ES&H Division
SLAC-R-1076

Annual Site Environmental Report: 2016

September 2017


Photo by D. Sabba
Environmental Protection Department

Prepared for the Department of Energy, Office of Science, under contract number DE-AC02-76-SF00515

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

SLAC
NATIONAL ACCELERATOR LABORATORY

U.S. DEPARTMENT OF ENERGY | Office of Science

SLAC Site Office
SLAC National Accelerator Laboratory
2575 Sand Hill Road, MS-8A
Menlo Park, CA 94025

August 23, 2017

Subject: 2016 Annual Site Environmental Report (ASER) for the SLAC National Accelerator Laboratory

This report, prepared by the SLAC National Accelerator Laboratory (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 2016. 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 2016 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

Disclaimer

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Preface

To satisfy the requirements of the United States Department of Energy (DOE) SLAC Site Office approved Site Compliance Plan for DOE Order 231.1B, "*Environment, Safety and Health Reporting,*" the Environment, Safety and Health Division (ES&H) of the SLAC National Accelerator Laboratory prepares an annual report describing its environmental programs and activities.

This *Annual Site Environmental Report: 2016* 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.

Acronyms

^{3}H	tritium
AB	Assembly Bill
ASER	Annual Site Environmental Report
ASTs	aboveground storage tanks
ATS	Action Tracking System
BAAQMD	Bay Area Air Quality Management District
BDE	beam dump east
BMP	best management practice
C&D	construction and demolition
CACM	Contractor Assurance and Contract Management Office
CalARP	California Accidental Release Prevention Program
CAS	Contractor Assurance System
CARB	California Air Resources Board
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERS	California Environmental Reporting System
cf.	cubic feet
CFR	Code of Federal Regulations
CHWMA	centralized hazardous waste management area
Ci	curie
CIWQS	California Integrated Water Quality System
CMS	chemical management system
COPCs	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
DREP	dosimetry and radiological environmental protection
DWQ	Department of Water Quality

DWS	drinking water standard
EA	Environmental assessment
EBR	Environmental Baseline Report
e.g.	for example
EIS	Environmental impact statement
EMS	environmental management system
EMP	Environmental Management Program
EO	Executive Order
EP	Environmental Protection Department
EPCRA	Emergency Planning and Community-Right-to-Know Act
ERT	emergency response team
ES&H	Environment, Safety & Health
FACET	Facility for Advanced aCcelerator Experiment
FHWSA	Former Hazardous Waste Storage Area
FMS	flow metering station
FS	Feasibility Study
FSUST	Former Solvent Underground Storage tank
FY	fiscal year
gal	gallons
GDF	gasoline dispensing facility
GHG	greenhouse gas
GIS	gas insulated switchgear
GWP	global warming potential
HAPs	hazardous air pollutants
Haas	Haas Group International
HPSB	high-performance sustainable building
HMBP	hazardous materials business plan
i.e.	that is
IAS	Integrated Assessment Schedule
IDPE	interim dual-phase extraction
IGP	industrial general permit
IH	industrial hygiene
IR	interaction region
ISEMS	integrated safety and environmental management system

ISM	integrated safety management
ISO	International Organization for Standardization
km	kilometer
L	liter
lbs.	pounds
linac	linear accelerator
LCLS	Linac Coherent Light Source
LLRW	low-level radioactive waste
LSY	lower salvage yard
M&O	management and operations
MAPEP	mixed-analyte performance evaluation program
MSub	Master Substation
MEI	maximally exposed individual
MFPF	metal finishing pre-treatment facility
MPMWD	Menlo Park Municipal Water Department
MPR	monitoring plan report
mrem	milli-rem
MS4	Small Municipal Separate Storm Sewer System
mSv	milli-Sievert
MSW	municipal solid waste
na	not available
n/a	not applicable
NAL	Annual Numeric Action Level
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NHPA	National Historic Preservation Act
No.	number
NOI	notice of intent
NOT	notice of termination
NOV	Notice of Violation
NPL	National Priorities List
OSHA	Occupational Safety and Health Administration
OU	operable unit
PBR	permit by rule

PCBs	polychlorinated biphenyls
PCGs	Preliminary Cleanup Goals
pCi/L	pico-Curies per liter
PSLB	Photon Science Laboratory Building
PTO	permit to operate
ppm	parts per million
PSA	Plating Shop Area
QA	quality assurance
QC	quality control
RA	risk assessment report
RAP	remedial action plan
REP	Radiological Environmental Protection
RCRA	Resource Conservation and Recovery Act
RD	remedial design report
RI	remedial investigation
RMP	risk management plan
RP	Radiation Protection Department
RPFO	Radiation Protection Field Operations Group
RWM	radioactive waste management
RWQCB	Regional Water Quality Control Board
SAP	sampling and analyses plan
SARA	Superfund Amendments and Reauthorization Act
SBSA	South Bayside System Authority
SF_6	sulfur hexafluoride
SLAC	SLAC National Accelerator Laboratory
SMEs	subject matter experts
SMOP	synthetic minor operating permit
SMP	self-monitoring program
SPCC	spill prevention, control, and countermeasures plan
SPEAR	Stanford Positron-Electron Asymmetric Ring
SSMP	Sanitary Sewer Management Plan
SSO	Department of Energy, SLAC Site Office
SSPP	Strategic Sustainability Performance Plan
SSRL	Stanford Synchrotron Radiation Lightsource

SVCW	Silicon Valley Clean Water
SVE	soil vapor extraction
SVOCs	semi-volatile organic compounds
SWPPP	Stormwater Pollution Prevention Plan
SWRCB	State Water Resources Control Board
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
WP	Work Plan
WTS	waste tracking system
yr.	year
ZWP	Zero Waste Program

Executive Summary

This report provides information about environmental programs during calendar year (CY) 2016 at the SLAC National Accelerator Laboratory (SLAC).in San Mateo County, California. Activities that overlap the calendar year - e.g., stormwater monitoring covering the winter season of 2015/2016 (October 1, 2015 through May 31, 2016) are also included.

Production of an annual site environmental report (ASER) is a requirement established by the United States Department of Energy (DOE) Site Office approved Site Compliance Plan for DOE Order 231.1B for all management and operations (M&O) contractors throughout the DOE complex. SLAC is a federally funded research and development center managed and operated by Stanford University for the DOE.

Under Executive Order (EO) 13693, *Planning for Federal Sustainability in the Next Decade,* and DOE Order 436.1, *Departmental Sustainability*, SLAC effectively implements and integrates the key elements of an Integrated Safety and Environmental Management System (ISEMS) 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 2016, SLAC continued to strengthen its management systems. These systems provided a structured framework for SLAC to implement "greening of the government" programs required by EO 13693 and DOE Order 436.1. Overall, management systems at SLAC are effective, supporting compliance with all relevant statutory and regulatory requirements. The following are among SLAC's progress on key environmental goals in the areas of energy, recycling, waste reduction, greenhouse gases, water, sustainable building, and fuel/fleet:

- SLAC recycled 427 tons of metals, including 200 tons from the Klystron Gallery, in support of the Linac Coherent Light Source (LCLS) II construction

- SLAC expanded its Zero Waste Program (ZWP) to fourteen buildings. Approximately 75 percent of SLAC's staff now work in buildings that are participating in the program, and diverted 71 percent of its municipal solid waste

- SLAC diverted 98 percent of its construction and demolition debris

- SLAC received an award for water conservation from the Silicon Valley Water Conservation Coalition for reducing potable water usage by 54 percent

- SLAC achieved a cumulative greenhouse gases emissions reduction of 42 percent for Scope 1 and 2 emissions and 3 percent for Scope 3 relative to the 2008 baseline

In 2016, there were no radiological impacts to the public or the environment from SLAC operations. The potential doses to the public were evaluated based on both calculation and measurements; the impacts are negligible and far below the regulatory and SLAC administrative limits. Potential exposure to the public from SLAC operations represents a very small fraction of the dose received from natural background radiation. No radiological incidents occurred that increased radiation levels to the public or released radioactivity to the environment.

SLAC is regulated under a site cleanup requirements order (Board Order) issued by the San Francisco Bay Area Regional Water Quality Control Board (RWQCB; Board Order number R2-2009-0072) 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 remediation efforts are being designed and implemented to meet these established goals. The Board Order also lists specific tasks and deadlines for completion of remediation activities. All deliverable submittals to the RWQCB in 2016 were completed and submitted on time. In 2016, SLAC Environmental Restoration Program personnel continued remediation efforts in specific areas impacted by chemicals of potential concern (COPCs). The COPCs present in groundwater and soil vapor are volatile organic compounds and semi-volatile compounds. As of the start of 2016, dual-phase extraction (DPE) systems, which involve the simultaneous extraction and treatment of chemically impacted groundwater and soil vapor, were operational at three of the four major areas within SLAC that have been impacted by COPCs in soil and groundwater. In December 2012, the RWQCB approved a three-year shutdown of the Test Lab/Central Lab (TL/CL) system for rebound testing. The third year rebound testing results indicate remediation goals for groundwater continue to be met. Operating data indicate that the remediation systems at the other three locations have also resulted in significant decreases in concentrations of COPCs in groundwater and soil vapor and are achieving hydraulic control of the groundwater plumes. In 2016, soil removal actions were completed at six additional areas within SLAC resulting in the removal of approximately 1,118 tons (927 cubic yards) of chemically impacted soil.

1 Site Overview

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

1.1 Introduction

SLAC is a national research laboratory operated by Stanford University under contract to the United States Department of Energy (DOE). SLAC is located on the San Francisco Peninsula, about halfway between San Francisco and San Jose, California (Figure 1-1). Current research and scientific user facilities are in the areas of photon science, particle physics, particle astrophysics, accelerator physics, and accelerator research and development. Research also includes cosmology, structural biology and medicine, material science, and emerging technologies. Four 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 the DOE Office of Science, with smaller contributions from the National Aeronautics and Space Administration, National Institutes of Health, and other federal and non-federal sources.

1.1.1 SLAC Mission

SLAC's mission is to leverage its intellectual capital, unique relationship with Stanford University, and location within Silicon Valley to:

- Innovate and operate world-leading accelerators, light sources and scientific tools
- Deliver transformative chemical, materials and biological science enabled by our unique experimental facilities
- Perform use-inspired and translational research in energy
- Define and pursue a frontier program in particle astrophysics and cosmology

In pursuit of this mission, SLAC is committed to operating a safe laboratory that employs and trains the best and brightest minds, helping to ensure the future economic strength and security of the nation.

1.1.2 Research Program

SLAC has three major research areas: photon science, particle physics, and accelerator science and technology. In the photon science program, SLAC develops and supports innovative research instrumentation for X-ray based studies of matter on length scales below the nanometer level and on time scales from milli- down to femto-seconds. Photon science research encompasses such diverse elements as magnetic materials science, molecular environmental science, and structural biology; and the rapidly developing field of ultrafast X-ray science.

The principal areas of particle physics studied at SLAC include 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 Model through investigations of dark matter and dark energy. The use of particle accelerators and observatories in space and on the ground helps us understand what our universe is made of at its most basic and fundamental level.

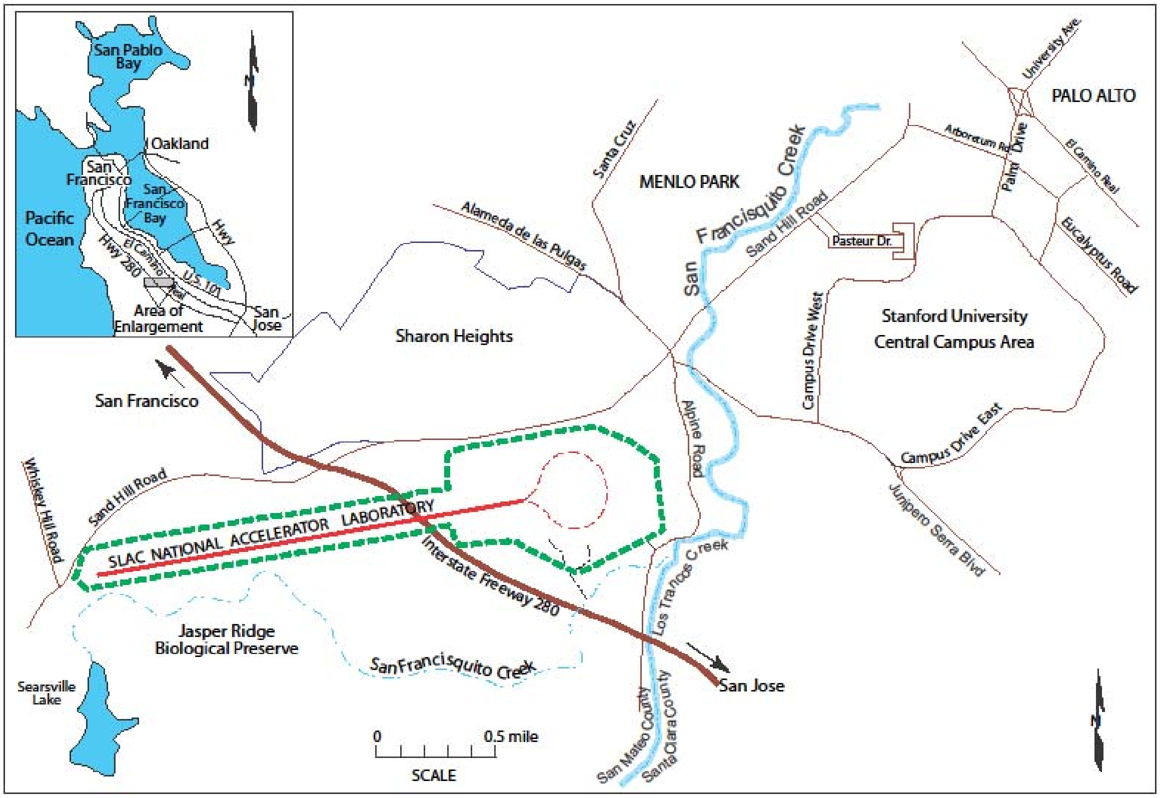

Figure 1-1 SLAC Site Location

The Linac Coherent Light Source (LCLS) Directorate continues its experimental operations with the world's first hard X-ray free-electron laser that is exceeding all expectations. This unique instrument produces X-ray beams that are a billion times more powerful than synchrotron sources, and is revolutionizing our understanding of the nanoscale world by creating the first stop-action movies of individual atoms and molecules undergoing chemical reactions. LCLS can provide both the intensity needed to probe ultra-small complex structures and the short pulses required to resolve their ultra-fast motion. Researchers have recently succeeded in reducing the pulse duration to one femto-second (10E-15 seconds). In 2016, a major upgrade of the LCLS commenced. When completed, LCLS II will have the capacity to produce X-ray beams that are 10,000 times brighter than the current LCLS, and produce pulses up to a million times per second.

