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Annual Site Environmental Report: 2008

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SLAC National Accelerator Laboratory, Stanford University, Stanford, CA 94309

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Preface

To satisfy the requirements of the United States Department of Energy Order 231.1, "*Environment, Safety and Health Reporting*", the Environment, Safety, and Health Division of the SLAC National Accelerator Laboratory prepares an annual report describing its environmental programs and activities.

This *Annual Site Environmental Report: 2008* summarizes the SLAC National Accelerator Laboratory compliance with standards and requirements, describes the management and monitoring systems in place, and highlights significant accomplishments for the year.

Organization

The report is published in a single volume, organized into the following chapters:

- Chapter 1, "Site Overview", describes the environmental setting of the SLAC National Accelerator Laboratory and the activities conducted at the site
- Chapter 2, "Environmental Compliance", gives an account of the regulatory framework and results concerning the site's environmental programs
- Chapter 3, "Management Systems", outlines the organizational structure, methods, and responsibilities relevant to environmental programs
- Chapters 4, 5, and 6, respectively "Environmental Non-radiological Programs", "Environmental Radiological Programs", and "Groundwater Protection and Environmental Restoration", give more detailed accounts of the programs and their results for the year

An executive summary provides an overview of the report.

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Editing and Publishing

ES&H Division Publishing edited and published this report; SLAC National Accelerator Laboratory Technical Publications provided electronic publishing and printing support.

Acronyms

^3H	tritium
AB	Assembly Bill
ASER	annual site environmental report
ASTs	aboveground storage tanks
BAAQMD	Bay Area Air Quality Management District
BaBar	SLAC B-Factory detector
BDE	beam dump east
BMP	best management practice
BTH	beam transport hall
CalARP	California Accidental Release Prevention Program
CARB	California Air Resources Board
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
Ci	curie
CMS	chemical management system
CRT	cathode ray tube
CUPA	certified unified program agency
CWA	Clean Water Act
CX	categorical exclusion
DES	Detailed Energy Survey
DOE	United States Department of Energy
DPE	dual phase extraction
DWS	drinking water standard
E85	mix of fuel where 85 percent is ethanol and 15 percent is gasoline
EA	environmental assessment
EBR	Environmental Baseline Report
ECM	energy conservation measures
EIS	environmental impact statement
EMP	environmental management program
EM	environmental management

EMS	environmental management system
EO	Executive Order
EP	Environmental Protection Department
EPCRA	Emergency Planning and Community-Right-to-Know Act
EPEAT	Electronic Production Environmental Assessment Tool
ESC	environmental safety committee
ESPC	energy saving performance contract
ES&H	environment, safety, and health
FHWSA	Former Hazardous Waste Storage Area
FMS	flow metering station
FSUST	Former Solvent Underground Storage Tank Area
ft^3	cubic feet
FY	fiscal year
GDF	gasoline dispensing facility
GHG	greenhouse gas
GLAST	Gamma Ray Large Area Space Telescope
gpd	gallons per day
GSA	United States General Services Administration
GWP	Global Warming Potential
HAPs	hazardous air pollutants
Haas	Haas *tcm*
HMBP	hazardous materials business plan
HMIS	hazardous materials inventory statement
ID/IQ	Indefinite Duration/Indefinite Quantity
IDPE	interim dual phase extraction
IH&IM	Industrial Hygiene and Information Management Department
IR	interaction region
ILC	International Linear Collider
INL	Idaho National Laboratory
ISEMS	integrated safety and environmental management system
ISM	integrated safety management
ISO	International Organization of Standardization
JRBP	Jasper Ridge Biological Preserve
km	kilometer

L	liter
lbs	pounds
linac	linear accelerator
LCLS	Linac Coherent Light Source
LLRW	low-level radioactive waste
LRDP	long-range development plan
LSY	lower salvage yard
m	meter
M&O	management and operating
MAPEP	mixed analyte performance evaluation program
MEI	maximally exposed individual
MEP	mechanical/electrical/plumbing systems
MFPF	metal finishing pre-treatment facility
mg/L	milligrams per liter
MGE	Main Gate East Channel
MPMWD	Menlo Park Municipal Water Department
mrem	millirem
mSv	milli Sievert
NA	not applicable
NAE	North Adit East Channel
NEPA	National Environmental Policy Act
NESHAPs	National Emission Standards for Hazardous Air Pollutants
ODS	ozone-depleting substance
PBR	permit by rule
PBV	parameter benchmark value
PCB	polychlorinated biphenyl
pCi	picoCuries
pCi/L	picoCuries per liter
PEP	Positron-Electron Project
ppd	pounds per day
ppm	parts per million
PPOA	pollution prevention opportunity assessments
PRGs	Preliminary Remediation Goals
PSA	Plating Shop Area

QA	quality assurance
QC	quality control
rad	unit used to quantify radiation dose
RCRA	Resource Conservation and Recovery Act
RI	remedial investigation
RM	Requirements Management
RMP	risk management plan
RP	Radiation Protection Department
RWQCB	Regional Water Quality Control Board
SARA	Superfund Amendments and Reauthorization Act
SBSA	South Bayside System Authority
SF_6	sulfur hexafluoride
SLAC	SLAC National Accelerator Laboratory
SMOP	synthetic minor operating permit
SMP	self-monitoring program
SPCC	spill prevention control and countermeasures
SPEAR	Stanford Positron-Electron Asymmetric Ring
SSO	DOE SLAC Site Office
SSRL	Stanford Synchrotron Radiation Laboratory
SVOCs	semi-volatile organic compounds
SWMP	stormwater monitoring program
SWPPP	stormwater pollution prevention plan
SWRCB	State Water Resources Control Board
TCA	1,1,1-trichloroethane
TDS	total dissolved solids
TL/CL	Test Lab and Central Lab Area
TPH	total petroleum hydrocarbons
TRI	toxic release inventory
TSCA	Toxic Substances Control Act
TSI	technical systems installations
UH	undulator hall
Unidocs	Uniform documents
USEPA	United States Environmental Protection Agency
VOCs	volatile organic compounds

WBSD	West Bay Sanitary District
WM	Waste Management Group
WSS	Work Smart Standard
WTS	waste tracking system

Executive Summary

This report provides information about environmental programs during the calendar year of 2008 at the SLAC National Accelerator Laboratory (SLAC), Menlo Park, California. Activities that span the calendar year, i.e., stormwater monitoring covering the winter season of 2008/2009 (October 2008 through May 2009), are also included.

Production of an annual site environmental report (ASER) is a requirement established by the United States Department of Energy (DOE) for all management and operating (M&O) contractors throughout the DOE complex. SLAC is a federally-funded research and development center with Stanford University as the M&O contractor.

Under Executive Order (EO) 13423, *Strengthening Federal Environmental, Energy, and Transportation Management*, and DOE Order 450.1A, *Environmental Protection Program*, SLAC effectively implements and integrates the key elements of an Environmental Management System (EMS) to achieve the site's integrated safety and environmental management system goals. For normal daily activities, SLAC managers and supervisors are responsible for ensuring that policies and procedures are understood and followed so that

- Worker safety and health are protected
- The environment is protected
- Compliance is ensured

Throughout 2008, SLAC continued to improve its management systems. These systems provided a structured framework for SLAC to implement "greening of the government" initiatives such as EO 13423 and DOE Orders 450.1A and 430.2B. Overall, management systems at SLAC are effective, supporting compliance with all relevant statutory and regulatory requirements.

SLAC continues to demonstrate significant progress in implementing and integrating EMS into day-to-day operations and construction activities at SLAC. The annual management review and ranking of environmental aspects were completed this year by SLAC's EMS Steering Committee, the Environmental Safety Committee (ESC), and twelve objectives and targets were established for 2008. For each objective and target, a work plan, or Environmental Management Program (EMP) was completed and progress reports were routinely provided to SLAC senior management and the DOE SLAC Site Office (SSO).

During 2008, there were no reportable releases to the environment from SLAC operations. In addition, many improvements in waste minimization, recycling, stormwater management, groundwater restoration, and SLAC's chemical management system (CMS) were continued during the year.

The following are amongst SLAC's environmental accomplishments for 2008: a composting program at SLAC's onsite cafeteria was initiated, greater than 800 cubic feet of legacy radioactive waste were packaged and shipped from SLAC, a chemical redistribution program was developed, SLAC reduced the number of General Services Administration leased vehicles from 221 to 164, recycling of municipal waste was increased by approximately 140 tons during 2008, and site-wide releases of sulfur hexafluoride were reduced by 50 percent.

In 2008, no radiological incidents occurred that increased radiation levels or released radioactivity to the environment. In addition to managing its radioactive wastes safely and responsibly, SLAC worked to reduce the amount of waste generated. SLAC has implemented programs and systems to ensure compliance with all radiological requirements related to the environment. Specifically, the Radiation Protection Radiological Waste Management Group developed a training course to certify Radioactive Waste Generators, conducted a training pilot, and developed a list of potential radioactive waste generators to train. Twenty eight generators were trained in 2008. As a best management practice, SLAC also reduced its tritium inventory by at least 95 percent by draining one of its accelerator cooling water systems; with the cooperation of the South Bayside System Authority, the West Bay Sanitary District and the DOE, SLAC discharged the cooling water to the sanitary sewer according to federal regulations and replenished the system with clean water.

In 2008, the SLAC Environmental Restoration Program personnel continued work on site characterization and evaluation of remedial alternatives at four sites with volatile organic compounds in groundwater and several areas with polychlorinated biphenyls and low concentrations of lead in soil. SLAC is regulated under a site cleanup requirements order (*board order*) issued by the California Regional Water Quality Control Board (RWQCB), San Francisco Bay Region in May 2005 for the investigation and remediation of impacted soil and groundwater at SLAC. The board order lists specific tasks and deadlines for completion of groundwater and soil characterization and other remediation activities. All 2008 submittals to the RWQCB were completed and submitted on time.

1 Site Overview

This chapter describes the environmental setting of SLAC National Accelerator Laboratory (SLAC) and the activities conducted at the site.

For an overview of site environmental planning, including descriptions of environmental resources, see the long-range development plan (LRDP) prepared in 2002 (revised June 2003).[1]

1.1 Introduction

SLAC is a national research laboratory operated by Stanford University under contract to the DOE. SLAC is located on the San Francisco Peninsula, about halfway between San Francisco and San Jose, California (see Figure 1-1). Current research and scientific user facilities are in areas of photon science, particle physics, and particle astrophysics. Six scientists have been awarded the Nobel Prize for work carried out at SLAC and there are 10 members of its faculty in the National Academies.

The majority of SLAC funding comes from DOE Office of Science, with smaller contributions from National Aeronautics and Space Administration, National Institute of Health, and other federal and non-federal sources. SLAC also receives funding from the DOE Office of Environmental Management (EM) for soil and groundwater investigation and remediation activities at the site managed by SLAC for EM.

1.1.1 SLAC Mission

Photon Science Discoveries

- To make discoveries in photon science at the frontiers of the ultrasmall and ultrafast in a wide spectrum of physical and life sciences

Particle and Particle Astrophysics Discoveries

- To make discoveries in particle and astroparticle physics that redefine humanity's understanding of what the universe is made of and the forces that control it

Operate Safely; Train the Best

- To operate a safe laboratory that employs and trains the best and brightest, helping to ensure the future economic strength and security of the nation

1.1.2 Research Program

SLAC has three major research areas. The first, in photon science, is to develop and support innovative research instrumentation for x-ray based studies of matter on length scales down to the nano- to atomic-level and on time

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[1] Stanford University Architect/Planning Office, *Stanford Linear Accelerator Center Long Range Development Plan* (December 2002, revised June 2003), http://www-group.slac.stanford.edu/bsd/SLAC_LRDP_final.pdf

scales from milli- down to femto-seconds. Photon science research includes complex, correlated and magnetic materials science, molecular environmental science, and structural biology; it is a rapidly developing new area of excellence in ultrafast x-ray science.

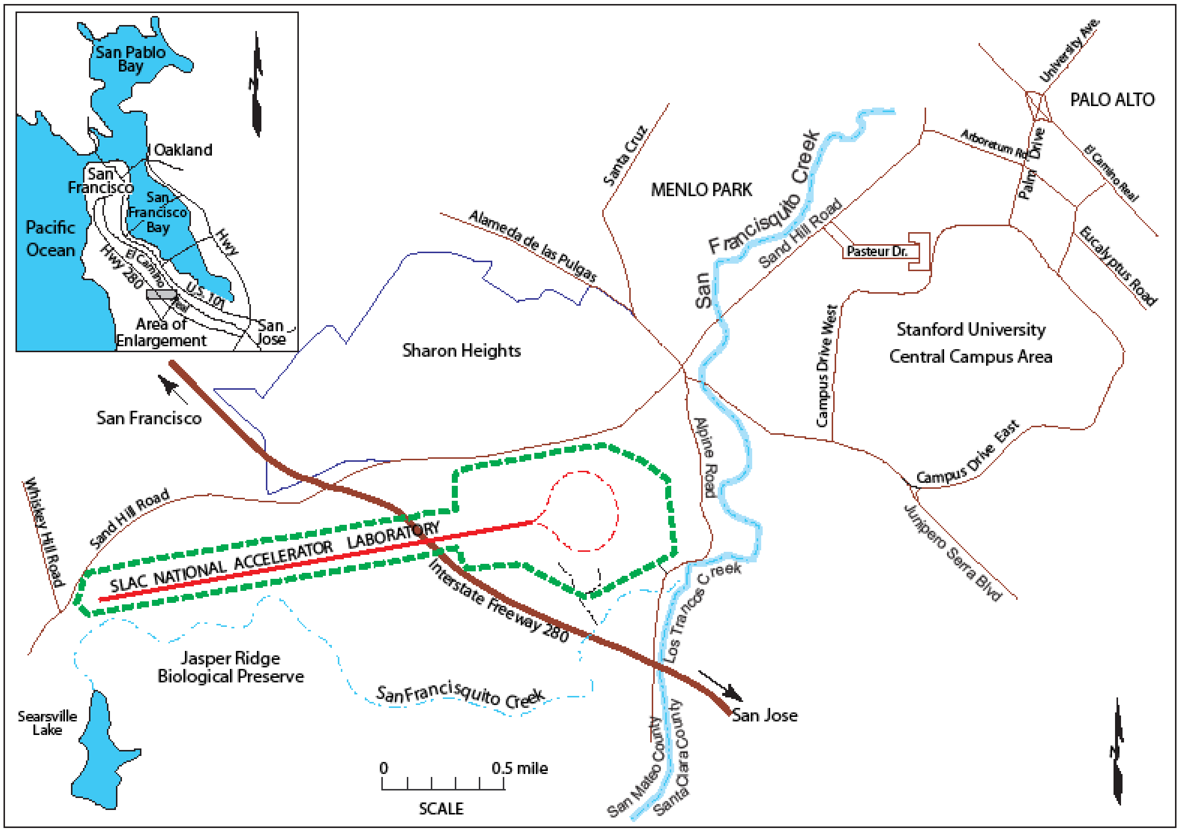

Figure 1-1 SLAC Site Location

Another research area is the use of particle accelerators and observatories in space and on the ground to understand what our universe is made of at its most basic and fundamental level. The principal areas of particle physics are the electron energy frontier using a linear collider, theoretical investigations of the quantum universe and, at the Kavli Institute for Particle Astrophysics and Cosmology, non-accelerator tests of the Standard Cosmology Model through investigations of dark matter and dark energy.

Continuing over 2008, a third research area at SLAC is the construction of the Linac Coherent Light Source (LCLS), the world’s first x-ray-free electron laser. SLAC is committed to the on-time and on-budget construction and rapid commissioning of this major new facility that will open revolutionary frontiers for photon science in the coming decades. In 2008, civil construction of the Beam Transport Hall (BTH), Undulator Hall (UH) and LCLS Electron Beam Dump (Dump) were completed. The construction included the installation and commissioning of the Mechanical/Electrical/Plumbing (MEP) systems. The civil construction was followed by technical systems installations (TSI) in these areas. When the TSI were installed they were commissioned. Commissioning included transporting electrons from the Linac through the BTH-West, into the BTH and through the UH and then terminating the electrons at the Dump.

SLAC supports other first class research in physics. The 2-mile linear accelerator (linac) at SLAC, constructed in the early 1960s, generates high intensity beams of electrons and positrons up to 50 giga-electron volts. The linac is also used for injecting electrons and positrons into colliding-beam storage rings for particle physics research. The Positron-Electron Project (PEP) storage ring, which is one of the colliding-beam storage rings is about 875 yards in diameter. While the original PEP program was completed in 1990, the storage ring has since been upgraded to serve as an asymmetric B factory (known as PEP-II) to study the B meson. In April 2008, the SLAC B Factory (BaBar) program was ended. A smaller storage ring, the Stanford Positron-Electron Asymmetric Ring (SPEAR), contains a separate, shorter linac and a booster ring for injecting accelerated beams of electrons. SPEAR is fully dedicated to synchrotron radiation research. The synchrotron light generated by the SPEAR storage ring is used by the Stanford Synchrotron Radiation Lightsource (SSRL), a division of SLAC, to perform experiments. At the SSRL, researchers view the nanoworld, leading to discoveries in solid-state physics, material science, environmental science, structural biology, and chemistry. In the past, researchers at SSRL have looked at remnants of soft tissues in hundred-million-year-old dinosaur fossils; mapped the distribution of elements in diseased brains, sought a deeper understanding of Alzheimer’s and Parkinson’s diseases; worked out the structures of scores of proteins; and characterized the quantum electronic workings of new materials, leading the way toward the superconductors of the future.

SLAC is committed to continuing its leadership in advocating and working on the design of the International Linear Collider (ILC) machine and the detector. The laboratory has the strongest electron accelerator group in the United States, if not the world, and in collaboration with our international partners will contribute to both the design and testing of major ILC subsystems as well as to the overall design.

1.2 Location

SLAC is located in a belt of low, rolling foothills between the alluvial plain bordering San Francisco Bay to the east and the Santa Cruz Mountains to the west. The site varies in elevation from 175 to 380 feet above sea level. The alluvial plain to the east around the bay lies less than 151 feet above sea level; the mountains to the west rise abruptly to over 2000 feet.

The site occupies 426 acres of land owned by Stanford University. The property was leased in 1962 for purposes of research into the basic properties of matter. The DOE now owns the original 50-year lease to the Atomic Energy Commission. The land is part of Stanford’s academic reserve and is located west of the university and the city of Palo Alto in an unincorporated portion of San Mateo County.

The site lies between Sand Hill Road and Alpine Road, bisected by Highway 280, on an elongated parcel roughly 2.75 miles long, running in an east-west direction. The parcel widens to about 0.65 miles at the target (east) end to allow space for buildings and experimental facilities. The south side of much of the western end of the parcel is bordered by Stanford University’s Jasper Ridge Biological Preserve (JRBP), which includes part of the San Francisquito Creek riparian channel, the last channel of its kind between San Jose and San Francisco still in its natural state.

1.3 Geology

The SLAC site is underlain by sandstone, with some basalt at the far eastern end. In general, the bedrock on which the western half of the SLAC linac rests is the Whiskey Hill Formation (Eocene age), and the bedrock under the eastern half is the Ladera Sandstone (Miocene age). On top of this bedrock at various places along the accelerator alignment is the Santa Clara Formation (Pleistocene age), where alluvial deposits of sand and gravel are found. At the surface is a soil overburden of non-consolidated earth material averaging from 0.3 to 3 feet in depth. Figure 1-2 shows the general geographic and geologic setting of the area.

