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Annual Site Environmental Report: 2009

September 2010

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

U.S. DEPARTMENT OF
ENERGY

Office of
Science

SLAC Site Office

SLAC National Accelerator Laboratory
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September 30, 2010

Subject: 2009 Annual Site Environmental Report (ASER) for the SLAC National Accelerator Laboratory (SLAC)

This report, prepared by SLAC for the U.S. Department of Energy (DOE), SLAC Site Office (SSO), provides a comprehensive summary of the environmental program activities at SLAC for calendar year 2009. Annual Site Environmental Reports (ASERs) are prepared for all DOE sites with significant environmental activities, and distributed to relevant external regulatory agencies and other interested organizations or individuals.

To the best of my knowledge, this report accurately summarizes the results of the 2009 environmental monitoring, compliance, and restoration programs at SLAC. This assurance can be made based on SSO and SLAC review of the ASER, and quality assurance protocols applied to monitoring and data analyses at SLAC.

Any questions or comments regarding this report may be directed to Dave Osugi of the SSO at (650) 926-3305, or by mail to the address above.

Sincerely,

Signature on File

Paul Golan
Site Manager
SLAC Site Office

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Contents

Disclaimer	
Publication Data	
Contents	i
Figures	v
Tables	vi
Appendices	vii
Preface	viii
Organization	viii
Contributors	ix
Primary Coordinators and Authors	ix
Additional Authors	ix
Editing and Publishing	ix
Acronyms	x
Executive Summary	ES-1
1 Site Overview	1-1
1.1 Introduction	1-1
1.1.1 SLAC Mission	1-1
1.1.2 Research Program	1-1
1.2 Location	1-3
1.3 Geology	1-3
1.4 Climate	1-4
1.5 Land Use	1-4
1.6 Water Supply	1-5
1.7 Demographics	1-5
2 Environmental Compliance	2-1
2.1 Introduction	2-1
2.2 Regulatory Framework	2-1
2.3 Environmental Permits and Notifications	2-1
2.4 Environmental Incidents	2-2
2.4.1 Non-radiological Incidents	2-2
2.4.2 Radiological Incidents	2-2

	2.5	Assessments, Inspections and Quality Assurance	2-2
	2.5.1	Assessments	2-2
	2.5.2	Inspections	2-3
	2.5.3	Quality Assurance	2-3
3		Management Systems	3-1
	3.1	Introduction	3-1
	3.2	SLAC Organization	3-1
	3.3	ES&H Division Organization	3-1
	3.3.1	Environmental Protection	3-1
	3.3.2	Risk Management and Response	3-1
	3.3.3	Radiation Protection	3-2
	3.3.4	Field Safety and Building Inspection	3-2
	3.3.5	Industrial Hygiene and Information Management	3-2
	3.4	Integrated Safety and Environmental Management System	3-2
	3.4.1	Integrated Safety and Environmental Management System	3-2
	3.4.2	Work Smart Standards	3-3
	3.4.3	Environmental Performance Measures	3-3
	3.4.4	Training	3-3
	3.5	Environmental Management System	3-4
4		Environmental Non-radiological Programs	4-1
	4.1	Introduction	4-1
	4.2	Air Quality Management Program	4-1
	4.2.1	Regulatory Framework	4-2
	4.2.2	Program Status	4-2
	4.2.3	Summary and Future Plans	4-5
	4.3	Industrial and Sanitary Wastewater Management Program	4-5
	4.3.1	Regulatory Framework	4-5
	4.3.2	Program Status	4-7
	4.4	Surface Water Management Program	4-8
	4.4.1	Regulatory Framework	4-9
	4.4.2	Program Status	4-10
	4.5	Hazardous Materials Management	4-12
	4.5.1	Regulatory Framework	4-12
	4.5.2	Program Status	4-13
	4.5.3	Hazardous Materials Business Plan Program	4-13

4.5.4	Toxics Release Inventory Program	4-13
4.5.5	California Accidental Release Prevention Program	4-14
4.5.6	Aboveground Storage Tank Program	4-14
4.5.7	Toxic Substances Control Act Program	4-15
4.5.8	Chemical Management System	4-15
4.6	Waste Minimization and Management	4-15
4.6.1	Waste Minimization Accomplishments	4-16
4.6.2	Hazardous Waste Management	4-19
4.6.3	Non-hazardous Waste Management	4-21
4.6.4	Other Waste Management Activities	4-22
4.7	Sustainability	4-22
4.7.1	Progress on Sustainability Goals of EO 13423 and EO 13514	4-23
4.8	Environmental Planning	4-25
4.8.1	SLAC Long Range Development Plan	4-25
4.8.2	National Environmental Policy Act	4-25
5	Environmental Radiological Program	5-1
5.1	Introduction	5-1
5.2	Sources of Radiation and Radioactivity	5-1
5.3	Monitoring for Direct Radiation	5-2
5.4	Assessment of Airborne Radioactivity	5-2
5.5	Assessment of Radioactivity in Water	5-3
5.5.1	Industrial Water	5-3
5.5.2	Stormwater	5-5
5.5.3	Groundwater	5-5
5.6	Assessment of Radioactivity in Soil	5-6
5.7	Release of Property Containing Residual Radioactive Material	5-6
5.8	Potential Dose to the Public	5-7
5.9	Biota Dose	5-8
5.9.1	Dose to Biota from Direct Radiation	5-8
5.9.2	Dose to Biota from Activation Products	5-9
5.10	Low-level Radioactive Waste Management	5-9
6	Groundwater Protection and Environmental Restoration	6-1
6.1	Introduction	6-1
6.2	Background Conditions	6-1
6.3	Areas with Potential Impact from Chemicals	6-1

6.4	Strategies for Controlling Potential Sources of Chemicals	6-2
6.5	Restoration Activities	6-2
6.6	Regulatory Framework	6-3
6.7	Groundwater Characterization Monitoring Network	6-3
6.8	Site Descriptions and Results	6-8
	6.8.1 Former Solvent Underground Storage Tank	6-9
	6.8.2 Former Hazardous Waste Storage Area	6-9
	6.8.3 Plating Shop	6-10
	6.8.4 Test Lab and Central Lab	6-10
	6.8.5 Beam Dump East	6-11
	6.8.6 Lower Salvage Yard	6-11
	6.8.7 Removal Actions	6-11
6.9	Excavation Clearance Program	6-11

Figures

Figure 1-1	SLAC Site Location	1-2
Figure 1-2	Site Area General Geographic and Geologic Setting	1-4
Figure 4-1	Industrial and Sanitary Wastewater Monitoring Locations	4-6
Figure 4-2	Surface Water Monitoring Locations	4-10
Figure 4-3	Routine Hazardous Waste Generation, 1999–2009	4-16
Figure 4-4	Municipal Solid Waste Recycling, 1999–2009	4-17
Figure 4-5	TSCA-Regulated Hazardous Waste, 1990–2009	4-20
Figure 4-6	Municipal Solid Waste Recycling and Disposal, 1999–2009	4-22
Figure 6-1	Groundwater Characterization Monitoring Network	6-5
Figure 6-2	Westside Groundwater Network and Impacted Areas	6-6
Figure 6-3	Eastside Groundwater Network and Impacted Areas	6-7

Tables

Table 1-1	Populations of Communities near SLAC	1-6
Table 2-1	General Permits Held by SLAC	2-1
Table 2-2	Environmental Audits and Inspections	2-3
Table 4-1	Recent Environmental Awards	4-1
Table 4-2	Halogenated Solvent Cleaning Sources Subject to NESHAPs	4-3
Table 4-3	Water Quality at the Sand Hill Road Station	4-7
Table 4-4	Water Quality at the Metal Finishing Pre-treatment Facility	4-8
Table 4-5	Stormwater Parameters Analyzed	4-11
Table 4-6	Aboveground Petroleum Tanks	4-14
Table 4-7	Waste Minimization and Pollution Prevention Projects	4-18
Table 4-8	Hazardous Waste Treatment Units Subject to Tiered Permitting	4-21
Table 4-9	Progress Against Select Sustainability Goals of EO 13423/13514 through FY2009	4-23
Table 4-10	NEPA Documentation Prepared during 2009	4-26
Table 5-1	Activation Products in Water or Air	5-2
Table 5-2	Airborne Radioactivity Released in 2009	5-3
Table 5-3	Radioactivity in Wastewater Released in 2009	5-4
Table 5-4	Summary of Radioactivity in SLAC Wastewater, 1999-2009	5-5
Table 5-5	Summary of Tritium (^3H) Concentrations Measured in Monitoring Wells in 2009	5-6
Table 5-6	Summary of Potential Annual Doses due to SLAC Operations in 2009	5-7
Table 5-7	Potential Dose (mrem) to Maximally Exposed Individual, 1999-2009	5-8
Table 6-1	Monitoring Locations and Number of Wells	6-8