SLAC also supports other world-class research in physics. The two-mile linear accelerator (linac) at SLAC, constructed in the early 1960s, generates high-intensity beams of electrons and positrons up to 50 billion electron volts. The linac was also used to inject electrons and positrons into colliding-beam storage rings for particle physics research. One of these storage rings, the Stanford Positron-Electron Asymmetric Ring (SPEAR), now contains a separate, shorter linear accelerator and a booster ring for injecting accelerated beams of electrons. SPEAR is dedicated to synchrotron radiation research, and the synchrotron light it generates is used by the Stanford Synchrotron Radiation Lightsource (SSRL), a division of SLAC, to perform experiments. At SSRL, researchers work at the nanoscale frontier, making discoveries in solid-state physics, material science, environmental science, structural biology, and chemistry. Examples of research performed at SSRL include: mapping the distribution of elements in diseased brains; seeking a deeper understanding of Alzheimer's and Parkinson's diseases; identifying the detailed structures of scores of proteins; examining remnants of soft tissues in hundred million-year-old dinosaur fossils; and characterizing 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 lies less than 151 feet above sea level and the mountains to the west rise abruptly to over 2,000 feet.

The site occupies 426 acres of land owned by Stanford University. The property was originally leased by Stanford University in 1962 to the U.S. Atomic Energy Commission, the predecessor to the DOE, for purposes of research into the basic properties of matter. The DOE and Stanford University signed a new lease in 2010, which extends through 2043. The land is part of Stanford's academic preserve, 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, oriented in an east-west direction. The parcel widens to about 0.6 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, 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. San Francisquito Creek is seasonal (dashed line, Figure 1-1) with sections of its streambed drying up during warmer months. Los Trancos Creek typically has water flowing year-round (Figure 1-1), but not during the recent drought conditions.

1.3 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 typically averages about 22 inches per year. The distribution of precipitation is highly seasonal. Approximately 75 percent of the precipitation, including most of the major storms, occurs during the four-month period from December through March of each year. Most periods of winter storms last from two days to a week in duration. The storm centers are usually characterized by relatively heavy rainfall and high winds.

1.4 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 30 percent of the property is developed with buildings and pavement, mostly in the core campus area.

Land use to the immediate west is commercial (office buildings and a hotel), and farther west is agricultural and the Jasper Ridge Biological Preserve. Land use to the north is mostly commercial, residential, and recreational (a golf course), with a school and office buildings located 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), preserved open space, and residential.

1.5 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, which 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 within the MPMWD. This separate system taps the Hetch Hetchy aqueduct and pumps water up to a 268,391cubic-feet reservoir north of Sand Hill Road, approximately 1.5 miles from SLAC.

Drinking and process water are transported throughout the SLAC site by a distribution system protected by backflow prevention devices. Use of water at SLAC is primarily utilized (as high as 80 percent usage) to support cooling of high-energy experimental equipment, buildings and associated processes. The remainder of water supply supports SLAC office buildings/grounds and the Stanford facilities on the SLAC campus that include the Guest House, Arrillaga athletic field, Stanford Research Computing Facility, and Kavli building. Five offsite groundwater wells have been identified within a one-mile radius of SLAC, three of which are in use. The closest downgradient groundwater well is located approximately 500 feet south of the SLAC boundary along the stream margin of San Francisquito Creek. This well was formerly used for agricultural supply but is now 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.

1.6 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 ranging from 0.3 to 3 feet in depth. Figure 1-2 shows the general geographic and geologic setting of the area.

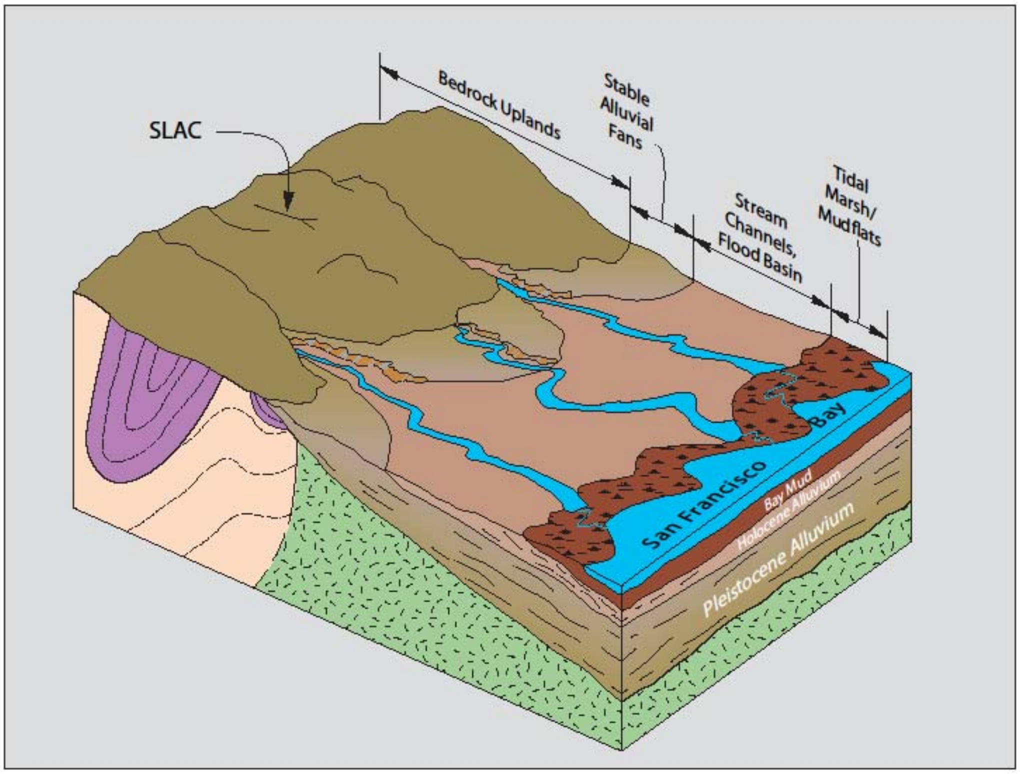

Figure 1-2 Site Area General Geographic and Geologic Setting

1.7 Demographics

SLAC has a daytime population of about 1,600 persons. This population consists of PhD physicist/scientists; professionals, including physicists, engineers, programmers, and other scientific-related personnel; and support personnel, including technicians, crafts personnel, laboratory assistants, and administrative associates. In addition to the regular population, SLAC hosts many visiting scientists, students, and researchers.

The populated area around SLAC is a mix of offices, schools, single-family housing, apartments, condominiums, and Stanford University. 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 located in Santa Clara County. Nearby unincorporated communities in San Mateo County, include Ladera and two neighborhoods located in western Menlo Park. Two public and two private schools with elementary and/or middle school students are located within one mile of SLAC's perimeter.

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 calendar year (CY) 2016.

2.2 Regulatory Framework

The SLAC External Requirements Management Dataset cites the environmental protection and safety requirements and standards that are applicable to the Laboratory.

2.3 Environmental Permits and Notifications

The permits held by SLAC in 2016 are shown in Table 2-1 below.

Table 2-1 General Permits Held by SLAC

Issuing Agency	Permit Type	Description	Number
BAAQMD	*Air quality*	SMOP issued per Title V of the Clean Air Act	1
		Encompasses 49 sources of air emissions - 38 permitted, 2 registered and 9 permit-exempt. After initial permitting, individual sources integrated into SMOP Separately, SLAC has a PTO for an onsite above-ground GDF from the BAAQMD	1
California Department of Toxic Substances Control	*Hazardous waste treatment*	Unit 1A – Building 025, 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
Silicon Valley Clean Water and West Bay Sanitary District	Wastewater discharge	Mandatory Wastewater Discharge Permit	1
Regional Water Quality Control Board	Stormwater	Industrial activities stormwater general permit	1
San Mateo County/CUPA	CUPA programs	PBR; Above-Ground Tank/SPCC plan; Hazardous Material Storage > 32,000 gal, 224,000 lbs.,	1

Issuing Agency	Permit Type	Description	Number
		11,2000 cf.; Hazardous Waste Generator 51-250 tons; CalARP	
US Environmental Protection Agency	Hazardous waste	90-day hazardous waste generator	1

BAAQMD - Bay Area Air Quality Management District
CalARP – California Accidental Release Prevention Program
cf – cubic feet
CUPA – Certified Unified Program Agency
gal – gallon
GDF – gasoline-dispensing facility
lbs. – pounds
cf. – cubic feet
PBR – permit by rule
PTO – permit to operate
SMOP - synthetic minor operating permit
SPCC - Spill Prevention, Control and Countermeasures Plan
> - greater than

2.4 Environmental Incidents

2.4.1 Non-radiological Incidents

No incidents of a non-radiological nature occurred at SLAC during 2016.

2.4.2 Radiological Incidents

During CY 2016, no radiological incidents occurred that would have increased radiation levels above natural background to the public, or released radioactivity to the environment; SLAC was compliant with all radiological requirements related to the environment and the public.

2.5 Assessments, Inspections, and Quality Assurance

The environmental programs at SLAC are subject to routine assessments, inspections, and quality assurance measures conducted by SLAC, DOE and external regulators. Those conducted during CY 2016 are reported here.

2.5.1 Assessments

External assessments conducted by regulators occur periodically and include quarterly radiation monitoring of the SLAC perimeter by the California Department of Health Services. Currently, monitoring results are not available to SLAC for 2016.

2.5.2 Inspections

Periodic inspections of the environmental programs are performed at SLAC by federal, state and local environmental regulatory agencies. Table 2-2 lists the inspections conducted in CY 2016 by these agencies.

Table 2-2 Environmental Audits and Inspections

Regulatory Agency	Inspection Title	Date	Violations
Silicon Valley Clean Water	Annual Compliance Inspection	September 6, 2016	0
San Mateo County Certified Unified Program Agency	Annual Compliance Inspection	December 12 through December 15, 2016	0

The San Mateo County Certified Unified Program Agency (CUPA) inspection included the Hazardous Materials Business Plan, Hazardous Waste Generator, Tiered Permitting and Waste Tires programs.

2.5.3 Quality Assurance

The SLAC Quality Assurance (QA) program is consistent with the DOE SLAC Site Office (SSO) approved Site Compliance Plan for DOE Order 414.1D, Quality Assurance, and includes documented roles, responsibilities, and authorities for implementing the QA criteria in the plan. The SLAC prime contract also includes an H clause that requires SLAC to implement a Contractor Assurance System (CAS) as outlined in the SLAC Contractor Assurance Description approved by the DOE SSO. Both the QA and CAS programs at SLAC require the performance of risk and compliance-based self-assessments and the management of associated issues. Environmental Program Assessments of program elements are conducted by SLAC and DOE based on past performance, management discretion or regulatory drivers and are tracked in the Integrated Assessment Schedule (IAS). Issues from these assessments are managed via the SLAC Action Tracking System (ATS). The IAS and ATS are maintained by the SLAC Contractor Assurance and Contract Management (CACM) Office.

The SLAC CACM Office is responsible for:

- Ensuring that risk and compliance-based self-assessments or audits are routinely performed for ES&H programs and documented in the SLAC IAS
- Ensuring that issues from ES&H Program assessments or audits are managed in the SLAC ATS
- Providing direction for implementation of the SLAC CAS and QA criteria from SSO-approved Site Compliance Plan for DOE Order 414.1D as they apply to ES&H program implementation

2.5.3.1 Environmental Non-radiological Program

The Environmental Protection Department uses the *Quality Assurance Project Plan for the Environmental Protection Program* [1] for data quality review of analytical laboratory results of solid and liquid samples. 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

[1] Stanford Linear Accelerator Center, Environment, Safety, and Health Division, Environmental Protection Department, *Quality Assurance Project Plan for the Environmental Protection Program* (SLAC-I-750-2A17M-003 R007, December 2015)

components include defining required laboratory and field QA, and quality control (QC) procedures and corrective actions, along with data validation and reporting.

2.5.3.2 Environmental Radiological Program

Programmatic QA/QC is governed by the SLAC Radiological Environmental Protection (REP) program manual. Specific radioanalysis laboratory procedures and data validation as well as reporting for environmental samples are governed by the SLAC Radioanalysis Laboratory Quality Assurance Manual. SLAC is in the process of resuming participation in the Mixed Analyte Performance Evaluation Program (MAPEP), which was discontinued in 2014 due to resource constraints. Duplicate samples (mainly well water samples) are periodically analyzed by both SLAC and the off-site radioanalysis laboratory. The results from these two laboratories are then compared and documented to identify any discrepancies and/or biases. For CY 2016, the results of these comparisons were consistent with each other, supporting the high level of QA/QC standards of the SLAC data.

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 the following six directorates: Mission Support, Accelerator Directorate, LCLS Directorate, Science Directorate, SSRL Directorate, and the Technology & Innovation Directorate. 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 the Work-For-Others program.

3.2.1 ES&H Division Organization

The ES&H Division is part of the Mission Support Directorate and consists of seven departments and a Division Office. The Division Office is tasked with overall strategic planning and management. The shared goal is to ensure that SLAC operates in compliance with federal, state, and local laws and regulations, as well as DOE directives.

3.2.1.1 Environmental Protection

The Environmental Protection (EP) Department has two primary functional areas that are responsible for developing and managing the requirements under the EMS: Environmental Compliance and Environmental Restoration. The EMS is the overarching management system that SLAC uses for identifying and managing environmental aspects and is further described in Section 3.5. The EP Department develops and implements the following programs: pollution prevention, stormwater and industrial wastewater, air quality, toxic substances control, National Environmental Policy Act (NEPA), the National Historic Preservation Act (NHPA), and spill prevention, as well as groundwater protection and oversees work to restore soil and groundwater impacted with chemicals from historical operations.

3.2.1.2 Field Services

The Field Services Department consists of three technical groups – the Safety Services Group, Chemical Management Group, and Waste Management (WM) Group. The Safety Services Group is responsible for providing industrial and Occupational Safety and Health Act (OSHA) construction safety oversight to construction projects, operations and maintenance, as well as providing training classes on safety to SLAC personnel. The Chemical Management Group is multifaceted and addresses chemical safety at every point in the chemical lifecycle from transportation, procurement, use, storage, inventory management, and implements the Toxic and Hazardous Material Reduction Plan. The WM Group is responsible for coordinating the management and off-site disposal of regulated and hazardous wastes, and developing and implementing hazardous waste minimization plans.

3.2.1.3 Security and Emergency Management

SLAC Security and Emergency Management provide oversight of two intertwined site safety functions - Fire and Emergency Management and SLAC Site Security. The Fire Protection program provides oversight provided by licensed fire protection engineers in conjunction with fire protection specialists. Emergency response oversight is led by the Assistant Fire Marshal, who is also SLAC's Emergency Management Coordinator.

The SLAC emergency management organization includes the SLAC Emergency Response Team (ERT) and SLAC Site Security, which has California Emergency Certified Technicians on duty 24 hours a day, seven days a week. As of May 1, 2012, SLAC has been supported by the County of San Mateo Fire Department through a Memorandum of Agreement with the Menlo Park Fire Protection District. Site Security is led by a SLAC Security Manager and staffed by contract security professionals who are responsible for providing site-wide security services and emergency assistance 24 hours a day, seven days a week.