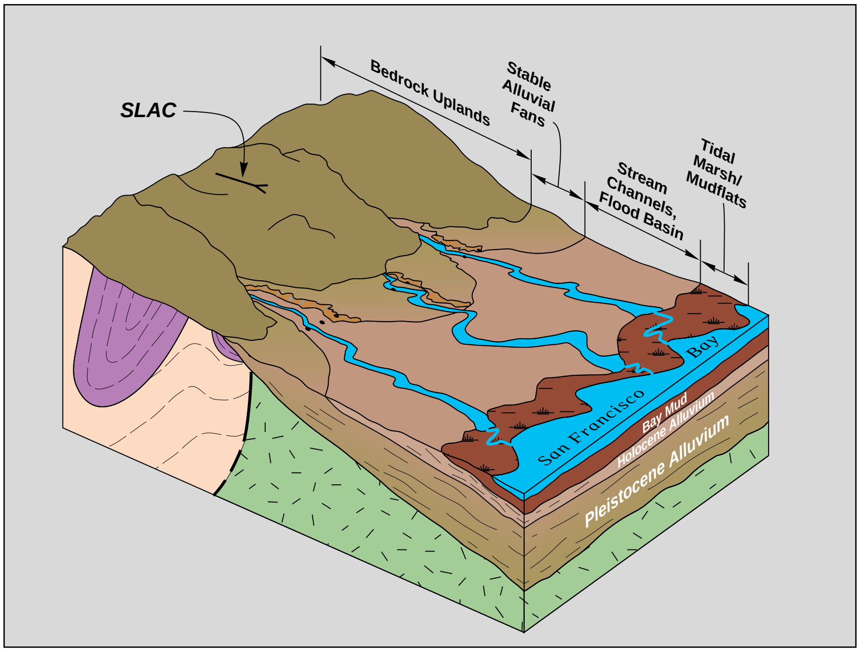

Figure 1-2 Site Area General Geographic and Geologic Setting

1.4 Climate

The climate in the SLAC area is Mediterranean. Winters are cool and moist, and summers are mostly warm and dry. Daily mean temperatures are seldom below 32 degrees Fahrenheit or above 86 degrees Fahrenheit.

Rainfall averages about 22 inches per year. The distribution of precipitation is highly seasonal. About 75 percent of the precipitation, including most of the major storms, occurs during the four-month period from December through March. Most winter storm periods are from two days to 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 substantial fluctuations in intensity, which can best be characterized as a series of storm cells following one another that produce heavy precipitation for periods of five to 15 minutes with lulls in between bursts.

1.5 Land Use

The SLAC site is located on an unincorporated portion of San Mateo County and is zoned in the San Mateo County General Plan as a residential estate. Approximately 34 percent of the property is developed with buildings and pavement, mostly in the core campus area.

Land use to the immediate west is commercial, and farther west is agricultural and the JRBP. Land use to the north is mostly commercial, residential, and recreational (a golf course), with a school and convalescent hospital north of the central campus. Land use to the east is residential, recreational (another golf course), and educational (the Stanford campus). Land use to the south is agricultural (including a horse boarding and training facility), reserved open space, and residential.

1.6 Water Supply

Domestic water for SLAC is supplied by the Menlo Park Municipal Water Department (MPMWD). The source is the City of San Francisco-operated Hetch Hetchy aqueduct system that is fed from reservoirs located in the Sierra Nevada. SLAC, the neighboring Sharon Heights development (to the north), and the Stanford shopping center, receive water service from an independent system (called *Zone 3*) within the MPMWD. This separate system taps the Hetch Hetchy aqueduct and pumps water up to a 268,391-cubic-feet reservoir in Atherton north of Sand Hill Road, approximately 1.5 miles from central SLAC.

The Zone 3 system was constructed in 1962 under special agreements between the City of Menlo Park, the Sharon Heights developer, Stanford University, and the DOE. The cost of construction, including reservoir, pump station, and transmission lines, was shared among the various parties, so each party has a vested interest in the system, and is entitled to certain capacity rights in accordance with these agreements.

Drinking and process water are transported throughout the SLAC site by a distribution system protected by backflow prevention devices. Groundwater is not currently used on-site at SLAC; however, five offsite groundwater wells have been identified within a one-mile radius of SLAC, three of which are currently in use. The closest downgradient groundwater well is located approximately 500 feet south of SLAC along the stream margin of San Francisquito Creek. This well was formerly used for agricultural supply but is currently capped. Of the other four wells, one is capped, one is used for watering livestock, and the other two are used for residential drinking water supply.

Use of water at SLAC is about equally divided between water used to cool equipment (such as the linac) and domestic uses (such as landscape irrigation and drinking water). The average water consumption by SLAC in 2008 was 29,654 cubic feet per day, or 10,820,600 cubic feet total.

1.7 Demographics

SLAC’s primary customers are the approximately 3,000 students, postdoctoral students, and scientists from around the world who make use of its accelerator-based instrumentation and techniques for their research. SLAC has a working population of about 1,400, of which about 218 are PhD physicists. Approximately 694 staff members are professional, including physicists, engineers, programmers, and other scientific-related personnel. The balance of the staff comprises support personnel, including technicians, crafts personnel, laboratory assistants, and administrative assistants. In addition to the regular population, at any given time SLAC hosts between 900 and 1,000 visiting scientists.

The populated area around SLAC is a mix of offices, schools, single-family housing, apartments, condominiums, and Stanford University. Approximately 3,500 people live within a one-mile radius of central SLAC. SLAC is surrounded by five communities: the city of Menlo Park; the towns of Atherton, Portola Valley, and Woodside; and the unincorporated community of Stanford University, which is in Santa Clara County. Nearby unincorporated communities in San Mateo County include Ladera and two neighborhoods located in western Menlo Park.

Table 1-1 provides a summary of populations in the communities around SLAC. Within one mile of SLAC's perimeter are two public and two private schools with elementary and/or middle school students.

Table 1-1 Populations of Communities near SLAC

Type	Community	County	Population
Incorporated town or city	Atherton	San Mateo	7,194
	Menlo Park	San Mateo	30,785
	Palo Alto	Santa Clara	58,598
	Portola Valley	San Mateo	4,462
	Woodside	San Mateo	5,352
Unincorporated community	Ladera	San Mateo	1,492
	Stanford	Santa Clara	13,200
	West Menlo Park	San Mateo	3,629
	Weekend Acres	San Mateo	268
Total			124,980

Sources:

1 Census 2000 data from the San Mateo County web site and from US Census Bureau site

2 Stanford population from Stanford University Planning Department estimates

Note: Population in unincorporated areas outside the defined communities is not included

2 Environmental Compliance

2.1 Introduction

This chapter provides a summary of the regulatory framework within which the environmental programs of SLAC operate, and compliance with those regulations for 2008.

2.2 Regulatory Framework

The SLAC Work Smart Standards (WSS) identify environmental protection and safety requirements and standards that are applicable to facilities and facility operations.[2]

2.3 Environmental Permits and Notifications

The permits held by SLAC in 2008 are shown in Table 2-1.

Table 2-1 General Permits Held by SLAC

Issuing Agency	Permit Type	Description	Number
Bay Area Air Quality Management District	Air quality	Synthetic minor operating permit (SMOP), issued per Title V of the Clean Air Act	1
		33 permitted sources and 21 exempt sources for operation of various types of equipment (after initial permitting, consolidated into SMOP)	54
California Department of Toxic Substance Control	Hazardous waste treatment	Unit 1A – Building 025, permit by rule (PBR) for cyanide treatment tanks	1
		Unit 1B – Building 038, PBR for metal finishing pretreatment facility	1
		Unit 1C – Building 038, PBR for batch hazardous waste treatment tank	1
		Unit 2 – Building 038, PBR for sludge dryer	1
		Unit 4 – Building 035, conditional authorization permit for Former Solvent Underground Storage Tank (FSUST) groundwater treatment system	1

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[2] SLAC National Accelerator Laboratory, “Work Smart Standards”, http://www-group.slac.stanford.edu/esh/general/isems/wss/

Issuing Agency	Permit Type	Description	Number
		Unit 5 – Former Hazardous Waste Storage Area (FHWSA), PBR for groundwater treatment system	1
South Bayside System Authority and West Bay Sanitary District	Wastewater discharge	Mandatory Wastewater Discharge Permit	1
Regional Water Quality Control Board	Stormwater	Industrial activities stormwater general permit	1
US Environmental Protection Agency	Hazardous waste	90-day hazardous waste generator	1

2.4 Environmental Incidents

2.4.1 Non-radiological Incidents

SLAC was in compliance with all non-radiological requirements related to the environment throughout 2008. There were no reportable releases to the environment during 2008.

2.4.2 Radiological Incidents

In 2008, no radiological incidents occurred that increased radiation levels or released radioactivity to the environment. As detailed in Chapter 5, “Environmental Radiological Program”, SLAC was in compliance with all radiological requirements related to the environment throughout 2008.

2.5 Assessments, Inspections, and Quality Assurance

The environmental programs at SLAC are subject to assessments, inspections, and quality assurance measures. Those conducted during 2008 are reported here.

2.5.1 Assessments

2.5.1.1 Internal

An assessment of SLAC’s air quality program was performed in August 2008. The assessment included a review of the regulatory framework, major program elements, recent accomplishments, projected activities, and compliance challenges.

SLAC’s Office of Assurance completed an Internal Independent Assessment of the EMS in May 2008. The assessment team found that the elements and framework of SLACs EMS is consistent with the International Organization for Standardization (ISO) 14001 standard, is well established, and appears to be strong and comprehensive. No Major Nonconformities were identified. There were 10 Minor Nonconformities identified as well as 14 Opportunities for Improvement, 1 Observation, and 5 Noteworthy Practices specific to the EMS.

2.5.1.2. External

External assessments conducted by regulators occur periodically and include quarterly radiation monitoring of the SLAC perimeter by California Department of Health Services. A review of SLAC's Spill Prevention, Control and Countermeasures (SPCC) Plan was performed by a consultant for SLAC in February 2008. As a result, revisions were made to the SPCC Plan to ensure the document is in compliance with the recently enacted 40 Code of Federal Regulations (CFR) 112 Final Rule.

2.5.2 Inspections

Periodic inspections of the environmental programs are performed at SLAC by environmental regulatory agencies. Table 2-2 lists the inspections conducted in 2008 by these agencies.

Table 2-2 Environmental Audits and Inspections

Regulatory Agency	Inspection Title	Date	Violations
South Bayside System Authority	No inspections or other site visits in 2008		0
Bay Area Air Quality Management District	No inspections or other site visits in 2008		0
San Mateo County Department of Health Services	Hazardous waste generation program, tiered permitting, and hazardous materials business plan	November 13, 14, 18, 21	0
	Verification of information presented in California Accidental Release Prevention Program (CalARP) Risk Management Plan, submitted September 2007	April 25	0

The California Certified Unified Program Agency (CUPA) issued two notices to comply. The following non-compliance issues were noted and have been corrected.

Tiered Permit Treatment Facilities:

- Several additional tanks and containers were noted at Treatment Units 1A, 1B, and 4. Corrected unit notifications were submitted.
- The additional tanks and containers noted above were not correctly labeled. Appropriate labels were attached to the tanks and containers.

2.5.3 Quality Assurance

The SLAC site-wide quality assurance (QA) program is consistent with the requirements of DOE Order 414.1C,[3] and has roles, responsibilities, and authorities for implementing the 10 criteria from the DOE order.

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[3] United States Department of Energy, DOE Order 414.1C, "Quality Assurance", http://www.directives.doe.gov/pdfs/doe/doetext/neword/414/o4141c.html

The SLAC Office of Assurance is responsible for:

- Auditing quality assurance for line work as well as Environment, Safety and Health (ES&H) programs
- Maintaining the *SLAC Institutional Quality Assurance Program Plan*
- Providing direction for implementation of the ten criteria from DOE Order 414.1C

2.5.3.1 Environmental Non-radiological Program

The Environmental Restoration Program uses the *Quality Assurance Project Plan for the Environmental Restoration Program*[4] for soil and groundwater characterization and remediation activities. This document includes all components required of quality assurance project plans and is consistent with United States Environmental Protection Agency (USEPA); Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, or Superfund); and DOE guidance documents. The components include defining required laboratory and field QA and quality control (QC) procedures and corrective actions, and data validation and reporting.

2.5.3.2 Environmental Radiological Program

Twice a year, SLAC participates in the Mixed Analyte Performance Evaluation Program (MAPEP) administered by the DOE Idaho National Laboratory (INL). Under this program, the INL provided the SLAC Radioanalysis Laboratory with samples that contained unknown gamma- and beta-emitting radionuclides. SLAC used these samples to test and improve its gamma counting and liquid scintillation counting capabilities. This ensures that the lab’s counting system performs accurate measurements. MAPEP Session 18 and Session 19 results, submitted in May 2008 and October 2008, were all acceptable, which is consistent with the previous year’s performance.

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[4] Stanford Linear Accelerator Center, Environment, Safety, and Health Division, Environmental Protection and Restoration Department, *Quality Assurance Project Plan for the Environmental Restoration Program* (SLAC-I-750-2A17M-003 R004, February 2008)

3 Management Systems

3.1 Introduction

This chapter provides an overview of the SLAC organizational structure, management approach, and EMS implementation used to protect the environment. The results for the various measures and reviews discussed below are contained in Chapter 2, “Environmental Compliance”.

3.2 SLAC Organization

SLAC is organized into five directorates: Director’s Office, Operations Directorate, Photon Sciences Directorate, Particle and Particle Astrophysics Directorate, and LCLS Construction Directorate. Additionally, the SLAC Office of Assurance was formed in 2006 in response to DOE Order 226.1. The purpose of SLAC’s assurance program is to ensure that products and services meet or exceed customers’ expectations. SLAC’s customers include the DOE, the many users who participate in experiments at SLAC using the laboratory’s unique experimental facilities, and the sponsors of work conducted under work-for-others program.

3.3 ES&H Division Organization

The ES&H Division consists of five departments (see below) and a division office. The division office is tasked with overall strategic planning and management. The shared goal is to ensure that SLAC operates in compliance with federal, state, and local laws and regulations, as well as DOE directives.

3.3.1 Environmental Protection

The Environmental Protection (EP) Department has three technical groups, and develops and manages requirements under the EMS. The EP Group provides oversight of stormwater and industrial wastewater, air, toxic substances control, and groundwater protection. The Environmental Restoration Group oversees work to restore soil and groundwater impacted with chemicals from historical operations. The Waste Management (WM) Group develops and implements waste minimization and pollution prevention plans, and coordinates the management and off-site disposal of sanitary, hazardous and low-level radioactive waste. The EMS is the overarching system that SLAC uses for managing environmental aspects and is further described in Section 3.5.

3.3.2 Risk Management and Response

The Risk Management and Response Department consists of four groups; the Fire and Emergency Management Group, the Incident Investigation and Lessons Learned Group, the Occupational Health Group and the Site Security Group.

During 2008, the Fire and Emergency Management Group, staffed by personnel from the Palo Alto Fire Department, continued to provide services on a 24 hour-a-day, seven days-a-week basis.

During 2008, the Occupational Health Group, staffed by contracted professional medical personnel, continued to provide a full range of occupational medicine services to the site.

3.3.3 Radiation Protection

The Radiation Protection (RP) Department includes five technical groups. The Radiation Physics Group provides expertise in shielding design for new experiments and facilities, and provides oversight for the safe operation of beam lines to protect workers, the general public and the environment. The Field Operations Group oversees radiological monitoring and control. The Dosimetry and Radiological Environmental Protection Group provides dosimetry services and environmental impact monitoring and assessment. The Radioactive Waste Management Group oversees radioactive waste management at SLAC. The Laser Safety Group is in charge of developing and implementing SLAC's Laser Safety Program.

3.3.4 Field Safety and Building Inspection

The ES&H Field Safety and Building Inspection Office includes two technical groups. The Field Safety group provides industrial and OSHA construction safety oversight to construction projects, as well as providing safety training classes to SLAC personnel. The Building Inspection Office provides Building Code oversight of construction projects during the Plan Review process, and during the construction phase.

3.3.5 Industrial Hygiene and Information Management

The Industrial Hygiene and Information Management Department (IH&IM) assists with the management of SLAC's safety and health programs, as well as programs in hazardous materials management, ES&H training, CMS, publishing, web and business applications.

3.4 Integrated Safety and Environmental Management System

SLAC ensures that the site is operated in a safe, environmentally responsible manner and complies with applicable laws, regulations, standards and other requirements through implementation of an Integrated Safety and Environmental Management System (ISEMS). The ISEMS is based on integrating the key elements of effective integrated safety and environmental management systems into the mission and everyday operations of the site, and as such embodied the ISEMS concepts prior to the DOE requirements that were formally incorporated into the management and operating contract for the site.

3.4.1 Integrated Safety and Environmental Management System

The "plan, do, check, and improve" approach of ISEMS[5] has been formally adopted by SLAC, and is the foundation of the site's ISEMS[6] and the ES&H program. Work at SLAC follows the five core functions of Integrated Safety Management (ISM), which is consistent with the EMS process (policy, planning, implementation, checking and corrective action, and management review):

1. Define the scope of work

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[5] Stanford Linear Accelerator Center, Environment, Safety, and Health Division, "Integrated Safety and Environmental Management Systems", http://www-group.slac.stanford.edu/esh/general/isems/

[6] Stanford Linear Accelerator Center, Environment, Safety, and Health Division, *SLAC Integrated Safety and Environmental Management System Description* (SLAC-I-720-0A00B-001), http://www-group.slac.stanford.edu/esh/general/isems/sms.pdf

2. Analyze the hazards
3. Develop and implement hazard controls
4. Perform work within controls
5. Provide feedback and continuous improvement

3.4.2 Work Smart Standards

To ensure that SLAC complies with safety and environmental standards, the laws and regulations that specify the environment, safety, and health requirements of the laboratory have been identified and incorporated into the SLAC management and operating contract. These contract requirements, known as the SLAC work smart standards (WSS), are reviewed at least annually, and are based on identification of potential safety and health hazards, environmental aspects and impacts and regulatory non-compliances identified by those who work at SLAC[7]. During 2008, the Requirements Management (RM) was under development to expand upon the functionality of the WSS, with the RM anticipated to supersede the WSS in 2009.

3.4.3 Environmental Performance Measures

In addition to adopting WSS, SLAC evaluates its activities against performance measures. The environmentally relevant performance measures for fiscal year (FY) 2008 covered the following areas:

- Environmental compliance and releases
- Environmental restoration program
- Hazardous materials management
- Waste minimization/pollution prevention
- Hazardous and radioactive waste management
- Environmental Management System (EMS) implementation

Specific performance objectives, measures and targets are developed by DOE and SLAC, approved and formally incorporated into the M&O contract each fiscal year. DOE uses the contract performance measures and ongoing field observations of SLAC operations and construction activities to formally evaluate contractor performance in all areas, including ES&H.

3.4.4 Training

To ensure every employee is both aware and capable of fulfilling his or her responsibilities, the ES&H Division operates an extensive program of classroom and computer-based training. For example, personnel who handle hazardous chemicals and waste are provided training in chemical and waste management, waste minimization, pollution prevention, stormwater protection, on-site transportation of hazardous

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[7] Stanford Linear Accelerator Center, “Work Smart Standards Set”, http://www-group.slac.stanford.edu/esh/general/isems/wss/.

chemicals and waste, and basic spill and emergency response. Details on the ES&H training program are available on line[8].

3.5 Environmental Management System

The EMS portion of the ISEMS is essentially a systematic approach for ensuring environmental improvement – a continual cycle of planning, implementing, reviewing and improvement to ensure protection of the air, water, land, and other natural resources that may be potentially impacted by operational activities. SLAC's EMS program, consistent with ISO 14001, was formally in place on December 21, 2005 following a DOE assessment of the site's EMS and issuance of a self-declaration letter of compliance with the requirements of DOE Order 450.1, and as described in Section 3.4, has been integrated with the ISM in the ISEMS for the site. SLAC's Environmental Safety Committee now serves as the EMS steering committee and an EMS Coordinator ensures conformance with EMS requirements specified in DOE Order 450.1A.

In January 2007, EO 13423[9], *Strengthening Federal Environmental, Energy, and Transportation Management*, was issued, revoking EO 13148, *Greening the Government Through Leadership in Environmental Management,* among other Executive Orders. EO 13423 lists a number of agency goals for enhancing environmental, energy, and transportation management performance, through implementation of an EMS. To implement the new requirements and goals listed in EO 13423, DOE Order 450.1 was replaced with DOE Order 450.1A[10] in June of 2008. SLAC's EMS will be declared in compliance with DOE Order 450.1A no later than June 30, 2009. To support the declaration, the EMS will be subject to a formal audit by a qualified party outside the control or scope of the EMS. Per DOE Order 450.1A, the EMS declaration will be renewed at least every 3 years.

