Supplement Analysis for the National Environmental Policy Act Linac Coherent Light Source-II (LCLS-II) Environmental Assessment, DOE/EA-1975

LOW EMITTANCE INJECTOR (LEI) FOR LINAC COHERENT LIGHT SOURCE-II HIGH ENERGY (LCLS-II-HE) PROJECT

DOE/EA-1975-SA-03

SLAC National Accelerator Laboratory
2575 Sand Hill Road
Menlo Park, California 94025

U.S. Department of Energy
Office of Science

December 2023

TABLE OF CONTENTS

TABLES

FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS

ALARA	as low as reasonably achievable
BAAQMD	Bay Area Air Quality Management District
CCR	California Code of Regulations
CEQ	Council on Environmental Quality
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
CO_2	carbon dioxide
cy	cubic yards
DART	Days Away, Restricted, or Transferred
dBA	A-weighted decibel(s)
DOE	U.S. Department of Energy
EA	Environmental Assessment
ESH	Environment, Safety and Health
FONSI	Finding of No Significant Impact
GeV	giga-electronvolts
GHG	greenhouse gas
HE	high energy
HSC	Health and Safety Code
Hz	Hertz
IIPP	Injury and Illness Prevention Program
keV	kiloelectronvolts
kW	kilowatt
lbs/MWh	pounds per megawatt-hour
LCLS	Linac Coherent Light Source
L_{eq}	equivalent continuous noise level
LEI	Low Emittance Injector
Linac	Linear Accelerator
MEC	Matters in Extreme Conditions
MEI	maximum exposed individual
MHz	megaHertz
mrem	millirems

mrem/h	millirems per hour
mrem/y	millirems per year
$MTCO_{2e}$/year	metric tons of GHG emissions per year
MW	megawatt
N/A	not applicable
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NHPA	National Historic Preservation Act
NO_x	nitrous oxides
ODH	Oxygen Deficiency Hazard
OSHA	Occupational Safety and Health Administration
PCB	polychlorinated biphenyl
PM_{10}	particulate matter with a diameter of 10 microns or less
$PM_{2.5}$	particulate matter with a diameter of 2.5 microns or less
SA	Supplement Analysis
SAAQS	State Ambient Air Quality Standards
SEM	sequential excavation method
SFBAAB	San Francisco Bay Area Air Basin
SHPO	State Historic Preservation Officer
SIP	State Implementation Plan
SLAC	SLAC National Accelerator Laboratory
SMOP	Synthetic Minor Operating Permit
SWPPP	Storm Water Pollution Prevention Plan
TRC	Total Recordable Case
U.S.C.	United States Code
USEPA	U.S. Environmental Protection Agency
VOC	volatile organic compound
XFEL	X-ray free electron laser

1.0 INTRODUCTION

SLAC National Accelerator Laboratory (SLAC) is operated by Stanford University under contract to the U.S. Department of Energy (DOE). SLAC's research campus is located west of the Stanford University Campus on the San Francisco Peninsula in an unincorporated portion of San Mateo County, California (**Figure 1-1** and **Figure 1-2**).

One of SLAC and DOE's major scientific user facilities is the Linac (Linear Accelerator) Coherent Light Source (LCLS). In 2014, DOE published a National Environmental Policy Act of 1969 (NEPA) Environmental Assessment (EA) for the Linac Coherent Light Source-II (LCLS-II) project (2014 EA; DOE 2014). DOE has prepared this Supplement Analysis (SA) to evaluate whether the potential environmental impacts associated with the low emittance injector (LEI) project will be within the scope and impact envelop of the potential environmental impacts previously analyzed in the 2014 EA. The Council on Environmental Quality (CEQ) NEPA regulations directs agencies to prepare a supplement if the "agency makes substantial changes to the proposed action that are relevant to environmental concerns" or there are "significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts" (40 CFR 1502.9(d)(1)(i)-(ii)). DOE's NEPA regulations state that when it "is unclear whether or not an [EA] supplement is required, DOE shall prepare a Supplement Analysis" (10 CFR 1021.314(c)). This Supplement Analysis (SA) provides enough information for DOE to determine whether (1) to supplement the existing EA, (2) to prepare a new EA, or (3) no further NEPA documentation is required (10 CFR 1021.314(c)(2)(i)-(iii)).

A previous SA was completed in 2015 to assess potential effects associated with the LCLS-II project (2015 SA; DOE 2015), which included reconfiguration of the cryoplants to add a larger second cryogenic plant, to determine whether these changes were within the original scope and impact envelope considered in the 2014 EA. In 2019, another SA was completed for the proposed LCLS-II High Energy (LCLS-II-HE) upgrade to include additional cryomodules and a higher operating power (2019 SA; DOE 2019a). The LCLS-II-HE energy upgrade to 8 giga-electronvolt (GeV) beams will increase the hard X-ray photon energy reach to 12.5 kilo-electronvolt (keV), which can be extended to more than 20 keV if the beam emittance can be reduced by a factor of two. The LEI facility will provide lower emittance bunches from the injector with minimal disruption to the photon science program. The new injector will be qualified and commissioned while the current injector remains in operation, and then used to drive the X-ray free electron laser (XFEL) exclusively or in combination with bunches from the original injector. The proposed LEI project will provide supporting infrastructure for this injector.

This SA was prepared in accordance with NEPA (42 U.S.C. § 4321 et seq.), DOE NEPA Implementing Procedures (10 CFR Part 1021), DOE P 451.1 (NEPA Compliance Program), and CEQ Regulations for Implementing the Procedural Provisions of NEPA (40 CFR §§ 1500–1508; CEQ 2021). If DOE determines, based on the findings of this SA, that the effects of the LEI are within the original project scope and effects envelope analyzed in the 2014 EA, then the project may proceed without further NEPA review. If DOE determines that the project is not within the original scope and effects envelope analyzed in the 2014 EA, additional NEPA analysis and documentation will be required.

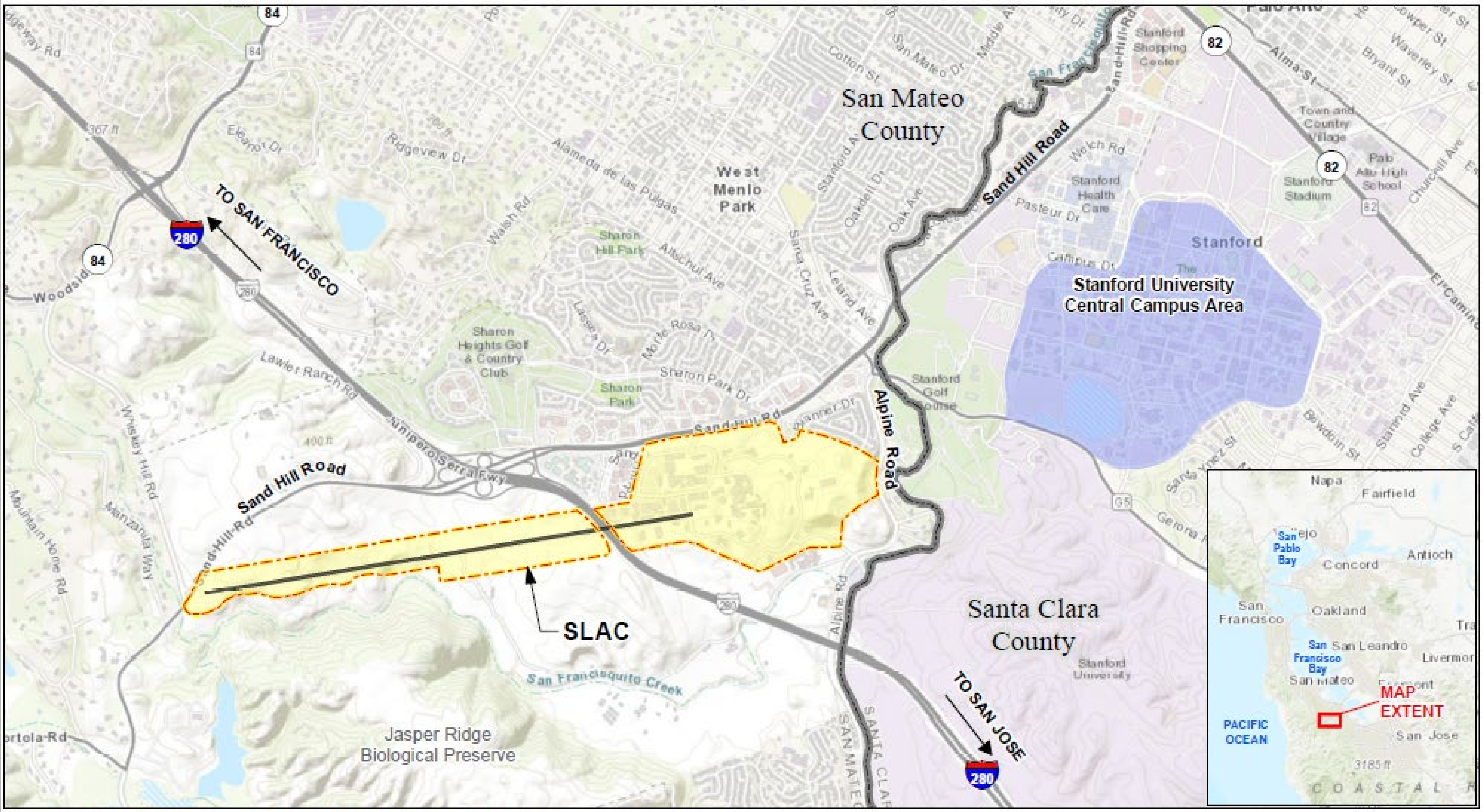
This document will be made available to the general public on the DOE's NEPA website.

1.1 Background 2014 Environmental Assessment, 2015 and 2019 Supplement Analyses

DOE completed a NEPA review for the LCLS-II project with enhanced capabilities and published the resulting 2014 EA (DOE 2014). After the 2014 EA and Finding of No Significant Impact (FONSI) were published, DOE and SLAC completed a more detailed design of the superconducting Linac and drew two conclusions: 1) the LCLS-II project will benefit from more refrigeration capacity for cryogenic helium to cool the accelerator than was envisioned in the 2014 EA, and 2) the second cryogenic plant—originally planned to be smaller than the primary plant—will need to be approximately the same size (4 kilowatts [kW]) as the primary plant. With the larger second cryogenic plant, the reconfigured cryoplants required a new cooling tower on the same site rather than using the existing cooling tower as originally planned. These changes to the LCLS-II were addressed in the 2015 SA (DOE 2015). DOE determined that the modified LCLS-II project could proceed without further environmental review.

Under the LCLS-II-HE project, SLAC proposed to fabricate and install approximately 24 additional cryomodules in the Linac. The 2019 SA analyzed whether the environmental effects of the proposed upgrade would be within the original scope and effect envelope considered in the 2014 EA. DOE determined that the LCLS-II-HE project could proceed without further environmental review.

