DOE/EIS-0547

DRAFT SITE-WIDE ENVIRONMENTAL IMPACT STATEMENT FOR CONTINUED OPERATION OF THE LAWRENCE LIVERMORE NATIONAL LABORATORY

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TITLE: *Draft Site-Wide Environmental Impact Statement for Continued Operation of the Lawrence Livermore National Laboratory* (LLNL SWEIS) (DOE/EIS-0547)

LOCATION: Livermore, California

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Abstract: The NNSA, a semi-autonomous agency within the DOE, is responsible for meeting the national security requirements established by the President and Congress to maintain and enhance the safety, reliability, and performance of the U.S. nuclear weapons stockpile. The continued operation of the Lawrence Livermore National Laboratory (LLNL) is critical to NNSA's Stockpile Stewardship and Management Program, to prevent the spread and use of nuclear weapons worldwide, and to many other areas that may impact national security and global stability.

NNSA has prepared this SWEIS to analyze the potential environmental impacts of the reasonable alternatives for continuing LLNL operations for approximately the next 15 years. This LLNL SWEIS has been prepared in accordance with Section 102(2)(C) of NEPA (42 U.S.C. §§ 4321–4347, as amended), regulations promulgated by the Council on Environmental Quality (CEQ) (40 Code of Federal Regulations [CFR] Parts 1500–1508), DOE's NEPA implementing procedures (10 CFR Part 1021), and NNSA Policy (NAP) 451.1.

This SWEIS analyzes two alternatives: (1) No-Action Alternative and (2) Proposed Action. This SWEIS also analyzes the new hybrid work environment due to increase in telework at LLNL under both alternatives. Under the No-Action Alternative, NNSA would continue current facility operations throughout LLNL in support of assigned missions. The No-Action Alternative includes the construction of new facilities; modernization/upgrade/utility projects; and decontamination, decommissioning, and demolition (DD&D) of excess and aging facilities through 2022.

The Proposed Action includes the scope of the No-Action Alternative and an increase in current facility operations or enhanced operations that may require new or modified facilities and that are reasonably foreseeable over the next 15 years. Continued re-investment would allow LLNL to meet mission deliverables and sustain science, technology, and engineering excellence to respond to future national security challenges. Approximately 75 new projects, totaling approximately 3.3 million square feet, are proposed over the period 2023–2035. Of this, 61 projects, totaling approximately 2.9 million square feet, are proposed at the Livermore Site; 14 projects, totaling approximately 385,000 square feet, are proposed at Site 300. In addition, NNSA proposes 20 types of modernization/upgrade/utility projects each involving several facilities. Under the Proposed Action, NNSA would also DD&D about 150 facilities, totaling approximately 1,170,000 square feet. NNSA is proposing operational changes that would increase the tritium emissions limits in the National Ignition Facility (Building 581) and the Tritium Facility (Building 331), decrease the administrative limit for fuels-grade-equivalent plutonium in the Superblock (Building 332), increase the administrative limits for plutonium-239 at Building 235, and revise the National Ignition Facility radioactive materials administrative limits to be consistent with DOE's Facility Hazard Categorization Standard.

Following completion of this LLNL SWEIS, NNSA intends to decide how operations will be conducted at LLNL, including construction and operation of new facilities, modification/upgrade of existing facilities and utilities, modification of operations, and/or DD&D of excess and aging facilities. These decisions will be provided in the NNSA Record of Decision (ROD).

Public Comments: DOE issued a Notice of Intent (NOI) in the *Federal Register* (85 FR 47362) on August 5, 2020, announcing a 45-day SWEIS scoping period to receive input on the preparation of this Draft SWEIS. In response to comments, NNSA extended that comment period until October 21, 2020. Comments received during that scoping period have been considered in the preparation of this Draft SWEIS. Comments on this Draft SWEIS will be accepted following publication of the U.S. Environmental Protection Agency's Notice of Availability (NOA) in the *Federal Register* for a period of 60 days and will be considered in the preparation of the Final SWEIS. Any comments received after the comment period will be considered to the extent practicable. During the public comment period for this Draft SWEIS, NNSA will hold in-person and/or online public hearings. The dates and times of those public hearings will be announced on the DOE NEPA web page and the NNSA NEPA web page (https://www.energy.gov/nepa, https://www.energy.gov/nnsa/nnsa-nepa-reading-room), as well as in local newspapers, and in Federal Register Notices of Availability. All comments received during that public comment period will be considered by NNSA in preparing the Final SWEIS.

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ABBREVIATIONS AND ACRONYMS

°F	Fahrenheit
2005 LLNL SWEIS	2005 *Site-wide Environmental Impact Statement for Continued Operation of Lawrence Livermore National Laboratory*
3D	three dimensional
AAALAC	Association for Assessment and Accreditation of Laboratory Animal Care International
ACDEH	Alameda County Department of Environmental Health
ACE	Altamont Commuter Express
ACFD	Alameda County Fire Department
ACM	asbestos-containing materials
ADT	average daily traffic (volume)
AEMGF	Alternative Energy Micro-Grid for the Future
ALARA	as low as reasonably achievable
Alts	alternation programs
AME	Applied Materials and Engineering
AML	Advanced Manufacturing Laboratory
AQCR	Air Quality Control Regions
ARBU	Radiographic and Diagnostics Hydrodynamic Test Building Upgrade
ARG	accident response group
ASC	Advanced Simulation and Computing
AVLIS	atomic vapor laser isotope separation
BAAQMD	Bay Area Air Quality Management District
BART	Bay Area Rapid Transit
BeO	beryllium oxide
BEU	beyond extremely unlikely
BGEPA	*Bald and Golden Eagle Protection Act*
BKC	Biological Knowledge Center
BLDG	Building
BLS	Bureau of Labor Statistics
BMP	Best Management Practice
Bq/L	Becquerel per liter
BSL	Biosafety Level
BSL-1	Biosafety Level 1
C&D	construction and demolition
CAA	*Clean Air Act*
CAAQS	California Ambient Air Quality Standards
CAMS	Center for Accelerator Mass Spectrometry
CARB	California Air Resources Board
CAS	Central Alarm System
CBRNE	Chemical, Biological, Radiological, Nuclear, and/or Explosive
CCR	*California Code of Regulations*
CDC	Centers for Disease Control and Prevention
CDFW	California Department of Fish and Wildlife
CDNL	C-weighted Day-Night Sound Level

CEQ	Council on Environmental Quality
CEQA	*California Environmental Quality Act*
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act*
CF - R&D	Community Facility - Research and Development
CFF	Contained Firing Facility
CFR	Code of Federal Regulations
Ci	Curies
CMR	compliance monitoring report
CNDDB	California natural diversity database
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
COC	constituent of concern
COVID-19	Coronavirus disease 2019
CRD	comment response document
CSA	container storage area
CSVRA	Carnegie State Vehicular Recreation Area
CTBT	Comprehensive Test Ban Treaty
CUPA	Certified Unified Program Agency
CVP	Central Valley Project
CVRWQCB	Central Valley Regional Water Quality Control Board
CWC	Chemical Weapons Convention Treaty
DARHT	Dual Axis Radiographic Hydrodynamic Test
dB	decibel
dBA	A-weighted decibel
dBC	C-weighted decibel
dBP	peak sound level
DBP	disinfection byproducts
DD&D	Decontamination, decommissioning, and demolition
DFEAT	Disposition and Forensic Analysis Team
DFO	DOE forensics operations
DHS	United States Department of Homeland Security
DNL	Day-night sound level
DoD	United States Department of Defense
DOE	United States Department of Energy
DOF	California Department of Finance
DOL	Design optimization laboratory
DRDF	Dynamic Radiography Development Facility
DSA	Documented Safety Analysis
DTSC	Department of Toxic Substances Control
DU	depleted uranium
DWTF	Decontamination and Waste Treatment Facility
ECFM	Exascale Complex Facility Modernization
EDD	California Employment Development Department
EIR	Environmental Impact Report

EIS	Environmental Impact Statement
EM	DOE Office of Environmental Management
EMDE	Energetic Materials Development Enclave
EMS	Environmental Management System
EO	Executive Order
EOC	Emergency Operations Center
EPA	California Environmental Protection Agency
EPHA	Emergency Planning Hazard Assessment
ES&H	Environment, Safety, and Health
ESA	*Endangered Species Act*
ESCRC	Experimental Synthesis/Chemistry Replacement Capability
ETF	Environmental Test Facility
EU	extremely unlikely
EWSF	Explosives Waste Storage Facility
EWTF	Explosives Waste Treatment Facility
FEMA	Federal Emergency Management Agency
FFA	Federal Facility Agreement
FFRDC	Federally Funded Research and Development Center
FGE	fuels-grade-equivalent
FHWA	Federal Highway Administration
FIMS	Facilities Information Management System
FONSI	Finding of No Significant Impact
FSC	Forensic Science Center
ft	feet
FXR	Flash x-ray
FY	Fiscal Year
G&A	General and Administrative
GAA	General Access Area
GAC	granular activated carbon
gal	gallons
GBSD	Ground Based Strategic Deterrent
GCR	general conformity rules
GHG	greenhouse gas
GP	guiding principle
GSA	General Service Area
GWP	Ground Water Project
HAP	Hazardous air pollutant
HC	Hazard Category
HE	high explosives
HEAF	High Explosives Applications Facility
HED	high energy density
HEMI	High Explosives Manufacturing Incubator
HEPA	high efficiency particulate air
HETEF	High Explosives Test and Evaluation Facilities
HEU	highly enriched uranium
HHAS	Hetch Hetchy Aqueduct System

HMX	Cyclotetramethylenetetranitramine
HPC	high performance computing
HPCIC	High Performance Computing Innovation Center
HSU	hydrostratigraphic unit
HT	tritiated hydrogen gas
HTO	tritiated water
HVAC	heating, ventilation, and air conditioning
I	Interstate
IAEA	International Atomic Energy Agency's
IBC	International Building Code
ICF	inertial confinement fusion
ICRP	International Commission on Radiation Protection
IDA	intentional destructive acts
IHE	insensitive HE
IPaC	Information for Planning and Consultation
IPCC	Intergovernmental Panel on Climate Change
IS	Initial Study
ISMS	Integrated Safety Management System
ISO	International Organization for Standardization
ISS	Institutional Strategic Support
JASPER	Joint Actinide Shock Physics Experimental Research
JTOT	Joint Technical Operations Team
LANL	Los Alamos National Laboratory
LCF	latent cancer fatality
LDRD	Laboratory Directed Research and Development
LEAF	Laser-Explosives Application Facility
LEED	Leadership in Energy and Environmental Design
LEP	Life Extension Program
Leq	equivalent sound level
LIA	Linear Induction Accelerator
LiOH	lithium hydride
LLESA	Livermore Laboratory Employee Services Association
LLNL or Laboratory	Lawrence Livermore National Laboratory
LLNL SWEIS or SWEIS	*Site-wide Environmental Impact Statement for Continued Operation of the Lawrence Livermore National Laboratory*
LLNS	Lawrence Livermore National Security, LLC
LLW	low-level radioactive waste
LOS	level of service
LPFD	Livermore-Pleasanton Fire Department
LSI	light science and industry
LVOC	Livermore Valley Open Campus
LWRP	Livermore Water Reclamation Plant
MAR	material at risk
MBTA	*Migratory Bird Treaty Act*
MCL	maximum contaminant level
MEI	maximally exposed individual