The annual review and ranking of environmental aspects was completed this year by SLAC's EMS Steering Committee, the ESC, and twelve objectives and targets were established for 2008. For each objective and target, a work plan, termed an Environmental Management Program (EMP) was completed. The objectives and targets established in 2008 are summarized below. Additional environmental accomplishments are discussed in subsequent sections of this document. The 2008 EMS objectives and targets were:

- Reduce release of greenhouse gases from SLAC operations by reducing site-wide release of sulfur hexafluoride (SF_6) by 50 percent.
- Reduce release of greenhouse gases from SLAC equipment by repairing or replacing the main circuit breakers in the Master Substation, to eliminate 99 percent of SF_6 emissions per year from the Master Substation.
- Reduce risks of hazardous chemicals through reduction of chemical inventory by reducing onsite chemical inventory at five buildings by September 30, 2008 and developing a chemical redistribution program.
- Store radioactive materials in an enclosed facility by re-evaluating the cost feasibility of enclosed radioactive materials storage facility and submitting a project proposal to Infrastructure Committee.

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[8] Stanford Linear Accelerator Center, Environment, Safety, and Health Division, "Training", http://www-group.slac.stanford.edu/esh/training/

[9] Executive Order 13423, http://www.ofee.gov/eo/eo13423_main.asp

[10] DOE Order 450.1A, http://www.directives.doe.gov/pdfs/doe/doetext/neword/450/o4501a.pdf

- Reduce the amount of radioactive waste and material stored outside by preparing 360 cubic feet of legacy radioactive waste for offsite shipment.
- Reduce chemically-impacted sediments from migrating in stormwater to the offsite Interaction Region (IR) 8 drainage channel by power washing 0.45 acres of pavement in the southern portion of the IR-8 Building Area and cleaning out stormwater sumps to remove sediment.
- Implement increased solid waste reduction through food composting program by increasing recycling of solid waste by 5 tons per year through kitchen waste composting.
- Increase procurement of energy efficient (i.e., Energy Star) and sustainable products for office and construction purchases by increasing procurement of energy efficient (i.e., Energy Star) and sustainable products for office & construction purchases by 5 percent per year.
- Reduce electrical energy use 3 percent annually or 30 percent by 2015 by completing Phase I and Phase 2 of the Super Energy Savings Performance Contract (ESPC) process, completing one (1) lighting retrofit project in Building 81, and supporting on-going communications at a monthly rate (12 minimum) to maintain energy conservation awareness site-wide.
- Reduce water consumption by 2 percent annually or 16 percent by the end of 2015 by completing Phase 1 and Phase 2 of the ESPC process, completing a landscape water system review to identify quick-fix corrective actions for immediate water use reductions, and completing several other minor tasks.
- Reduce consumption of petroleum fuels by reducing fleet consumption of petroleum fuels by 2 percent in FY08 through fleet reductions and conversion of onsite fueling station to ethanol (E85).
- Minimize and divert construction waste from entering landfills by recycling on a monthly basis greater than 50 percent of the construction waste generated from the LCLS construction project

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Notable accomplishments for each of the 2008 EMPs include the following:

- A 50 percent reduction in site-wide release of SF_6 and elimination of 99 percent of SF_6 emissions in the Master Substation were likely achieved with completion of repairs to the T1 transformer circuit breaker. Top-off quantities will be monitored over time to confirm whether minor leakage persists. The project represents a potential reduction of carbon dioxide equivalent emissions of 726 metric tons per year (outcome pending additional monitoring).
- Chemical inventory reduction was completed at five buildings and a chemical redistribution program was developed. Over 1,000 containers were removed and disposed and over 250 containers were placed into redistribution.
- Plans to install a new enclosed radioactive materials storage facility were placed into SLAC's 20 year plan. If funded, construction is expected to begin in 2015.
- Greater than 800 cubic feet of legacy radioactive waste was packaged and shipped in FY08.
- 2.4 tons of metals-impacted sediments were removed from pavement and properly disposed as a stormwater pollution prevention measure.
- A composting program at SLAC's onsite cafeteria was initiated in 2008. Approximately 0.65 tons of organic waste from SLAC's cafeteria is now composted offsite, including food and compostable food service ware.

- In the area of environmentally preferable purchasing, SLAC's janitorial vendor switched to more eco-friendly cleaners, including replacing five products which possessed a health hazard rating of 3 (moderate health hazard), with Green Seal Certified products. SLAC also increased environmentally preferable purchasing by 2.4 percent over last year (excluding purchases of concrete and furniture). In addition, 100 percent of desktops, monitors, and laptops purchased were Electronic Product Environmental Assessment Tool (EPEAT) certified.

- SLAC and DOE initiated an ESPC in order to progress toward achieving the energy and water savings specified in Executive Order 13423 using third party financing. Phase 1 and 2 of the ESPC process were completed this year including completion of the Initial Proposal to identify energy conservation measures (ECMs) and issuance of the Notice of Intent to Award for the Detailed Energy Survey (DES). In late 2008, completion of the DES was placed on hold by DOE. In addition to the ESPC work, the Building 81 light retrofit project was completed, landscape watering improvements were initiated, and more than 12 articles were published in SLAC today to maintain energy and environmental conservation awareness site-wide.

- SLAC reduced the number of vehicles in the General Services Administration (GSA) leased fleet from 221 to 164, a reduction of 25.8 percent or 57 vehicles. Fleet fuel usage was reduced by 4.94 percent or 3,092 gallons, primarily as a result of fleet reductions. Conversion of the on-site fueling station to E 85 did not occur this year due to various project delays.

- Over the course of the 2 plus year LCLS construction project, 607.1 tons of non-hazardous waste was generated, of which 524.3 tons was recycled, achieving an overall recycling rate of 86.4 percent for the project.

- The volume of municipal waste that was recycled increased by approximately 140 tons during 2008 compared to 2007, in large part due to construction debris recycling for the LCLS project, which recycled 86 percent of its debris over the life of the construction project (see Section 4.6.1).

4 Environmental Non-radiological Programs

4.1 Introduction

During the course of providing accelerators, detectors, instrumentation, and support for national and international research programs, SLAC manufactures and maintains one-of-a-kind research equipment, which requires the use and management of industrial chemicals, gases, and metals. In addition, SLAC has the potential to impact the environment due to storage and handling of chemicals and the large quantities of electricity and cooling water that are used in the operation of the accelerator. Finally, SLAC has environmental management issues relevant for any employer with more than 1,400 full-time staff, 3,000 scientific users per year, hundreds of buildings, and 426 acres of land situated in an environmentally sensitive location.

SLAC has focused considerable efforts to identify and eliminate or minimize waste generation and emissions. SLAC first works to avoid generating waste and emissions. When unavoidable, SLAC attempts to minimize the amount it does produce and then carefully manages the impacts that may occur. Recent recognition of SLAC's environmental performance accomplishments is provided in Table 4-1.

Table 4-1 Recent Environmental Awards

Year	Organization	Award/Recognition Program	Description
2004	DOE	Pollution Prevention Award	Development of a site-wide chemical management system
2004	USEPA	Champion of Green Government Award	By upgrading lighting in Klystron Gallery will save $236,000 annually
2006	DOE	Pollution Prevention and Environmental Stewardship Accomplishment – Noteworthy Practice	Resource conservation achieved by building experimental facilities with reused materials
2006	DOE	Pollution Prevention and Environmental Stewardship Accomplishment – Best in Class	Instituted the Chemical Management Services which manages chemicals procurement and use
2008	USEPA	Federal Electronics Challenge – Bronze Award	Reducing the environmental impacts of electronics in one life-cycle phase

Additionally, SLAC continually strives to increase its environmental performance, per the objectives of EO 13423, *"Strengthening Federal Environmental, Energy, and Transportation Management"* (see Chapter 3).

This chapter provides an overview of the non-radiological environmental programs SLAC implements to protect air and water quality, to manage hazardous materials in a safe and environmentally responsible manner, and to eliminate or minimize the generation of hazardous, non-hazardous, and solid waste. The chapter sections are organized by protection program and describe the regulatory framework, program status for 2008, and relevant performance trends. The environmental radiological program is discussed in Chapter 5, and programs covering the monitoring and remediation of groundwater, soil, and sediment are discussed in Chapter 6.

4.2 Air Quality Management Programs

SLAC operates various sources that emit air pollutants, including a plating shop, a paint shop, several machine shops, boilers, solvent degreasers, backup generators, and a vehicle fueling station. In addition, high-energy physics experiments have the potential to emit volatile organic compounds (VOCs) due to the composition of the gas atmospheres used in particle detectors. Finally, greenhouse gases (GHGs) used in electrical substations and research equipment are being actively managed in response to the passage of Assembly Bill 32 (AB32), the California Global Warming Solutions Act. This section describes the regulatory framework to which SLAC is subject for the purpose of air quality protection, and presents the status of SLAC's air quality protection programs in 2008.

4.2.1 Regulatory Framework

In the San Francisco Bay Area, most federal and state air regulatory programs are implemented through the rules and regulations of the Bay Area Air Quality Management District (BAAQMD). Included in the BAAQMD roles and responsibilities are implementation of Title V of the Clean Air Act. SLAC's Title V synthetic minor operating permit (SMOP) permit was issued by BAAQMD on July 26, 2002. The Title V SMOP placed limits on facility-wide emissions of VOCs, total hazardous air pollutants (HAPs), and individual HAPs.

At the local level, BAAQMD regulates SLAC's air emissions through:

1. Annual enforcement inspections
2. New source permit applications
3. Annual information updates for emissions of air toxics as identified by the California Air Resources Board (CARB) in its toxic substances checklist
4. Annual information updates for adhesives usage as specified in BAAQMD Regulation 8-51-1502.2C
5. Notification requirements for demolitions, significant renovations, and any activity involving asbestos

At the state level, CARB is responsible for the implementation of AB32, and provides notices, workshops, lectures, and other means to disseminate information as it is developed and solicits input.

Finally, SLAC is subject to the following two federal air quality programs, both of which are administered through the Air Division of USEPA Region 9:

- National Emission Standards for Halogenated Solvent Cleaning, under Title 40 CFR, Part 63.460
- Protection of Stratospheric Ozone, under 40 CFR 82

4.2.2 Program Status

4.2.2.1 Annual Facility Enforcement Inspection

The annual facility-wide inspection performed by BAAQMD was deferred until January 13, 2009, so no inspections occurred in 2008.

4.2.2.2 New Source Permits

Three new emissions sources were permitted in 2008, all of them emergency standby generators. Two outstanding permit applications, originally submitted to BAAQMD in 2006, were approved in 2008. Both permits were for portable generators, one of which was originally dedicated to the GLAST project. In addition, the stationary emergency standby generator for the LCLS Central Utilities Plant was permitted.

A total of six permitted sources were taken out of service in 2008, including two of SLAC's older portable emergency standby generators and the prototype soil vapor extraction system located at the Former Hazardous Waste Storage Area (FHWSA). Most significantly, however, the BaBar experiment was terminated in April 2008, six months earlier than expected. As such, its three permitted subsystems ceased operations as well: the Drift Chamber, the Resistive Plate Chamber/Instrumented Flux Return, and the Limited Streamer Tubes.

As a result of these changes, at the end of 2008, SLAC managed a total of 54 sources of air emissions listed in its facility-wide permit-to-operate, comprising 33 permitted and 21 exempt sources.

4.2.2.3 Annual Update for Permit-to-Operate and Annual Title V SMOP Emissions Report

SLAC submits two primary annual reports to the BAAQMD. One is the annual update that is prepared in response to the BAAQMD information update request for selected permitted sources, and covers calendar year 2008. The other is the Title V annual emissions report for all onsite sources for the SMOP and covers the period of July 1, 2007 through June 30, 2008. Following submittal of the former report, SLAC received the renewal of its permit-to-operate on June 25, 2008, effective through July 1, 2009. SLAC submitted the Title V annual emissions report on time in July 2008.

For several years, the largest source of regulated air emissions at SLAC has been the BaBar detector. SLAC operated the detector within permit conditions at all times since its initial startup in 1999, using isobutane, which is the only significant Precursor Organic Compound used at SLAC. As noted above, BaBar was terminated in April 2008, substantially reducing the emissions for calendar year 2008. At the same time, the refrigerant H-134a became much more significant due to its relatively high Global Warming Potential (GWP) of 1,300 relative to carbon dioxide, which has a GWP of 1. However, no regulations have yet been promulgated for greenhouse gases.

4.2.2.4 Annual Adhesives Usage Report

SLAC submitted its annual adhesives usage report to BAAQMD to satisfy Regulation 8-51-502.2c on April 13, 2008 (covering the 2007 reporting year) and reported using a total of 34 adhesives.

4.2.2.5 Asbestos and Demolition Project Notification Program

For projects that involve the demolition of existing structures or the management of regulated asbestos-containing material, SLAC is required to provide advance notice to BAAQMD. During 2008, approximately 29 construction projects were evaluated for the purpose of air quality protection. Based on the project scopes and the results of pre-work asbestos surveys, asbestos/demolition/renovation notifications were submitted to BAAQMD for three of these projects.

4.2.2.6 National Emission Standards for Hazardous Air Pollutants

SLAC operates four sources that are subject to 40 CFR 63, Subpart T, “National Emission Standards for Halogenated Solvent Cleaning”, part of the National Emission Standards for Hazardous Air Pollutants (NESHAPs) regulations, as shown in Table 4-2. The required reporting comprises an annual performance report and two semi-annual exceedance reports.

No exceedances occurred during the covered reporting periods. The four NESHAPs units were operated in accordance with their NESHAPs emissions limits during the covered reporting periods.

Table 4-2 Halogenated Solvent Cleaning Sources Subject to NESHAPs

Source	Source Description	Location	Halogenated Solvent Used
S-4	Batch vapor degreaser	Plating Shop	1,1,1-Trichloroethane (TCA)
S-54	Near-zero emission degreaser	Plating Shop	Tetrachloroethylene
S-58	Batch cleaning tank	Electron Gun Testing/Maintenance	TCA
S-61	Batch cleaning tank	Plating Shop	Methylene chloride

4.2.2.7 Protection of Stratospheric Ozone

No releases of stratospheric ozone-depleting substances (ODS) occurred during 2008 that were subject to the release reporting and corrective action requirements in the ODS regulations (40 CFR 82).

At the end of 2008, SLAC turned off its only chiller that uses a Class I ODS and a new 360-ton chiller was installed outside the SPEAR ring. However, the old chiller is being retained as a backup unit for one year after the new chiller is fully commissioned. At that time, the ODS chiller will be drained.

In addition, SLAC is working on the following projects with the goal of eliminating all Class I ODS on site:

- Halon Fire Systems Replacement (two systems) – under review for applicability
- Miscellaneous heating, ventilation, and air conditioning Equipment Replacement (approximately six small systems) – in progress
- TCA Relocation Project, Facilities Department – in progress

4.2.2.8 Vehicle Fleet Management

SLAC operates, fuels, and maintains a diverse fleet of cars, trucks, and specialized pieces of heavy equipment to support its daily operations. Vehicles are provided by one of two federal agencies: the DOE and the GSA. SLAC continues to replace and upgrade its service fleet as resources allow.

The onsite gasoline dispensing facility (GDF) is regulated as a permitted emissions source by the BAAQMD. The GDF provides both gasoline and diesel for SLAC vehicles, and fuel dispensing is tracked and reported annually to BAAQMD. Under the conditions of SLAC’s site-wide air permit, the gasoline dispensing system requires an annual source test to ensure proper functioning. In accordance with its individual permit, a source test was performed for the GDF in September 2008 and all results were within regulatory limits. The results were transmitted automatically to the BAAQMD.

Secondary fuel distribution is achieved by portable diesel dispensing tanks. These tanks are also filled at the GDF and then transported throughout SLAC to refuel heavy equipment and stationary engines, such as emergency back-up generators.

To reduce the amount of petroleum-based fuel used at SLAC, in accordance with EO 13423, SLAC Fleet Services is moving ahead with converting the GDF from gasoline and diesel to E85 ethanol blend and gasoline.

4.2.2.9 Greenhouse Gas Inventory and Baseline

SF_6, the most potent GHG known, is used at SLAC in both electrical equipment and experimental apparatus. In light of recent concerns about GHG and new California legislation (AB 32), research proposals now routinely address the use of SF_6, evaluate potential alternatives, and address the responsible management of this gas, even in minute quantities. It remains clear that SF_6 is an extremely useful material, by far the most appropriate for some applications, and that more research into acceptable substitutes is urgently needed. In the meantime, the ES&H Division continued its efforts to raise awareness of the need for rigorous management of SF_6 throughout the facility. AB32 has a five-year implementation schedule that extends through 2012, and SLAC is actively working to address the likely major requirements.

4.2.3 Summary and Future Plans

SLAC emits pollutants to the atmosphere from its operation of one-of-a-kind research and manufacturing equipment, as well as from more conventional sources such as building maintenance and vehicle fleet operation. SLAC operates its air quality management program in compliance with its established permit conditions. SLAC maintains an active program to improve its environmental performance in the air quality arena. Recent years have witnessed the following accomplishments:

- Decrease of more than 90 percent in halogenated solvent emissions from SLAC's Plating Shop
- Replacement of three pre-1984 chillers using a Class 1 ODS with new non-ODS chillers. The fourth and last pre-1984 chiller is scheduled to be replaced in 2010.Continued decrease in the average age of SLAC's vehicle fleet
- Successful negotiations to obtain a Title V SMOP, which implements limits on facility-wide HAP emissions
- Installation of new natural-gas flow meters and instrumentation control systems at its main boilers
- Submission of certified GHG emissions data to The Climate Registry, which is currently voluntary but affords facilities the opportunity to develop a GHG inventory and establish a baseline against which all future reductions can be measured
- Installation of auto-dialers on emergency standby generators that can be activated automatically, in order to alert maintenance personnel to monitor and re-fuel as necessary.

Future plans include the phasing out of all Class 1 ODS, refinement of the GHG baseline / inventory pursuant to new mandatory reporting requirements, development and implementation of an air-emissions data management system, and further upgrades to the SLAC vehicle fleet.

4.3 Industrial and Sanitary Wastewater Management Program

SLAC discharges industrial pollutants and sanitary sewage to the sewage collection system operated by the West Bay Sanitary District (WBSD). The sewage is then conveyed via the WBSD's collection system to the wastewater treatment plant operated by the South Bayside System Authority (SBSA). Much of SLAC's industrial pollutants are removed prior to discharge at such facilities as the metal finishing pre-treatment facility (MFPF) and the contained water treatment system at Cooling Tower 1701. This section describes the regulatory framework under which SLAC operates for the purpose of water quality protection, and presents the status of SLAC's water quality protection programs in 2008.

4.3.1 Regulatory Framework

The Federal Water Pollution Control Act, also referred to as the Clean Water Act (CWA), was enacted in 1972 to halt the degradation of our nation's waters. The CWA established the National Pollutant Discharge Elimination System, which regulates discharges of wastewater from point sources such as a publicly owned treatment work and categorically regulated industrial facilities such as electroplating shops. In 1987, the CWA was amended to include non-point source discharges such as stormwater run-off from industrial, municipal, and construction activities. The CWA is the primary driver behind the SLAC water quality protection programs.

SLAC operates its industrial and sanitary wastewater programs under a mandatory wastewater discharge permit (WB 061216) which is negotiated jointly with the WBSD and SBSA. The permit, which covers the entire facility, was issued on December 16, 2006, and may be renewed annually until December 15, 2011. SLAC also has a contractual relationship with the WBSD, which specifies the total industrial and sanitary flow allowed to be discharged.

SLAC's industrial and sanitary monitoring locations are shown in Figure 4-1. SLAC's Sand Hill Road flow metering station (Sand Hill flow meter station [FMS]) is located immediately upstream of SLAC's sewer system connection to WBSD's Sand Hill Road trunk line, just to the north of the SLAC main gate.

