboratory where the piping had to be replaced due to acid corrosion. This area reportedly is now a darkroom.

- SSRL South Arc Building (Building 131)

This building is on the SLAC LCW system. During the Survey, the pumps providing chilled water for air conditioning were out of service, and water was being routed to a sewer through a metal channel along the building.

Room 209 is the biotechnology laboratory where samples (e.g., rubidium) are loaded into cells to put into the beam. Five sinks were in this area, one of which had a small ion exchange unit on the influent water. Although acids have reportedly not been put into the drains for 3 years, there was a sign over one sink that read "Dilute acid and use sink next to hood". The sink in one of the three hoods was reportedly used to neutralize and dilute acid or other reactive chemicals before they were placed in the drain. An emergency shower was also in the room.

Room 214 is used to cut and polish silicon and germanium crystals on a small scale, and for some laboratory development activities. This area uses zinc metal as well as acetone, MEK, and methyl isobutyl ketone (MIBK). The room is expected to be converted into a darkroom.

Adjacent to this is the current darkroom. This area uses 1 quart of developer and 0.5 quart of fixer every 3 weeks. These solutions are disposed of through the sanitary sewer. It is not known whether a silver recovery unit is present in this area.

Sanitary Wastewater

Sanitary wastewater is produced in most major buildings at the SLAC. Main sources of sanitary wastewater include lavatories, drinking water fountains, sinks, and floor drains. The sanitary wastewater effluent combines with the industrial wastewaters previously described and is directed through the WBSD sewer lines to the SBSA treatment plant.

3.3.2.3 Discharges to Surface Waters

To comply with Section 311 of the Federal Water Pollution Control Act (FWPCA) (PL 92-500) as amended, the SLAC is required to prepare and implement a plan to prevent the degradation of surface waters. In accordance with its National Pollutant Discharge Elimination System (NPDES) permit requirements, the SLAC has prepared a Best Management Practices (BMP) Plan for Water Quality which addresses general spill response and mitigation procedures at the facility. It has also prepared a draft Spill Prevention Control and Countermeasure (SPCC) Plan; however, it has not formally adopted or implemented the SPCC Plan in accordance with the FWPCA. These aspects are further discussed in Section 4.2.

Various potential sources of spills and releases exist at the SLAC that could impact San Francisquito Creek, either directly through overland transport or indirectly through the storm drain system. Some of these, such as the cooling tower blowdown or discharges from sumps into the storm drain system, are deliberate, planned discharges; others may be inadvertent. Inadvertent discharges include the following:

- Unbermed drum storage of wastes (see Section 4.1.1);
- Unbermed storage of bulk chemicals (see Section 4.2.1);
- Storage tanks lacking secondary containment and controls (see Section 4.2.1);
- Past and current spill areas (see Section 4.5.1); and

- Leaking operating equipment.

Leaking operating equipment observed during the on-site Survey includes:

- Heavy Fabrication Building (Building 26) - large compressor and pumps leaking oil;
- North of Cooling Tower 1701 - LCW system pump oil leaks;
- Diesel Fueling Area - evidence of extensive spills from the fueling of SLAC vehicles. Soil and pavement around the pump are stained or have accumulations of thick tar-like oil on the surface;
- Helium Compressor Building (Building 127) - stained soil, and equipment leaking vacuum pump oil, compressor oil, diesel fuel, and oily sludges;
- Beam Switchyard (BSY) - leaking vacuum pumps; and
- Casting Pad near New Warehouse/Magnet Factory - parts degreaser leaking solvent onto soil (see Section 3.2.2).

Three general sources of potential contamination exist in the form of planned discharges. These include the storm drain system, the cooling towers, and the holding sumps, and are discussed below.

Storm Drain System

Water effluent which discharges into the storm drain system is a combination of the following (SLAC, 1982):

- Cooling tower blowdown;
- Water runoff from SLAC landscaping irrigation;
- Rainwater runoff during the winter; and

- Miscellaneous uses, mainly once-through cooling of various small systems.

The largest potential source of chemical effluents discharged to San Francisquito Creek is cooling tower blowdown, which is discharged into natural open drainage ditches leading to the creek. The cooling towers are further discussed in the following subsection.

As mentioned in Section 3.3.1.2, stormwater at the SLAC is drained by three major natural drainage channels. In addition to the channels near Sector 19 of the LINAC, stormwater runoff is also discharged to drainage pathways north and northeast of the campus area, north of PEP IR-12, southwest of PEP IR-2, south and east of PEP IR-4, and near PEP IR-6 and IR-8. Drainage along the LINAC alignment also flows toward the creek at a number of locations.

Drainage from the SLAC is basically divided along topographic lines, with most slopes going south toward the creek (SLAC, 1985b). A spill in the southern end of the campus area, support complex, or research area will drain into the storm drain system which enters the ditches and leaves the site near IR-6 and IR-8. These drainage channels cross under a flat area now occupied by a horse track and stable, before discharging into the creek (SLAC, 1982). Spills in some storage ring research areas drain to the north and enter the drain near Sand Hill Road (SLAC, 1985b), which flows to the storm drain system of Menlo Park (SLAC, 1982). This system then flows under a shopping center and residential areas to discharge into the San Francisquito Creek north of Sand Hill Road.

The major drainage pathway north of PEP IR-12 does not contain an oil/water separator, nor is it monitored. However, most of the storm drains at the SLAC empty into the lines which discharge at PEP IR-8 and IR-6, which do have oil/water separators. These two separators are discussed in more detail in Section 3.3.3.3.

The sources of wastewater which enter the oil/water separators include stormwater, cooling tower blowdown, and groundwater which seeps into the LINAC gallery and BSY. The latter is discussed in more detail in Section 3.4.1.

There are currently no written procedures to ensure that the oil/water separators are operating properly. A SLAC surveillance crew reportedly checks the separators weekly and performs routine maintenance. During the Survey, however, the separator at IR-8 was clogged with debris for a few days, and the weir was improperly adjusted to allow skimming of the oil from the effluent for routing to the oil/water separator. The debris was removed prior to the conclusion of the on-site Survey activities.

In 1984, the SLAC was cited by the California Department of Fish and Game for one of its construction contractors discharging sediment from construction activities to a drainage ditch and to San Francisquito Creek (SLAC, 1985a). The areas were subsequently cleaned up to the satisfaction of the Department.

Cooling Towers

The SLAC currently employs four cooling towers with a total capacity of 73 MW, to dissipate the heat generated by the LINAC and other experimental equipment (SLAC, 1987a). These towers are of the induced-draft counterflow type, and the primary system in all cases is a closed-loop, low-conductivity system. Tower 101 is located at the Central Utility Building (Building 23) and provides cooling for laboratories and shops of the SLAC campus area. Tower 1201 is adjacent to the LINAC near the western end and is meant to cool the injector, positron source, and the first mile of the LINAC. Tower 1202 is also adjacent to the LINAC, but further east of Tower 1201, and cools the second mile. Tower 1701 is near the BSY and Research Area and provides cooling for these areas (SLAC, 1982). The locations of the cooling towers and their drainage pathways are shown in Figure 3-4.

The cooling tower water is chemically treated with silica and organic algicides. The blowdown water consists of primarily source water whose solutes are concentrated by a factor of four to six times (SLAC, 1982). The cooling tower effluents are subject to control by the California Regional Water Quality Control Board (RWQCB), NPDES Permit No. CA0028398, Order No. 85-36, as discussed in Section 3.3.3.1. Table 3-7 shows a comparison between the concentration of chemicals in cooling water blowdown discharged from the SLAC and Public Health Service drinking water standards, where such standards are applicable. These data show that the water

Source: WESCO, 1987

FIGURE 3-4

COOLING TOWERS
AND ASSOCIATED DRAINAGE PATHWAYS AT THE SLAC

TABLE 3-7
COOLING WATER BLOWDOWN ANALYSES^a

Constituent	Cooling Tower Water Analysis	Public Health Service Drinking Water Standards
Hardness	46	--
Calcium	34	--
Magnesium	12	--
Alkalinity (Methyl Orange)	108	--
Sulfate	12	250
Chloride	7.5	250
Silica	39.2	--
Inorganic Phosphate	2.5	--
Ortho Phosphate	2.2	--
pH (standard units)	8.0	--
Specific Conductance: micro mhos at 18°C	240	--
micro mhos at 25°C	285	--
Copper	0.14	1.0
Zinc	0.2	5.0

Source: SLAC, 1982

^a Figures are in milligrams per liter (mg/L), unless otherwise indicated.

from the cooling towers meets the drinking water standards imposed by the Public Health Service for the parameters shown (SLAC, 1982).

Blowdown frequency and volumes are based on operational needs. Blowdown is automatically controlled by the conductivity of the cooling water. Normally, blowdown occurs once a day at a maximum of about 20 gpm at each cooling tower (James, 1987b). According to SLAC personnel and Betz Laboratories, Inc., their supplier, chromates have never been used in any of the facility's cooling towers.

The blowdown from all four cooling towers eventually discharges to San Francisquito Creek. The blowdown from Tower 1202 is discharged to a drainage channel which flows north under the LINAC for about 1/2 mile and discharges through a polyvinyl chloride (PVC) pipe to a drainage ditch north of Sector 22, then loops to the west and back underneath the LINAC and flows toward San Francisquito Creek. The blowdown from Towers 101 and 1701 is combined prior to entering the creek, while that of Tower 1201 flows separately toward the creek. The average blowdown flowrate from the cooling towers is currently the following:

Tower Designation	Average Blowdown Flowrate
1201	5,100 gpd
1202	5,000 gpd
101 and 1701 (combined)	16,000 gpd

Source: James, 1987a

Holding Sumps

Various areas at the SLAC contain sumps where potentially contaminated wastewaters are held up prior to or instead of discharging to the storm drain system or drainage ditches. These areas are discussed below.

- Plant Maintenance and Utilities (PMU) Building (Building 35) - A catch basin in front of the outdoor drum storage area leads to a sump. This sump was filled with water during the Survey and is normally pumped out when filled with rainwater.

- PCB Waste Storage Area/Master Substation - There are a number of sumps inside the fenced area where the PCB Waste Storage Area and the Master Substation are located. One sump is in the covered PCB waste storage pad. West of the covered pad is a concrete-lined shallow pit that contains two sumps. In addition, each group of transformers comprising the Master Substation is surrounded by crushed stone with a sump system which is used to remove rainwater. The sumps are pumped out to a natural ditch around the perimeter of the fenced area, which eventually leads to an oil/water separator. If a visible oil sheen or an odor is present, the waters are not released. Spills and potential PCB contamination in this area are discussed in Section 4.5.1.
- Hazardous Waste Storage Area (HWSA) - Two sumps are present in this area. One is a blind sump at the solvent storage bay to contain any leaks from this bermed area. The second sump is located at the southeastern corner of the HWSA. Runoff or any spills in this area drain to this sump and can be discharged to a nearby drainage ditch via an unlocked control valve. This area is further discussed in Section 4.1.1.1.

3.3.3 Environmental Monitoring Program

This section describes the environmental monitoring program at the SLAC for surface waters and effluent wastewaters, including both radiological and chemical parameters. Discussions include monitoring of NPDES requirements, San Francisquito Creek, stormwater, and the sanitary sewer.

3.3.3.1 NPDES Monitoring

As mentioned in Section 3.3.2, the SLAC has an NPDES permit for the discharge of blowdown from its four cooling towers to San Francisquito Creek. An NPDES permit was originally issued to the SLAC on September 30, 1973 by the California RWQCB, San Francisco Bay Region. The current SLAC operations are governed by NPDES Permit Number CA0028398, Order No. 85-36. This permit requires semiweekly sampling of the cooling tower blowdown, weekly sampling of the creek at one upstream and one downstream location, and a quarterly toxicity bioassay of the cooling tower effluent (SLAC, 1987a). The required sample types and frequencies

are summarized in Table 3-8, and the most recent available sampling results are presented along with their regulatory limits in Table 3-9. Sample results for 1986 indicated noncompliance with the limits for oil and grease, phosphate, and toxicity.

The weekly NPDES sampling was observed during the Survey for the cooling tower blowdown and the creek. Sampling was performed by a member of the ESO staff. No written procedures were followed, however, as none exist. The pH meters and strip chart recorders at the cooling towers, as well as the conductivity probes, are cleaned monthly. The pH meters at the cooling towers are adjusted by matching the reading recorded at the tower with that measured in the sample at the SLAC laboratory. Samples are sent to McIntosh Laboratories, Inc., of San Jose for the analyses required by the NPDES permit. No chain-of-custody paperwork is initiated by the SLAC in the field for the transfer of samples from the SLAC to McIntosh Laboratories, Inc., upon pickup by the latter. McIntosh Laboratories, Inc., does, however, initiate chain-of-custody upon sample pickup. Sample locations, shown on Figure 3-5, are as follows:

Sample Designation	Location	Sample Content
E-001	Cooling tower 1201	CT 1201 effluent
E-002	Cooling tower 1202	CT 1202 effluent
E-003	Effluent from oil/water separator south of JR-8	CT 101 and 1701 effluent, stormwater, groundwater from LINAC sectors 22-30 and BSY
C-1	Jasper Ridge	Upstream of SLAC cooling towers
CR-2 (C-R)	Pier Road Bridge off Alpine Road	Downstream of SLAC cooling towers

The SLAC is currently applying for an amendment to its NPDES permit due to the increased discharge expected from its cooling towers as a result of the SLC operation. This is further discussed in the following section.

TABLE 3-8
NPDES SAMPLING REQUIREMENTS

Sampling Stations	E-001, E-002 E-003			C-R, C-1(a)
	Obs	Cont	Grab	Grab
Type sample				
Flow rate (gal/day)	--	M	--	--
Settleable matter (ml/L/hr)	--	--	M(b)	--
Oil and grease (mg/L)	--	--	W	--
Total phosphate (mg/L)	--	--	2/W	W(b)
Total suspended solids (mg/L)	--	--	W	W(b)
Total dissolved solids (mg/L)	--	--	W	W(b)
pH (standard units)	--	--	M	--
Temperature (°C)	--	--	M	M(b)
Toxicity (% survival)	--	--	Q(b)	--
All applicable standard observations	M	--	--	--
Cooling water chemicals (type and lbs/mo added)	M	--	--	--

Source: SLAC, 1987a

Type of Sample

Obs = observation

Cont = continuous sample

Grab = grab sample

Frequency of Sampling

W = once each week

M = once each month

Q = once each quarter

2/W = twice a week

(a) San Francisquito Creek upstream and downstream of discharge points.

(b) To be sampled on days coincident with effluent sampling.

TABLE 3-9
NPDES MONITORING RESULTS(a)

Parameter	Limit	1986 Summary				February 29, 1988, Sampling				
		Value	E-1	E-2	E-3	E-1	E-2	E-3	C-1	CR-2
Daily Flowrate (gal/day)	—	Minimum Maximum	0 40,000	0 34,800	0 72,740	NA	NA	NA	NA	NA
Monthly Flowrate (gal/mo)	—	Minimum Maximum	200 208,300	100 444,600	2,000 864,770	NA	NA	NA	NA	NA
Settleable matter (ml/L/hr)	0.1		<0.1			NA	NA	NA	NA	NA
Oil and grease (mg/L)	5		Range <1 to 9.0(b)			<1	<1	<1	NA	NA
Total phosphate (mg/L)	<20		Range 0.21 to 22.2			12.24	13.77	0.28	<0.03	0.06
Total suspended solids (mg/L) 30-day avg	—		Range <1 to 80			3.8*	2.6*	5.6*	2.4*	3.2*
Total dissolved solids (mg/L) 30-day avg	—		Range 82 to 678			374*	340*	158*	392*	424*
Toxicity (% survival)	90		85-100(c)			NA	NA	NA	NA	NA
pH (units)	6.5 - 8.5		Range 6.5 to 8			NA	NA	NA	NA	NA

Sources: SLAC, 1987a; McIntosh, 1988a

(a) 1986 Data.

(b) Oil and grease values over 5 mg/L are normally seen at the beginning and during the rainy season as storm drains pick up oil and grease from vehicle parking areas.

(c) Toxicity tests on E-001, E-002 and E-003 samples were run in January, April, July, and October of 1986.

* Not 30-day average.

NA - Not Available

Source: WESCO, 1987; Survey/ team observations, 1988

NPDES MONITORING LOCATIONS
AT THE SLAC

FIGURE 3-5

3.3.3.2 San Francisquito Creek Monitoring

In addition to the monitoring currently required by SLAC's NPDES permit, San Francisquito Creek has been monitored as part of two other studies. These include a biological study recently conducted in conjunction with the NPDES permit amendment application, and past environmental monitoring for radioactivity due to SLAC operations. These monitoring programs are as follows.

NPDES Permit Amendment Biological Study

In August 1986, the SLAC applied to the California RWQCB for an amendment to its NPDES permit to allow an increase in the discharge flows from its four cooling towers due to the anticipated operation of the SLC. The operation of the SLC is expected to increase the cooling requirements and blowdown by almost a factor of three (SLAC, 1987a). The California RWQCB and California Fish and Game personnel raised two major areas of concern: the incidence of scouring due to the increased volume and the effects of discharge temperature on the creek. To address these concerns, Western Ecological Services Company (WESCO) of Novato, California, was contracted for a year-round study to determine whether the increased discharge would affect the creek environment. The SLAC must show an enhancement of the creek from the increased discharge in order to be permitted (SLAC, 1987a). Quarterly reports were submitted to the California RWQCB and Fish and Game, and a final summary report was to be submitted in November 1987. The final summary report was not yet available at the time of the on-site Survey.

Preliminary results obtained from the quarterly reports indicate that the creek is nitrate-dependent rather than phosphate-dependent. The phosphorus level in a water sample from a cooling tower was 35 times the phosphorus concentration of the stream, i.e., the phosphorus levels in the creek show little evidence of input from the cooling tower discharges (WESCO, 1987). The effects of cooling tower water discharge temperature and flow volume on the creek are currently not available pending the submission of the WESCO final summary report to the SLAC.

Past Environmental Monitoring

Upon start-up of its activities in 1966, the SLAC instituted an environmental monitoring program that included surface water sampling of San Francisquito Creek. Samples were analyzed for gross beta, gross beta-gamma, and tritium activity. Available background data and sample results are given in Table 3-10. Based on these and similar results obtained throughout the years, SLAC personnel determined that its operations were not having any significant impact on the environment due to radiological contaminants (Convisor, 1966; ERDA, 1976; SLAC, 1972). Environmental monitoring of the creek was therefore discontinued in approximately the late 1970s (SLAC personnel, 1988). No data are available for any nonradiological parameters for the creek other than the NPDES monitoring results and indicator parameters gathered as a result of the permit amendment application discussed in the previous section.

3.3.3.3 Stormwater Monitoring

Stormwater from the SLAC exits the facility both to the north and to the south, as discussed in Sections 3.3.1.2 and 3.3.2.3. The majority of stormwater which exits to the south flows through two oil/water separators prior to flowing off-site. As shown on Figure 3-6, these stations are Environmental Monitoring Station (EMS)-2 and EMS-3, located near PEP IR-8 and IR-6, respectively. The sanitary sewer station, EMS-1, is discussed in the following section. EMS-2 is also sampled as part of the NPDES permit requirements, as discussed in Section 3.3.3.1.

Continuous monitoring stations for stormwater were first put into operation in the summer of 1971 (ERDA, 1976). The stations operated such that a pump continuously sampled the effluent at a rate of 5 milliliters per minute (mL/min), and the samples were stored in drums. Every quarter, the drum contents were composited and a 1-liter sample removed for chemical-radiological analysis. The sampling rate was constant, independent of the flowrate. Measured flowrates reportedly ranged from 25-120 gpm (SLAC, 1982). This wide range is due to the variation in the LINAC operating schedule, rainfall, and seasonal seepage. In September 1980, the stormwater sampling stations were relocated to the locations shown in Figure 3-6 due to PEP construction (SLAC, 1982). The exact locations of the stations previously used are not known.

TABLE 3-10

SAN FRANCISQUITO CREEK RADIOLOGICAL MONITORING RESULTS

Sample Location	Date	Gross Beta-Gamma Activity (pCi/L)	Tritium (pCi/L)
Background Samples:			
Creek Water (filtrate and solid)	3/66	13	$\leq 5 \times 10^3$
San Francisquito (SF) Creek	6/66	6	$\leq 5 \times 10^3$
Lake Lagunita	6/66	88	$\leq 5 \times 10^3$
SF Creek Stream Silt (pCi/gm)	3/66	23	--
Sample Results:			
Surface Water(1)	7/71-12/71	$\leq 5-9$	$< 3 \times 10^3$
Surface Water(2)	1971	10-23	$< 3 \times 10^3$
Stream Silt as Soil (pCi/gm)(1)	1971	32-36	--
Surface Water(2)	1/73-12/73	$\leq 5-34$	$< 3 \times 10^3$
Stream Silt as Soil (pCi/gm)(3)	1/73-12/73	24-28	--

Sources: Convisor, 1966; ERDA, 1976; SLAC, 1972

- (1) - Gross beta activity, based on 2 samples
 (2) - Gross beta activity, based on 4 samples
 (3) - Gross beta activity, based on 3 samples

Sources: SLAC, 1982

FIGURE 3-6

STORMWATER AND SANITARY SEWER MONITORING STATIONS AT THE SLAC

The SLAC currently does not monitor its stormwater discharges except for EMS-2, as mentioned previously, in conjunction with the NPDES permit. The exact date when the SLAC ceased monitoring stormwater is unknown. However, past radiological analyses of stormwater are available. Results for 1971, 1973, 1975 and 1976 are summarized in Table 3-11. According to SLAC personnel, operations during the mid-1970s were at their highest; therefore, any radioactivity detected during that period should represent the highest activity to be expected under normal operations. Since levels detected during that time were near background levels and within established guidelines, SLAC personnel eventually discontinued monitoring of the stormwater some time subsequent to this period. Operation of the SLAC will result in increased energies due to the required upgrade of the klystrons. As a result of the potential for increased radioactivity from the BSY and the research yard beam dumps of ESA and End Station B (ESB) (Building 62), SLAC currently plans to reinstitute monitoring at the oil/water separators at IR-8 (EMS-2) and IR-6 (EMS-3) in the near future for radioactivity.

3.3.3.4 Sanitary Sewer Monitoring

A continuous sanitary sewer monitoring station was placed into operation in the summer of 1971, and operates identically to the stormwater monitoring stations described in the previous section (ERDA, 1976). This station was also relocated in September 1980 due to PEP construction (SLAC, 1982), and the current location is north of PEP IR-12, as shown on Figure 3-6. This is the main sanitary sewer outfall currently in use for SLAC wastewaters. A second outfall, located along Alpine Road, receives wastewaters from the New Warehouse/Magnet Factory, PEP IR-4, IR-6, IR-7, and IR-8 (SLAC, 1988d). This connection only receives a small amount of domestic wastes, and no process or cooling water from the SLAC (SLAC, 1987a); therefore, it is not monitored. SLAC personnel indicate that some craft shops may be put in the old Magnet Factory, which would then require monitoring of this outfall as well.

Normally, the main sanitary sewer station is monitored quarterly by SBSA for compliance with the discharge limits shown in Table 3-12. Grab samples are also obtained monthly by SBSA for the same parameters. West Bay Sanitary District (WBSD) operates the flowmeter station for sanitary wastewaters. The sanitary sewer has not been monitored by the SLAC since 1984 due to SLC construction. The

TABLE 3-11

STORMWATER RADIOLOGICAL MONITORING RESULTS

Sample Date	No. of Samples	Gross Beta Activity (pCi/L)	Tritium (pCi/L)
7/71 - 12/71	Composite	13	<3000
1/73 - 12/73	Composite	≤ 4	<3000
1/75 - 12/75	3(a)	3-10	NA
7/20/76	NA	$\leq 18(b)$	≤ 6000
9/29/76	NA	$18 \pm 8(b)$	≤ 6000
12/29/76	NA	$12 \pm 7(b)$	≤ 6000

Sources: SLAC, 1972, 1976; ERDA, 1976; Hughes, 1977

NA - Not available

a - 1 aliquot sample from 2,000-liter volume

b - Gross beta-gamma activity

TABLE 3-12

**CHEMICAL AND RADIOLOGICAL SANITARY SEWER
DISCHARGE LIMITS AND MONITORING RESULTS (1984)**

Species	Discharge Limit (mg/L)*	Result (mg/L)
Arsenic	0.1	<0.01
Cadmium	0.2	0.01
Chromium (total)	0.5	0.07
Copper	2.0	0.18
Cyanide (total)	1.0	<0.005
Lead	1.0	0.23
Mercury	0.01	0.0014
Nickel	1.0	0.06
Silver	0.2	0.03
Sulfides (dissolved)	0.1	0.2
Zinc	3.0	0.99
Oil or grease, animal or vegetable origin	300	NA
Oil or grease, mineral or petroleum origin	100	NA
Chlorinated hydrocarbons	0.02	ND
Phenolic compounds	1.0	<0.01
Temperature (°C)	<65	NA
pH (standard units)	>6.0	NA
Organochlorine pesticides	NA	ND
Polychlorinated biphenyls	NA	ND
Gross Beta (pCi/L)	NA	20.4 ± 4.1
Tritium (pCi/L)	NA	6000 ± 1000

Sources: SLAC, 1984-1985, 1985a, 1987a

* Units are in mg/L unless otherwise noted.

NA - Not Available

ND - None detected; detection limits range from 0.01 to 0.4 mg/L depending on species.

SLAC plans to reinstitute radiological monitoring of the sanitary sewer in the near future. SBSA last sampled the sewer in November 1987.

The most recent complete set of sampling results is that for 1984 and consists of both chemical and radiological parameters. These data are also given in Table 3-12. All chemical constituents available are below the SBSA sewer standards except for sulfides (i.e., 0.2 milligram per liter [mg/L] measured vs. 0.1 mg/L standard). Analyses for pesticides and PCBs were also conducted but none were detected. Radiological parameters were near background levels. In the past, however, violations of limits were noted for copper, silver, cyanide, and pH.

During 1984, 0.063 curie of tritium was discharged via the sanitary sewer (SLAC, 1985a). Although the source of this wastewater is not specified, it is believed to be from leaks in the primary cooling water system in the BSY. The DOE DCG for the release of tritium to the sanitary sewer is 2 million picocuries per liter (pCi/L) (SLAC, 1985a). Typically, 42 million liters per year (L/yr) was released to the sanitary sewer for the 1984 time period (SLAC, 1985a); therefore, up to 84 curies per year (Ci/yr) of tritium is allowed to be disposed of via the sanitary sewer. SLAC's value for 1984 is only 0.075 percent of this guideline.

The most recent set of data is for inorganic analyses conducted in August 1987. These data are given in Table 3-13. Values for all parameters shown are less than the established limits. Past data for gross beta-gamma activity and tritium in the sanitary sewer samples for 1971, 1975, and 1976 all show the same order of magnitude of activity as the 1984 results (SLAC, 1972, 1976; Hughes, 1977).

3.3.4 Findings and Observations

3.3.4.1 Category I

None

3.3.4.2 Category II

None

3.3.4.3 Category III

1. Potential contamination of storm sewer discharges. There is a potential for storm sewer discharges to be contaminated from past and current spills from vacuum pump oil, compressor oil, diesel fuel, and oily sludges from SLAC operating equipment, particularly at the Helium Compressor Building (Building 127). Contamination of the storm sewer may result in contaminants being transported to San Francisquito Creek with subsequent off-site migration.

During the Survey, various actual and potential sources of contamination of the storm sewer system were noted at the Helium Compressor Building of the SLAC Research Area. This building is a "Butler" building which has no containment or method to prevent seepage of fluids outside of the building between the floor and walls. Inside the building, leaking vacuum pumps without containment were located on the floor. A diesel generator was within a diked area which contained approximately 6 inches of oily sludges. There was evidence that the dike leaked, as stains were present outside the building to the southeast. Although this area is paved, runoff could potentially reach the storm sewer which is located about 2 feet from the residual oil. Compressors and other leaking equipment, especially outdoors and north of the building, also have the potential to contaminate the storm sewer system. Leaking equipment (i.e., vacuum pumps) at the BSY was also observed during the Survey.

Survey-related sampling and analysis is planned to determine whether any contaminants are reaching San Francisquito Creek via discharges from the storm sewer system.

3.3.4.4 Category IV

1. Insufficient effluent monitoring. There is insufficient effluent monitoring to assess the off-site impacts of discharges of chemical or radiological contaminants through the sanitary and storm sewer systems. The lack of monitoring may result in contaminants going undetected to the SBSA treatment plant or to San Francisquito Creek.