MGD	million gallons per day
MLLW	mixed low-level radioactive waste
MNL	Micro/Nano Laboratory
Mod	modification program
MOU	Memorandum of Understanding
MRZ	Mineral Resource Zone
MW	megawatts
NAAQS	National Ambient Air Quality Standards
NAGPRA	*Native American Graves Protection and Repatriation Act of 1990*
NAP	National Nuclear Security Administration Policy
National Register	National Register of Historic Places
NCA4	Fourth National Climate Assessment
NCDL	Non-destructive Characterization Laboratory
NCRP	National Council on Radiation Protection
NDE	non-destructive evaluation
NEP	nuclear explosives packages
NEPA	*National Environmental Policy Act*
NESHAP	National Emission Standards for Hazardous Air Pollutants
NEST	nuclear emergency response team
NHPA	*National Historic Preservation Act*
NIF	National Ignition Facility
NIF&PS	National Ignition Facility and Photon Science Program
NIH	National Institutes of Health
NMED	New Mexico Environment Department
NNSA	National Nuclear Security Administration
NNSS	Nevada National Security Site
NOI	Notice of Intent
NOx	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NPR	Nuclear Posture Review
NPT	Nuclear Nonproliferation Treaty
NRHP	National Register of Historic Places
NSE	Nuclear Security Enterprise
O&B	Operations and Business
O_3	ozone
OGC	Office of General Council
OHSMS	Operational Health and Safety Management System
OPCW	Organisation for the Prohibition of Chemical Weapons
OSHA	Occupational Safety and Health Administration
OST	Office of Secure Transportation
OU	Operable Unit
PAC	protective action criteria
Pb	lead
PBX	polymer-bonded explosive
PCBs	polychlorinated biphenyl

PCE	perchloroethylene (or perchloroethene); also called tetrachloroethylene or tetrachloroethene
pCi/L	picocuries per liter
pg/m3	picograms per cubic meter
PGA	Peak Ground Acceleration
PLS	Physical and Life Sciences
PMn	Particulate matter less than or equal to n microns in diameter
PPA	power purchase agreement
PS	Photon Science
Pu-239	plutonium-239
PV	photovoltaic
R&D	Research and Development
RADTRAN	Radioactive Material Transportation Risk Assessment
RAP	Radiological Assistance Program
RCRA	*Resource Conservation and Recovery Act*
RDT&E	research, development, test, and evaluation
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
RG	Risk Group
RGD	Radiation Generating Devices
RHWM	Radioactive and Hazardous Waste Management
RiMS	Regional Input-Output Modeling System
ROD	Record of Decision
ROI	Region of Influence
SA	Supplement Analysis
SBD	Safety Basis Document
SEIS	Supplemental Environmental Impact Statement
SFPUC	San Francisco Public Utility Commission
SFTF	Small Firearms Training Facility
SHPO	State Historic Preservation Officer
SJVAPCD	San Joaquin Valley Air Pollution Control District
SMRDC	Stockpile Materials R&D Center
SNL/CA	Sandia National Laboratories/California
SNL/NM	Sandia National Laboratories/New Mexico
SNM	special nuclear materials
SO	Security Organization
SOx	sulphur oxides
SPCC	Spill Prevention Control and Countermeasures
SPEIS	Supplemental Programmatic Environmental Impact Statement
SPP	Strategic Partnership Projects
SRS	Savannah River Site
SSM PEIS	*Stockpile Stewardship and Management Programmatic Environmental Impact Statement*
SST	safe secure transport
SWEIS	Site-wide Environmental Impact Statement
SWP	state water project
SWPPP	Stormwater Pollution Prevention Plan

TCE	trichloroethylene
TEDA	triethylenediamine
TFD	Treatment Facility D
TFE	Treatment Facility E
TRC	total recordable case
TRI	Toxics Release Inventory
TRU	transuranic
TRUPACT-II	Transuranic Package Transporter Model 2
TSDF	Treatment, Storage, and Disposal Facility
TTHMS	trihalomethanes
U	unlikely
U.S.	United States
U.S.C.	United States Code
UC	University of California
UCMP	University of California Museum of Paleontology
UDEQ	Utah Department of Environmental Quality
UQ	Uncertainty quantification
Uranium-AVLIS	uranium- atomic vapor laser isotope separation
USACE	United States Army Corps of Engineers
USDOT	United States Department of Transportation
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
VOC	volatile organic compound
WCI	Weapons and Complex Integration
WDR	waste discharge requirement
WETRC	Weapons Environmental Testing Replacement Capability
WIPP	Waste Isolation Pilot Plant
WMU	Waste Management Unit
WMUA	Waste Management Unit Area
WP&C	Work Planning and Control
WRP	Water Reclamation Plant
WWTP	Wastewater Treatment Plant
YR	Year
Zone 7	Alameda County Flood and Water Conservation District, Zone 7

CONVERSION CHART

TO CONVERT FROM U.S. CUSTOMARY INTO METRIC			TO CONVERT FROM METRIC INTO U.S. CUSTOMARY		
If you know	**Multiply by**	**To get**	**If you know**	**Multiply by**	**To get**
			Length		
inches	2.540	centimeters	centimeters	0.3937	inches
feet	30.48	centimeters	centimeters	0.03281	feet
feet	0.3048	meters	meters	3.281	feet
yards	0.9144	meters	meters	1.094	yards
miles	1.609	kilometers	kilometers	0.6214	miles
			Area		
square inches	6.452	square centimeters	square centimeters	0.1550	square inches
square feet	0.09290	square meters	square meters	10.76	square feet
square yards	0.8361	square meters	square meters	1.196	square yards
acres	0.4047	hectares	hectares	2.471	acres
square miles	2.590	square kilometers	square kilometers	0.3861	square miles
			Volume		
fluid ounces	29.57	milliliters	milliliters	0.03381	fluid ounces
gallons	3.785	liters	liters	0.2642	gallons
cubic feet	0.02832	cubic meters	cubic meters	35.31	cubic feet
cubic yards	0.7646	cubic meters	cubic meters	1.308	cubic yards
			Weight		
ounces	28.35	grams	grams	0.03527	ounces
pounds	0.4536	kilograms	kilograms	2.205	pounds
short tons	0.9072	metric tons	metric tons	1.102	short tons
			Temperature		
Fahrenheit (ºF)	subtract 32, then multiply by 5/9	Celsius (ºC)	Celsius (ºC)	multiply by 9/5, then add 32	Fahrenheit (ºF)
Kelvin (K)	subtract 273.15	Celsius (ºC)	Celsius (ºC)	add 273.15	Kelvin (K)

Note: 1 sievert = 100 rems

METRIC PREFIXES

Prefix	Symbol	Multiplication factor
exa-	E	1,000,000,000,000,000,000 = 10^{18}
peta-	P	1,000,000,000,000,000 = 10^{15}
tera-	T	1,000,000,000,000 = 10^{12}
giga-	G	1,000,000,000 = 10^{9}
mega-	M	1,000,000 = 10^{6}
kilo-	k	1,000 = 10^{3}
deca-	D	10 = 10^{1}
deci-	d	0.1 = 10^{-1}
centi-	c	0.01 = 10^{-2}
milli-	m	0.001 = 10^{-3}
micro-	µ	0.000 001 = 10^{-6}
nano-	n	0.000 000 001 = 10^{-9}
pico-	p	0.000 000 000 001 = 10^{-12}

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CHAPTER 1

Introduction and Purpose and Need for Action

1.0 INTRODUCTION AND PURPOSE AND NEED FOR ACTION

1.1 INTRODUCTION

The National Nuclear Security Administration (NNSA), a semi-autonomous agency within the United States (U.S.) Department of Energy (DOE), is responsible for meeting the national security requirements established by the President and Congress to maintain and enhance the safety, reliability, and performance of the U.S. nuclear weapons stockpile (NNSA 2019a). The continued operation of Lawrence Livermore National Laboratory (LLNL or Laboratory) is critical to NNSA's Stockpile Stewardship and Management Program, to prevent the spread and use of nuclear weapons worldwide, and to many other areas that may impact national security and global stability (50 U.S.C. §2521) (*see* Chapter 2 for a detailed discussion on LLNL missions and support of NNSA Core Capabilities).

Stockpile Stewardship and Management Program

The Stockpile Stewardship and Management Program enables NNSA to extend the lifespan and ensure the continued safety, reliability, and performance of nuclear weapons that have reached the end of their original design life through life extension and modification programs.

NNSA has prepared this *Site-wide Environmental Impact Statement for Continued Operation of Lawrence Livermore National Laboratory* (DOE/EIS-0547) (LLNL SWEIS or SWEIS) to analyze the potential environmental impacts of the reasonable alternatives for continuing LLNL operations for approximately the next 15 years. Following completion of this LLNL SWEIS, NNSA intends to decide how operations will be conducted at LLNL, including construction and operation of new facilities, modification/upgrade of existing facilities and utilities, modification of operations, and/or demolition of excess and aging facilities.

In addition to this introduction, this chapter consists of seven sections: Section 1.2 provides background information on LLNL; Section 1.3 describes the purpose and need for action on ongoing operations and proposed projects; Section 1.4 discusses the alternatives included within the scope of this SWEIS; Section 1.5 describes other *National Environmental Policy Act* (NEPA) documents relevant to this LLNL SWEIS; Section 1.6 discusses the public participation process, including comments received during scoping; and Section 1.7 explains the organization of the chapters and appendices in this SWEIS.

1.2 BACKGROUND

LLNL is a federally funded research and development center (FFRDC) managed by a public-private partnership that conducts research for the U.S. government in accordance with Title 48 *Code of Federal Regulations* Section 35.017 (48 CFR 35.017). LLNL has been in existence since 1952, employs approximately 8,000 people (employees and contractors), and has a current annual budget approaching $3 billion. Lawrence Livermore National Security, LLC (LLNS)[1] has been the management and operating contractor for LLNL since October 1, 2007. Prior to that date, LLNL was managed by the University of California.

[1] The organizations which currently comprise LLNS include Bechtel National, Inc., the University of California, BWX Technologies, Inc., and Amentum.

LLNL consists of two federally owned sites: an 821-acre site in Livermore, California (Livermore Site), and a 7,000-acre experimental test site (Site 300) southeast of the Livermore Site between Livermore and Tracy, California (*see* Figures 1-1 and 1-2). Most LLNL operations are located at the Livermore Site, which is situated about 50 miles east of San Francisco in southeastern Alameda County. Site 300 is primarily a test site for high explosives and non-nuclear weapons components; it is located about 15 miles southeast of Livermore in the hills of the Diablo Range. Most of Site 300 is located in San Joaquin County; the western edge of the site is in Alameda County. LLNL also conducts limited activities at several leased properties, including but not limited to storage facilities and office space. Additionally, LLNL owns and operates equipment at offsite properties including at the Arroyo Mocho Pump Station, located seven miles south of the Livermore Site, and several offsite environmental monitoring locations (*see* Section 4.5).