Appendices

A Distribution List

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: 2009* 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

³ H	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
Bldg	Building
BMP	best management practice
CalARP	California Accidental Release Prevention Program
CARB	California Air Resources Board
CERS	California Environmental Reporting System
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
Ci	curie
CMS	chemical management system
COPC	chemicals of potential concern
CUPA	certified unified program agency
CWA	Clean Water Act
CY	calendar year
CX	categorical exclusion
DOE	United States Department of Energy
DPE	dual phase extraction
DTSC	Department of Toxic Substances Control
DWS	drinking water standard
E85	blend of fuel where 85 percent is ethanol and 15 percent is gasoline
EA	environmental assessment
EBR	Environmental Baseline Report
EIS	environmental impact statement
EM	environmental management

EMP	environmental management program
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
ES&H	environment, safety, and health
FHWSA	Former Hazardous Waste Storage Area
FMS	flow metering station
FSUST	Former Solvent Underground Storage Tank Area
FY	fiscal year
GDF	gasoline dispensing facility
GHG	greenhouse gas
gpd	gallons per day
HAPs	hazardous air pollutants
Haas	Haas <i>tcm</i>
HMBP	hazardous materials business plan
HMIS	hazardous materials inventory statement
ID/IQ	Indefinite Delivery/Indefinite Quantity
IDPE	interim dual phase extraction
IH&IM	Industrial Hygiene and Information Management Department
IR	interaction region
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
LEED	Leadership in Energy and Environmental Design
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
MFPP	metal finishing pre-treatment facility
mg/L	milligrams per liter
MGE	Main Gate East Channel
MPMWD	Menlo Park Municipal Water Department
MPR	monitoring plan report
mrem	millirem
mSv	milli Sievert
MT-CO ₂ e	metric tons of carbon-dioxide equivalents
MWh	megawatt per hour
NAE	North Adit East Channel
NEPA	National Environmental Policy Act
NESHAPs	National Emission Standards for Hazardous Air Pollutants
ODS	ozone-depleting substance
PAFD	Palo Alto Fire Department
PBR	permit by rule
PBV _s	parameter benchmark levels
PCB	polychlorinated biphenyl
PCGs	Preliminary Cleanup Goals
pCi/L	picoCuries per liter
PEP	Positron-Electron Project
ppd	pounds per day
ppm	parts per million
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
RECs	Renewable Energy Certificates
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
SME	subject mater expert
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
STA	safety training assessment
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
TCR	The Climate Registry
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
USEPA	United States Environmental Protection Agency
VOCs	volatile organic compounds
WBSD	West Bay Sanitary District
WM	Waste Management Group

Waste Min/P2	Waste Minimization/Pollution Prevention
WSS	Work Smart Standard
WTS	waste tracking system

Executive Summary

This report provides information about environmental programs during the calendar year of 2009 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 2009/2010 (October 2009 through May 2010), 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*, EO 13514, *Federal Leadership in Environmental, Energy, and Economic Performance*, 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 2009, 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, EO 13514, 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. SLAC's EMS was audited by a review team from the DOE Oak Ridge Office and the DOE SLAC Site Office (SSO) on March 31, 2009. The review team found the EMS to be in substantial conformance with the appropriate EMS requirements. Based on the audit results, SLAC and DOE were able to declare conformance with DOE Order 450.1A ahead of the June 30, 2009 mandated deadline.

During 2009, 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 2009. Hazardous materials field verifications of 36 buildings identified a number of materials that could be removed from inventory due to lack of need or age of the material. In all, 124 chemical containers were removed from inventory. SLAC's chemical purchase approval process was reconfigured to allow for more effective control over purchase of highly toxic materials. One hundred percent of SLAC's purchased desktops, laptops, and monitors were either Silver or Gold level Electronic Product Environmental Assessment Tool (EPEAT) certified in fiscal year (FY) 2009. SLAC continues to make progress on achieving the sustainability goals of EOs 13423 and

13514, which include, but are not limited to reductions in the use of water, energy, and fuel, building to green standards and reductions in greenhouse gas (GHG) emissions.

In 2009, 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. During calendar year (CY) 2009, SLAC shipped 1324 cubic feet of low-level radioactive waste, legacy waste accounted for 40 percent of the volume, to appropriate treatment and disposal facilities for low-level radioactive waste. Moreover, SLAC continued its efforts in the inventory reduction of materials no longer needed for its mission: returned 28 sealed sources to the manufacturer, transferred additional 3 sources to Los Alamos National Laboratory, and disposed of 636 kilograms of depleted uranium tiles.

In 2009, 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 on October 19, 2009, for the investigation and remediation of impacted soil and groundwater at SLAC. Risk-based preliminary cleanup goals for impacted soil and groundwater have been established for SLAC, and the remedial efforts are being designed to meet these established goals. The board order also lists specific tasks and deadlines for completion of groundwater and soil characterization and other remediation activities. All deliverable submittals to the RWQCB in 2009 were completed and submitted on time.

1 Site Overview

This chapter describes the environmental setting of 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, particle astrophysics, accelerator physics and accelerator research and development. 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-

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

level and on time 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.

In 2009, construction of the Linac Coherent Light Source (LCLS) Project continued civil construction and technical systems installations. The project commissioned more beamline systems, continuing from 2008. In addition, through a reorganization of the Laboratory the LCLS Directorate was formed. The LCLS Directorate began experimental operations with the world's first x-ray-free electron laser with better than anticipated results.

SLAC supports other world 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 was upgraded to serve as an asymmetric B factory (known as PEP-II) to study the B meson. PEP-II ceased operation in 2008. A 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.

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 to the Atomic Energy Commission for purposes of research into the basic properties of matter. The DOE now owns the original 50-year lease. 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, all 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-foot reservoir 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 2009 was 19,457 cubic feet per day, or 7,102,000 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 each year. SLAC has a working population of about 1,500, of which about 20 percent are PhD physicists. Approximately 60 percent 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 2009.

2.2 Regulatory Framework

The SLAC External Requirements Management Dataset cites the 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 2009 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
		Encompasses 34 permitted sources and 21 exempt sources of air emissions (after initial permitting, integrated into SMOP)	55
California Department of Toxic Substances Control (DTSC)	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

² SLAC National Accelerator Laboratory, External Requirements Database
<https://slacspace.slac.stanford.edu/sites/requirementsmanagement/database/>

Issuing Agency	Permit Type	Description	Number
DTSC, continued		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 2009. There were no reportable releases to the environment during 2009.

2.4.2 Radiological Incidents

In 2009, 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 2009.

2.5 Assessments, Inspections, and Quality Assurance

The environmental programs at SLAC are subject to assessments, inspections, and quality assurance measures. Those conducted during 2009 are reported here.

2.5.1 Assessments

2.5.1.1 Internal

A self assessment of the Waste Minimization/Pollution Prevention (Waste Min/P2) program was completed in July 2009. Eight specific areas of the Waste Min/P2 were assessed including, but not limited to, compliance with regulations and standards, field execution, waste reduction results, and use of chemical substitutions and bio-based products. No major non-conformities were found and opportunities for achieving additional progress in waste reduction efforts were identified.

A self assessment of the spill prevention program was performed in February 2009. The findings were very positive as no reportable releases to the environment had occurred for the period assessed and the four milestones set for the program had all been completed. The completed milestones included: 1) revision of the spill prevention control and countermeasures (SPCC) Plan; 2), update of the stormwater pollution prevention plan (SWPPP); 3) conduct of a site-wide stormwater compliance inspection, and 4) the performance of monthly inspections and documentation of above ground tanks.

SLAC's Environmental EMS was audited by a review team from the DOE Oak Ridge Office and the DOE SLAC SSO on March 31, 2009. The review team found the EMS to be in substantial conformance with the appropriate EMS requirements. Based on the audit results, SLAC and DOE were able to declare conformance with DOE Order 450.1A ahead of the June 30, 2009 mandated deadline. The review team noted proficiencies in areas of sustainability efforts and collaboration with Stanford University campus in areas such as chemical reuse, waste reduction and other sustainability practices.