3.3.4.3 Category III

1. Potential contamination of storm sewer discharges. There is a potential for storm sewer discharges to be contaminated from past and current spills from vacuum pump oil, compressor oil, diesel fuel, and oily sludges from SLAC operating equipment, particularly at the Helium Compressor Building (Building 127). Contamination of the storm sewer may result in contaminants being transported to San Francisquito Creek with subsequent off-site migration.

During the Survey, various actual and potential sources of contamination of the storm sewer system were noted at the Helium Compressor Building of the SLAC Research Area. This building is a "Butler" building which has no containment or method to prevent seepage of fluids outside of the building between the floor and walls. Inside the building, leaking vacuum pumps without containment were located on the floor. A diesel generator was within a diked area which contained approximately 6 inches of oily sludges. There was evidence that the dike leaked, as stains were present outside the building to the southeast. Although this area is paved, runoff could potentially reach the storm sewer which is located about 2 feet from the residual oil. Compressors and other leaking equipment, especially outdoors and north of the building, also have the potential to contaminate the storm sewer system. Leaking equipment (i.e., vacuum pumps) at the BSY was also observed during the Survey.

Survey-related sampling and analysis is planned to determine whether any contaminants are reaching San Francisquito Creek via discharges from the storm sewer system.

3.3.4.4 Category IV

1. Insufficient effluent monitoring. There is insufficient effluent monitoring to assess the off-site impacts of discharges of chemical or radiological contaminants through the sanitary and storm sewer systems. The lack of monitoring may result in contaminants going undetected to the SBSA treatment plant or to San Francisquito Creek.

Currently, no sampling or assessment of potential source terms is being performed for the sanitary sewer (radiological parameters) or storm sewer systems to determine whether contaminants are being released. The SLAC does not have any written procedures to prohibit disposal of wastes via these systems. Evidence of prior disposal of hazardous chemicals to the sanitary sewer system exists based on past sanitary sewer monitoring data; exceedances for copper, silver, cyanide, and pH have been noted. The Survey noted locations where potentially hazardous substances were or potentially could be discharged to these systems. These areas are listed in Table 3-14. Additional evidence of poor management practices for bulk chemical and waste storage is given in Sections 4.2.1 and 4.1.1, respectively.

2. Lack of oil/water separator maintenance and surveillance procedures. There are no written procedures to ensure that routine maintenance and surveillance are performed on oil/water separators. This lack of written procedures may result in the release of inadequately-treated wastewaters to the creek or to the sanitary sewer, which could result in negative impacts on the environment and/or the local sewage treatment plant.

The two oil/water separators for storm sewer effluent discharge to San Francisquito Creek. During the Survey, the oil/water separator at IR-8 was not operating properly due to debris clogging the inlet pipe and an improperly adjusted weir. The debris was removed prior to the conclusion of the on-site Survey activities by a member of the SLAC surveillance crew. The Motor Pool oil/water separator at the General Services Building discharges to the sanitary sewer. SLAC ESO personnel stated that building personnel call ESO when the sump collecting the oil becomes full and must be pumped out and disposed of as hazardous waste. No written procedures are maintained to specify the frequency at which routine maintenance and surveillance should occur at these units, to specify the proper procedures to be followed for these tasks, or to document observations and maintenance functions which are actually performed. Failure to adequately maintain these units by following written procedures may result in inadequate operation of the units, with subsequent off-site discharge of inadequately-treated wastewaters.

TABLE 3-14

DISCHARGES TO THE SANITARY AND STORM SEWER SYSTEMS

Building/Area	Location	Effluent
Sanitary Sewer:		
Buildings 1 and 2	Accelerator/Klystron Gallery	Groundwater seepage, heat exchanger leaks
Building 24	Polishing machine for copper	Filtrate
Building 24	Photoprocessing area	Aqueous solutions from development
Building 24	Silk screenings	Solvents washed off to sink
Behind Building 25	Cleaning pad	Large equipment washing
Building 30	Aluminum parts cleaning	Carryover/tapwater rinses
Building 35	Paint shop	Latex paint brush washings
Building 40	Physical electronics lab	Acids (neutralized w/ CaCO_3 - pH not monitored)
Building 40	Physical electronics lab	Sand blast and paint-spray materials
Building 40	Physical electronics lab	Potential from cardboard box on floor near drain w/ gear oil, mineral spirits, vacuum pump wastes (5, 5-gal containers)
Building 81	Motor pool pump	Oil/water separator effluent (water)
Building 131	Biotechnology lab (Rm 209)	Diluted acids
Building 131	Biotechnology lab (Rm 214)	Photoprocessing solutions
DI/LCW Plant	Near Building 25	Regenerant solutions
Misc.	Holding tanks (rad)	Rad wastewater from beam dump and cooling water systems, heat exchangers/ion exchangers
Storm Sewer:		
Building 26	Leaking compressor and pumps	Oils
LCW System	Pumps north of CT 1701	Oils
Diesel Fueling Area	Fuel pump	Diesel fuel

TABLE 3-14**DISCHARGES TO THE SANITARY AND STORM SEWER SYSTEMS (Continued)**

Building/Area	Location	Effluent
Building 127	Leaking equipment indoors/outdoors southeast of building	Stain (oils/fuel) leading to sewer
Building 127	Outdoor leaks of vacuum pumps north of building	Oils
Beam Switchyard	Leaking vacuum pumps	Oils
Casting Pad near Building 15	Leaking parts degreaser	Solvent

Source: Survey team observations

3. Lack of NPDES monitoring procedures. There are no written procedures for effluent sampling at the NPDES monitoring locations to ensure the validity of the analytical data generated as a result of sampling.

The lack of written procedures to follow for sampling may lead to inaccurate results due to improper or inconsistent sampling methods. SLAC personnel collecting the samples did not establish chain-of-custody in the field at the time of sampling, which may result in questionable data. The method of calibrating the pH meter at the cooling towers is also questionable.

PRELIMINARY

3.4 Hydrogeology

3.4.1 Background Environmental Information

3.4.1.1 Geology

Physiographic Setting

The Stanford Linear Accelerator Center (SLAC) is located on the western edge of a structural depression of Late Tertiary age that forms San Francisco Bay. The bay is located within the California Coastal Ranges geomorphic province, which is characterized by northwest-trending low mountain ranges extending along the length of northern and central California. The Coastal Ranges are composed of deformed and metamorphosed Mesozoic-age marine sedimentary and volcanic rocks of the Franciscan assemblage.

Regional Geology

The geology of the region surrounding the SLAC facility consists of a complex of igneous, metamorphic, and sedimentary rocks as shown in Figure 3-7. Igneous rocks were formed by solidification from a molten or partially molten mass. Metamorphic rocks include all those rocks that were formed in response to changes in temperature, pressure, and chemical environment which are associated with crustal deformation. Sedimentary rocks were formed by the accumulation of rock particles and the remains of plants and animals in rivers, lakes, and oceans or by chemical precipitation in marine and freshwater environments (Sokol, 1963; Skjei et al., 1965).

The Franciscan assemblage, the oldest and most extensive bedrock unit, was deposited from 180 to 70 million years ago during Jurassic to Cretaceous time in a marine environment. Extensive tectonic activity uplifted and folded the Franciscan sedimentary and volcanic rocks, creating mountain ranges and broad shallow basins into which both continental and marine sediments were deposited. Gradual downwarping of the region created shallow depressions where younger sediments including lava flows were deposited. Sea level changes during glacial stages

GEOLOGIC MAP OF THE SLAC AREA

FIGURE 3-7

resulted in the deposition of a variety of recent sediments in San Francisco Bay (Sokol, 1963; Skjei et al., 1965).

Extensive faulting has occurred during the geologic history of the San Francisco Bay region. Enormous compressional forces, developed by the collision between the continental and oceanic crustal plates, uplifted, folded, and faulted the rocks of the ancestral Franciscan depositional basin. The result is a heterogeneous mixed zone containing competent rock in a matrix of highly sheared and crushed rocks. Although most of this tectonic activity has decreased, the San Francisco Bay Region, as well as most of California, is still seismically active (Sokol, 1963). A number of faults, notably the San Andreas and the Hayward, continue to generate earthquakes, some of which are of sufficient magnitude to cause extensive damage in heavily populated areas (USGS, 1988).

Site Geology

Bedrock beneath the SLAC consists of Eocene-age rock in the western portion of the site and Miocene-age rock in the eastern portion. Overlying these rocks are the sands and gravels of the Santa Clara Formation and Recent terrace and stream channel alluvial deposits. A cross-section of the site geology is shown in Figure 3-8.

Eocene Rocks

Sandstone and claystones of Eocene age (40-50 million years ago) are marine in origin. They have been divided into two groups, the rocks of "normal" deposition and those of "chaotic" deposition (Skjei et al., 1965). The "normal" deposits consist of light to dark gray, blue-gray, and green-gray poorly sorted sandstones, and massive siltstones and claystones. They are characterized by an ordered bedding sequence.

Rocks of "chaotic" depositions are described as disoriented masses of claystone and siltstone resulting from the gravity displacement of normally deposited Eocene or pre-Eocene rock as a result of folding or faulting (Skjei et al., 1965).

FIGURE 3-8

CROSS-SECTION MAP OF BEDROCK GEOLOGY ALONG
LINEAR ACCELERATOR ALIGNMENT

Miocene Rocks

Miocene (20-40 million years old) bedrock consists of very fine to medium marine sandstone with interbedded claystone. The sandstones are poorly cemented, well-sorted, and often silty. Jointing is well developed and runs north-northwest. Color bands along joint sets, which were produced by the infiltration of groundwater, are easily confused with bedding planes. Clay is commonly observed in fractures in the sandstone units (Ecology & Environment, Inc., 1985).

Santa Clara Formation

Reddish-brown sandstones, siltstones, and gravels derived from earlier deposited rocks represent the Santa Clara Formation and are of Pliocene-Pleistocene age (7-10 million years old). They were deposited by rivers and streams on floodplains and deltas and range in thickness from 7 feet to 23 feet across the site. The contact with the older Miocene sandstone near Station 90+00 of the Linear Accelerator (LINAC) centerline is a north-northeasterly-striking fault (Skjei et al., 1965).

Recent Alluvial Deposits

Recent alluvial deposits are limited in areal distribution and thickness. They are confined to the gravel, which forms a well-defined terrace on the north side of San Francisquito Creek, and sands and gravels that are deposited in the bottoms of the ephemeral streams that flow through the SLAC site (Skjei et al., 1965).

Seismicity

Severe deformation occurred in the SLAC area during the Tertiary period. Complex faulting is typical of the older Eocene deposits in the southwest portion of the SLAC area. Complex folding also occurred during the lower and upper Eocene epoch. In contrast, the younger Miocene rocks are gently folded. During the Pliocene and Pleistocene, faulting was the predominant process of crustal deformation.

The western end of the LINAC is less than 1 mile from the San Andreas Fault Zone. There is a potential for an earthquake of magnitude 6.5 to 8.5 to occur in this part of the San Andreas Fault Zone (SLAC, 1982).

3.4.1.2 Hydrogeology

Groundwater at the SLAC site occurs in both alluvial deposits and bedrock. The water table surface roughly parallels the topographic surface and is approximately 30 feet beneath the topographic highs and 10 feet beneath the surface in the vicinity of San Francisquito Creek. Fluctuations of groundwater levels occur in direct response to seasonal precipitation, with high levels occurring in late spring and low levels in the fall. Maximum fluctuations in alluvial deposits are about 10 feet and only a few feet in the bedrock (Sharp, 1965). Flow in the alluvial deposits is through the porous matrix, while flow in bedrock is primarily along fractures and joints.

A topographic high north of the LINAC alignment roughly coincides with Sand Hill Road and is possibly a groundwater divide. Groundwater from a distance of 250 to 2,000 feet north of the LINAC alignment flows to the south-southeast toward San Francisquito Creek. This area represents the majority of the SLAC site. North of the divide, flow is to the north. Water-level measurements from testholes drilled into bedrock south of the LINAC alignment indicate that artesian conditions exist, which suggests that the bedrock aquifer may be confined in localized areas. Thus, groundwater flow in the bedrock is toward San Francisquito Creek and downstream with a portion of the flow discharging laterally and upward into the alluvial deposits along the stream channel (Sharp, 1965).

Flow reversal occurs between the alluvial deposits and the stream channel based on seasonal changes in rainfall and subsequently, the amount of runoff entering the creek. During periods of low runoff, the predominant groundwater flow is from the alluvium into San Francisquito Creek. During periods of high runoff, the shallow hydraulic gradient reverses such that water from the creek infiltrates into the alluvium. The overall flow direction in the alluvium follows the north-northeast direction of the stream channel (Sharp, 1965).

Groundwater levels and flow conditions at the SLAC site have been altered by the construction of the LINAC and its associated facilities. A subdrain is located in the base of the LINAC and the Beam Switchyard (BSY). The system serves to collect peak groundwater flow during periods of high precipitation. Spaced along the LINAC alignment are four outfalls that discharge the collected groundwater to the storm

drainage system. During periods of normal low flow, only the subdrain system at the eastern end of the LINAC alignment actively diverts groundwater away from the structure. During high flow periods, the entire subdrain system may actively divert groundwater away from the structure. A comparison of the water table contour map prepared by Sharp for a period of average groundwater conditions before construction of the LINAC (Figure 3-9) and probable water table contours after construction (Figure 3-10) clearly shows the influence of the subdrain system. There is a decrease in the hydraulic gradient south of the east end of the LINAC alignment, a slight northward shift of the groundwater divide north of the BSY, and lowering and flattening of the groundwater surface north of the east end of the alignment (Sharp, 1965).

In addition to the LINAC and BSY subdrain system, two other major facilities have been built at the SLAC which may affect the local groundwater flow. In 1980, construction of the Positron Electron Project (PEP) storage ring was completed and in 1987, the major construction activities for the SLAC Linear Collider (SLC) were completed. Both of these facilities are housed in tunnels. The depth of the SLC tunnel ranges from 34 to 90 feet below the existing site topography (SLAC, 1982). The presence of these tunnels has likely affected the local hydrogeologic regime on the SLAC facility; however, the SLAC has not characterized the nature of these changes or the extent of influence that these tunnels may have on the local groundwater conditions.

3.4.1.3 Groundwater Use

In 1963, an inventory of the wells in the San Francisquito Creek hydrologic basin was compiled and indicated that numerous wells were used in the area for municipal, domestic, and irrigation purposes (Sokol, 1963). A more recent well inventory was completed in 1985, in association with a study of a leaking underground storage tank (UST) at the SLAC. This inventory focused on actively used wells within a 3-mile radius of the leaking UST. Six wells were identified through this inventory (Ecology & Environment, Inc., 1985).

Three of the wells are located on the Webb Ranch, which is immediately south of San Francisquito Creek near its confluence with Los Trancos Creek. Based on both the 1963 and 1985 inventories, there have been nine wells drilled at Webb Ranch

FIGURE 3-9

GROUNDWATER POTENTIOMETRIC MAP
 BEFORE CONSTRUCTION OF THE LINAC

FIGURE 3-10

GROUNDWATER POTENTIOMETRIC MAP
AFTER CONSTRUCTION OF THE LINAC

Source: Sharp, 1965

ranging in depth from 12 to 28 feet. Some of the wells were recorded as being abandoned in 1963 and based on the most recent inventory, only three of the wells remain in use. The 1985 study reported that the three wells are used for both domestic and irrigation purposes; however, SLAC personnel indicated that the wells were actually only used for irrigation. The wells are reportedly located close to San Francisquito Creek. Overall, the creek serves as a groundwater discharge area between the SLAC facility and the hills located south of the creek (Sokol, 1963; Ecology & Environment, Inc., 1985). However, considering the close proximity of the Webb Ranch wells to San Francisquito Creek, the hydraulic relationship between the wells, the creek, and groundwater in the alluvium beneath the creek is unclear. There are no site-specific data available to assess the hydrology in this area. In addition, Webb Ranch also withdraws water directly from San Francisquito Creek when the flow is sufficiently high to allow pumping.

The other three wells are owned and operated by Stanford University. These wells are located between 2 and 3 miles northeast of the SLAC facility and are 320, 575, and 828 feet deep, respectively. According to the log of the 828-foot well, these wells are drilled into the Pressure Zone which is part of the alluvial fan underlain by confined aquifers (Sokol, 1963). The wells are only used for emergency back-up purposes for both domestic and irrigation supplies (Ecology & Environment, Inc., 1985).

Low storage coefficients, poor hydraulic conductivity, and fractures that are too widely spaced make the bedrock aquifer generally inadequate for even a one-family domestic water supply. Small, seasonal water level fluctuations and high total dissolved solids concentrations [240 to 6,600 parts per million (ppm)] indicate poor interconnection between alluvial deposits and saturated bedrock fracture zones (Sokol, 1963).

The SLAC domestic water is furnished by the Menlo Park Municipal Water Department (MPMWD), whose source is the City of San Francisco operated Hetch-Hetchy Aqueduct System from reservoirs in the Sierra Nevada. The SLAC and the neighboring development of Sharon Heights receive water from a separate independent system within the MPMWD (see related discussion in Section 3.3.1.3) (SLAC, 1987a).

3.4.2 General Description of Pollution Sources and Controls

One known source of groundwater pollution at the SLAC is an underground storage tank (UST) that leaked in the past and was removed, but continues to be the site of remedial activities. Other potential sources of groundwater contamination include surface spills and leaks from past and present site operations.

3.4.2.1 Leaking Waste Solvent Storage Tank

One UST was located west of the PMU Building and used for storage of wastewater generated from the paint shop. The paint shop effluent included various organic solvents, paint thinners, and cleaners discarded as waste. The tank, with an estimated capacity of 3,500 gallons, was in service from 1965 to 1978. In 1983, the tank was pressure-tested and found to be leaking. The tank and a limited amount of contaminated soil were removed in December 1983 (ESO, ND). A site investigation began in January 1984 with the collection of soil samples and the installation of monitoring wells. Methylene chloride, 1,1,1-trichloroethane, and other volatile organic compounds (VOCs) were found in soil and groundwater samples. Additional information on the remediation efforts is provided in Section 4.5.1.2 and further details on the concentration of contaminants identified in the groundwater are provided in Section 3.4.3.

During the on-site portion of the Survey, groundwater elevation measurements made during 1987 were reviewed (Blaine, 1988). The groundwater flow direction calculated from these data is to the northwest. None of the monitoring wells at the site is in a position to intercept contaminants which may be moving away from the site of the soil contamination in groundwater. A discussion of the method used to determine groundwater flow direction is provided in Appendix E.

3.4.2.2 Locations of Known or Suspected Past Spills and Leaks

Chemical contamination of soil has occurred from past spills and leaks at Salvage Yard 1 and the Former Chemical Waste Storage Area. Remedial actions taken at these locations involved soil removal but did not address the potential for chemical contamination of groundwater from these spills and leaks. These two areas are discussed in detail in Section 4.5.1, Inactive Waste Sites and Releases.

Evidence of chemical spills and leaks from present operations at Salvage Yard 2, the Master Substation, the Casting Pad, and the Crafts Shop portion of the Radioactive Waste Storage Area (RWSA) was observed during the Survey. There are no sampling and analysis data to further characterize these probable areas of contamination. Information on the past use of these areas is provided in Section 4.5.1, Inactive Waste Sites and Releases.

3.4.3 Environmental Monitoring Program

3.4.3.1 Historical Environmental Monitoring

There is no program to routinely monitor groundwater quality at the SLAC. Twenty-five groundwater monitoring wells were installed around the SLAC during pre-construction and post-construction hydrogeologic studies. The locations of 19 of the original wells are shown in Figure 3-11. The locations of the remaining six wells could not be determined. The 25 wells were sampled from 1966 to 1978 (SLAC, 1982). Twenty-two of these wells were inadvertently destroyed during construction activities which began in 1979. There is no record to indicate that these wells were properly abandoned to prevent migration of surface contamination into the groundwater. Three wells, W-19, W-23, and W-24, near major beam absorbers, were maintained. The wells were not sampled in 1979, 1980, and 1981 (SLAC, 1986a). During the on-site portion of the Survey, SLAC personnel stated that wells W-19, W-23, and W-24 are no longer sampled.

Seven groundwater monitoring wells and one recovery well were installed at the site of a former leaking solvent UST west of the PMU Building. Samples of groundwater have been collected and analyzed for volatile halocarbons and volatile aromatics.

3.4.3.2 Environmental Monitoring Data

The only historical monitoring data available to the Survey are the results of radiological monitoring of groundwater samples obtained from monitoring wells W-19, W-23, and W-24 in March, August, and November of 1984 (SLAC, 1985). These data are presented in Table 3-15. Three samples from W-24 contained

Source: SLAC, NDA

LOCATION OF MONITORING WELLS

FIGURE 3-11

TABLE 3-15

RADIOLOGICAL RESULTS OF GROUNDWATER MONITORING
AT THE SLAC FOR 1984

Sample Source	Date	pCi/L $\pm 2\sigma$	
		Gross Beta	Tritium (1 x 10 ³)
W-23	3/30/84	25.5 $\pm$ 6.6	0 $\pm$ 1
W-24	3/30/84	103.8 $\pm$ 35.2	11 $\pm$ 1
W-23	8/1/84	5.3 $\pm$ 5.3	0 $\pm$ 1
W-23	11/7/84	6.0 $\pm$ 7.8	0 $\pm$ 1
W-24	8/1/84	47.0 $\pm$ 19.9	10 $\pm$ 1
W-24	11/7/84	55.0 $\pm$ 14.7	15 $\pm$ 1
W-19	8/1/84	10.3 $\pm$ 10.9	0 $\pm$ 1
W-19	11/7/84	7.4 $\pm$ 12.3	0 $\pm$ 1

Source: SLAC, 1985a

elevated concentrations of tritium. All the results were less than the U.S. Environmental Protection Agency (EPA) Drinking Water Standard of 20,000 picocuries per liter (pCi/L) for tritium. According to the SLAC report, the elevated tritium concentrations were attributed to higher-than-normal uranium concentrations in the soil around the well, although the data to support this conclusion were not available during the Survey (SLAC, 1985a).

Groundwater samples have been collected from monitoring wells in the vicinity of the former leaking solvent storage tank west of the PMU Building periodically since 1984. The most recent sampling effort was conducted on January 15, 1988. These samples were analyzed for volatile halocarbons and volatile aromatics. Table 3-16 lists the compounds detected and their concentrations in the samples (Rouse, 1988).

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. Potential for groundwater contamination. Soil and groundwater at several areas on-site are or may be contaminated with hazardous substances from past spills, leaks, or releases. The nature and extent of the contamination, if any, is either unknown or inadequately characterized. The Survey identified the following actual or potential sources/areas of contamination.

- Groundwater is contaminated with VOCs in the vicinity of a recently removed leaking solvent storage tank near the PMU Building. None of the monitoring wells at the site is located directly downgradient, i.e., to the northwest, to adequately determine the extent of the contamination. The SLAC has been working with the California Regional

TABLE 3-16

**CONSTITUENTS IDENTIFIED IN GROUNDWATER SAMPLES
COLLECTED NEAR THE FORMER LOCATION OF THE WASTE
SOLVENT STORAGE TANK**

Constituent* (Units in ppb)	Monitoring Well Designation			
	MW-1	MW-2	MW-7	EM-1
1,1-Dichloroethane	-	-	0.6	1,500
1,1-Dichloroethylene	-	-	4.7	-
1,1,1-Trichloroethane	-	-	-	3,500
Trichloroethylene	-	-	-	420
Methylene Chloride	48	16		

Source: Rouse, 1988

*Constituents listed are only those identified above the analytical detection limit. Samples were collected on January 15, 1988.

Water Quality Control Board (RWQCB) on this and other groundwater issues.

- Soil contamination has been identified at the Former Chemical Waste Storage Area and Salvage Yard 1. Past practices at each of these areas resulted in polychlorinated biphenyl (PCB) contamination of soils. At Salvage Yard 1, lead contamination was also detected. The SLAC has conducted cleanup at both areas which included soil removal. During the cleanup, the SLAC did not analyze for other possible contaminants in soil. Also, the potential for groundwater contamination was not investigated.
- Soil and groundwater at Salvage Yard 2 are potentially contaminated. Past spills and leaks of chemicals have not been completely characterized at Salvage Yard 2. An investigation of the site has not been undertaken to assess the potential for groundwater contamination from spills and leaks; however, soil samples have been collected and analyzed for PCBs.
- Potential contamination exists at the Casting Pad, Master Substation, and the Crafts Shop portion of the RWSA. Past leaks and spills of chemicals in these areas have not been characterized. Investigations of these sites have not been undertaken to assess the potential for groundwater contamination from these spills and leaks.

3.4.4.4 Category IV

1. Lack of comprehensive groundwater monitoring program. The lack of a comprehensive groundwater monitoring program precludes an accurate assessment of past and present environmental impacts of SLAC operations. There is evidence of soil contamination from past practices resulting in elevated levels of PCBs, lead, and tritium in localized areas. The potential for groundwater contamination by these and other contaminants has not been assessed.

The SLAC facility does not use groundwater for drinking water or irrigation. The direction of groundwater flow is south-southeast toward San Francisquito

Creek. In addition, groundwater is discharged to surface water at the SLAC via a subdrain system constructed along the LINAC. This may result in any contaminants present in the groundwater being transported to San Francisquito Creek and subsequently off-site.

The closest off-site wells are located on the south side of San Francisquito Creek at Webb Ranch. These three wells are used for irrigation and based on a well inventory compiled in 1963, the wells at Webb Ranch have typically been drilled to depths ranging from 12 to 28 feet. The hydraulic connection between these wells, the creek, and groundwater in the alluvial deposits is unclear considering that the wells are reportedly located close to the creek.

2. Abandoned wells or destroyed monitoring wells. Monitoring wells installed for the initial hydrogeologic study of the SLAC were inadvertently destroyed during the construction of the LINAC and subsequent projects. These wells were not properly sealed and may be potential conduits to groundwater for surface spills of contaminants.

4.0 NON-MEDIA-SPECIFIC FINDINGS AND OBSERVATIONS

This section discusses findings and observations pertaining to waste management, toxic and chemical materials, direct 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 one medium as was the case with the discussions in Section 3.0. The discussions include an environmental monitoring program section where appropriate and where information was available.

4.1 Waste Management

Activities at the Stanford Linear Accelerator Center (SLAC) generate a variety of solid and liquid wastes. Type of wastes generated at the SLAC are:

- Hazardous wastes -- solid and liquid wastes that contain hazardous constituents. Management and disposal of these wastes are regulated under California Hazardous Waste Management Regulations, which are used to implement the requirements of Subtitle C of the Federal Resource Conservation and Recovery Act (RCRA).
- Radioactive wastes -- wastes that contain radioactivity. Because these wastes are generated at a U.S. Department of Energy (DOE) facility, they are not subject to U.S. Nuclear Regulatory Commission (NRC) regulations, but are regulated by internal DOE Orders.
- Radioactive mixed wastes -- wastes that display characteristics of both hazardous and radioactive wastes. These wastes are subject to regulation by California Hazardous Waste Management Regulations as well as by DOE Orders.
- Solid wastes -- wastes that do not contain regulated amounts of hazardous or radioactive materials. Handling and disposal of these wastes are regulated by California Solid Waste Management Regulations.

Discussions of the generation and management of each of these waste categories follow. Unless otherwise referenced, descriptions of facilities and wastes are based on observations made during the Survey.

4.1.1 General Description of Pollution Sources and Controls

4.1.1.1 Hazardous Waste

General hazardous waste management practices at the SLAC include on-site accumulation at the point of generation, on-site storage at a less-than-90-day storage facility, off-site disposal of containerized wastes and bulk liquids, and on-site treatment of hazardous wastewaters. The total amounts of hazardous wastes shipped from the SLAC during 1986 and 1987 are summarized in Table 4-1.

Sources and Types of Hazardous Wastes

Major sources of hazardous wastes at the SLAC include:

- maintenance shops and facilities, which generate waste oils and solvents;
- fabrication, assembly, and testing shops, which generate waste oils, solvents, corrosives, plating wastes, and polychlorinated biphenyl (PCB) wastes;
- the Linear Accelerator (LINAC), which generates corrosive wastes and waste oils and solvents;
- research laboratories and support shops, which generate waste reagent chemicals, solvents, oils, and corrosives;
- experimental areas and support shops, which generate waste oils and solvents; and
- remedial action activities, which generate contaminated soil.