LLNL's primary responsibility is ensuring the safety, reliability, and performance of the nation's nuclear weapons stockpile. However, LLNL's mission is broader than stockpile stewardship, as dangers ranging from nuclear proliferation and terrorism to biosecurity and climate change threaten national security and global stability. Fifteen (15) years have passed since the publication of the 2005 *Final Site-wide Environmental Impact Statement for Continued Operation of Lawrence Livermore National Laboratory and Supplemental Stockpile Stewardship and Management Programmatic Environmental Impact Statement* (2005 LLNL SWEIS) (NNSA 2005). Because of proposed plans for new facilities, demolition of older facilities, enhanced and modernized site utilities projects, as well as needed modifications/upgrades of existing facilities to ensure ongoing safe operations, NNSA determined that it was appropriate to update the previous 2005 LLNL SWEIS analysis. With issuance of the Notice of Intent (NOI) on August 5, 2020, NNSA determined that a new SWEIS will be prepared for LLNL (85 FR 47362).

1.3 Purpose and Need for Agency Action

NNSA is responsible for meeting the national security requirements established by the President and Congress to maintain and enhance the safety, reliability, and performance of the U.S. nuclear weapons stockpile (NNSA 2019a). This requires NNSA to maintain core competencies in nuclear weapons as well as a modern nuclear weapons infrastructure. As one of only three nuclear weapons laboratories in the U.S., LLNL contributes significantly to the core intellectual and technical competencies of the U.S. related to nuclear weapons. These competencies embody more than 70 years of weapons knowledge and experience. LLNL maintains specific core competencies in activities associated with research, development, design, and surveillance of nuclear weapons, and supports the assessment and certification of their safety and reliability. The continued operation of LLNL is critical to NNSA's Stockpile Stewardship and Management Program and to preventing the spread and use of nuclear weapons worldwide (LLNL 2017a).

The 21st century presents a growing set of challenges to national security and global stability that are the focus of the Laboratory's national security mission. As discussed below, national security considerations and requirements provide the foundation for the expanding mission areas, and the projects proposed by NNSA to meet these challenges.

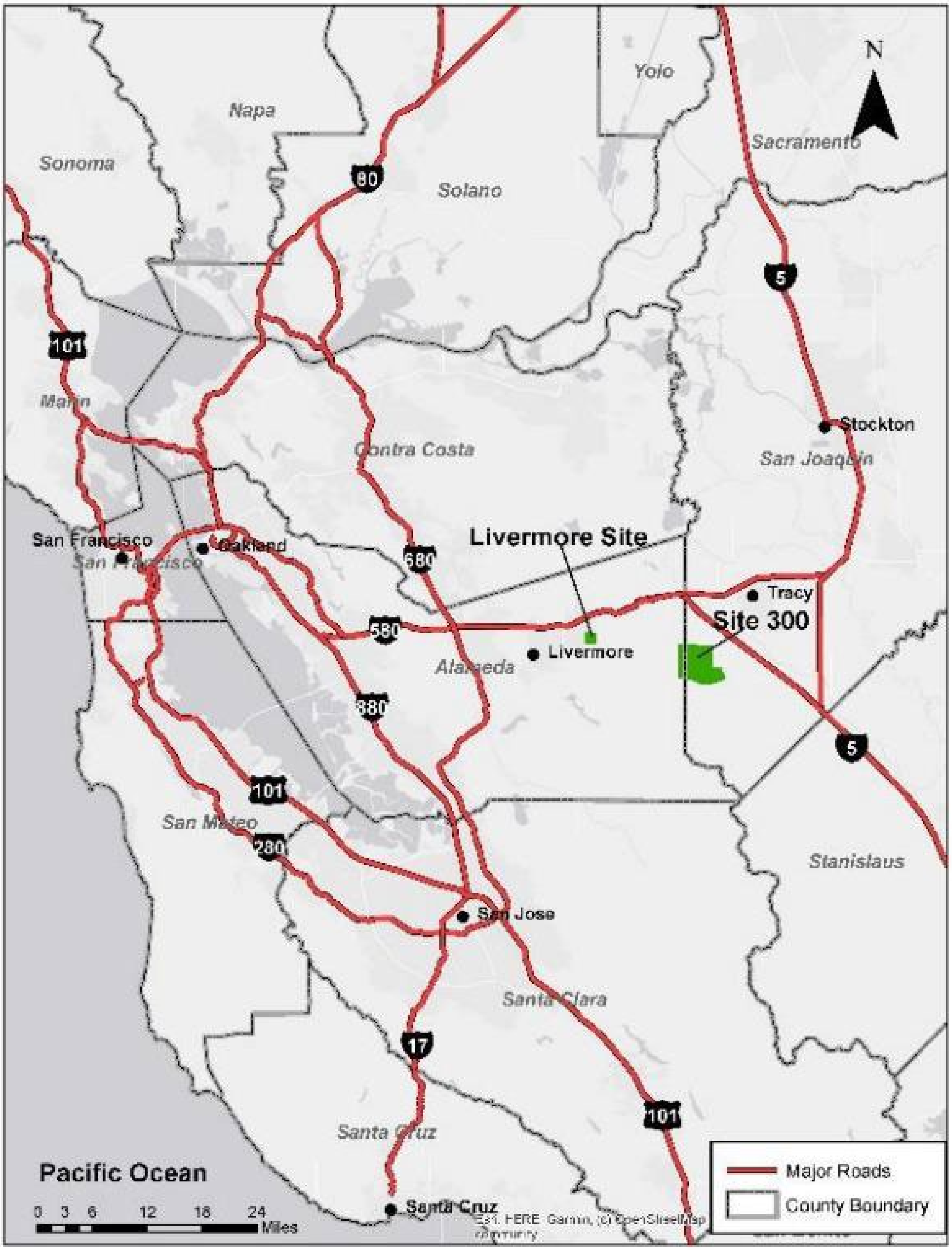


Figure 1-1. Location of LLNL Livermore Site and Site 300

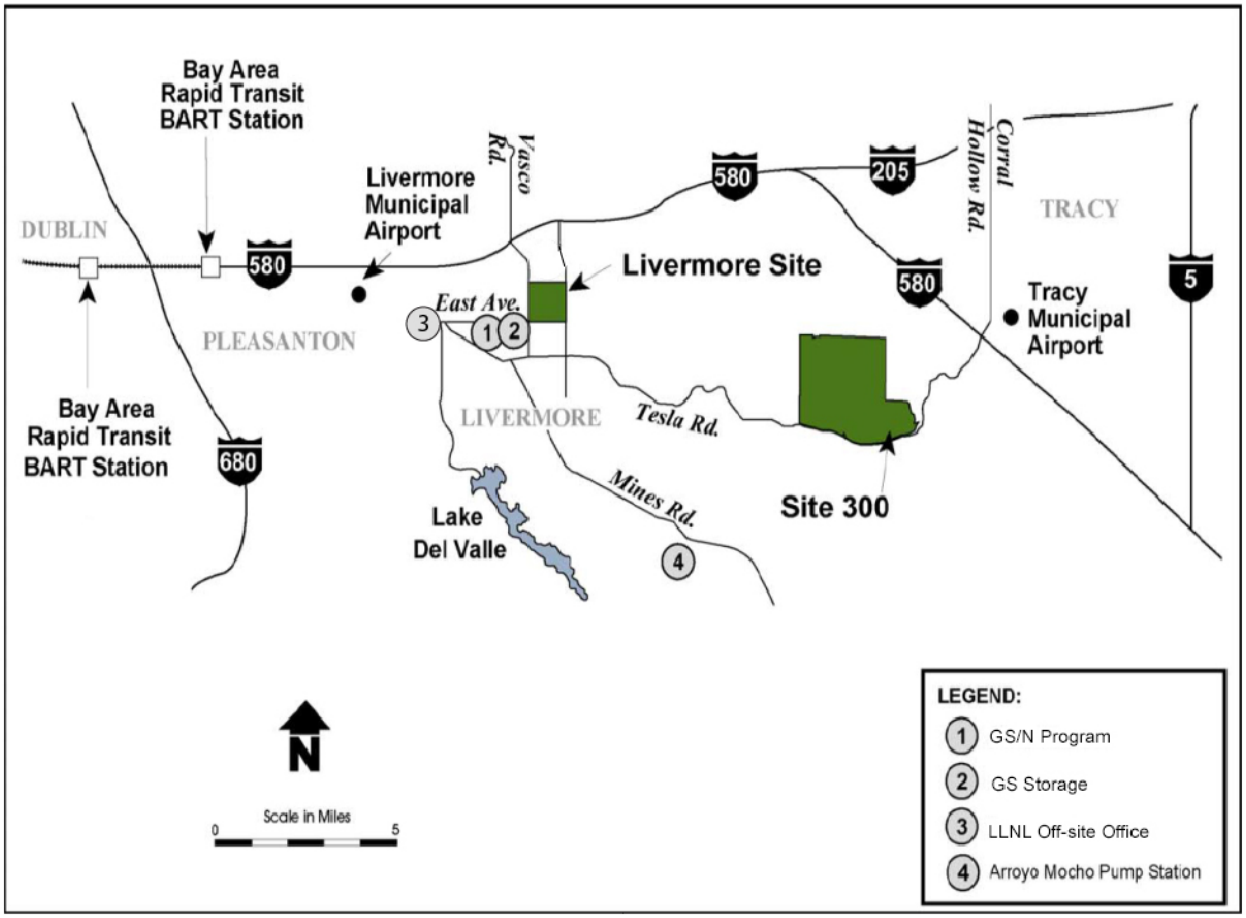


Figure 1-2. Locations of LLNL's Livermore Site, Site 300, and Offsite Facilities Relative to Surrounding Communities

1.3.1 National Security Considerations and Requirements

1.3.1.1 *Nuclear Posture Review*

The Nuclear Posture Review (NPR) is a legislatively mandated, comprehensive review of the U.S. nuclear deterrence policy, strategy, and capabilities. NPRs have been prepared in 1994, 2002, 2010, and most recently in 2018.[2] On January 27, 2017, the President directed the Department of Defense (DoD) to conduct a new NPR (DoD 2018) to ensure a safe, secure, and effective nuclear deterrent that protects the homeland, assures allies, and, above all, deters adversaries. The Administration also emphasized both the long-term goal of eliminating nuclear weapons and the requirement that the U.S. have modern, flexible, and resilient nuclear capabilities that are safe and secure, until such a time as nuclear weapons can prudently be eliminated from the world. The 2018 NPR also states the following (DoD 2018):

- An effective, responsive, and resilient nuclear weapons infrastructure is essential to the U.S. capacity to adapt flexibly to shifting requirements. Such an infrastructure offers