SLAC also has four flow monitoring stations on the south side of the facility, which collectively monitor the flow SLAC discharges to the WBSD's Alpine Road trunk line. The four locations are the MSub, Alpine, FHWSA Treatment System and IR-8 (IR08), as shown on Figure 4-1

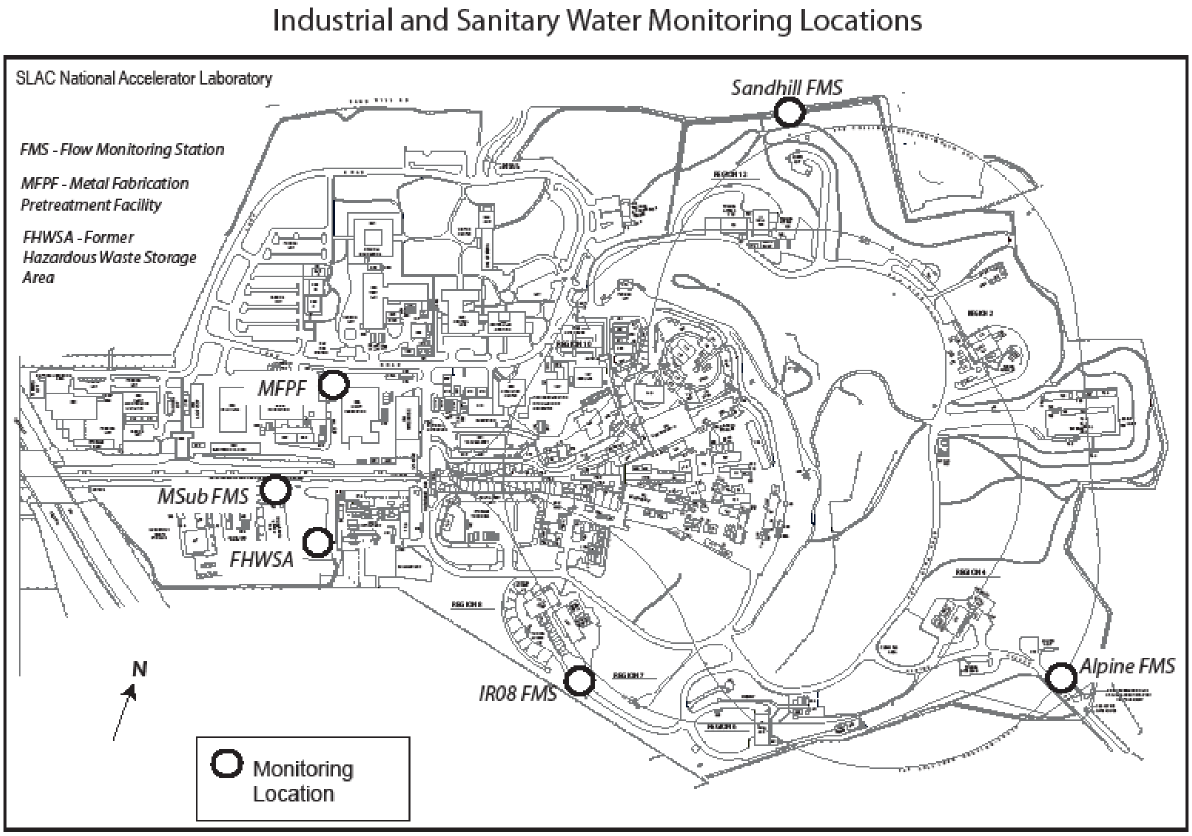

Figure 4-1 Industrial and Sanitary Wastewater Monitoring Locations

SLAC is required to submit a semi-annual self-monitoring report[11] which includes the results of its monitoring of the MFPF and FHWSA Treatment System, certification of a solvent management plan for approximately 100 solvents selected by the SBSA, and reports for discharges of radioactivity in industrial wastewater (see Section 5.5.1).

4.3.2 Program Status

4.3.2.1 Annual Facility Enforcement Inspection

The SBSA did not conduct an inspection of SLAC in 2008.

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[11] SLAC National Accelerator Laboratory, Environment, Safety, and Health Division, Environmental Protection Department, *Semiannual Self-Monitoring Report and SMP Certification Required Under Mandatory Wastewater Discharge Permit WB 061216* (July 30, 2008, submitted to Norman Domingo, Technical Services Supervisor, SBSA)

SLAC National Accelerator Laboratory, *Semiannual Self-Monitoring Report and SMP Certification Required Under Mandatory Wastewater Discharge Permit WB 061216* (January 30, 2009, submitted to Norman Domingo, Technical Services Supervisor, SBSA)

4.3.2.2 Flow Monitoring Results

Total industrial and sanitary wastewater discharged to the WBSD's regional collection system was approximately 17.6 million gallons, which equates to an average of approximately 48,200 gallons per day (gpd). SLAC was within its discharge entitlement of approximately 23.5 million gallons, or 64,400 gpd.

4.3.2.3 Water Quality Monitoring Results

A summary of the water quality results for the Sand Hill Road station is presented in Table 4-3, along with the discharge limits set forth in SLAC's permits. SLAC was in compliance with all permitted discharge limits at the Sand Hill Road Station.

Table 4-3 Water Quality at the Sand Hill Road Station

Parameter	SBSA Calculated Results (ppd)				Wastewater Discharge Limits* (ppd)
	January 25, 2008	Arpil 29, 2008	September 11, 2008	November 6, 2008	
Cadmium	0.001160	0.001123	0.000859	0.001031	0.14
Chromium	<0.001933	0.04413	0.003925	0.004547	0.29
Copper	0.046389	0.036510	0.044979	0.035156	0.27
Lead	0.001933	0.002808	0.002045	0.02344	0.28
Nickel	0.005412	0.011234	0.008178	0.02344	0.071
Silver	0.022808	0.001765	0.01472	0.001406	0.065
Zinc	0.119838	0.048144	0.069513	0.041719	0.9

ppd = pounds per day

* Compliance is determined by comparing the mass discharge limit with the average of the samples taken for the previous 12 months.

The analytical results and permit limits for water quality samples collected at the MFPF are presented in Table 4-4. SLAC was in compliance with all discharge limits.

Table 4-4 Water Quality at the Metal Finishing Pre-treatment Facility

2008			SBSA Annual Sampling	SLAC Semi-Annual Sampling	
Analytical Parameter	Discharge Limits		September 11,12	June 4	October 30
	Federal Daily Maximum (mg/L[2])	Federal Monthly Average (mg/L)	SBSA Monitoring Results (mg/L)	SLAC Monitoring Results (mg/L)	SLAC Monitoring Results (mg/L)
Metals					
Cadmium	0.11	0.07	<0.0010	0.000085	0.00013
Chromium	2.77	1.71	<0.027	0.1	0.0036
Copper	3.38	2.07	0.30	0.076	0.15
Lead	0.69	0.43	<0.005	0.0021	0.004
Nickel	3.98	2.38	0.41	0.067	0.29
Silver	0.43	0.24	0.029	0.0044	0.0018
Zinc	2.61	1.48	0.037	0.01	0.0092
Non-metals					
Cyanide	1.20	0.65	<0.003	<0.0064	<0.025

1 All monitoring results are expressed in units of milligrams per liter (mg/L).

2 mg/L = milligram per liter

4.3.2.4 Sanitary Sewer Overflow

SLAC filed a Notice of Intent with the State Water Resources Control Board (SWRCB) to comply with the terms of the Statewide General Waste Discharge Requirements for Sanitary Sewer Systems.[12] This requires SLAC to develop a Sanitary Sewer Management Plan and report sanitary sewer overflows to the SWRCB and other agencies.

SLAC registered with the SWRCB and the San Francisco Bay RWQCB sanitary sewer overflow reporting systems in October 2008. All spills from the sanitary sewer system are reported using the sanitary sewer overflow reporting systems. A Category 1 sanitary sewer overflow is any spill from the sanitary sewer which enters a storm drain channel, is not recovered from the storm drain system, or is greater than 1,000 gallons and must be reported within two hours. A Category 2 sanitary sewer overflow is any spill which is not Category 1 and is reported within 30 days after the end of the month in which it occurred. A no spill certification must be completed within 30 days of a month in which no spills occur. In 2008, SLAC reported one Category 1 and three Category 2 spills.

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[12] *Statewide General WDRs for Sanitary Sewer Systems*, WQO No. 2006-0003. *available at* http://www.swrcb.ca.gov/water_issues/programs/sso/

4.4 Surface Water Management Program

Stormwater flows from the 426-acre SLAC site through 25 drainage channels. In certain areas of the site, stormwater has the potential to come into contact with industrial activities or facilities. Such activities or facilities include metal working, outdoor storage, cooling towers, electrical equipment operation, and secondary containments. Many of the channels drain areas where the stormwater has little or no potential of exposure to industrial activities. SLAC has identified eight monitoring locations which are representative of stormwater discharges associated with industrial activities. These are listed below and shown in Figure 4-2.

- IR-8 Channel (IR-8)
- IR-6 Channel (IR-6)
- North Adit East Channel (NAE)
- Main Gate East Channel (MGE)
- IR-2 North Channel (IR-2)
- Building 81 North Channel (B81)
- Building 15
- Building 18

4.4.1 Regulatory Framework

Federal regulations allow authorized states to issue general permits to regulate industrial stormwater or non-point source discharges. California is an authorized state; and in 1991, the SWRCB adopted the industrial activities stormwater general permit, with the goal of reducing water pollution by regulating stormwater discharges associated with industrial activities. SLAC filed a notice of intent to comply with the general permit.

California's general permit was re-issued in 1997. SLAC adheres to the requirements of the general permit, through its development and implementation of a stormwater pollution prevention plan (SWPPP).[13] The SWPPP has two main components: a stormwater monitoring program (SWMP) and a best management practice (BMP) program.[14] The SWMP presents the rationale for sampling, lists the sampling locations, and specifies the analyses to be performed. The BMPs include a list of 17 generic and site-specific practices that serve to minimize the impact on stormwater from SLAC's industrial activities (see Section 4.4.2.2).

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[13] Stanford Linear Accelerator Center, Environment, Safety, and Health Division, Environmental Protection and Restoration Department, *SLAC Stormwater Pollution Prevention Plan* (SLAC-I-750-0A16M-002)

[14] Stanford Linear Accelerator Center, Environment, Safety, and Health Division, Environmental Protection Department, "Stormwater", http://www-group.slac.stanford.edu/esh/groups/ep/water/stormwater/

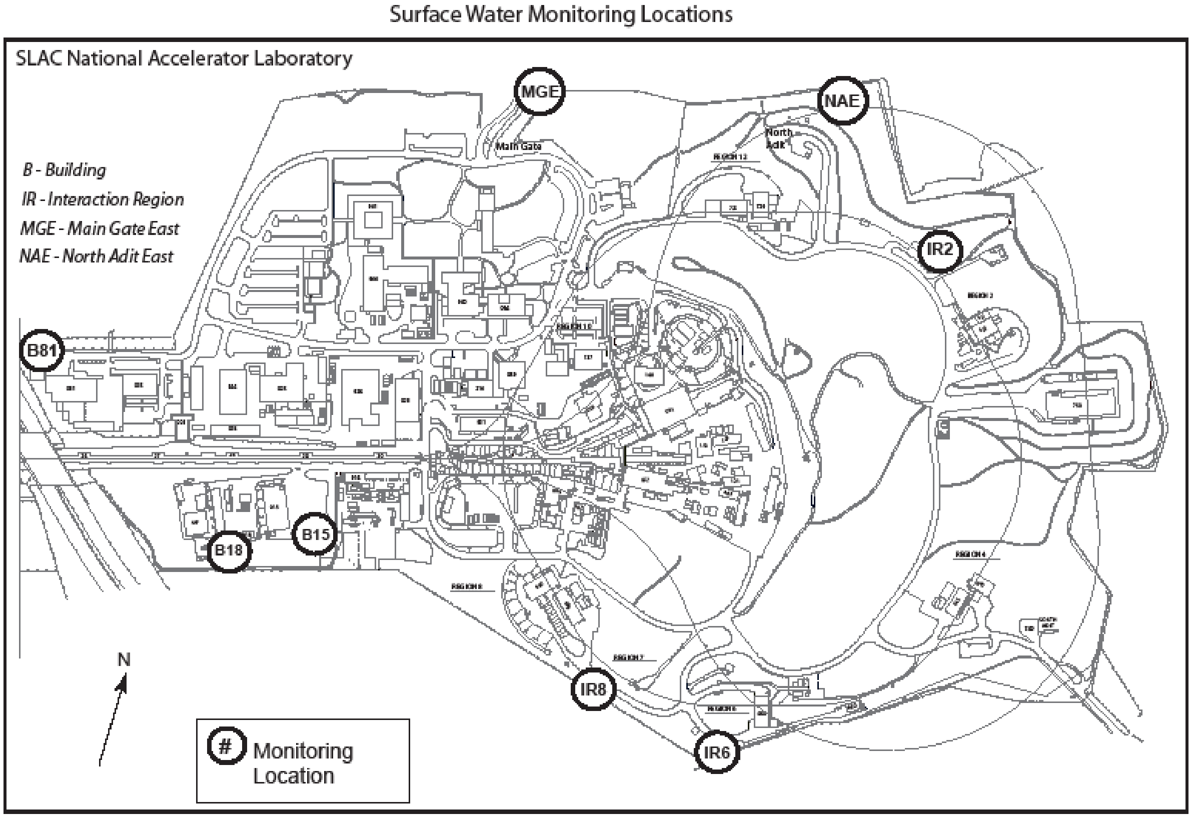

Figure 4-2 Surface Water Monitoring Locations

4.4.2 Program Status

4.4.2.1 Water Quality Monitoring Results

SLAC's SWMP incorporates all general permit sampling and analysis requirements, such as frequency (samples collected from first storm of season and one additional storm), locations (samples collected from locations where stormwater comes into contact with industrial activities), analytes (SLAC analyzes for five metals and nine non-metal analytes), and sampling methodologies.

The general permit's definition of wet season runs from October 1 through May 31. This reflects SLAC's climatological conditions, as rain rarely falls during June through September. Since the general permit's definition of wet season spans two calendar years, the 2008 water quality monitoring results published in the ASER are for the 2008–2009 wet season (October 2008 through May 2009).

The general permit requires submission of an annual report on stormwater activities by July 1, following the May 31 close of the wet season.[15] SLAC met all sampling and analysis requirements in its SWMP and delivered its annual report, which included all water quality monitoring results, to the RWQCB.

Automated samplers are located at each of the stormwater monitoring sites. The samplers are triggered by rain gauges and level sensors. Samples are collected during the first storm event at each location and one other event during the rainy season. During the 2008-2009 wet season 16 samples (two samples per location) were collected during seven storm events.

Stormwater samples were analyzed for 11 parameters. Many of the parameters that SLAC monitors have parameter benchmark values (PBVs) established by the SWRCB.[16] PBVs are not regulatory discharge limits, rather, they are meant to be used as guidance for comparison with measured results to determine the effectiveness of BMPs in drainage areas. Exceeding a BPV is not considered a stormwater violation.

Table 4-5 summarizes the results and compares them to the PBVs. The majority of the analytical results were below the PBVs. Analytes that exceeded the PBVs were specific conductance, aluminum, iron, zinc, copper, and total suspended solids. The source of these analytes in the stormwater is believed to be primarily from natural sources in the soil and groundwater. SLAC continues to investigate potential industrial sources for these analytes.

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[15] SLAC National Accelerator Laboratory, Environment, Safety, and Health Division, Environmental Protection Department, *2008–2009 Annual Stormwater Report* (30 June 2009, submitted to Rico Duazo, San Francisco Bay RWQCB)

[16] State of California, State Water Resources Control Board, *Sampling and Analysis Reduction Certification* (no date), http://www.swrcb.ca.gov/stormwtr/docs/smanlrdc.doc

Table 4-5 Water Quality Results and Comparison to Parameter Benchmark Values

Analyte	Units	Number of Results	Number of Detects	Maximum Conc. Detected	SWRCB PBV (1)	Number of Results >PBV
Metals						
Aluminum	mg/L	16	16	6.8	0.75	9
Copper	mg/L	16	16	0.04	0.0636(H)	1
Iron	mg/L	16	16	7.7	1	11
Lead	mg/L	16	16	0.023	0.0816(H)	0
Zinc	mg/L	16	16	0.49	0.117(H)	8
Non-Metals						
Total Suspended Solids	mg/L	16	16	350	100	2
Total Organic Carbon	mg/L	16	16	86	110	0
pH	SU	16	16	8.25	6-9	0
Specific Conductance	µs	16	16	1420	200	7
Polychlorinated Biphenyls	mg/L	16	0	ND	0.000477	0
Radioactivity	pCi/L	16	0	ND	NA	NA
Total		176	144			38

Notes:

PBV = parameter benchmark value

pCi/L = picoCuries per liter

1 SWRCB parameter benchmark values are available at www.swrcb.ca.gov/stormwtr/docs/smanlrdc.doc. Metal PBVs shown are on a total metal basis. (H) signifies that this is a hardness dependant benchmark. The PBV shown for polychlorinated biphenyls (PCBs) is for Aroclor-1260. SWRCB PBVs have not been set for chromium, molybdenum, radioactivity (tritium, gamma), or turbidity. SLAC may choose to develop benchmarks for site specific conditions.

NA = Not available

ND = Not detected above the reporting limit

4.4.2.2 Stormwater Management Improvements

BMPs are implemented at SLAC to reduce the potential for stormwater to come into contact with industrial activities. The BMPs are one component of an environmental management system that includes planning, implementing, checking, and improving performance.

BMP and surface water program-related accomplishments during 2008 included the following:

- The stormwater awareness training frequency has been increased and will now be required once every three years for affected employees. Refresher training for Facilities and Mechanical Fabrication Department employees was performed.
- Increased preventive maintenance schedule for stormwater protection activities including annual site-wide street cleaning and continuation of catch basin cleanouts
- Worked with the Facilities Department to increase the maintenance at several stormwater channels to prevent erosion
- The EP Department staff worked closely with the Indefinite Duration/Indefinite Quantity (ID/IQ) contractor on the development of a construction SWPPP for upcoming work at the boneyard and clean landfill

4.5 Hazardous Materials Management

SLAC uses hazardous materials as part of its experimental programs including the manufacturing and maintenance of experimental devices; as well as in conventional facilities operations, maintenance and construction projects. Examples of hazardous materials managed at SLAC include

- Cryogens
- Flammable gases
- Compressed gases
- Acids and bases
- Solvents
- Oils and Fuels
- Adhesives
- Paints and epoxies
- Metals

Hazardous materials management spans numerous programs; but the purpose remains the same: to ensure the safe handling of hazardous materials in order to protect workers, the community, and the environment.

4.5.1 Regulatory Framework

The regulatory framework for hazardous materials regulations, especially in California, has historically been a complex and overlapping web of statutes and regulations. Some of the most important regulatory drivers at the federal level include Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA) also referred to as the Emergency Planning and Community Right-to-Know Act (EPCRA) which focuses on community safety, the Occupational Safety and Health Act (1970) addressing worker safety, the Hazardous Materials Transportation Act whose purpose is to ensure the safe transport of hazardous materials in commerce and the Toxic Substances Control Act (TSCA), the federal statute under which polychlorinated biphenyl (PCB) and asbestos are regulated.

Important drivers at the state level generally date back to the mid-1980s and include hazardous materials business plans (HMBP), the California Accidental Release Program (CalARP), the underground and aboveground storage tank programs, and pollution prevention and waste minimization programs.

In general, the local implementing agency for hazardous materials regulation in California is the California CUPA. The Environmental Health Division of the San Mateo County Health Services Agency is the CUPA responsible for overseeing hazardous materials and waste management at SLAC. A CUPA has broad enforcement responsibilities. Recently, the scope has expanded to include Storm Water Pollution Prevention, the SPCC and Waste Tire Survey and Inspections in addition to the following six hazardous material subject areas:

- Hazardous Materials Business Plan/Emergency Response Plan
- Hazardous Waste/Tiered Permitting/Waste Minimization and Pollution Prevention
- Underground Storage Tanks
- Aboveground Storage Tanks (SPCC only)
- California Accidental Release Program

- California Fire Code Hazardous Materials Management Plan

4.5.2 Program Status

Discussed in the following sections are the status of SLAC's current programs related to hazardous materials management, including its hazardous materials business plan, toxics release inventory (TRI), and CalARP programs. Also discussed are SLAC's above ground storage tanks program and its PCBs management program under the TSCA.

4.5.2.1 Annual Facility Enforcement Inspections

The annual CUPA inspection was conducted on November 13, 14, 18 and 21, 2008. See Section 2.5.2, Table 2-2.

4.5.3 Hazardous Materials Business Plan Program

The EPCRA was passed in 1986 as Title III of the SARA, which established requirements for emergency planning, notification, and reporting. In California, the requirements of SARA Title III are incorporated into the state's Hazardous Materials Release Response Plan and Inventory Law, more commonly referred to as the HMBP program.