TABLE 4-1

**SUMMARY OF HAZARDOUS WASTE SHIPPED FROM THE SLAC
DURING 1986 AND 1987**

Waste Type	Tons Shipped During 1986	Tons Shipped During 1987
Hazardous Waste Liquid, N.O.S.	26.92	43.2
Hazardous Waste Solid, N.O.S.	234.66	227.4
Alkaline Liquid, N.O.S.	398.18	3.4
Acid Liquid, N.O.S.	254.95	95.5
Corrosive Liquid, N.O.S.	0.47	37.8
Corrosive Solid, N.O.S.	N.R.	0.2
Combustible Liquid, N.O.S.	2.91	0.22
Flammable Liquid, N.O.S.	0.88	3.1
Flammable Solid, N.O.S.	N.R.	0.4
Cyanide Solution, N.O.S.	0.94	N.R.
Painting Waste	2.08	N.R.
Waste Alcohol	2.79	1.5
Waste 1,1,1-Trichloroethane	3.14	4.2
Waste Acetone	0.43	0.4
Waste Benzene	N.R.	0.15
Waste Fuel Oil	N.R.	0.22
Waste Gasoline	N.R.	0.22
Waste Oil	34.94	11.6
Solid PCB Hazardous Waste	N.R.	1.25
Liquid PCB Hazardous Waste	N.R.	24.13
Waste PCB	44.03	22.7
Lab-Pack Wastes (Poison Solids, Flammable Liquid, Corrosive Liquid, Poison B Liquid, Acid Liquid, Poison Solid Corrosive, Combustible Liquid, Oxidizer)	1.68	N.R.
Waste Gasoline Tank	N.R.	0.004

Source: Wong, 1988a

N.O.S. = Not Otherwise Specified

N.R. = None reported to be generated in this year

More detailed discussions of hazardous waste generation and management practices for each of the above sources follow.

Maintenance shops and facilities at the SLAC are used to maintain the buildings and equipment at the site. Major facilities are the Plant Maintenance and Utilities (PMU) Building (Building 35), the General Services Building (GSB or Building 81), the Sand Blast Facility (Building 126), and the Casting Pad. The PMU Building includes a number of shops used by electricians, painters, carpenters, and machinists. The main sources of hazardous wastes are painting waste and solvents from the Paint Shop, with minor amounts of waste solvents generated at other shops. The Sand Blast Facility, associated with the PMU Building, is used to clean large metal parts prior to painting. Waste blasting sand is generated from that facility, but is not considered hazardous waste.

The GSB includes the SLAC Motor Pool Shop, which is used to maintain vehicles assigned to the SLAC. Hazardous wastes generated from the Motor Pool include waste motor oil, oil-contaminated wastes (e.g., oil filters, rags), cleaning solvents, and lead-acid storage batteries. There is also a steam cleaning pad outside the GSB, which is used to clean vehicles and equipment. This pad drains to an oil/water separator. Waste oil and oily sludge are hazardous waste streams from the separator.

The Casting Pad is a storage and shop area located south of Sector 28 of the Klystron Gallery. This area was formerly used for casting concrete shielding blocks, and now houses several small maintenance shops. Hazardous wastes at this area during the Survey included cleaning solvents and lead-acid storage batteries.

Fabrication, assembly, and testing shops are used to fabricate, maintain, and test components and equipment used in research programs. Such facilities include the New Warehouse/Magnet Factory (Building 15), Electronics Building (Building 24), Light Fabrication Building (Building 25), Heavy Fabrication Building (Building 26), Cleaning Facility (Building 30), Vacuum Assembly Building (Building 31), Light Assembly Building (Building 33), Test Laboratory (Building 44), Quality Control Inspection (Building 45), Stanford Positron Electron Asymmetric Ring (SPEAR) Experiment Assembly Building (Building 101), and EFD Shops (Building 104). The Magnet Factory was formerly used for assembly of electromagnets. The building is now used for testing and storage of electronic equipment to be used in the SLAC

Large Detector (SLD) project. At the time of the Survey, no hazardous wastes were being generated.

The Electronics Building is primarily used for fabrication and assembly of electronic components and printed circuit boards. Hazardous wastes generated include waste oil from a reflow machine, waste Freon from circuit board cleaning, waste caustic stripping solution, and spent photographic chemicals.

The Light Fabrication Building consists of plating shops and machine shops. The plating shops are used for cleaning, plating, and anodizing metal parts used in equipment at the SLAC. Plating operations involve a variety of metals including copper, chromium, cadmium, nickel, and gold. Metal cleaning includes vapor degreasing with 1,1,1-trichloroethane (TCA) as well as chemical cleaning with acids, caustics, and solvents [toluene, acetone, methyl ethyl ketone (MEK), isopropyl alcohol, Freon]. Hazardous wastes generated at the plating shop include spent TCA degreasing solvents, metal-contaminated filters from plating bath cleanup, spent acid and caustic baths, solvents, and metal-contaminated rinsewaters. The machine shops in the Light Fabrication Building are used to fabricate and assemble light equipment. Hazardous wastes generated include spent TCA and kerosene cleaning solvents, metal grinding sludges, and machine coolants.

Associated with the Light Fabrication Building plating shop are the Cleaning Facility and a wastewater pretreatment plant. The Cleaning Facility is used for cleaning and etching large aluminum parts. Hazardous wastes generated are waste cleaning and etching solutions and rinsewaters. The treatment plant is used to treat plating and metal cleaning rinsewaters and acid and caustic wastes prior to discharge to the sanitary sewer (see Section 3.3.2.1 for a description of this system). This treatment plant generates hazardous wastes in the form of metal-contaminated sludges. Adjacent to the pretreatment plant is an ion exchange regeneration facility, which is used to regenerate canisters of ion exchange resins from throughout the SLAC. Resulting hazardous wastes are acid and caustic regenerant streams, some of which are copper-contaminated.

The Heavy Fabrication Building contains shops used for the fabrication and assembly of heavy equipment used in experimental programs. The facility includes machine shops, a sheet metal shop, and a welding shop. Hazardous wastes

generated include waste cleaning solvents (primarily TCA and acetone), waste lubrication and cutting oils, and waste machine coolant.

The Vacuum Assembly Building and Light Assembly Building are used to assemble experimental equipment. Hazardous wastes generated are waste solvents (acetone, alcohol, Freon) used to clean components prior to assembly, and waste vacuum pump oil.

The Test Laboratory and Quality Control Inspection Building are used to manufacture, rebuild, and test klystrons. These facilities include a machine shop for fabrication and repair of components, assembly areas, and testing stations. Hazardous wastes include spent degreasing solvents (TCA and PCB-contaminated Freon), waste alcohol from parts cleaning, and waste PCB-contaminated klystron oil. Also present is a klystron oil treatment unit used to treat oil removed from klystrons during servicing. According to Test Laboratory staff, oil removed from klystrons is first sampled for PCBs. Oil containing more than 50 parts per million (ppm) of PCBs is drummed for disposal. Oil containing less than 50 ppm of PCBs is processed for reuse. During processing, the oil is centrifuged to remove water and solids, which are collected as hazardous wastes. The oil is also placed under vacuum for degassing. The processed oil is then stored and reused in new or rebuilt klystrons.

The SPEAR Assembly Building and EFD Shops are used to assemble components used in experimental facilities. These buildings have small machine shops and use small amounts of solvents (TCA, acetone, propanol, and Freon) for cleaning purposes. The solvents are wiped on the components and evaporated. No accumulation of hazardous wastes was noted during the Survey.

The LINAC consists of the Accelerator Housing (Building 1) and the Klystron Gallery (Building 2). Hazardous wastes are generated from these facilities from maintenance activities. These activities include periodic cleaning of the copper tubing and components used to convey cooling water. This cleaning results in generation of copper-contaminated corrosive solutions. Other wastes from the LINAC include small quantities of waste oil and solvents.

There are several research laboratories and support shops at the SLAC, including the Central Laboratory (Building 40), Central Laboratory Addition (Building 84), the

Stanford Synchrotron Radiation Laboratory (SSRL) Storage Building (Building 103), and the SSRL South Arc Building (Building 131). The Central Laboratory and Central Laboratory Addition are the main research laboratories at the SLAC. The Central Laboratory contains laboratories that are primarily engaged in small-scale metallurgical work. Hazardous wastes generated include small amounts of acid wastes from metal cleaning and etching, small quantities of waste solvents [acetone, alcohol, trichloroethylene (TCE), and Freon], discarded chemical reagents, and waste vacuum pump oil. The Central Laboratory also has several small shops (machining, plumbing, welding, and sheet metal) for small-scale fabrication and maintenance. Hazardous wastes generated from these shops include small quantities of TCA cleaning solvent and small amounts of machine coolant and cutting fluid. The Central Laboratory Addition consists mainly of dry laboratories, which are used for electronic and mechanical assembly and testing. These activities generate small amounts of waste solvents, including methyl alcohol, ethyl alcohol, MEK, and Freon.

The SSRL Storage Building has been used for experiments involving lithium metals. Hazardous wastes generated from these activities are lithium hydroxide solutions.

The SSRL South Arc Building includes a biology laboratory, which has a wet laboratory for experiment preparation, and a small darkroom. Hazardous wastes generated at this laboratory are discarded reagent chemicals and photographic chemicals.

Experimental areas are the areas where experiments involving interactions with the LINAC beam or synchrotron radiation occur. These areas and their supporting shops include End Station A (ESA or Building 61), SSRL (Building 120), the SSRL South Arc Building (Building 131), and the Positron Electron Project (PEP) Interaction Regions (IRs). The ESA facility includes a small machine shop for maintenance of experimental equipment. Hazardous wastes generated from this facility are waste lubrication, vacuum, and compressor oils. The shop is also used to store a drum of depleted uranium, which is used as shielding, though this material is not considered to be a waste.

The SSRL facility consists of a number of experimental stations for conducting research involving synchrotron radiation. The only hazardous wastes generated at

this facility are small quantities of photographic chemicals from a darkroom. The SSRL South Arc Building has similar experimental stations. Hazardous wastes consist of waste solvents (acetone, alcohol, and Freon) which are generated from a "clean room" used to assemble components.

Several of the PEP facilities have machine shops and assembly and testing areas to support experimental programs. Such facilities exist at IR-2 (Building 620) and IR-8 (Building 680) and use small amounts of cleaning solvents and vacuum pump oils. No accumulations of hazardous wastes were noted during the Survey.

A support facility for experimental areas is the Helium Compressor Building (Building 127). This facility has several large compressors and vacuum pumps and generates waste vacuum and compressor oils.

Remedial action activities were not ongoing at the SLAC during the Survey, but have been conducted in the past. These projects have involved the excavation of contaminated soil, which was disposed of as hazardous waste.

Hazardous Waste Management Activities

Hazardous waste management activities at the SLAC are conducted by the generators of the wastes, and by the Environment and Safety Office (ESO). In general, generators are responsible for proper identification, designation, and segregation of hazardous wastes and for on-site accumulation. ESO is responsible for on-site collection and transportation of the wastes, on-site storage, manifesting and recordkeeping, and preparation for transportation for off-site treatment or disposal.

Most of the hazardous wastes generated at the SLAC are of known composition, consisting of spent or discarded chemical products (e.g., waste acids, spent solvents, waste oils, discarded chemical products). To minimize the need for waste analysis, the SLAC relies on the use of waste profiles. These profiles are developed by analysis of hazardous wastes from specific sources. Once wastes have been analyzed and profiles developed, additional wastes from these sources do not require analysis. At the time of the Survey, the SLAC had developed profiles for 77 hazardous wastes. ESO staff reported that only about 20 percent of the hazardous

wastes now generated at the SLAC are not included in these profiles and require analysis. ESO staff indicated, however, that because of the large amounts of PCBs in use at the SLAC and the potential for PCB contamination, all waste oil is sampled and analyzed for PCBs. In addition, all empty drums from unknown sources are treated as PCB-contaminated.

Once wastes have been properly identified by the generator, they are typically accumulated by the generator at satellite accumulation areas. The term "satellite accumulation area" refers to a hazardous waste accumulation area located near the point of waste generation and operated by the waste generator. Under the Federal RCRA regulations, there are less stringent accumulation time limits for satellite areas than for other accumulation areas (i.e., generator less-than-90-day accumulation areas). Under the California Hazardous Waste Management Regulations, however, no distinction is made between satellite areas and other waste accumulation areas. The term, therefore, is used to refer to the location of the area and to identify those areas used by only one generator, and does not refer to regulatory status or requirements.

At the time of the Survey, ESO staff were developing a guidance document for generators of hazardous wastes (Jensen, 1987). This guidance addresses hazardous waste identification, containerization, packaging, segregation, separation, and transportation. As this guidance had not been issued at the time of the Survey, there was a good deal of variability in the manner in which wastes were managed at accumulation areas. Waste containers were not labeled in a consistent manner and were not dated to indicate the start date of accumulation. Containers at some areas were not kept closed during accumulation.

Several instances of improper waste segregation were noted during the Survey. The Survey observed a bottle of discarded photographic chemicals mixed with solid wastes. In addition, six drums of uncharacterized wastes from unknown sources were delivered to the Radioactive Waste Storage Area (RWSA). These wastes were apparently not radioactive and should not have been sent to this site. Also, the SLAC staff indicated that hazardous wastes are occasionally discovered in solid waste containers.

The bulk of containerized hazardous wastes are accumulated outdoors in 55-gallon drums, while small amounts of waste may be accumulated indoors in small (i.e., several gallon) flammable liquid storage cans. Drummed waste accumulation areas are generally outside the generating facilities, and are typically in the open with no secondary containment for spills. ESO staff indicated that there is no formal designation or listing of these satellite accumulation areas and that they are not inspected on a regular basis. Many of these areas are unprotected from traffic and some are located very near storm sewer inlets. The outdoor drummed waste satellite accumulation areas observed during the Survey are identified in Figure 4-1. The types of wastes observed at the satellite accumulation areas during the Survey are summarized in Table 4-2.

Wastes are accumulated at the satellite areas until the accumulation container is full. At that time, ESO is notified and requested to pick up the container. ESO picks up hazardous waste containers and transports them for storage at the Hazardous Waste Storage Area (HWSA). Wastes received and put into storage are entered into a logbook, which identifies the waste, the container it is stored in, the waste profile number appropriate for the waste, a description of the waste, and the date storage began. There is no formal inspection program for wastes in storage. ESO staff did indicate, however, that they are present at the HWSA at least every other day and inspect containers whenever they visit the HWSA.

The HWSA is not permitted as a RCRA treatment, storage, and disposal (TSD) unit. As a result, hazardous wastes cannot be stored at the facility for longer than 90 days. At a minimum of every 90 days, therefore, ESO staff arranges for off-site transportation contractors to pick up the stored waste inventory for transport to an off-site TSD unit. Prior to collection, ESO staff are responsible for preparation of hazardous waste manifests. Copies of these manifests and other records are kept by ESO in the Electronics Building Annex (Building 34). A variety of off-site treatment and disposal contractors are used by the SLAC, depending on the type of waste. Empty drums are typically sent to a drum recycler, clean oils and solvents (i.e., those not contaminated with other materials) to recyclers, dirty oils and solvents to an incinerator, and other wastes to a landfill. Appendix F provides a listing of hazardous waste transporters and TSD facilities used by the SLAC during 1987.

Sources: Adapted from SIAC, 1980b

TABLE 4-2

**SUMMARY OF HAZARDOUS WASTE SATELLITE ACCUMULATION AREAS
AND WASTES OBSERVED AT THE SLAC DURING THE SURVEY**

Location	Wastes in Storage During Survey	Comments
Casting Pad	Lead-acid storage batteries, unmarked cans, empty hazardous material cans.	Storage on soil.
Central Laboratory (Bldg. 40), Inside	5-gallon cans of waste solvent (acetone, alcohol, TCE, Freon).	
Central Laboratory (Bldg. 40), West Side	Drums of waste oil.	
Central Laboratory (Bldg. 40), Transportainer South of Building	Cans of waste laser dye.	
Chemical Storage Building (Bldg. 36), West Side	Empty waste treatment chemical drums.	
Chemical Storage Building (Bldg. 36), Inside	Drums of gold-bearing stripping solution from plating shop, drums of waste acid from plating shop.	
Chemical Storage Shelter West of Heavy Fabrication Building (Bldg. 26)	Drums North Bay - Drums of waste machine coolant, oils and solvents.	Open drums of waste.
Cleaning Facility (Bldg. 30), East Side	Drums of waste acid, empty chemical drums.	
Electronics Building (Bldg. 24), Inside	5-gallon can of waste Freon.	Open container of waste.
Electronics Building (Bldg. 24), Southwest Corner	Drum of waste Freon flux thinner.	
End Station A (Bldg. 61), South Side	Drum of waste compressor oil.	
GSB (Bldg. 81), Drum Storage Area South of Building	Drum of waste oil.	

TABLE 4-2

**SUMMARY OF HAZARDOUS WASTE SATELLITE ACCUMULATION AREAS
AND WASTES OBSERVED AT THE SLAC DURING THE SURVEY (Continued)**

Location	Wastes in Storage During Survey	Comments
GSB (Bldg. 81), Southeast Corner	Drums of waste oil, drum with absorbent and oily waste, lead-acid storage batteries.	Open drums of waste.
Helium Compressor Building (Bldg. 127), East Side	Drums of waste vacuum oil, empty solvent drum.	Open drum of waste, ground staining.
Light Fabrication Building (Bldg. 25), East Side	Drums of waste machine coolant, kerosene, and parts cleaner.	Drum stored above storm drain.
Plating Treatment Plant (Bldg. 38)	Drums of dewatered metal-contaminated sludge.	
PMU Building (Bldg. 35), Paint Shop	Drum of waste paint and solvents.	Open drum of waste.
PMU Building (Bldg. 35), Storage Area at Northwest Corner	Drum of unknown material.	Drum stored above storm drain.
SSRL South Arc Building (Bldg. 131), North Side	Drums of waste solvent (acetone, alcohol, Freon).	
SSRL South Arc Building (Bldg. 131), Biology Laboratory	Discarded reagent chemicals in hood.	
SSRL Storage Building (Bldg. 103), South Side	Cans of waste lithium hydroxide solution.	
Test Laboratory (Bldg. 44), East Side	Cans of waste alcohol, drums of PCB-contaminated klystron oil.	Open drum of waste.
Test Laboratory Substation (Bldg. 45), East Side	Drums of PCB-contaminated klystron oil.	
Vacuum Assembly Building (Bldg. 31)	5-gallon cans of waste solvents (acetone, alcohol, Freon).	
82-Inch Bubble Chamber Building (Bldg. 113), Northwest Corner	Drums of waste compressor oil.	Evidence of spillage.

Source: Survey team observations

In addition to containerized wastes, bulk liquid hazardous wastes are also accumulated in tanks at the SLAC. Acid and caustic ion exchange regeneration wastes are stored in polyethylene tanks at the ion exchange regeneration facility. These wastes are then transferred to the plating waste pretreatment plant for treatment. Wastes from regeneration of ion exchange resins from the Klystron Gallery which contain elevated levels of copper that cannot be treated at the pretreatment plant are accumulated in a 4,000-gallon tank trailer adjacent to the regeneration facility and sent to an off-site disposal facility. Acid and caustic wastes from the plating shop (e.g., cleaning baths) are transferred to the pretreatment plant and stored in polyethylene tanks for treatment. Copper-contaminated wastewaters from cleanup of cooling water systems in the Klystron Gallery are accumulated in three 4,000-gallon tank trailers at the Klystron Gallery for shipment to an off-site disposal facility.

As part of hazardous waste management practices, the SLAC is in the process of implementing a program of waste minimization. ESO staff indicated that this program will be implemented in three phases: training and notification; improvement of satellite accumulation areas (i.e., berming, fencing, covers); and increased recycling. At the time of the Survey, the training course was under development by ESO staff.

As a hazardous waste generator, the SLAC is regulated by the San Mateo County Department of Health Services. The County performs annual inspections to determine if the SLAC is compliant with regulatory requirements for hazardous waste generators. Inspections were performed in February 1986, and November 1987, and indicated that the SLAC was in compliance with all requirements (Lent, 1986; Dana, 1987).

Hazardous Waste Management Facilities

The SLAC has several facilities which are used for the storage and treatment of hazardous wastes. These storage facilities, in addition to the satellite accumulation areas previously described, are the HWSA and the PCB Waste Storage Area (Building 17). Neither of these facilities is permitted as a storage unit because wastes are not stored in excess of regulatory limits of 90 days in the case of hazardous wastes and 1 year in the case of PCB wastes. The major waste treatment facility at the SLAC is the

plating wastewater pretreatment plant. While this plant is used for the treatment of hazardous wastes, a variance from RCRA permitting requirements has been requested from the California Department of Health Services (DOHS) because this facility is also regulated under the Clean Water Act (Rickansrud, 1986). Other treatment units are oil/water separators at the GSB and stormwater discharge points. These units are regulated under the SLAC wastewater discharge permits. The pretreatment plant and oil/water separators are described in more detail in Sections 3.3.2.1 and 3.3.2.3. Descriptions of the storage facilities follow.

The HWSA is south of Sector 28 of the Klystron Gallery and is used for the less-than-90-day storage of hazardous wastes. The HWSA consists of an asphalt pad occupying an area of approximately 8,500 square feet and surrounded by a 10-inch-high asphalt berm (Lavagnino, ND). The storage area is completely fenced and has a locked gate. The area slopes to a 120-gallon drainage sump at the southeast corner of the pad. This sump has an unlocked drainage valve that can be used to discharge uncontaminated runoff to a drainage ditch. At the time of the Survey, this sump contained rainwater and the valve was noted to be leaking.

Containerized wastes are stored at the HWSA in four storage bays at the west end of the pad. These bays are covered by a roof but do not have walls. Each bay is surrounded by an asphalt berm. One bay is used for storage of solvents, one for waste oils, one for corrosives, and one for other hazardous wastes. The solvent bay has a concrete floor and the others have asphalt. The solvent bay also has a blind sump for collection of leaks. At the time of the Survey, the only hazardous wastes at the HWSA were two drums of solvents and seven drums of waste oil. Two of the waste oil drums were noted to have funnels in the bung holes which were open.

Also at the HWSA is a small storage shed used for the accumulation of discarded chemicals (i.e., lab-pack wastes). These wastes are segregated according to hazard class and accumulated until there is a sufficient quantity for disposal. The disposal contractor is responsible for packaging the wastes into lab-pack drums.

The PCB Waste Storage Area is south of Sector 30 of the Klystron Gallery, within the Master Substation on the south side, and is used for storage of PCB wastes, including those regulated as hazardous wastes (i.e., PCB concentrations between 5 and 50 ppm). The facility consists of a concrete pad occupying an area of

approximately 1,100 square feet and completely surrounded by a 1-foot high concrete berm (Lavagnino, ND). The concrete has been sealed to prevent absorption of wastes. The storage pad is covered and has walls on two sides. ESO staff reported that a large tarpaulin has been ordered to cover one of the sides that does not have a wall. The storage pad drains to a blind sump. Sump drainage is disposed of as PCB waste unless analysis shows it to be uncontaminated. If uncontaminated, it can be discharged to a drainage ditch. The sump is reportedly contaminated with PCBs to the level that virtually all of the water collected in the sump contains greater than 5 ppm of PCBs and must be disposed of as hazardous waste (Soden, 1987).

4.1.1.2 Radioactive Waste

Activities at the SLAC concerning radioactive wastes include generation, handling, and on-site storage of low-level radioactive waste (LLW). Radioactive waste management practices at the SLAC are primarily limited to on-site storage of LLW at a radioactive waste storage area.

Sources and Types of Radioactive Waste

Radioactive wastes generated at the SLAC consist of low-level solid wastes, principally equipment and shielding from the LINAC and experimental areas which have induced radioactivity. These wastes typically consist of small equipment and small metal parts, but can also include large metal parts and blocks of concrete shielding. Generation of these wastes is sporadic, depending on the nature of experiments and the maintenance operations for the LINAC. ESO staff estimated the total generation rate of radioactive wastes requiring disposal to be 50 cubic feet/year. The SLAC does not generate other classes of radioactive waste such as high-level wastes or transuranic (TRU) wastes.

Radioactive Waste Management Activities

Radioactive waste management activities at the SLAC are primarily the responsibility of the ESO staff. In general, generators are responsible for notification of ESO when wastes are generated (i.e., when radioactive equipment must be removed from experimental areas). ESO staff first inspect the equipment in

place to determine surface exposure rates for proper handling. The waste is then taken to a location with low background radiation and reinspected to determine whether the material can be released through salvage (salvage of radioactive material is discussed in Section 4.3.2.3). Finally, the radioactive wastes are transferred to the RWSA. The storage area is used to store wastes that will ultimately be disposed of, as well as wastes being stored for possible reuse at the SLAC. Wastes to be disposed of are packaged into drums or shipping boxes for off-site transportation. The SLAC does not have a written plan for the management of radioactive waste.

Radioactive wastes have not been shipped from the SLAC for disposal for 12 years. The last shipment of radioactive wastes from the SLAC was to a commercial disposal site in Nevada. Currently, the SLAC is working with DOE to arrange for disposal of radioactive wastes at the Idaho National Engineering Laboratory, Nevada Test Site, or Hanford Site.

Radioactive Waste Management Facilities

Radioactive waste management facilities at the SLAC are the RWSA, located south of the Beam Switchyard (BSY), and a radioactive material storage area north of Sector 15 of the Klystron Gallery. The RWSA consists mainly of an open storage area, approximately half of which is behind a locked fence. Wastes stored in the fenced area are mainly small equipment, while those outside the fence are larger items such as shielding blocks (Lavagnino, ND). The RWSA is used to store wastes that will be disposed of as well as those that may be reused at the SLAC. ESO staff reported that wastes in storage in this area have dose rates of 2 to 100 milliroentgen per hour (mR/hr) at 1 foot, with most at the low end of this range. There is also a "cave" within the fenced area for storage of wastes having dose rates above 100 mR/hr.

Containerized radioactive wastes to be shipped off-site for disposal are stored in an enclosed area at the RWSA between the Health Physics BSY Storage Building (Building 105) and the PMU Storage Building (Building 106). Wastes in storage at the time of the Survey were contained in five 50-cubic-foot shipping boxes and forty-seven 55-gallon drums.

The radioactive material storage area north of the Klystron Gallery is used to store shielding material, primarily concrete and steel, which has induced radioactivity. While these materials are no longer in use, they can be reused and may not strictly be considered wastes. These materials are less radioactive than the materials stored in the RWSA (i.e., less than 0.5 mR/hr), but are too radioactive to be released to the public. This storage area is not fenced, but is located within the fenced security area surrounding the Klystron Gallery.

4.1.1.3 Radioactive Mixed Waste

Activities concerning radioactive mixed waste (RMW) at the SLAC include generation, handling, and on-site storage. General RMW management practices at the SLAC include on-site accumulation of RMW at the point of generation and on-site storage of RMW.

Sources and Types of Radioactive Mixed Waste

RMW generated at the SLAC consists of spent ion exchange resins containing activation products and tritium-contaminated waste vacuum oil. The ion exchange resins are from purification of demineralized water systems which come into contact with the LINAC beam. According to ESO staff, there are six such systems at the SLAC: two at the BSY, one under ESA, one at Beam Dump East (Building 63), one at the B Target Room, and one at the Sector 20 positron source. The water treated by these systems contains induced radioactivity, mainly in the form of beryllium-7. The radioactive products are removed from the water and captured on the ion exchange resins. Each of these resin beds contains approximately 1.5 cubic feet of resin and is changed once per year for a total generation rate of approximately 10 cubic feet/year (or roughly 2 drums). While these resins have not been analyzed for hazardous constituents, the SLAC considers them mixed wastes because of their potential for heavy metal contamination (i.e., chromium and nickel from stainless steel systems, and copper from copper systems).

The tritium-contaminated vacuum oil is generated at the BSY. The tritium is produced in the beam stop and contaminates the oil in the vacuum pumps. ESO staff reported that the levels of tritium in the oil are quite low, approximately

10,000 picocuries per liter (pCi/L). This waste is generated in very small amounts (i.e., less than 5 gallons/year), and the total inventory at the SLAC is less than 30 gallons.

Radioactive Mixed Waste Management Activities

RMW management activities are conducted by ESO staff and are generally the same as radioactive waste management activities. Spent ion exchange resins are removed from the ion exchange cartridges and transferred to polyethylene drums. The water from these cartridges is drained into drums and is ultimately discharged to the sanitary sewer. The water is not sampled prior to discharge into the sewer but would be expected to contain only tritium. The tritium-contaminated vacuum pump oil is accumulated in drums. The containers of RMW are stored at the RWSA. The SLAC does not have a written plan for the management of RMW. As with radioactive wastes, RMW is being stored on-site pending DOE approval for shipment to another DOE facility for disposal.

Radioactive Mixed Waste Management Facilities

RMW management activities occur at the RWSA. This area was previously described in Section 4.1.1.1.