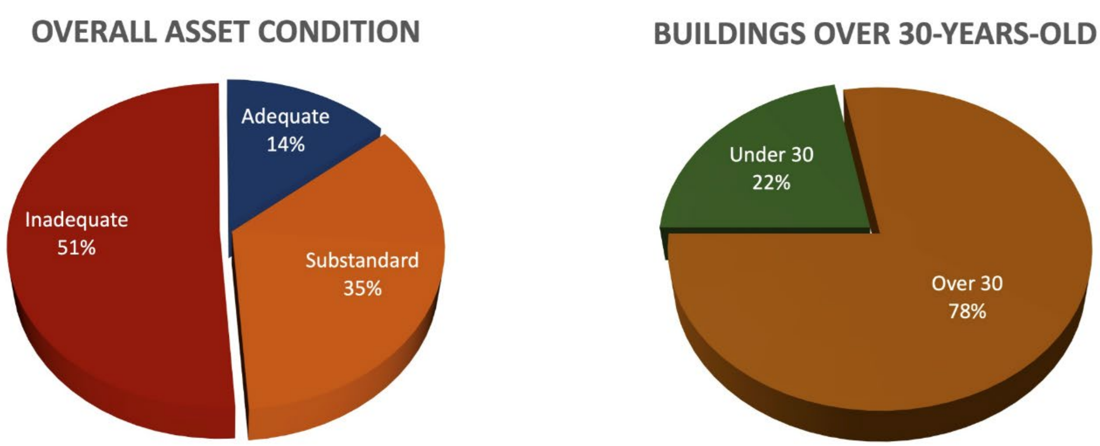
[2] The current Administration is conducting a new NPR, which is expected to be finished in 2022.

tangible evidence to both allies and potential adversaries of U.S. nuclear weapons capabilities, and thus contributes to deterrence, assurance, and hedging against adverse developments. It also discourages adversary interest in arms competition, supporting nonproliferation efforts worldwide.

- Over the past several decades, the U.S. nuclear weapons infrastructure has suffered the effects of age and underfunding. Over half of NNSA's infrastructure is more than 40 years old and 25 percent dates back to the Manhattan Project era. All previous NPRs highlighted the need to maintain a modern nuclear weapons infrastructure, but the U.S. has fallen short in sustaining a modern infrastructure that is resilient and has the capacity to respond to unforeseen developments. Just as nuclear forces are an affordable priority, so is a resilient and effective nuclear weapons infrastructure, without which the U.S. nuclear deterrent cannot exist.

- Recapitalizing the nuclear weapons complex of laboratories and plants is long past due; it is vital the U.S. ensure the capability to design, produce, assess, and maintain its nuclear weapons for as long as they are required.

As shown on Figure 1-3, approximately 78 percent of LLNL facilities are more than 30 years old, and approximately 86 percent of assets (buildings and trailers) are considered substandard or inadequate (LLNL 2021a). Older buildings require more maintenance, including utility replacements and other large-scale refurbishments that are weighed against replacement with newer, more efficient, and better designed buildings. Although LLNL maintains these facilities and conducts operations safely with appropriate environmental and safety controls, there is a need to re-invest in a modern infrastructure for the future.



Source: LLNL 2021a.

Figure 1-3. Infrastructure Conditions at LLNL

1.3.1.2 *Deterrent Requirements by Growing Threats*

Nuclear weapons have played, and will continue to play, a critical role in deterring nuclear attack and in preventing large-scale conventional warfare between nuclear-armed states for the foreseeable future. U.S. nuclear weapons not only defend the U.S. and our allies against conventional and nuclear threats, but also help allies avoid the need to develop their own nuclear arsenals. This, in turn, furthers global security (DoD 2018). While the U.S. has continued to reduce the number and prominence of nuclear weapons, others, including Russia and China, have moved in the opposite direction. They have added new types of nuclear capabilities to their arsenals, increased the prominence of nuclear forces in their strategies and plans, and engaged in increasingly aggressive behavior, including in outer and cyber space (DoD 2018).

An effective, responsive, and resilient Nuclear Security Enterprise offers tangible evidence to both allies and potential adversaries of U.S. nuclear weapons capabilities. This contributes to deterrence, assurance, and hedging against adverse developments. It also discourages adversary interest in arms competition (DoD 2018). LLNL supports the advancement of these capabilities.

1.3.1.3 *Annual Weapon Certification Process*

Consistent with the NPR, LLNL participates in the formal annual weapon certification process of the nuclear weapons stockpile. For the past 23 consecutive years, the science-based Stockpile Stewardship and Management Program has allowed DOE/NNSA and DoD to certify the safety, reliability, and performance of the U.S. nuclear weapons stockpile to the President without the use of underground nuclear explosive testing (NNSA 2019a).

LLNL is one of three nuclear weapons design agencies for NNSA. As such, LLNL is responsible for maintaining and certifying the safety, security, and reliability of three of the seven active stockpile weapon systems through the annual weapon certification process. LLNL designs the nuclear explosive package for life extension programs (LEPs), modification programs (Mods), and alteration programs (Alts), and certifies the life-extended weapons as they enter the stockpile (*see* Chapter 2 for information regarding LLNL LEPs and Mods activities). Through routine surveillance of the systems and annual stockpile assessment, weapons issues that could lead to future performance degradation, such as aging effects, are discovered and addressed. Depending on the nature of these changes, parts may need to be replaced or refurbished to meet safety, reliability, and performance requirements. In this way, LEPs, Mods, and Alts extend the weapons' lifetimes for an additional 20 to 30 years and are carried out without conducting underground nuclear explosive tests. Weapons refurbishment efforts enable NNSA to maintain the nation's nuclear deterrent without resuming the production of new weapons or underground nuclear explosive tests (LLNL 2017a).

> **LEPs, Mods, and Alts**
>
> **LEPs**: Life extension activities addressing aging and performance issues within the stockpile as a result of use beyond the originally designed component/system life span.
>
> **Mods**: Change in operational capability that results from a design change that affects delivery (employment or utilization), fuzing, ballistics, or logistics.
>
> **Alts**: Material change to, or a prescribed inspection of, a nuclear weapon or major assembly that does not alter its operational capability but is sufficiently important to the user (regarding assembly, maintenance, storage, or test operations) as to require controlled application and identification.
>
> Source: DoD 2020.

The annual weapon certification process of refurbished warheads requires weapons experts to rely upon research and development (R&D) experiments, simulation capabilities, and the historical nuclear test database. Many of those capabilities are located at LLNL, and some need modernization/upgrade to improve LLNL's ability to certify the safety, reliability, and performance of the stockpile.

1.3.1.4 *Nonproliferation and Treaty Compliance*

As discussed in this section, NNSA missions are conducted fully consistent with current treaty obligations. The Stockpile Stewardship and Management Program is fully consistent with and supports the U.S. commitment to the Nuclear Nonproliferation Treaty (NPT) and enables the U.S. to continue the 1992 moratorium on underground nuclear explosive testing. Another benefit of the Stockpile Stewardship and Management Program is that by preventing the loss of credibility in the U.S. nuclear stockpile, it avoids creating an incentive within non-weapon states, whose security relies on the U.S. nuclear deterrent, to develop their own nuclear weapons. In addition to stockpile stewardship responsibilities, LLNL operations also support nonproliferation objectives and nuclear materials stewardship.

Nuclear Nonproliferation Treaty. The NPT was ratified by the Senate in 1969 and officially entered into force as a Treaty of the United States in 1970. Today, the U.S. continues to view the NPT as the cornerstone of the nuclear nonproliferation regime (DoD 2018). Article VI of the NPT obligates the parties "to pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament, and on a treaty on general and complete disarmament under strict and effective international control." The U.S. has taken this obligation seriously and has emphasized both the long-term goal of eliminating nuclear weapons and the requirement that the U.S. have modern, flexible, and resilient nuclear capabilities that are safe and secure, until such a time as nuclear weapons can prudently be eliminated from the world (DoD 2018). The NPT does not provide any specific date for achieving the ultimate goal of nuclear disarmament, nor does it preclude the maintenance of nuclear weapons until their disposition. Continued operations at LLNL enable NNSA to maintain the safety, reliability, and performance of the U.S. nuclear weapons stockpile until the ultimate goals of the NPT are attained and are consistent with the NPT.

The nonproliferation and treaty compliance aspects of the Stockpile Stewardship and Management Program were evaluated in the 1996 *Stockpile Stewardship and Management Programmatic Environmental Impact Statement* (DOE/EIS-0236) (SSM PEIS) (DOE 1996) and, more recently, in the *Complex Transformation Supplemental Programmatic Environmental Impact Statement* (DOE/EIS-0236-S4) (Complex Transformation SPEIS) (NNSA 2008). Those documents analyze the nonproliferation aspects of the Stockpile Stewardship and Management Program and conclude that implementation of the Stockpile Stewardship and Management Program is fully consistent with the NPT while maintaining nuclear weapons competencies and capabilities at the weapons laboratories. Those evaluations included the operation of LLNL and its responsibilities under the Stockpile Stewardship and Management Program for several weapons systems. The activities identified in this SWEIS for the continued operation of LLNL are consistent with LLNL's assigned Stockpile Stewardship and Management Program mission and as a result do not affect U.S. compliance with any treaty now in force.

Comprehensive Test Ban Treaty. The U.S. signed the Comprehensive Test Ban Treaty, which bans all nuclear explosions for civilian or military purposes, on September 24, 1996, but the Senate has never ratified it. Nonetheless, the U.S. has been observing a moratorium on nuclear explosive testing since 1992, and the NPR strategy discussed in Section 1.3.1.1 reflects this policy. The stated policy of the U.S. is to not resume underground nuclear explosive testing unless necessary to ensure the safety and effectiveness of the U.S. nuclear arsenal (NNSA 2019a). The Proposed Action in this SWEIS would support certification of the safety, reliability, and performance of the U.S. nuclear weapons stockpile to the President without the use of nuclear explosive testing. As such, it would be consistent with a continuing U.S. moratorium and the Comprehensive Test Ban Treaty.

1.3.2 Other LLNL Program Considerations and Needs

Basic science is the engine that drives research at LLNL. Funded by a broad contingent of the scientific community—including the DOE Office of Science, academic and industry partners, and Laboratory Directed Research and Development investments—basic science ensures that LLNL's research capabilities remain at the cutting edge and that LLNL scientists and engineers are prepared to solve critical challenges across national missions. As discussed in detail in Chapter 2, these other missions include counterterrorism, energy security and long-term energy needs, advancing bioscience and biosecurity, and breakthroughs in fundamental sciences and applied technology. Additionally, LLNL supports other government organizations and science and industry through the transfer of technology (LLNL 2017a).

Much of the same infrastructure used to support the national security missions supports other LLNL program missions. Consequently, the effects of age and lack of infrastructure recapitalization have resulted in a similar need for facility and infrastructure investments.