For the 2008 reporting year, SLAC updated its HMBP and electronically submitted it through the Uniform documents (Unidocs) web tool as well as sending disks to the CUPA on April 1, 2009. The HMBP includes the Hazardous Materials Inventory Statement (HMIS). The inventory consists of all hazardous materials present at SLAC in amounts exceeding the state's aggregate threshold quantities (55 gallons for liquids, 500 pounds (lbs) for solids, and 200 cubic feet (ft^3) for compressed gases) on a building-by-building basis. It includes hazardous materials in storage as well as hazardous waste, oil-filled equipment, treatment, process and bulk tanks, and lead/acid batteries. A portion of the hazardous materials inventory is based on procurement data generated through the CMS. The hazardous waste inventory is based on the database maintained by the WM Group. Mixed waste and radioactive materials data are provided by the RP Department. Inventory of process and bulk tanks are part of the SLAC property and building databases. The CMS maps are used to indicate storage area locations. The plan also includes the SLAC *Consolidated Chemical Contingency Plan*.[17] This plan combines the emergency response requirements for the following programs:

- Hazardous Materials Business Plan
- Hazardous Waste Contingency Plan
- Spill Prevention Control & Countermeasure Plan
- Risk Management Plan

4.5.4 Toxics Release Inventory Program

Under EO 13148, "*Greening the Government through Leadership in Environmental Management*", the DOE requires its facilities to comply with the Toxic Chemical Release Reporting and Community Right-to-Know requirements (40 CFR 312), more commonly referred to as the TRI program. SLAC annually

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[17] SLAC National Accelerator Laboratory *Consolidated Chemical Contingency Plan* (SLAC-I-730-3A86H-008)

provides the appropriate information to meet these program requirements to the DOE. Submittals are provided by SLAC to the DOE SSO which reviews and sends the TRI information to the USEPA.

Of the more than 400 listed TRI chemicals, only two, lead and copper, are used at SLAC in excess of their respective regulatory threshold criteria. As a result, SLAC prepared the 2008 release inventory forms for lead and copper and submitted them to the DOE SSO. An estimated 12,750 lbs of lead left SLAC during 2008, 97 percent of which was disposed of in a landfill and 3 percent was recycled. An estimated 21,050 lbs of copper left SLAC during 2008, 88 percent of which was sent to be recycled and 12 percent disposed of in a landfill. For both lead and copper, less than 1 percent left the site via stormwater and sewer discharges.

4.5.5 California Accidental Release Prevention Program

SLAC has only one regulated chemical in excess of the CalARP threshold, potassium cyanide, which is used only in the Plating Shop complex. Spent plating baths containing cyanide are stored temporarily at the Chemical Hazardous Waste Management Area pending transport for offsite disposal. In light of this situation, the CUPA determined that a risk management plan (RMP) would be required.

After extensive investigation and discussion, it was determined that, because the worst-case scenario for a release of potassium cyanide did not generate offsite consequences, a more detailed process hazard assessment and offsite consequence analysis were not required. The final Program 1 RMP for SLAC was submitted to the CUPA on September 1, 2006, and received 100 percent certification from the CUPA. A follow-up site visit by the CUPA was performed on April 25, 2007, to observe operations in the Plating Shop and verify the information provided in the RMP. The final step in the RMP process was a 45-day public comment period administered by the CUPA. The public comment period occurred from September 16, 2008 through October 31, 2008. No additional comments were received, so the RMP was finalized without further revision.

4.5.6 Aboveground Storage Tank Program

Aboveground Storage Tanks (ASTs) are regulated under the authority of the CWA and California’s Aboveground Petroleum Storage Act. A listing of ASTs containing petroleum at SLAC during 2008 is presented in Table 4-6. All of the petroleum tanks at SLAC are constructed of steel. Each tank is either double-walled, or has a cinder-block or poured-concrete containment basin surrounding the tank base.

An SPCC plan is required by 40 CFR 112 for all petroleum-containing ASTs greater than 660 gallons in size. The SLAC SPCC plan[18] was revised in 2008 to ensure it was in compliance with 40 CFR 112 Final Rule prior to its enactment.

SLAC did not have any underground storage tanks in operation during 2008.

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[18] Stanford Linear Accelerator Center, Environment, Safety, and Health Division, Environmental Protection Department, *Spill Prevention, Control, and Countermeasures Plan* (SLAC-I-750-0A16M-001-R003), https://www-internal.slac.stanford.edu/esh/documents_internal/SPCC.pdf

Table 4-6 Aboveground Petroleum Tanks

Petroleum Product	Property Control Number	Location	Capacity (gallons)
Diesel	20501	B023 Central Utility	10,000
Diesel	19683	B112 Master Substation	2,000
Gasoline/Diesel	21443	B035 Vehicle Refueling Station	1,500/500
*Vacuum Oil	19596	B020 North Damping Ring	500
Diesel	22658	B082 Fire Station	500
Diesel	19781	B505A Generator Fueling	500
Diesel	21287	B007 MCC Generator Fueling	500
*Vacuum Oil	19595	B021 South Damping Ring	300
X-ray Oil	15192	B044 Klystron Test Lab	364/227/227
Compressor Oil	NA	B127 Cryogenics	200
Compressor Oil	18562	B127 Cryogenics	200
Diesel	NA	B756 SLD Generator Fueling	500

* These tanks are used only for short-term storage

4.5.7 Toxic Substances Control Act Program

The objective of TSCA is to minimize the exposure of humans and the environment to chemicals introduced by the manufacturing, processing, and commercial distribution sectors. One portion of TSCA regulates equipment filled with oil or other dielectric fluids that contain PCBs.

TSCA regulations are administered by the USEPA. No USEPA inspections regarding TSCA were conducted at SLAC during 2008.

At the end of 2008, 102 transformers were in service at SLAC. Three of the transformers were newly acquired in 2008 for the LCLS. Transformers with PCB concentrations equal to or greater than 50 parts per million (ppm) but less than 500 ppm are defined by TSCA as PCB-contaminated transformers. Of the 102 transformers in service at SLAC, only 12 are PCB-contaminated. SLAC has no PCB transformers (transformers with concentrations of PCB equal to or greater than 500 ppm). The total quantity of PCBs contained in the 102 transformers currently in service is estimated to be approximately 24 lbs.

4.5.8 Chemical Management System

SLAC has officially been purchasing chemicals solely through Haas *tcm* (Haas) since August 2005 under its CMS. Haas provides sourcing, purchasing, expediting, and vendor management support for all non-radioactive chemicals and gases used by SLAC.

The key objectives of the CMS program at SLAC are to:

- Reduce SLAC’s chemical and gas cost through vendor leveraged buying power
- Reduce SLAC’s risk and space requirements associated with storing, managing and handling chemicals
- Reduce time spent by SLAC researchers and other personnel on sourcing, ordering and tracking chemicals

By the end of calendar year 2008, the program has achieved the following:

- 2659 active chemicals were set up in the catalogue
- Approximately 26 items in vendor-owned inventory stocked for just-in-time delivery. This is a decrease from last year. There continues to be a reduction in the number of items stocked in the Haas Hub due to the non-routine purchases of most non-bulk items.
- There were 322 users of the CMS system.
- Purchase order cycle time continues to decrease and is now less than half a business day on average
- The commodity cost reduction did not meet goals due to a drop in commodity prices in the last months of 2008; however Haas was able to reduce the cost of liquid helium and nitrogen and expect an annual savings of $63,000.

SLAC's CMS program continues to operate at a steady state for the originally defined scope of work. All the defined performance goals are being met except the commodity cost reduction discussed above.

4.6 Waste Minimization and Management

During the course of its research operations, SLAC generates a variety of waste streams, including hazardous waste, non-hazardous industrial waste, municipal solid waste, and scrap metal.

Whenever practicable, SLAC actively practices the pollution prevention hierarchy with respect to each of these waste streams:

- First, reduce waste and prevent pollution at the source through process changes, substitutions, and work practices
- Second, reduce waste and prevent pollution by reusing or recycling materials
- Third, reduce waste and prevent pollution by using appropriate control technologies
- Finally, after exhausting the first three approaches, exercise proper disposal

4.6.1 Waste Minimization Accomplishments

SLAC continues to make progress in reducing hazardous waste generated from routine operations, as shown in Figure 4-3. For 2008, SLAC reduced its hazardous waste from routine operations by 85 percent from the 1993 baseline of 147 tons. This represents a significant increase to last year's number of a 73 percent reduction, as the 2008 numbers take into consideration 15 tons of routine hazardous waste generated that was able to be recycled instead of disposed of as a hazardous waste including but not limited to oils, solvents, and antifreeze. Measures will continue to be taken to further reduce hazardous waste by helping smaller generators increase their awareness of waste reduction opportunities and helping them learn to develop for themselves more focused waste reduction measures for their work areas.

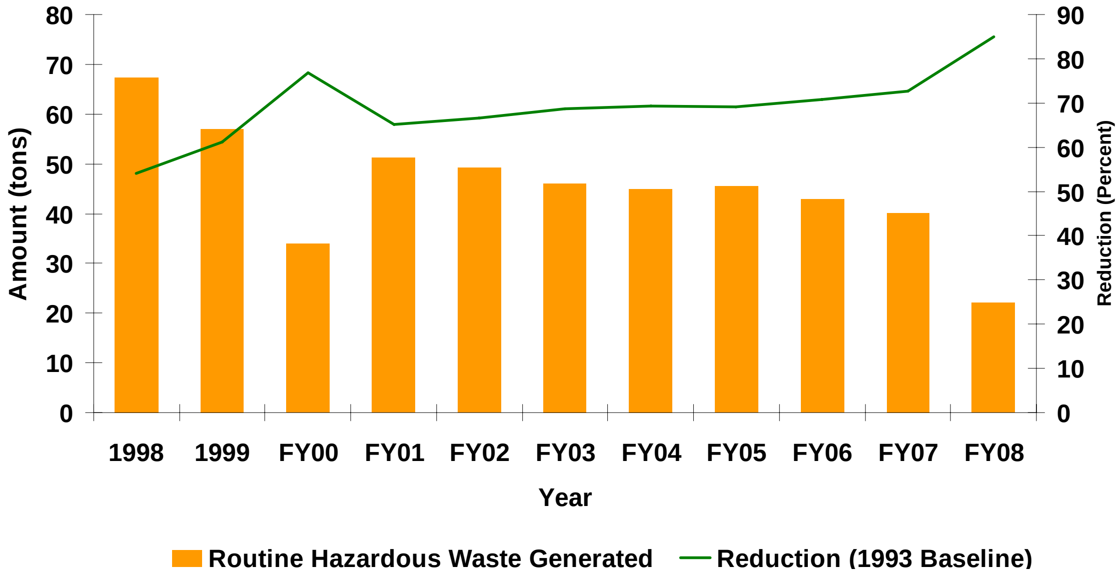

Figure 4-3 Routine Hazardous Waste Generation, 1998–2008

SLAC's progress in recycling its municipal solid waste is shown in Figure 4-4. For 2008, SLAC recycled 62 percent of its municipal solid waste. The term *municipal solid waste* refers to the following waste streams generated at SLAC:

- Beverage containers (glass, aluminum, plastic)
- Paper (white paper, mixed paper)
- Cardboard
- Wood
- Scrap metal
- Garden/landscaping waste
- Construction debris (asphalt, concrete, and soils)
- Universal (fluorescent light bulbs and mercury-containing equipment) and electronic wastes including cathode ray tubes (CRTs)
- Batteries (automotive and common (AA, AAA, C, D, nickel-cadmium, other) batteries)
- Salvage sales and transfers
- Office materials (toner and inkjet cartridges)
- Tires
- Trash not otherwise sorted at the source and placed into dumpsters

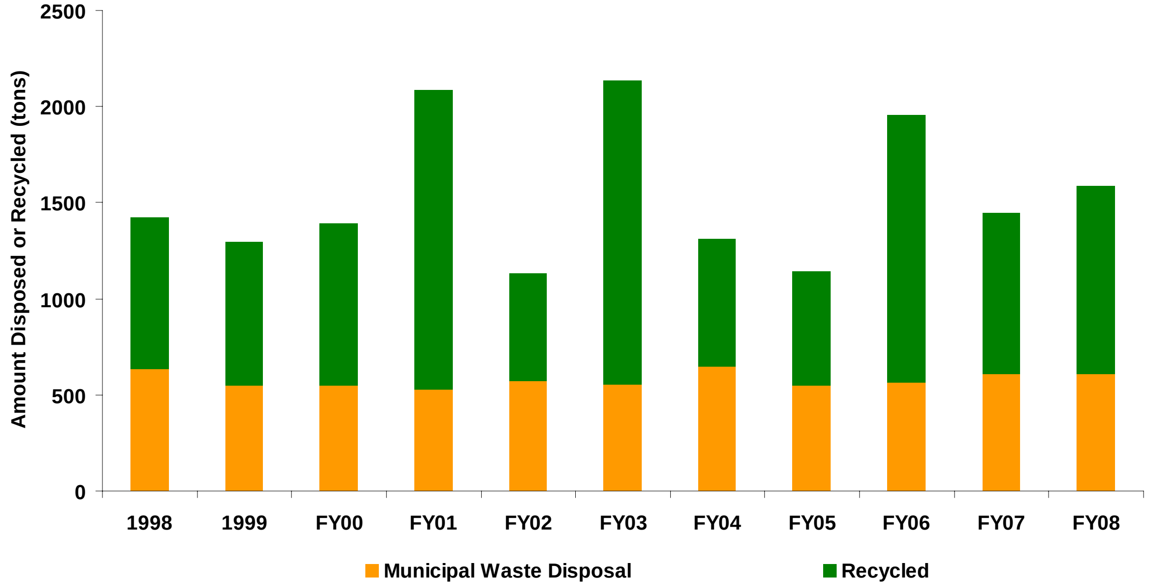

Figure 4-4 Municipal Solid Waste Recycling,1998-2008

The volume of municipal waste that was recycled increased by approximately 140 tons during 2008 compared to 2007. This was in a large part due to construction debris recycling for the LCLS project which recycled 86 percent of its debris over the life of the construction project.

Waste minimization and pollution prevention projects initiated during the last five years and continuing during 2008 are listed in Table 4-7.

In addition to the projects below, SLAC has continued to perform process waste assessments or pollution prevention opportunity assessments (PPOA) and pollution prevention projects to reduce the use of toxic materials, to conserve resources, and to prevent pollution in a technically and economically feasible manner for the future. The four assessments completed for FY08 include:

- Green janitorial cleaners
- Construction and demolition debris recycling program
- Junk mail reduction program
- Carpet recycling program

This year, SLAC implemented two of the PPOA projects identified in FY07 and one from FY08. The implemented projects are:

- Green janitorial cleaners
- Recycled paint pilot project
- Composting of cafeteria kitchen waste

Select waste minimization and pollution prevention projects completed since 2004 are summarized in Table 4-7.

Table 4-7 Waste Minimization and Pollution Prevention Projects

Name/Description	Year Initiated	Waste Reduction/Pollution Prevention Result
Water Conservation	2004	A pilot project is in progress to conserve water through the use of waterless urinals.
Development of EMS Objectives and Targets	2005	EMS Objectives and Targets were developed to help further integrate pollution prevention into SLAC day-to-day activities
Chemical Management Service	2005	The CMS program is fully implemented. Through streamlining the chemical supply chain has removed the need to order excess chemicals.
Incorporating pollution prevention initiatives into the Linac Coherent Light Source Project	2005	A number of environmental initiatives have been included in the LCLS Project while it is in the design and construction phase – procurement of recycled material content products, soil reuse, radioactive materials reuse, pollution prevention measures to prevent soil and water contamination from lead, construction measures to prevent soil erosion and stormwater pollution
Revision of the Hazardous Waste Chapter and the Waste Minimization and Pollution Prevention (P2) Chapter in SLAC ES&H Manual	2006	Developed improved procedures and guidance for management of hazardous waste by employees and for the implementation of waste minimization and pollution prevention. SLAC achievements in waste minimization and pollution prevention are presented site-wide through a SLAC-implemented recognition program for employees.
Phase out of old gas tanks	2006	Using the CMS, SLAC reviewed its use of gasses and associated tanks and phased out numerous gas tanks that were no longer needed or were not acceptable for long-term storage, in turn, reducing SLAC’s on-site chemical inventory.
Eliminating Hexavalent Chromium from SLAC Metal Finishing Operations	2007	The use of hexavalent chromium in plating operations was eliminated. Specifically, 900 gallons of chromic acid solution and approximately 300 gallons of Alodine solution were replaced with a less toxic material.
Klystron Gallery Capacitor Replacement Project	2007	346 PCB capacitors in the Klystron Gallery were replaced with non-PCB capacitors.
PULSE Building Renovation Project	2007	The solicitation for the building renovation project includes sustainable or “green” building requirements based on the *Guiding Principles for Federal Leadership in High Performance and Sustainable Buildings.*
LCLS Construction Debris Recycling	2008	LCLS construction project diverted 86 percent of their construction debris from a landfill through recycling at a materials processing facility.
Cafeteria Compost Project	2008	Disposable cafeteria service ware was converted to compostables and both “behind the counter” and “front of the counter” composting of organic waste was initiated in 2008.
Fleet Reduction Program	2008	As a cost and fuel saving measure, SLAC’s vehicle fleet was reduced by 26 percent in 2008.
Green Janitorial Cleaners	2008	Janitorial vendor converted cleaners to greener alternatives such as Green Seal certified.

4.6.2 Hazardous Waste Management

SLAC is a 90-day hazardous waste generator. SLAC does not have a Resource Conservation and Recovery Act (RCRA) Part B permit that would allow it to treat hazardous waste, store it on site, and/or dispose of it on site (that is, a treatment, storage, and disposal facility permit) under the federal-level RCRA regulations. SLAC does have permits to treat a few RCRA-exempt and non-RCRA (that is, California-only) hazardous waste streams (see Section 4.6.2.4 regarding the state-level tiered permit program).

4.6.2.1 Regulatory Framework

RCRA provides cradle-to-grave authority to regulate hazardous waste, from generation to disposal. Regulation is through a system of recordkeeping, permitting, monitoring, and reporting. The primary objective of RCRA is to protect human health and the environment. A secondary objective is to conserve valuable material and energy resources by promoting beneficial solid waste management, resource recovery, and resource conservation systems.

The USEPA has delegated authority to the state of California for implementing the federal RCRA program. In turn, the state has delegated its authority for certain aspects of hazardous waste program oversight to the local CUPA; the San Mateo County Health Services Agency, Environmental Health Division, serves as the CUPA with delegated authority to oversee SLAC’s hazardous waste management.

4.6.2.2 Annual Facility Enforcement Inspection

The CUPA inspected the hazardous waste management program and tiered permit program treatment facilities on November 13, 14, 18, and 21, 2008.

4.6.2.3 Hazardous Waste Generation and Tracking

SLAC utilizes a self-developed, site-specific computerized hazardous waste tracking system (WTS). Hazardous waste containers are tracked from the time they are issued to the generator to eventual disposal off-site. The WTS includes fields that generate information for the biennial SARA Title III, TRI, and TSCA PCBs annual reports.

SLAC categorizes the hazardous wastes it generates into the following categories:

- Hazardous wastes from routine laboratory operations
- Hazardous wastes considered to be TSCA-regulated waste
- Hazardous wastes resulting from remediation and/or cleanup/stabilization projects

Hazardous wastes regulated by the TSCA at SLAC result from two primary sources: removal of old electrical equipment containing PCBs and construction projects containing asbestos. TSCA wastes result from the phasing-out of these chemicals from use at SLAC. SLAC’s progress in reducing the quantities of TSCA waste from these sources is shown in Figure 4-5. Specifically, during FY08, SLAC achieved a 97 percent reduction in its TSCA waste generation compared to the TSCA waste generated in 1990.