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 compliance assessment of SLAC's air quality program was performed by a consultant in September 2009. The assessment included a review of the regulatory framework, major program elements, recent accomplishments, projected activities, and compliance challenges. The consultant gave SLAC a positive rating and made several recommendations to ensure complete compliance with applicable federal, state and local regulations.

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 2009 by these agencies.

Table 2-2 Environmental Audits and Inspections

Regulatory Agency	Inspection Title	Date	Violations
South Bayside System Authority	Annual Compliance Inspection	December 8	0
Bay Area Air Quality Management District	Annual Compliance Inspection	January 13	0

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.

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

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

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

Programmatic QA/QC is governed by the Radiological Environmental Protection program manual, and specific laboratory procedures and data validation and reporting are governed by the SLAC Radioanalysis Laboratory Quality Assurance manual. In addition, twice per 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 20 and Session 21 results, submitted in May 2009 and October 2009, were all acceptable, which is consistent with the previous year's performance.

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 six directorates: Accelerator Directorate, Operations Directorate, Photon Science Directorate, Particle Physics and Astrophysics Directorate, Stanford Synchrotron Radiation Lightsource Directorate and Linac Coherent Light Source Directorate. Additionally, the SLAC Office of Assurance was formed in 2006 in response to DOE Order 226.1A, *Implementation of Department of Energy Oversight Policy*. 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 and work planning and control. 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 develops and implements waste minimization and pollution prevention plans, and provides oversight of stormwater and industrial wastewater, air, toxic substances control, spill prevention 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 coordinates the management and off-site disposal of sanitary and hazardous 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.

The Fire and Emergency Management Group is staffed by fire protection engineering professionals and is supported by personnel under contract from the Palo Alto Fire Department (PAFD). PAFD staffs Station 7 which is on-site and provides emergency response services on a 24 hour-a-day, seven days-a-week basis.

The incident investigation/lessons learned program is coordinated by SLAC's Operating Experience Program Manager. Incidents are investigated; corrective actions are generated and then disseminated to minimize the likelihood of future recurrences.

During 2009, 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 and safety systems 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 and low level radioactive waste disposal 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.

3.4.1 Integrated Safety and Environmental Management System

The "plan, do, check, and improve" approach of ISEMS⁵ has been formally adopted by SLAC, and is the foundation of the site's ISEMS⁶ 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):

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-R004), <http://www-group.slac.stanford.edu/esh/general/isems/sms.pdf>

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

3.4.2 Requirements Management System

The laws and regulations that specify the ES&H and other external requirements of the Laboratory are cited in the centralized SLAC External Requirements dataset which is maintained by the SLAC Requirements Management (RM) team. Updates to the RM dataset occur when the DOE/Stanford University Contract for SLAC is modified affecting clauses or DOE Directives; when Management System documentation (i.e. ES&H Manual) is revised; and when other non-contractual external requirements (e.g. Industrial Standards) are identified based on subject matter expert (SME) input. In addition, RM vets the dataset content with respective SMEs at least annually to ensure that regulatory drivers are accurately captured.⁷ In 2009, the Requirements Management System's External Requirements Database replaced what was formerly called the work smart standards (WSS).

3.4.3 Environmental Performance Measures

In addition to complying with external requirements, SLAC evaluates its activities against performance measures. 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.

In FY 2009, SLAC's environmentally relevant performance goals were to provide the following: a work environment that protects worker safety, health and the environment; an efficient and effective implementation of ISEMS; and efficient and effective waste management, minimization, and pollution prevention.

SLAC received a grade of A- for its environmental performance, with the DOE noting among other things, good progress on the implementation of the EMS across the site, no notice of violations for non-compliance, timely implementation of DOE Order 450.1A, and acknowledgment that SLAC's subject matter experts in the environmental program areas possess necessary knowledge and skills.

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 chemicals and waste, and basic spill and emergency response. Details on the ES&H training program are available on line⁸. Workers are required to have all appropriate training related to environmental and safety

⁷ SLAC National Accelerator Laboratory, Requirements Management, <https://slacspace.slac.stanford.edu/sites/ipm/requirementsmanagement/default.aspx>

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

prior to performing any work assigned to them. Training received by each worker is documented in their Safety Training Assessment (STA), which is reviewed and approved by their supervisor.

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 is described in detail in the *EMS Description*⁹ document.

The Office of Management and Budget issues an annual Environmental Stewardship scorecard for the federal agencies and an EMS Report Card is one of four elements. SLAC achieved a score of "green" on its 2009 EMS Report Card, indicating that all elements of the EMS are in place and working. Despite a score of "green", SLAC strives to continually improve its EMS. In 2009, system improvements included but were not limited to revising the EMS Description document to incorporate new requirements of DOE Order 450.1A, updating SLAC's significant aspects and objectives to include aspects and goals of federal EOs, and establishing 'director-level' objectives and targets to enhance flow down of the EMS into all of SLAC's directorates.

SLAC's EMS program is consistent with International Organization of Standardization (ISO) 14001:2004. It was first 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. As described in Section 3.4, the site's EMS program 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 13423¹⁰, *Strengthening Federal Environmental, Energy, and Transportation Management*, was issued, revoking EO 13148, *Greening the Government Through Leadership in Environmental Management*, among other EO. Executive Order 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 450.1A¹¹ in June of 2008. SLAC's EMS was declared in compliance with DOE Order 450.1A on June 1, 2009. To support the declaration, the EMS was 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. SLAC conducts an ISEMS Effectiveness Review annually.

Additional updates to the SLAC EMS are anticipated in 2010 as a result of EO 13514, *Federal Leadership in Environmental, Energy, and Economic Performance*¹², issued October 8, 2009. This EO builds on the sustainability requirements of EO 13423, with greater emphasis on the reduction of GHG emissions by federal agencies. It is expected that DOE Orders 450.1A and 430.2B will be updated or combined to incorporate the new requirements of EO 13514.

The annual review and ranking of environmental aspects and determination of significance was completed this year by SLAC's EMS Steering Committee, the Environmental Safety Committee (ESC), and ten objectives and targets were established for 2009. For each objective and target, a work plan, termed an

⁹ SLAC National Accelerator Laboratory, "EMS Description", SLAC-750-0A03H-002 R2, January 2009

¹⁰ Executive Order 13423, <http://edocket.access.gpo.gov/2007/07-374.htm>

¹¹ DOE Order 450.1A, <http://www.directives.doe.gov/pdfs/doe/doetext/neword/450/o4501a.pdf>

¹² Executive Order 13514, <http://edocket.access.gpo.gov/2009/pdf/E9-24518.pdf>

Environmental Management Program (EMP) was completed. Many of the EMPs developed for 2009 were developed to support progress toward achievement of the sustainability goals of EO 13423 and help reduce SLAC's environmental impacts. Objectives and targets were developed for the following environmental aspects in FY2009:

- Chemical use, storage, and inventory
- Surface and stormwater contamination
- Use, reuse, and recycling – non-hazardous waste
- Use, reuse, and recycling – environmentally preferable purchasing
- Use, reuse, and recycling – electronics stewardship
- Conservation of resources – energy
- Conservation of resources – water
- Conservation of resources – fuel
- Construction, renovation and demolition by-products

Notable accomplishments for 2009 EMPs include the following:

- Hazardous materials field verifications of 36 buildings identified a number of materials that could be removed from inventory due to lack of need or age of the material. In all, 124 chemical containers were removed from inventory. A number of materials still in usable condition were able to be placed in SLAC's redistribution inventory or distributed to other SLAC operations, Stanford University's redistribution program, or other labs.
- SLAC's chemical purchase approval process was reconfigured to allow for more effective control over purchase of highly toxic materials. The new process helps to ensure the following: appropriate chemical specific controls are in place prior to materials being delivered onsite, that banned items are not ordered, and that "greener choices" are substituted for more hazardous materials where they are available and meet operational needs.
- Approximately 4,900 linear feet of storm drain lines and over 50 associated catch basins located in the Research Yard and selected areas within the main campus area were cleaned of standing sediment, in ongoing efforts to protect stormwater and drainages from potential impacts from PCBs and lead. A total of 8 tons of sediment were collected and properly disposed of.
- An outreach effort to reinvigorate SLAC's recycling program for non-hazardous waste was conducted. Work included conducting outreach through 16 articles on recycling in SLAC on-line newsletter, completion of two waste audits by SLAC volunteers from different directorates, and distribution of desktop recycling trays. The two waste audits, conducted prior to the outreach and following completion of outreach, showed a noticeable difference in the amount of recyclables making their way into the trash.
- The percent of environmentally preferable purchases in the category of "paper and paper products" increased from 54.5 percent in FY 2008 to 63.1 percent in FY 2009. In addition, purchases of recycled toner cartridges increased by 5 percent over the previous year.
- One hundred percent of SLAC's purchased desktops, laptops, and monitors were either Silver or Gold level EPEAT certified in FY 2009.