Because the LEI will be located within the boundaries of the SLAC site (DOE-leased property) and will support the LCLS-II project, as described in the 2014 EA, DOE has determined that development of the LEI should be analyzed using an SA pursuant to DOE guidance titled Recommendations for the Supplement Analysis Process (DOE 2019b). The intent of this SA is to determine whether the environmental effects of the LEI will be within the original scope and impact envelope analyzed in the 2014 EA (i.e., to determine whether any significant new circumstances or environmental concerns will result from implementation of the LEI) and whether further NEPA documentation is required.



SOURCE: WORLD TOPOGRAPHIC BASEMAP OBTAINED FROM ESRI 2022.

LEGEND

- SLAC NATIONAL ACCELERATOR LABORATORY BOUNDARY
- STANFORD UNIVERSITY CENTRAL CAMPUS AREA
- LINEAR ACCELERATOR
- COUNTY BOUNDARY

N

0 3,000 Feet

Graphic Scale: 1" = 3000'

SLAC LEI SUPPLEMENTAL ANALYSIS

REGIONAL LOCATION MAP

ARCADIS

FIGURE 1-1

Author: MSMiller T:_EPP\DOE\SLAC\MXD_Pro\2023\Figure 1-2 General Site Overview.mxd 4/27/2023

SLAC LEI SUPPLEMENTAL ANALYSIS

GENERAL SITE OVERVIEW AND KEY SURROUNDING FEATURES

ARCADIS

FIGURE 1-2

2.0 CHANGES TO THE PROPOSED ACTION OR NEW INFORMATION

The LEI would be part of the supporting infrastructure for SLAC's LCLS-II-HE project, which seeks to increase the maximum X-ray energy capability of SLAC's existing XFEL. To achieve this upgrade, a lower emittance electron beam source (injector) is required. This injector would be housed in the LEI in the vicinity of Sector 0, near the western end of the existing injector, which is in line with SLAC's existing linear accelerator beamline as shown on **Figure 2-1**. The design life is a minimum of 50 years.

The LEI would be a total of 267 feet in length, with a long reinforced concrete tunnel structure with internal clear dimensions of 14-feet wide by 14-feet high and would be sited on the north side of the existing Linac tunnel. The LEI would be located as close as feasible to the north of the existing Linac tunnel to minimize the required length of the transfer line and laser penetration. The proposed LEI would be located at the western end of the existing Linac, about 1,200 feet to the west of the LCLS-II Cryogenic Building. A new 500-watt cryoplant would be built near the LEI to cool the LEI cryomodules.

The following subsections describe construction and installation, operations and maintenance, decommissioning, and cost for the LEI project. With the addition of the LEI, SLAC would offer researchers access to the full range of research capabilities.

2.1 Construction and Installation

A schematic 3D model of the LEI is provided in **Figure 2-2**. The construction method for the LEI tunnel would involve a combination of cut and cover at areas of shallow depth, such as at the portal area, and sequential excavation method (SEM) using an excavator with a bucket/hoe-ram or roadheader excavation. The transfer tunnel would be constructed using conventional excavation with ground control (Mott MacDonald 2022). A new portal entry would be created as the primary tunnel access by mining under the Sector 0 alcove and would daylight north of the existing Linac portal entrance, along with the second level on the portal entry. Stair egress access would be provided at the far east end of the new tunnel. An aboveground east stairwell headhouse structure will be attached to the Gallery. The stairwell will accommodate routing of utilities which tie into existing SLAC facility infrastructure (Mott MacDonald 2022).

The Collider Injection Development area, which is designated as a "deferred site" due to legacy polychlorinated biphenyls (PCBs), petroleum hydrocarbons, and lead soil contamination, is located at Sector 0. Any planned excavation at Sector 0 must evaluate potential effects for future remediation of the Collider Injection Development area. Transportation and disposal of all hazardous and Class II wastes would be coordinated with SLAC Waste Management.

Preliminary results from recent groundwater investigations suggest variable and likely perched/transient groundwater levels. Groundwater observations during drilling can be influenced by many factors, and additional readings of the recently installed wells are needed to confirm the groundwater regime. Construction methods for the new LEI are anticipated to be affected by existing groundwater conditions and dewatering may be required (Arup 2020). Groundwater would be discharged into a nearby existing storm drainage system wherever possible (Mott MacDonald 2022).

2.1.1 Excavation and Backfill Volume Estimates

Preliminary excavation estimates were developed for the various construction methods. Excavation of the top 12 inches of soil would require removal of approximately 600 cubic yards (cy) of soil. Excavation below 12 inches would remove approximately 9,600 cy (bulk), and mining would remove approximately 6,000 cy (bulk). The top 1 or 2 feet of excavated material would be transported to an off-site facility. The remaining excavated material is anticipated to remain on-site pending approval from SLAC's Environmental Protection Department. A compaction value of 20 percent was used for the costing of both hauling and installation of backfill (Arup 2020).

2.1.2 Utilities

Existing utilities in the vicinity of the proposed LEI facilities include domestic water, cooling tower water, compressed air, electrical, and sanitary sewers. Existing stormwater infrastructure is minimal, with some drainages directed north to a catch basin, which outlets toward Sand Hill Road. The existing sanitary sewer gravity system is approximately 6 feet below grade. The other nearby utilities in the vicinity are assumed to be placed 3 feet below grade per standard design practices (Arup 2020).

Utility modifications and relocations would be required including rerouting the existing utilities; however, existing utilities would have adequate capacity to support construction, operation, or decommissioning of the LEI project. The proposed utility modifications would be within the boundaries of the existing SLAC site and would not require construction of off-site power, stormwater, wastewater, or other utilities.

Utility modifications include relocation of a catch basin at the new portal entry, as well as several relocations and removals of 2-inch domestic water lines. The 2-inch water line relocations would be performed in sequence with cut and cover operations. A new fire hydrant should be added near the new portal entry to allow compliance with SLAC's fire design standards and reduce dependence on the existing fire hydrant located on Sand Hill Road. An existing sanitary sewer connection from the nearby 6-inch pipe does not require relocation and can remain in place, as the section of the LEI under the Sector 0 alcove would be mined to protect the existing above-grade structure. The sanitary sewer point of connection would be protected in place and monitored as appropriate (Arup 2020).

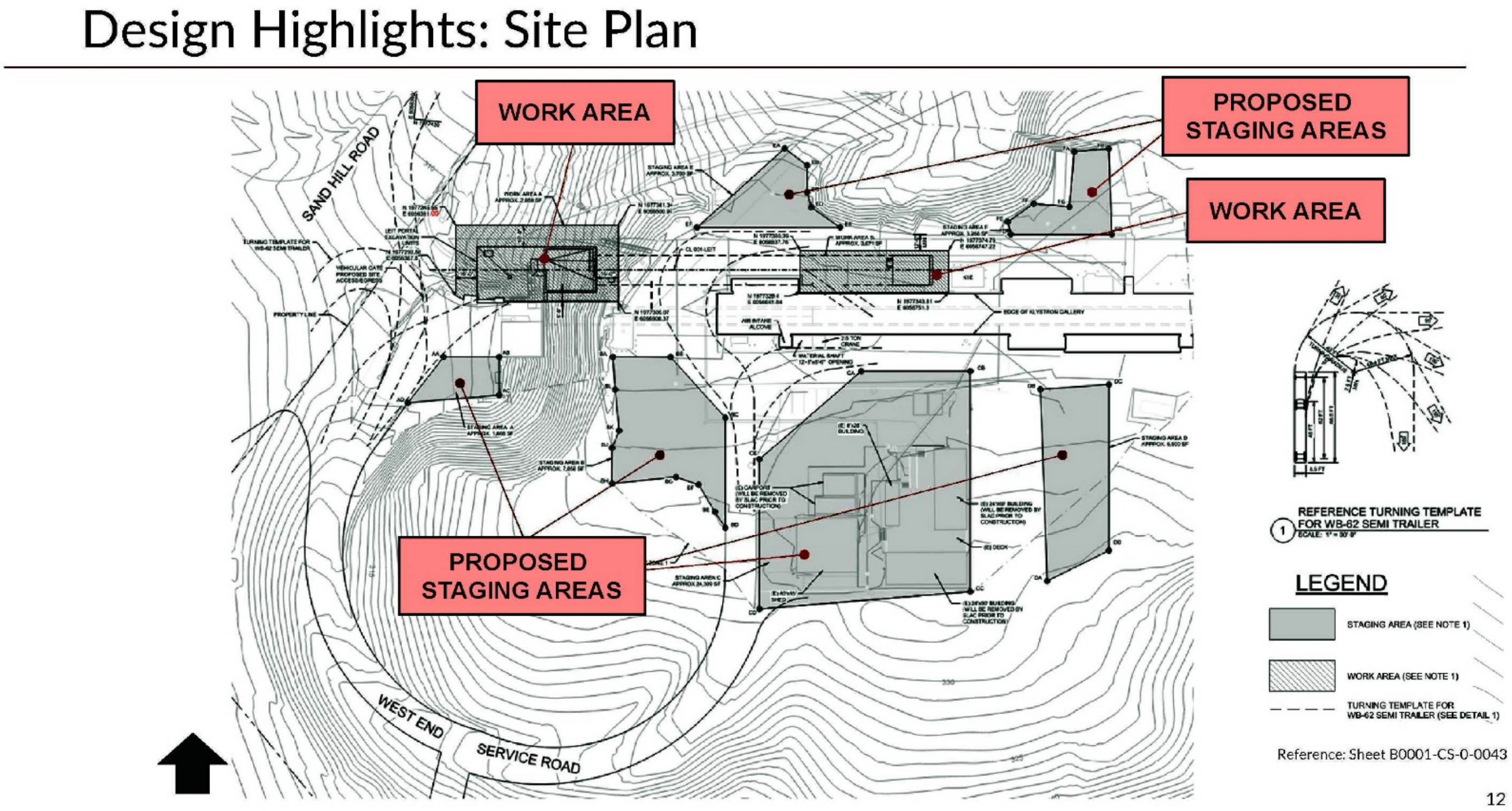
2.1.3 Access Roads and Haul Routes

Construction of the LEI would use existing SLAC entrances and access roads. Entry to SLAC is typically via either the main gate at Sand Hill Road or the rear gate (Sector 0 access gate) off of Alpine Road (**Figure 1-2**). The Sector 0 entrance off Sand Hill Road would also provide access to the LEI; however, it is undetermined whether this access point would be used during construction.

Potential repairs or improvements to existing roads within the SLAC boundary may be needed to accommodate vehicle traffic during LEI construction (Arup 2020). The curved access road and portal entry areas and the area near the portal entries are anticipated to require pavement replacement (Arup 2020).