3.2.1.4 Radiation Protection

The SLAC Radiation Protection (RP) Department includes five technical groups – The Radiation Physics Group, Radiation Protection Field Operations (RPFO) Group, Dosimetry and Radiological Environmental Protection Group (DREP), Radioactive Waste Management (RWM) Group, and Laser Safety Group. The Radiation Physics Group is responsible for providing support in safety analysis and control (including shielding calculations and safety system design) for new or modified beam lines, experiments and facilities, and providing authorization and oversight for the safe operation of beam lines and experiments to protect the workers, general public and the environment. The RPFO is responsible for overseeing radiological monitoring, training, radiological control and work support. The DREP Group is responsible for providing dosimetry services (external, internal and area), assessment and/or monitoring of environmental impacts (described in more detail in Section 5), operation of the Radioanalysis Laboratory, and operation of the instrumentation program. The RWM Group is responsible for overseeing radioactive waste management at SLAC, such as low-level radioactive waste disposal (described in more details in Chapter 5). The Laser Safety Group is responsible for developing and implementing SLAC’s Laser Safety Program.

3.2.1.5 Project Safety

The ES&H Project Safety Department includes the Building Inspection Office, Project Safety Group, and two Safety Officers - the Electrical Safety Officer and the Fire Marshal. The Building Inspection Office is responsible for providing building code oversight of construction projects during the plan review process and construction phases. The Project Safety Group, which includes Industrial Hygienists (IH), is responsible for general construction safety oversight, project support (ES&H liaison) to project managers and scientists, and safety oversight of specific programs in areas such as oxygen deficiency hazards, and compressed gas systems. The IH personnel are responsible for assisting with the management of SLAC’s safety and health programs, and keeping SLAC healthy and safe by anticipation, recognition, evaluation, prevention, and control of environmental factors or stresses.

3.2.1.6 Training and Information Management

The Information Management Department assists with the implementation of SLAC's safety and health programs including ES&H training, ES&H publishing, and ES&H web and business applications.

3.2.1.7 Occupational Health

The Occupational Health Center provides on-site medical services including treatment of minor injuries such as cuts, minor abrasions and burns, sprains/strains, and removing splinters and ticks. The department also provides a medical surveillance program for employees who may be potentially exposed to chemical and physical hazards.

3.3 Integrated Safety and Environmental Management System

SLAC's commitments to protecting the health and safety of on-site personnel, the public, and the environment are embodied in the SLAC Environment, Safety and Health Policy.[2] SLAC ensures the site is operated in a safe and 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 integrates the key elements of effective safety and environmental management systems into the mission and everyday operations of the site.

3.3.1 Integrated Safety and Environmental Management System

The 'plan, do, check, and improve' approach of ISEMS[3] has been formally adopted by SLAC, and has been incorporated into the SLAC Worker Safety and Health Program.[4] 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):

- Define the scope of work
- Analyze the hazards

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[2] SLAC Environment, Safety and Health Policy,

http://www-group.slac.stanford.edu/esh/about_esh/eshpolicy.htm

[3] SLAC Environment, Safety, and Health Division, "Integrated Safety and Environmental Management Systems",

http://www-group.slac.stanford.edu/esh/general/isems/

[4] SLAC National Accelerator Laboratory, Environment, Safety, and Health Division, SLAC Worker Safety and Health Program, (SLAC-I-720-0A21B-001-R010),

http://www-group.slac.stanford.edu/esh/general/wshp/

- Develop and implement hazard controls
- Perform work within controls
- Provide feedback and continuous improvement

3.3.2 Requirements Management System

The laws and regulations that specify ES&H and other external requirements of the Laboratory are derived from the following:

- The DOE/Stanford University prime contract for SLAC
- DOE approved site compliance plans for contractual DOE Directives
- SLAC program documentation (ES&H Manual)
- SLAC subject matter experts (SMEs)

SLAC's External Requirements dataset contains laws and regulations not specifically cited in the prime contract in DOE Directive site compliance plans. Updates to the dataset are managed by SLAC's Prime Contract Office and occur when SLAC program documentation is updated affecting citations of external regulations (industrial safety standards, local laws), and when external regulations are identified by SMEs as applicable to the work performed at SLAC. SMEs notify the Prime Contract Office of any new or changed regulations so the dataset can be updated, as appropriate.

3.3.3 Environmental Performance Measures

In addition to complying with external requirements, SLAC evaluates its performance against measures and metrics. Specific performance objectives, measures and targets are jointly developed by DOE and SLAC, and are approved and formally incorporated into the M&O contract each fiscal year. DOE uses the contract performance measures, and results of ongoing field observations, surveillances and routine assessments of SLAC operations and construction activities to formally evaluate contractor performance in all areas, including ES&H.

In FY 2016, SLAC established environmentally relevant performance goals to ensure protection of the environment. Measures were initiated to ensure the effective development, implementation, and maintenance of an efficient Environmental Management System.

SLAC received a grade of A- from DOE for its environmental performance. In particular, the following accomplishments were noted for FY 2016*:*

- SLAC demonstrated significant improvement in hazardous waste/material management at waste generating locations.

- SLAC was the primary author of a DOE Technical Standard for Clearance and Release of Personal Property from Accelerator Facilities.

- SLAC recycled 200 tons of metals from the Klystron Gallery in support of the LCLS II construction.
- SLAC initiated site-wide legacy cleanup activities.
- SLAC expanded the ZWP to a total of fourteen buildings.
- SLAC completed a major revision to its Storm Water Pollution Prevention Plan.
- SLAC accelerated the removal of PCB-impacted soil.

3.3.4 Training

To ensure every employee is both aware and capable of fulfilling his or her responsibilities, SLAC maintains an extensive program of classroom and computer-based environmental and health and safety 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 SLAC's training program are available online.[5] Workers are required to have all appropriate environmental and health and safety training prior to performing any work assigned to them. Training received by every worker is documented in his or her Safety Training Assessment, which is formally reviewed and approved by the worker's supervisor annually.

3.4 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 improving 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* [6] 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 2016 EMS Report Card, indicating that all elements of the EMS are in place and working. Despite receiving a score of "green", SLAC continually strives to improve its EMS.

SLAC's EMS is consistent with International Organization of Standardization (ISO) 14001:2004. The SLAC EMS was formally in place on December 21, 2005, following a DOE assessment and declaration, and has been assessed and revalidated by DOE every three years. SLAC's EMS was last assessed in April 2015 by the DOE who determined the EMS to be fully implemented and in conformance with the ISO

5 SLAC National Accelerator Laboratory, *SLAC Training*, http://www-group.slac.stanford.edu/esh/training/

6 SLAC National Accelerator Laboratory, *EMS Description*, SLAC-750-0A03H-002 R6, September 2015

14001:2004 standard for EMS. Based on these results, SLAC's EMS was formally revalidated by the DOE in June 2015.

The annual review and update of environmental aspects and determination of significance was completed during the year by SLAC's EMS Working Group. Seven new objectives and targets were established for 2016. For each objective and target, a work plan, also referred to as an Environmental Management Program (EMP), was completed. These EMPs addressed the following environmental aspect categories:

- Air emissions
- Use, reuse, and recycling
- Conservation of resources - Water

Several of the notable accomplishments achieved during FY 2016 for the EMPs include the following:

- Phase I of a two-phase project to upgrade SLAC Building 048 to a High Performance Sustainable Building was completed.
- SLAC's ZWP was expanded to two additional buildings, bringing the total to fourteen buildings. Approximately 75 percent of SLAC's staff now work in buildings that are participating in the program.
- SLAC completed an energy evaluation and a detailed energy survey of the site, involving energy audit walk-throughs of over 50 buildings.

Additionally, SLAC's progress on the sustainability goals of EO 13693, including those related to GHGs, energy, water, fuel-reduction and high-performance sustainable buildings is provided in Section 4.7, *Sustainability*. SLAC's greenhouse gases (GHG) inventory work is 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, uses, maintains and runs one-of-a-kind research equipment, which requires the use and management of various industrial chemicals, gases and metals, and utilizes resources such as energy and water. SLAC also has environmental management issues typical of any employer with about 1,600 full-time staff. In addition to the regular population, SLAC hosts many visiting scientists, students, and researchers.

SLAC has focused considerable efforts to minimize potential environmental impacts including working to eliminate the generation of waste and emissions. Additionally, SLAC continually strives to improve its environmental performance.

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
2011	DOE	Secretarial Honors Achievement Award	Reducing fugitive emissions of sulfur hexafluoride (SF_6) while raising awareness and sharing case studies
2013	USEPA	Federal Electronics Challenge – Bronze Award	Reducing the environmental impacts of electronics in the End-of-Life phase
2016	Silicon Valley Water Conservation Awards Coalition	Silicon Valley Water Conservation Award for a Government Agency	Reducing potable water usage

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 sections in this chapter are organized by environmental protection programs, which describe the regulatory framework and program status for CY 2016, 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 Program

SLAC operates various sources of regulated air emissions, including a plating shop, a paint shop, several machine shops, boilers, solvent degreasers, emergency generators, and a vehicle fueling station, as well as diesel trucks and several types of off-road equipment. In addition, GHGs, which are generated indirectly through electricity use and used in electrical substations as well as research equipment, are being actively managed per Assembly Bill (AB) 32, the California Global Warming Solutions Act of 2006. 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 program during CY 2016.

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 (Operating Permits) of the Clean Air Act. SLAC's Title V synthetic minor operating permit (SMOP) was issued by the BAAQMD on July 26, 2002. The SMOP stipulates limits on facility-wide emissions of volatile organic compounds, VOCs, total hazardous air pollutants (HAPs), and individual HAPs, along with various other requirements. At the state level, the California Air Resources Board (CARB) is responsible for administering AB 32, the implementation of which was completed in 2012, and providing notices, workshops, training, lectures, and other means to disseminate information as it is developed.

Finally, SLAC is subject to 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

All air quality deliverables were submitted to regulators on a timely basis during CY 2016.

4.2.2.1 Biennial Facility Inspection

The biennial BAAQMD site inspection, which was performed in April 2015, found no issues and no Notice of Violations (NOVs) were issued. There was no BAAQMD inspection of SLAC in CY 2016.

4.2.2.2 New Source Permits

No new stationary emissions sources were permitted during CY 2016. At the end of CY 2016, under the SMOP SLAC managed 49 sources of air emissions, 38 of which were permitted sources, two were registered sources, and 9 were exempt sources (Chapter 2, Table 2-1). Separately, SLAC manages an onsite above ground gasoline dispensing facility (GDF) under a BAAQMD operating permit.

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

SLAC has two overarching annual deliverables to the BAAQMD, as well as other deliverables described in subsequent sections. One overarching annual deliverable is an annual information update requested by BAAQMD for selected permitted sources. This report was submitted to the BAAQMD in April 2016. The BAAQMD permit to operate is renewed annually, and spans two years, from July 1, to June 30 of the following year. SLAC's permit-to-operate was renewed on June 27, 2015 and was effective from July 1, 2015 through June 30, 2016. The 2016-2017 renewal went into effect on July 1, 2016.

The other overarching annual BAAQMD deliverable is the Title V annual emissions report for all onsite sources included in the SMOP, covering the period of July 1, 2015, through June 30, 2016. SLAC submitted the Title V annual emissions report in July 2016.

4.2.2.4 Annual Adhesives Usage Report

In April 2016, SLAC submitted its CY 2015 adhesives usage report to the BAAQMD to satisfy BAAQMD Regulation 8-51-502.2c.

4.2.2.5 Annual Air Toxics Report

SLAC submitted its annual air toxics report covering CY 2015 to BAAQMD in April 2016, in accordance with AB 2588.

4.2.2.6 Asbestos and Demolition Project Notification Program

For projects that involve the demolition or significant renovation of existing structures, or the management of regulated asbestos-containing material, SLAC is required to provide advance notice to the BAAQMD. During CY 2016, demolition projects were evaluated by the SLAC Air Quality Program Manager for the purpose of air quality protection. Based on the projects' scope and the results of pre-work asbestos surveys, asbestos demolition/renovation notifications were submitted to BAAQMD for three of these projects.

4.2.2.7 National Emission Standards for Hazardous Air Pollutants

During CY 2016, SLAC owned four emissions sources that report under 40 CFR 63, Subpart T "National Emission Standards for Halogenated Solvent Cleaning", which is part of the National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations. None of these solvent cleaners and degreasers were in service during CY 2016. The NESHAP deliverables required by the USEPA is comprised of one annual performance report and two semi-annual exceedance reports. For CY 2015, the annual report was consolidated with the second semi-annual report, and was submitted to the USEPA in January 2016. The first semi-annual report for CY 2016 was submitted to USEPA in July 2016.

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 or the United States General Services Administration. SLAC continues to replace and upgrade its service fleet as resources allow. The annual off-road diesel equipment report was submitted to the BAAQMD in February 2016.

Fuel purchasing and dispensing is tracked and reported annually to BAAQMD. The permit for SLAC's onsite GDF requires annual source testing of the gasoline dispensing system to ensure proper functioning. A routine annual source test was performed on the GDF in September 2016; all results were within regulatory limits. The GDF has two tanks, each with its own dispensing nozzle: a larger 1,500-gallon tank and a smaller 500-gallon tank. Currently, both tanks are equipped to store and dispense unleaded gasoline.

4.2.2.9 Greenhouse Gas Inventory and Baseline

GHG emissions are divided into 3 categories, or scopes. Scope 1 emissions are generated onsite and are under the direct control of the facility, such as those produced by combustion of natural gas in a boiler. Scope 2 emissions are associated with onsite use, but are generated by an offsite entity, such as electrical power. Nearly all of SLAC's GHG emissions are Scope 2, due to its high demand for electricity. Scope 3 emissions are business-related but generated offsite. Employee commuting and business travel are included in this category.

In accordance with requirements outlined in EO 13693, the DOE established an agency-wide GHG reduction target relative to a 2008 baseline. In FY 2016, SLAC achieved a cumulative reduction in Scope 1 and 2 emissions of 42 percent and in Scope 3 emissions of 3 percent relative to the 2008 baseline.

As part of its GHG management program, CARB established a program that specifically addresses gas-insulated switchgear (GIS), electrical equipment filled with sulfur hexafluoride (SF_6). This compound is the most powerful GHG known, having a Global Warming Potential (GWP) of 23,900 relative to carbon dioxide (CO_2), which has a GWP of 1. In CY 2016, SLAC purchased less than one pound of SF_6. The annual SF_6 GIS inventory report was submitted to CARB by the June 1, 2016 due date.

4.3 Industrial and Sanitary Wastewater Management Program

SLAC discharges industrial wastewater and sanitary sewage to the wastewater 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 Silicon Valley Clean Water (SVCW), formerly known as the South Bayside System Authority (SBSA).

4.3.1 Regulatory Framework

The Federal Water Pollution Control Act, now referred to as the Clean Water Act (CWA), was enacted into law 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 facilities and categorically regulated industrial facilities, such as electroplating and metal finishing shops.

SLAC operates its industrial and sanitary wastewater programs under mandatory wastewater discharge permits, negotiated jointly with the WBSD and SVCW and covering the entire SLAC facility. The permits are for the duration of one year, with automatic renewal annually for successive one-year terms, up to 5 years. SLAC's Mandatory Wastewater Discharge Permit number WB 111216 expired on December 15, 2016. The permit was replaced by Mandatory Wastewater Discharge Permit number WB 161215, which will expire on December 15, 2021. SLAC also has a contractual relationship with the WBSD, which specifies the total industrial and sanitary water flow volumes allowed to be discharged into the municipal wastewater collection system.

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

SLAC also has four wastewater flow monitoring stations located 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 Master Substation (MSub), Alpine Gate (Alpine), Interaction Region 8 (IR08) and IR06 Adit, as shown on Figure 4-1.