Additionally, SLAC's progress on the sustainability goals of EO 13423 and EO 13514, including GHG, energy, water, fuel reduction, high performance sustainable building is provided in Section 4.7, *Sustainability*. SLAC's GHG inventory work is also discussed in Section 4.2.2.9.

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 1,500 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 minimize potential environmental impacts. SLAC 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. Additionally, SLAC continually strives to increase its environmental performance, per the sustainability goals of EO 13423 “*Strengthening Federal Environmental, Energy, and Transportation Management*” (see Chapter 3).

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
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 the purchasing life-cycle phase
2009	USEPA	Federal Electronics Challenge – Bronze Award	Reducing the environmental impacts of electronics in the purchasing life-cycle phase

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 2009, 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, GHGs are used extensively in electrical substations and research equipment, and are being actively managed in response to the passage of Assembly Bill (AB) 32, 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 during 2009.

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 is the implementation of Title V of the Clean Air Act. SLAC's Title V SMOP permit was issued by BAAQMD on July 26, 2002. The Title V SMOP stipulates limits on facility-wide emissions of VOCs, total hazardous air pollutants (HAPs), and individual HAPs, along with various other requirements.

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

1. Annual compliance inspections
2. New source permit applications
3. Periodic information updates on permitted emissions sources, according to their respective permit renewal cycles
4. Annual information updates for emissions of air toxics as identified by the California Air Resources Board (CARB) in its Toxic Substance Check List, per the AB Air Toxics Hot Spots Information Act (AB2588)
5. Annual information updates for adhesives usage as specified in BAAQMD Regulation 8-51-502.2C
6. Notification requirements for demolitions, significant renovations, and any activity involving asbestos-containing materials

At the state level, CARB is responsible for the implementation of AB32, and provides notices, workshops, training, 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, Code of Federal Regulations (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 by BAAQMD was performed on January 13, 2009. The inspection was routine and no violations or significant compliance issues were identified.

4.2.2.2 New Source Permits

No new emissions sources were permitted in 2009. At the end of 2009, SLAC managed a total of 55 sources of air emissions, comprising 34 permitted sources 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 deliverables to the BAAQMD. One is the annual information update requested by the BAAQMD for selected permitted sources, and covers Calendar Year 2008. This report was submitted on time in April 2009, and SLAC's permit-to-operate was renewed on June 25, 2009, effective through July 1, 2010.

The other BAAQMD deliverable is the Title V annual emissions report for all onsite sources for the SMOP and covers the period of July 1, 2008 through June 30, 2009. SLAC submitted the Title V annual emissions report on time in July 2009.

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 15, 2009 (covering the 2008 reporting year) and reported using a total of 28 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 2009, approximately 27 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 deliverables required comprise of an annual performance report and two semi-annual exceedance reports.

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

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 (PCE)
S-58	Batch cleaning tank	Electron Gun Testing/Maintenance	Trichloroethylene (TCE)
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 2009 that were subject to the release reporting and corrective action requirements in the ODS regulations (40 CFR 82).

At the end of 2008, SLAC installed a new 360-ton chiller, intended to replace its only remaining large (150-ton) chiller that uses a Class I ODS. The new chiller was being commissioned during 2009, but in the interim the old chiller is still in service.

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

- 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 and Source Testing

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 United States General Services Administration. SLAC continues to replace and upgrade its service fleet as resources allow.

Despite its name, the onsite Gasoline Dispensing Facility (GDF) currently 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 2009 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 filled at the GDF and then transported throughout the facility to refuel heavy equipment and stationary engines, such as emergency back-up generators. Due to their small size, these portable tanks are exempt from BAAQMD permitting requirements.

To reduce the amount of petroleum-based fuel used at SLAC, in accordance with EO 13423 and EO 13514, SLAC Fleet Services is moving ahead with converting the GDF from gasoline and diesel to a blend of fuel where 85 percent is ethanol and 15 percent is gasoline (E85).

SLAC commissioned source tests for three other emissions sources in 2009: the two main boilers in the Central Utilities Plant, and the sludge dryer associated with the metal finishing pre-treatment facility (MFPF), which receives all the wastewater from the onsite Plating Shop complex. All testing was successfully completed and the units were found to be in compliance with applicable emissions standards.

4.2.2.9 Greenhouse Gas Inventory and Baseline

Sulfur hexafluoride (SF₆), the most powerful GHG known, is used at SLAC in both electrical equipment and experimental apparatus. In light of recent concerns about GHG impacts and new California legislation (AB32), research proposals now routinely address the use of SF₆, evaluate potential alternatives, and address the responsible management of this gas, even in minute quantities. SF₆ remains an extremely useful material for quenching and insulation purposes, and is by far the most appropriate option for many applications. However, 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 SF₆ throughout the facility. AB32 has a five-year implementation schedule that extends through 2012, and SLAC is actively working to address the requirements delineated to date.

SLAC compiled its first GHG inventory in 2004, and beginning with CY 2007 as the first validated baseline year, has been reporting its GHG emissions voluntarily to The Climate Registry (TCR), an international entity, until such time as SLAC either becomes subject to mandatory regulatory or DOE reporting requirements. Between reporting CY 2007 and CY 2008, SLAC GHG emissions decreased more than 40 percent, from 152,972 to 89,480 metric tons of carbon-dioxide equivalents (MT-CO₂e). This dramatic reduction was largely due to the cessation of the SLAC B-Factory detector (BaBar) operations, which accounted for the majority of both the GHGs and electricity used onsite. GHG emissions for 2009 were comparable to those for 2008, and will be validated and uploaded to the TCR in 2010.

The DOE, in conformance with EO 13514 requirements, also began establishing an agency-wide GHG baseline of its scope 1 and 2 emissions for FY 2008, using energy and fuel data collected in existing DOE reporting systems. Fugitive emissions data were calculated based on site chemical purchasing data. The results of the FY 2008 inventory have not yet been formally published, but shall be used by the DOE to establish a GHG reduction goal in 2010.

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 decommissioned in the next few years.
- Continued decrease in the average age of SLAC's vehicle fleet
- Salvaging of nine pieces of heavy equipment by the end of 2009 to reduce fleet average emissions, with two more units slated for salvaging in 2010
- 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 TCR, which is voluntary but affords facilities the opportunity to develop a GHG inventory and establish a baseline against which all future reductions can be measured
- GHG emissions reduction of more than 40 percent between 2007 and 2008, due in large part to the termination of the BaBar program
- 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). 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 2009.

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 Interaction Region 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 report¹³ which includes the results of its monitoring of the MFPF and FHWSA Treatment System, certification of a solvent management plan for

¹³ 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)

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 conducted the annual facility enforcement inspection on December 7, 2009. No issues were noted.

4.3.2.2 Flow Monitoring Results

Total industrial and sanitary wastewater discharged to the WBSD's regional collection system was approximately 15.6 million gallons, which equates to an average of approximately 42,700 gallons per day (gpd). SLAC was within its discharge entitlement of approximately 23.6 million gallons, or 64,600 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. Compliance is determined by comparing the mass discharged limit with the average value of the samples taken over the previous 12 months. 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)				Annual Average Wastewater Discharge Limits* (ppd)
	February 2, 2009	April 15, 2009	September 10, 2009	November 11, 2009	
Cadmium	0.001306	0.003200	0.003179	0.003255	0.14
Chromium	0.005485	0.003200	0.003719	0.006835	0.29
Copper	0.044401	0.023360	0.034649	0.041988	0.27
Lead	0.002873	0.003200	0.003179	0.005533	0.28
Nickel	0.004179	0.008320	0.006358	0.006510	0.071
Silver	0.105779	0.003200	0.003179	0.028317	0.065
Zinc	0.058766	0.048001	0.070887	0.066724	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 MFPP 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 Facility¹

2009			SBSA Annual Sampling	SLAC Semi-Annual Sampling	
Analytical Parameter	Discharge Limits		March 17, 18	April 29	October 22
	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	<0.005	<0.01	<0.01
Chromium	2.77	1.71	0.012	0.015	0.027
Copper	3.38	2.07	0.142	0.071	0.11
Lead	0.69	0.43	<0.005	<0.05	<0.05
Nickel	3.98	2.38	0.514	0.27	0.93
Silver	0.43	0.24	0.080	0.056	0.016
Zinc	2.61	1.48	0.024	0.014	0.024
Non-metals					
Cyanide	1.20	0.65	<0.003	<0.025	<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.¹⁴ 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 2009, SLAC reported one Category 1 and two Category 2 spills.