Material to be removed for off-site disposal would be hauled via the Sector 0 access gate or the Alpine Road gate. Clean soil that would remain on-site is anticipated to be stockpiled north of the Gallery around Sector 9.

Author: MSMiller T:_EPP\DOE\SLAC\MXD_Pro\2023\Figure 2-1 LEI Conceptual Layout Update.mxd 4/27/2023



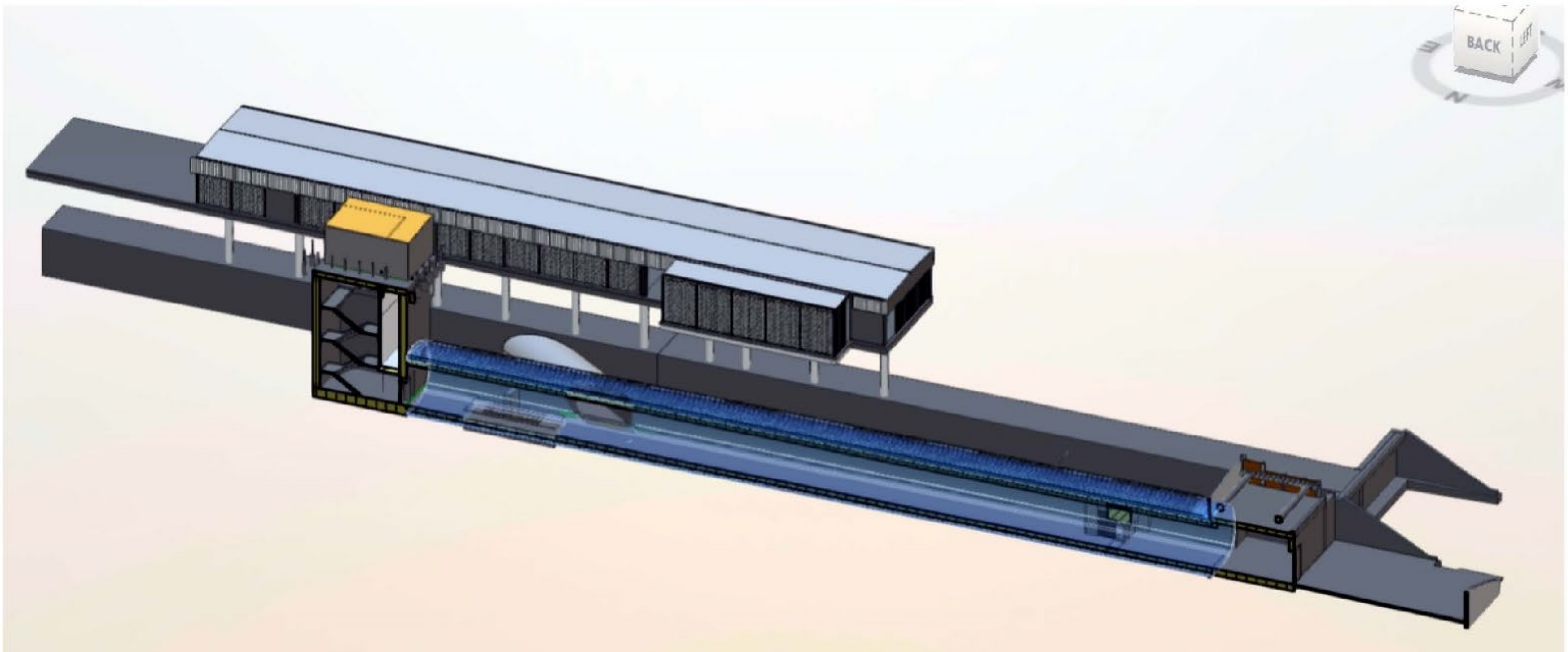
SLAC LEI SUPPLEMENTAL ANALYSIS

LEI CONCEPTUAL LAYOUT

ARCADIS

FIGURE 2-1

Author: MSMiller T:_EPP\DOE\SLAC\MXD_Pro\2023\Figure 1-3 SCHEMATIC 3D MODEL OF THE LEI FACILITY.mxd 4/27/2023



SLAC LEI SUPPLEMENTAL ANALYSIS

SCHEMATIC 3D MODEL OF THE LEI FACILITY

ARCADIS

FIGURE 2-2

2.1.4 Construction Workforce and Schedule

The number of construction workers required for the LEI would be low compared to LCLS-II, which required 40 workers in Sectors 0 through 10 of the Linac. The peak workforce during construction and installation of the LEI would be approximately 10 to 20 personnel.

Construction of the primary civil works is anticipated for the Fall of 2025 with heavy civil construction estimated to start by October of 2025, scheduled to be coincident with a programmed period of beam shutdown. To accommodate this schedule, the heavy civil and construction including the permanent LEI structure, transfer tunnel, Linac modifications, west portal, east egress shaft, and the installation of radiation shielding must all be completed before the Fall of 2026.

Construction is anticipated to continue for approximately 14 months. A period of approximately 10 months has been targeted for heavy civil construction (Mott MacDonald 2022). Construction work is assumed to be performed over one 10-hour shift, 6 days per week, and tunneling work is assumed to be performed over two 10-hour shifts per day, 6 days per week. LEI construction would be scheduled to minimize any effects on the LCLS-II-HE operational schedule.

2.2 Operations

Following completion of construction and a subsequent 2-year equipment commissioning process, the injector will be ready to deliver the beam for user experiments in 2028. LEI operations would not represent a substantial change to existing LCLS operations and would be a continuation of the LCLS-II-HE operations. SLAC would operate and maintain the superconducting Linac and cryogenic plants as described for LCLS-II in the 2014 EA, the 2015 SA, and the 2019 SA. As shown in **Table 2-1**, less than 5 additional SLAC workers are anticipated to be needed for LEI operations and maintenance.

Based on the 2014 EA, the LCLS-II startup would require three to ten liquid helium deliveries for the startup volume of 6,800 gallons (approximately 4 tons), followed by one to three deliveries per year during operations. The LEI would operate with approximately 2,000 additional gallons of liquid helium and require one to three additional deliveries of liquid helium per year. The LEI would also require an additional 2,000 gallons of liquid nitrogen and require one to two additional liquid nitrogen deliveries per week.

SLAC operations would continue to use hazardous materials as authorized by the State of California (Cal. HSC § 25201.6) including solvents and fuels during construction, cryogens, and compressed gases. Radioactive components will also require disposal during operations. SLAC would update its hazardous materials business plan and spill control plan for LEI operations, as needed. The LEI would comply with federal environmental laws including the Occupational Safety and Health Act of 1970 and the Hazardous Materials Transportation Act of 1975. Furthermore, the LEI would comply with the National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations, and SLAC would continue to monitor and report releases of radionuclides to the ambient air in SLAC's Annual Site Environmental Report. SLAC's emissions of radionuclides to the ambient air would not result in effective dose equivalent to any member of the public in any year that would exceed the regulatory limit of 10 millirem/year (40 CFR Part 61).

The LEI would not add substantially to risks related to air exposures. Further information regarding the on- and off-site doses and risks from radionuclides in air and other media is presented in Section 3.4, Health and Safety.

LEI operations would comply with all the site's plans and environmental measures, as described in the 2014 EA, including SLAC's site-wide Storm Water Pollution Prevention Plan (SWPPP; SLAC 2019a); SLAC's Site Sustainability Plan (SLAC 2021); SLAC wastewater discharge permits; and SLAC's procedures for spill prevention, traffic control, health and safety, radiological safety, fire prevention, and waste management.

Table 2-1 summarizes the operational features of the LCLS, LCLS-II, and LCLS-II with revised cryoplant design (evaluated in the 2015 SA); LCLS-II-HE (evaluated in the 2019 SA); and the LEI. This table includes power and water usage, beam energy, particle acceleration, brightness, and coherence.

Table 2-1 Operational Parameters of LCLS, LCLS-II, LCLS-II-HE, and LEI

Operational Parameter	LCLS	LCLS-II	LCLS-II (revised cryoplant design)	LCLS-II-HE	LEI
Beam Energy (GeV)	15 (WarmCu)	3.3 to 4	3.3 to 4	8	0.1
Cryomodules	N/A	35	35	23	1
Acceleration gradient (Megavolt/meter)	120	16	16	18.8	16
Repetition rate (temporal coherence)	120 Hertz (Hz)	Up to 1 Megahertz (MHz)	Up to 1 MHz	Up to 1 MHz	Up to 1 MHz
Spectral range (brightness)(keV)	0.25 to 12.8	0.25 to 5	0.25 to 5	0.25 to 12.8-20	Up to 20
Helium inventory (gallons)	NA	4,200	6,800	10,200	2,000
Helium deliveries (per year)	NA	1 to 3	1 to 3	2 to 4	1 to 3
Nitrogen inventory (gallons)	NA	20,000	40,000	40,000	2,000
Nitrogen deliveries (per week)	NA	3 to 4	4 to 5	8 to 10	1 to 2
Undulator sources	1	2	2	2	N/A
Water use (gallons per day)	117,000	193,500	237,000	307,000	16,000
Power use (megawatts[MW])	12	13	25	32	0.5
Project staff and research population	60 staff 40 researchers	100 staff 40 researchers	106 staff 55 researchers	109 staff 61 researchers	<5 staff No researchers
Hutch space	7 hutches	9 hutches	9 hutches	11 hutches	N/A
Opening date	2009	2020	2020	2026 (proposed)	2026 (proposed)

Notes:
Hz = Hertz
MHz = megaHertz
N/A = Not applicable

2.3 Decommissioning

Decommissioning would not occur for decades into the future and would be completed pursuant to a decommissioning plan prepared to outline the SLAC and DOE policies and procedures in effect at the time. The additional cryomodules and supporting equipment would add to the volume of equipment that would require detailed radiological surveys and appropriate disposal, which could require on-site storage, reuse, or final disposal. SLAC would continue to update and implement its Environment, Safety and Health (ESH)

Manual and Radiological Control Manual to govern decommissioning such as monitoring by radiation safety professionals, disconnecting the cryomodules, initial decontamination, storing components within Radioactive Material Areas, and/or packaging components for transport and disposal.

2.4 Cost

The preliminary cost estimate for the LEI is $31.4 million to $55.3 million (Mott MacDonald 2022) including design, equipment capital costs, installation, commissioning, and project management. The operating budget would account for additional power costs, maintenance of the additional cryomodules, consumables, replacement equipment parts, and SLAC staff to support additional researchers. In the 2014 EA, LCLS-II was estimated to carry a total cost of approximately $895 million. The incremental LEI operational cost represents a minor budget increase (less than 3 percent) over the LCLS-II because the LEI would use many of the same staff for operations.