1.3.3 Purposes to be Achieved by the Proposed Action

Nuclear dangers persist, and in many ways, are growing. Through the Stockpile Stewardship and Management Program, NNSA will continue to extend the stockpile life of aging U.S. nuclear weapons and certify their safety, reliability, and performance. Over the next 15 years, one of LLNL's primary responsibilities will be to continue to support LEPs and Mods, which extend the service life and enhance the safety, security, and reliability of nuclear weapons. One such project is the W80-4 LEP, which involves refurbishing the existing W80 warhead, which will be paired with a new cruise missile that is being developed in parallel by the U.S. Air Force. This would represent the first life-extended warhead to be implemented in a new delivery system since the start of the Stockpile Stewardship and Management Program more than 25 years ago (LLNL 2020a). The W87-1 Modification Program (W87-1 Mod) will be the second program to use a new delivery system, Sentinel, formerly known as the Ground Based Strategic Deterrent (GBSD). Sentinel is the replacement for the Minuteman III. Programs like the W80-4 LEP and the W87-1 Mod require the full array of NNSA's computational, experimental, and manufacturing capabilities to meet all the prototyping, proof-of-concept testing, and certification requirements.

Stemming nuclear proliferation is also a top national priority. LLNL's nonproliferation program supports NNSA by providing expertise pertaining to weapons of mass destruction worldwide and leadership in advancing technologies to monitor, detect, and limit or prevent the proliferation of nuclear materials and technology. The goal of the program is to prevent proliferation and reduce the global risk posed by inadequately secured and/or noncompliant development of chemical, biological, radiological, nuclear, and explosive (CBRNE) materials by both State and non-State actors. The program also includes activities to reduce the risk of cybersecurity.

LLNL is home to many key facilities that provide essential support to NNSA missions and enable LLNL to pursue many strategic partnership programs that meet a wide range of national security needs. Several LLNL facilities are flagships for stockpile stewardship, including the Livermore Computing Center, the National Ignition Facility (NIF), the High Explosives Applications Facility (HEAF), the Superblock facilities, and Site 300's Contained Firing Facility (CFF) (LLNL 2017a). As an example of Stockpile Stewardship and Management Program activities at LLNL facilities, hydrodynamic experiments fired in the CFF supported down-select decisions for the W80-4 LEP (LLNL 2019a).

As discussed in Section 1.3.1.1, more than half of the LLNL operating buildings are considered substandard or inadequate to meet future mission requirements. The deterioration of assets presents program and operational risks in meeting national security requirements and other mission needs, attracting and maintaining a high-quality workforce, and meeting regulatory requirements (LLNL 2017a).

The Proposed Action and alternatives represent an investment in the facilities and infrastructure that would enable LLNL to successfully meet national security requirements and other mission needs. The net effect of the Proposed Action would increase LLNL's footprint, improve efficiency, and enhance the safety of required operations.

1.4 Proposed Action, Alternatives, and SWEIS Scope

This SWEIS analyzes two alternatives: (1) No-Action Alternative and (2) Proposed Action. In addition, the SWEIS also analyzes the new hybrid work environment due to increase in telework at LLNL under both alternatives. A brief description of the alternatives is presented below. Chapter 3 provides a detailed description of the alternatives.

Under the No-Action Alternative, NNSA would continue current facility operations throughout LLNL in support of assigned missions. It is important to note that effects of age and the absence of adequate infrastructure recapitalization have resulted in a need for facility and infrastructure investments. NEPA regulations require analysis of the No-Action Alternative to provide a benchmark for comparison with environmental effects of the other alternatives. The No-Action Alternative includes the programs and activities described in Chapter 2 and Chapter 4, and those activities for which NEPA review is already completed or underway.

The programmatic context for the Proposed Action is the continued support of existing programs, and the development of additional projects that would be needed to meet DOE/NNSA current and future mission requirements. The Proposed Action includes the scope of the No-Action Alternative and an increase in current facility operations or enhanced operations that may require new or modified facilities and that are reasonably foreseeable over the next 15 years. Continued re-investment would allow LLNL to meet mission deliverables and sustain science, technology, and engineering excellence to respond to future national security challenges. In addition to ongoing missions and programs, NNSA has identified four categories of actions associated with the Proposed Action: (1) New Facility Construction Projects; (2) Modernization/Upgrade/Utility

Projects; (3) Operational Changes; and (4) Decontamination, Decommissioning, and Demolition (DD&D) Projects. Each of these categories of actions is summarized below.

Elements of the Proposed Action

- Ongoing missions and programs;
- New facility construction projects;
- Modernization/upgrade/utility projects;
- Operational changes; and
- Decontamination, decommissioning, and demolition projects.

1. NNSA has identified approximately 75 new projects, totaling approximately 3.3 million square feet, over the period 2023–2035. Of this, 61 projects, totaling approximately 2.9 million square feet, are proposed at the Livermore Site; 14 facilities, totaling approximately 385,000 square feet, are proposed at Site 300. The projects include laboratory facilities related to materials engineering and biosciences; laser-explosives applications, and high explosives R&D; general office buildings; maintenance facilities; science centers for both nuclear security and forensics; and a new fire station. The majority of these new facilities are replacements for the aging fleet of buildings that would then undergo DD&D.

2. With regard to modernization/upgrade utility projects, NNSA has identified approximately 20 types of projects, many involving multiple facilities. These projects include modernization of firing and control systems at Site 300; NIF laser power upgrades and utility system replacements; modernization of high-performance computing capabilities; seismic risk reduction initiatives; and waste management facility enhancements. Modernization/upgrades would extend facility lifetimes, improve work environments with updated safety controls, and enhance operational capabilities. Proposed site-wide utility projects include mechanical and electrical system replacements and upgrades; security fencing and security upgrades; sanitary sewer, septic, and stormwater system upgrades and replacements; domestic water supply and distribution system upgrades; erosion control projects; and road upgrades.

3. Proposed operational changes are expected to include: (a) increase tritium emissions limits at the NIF and the Tritium Facility; (b) decrease administrative limits for fuels-grade plutonium equivalent and for enriched uranium and natural and depleted uranium (DU) at the Plutonium Facility; (c) revise NIF radioactive materials administrative limits to below Hazard Category (HC)-3 thresholds; and (d) administrative limit increase for Building 235 to below HC-3 thresholds. Less-than HC-3 facilities are classified in accordance with DOE-STD-1027 approved for use at LLNL. Hardened Engineering Test Building (HETB) facility limits for enriched uranium, natural uranium, DU, and plutonium are included in the Plutonium Facility limits. NIF would continue to use tritium, uranium, plutonium, and other radionuclides. Inventory limits

Administrative Limits

Administrative limits are defined as the maximum amount of the referenced material allowed at a facility. The actual inventory for some materials at LLNL for which there is an administrative limit may be classified.

would remain below HC-3 thresholds, with continued operation as a low-hazard, radiological facility.[3]

4. DD&D of older facilities would be conducted on a continuing basis to eliminate excess facilities and reduce costs and risks. For the Proposed Action, NNSA has identified about 150 facilities, totaling approximately 1,170,000 million square feet, to undergo DD&D.

This SWEIS presents the direct, indirect, and cumulative impacts associated with the No-Action Alternative and the Proposed Action. Methodologies for the resource analyses are described in Appendix B.

1.5 Relevant NEPA Documents and Other Documents

NEPA ensures that environmental information is available to public officials and citizens before decisions are made and actions taken. This LLNL SWEIS has been prepared in accordance with Section 102(2)(C) of NEPA (42 U.S.C. §§ 4321–4347, as amended), regulations promulgated by the Council on Environmental Quality (CEQ) (40 CFR Parts 1500–1508),[4] DOE's NEPA implementing procedures (10 CFR Part 1021) and NNSA Policy (NAP) 451.1. In accordance with 10 CFR 1021.330, NNSA has a policy to prepare SWEISs for certain large, multiple-facility sites such as LLNL. In addition to compliance with NEPA, this LLNL SWEIS addresses requirements in the *California Environmental Quality Act* (CEQA), Public Resources Code Sec 21000 et seq. Because requirements for NEPA and CEQA are somewhat different, the document has been prepared to comply with whichever requirements are more stringent.

For preparation of the LLNL SWEIS, NNSA incorporates information by reference and tiers from previous NEPA documents to succinctly present the analysis. Information from these documents provides a context for understanding the current status of NEPA compliance, which forms the foundation for preparing this SWEIS. The following documents are relevant to this SWEIS analysis.

1.5.1 NEPA Documents

***Stockpile Stewardship and Management Programmatic Environmental Impact Statement* (DOE/EIS-0236)** (SSM PEIS) (DOE 1996): During the mid-1990s, DOE prepared the SSM PEIS, which evaluated alternatives for maintaining the safety and reliability of the nuclear weapons stockpile and preserving competencies in nuclear weapons in the post-Cold War era. With regard to LLNL activities, the SSM PEIS analyzed the potential impacts associated with a Proposed Action to provide enhanced experimental capability for stockpile stewardship. In particular, the construction and operation of the NIF and CFF were evaluated in the SSM PEIS. The SSM PEIS Record of Decision (ROD) (61 FR 68014), published in the *Federal Register* on December 26,

[3] Under 10 CFR Part 830, DOE assigns hazard categories to nuclear and radiological facilities in accordance with the potential consequences of a radiological accident. The HC is based on the quantities of hazardous radiological materials, per DOE-STD-1027. An HC-3 nuclear facility would only have the potential for localized consequences.

[4] On July 16, 2020, the CEQ issued a final rule to update its regulations for federal agencies to implement NEPA (85 FR 43304). The effective date for the new regulations is September 14, 2020. Because this SWEIS was initiated prior to that effective date, this SWEIS has been prepared in accordance with the CEQ regulations dated 1978, as amended in 1986 and 2005.

1996, documents the decisions to construct and operate the NIF at the Livermore Site and the CFF, Building 801, at Site 300.

Site-wide Environmental Impact Statement for Continued Operation of Lawrence Livermore National Laboratory and Supplemental Stockpile Stewardship and Management Programmatic Environmental Impact Statement **(DOE/EIS-0348 and DOE/EIS-0236-S3)** (2005 LLNL SWEIS)[5] (NNSA 2005): NNSA prepared the 2005 LLNL SWEIS to evaluate alternatives for the continued operation of LLNL and the use of plutonium, other fissile materials, fissionable materials, and lithium hydride in experiments to be conducted at NIF. Previously, a LLNL EIS/Environmental Impact Report (EIR)[6] was issued in 1992 (DOE 1992a). The 2005 LLNL SWEIS analyzed the following alternatives: (1) No Action Alternative; (2) Proposed Action; and (3) Reduced Operation Alternative. The 2005 LLNL SWEIS ROD (70 FR 71491), published in the *Federal Register* on November 29, 2005, documents the decisions to implement the Proposed Action with the exception of the Energetic Materials Processing Center Replacement and High Explosives Development Center Project. As a result of the ROD, NNSA decided to expand operations at LLNL to support NNSA's Stockpile Stewardship and Management Program. The major decisions included an increase in the administrative and material-at-risk (MAR) limits for plutonium in the Plutonium Facility (Building 332) and an increase in the administrative and MAR limits for tritium in the Tritium Facility (Building 331). With respect to the NIF, NNSA decided to use small quantities of plutonium, other fissile materials, fissionable materials, and lithium hydride in experiments at the NIF.