4.1.1.4 Solid Waste

Solid waste activities at the SLAC include generation, handling, temporary storage, and salvage. General solid waste management practices include storage at generator facilities in contractor-provided collection containers, collection of solid wastes by SLAC staff and an off-site contractor, and on-site storage of salvageable wastes. Solid wastes generated at the SLAC include trash, which is generated at virtually all offices and laboratories; putrescible waste from the cafeteria; construction wastes (e.g., concrete, wood, steel), which are generated during construction activities; scrap metals, which are generated in fabrication and maintenance shops; and unwanted mechanical and electrical equipment.

Trash and construction wastes are collected by an off-site contractor, Feninsula Sanitation. These wastes are collected at various buildings throughout the SLAC in dump boxes. Trash is also collected in bags at some buildings and transported by

SLAC staff to drop-boxes at the storage yard southeast of the Master Substation. The drop-boxes are then collected by the disposal contractor.

Segregation of hazardous and radioactive wastes from solid wastes is the responsibility of the generators of these wastes. There is no formal procedure for inspection of solid wastes, either by the SLAC or the collection contractor, to determine if unauthorized materials are being disposed of. SLAC staff transporting bagged wastes to the drop-boxes perform an informal inspection of these wastes for hazardous materials.

Most scrap metals and unwanted equipment are taken to the SLAC salvage yard, which is south of the Warehouse Building (Building 28) for temporary storage prior to being excessed to other Government agencies or sold to the public. Any materials coming to the salvage yard from the LINAC or from any area where the LINAC beam is shaped or stopped are inspected for radioactivity to determine if they are below release levels (see Section 4.3.2.3). The operators of the salvage yard are trained not to accept hazardous materials or wastes.

4.1.2 Findings and Observations

4.1.2.1 Category I

None

4.1.2.2 Category II

1. Release from hazardous waste collection sump. Leakage from the collection sump at the HWSA presents the potential for soil and surface-water contamination.

The HWSA yard drains to a 120-gallon sump at the southeast corner of the yard. This sump collects rainwater which falls on the yard and will also contain hazardous waste spills which may occur in the yard. This sump has a drain valve to allow uncontaminated rainwater to be drained to a drainage ditch which runs south from the SLAC. The valve is not locked. At the time of the Survey, the sump contained rainwater, and the drainage valve was observed to

be leaking. This leakage presents the potential for release of hazardous wastes should they be present in the sump.

The SLAC has recognized the problems associated with the sump drainage valve and has plans underway to remove it (Soden, 1987). These plans call for the drain line to be blocked off and a sump pump installed which can be used to pump liquids from the sump to drums.

4.1.2.3 Category III

None

4.1.2.4 Category IV

1. Inadequate segregation of hazardous wastes. Current waste segregation practices for solid, hazardous, and radioactive wastes may result in improper handling and disposal.

Segregation of hazardous, solid, and radioactive wastes at the SLAC is the responsibility of the waste generator. Proper segregation is accomplished through the use of administrative controls, typically in the form of training and procedures. Some of these controls had not been fully implemented at the time of the Survey (e.g., the guidance for generators of hazardous wastes, the waste minimization training program). In addition, there are no formalized means (i.e., inspections, inventory controls) of determining if proper segregation is occurring. Inadequate segregation presents the opportunity for improper disposal of hazardous wastes. Such disposal is of concern with respect to RCRA compliance, and could result in environmental impacts. In addition, inadequate segregation could result in safety concerns related to waste handling. The SLAC has indicated that it is currently developing additional waste segregation procedures.

Several instances of improper waste segregation were brought to the attention of the Survey team. SLAC ESO staff indicated that hazardous wastes are occasionally discovered in solid waste containers. The Survey observed a bottle of discarded photographic chemicals mixed with solid wastes. This

container was removed for disposal as hazardous waste. In addition, six drums of uncharacterized wastes from unknown sources were recently delivered to the RWSA.

2. Lack of radioactive and mixed waste management plan. The SLAC has no formal plans for management of radioactive wastes and RMW and does not comply with DOE requirements and RCRA regulations.

Requirements for management of radioactive wastes, including radioactive mixed wastes, at DOE facilities are given in DOE Order 5820.2. Among the requirements of this Order is the development and annual updating of radioactive waste management plans. The objective of these plans is to ensure that radioactive wastes are managed in a manner that protects public health and safety and meets radiation protection standards. The SLAC has not prepared such a plan. The lack of such a plan constitutes noncompliance with DOE Order 5820.2 and can increase the opportunity for inadequate management of these wastes. Storage of RMW at the SLAC does not meet RCRA requirements. RMW containers are stored longer than 90 days, are not properly labeled as hazardous wastes, and are not inspected weekly.

3. Potential releases of hazardous wastes. There is a potential for releases of contaminants to soil and surface water as a result of inadequate hazardous waste management practices at hazardous waste satellite accumulation areas.

Satellite accumulation areas are used at the SLAC to accumulate hazardous wastes at the point of generation prior to transfer to the HWSA. During the Survey, 25 such areas were observed, 9 of which were inside buildings or in contained areas, and 16 of which were outside. All the outside areas lacked secondary spill containment, most are uncovered, many are unprotected from traffic, and some are located very near storm sewer inlets. In addition, at some of the satellite areas (both inside and outside), drum management practices do not meet RCRA requirements, increasing the potential for releases. There are no formal procedures for generators on-site to assure that proper accumulation of waste is occurring. At some locations, waste containers were not closed, but had open funnels, increasing the potential for release of volatiles as well as increasing the risk of spills. This practice was observed with

a drum of paint waste and solvents in the PMU Paint Shop, a drum of waste oil south of the GSB, a drum of PCB-contaminated waste oil outside the Test Laboratory, drums of machine coolant and waste oil in the storage shed west of the Heavy Fabrication Shop, a drum of waste vacuum oil outside the Helium Compressor Building, and a 5-gallon can of waste Freon in the Electronics Building. Waste drums are not properly labeled with hazardous waste labels and formal inspections of accumulation areas are not performed.

The SLAC has recognized the problems related to hazardous waste accumulation and has planned actions to address them. The waste generation guidelines (Jensen, 1987) and waste minimization training under development at the time of the Survey should address proper container management practices. Also, plans are under development for berming and covering some of the larger satellite accumulation areas (Jensen, 1988a, b).

PRELIMINARY

4.2 Toxic and Chemical Materials

4.2.1 General Description of Pollution Sources and Controls

Bulk chemicals, polychlorinated biphenyls (PCBs), asbestos, and pesticides are in use at the Stanford Linear Accelerator Center (SLAC). This section describes the procurement and inventory control procedures used by the SLAC, along with the current storage practices and conditions of the equipment/containers associated with these materials.

4.2.1.1 Toxic Materials and Bulk Chemical Management

The overall policy for management of toxic materials and bulk chemicals is established by the Environment and Safety Office (ESO) and is administered by building and area supervisors (SLAC personnel, 1988). The following describes the SLAC's procedures for procurement and inventory control of bulk chemicals.

Procurement

The major solvents used on-site include acetone, fluorocarbons, isopropyl alcohol, methylene chloride, paint/enamel thinners, Stoddard solvent, and 1,1,1-trichloroethane. These solvents are available through SLAC General Stores. Alternatively, chemicals may be obtained through the Purchasing Department or, if they cost less than \$50, can be ordered directly from petty cash. It is SLAC policy that Material Safety Data Sheets (MSDSs) are required for all chemicals and toxic materials purchased, and copies must be readily accessible to the employees (SLAC personnel, 1988).

Inventory Control

Inventory records at the SLAC are kept by the Purchasing Department, the SLAC Stores, and the building and area supervisors. However, there is no central site-wide listing of annual chemical usage. The ESO is working on a computer-based program that will track all site chemical purchases so that inventory data can be readily accessed. This program is being developed to comply with the Superfund

Amendments and Reauthorization Act (SARA) hazardous substance reporting requirements.

Also, as an additional control, the ESO is planning to institute a waste minimization plan in the near future, which would include the following objectives (ESO personnel, 1988):

- Educate waste generators to better segregate waste types;
- Recycle waste materials as better segregation occurs;
- Inform generators of other users that may share chemicals so as to minimize waste; and
- Recommend that users limit quantities purchased to fit actual needs (i.e., reduce orders to minimize quantities).

4.2.1.2 Toxics and Bulk Chemical Storage

Bulk chemicals are stored throughout the SLAC in drums, aboveground storage tanks (AST's), and underground storage tanks (USTs). During a review of these storage areas and tanks, the following situations were observed: some drum storage areas (e.g., Cooling Towers 1201 and 1202) are unprotected and unbermed; an AST behind the Beam Switchyard (BSY) substation (Building 7) is insufficiently bermed; and AST P-1 has a drain valve in the containment area that cannot be locked shut. Also, a Spill Prevention, Control, and Countermeasures (SPCC) Plan to aid in preventing and mitigating potential spills and releases at the SLAC has not been completed and implemented.

Table 4-3 lists the site drum bulk chemical storage areas that were reviewed. The storage location, chemicals stored, and observations are presented. Also, Tables 4-4 and 4-5 list information and observations on the site ASTs and USTs, respectively. Figure 4-2 shows the location of the drum bulk chemical storage areas.

The ESO has proposed a project to correct the bulk chemical storage area deficiencies. The project involves restricting, as much as feasible, the number of

TABLE 4-3
BULK CHEMICAL STORAGE AREAS REVIEWED
AT THE SLAC

Area	Chemicals Used	Observations
Cooling Tower 1201	Sodium hypochlorite Foam control Slimeicide Deposit control	Storage area is paved and diked, but there is a break (several feet) in the dike; 55-gallon drum stored on a pallet outside the bermed area; area is unprotected.
Cooling Tower 1202	Pipeflushing compounds Sodium hypochlorite	Storage area is unprotected and unbermed; contains one unlabeled 55-gallon drum and three 55-gallon drums of what may be "orphaned" chemicals (Baron-Bakeslee).
PMU Building (Building 35)	Lacquer thinner Mineral spirits	Area is protected and equipped with a sprinkler system; area not bermed but spillage would be collected in a catch basin which leads to a blind sump. Catch basin is cluttered with soil and debris.
Paint Storage (South of General Services Building)	Paints	Area is protected, heated, kept locked, and overall is well-maintained.
General Stores (Adjacent to Paint Storage)	Acetone Stoddard solvent 1,1,1-trichloroethane	Area is roofed, fenced, and kept locked. Floor is sloped toward blind sump. Overall, area is well-maintained.
Motor Pool	Oils Gasoline	Several 55-gallon drums of chemicals are stored on pallets and a drum rack in an unbermed area. Four 55-gallon drums of gasoline (for the site mopeds) are stored without secondary containment next to the paint storage shed. An AST is on order.
Wastewater Treatment Facility (Adjacent to Building 26)	Ferric chloride Sodium hypochlorite Sodium hydroxide Hydrochloric acid	Area is bermed, covered, and kept locked. Overall, area is well-maintained.
Chemical Storage (Building 36)	Acids Cyanides	Area is bermed, covered, and kept locked, and the chemicals are segregated. Overall, area is well-maintained.

TABLE 4-3
BULK CHEMICAL STORAGE AREAS REVIEWED
AT THE SLAC (Continued)

Area	Chemicals Used	Observations
Test Laboratory (Building 44)	Freon Mineral oil	Two 55-gallon drums of Freon and eight 55-gallon drums of mineral oil are stored outside in a protected but unbermed area.
Central Utility (Building 23)	Water treatment chemicals	Four 55-gallon drums are stored in an unbermed and unprotected area.
Cooling Tower 1701	Water treatment chemicals Oils Solvents	Storage area is paved and bermed but four 55-gallon drums are stored outside the bermed area. Also, area is not covered. Twenty-five 55-gallon drums are stored (surveillance mechanics shop) in an unbermed and unprotected area. A roofed and bermed storage area is being built adjacent to Endstation B.
Building 413	Oils	Two 55-gallon drums are stored on a rack which has no secondary containment. The rack is near a storm drain.
Light Fabrication (Building 25)	Kerosene Degreasol Lubricants	Area is well-maintained.
Heavy Fabrication (Building 26)	Acetone Kerosene Lubricating oil Coolants	Area is well-maintained; blind sump in floor.
Cleaning Facility (Building 30)	Sodium hydroxide	Area is well-maintained.
Central Lab Machine Shop (Building 40)	Cutting oils 1,1,1-trichloroethane	Area is well-maintained.

Source: Survey team observations

TABLE 4-4

**ABOVEGROUND BULK CHEMICAL STORAGE TANKS
AT THE SLAC**

Tank Number	Location	Capacity (gallons)	Stored Material	Construction	Comments and Observations
P-1	Bldg. 23	10,000	Diesel	Steel (single wall)	Fuel for site vehicles and emergency fuel for the boilers in Building 23; tank has adequate secondary containment but containment drain valve is not locked when closed.
P-2	Bldg. 37	4,000	Diesel	Steel (single wall)	Emergency fuel for boiler; tank has adequate secondary containment; containment drain valve locked when closed.
Unknown	Bldg. 7	614	Diesel	Steel (single wall)	Fuel for emergency generator; secondary containment not adequate to handle the entire contents of the tank; containment does not have a drain valve.

Source: Survey team observations

TABLE 4-5
UNDERGROUND BULK CHEMICAL STORAGE TANKS
AT THE SLAC

Tank Number	Year Installed	Capacity (gallons)	Stored Material	Construction	Comments
A-1 A-2 A-3 A-4	1975 1975 1975 1975	10,000 10,000 10,000 10,000	Empty Empty Empty Empty	Fiberglass Fiberglass Fiberglass Fiberglass	Tanks formerly stored diesel fuel and all have been leak-tested (passed). Future plans are to clean the tanks, modify the piping, and use them to store chilled water for use in air conditioning during peak load periods.
A-5	1969	10,000	NA	Steel	Unit removed 7/87; it formerly stored unleaded gasoline.
A-6	1973	1,000	Unleaded gasoline	Steel	Unit leak-tested (passed); plans are to remove the unit and replace it with an AST.
A-7	1983	550	Diesel	Fiberglass	Unit leak-tested (passed); unit scheduled for removal.

Source: Survey team observations

NA - Not Applicable

Source: Survey team observations, 1988

Page 1 of 2

DRUM BULK CHEMICAL STORAGE AREAS
REVIEWED AT THE SLAC

FIGURE 4-2

Page 2 of 2

DRUM BULK CHEMICAL STORAGE AREAS REVIEWED AT THE SLAC
(CONTINUED) **FIGURE 4-2**

storage areas; berming storage locations to 110-percent capacity of the largest container that would be stored in the area; enclosing the bermed area with a lockable 6-foot fence; and covering the areas.

In addition to bulk storage of liquids, metallic lead materials are stored at two outdoor locations: the Radioactive Waste Storage Area (RWSA) and Salvage Yard 2. The storage areas are unpaved and unprotected.

4.2.1.3 Polychlorinated Biphenyls

PCBs are used as the insulating fluid in some capacitors and transformers at the SLAC, and the control of these PCBs is the responsibility of the ESO. The ESO has therefore developed a PCB control program that includes the following:

- A PCB Spill Prevention and Cleanup Plan (SLAC, 1987b), which covers the handling of spillage on cement/concrete surfaces, soil, vegetation, and nonremovable items as well as the proper disposal of the resulting PCB materials and debris;
- Training lectures on the handling and disposal of PCB-contaminated oil (Dabney, 1987); and
- A project to remove all the existing PCB transformers [i.e., >500 parts per million (ppm)] from the SLAC site (SLAC, 1988a).

Currently there are 21 PCB transformers at the SLAC. Table 4-6 lists the location, age, dielectric oil quantity, and observations and comments based on a review of these units, and Figure 4-3 shows their location. Five of the SLAC PCB transformers were acquired as surplus units within the past 5 years, and a sixth unit is due on-site in the near future.

All PCB transformers at the SLAC are at least 17 years old, and there is concern over a potential increase in maintenance (leakage) problems. ESO therefore conducts monthly PCB transformer inspections rather than the quarterly inspections required by the Toxic Substances Control Act (TSCA). All inspection observations are recorded on a logsheet. Deficiencies are reported to the Plant Engineering

TABLE 4-6
PCB TRANSFORMERS AT THE SLAC

No.	Location	Age (years)	Oil Volume (gallons)	Observations and Comments
1	Computer Center	20	203	Unit is scheduled for removal 10/88.
2	IR-4	17	840	Some dry vegetation in the sump. Unit roofed and equipped with a splash guard.
3	SLC Building 136	17	1,375	Rainwater in the dike but no oil sheen; unit not equipped with roof or splash guard.
4	SLC Mark II	17	1,375	Slight oil sheen on water in the dike area. Unit not equipped with a roof or splash guard.
5	Building 132	21	385	Standing oil from leakage; requires cleanup. Unit equipped with a roof and splash guard.
6	Building 132	21	385	Unit clean and equipped with roof and splash guard.
7	Building 114	17	840	All units roofed and equipped with splash guards; spill control material under one of the unit's drain valve requires cleanup; standing oil from leakage under another unit; other two units clean.
8		17	840	
9		17	840	
10		17	840	
11	Substation 501	18	322	Unit located atop Building 401; roof of building is containment; there is a drain pipe from the roof to ground level; valve on the pipe cannot be locked into the closed position; storm drain near the drain valve; transformer currently drained but oil beads present at drain valve; No. 2 priority for removal.

TABLE 4-6
PCB TRANSFORMERS AT THE SLAC (Continued)

No.	Location	Age (years)	Oil Volume (gallons)	Observations and Comments
12	Substation 503	31	2,000	Unit in underground vault in very confined space; float-controlled pump used to remove water seepage to the surface; No. 1 priority for removal.
13	Substation 504	19	322	Unit clean and equipped with a roof and splash guard.
14	Substation 510	20	371	Recent, wet, oil stain at drain valve; unit equipped with a roof and splash guard.
15	Substation 511	18	290	Small puddle of oil at the drain valve; unit equipped with a roof and splash guard.
16	Substation 512	17	398	Old discoloration at drain valve; unit equipped with a roof and splash guard.
17	BSY 3B	18	600	Units enclosed in a locked building; area diked.
18	BSY 3A	17	426	
19	SLD Power Supply	17	1,375	Slight oil sheen on water in the dike area; units not equipped with a roof or splash guard.
20		17	1,375	
21	SLC Building 136	Unknown	1,375	Rainwater in the dike but no oil sheen; unit not equipped with a roof or splash guard.

Source: Survey team observations

Note: All units have PCB labels and the PCB concentrations are between 400,000 and 600,000 ppm.

Department, which is responsible for performing the required remedial action within the 48-hour period specified by TSCA. For tracking purposes, the SLAC requires that both the cleanup requests and the remedial actions be documented in writing (SLAC personnel, 1988).

PCB-contaminated wastes are stored for removal in the PCB Waste Storage Area, located within the Master Substation fenced area. Access to the fenced area is controlled by a locked gate and the area is posted with a PCB label. The PCB Waste Storage Area consists of a diked concrete pad of 66 feet by 17 feet by 1 foot, which is roofed and walled on two sides. The concrete has been treated with an epoxy-based sealant, and any water that enters the unit is collected in a blind sump and removed as waste. Wastes are stored in 55-gallon drums, and information on drum contents is maintained in a logbook. The drums observed at the storage area had PCB and hazardous waste labels affixed, and each drum was marked with an accumulation start date. All PCB liquids, contaminated solids, capacitors, and transformer carcasses are sent to U.S. Environmental Protection Agency (EPA)-approved sites for disposal. Disposal methods include landfilling at EnviroSafe of Grandview, Idaho; incineration at Ensco, Inc., of El Dorado, Arkansas; and chemical stripping of liquids at USPCI of Clive, Utah. Disposal information from 1981 to the present is kept in the Hazardous Waste Shipment Log, which lists the date, type, and amount of waste; type of shipping container; and the manifest and receipt numbers (Convisor, 1966; SLAC, 1988c).

The following summarizes the general condition of PCB equipment and PCB storage and handling procedures at the SLAC facility.

- Five PCB transformers, approximately 25 percent of the PCB transformers on-site, were found to be leaking;
- Eight transformers that have not been sampled for PCBs are being stored in the Master Substation without secondary containment;
- Potential oil leakage at two PCB transformers could bypass the secondary containment and impact adjacent soil and surface water;

FIGURE 4-3

LOCATIONS OF TRANSFORMERS AT THE SLAC

Source: Survey team observations, 1988

- The SLAC continues to acquire PCB transformers from other sites which have surplus equipment;
- PCB-contaminated and non-PCB transformers along with other equipment are not labeled consistently;
- The storage of PCB and PCB-contaminated waste within the Master Substation exposes the wastes to a fire risk from a downed power line;
- PCB-contaminated wastes are being stored in satellite areas without secondary containment; and
- Seven transformers, all with fewer than 50 ppm PCBs in the dielectric fluid, are being stored in the Master Substation in an unbermed area. Although not regulated by TSCA, 2 of the units, with 7 and 10 ppm PCBs, respectively, are subject to the California Administrative Code which regulates PCBs down to 5 ppm (SLAC, 1988a).

In addition, approximately 100 capacitors, which were labeled by the manufacturer as containing no PCBs, were stored outdoors at the west end of the Linear Accelerator (LINAC). The storage area was unpaved and unprotected.

4.2.1.4 Asbestos

A comprehensive asbestos sampling and analysis program has not been conducted at the SLAC, although the lagging in the boiler rooms and around water pipes is assumed to contain asbestos. Only minor repairs on covered piping are conducted by the site, and written instructions issued by the ESO to maintenance personnel require that asbestos materials be thoroughly wetted and double-bagged (SLAC personnel, 1988). Any major repairs or removals are performed by off-site contractors with ESO supervision. Only one major asbestos removal project has been conducted at the SLAC.

From June 17, 1985, through July 30, 1985, approximately 131 tons of serpentine rock containing about 25-30 percent asbestos were removed from the Klystron Gallery (SLAC, 1985c). The Bay Area Air Quality Management District was notified

of the removal (Lavagnino, ND), and the material was disposed of in an EPA-approved sanitary landfill (SLAC, 1988c). A review of the site hazardous waste shipment log revealed that since 1981 the only other asbestos removal occurred in 1984, when about 60 cubic yards of asbestos-containing materials were sent to an approved sanitary landfill.

4.2.1.5 Pesticides

All pesticide and herbicide applications at the SLAC are conducted on weekends by an off-site contractor. No site personnel apply pesticides, and no pesticides are stored on-site. The current contractor is the Bates Pest Control Company, which is certified by the State of California. The contractor supplies the SLAC with copies of the MSDSs for the pesticides used at site facilities. The pesticides currently used at the SLAC are Ficam W[®], Knox Out 2FM[®] (diazinon), and PT515 Wasp Freeze[®] for insect control; and Talon-G[®] for rodent control. The herbicides currently used at the SLAC are Trimec[®], Orthene[®], and Roundup[®] (SLAC personnel, 1988). In the past, chlordane was used at the SLAC; details are presented in Soils Section 3.2.

The SLAC pest control blanket purchase order instructs the contractor to use only pesticides approved by the State of California Department of Agriculture and EPA. The SLAC also maintains on-file verification of the contractor's qualifications, including licenses and certifications, along with information on the hazardous properties of the pesticides used on-site (Brett, 1987).

4.2.2 Findings and Observations

4.2.2.1 Category I

None

4.2.2.2 Category II

1. Evidence of leaks found at 5 of the 21 PCB transformers. Five PCB transformers (i.e., approximately 25 percent of all active PCB transformers on-site) were found to be leaking. These transformers are located at Substations 510, 501, 511, 114, and 132. It is suspected that the leaks are a result of age,

maintenance practices, and general deterioration. There is the potential for a release of a greater quantity of PCB oil, such as that which occurred in 1980 when the pressure relief valve blew out, or in the event of a rupture in the transformer. A major release of dielectric oil may contaminate the area adjacent to the transformer pads with PCBs.

Although the SLAC has requested that funding be made available for the removal and replacement of PCB transformers, it continues to acquire surplus PCB transformers from other sites. The SLAC has received 5 such units within the past 5 years and expects an additional unit on-site in the near future.

4.2.2.3 Category III

None

4.2.2.4 Category IV

1. Potential contamination from the release of petroleum products and hazardous chemicals from ASTs and drums. Potential spills of petroleum products and hazardous chemicals may result from failure to follow procedures outlined in the Best Management Practices (BMP) Plan. In addition, an SPCC Plan to aid in preventing and mitigating potential spills and releases at the SLAC has not been completed and implemented.

Insufficient containment or the absence of containment or controls exists for ASTs and drums at the SLAC. Accidental uncontrolled releases of petroleum hydrocarbons and hazardous chemicals may contaminate soil and surface water. Areas where containment or control deficiencies were observed at the SLAC include the following:

- Diesel Tank P-1: unlocked drain valve for the release of rainwater from containment;
- Diesel Tank, BSY Substation: insufficient containment to hold tank contents;

- Cooling Towers 1201 and 1202: drums of treatment chemicals stored in unbermed area;
- General Services Building: four 55-gallon drums of Freon and eight 55-gallon drums of mineral oil stored in unbermed area;
- Test Laboratory: two 55-gallon drums of Freon and eight 55-gallon drums of mineral oil stored in unbermed area;
- Central Utility Building: four 55-gallon drums of water treatment chemicals stored in unbermed area;
- EFD Storage Building: two 55-gallon drums of chemicals stored on a drum rack without secondary containment and near a storm drain;
- Cooling Tower 1701: four 55-gallon drums of water treatment chemicals stored outside the bermed storage area.

In addition, approximately 100 capacitors, which were labeled by the manufacturer as containing no PCBs, were stored outdoors at the west end of the LINAC. The storage area was unpaved and unprotected and any accidental release of dielectric liquid may contaminate soil and surface water.

2. Potential contamination from the release of PCB and PCB-contaminated oil.

There is a potential for soil and surface-water contamination from the uncontrolled release of PCB and PCB-contaminated oil. Areas where deficiencies were observed at the SLAC include the following:

- PCB transformer 503 is in an underground vault, and groundwater seepage is pumped out of the vault to the surface via a float-controlled pump. Dielectric oil leakage could be transported to the surface along with the groundwater seepage.
- Eight transformers with inventory numbers 18859 through 18866 are being stored in an unbermed area of the Master Substation. These transformers are not listed on the ESO inventory, and therefore it is not

known if the oil in these units contains PCBs. According to 40 CFR 761, oil-filled electrical equipment whose PCB concentration is unknown must be assumed to be PCB-contaminated (EPA, 1987). Potential release of transformer oil could contaminate the area adjacent to the transformers. ESO requested that site electricians withdraw samples for analysis and recommended that if the units are to be kept in storage they should be drained of dielectric fluid.

- The PCB Waste Storage Area is located within a fenced area that also encompasses the Master Substation where the potential exists for a downed wire impacting on the PCB waste containers and causing a fire. Although SLAC personnel did not believe the current conditions pose a fire hazard, the risk of discharging PCBs exists during a fire.
- PCB-contaminated and non-PCB transformers are not labeled consistently. Some site PCB-contaminated transformers (GE D578015, GE D578016, and GE D578017) were labeled, while others (substations 507 and 514) were not. It was not possible to determine if an unmarked transformer was PCB-contaminated or non-PCB without checking the serial number against the ESO inventory list. In the case of an accidental release or fire, it would be difficult to determine the proper response required.
- Seven PCB-containing transformers, all with fewer than 10 ppm PCBs in the dielectric fluid, are being stored at the Master Substation in an unbermed area. A release of transformer dielectric fluid may contaminate soil in this area.
- PCB-contaminated wastes are being stored in satellite areas without secondary containment. Eight 55-gallon drums of PCB-contaminated mineral oil are being stored in unbermed satellite areas awaiting disposal. Four of the drums are adjacent to the Test Laboratory, and the other four are adjacent to the Test Laboratory substation (Building 45). A release from these containers would result in contamination of the adjacent area and potentially could be further spread by rainwater. The

ESO has proposed that all satellite waste and product storage areas be bermed, covered, enclosed with a fence, and kept locked (Jensen, 1988b).

Potential for soil and groundwater contamination from the storage of lead materials. There is the potential for soil and groundwater contamination from the storage of lead materials at Salvage Yard 2 and in the RWSA. Scrap lead, lead bricks, and other lead shielding materials are being stored in the open and on permeable surfaces.

Weathering effects may eventually cause lead to be oxidized and leached from these materials and contaminate soil and groundwater. Exposed lead can be readily oxidized to form lead oxide which is soluble in water. Other lead compounds may also be formed and released to the environment through erosion or agitation of the materials.