This page intentionally left blank

3.0 SUPPLEMENT ANALYSIS

This section describes the potential environmental effects of the proposed LEI project and the potential incremental effects of the project compared to the environmental analysis conducted in the 2014 EA, the 2015 SA, and the 2019 SA. Per DOE's SA guidelines, this analysis determines whether the project's effects are within the original scope and effect envelope considered in the 2014 EA and whether further NEPA review is required. As described in the DOE guidelines, this SA is not a substitute for any further NEPA review that may be required.

This SA was completed without conducting additional air emissions, noise, or other modeling. Because the LEI footprint is within the proposed action project area analyzed in the 2014 EA and the proposed activities would be very similar to those analyzed for the LCLS-II, this SA relies on the results of calculations and modeling completed for the LCLS-II in the 2014 EA. In some cases, the LEI involves identical activities over a longer period. Rather than completing new modeling, this SA describes the potential effects of the LEI by extrapolating from previous analyses. Using the results of previous modeling completed for the LCLS-II project, the effect descriptions presented in this SA that are based on LCLS-II modeling overestimate environmental effects and are therefore conservative.

Construction would be subject to the same standard environmental protection, minimization, and avoidance measures described in the 2014 EA to reduce or eliminate potential minor adverse construction and operational effects from dust, potential minor spills, noise, and waste disposal. Examples relevant to the LEI include radiological protection programs, spill prevention and control, and compliance with site sustainable design policies including selecting equipment that minimizes water use and maximizes energy efficiency.

As with the 2014 EA, this SA does not describe potential implications for land use because the LEI project would be within the boundaries of lands leased and used by DOE; therefore, there would be no land use effects. The LEI project would not require construction of off-site power, stormwater, wastewater, or other utilities or interruption of off-site residential or commercial utility service; therefore, there would be no effects on utilities, and no further analysis is presented in this SA.

3.1 Resource Areas Not Analyzed in this Supplement Analysis

The following resource areas would not be affected by the proposed change or new information and therefore, consistent with the sliding scale approach (see 40 CFR 1502.2 [DOE 2004]), are not analyzed or only minimally analyzed/discussed in this SA:

- Biological Resources – No federally listed threatened or endangered species, critical habitat, or special status species have been observed within the SLAC boundary. The LEI footprint is within the proposed action project area analyzed in the 2014 EA. The addition of the LEI would not directly or indirectly affect federally listed species, wetlands, or other aquatic habitat; therefore, the addition of the LEI would not change the 2014 EA analysis for this resource area.
- Cultural Resources – The Gallery structure is a historic structure under the National Historic Preservation Act (NHPA). A Section 106 report was completed for LCLS-II and the State Historic Preservation Officer (SHPO) concurred with DOE's finding that the LCLS-II project would not adversely affect historic properties on April 30, 2014. Though the LEI footprint is within the action

project area analyzed in the 2014 EA and the LCLS-II Section 106 report, a separate Section 106 report was completed for the LEI which determined that the project would have no adverse effects on historic properties under Section 106 of the NHPA. The SHPO concurred with the DOE's finding on November 28, 2023. Additionally, SLAC has an Inadvertent Discovery Plan for Cultural Resources which would be implemented if ground-disturbing activities resulted in the unanticipated discovery of archaeological materials or other cultural resources.

- Socioeconomics and Environmental Justice – The LEI project would require less than 5 additional SLAC workers are anticipated to be needed for LEI operations and maintenance; therefore, there would be minimal additional project expenditures and annual operating costs. The LEI operations staffing levels were already considered in determining the operations and support staff in the 2014 EA. The 2014 EA noted that no high and adverse human health or environmental effects were anticipated for construction, operation, or decommissioning. Consequently, there would be no "disproportionately high and adverse" effects on minority or low-income populations. The addition of the LEI would not change the previous assessment.
- Land Use and Visual Resources – No land use or visual effects from construction, operation, or decommissioning were anticipated in the 2014 EA. The LEI footprint would be within the proposed action project area analyzed in the 2014 EA; therefore, the proposed change and new information do not change the analysis in the 2014 EA.

The following subsections (3.2 through 3.9) analyze the potential effects from implementation of the LEI to air quality and greenhouse gases (GHG), geology and soils, health and safety, hydrology and water quality, noise and vibration, transportation, waste management, and cumulative effects. This analysis was conducted to determine whether the effects of the LEI are within the original scope and impact envelope considered in the 2014 EA.

3.2 Air Quality and Greenhouse Gases

This section describes potential incremental effects on air quality from emissions of criteria air pollutants during installation and operation of the LEI. Because GHG emissions would only have effects when considered together with other emissions sources, GHGs are addressed in Section 3.9.1, Cumulative Effects.

Criteria pollutant emissions associated with the addition of the LEI were estimated based on the calculations completed for the 2014 EA. Emissions were evaluated for those criteria pollutants for which the region does not comply with National Ambient Air Quality Standards (NAAQS) and State Ambient Air Quality Standards (SAAQS) or Bay Area Air Quality Management District (BAAQMD) Standards. Area air quality is classified by the U.S. Environmental Protection Agency (USEPA) as a nonattainment/marginal area for the 8-hour ozone standard and 24-hour fine particulates (particulate matter with a diameter of 2.5 microns or less [$PM_{2.5}$]) standard. For all other federal standards, the San Francisco Bay Area Air Basin (SFBAAB) is in attainment or unclassified. Based on the SAAQS, the SFBAAB currently is in nonattainment for both the 1-hour and 8-hour standards for ozone, particles with a diameter of 10 microns or less (PM_{10}), and $PM_{2.5}$.

The 2014 EA also evaluated air pollutants for which SLAC has permit limits. Therefore, consistent with the 2014 EA, the 2015 SA, and the 2019 SA, the following analysis evaluates emissions of precursor organics (volatile organic compounds [VOCs]), nitrous oxides (NOx), and particulate matter (PM_{10} and $PM_{2.5}$).

Installation ─ The 2014 EA used CalEEMod to calculate emissions, including those from installation of cryomodules in the accelerator housing (see Section 3.4, Table 3-3, and Appendix A of the 2014 EA). **Table 3-1** shows the LCLS-II 2016–2018 construction emissions (as calculated in the 2014 EA, the 2015 SA, and the 2019 SA) and the estimated emissions of the LEI. This analysis assumes that the LEI project installation would be comparable to previous installations and that emissions would be proportional to the installation work done for the LCLS-II. The results for projected 2025 emissions are presented below and compared with: 1) general conformity de minimis levels for compliance with USEPA's General Conformity Rule and for achieving federal standards, 2) overall SLAC emissions for 2017, and 3) SLAC's Synthetic Minor Operating Permit (SMOP) limits (BAAQMD 2020). **Table 3-1** shows that emissions for the LCLS-II, LEI, and site-wide emissions would be well below conformity levels and SMOP limits.

Table 3-1 LCLS-II and Incremental LEI Emissions from Installation of Additional Cryomodules and Supporting Equipment

Construction Activity/Year	Annual Emissions (tons per year)			
	VOCs	**NO_x**	**PM_{10}**	**$PM_{2.5}$**
LCLS-II				
Cryoplant construction (2016-2017)	1.31	16.26	2.14	1.38
Installation of 35 cryomodules (2018)	0.25	2.28	0.84	0.48
Reconfigured cryoplants (2016-2018)	<u>0.44</u>	<u>5.29</u>	<u>0.85</u>	<u>0.53</u>
Total LCLS-II construction emissions†	2.00	23.83	3.83	2.39
LEI				
Installation of 1 additional cryomodule (2025)[1]	0.021	0.20	0.072	0.041
Comparative Values				
de minimis levels[2]	100	100	100	100
Overall 2020 SLAC emissions[3]	3.52	2.90	<1	<1
SLAC's SMOP limits	35	35	95	95
Exceed *de minimis* levels or SMOP limits?	No	No	No	No

Notes:
† 2016 to 2018 total emissions include the original LCLS-II proposed action and cryogen plant reconfiguration (DOE 2015).
1 2025 emissions include installation of additional cryomodules and supporting equipment. These emissions were estimated to be approximately 9 percent of LCLS-II 2018 emissions.
2 USEPA adopted the General Conformity Rule in November 1993 to implement the conformity provision of Title I, Section 176 (c)(1) of the federal Clean Air Act. USEPA requires each state to prepare a State Implementation Plan (SIP). The *de minimis* levelsfor conformity of each criteria pollutant in nonattainment are 100 tons per year.
3 Does not include emissions from LCLS-II).

Sources: DOE 2014, 2015; BAAQMD 2020

Operations ─ The 2014 EA (see Section 3.4, Table 3-4, and Appendix A of the 2014 EA), 2015 SA, and 2019 SA also estimated operational emissions including those from energy consumption, water use, and vehicle trips for additional employees. Table 3-2 presents the current estimated annual operations emissions for the LCLS-II and the estimated incremental increase in emissions from the LEI. The incremental increase was estimated using a conservative method, similar to that described above for construction, and assumed that the added emissions would be derived from the incremental increase in energy consumption required to operate the additional cryomodules and to cool an incrementally larger operational volume of helium. The installation of an additional three to four cryomodules would increase LCLS energy demand by approximately 1.0 MW. This SA also assumes that emissions from additional SLAC employee commutes, researcher commutes, and helium/nitrogen deliveries would be the same as those associated with the LCLS-II. In this way, this analysis assumes an increase equal to the larger LCLS-II; therefore, this estimate is conservative and would account for the very small emissions related to installing other equipment. Table 3-2 shows that, with the increase in energy demand and operational vehicle trips, SLAC's operational emissions would still be well below its SMOP limits and conformity levels for each pollutant. Based on this analysis, the small incremental increases in criteria pollutant emissions from installation of the LEI would be within the original scope and effect envelope considered in the 2014 EA.

Table 3-2 LCLS-II and Incremental LEI Emissions from Operation of Additional Cryomodules and Supporting Equipment

Operational Emissions Source	**Annual Emissions (tons per year)**			
	VOCs	**NO_x**	**PM_{10}**	**$PM_{2.5}$**
LCLS-II				
Area	0.305	0.000	0.000	0.000
Energy consumption	0.004	0.034	0.003	0.003
Motor vehicles	0.005	0.010	0.009	0.003
Increased energy consumption from reconfigured powerplants	0.0064	0.0544	0.0048	0.0048
Emissions from increased motor vehicle trips	0.005	0.010	0.009	0.003
Total LCLS-II operational emissions	0.33	0.11	0.03	0.01
LEI				
Increased emissions from energy consumption (9 percent)[1]	0.00038	0.0029	0.00022	0.00022
Increased emissions from increased vehicle trips[2]	0.005	0.010	0.009	0.003
Comparative Values				
de minimis levels[3]	100	100	100	100
Overall 2020 SLAC emissions[4]	3.52	2.90	<1	<1
SLAC's SMOP limits	35	35	95	95
Exceed *de minimis* levels or SMOP limits?	No	No	No	No

Notes:
1 Incremental increase in annual operational emissions from energy consumption for the LEI. See Table 3-5 of the 2014 EA.
2 Emissions from transportation. See Table 3-2 of the 2015 SA in Appendix B, Page B-3.
3 USEPA adopted the General Conformity Rule in November 1993 to implement the conformity provision of Title I, Section 176 (c)(1) of the federal Clean Air Act. USEPA requires each state to prepare a State Implementation Plan (SIP). The *de minimis* levelsfor conformity of each criteria pollutant in nonattainment are 100 tons per year.
4 Overall 2020 SLAC emissions – these values do not include LEI emissions.