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

¹⁴ *Statewide General WDRs for Sanitary Sewer Systems*, WQO No. 2006-0003. Available at [State Water Resources Control Board](#)

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 SWPPP.¹⁵ The SWPPP has two main components: a stormwater monitoring program (SWMP) and a best management practice (BMP) program.¹⁶ 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).

¹⁵ Stanford Linear Accelerator Center, Environment, Safety, and Health Division, Environmental Protection and Restoration Department, *SLAC Stormwater Pollution Prevention Plan* (SLAC-I-750-0A16M-002)

¹⁶ 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 2009 water quality monitoring results published in the ASER are for the 2009–2010 wet season (October 2009 through May 2010).

The general permit requires submission of an annual report on stormwater activities by July 1, following the May 31 close of the wet season.¹⁷ 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

¹⁷ SLAC National Accelerator Laboratory, Environment, Safety, and Health Division, Environmental Protection Department, *2009–2010 Annual Stormwater Report* (30 June 2010), submitted to Rico Duazo, San Francisco Bay RWQCB)

other event during the rainy season. During the wet season of 2009-2010, 16 samples (two samples per location) were collected during four storm events.

The general permit requires analysis of stormwater samples for four parameters (pH, total suspended solids, specific conductance, and total organic carbon), and any other potential pollutants, identified by the facility, which may be present in the stormwater in significant quantities. During the wet season of 2009-2010, stormwater samples were analyzed for the four required parameters as well as seven additional parameters (Table 4-5). The additional parameters were selected after a review of SLAC's industrial activities and the results of previous sampling events.

SLAC reviews and compares the analytical results with previous sampling data, background levels and the SWRCB developed parameter benchmark levels (PBVs).¹⁸ PBVs are not regulatory discharge limits, rather, they are meant to be used as guidance. The majority of the sample results from the wet season of 2009-2010 were below PBVs. At several of the discharge locations, specific conductance, aluminum, iron, zinc, copper, and total suspended solids were present at levels above PBVs. SLAC continues to investigate potential sources of these analytes to assist in the implementation of effective BMPs.

Table 4-5 Stormwater Parameters Analyzed

Metals	Non-Metals
Aluminum	Total Suspended Solids
Copper	Total Organic Carbon
Iron	pH
Lead	Specific Conductance
Zinc	Polychlorinated Biphenyls
	Radioactivity

1 PBVs are published by the SWRCB as guidance to assist in the determination of the effectiveness of BMPs in drainage areas. The PBVs are available at www.swrcb.ca.gov/stormwtr/docs/smanlrdoc.doc.

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 initiatives during 2009 included the following:

- Increased preventive maintenance schedule for stormwater protection activities including annual site-wide street cleaning and catch basin cleanouts
- Increased storm drain channel maintenance conducted by the landscaping contractor
- The EP Department staff provided oversight of the SWPPP implementation at the Indefinite Delivery /Indefinite Quantity (ID/IQ) contractor remediation sites as well as Building 901 construction
- The EP Department collected additional stormwater samples from selected locations across the facility to determine sources of stormwater constituents

¹⁸ State of California, State Water Resources Control Board, *Sampling and Analysis Reduction Certification* (no date), <http://www.swrcb.ca.gov/stormwtr/docs/smanlrdoc.doc>

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

- Cryogenics
- 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 certified unified program agency (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 the SWPPP, 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 (petroleum tanks only)
- California Accidental Release Program
- California Fire Code Hazardous Materials Management Plan (Section 2701.5.1 and 2701.5.2)

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 TSCA.

4.5.2.1 Annual Facility Enforcement Inspections

There were no inspections of SLAC's hazardous materials management by the CUPA during 2009.

4.5.3 Hazardous Materials Business Plan Program

The EPCRA, passed in 1986 as Title III of the SARA, establishes 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 2009 reporting year, SLAC updated its HMBP and electronically submitted it through the California Environmental Reporting System (CERS). 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 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*.¹⁹ 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 13423, "Strengthening Federal Environmental, Energy, and Transportation 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 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.

The TRI report is submitted to the USEPA in June each year and reports quantities from the previous calendar year. The report submitted in June 2009 covers the calendar year 2008. 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 16,250 lbs of lead left SLAC during 2008, 76 percent of which was disposed of in a landfill and 24 percent was recycled (21 percent onsite and 3 percent offsite).

¹⁹ SLAC National Accelerator Laboratory *Consolidated Chemical Contingency Plan* (SLAC-I-730-3A86H-008-R002)

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.

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. A Risk Management Plan (RMP) is required and has been submitted to the CUPA.

Because the worst-case scenario for a release of potassium cyanide does not generate offsite consequences, a more detailed process hazard assessment and an offsite consequence analysis are 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 RMP was finalized without further revision in November 2008.

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 2009 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 plan²⁰ 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 2009.

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	Not applicable	B127 Cryogenics	200
Compressor Oil	18562	B127 Cryogenics	200
Diesel	Not applicable	B756 SLD Generator Fueling	500

* These tanks are used only for short-term storage

²⁰ 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

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 2009.

Four oil-filled transformers were installed at SLAC during 2009 to support the new LCLS experiments, bringing the total number of oil-filled transformers at SLAC to 106. 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. Only eleven of the oil-filled transformers 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 20 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 2009, the program has achieved the following:

- 2879 active chemicals were set up in the catalogue
- Approximately 50 items in vendor-owned inventory stocked for just-in-time delivery. This is an increase from last year, but represents only 3.5 percent of the total chemical spend. Most chemicals are not used routinely and are ordered on request.
- There were 416 users of the CMS system.
- Purchase order cycle time continues to be less than half a business day on average
- The commodity cost reduction of 1 percent offsets the slightly inflationary year (2009) for chemical prices.

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 2009, SLAC reduced its hazardous waste from routine operations by 89 percent from the 1993 baseline of 147 tons. This represents a significant improvement to the 73 percent reduction in 2007, as the 2009 numbers take into consideration an additional 19 tons of recycled routine hazardous waste. Routine wastes are those wastes associated with SLAC's routine operations and maintenance processes. These materials included but were 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, helping them select less hazardous chemicals, and helping them learn to develop for themselves more focused waste reduction measures for their work areas.

Figure 4-3 Routine Hazardous Waste Generation, 1999–2009

SLAC's progress in recycling its municipal solid waste is shown in Figure 4-4. For 2009, SLAC recycled 63 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 (soil and miscellaneous non-hazardous construction and demolition debris)
- Universal (fluorescent light bulbs and mercury-containing equipment) and electronic wastes including cathode ray tubes
- Batteries (automotive and common (AA, AAA, C, D, nickel-cadmium, other) batteries)
- Salvage sales and transfers
- Office materials (toner and inkjet cartridges)
- Cafeteria wastes
- Tires
- Trash not otherwise sorted at the source and placed into dumpsters

Figure 4-4 Municipal Solid Waste Recycling, 1999-2009

The volume of materials recycled in 2009 was similar to 2008, with less construction debris than 2008, but greater tonnage of sales and transfers of equipment compared to 2008.

Waste minimization and pollution prevention projects initiated during the last five years and continuing during 2009 are listed in Table 4-7.

Table 4-7 Waste Minimization and Pollution Prevention Projects

Name/Description	Year Initiated	Waste Reduction/Pollution Prevention Result
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 LCLS 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 <i>Guiding Principles for Federal Leadership in High Performance and Sustainable Buildings</i> .
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.
Green Janitorial Cleaners	2008	Janitorial vendor converted cleaners to greener alternatives such as Green Seal certified.
Fleet Reduction Program	2008-2009	As a cost and fuel saving measure, SLAC's vehicle fleet was reduced by 37 percent between 2008 and 2009. The fuel savings of 13,531 gallons results in a green house gas emissions reduction of approximately 280,000 lbs or 127 metric tons CO ₂ equivalent (based on a CO ₂ equivalent value of 20.7 lbs per gallon).
Building 901 Leadership in Energy and Environmental Design (LEED) Construct.	2009	Building 901 is SLAC's first building to be built to LEED Gold certification standards. In addition, in 2009, greater than 95 percent of non-hazardous debris was recycled. Construction to be completed in 2010.