Final Complex Transformation Supplemental Programmatic Environmental Impact Statement **(DOE/EIS-0236-S4)** (Complex Transformation SPEIS) (NNSA 2008): In 2008, NNSA prepared the Complex Transformation SPEIS (NNSA 2008), which is a supplement to the SSM PEIS, to evaluate the potential environmental impacts of alternatives for transforming the nuclear weapons complex (Complex) into a smaller, more efficient enterprise that could respond to changing national security challenges and ensure the long-term safety, security, and reliability of the nuclear weapons stockpile. The Complex Transformation SPEIS RODs (73 FR 77644 and 73 FR 77656), published in the *Federal Register* on December 19, 2008, document the following decisions related to LLNL: (1) consolidate LLNL Security Category I/II special nuclear material (SNM) from LLNL under the No-Action Alternative and phase out Security Category I/II operations at LLNL by the end of 2012 to the Los Alamos National Laboratory (LANL); (2) transfer tritium R&D in support of gas transfer system development from LLNL to the Savannah River Site (SRS) (production of NIF targets at LLNL, which involves small quantities of tritium, will continue at the site); and (3) consolidate Environmental Test Facility (ETF) operations from LLNL to Sandia National Laboratories/New Mexico (SNL/NM), which would result in closing three facilities at LLNL (Engineered Building 834 Complex, Dynamic Testing Facility [836 Complex], and Building 334). Because the relocation of ETF operations required NNSA to refurbish existing facilities or build new facilities at the recipient site, which were not done, these facilities at LLNL continue to operate due to programmatic needs.

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[5] The 2005 LLNL SWEIS is both a site-wide NEPA document and a Supplemental PEIS for NIF; for simplicity, that document is referred to as "SWEIS" rather than "SWEIS/SPEIS."

[6] An EIR is similar to an EIS but is prepared in accordance with the *California Environmental Quality Act* (CEQA) requirements (*see* Appendix F).

***Supplement Analysis of the 2005 Site-wide Environmental Impact Statement for Continued Operation of Lawrence Livermore National Laboratory* (DOE/EIS-0348-SA-03)** (2011 SA) (NNSA 2011): In August 2011, NNSA prepared a supplement analysis (SA) to evaluate continued operations at LLNL (including new and modified projects and modifications in site operations). The purpose of the 2011 SA was to determine if continued operations constitute a substantial change that is relevant to environmental concerns, or if there are significant new circumstances or information relevant to environmental concerns and bearing on continued operations at LLNL compared to the analysis in the 2005 LLNL SWEIS. The conclusion in the 2011 SA was that new and modified projects and modifications in site operations remain consistent with impacts analyzed in the 2005 SWEIS, and no further NEPA documentation was required.

***Final Environmental Assessment for the Proposed Increase in the Weight of Explosives Detonated at Lawrence Livermore National Laboratory Experimental Test Site, Site 300* (DOE/EA-2076)** (2018 EA) (NNSA 2018a). In January 2018, NNSA prepared this EA to evaluate the potential environmental consequences of the Proposed Action to increase the explosives weight for outdoor explosives tests (otherwise known as open detonations) at Site 300. R&D activities at LLNL's Site 300 Building 851 currently involve (and have historically involved) detonation of explosives up to 100 pounds per day and 1,000 pounds per year. Under the Proposed Action, the maximum cumulative weights of explosives detonated at the Building 851 firing table would increase to up to 1,000 pounds per day and 7,500 pounds per year. Based on the analysis in the EA, and after considering all comments received, NNSA determined that the Proposed Action does not constitute a major federal action significantly affecting the quality of the human environment within the meaning of NEPA and issued a Finding of No Significant Impact (FONSI) on March 5, 2018 (NNSA 2018b). The increase in detonation size has not yet been implemented at Building 851 and is not further analyzed in this SWEIS.

***Supplement Analysis of the 2005 Site-wide Environmental Impact Statement for Continued Operation of the Lawrence Livermore National Laboratory, Decontamination and Decommissioning Projects* (DOE/EIS-0348-SA-06)** (2019 SA) (NNSA 2019b): In December 2019, NNSA prepared a SA to evaluate DD&D projects planned for 2021–2024. Based on the 2019 SA, NNSA concluded that although the DD&D projects would generate annual waste and truck trip levels above the 2005 SWEIS yearly estimates, total generated waste since 2005 has remained below the SWEIS projections, and overall traffic volume has decreased since 2005. The conclusion in the SA was that DD&D impacts were consistent with those analyzed in the 2005 SWEIS and no further NEPA documentation was required.

1.5.2 Other Relevant Documents

Fiscal Year 2020 Stockpile Stewardship and Management Plan – Biennial Plan Summary: Report to Congress (NNSA 2019a) describes NNSA's plans to ensure the safety, reliability, and performance of the U.S. nuclear weapons stockpile mission to carry out national security responsibilities by maintaining a safe, secure, and effective nuclear deterrent; preventing, countering, and responding to the threats of nuclear proliferation and terrorism worldwide; and providing naval nuclear propulsion.

***Nuclear Posture Review* (2018 NPR)** (DoD 2018) assesses previous nuclear policies and requirements and focuses on identifying the nuclear policies, strategy, and corresponding capabilities needed to protect the nation in the deteriorating threat environment that confronts the U.S., its allies, and partners. The 2018 NPR provides guidance for the nuclear force posture and policy requirements needed now and in the future.

1.6 Public Participation Process

Figure 1-4 depicts the NEPA process. That process includes two opportunities in which NNSA specifically requests public involvement: the scoping process and the public comment period for the Draft SWEIS. Additionally, after the Final SWEIS is issued, there is a 30-day waiting period during which the public can provide additional input. Scoping is a process in which the public and stakeholders provide comments directly to the federal agency on the scope of an EIS. This process begins with the publication of a Notice of Intent (NOI) in the *Federal Register*. On August 5, 2020, NNSA published a NOI to prepare this LLNL SWEIS (85 FR 47362) and announced a 45-day SWEIS scoping period that was scheduled to end on September 21, 2020. In response to public comments, NNSA extended the comment period until October 21, 2020.

Due to recent health concerns associated with the Coronavirus Disease 2019 (COVID-19), NNSA elected to hold online scoping meetings instead of in-person meetings. That approach allowed NNSA to reach a broader audience with the same presentation. Online NEPA meetings have previously been implemented within DOE and other federal agencies and are consistent with Council on Environmental Quality (CEQ) regulations and/or DOE NEPA implementing procedures.

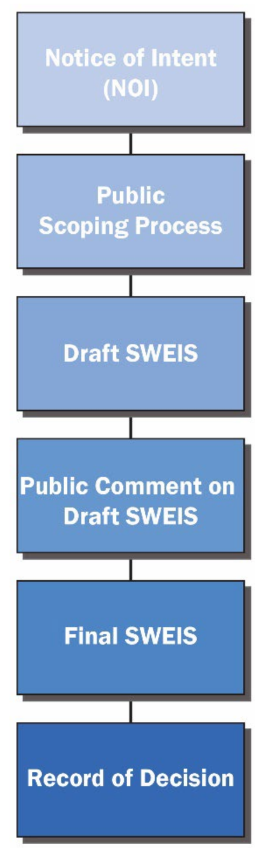

Figure 1-4. NEPA Process

In addition to online scoping meetings, NNSA provided other methods (i.e., email or postal mail) for submitting comments on the SWEIS scope. NNSA held the first online scoping meeting on September 2, 2020, to discuss the SWEIS and to receive comments on the potential scope. In response to public comments, NNSA held a second online scoping meeting on October 5, 2020.

A court reporter provided a transcript of the comments made at the online scoping meetings. Twelve people spoke at the first scoping meeting and five people spoke at the second meeting. In addition to the oral comments made at the scoping meetings, NNSA received 116 documents with comments. NNSA considered all comments received during the scoping process for this SWEIS, including comments received after the close of the comment period. Comments were systematically reviewed by NNSA. Where possible, comments on similar or related topics were grouped under comment issue categories as a means of summarizing the comments. The comment issue categories were used to identify specific issues. Table 1-1 provides a summary of the comments received during the public scoping process. All comments were considered in preparing this Draft SWEIS. The transcripts from the scoping meetings and all comment documents received are included in the Administrative Record for this SWEIS.

Table 1-1. Summary of Scoping Comments

Scoping Comment Issue	Section(s) of SWEIS where addressed
Purpose and Need	
The SWEIS should take into account the need for capabilities at LLNL that might be duplicative of other NNSA sites.	1.3; 3.5
An analysis must be done of the utility, cost, and environmental impacts of maintaining Site 300 when other NNSA sites perform much of the same function farther away from population centers.	1.3; 3.5
Disagreement that the nuclear weapons infrastructure is underfunded.	1.3.1
LLNL should be able to adequately maintain its infrastructure using existing funds.	1.3.1
National Security Policies	
The SWEIS should not be driven by the 2018 NPR, which is a policy document and not a law.	1.3.1
Plutonium experiments at the Livermore Site and Site 300 that are not directly related to the determination of the viability of nuclear weapons currently in the arsenal should stop because they violate the NPT.	1.3.1
The Proposed Action will violate the NPT.	1.3.1
Proposed Action and SWEIS Alternatives	
The SWEIS should analyze alternative futures for LLNL such as: (1) more unclassified, civilian science work and less work on developing new and modified nuclear bomb designs (in some circles this alternative is spoken of as LLNL becoming a national "Center of Excellence" in civilian sciences); (2) cessation of all work on new nuclear weapon system design; and (3) Reduced Operations Alternative similar to the 2005 SWEIS.	3.5
The SWEIS should not be used to justify increasing any radioactive emissions. Instead, the SWEIS should analyze an alternative in which LLNL's operations with radioactive materials are reduced or curtailed. The emission limits for all hazardous materials should be reduced, not increased.	3.5
The scope of the SWEIS should include a proposal for lowering the threshold for the release of plutonium and tritium during operations at the Livermore Site and Site 300 to protect the citizens of the Bay Area and the rest of California.	3.5
Opposition to increased weight of explosives at Site 300. The SWEIS must analyze a future alternative that foregoes these outdoor detonations with hazardous materials at Site 300.	3.5
The scope of the SWEIS should include the alternative of moving, when possible, plutonium research activities to a less populated area.	3.5
Include information in the SWEIS about plans to DD&D facilities, specifically prioritization of DD&D work, time frame, and maintenance of the facilities prior to DD&D.	3.2.2; 3.3.2
The SWEIS should be clear about which new facilities will be used for nuclear weapons R&D and which ones will not.	Chapter 2; 3.2.1; 3.3.1; Appendix A
The SWEIS should consider an alternative to completely close and DD&D LLNL.	3.5
For alternatives identified by stakeholders during the scoping process, but not fully evaluated in detail within the Draft SWEIS, NNSA should include a robust justification for not analyzing suggested alternatives.	3.5
NEPA Process	
The public scoping and comment period should be extended due to the COVID-19 pandemic, western wildfires and related evacuations, upcoming elections, and current civil rights instability.	1.6
Provide at least 120-day notice to the public of any future public meetings.	1.6
There should be a second scoping meeting.	1.6
The link for the October scoping meeting displays the information for the September meeting.	1.6