Sources: DOE 2014, 2015; BAAQMD 2020

3.3 Geology and Soils

No major active faults have been inferred to cross the LEI footprint; however, the San Andreas Fault Zone is about 0.7 mile from site (Adolphsen et al. 2020). For the LEI, surface excavation would predominantly be through native fill. This fill typically consists of native material that was moved during previous construction and grading at SLAC. The majority of LEI tunnel excavation would be within the Whiskey Hill Formation, which underlies the native fill (Arup 2020).

The potential effects of the LCLS-II project on geology and soils were evaluated in the 2014 EA (see Section 3.7 of the 2014 EA) including the effects of foundation excavation, seismic activity, and soil activation. The LEI footprint is within the boundaries of the proposed action project area evaluated in the 2014 EA; therefore, the LEI is within the original scope and effect envelope considered in the 2014 EA.

3.4 Health and Safety

The environmental effects of the LCLS-II were evaluated in the 2014 EA (see Section 3.8 of the 2014 EA). This section describes how the proposed LEI project could result in increased human health risks and safety hazards. Construction would result in additional occupational safety hazards, potentially resulting in industrial injuries. Operating at the higher energy levels provided by the LEI would result in higher levels of ionizing radiation, potentially resulting in incrementally higher radiation doses and risks for workers and off-site receptors as described in Section 3.4.2. In addition, the increased operational cryogen volume and helium and nitrogen deliveries could increase the risk of spills. The potential for an increased risk of traffic accidents during construction is evaluated in Section 3.7, Transportation.

The proposed LEI components would be similar to those installed for the LCLS-II and would not introduce any new types of work hazards. Before construction, the LEI-specific activities would be evaluated under SLAC's Work Planning and Control Program, which is a formal process for identifying and mitigating risks to workers, the public, and the environment. The program addresses both construction and operations and would evaluate LEI's higher energy and needed controls (see Radiation Risks below).

3.4.1 Occupational Safety

The occupational hazards associated with the LEI would be nearly identical to those encountered for the LCLS-II, as described in Section 3.8 of the 2014 EA, and would include potential risks associated with the use of heavy equipment, high voltage, dust, fumes, and equipment noise.

In general, construction and industrial activities have associated risks of occupational accidents and injuries. Workplace injuries and illnesses are tracked by the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA), which requires employers to report recordable injuries. The Bureau of Labor Statistics maintains injury and illness statistics for the construction industry. Under OSHA regulations (29 CFR Part 1904), a work-related injury is "recordable" if it results in death; days away from work, restricted work, or transfer to another job; medical treatment beyond first aid; or loss of consciousness. Injuries or illnesses that require a hospital visit or prescription medication are tracked as Total Recordable Cases (TRCs). The rate is based on 100 employees working full-time for 1 year and is "normalized" for different size employers by taking the number of recordable cases divided by the hours worked and then multiplying the result by 200,000 (100 employees working 40 hours per week for 50 weeks). If an injury prevents an employee from performing any or all of their duties and the employee must be assigned "light duty" or cannot work at all, the injury is classified as a Days Away, Restricted, or Transferred (DART) case. DART cases are a subset of the TRCs.

The risk of construction-related injuries resulting from the LEI would not be substantially different in nature or occurrence than from the LCLS-II. The 2014 EA estimated the potential workplace injuries from construction of the LCLS-II and predicted that the LCLS-II would potentially result in 0.84 TRC and 0.4 DART case. SLAC's 2019 TRC and DART rates of 1.09 and 0.38, respectively (Evans 2021) are substantially lower than the 2019 injury rates for the U.S. as a whole, which were 2.8 TRC and 1.6 DART cases (Bureau of Labor Statistics 2020). During LEI construction, an additional 10 to 20 workers would be required for an additional 12 to 18 months of construction. Considering the additional number of workers and months needed, the risk of injuries during construction are within the original scope and effect envelope considered in the 2014 EA.

Operation of the accelerator with the LEI would be nearly identical to that associated with the LCLS-II and would result in the same types of operational hazards including fire, electric shock, hazardous materials exposure, and other routine workplace hazards. LCLS-II operations, before and after the LCLS-II-HE and LEI, involve cryogenic hazards including "burns" from inadvertent contact, pressure hazards from over-pressurized systems, and the potential for oxygen-deficient atmospheres in the event of an indoor leak from the cryogenic systems.

The potential for occupational injuries resulting from LEI operations are not anticipated to be substantially different in nature or occurrence relative to those estimated for the LCLS-II. Less than 5 additional SLAC staff would be required for the LEI; therefore, risk of injuries during operations are within the original scope and effect envelope considered in the 2014 EA.

SLAC has developed an Injury and Illness Prevention Program (IIPP) in accordance with 10 CFR Part 851 to minimize the potential for injuries, illnesses, and accidents to protect workers and the public. SLAC has integrated safety into its management and work practices at all levels, including for construction contractors, by developing and implementing an Integrated Safety and Environmental Management System. The IIPP Manual (SLAC 2020) applies to all non-radiological safety and health issues associated with design, construction, operation, maintenance, decontamination and decommissioning, research and development, and restoration activities at SLAC.

3.4.2 Radiation Risks

Radiation risks to workers, the general public, and environment for an accelerator facility include: 1) potential doses to the public from direct radiation and radioactive air effluent, and 2) potential radioactivity introduced to the groundwater outside the accelerator housing, and 3) potential radioactivity added to the closed-loop cooling water system. The unmitigated risk levels depend on the electron beam energy and average power and the shielding around beam loss points.

Radiological hazards are managed in accordance with SLAC's Radiological Control Manual (SLAC 2019b), which complies with DOE regulations for Occupational Radiation Protection (10 CFR Part 835 [DOE 2017]), which establish dose limits for radiation workers. Although the limits vary depending on the affected part of the body, the annual dose limit for the whole body is 5,000 millirem (mrem) for occupational workers (10 CFR § 835.202).

The average beam power of LCLS-II is near 100 kW. To stay below regulatory and SLAC limits, the LCLS-II facility requires significant shielding and other beam loss controls (mainly through intensive concrete housing, local shielding, and beam/radiation interlocks). Design criteria for radiation shielding at SLAC are based on controlling individual doses from external radiation sources to no more than 1,000 mrem total effective dose per year for radiological workers (or 100 mrem/y for users) and kept "as low as reasonably achievable" (ALARA).

LEI would produce an average beam power of comparable energy relative to that of LCLS-II, which would potentially result in radiation exposure for workers similar to that of the existing LCLS-II operations. Under implementation of the LEI, radiation generated by the beam would continue to be managed under SLAC's robust radiation safety programs similar to existing operations.

Because LEI would produce a higher energy beam, the exposure pathways could result in incrementally higher radiological risks for public exposures. Federal regulations and DOE orders require SLAC to demonstrate that the public does not receive an annual radiation dose of greater than 100 mrem from all exposure pathways. DOE standards limiting radiological doses to members of the public (not occupational workers) are addressed in 10 CFR § 835.208 and DOE Order 458.1 (DOE 2020). Because the LEI would be outfitted with additional local shielding as needed, the maximum off-site public dose would be similar to that associated with current conditions.

SLAC would shield the LEI electron beam enclosures to maintain the annual dose below 1 rem/y (0.5 mrem/h [millirems per hour] for 2,000 hours occupancy) in accessible areas of the accelerator and research yard and less than 0.1 rem/y (0.05 mrem/h for 2,000 hours occupancy) for other areas within the boundaries of the SLAC site with public access. SLAC implements well-established radiological protection programs that would maintain exposure at below DOE limits including monitoring public radiation dose exposures and submitting annual reports on airborne radioactivity as required by DOE and SLAC policies (SLAC 2018b) in compliance with state and federal regulations. In 2020, the maximum dose that could have been received by a member of the public due to direct radiation and radioactive air effluent from SLAC was 0.43 mrem (**Table 3-3**). This is 0.43 percent of the 100 mrem regulatory limit (SLAC 2020). As in several past years, the dose received by the public from SLAC operations is well below the regulatory limit of 100 mrem/y.

Table 3-3 SLAC Radiation Dose Estimates and Associated Risks Based on 2020 Estimates

Pathway	Dose [rem per year]	Population Dose [person-rem per year]	MEI Lifetime Risk for 30 years of Operation	Population Dose Lifetime Risk for 30 years of operation
Direct	0.0004 (4.00E-04)	1.53 (1.53E+00)	0.0000048 (4.80E-06)	0.0184 (1.84E-02)
Air	0.00003 (3.00E-05)	0.06 (6.00E-02)	0.00000036 (3.60E-07)	0.00072 (7.20E-04)
Total	0.00043 (4.30E-04)	1.59 (1.59E+00)	0.0000052 (5.16E-06)	0.00019 (1.91E-02)

Note:
MEI = maximum exposed individual

The maximum exposure to a radiological worker from LEI operations would be well below the SLAC administrative control level of 0.5 rem in 1 year and the SLAC dose-management "ALARA Level" of 360 mrem/year. The average annual dose to an individual worker would not exceed 0.1 rem. The actual dose received by most SLAC personnel is well below these levels. For the past several years, no SLAC employee received more than 40 mrem/y (DOE 2019a).

The higher beam power of the LEI would also result in a slight increment of radioactive air that would be released through ventilation due to the cryomodule operation at Sectors 0 through 10. To achieve the increased beam energy, more cryomodules operated at a higher acceleration gradient are needed for the LEI, which would lead to an increase in radiation. Air activation would increase, as would activation of the cryomodules and nearby components. Depending on the magnitude of the increase, these components would require longer cool-down times and other radiation protection measures before workers access the Linac.

Per regulations, every year SLAC prepares conservative radiation dose estimates and risks to the maximum exposed individual (MEI) of the public and the surrounding population within 50 miles (approximately 5 million persons) from the SLAC operations and submits this to DOE and USEPA. The estimates are based on exposure to direct radiation (or skyshine) and radioactive air releases. In summary, potential radiation exposures to the public during LEI operations would be very similar to those presented in **Table 3-3** and those described for LCLS-II in Section 3.8 of the 2014 EA.

During LEI operations, SLAC would continue to reduce potential exposures through continued implementation of existing radiation safety systems (including physical shielding) and in compliance with regulatory exposure limits and DOE standards. With shielding, other engineering controls, and management protocols under SLAC's radiological safety programs, the incremental radiation risk from the higher power LEI beam would only be slightly higher than that associated with the LCLS-II. This would be within the original scope and effect envelope considered in the 2014 EA and almost no different than those from high energy (HE) operations with the current injector.