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

There were no inspections of SLAC's regulated hazardous waste by the CUPA during 2009.

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 FY 2009, SLAC achieved a 99 percent reduction in its TSCA waste generation compared to the TSCA waste generated in 1990.

Figure 4-5 TSCA-Regulated Hazardous Waste, 1990–2009

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. SLAC 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 FY 2006, 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 15 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 placed around the site and a specific location is provided for waste wood and non-hazardous construction and demolition debris. 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, 1999–2009

Batteries and office materials, although recycled, are not depicted in Figure 4-6 because quantities are small in relation to the other recycled categories of waste.

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 Sustainability

SLAC continues to make progress on achieving the sustainability goals of EO 13423 and EO 13514, which include but are not limited to reductions in the use of water, energy, and fuel, and building to green standards. A core part of SLAC's Environment, Safety and Health Policy is to "wisely use and conserve natural resources and conduct our activities in a sustainable manner", so the EO goals and associated DOE Orders 230.2B and 450.1A compliment SLAC's values on sustainability and provide quantifiable objectives and timeframes, consistent over the federal complex.

SLAC's Infrastructure/Mission Readiness Program will greatly support the achievement of the sustainability objectives. SLAC has identified facility and infrastructure gaps that need to be invested in order to support the Laboratory's core capabilities and future initiatives, and within these needs include a

number of infrastructure modernization projects that will help to replace obsolete equipment and modernize older, inefficient office space. All of SLAC's new construction and renovation work will meet high performance sustainable building requirements and projects greater than 5million dollars will be LEED Gold certified.

SLAC's plans for achieving the goals of the EO's is further described in SLAC's *Executable Plan*²¹, required to be published annually under DOE Order 430.2B. It is anticipated that this plan will be broadened into a Site Sustainability Plan, as a result of EO 13514 requirements.

4.7.1 Progress on Sustainability Goals of EO 13423 and EO 13514

Included below is a summary of progress on key sustainability goals of EO 13423 and EO 13514, in the key areas of energy, GHG, water, fuel/fleet, and sustainable building.

Table 4--9 Progress Against Select Sustainability Goals of EO 13423/13514 through FY 2009

Category	EO 13423/13514 Goal	Progress
Energy Reduction	Reduce energy intensity 3 percent/year or 30 percent by 2015 relative to FY 2003 baseline.	<p>Primarily due to programmatic change (cessation of the BaBar experiment), electric energy has been reduced by 41percent in FY 2009 (213,186 megawatt per hour (MWh)) compared to FY 2003 (363,232 MWh).</p> <p>The design of advanced metering for buildings will be completed in CY 2010.</p> <p>A number of projects have been identified for reducing non-programmatic electric energy use, and additional assessments will be conducted to further identify projects</p>
Renewable Energy	<p>Implement renewable energy projects on agency property.</p> <p>Ensure that half of statutorily required renewable energy consumed by the agency in a fiscal year comes from renewable sources.</p>	<p>Building (Bldg) 901 has been constructed with a roof-mounted photo-voltaic system.</p> <p>Renewable Energy Certificates (RECs) are being purchased equivalent to 7.5 percent of annual energy.</p>

²¹ SLAC National Accelerator Laboratory, "FY 2009 Annual Report on Energy Management and the FY 2010 Sustainability Executable Plan Update", dated December 2009.

Category	EO 13423/13514 Goal	Progress
Greenhouse Gas Reduction	Head of each Agency to establish agency-wide 2020 reduction targets relative to 2008 baseline	The DOE shall establish a GHG reduction goal for its agency for scope 1, 2, and 3 emissions in 2010.
	Establish and report GHG inventory annually (complete inventory for FY 2008 baseline and annually beginning with FY 2010 emissions)	As described in Section 4.2.2.9, SLAC's GHG emissions are driven largely by energy usage and dependent on research mission, as illustrated by a significant reduction in GHGs from CY 2007 to CY 2008, Non-programmatic GHG reductions will be most influenced by completion of projects identified to achieve energy reduction goals.
		SLAC has completed GHG inventories for CY 2007, 2008, and is in the progress of completing 2009.
Water Reduction	Reduce potable water consumption intensity 2 percent per year through 2020 or 26 percent by 2020 relative to the FY 2007 baseline	Primarily due to programmatic change (cessation of the Babar experiment), water has been reduced by 55 percent in FY 2009 (51.4 million gallons) compared to FY 2007 (114.9 million gallons).
	Reduce industrial, landscaping, and agricultural water consumption by 2 percent a year through 2020 or 20 percent by 2020 relative to FY 2010 baseline	A number of projects have been identified for reducing water use, including repairs and upgrades to irrigation, piping upgrades, and fixture replacements.
Sustainable Building	New construction and major renovation comply with the <i>Guiding Principles for Federal Leadership in High Performance and Sustainable Buildings</i> . DOE O 430.2B: greater than 5 million dollars LEED Gold	Two new buildings, one under construction (Bldg 901) and one in design (Bldg 52) are planned to achieve LEED Gold certification.
	15 percent of building inventory incorporate the <i>Guiding Principles</i> (conform to High Performance Sustainable Building tool) by end of 2015	Two additional major renovation projects, Bldg 28 and Bldg 41 are under in the design phase and planned to achieve LEED Gold certification. In FY 2009, an assessment of 31 existing buildings was completed to identify candidates and needs for meeting the existing building goals.

4.8 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 the National Environmental Policy Act (NEPA) analyses on a project-by-project basis.

4.8.1 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

In 2009, SLAC prepared the Annual Laboratory Plan, which consists of a set of strategic planning goals for SLAC's lab agenda. The document includes a description of SLAC's core capabilities and of the science strategy for the future.

4.8.2 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)

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 twenty eight projects during 2009, listed in Table 4-10. 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 4-10 NEPA Documentation Prepared during 2009

Project Name	Project ID	Date
Infrastructure Modernization Project	4420	8/21/2009
SSRL Slope Stability Mitigation	94002	3/27/2009
Building 120 Duplex Sump Pump	94001	3/27/2009
Electrical Substation Modernization	5941	4/20/2009
IR-6 Storage Racks	30151	4/15/2009
Facilities for Accelerator Science and Experimental Test Beams (FACET)	4000	5/5/2009
Infrastructural Modernization	5911	4/29/2009
Building 40 Site and Building Exterior ADA	94003	5/22/2009
Building 40 SIMES Renovation Phase 2	5953	5/25/2009
Move Salvage Operations to IR-8	7780016	7/1/2009
Research Support Building	4421	8/21/2009
Recoating of the Hazardous Waste Yard Floor	30000	8/19/2009
Liquid Nitrogen Distribution System	3390	8/19/2009
ROB Building 048 Remodel	3010147	8/12/2009
Compressed Air Systems	5951	8/19/2009
Backup Pumps and Chiller	5950	8/19/2009
End Station for Inelastic X-ray Scattering and Advanced Spectroscopy	5912	8/19/2009
Beam Line for Angle-resolved Photoemission Spectroscopy-BL 5	390001	9/22/2009
MBE-ARPES Thin Film Equipment	390005	9/23/2009
Chemical Vapor Deposition (CVD) System	390004	9/23/2009
MFP-30 Atomic Force Microscope (AFM)	390003	9/23/2009

Project Name	Project ID	Date
Renishaw Invia Raman Spectrophotometer	390002	9/23/2009
Beamline Transport Hall slope repair/Undulator Hall HVAC pad	99999995	12/2/2009
SLAC Data Center Power Distribution System Modernization	99999994	12/7/2009
Sanitary Sewer Inspection and Cleaning	99999999	12/4/2009
Building 050 North Elevator Modernization	99999998	12/4/2009
Building 040 Freight Elevator Modernization	99999992	12/14/2009
Radioactive Sources processing and disposal	99999993	12/14/2009

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 2009, 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 and lost, 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

³H = 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.²² In 2009, the maximum dose that could have been received by a member of the public due to direct radiation from SLAC was less than 0.06 mrem (6.0×10^{-4} milli Sievert (mSv)), which is the International System of units). This is 0.06 percent of the 100 mrem regulatory limit. This maximally exposed individual (MEI) is located near the business offices in the Addison Building area.

During 2009, 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, which was 0.005 person-rem for 2009.