SLAC is required to submit a semi-annual self-monitoring report, which includes the results of its monitoring of the metal finishing pre-treatment facility (MFPF) and Former Hazardous Waste Storage Area (FHWSA) treatment system. The report also contains certification of a solvent management plan for approximately 100 solvents selected by the SCVW, and reports for discharges of radioactivity in industrial wastewater (see Section 5.5.1).

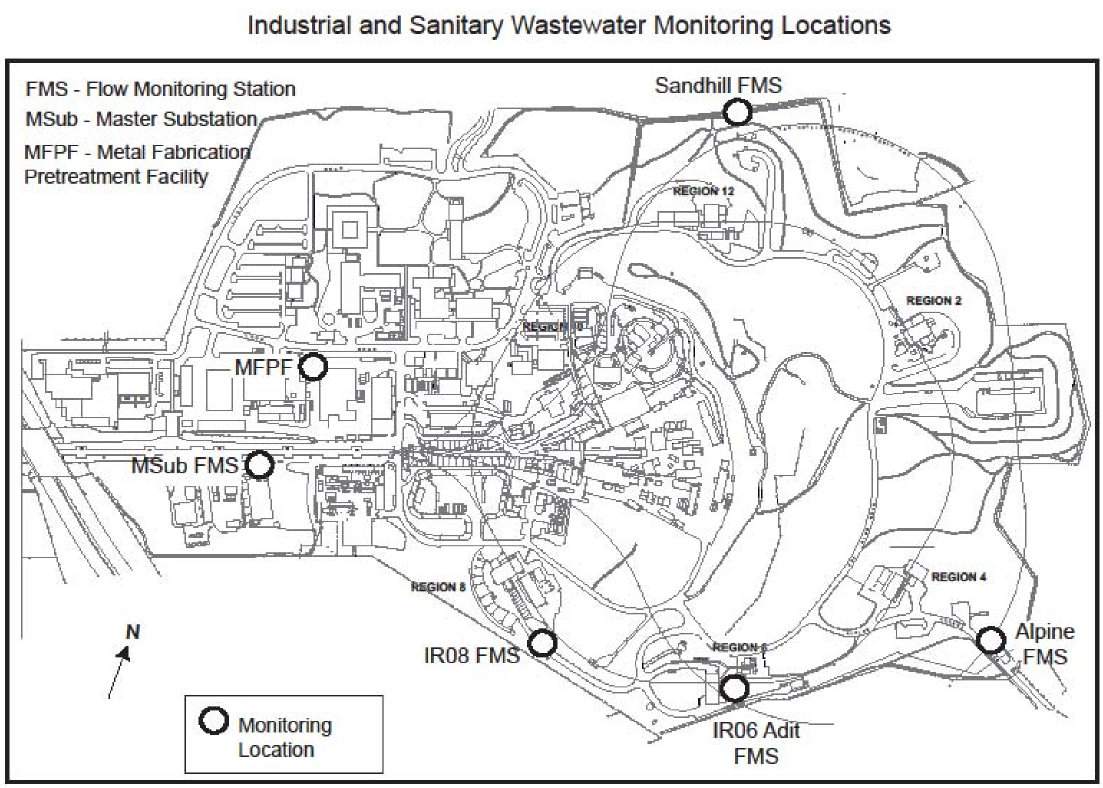

Figure 4-1 Industrial and Sanitary Wastewater Monitoring Locations

4.3.2 Program Status

4.3.2.1 Annual Facility Enforcement Inspection

The SCVW conducted the annual facility enforcement inspection on September 6, 2016. SLAC was found to be in compliance and no issues were noted by the SVCW.

4.3.2.2 Water Quality Monitoring Results

SLAC collects water quality samples semi-annually from the MFPF and FHWSA monitoring locations. In addition, SCVW collects samples quarterly at the Sand Hill Road FMS and annually at both the MFPF and FHWSA. Compliance with the water quality parameters contained in the permit is determined at the Sand Hill Road FMS and FHWSA by comparing the mass discharge limit with the daily maximum mass limit.

During 2016, SLAC was within compliance for all permitted discharge limits at all three monitoring locations.

4.3.2.3 Sanitary Sewer Overflow Management

SLAC registered with the SWRCB and the San Francisco Bay RWQCB sanitary sewer overflow reporting systems in October 2008.[7] All spills from the sanitary sewer system are reported to the SWRCB using the sanitary sewer overflow reporting systems. A Category 1 sanitary sewer overflow is a spill of any volume from the sanitary sewer, which reaches surface water and/or enters a stormdrain channel tributary to surface water. Category 1 spills greater than or equal to 1,000 gallons must be reported within two hours of discovery to the California Office of Emergency Services. A Category 2 sanitary sewer overflow is any spill of 1,000 gallons or greater that does not reach surface water or a drainage channel tributary to surface water. Category 2 spills require that a draft report must be submitted electronically to the California Integrated Water Quality System (CIWQS) within three business days. A Category 3 sanitary sewer overflow is any spill less than 1,000 gallons that does not reach surface water or a drainage channel tributary to surface water. Category 3 spills are reported electronically via CIWQS within 30 calendar days after the end of the month in which the overflow occurred. A no-spill certification must be completed and certified via CIWQS within 30 days of a month in which no spills occur.

In 2016, SLAC had no incidents of sanitary sewer overflows. All no-spill certifications were submitted on schedule.

In August 2010, the SLAC Sanitary Sewer Management Plan (SSMP) was completed. The Plan includes descriptions of SLAC’s sanitary sewer operations and maintenance activities, spill response, and reporting procedures. The SSMP was updated in April 2014 to comply with the new monitoring, recordkeeping, reporting and public notification requirements under Order No. 2013-0058-EXEC, which came into effect on September 9, 2013.

4.4 Surface Water Management Program

Stormwater flows out of the 426-acre SLAC site through 25 drainage channels. Many of the channels drain areas where the stormwater has little or no potential of exposure to industrial activities. As defined in Attachment A of the SWRCB’s Industrial General Permit (IGP) Order 2014-0057- Department of Water Quality (DWQ), stormwater has the potential to come into contact with support activities or facilities. Such activities or facilities include SLAC’s Transportation Department at Building 81 (B081), the Lower Salvage Yard and the IR-8 Salvage Yard. Based on the permit requirements of the IGP and SLAC’s Stormwater Pollution Prevention Plan (SWPPP), completed June 2016, two locations representative of stormwater discharges associated with support activities are monitored. These locations are listed below and shown in Figure 4-2.

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[7] *Statewide General WDRs for Sanitary Sewer Systems, WQO No. WA 2013-0058-EXE. Available at https://www.waterboards.ca.gov/*

- IR-8 Channel, which includes flow from the Lower Salvage Yard and the IR-8 Sump in the Salvage Yard
- Transportation Department at B081 stormwater catch basin number CB27E-5

Surface Water Monitoring Locations

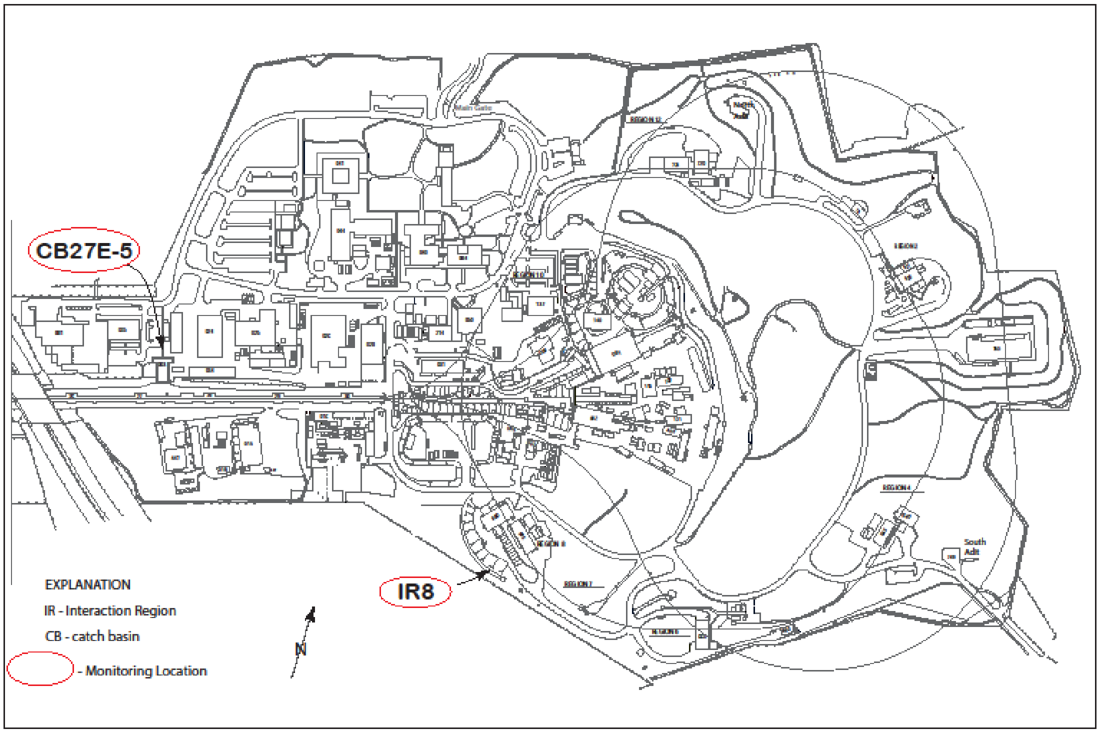

Figure 4-2 Surface Water Monitoring Locations

4.4.1 Regulatory Framework

In 1987, the CWA was amended to include non-point source discharges such as stormwater run-off from industrial, municipal, and construction activities. 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.

From 1997 through June 26, 2015, SLAC's stormwater was regulated under IGP Order 97-03-DWQ. On July 1, 2015, a new State IGP Order, 2014-0057-DWQ, became effective. There were major changes to the IGP, including its applicability to SLAC. Prior to the new IGP's implementation date, SLAC consulted with the RWQCB and SWRCB staff regarding whether permit coverage under the new IGP was most appropriate for SLAC or, whether coverage under a Phase II Small Municipal Separate Storm Sewer System (MS4) permit would be more appropriate.

Based on these discussions, it was determined that the MS4 permit would be more appropriate for SLAC, and accordingly, SLAC filed a Notice of Termination (NOT) of coverage from the IGP Order (number (No.) 97-03-DWQ) on June 26, 2015, with the intention of applying for coverage under the MS4 following approval of the NOT. The NOT was approved by the RWQCB on October 7, 2015, but was subsequently rescinded by the regulatory agency on November 24, 2015. After additional discussions with the RWQCB regarding stormwater permit coverage, the RWQCB recommended that SLAC file a Notice of Intent (NOI) for coverage under IGP Order 2014-0057-DWQ. SLAC then filed an NOI for coverage under IGP Order 2014-0057-DWQ on July 15, 2016, which included submission of a revised SWPPP.

The SWPPP has two main components: a Monitoring Plan and Best Management Practice (BMP). The Monitoring Plan describes 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).

4.4.2 Program Status

The reporting period for IGP Order 2014-0057-DWQ runs from July 1 through June 30 of the following year. Since the IGP's period of coverage spans two calendar years the period for monitoring water quality during the wet season of 2015–2016 was July 1, 2015 through June 30, 2016.

The IGP requires analysis of stormwater samples for three parameters (pH, total suspended solids, and oil /grease); potential pollutants that could result from support activities and operations (identified by Standard Industrial Code in Attachment A of the IGP); and any additional parameters related to receiving waters with 303(d) listed impairments or approved total maximum daily load. During the wet season of 2015-2016, stormwater samples were analyzed for the three required parameters as well as seven additional parameters –five metals and two non-metals (Table 4-2). The additional parameters were selected after a review of SLAC's support activities and operations.

SLAC compares its stormwater analytical results to the SWRCB-developed Annual Numeric Action Levels (NALs), in particular those for the parameters listed in Table 4-2. A comparison is also made with the Instantaneous NAL values, as applicable. During the 2015-2016 wet season, there were no exceedances of the Instantaneous or Annual NALs at the IR-8 Channel and at the Building 081 stormwater catch basin, SLAC's two locations monitored as part of the IGP and SLAC SWPPP.

SLAC completed its 2015 - 2016 wet season stormwater sampling (IR-8 Channel and the stormwater catch basin at Building 081 (B081, CB31G-7)) as necessary. However, SLAC's coverage under IGP 97-03-DWQ was terminated and the timing of submitting the NOI for the new IGP (2014-0057-DWQ), including analytical sampling and the preparation of the annual stormwater sampling report, were not required by the SWRCB.

Table 4-2 Stormwater Parameters Analyzed

Metals	Non-Metals
Aluminum	Total Suspended Solids *
Copper	pH *
Iron	Oil and Grease *
Lead	Chemical Oxygen Demand
Zinc	Diazinon

* - Required parameter under Industrial Stormwater General Industrial Permit Order 2014-0057-DWQ

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 the following:

- Cryogens
- Compressed gases
- Acids and bases
- Solvents
- Oils and Fuels, including Propane
- Adhesives
- Paints and epoxies
- Metals

Hazardous materials management encompasses numerous programs at SLAC, but the primary goal remains the same: to ensure the safe handling of hazardous materials in order to protect the workers, 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 the following listed acts. The Superfund Amendments and Reauthorization Act of 1986 (SARA - Title III) is also known as the Emergency Planning and Community Right-to-Know Act (EPCRA) and focuses on community safety. The Occupational Safety and Health Act (1970) was enacted for protection of worker health and safety. The Hazardous Materials Transportation Act of 1975 ensures the safe transport of hazardous materials in commerce; and the Toxic Substances Control Act (TSCA) of 1976, is the federal statute under which polychlorinated biphenyls (PCBs) and asbestos are regulated.

Important drivers at the state level generally date back to the mid-1980s and include a Hazardous Materials Business Plan (HMBP), the 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 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, which include the SWPPP, the Spill Prevention, Control, and Countermeasures (SPCC) plan, and the Waste Tire Survey and Inspections, as well as the following four hazardous material subject areas:

- Hazardous Materials Business Plan/Emergency Response Plan
- Hazardous Waste/Tiered Permitting/Waste Minimization and Pollution Prevention

- 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 2016 programs related to hazardous materials life-cycle management, including the hazardous materials business plan, the Toxics Release Inventory (TRI), and the CalARP program.

For the period between January 1 and December 31, 2016, 17 chemical storage buildings/areas (or 15 percent of the identified buildings/areas) were field-verified. Usable legacy or unneeded chemicals were removed for redistribution, and products that had expired or had damaged containers or labels were removed for disposal as hazardous waste.

4.5.2.1 Annual Facility Enforcement Inspections

The San Mateo County CUPA inspected SLAC from December 12 through December 15, 2016. There were no violations issued. The CUPA made a very small number of observations of non-compliance, which were corrected at the time of the inspection. The inspector expressed his recognition that SLAC places a high priority on its responsibility to comply with ES&H regulations. SLAC's WM programs have been recognized as an effective tool to identify inventory reduction opportunities and provide avenues for reuse and waste reduction.

4.5.3 Hazardous Materials Business Plan Program

EPCRA, passed in 1986 as Title III of SARA, establishes requirements for emergency planning, notification, and reporting. In California, the requirements of SARA Title III are incorporated into the state's HMBP program.