3.4.3 Cryogenic Hazards

The LEI would require one new cryomodule; therefore, it would add to the overall cryogen volume and the frequency of deliveries of liquid helium and nitrogen. The increased cooling required to create cryogenic helium would require a total of two to five additional deliveries of helium and liquid nitrogen per week.

Potential hazards to workers in indoor working areas could include an oxygen deficiency hazard (ODH). This condition would result from an indoor spill of liquid helium that could displace enough air to cause injury or death.

As was completed for the LCLS-II, SLAC would review cryogenic hazards for the LEI through the hazard analysis process defined in SLAC's ESH Manual chapter titled Cryogenic and Oxygen Deficiency Hazard Safety (SLAC 2018a). This process would evaluate any additional protective measures required for an ODH and any additional engineering controls needed for piping, valves, and other devices. The LEI project would not generate new hazards that have not already been identified and addressed at SLAC or across the DOE complex. Thus, the cryogenic hazards from the LEI are within the original scope and effect envelope considered in the 2014 EA.

3.4.4 Accidents and Intentional Destructive Acts

Construction and operation of the LEI would be very similar to the construction and operation of the existing LCLS/LCLS-II and would not increase the probability of an accident or make the area more prone to damage from an intentional act. The risk of damage from an intentionally destructive act would be reduced using the same measures used for the LCLS-II, and the risk is within the original scope and effect envelope considered in the 2014 EA. The potential for an increased risk of traffic accidents during construction is evaluated in Section 3.7, Transportation.

3.4.5 Wildfire Risk

The LCLS-II project increased the risk of a potential wildfire, and Section 3.8 of 2014 EA outlined several avoidance measures. The LEI project would not substantially increase the risk of wildfire; therefore, the incremental risk of wildfire would be within the original scope and effect envelope considered in the 2014 EA. The same avoidance measures included in the 2014 EA would be implemented for LEI.

3.5 Hydrology and Water Quality

The LEI footprint is located west of an unnamed tributary to San Francisquito Creek (**Figure 3-1**). The eastern two thirds of the project site are relatively flat and separated from the western third of the site, which is at a lower elevation, by a vegetated westerly facing fill slope. Drainage from the existing topography is towards the San Francisquito Creek, located about 600 feet to the south. The slopes are stabilized with vegetation consisting of dry grasses and trees (Arup 2020).

Potential environmental effects on hydrology and water quality would be nearly identical to those described in the 2014 EA (see Section 3.9 of the 2014 EA). The LEI would be installed within the footprint of the Linac and cryogenic plant area. Therefore, the volume and the peak rate of runoff from the site would be the same as those described in the 2014 EA and 2015 SA, and no incremental effect on San Francisquito Creek, Bear Creek, or their tributaries would occur.

The objective of the LEI would be a higher operating power, which would have the potential for an incremental increase in beam loss from the Linac, resulting in the formation of tritium in soil and water. However, as described above, SLAC would evaluate the Linac and beam dumps for potential beam loss and install additional shielding to reduce the potential for residual activity in the soil and groundwater below the dump enclosure. SLAC would evaluate potential activation of groundwater and would design a monitoring well network and shielding to ensure that effects on soil would be ALARA and that tritium concentrations in groundwater would be below applicable limits.

Potential effects on water quality would not change substantially from those described in the 2014 EA. Stormwater runoff during construction would be addressed by a Project-specific SWPPP and implementation of stormwater best management practices, and SLAC would obtain a Construction Stormwater Permit. Truck deliveries and workers would continue to use site roadways to access the work site; however, those effects would continue to be addressed by stormwater best management practices and would not contribute substantially to effects on downstream water quality.

The increased cooling water flow and subsequent additional cooling tower blowdown water would be discharged to the sewer system, as is cooling water from all other SLAC facilities. The extended superconducting Linac would require additional cooling, and an additional increment of cooling water would be lost to evaporation. The additional flow and evaporation would add 16,000 gallons per day to SLAC's current daily water use. SLAC would continue to offset this additional water consumption to the extent practicable by designing and operating the LEI in a manner consistent with the SLAC Site Sustainability Plan (SLAC 2021).

The LEI would be designed to minimize wastewater and groundwater discharges. Potential wastewater discharges include cooling water replacement and discharge as well as water originating within the accelerator housing. During excavation of the LEI tunnel, groundwater may be encountered. Potential effects on groundwater flow would be temporary and localized. Dewatered groundwater and wastewater would be collected at sumps and pumped to holding tanks outside the accelerator housing. SLAC would continue to manage storage, radiological monitoring and analysis, and discharge of wastewater with radioisotopes into the sanitary sewer to meet the discharge limits of the site's wastewater permit.

SOURCES:
1. NOVEMBER 2019 AERIAL IMAGERY OBTAINED FROM ESRI IMAGERY SERVICE.
2. NATIONAL HYDROGRAPHY DATASET (NHD) OBTAINED FROMUS GEOLOGIC SURVEY AT HTTPS://NHD.USGS.GOV (2016)

LEGEND
- DRAINAGE DITCH (APPROXIMATE LOCATION)
- STREAM/CREEK
- SEARSVILLE RESERVOIR
- SLAC NATIONAL ACCELERATOR LABORATORY BOUNDARY

N

0 1,200 Feet

Graphic Scale: 1" = 1200'

SLAC LEI SUPPLEMENTAL ANALYSIS

WATER RESOURCE LOCATIONS

ARCADIS

FIGURE 3-1

This page intentionally left blank

SLAC monitors radioactivity in industrial wastewater, stormwater, and groundwater. Federal (10 CFR § 20.2003) and state (17 CCR § 30253) regulations set limits on radioactivity discharged to industrial wastewater. The annual limit for discharge to the sanitary sewer is 5 Curies for tritium, the main radionuclide in the activated water.

By employing the same avoidance and minimization measures as the LCLS-II, including stormwater controls, water-saving measures, and shielding and monitoring to protect groundwater, any incremental effects of the LEI on water quality would be within the original scope and effect envelope considered in the 2014 EA.

3.6 Noise and Vibration

During construction, the LEI project would generate noise during soil excavation, as well as on the site access roads, from vehicles transporting workers, equipment, and materials to and from the site. This noise would be short-term and limited to the 12- to 18-month construction period. The added installation work would be nearly identical to that described in the 2014 EA (DOE 2014) and would not result in increased noise relative to LCLS-II. The construction noise analysis demonstrated that noise from construction equipment would only marginally exceed existing ambient noise levels, and construction noise effects would be minor.

In addition, heavy construction can cause excessive vibration levels exceeding criteria in the nearby research facilities. Arup has performed on-site construction vibration testing at SLAC as part of the XEH conceptual design report (Arup 2020). To further assess the risk of construction-induced vibration, the criteria of the existing nearby facilities would be defined (Arup 2020). A vibration analysis will be conducted between the 30 percent and 60 percent design phases.

The LEI may result in a small incremental increase in operational noise that would only be audible to workers in the immediate area. As described in the 2014 EA, Sector 0 is located in an isolated area on the western end of the SLAC campus, and the previous noise evaluation (see Section 3.10 of the 2014 EA) showed that any receptors at SLAC (more than 1 mile to the east) or in residential or commercial areas to the north, east, or south of SLAC would not be affected. Furthermore, any noise receptors at the west end of SLAC near Sand Hill Road are exposed to substantial ambient noise from traffic, which was measured in the field for the 2014 EA and ranged from 46.2 to 67.5 A-weighted decibel (dBA) equivalent continuous noise level (L_{eq}) (DOE 2015).

The LEI and its operating procedures would be designed to minimize noise, such as selecting quieter equipment or adding enclosures. For these reasons, any incremental noise effects from the LEI operations would be within the original scope and effect envelope considered in the 2014 EA (DOE 2014).

The new facility would house equipment sensitive to vibration and would be located close to existing vibration-sensitive equipment. Vibration sources can be internal and external, such as mechanical equipment at SLAC or nearby road traffic (Arup 2020). The existing external vibration sources proximal to the LEI are shown on **Figure 3-2**. As described in the 2014 EA, any increase in equipment vibration from the LCLS-II would not be perceptible. Because the LEI operations would add the same types of static equipment (e.g., cryomodules, waveguides, solid state amplifiers), and because of the substantial distance to sensitive receptors, there would be no vibration effects. For these reasons, any incremental vibration effects from the LEI operations would be within the original scope and effect envelope considered in the 2014 EA.

3.7 Transportation

The LEI would result in short-term construction-related increases in traffic from delivery of construction equipment and materials, worker commutes, demolition, and excavated soil and waste removal. Most worker traffic and deliveries would occur at off-peak times.

Less than 5 additional SLAC staff would be required for the LEI operations and maintenance. Nitrogen deliveries would add one to three truck trips per week. This level of increase in operational traffic is within the normal variability in traffic arriving at SLAC including from facility shutdowns.

The LEI would result in an increase in truck and worker traffic on local roads near SLAC; however, as described in the 2014 EA (see Section 3.12 of the 2014 EA), traffic on local roads (i.e., Sand Hill Road and Alpine Road [**Figure 1-1**]) ranges from approximately 14,000 to 19,000 trips per day. Considering SLAC's research population and the daily variability of construction traffic, this temporary increase in vehicle traffic would be negligible. Traffic effects during operation of the LEI would be minor.

Given the small, temporary increase in traffic expected during construction and installation, and the small incremental increase in operational deliveries and workers, any related effects would be within the original scope and effect envelope considered in the 2014 EA.

Likewise, the LEI would result in only a minor incremental increase in the risk of traffic accidents from construction-related vehicles. In the 2014 EA, the calculated number of potential project traffic injuries was 0.5, and the number of traffic fatalities was close to zero. This was based on 40 workers driving 25 miles round-trip for a year, and 1,000 truck trips traveling one 35-mile round-trip each, resulting in a peak of 36,000 vehicle miles traveled. Because equipment would be removed over a brief period of weeks, and the installation of the additional cryomodules and supporting equipment would require only three to four workers and one truck for on-site trips, the incremental increase in accident risk would be negligible. Furthermore, project truck drivers would be required to comply with SLAC's traffic safety policy. For construction, this policy requires signage and/or flashing lights, traffic cones, and flaggers to direct trucks where visibility is obstructed. Trucks would be required to adhere to on- and off-site speed limits. Traffic management would be incorporated into the construction contract. Cryomodule installation would not require the transport of substantial volumes of hazardous materials or any radioactive materials or wastes.

For operational traffic, the 2014 EA estimated one injury and zero fatalities based on six SLAC employees and 15 additional researchers driving approximately 1,950,000 vehicle miles over the 20-year project life. Because operation of the LEI would require less than 5 additional SLAC staff, there would be no increase in the risk of traffic accidents during operations. Traffic associated with the LEI operations would be within the original scope and effect envelope considered in the 2014 EA.