Lead has been stored in the past at Salvage Yard 1. Samples were collected from this salvage yard as part of a cleanup activity and analyzed for lead. Lead contamination was detected, with the highest concentration reported as 4,720 ppm (see related Finding 1 in Section 4.5.2.3). For comparison, a few samples were found to have a lead concentration below the detection limit of 20 ppm. Contamination such as that found at Salvage Yard 1 may be present at Salvage Yard 2 or the RWSA as a result of outdoor lead storage.

4.3 Radiation

4.3.1 Background Environmental Information

This section is a discussion of the actual or potential radiological impacts to the environment that are multi-media in nature (i.e., air, soils, surface water, and groundwater). Radionuclides can be transported via any or all of the primary media and result in contamination of ambient air, soils, drinking water, groundwater, vegetation, and food. Figure 4-4 depicts some of these transport/exposure scenarios (MEPAS, 1987).

Background radiation in the vicinity of the Stanford Linear Accelerator Center (SLAC) is a consequence of both natural and man-made sources. These sources include natural cosmic radiation; natural radioactive materials in 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 natural and man-made 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 (EDE) from natural background radiation in the United States is approximately 189 millirem/year (mrem/yr) (EPA, 1986). This dose is detailed in Table 4-7. About one-half of the EDE is attributable to the inhalation of naturally occurring radon-222 and its decay products. Previously accepted estimates of the background dose did not include the radon contribution and were set at about 100 mrem/yr EDE.

The data in Table 4-7 were derived in accordance with the approach recommended by the International Commission on Radiological 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" to the effective 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 resulting dose equivalents (DEs) for the individual organs provides an estimate of the total effect of the radiation on the whole body.

Source: MEPAS, 1987

TRANSPORT/EXPOSURE SCENARIOS

FIGURE 4-4

TABLE 4-7**AVERAGE ANNUAL EFFECTIVE DOSE EQUIVALENT TO HUMANS
FROM NATURAL BACKGROUND RADIATION**

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	189

Source: Adapted from EPA, 1986

The U.S. Environmental Protection Agency (EPA) reports on a quarterly basis ambient gamma exposure rates, including those from natural cosmic radiation, for selected locations throughout the continental United States. These ambient gamma exposure rates do not measure the contribution attributable to the inhalation of naturally occurring radon-222 and its decay products. The latest available data are for the 12-month period from April 1986 to March 1987. For this period, the EPA reported ambient gamma exposure rates equivalent to annual doses of between 136 ± 82 mrem DE in Denver, Colorado, and 58 ± 43 mrem DE in Berkeley, California. The average measured ambient gamma exposure rate equivalent to an annual dose at the 22 locations monitored was 89 ± 45 mrem DE (EPA, Office of Radiation Programs, 1986; 1987a, b, c).

The U.S. Department of Energy (DOE) establishes radiation protection guidelines for its facilities. Radiation standards for the protection of the public in the vicinity of the SLAC are given in DOE Order 5480.1A, Chapter XI, as amended on August 5, 1985 (Vaughan, 1985). These standards are based on the recommendations of the ICRP and the National Council on Radiation Protection and Measurements (NCRP). The amended order also includes the EPA limits for the atmospheric pathway radiation dose received from DOE facilities as contained in the National Emission Standard for Radionuclide Emissions from Department of Energy Facilities (40 CFR 61, Subpart H) (EPA, 1985). The DOE dose limit is 100 mrem/yr EDE, excluding natural background and medical exposures, for all pathways to any member of the general public for a prolonged exposure from normal DOE operations. The previously recommended limit of 500 mrem/yr EDE is retained for non-continuous exposures. In addition, as stated in the EPA regulation (40 CFR 61, Subpart H), any member of the general public shall not receive a radiation dose from the air pathway of greater than 25 mrem/yr to the whole body or 75 mrem/yr DE to any organ from normal DOE operations.

DOE Order 5484.1 requires its facilities to make an annual assessment of releases and potential dose to the public. The results are to be reported in an Annual Environmental Summary or Annual Environmental Monitoring Report.

4.3.2 General Description of Pollution Sources and Controls

Direct penetrating radiation sources and controls, and the release of accelerator-induced radioactivity in materials for unrestricted use, are discussed in this section. The radioactive sources and controls for air, soil, surface water, and groundwater are discussed in Sections 3.1.2, 3.2.2, 3.3.2, and 3.4.2, respectively.

The major sources of direct penetrating radiation at the SLAC can be divided into two categories. These categories are the operation of the accelerator and storage rings, and the use of gamma and neutron sources.

4.3.2.1 Operation of the LINAC and Storage Rings

The SLAC facility is designed around the 2-mile-long Linear Accelerator (LINAC). The LINAC supplies beam particles, electrons and positrons, to the fixed target area, which consists of End Stations A (Building 61), B (Building 62), and C; storage rings, which include the Positron Electron Project (PEP) and Stanford Positron Electron Asymmetric Ring (SPEAR); and the soon-to-be completed SLAC Linear Collider (SLC). Figure 4-5 shows these areas and their relationship to the LINAC. The Beam Switchyard (BSY) (Building 9) diverts the beam particles to the desired receptor areas (SLAC, 1987a). Heavy construction of the SLC during 1986 and 1987 prevented operation of the LINAC.

The LINAC is currently capable of simultaneously accelerating electrons and positrons to 50 giga electron volts (GeV). Associated with the LINAC are the positron source, north (positron) damping ring, south (electron) damping ring, and the BSY. The LINAC accelerates electrons and stores them in the electron damping ring, allowing the more energetic electrons to lose energy and less energetic electrons to die out. This produces a relatively mono-energetic bundle of electrons suitable for injection into the LINAC for final acceleration before the BSY directs them to their final destination. Additionally, the LINAC accelerates electrons and directs the beam particles to a target in the positron source. The interaction of the electrons with the target produces positrons. The positrons are then accelerated and stored in the positron damping ring before reinjection into the LINAC. In the BSY, pulsed magnets direct the beam particles to the fixed target area, PEP, SPEAR, or the SLC (SLAC, 1987a).

FIGURE 4-5

A SCHEMATIC OF THE LINAC, STORAGE RINGS, AND SLC

The fixed target area consists of End Stations A, B, and C. Only End Station A is currently used. Fixed target areas are the locations where the LINAC beam is collided with a stationary material (target) to study or change the material or study the particles emitted by the collision. The remainder of the beam that passes through the target is terminated at a beam dump (absorbing) area. The beam dump (absorbing) areas are the locations where the LINAC beam is safely terminated after use. This is usually accomplished by dissipating the energy in a mass of material or water and is in some cases a combination of both.

The PEP is a colliding beam storage ring, where the same bunches of beam particles are brought into collision over and over, rather than striking a target only once. In the PEP, beams of electrons and positrons circulate in opposite directions at energies up to 15 GeV. The two beams can then be collided in any or all of the 6 PEP Interaction Regions (IRs) shown in Figure 4-5 (SLAC, 1987a).

The SPEAR is a colliding beam storage ring, which was actually a prototype for the larger PEP. The SPEAR currently serves as a source of synchrotron light for the Stanford Synchrotron Radiation Laboratory (SSRL) (Buildings 120/131). Electromagnetic radiation produced by the SPEAR is used for material studies at the SSRL.

The SLC is a new type of electron-positron colliding beam facility housed in a 1.9-mile underground tunnel, which is in the final stages of construction. The SLC operation is based on the acceleration of a single intense positron bunch and a single intense electron bunch to an energy of approximately 50 GeV each in one pulse of the LINAC. The Mark II particle detector will be used initially with the SLC, and a new SLAC Large Detector (SLD) will be installed in the future at the Collider Experimental Hall (CEH) (SLAC, 1987a).

Operation of the LINAC, fixed target area, and colliding beam storage rings at current energies and intensities results in direct penetrating radiation outside the shielding that surrounds the LINAC, target areas, storage rings, and beam dump areas. The two forms of direct penetrating radiation produced are neutrons and gamma rays.

Controls employed at the SLAC for these sources of direct penetrating radiation are primarily shielding, monitoring, and distance from the source. The other generally accepted direct penetrating radiation control method, reducing the time of exposure, is used to limit occupational and visitor exposures. Exposure time is controlled administratively, by posting radiation areas that exceed 2 milliroentgens per hour (mR/hr) and by prohibiting access in the LINAC and storage rings during operation with interlocked key capture control systems.

Other environmental radiation concerns associated with accelerator operations are the radioactivation of air, soil, accelerator component cooling water and groundwater by interaction of the beam or spray of secondary particles resulting from beam contact with accelerator components and these media. See Sections 3.1.2, 3.2.2, 3.3.2, and 3.4.2, respectively, for a more detailed discussion.

4.3.2.2 Use of Gamma and Neutron Sources

Several multicurie gamma and neutron sources are in use at the SLAC. These sources are used for instrument calibration, radiography, and research. Due to shielding and distance to the site boundary, these sources do not contribute to the off-site direct penetrating radiation levels, and therefore are not discussed further. Shielding, monitoring, and limiting access to these areas via administrative controls and unique keyed locks that allow entry of only Operational Health Physics (OHP) personnel are employed at the SLAC for these sources of direct penetrating radiation.

4.3.2.3 Release of Materials Containing Induced Radioactivity for Unrestricted Use

The SLAC releases materials to the general public via scrap dealers and other channels. According to interviews with site personnel, this practice has been in effect since the SLAC was established. Knowing that operations at the SLAC can produce materials that are activated (i.e., containing induced radioactivity), the SLAC has a procedure and criteria for releasing material for unrestricted use. The SLAC Radiation Rule Book (SLAC, 1980c) states:

REMOVAL OF MATERIALS. Equipment or materials which have been exposed to the beam or near the beam are apt to be radioactive and must not be removed without consulting Operational Health Physics. Operational Health Physics should be informed what is to be done with the item, e.g., repair in place, remove to a machine shop, etc. so it can be surveyed and tagged appropriately. Even if it is not radioactive, it will not be accepted in the shops without an Operational Health Physics "Clearance" tag.

To determine if a material is radioactive, the SLAC uses Operational Health Physics Procedure No. 4 (OHP P-4) (Rickansrud, 1988b). The purpose of this procedure is to "...prevent disbursement of radioactive material to the general public via scrap dealers or other channels...to prevent recycled materials that are radioactive from being used for support structures or fixtures housing sensitive radiation detectors..." OHP P-4 states that material or devices scheduled for removal should be surveyed for radiation (screened) in place. If this is not possible, then the screening shall be performed after removal and prior to transporting to its final destination. If the external gamma exposure rate at all surfaces at 30 centimeters (cm) is less than ($<$) 0.02 mR/hr, then it is considered nonradioactive. If this nonradioactive material is to be discarded, then it is transported to the scrapyard. At the scrapyard, the SLAC uses OHP P-1 (Rickansrud, 1988b) to check the scrap before its release to the general public via scrap recovery. This procedure states that each container placed in the scrapyard shall be screened for evidence of radioactive material. A Tech Associate/TBM-3 Geiger-Mueller (GM) survey meter or approved substitute shall be used for the screening. The meter shall be placed at the surface of each container at several locations. Any value in excess of a rate of 200 counts per minute (cpm) shall be considered positive evidence of radioactive materials. If such evidence is found, then the container shall be emptied and the contents sorted to locate the radioactive material. The material will then be removed and placed in a container labeled with a placard indicating radioactivity. If no evidence is found, the container shall be labeled with a green and white "clearance" tag.

Review of the SLAC's standard operation for releasing material for unrestricted use revealed the following:

1. There is no written procedure on how the radiation screening of the material is to be performed. Since there was no written procedure, a review of the procedure was performed by interviews with site personnel on how they conduct the radiation screening.
2. The procedure as described by interviews with site personnel and alluded to in OHP P-4 and OHP P-1 revealed the following:
 - a. The entire surface of the material or container is not screened.
 - b. The distance the survey meter is to be held from the surface of the material or container is not specified.
 - c. The speed at which the survey meter is to be moved over the surface of the material is not specified.
 - d. There is no difference in the procedure to compensate for the different self-shielding factors for materials of varying thicknesses.
 - e. No correction is made to account for the different response of the survey meter to radionuclides having different gamma energies from the radionuclide used to calibrate the survey meter.
 - f. No compensation is made to reflect the difference in response from one survey meter to another of the same type to the same radiation field.
 - g. There are no criteria to establish who is qualified to perform the screenings.
 - h. No requirements for documentation of the screening procedure are established.
 - i. Periodic core samples are not taken and analyzed to verify the surface screening results.

3. There are no training records establishing that individuals who perform the screenings are qualified for this procedure.
4. OHP logbooks contain insufficient information to determine that the screenings were performed.
5. There is no agreement with Federal or state agencies on the screening procedure used.
6. No written documentation tracking the materials released through this procedure exists.
7. No quality assurance (QA) program is in effect for this screening procedure.

Interviews with site personnel revealed an incident when a large piece of activated metal, marked "0.5 mR" per hour was accidentally released for salvage. The material was retrieved when the SLAC was called by the salvage company.

4.3.3 Environmental Monitoring Program

This section discusses the SLAC's direct penetrating radiation environmental monitoring program (Section 4.3.3.1) and dose assessments for the general public (Section 4.3.3.2). A comparison of each reported dose assessment of the radiological releases at the SLAC will be made with the applicable standards. The environmental monitoring programs for individual media are discussed in the appropriate sections for Air (3.1.2), Soil (3.2.2), Surface Water (3.3.2), and Hydrogeology (3.4.2).

4.3.3.1 Direct Penetrating Radiation Environmental Monitoring Program

To determine the direct penetrating radiation impact of SLAC operations on the environment, six peripheral monitoring stations (PMSs) are maintained about SLAC's perimeter as shown in Figure 4-6. Each station contains neutron and gamma pulse counters. The neutron detectors are boron fluoride (BF₃) gas proportional counters housed in paraffin moderators. The gamma detectors are GM chambers.

FIGURE 4-6

LOCATIONS OF PERIPHERAL MONITORING STATIONS (PMSs)
AT THE SLAC

The output from each detector is printed hourly on the attached Sodeco registers. Dead time per printout cycle is less than 20 seconds per hour. Related corrections are negligible and are not made. During 1986, the LINAC and PMSs 2, 3, 4, and 6 were out of service for the entire year because of heavy construction on the SLC. Also, the gamma sensor at PMS 1 was modified to test a neutron counter that could permit a more precise evaluation of neutron dose from SLAC operations. This unit was tested under actual environmental conditions (SLAC, 1987a).

Table 4-8 lists the EDEs measured at each PMS during 1986. As can be seen from this table, the highest reading above background was for the neutron dose at PMS 1. This dose was 4.3 mrem EDE. The gamma dose reported was within normal fluctuation of background radiation.

Documentation related to the Radiological Monitoring Program (RMP) was also reviewed. While there were written procedures for the calibration of the air samplers and BF₃/GM detectors, other written procedures did not exist. A lack of written procedures for sample collection, analyses, analytical equipment calibration and quality control (QC) requirements, data reduction, reporting, records required, and training was observed. Additionally, there was no QA program. A finding associated with this observation is discussed in the Quality Assurance Section 4.4.2.4, Finding 1.

4.3.3.2 Summary of Exposures

In the 1986 Annual Environmental Monitoring Report, the maximum EDE delivered to a hypothetical member of the community was defined as the maximum perimeter dose. That value for 1986 was 4.3 mrem EDE for penetrating radiation (see Section 4.3.3.1), or 4.3 percent of the DOE dose limit of 100 mrem/yr EDE. There were no liquid or airborne releases reported for 1986. Therefore, no dose assessment was performed for these pathways. The total exposure for 1986 was 4.3 mrem EDE or 4.3 percent of the DOE dose limit of 100 mrem/yr EDE.

TABLE 4-8

ANNUAL PENETRATING RADIATION DOSE MEASURED NEAR SLAC
BOUNDARIES FOR 1986

PMS No.	Gamma (mrem)			Neutron (mrem)		
	Total	Background	Net	Total	Background	Net
1	OS	OS		17.3	13	4.3
2	OS	OS		OS	OS	
3	OS	OS		OS	OS	
4	OS	OS		OS	OS	
5	75	70.0	(a)	13	12	(a)
6	OS	OS		OS	OS	

Source: SLAC, 1987a

(a) Within normal fluctuation of background radiation.
OS = Out of Service

4.3.4 Findings and Observations

4.3.4.1 Category I

None

4.3.4.2 Category II

1. Release of activated (i.e., containing induced radioactivity) materials for unrestricted use. Salvaged activated equipment and parts are being released to the general public or for burial off-site in sanitary landfills without complete written procedures in place and documentation to adequately assess the potential dose or environmental impact. This could result in an inadvertent exposure to an individual or an inadvertent off-site release to the environment exceeding the levels this program is intending to meet.

OHP procedures require that materials removed from the high-energy transport line be screened for radioactivity. If the exposure rate at all surfaces is <0.02 mR/hr, the material is considered nonradioactive and is released for unrestricted use. These materials have been released to the general public through salvage operations or burial in sanitary landfills since the SLAC was established. For instance, a large piece of radioactive induced metal, marked "0.5 mR" per hour, was accidentally released for salvage. The material was retrieved when the SLAC was called by the salvage yard.

The combination of the following observed inadequacies results in a lack of confidence that either the potential dose to the general public or the environmental impact is accurately assessed:

1. No written procedure exists on conducting the radiation screening of the materials.
2. The procedure used for the radiation screening of materials as described by interviews with site personnel is inadequate for the following reasons:

- a. The entire surface of the material or container is not screened. This could result in missing a radioactive area and falsely labeling it nonradioactive.
- b. The distance the survey meter is to be held from the surface of the material or container is not specified. Again, this could result in missing a radioactive area.
- c. The speed at which the survey meter is to be moved over the surface of the material is not specified. This could lead to missing a radioactive area because the speed of the survey meter passing over the surface of the material may be too fast for the response time of the survey meter to accurately register the readings.
- d. There is no difference in the screening procedure to compensate for the different self-shielding factors for materials of varying thicknesses. Site personnel indicated that this could account for a lower survey meter reading by up to a factor of 4. This could result in releasing radioactive material up to 4 times higher than the established criteria.
- e. There is no correction made to account for the different response of the survey meter to radionuclides having different gamma energies from the radionuclide used to calibrate the survey meter. This can cause a lower or higher reading than actual, leading to an erroneous conclusion.
- f. There is no compensation made to reflect the difference in response from one survey meter to another to the same radiation field. Each survey meter has a different response curve. This can cause a lower or higher reading than actual, again leading to an erroneous conclusion.

- g. There are no criteria to establish who is qualified to perform the screenings. This could lead to misuse of the survey meter and incorrect results being obtained.
 - h. No requirements for documentation of the screening procedure are established, including what the background reading was, identification of survey meter used, whether the survey meter was in calibration, description of material or container screened, what the results of the screening were, and final disposition of the item. As a result, these records are not kept or are inconsistently kept, making a review of the documentation for any reason difficult if not impossible.
 - i. Periodic core samples are not taken and analyzed to verify the surface screening results. This makes it difficult to verify the accuracy or adequacy of the screening procedure.
- 3. No training records exist for individuals conducting the screenings.
- 4. There is inadequate documentation to conclude that the screening was performed or that it was properly performed.
- 5. There is no agreement with Federal and state agencies that the screening procedure is adequate and acceptable. In a 1985 appraisal (referred to in Rickansrud, 1988b), SAN stated that the criterion for release of ≤ 0.02 mR/hr was conservative, but did not endorse the use of the criterion or state whether the screening procedure used was adequate.
- 6. There is a lack of a QA program and written documentation tracking the materials released through this procedure to ensure overall program integrity. This also prevents verification or review of circumstances surrounding the release of material should a future need arise to do so.

The SLAC has taken steps to begin correcting these deficiencies. On March 18, 1988, a memorandum was issued reemphasizing guidelines for handling radioactive equipment from the beam line.

4.3.4.3 Category III

None

4.3.4.4 Category IV

1. Lack of written Radiological Monitoring Program (RMP) procedures. Written RMP procedures are either incomplete or non-existent, which may result in questionable analytical data.

While there are written procedures for the calibration of the air samplers and BF₃/GM detectors, other written procedures did not exist. A lack of written procedures for sample collection, analyses, analytical equipment calibration and QA requirements, data reduction, reporting, records required, and training was observed. The SLAC has indicated that some procedures have been written but not yet issued.

4.4 Quality Assurance

This section reviews the procedures for the collection and analysis of environmental data, with emphasis on the program used to ensure the quality of the data produced. Two aspects of quality assurance (QA) are considered: quality control (QC) and quality assessment. QC refers to those actions taken in the laboratory to ensure that the accuracy and precision of the analyses are within acceptable limits. Examples would be running reference standards through the system; calibrating the instruments; and running splits, spikes, and surrogates. Quality assessment refers to the system or program whereby management assures itself that the QC measures are being applied.

An adequate QA program should include the following:

- Chain-of-custody
- Good laboratory practices
- Good measurement practices
- Standard operating procedures
- Inspections/audits
- Documentation
- Training.

4.4.1 General Description of Sampling and Data Handling Procedures

Environmental surveillance at the Stanford Linear Accelerator Center (SLAC) is the responsibility of the Environment and Safety Office (ESO). The surveillance program consists of radiological and National Pollutant Discharge Elimination System (NPDES) sample collection and analysis, and data from the program are included in the site annual environmental monitoring report (SLAC personnel, 1988).

The Health Physics Group of ESO is responsible for the collection and analysis of the radiological samples which cover airborne radionuclides and penetrating radiation monitoring. A review of the site Radiological Monitoring Program (RMP) and supporting documentation was conducted and observations are discussed in Section 4.3.3. The review revealed that there is no mechanism or documentation in place to

ensure that the procedures and QC of the RMP Quality Assurance Plan (QAP) are adequate or are being followed.

The Environmental Monitoring (EM) Group of ESO is responsible for the collection and analysis of the NPDES samples. The samples are collected by site personnel and analyzed by a contract laboratory (SLAC personnel, 1988).

The NPDES sample collection techniques were observed, and the observations are presented in Section 3.3.3. It was noted that there are no written procedures for effluent sampling at the NPDES monitoring locations, and the sampler does not initiate a chain-of-custody document at the time of sampling. The collected samples are relinquished to the EM group, which in turn relinquishes them, with chain of custody, to the contract laboratory (SLAC personnel, 1988).

McIntosh Laboratories, Inc., of San Jose, California, is the contract laboratory that analyzes the SLAC NPDES samples. McIntosh is a California-approved water laboratory, maintaining approvals in chemical, bacteriological, and bioassay analyses of water. The laboratory has a formal and extensive QA manual (McIntosh, 1988). For example, the laboratory's QA requirements include the following:

- Standard analytical texts such as the "Environmental Protection Agency Methods for Chemical Analysis of Water and Wastes" (EPA, 1979) and "Standard Methods for the Examination of Water and Wastewater" (APHA, 1981) are used;
- Control of analytical methods and results is ensured by participating in "round robin" testing with both private and Governmental agencies;
- Daily control of analytical results is assured by running standards, blanks, and replicate samples;
- Day-to-day analytical activities are monitored using QC charts based on precision and accuracy data generated each day; and
- Good laboratory practices are ensured through detailed instructions covering sample tracking, reagent preparation and monitoring,

instrument maintenance and calibration, and mathematical manipulations.

Oversight of the contract laboratory is handled by the EM Group (SLAC personnel, 1988). However, there are currently no formal written procedures in place specifying what steps management should take to ensure that the contract laboratory QC requirements are carried out. Also, there are no written procedures for monitoring the actual collection of samples.

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. Inadequate QAP for environmental monitoring. The QAP is inadequate to ensure that QC requirements for the environmental monitoring sampling and analysis procedures are adequate or are being followed. This may raise questions as to the validity of analytical results.

Written radiological environmental monitoring program procedures are either incomplete or nonexistent, which may result in questionable analytical data. Although there are written procedures for the calibration of the air samplers and the neutron and gamma detectors, no other procedures exist for

sampling, counting equipment calibration, data reduction, recordkeeping and reporting, or training. The SLAC has indicated that some procedures have been written but not yet issued. Also, there are no written procedures covering the sampling of the cooling towers for the required NPDES parameters, and it was noted that the sampler does not initiate a chain-of-custody document at the time of sampling. If the chain-of-custody document is not filled out at the time of sampling, the SLAC cannot document sample custody. There is a written QAP for the contract laboratory which analyzes the NPDES samples. However, there are no formal written procedures in place specifying what steps SLAC management should take to ensure that the QC requirements for sample collection and for the contract laboratory are carried out.

4.5 Inactive Waste Sites and Releases

4.5.1 General Description of Pollution Sources and Controls

This section provides an inventory and description of areas on the Stanford Linear Accelerator Center (SLAC) that may be sources of environmental pollution due to past spills, leaks, or accidental releases. From the review of available background information, there is no indication that a hazardous waste or radioactive waste land-disposal site exists on the SLAC. There is evidence, however, of chemical contamination associated with some past operational and storage practices at the SLAC, including use of an underground storage tank (UST) for waste solvents. In addition, there are several locations on the SLAC where spills potentially occurred. The following groups of sites are described in this section:

- Storage Locations with Known or Suspected Soil Contamination;
- Underground Storage Tanks That Have Been Removed;
- Other Potentially Contaminated Areas; and
- Asphalt and Earth Fill Areas.

The information presented in this section was obtained from a review of historical aerial photographs for 1973, 1974, 1975, 1976, and 1986; interviews with site employees; field notes from various SLAC staff; historical engineering drawings; previous investigations; and the Draft Phase I Installation Assessment prepared in accordance with DOE Order 5480.14, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, and the Superfund Amendments and Reauthorization Act (SARA) of 1986. In addition, site visits were conducted for each of the areas discussed below.

4.5.1.1 Storage Locations With Known or Suspected Soil Contamination

Four areas on the SLAC have been used for storage, with past practices resulting in soil contamination. These areas, which are shown on Figure 4-7, are as follows:

- Former Chemical Waste Storage Area
- Salvage Yard 1

Source: SLAC personnel, 1988

FIGURE 4-7

STORAGE LOCATIONS AT THE SLAC
WITH KNOWN OR SUSPECTED SOIL CONTAMINATION

- Salvage Yard 2
- Master Electrical Substation

The following paragraphs provide a description of the past practices in each of these areas along with information on the type and level of contamination detected or suspected.

Former Chemical Waste Storage Area

The Former Chemical Waste Storage Area was located in the vicinity of the present-day New Warehouse/Magnet Factory (Building 15) as shown on Figure 4-7. Based on historical aerial photographs (SLAC, 1973), this area was in use as of 1973; information on its earlier use was not available. According to SLAC personnel, the area was first used as a location for two aboveground storage tanks (ASTs) containing diesel fuel and/or gasoline. Gradually, drums containing chemical waste were brought to this area and allowed to accumulate (SLAC personnel, 1988).

In late 1979 and 1980, the Chemical Waste Storage Area was brought to the public's attention and SLAC responded by initiating cleanup of the area. Hazardous waste manifests made available by the SLAC Environment and Safety Office (ESO) personnel indicate that from November 4 to 14, 1980, 710 55-gallon drums containing paint thinners, oxygenated solvents, chlorinated solvents, and oil were shipped off-site for disposal in Casmalia, California. These wastes were reportedly generated from machining operations and parts degreasing activities. Also during this period, 79 drums containing solvents, oil, and alkaline solutions generated from plating and machining operations were shipped off-site, along with approximately 100 empty drums (SLAC, 1980a).

In February 1981, eight samples were collected of the asphalt and soil in the storage area and analyzed for polychlorinated biphenyls (PCBs). The results of these tests showed PCB contamination at levels of up to 33 parts per million (ppm). Consequently, in June of 1981, 80 tons of contaminated asphalt, soil, wood and some crushed drums were removed from the site and disposed of at the Kettleman Hills Site operated by Chemical Waste Management in Coalinga, California (SLAC, 1981; California DOHS, 1981). According to ESO personnel, asphalt and soil were removed from an approximately 300-square-foot area (SLAC personnel, 1988).

Between 1981 and 1983, the SLAC continued to use this location as a hazardous waste accumulation area. Following the 1981 cleanup actions, the area was repaved, a berm was constructed for spill control, and a fence was installed to restrict access. In 1983, the SLAC decided to construct a new building, the Magnet Factory, in the location of the Chemical Waste Storage Area (ESO, ND). Six samples of soil and asphalt were collected in November 1983 for analysis of 1,1,1-trichloroethane and PCBs. This solvent was selected for analysis because it had been used in large quantities at the SLAC. Neither constituent was detected in the analyses, with the detection level for trichloroethane reported as 0.005 ppm and for PCBs as 0.5 ppm (Rickansrud, 1985).

Presently, the location of the Former Chemical Waste Storage Area is occupied by the asphalt parking lot and the building housing the Magnet Factory. The Hazardous Waste Storage Area (HWSA) was relocated west of this building and continues to be active (see related discussion in Section 4.1).