Section 5.8 and Table 5-6 summarize annual doses from both direct radiation (0.06 mrem) and airborne radioactivity (0.00083 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 requires 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.²³ In 2009, the maximum dose that could have been received by a member of the public due to airborne radioactivity from SLAC was 0.00083 mrem (8.3×10^{-6} mSv), or less than 0.008 percent of the 10 mrem regulatory limit. This MEI is located at the north end of SLAC near Sand Hill Road, approximately 350 meters (m) (1,148 feet) from Sector 28.

²² United States Department of Energy, 10 CFR 835, "Occupational Radiation Protection," <http://www.hss.energy.gov/healthsafety/wshp/radiation/rule.html>

²³ 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.²⁴ As detailed in that report, the released airborne radioactivity was calculated, based on conservative information about accelerator operations in 2009. 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, which was 0.005 person-rem for 2009.

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 2009

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)	0.03
Short-lived activation products (T _{1/2} < 3 hr)	Oxygen (¹⁵ O)	0.38
	Nitrogen (¹³ N)	0.71
	Carbon (¹¹ C)	0.08
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		1.19

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 2009 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 2009, SLAC releases totaled less than 0.002 percent of the applicable limits.

Throughout the year, SLAC sampled and analyzed wastewater discharges. Total activity released during CY09 is summarized in Table 5-3.

²⁴ Stanford Linear Accelerator Center, Environment, Safety, and Health Division. Radiation Protection Department, *Radionuclide Air Emissions Annual Report – CY 2009* (May 2010)

As required by regulation, for each quarter of 2009, SLAC reported the results of wastewater monitoring and discharge to the SBSA at the end of each calendar quarter.²⁵

Table 5-3 Radioactivity in Wastewater Released into Sanitary Sewer in 2009

Category	Radioactive Element	Activity (Ci)	Annual Release Limit (Ci)
Tritium	Hydrogen (³ H)	9.1 X 10 ⁻⁵	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 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

n/a – not applicable

Table 5-4 summarizes the historical results of wastewater monitoring for calendar year 1999 through 2009. 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.

²⁵ Stanford Linear Accelerator Center, Environment, Safety, and Health Division, Radiation Protection Department, *Radioactivity in Industrial Wastewater for the Period of 1 January 2009 to 31 March 2009, for the Period of 1 April 2009 to 30 June 2009, for the Period of 1 July 2009 to 30 September 2009, and for the Period of 1 October 2009 to 31 December 2009*

Table 5-4 Summary of Radioactivity in SLAC Wastewater, 1999–2009

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
2009	Hydrogen (^3H)	9.1×10^{-5}	0.002

* 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 2009 (and in all previous years), no radioactivity above natural background was found in any stormwater or storm drain sediment sample.

SLAC reported the results of the 2009-2010 stormwater monitoring (including checks for radioactivity) to the RWQCB.²⁶

5.5.3 Groundwater

Throughout 2009, SLAC performed in-house analysis of water samples from monitoring wells for the presence of radioactivity each time the wells were sampled under SLAC's groundwater Self-Monitoring Program (SMP) as described in Chapter 6 of this report. The SMP includes a Groundwater Sampling Plan which outlines the frequency of sampling the wells (see Section 6.7). Select groundwater samples collected as part of the SMP are also sent to an external California-certified laboratory for independent 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 (picoCuries per liter) under 22 CCR 64443 and 40 CFR 141.66). In addition, groundwater is not used at SLAC for any

²⁶ SLAC National Accelerator Laboratory, Environment, Safety, and Health Division, Environmental Protection Department, *2009–2010 Annual Report for Stormwater Discharges Associated with Industrial Activities* (June 30, 2010, to be submitted to Rico Duazo, San Francisco Bay RWQCB)

purposes because of its 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 2009 (in-house analysis)

Period (Month)	Jan to March	April to June	July to Sep	Oct to Dec
Well				
Variable				
EXW-4				
Avg ^3H (pCi/L)	2942	3381	2687	2576
percent of DWS ¹	15	17	13	13
No. of Samples	5	8	4	6
MW-30				
Avg ^3H (pCi/L)	< 500 ²	< 500 ²	< 500 ²	< 500 ²
percent of DWS ¹	n/a	n/a	n/a	n/a
No. of Samples	1	1	1	1
MW-81				
Avg ^3H (pCi/L)	1707	2639	< 500 ²	< 500 ²
percent of DWS ¹	9	13	n/a	n/a
No. of Samples	2	1	1	1
MW-94				
Avg ^3H (pCi/L)	934	2858	2692	3970
percent of DWS ¹	5	14	13	20
No. of Samples	1	1	2	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 2009

n/a – not available

5.6 Assessment of Radioactivity in Soil

Throughout 2009, SLAC sampled and analyzed soil for projects involving soil excavation on the SLAC site (such as the construction of the new LCLS facility).

Due to remediation activities for VOCs in the Plating Shop Area (PSA), soil samples were taken prior to work being done near groundwater well MW-81, in which tritium has been detected in groundwater samples. The soil samples taken in the area around the well were found to have low tritium concentrations less than and consistent with the tritium concentration in the well water. No soil removal was performed in 2009; the approximately 1.7 cubic feet of sampled soil remaining after analysis was disposed of as radioactive waste and is included in Section 5.10.

No other soil samples were found to contain radioactivity in excess of natural background.

5.7 Release of Property Containing Residual Radioactive Material

Throughout 2009, 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. Some non-radioactive materials were released from any further radiological controls; however, materials that were subject to the DOE metals moratorium or suspension were held on site. 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 2009: direct radiation (0.06 mrem) and airborne radioactivity (0.0008 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 2009 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 2009 at the north end of SLAC near Sand Hill Road, approximately 350 m from Sector 28.

The MEI due to direct radiation is near the business offices in the Addison Building Area. Like previous years' calculations, the 2009 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 2009

	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 2009	0.06 mrem	0.0008 mrem	0.06 mrem	0.005 (direct) + 0.005 (air) = 0.01 person-rem
DOE Radiation Protection Standard	100 mrem	10 mrem	100 mrem	n/a
SLAC 2009 Maximum Dose as Percentage of DOE Standard	0.06 %	0.0008 %	0.06%	n/a
Dose from Natural Background ²⁷	100 mrem	200 mrem	300 mrem	1,667,000 person-rem
SLAC 2009 Maximum Dose as Percentage of Natural Background	0.06%	0.0004 %	0.02 %	0.0000006 %
n/a – not applicable				

²⁷ National Council on Radiation Protection and Measurement, NCRP Report No. 94, "Exposure of the Population in the United States and Canada from Natural Background Radiation," <http://www.ncrponline.org/Publications/94press.html>

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 2009 and compares it with the average dose due to natural background radiation and radioactivity.

Table 5-7 Potential Dose (mrem) to Maximally Exposed Individual, 1999–2009

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
2009	0.06	300	0.02

* 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 2009, SLAC monitored dose and dose rate at approximately 400 on-site locations (most outside shielding and some inside shielding) using passive radiation dosimeters posted for six month periods. For each period, the average dose rate among these 300 dosimeters was found to be less than 0.00019 rad/day²⁸ (dominated by those inside shielding), and the maximum dose rate was less than 0.007 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 2009.

²⁸ RP Note RP-10-06, “Monitoring Results for Integrated Area Dose around SLAC For Period from January 2009 through June 2009”; RP Note RP-10-07, “Monitoring Results for Integrated Area Dose around SLAC For Period from July 2009 through December 2009.”

5.9.2 Dose to Biota from Activation Products

In 2009, 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 2009, but plant and animal populations have no opportunity for access to industrial wastewater at SLAC. Since the radioactivity 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 2009, no groundwater was found with tritium concentrations in excess of the human drinking water standard 20,000 pCi/L set by state and federal regulations. Section 5.5.3 summarizes the 2009 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

SLAC generates low-level radioactive waste (LLRW) sporadically from routine operations, repairs, and special projects or experiments. Non-routine operations generate the bulk of LLRW at SLAC, amounting to 150 cubic feet for CY09. Additionally, SLAC generated a total of 63.7 cubic feet of routine low level wastes; 61.2 cubic feet of LLRW and 2.5 cubic feet 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 CY 2009, SLAC shipped 1300 cubic feet of LLRW (a total of 4736 mCi and 75,622 kg) to appropriate treatment and disposal facilities for low-level radioactive waste. Legacy waste accounted for 40 percent of the volume. Moreover, SLAC continued its efforts in the inventory reduction of materials no longer needed for its mission: returned 28 sealed sources to the manufacturer, transferred additional 3 sources to Los Alamos National Laboratory, and disposed of 636 kg of Depleted Uranium tiles.