For the 2016 reporting year, SLAC's HMBP was submitted to the San Mateo County CUPA in December 2016 using the California Environmental Reporting System (CERS).

The HMBP includes the Hazardous Materials Inventory Statement. The inventory consists of all hazardous materials present at SLAC in amounts exceeding the state's aggregate threshold quantities (55 gallons for liquids, 500 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, process and bulk tanks, emergency generators containing fuel, 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 Emergency Management Plan. 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 (RMP)

4.5.4 Toxics Release Inventory Program

Under EO 13693, *Planning for Federal Sustainability in the Next Decade*, DOE requires its facilities to comply with Toxic Chemical Release Reporting and Community Right-to-Know requirements (40 CFR 372), more commonly referred to as the TRI program. SLAC provides the required information annually to DOE, which reviews, approves, and sends the TRI information to the USEPA and the state of California.

The TRI report is submitted to USEPA by June 30 of each year and reports quantities from the previous calendar year. The TRI report for SLAC submitted to USEPA and the state of California in June 2016 covered the CY 2015 reporting year. Of the more than 400 listed TRI chemicals, only lead is used at SLAC above its regulatory threshold for reporting. As a result, SLAC prepared a TRI Form R for lead and submitted it to the DOE SSO for review and approval in June 2016. TRI data are available to the public via the USEPA website.[8]

4.5.5 California Accidental Release Prevention Program

SLAC has only one regulated chemical that is used above its CalARP threshold: potassium cyanide, which is used only in the Plating Shop complex. For this usage, a RMP was originally prepared and submitted to the CUPA in 2006. As part of the RMP, worst-case scenarios were modeled for a catastrophic release of potassium cyanide, but none of the scenarios led to offsite consequences. Since the impact of such a release was limited to the immediate area of use, SLAC qualified for a Program 1 RMP (the lowest level), whereby a more detailed process hazard assessment and an offsite consequence analysis were not required. The final Program 1 RMP for SLAC was finalized in 2008 following a public comment period. The 5-year review and update of the RMP was submitted to the CUPA in April 2012, and the next update will be completed in 2017.

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 list of all 12 active and regulated ASTs containing petroleum at SLAC during CY 2016 is presented in Table 4-3. All of the petroleum tanks at SLAC are constructed of steel with secondary containment. An SPCC plan is required by 40 CFR 112 for all petroleum-containing ASTs greater than 660 gallons in size. The SLAC SPCC plan was updated in 2013. SLAC does not have any underground storage tanks.

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8 http://www.epa.gov/tri/tridata/index.html

Table 4-3 Aboveground Petroleum Tanks

Petroleum Product	Property Control Number	Location	Number of Tanks	Capacity (gallons)
Diesel	19683	B112 Master Substation	1	2,000
Gasoline	21443	B035 Vehicle Refueling Station	2	1,500/500
Vacuum Oil *	19596	B020 North Damping Ring	1	516
Diesel	19781	B505A Generator Fueling	1	500
Diesel	21287	B007 MCC Generator Fueling	1	500
Vacuum Oil *	19595	B021 South Damping Ring	1	260
X-ray Oil	15192	B044 Klystron Test Lab	3	364/ 227/ 227
Compressor Oil	na	B127 Cryogenics	1	200
Compressor Oil	18562	B127 Cryogenics	1	200

* These tanks are used only for short-term storage

na - not available

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 CY 2016.

No new transformers were added to SLAC's transformer inventory during CY 2016, but six were removed from service, bringing the current total inventory of oil-filled transformers at SLAC down from 97 in 2015 to 91 in 2016. Transformers with PCB concentrations of 500 parts per million (ppm) and greater are defined by TSCA as PCB transformers. SLAC has no PCB transformers. Transformers with PCB concentrations equal to or greater than 50 ppm but less than 500 ppm are defined by TSCA as PCB-contaminated transformers. Four of the six transformers removed were classified as PCB-contaminated. Only five of SLAC's remaining 91 transformers are PCB-contaminated. The other 86 transformers contain PCBs at concentrations of less than 50 ppm. As such, they are defined by TSCA as non-PCB transformers. The total quantity of PCBs contained in the 91 transformers in service during 2016 is estimated to be approximately 13.9 lbs.

4.5.8 Chemical Management System

SLAC has been purchasing chemicals solely through *Haas Group International* (Haas) since August 2005 under its CMS program. 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
- Generate chemical usage and compliance reports directly from procurement data

Haas is continuing to work with SLAC on the following services:

- Supporting SLAC's sustainability efforts by identifying safer or preferred alternative products and setting up opportunities with potential SLAC users to meet the suppliers and test products

At the end of calendar year 2016, the program had achieved the following:

- Maintained excellent safety performance in the CMS program; no illnesses/injuries or reportable chemical spills in CY 2016
- Ensured contractors have met their training requirements
- Achieved inventory of 5,557 active chemicals in the catalog
- Identified 1,106 users of the CMS program and 107 work areas

4.6 Waste Management and Minimization

During the course of its research operations, SLAC generates a variety of waste streams, including both hazardous wastes and non-hazardous wastes. The latter includes industrial waste, municipal solid waste, and construction and demolition debris.

4.6.1 Hazardous Waste Management and Minimization

4.6.1.1 Regulatory Framework

SLAC is a 90-day hazardous waste generator and as such, is not required to obtain a Resource Conservation and Recovery Act (RCRA) Part B permit that would allow the treatment, storage and/or disposal of hazardous waste onsite (i.e. a treatment, storage, and disposal facility permit) under the federal RCRA regulations. However, SLAC does have permits to treat a few RCRA-exempt and non-RCRA (i.e. California-only) hazardous waste streams (see Section 4.6.1.2 regarding the state-level tiered permit program).

The USEPA has delegated authority for implementing the federal RCRA program to the state of California. In turn, the state has delegated its authority on 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 activities.

4.6.1.2 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 four hazardous waste treatment units, all under permit by rule. These units are authorized to treat listed or characteristic hazardous wastes. The various units and tiered permit level are summarized in Table 4-4.

Table 4-4 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

4.6.1.3 Hazardous Waste Tracking

This section does not include radioactive waste. SLAC utilizes a self-developed, site-specific computerized hazardous waste tracking system (WTS). Hazardous wastes are tracked from the time they are generated to final appropriate disposal off-site. The WTS includes fields that generate information required for the SARA Title III, TRI, SB 14 and TSCA PCB reports.

4.6.1.4 Hazardous Waste Minimization

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

- Reducing generation of excess chemicals through CMS
- Converting non-hazardous empty metal containers and drums to scrap metal
- Exchanging chemicals with other users
- Reclassifying waste streams to reduce hazardous waste volumes
- Re-using chemicals
- Returning unused material to the vendor or manufacturer
- Sending electrical equipment offsite for re-use by other organizations

SLAC continues to make progress in reducing hazardous waste generated from routine operations. Routine wastes are those wastes associated with SLAC's routine operations and maintenance processes. For FY 2016, SLAC reduced its hazardous waste generated by routine operations from the 1993 baseline of 147 tons to 15 tons, a 90 percent reduction. Measures will continue to be taken to further reduce hazardous waste by helping smaller generators increase their awareness of waste reduction opportunities, helping them procure less hazardous chemicals, and helping them learn to develop for themselves more focused waste reduction measures for their work areas.

4.6.2 Non-Hazardous Waste Management and Minimization

Non-hazardous waste can be grouped into non-hazardous industrial waste, municipal solid waste, and, construction and demolition (C&D) debris.

4.6.2.1 Non-hazardous Industrial Waste Management

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 containing low levels of petroleum hydrocarbons, PCBs or metals that are classified as non-hazardous but are not acceptable for disposal at 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).

4.6.2.2 Municipal Solid Waste Management

The term *municipal solid waste* (MSW) refers to the following waste streams generated at SLAC:

- Beverage containers (glass, aluminum, plastic)
- Paper (white paper, mixed paper)
- Cardboard
- Scrap wood
- Scrap metal
- Garden/landscaping waste
- Salvage sales and transfers
- Food wastes
- Tires
- Trash (non-recyclable waste)

SLAC's Facilities & Operations Department operates a MSW management program that collects a variety of recyclable and compostable materials as well as regular dumpster refuse (i.e., trash). SLAC's Property Control Department operates a salvage operation that sells metal, equipment, and other salvageable commodities for their cash value or makes them available to the site and others for reuse. Both of these programs help SLAC minimize disposal of MSW in landfills.

SLAC also has programs in place to manage other wastes including C&D wastes, electronic wastes (e-wastes), and universal wastes, as described in Sections 4.6.2.3 and 4.6.3.

SLAC has made substantial gains in MSW diversion from landfills, as indicated in Table 4-5 and Figure 4-3 below. SLAC's MSW percentage diversion rates since FY 2013 are significantly higher than in past years, due to a large quantity of scrap metal recycled by SLAC starting in FY 2013.

SLAC continues to strive for MSW waste reduction through expansion of zero waste programs in SLAC office buildings. SLAC's zero waste program utilizes a model developed by the City of San Francisco for commercial office buildings, which includes centralized waste, recycling, and compost collection areas, and compost collection of paper towels in the restrooms. The program was first instituted in 2008 at the SLAC cafeteria, and in 2012, SLAC began expanding this program to office buildings.

Through FY 2016, the program has been implemented in fourteen buildings (Buildings 024, 028, 035, 040, 041, 051, 052, 053, 120, 137E/W, 750/751, 901, 950, 999). Approximately 75 percent of SLAC staff work in buildings participating in the program.

Table 4-5 Breakdown of Municipal Solid Waste Diversion Quantities FY 2011-FY 2016, (Excluding C&D, E-Waste, and Universal Waste)

Year (FY)	MSW Disposed (all Offsite) (tons)	MSW Diverted (1) (tons)	MSW Composted (2) (tons)	Waste to Energy (3) (tons)	MSW Diversion Percentage Rate (%)
2011	522.4	425.5	169.5	-	53.3
2012	399.2	545.6	164.9	-	64.0
2013	399.3	1769.5	115.2	-	82.5
2014	306.1	1493.1	105.9	28.8	84.2
2015	269.9	982.8	131.7	34.9	81.0
2016	301.1	505.4	190.3	51.6	71.3

(1) "MSW Diverted" includes materials recycled including paper, cardboard, scrap metal, scrap wood, equipment sold or transferred, and tires, and does not include C&D, e-waste, or universal wastes.

(2) "MSW Composted" includes materials composted including green waste such as garden and landscape trimmings and food waste.

(3) Waste to Energy includes those materials diverted from landfill and used for energy, such as scrap wood sent as fuel to boilers. Prior to FY2014, this category was not tracked separately but included in the MSW Diverted tonnage.

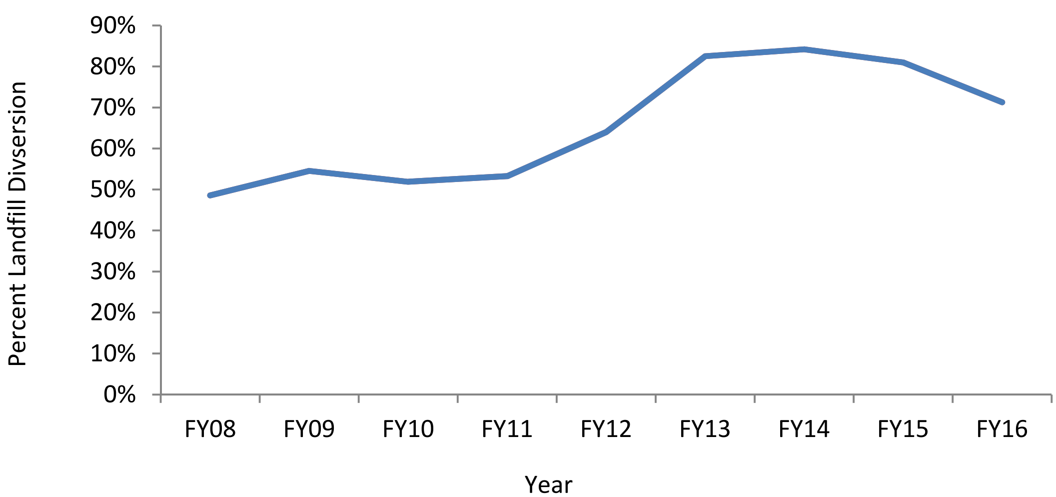

Figure 4-3 Municipal Solid Waste Diversion Rates 2008 – 2016 (Excluding C&D, E-Waste, and Universal Wastes)

Additional information on SLAC's MSW diversion program and data are provided in SLAC's *Site Sustainability Plan.* [9]

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[9] SLAC National Accelerator Laboratory, *Site Sustainability Plan FY 2017*, December 2016

4.6.2.3 Construction and Demolition Debris

C&D debris include a variety of non-hazardous materials generated as a result of construction projects, and may include concrete, wood, metal, gypsum board, and other materials. SLAC's major construction and renovation contracts include requirements for recycling of C&D wastes and as a result, SLAC achieves high landfill diversion rates for C&D materials, as illustrated in Table 4-6. Recycling of demolition materials from a number of construction projects including the LCLS II, the Photon Science Laboratory Building (PSLB), and trailer removals, as well as the crushing and reuse of concrete blocks, accounted for the very high tonnage of C&D diverted in FY 2016.

Table 4-6 Breakdown of Construction and Demolition Diversion Quantities FY 2011 - FY 2016 (Excluding Soil Reuse)

Year (FY)	C&D Disposed (tons)	C&D Diverted (tons)	Diversion (%)
2011	25	1,502	99
2012	21	283	93
2013	39	509	93
2014	33	2,414	99
2015	71	923	93
2016	107	4,579	98

% - percentage
FY – fiscal year

4.6.3 Other Waste Management Activities

SLAC has programs in place to recycle electronic waste (e-waste) and universal wastes (e.g., bulbs and batteries). In FY 2016, over 107 metric tons of these wastes were recycled, and all of SLAC's electronic wastes were recycled through electronics recyclers that were certified under either the e-Stewards or Responsible Recycling programs, helping to ensure proper disposition of these materials.

SLAC generates a small quantity of low-level radioactive waste every year; this waste stream is discussed in Chapter 5. In addition, 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's *Site Sustainability Plan,*[10] summarizes SLAC's planned actions and performance status on the sustainability goals derived from EO 13693, as adopted by DOE in their *Strategic Sustainability Performance Plan (SSPP).*[11]

[10] SLAC National Accelerator Laboratory, *Site Sustainability Plan FY 2017*, December 2016.

[11] U.S. Department of Energy, *2016 Strategic Sustainability Performance Plan, September 2016*.

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". The EO and DOE Strategic Sustainability Performance Plan (SSPP) goals complement SLAC's values on sustainability and provide quantifiable objectives and timeframes, consistent across the federal complex.

Included below is a summary of progress on key sustainability goals, in the areas of energy, GHG, water, sustainable building, and waste, as reported in SLAC's *Site Sustainability Plan*.