Salvage Yard 1

An equipment and materials salvage yard is located southeast of the Main Electrical Substation along South Target Area Road. This storage area has been designated by the SLAC as Salvage Yard 1. Based on historical aerial photographs, this salvage yard has been in use since 1973 (SLAC, 1973). With operation of the Linear Accelerator (LINAC) beginning in 1966, it is possible, however, that this area was used for storage for up to 7 years earlier than specific records or available photographs indicate.

There are no records available to document the types of materials stored in Salvage Yard 1; however, according to ESO personnel, surplus equipment, parts, excess lead shielding, and other miscellaneous items were accumulated in the area. Although it was not authorized as a chemical waste accumulation area, ESO personnel occasionally noted 55-gallon drums of waste placed in Salvage Yard 1. Also, many of the items stored in the open yard contained oil and were susceptible to leakage. Salvage Yard 1 was not intended for radioactive waste storage or accumulation; therefore, the materials in the yard were periodically checked to ensure that radioactively contaminated salvage was not improperly stored. According to ESO

personnel, if necessary, contaminated items were removed and placed in the designated Radioactive Waste Storage Area (RWSA) (SLAC personnel, 1988).

In 1988, the SLAC initiated cleanup of Salvage Yard 1. All equipment and various materials stored in the yard were temporarily removed. A sampling and analysis strategy was developed for the area to determine if soil contamination existed. One aspect of this strategy was to collect samples from the topographically downgradient area, which includes a storm drain that discharges into San Francisquito Creek. Thirty-two samples were collected for PCB analyses, some at random locations and some from obviously stained surface soil areas. Most of these samples were collected from the surface; however, a few shallow subsurface samples were also collected at a depth of up to 7 inches. Ten samples were also analyzed for lead (SLAC, 1988b).

The results of this sampling effort found PCB contamination in the salvage yard soils at levels generally ranging from 10 to 200 ppm. In the storm drain, concentrations up to approximately 500 ppm were detected. Lead contamination was also detected, with the highest concentration reported as 4,720 ppm. For comparison, some samples collected from the area were found to have nondetectable levels of PCBs and lead, with the detection limits reported as 0.1 and 20 ppm, respectively (SLAC, 1988b). According to ESO personnel, some of the soil submitted for analyses contained lead fragments, and therefore likely accounted for the elevated concentrations.

Based on the PCB analyses, the SLAC identified portions of Salvage Yard 1 that required soil removal. Generally, the top 6 inches of surface soil was scraped from two portions of the salvage yard, except in the vicinity of the storm drain, where soil was removed from a depth of approximately 2.5 feet. According to ESO personnel, a total of about 90 cubic yards of soil was excavated from Salvage Yard 1 and disposed of off-site. The area was then covered with crushed rock and returned for use as a storage yard for salvageable items (SLAC, 1988b).

Salvage Yard 2

Salvage Yard 2 is located south of the Warehouse Building (Building 28) as shown in Figure 4-7. This area was in use for storage of materials as of 1974, based on historical aerial photographs (SLAC, 1974). Similar to Salvage Yard 1, information was not available to pinpoint the date this location was first used as a storage area. According to interviews with SLAC personnel, in the early years of SLAC operations, the Motor Pool was located at the present-day location of Salvage Yard 2 (see related discussion in Sections 4.5.1.2 and 4.5.1.3).

Salvage Yard 2 remains active for storage of old equipment, scrap metal, and other assorted items. A dark, oil-like substance has stained the soil over a large portion of the area, indicative of past spills or leaks from the items placed in storage. Following the cleanup of Salvage Yard 1, the SLAC collected samples from Salvage Yard 2 for analyses of PCBs. The sampling effort was designed to include randomly selected sample locations as well as some locations of heavily stained soil. A storm drain is located within 2 feet downslope of some of the worst stained soil, and samples from this area were included in the sampling design (SLAC, 1988b). The analytical data from this SLAC study were not available from the contract laboratory at the time of the Survey; however, ESO staff stated that it is highly probable that PCB contamination will be detected. Analyses for other constituents were not performed (SLAC personnel, 1988).

Master Electrical Substation

The Master Electrical Substation is located south of Sector 30 of the Klystron Gallery of the LINAC, as shown in Figure 4-7. As described in earlier sections (i.e., Sections 3.3, 4.1, and 4.2), this area has a variety of uses -- the substation itself, electrical equipment storage, and the PCB Waste Storage Area. Large transformers are located within this fenced area and are in use as part of the substation, as discussed in Section 4.2. In addition, the area has been used for storage of idle electrical components, both usable and scrap, since 1973 (SLAC, 1973). Although inventories of the items in storage were not available, it is suspected that in the past, some of this equipment contained PCB oil or PCB-contaminated oil that potentially may have leaked. The area has also been used for servicing electrical equipment, during which spills may have occurred (SLAC personnel, 1988). In addition, a portion of the

Master Electrical Substation has been designated for storage of drums containing PCB waste (see related discussions in Sections 4.1 and 4.2). In the past, some of these drums were stored outside the covered, concrete storage pad and may have leaked onto surface soils.

The topography of the substation is relatively flat. However, storm drainage from the yard is influenced by several sumps that are regularly pumped out into the perimeter stormwater ditches. There are five groups of transformers that are surrounded by crushed stone fill that extends to a depth of approximately 4 feet. A sump has been constructed in each of the five fill areas to collect rainwater and groundwater. Periodically, a submersible pump is used to remove the water from these sumps and to discharge it into the ditches on the periphery of the substation as depicted in Figure 4-8. Three additional sumps are located in this area - one in the active PCB Waste Storage Area and two in a concrete-lined shallow pit on the southwest corner of the substation yard. In the past, the water that collected in the southwest corner was discharged to the perimeter ditch. Some reports indicate that the water in these two sumps was filtered prior to discharge into the ditch, for the purpose of removing any oil that might have been mixed with the stormwater. Current practices, however, have been modified such that if an oil sheen is on it, the water is drummed and not released to the perimeter ditches (SLAC personnel, 1988).

Stained soil is evident in the Master Electrical Substation; consequently, the SLAC plans to collect and analyze soil samples from this area. According to ESO staff, PCB contamination is likely to be present in the soils based on past use of this area (SLAC personnel, 1988).

4.5.1.2 Underground Storage Tanks That Have Been Removed

Three USTs were used in the past at the SLAC that have since been removed. The approximate location of these USTs is provided on Figure 4-9. One tank received liquid waste and the other two were used for product storage. The liquid waste tank has been the subject of considerable study over the past 5 years and was included in the Draft Phase I Installation Assessment; the other two tanks were not included. The following paragraphs provide additional information on each of these tanks.

Sources: SLAC personnel, 1988; Survey team observations

SKETCH OF THE MAIN ELECTRICAL SUBSTATION

FIGURE 4-8

Waste Solvent Tank B-1

A 3,500-gallon UST constructed of steel was formerly located next to the northwest corner of the Plant Maintenance and Utilities (PMU) Building (Building 35). The UST was used from 1967 to 1978 for storage of wastes from the paint shop, which included paint thinners, lacquers, and other solvents. In early 1983, a pressure test of the tank revealed that it was leaking and by December 1983, the tank was removed along with some soil visually identified as being contaminated (ESO, ND). In March 1984, a shallow monitoring well was installed a few feet east of the former tank location. Soil from the well boring and groundwater samples indicated the presence of organic contamination (Ecology & Environment, Inc., 1985).

During the fall of 1984 and in June 1985, a two-phase study was performed to determine the extent of soil and groundwater contamination in the vicinity of the waste solvent tank. A total of 14 soil borings were drilled and sampled at discrete depths as part of this study. In addition, four shallow monitoring wells ranging in depth from 26 to 55 feet below land surface were installed. One deep monitoring well was also installed and completed to a depth of 100 feet with the screened interval set at 40 to 80 feet below land surface. The principal contaminants identified through this investigation were volatile organic compounds (VOCs). The extent of contamination was concluded to be confined to an area within 10 feet of the former tank location (Ecology & Environment, Inc., 1985). In March 1987, additional soil was removed from around the former tank location as an interim cleanup measure that was approved by the California Regional Water Quality Control Board (RWQCB) (Millan, Higgins, and Pera, 1987).

In July 1987, another field study was performed that involved drilling three more borings to depths ranging from 25 to 30 feet, with samples collected at discrete intervals. These borings were located between the tank site and the PMU Building. The results of this investigation revealed that VOCs were still present in the subsurface soil. The study was not successful in defining the total depth or extent of contamination. Following this study, a remediation technique known as soil venting was proposed (Millan, Higgins, and Pera, 1987). The field test using this technique was implemented in early 1988, but failed to be successful (SLAC personnel, 1988).

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More specific information on the sample protocols, the analytical results, and the data qualifications are available in the referenced studies. The following lists the compounds identified in the samples collected during these investigations and the media in which they were detected. This list is provided as a general overview of the types of contaminants found to be present over the past five years of study, recognizing that contaminated soil has been removed as described above.

<u>Constituent</u>	<u>Soil</u>	<u>Groundwater</u>
Benzene	X	X
Chloroform	X	X
1,1-dichloroethane	X	X
1,1-dichloroethylene	X	X
Trans-1,2-dichloroethylene	X	X
Ethyl benzene	X	X
Methylene chloride	X	X
Tetrachloroethylene	X	X
Toluene	X	X
1,1,1-trichloroethane	X	X
Trichloroethylene	X	X
Xylene	X	X
Acetone	X	X
Methyl ethyl ketone	X	X
Methyl isobutyl ketone	X	X
bis-(2-ethylhexyl)phthalate	X	X
Naphthalene	X	
Phenol	X	
Carbon tetrachloride	X	

Total xylenes, toluene, 1,1,1-trichloroethane, and phenol have been detected in the highest concentrations (i.e., from 100 to 600 ppm) in the soil samples. Toluene, 1,1-dichloroethane, trichloroethylene, and ethyl benzene have been identified in groundwater samples in the parts-per-million range (i.e., from 2 to 17 ppm). The most recent analytical results of groundwater samples collected from this site are provided in Hydrogeology, Section 3.4.3.

Unnumbered Fuel Tank

An engineering drawing dated 1964 provides the specifications for a 1,000-gallon steel UST to be installed in the vicinity of the present-day Warehouse Building (Building 28) (SLAC, 1964). Based on the drawing, the tank was connected to a fuel pump at a fuel station that supplied the SLAC. According to interviews with SLAC personnel conducted during the Survey, the Motor Pool was first located in one of three temporary buildings in the area currently occupied by the Warehouse and Salvage Yard 2, thus confirming that the tank existed. When the temporary buildings were dismantled and/or removed to allow for construction of the Warehouse Building, the tank was reportedly also removed (SLAC personnel, 1988).

This tank had not been identified in the SLAC inventory of USTs and no additional information on its status was available. Another fuel tank was installed in 1969 at the present-day location of the Motor Pool (see discussion for Tank A-5 presented below). Based on this installation date, it may be reasonable to assume that the unnumbered tank in the vicinity of the Warehouse Building was not used for more than approximately 5 years.

Fuel Tank A-5

In 1969, a 10,000-gallon carbon steel UST was installed east of the General Services Building (Building 81) and used to store fuel at the Motor Pool (Rickansrud, 1984). The tank reportedly required repairs in the past, but specific dates and the nature of these repairs were not available.

According to SLAC personnel, the integrity of the tank was checked in the early 1980s and it failed the leak test. Therefore, the tank was removed in January 1983, with the approval of the San Mateo County Department of Health, Division of Environmental Health. Soil surrounding the tank was checked in the field with a photoionization detector for the presence of VOCs and none were found. The removed soil was returned to the excavation and the backfill operation completed (SLAC personnel, 1988).

4.5.1.3 Other Potentially Contaminated Areas

During the Survey, six areas were identified as locations where spills may have occurred in the past, resulting in chemical contamination. Sufficient documentation is not available to determine if contaminants are actually present; however, based on the historical activities in these areas there is a potential for contamination. These areas, which were not previously identified in the SLAC Draft Phase I Installation Assessment, are shown on Figure 4-10 and described below.

- Former Motor Pool and Crafts Shop Locations - As discussed in Section 4.5.1.2, the Motor Pool was originally located in the vicinity of the Warehouse Building (Building 28). In addition to serving as a fuel station, activities at the Motor Pool probably included vehicle repairs, which may have generated waste oils and degreasers. In addition, a site map indicates that the Crafts Shop was located in one of the three temporary buildings originally in this area (SLAC, 1964). Wastes from these activities may have been spilled or released to surface soils in this area.
- Crafts Shop Portion of the RWSA - Two of the temporary buildings once used to house the Motor Pool and Crafts Shop described above were moved to the present-day location of the RWSA. These buildings are designated as Buildings 105 and 106 on current site maps. The buildings were primarily used only for storage, according to SLAC personnel, as evidenced by the lack of plumbing and electrical connections. The Crafts Shop also used the surrounding area outside the buildings for storage. According to SLAC personnel, it was announced approximately 6 months prior to the Survey that the two buildings were going to be permanently removed. Consequently, most of the materials or parts in storage were transported elsewhere prior to the Survey, and an inventory of the items was not available. However, soil disturbance and some discoloration were noted along the western side of the buildings, presumably due to these past practices. Based on the general housekeeping practices and spills noted at the Casting Pad (see related discussion in Sections 3.2 and 4.1), which is also used for activities related to the Crafts Shop, there is a

LOCATION OF FIVE POTENTIALLY CONTAMINATED AREAS
AT THE SLAC

FIGURE 4-10

potential that chemical spills occurred in the vicinity of Buildings 105 and 106.

- Former General Stores Facility at the SLAC - According to interviews with site personnel and a 1964 site engineering drawing, the original location of the General Stores Facility was in the present-day location of the Light Assembly Building (Building 33). Bulk materials, including chemicals, were purchased by and received at the General Stores Facility. Accidental spills may have occurred during the process of off-loading materials or while they were in storage.
- Buildings M-1 and M-2 at the Original SLAC Site - Prior to construction of the SLAC, experiments and pilot-scale tests were performed at two buildings designated M-1 and M-2 that were located off-site. Available data are insufficient to describe specific activities in these buildings other than that they were related to the development of the LINAC, including fabrication of the klystrons. Consequently, it is likely that oils containing PCBs were used at these two buildings.
- Solid Waste Collection Area - The Solid Waste Collection Area is located between the Master Electrical Substation and Salvage Yard 1. Occasionally, items such as batteries and small quantities of chemicals are not properly segregated from the solid waste and instead are brought to this collection area (see related discussion in Section 4.1). If this was a regular occurrence in the past, then there is a potential for chemical leaks and spills in this area.
- Former Drum Storage Area at the Plating Shop - A plating shop has been located in the Light Fabrication Building (Building 25) since the mid-1960s. Bulk chemicals used for plating were stored in drums in an area near the northeast corner of the building. This drum storage area is evident in a 1973 photograph of the site, at which time the area was not enclosed or sheltered from weathering. There are no records or employee recollections to suggest that large spills occurred in this area in the past; however, leaks or smaller quantity spills from dispensing chemicals may have occurred. According to site plans dated in the 1960s,

runoff from the storage area would have entered the storm sewer via a drain in the northeast corner. Most of this area is currently occupied by the Chemical Storage Building (Building 36) or has been resurfaced such that signs of residual contamination are not visible.

4.5.1.4 Asphalt and Earth Fill Areas

Major construction projects have been undertaken over the history of the SLAC that have required significant earth-moving activities. The LINAC and its associated storage rings, along with the SLAC Linear Collider (SLC), are below-grade structures that have been built using both excavation and tunneling techniques. As a result, many areas on the SLAC are regraded fill areas where excess material has been placed to fill low-lying areas or contoured as hills. In addition, these construction activities together with normal maintenance have required removing/repairing asphalt roads and parking lots. One location on the south side of the Klystron Gallery has been designated as an area for disposal of construction spoil. This area is a ravine which is gradually being filled with broken pieces of asphalt and construction spoil/earth. Access to the area is controlled and the area is posted as accepting only clean fill for disposal.

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. Chemical contamination of soil and possibly groundwater at several areas on-site. Surface soil at several localized areas on the SLAC has been found to be contaminated with PCBs, oils, and/or lead. Groundwater at one location is contaminated with volatile organic chemicals.

Past operation of the Former Chemical Waste Storage Area and the storage practices at Salvage Yard 1 are known to have resulted in contamination of soil as documented by chemical analyses. Leaks occurred from a UST used for storage of waste solvents and are known to have resulted in both soil and groundwater contamination. Two other areas, Salvage Yard 2 and the Master Electrical Substation, have also been used for equipment storage and the presence of dark stained soil in both areas is indicative of chemical contamination.

The Former Chemical Waste Storage Area and Salvage Yard 1 were used for approximately 10 to 15 years during which time spills and/or leaks occurred and resulted in soil contamination. Cleanup of the Chemical Waste Storage Area took place in the late 1970s and early 1980s. As part of these actions, the SLAC shipped approximately 800 55-gallon drums of liquid waste and 80 tons of PCB-contaminated asphalt/soil off-site for disposal. At Salvage Yard 1, soil removal totaling approximately 90 cubic yards was recently completed due to the presence of PCB contamination. Full analytical characterization of other possible chemical contaminants was not included in these remedial activities, nor was the potential for groundwater contamination addressed.

The former waste solvent tank located next to the PMU Building leaked in the past and resulted in organic chemical contamination of soil and shallow groundwater. The tank has been removed and some contaminated soil was excavated and disposed of off-site. The extent of contamination and feasible remedial alternatives continue to be under investigation.

Salvage Yard 2 and the Master Electrical Substation have been used for equipment and/or materials storage. Past practices at each of these areas have resulted in releases that stained the surface soil. Based on the prevalence of PCB oils and PCB-contaminated oils at the SLAC, it is highly probable that the dark stained areas are contaminated with PCBs. Furthermore, at Salvage Yard 2 scrap metal is collected and may have resulted in lead contamination of soils such as that found in Salvage Yard 1.

Both Salvage Yard 1 and the Master Electrical Substation drain into a common storm drainage system. The original outfall from this pipe was recently covered by soil moved in the construction of the SLC. Consequently, downstream samples collected as part of the study for Salvage Yard 1 did not include this discharge point.

2. Potential areas of soil contamination. During the Survey, six areas were identified as locations where spills may have occurred in the past and resulted in chemical contamination. Sufficient documentation is not available to determine if contaminants are actually present; however, based on the historical activities in these areas there is a potential for contamination. These areas, which were not previously identified in the SLAC Draft Phase I Installation Assessment, are listed below along with the major contaminants suspected.

- Former Motor Pool and Crafts Shop Locations, including the unnumbered UST Used for Fuel Storage

The present-day Warehouse Building (Building 28) was once the location of a fuel station, the Motor Pool, and the Crafts Shop. Wastes generated from these activities may have included degreaser solutions, various solvents, and waste oils. Also, the integrity of the fuel tank once located in this area is unknown. Spills may have occurred in this area and resulted in soil contamination.

- Crafts Shop Portion of the RWSA

The Crafts Shop materials stored in and around Buildings 105 and 106 at the RWSA have recently been removed; however, soil disturbances and discoloration were noted and may be indications of past spills. The types of materials possibly spilled are unknown, but may be similar to those that the Crafts Shop personnel are currently using at the Casting Pad (i.e., diesel oil and "form oil"). Further information on the Casting Pad is presented in Soils, Section 3.2.

- **Former General Stores Facility at the SLAC**

Bulk materials, including chemicals, were originally received at Building 33, the former location of the General Stores Facility. Accidental spills may have occurred during storage or transport of the products received in this area.

- **Buildings M-1 and M-2 at the Original SLAC Site**

The nature of the activities at these buildings included fabrication of klystrons as part of the development of accelerators. Historically, these klystron units have been filled with oils containing PCBs. Spills may have occurred in this area.

- **Solid Waste Collection Area**

Items such as batteries and small containers of discarded chemicals have occasionally been taken to the Solid Waste Collection Area. There are no containment measures constructed around this collection area and incidents of spills in the past may have resulted in soil contamination.

- **Former Drum Storage Area at the Plating Shop**

The original drum storage area for the Plating Shop was located outside and not sheltered from weathering. Leaks or small-quantity spills from the drums may have occurred in this area while the materials were in storage or through dispensing the chemicals into smaller containers used inside the shop. In the 1960s, the area drained into the storm sewer which discharges into San Francisquito Creek. Currently, the area has been resurfaced such that signs of residual contamination are not visible.

Survey-related sampling and analysis is planned to determine if chemical contaminants are present in on-site soil above background levels.

4.5.2.4 Category IV

1. Additional sites not identified in the Phase I Installation Assessment. There are additional sites at the SLAC that were not identified, and therefore not evaluated, in the Draft Phase I Installation Assessment Report prepared in accordance with DOE Order 5480.14 and CERCLA. Spills may have occurred in the past at these six sites, which are discussed in Finding 2 of Section 4.5.2.3, and may have resulted in contamination of soil and/or shallow groundwater.

The SLAC Phase I Report was not finalized at the time of the Survey and thus the SLAC has not met the schedule requirements of the DOE Order. Furthermore, the methodology used to investigate past practices at the SLAC did not include interviews with site personnel, particularly those who had worked at the facility since its inception. Historical engineering drawings were also not reviewed to facilitate discovery of areas potentially contaminated based on their prior uses. The identification of these areas during the Survey but not in the Phase I Report leads to questions concerning the thoroughness and accuracy of the SLAC assessment of its potential inactive waste sites and releases.

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PRELIMINARY

APPENDIX A

SURVEY PARTICIPANTS

PRELIMINARY

SLAC
Survey Participants
February 29 - March 4, 1988

DOE

Team Leader
Assistant Team Leader
Operations Office Representatives

V. Fayne
M. Kleinrock
G. Lavagnino
R. Roberts

NUS Corporation

Coordinator/Inactive Waste Sites

J. Clay

Air

T. Koss

Surface Water

M. Hlavacik

Hydrogeology

R. Germeroth

Toxic and Chemical Materials/QA

D. Olson

Radiation

E. Harr

ICF Technology

Waste Management

J. English

APPENDIX B

SITE-SPECIFIC SURVEY ACTIVITIES

PRELIMINARY

B.1 Pre-Survey Preparation

The DOE Assistant Secretary for Environment, Safety and Health, Office of Environmental Audit, selected a Survey team for the Stanford Linear Accelerator Center (SLAC) in the spring of 1987. The site is operated for the DOE by Stanford University. Mr. Vincent Fayne was designated the DOE Team Leader, and Mr. Michael Kleinrock the Assistant Team Leader. The remainder of the team was composed of contractor specialists from the NUS Corporation and ICF Corporation.

The Survey team members began reviewing the SLAC general environmental documents and reports in December 1987. Messrs. Fayne, Kleinrock, Harr, and Ms. Clay conducted a pre-Survey site visit on January 13, 1988, to gain familiarity with key DOE and SLAC personnel and the site. An orientation meeting was held and the facility was toured. A cursory review of the data generated in response to an information request of December 2, 1987, was also conducted during the pre-Survey site visit. The request listed environmental information of interest to the Survey team for planning purposes. The Survey team intensively reviewed the information generated during the pre-Survey visit, and during the week of February 1, 1988, prepared a Survey Plan for the SLAC. This plan discussed the specific approach to the Survey for each of the technical disciplines and included a proposed schedule of activities for on-site activities. The Survey Plan was transmitted to the San Francisco Operations Office (SAN) on February 16, 1988.

B.2 On-site Activities

The on-site portion of the Survey was conducted during the period of February 29-March 4, 1988. The opening meeting held on February 29, 1988, at the site was attended by representatives from DOE Headquarters, SAN, SLAC personnel, and the Survey team members. Discussions during this meeting centered on the purpose of the Survey, logistics at the SLAC, 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 laboratory activities were thoroughly analyzed to identify existing and potential pollutants. Site operations and monitoring procedures were observed. Extensive interviews were conducted with plant personnel regarding

environmental controls, operations, monitoring and analysis, past operations, regulatory permits, and waste management.

Daily meetings of the Survey team members were held to report observations and compare findings. A representative from the Environment and Safety Office of the SLAC met daily and often more frequently with the DOE Team Leader, Assistant Team Leader, and the NUS Coordinator to arrange for specific site personnel and facilities to be available, as needed, on the following day. SLAC or SAN personnel accompanied Survey team members on all field reconnaissances.

A site closeout briefing was held on March 4, 1988, where the DOE 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.

The Survey team members identified further Sampling and Analysis (S&A) requirements necessary to complete the Survey effort. The S&A requirements were discussed by the team on May 24, 1988. The S&A request package was transmitted to Idaho National Engineering Laboratory (INEL), the laboratory designated by DOE to provide a sampling team for the SLAC and to perform the analytical services.

B.3 Sampling and Analysis

INEL will perform the Sampling and Analysis portion of the SLAC Survey. INEL evaluated the S&A requests made by the Survey team and determined logistics, costs, and schedules. The S&A Plan prepared by INEL includes a quality assurance plan and a health and safety plan. The S&A Plan will be completed during fall of 1988 and the sampling team will begin work at the site during fiscal year 1989 (FY 89).

B.4 Report Preparation

An Environmental Survey Preliminary Report for the SLAC will be prepared to summarize the findings from the on-site Survey effort. This report will be provided to the SAN and the SLAC for review. The findings presented in the Preliminary Report are considered preliminary until comments are received and S&A results are

available. At that time, the comments and S&A results will be evaluated and an Interim Report will be prepared.

PRELIMINARY

APPENDIX C

SURVEY PLAN

PRELIMINARY

**ENVIRONMENTAL SURVEY
STANFORD LINEAR ACCELERATOR CENTER
STANFORD UNIVERSITY**

**February 29 through March 4, 1988
Stanford, California**

1.0 INTRODUCTION

The Environmental Survey is a one-time baseline inventory of existing environmental information and environmental problems and risks at DOE operating facilities. The Survey will be conducted in accordance with the principles and procedures contained in the DOE Environmental Survey Manual.

The Survey is an internal management tool to aid the Secretary and Under Secretary in allocating resources for maintaining aggressive environmental programs and for mitigating environmental problems at DOE facilities.

2.0 SURVEY IMPLEMENTATION

The Stanford Linear Accelerator Center (SLAC) is operated by Stanford University and is located adjacent to and on University-owned land. This Survey will address the SLAC facility activities and other facilities on and off the Stanford University campus that support activities or operations at the SLAC.

The Environmental Survey at the SLAC facility will be managed by DOE Team Leader, Vincent Fayne, and Assistant Team Leader, Michael Kleinrock. Gary Lavagnino will serve as the San Francisco Operations Office (SAN) representative on the Survey team. Technical support will be provided by contractor personnel as follows:

Air: Theodore Koss, NUS Corporation

Radiation: Ernest Harr, NUS Corporation

Surface Water/Drinking Water: Mara Hlavacik, NUS Corporation

Waste Management:	Joseph English, ICF Technology
Inactive Waste Sites/Releases:	Jennifer Clay, NUS Corporation
Hydrogeology:	Robert Germeroth, NUS Corporation
QA/Toxic & Chemical Materials:	David Olson, NUS Corporation

2.1 Pre-Survey Activities

Survey team members began reviewing the SLAC facility general environmental documents and reports in December 1987. Mr. Fayne and Mr. Kleinrock, along with Ms. Clay and Mr. Harr conducted a pre-Survey site visit on January 13, 1988 to gain a familiarization with key DOE staff and contractor personnel. The facility was toured, a cursory review of documents was completed, and data that were generated in response to an information request letter of December 2, 1987 were discussed. The letter proposed the Survey schedule and listed environmental information of interest to the Survey team for planning purposes.

A meeting was held with representatives of the San Mateo County Office of Environmental Health and the Bay Area Air Quality Management District on January 14, 1988 to review environmental issues and to explain the purpose and scope of the Survey. EPA Region IX was also contacted to solicit their opinion on the environmental status of SLAC. These discussions identified issues of Federal, state and county governmental concern which will be addressed during the Survey.

This Survey Plan will be transmitted to the San Francisco Operations Office prior to the Survey.

2.2 On-Site Activities

The Survey will be conducted from February 29 - March 4, 1988 at the SLAC facility. The agenda is as shown in Table 1. Modifications may be made as appropriate, to minimize disruption of site activities and to enhance the efficiency and effectiveness of the Survey.