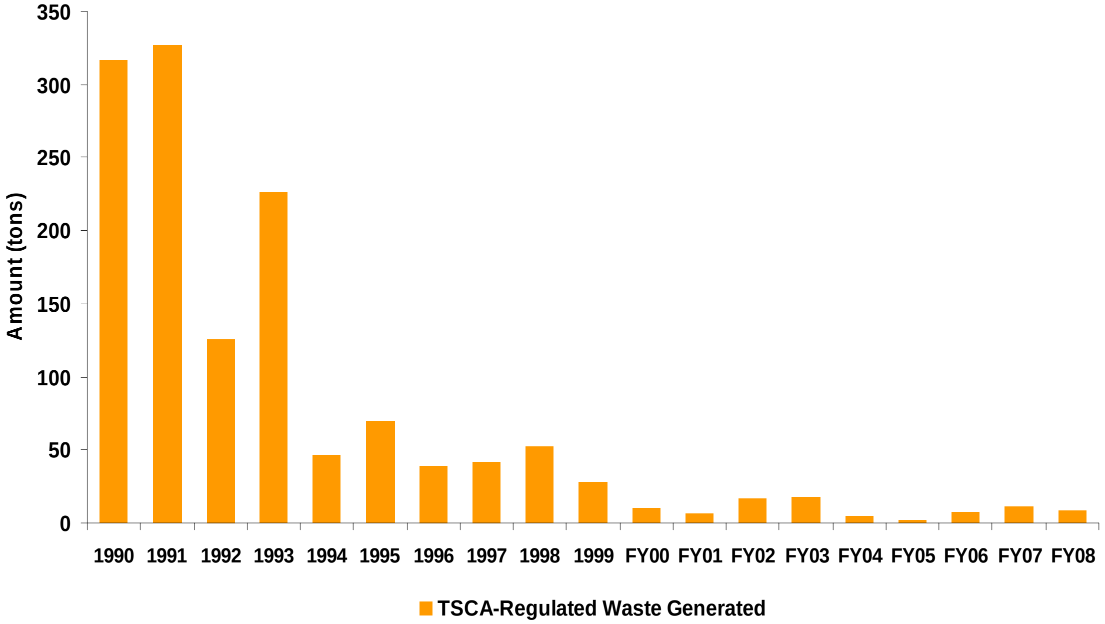

Figure 4-5 TSCA-Regulated Hazardous Waste, 1990–2008

Remediation wastes including TSCA remediation wastes result from cleanup of soil and/or groundwater contaminated by historical management practices or accidental spills. Common remediation wastes at SLAC include metal- and PCB-contaminated soils, and volatile and semi-volatile organics in groundwater. Annual quantities of remedial waste generated vary based on projects scheduled for any given year. Waste quantities from remediation are not included in Figures 4-3 and 4-5. For a discussion of SLAC's environmental restoration programs that result in the generation of remediation wastes, see Chapter 6.

SLAC's hazardous waste generation rates have been reduced through a combination of waste minimization and pollution prevention techniques, including the following:

- Reducing generation of excess chemicals through CMS
- Converting empty metal containers and drums to scrap metal
- Exchanging chemicals with other users
- Reclassifying waste streams to reduce hazardous waste volumes
- Reusing chemicals
- Returning unused material back to the vendor or manufacturer
- Sending electrical equipment off site for reuse by other organizations

SLAC expects to continue to make progress in reducing the generation of hazardous waste from routine laboratory operations, although in much smaller increments than was previously the case. Additionally, the generation of TSCA and remediation wastes will decrease as SLAC continues to phase out its use of PCBs, removes soils impacted with PCBs, and removes asbestos-containing materials.

4.6.2.4 Hazardous Waste Treatment: Tiered Permitting Program

The five tiers of California hazardous waste permits, presented in order of decreasing regulation, are the full permit, standard permit, permit by rule, conditional authorization, and conditional exemption. *S*LAC operates a total of six hazardous waste treatment units, five under permit by rule and one under conditional authorization. These units are authorized to treat listed or characteristic hazardous wastes. The various units and tiered permit level are summarized in Table 4-8.

Table 4-8 Hazardous Waste Treatment Units Subject to Tiered Permitting

Tiered Permit Level	Unit Number	Location/Description
Permit by rule	Unit 1A	Cyanide Treatment Tanks
Permit by rule	Unit 1B	Metal Finishing Pre-treatment Facility
Permit by rule	Unit 1C	Batch Hazardous Waste Treatment Tank
Permit by rule	Unit 2	Metal Finishing Pre-treatment Facility – Sludge Dryer
Conditional authorization	Unit 4	Groundwater Treatment System at the FSUST
Permit by rule	Unit 5	Groundwater Treatment System at the FHWSA

4.6.3 Non-hazardous Waste Management

Non-hazardous waste can be grouped into non-hazardous industrial waste and municipal solid waste.

4.6.3.1 Non-hazardous Industrial Waste Management

In addition to its hazardous waste management program, SLAC also operates various projects that involve disposal of non-hazardous waste classified as either non-hazardous industrial or regulated waste. SLAC’s WM Group manages industrial waste resulting from SLAC’s laboratory operations and remediation operations that, while not classified as hazardous, is not sufficiently “clean” to be disposed of in a municipal or sanitary solid waste landfill. Examples of industrial wastes include soils contaminated with low levels of petroleum hydrocarbons, PCBs or metals such that qualify as non-hazardous but are not acceptable to municipal landfills. In California, industrial wastes are generally termed *Class 2* waste, since they are specifically required to be disposed of at Class 2 landfills (these provide an intermediate level of protection to the environment between *Class 1*, hazardous waste landfills and *Class 3*, municipal solid waste landfills).

4.6.3.2 Municipal Solid Waste Management

SLAC’s Facilities Department operates a municipal solid waste program that collects a variety of recyclable materials as well as regular dumpster refuse. SLAC’s Property Control Department operates a salvage operation that sells metal and other industrial recyclables (construction materials, for example, concrete, clean soils, asphalt, wood) and equipment for their cash value. SLAC integrates the results of its metal salvage operations when reporting data about its municipal solid waste program. In FY06, SLAC also started including electronic waste collected under salvage operation as a recyclable material.

A site-wide program that recycles mixed paper, beverage containers (glass, aluminum, and plastic), cardboard, and scrap wood has been fully operational for more than 10 years. Collection stations are strategically distributed around the site with each station incorporating anywhere from one to a dozen green containers. Dumpsters for cardboard collection are strategically place around the site and a specific location is provided for waste wood. Scrap metal and electronic waste is collected and construction materials from building demolition and rehabilitation projects are also recycled. The contributions of the various waste streams being recycled are shown in Figure 4-6.

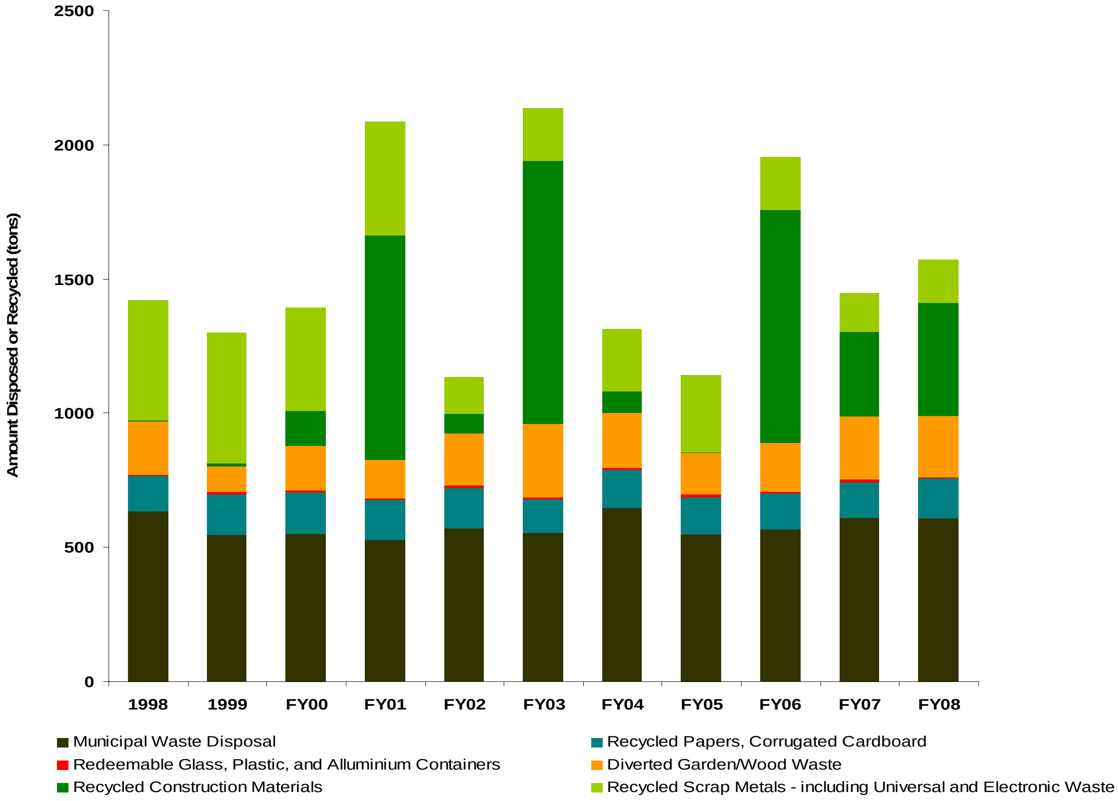

Figure 4-6 Municipal Solid Waste Recycling and Disposal, 1998–2008

Note: Batteries and office materials, although recycled, are not depicted above because quantities are small in relation to the above.

4.6.4 Other Waste Management Activities

SLAC generates a small quantity of low-level radioactive waste every year; this waste stream is discussed in Chapter 5.

SLAC generates a small quantity of medical waste from the on-site Medical Department. In California, the state Medical Waste Management Act requires proper storage, treatment, and disposal of medical waste. The state program is administered by the California Department of Health Services.

4.7 Environmental Planning

SLAC's scientific and support facilities were constructed under a clearly conceived planning framework established in the site's original general development plan (1961) and master plan (1966). For over four decades, SLAC facilities expanded within this original framework, but over the years, many small support and storage buildings and more parking demands have crowded the core research areas and obscured the original circulation plan. To meet the challenges of constructing major new projects in this constricted and environmentally sensitive location, SLAC employs two primary tools: National Environmental Policy Act (NEPA) analyses on a project-by-project basis, and conformance with SLAC's LRDP.[19]

4.7.1 SLAC Long Range Development Plan

In December 2002, SLAC published its LRDP, the result of both SLAC's LRDP Working Committee and the professional land use, environmental, and campus planners from the Stanford University Architect and Planning Office. The LRDP was revised in June 2003.

The LRDP encourages the gradual replacement of small, outdated structures with more efficient and well-planned development. The plan includes a series of diagrams that overlay planned structures and circulation systems with environmental constraints to intelligently guide the location of future projects. Environmental factors considered in developing the plan include the following:

- Geology and seismicity
- Topography
- Sedimentation and erosion potential
- Hazardous materials
- Considerations of site locations relative to sensitive receptors
- Flooding and wetlands
- Habitat and species protection
- Visual character of SLAC

4.7.2 National Environmental Policy Act

SLAC developed its NEPA program in 1992. It is administered by SLAC's Operations Directorate, with staff from the EP Department providing environmental resources input and document review as requested. Under this program, proposed projects and actions are reviewed to evaluate NEPA documentation requirements, as required. The Operations Directorate works in conjunction with the DOE SSO and NEPA Compliance Officer to determine which of the following three categories of NEPA documentation, presented in increasing order of complexity, is required:

- Categorical exclusion (CX)
- Environmental assessment (EA)
- Environmental impact statement (EIS)

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[19] Stanford University Architect/Planning Office, *Stanford Linear Accelerator Center Long Range Development Plan* (December 2002, revised June 2003), http://www-group.slac.stanford.edu/bsd/SLAC_LRDP_final.pdf

Environmental aspects that must be considered when scoping and preparing NEPA documentation commonly include potential increases in air emissions or hazardous materials usage; waste generation; impacts on wetlands, sensitive species, and critical habitats; and increases in water consumption and wastewater discharge.

SLAC prepared and reviewed NEPA documentation for seventeen projects during 2008, listed in Table 4-9. The projects were relatively minor in scope and environmental impact. The projects were assigned a CX reference number. Completed NEPA documents are forwarded to the DOE SSO and the NEPA Compliance Officer located at the Integrated Support Center, Oak Ridge Office, if necessary, for review and approval.

Table 4-9 NEPA Documentation Prepared during 2008

Project Name	Project ID	Date
Pathway Sector 30 to B 033	140128	1/30/08
Lithium Hydride Cylinder Disposal	140152	2/15/08
Building 750 Elevator Maintenance	140122	2/28/08
Sector 10 Drainage and Hillside Maintenance	030146	3/14/08
B034 Office and Lab Reconfiguration - Phase 1	5817	2/25/08
Building 034 Remodel	140142	2/25/08
PULSE Project	380004	2/25/08
Building 040 Occupant Relocation	88801	4/3/08
Fuel Management System Conversion Project	030159	5/15/08
SSRL Chiller Upgrade	5840	7/16/08
VVS Transformer Containment	140166	7/16/08
Building 081 Metal Stair Replacement	030136	7/31/08
Building 50 Communication Room DC	5845	7/23/08
Re-Roof Building 042/043	030132	7/23/08
Aboveground Storage Tank Upgrade	030143	10/9/08
LDRD FY 2009	0930001-06	10/30/08
B280C Stair Replacement	99999999	11/25/08

5 Environmental Radiological Program

5.1 Introduction

All members of the public receive radiation doses from natural background radiation and from an assortment of human activities. This chapter describes sources of radiation and radioactivity at SLAC and provides an overview of how SLAC's Radiological Environmental Protection Program assesses direct radiation and radioactivity in water, air, and soil for the purpose of determining the potential radiation dose to the public and impacts to the environment.

As in past years, in 2008, the dose that members of the public receive due to SLAC operations is a small fraction of the dose received from natural background radiation. In addition, the potential radiation dose to the public and the radiation-related impacts to the environment from SLAC operations were significantly below all regulatory limits.

5.2 Sources of Radiation and Radioactivity

The 2-mile-long linac at SLAC is encased in a concrete tunnel 25 feet beneath the surface of the ground. Through this underground tunnel, beam particles are accelerated to nearly the speed of light.

Some beam particles strike accelerator components during the acceleration process. When that happens, the decelerating particles may emit secondary radiation in the form of high-energy photons and neutrons. This secondary radiation is present whenever beam particles are accelerated, but that ceases as soon as power to the accelerator is terminated.

The secondary radiation may also make the substances they strike become radioactive. Table 5-1 lists the predominant radioactive elements produced in water or air and their half-lives.

Facilities at SLAC are designed to meet all applicable safety and environmental requirements. Nearly all direct radiation is stopped by the combined shielding on the accelerator structure and the ground or thick concrete walls that surround the accelerator tunnel. SLAC monitors the small fraction of photons and neutrons that pass through the accelerator components, through the surrounding earth or walls, to reach areas outside of the accelerator housing. This direct-radiation monitoring is described in Section 5.3.

SLAC also assesses, measures, and reports on radioactivity as required by its policies and by state or federal regulations. Sections 5.4 through 5.6 and 5.9 describe SLAC's programs to assess and control radioactivity that can be released into the environment. All known releases of radioactive materials are included in the tables in those sections.

Table 5-1 Activation Products in Water or Air

Radioactive Element	Half-life	Primarily Produced In
Oxygen (^{15}O)	123.0 seconds	Water or air
Nitrogen (^{13}N)	10.0 minutes	Air
Carbon (^{11}C)	20.3 minutes	Water or air
Argon (^{41}Ar)	1.8 hours	Air
Beryllium (^{7}Be)	53.6 days	Water
Hydrogen (^{3}H)	12.3 years	Water

^{3}H = tritium

5.3 Monitoring for Direct Radiation

DOE regulations (10 CFR 835) require SLAC to demonstrate that radiation and radioactivity from SLAC did not cause any member of the public to receive a radiation dose greater than 100 millirems (mrem, a unit used to quantify radiation dose to humans) during the year.[20] In 2008, the maximum dose that could have been received by a member of the public due to direct radiation from SLAC was less than 0.002 mrem (2.0 x 10^{-5} milli Sievert (mSv)), which is the SI unit). This is 0.002 percent of the 100 mrem regulatory limit. This maximally exposed individual (MEI) is located near Sand Hill Road, approximately 600 meters (m) (2,133 feet) from Sector 4.

During 2008, SLAC measured direct radiation at 43 locations around the SLAC site boundary to determine the potential radiation dose to a member of the public. Readings from dosimeters used to measure radiation were recorded each calendar quarter. Landauer Incorporated, accredited by the DOE's Laboratory Accreditation Program and National Voluntary Laboratory Accreditation Program as a dosimeter supplier, provided and processed the dosimeters. Results from these dosimeters were also used to calculate the collective dose to the population (about 5 million) that lives within 80 kilometers (km) (50 miles) of SLAC.

Section 5.8 and Table 5-6 summarize annual doses from both direct radiation (0.002 mrem) and airborne radioactivity (0.045 mrem) and show how those doses compare with those from natural background radiation.

5.4 Assessment of Airborne Radioactivity

USEPA regulations (40 CFR 61) enacted under the Clean Air Act and DOE Order 5400.5 require SLAC to demonstrate that airborne radioactivity released did not cause any member of the public to receive a dose greater than 10 mrem during the year. In 2008, the maximum dose that could have been received by a member of the public due to airborne radioactivity from SLAC was 0.045 mrem (4.5 x 10^{-4} mSv), or less than one percent of the 10 mrem regulatory limit. This MEI is located in the business offices in the Portola Valley Training Center on the south east side of SLAC.

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[20] United States Department of Energy, DOE Order 5400.5, "Radiation Protection of the Public and the Environment," http://www.directives.doe.gov/pdfs/doe/doetext/oldord/5400/o54005c2.html

SLAC files an annual report to the USEPA that describes the possible sources, types, and quantities of airborne radioactivity released into the atmosphere.[21] As detailed in that report, the released airborne radioactivity was calculated, based on conservative information about accelerator operations in 2008. Table 5-2 summarizes the released radioactivity, showing the quantities in curies (Ci). Potential doses to members of the public due to the released radioactivity were determined using USEPA- software CAP88. In addition to providing information on maximum individual doses, SLAC also assessed and reported the collective dose to the population that lives within 80 km (50 miles) of SLAC.

Table 5-2 and Table 5-6, as well as Section 5.8, provide a summary of the results and information on how the maximum possible doses compare with natural background radiation.

Table 5-2 Airborne Radioactivity Released in 2008

Category	Radioactive Element	Activity (Ci)
Tritium	Hydrogen (^{3}H)	n/a
Krypton-85	Krypton (^{85}Kr)	n/a
Noble gases ($T_{1/2} < 40$ days)	Argon (^{41}Ar)	1.03
Short-lived activation products ($T_{1/2} < 3$ hr)	Oxygen (^{15}O)	21.9
	Nitrogen (^{13}N)	40.9
	Carbon (^{11}C)	4.38
Other activation products ($T_{1/2} > 3$ hr)	n/a	n/a
Total radioiodine	n/a	n/a
Total radiostrontium	n/a	n/a
Total uranium	n/a	n/a
Plutonium	n/a	n/a
Other actinides	n/a	n/a
Total		68.2

n/a – not applicable

$T_{1/2}$ – half life

5.5 Assessment of Radioactivity in Water

Three types of water are monitored for radioactivity at SLAC: industrial wastewater, stormwater, and groundwater. This section summarizes the 2008 monitoring and results for each water type.

5.5.1 Industrial Wastewater

Federal and state regulations (10 CFR 20.2003 and 17 CCR 30253) limit the radioactivity in industrial wastewater that SLAC releases to the sanitary sewer system. In 2008, SLAC releases totaled less than 40% of the applicable limits.

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[21] Stanford Linear Accelerator Center, Environment, Safety, and Health Division. Radiation Protection Department, *Radionuclide Air Emissions Annual Report – CY2007* (May 2008)

Although most of the cooling water or other water present in the accelerator does not contain radioactivity other than what is naturally present, some of the water becomes activated by radiation from the accelerator (see Section 5.2). Thus a small fraction of SLAC's wastewater volume contains radioactivity. Routine operations may require SLAC to completely or partially drain and replenish accelerator cooling systems from time to time, and cooling water is disposed of as part of SLAC's industrial wastewater. Approximately every 5 to 10 years, depending on operations, an entire system may be discharged and refilled. This was the case in 2007 and 2008 when the entire system of water cooling one of SLAC's highest beam power dumps and all the water in the dump itself was discharged to the sewer, an operation that has not occurred for this system for at least 10 years. The cleaning of the system took several discharges and has spanned 2007 and 2008. Due to this system's large volume and high tritium concentration, the total SLAC release for 2008 is considerably higher than in previous years. This has significantly reduced the tritium inventory at SLAC.

Throughout the year, SLAC sampled and analyzed wastewater discharges. Total activity released during CY08 is summarized in Table 5-3.