Scoping Comment Issue	Section(s) of SWEIS where addressed
NNSA and LLNL should post an easily accessible recording and transcript of the public meetings.	1.6
Public should have access to attend a virtual "poster session" with a Question and Answer session.	1.6
The agency's choice of timing appears intended to minimize public involvement in the activities of LLNL.	1.6
All Draft SWEIS references should be made accessible online.	Comment noted
NNSA should identify the version of the CEQ regulations being used for the SWEIS.	1.5
General Support or Opposition	
Opposition to LLNL's existence for a variety of reasons including nuclear proliferation, health, environmental risks, and accidents.	Comment noted
The United States should put our resources toward working for peace and other societal problems.	Comment noted
SWEIS Resource Analyses	
Land Use: The SWEIS should discuss how the Proposed Action relates to, and will be integrated with, federal, state, tribal, and local land use plans in the project area.	4.2; 5.2
Land Use: The surrounding population of Livermore has increased in density and footprint to the point that it is no longer safe to conduct nuclear research at the Livermore Site.	4.2; 5.2; 4.14; 5.14; Appendix C
Geology and Soils: The SWEIS must fully consider the latest data from the USGS on earthquake scenarios in the Bay Area near LLNL.	4.4.3; 5.4; 5.16
Water: The SWEIS should include an analysis of water demands from providers like Zone 7, the city of Livermore, the San Francisco Public Utilities Commission, and others as applicable, preferably over the next 20–25 years. The analysis should identify the type of water supply needed (e.g., treated water, recycled water) from each provider.	4.5; 4.12.3; 5.5; 6.4.5; 6.4.12
Water: The SWEIS should include a comprehensive analysis of stormwater runoff and contribution to local flood control channels.	4.5.1; 5.5
Water: All wells in the project area must be protected or decommissioned. Well construction, modification, and destruction must comply with Alameda County's "Water Wells Ordinance" (General Ordinance Number 0-2015-20) in Eastern Alameda County, and well completion reports must be submitted to Zone 7 Water Agency.	4.5.2; 5.5
Water: Include the acreage for streams as well as for wetlands, ponds, and other waters in the acreage values for the direct and secondary impact footprints and quantify the loss of channel length of streams by linear feet and/or miles. In addition to the areal or linear extent, impacts to aquatic resources should also be quantified by the expected change in the function these resources perform, or change in the condition of the resource.	4.5; 4.8.4; 5.5; 5.8
Water: The SWEIS should characterize baseline surface water and groundwater quality, quantity, and interactions; evaluate the direct, indirect, and cumulative impacts of all aspects of the proposed project on these hydrologic components; and describe mitigation for adverse impacts.	4.5; 5.5; 5.17.4; 6.4.5; 6.4.12
Climate and Air Quality: The SWEIS must fully consider climate change, specifically: (1) Intergovernmental Panel on Climate Change (IPCC) five released assessment reports and the special reports that followed the main reports, and U.S. Fourth National Climate Assessment (NCA4) volumes released in October 2017 and in November 2018; (2) Livermore Lab operations' potential contribution to global climate change due to emissions; (3) impact of fires and other extreme weather events related to climate change on the Livermore Lab itself; (4) how nuclear weapons can accelerate a climate catastrophe.	4.6.3; 5.6
Climate and Air Quality: Provide a detailed discussion of ambient air conditions, National Ambient Air Quality Standards (NAAQS), criteria pollutant nonattainment zones in the project area, and potential air quality impacts of proposed project activities, including indirect and cumulative impacts.	4.6; 5.6
Noise: Newly constructed building(s) at the Livermore Site adjacent to neighboring residential areas have air handling systems that emit constant noise pollution.	4.7; 5.7

Scoping Comment Issue	Section(s) of SWEIS where addressed
Biological: The SWEIS should include an invasive plant management plan to monitor and control detrimental vegetation and transport of invasive species during construction. If the proposed project would entail new landscaping, describe how the project would meet requirements of Executive Order 13112 ("Invasive Species").	4.8; 5.8
Biological: The SWEIS should describe aquatic habitats in the affected environment by resource type using the data sources and classification approaches that provide the greatest resolution possible.	4.8; 5.8
Biological: LLNL should prioritize the use of sustainable, climate-appropriate, and drought tolerant plants, trees and grasses that thrive in the Tri-Valley area.	4.8; 5.8
Cultural: The SWEIS should address the existence of Indian sacred sites in the project area.	4.9; 5.9
Cultural: Describe the process and outcome of government-to-government consultation between the NNSA and each of the tribal governments within the project area, issues that were raised (if any), and how those issues were addressed in the selection of the proposed alternative.	4.9; 5.9
Socioeconomic and Environmental Justice: Describe how the Proposed Action would address the potential for disproportionate adverse impacts to minority and low-income populations, and the approaches used to foster public participation and coordination with these populations.	4.10.5; 5.10
Socioeconomic and Environmental Justice: Minority and low-income populations have suffered disproportionately high adverse human health and environmental effects from nuclear energy and weapons programs of the U.S.	4.10.5; 5.10
Transportation: The SWEIS must include a description of the radionuclides and activities of waste that will be transported to New Mexico for disposal at WIPP, along with anticipated changes in waste generation and disposal that will result from the Proposed Action.	4.11; 5.11; Appendix C
Waste Management: The SWEIS should cover the connection between LLNL and SRS [Savannah River Site]. This includes any shipment of material, including plutonium, from LLNL to SRS (or via an intermediary site such as Los Alamos) and any exchange of information or staff in planning for the proposed SRS Plutonium Bomb Plant (for plutonium pit production) and for "plutonium disposition."	4.11; 5.11; 4.13; 5.13; Appendix D
Waste Management: There must be an explicit analysis of the potential impacts of any instituted changes to the administrative limits of security Category I and II special nuclear materials when these materials were removed.	4.13; 5.13
Materials Management: The SWEIS should address potential direct, indirect, and cumulative impacts of hazardous materials management and storage from proposed project activities. If any pesticides or biocides will be used during construction or operation and maintenance, the SWEIS should address any potential toxic hazards related to the use of such substances and describe what actions will be taken to assure that impacts by toxic substances released to the environment will be minimized.	4.13; 5.13
Waste Management: The SWEIS needs to detail all potential impacts of LLNL undertaking "materials testing" of plutonium and explain in detail how this activity does or does not comply with the MAR and administrative limits.	4.13; 5.13; Appendix C
Waste Management: The SWEIS should address potential direct, indirect, and cumulative impacts of hazardous materials management and storage from proposed project activities.	4.13; 5.13
Health and Safety: The SWEIS must consider worker health and safety in all of its analyses. Further, the document must consider past worker exposures when contemplating further operations with these potentially deadly materials.	4.14; 5.14
Health and Safety: The SWEIS needs to detail the scope and timeframes of the LEPs planned for Livermore Lab. It also needs to explain to what extent – and in what quantities – radioactive and toxic materials will be on site to accomplish the LEPs.	1.3; Chapter 2; 4.13; 5.13
Accidents: The SWEIS should analyze the potential impacts of a wildfire on LLNL.	5.16, Appendix C
Accidents: The SWEIS should consider accidents such as the explosion that occurred recently in Beirut.	5.16, Appendix C

Scoping Comment Issue	Section(s) of SWEIS where addressed
Contamination and Remediation: Past contamination must be fully considered in the SWEIS. Additionally, the SWEIS must state whether any program activities considered in the document will complicate or delay any of the Superfund monitoring or cleanup underway.	4.15; 5.15
Out of Scope	
The U.S. should cease all nuclear activities: design, production, refinement, and refurbishment.	1.3; 3.5
NNSA should consider a future that does not include the W87-1 development. The SWEIS must fully consider the direct connection between NNSA's plans for expanded pit production and the present day development at LLNL of a new warhead, called the W87-1 [formerly called the Interoperable Warhead], which will require those new pits.	3.5
Adding new or "refurbished" nuclear weapons to our present arsenal is unconscionable in light of our growing security needs for basic human health (including a vaccine), safety from wildfires, safe and "refurbished" infrastructure, and full employment in vocations and work which serve the common good.	1.3; 3.5
Nuclear waste lasts virtually forever – though not as long as petroleum-based plastic.	4.13; 5.13
LLNL should put resources towards monitoring and protecting sources of fresh water.	1.3; 3.5; 4.5; 5.5
Socioeconomic and Environmental Justice: Action Alternatives in the SWEIS that involve transporting material from LLNL to New Mexico must ensure any action will achieve environmental justice for the high percentage of minority and low-income populations in New Mexico.	4.10; 5.10; 4.11; 5.11
It is hypocritical of NNSA to begin a new LLNL SWEIS but not a LANL SWEIS. Thus, the Draft LLNL SWEIS should explain why it exists but not a LANL SWEIS.	1.3
Opposition to the Los Alamos National Laboratory's proposal for a temporary authorization to vent 114,000 Curies of radioactive tritium into the air.	Comment noted

During the public comment period for this Draft SWEIS, NNSA will hold in-person and/or online public hearings. The dates and times of those public hearings will be announced on the DOE NEPA web page and the NNSA NEPA web page (https://www.energy.gov/nepa, https://www.energy.gov/nnsa/nnsa-nepa-reading-room), as well as in local newspapers, and in Federal Register Notices of Availability. All comments received during that public comment period will be considered by NNSA in preparing the Final SWEIS.

1.7 ORGANIZATION OF THIS SWEIS

Volume 1 of this Draft LLNL SWEIS contains 10 chapters, which include the following information:

- **Chapter 1. Introduction –** Contains background information and reasons why NNSA needs to take action and purposes to be achieved.
- **Chapter 2. Overview of Lawrence Livermore National Laboratory Management Structure and Capabilities** – Provides an overview of LLNL history, organization, missions, operations, programs, and facilities.
- **Chapter 3. Proposed Action and Alternatives** – Describes the way NNSA proposes to meet the specified need and achieve the objectives. This chapter also describes alternatives considered but eliminated from detailed analysis and includes a summary comparison of

the potential environmental impacts of the SWEIS alternatives and identifies any preferred alternative.

- **Chapter 4. Existing Environment** – Discusses aspects of the environment that might be affected by the alternatives.
- **Chapter 5. Environmental Consequences** – Presents analyses of the potential impacts on the environment that could result from the Proposed Action. Impacts are compared to the projected environmental conditions that would be expected if the No-Action Alternative were taken.
- **Chapter 6. Cumulative Impacts –** Provides analyses of the potential cumulative impacts on the environment from the alternatives and other past, present, and reasonably foreseeable future actions.
- **Chapters 7–10.** Contain a list of references cited, an index, a glossary, and a list of preparers.