TABLE 1
SLAC ON-SITE SURVEY AGENDA

	Air	Radiation	Surface Water/Drinking Water	Waste Management	Inactive Waste Sites/Releases	Hydrogeology	QATSCA
<p>Meet of 2/29/88 Monday</p>	<p>AM Site briefing and four PM Overview of emission inventory (radiological and non-radiological) and controls; overview of meteorological monitoring program; and dose calculations; visit meteorological tower.</p>	<p>AM Site briefing and four PM Overview presentation on Radiological Monitoring Program - potential and actual sources, site history, criteria, location, frequency, analytical procedures, analysis performed and frequency; laboratories that perform analyses, QA/QC, dose calculations and displays used.</p>	<p>AM Site briefing and four PM Generation of wastewater streams in Bldgs 38, 25, 26, 30; plating wastewater treatment plant.</p>	<p>AM Site briefing and four PM Meet with SLAC EROS staff; review waste management procedures and documentation.</p>	<p>AM Site briefing and four PM Return to LBL for Survey Close-out Meeting.</p>	<p>AM Site briefing and four PM Cooling Towers and Chemical Storage Areas Document Review - monitoring well location; plan, logs, construction details; water level measurements; test results for all existing, abandoned or destroyed groundwater monitoring wells. Off-site well inventory to include location, screen interval and drill logs.</p>	<p>AM Site briefing and four PM Overview of the environmental monitoring program - review QA programs and QA documentation concerning the analysis of HPCDES discharges, WWTP effluents, the main line (Sand Hill Road) sanitary sewer discharges, and transformers oil for PCBs. Review the bulk chemical storage areas at cooling towers 1261 and 1292.</p>
<p>Tuesday</p>	<p>AM Review of Emission monitoring calibration and sample handling procedures at Bldg 5 with Radiation Survey team member. Potential Air Emission sources in Bldg 9, Bldg 61.</p>	<p>AM Radiological environmental monitoring and sampling locations to observe sampling; calibration procedures and frequency; specifications for monitoring equipment; equipment maintenance; reliability and past down time; emergency (unexpected or accidental release) measurement capabilities.</p>	<p>AM Generation of wastewater streams in Bldgs 35, 33, 24, 81; paint shop, paint shop.</p>	<p>AM Waste generation and management at shops in Bldgs 81, 35, 33, 126, and 25.</p>	<p>AM Review historical photographs and interview notes from the CEHCLA Phase I assessment; discuss with SLAC personnel the recent analytical results of soil samples collected from a former equipment storage yard; obtain information on past sewer maintenance work.</p>	<p>AM Bldg 35 - soil contamination from solvent storage tank. Review status of cleanup project, monitor well data, extraction well and soil venting project. Storage area for paint thinners and solvents. Bldg 81 - review monitoring method and bulk test data for four underground diesel storage tanks and above-ground 1,000 gal diesel storage tank.</p>	<p>AM Bldg 81 - bulk chemical storage and facility security control measures. Storage shed (south of Bldg 81) - flammable and corrosive liquids. Bldg 35 - paint and solvents. Bldg 25 - quantities of various chemicals, corrosives. Bldg 36 - various bulk chemicals.</p>
<p>PM</p>	<p>Bldg 44 - degreasers, hydrogen furnaces, machine shops, etc.; Bldg 40 - laboratory air emission sources; Bldg 23 - industrial boilers; Bldg 37 - boilers.</p>	<p>Overview of non-routine monitoring (i.e., gamma calibration sources, Californium source, building surveys, decommissioned or decontaminated buildings, soil sampling performed for radiological or non-radiological constituents) and review of data. Review records of radioactive sources ordered by SLAC (including any that were drop shipped / H-are).</p>	<p>PM Bldg 38 - wastewater treatment plant; waste generation and management at shops in Bldgs 36, 26, 35, and 51.</p>	<p>PM Former and current outdoor storage area locations - the area south of Bldg 26, the area adjacent to the Hazardous Waste Storage Facility, the drum and equipment storage area at the electrical substation, west of the PCB storage area, the former storage area and dump east of the electrical substation.</p>	<p>PM Fire Station - 2 underground storage tanks. Motor pool - Underground gasoline storage tank. Review monitoring methods and leak test data. Observe operation of gasoline dispensing truck.</p>	<p>PM Bldg 26 - bulk chemicals, Cooling Tower 101 - bulk chemical storage area; Bldg 44 - bulk chemical storage. Bldgs 40 and 84 - inspect bulk chemical reagent storage and review laboratory practices.</p>	<p>PM</p>
<p>Wednesday</p>	<p>AM Potential air emission sources in Bldg 63, Bldg 2, and the shops at SPEAR and PEP.</p>	<p>ALL INAC (underground tunnel) Day SPEAR, PEP, SSRL, SLC and Bldgs 2, 9, 61, 117, 720, 620, 750, 650 and 685 - direct radiation and effluent monitoring; possible activation of soil, groundwater and surrounding materials; and past and present radiological releases (normal or accidental). Copies of UOBS for these facilities should be provided.</p>	<p>AM Generation of wastewater streams in Bldgs 137, 130, 101, 120, 131, 51. The Cave.</p>	<p>AM Waste generation and management at shops in Bldgs 137, 130, 101, 120, and 104.</p>	<p>AM Site perimeter fence - signs of past disposal; Krypton gas; cooling towers; chemical storage; and decontamination materials; fire area of north perimeter road.</p>	<p>AM Bldg 25 - sump beneath the floor and storage tanks for cleaning and rinsing solutions; storage shed next to Bldg 25.</p>	<p>AM Inspect PCB transformers at the following facilities: Bldg 136, Computer Substation, BSY Substation, Substation 501, Bldg 417, Substation 510. Inspect the cooling tower 1781 chemical storage area. Inspect PCB-contaminated transformers at the following substations: 505, 505A, 507, and 514.</p>

**TABLE 1
SLAC ON-SITE SURVEY AGENDA**

	Air	Radiation	Surface Water/Drinking Water	Waste Management	Inactive Waste Sites/Releases	Hydrogeology	QA/QC
	PM Potential air emission sources in Bldgs 620, 640, 660, 680, 720, 51C interaction area, the accelerator and storage rings		PM Environmental monitoring locations: street, sanitary sewers, storm sewers, oil/water separators, NPDES monitoring localities, wastewater treatment facility monitoring, drinking water monitoring, non-operating reactors, site compliance reports; site water balance calculations	PM Waste generation and management at laboratories and shops in Bldgs 40, 44, and 84; Bldg 9 - radioactive waste management	PM Bldgs 81, 35, and 26 - past product and waste handling procedures; storage areas between End Stations A and B	PM Accelerator Cooling Water Tanks - portable tanks containing contaminated water (SPCC issues)	PM Inspect PCB transformers at the following facilities: Bldg 132, Bldg 114, Substation 50A, Substation 512, Substation 511, Bldg. 647, and Bldg. 114.
Thursday	AM Bldg 24 - degreasers, plating and etching operations, other permitted sources, etc.; Bldg 35 - paint spray booth, carpenter shop, etc.; CERCLA site next to sandblasting. PM Bldg 25 - electroplating, circuit printing, metal grinding, sandblasting, etc.; Bldg 26 - machining and welding, etc.	AM Bldgs 40 & 84 - radioactive laboratories, controls on releases, environmental monitoring and radioactive waste handling procedures. PM Radioactive material storage area, Californium source and gamma calibration sources - controls or surveillance, monitoring, past and present radiological releases (normal and accidental). Copies of UORs for these facilities should be provided.	AM Generation of wastewater streams in Bldgs 40 & 44, labs, Bldg 106 shops, Bldg 560; Klystron fabrication; oil separation unit; Cooling Towers 101, 1701. PM Generation of wastewater streams in Bldgs 1, 2, 9; Cooling Towers 1201, 1202; BSY Ion Exchange Plant; DI Water Plant; Stormwater Control System; linac gallery/subsurface storage ring groundwater discharge location.	AM Hazardous Waste Storage Yards, radioactive waste storage at Bldgs 105 and 106. PM Waste generation and management at laboratories and shops in R2, IR4, IR6, IR8, and IR12.	AM Radioactive waste storage area, former Hazardous Waste Storage Area - history of use and decontamination procedures; review spill reports and UORs. PM Pre-Closeout Meeting with Survey Team Leader and Assistant Team Leader, follow-up activities and document review.	AM Monitoring wells at 3 beam absorbers - review monitoring well construction details, sampling methods and water sample analyses. PM Accelerator subdrain outfalls - review water sampling methods and sample analyses	AM Inspect the PCB storage area and the PCB-contaminated transformers in Bldg. 2. PM Pre-Closeout Meeting with Survey Team Leader and Assistant Team Leader, follow-up activities and document review.
Friday	AM Pre-Closeout Meeting with Survey Team Leader and Assistant Team Leader, follow-up activities and document review	AM Pre-Closeout Meeting with Survey Team Leader and Assistant Team Leader, follow-up activities and document review	AM Pre-Closeout Meeting with Survey Team Leader and Assistant Team Leader, follow-up activities and document review. Observe NPDES outfall sampling.	AM Pre-Closeout meeting with Survey Team Leader and Assistant Team Leader, follow-up activities and document review.	AM Pre-Closeout Meeting with Survey Team Leader and Assistant Team Leader, follow-up activities and document review.	AM Pre-Closeout meeting with Survey Team Leader and Assistant Team Leader, follow-up activities and document review.	AM Pre-Closeout Meeting with Survey Team Leader and Assistant Team Leader, follow-up activities and document review. PM Closeout Meeting.

Table 2 is a listing of specific areas that each Survey team member will evaluate. This list is intended to assist SAN and their contractor in identifying the most appropriate technical contacts who should be matched with individual Survey team members.

Interviews and consultations will be conducted with environmental, safety, research, operations, waste management, purchasing, and engineering personnel, among others, in the course of the Survey. Also, the Survey team will continue their review of records and other documentation during the Survey. These records are identified in the "Records Required" sections of this plan. The Survey team has already reviewed some of these documents, so copies need not be made of documents previously submitted by SAN and their contractor. However, the original documents should be readily available for reference during the on-site activities.

2.3 Sampling and Analysis

It is not expected that Survey Sampling and Analysis (S&A) will be necessary at the SLAC. However, a final determination shall be made based on results of the on-site Survey activities. If it is determined that S&A is necessary, it will be conducted by a DOE Survey laboratory.

2.4 Conclusions and Reporting on the Survey

A closeout briefing will be conducted on Friday afternoon, March 4 to describe the general conclusions of the on-site activities. Within 10-12 weeks of the on-site Survey team visit, an Environmental Survey Preliminary Report will be developed for SLAC. An Interim Report will then be completed which reflects additional data received or changing conditions.

TABLE 2

STANFORD LINEAR ACCELERATOR CENTER
AREAS OF INTEREST FOR TECHNICAL SPECIALISTS

AIR

Theodore Koss

Meteorology
 Local Air Quality Data
 Radioactive and Nonradioactive Emission Sources,
 Controls and Monitoring
 Environmental Monitoring - Air
 Air Permits and Air Emission Inventory
 Fugitive Airborne Emissions
 Accidental Releases to Air

RADIATION

Ernest Harr

Radioactive Emissions and Effluents
 Source Controls and Monitoring
 Environmental Monitoring - Radioactive
 Laboratory Analysis - Radioactive
 Radioactive Waste
 Soil Contamination - Radioactive and Non-
 Radioactive

SURFACE WATER/DRINKING WATER

Mara Hlavacik

Effluent Sources
 Process and Sanitary Wastewater Treatment
 Facilities
 Stormwater Management
 Cooling Water Systems
 Environmental Monitoring-Water
 Drinking Water Sources and Distribution

WASTE MANAGEMENT

Joseph English

Hazardous Waste
 Radioactive Waste
 Non-Hazardous Solid Waste
 RCRA/Solid Waste Permits
 Mixed Waste

INACTIVE WASTE SITES/RELEASES

Jennifer Clay

Past Waste Storage and Disposal Sites
 Characterization Studies
 Remediation Work
 Spill/Accident Locations

TABLE 2 (Continued)

STANFORD LINEAR ACCELERATOR CENTER
AREAS OF INTEREST FOR TECHNICAL SPECIALISTS

HYDROGEOLOGY

Robert Germeroth

Regional Geology and Groundwater
Well Inventory and Construction (drinking water
supplies, irrigation, private and monitoring
wells)
Groundwater Monitoring Program and Studies
Underground Storage Tanks
Warehousing and Storage Tanks for Process
Chemicals
Spill Prevention, Control and Countermeasure Plan
Spill/Accident Locations

QUALITY ASSURANCE

David Olson

Environmental Sampling Program
Environmental Analytical Program
Data Management and Handling
QA Program Overview

TOXIC AND CHEMICAL MATERIALS

David Olson

Process Chemicals and Substances Inventory
Asbestos Removal and Disposal
PCBs in Service, Storage, and Disposal
Pesticide Use, Storage, and Disposal

3.0 AIR

3.1 Issue Identification

The radioactive and regulated/hazardous air-related Survey activities involve an assessment of the facility-wide air emissions and emissions controls, a review of the monitoring program and equipment, and the acquisition of ambient air quality data. Areas of review will include the laboratory and shop emissions of radionuclides and toxic pollutants, and emissions of acid fumes, organics, and volatile hydrocarbons (VOCs). Operational and procedural practices associated with emission controls and emission monitoring equipment will be evaluated. Fugitive sources of radioactive and regulated/hazardous particulate and gaseous emissions, including emissions from chemical and waste storage/handling areas, will be reviewed.

The general approach to the Survey will involve a review of existing environmental reports, chemical inventories, operating procedures, ventilation diagrams, stack monitoring reports, radioactive effluent reports, regulatory requirements and other relevant documents to identify sources of air emissions. Following the document review will be the physical inspection of most laboratory, shop and fuel combustion sources, control and monitoring equipment, and other potential emission sources. The Survey will identify air contaminants from significant sources at the SLAC (such as the vapor degreasers), identify and evaluate existing control equipment for air contaminants, and assess the potential for environmental problems from the emissions.

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

- Toxic and radioactive emissions and controls;
- Laboratory emissions compared with Bay Area Air Quality Management District (BAAQMD) thresholds for source permits; and
- Compliance with BAAQMD requirements on use of solvent degreasers, and use of coatings over the volatile organic compound limit.

3.2 Records Required

The following records should be available for on-site review:

- Source and emission inventories for both radiological and regulated/hazardous emission sources;
- Description of current air contaminant producing operations (flow diagrams, narratives, and sketches);
- Identification of fugitive/accidental release points;
- Ambient air dispersion and dose calculations;
- Descriptive documentation on existing emission controls and ventilation system drawings;
- Operating, testing, and maintenance procedures for control equipment;
- Correspondence between SLAC and regulatory agencies related to air/radiological issues;
- Reports on accidental releases/unusual occurrences relating to radiological and regulated/hazardous and toxic airborne releases; and
- Radiological stack monitoring/sampling program and procedures/documentation, including:
 - Calibration procedures and records
 - Emission rate data from individual sources.

4.0 RADIATION

4.1 Issue Identification

The radiological focus of the Environmental Survey will involve identification of the species and quantities of radioactive materials processed and/or handled at the facility since its inception and determination of whether hazardous quantities of those materials could or do currently exist in the environment. Information concerning the past liquid waste streams and atmospheric effluents will be collected, and the possibility of hazardous quantities remaining will be examined.

The Survey will involve an assessment of the site-wide radioactive release controls, on-site and off-site monitoring equipment, and the associated impact on the environment and general off-site population. The radiological assessment will encompass three major areas: 1) airborne radioactive emissions; 2) liquid radioactive effluents; and 3) liquid and solid radioactive waste management. The radiological aspects will be coordinated with the air, surface water, waste management (CERCLA/RCRA), hydrogeology, and the quality assurance specialist.

The Survey will determine whether radioactive materials released, or potentially released, to the environment from the site create any actual or potential environmental problems. Existing environmental standards, regulations, and guidelines will be used for comparison to assess the potential magnitude of these problems. The review will also determine if appropriate actions are being taken or planned to minimize accidental releases and/or mitigate the consequences of such releases and whether there are conditions that potentially may lead to environmental problems.

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

- Review of radiological monitoring program;
- Possible residual radioactive and non-radioactive soil contamination from past activities;

- Radioactive material inventory tracking and storage;
- Possible activation of soil and groundwater from accelerator operations;
- Monitoring and surveillance performed on gamma calibration sources and Californium source; and
- Radiochemical laboratories' release controls, effluent monitoring and radioactive waste handling practices.

4.2 Records Required

The following records should be available for on-site review:

- Radiological sampling and analysis methods and data, such as:
 - Radioactive material inventory
 - Radioactive waste shipments
 - Effluent monitoring manual
 - Environmental program manual
 - Effluent sampling schedule
 - Effluent data (radionuclides, concentrations, and curies released by release point/facility)
 - Environmental sampling schedule (soil, ambient air, surface water)
 - Environmental sampling data (related to facility or area if possible)
 - Radioanalytical procedures, related QA procedures and documentation
- Radioactive emission reports (air and surface water discharges);
- Environmental monitoring, sampling equipment, calibration and maintenance records;
- Documents on the selection of sampling locations and design of monitors;

- Status reports on effluent and environmental controls and monitoring systems upgrades;
- Radioactive waste management procedures;
- Reports on accidental releases;
- Reports on radioactive wastewater storage tanks;
- Description of dose calculation programs; and
- Description on soil sampling performed for radiological or non-radiological constituents.

5.0 SURFACE WATER/DRINKING WATER

5.1 Issue Identification

The primary focus of the surface water/drinking water portion of the Survey will be on the potential or actual release of contaminants to surface waters from past and present activities at the Stanford Linear Accelerator Center (SLAC). Potential pathways of contaminants include discharges of radiological or chemical substances to the sanitary sewer or to the stormwater system through inadvertent or deliberate means. The secondary focus of this discipline will be on the potential for contamination of the SLAC drinking water supply through cross-connections with piping containing hazardous materials.

The sanitary sewer at SLAC leads to the West Bayside System Authority treatment facility at San Carlos prior to being released to the San Francisco Bay. The South Bayside System Authority (SBSA) operates the treatment plant. Contaminants from SLAC may enter this system via any of the following scenarios:

- Inadvertent discharges and disposal via sinks and drains in SLAC laboratories;

- Inadequate treatment of acidic and metals-containing wastewaters from the electroplating shop; and
- Inadequate hold-up or inadvertent discharge from waste holding tanks.

SLAC is currently operating under a NPDES permit for blowdown from its four cooling towers, runoff in three natural on-site drainage areas which lead to San Francisquito Creek and eventually to the San Francisco Bay, and for groundwater which seeps into the linear accelerator (linac) gallery.

Releases to the stormwater system at SLAC flow to either natural open ditches or the city/county storm sewer system, and eventually to the San Francisco Bay. Potential sources of contaminants in this system include:

- Groundwater pumped from the linac gallery or subsurface storage rings;
- Blowdown from SLAC's four cooling towers;
- Stormwater runoff from contact with contaminated soils;
- Inadvertent spills or discharges into the storm sewers; and
- Runoff from parking lots and other paved areas.

The effects of prior operations on naturally occurring springs, seeps, and/or surface waters, such as San Francisquito Creek, will be reviewed in conjunction with the inactive waste sites and hydrogeology portions of the Survey. Emphasis will be placed on past liquid effluent management practices, e.g., the routing of liquid effluents prior to discharge or treatment.

The Survey will assess the potential for inorganic, organic, and radioactive contamination of wastewaters, as well as review present conditions of wastewater control, collection, monitoring and treatment. Liquid waste collection, treatment, and handling equipment will be examined and records of operation will be reviewed, as will the methods of sludge disposal as a result of these treatment processes.

The Survey will include identification of potential discharges to surface waters from SLAC which may not be addressed in operating permits or other documents. This will include a record search for evidence of possible breaks or obstructions in the

sewer system which could result in releases of wastewater to the environment. The Survey will also address the possibility of cross-contamination of the potable water supply system by either the sanitary or stormwater systems. Copies of standard operating procedures (SOPs), operating logbooks, and maintenance records will be reviewed with respect to wastewater monitoring and treatment systems, and SLAC field practices will be observed to determine how closely SOPs are being followed. Site managers and operators of monitoring equipment and treatment systems will be interviewed in order to understand modifications or significant deviations, if any, from written SOPs.

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 actual sampling and analytical procedures will be observed at the NPDES outfall, the wastewater treatment facility, and other water environmental monitoring locations. Emphasis will be placed on the major contributors to wastewater generation, i.e., the electroplating facility, the deionized water plant, the ion-exchange treatment plant, the shops, assembly areas, the motor pool, and various research laboratories.

The sanitary wastewater collection, holding and treatment systems will be evaluated under normal operating conditions, as will the final effluent monitoring and sampling stations. Site surface drainage characteristics, such as culverts and retention basins, will also be examined, along with any man-made efforts to control surface runoff and runoff. The impact of changes resulting from construction of new facilities will also be evaluated.

5.2 Records Required

Specific records which should be available for on-site review include:

- Water distribution and sewer plans (current and historical) for all four SLAC planning areas;
- Information submitted by SLAC to SBSA regarding sanitary sewer and wastewater sampling and analysis data;

- Information submitted to the California Regional Water Quality Control Board regarding SLAC's NPDES permit;
- Information regarding the generation of sludges from the on-site wastewater pretreatment operations, its potential for containing toxic substances, results of sludge analyses, and ultimate handling;
- Information pertaining to periodic environmental monitoring of nearby surface waters, storm drains, and potable water;
- Correspondence with regulatory agencies regarding wastewater discharges from SLAC and Stanford University;
- Past wastewater treatability or characterization studies;
- Accidental release or unusual occurrence reports that may relate to potential past discharges to the sanitary system or stormwater system;
- Information regarding current or past potential discharges of toxic chemical and/or radiological materials to subsurface disposal systems, including septic tanks and leach fields;
- List and drawings of any current and abandoned septic tanks and leach fields;
- Analytical data on influent potable and process water and on any wells, springs or seeps on SLAC property that are available;
- Identification of flood-prone regions in the area of the SLAC facility, including floodplain maps;
- Water balance calculations and drawings, and records of water consumption;
- Identification of any uses of surface water in the area downstream of SLAC (e.g., public drinking water intakes, recreational uses, etc);

- Operational procedures of the wastewater treatment system;
- Summary of major building missions over time (current missions do not necessarily reflect activities conducted from the 1960s to the present);
- Detailed topographic maps of the SLAC facility and surrounding area, and information pertaining to former/alterd drainage pathways on-site;
- Historical overview of SLAC water treatment operations, including any on-site and/or off-site facilities utilized;
- Identification of on-site and off-site surface water sampling locations;
- Recent analytical data on wastewater releases to San Francisquito Creek;
- Notices of violation relating to wastewater releases;
- Operators logbooks, treatment plant reports, and monitoring equipment maintenance records;
- Standard operating procedures for wastewater collection, holding, and treatment;
- Sampling protocols and logbooks, and wastewater lab tracking reports;
- Detailed drawings of the domestic water supply, storage and distribution system;
- Records of drinking water quality;
- Internal memos and correspondence relating to surface water/drinking water problems (e.g., back-flow prevention measures); and

- Internal memos and correspondence relating to exfiltration losses from sanitary sewers and on-site losses to groundwater.

6.0 WASTE MANAGEMENT

6.1 Issue Identification

The waste management review at SLAC will focus on the identification of hazardous waste, solid waste, radioactive waste, and mixed waste generation, storage, treatment, and off-site disposal. The pre-Survey document review shows that hazardous waste generation at SLAC is primarily associated with fabrication and maintenance activities in shops, with a small contribution from on-site laboratories. The documents reviewed indicated that radioactive and mixed waste generation is primarily related to induced activity in metals, shielding and cooling water. Solid waste (i.e., nonhazardous, nonradioactive) generation was not well characterized, but such wastes are expected to be generated at virtually all SLAC facilities. The documents reviewed indicated that waste management activities at SLAC include on-site treatment of some liquid hazardous and radioactive wastes (e.g., chemical treatment of plating wastes and demineralization of radioactive cooling water). Waste management activities also include on-site storage of hazardous, radioactive, and mixed wastes and off-site disposal of hazardous wastes. Solid wastes are collected and disposed of off-site. No on-site disposal of any wastes has reportedly occurred.

The Survey will include a review of waste management records, procedures, and practices and inspection of facilities where wastes are generated, handled, treated, and stored. Areas for investigation identified as a result of the document review include:

- Identification of points of generation of hazardous, radioactive, and mixed wastes;
- Practices and procedures for designation and segregation of hazardous, radioactive, mixed, and solid wastes;

- Generation, accumulation, storage, and disposal of liquid and solid radioactive wastes;
- On-site treatment and storage of hazardous and mixed wastes; and
- Off-site disposal of hazardous wastes.

The on-site activities will include visits to all major hazardous, radioactive, and mixed waste generators, as identified in the document review. The emphasis of the visits will be to identify the types and amounts of wastes generated and review waste management practices. Visits will also be made to a number of other facilities which generate, or potentially generate, hazardous, radioactive, and mixed wastes. These facilities include most of the shops and laboratories at SLAC. The focus of these visits will also be waste generation and management. Also visits will be made to the waste treatment and storage facilities. The focus of these visits will be to identify waste management practices.

The waste management review will be coordinated with the surface water review for those operations which include liquid effluents (e.g., pretreatment of plating wastes), with the toxic and chemical substances review for those facilities managing PCB wastes, and with the radiation review for those facilities managing radioactive and mixed wastes.

6.2 Records Required

The following records should be available for on-site review:

- Written procedures for waste generators describing waste analysis, designation, segregation, and minimization;
- Operating procedures for SLAC staff responsible for hazardous, radioactive, mixed, and solid waste collection, packaging, transportation, and storage;
- Waste analysis and monitoring records;

- Waste manifests, disposal requests, and other records documenting the disposition of wastes sent off-site;
- Hazardous and mixed waste annual reports;
- Records describing and documenting inspections of waste management facilities;
- Records documenting the inventories and disposition of hazardous materials; and
- Correspondence with regulatory agencies related to waste management activities.

7.0 INACTIVE WASTE SITES/RELEASES

7.1 Issue Identification

The inactive waste sites/releases specialty area review will identify environmental problems associated with the historical handling, storage and disposal of hazardous and radioactive substances at the site. The survey will focus on current and future environmental problems related to past land use and disposal practices, and past spills/releases. The review will evaluate information developed in response to the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and the Superfund Amendments and Reauthorization Act (SARA) regulations.

The SLAC background information indicates that there has been no chemical or radioactive waste burial on the property occupied by the laboratory. Therefore, the inactive waste sites/releases portion of the Survey will be focused on areas where possible spills or releases occurred in the past. Such releases potentially may have resulted in contamination of soil, of sediment in the stormwater ditches or San Francisquito Creek, or of shallow groundwater. Consequently, the CERCLA/SARA review effort will be closely coordinated with the Hydrogeology and Surface Water Specialists. A determination will be made of the influence of past handling and disposal of hazardous and mixed chemicals/wastes with regard to the existence of

undocumented inactive waste sites/releases. Also, historical photographs will be reviewed on the second day of the Survey.

Several areas of concern have been identified during a review of available documentation. These areas will be reviewed in addition to interviewing personnel who have worked at SLAC for a number of years. Major areas of investigation include:

- Locations used in the past for both salvageable and non-salvageable equipment storage such as the area south of Buildings 26 and 28, the storage area adjacent to the Hazardous Waste Facility; the drum and equipment storage area next to the PCB waste storage facility at the Electrical Substation; and the formerly used, fenced storage yard off the South Target Area Road. Results of soil samples collected from these areas by SLAC should also be made available;
- Unrestricted dump area south of the Electrical Substation where toxic materials may be accidentally disposed;
- Areas used in the past for earth/construction materials fill, such as the one north of the Klystron Gallery along the outer perimeter access road;
- Past leaks or spills that may have occurred at Building 81 (General Services) and its storage area or at the various satellite chemical storage or dispensing areas;
- Information on past maintenance for sumps, connection boxes, and drain lines where cracks may have been repaired;
- Potential contamination associated with the past use of chromates in the cooling towers;
- Methods for handling and disposing of PCB contaminated items prior to the implementation of a formal program;

- Inactive, abandoned, or removed waste storage tanks and product storage tanks that have been included in the SLAC Underground Tank Program;
- Buildings and areas with known fixed or induced radioactive contamination.

Underground and above-ground product and waste storage tanks that are inactive, abandoned, or removed will also be reviewed by the Survey hydrogeology specialist.

Other possible areas of investigation include:

- Existing and former facilities that have handled hazardous, mixed, and low-level radioactive wastes; and
- Areas where past undocumented disposal may have occurred.