As required by regulation, for each quarter of 2008, SLAC reported the results of wastewater monitoring and discharge to the SBSA at the end of each calendar quarter.[22]

Table 5-3 Radioactivity in Wastewater Released into Sanitary Sewer in 2008

Category	Radioactive Element	Activity (Ci)	Annual Release Limit (Ci)
Tritium	Hydrogen (^{3}H)	1.8	5
Activation products ($T_{1/2}$ > 3 hr)	Sodium (^{22}Na)	0	1*
	Beryllium (^{7}Be)	0	
Total radioiodine	n/a	0	
Total radiostrontium	n/a	0	
Total uranium	n/a	0	
Plutonium	n/a	0	
Other actinides	n/a	0	

* Combined. Excluding ^{3}H (for which there is a 5 Ci annual limit), there is a 1 Ci limit for the combined activity of all radioactive elements released during the calendar year

n/a – not applicable

Table 5-4 summarizes the historical results of wastewater monitoring for calendar year 1999 through 2008. The final column of the table compares the radioactivity discharged by SLAC into the sanitary sewer with the annual limit for such discharges set by federal and state regulation. Each year, the quantities and types of radioactivity in wastewater discharged depend on past accelerator operations and on details of wastewater handling.

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[22] Stanford Linear Accelerator Center, Environment, Safety, and Health Division, Radiation Protection Department, *Radioactivity in Industrial Wastewater for the Period of 1 January 2008 to 31 March 2008, for the Period of 1 April 2008 to 30 June 2008, for the Period of 1 July 2008 to 30 September 2008, and for the Period of 1 October2008 to 31 December 2008*

Table 5-4 Summary of Radioactivity in SLAC Wastewater, 1999–2008

Year	Radioactive Element	Activity (Ci)	Percentage of Annual Limit
1999	Hydrogen (^3H)	7.1×10^{-3}	0.1
2000	Hydrogen (^3H)	2.4×10^{-3}	0.05
2001	Hydrogen (^3H)	2.1×10^{-3}	0.04
2002	Hydrogen (^3H)	2.4×10^{-2}	0.5
	Sodium (^{22}Na)	5.1×10^{-5}	1.4*
	Beryllium (^7Be)	1.4×10^{-2}	
2003	Hydrogen (^3H)	4.1×10^{-4}	0.008
2004	Hydrogen (^3H)	2.0×10^{-2}	0.4
2005	Hydrogen (^3H)	1.4×10^{-3}	0.03
2006	Hydrogen (^3H)	1.2×10^{-3}	0.02
2007	Hydrogen (^3H)	2.3	46
2008	Hydrogen (^3H)	1.8	36

* Sodium-22 and Beryllium-7 combined. Excluding ^3H (for which there is a 5 Ci annual limit), there is a 1 Ci limit for the combined activity of all radioactive elements released during the calendar year

5.5.2 Stormwater

The program for monitoring stormwater is described in Section 4.4 of this report. In 2008 (and in all previous years), no radioactivity above natural background was found in any stormwater sample.

SLAC reported the results of the 2008-2009 stormwater monitoring (including checks for radioactivity) to the RWQCB.[23]

5.5.3 Groundwater

Throughout 2008, SLAC performed in-house analysis of water samples from monitoring wells for the presence of radioactivity each time the wells were sampled under the groundwater monitoring plan described in Chapter 6 of this report. As part of the groundwater monitoring program (see Section 6.7), select samples are also sent to an external California-certified laboratory for tritium analysis. The results from the external laboratory are in general agreement with the in-house analysis.

With the exception of the four monitoring wells listed in Table 5-5 (these are in-house results), no radioactivity above natural background was detected in any of the groundwater samples.

The detected concentrations of tritium in the water samples summarized in Table 5-5 were below federal and state limits set for tritium in drinking water (drinking water standard is 20,000 pCi/L under 22 CCR 64443 and 40 CFR 141.66). In addition, groundwater is not used at SLAC for any purposes because of its

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[23] SLAC National Accelerator Laboratory, Environment, Safety, and Health Division, Environmental Protection Department, *2008–2009 Annual Report for Stormwater Discharges Associated with Industrial Activities* (June 30, 2008, to be submitted to Rico Duazo, San Francisco Bay RWQCB)

very low well yields. Even if there was an adequate supply of groundwater available at SLAC, it could not be used as drinking water due to the naturally high content of total dissolved solids (TDS).

Table 5-5 Summary of Tritium Concentrations Measured in Monitoring Wells in 2008 (in-house analysis)

Period (Month)	Jan to March	April to June	July to Sep	Oct to Dec
Well Variable				
EXW-4				
Avg ^{3}H (pCi/L)	3980	3341	2983	2482
% of DWS[1]	20	17	15	12
No. of Samples	2	4	4	2
MW-30				
Avg ^{3}H (pCi/L)	526	< 500[2]	< 500[2]	671
% of DWS[1]	3	n/a	n/a	3
No. of Samples	1	1	1	1
MW-81				
Avg ^{3}H (pCi/L)	2452	1370	528	673
% of DWS[1]	12	7	3	3
No. of Samples	1	1	1	1
MW-94				
Avg ^{3}H (pCi/L)	2842	1054	2095	1843
% of DWS[1]	14	5	10	9
No. of Samples	1	1	1	1

[1] DWS – drinking water standard: 20,000 pCi/L for tritium

[2] 500 pCi/L was the minimum tritium concentration that was detectable by SLAC in 2008

n/a – not available

5.6 Assessment of Radioactivity in Soil

Throughout 2008, SLAC sampled and analyzed soil for projects involving soil excavation on the SLAC site (such as the construction of the new LCLS facility). No soil samples were found to contain radioactivity in excess of natural background.

5.7 Release of Property Containing Residual Radioactive Material

Throughout 2008, all property, real and personal, exposed to any process that could cause it to become radioactive were surveyed for radioactivity before it was permitted to be removed from SLAC. Property that had any detectable radioactivity was identified as *radioactive*, and was either retained for appropriate reuse on site or was disposed of as radioactive waste. Therefore, property releases do not add to the potential public dose. Material which did not have detectable radioactivity was not considered radioactive and was released from any further radiological controls. There were additional controls on movement of property between locations on site, but these are not relevant to this report and are documented elsewhere.

5.8 Potential Dose to the Public

The maximum possible dose to members of the public due to SLAC operations are very small compared with doses from natural background radiation and are well below all regulatory limits.

Table 5-6 summarizes the dose results for the two modes that were the potential contributors to public radiation dose in 2008: direct radiation (0.002 mrem) and airborne radioactivity (0.05 mrem). Releases of radioactivity in water and property were too small to result in a radiation dose to a member of the public under any imaginable, credible scenario. Table 5-6 also compares the 2008 dose results with regulatory limits and natural background.

The reported maximum dose for the MEI, dominated by the potential emission of radioactive air, is based on a person being present 24 hours per day in 2008 in the business offices in the Portola Valley Training Center on the south east side of SLAC.

The MEI due to direct radiation is at the location Sand Hill Road approximately 600 m from Sector 4. Like previous calculations, the 2008 calculation of the MEI dose does not include any dose reduction for hills that may lie between the locations of dose measurements and the MEI. However, since 2003, the effects of air attenuation for direct photon radiation calculations (a factor of 40) are taken into account.

Table 5-6 Summary of Potential Annual Doses due to SLAC Operations in 2008

	Maximum Dose to General Public – Direct Radiation	Maximum Dose to General Public – Airborne Radioactivity	Maximum Dose to General Public – Airborne + Direct	Collective Dose to Population within 80 km of SLAC
Dose from SLAC in 2008	0.002 mrem	0.045 mrem	0.047 mrem	0.012 (direct) + 0.29 (air) = 0.30 person-rem
DOE Radiation Protection Standard	100 mrem	10 mrem	100 mrem	n/a
SLAC 2008 Max. Dose as Percentage of DOE Standard	0.002%	0.5%	0.05%	n/a
Dose from Natural Background	100 mrem	200 mrem	300 mrem	1,667,000 person-rem
SLAC 2008 Max. Dose as Percentage of Natural Background	0.002%	0.02%	0.016%	0.00002%

n/a – not applicable

Table 5-7 presents the maximum dose potentially received by a member of the public from both direct radiation and airborne radioactivity due to SLAC operations in 1999 through 2008 and compares it with the average dose due to natural background radiation and radioactivity.

Table 5-7 Potential Dose (mrem) to Maximally Exposed Individual, 1999–2008

Year	SLAC Direct and Airborne Radiation	Average, Total Natural Background Radiation	Percentage of Background
1999	4.5	300	1.50
2000	5.7	300	1.90
2001	5.3	300	1.77
2002	2.1	300	0.70
2003*	0.2	300	0.07
2004	0.2	300	0.07
2005	0.3	300	0.1
2006	0.5	300	0.2
2007	0.1	300	0.03
2008	0.05	300	0.016

* Starting with the 2003 calculations, the effects of air attenuation were taken into account.

5.9 Biota Dose

The DOE technical standard, “A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota” (DOE-STD-1153-2002), suggests that DOE facilities protect plants and animals by assuring the following dose rates due to “exposure to radiation or radioactive material releases” into the applicable environment are not exceeded:

- Aquatic animals: should not exceed 1 rad/ day
- Terrestrial plants: should not exceed 1 rad/day
- Terrestrial animals: should not exceed 0.1 rad/day

rad is a unit used to quantify radiation dose.

5.9.1 Dose to Biota from Direct Radiation

In 2008, SLAC monitored dose and dose rate at approximately 300 on-site locations (most outside shielding and some inside shielding) using passive radiation dosimeters posted for three to six month periods. For each period, the average dose rate among these 300 dosimeters was found to be less than 0.004 rad/day (dominated by those inside shielding), and the maximum dose rate was less than 0.08 rad/day (inside shielding). Based on the results of this monitoring program and the fact that we know animal populations could not have been present except in locations with the low dose rates outside shielding, doses to plant and animal populations at SLAC were well within the limits of the DOE standard throughout 2008.

5.9.2 Dose to Biota from Activation Products

In 2008, SLAC tested soil and water samples for the presence of radioactivity in excess of natural background, as described in sections 5.5 and 5.6. Tritium was occasionally found in industrial wastewater in 2008, but plant and animal populations have no opportunity for access to industrial wastewater at SLAC. Since the radioactive activation concentrations in these sampled media are much lower than from direct radiation, there is no possibility that plants or animals will receive dose rates that exceed the limits of the standard due to radioactive activation products at SLAC.

In 2008, no groundwater was found with tritium concentrations in excess of the human drinking water standard set by state and federal regulations. Section 5.5.3 summarizes the 2008 results of monitoring for radioactivity in groundwater. There is no potential that plants or animals will receive dose rates that exceed the limits of the standard due to radioactive activation products in groundwater at SLAC.

5.10 Low-level Radioactive Waste Management

Low-level radioactive waste (LLRW) is produced at SLAC sporadically. Prior to 2002, wastes resulting from routine operations had not been tracked as a category separate from other operations such as one-time upgrade, equipment failure replacement, and special projects. A system is now in place to allow tracking of *routine operation waste.* In 2008, SLAC generated a total of 179.35 ft^3 of routine low level wastes; 117.86 ft^3 of LLRW and 61.49 ft^3 of mixed LLRW.

LLRW minimization is accomplished through education and training for the waste generator, careful planning of work operations, thorough survey and characterization of materials, segregation, reuse, and volume reduction when applicable.

SLAC continues to manage its LLRW in compliance with all applicable laws and regulations. During CY08, SLAC shipped approximately 4,100 cubic feet of LLRW to appropriate treatment and disposal facilities for low-level radioactive waste.

6 Groundwater Protection and Environmental Restoration

6.1 Introduction

This chapter describes the groundwater protection and environmental restoration programs at SLAC, including the regulatory framework, site cleanup objectives, an overview of potential chemical impacts, summary of most recent restoration activities, and SLAC's groundwater monitoring program.

6.2 Background Conditions

The groundwater regime at SLAC and nearby off-site areas has been comprehensively documented in the *SLAC Hydrogeologic Review* completed in 1994.[24] This report compiles data and summarizes results of the numerous geologic, hydrogeologic, and hydrogeochemical investigations that had taken place at or near SLAC for the following reasons:

- Water resources studies
- Research
- Geotechnical studies (used to site structures being built at SLAC)
- Environmental monitoring

The report developed a conceptual model of the groundwater regime at SLAC. Based on many tests in exploratory borings and wells, the hydraulic conductivity of this bedrock is overall much less than the range of that generally accepted as representing natural aquifer material. The groundwater at SLAC is not used as a drinking water source because of low yield as well as naturally occurring high TDS content.

The document *Geologic Field Guidebook of SLAC* [25] provides a detailed description of the geology of SLAC.

6.3 Areas with Potential Impact from Chemicals

A SLAC 1994 report entitled *Summary and Identification of Potentially Contaminated Sites*[26] provides a summary of areas that may have been impacted by chemicals of concern from past SLAC operations. Information for the report was collected from a variety of sources including incident reports, aerial photographs, operations records, reports on previous investigations, and interviews with personnel throughout the facility. Two additional environmental summary documents were completed in 2006. The

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[24] Stanford Linear Accelerator Center, *Hydrogeologic Review* (SLAC-I-750-2A15H-002, 1994)

[25] Stanford Linear Accelerator Center, *Geologic Field Guidebook of SLAC* (SLAC-I-750-2A32H-015, November 2006) http://www-group.slac.stanford.edu/esh/groups/ep/geology/geologicreport.pdf

[26] ESA Consultants, *Stanford Linear Accelerator Center, Summary and Identification of Potentially Contaminated Sites* (February 1994)

Environmental Baseline Report[27] (EBR) provides an updated inventory of facilities and areas at SLAC that were considered to have the potential to have chemical impacts, and summarizes the results of the environmental investigations and remediation activities that have occurred to date. The EBR identifies chemicals of potential concern, defines Investigation Areas, and provides a decision process for determining which areas still require additional actions. The *Work Plan for the Remedial Investigation and Feasibility Study*[28] provides additional description and current status of investigation areas, defines Operable Units, and describes the framework for completing the environmental investigations and remedial actions at the facility.

6.4 Strategies for Controlling Potential Sources of Chemicals

Strategies for chemical source control involve measures to control known soil or groundwater impacts as discussed in this chapter, and procedures and requirements to avoid practices that could adversely affect soil and groundwater as discussed in Chapter 4. These procedures include the site's SWPPP [29] which discuss BMPs for preventing adverse impacts from spills and operations at SLAC.

6.5 Restoration Activities

SLAC first began environmental investigation and restoration activities in the mid-1980s and by 1991 had developed a comprehensive environmental restoration program. Program activities range from discovery and characterization to remediation and long-term monitoring or maintenance where required.

The restoration approach at SLAC is to accomplish the following steps:

- Identify sites with actual or potential impacts (involving soil, groundwater, surface water, and/or air)
- Prioritize impacted sites based on site complexity, nature of chemical impact, associated risks, remaining data needs, and projected remedy
- Investigate sites and identify remedies that protect human health and the environment, beginning with the highest-priority sites
- Implement remedies and monitor for effectiveness

As of 2008, SLAC had generally reached the third and fourth steps. Restoration work conducted to date generally consists of two categories, soil excavation to remove localized areas of PCB or other chemically-impacted soils, and extraction and treatment of solvent-impacted soil vapor and groundwater. There are six areas with chemicals of potential concern in groundwater. Each of these is described in Section 6.7, along with a description of sites where soil removal has recently been conducted.

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[27] Sapere Consulting, *Stanford Linear Accelerator Center Environmental Baseline Report* (February 2006)

[28] Stanford Linear Accelerator Center, *Work Plan for the Remedial Investigation and Feasibility Study* (SLAC-I-750-A17M-008, May 2006)

[29] Stanford Linear Accelerator Center, Environment, Safety, and Health Division, Environmental Protection and Restoration Department, *SLAC Stormwater Pollution Prevention Plan* (SLAC-I-750-0A16M-002)

6.6 Regulatory Framework

In May 2005, the RWQCB issued a new Board Order (No. R2-2005-0022) for SLAC for the investigation and remediation of impacted soil and groundwater resulting from historical spills and leaks that occurred during the course of operations at SLAC. The Board Order addresses release sites at SLAC and consolidates the investigation and cleanup activities at the facility. It also rescinds an earlier Board Order that addressed contamination at only one of the sites, the Former Solvent Underground Storage Tank area (FSUST), which is now incorporated into the new Board Order. In January 2006, the RWQCB was designated by the State as the Administering Agency (i.e., lead agency) for the environmental cleanup work at SLAC[30]. As the lead agency, the RWQCB has the responsibility to determine the adequacy and extent of cleanup, issue necessary authorizations and permits, and following the determination that an approved remedy has been accomplished, issues a certificate of completion. The RWQCB has specified site cleanup to residential standards for un-restricted land use[31], consistent with how the SLAC property is zoned.

SLAC follows as practicable the general CERCLA technical guidance in investigating and remediating soil and groundwater. SLAC was not listed in the National Priorities List as a Superfund site because USEPA determined that the conditions at the site did not warrant inclusion.

All sampling activities are performed according to the environmental restoration program's Standard Operating Procedures[32]. All samples are submitted to analytical laboratories certified by the California Department of Health Services. Analytical data generated by field activities are reviewed and validated for QA and QC purposes.

6.7 Groundwater Characterization Monitoring Network

As part of the May 2005 Board Order, SLAC has a self-monitoring program (SMP) that contains a monitoring schedule for sediment from two drainage channels, surface water, and groundwater. The SMP outlines the frequency at which monitoring samples are to be collected and the chemicals to be analyzed for. Figures 6-1 through 6-3 show the monitoring network.

SLAC has 134 wells across the site used for groundwater monitoring and extraction. Figure 6-2 and Figure 6-3 identify the specific well locations. The groundwater monitoring wells are used to monitor general groundwater quality in the major areas of the facility that historically or currently store, handle, or use chemicals. Of the 134 wells, 90 wells are used to monitor chemicals of potential concern in six plumes and 31 wells are used as extraction wells for two of the six plumes. The other 13 groundwater monitoring wells are used for general site-wide surveillance.

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[30] California Environmental Protection Agency, *Site Designation Committee Resolution No. 06-01* (January 2006)

[31] Regional Water Quality Control Board, *Approval of Stanford Linear Accelerator Center Long Range Redevelopment Plan* (November 18, 2005)

[32] Stanford Linear Accelerator Center, *Standard Operating Procedures for the Environmental Restoration Program Revision 004* (SLAC-I-750-2A15H-001 R004, June 2008).