SOURCE: ARUP 2020.

N

SLAC LEI SUPPLEMENTAL ANALYSIS

EXTERNAL VIBRATION SOURCES

ARCADIS

FIGURE
3-2

This page intentionally left blank

A Project-specific Traffic Control Plan would be developed to identify transportation routes and facilitate trucking of excavated materials and debris including access from local roadways. The Proposed Action construction traffic would be coordinated with construction-related traffic from other SLAC projects. Traffic management requirements would be incorporated into the construction contract. Construction vehicles and workers would be required to enter SLAC via Alpine Road or, in special circumstances, the Sector 0 access gate off the entrance of Sand Hill Road. To minimize traffic delays resulting from vehicles turning left from either entrance, the traffic management plan outlines constraints on making left turns against oncoming traffic. The traffic management plan also establishes project-specific traffic management measures such as arrival and departure times. Construction traffic typically occurs outside the normal commute peak periods. Heavy haul deliveries would arrive after 9 a.m. and depart after 7 p.m. With implementation of these measures, SLAC would minimize off-site construction traffic effects.

Any added traffic at the component fabrication sites would be negligible, as there would be no construction (e.g., excavation, building construction) at these sites. The fabrication work would be completed by existing SLAC staff along with less than 5 additional staff, and truck deliveries of materials would be consistent with the existing frequency of deliveries. This work would be completed at active machine shops, laboratories, and clean rooms at these locations. There would be no incremental increase in traffic volume or accidents, and any transportation effects would be within the original scope and effect envelope considered in the 2014 EA.

For the LEI operations, the increased heat load and cooling requirements would require an additional one to three truck trips per week for liquid helium deliveries and an additional one to two truck trips per week for liquid nitrogen deliveries. Based on the area traffic numbers described in the 2014 EA, and the low number of miles that would be driven for the additional truck trips for liquid helium and nitrogen deliveries, any related traffic and potential injury effects would be within the original scope and effect envelope considered in the 2014 EA, and no additional quantitative analysis is required.

3.8 Waste Management

The LEI construction would generate a minor additional increment of hazardous waste (e.g., waste paint, fuels, rags) and a small additional increment of solid waste, such as packaging, which would be handled by existing SLAC waste management programs and would be recycled to the extent practicable.

The 2014 EA analyzed potential effects associated with excavation of approximately 15,000 to 30,000 cy of soil for the cryogenic plant foundations. In contrast, the LEI would require excavation of a total of approximately 16,200 cy of soils from Sector 0 as described in Section 2.1.1. The LEI would have only a minor incremental effect on waste volumes, and the effects would be nearly identical to those described in the 2014 EA (see Section 3.14 of the 2014 EA).

The Collider Injection Development area, which is designated as a "deferred site" due to legacy PCBs, petroleum hydrocarbons, and lead soil contamination, is located at Sector 0. Any planned excavation at Sector 0 must evaluate potential effects for future remediation of the Collider Injection Development area. The excavated soils would be tested according to SLAC's Excavation Program to confirm that there are no chemicals from past site activities at concentrations that exceed future land use criteria and to identify disposal options. Transportation and disposal of all hazardous and Class II wastes would be coordinated with SLAC Waste Management.

If chemicals were present in the soil at concentrations that exceed future land use criteria, they would require off-site disposal in a permitted industrial waste landfill. Covered trucks would transport the material to an off-site disposal facility. SLAC would handle and dispose of all wastes in accordance with SLAC procedures. Any effects from increased waste would be addressed by existing SLAC programs.

Radiological wastes associated with LEI operations would not affect other aspects of construction or operation and would be managed in compliance with DOE Order 435.1 (DOE 2021) and SLAC's existing radioactive waste program. Any additional wastes generated for LEI operation would be addressed by complying with existing regulations and SLAC's existing policies and programs for safe handling, storage, and transport of hazardous materials as described in detail in the 2014 EA. Any potential on-site waste management effects associated with the LEI would be within the original scope and effect envelope considered in the 2014 EA.

3.9 Cumulative Effects

This section identifies potential cumulative effects of the LEI along with reasonably foreseeable future actions to assess whether additional effect analysis is required for project changes related to the additional equipment removal, installation of additional cryomodules, additional cryogen deliveries, and higher operating power. Potential incremental cumulative effects of other SLAC activities and other projects in the region include the following:

- Basic Energy Sciences – LCLS-II-HE.
- Fusion Energy Sciences – Matters in Extreme Conditions Upgrade (MEC-U).
- Science Laboratory Infrastructure:
  - Large Scale Collaboration Center; and
  - Critical Utilities Infrastructure Revitalization.

The 2014 EA noted that effects would be small and that those effects, collectively with effects associated with other reasonably foreseeable actions, are also expected to be small. For resources on which the LEI would have no effect, cumulative effects would not be relevant. Therefore, this section does not identify cumulative effects on biological resources, cultural resources, socioeconomics, environmental justice, land use, and visual resources.

Sections 3.9.1 through 3.9.7 identify the potential for cumulative effects on air quality and GHGs, geology and soils, health and safety, hydrology and water quality, noise and vibration, transportation, and waste management.

3.9.1 Air Quality and Greenhouse Gases

The LEI would result in small incremental emissions of criteria pollutants that would be below permit limits. Other projects at SLAC, Stanford University, and throughout the region would contribute to regional emissions. As demonstrated in Section 3.15.1 of the 2014 EA and in the 2015 SA, LCLS-II emissions would be a small fraction of regional emissions. Any effects of the LEI on regional air quality would be within the original scope and effect envelope considered in the 2014 EA.

The LEI would also result in an incremental increase in construction-related GHG emissions relative to LCLS-II; however, similar to the emissions analyzed in the 2015 and 2019 SAs, the incremental construction GHG emissions would be within the original scope and effect envelope considered in the 2014 EA. The higher energy Linac would result in increased power demand during operation relative to the LCLS-II. The 2014 EA, 2015 SA, and 2019 SA showed that the increased energy consumption required to operate the LCLS-II superconducting Linac increased the annual operational GHG emissions above the previously published CEQ reference point cited in the 2014 EA for quantifying GHG emissions under NEPA. However, the utility GHG intensity factor has decreased over time and thus counterbalances a portion of the GHG emissions associated with the increased energy consumption. Therefore, this SA provides an additional comparison of annual operational emissions with the CEQ reference point for quantifying GHG emissions under NEPA of 25,000 metric tons of GHG emissions per year ($MTCO_{2e}$/year; CEQ 2014). This additional evaluation of operational GHG emissions is presented below.

Table 3-4 provides a summary of the estimated cumulative operational GHG emissions for the LCLS-II, LCLS-II-HE, and LEI. The 2014 EA estimated GHG emissions at 20,358 $MTCO_{2e}$/year with a utility carbon dioxide (CO_2) intensity factor of 1,001.57 pounds per megawatt-hour (lbs/MWh). For the LEI project, this SA assumed that the project's increased power use would be proportionate to the increase in the number of cryomodules, but the utility CO_2 intensity factor would decrease to 453.21 lbs/MWh, consistent with the most recent version of CalEEMod. With these assumptions, the LEI project would generate approximately 9 percent of the LCLS-II's energy (electricity) emissions (672 $MTCO_{2e}$/year for operating the three LCLS-II cryomodules), bringing the estimated combined GHG emissions for LCLS-II, LCLS-II-HE, and LEI to approximately 47,139 $MTCO_{2e}$/year.

Table 3-4 Estimated Proposed Action Operational GHG Emissions for LCLS-II, LCLS-II with Reconfigured Cryoplants, LCLS-II-HE, and LEI

Source	Annual Emissions ($MTCO_{2e}$/year)				
				LEI	
	LCLS-II Project	LCLS-II (with Reconfigured Cryoplants)	LCLS-II-HE	Incremental Increase from LCLS-II-HE	Total
Indirect (Annual Operational Emissions)					
Electricity	17,324	27,718	40,537	672	41,209
Water Use	3,034	4,490	5,816	114	5,930
Waste Generation	0.35	0.35	0.35	0	0.35
Total Indirect	**20,358**	**32,209**	**46,353**	**786**	**47,139**

Notes:
$MTCO_{2e}$ = metric ton carbon dioxide equivalent; N/A = not applicable
The California Environmental Quality Act (CEQA) reference point of 25,000 $MTCO_{2e}$/year was used in the 2014 EA but was not included in the 2019 Supplement Analysis (DOE 2019a).
CEQ guidance (Federal Register, Vol. 84, No. 123, June 26, 2019) for consideration of GHG emissions (CEQ 2019).

Sources: DOE 2014, 2015, 2019a

Although the LEI project would increase GHG emissions, these emissions would have minimal effects on climate change. Further, SLAC will continue to increase its energy efficiency in compliance with Executive and DOE Orders and reduce its emissions across all programs. Thus, by continuing to increase the energy efficiency of DOE's operations and those of all federal agencies, the potential effects of the LEI's increased GHG emissions would be minimal and within the original scope and effect envelope considered in the 2014 EA.

3.9.2 Geology and Soils

The LEI would result in small incremental effects to geology and soils. Other projects at SLAC, Stanford University, and throughout the region would contribute to short-term effects on soils including increased risk of erosion due to vegetation removal caused by the use of heavy equipment. These potential effects would be reduced through erosion control BMPs and site restoration. Other projects would be subject to similar geologic and seismic engineering design and geotechnical measures as required by local and state building codes. Cumulative effects associated with the LEI would be within the original scope and effect envelope considered in the 2014 EA.

3.9.3 Health and Safety

In conjunction with the LCLS-II, the LEI would affect worker health and safety during construction and installation by increasing beam power and adding to the frequency of cryogen deliveries. However, these effects would be managed under DOE and SLAC safety programs and by adding shielding to the Linac to minimize beam loss. Any cumulative effects would be within the original scope and effect envelope considered in the 2014 EA.

3.9.4 Hydrology and Water Quality

The LEI would not require long-term ground disturbance and would have no long-term effects on hydrology. Thus, there would be no contribution to cumulative effects from stormwater runoff or flooding, which is within the effect envelope considered in the 2014 EA. Any increased pollutants resulting from additional workers and truck deliveries or additional operation and maintenance would be offset by SLAC's compliance with stormwater regulations and the implementation of the SWPPP. Thus, any incremental effect on water quality would not contribute substantially to cumulative effects on hydrology or water quality in adjacent waterways, which are addressed at the regional level as described in the 2014 EA (i.e., by the Santa Clara Valley Urban Runoff Pollution Prevention Plan and San Mateo County).