7.2 Records Required

The following records should be available for on-site review:

- Records of the interviews conducted during the CERCLA assessment effort (Phase I);
- Past and ongoing CERCLA/SARA related studies and remediation reports, including recent soil sampling results;
- Records of historical research facilities, locations, operations, processes and substances used, and methods of materials and waste handling and disposal;
- Description and location maps of all inactive waste management facilities, including buried tanks (USTs and septic) and structures;

- Descriptions and notifications (as per CERCLA Section 103) of inactive waste sites and potential areas of contamination;
- Listing of inactive areas used for hazardous substances use, storage, receiving and shipping, and disposal;
- Descriptions of corrective actions;
- Historical standard operating procedures (SOPs) regarding management of hazardous substances, disposal areas, and storage areas;
- Hazardous substances inventories;
- Waste generation reports and characterization studies;
- Waste management plans (past and current);
- Files on past off-site waste handling and disposal (period of use, waste types and quantities, etc.);
- Historical aerial photographs and site plans that may provide clues to undocumented disposal;
- Descriptions and notification of spills/releases (Unusual Occurrence Reports and Minor Release Reports); and
- Records of facility expansion and building rubble disposal.

8.0 HYDROGEOLOGY

8.1 Issue Identification

The preliminary review of the documents supplied for the Stanford Linear Accelerator Center facility indicates that there is not a groundwater monitoring program in place at the facility to assess the environmental impact of its operation on the groundwater regime. In general, groundwater flow is to the south-

southeast toward San Francisquito Creek. Releases of radiological or chemical substances to groundwater may be discharged to surface water. Additionally, an underdrain system for the collection of groundwater beneath the accelerator discharges groundwater into the storm water system. Large quantities of diesel fuel, gasoline, waste oils, solvents and other chemicals are stored in underground and aboveground tanks. Some of these tanks have leaked in the past. Radioactive and non-radioactive wastes are stored on-site.

A review of groundwater sampling procedures, chain of custody and quality assurance/quality control procedures will be made, and interviews with site personnel will be conducted. Water level elevation readings taken in monitor wells and boring logs will be reviewed to determine if lateral variation in the alluvial aquifer has caused localized changes in the general site groundwater flow direction. In addition, information will be reviewed on the regional geology, and data will be collected on the irrigation and private wells located in the vicinity of the SLAC facility.

The adequacy of spill prevention control and countermeasures for above ground storage of petroleum products and hazardous substances which have a potential to enter groundwater and surface waters will be examined. This effort will be coordinated with the Surface Water, Waste Management and the Toxic and Chemical Materials Specialists.

Several specific areas of investigation have been identified during the document review. These include:

- Review of leak detection methods, monitoring well data and soil testing for underground storage tanks, both active and abandoned;
- Spill prevention, control and countermeasure (SPCC) plans, data used in their preparation, and any notifications or reports on past spills;
- Building 25 - potential for spills of process chemicals to enter groundwater through the sump beneath the floor;
- Activation of groundwater; and

- Contamination of soil from leaking solvent storage tank;

8.2 Records Required

The following documents should be available for on-site review:

- New and recent data and reports on groundwater quality;
- Well sampling schedules and procedures;
- Well installation reports, boring logs and as - built drawings;
- Off-site well inventories which include location, depth, length of screened interval, and the owner of the well;
- Location plan, boring logs and as-built drawings for all monitoring wells including abandoned wells and those destroyed during construction; water level measurements, and sample analyses;
- Underground storage tank registration forms filed with the California Water Resources Control Board;
- Location of all present and abandoned underground storage tanks and methods of leak detection;
- Copies of data from leak tests performed on underground tanks and lines;
- Location and background information on aboveground storage tanks; and
- Any updates to the draft Spill Prevention, Control and Countermeasure Plan.

9.0 QUALITY ASSURANCE (QA)

9.1 Issue Identification

The SLAC analytical Quality Assurance programs will be reviewed to determine the degree to which existing site environmental data can be utilized by the Survey team. The review will be used to identify environmental data gaps and to assess the need for additional sampling and analysis. The review will focus on the QA programs covering the analysis of effluent from the Wastewater Treatment Plant the analysis of wastewater discharges to the SBSA via the Sand Hill Road sewer system, the analysis of cooling tower and facility runoff discharges (NPDES), and the analysis of transformer oils for PCBs. The QA program for the environmental monitoring conducted by the SLAC Environment and Safety Office will also be reviewed.

The intent of this review will be to focus on the quality assurance procedures for obtaining process effluent and environmental samples, the procedures for performing the analytical work to identify pollutants, and the procedures for handling and reporting of data. All aspects of the QA program relating to environmental monitoring and analysis at the SLAC site will be reviewed.

The environmental sampling performed by the Environment and Safety Office will be evaluated by reviewing procedures; data handling, records, and logbooks. Field techniques will be observed by other Survey team members to determine actual sampling practices.

The analytical laboratories will be reviewed through an evaluation of procedures and records, and observations of laboratory operations. Off-site laboratories, including the SBSA laboratory, will be evaluated by using documents at the SLAC. No visits to off-site laboratories are anticipated.

Several areas for investigation have been identified during the pre-Survey review of available documentation:

- Training records for laboratory and sampling personnel;
- Equipment and instrument calibration and maintenance logs;

- Precision and accuracy studies;
- Blank, split, and spiked sample analyses;
- Sample handling and chain-of-custody procedures;
- Data reduction and validation;
- Data reporting and documentation; and
- Calculation and logbook reviews.

The QA program for the radiological analyses conducted by SLAC will be reviewed by the Survey radiation specialist.

9.2 Records Required

The following records relevant to the analysis of effluent and environmental monitoring samples should be available for on-site review:

- Laboratory QA manual and analytical procedures;
- Sampling QA manual and procedures;
- Previous QA audits of laboratory and sampling programs;
- Reports for precision and accuracy;
- External performance standard results (e.g., DOE Environmental Measurements Laboratory and other outside agencies);
- Training records for the laboratory and sampling personnel;
- Maintenance and calibration records for the laboratory and sampling instruments; and
- Laboratory and sampling logbooks and standard data reporting forms.

10.0 TOXIC AND CHEMICAL MATERIALS - TSCA

10.1 Issue Identification

The toxic and chemical materials review will address the raw materials and process-related chemicals used at SLAC. The use, handling, and disposal of PCBs, asbestos, and pesticides will also be within the scope of this effort.

Several areas for investigation have been identified during the pre-Survey review of available documentation:

- Adequacy of tracking, control, and management of toxic materials purchased through SLAC stores or purchased on an individual project basis. Building supervisors will be requested to provide estimates of the quantities of toxic materials used annually;
- The inventory of PCB equipment and PCB-contaminated equipment has been obtained from SLAC and reviewed. The condition of this equipment, its potential for leakage, and the quantity of contaminated fluids will be assessed;
- Obsolete or used PCB items and contaminated items in storage will be inspected for proper packaging, adequate storage protection requirements, and inventory controls;
- Disposal practices for current and past PCB inventories will be reviewed to determine the method(s) of disposal and location(s) of disposal sites;
- Procedures for PCB analysis, removal, handling, and disposal will be reviewed;
- The presence of asbestos building materials and insulation at the site will be identified/confirmed based on the facility asbestos inventory. Specifications or plans for modification/removal projects will be reviewed with the site construction/operation contractor and subcontractors;

- Training and certification of asbestos workers will be reviewed. Practices will be reviewed to determine disposal methods and locations; and
- The use of pesticides at SLAC will be reviewed, as well as personnel training/certification, application records, and storage and disposal practices.

10.2 Records Required

The following records should be available for on-site review:

- Standard Operating Procedures (SOPs) covering the management of toxic materials, i.e. purchasing, labeling, and tracking;
- Site hazard communication program;
- SOPs and records for the handling, storage, and disposal of pesticides;
- Inventory of toxic materials used at SLAC;
- List of buildings that contain asbestos;
- Asbestos disposal records including the location of the disposal sites;
- Annual PCB inventory reports; and
- The quarterly reports, prepared by the Best Management Practices Committee, which evaluate the potential overflows from the site hazardous waste and PCB storage areas.

APPENDIX D

LISTING OF SLAC BUILDINGS

PRELIMINARY

LISTING OF SLAC BUILDINGS

Building No.	Building Name	Location
001	Accelerator Housing	Below Klystron Gallery
002	Klystron Gallery	
	Cooling Tower 1201	S of Kly. Gal. Sec. 8
	Cooling Tower 1202	S of Kly. Gal. Sec. 23
003	Auxiliary Control Building	SE of Craft Shop
004	Research Area Sub-Station	W of ESA Counting House
005	Main Control Center (MCC)	S of BSY
005 A	MCC Portable Bldg.	Upper Lot S. Side
005 B	MCC Office Trailer	Upper Lot S. Side
005 C	MCC Office Trailer	Upper Lot S. Side
005 D	MCC Office Trailer	Upper Lot S. Side
	Cooling Tower 1701	
006	Cryogenics Building	E of Computer Building
007	BSY Sub-Station	E of MCC
008	Test Cell Facility	E of Cryogenics Building
009	Beam Switchyard (BSY)	E of Accel. Tunnel
010	Damping Ring Vault, South	S of Kly. Gal. Sec. 1
011	Damping Ring Vault, North	N of Kly. Gal., Sec. 1
012	Helium Dewar Shelter #1	--
013	Helium Dewar Shelter #2	--
014	Helium Pump Shelter	--
015	New Warehouse/Magnet Factory	W of Master Sub-Station
016	Master Sub-station	S of Sector 30 Kly. Gal.
017	PCB Storage Shelter	S of Master Sub-Station
023	Central Utility Building	SE of Test Laboratory
	Cooling Tower 101	S of Central Utility Building
024	Electronics Building	Bet. Light Ass. & Light Fab.
025	Light Fab. Building (LFB)	Bet. Elec. Bldg. & HFB
0255	LFB Sub-Station	SE of LFB
026	Heavy Fab. Building (HFB)	E of LFB

LISTING OF SLAC BUILDINGS

Building No.	Building Name	Location
0265	HFB Sub-Station	W of HFB
027	Shops Dining Room	Bet. LFB & Elect. Bldg.
028	Warehouse Building	E of HFB
029	Metal Stores Shelter	S of LFB
030	Cleaning Facility	S of LFB Next to 029.
031	Vacuum Assembly Bldg.	S of Bldg. 214
032	SW/Gear Block House	W of Bldg. 214.
033	Light Assembly Building (LAB)	Bet. Craft & Elect. Bldg.
034	Electronics Bldg. Annex	S of Electronics Bldg.
035	PMU Shops Building	E of General Services Bldg.
036	Chemical Storage Shelter	E of Light Fab. Bldg.
037	LFB Boiler Plant	NE of LFB
038	Treatment Plant Plating	NW of HAB
040QA	Central Laboratory	E of Test Laboratory
040S	Central Lab. Sub-Station	W. of Central Lab.
041	Admin. and Engineering Bldg.	N of Test Lab.
042	Cafeteria	N of Central Lab.
043	Auditorium	N of Central Lab.
044	Test Laboratory	S of A&E
045	Test Lab. Sub-Station	W of Test Lab
050	Computation Center	S of Central Lab. Addition
050S	Computation Center Sub-Station	S of Computation Center
060	ESA Counting House	W of ESA, Upper Level
061	End Station A (ESA)	N of ESB
062	End Station B (ESB)	S of ESA
063	Beam Dump East	E of End Station A
081	General Services Building (GSB)	Next to Freeway
082	Fire Station	S of Test Laboratory
083	Main Gatehouse	Sand Hill Road Ent. to SLAC
084	Central Lab. Addition	E of Central Lab. Annex

LISTING OF SLAC BUILDINGS

Building No.	Building Name	Location
085	Sector 30 Gate House	E of Warehouse
086	Gate 17 Guard House	E of Central Lab. Addition
087	Research Area Canteen	S of 104
088	Alpine Gate Guard House	SE Corner of SLAC Property
101	SPEAR Assembly Bldg.	N of ESA
102	EFD Shops and Storage	SE of ESA
103	SSRL Storage Bldg. (TEMP)	E of Gate 17
104	EFD Shops	E of ESB
105	Health Physics BSY Storage	BSY Magnet Yard
106	PMU Storage	BSY Magnet Yard
107	Research Yard Machine Shop	SE of ESA
108	PS Building for ESA	S of ESA
109	Spark Chamber Building	E of ESB
110	Streamer Chamber Building	S of ESA
111	40" Bubble Chamber Building	In C-Beam E of 113
113	82" Bubble Chamber Building	S of ESA
114	Power Supply Building	SE of ESA
115	MG Set Building	SE of ESB
116	SPEAR East Pit	SPEAR East Side
117	SPEAR Control Building	Inside SPEAR Ring
118	SPEAR Power Supply Building	Inside SPEAR Ring
119	SPEAR West Pit	SPEAR West Side
120	SSRL	SPEAR North Side
121	Testbeam Facility	E of ESB
122	New SPEAR Klystron Shelter	Inside SPEAR Ring
123	Hyd. Furnace Housing	E of Test Lab.
124	Rigging Loft	Res Yard South Bank
125	TBF Control Room	E of ESB
126	Sand Blast Facility	S of PMU Shops
127	Helium Comp. Building	E of ESB

LISTING OF SLAC BUILDINGS

Building No.	Building Name	Location
128	Cable Yard Wonder Building	Sec. 28 Storage Yard
130	Shelter	Inside of BDE Fence
131	SSRL South Arc Building	S of SPEAR Ring
132	Crane Shelter West Pit	SPEAR West Side
133	Sld Crd Clean Room	E of Building 111
134	Power Supply Building	E of Building 109
135	MG Set Control Building	Res. Yard South Bank
136	SLC Power Supply/I&C Building #1	E of Sector 30
137	SSRL Lab. Office Shops (LOS)	
201	Office Trailer	W of Building 214 PEP City
202	Office Trailer	S of PEP Vac. Assy. Bldg.
205	Office Trailer	N of Warehouse
206	Office Trailer	N of Warehouse
207	SLC City Office	NW of 214
208	SLC City Office	NW of 214
209	Electronics Building	N of ESB
210	SLC City Office	NW of 214
211	EFD Field Office	Res. Yard East Bank
212	SLC City Office	N of 214
213	SLC City Office	N of 214
214	SLC City Office	W of Computer Center
215	40" Bubble Chamber Cont. Building	E of 111
216	Van Group D	SPEAR Y
217	Van Group D	SPEAR Y
218	Van Group D Photo Lab	S of ESA
220	Exper. Control C - Beam	Between ESA & ESB
221	East Pit Control Room	Inside SPEAR Ring
222	82" Bubble Chamber Support	SE of ESA
223	82" Bubble Chamber Support	SE of ESA
225	40" Bubble Chamber Support	E of ESB

LISTING OF SLAC BUILDINGS

Building No.	Building Name	Location
226	West Pit Detector Support Building	Inside SPEAR Ring
228	Hansen Lab. Trailer	N of Warehouse
230	Storage Trailer Civil Defense	Casting Pad Area
231	Bubble Chamber Elect. Shop	E of ESB
232	Bubble Chamber Exp. Cont. Room	E of 111
233	Cal Tech Office Trailer	E of ESB
234	Cal Tech Office Trailer	W of 214
236	Princeton Exp. Trailer	S of ESB
237	Vacuum Lab Shop (VAN)	E of Vacuum Assy. Bldg.
238	SLC Office Trailer	S of Vacuum Assy. Bldg.
239	SLC Office Trailer	S of Vacuum Assy. Bldg.
240	Office Trailer	S of Sector 1
242	Office Trailer	N of Vacuum Assy. Bldg.
243	Office Trailer	N of Vacuum Assy. Bldg.
244	Office Trailer	N of Vacuum Assy. Bldg.
245	Office Trailer	Sector 16 South
246	Office Trailer	N of Vacuum Assy. Bldg.
247	Office Trailer	W of 214
248	Office Trailer	Between Test Lab & Sub Station
250	Office Trailer	S of IR 2
252	Office Trailer, LH2 Group	West of 110
253	Electronic Shop Trailer	S of 104
255	Office Trailer	Sector 16 South
256	Office Trailer Mark III	E of 101
257	Office Trailer	N of Vacuum Assy. Bldg.
258	Office Trailer MCC	E of MCC
259	Electronic Storage Trailer	Bet. 233 & 235
260	SLC Office Trailer	W of 214
261	Instrument Shop Office Trailer	N of Sec 20
262	Office Trailer	IR-8 Lower Level

LISTING OF SLAC BUILDINGS

Building No.	Building Name	Location
263	Office Trailer	E of Stores (Bldg. 81)
264	Office Trailer SSRL	E of SPEAR Ring S of TRSL
265	Office Trailer	W of TBF
266	Office Trailer SSRL	E of SPEAR Ring S of TRSL
267	Storage Trailer SSRL	E of SPEAR Ring S of TRSL
268	Office Trailer SSRL	W of 120
269	Office Trailer SSRL	W of 120
270	Shop Trailer MCC	E of MCC
271	SSRL 6 GeV Trailer	On Hill W of 120
273	Micro Equipment Trailer	N of Vacuum Assy. Bldg.
274	Office Trailer	Sector #16 S Side
275	SLC Office Trailer	N of Vacuum Assy. Bldg.
276	Office Trailer	N of Sector 10
277	SLC Office Trailer	N of Vacuum Assy. Bldg.
278	Office Trailer	E of HFB
279	SLC Design Trailer	S of Vac. Assy. Bldg.
281	SLC Engineering Trailer, North	E of Vac. Assy. Bldg.
282	SLC Engineering Trailer, South	E of Vac. Assy. Bldg.
283	SLC Engineering Trailer, East	E of Vac. Assy. Bldg.
284	Sector #1 North Side	North Damping Ring
285	SLC Lunchroom	W of 214
287	SSRL Off/Elect. Trailer	N of 131, S of Trestle
288	SSRL Office Trailer, South	On Bank, W of 120
289	SSRL Office Trailer	On Bank, W of 120
290	SSRL Office Trailer, North	On Bank, W of 120
291	NPAS Office Trailer #2	On Top of BSY
293	SSRL Office Trailer NW	On Bank, W of 120
294	SSRL Office Trailer SW	On Bank, W of 120
295	NPAS Office Trailer #1	On Top of BSY
296	CRYO Trailer West	SE of Comp. Center

LISTING OF SLAC BUILDINGS

Building No.	Building Name	Location
297	CRYO Trailer East	SE of Comp. Center
301	Power Supply Shelter	N of ESB
302	Power Supply Shelter	N of ESB
303	Power Supply Shelter	NE Corner of ESB
305	Shelter	S of ESB
306	Power Supply Shelter	S of ESB
307	Power Supply Shelter	Bet. ESA & ESB
309	Power Supply Shelter	Bet. ESA & ESB
310	Power Supply Shelter	NW of TBF
312	Power Supply Shelter	NE of ESB
401	Substation Support & PS Shelter	S of ESB
402	Power Fact. Correction Encl.	W of MCC Cooling Tower
403	Experimental Equip. Shelter	E of ESB S of 121
404	Experimental Shelter	SE Corner of ESB
406	B/L 6 Test Building	Bet. ESA & ESB
407	Electrical Cable Storage	E of ESA
408	Electrical Equip. Shelter	E of 104
411	Neut. Particle Facility	Top of Hill Above BDE
413	EFD Storage Building	Res. Yard South Bank
417	RF Separator #31-2	NE Corner of ESB
418	RF Separator #31-3	N of ESB
419	Laser Building	Bet. ESA & ESB
420	Storage Building	E of ESB
421	Army Storage Box, TBF	S of TBF
422	Army Storage Box 40" HBC	SE Corner CEH
423	Army Storage Trailer	E of 104
425	Army Storage Box TBF	S of TBF
427	Army Storage Box SPEAR PSOG	Res. Yard So. Bank
428	Army Storage Box SPEAR	Inside SPEAR Ring
429	SPEAR Storage Box	Inside SPEAR Ring

LISTING OF SLAC BUILDINGS

Building No.	Building Name	Location
431	CRYO Op's Storage Box	E of 111
433	20' Storage Box, Riggers	South Bank Res. Yard
434	Storage Shed	SPEAR Y SE Corner
435	Storage Shed	SW of 131
436	High Voltage Test Laboratory	SE of ESB
437	Diagnostics Laboratory	On SPEAR Roof N of W Pit
440	Cable Yard Storage Box, East	Sec. 28 LWR Storage Yard
441	Cable Yard Storage Box, West	Sec. 28 LWR Storage Yard
442	Cable Yard Wonder Building	Sec. 28 LWR Storage Yard
443	Radio Building	Base of Alignment Tower
444	EFD El. Storage Box	S of 104, West
445	EFD El. Storage Box	S of 104, East
446	SLC El. Inst Contr Trailer	BSY Magnet Yard
451	SSRL Engr. Trailer #1	On Hill, West of 120
452	SSRL Engr. Trailer #2	On Hill, West of 120
453	SSRL Engr. Trailer #3	On Hill, West of 120
454	SSRL Engr. Trailer #4	Future
455	SSRL Engr. Trailer #5	Future
501	Sub-Station	Top of 401 S of ESB
502	Sub-Station	Roof of 131-SSRL
503	Underground	N of ESB
504	Sub-Station	N of 113
505	Sub-Station	E of 104
505A	Sub-Station, HE Comp. Bldg.	E of 104
506	N Yard Sub-Station	N of 101
507	Sub-Station SPEAR	W of 118
508	Sub-Station	E of 104
509	Sub-Station	W of 102
510	Sub-Station	W of 413
511	Sub-Station	S of 121

LISTING OF SLAC BUILDINGS

Building No.	Building Name	Location
512	Sub-Station	SE of 113
513	Sub-Station	SW of Cool. Twr. 1701
514	Sub-Station SPEAR RF PS	N of SPEAR Trestle
600	PEP Ring, Accessways, Utility Shafts	
610	E of 137 Exp. Bldg.	N of IR 2
611	E of 137 Counting House	N of IR 2
613	I & EI CEH Trailer	N of IR 2
620	IR 2 Hall	Lower Level
620A	IR 2 Hall Annex	Lower Level
621	IR 2 Counting House	Lower Level
622	IR 2 TPC Leach	Lower Level
623N	IR 2 North Leach	Lower Level
623S	IR 2 South Leach	Lower Level
624	IR 2 Gas House	Lower Level
625	IR 2 Support Building	Upper Level
626	IR 2 Electrical Pad	Upper Level
627	IR 2 PEP 9 Elect. Nev. Box	Upper Level E of 625
628	IR 2 TPC Storage Box	Lower Level
629	IR 2 TPC Storage Box	Lower Level
630	IR 2 Storage Shed	Lower Level
631	IR 2 TPC Aux Gas Shed	Upper Level
632	IR 2 Storage Box	Lower Level
633	IR 2 Mini Beta PS Shelter	Upper Level
640	IR 4 Hall	Lower Level
641	IR 4 Counting House	Lower Level
642	IR 4 Tale	Lower Level
644	IR 4 Storage Box	Lower Level
645	IR 4 Support Building	Upper Level
646	IR 4 Electrical Pad	Upper Level
647	IR 4 Power Supply Building	Upper Level

LISTING OF SLAC BUILDINGS

Building No.	Building Name	Location
650	SSRL PBF-5B	--
660	IR 6 Hall	Lower Level
661	IR 6 Counting House	Lower Level S Side
662	Sector #28	Casting Pad (Shop)
664	Storage Box	BSY Magnet Yard
665	IR 6 Support Building	Upper Level
666	IR 6 Electrical Pad	Upper Level
668	IR 6 Storage Box	Lower Level N Side
669	SLC Power Supply/I&C Building #2	NW of IR 6
675	REG #7 Support Building	Upper Level
680	IR 8 Hall	Lower Level
682	IR 8 Leach	Lower Level
684	IR 8 Office	Lower Level
685	IR 8 Support Building PEP Operations Center	Upper Level
686	IR 8 Electrical Pad	Upper Level
687	IR 8 Power Supply Building	Lower Level
689	IR 8 Portable Field Toilet	Lower Level
690	IR 8 Exper. Conf. Room	Lower Level
705	IR 10 Support Building	Upper Level
706	IR 10 Electrical Pad	Upper Level
720	IR 12 Hall	Lower Level
721	IR 12 Counting House	Lower Level
723	IR 12 Office Trailer	Lower Level
725	IR 12 Support Building	Upper Level
726	IR 12 Electrical Pad	Upper Level
727	IR 12 Power Supply Building	Upper Level
730	SSRL PBF-1B	Bet. IR 12 & IR 2
748	Collider Housing North Arc	--
749	Collider Housing South Arc	--

LISTING OF SLAC BUILDINGS

Building No.	Building Name	Location
750	CEH SLC Experimental Building	--
751	CEH Exp. Control Rooms	N. Inside Part of 750
752	MK II Leach Building	N. of 750
753	Storage Box	CEH
754	MK II Army Storage Box	CEH
755	SLD Storage Box	CEH Pit
756	SLC Electrical Pad	
757	MK II Power Supply Building	N. of 750
758	SLD Power Supply Building	N. of 750
759	MK II Gas House	N. of 750
760	SLD Rigging Gear Box	SW Corner of 750
761	SLD Storage Shelter	SW of 750

Source: Excerpted from SLAC, 1987

REFERENCE FOR APPENDIX D

SLAC (Stanford Linear Accelerator Center), 1987. Directory of SLAC Buildings and Building Managers, Stanford Linear Accelerator Center, Stanford, California.

PRELIMINARY

APPENDIX E

GROUNDWATER FLOW DIRECTION CALCULATION

PRELIMINARY

GROUNDWATER FLOW DIRECTION CALCULATION

Groundwater moves from areas of high hydraulic head to areas of lower hydraulic head. If measurements of hydraulic head can be made in three wells at a site, the direction of groundwater flow can be determined. In the example shown in Figure D-1, monitoring wells MW-1, MW-2 and MW-5 were selected, and the water-level elevation measured on January 15, 1988, were used (Blaine, 1988). A line was drawn connecting MW-2 and MW-1. The point on this line at which the hydraulic head was equal to the hydraulic head measured in MW-5 was calculated, and a line drawn connecting it to MW-5. The line represents the 305.8-foot water-level elevation contour. A line perpendicular to this contour line and passing through the location of the former solvent storage tanks in the downgradient direction indicates the direction of groundwater flow through the site of the contamination.

Source: Adapted from Ecology & Environment, Inc., 1985

FIGURE E-1

GROUNDWATER FLOW DIRECTION CALCULATION

REFERENCES FOR APPENDIX E

Blaine, R.C., 1988. "Monitoring of Eight Wells at 2575 Sand Hill Road, Menlo Park, California, January 15, 1988," 88015F1, Blaine Tech Services, Inc., San Jose, California.

Ecology & Environment, Inc., 1985. Soil and Groundwater Investigation, Stanford Linear Accelerator Center, SL-2900-D880, Ecology & Environment, Inc., San Francisco, California.

PRELIMINARY

APPENDIX F

HAZARDOUS WASTE TRANSPORTERS AND TREATMENT, STORAGE AND DISPOSAL (TSD) FACILITIES USED BY THE SLAC DURING 1987

PRELIMINARY

**HAZARDOUS WASTE TRANSPORTERS AND TREATMENT, STORAGE
AND DISPOSAL (TSD) FACILITIES USED BY THE SLAC DURING 1987**

TRANSPORTERS

Alvisco Oil Company; Alvisco, CA; CAD980695340
American Environmental Management; Rancho Cordova, CA; CAD980884183
Baron-Blakeslee; Newark, CA; CAD074644659
California Solvent Recycling; CAT080031248
ENSCO; El Dorado, AR; ARD069748192
Great Western; Milpitas, CA; CAD095991253
H and H Shipping Service Company; South San Francisco, CA; CAD004771168
International Transport, Inc.; CAD981164387
IT Transportation; Martinez, CA; CAD000058917
North American Environmental; CAD980813703
Stamco; CAD063547996
U.S. Pollution Control, Inc.; UTD006913201, OKD98154474, UTD980635890

TSD FACILITIES

Alvisco Oil Company; Alvisco, CA; CAD980695340
American Environmental Management; Rancho Cordova, CA; CAD980884183
Baron-Blakeslee; Newark, CA; CAD074644659
ENSCO; El Dorado, AR; ARD069748192
Great Western; Milpitas, CA; CAD095991253
H and H Shipping Service Company; South San Francisco, CA; CAD004771168
IT Vine Hill; Martinex, CA; CAD000094771
North American Environmental, Inc.; Wilmington, CA; CAD980665947
Romic Chemical Corporation; East Palo Alto, CA; CAD009452657
U.S. Pollution Control, Inc.; Clive, UT; UTD991301748

Source: SLAC, 1988

REFERENCE FOR APPENDIX F

SLAC (Stanford Linear Accelerator Center), 1988. Hazardous Waste Shipment Log, Stanford Linear Accelerator Center, Stanford, California.

PRELIMINARY

END

DATE FILMED

11 / 27 / 90