Table 4-7 Progress against Select Sustainability Goals of EO 13693 and the DOE Strategic Sustainability Performance Plan through FY 2016

Category	EO 13693/DOE Goal	Progress
Energy Reduction	25 percent energy intensity (BTU per gross square foot) reduction by FY 2025 from the FY 2015 baseline value (2016 target 2.5 percent)	SLAC did not meet the 2.5 percent reduction target. SLAC estimates that there was no appreciable (0 percent) change in energy intensity for goal subject buildings between FY 2015 and FY 2016. Not all goal subject buildings were individually metered. Enhanced metering is underway in FY 2017.
Renewable Energy	Renewable electric energy shall account for at least 10 percent of total electric consumption	SLAC met the target by offsetting 12 percent of the site's electrical consumption with renewable energy from a combination of wind and hydroelectric sources. This effectively avoided generating 53,000 metric tons of GHG.
Greenhouse Gas Reduction	50 percent Scope 1 and 2 GHG reduction by FY 2025 from the FY 2008 baseline (2016 target: 22 percent)	SLAC met the interim target of 22 percent reduction for FY 2016, by achieving 42 percent reduction compared to the FY 2008 baseline.
Water Reduction	36 percent potable water intensity (gallons per gross square foot) reduction by FY 2025 from the FY 2007 baseline (2016 target: 18 percent)	SLAC met the water reduction target by achieving a 54 percent reduction. SLAC reduced water consumption each year, for the last three years.

Category	EO 13693/DOE Goal	Progress
Sustainable Building	17 percent of buildings larger than 5,000 gross square feet to be compliant with the HPSB by FY 2025, with progress to 100 percent thereafter.	SLAC's goal is nine HPSB buildings. Currently, SLAC has five HPSB compliant buildings, plus two additional buildings in process.
Waste Reduction	Divert at least 50 percent non-hazardous solid waste (excluding C&D debris) by FY 2016. Divert 50 percent of C&D materials by FY 2016.	SLAC met the target and has exceeded the MSW diversion goal for the last several years, with a 71 percent diversion rate for FY 2016 (excluding C&D debris). Similarly, the C&D diversion goal was exceeded, with a 98 percent diversion rate for FY 2016.

N
N
BTU – British thermal units
C&D – construction and demolition
FY – fiscal year
GHG – greenhouse gases
HPSB – high-performance sustainable building
MSW – municipal soil waste

4.8 National Environmental Policy Act

SLAC's mission has expanded from a single-purpose high-energy physics laboratory to a multi-program laboratory conducting research in the areas of photon science, particle physics, cosmology, structural biology and medicine, material science, and emerging technologies. SLAC continues to upgrade the original linear accelerator and its associated machines and hardware in response to its evolving programs, and ensures that the NEPA requirements are followed on a project-by-project basis for all new construction projects.

NEPA, the goal of which is to protect, restore and enhance the environment, was enacted into law in 1970. SLAC developed its formal NEPA program in 1992, which is jointly administered by the DOE and SLAC's EP Department. Under this program, proposed SLAC projects and actions are reviewed to evaluate NEPA documentation requirements. The three categories of NEPA documentation in increasing order of complexity are:

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

SLAC staff provides information and technical support to DOE to be used in determining whether proposed federal actions will have a significant effect on the environment. The completed NEPA documents are forwarded to the DOE SSO for review, concurrence, and/or approval by the DOE NEPA Compliance Officer located at the DOE Office of Science Integrated Support Center in Oak Ridge, Tennessee.

Environmental aspects that must be considered when conducting the environmental analysis and preparing NEPA documentation commonly include: potential increases in air emissions, hazardous materials usage, and waste generation, impacts on wetlands, sensitive species and critical habitats, increases in water consumption and wastewater discharge, and impacts to historical and cultural resources.

To be consistent with the DOE NEPA Openness Policy, SLAC's CX determinations are available to the public at the link provided below.[12] All of the projects reviewed for NEPA purposes in 2016 were relatively minor in scope and impacts, and were classified as CXs.

[12] http://science.energy.gov/SSO/nepa-documents/

5 Environmental Radiological Program

5.1 Introduction

All members of the public receive radiation doses from natural background radiation and from various human activities. This chapter describes sources of radiation and radioactivity at SLAC and provides an overview of how SLAC's REP program assesses direct radiation and radioactivity in air, soil and water to determine the potential radiation dose to the public and any impacts to the environment.

DOE O 458.1, *Radiation Protection of the Public and the Environment (Change 3),* requires that radiation and radioactivity from SLAC do not cause any member of the public to receive a radiation dose greater than 100 milli-rems (mrem, a unit used to quantify radiation dose to humans) in a year.[13]

As in past years, the potential dose that members of the public receive due to SLAC operations in CY 2016 was a very small fraction of the dose received from natural background radiation. In addition, the potential dose to the public and the radiation-related impacts to the environment from SLAC operations were significantly below all regulatory limits and SLAC administrative limits.

5.2 Sources of Radiation and Radioactivity

The 2-mile linac at SLAC is located inside 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 up to giga-electron volt levels.

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 of the 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 potentially released to the environment 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 have the potential to be released into the environment. All potential releases of radioactive materials are included in the tables in those sections.

[13] United States Department of Energy, DOE O 458.1, *Radiation Protection of the Public and the Environment.*

Table 5-1 Activation Products in Water or Air

Radioactive Element	Half-life	Primarily Produced In
Oxygen (^{15}O)	123 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 (tritium (^{3}H))	12.3 years	Water

5.3 Monitoring for Direct Radiation

In CY 2016, the maximum dose that could have been received by a member of the public due to direct radiation from SLAC was 0.05 mrem [5.0E-04 milli-Sievert (mSv) - the International System of units for dose equivalent]. [14] This is 0.05 percent of the 100 mrem regulatory limit. The maximally exposed individual (MEI) for this direct radiation is located near the Addison Building Area, an office business property adjoining the north side of SLAC.

During CY 2016, 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 these site-boundary dosimeters used to measure radiation were recorded each calendar quarter. The annual doses from these dosimeters were used to estimate the doses to the MEI based on continuous occupancy of 24 hours a day, 365 days per year. 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 5.3 million) that lives within 80 kilometers (km) (equivalent to 50 miles) of SLAC. The collective dose was 0.036 person-rem for CY 2016.

Section 5.8 and Table 5-6 summarize annual doses to the MEI from both direct radiation (0.05 mrem) and airborne radioactivity released (2.4E-03 mrem) and show those doses are much smaller when compared with those from natural background radiation.

5.4 Assessment of Airborne Radioactivity

As required by 40 CFR 61, Subpart H, SLAC files an annual report to the USEPA that describes the possible sources, types, and quantities of airborne radioactivity released into the atmosphere. [15] As detailed below, the potential dose to the MEI of the off-site general public from CY 2016 releases of airborne radioactivity was calculated to be 2.42E-03 mrem (2.42E-05 mSv). This is well below the regulatory limit, which requires releases to be limited so that no member of the public receives a dose in excess of 10 mrem

[14] Radiation Protection Department Memo. CY 2017 SLAC Site Boundary Environmental Dosimeter Monitoring Results and Public MEI Dose Calculations, RP-DREP-20170413-MEM-01

[15] SLAC National Accelerator Laboratory, Environment, Safety & Health Division. Radiation Protection Department, *Radionuclide Air Emissions Annual Report – CY 2016* (June 2017)

(0.1 mSv) in any one year. Approximately 1.85E-03 mrem (or 77 percent of the MEI dose) can be attributed to ^{13}N radioisotope. The MEI location that corresponds to the highest calculated effective dose equivalent for releases in CY 2016 is along SLAC's northern boundary with Sand Hill Road, 560 meters north of the linac's Sector 20.

The collective effective dose equivalent to the population within 80 km of SLAC's site boundary (estimated at 5.3 x 10^6 persons) due to releases of airborne radioactivity at SLAC in CY 2016 was calculated to be 1.44E-02 person-rem.

In addition, there was no individual release point within SLAC exceeding the 0.1 mrem/year (0.001 mSv/yr.) limit for the continuous monitoring requirement. The maximum value from an effluent source at the Facility for Advanced aCcelerator Experimental Tests (FACET) Positron Vault release point was 2.32E-03 mrem/yr. Approximately 96 percent of the 2.42E-03 mrem (MEI dose) can be attributed to emissions from FACET operations. All the FACET release points contribute about 76 percent of the total airborne radioactivity released to the atmosphere from all SLAC operations in CY 2016.

As detailed in the annual NESHAPs report, the released airborne radioactivity was calculated based on conservative information (i.e. operating parameters) about SLAC accelerator operations in CY 2016. Table 5-2 summarizes the estimated radioactivity released, showing the quantities in curies (Ci). Potential doses to members of the public due to the released radioactivity were determined using the USEPA-approved software CAP-88 version 2.

Table 5-2, Table 5-6, and Section 5.8 provide a summary of how the calculated potential maximum doses compare with natural background radiation.

Table 5-2 Airborne Radioactivity Released in CY 2016

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)	0.04
Short-lived activation products ($T_{1/2}$ < 3 hr)	Oxygen (^{15}O)	1.0
	Nitrogen (^{13}N)	2.0
	Carbon (^{11}C)	0.2
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		3.3

n/a – not applicable

$T_{1/2}$ – half life

< - less than

> - greater than

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 CY 2016 monitoring and results for each water type.

5.5.1 Industrial Wastewater

Federal and state regulations (10 CFR 20.2003 and 17 California Code of Regulators 30253) limit the radioactivity in industrial wastewater that SLAC releases to the sanitary sewer system. In CY 2016, SLAC released 0.0013 percent of the applicable limits (only 6.23×10^{-5} Ci for tritium).

Throughout CY 2016, SLAC sampled and analyzed wastewater discharges for tritium. Total activity released during CY 2016 is summarized in Table 5-3.

As required by regulations, at the end of each calendar quarter of CY 2016, SLAC reported the results of wastewater monitoring and discharge to the SVCW.[16]

Table 5-3 Radioactivity in Wastewater Released into Sanitary Sewer in CY 2016

Category	Radioactive Element	Activity (Ci)	Annual Release Limit (Ci)
Tritium	Hydrogen (^{3}H)	6.23×10^{-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 ^{3}H (for which there is a 5 Ci annual limit), there is a 1 Ci limit for the combined activity of all radioactive elements released during the calendar year

n/a – not applicable

Table 5-4 summarizes the historical results of wastewater monitoring for CY 2006 through CY 2016. 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.

16 SLAC, ESH Division, Radiation Protection Department, *Radioactivity in Industrial Wastewater for the Period of 1 January 2016 to 31 December 2016*

Table 5-4 Summary of Radioactivity in SLAC Wastewater, CY 2006– 2016

Year	Radioactive Element	Activity (Ci)	Percentage of Annual Limit
2006	Hydrogen (^{3}H)	$1.2x10^{-3}$	0.02
2007	Hydrogen (^{3}H)	2.3	46
2008	Hydrogen (^{3}H)	1.8	36
2009	Hydrogen (^{3}H)	$9.1x10^{-5}$	0.002
2010	Hydrogen (^{3}H)	$1.2x10^{-2}$	0.24
2011	Hydrogen (^{3}H)	$2.08x10^{-4}$	0.004
2012	Hydrogen (^{3}H)	$1.1x10^{-4}$	0.002
2013	Hydrogen (^{3}H)	$4.63x10^{-5}$	0.0009
2014	Hydrogen (^{3}H)	$4.86x10^{-4}$	0.01
2015	Hydrogen (^{3}H)	$1.36x10^{-5}$	0.0003
2016	Hydrogen (^{3}H)	$6.23x10^{-5}$	0.0013

^{3}H – tritium
Ci - Curie

5.5.2 Stormwater

The stormwater monitoring program is described in Section 4.4 of this report. In CY 2016 (and in all previous years), no radioactivity above natural background was found in any stormwater or storm drain sediment samples.

5.5.3 Groundwater

Throughout CY 2016, 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 (SAP) that outlines the frequency of sampling the wells. Groundwater samples collected as part of the SMP and analyzed for tritium are sent to a California-certified analytical laboratory for tritium analysis. Splits of these samples are also analyzed by SLAC’s RP Department. The results from the in-house laboratory are in general agreement with the results of the external laboratory.

SLAC has 183 groundwater monitoring wells (see Chapter 6), 19 of which are sampled for tritium at least once a year, per the groundwater monitoring program’s SAP. However, tritium has historically been detected above the analytical method’s reporting limit in only the five wells listed in Table 5-5 below (SLAC’s RP Department data).

Table 5-5 Summary of Tritium Concentrations Measured in Five Monitoring Wells in CY 2016

Period (Month)		Jan. to March	April to June	July to Sept.	Oct. to Dec.
EXW-4	Avg ^{3}H (pCi/L)	617	< 500[2]	640	711
	percent of DWS[1]	3	na	3	4
	No. of Samples	1	1	1	1
MW-30	Avg ^{3}H (pCi/L)	< 500[2]	< 500[2]	< 500[2]	< 500[2]
	percent of DWS	na	na	na	na
	No. of Samples	1	1	1	1
MW-81	Avg ^{3}H (pCi/L)	< 500[2]	< 500[2]	< 500[2]	na
	percent of DWS	na	na	na	na
	No. of Samples	1	1	1	0
MW-82	Avg ^{3}H (pCi/L)	<500[2]	< 500[2]	< 500[2]	786
	percent of DWS	na	na	na	4
	No. of Samples	1	1	1	1
MW-94	Avg ^{3}H (pCi/L)	528	1,314	1,824	1,621
	percent of DWS	3	1	9	8
	No. of Samples	1	1	1	1

[1] DWS – Drinking Water Standard: 20,000picocuries per liter (pCi/L) for tritium

[2] 500 pCi/L was the minimum tritium concentration that was detectable by SLAC in CY 2016

na – not available

Other than groundwater from these five wells, no radioactivity above natural background levels has ever been detected in samples from any of the other wells. 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, which is 20,000 picoCuries per liter (pCi/L) under 22 CCR 64443 and 40 CFR 141.66. In addition, groundwater beneath SLAC is not used for any purpose because of its very low well yields, and because of the water's naturally high content of total dissolved solids (TDS).

5.6 Assessment of Radioactivity in Soil

Throughout CY 2016, SLAC did not perform any sampling and analysis of soil for radioactivity because there were no excavations within areas at SLAC where soil could potentially be activated from SLAC operations.

5.7 Release of Property Potentially Containing Residual Radioactive Material

All property, both real and personal, exposed to any process at SLAC that could cause the property to have the potential for surface or volumetric radiation contamination has to be measured using appropriate instruments with sufficient detection capabilities. In addition to radiological surveys, SLAC also uses process knowledge to ensure that the material meets the release criteria for recycling metals. The materials are verified to have no detectable radioactivity before they are cleared and permitted to be released from the radiological controlled areas. At SLAC, property that has any detectable radioactivity is identified as radioactive, and either is retained for appropriate reuse on site or is disposed of as radioactive waste. Only material which does not have detectable radioactivity can be released from radiological controlled areas. Therefore, property releases at SLAC do not add to the potential public dose.

The SLAC material release program has been benchmarked with other similar DOE laboratories and peer-reviewed. The protocols and the releases for certain batches of metals have also been validated and verified by the DOE SSO. Following the protocol described above, 427 tons of metal were recycled from several locations at SLAC in CY 2016, including materials removed from the linac's Sectors 0 through 10 in support of the LCLS II project. The recycled metal included material from the Klystron Gallery (linac Sectors 0 through 10), rebar from excess concrete shield blocks that have been crushed, and excess equipment stored in the Beam Dump East Yard. A radiation portal-gate monitor is in operation at SLAC, which is used as a final screening by SLAC of trucks full of metal that has been tentatively released and is ready to be transported to the appropriate recycling center.