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 1994.²⁹ 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*³⁰ 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*³¹ 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

²⁹ Stanford Linear Accelerator Center, *Hydrogeologic Review* (SLAC-I-750-2A15H-002, 1994)

³⁰ 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>

³¹ ESA Consultants, *Stanford Linear Accelerator Center, Summary and Identification of Potentially Contaminated Sites* (February 1994)

*Environmental Baseline Report*³² (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*³³ 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 SWPPP³⁴ which discusses 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 2009, 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 (COPC) in groundwater. Each of these is described in Section 6.7, along with a description of sites where soil removal has recently been conducted.

³² Sapere Consulting, *Stanford Linear Accelerator Center Environmental Baseline Report* (February 2006)

³³ Stanford Linear Accelerator Center, *Work Plan for the Remedial Investigation and Feasibility Study* (SLAC-I-750-A17M-008, May 2006)

³⁴ 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 October 2009, the RWQCB issued a new Board Order (No. R2-2009-0072) 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 the Board Order issued in May 2005. In January 2006, the RWQCB was designated by the State as the Administering Agency (i.e., lead agency) for the environmental cleanup work at SLAC³⁵. 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 use³⁶, 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 Procedures³⁷. 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 Board Order, SLAC has a SMP that includes a Groundwater Sampling Plan with a schedule for collecting sediment samples from select catch basins and drainage channels, surface water samples, and groundwater samples from extraction and monitoring wells. The SMP Groundwater Sampling Plan 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 network of wells used for monitoring.

SLAC has 131 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 131 wells, 87 wells are used to monitor COPC 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.

³⁵ California Environmental Protection Agency, *Site Designation Committee Resolution No. 06-01* (January 2006)

³⁶ Regional Water Quality Control Board, *Approval of Stanford Linear Accelerator Center Long Range Redevelopment Plan* (November 18, 2005)

³⁷ Stanford Linear Accelerator Center, *Standard Operating Procedures for the Environmental Restoration Program Revision 004* (SLAC-I-750-2A15H-001 R004, June 2008).

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)

The COPC in groundwater at SLAC are primarily VOCs and to a lesser extent semi-volatile organic compounds (SVOCs). Two of the six plume sites, the FSUST and the FHWSA, have treatment systems that extract soil vapor and groundwater. Treatment systems for two other sites, the PSA and TL/CL, will be constructed during 2010. The operating treatment systems at the FSUST and FHWSA have helped to decrease concentrations of COPC since full-scale operation began in 2001 and 2006, respectively. Preliminary Cleanup Goals (PCGs) at SLAC have been established for groundwater and soil vapor. The systems at the FSUST and FHWSA, and the future systems at the PSA and TL/CL have been designed with the goal of achieving these PCGs.

Groundwater samples were collected at least once from 108 wells in 2009 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 2009³⁸ and the summer of 2009.³⁹ 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)

³⁸ Stanford Linear Accelerator Center, *Semi-annual Self-Monitoring Report, Winter 2009* (SLAC-I-750-2A15H-029, May 2009)

³⁹ SLAC National Accelerator Laboratory, *Semi-annual Self-Monitoring Report, Summer 2009* (SLAC-I-750-2A15H-030, December 2009)

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

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

Table 6-1 Monitoring Locations and Number of Wells

Location	Number of Wells
<i>Plume Monitoring</i>	
Beam Dump East	9
Former Hazardous Waste Storage Area	22
Former Solvent Underground Storage Tank	22
Lower Salvage Yard	2
Plating Shop	23
Test Lab and Central Lab	9
Subtotal	87
<i>Extraction</i>	
Former Solvent Underground Storage Tank	8
Former Hazardous Waste Storage Area	23
Subtotal	31
<i>Environmental Surveillance</i>	
Centralized Waste Management Area	1
End Station B	1
Magnet Yard	2
Other (remote)	5
Research Yard	3
Vacuum Assembly	1
Subtotal	13
<i>Total</i>	131

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 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. This evaluation was subsequently incorporated as part of the draft Feasibility Study (under preparation) for the VOC-impacted groundwater areas. An interim remedial alternative for the FSUST, a groundwater extraction and treatment system, similar to that recommended in the Feasibility Study⁴⁰, 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 lbs per day to an average of 2.2 lbs per day for the remainder of 2007. In 2008, the mass removal rate of VOCs and SVOCs was an average of 0.57 lbs per day (recalculated based on actual operating period) and in 2009, the mass removal rate was 0.47 lbs per day.

Since the start up of the remediation system at the FSUST in August 2001 and through December 2009, approximately 729,688 gallons of groundwater have been extracted and treated. Over 850 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, 18 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 2004⁴¹ 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.

⁴⁰ Stanford Linear Accelerator Center, *Draft Feasibility Study for the Groundwater VOC Operable Unit* (SLAC-I-750-0A32H-006, November 2009)

⁴¹ Stanford Linear Accelerator Center, *Draft Site Characterization for the Former Hazardous Waste Storage Area* (SLAC-I-750-3A33H-015, September 2004).

The design of an interim full scale DPE system for the FHWSA was finalized in 2004⁴² 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 2009, the system extracted an average of approximately 560 gallons of groundwater. At the end of December 2009, the IDPE and interim full scale DPE treatment systems at the FHWSA extracted a cumulative combined total of 1,073,902 gallons of groundwater and removed a cumulative combined total of 36.6 lbs of VOCs via groundwater and soil vapor extraction. The operating interim DPE system at the FHWSA is similar to that recommended in the formal Feasibility Study under preparation,

6.8.3 Plating Shop Area

In 1990, three monitoring wells were installed down-gradient of the 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 draft site characterization report for the PSA was submitted to the RWQCB in 2003⁴³ 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. The probes were most recently sampled in July 2009. A draft Feasibility Study Report has been prepared which recommends construction of a full-scale DPE system at the PSA. The draft final design for interim full-scale system was completed in 2009. Construction of the interim DPE system with additional soil vapor probes and monitoring wells is scheduled to begin in 2010 in advance of the formal completion of the Feasibility Study and Remedial Action Plan (both plans under preparation).

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 continued investigations of the possible source areas, four additional soil vapor probes were installed in 2009 and a total of 10 soil vapor probes at the TC/CL were sampled as recently as December 2009. The results of these recent sampling efforts verified the presence of two separate risk-based areas of concern at the TL/CL Area. A draft final design for two separate interim DPE systems at the TL/CL Area was completed in 2009. Similar to the PSA, construction of the interim DPE systems at the TL/CL area is scheduled to begin in 2010 in advance of the completion of the Feasibility Study and Remedial Action Plan.

⁴² Erler & Kalinowski, *Technical Specifications and Drawings for the Dual Phase Extraction and Treatment System at the Former Hazardous Waste Storage Area* (2004)

⁴³ 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)

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 2009, 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 formal Remedial Investigation Report has been prepared by SLAC under the Board Order and approved by the Water Board in June 2009. In addition, a Monitoring Plan Report (MPR) was prepared by SLAC under the Board Order and approved by the Water Board in December 2009. The MPR specifies continued groundwater monitoring at the BDE with contingent actions in the unlikely event that monitored tritium levels exceed any established threshold concentrations.

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 March and September 2009. In mid-November 2009, three of the monitoring wells were abandoned in preparation for a soil removal action to be conducted at the LSY. Low levels of TPH continue to be reported in groundwater samples collected at the LSY.

6.8.7 Removal Actions

Soil removal actions were completed at five Group I Investigation Areas (Group I IAs) in 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 five Group I IAs are the 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. The *Group I Removal Action Implementation Report* was prepared by SLAC and approved by the Water Board, and distributed to stakeholders in April 2009. This report documents the excavation and removal of approximately 5,000 tons of chemically impacted soil and debris from the five areas at SLAC. The report includes a residual risk evaluation and forms the basis for proceeding to the closure process for these specific areas.

Removal action work at several additional Investigation Areas, collectively comprising the “Group 2 Investigation Areas”, began in the summer of 2009 with the field work scheduled for completion by the end of 2010. These areas include the FHWSA Artificial Ridge, Buildings 24 and 34 Area, Sector 16 Soil Removal Area Drainage Channel Swale, Bone Yard Phase 1, Casting Pad/Building 18, Clean Landfill, and Lower Salvage Yard.

6.9 Excavation Clearance Program

During 2009, 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. Seventy three projects were supported by this program during 2009.

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