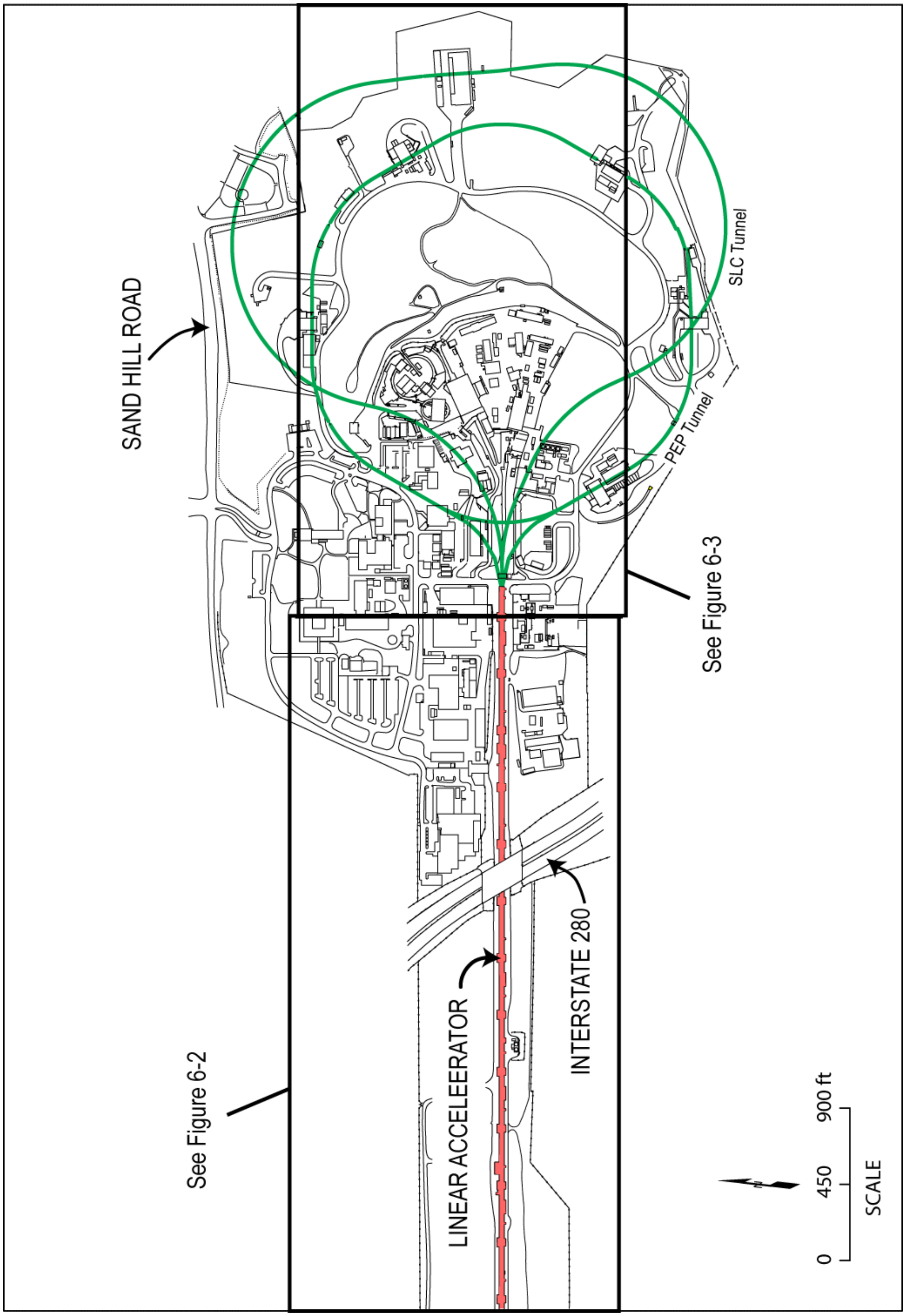

Figure 6-1 Groundwater Characterization Monitoring Network

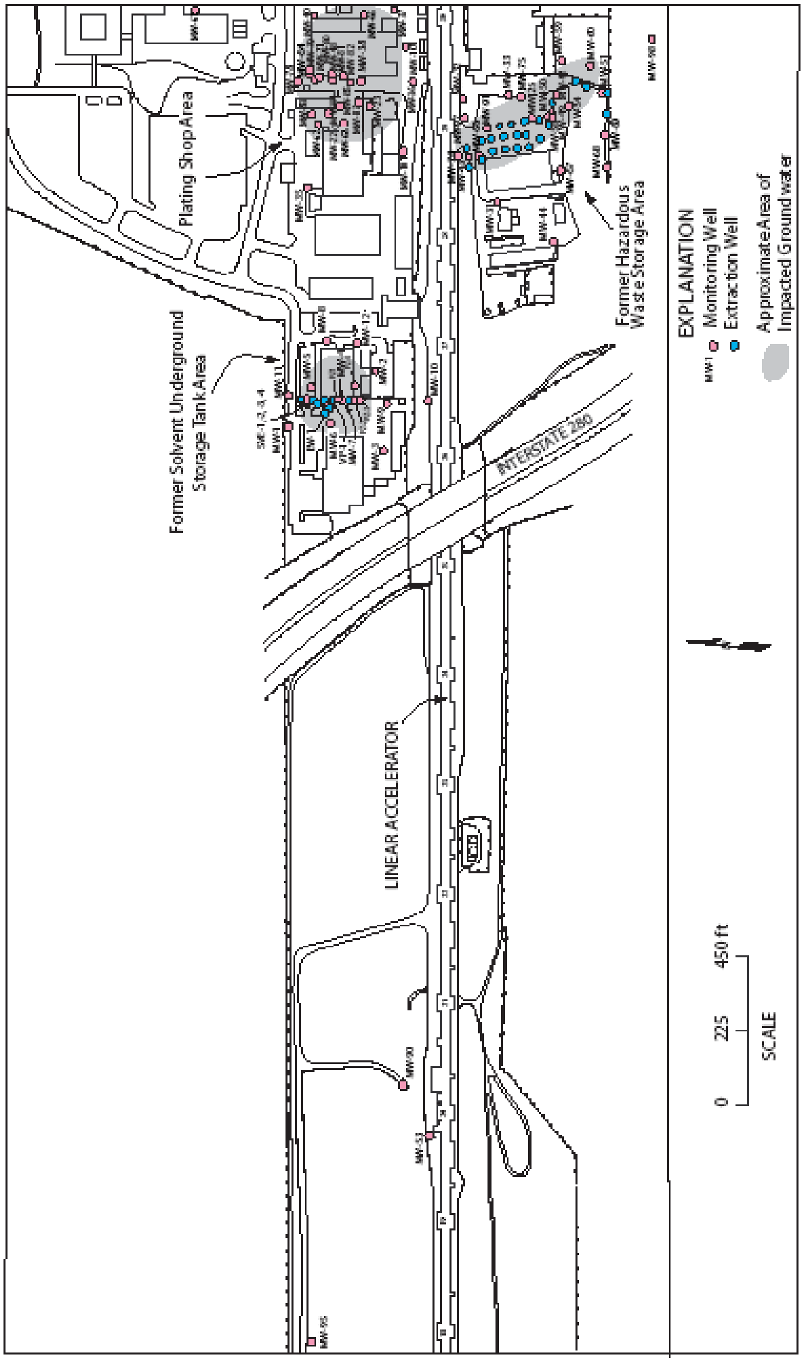

Figure 6-2 Westside Groundwater Network and Impacted Area

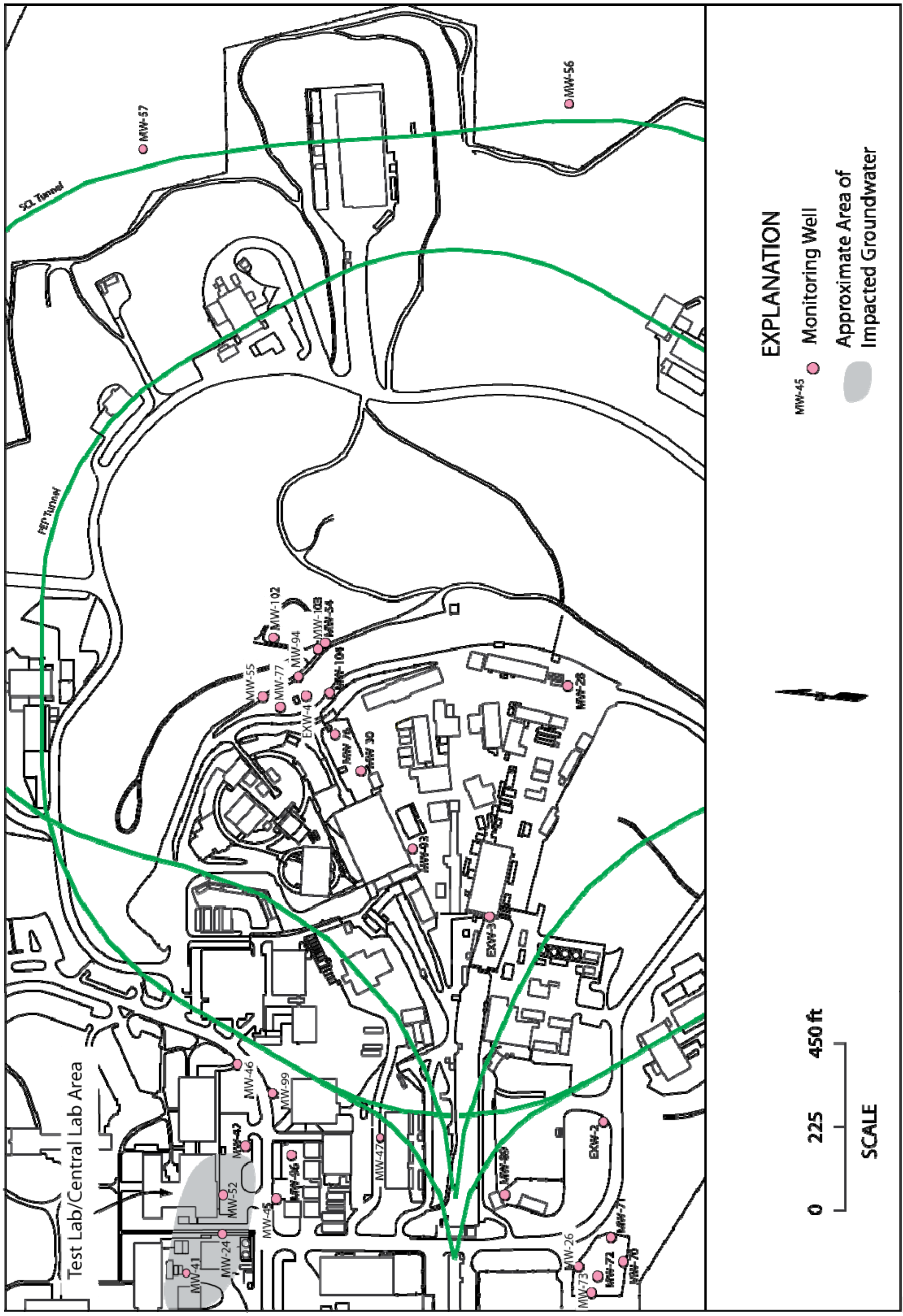

Figure 6-3 Eastside Groundwater Network and Impacted Areas

The six locations where plume monitoring occurs include the following:

- Former Hazardous Waste Storage Area (FHWSA)
- Former Solvent Underground Storage Tank (FSUST) Area
- Test Lab and Central Lab Area (TL/CL)
- Plating Shop Area (PSA)
- Lower Salvage Yard (LSY)
- Beam Dump East (BDE)

Table 6-1 summarizes the wells at SLAC by location, number, and purpose of the wells.

Table 6-1 Monitoring Locations and Number of Wells

Location	Number of Wells
Plume Monitoring	
Beam Dump East	9
Former Hazardous Waste Storage Area	22
Former Solvent Underground Storage Tank	22
Lower Salvage Yard	5
Plating Shop	23
Test Lab and Central Lab	9
Subtotal	90
Extraction	
Former Solvent Underground Storage Tank	8
Former Hazardous Waste Storage Area	23
Subtotal	31
Environmental Surveillance	
Centralized Waste Management Area	1
End Station B	1
Magnet Yard	2
Other (remote)	5
Research Yard	3
Vacuum Assembly	1
Subtotal	13
Total	134

Groundwater samples were collected at least once from 113 wells in 2008 and analyzed for a variety of constituents. The results of groundwater monitoring of wells were reported to the RWQCB in the semi-annual self-monitoring report for the winter of 2008[33] and the summer of 2008.[34] The groundwater analytical results were generally within each well's historical range of concentrations. Samples were analyzed for one or more of the following:

- Total petroleum hydrocarbons (TPH)
- Metals
- Polychlorinated biphenyls (PCBs)
- Tritium
- Volatile organic compounds (VOCs)
- Semi-volatile organic compounds (SVOCs)

6.8 Site Descriptions and Results

The six groundwater sites are described below. The sites pose no current risk to human health or the environment. Through the work described below, remediation strategies that protect current and future potential uses of the property are being defined. Under the 2005 Board Order, a formal Feasibility Study and Remedial Action Plan for the VOC-impacted groundwater Investigation Areas described below is under preparation by SLAC.

6.8.1 Former Solvent Underground Storage Tank Area

A chemical plume in groundwater associated with the FSUST is located in proximity to the SLAC Plant Maintenance building in the northwestern portion of the main SLAC campus (see Figure 6-2). The FSUST was used to store organic solvents from 1967 to 1978. A pressure test performed on the FSUST in 1983 indicated a leak. The FSUST and accessible chemically impacted soil were removed in December 1983. A network of 22 monitoring wells and eight extraction wells were subsequently installed, and groundwater has been monitored for VOCs and SVOCs.

The evaluation of Interim Remedial Alternatives Report for the FSUST established remedial action objectives and evaluated 42 alternatives to determine which would best meet the objectives.[35] The recommended interim remedial alternative for the FSUST, a groundwater extraction and treatment system, was constructed at the FSUST area during the summer of 2001 as a pilot system and has been in operation since August 27, 2001. Construction associated with an upgrade of the interim FSUST treatment system to dual phase soil vapor/groundwater extraction (DPE) was completed in August 2007. DPE operations, which started on October 18, 2007, increased the mass removal rate of VOCs and SVOCs from an average of 0.14 pounds per day to an average of 2.2 pounds per day for the remainder of 2007. In 2008, the mass removal rate of VOCs and SVOCs was an average of 0.41 pounds per day.

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[33] Stanford Linear Accelerator Center, *Semi-annual Self-Monitoring Report, Winter 2008* (SLAC-I-750-2A15H-023, May 2008)

[34] SLAC National Accelerator Laboratory, *Semi-annual Self-Monitoring Report, Summer 2008* (SLAC-I-750-2A15H-026 November 2008)

[35] Stanford Linear Accelerator Center, *Evaluation of Interim Remedial Alternatives for the Former Solvent Underground Storage Tank Area* (SLAC-I-750-3A-33H-006, 2003)

Since the start up of the remediation system at the FSUST in August 2001 and through December 2008, approximately 639,395 gallons of groundwater have been extracted and treated. Over 685 lbs of VOCs and SVOCs have been extracted from groundwater and soil vapor. Monitoring well data collected thus far indicate a capture zone encompassing the entire plume has been established and chemical data indicate that the plume appears to be shrinking in size.

6.8.2 Former Hazardous Waste Storage Area

The FHWSA was in use as a storage area from approximately 1973 to 1982. Following cessation of its use as a storage area, PCBs were found in shallow soils. As a result, several inches of topsoil were removed. A monitoring well was installed in this area in 1990, and VOCs were detected in the groundwater. Since then, two passive soil gas surveys have been performed; 22 monitoring wells, 23 soil vapor and groundwater extraction wells, 15 soil gas probes, and more than 50 soil borings have been installed at this site. Figure 6-2 shows the extent of VOCs in the groundwater. The draft site characterization report for the FHWSA was submitted to the RWQCB in 2004[36] and approved in June 2006 as a Remedial Investigation (RI)-equivalent report required under the Board Order.

In 2002, a DPE pilot test proved promising to treat impacted soil, and groundwater, and was recommended as a suitable remediation technology. Two DPE wells were installed at the FHWSA in 2003 as part of an interim dual-phase extraction (IDPE) system. The IDPE system was in operation from December 2003 to March 2006, resulting in the extraction and treatment of a total of 55,000 gallons and the removal of approximately 20 lbs of VOCs.

The design of an interim full scale DPE system for the FHWSA was finalized in 2004[37] and the construction of the system was completed in March 2006 after six months of construction. The interim full scale DPE system is designed to reduce the concentration of VOCs in soil and groundwater, at the FHWSA and prevent the migration of impacted groundwater. The full scale system utilizes 19 groundwater/soil vapor extraction wells and four vacuum-enhanced groundwater extraction wells. Groundwater extraction and treatment began on March 6, 2006. Soil vapor extraction began on April 3, 2006.

During 2008, the system extracted and treated an average of approximately 560 gallons of groundwater per day using air stripping technology. At the end of December 2008, the IDPE and interim full scale DPE treatment systems at the FHWSA extracted a cumulative combined total of 946,900 gallons of groundwater and removed a cumulative combined total of 36.2 lbs of VOCs via groundwater and soil vapor extraction.

6.8.3 Plating Shop Area

In 1990, three monitoring wells were installed down-gradient of the Plating Shop Area (PSA). Chemicals of interest were detected in all three wells; and an investigation began and included installation of additional monitoring wells, a soil gas survey, and remediation beneath a steam cleaning pad.

A total of 23 groundwater monitoring wells are currently located at the PSA (see Figure 6-2). Groundwater sampling results indicate that chemicals are present in groundwater within three co-mingled plumes. The

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[36] Stanford Linear Accelerator Center, Draft Site Characterization for the Former Hazardous Waste Storage Area (SLAC-I-750-3A33H-015, September 2004).

[37] Erler & Kalinowski, *Technical Specifications and Drawings for the Dual Phase Extraction and Treatment System at the Former Hazardous Waste Storage Area* (2004)

draft site characterization report for the PSA was submitted to the RWQCB in 2003[38] and approved in 2007 as an RI-equivalent report required under the Board Order. In support of remedial design efforts, a total of 13 soil vapor probes were installed at the PSA in December 2004, and the probes were most recently sampled in May and November 2008. A draft remedial alternatives evaluation report[39] has been prepared which recommends soil vapor and groundwater extraction followed by treatment. A Preliminary Design was completed in 2007 for the construction of a full-scale DPE system at the PSA. Construction of the DPE system to address identified risk-based areas of concern will be evaluated as part of the Board Order required Feasibility Study under preparation by SLAC.

6.8.4 Test Lab and Central Lab Area

A monitoring well was installed between the TL and the CL in 1990 at the site of a former, leaking, diesel pump spigot after soil containing diesel was removed. Diesel has never been detected in this well, but chlorinated solvents have been detected.

Data from a soil gas survey, soil borings and additional monitoring wells installed in the TL/CL helped delineate the sources of contamination (see Figure 6-3). Results of the investigation indicated three possible source areas for VOCs, including one adjacent to the TL, and two adjacent to the CL. As part of further investigation of the possible source areas, six soil vapor probes were sampled in May and November of 2007 and again in November 2008. The results of the effort identified a risk-based area of concern and that a groundwater remediation system may be required to achieve site cleanup goals. The evaluation on the need of a groundwater remediation system in this area is currently underway as part of the Feasibility Study to be completed as part of the Board Order.

6.8.5 Beam Dump East

BDE is used as a subsurface high-energy beam termination point for the End Station A beamline operations and is located in the hillside along the northeastern edge of the research yard. Groundwater is monitored in nine wells and sampled at least two times per year. Three of the nine wells were installed during 2007 to evaluate the groundwater for tritium. In 2008, as in previous years, the monitoring indicates that the tritium is localized to two wells in the area of the beam dump and present at levels far below the drinking water standards. The BDE is part of the Tritium Operable Unit, for which a draft Remedial Investigation Report has been prepared by SLAC under the Board Order and submitted for review to the Water Board in December 2008.

6.8.6 Lower Salvage Yard

There have been minor detections of TPH and VOCs in wells at the LSY. The five monitoring wells at the LSY were sampled in 2008. Low levels of TPH were reported in groundwater samples collected at the LSY.

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[38] Stanford Linear Accelerator Center, Environment, Safety, and Health Division, *Draft Site Characterization Report for the Plating Shop Area* (SLAC-I-750-3A33H-12, December 2003)

[39] Erler & Kalinowski, Inc., *Draft Remedial Alternatives Report for the Plating Shop Area, Stanford Linear Accelerator Center, Menlo Park, California* (December 2003)

6.8.7 Removal Actions

Soil removal actions were completed at five Group I Investigation Areas (Group I IAs) in 2007 and 2008 to remove debris and soil impacted with PCBs, TPH, polycyclic aromatic hydrocarbons and/or metals at concentrations above Preliminary Remediation Goals (PRGs) or pre-established cleanup goals. Work was completed in accordance with a Removal Action Work Plan prepared and approved by the Water Board in June 2007. The removal action successfully removed chemically-impacted soils and debris from Former Substation 406, the Building 081 Drainage Swale, the Sector 0 Storage Area and Drainage Swale, the Sector 16 Soil Relocation Area, and the Former Cement Plant Area.

A combined total of approximately 5,000 tons of soil and debris were excavated and disposed of at licensed off site disposal facilities and the areas were restored. The removal actions and restoration efforts were documented in the draft Group 1 Investigation Area Implementation Report prepared by SLAC and submitted to the Water Board for review in June 2008.

Six additional Investigation Areas, collectively comprising the Group 2 Investigation Areas, are scheduled for removal actions in the summer of 2009.

6.9 Excavation Clearance Program

During 2008, the excavation clearance program continued to support SLAC-wide projects to ensure proper disposal of excavated soil. An excavation permit form must be completed for activities that involve excavation or relocation of soil at SLAC. The permitting process is intended to identify potential hazards associated with excavation work at SLAC and ways to reduce worker exposure to these hazards. These hazards include underground utility lines, chemical contamination, and radiological hazards and ensure proper management and disposal of excavated materials.

Eighty two projects were supported by this program during 2008. This included the collection of multiple rounds of samples for waste characterization for one of these projects.

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