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 CY 2016, namely direct radiation (0.05 mrem) and airborne radioactivity (2.42E-03 mrem). Releases of radioactivity into water and property were too small to result in a radiation dose to a member of the public under any credible scenario. Table 5-6 also compares the CY 2016 dose results with regulatory limits and natural background.

The MEI due to direct radiation is located near the business offices in the Addison Building area (590 meters north from Sector 20 of the linac), which is located immediately north of SLAC. As with previous years' calculations, the CY 2016 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, the effects of air attenuation for direct photon radiation calculations (a factor of 40) were taken into account.

Table 5-6 Summary of Potential Annual Doses due to SLAC Operations in CY 2016

	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	0.05 mrem	2.42E-03 mrem	0.052 mrem	0.036 (direct) + 0.014 (air) = 0.05 person-rem
DOE Radiation Protection Standard	100 mrem	10 mrem	100 mrem	n/a
SLAC Maximum Dose as Percentage of DOE Standard	0.05 %	0.03%	0.05 %	n/a
Dose from Natural Background[17]	100 mrem	200 mrem	300 mrem	1,667,000 person-rem
SLAC Maximum Dose as Percentage of Natural Background (%)	0.05	0.0012	0.017	3.0E-06

mrem – millirem
n/a - not applicable
% - percent

[17] 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*

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 CY 2006 through CY 2016, and compares it with the average dose due to natural background radiation and radioactivity.

Table 5-7 Potential Annual Dose * (mrem/yr) to Maximally Exposed Individual, CY 2006–2016

Year	SLAC Direct and Airborne Radiation (mrem)	Average, Total Natural Background Radiation (mrem)	Percentage of SLAC Dose to Natural Background
2006	0.5	300	0.2
2007	0.1	300	0.03
2008	0.05	300	0.02
2009	0.06	300	0.02
2010	0.13	300	0.04
2011	0.42	300	0.14
2012	0.53	300	0.18
2013	0.04	300	0.013
2014	0.045	300	0.015
2015	0.045	300	0.015
2016	0.052	300	0.017

* 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), indicates DOE facilities are to 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, instead of rem, is used in this report, as rad is the unit to quantify radiation dose in a material, in this case animal and plants.

5.9.1 Dose to Biota from Direct Radiation

In CY 2016, SLAC monitored radiation dose and dose rate at approximately 600 on-site locations (most are outside accelerator shielding housing and the rest are inside shielding housing) using passive radiation dosimeters posted for six-month periods. For each period, the average dose rate of these 600 dosimeters was found to be less than 0.0005 rad/day[18] (dominated by those inside shielding housing), and the

[18] Monitoring Results for Integrated Area Dose around SLAC for the period from January 2016 through June 2016, and Monitoring Results for Integrated Area Dose around SLAC for the period from July 2016 through December 2016

maximum dose rate was less than 0.03 rad/day (inside shielding housing). Based on these results, and the fact that the animal population could only have had access to areas with low dose rates (outside shielding housing), doses to plant and animal populations at SLAC were well within the limits of the DOE standard throughout CY 2016.

5.9.2 Dose to Biota from Activation Products

In CY 2016, SLAC tested water samples for the presence of radioactivity above natural background levels, as described in Sections 5.5 and 5.6. Tritium was occasionally found in industrial wastewater, but plants as well as animal populations have no path by which to come into contact with 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 have received dose rates from radioactive activation products at SLAC that exceed the standard radiation limits.

In CY 2016, all groundwater samples analyzed for tritium were reported as either non-detects (i.e. below the reporting limit 500 pCi/L) or, if tritium was detected, the concentration was well below the human drinking water standard of 20,000 pCi/L. This value is set by the USEPA regulation. Section 5.5.3 summarizes the CY 2016 results of monitoring for radioactivity in groundwater and it shows that the levels of tritium in the groundwater have been decreasing over time. There is no potential that plants or animals will have received dose rates from activation products in groundwater at SLAC that exceed the limits of the standard.

5.10 Low-level Radioactive Waste Management

SLAC generates low-level radioactive waste (LLRW) and mixed waste from its routine operations, repairs, experiments and special projects such as decommissioning. The total waste generated during CY 2016 was 37,513 cubic feet (ft^3), including legacy waste that was processed during CY 2016. Routine operations generated 22 ft^3 of which 13 ft^3 was mixed LLRW. Waste minimization is accomplished through training of the waste generators, 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 and DOE directives. During CY 2016, SLAC shipped 38,516 ft^3 of LLRW containing 2.4 Ci of activity and weighing 2,392,291 kilograms to appropriately permitted and licensed treatment and disposal facilities for low-level radioactive waste. SLAC also disposed of 38 sealed sources.

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 document *The Geology of SLAC* [19] provides a detailed description of the geology of SLAC. Based on many tests in exploratory borings and wells, the hydraulic conductivity of SLAC's 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.

6.3 Areas with Potential Impact from Chemicals

A SLAC 1994 report entitled *Summary and Identification of Potentially Contaminated Sites* [20] 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. Additional environmental summary documents were completed in 2006 through 2012. The *2006 Environmental Baseline Report* [21] (EBR) provided an inventory of facilities and areas at SLAC that were considered to have the potential to have chemical impacts, and summarized the results of the environmental investigations and remediation activities that had occurred. The EBR identified COPCs, defined Investigation Areas, and provided a decision process for determining which areas still required additional actions. At that time, The *Work Plan for the Remedial Investigation and Feasibility Study* [22] (RI/FS WP) provided additional description and updated the status of investigation areas, defined the four Operable Units (OUs) at SLAC, and described the framework for completing the environmental investigations and remedial actions at the facility. As discussed further in Section 6.5, remedial

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19 Stanford Linear Accelerator Center, *The Geology of SLAC* (SLAC-I-750-3A33X-002, November 2006) http://www-group.slac.stanford.edu/esh/groups/ep/geology/geologicreport.pdf

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

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

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

investigations and remedial actions at each OU have been completed at SLAC in accordance with the Board Order and RI/FS WP.

In 2016, SLAC Environmental Restoration Program personnel continued remediation efforts in specific areas impacted by COPCs. The progress of these remediation efforts are discussed in detail in Sections 6.8.1 through section 6.8.6. Current operating data indicate that the remediation systems have resulted in a significant decrease in concentrations of COPCs in groundwater and soil vapor and are achieving hydraulic control of the groundwater plumes.

6.4 Strategies for Controlling Potential Sources of Chemicals

Strategies for chemical source control include measures to control known soil or groundwater impacts (as are discussed in this chapter), and required procedures that are meant to prevent practices that could adversely affect soil and groundwater (as discussed in Chapter 4). These procedures include the site's SWPPP,[23] 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 general restoration approach at SLAC is to accomplish the following steps:

1. Identify sites with actual or potential impacts (involving soil, soil vapor, groundwater, surface water, and/or air)

2. Prioritize impacted sites based on site complexity, nature of chemical impacts, associated risks, remaining data needs, and projected remedy

3. Investigate sites and identify remedies that protect human health and the environment, beginning with the highest-priority sites

4. Implement remedies and monitor for effectiveness

As of 2016, SLAC had generally reached and continued work towards completion of the fourth step. 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 four main areas impacted with COPCs in groundwater: the FHWSA, Former Solvent Underground Storage Tank Area (FSUST), the Test Lab/Central Lab area (TL/CL), and the Plating Shop Area (PSA). Each of these is described in Section 6.7, along with a description of sites where soil removal has recently been conducted.

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[23] 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 an updated 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 of California as the Administering Agency (i.e., lead agency) for the environmental cleanup work at SLAC.[24] 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 closure. The RWQCB has specified site cleanup to standards for un-restricted land use, [25] consistent with how the SLAC property is zoned.

In accordance with the Board Order and the RI/FS WP, the framework for ongoing cleanup activities parallels as practicable the CERCLA RI/FS Process, whereby a sequential series of documents are prepared for accessible areas within each of the four OUs established at SLAC. These OUs include: 1) the Groundwater VOC OU, 2) the Tritium OU, 3) the West SLAC/Campus Area/IR-8 Drainage Channel OU (WSLAC OU), and 4) the Research Yard/SSRL/IR-6 Drainage Channel OU (RY OU). However, it is noted that while SLAC follows the CERCLA RI/FS process, SLAC is not listed in the National Priorities List (NPL) as a Superfund site because the USEPA determined that the conditions at the site did not warrant inclusion on the NPL.

Many of the RI/FS documents required under the Board Order for each OU have been completed or are under review by the Water Board. These documents include a detailed summary of the nature and extent of the impact (RI reports), baseline human health and ecological risk assessments (Risk Assessment (RA) Reports), followed by a thorough review of remedial options (FS Reports) to address any remaining soil and groundwater remediation issues at the site. The reports take into consideration the removal actions already implemented and incorporate, in accordance with DOE guidance, an assessment of the NEPA values for the interim actions planned for the OU. Remedial alternatives are evaluated in the FS reports against a number of criteria including effectiveness, ability of implementation, cost, and community acceptance. Upon RWQCB approval of the RI, RA, and FS reports, as applicable, Remedial Action Plans (RAP) and Remedial Design (RD) reports are prepared for each OU. The RAPs outline the steps required to implement the proposed remedial actions required to achieve the cleanup objectives for the site and the RD reports provide the engineering design details for the remedial action.

The following Water Board Order deliverables and other documents were submitted to, or approved by the Water Board during the 2016 calendar year:

- Final *West SLAC/Campus Area/IR-8 Drainage Channel OU Baseline Risk Assessment* (BRA) was approved by the Water Board on June 8, 2016.
- *Group 3 Removal Action Work Plan* was approved by the Board on June 15, 2016.

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

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

- Draft *Human Health Preliminary Remedial Goal* report *Addendum no. 5* was submitted to the Water Board for review on May 3, 2016.

- *Semi-Annual Self-Monitoring Program Report, Winter 2016* was completed and submitted to the Water Board on June 13, 2016.

- *Semi-Annual Self-Monitoring Program Report, Summer 2016* was completed and submitted to the Water Board on December 12, 2016

Table 6-1summarizes the status for the RI/FS deliverables required under the Board Order as of the end of calendar year 2016.

Table 6-1 Regional Water Quality Control Board Order Deliverables Status

Operating Unit	RI Report	RA Report	FS Report	RAP	RD Report
Groundwater VOC	Complete	Complete	Complete	Complete	Complete
West SLAC	Complete	Completed	-	-	-
Research Yard	Complete	Complete	Draft Submitted	-	-
Tritium	Complete	Complete	Complete [26]	n/a [27]	n/a

n/a – not applicable

Regular Core Team meetings regarding site cleanup status continued through 2016. The Core Team is a decision-making body consisting of representatives from the RWQCB, DOE, Stanford University, and SLAC. As needed, members of the technical team are present at these meetings.

6.7 Groundwater Monitoring and Characterization Network

As part of the Board Order, SLAC implements an SMP that includes a Groundwater SAP with a schedule for collecting groundwater samples from extraction and monitoring wells, surface water samples, and sediment samples from select catch basins and drainage channels. The Groundwater SMP SAP [28] outlines the frequency of sampling the monitoring wells, and the analyses to be performed on each sample. Figures 6-1 through 6-3 show the areas where wells are used for monitoring.

The six locations where plume monitoring is performed are listed below and shown on Figures 6-2 and 6-3.

- Former Hazardous Waste Storage Area (FHWSA)
- Former Solvent Underground Storage Tank (FSUST) Area

[26] A Tritium OU Monitoring Plan was prepared in lieu of a FS Report and approved by the RWQCB

[27] Per the RWQCB approved Tritium RI Report, a RAP and Remedial Design Report are not necessary at this time

[28] Stanford Linear Accelerator Center, *Self-Monitoring Program Sampling and Analysis Plan, Revision 3* (SLAC-I-750-0A32M-005 R002) 2012.

- Test Lab and Central Lab Area (TL/CL)
- Plating Shop Area (PSA)
- Lower Salvage Yard (LSY)
- Beam Dump East (BDE)

Of the 183 wells used by the Restoration Program at SLAC, 112 wells are used for monitoring groundwater quality, COPCs, or water level measurements, 66 wells are extraction wells at a total of five groundwater remediation systems, three wells are inactive soil vapor extraction (SVE) wells, and two wells at the FSUST Area are infiltration wells. Thirteen wells are used for general site-wide surveillance. Table 6-2 summarizes the wells at SLAC by location, number of wells per location, and purpose of the wells.

The COPCs in groundwater at SLAC are primarily VOCs and to a lesser extent SVOCs. All four main locations have remediation systems that extract soil vapor and groundwater. Preliminary Cleanup Goals (PCGs) at SLAC have been established for groundwater and soil vapor. The systems at the FSUST and FHWSA, PSA and TL/CL were designed with the goal of achieving these PCGs. Operating and monitoring data from the other locations indicate that the remediation systems have resulted in significant decreases in concentrations of COPCs in both groundwater and soil vapor, and are achieving hydraulic control of the plumes. In December 2012, the RWQCB approved the shutdown of TL/CL system for a rebound testing. Calendar year 2016 marked the fourth year of rebound testing.