As part of the LEI design, the Linac and beam dumps would be evaluated for potential beam loss and shielding would be added to reduce the potential for residual activity in the soil and groundwater. The added shielding is designed to keep tritium concentrations below detection limits. Groundwater wells would be used to monitor water quality at those sites. Beam line operations are the only sources of tritium or other radionuclides in soil or groundwater at these sites. The additional shielding and continued monitoring would ensure that the cumulative effects would be within the original scope and effect envelope considered in the 2014 EA.

3.9.5 Noise and Vibration

Construction and operation of the LEI would result in an additional increment of noise and vibration during drilling of the tunnel, primarily at Section 0. However, other SLAC projects would be located approximately 2 miles away, and no other projects that generate noise would overlap. Therefore, the LEI noise and vibration effects would be minor. Cumulative effects would be within the original scope and effect envelope considered in the 2014 EA.

3.9.6 Transportation

Potential repairs may be needed to existing roads to accommodate heavy vehicle traffic. The 2014 EA identified the potential for minor, short-term (construction-related) cumulative traffic effects on Sand Hill Road and Alpine Road from workers and truck traffic. However, as described above, a Project-specific Traffic Control Plan would be developed to minimize traffic effects. With implementation of this plan, the LEI would have a negligible contribution to traffic and the risk of accidents and would have an even smaller contribution to cumulative effects. Cumulative effects would be within the original scope and effect envelope considered in the 2014 EA.

3.9.7 Waste Management

The LEI would have only a minor incremental effect on the generation of construction and operational waste that would be addressed by site plans and policies including reduction and recycling requirements per SLAC's Site Sustainability Plan (SLAC 2021). Soils excavated from Sector 0 would be tested according to SLAC's Excavation Program to confirm that there are no chemicals from past site activities at concentrations that exceed future land use criteria and to identify disposal options. If chemicals were present in the soil at concentrations that exceed future land use criteria, they would require off-site disposal in a permitted industrial waste landfill. Covered trucks would transport the material to an off-site disposal facility. SLAC would handle and dispose of all wastes in accordance with SLAC procedures. Any effects from increased waste would be addressed by existing SLAC programs.

The LEI radioactive, hazardous, and mixed waste would be managed using the same procedures used for the LCLS-II. SLAC and DOE's contribution to irradiated components that would require long-term storage would be managed under DOE Orders. Other projects also would produce solid waste including excavated material and construction and demolition wastes. The LEI would have a negligible contribution to waste management and would have an even smaller contribution to cumulative effects. Cumulative effects would be within the original scope and effect envelope considered in the 2014 EA.

This page intentionally left blank

4.0 DETERMINATION

For this analysis, the LEI project and its potential environmental effects were compared with the original proposed action evaluated in the 2014 EA, the 2015 SA, and the 2019 SA. Based on this analysis, DOE has determined that the LEI would not require new activities outside of those already being implemented for installation tasks and would comply with existing DOE requirements, SLAC procedures, and the project-specific avoidance and minimization measures described in the 2014 EA, and the effects of the LEI are within the original scope and effect envelope considered in the 2014 EA.

In accordance with the NEPA and CEQ's and DOE's implementing NEPA regulations, DOE prepared this SA to evaluate whether the effects of the proposed LEI project are within the original scope and effect envelope considered in the 2014 EA and, accordingly, whether further environmental analysis and documentation are required under NEPA. DOE concludes that the proposed new actions associated with the LEI relevant to environmental concerns are not significant and therefore do not require further environmental analysis. No further NEPA documentation is required.

This page intentionally left blank

5.0 LIST OF PREPARERS AND REVIEWERS

The following table lists the individuals responsible for preparing this SA. The SA was prepared for DOE and SLAC through a contract with Arcadis U.S., Inc.

Name	Resource Area
DOE Reviewers	
Charina Rockwell	Director of ESH and Operations, SLAC Site Office
Risa Benwell	NEPA Compliance Officer, SLAC Site Office
Katatra Vasquez	NEPA Compliance Officer, SC Office of Safety and Security
John Cummins	SC Legal Counsel, SLAC Site Office
SLAC Reviewers	
Ian Evans	ESH Division, Director
Greg Hays	LCLS-II-HE, Project Director
Helen Nuckolls	ESH Division, Environmental Protection, Department Head
Michelle DeCamara	ESH Division, Environmental Compliance, Section Lead
Maia Coladonato	ESH Division, Air Quality Program Manager
Wendy Greene	ESH Division, Biological Resources Protection and NEPA/NHPA Program Manager
April Giangerelli	ESH Division, Water Resources Program Manager
Janet Argyres	ESH Division, Environmental Restoration, Section Lead
Rohendra Atapattu	ESH Division, Sustainability Program Manager
Sayed Rokni	ESH Division, Radiation Protection Department, Department Head
Saurabh Anand	Stanford Legal Counsel
Sarah Perry	Stanford Legal Counsel
Arcadis, U.S., Inc. Preparers	
Dori Baker	Project Manager
Kathryn Cloutier	NEPA Specialist
Eric Cowan	Quality Assurance
Lee Miles	Aquatic and Biological Resources
Chuck Pardini	Geology, Soils, and Seismic
Bryan Chen	Air Quality and GHG
Yinka Afon	Noise and Vibration
Deb Ballheim	Technical Editor
Carrie Womack	Document Production

This page intentionally left blank

6.0 REFERENCES

Adolphsen, C., B. Dunham, M. Dunne, C. Eason, I. Evans, G. Hays, N. Holtkamp, and C. Kao. 2020. Proposal and Recommendation for a Low Emittance Injector for LCLS-II-HE, SLAC National Accelerator Laboratory, June 22. 6 pages.

Arup North America LTD (Arup). 2020. LEIT: Low Emittance Injection Tunnel Feasibility Study. SLAC ID: SRP-RPT-TCS-20001. Final. SLAC National Accelerator Laboratory. September 29. 86 pages.

Bay Area Air Quality Management District (BAAQMD). 2020. Permit to Operate and Synthetic Minor Operating Permit for SLAC National Accelerator Laboratory.

Bendanillo, Irene. 2022. LCLS-II-HE. Low Emittance Injector Tunnel (LEIT) Design Review. 1.06.03 Preliminary Design Review (PDR). October. 31 pages

Bureau of Labor Statistics. 2020. Employer-Reported Workplace Injuries and Illnesses – 2019. USDL-20-2030. November 4. 9 pages. [Web Page]. Located at https://www.bls.gov/news.release/archives/osh_11042020.pdf. Accessed: September 1, 2021.

Council on Environmental Quality (CEQ). 2014. Revised Draft Guidance for Greenhouse Gas Emissions and Climate Change Impacts.

———. 2019. Draft National Environmental Policy Act Guidance on Consideration of Greenhouse Gas Emissions. [Web Page]. Located at https://www.govinfo.gov/content/pkg/FR-2019-06-26/pdf/2019-13576.pdf. Accessed: November 18, 2021. National Environmental Policy Act (NEPA) regulations and guidance (40 CFR 1500–1508), effective September 14, 2020.

———. 2021. Executive Office of the President, National Environmental Policy Act Implementing Regulations. [Web Page]. Located at https://ceq.doe.gov/docs/laws-regulations/nepa-implementing-regulations-desk-reference-2021.pdf. Accessed: November 18, 2021.

Evans, Ian Walters. 2021. Personal communication. [*August 31* e-mail to K. Cloutier, Arcadis, Highland Ranch, Colorado. *RE*: SLAC DART and TRC Rates]. LCLS-II-HE, ESH Manager. SLAC National Accelerator Laboratory, San Mateo County, California.

Mott MacDonald. 2022. SLAC LCLS-II-High Energy (HE) Low Emittance Injector Tunnel (LEIT) Project Narrative Description, 60 Percent Submittal. September 9. 13 pages. SLAC National Accelerator Laboratory (SLAC). 2018a. SLAC Worker Safety and Health Program. SLAC-I-720-0A21B-001-R011. Environment,Safety and Health Division. May. [Web Page]. Located at https://www-group.slac.stanford.edu/esh/general/wshp/wshp.pdf. Accessed: September 1, 2021.

———. 2018b. SLAC Radiation Protection Program. 10 CFR 835 Implementation Plan. SLAC-I-720-1A05M-002-R006. October.

———. 2019a. SLAC Storm Water Pollution Prevention Plan. Environmental Safety and Health Division.

SLAC-I-750-0A16M-002-R005. December. 184 pages.

———. 2019b. Radiological Control Manual. [Web Page]. Located at http://www-group.slac.stanford.edu/esh/documents/RCM.pdf. https://www-group.slac.stanford.edu/esh/documents/RCM.pdf. Accessed: September 1, 2021.

———. 2020. SLAC Injury and Illness Prevention Program (IIPP). [Web Page]. Located at https://www-group.slac.stanford.edu/esh/general/iipp/SLAC_IIPP.pdf. Accessed: November 18, 2021.

———. 2021. Site Sustainability Plan 2022. SLAC National Accelerator Laboratory. December 1. 37 pages.

U.S. Department of Energy (DOE). 2004. Recommendations for the Preparation of Environmental Assessments and Environmental Impact Statements. Second Edition. December. 53 pages. [Web Page]. Located at https://www.energy.gov/sites/prod/files/nepapub/nepa_documents/RedDont/G-DOE-greenbook.pdf. Accessed: September 1, 2021.

———. 2014. Environmental Assessment, Linac Coherent Light Source-II (DOE/EA-1975). July. 226 pages.

———. 2015. Supplement Analysis for the National Environmental Policy Act Environmental Assessment Linac Coherent Light Source-II (DOE/EA-1975-SA-01). September. 50 pages. [Web Page]. Located at https://www.energy.gov/sites/prod/files/2015/09/f26/EA-1975-SA-2015.pdf. Accessed: September 1, 2021.

———. 2017. 10 CFR 835, Occupational Radiation Protection. As amended at 82 FR 37514, Aug. 11, 2017. [Web Page]. Located at https://www.energy.gov/ehss/occupational-radiation-protection-program-10-cfr-835. Accessed: September 1, 2021.

———. 2019a. Supplement Analysis for the National Environmental Policy Act Environmental Assessment Linac Coherent Light Source-II LCLS-II High Energy (LCLS-II-HE) Project (DOE/EA-1975-SA-02). October. 78 pages. [Web Page]. Located at https://www-group.slac.stanford.edu/esh/groups/ep/epg/EPA-92_LCLS-II_HE_SA_EA.pdf. Accessed: September 1, 2021.

———. 2019b. Recommendations for the Supplement Analysis Process, Second Edition. Office of NEPA Policy and Compliance. January. 20 pages. [Web Page]. Located at https://www.energy.gov/sites/default/files/2019/01/f59/SA-guidance-2019-01-31.pdf. Accessed: September 1, 2021.

———. 2020. DOE Order 458.1, Change 4, Radiation Protection of the Public and the Environment.

———. 2021. Radioactive Waste Management DOE Order 435.1-1 Chg 2 (AdminChg). Office of Environmental Management. January 21.