Groundwater samples were collected at least once from 98 wells in 2016 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 2016 [29] and the summer of 2016.[30]

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)

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[29] Stanford Linear Accelerator Center, *Semi-annual Self-Monitoring Program Report, Winter 2016* (SLAC-I-750-2A15H-051, June 2016)

[30] SLAC National Accelerator Laboratory, *Semi-annual Self-Monitoring Program Report, Summer 2016* (SLAC-I-750-2A15H-053, December 2016)

Table 6-2 Monitoring Locations and Number of Wells

Location		Number of Wells
Plume Monitoring		
Beam Dump East		9
Former Hazardous Waste Storage Area		24
Former Solvent Underground Storage Tank		22
Lower Salvage Yard		4
Plating Shop Area		26
Test Lab and Central Lab		7
	Subtotal	*92*
Extraction		
Former Solvent Underground Storage Tank		10
Former Hazardous Waste Storage Area		23
Plating Shop Area		26
Test Lab and Central Lab		7
	Subtotal	*66*
Infiltration		
Former Solvent Underground Storage Tank	*Subtotal*	2
Environmental Surveillance		
Centralized Waste Management Area		1
End Station B		1
Magnet Yard		2
Other (remote)		5
Research Yard		3
Vacuum Assembly		1
	Subtotal	*13*
Piezometer		
Plating Shop Area		4
Former Hazardous Waste Storage Area		3
	Subtotal	*7*
Inactive		
Former Solvent Underground Storage Area		3
	Subtotal	*3*
TOTAL		*183*

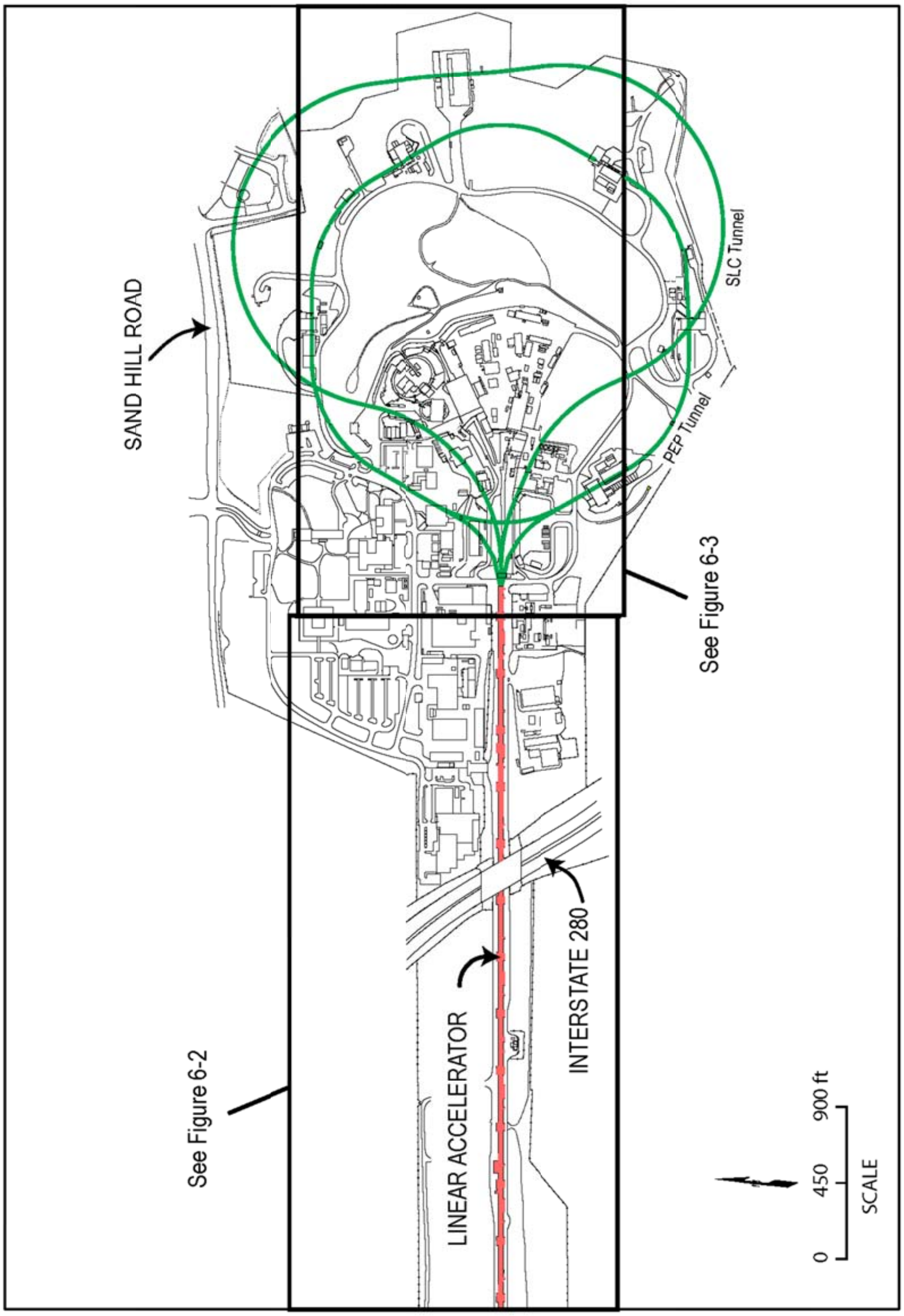

Figure 6-1 Groundwater-Impacted Well Network

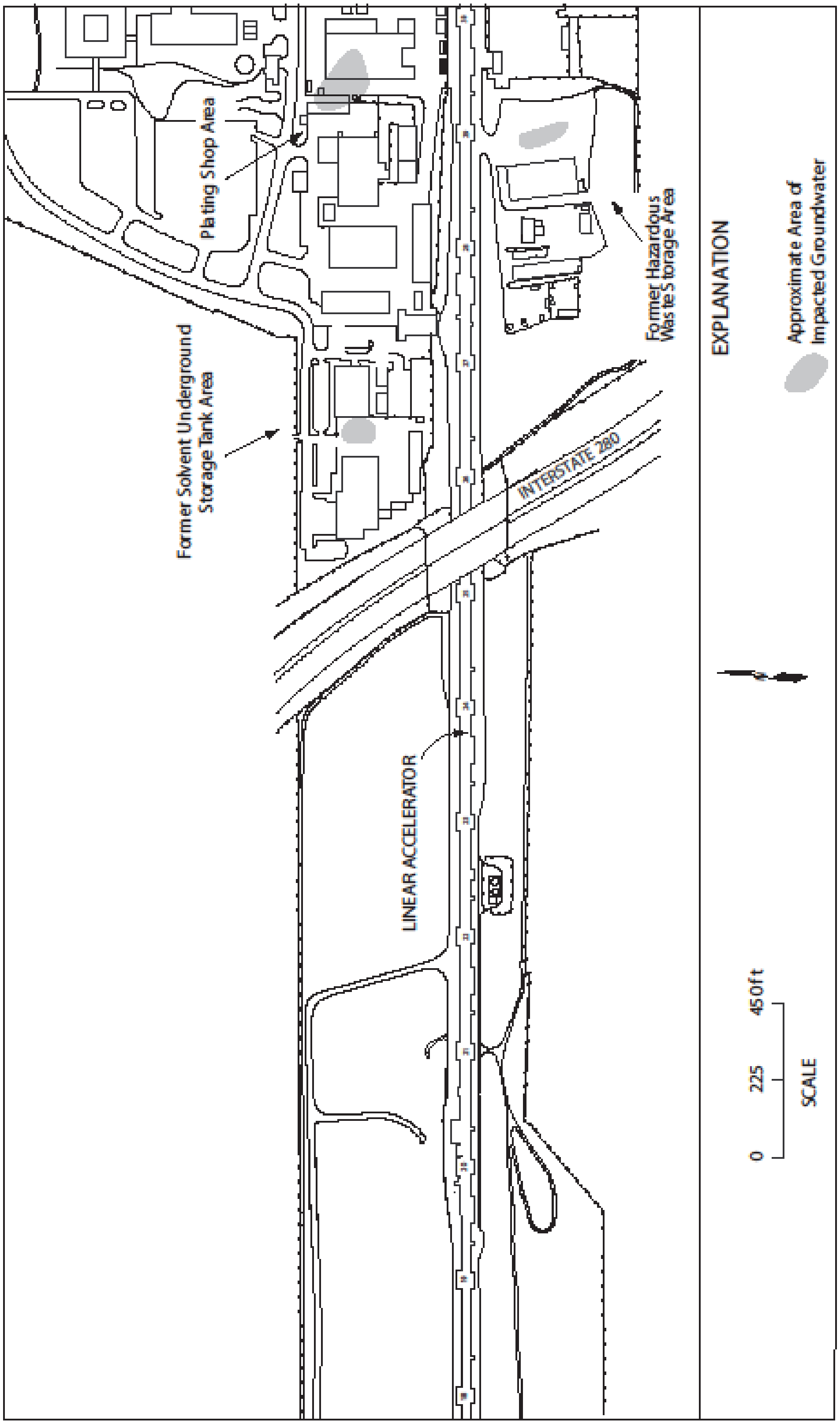

Figure 6-2 Areas in West SLAC where Groundwater is Impacted

Figure 6-3 Areas in the Main Campus and East end of SLAC where Groundwater is Impacted

6.8 Site Descriptions and Results

The groundwater Investigation Areas are described below, including four VOC-impacted areas (TL and CL are combined) and one low-level tritium-impacted area. Under the Board Order, the formal FS and RAP reports for the four VOC-impacted groundwater Investigation Areas were prepared by SLAC and approved by the RWQCB in January 2010 and August 2010, respectively. The Remedial Design report for the Groundwater VOC Operable Unit,[31] which includes the four VOC-impacted plume areas, was approved by the RWQCB in March 2011, and construction of the selected remedy (DPE at the four VOC-impacted areas) was completed by December 2010. Performance Evaluation Reports for all DPE systems are prepared either annually (PSA and TLCL) or biennially (FSUST and FHWSA) as part of the approved RAP. These reports are provided to the RWQCB for information.

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 (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 presence of a leak. The FSUST and accessible chemically impacted soil were removed in December 1983. A network of 21 monitoring wells and 8 extraction wells were subsequently installed, and groundwater is monitored for VOCs and SVOCs.

An interim groundwater extraction and treatment system was installed in 2001 and upgraded to include a soil vapor extraction component in 2007. The DPE operations, which started at the FSUST 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. The average mass removal rate has since declined, as anticipated, as the more concentrated sources are removed in the soil vapor. In 2014, two DPE wells (XW-9 and XW-10) were brought online bringing the total number of DPE wells to ten. The two new wells are intended to improve overall mass removal. In September 29, 2015, the first phase of a two-phase pilot study using in-situ chemical oxidation at the FSUST was conducted. The objective of the pilot study was to determine if infiltration of an oxidant solution into the residual chemically impacted soil source zone could accelerate the VOC and SVOC removal rates from both soil and groundwater. The second phase of the pilot study was conducted in April 2016. Monitoring to evaluate the effectiveness of the first and second phases of the pilot test continues.

Since the startup of the remediation system at the FSUST in August 2001 and through December 2016, the DPE system had removed approximately 880.22 lbs. of VOCs and SVOCs from the subsurface (soil vapor and groundwater combined), and treated approximately 1,265,600 gallons of extracted groundwater. Monitoring well data collected thus far indicate a capture zone encompassing the entire plume has been established and chemical data indicate that the plume continues to shrink in size. In addition, the monitoring data show that significant progress has been made to reduce soil vapor VOC concentrations, which is one of the remedial action goals for all the groundwater VOC-impacted areas.

[31] C/P/E, *Remedial Design Report for the Groundwater VOC Operable Unit*, (C/P/E SL-22GW-RPTS-CD000001 R0, November 2010)

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 DPE wells, and 18 soil gas probes have been installed, and more than 50 soil borings have been drilled at this site. Figure 6-2 shows the current extent of VOCs in the groundwater.

In 2002, a DPE pilot test performed at the FHWSA proved promising as a treatment method for soil and groundwater impacted by COPCs, 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 (IDPE) system. The IDPE system was in operation from December 2003 to March 2006. The design of an interim full-scale DPE system for the FHWSA was finalized in 2004 [32] and the construction of the system was completed in March 2006 after six months of construction. The full-scale system utilizes 19 groundwater/soil vapor combined 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.

Between the startup of the system in December 2003 to December 31, 2016, the FHWSA interim and full-scale systems removed approximately 2,304,117 gallons of groundwater and 41.21 lbs. mass of total VOCs and SVOCs. Similar to the FSUST area, groundwater analytical data collected thus far from the monitoring wells indicate that a capture zone encompassing the entire plume has been established and that the plume continues to shrink in its lateral and vertical extent. In addition, the analytical data indicate that significant progress has also been made in reducing the concentrations of VOCs in soil vapor. However, there appears to be an area within the FHWSA where DPE has thus far been unable to reduce VOCs concentrations in soil vapor. This area was further evaluated in 2015 and 2016 and its lateral and vertical extent established. The recalcitrant area is characterized by very low permeability shallow clayey soils. Alternative remedial options for this area are being evaluated in the upcoming *Five-Year Technology Review Report*, which requires review and reevaluation of a remedial action after a period of five years from the beginning of the RAP implementation.

6.8.3 Plating Shop Area

In 1990, three downgradient monitoring wells were installed at the PSA. COPCs 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. Twenty-six monitoring wells are currently located at the PSA (Figure 6-2). Groundwater sampling results indicate that chemicals are present in groundwater within three co-mingled plumes.

Twenty-six DPE wells make up the treatment system at the PSA, in operation since November 2010. Between the start-up of the system and December 31, 2016, approximately 3,703,013 gallons of groundwater were extracted by the PSA DPE system and 13.84 lbs. mass of total VOCs and SVOCs were removed by the system. Analytical data collected from the monitoring wells thus far indicate that a capture zone encompassing the entire plume has been established and that the plume appears to be shrinking in its

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

vertical and lateral extent. In addition, the data show that significant progress has been made in reducing soil vapor VOC concentrations.

6.8.4 Test Lab and Central Lab Area

Data from previous investigations, including a soil gas survey, soil borings and monitoring wells installed in the TL/CL have helped delineate the sources of groundwater and soil vapor impacts. Results of the investigation indicated three possible source areas for VOCs, including one adjacent to the TL, and two adjacent to the CL. The final remedial design specified two separate DPE systems at the TL/CL.

Construction of separate DPE-well systems at the TL and at the CL with additional soil vapor probes and monitoring wells was completed and started in November 2010. Between the start-up of the system in November 2010 and the last day of operation in December 2012, when the system was shut down for rebound testing (see below) approximately 200,261 gallons of groundwater was extracted by the TL DPE systems and 682,572 gallons of groundwater was extracted by the CL DPE system. In addition, 0.77 lbs. of total VOCs and SVOCs mass was removed by the TL system, and 3.08 lbs. of total VOCs and SVOCs mass was removed by the CL system. Based on the remediation progress, the RWQCB approved turning off the DPE system for rebound testing in December 2012. The fourth year of the rebound test period (initially planned to be a 3-year rebound period) was completed in December 2016. The four-year rebound testing and monitoring results indicate remediation goals, with the exception of one newly identified localized shallow soil vapor zone at the CL, continue to be met. The decision (and technical basis) to continue or discontinue DPE operations at the TL/CL will be presented in the upcoming Five-Year Technology Review Report for the site.

6.8.5 Beam Dump East

The BDE was 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. In 2016, as in previous years, the monitoring of groundwater indicates that tritium is localized to two wells in the area of the beam dump, at levels far below the drinking water standards (see Section 5.9). The BDE is part of the Tritium OU, for which a formal RI report has been prepared by SLAC under the Board Order and approved by the RWQCB in June 2009. In addition, a Monitoring Plan Report (MPR) was prepared by SLAC under the Board Order and approved by the RWQCB 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

Low levels of TPH continue to be detected in groundwater samples collected at the LSY during 2016. Based on the draft West SLAC OU Baseline Risk Assessment, the detected levels do not represent a human health or ecological risk. The non-risk based levels in the local groundwater and potential remedial actions will be evaluated as needed as part of the WSLAC/Campus Area/IR-8 Drainage Channel OU Feasibility Study.

6.8.7 Removal Actions

Since CY 2008, soil removal actions have been completed in advance of the formal FS or RAP reports for the West SLAC and RY OUs based on an Engineering Evaluation and Cost Analysis. In 2016, removal actions were completed at six additional areas within SLAC resulting in the removal of approximately 1,118 tons (927 cubic yards) of chemically impacted soil. The removed soil was disposed of at off-site permitted facilities. Since CY 2008, soil removal actions have been completed at 24 areas within SLAC. The Implementation Report for the 2016 soil removal actions is under preparation and will be submitted to the RWQCB for approval. Removal actions since CY 2008 have resulted in the removal of approximately 41,000 cubic yards of impacted soil and debris from 24 areas.

6.9 Excavation Clearance Program

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 within SLAC. The excavation clearance program addresses potential worker exposure hazards associated with underground utility lines, chemical contamination, and radiological hazards. The program also ensures proper management and disposal of excavated materials. Fifty-two projects were supported by this program during 2016.

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