Volume 2 of this Draft LLNL SWEIS contains appendices of technical information that support the environmental analyses presented in the SWEIS chapters. These appendices are as follows:

- **Appendix A.** Description of Major Missions and Facilities at LLNL and Major Site-wide Changes Since the 2005 SWEIS
- **Appendix B.** Methodologies Used in SWEIS
- **Appendix C.** Human Health, Safety, Accidents, Intentional Destructive Acts, and Emergency Management
- **Appendix D.** Radiological Transportation
- **Appendix E.** Floodplain and Wetlands Assessment
- **Appendix F.** NEPA and CEQA Crosswalk
- **Appendix G.** Project Notices
- **Appendix H.** Contractor Disclosure Statements
- **Appendix I.** Biological Surveys

A SWEIS Summary has also been prepared.

Following the public comment period on this Draft SWEIS, NNSA will prepare Volume 3 (Comment Response Document), which will include all comments received on the Draft SWEIS and NNSA's responses to those comments. A Mitigation Action Plan may also be prepared.

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CHAPTER 2

U.S. Department of Energy and National Nuclear Security Administration Capabilities Supported by the Lawrence Livermore National Laboratory

2.0 U.S. DEPARTMENT OF ENERGY AND NATIONAL NUCLEAR SECURITY ADMINISTRATION CAPABILITIES SUPPORTED BY THE LAWRENCE LIVERMORE NATIONAL LABORATORY

2.1 LLNL ORGANIZATIONAL STRUCTURE AND MAJOR PROGRAMS

The Lawrence Livermore National Laboratory (LLNL or Laboratory) organizational structure is shown in Figure 2-1. As described in this section, LLNL employs a highly matrixed management structure to support the Laboratory's missions and programmatic objectives. The major program areas are managed within one of three Principal Directorates (Global Security, Weapons and Complex Integration, and National Ignition Facility (NIF) and Photon Science) with technical discipline capabilities provided by the three scientific organizations (Computing, Engineering, and Physical and Life Sciences). U.S. Department of Defense (DoD) activities are supported by the three major program areas and coordinated through the Office of Defense Coordination in the Laboratory Director's Office. Operations and Business functions are supported by a fourth organizational Principal Directorate, with additional functionality provided and managed by the Deputy Director. The Operations and Business Principal Directorate is responsible for administrative, business, and operations which are broadly applied across the Laboratory. Environment, Safety, and Health (ES&H) and the Security Organization are also managed by the Operations and Business Principal Directorate. Integration and oversight of all basic LLNL science and technology (including the Laboratory Directed Research and Development [LDRD] program) are managed by the Deputy Director for Science and Technology.

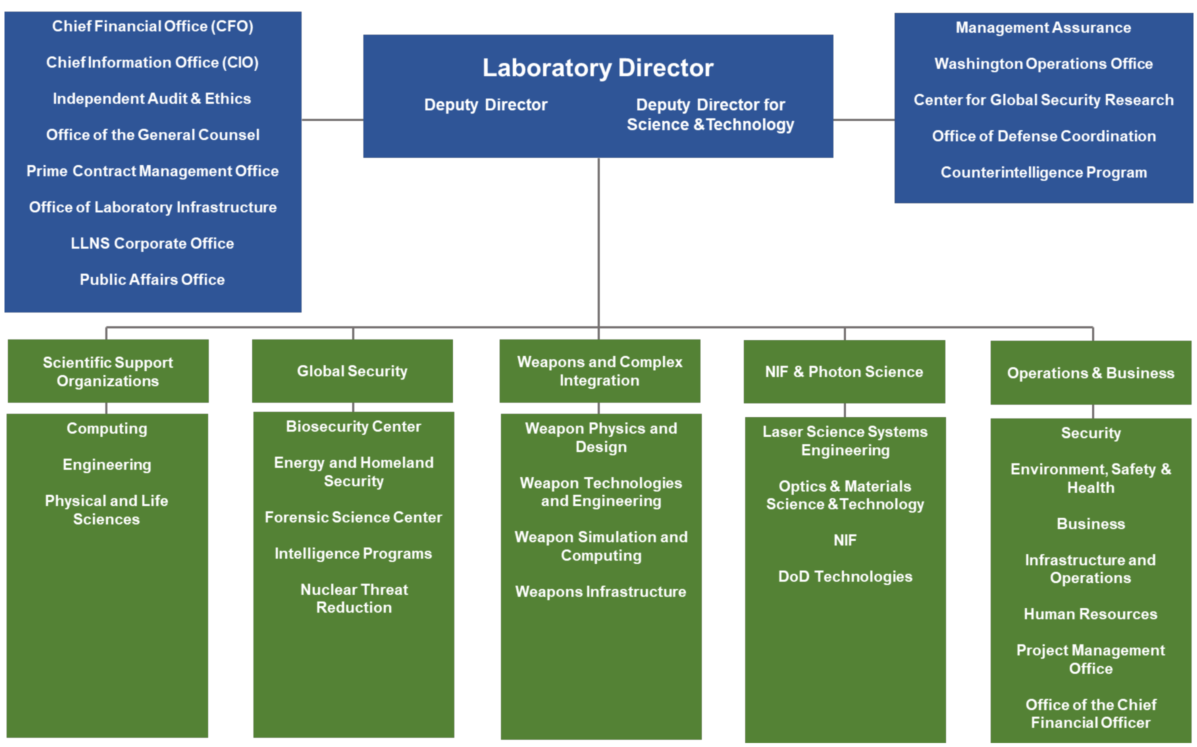


Figure 2-1. LLNL Organization Chart 2022

2.1.1 Laboratory Director's Office

The Laboratory Director's Office is responsible for the oversight of all activities at LLNL and reports to the DOE/NNSA Livermore Field Office and the Lawrence Livermore National Security, LLC (LLNS) Board of Governors regarding overall contract performance related to operating LLNL.

2.1.1.1 *Deputy Director*

The Deputy Director's office provides oversight for all of the functions of the Laboratory, allowing LLNL to operate as efficiently as possible while meeting its national security mission. This role specifically includes oversight of the Operations and Business (O&B) Principal Directorate, which includes all ES&H functions, including regulatory compliance, as well as security, purchasing, hiring, construction, facility and infrastructure maintenance, and the management of legacy facilities (including demolition). Additionally, the Deputy Director's office is directly responsible for a broad range of institutional programs including information technology, management assurance, independent audits, and ethics.

2.1.1.2 *Deputy Director for Science and Technology*

The Deputy Director for Science and Technology office coordinates LLNL internal science strategy and manages the institutional investments for General and Administrative (G&A), the Institutional Strategic Support (ISS), and the LDRD program. These investments provide critically needed support to explore new research and development (R&D) ideas that anticipate the future needs of LLNL's national security mission. In addition, part of the G&A funding is used to manage, maintain, and upgrade general purpose facilities and property. This office also manages the Innovation and Partnership Office, which includes license- and royalty-funded research, and provides a conduit for technology transfer, business partnerships, and cooperative R&D agreements. This office undertakes large-scale strategic activities and initiatives—such as the Livermore Valley Open Campus (LVOC)—for engaging prospective partners and building strong relationships with them.

2.1.2 LLNL Major Program Areas

2.1.2.1 *Weapons and Complex Integration Program*

The NNSA Weapons Program provides for continued maintenance and investment in the NNSA Nuclear Security Enterprise (NSE) to be more responsive and resilient. A key priority at LLNL is to support NNSA's production capability and capacity to produce necessary warhead components. This is reflected in this SWEIS.

The Weapons and Complex Integration (WCI) Program works to ensure that the nation's nuclear deterrent remains safe, secure, and reliable. The Program accomplishes this through the NNSA Stockpile Stewardship and Management Program, an ongoing effort to develop and apply a science-based fundamental understanding to the assessment and certification of nuclear weapons, enhanced warhead surveillance tools that detect the onset of problems, and advanced manufacturing capabilities that produce critical components. Essential to this work is the use of high performance computational capabilities and advanced experimental facilities. WCI also partners with Combatant Commands and the Joint Staff, the Office of the Secretary of Defense, DoD agencies, and service components to ensure that integrated NNSA and DoD priorities are met.

2.1.2.2 *National Ignition Facility and Photon Science Program*

The NIF and Photon Science (NIF&PS) Program is an important national scientific resource that uses advanced lasers to research materials at temperatures and pressures that otherwise would only exist in the cores of stars, giant planets, and inside nuclear weapons explosions. NIF&PS's primary purpose is assuring viability of the nation's nuclear deterrent as part of the NNSA Stockpile Stewardship and Management Program. With the most powerful laser in the world, NIF&PS also supports a variety of scientific studies conducted by other DOE/NNSA national laboratories, high-energy density science research centers, academia, industry, and other national and international scientific programs.

2.1.2.3 *Global Security*

The Global Security Program supports a broad range of national security missions for a wide sponsor base, which includes DOE/NNSA, as well as other federal, state, and local agencies. This includes R&D support for counterterrorism, nonproliferation, intelligence, and energy security. LLNL provides technical and programmatic support to help prevent and mitigate catastrophic incidents arising from Chemical, Biological, Radiological, Nuclear, and/or Explosive (CBRNE) materials. LLNL's Intelligence Program delivers comprehensive analysis, policy, and operational support in areas where technology R&D are critical to national strategic priorities ranging from combating weapons of mass destruction and cybersecurity, to space and other emerging and disruptive technologies. Additionally, the Global Security Program advances the nation's energy security through innovative science and technology solutions, while understanding and reducing their environmental impact.

2.1.3 LLNL Technical Discipline Support Organizations

2.1.3.1 *Engineering*

The Engineering Directorate creates and applies engineering knowledge to advance national security and support the key mission areas of the Laboratory. Since LLNL's founding, applied science and engineering has been the focus to advance technology from science to design, to prototype development, and testing. Engineering at LLNL relies on multidisciplinary collaboration to achieve breakthroughs in fields vital to national security, such as nuclear engineering, materials engineering and manufacturing, bioengineering, data analytics, machine learning, sensing, and autonomous systems. Infrastructure capabilities include the Advanced Manufacturing Laboratory (AML), the Micro/Nano Laboratory (MNL), the Design Optimization Laboratory (DOL) and the Non-Destructive Characterization Laboratory (NDCL).

2.1.3.2 *Physical and Life Sciences*

The Physical and Life Sciences (PLS) Directorate anticipates and delivers essential scientific expertise and technology to support the Laboratory's national security and research programs. PLS researchers are leaders in a wide range of disciplines and use the latest models, capabilities, and technologies to tackle large and complex scientific challenges. The PLS Directorate combines unique Laboratory capabilities in measurement science, simulation, and information science to find solutions for national security problems, and to advance the scientific foundations of the Laboratory. Among the many science and technology areas that PLS actively pursues are six core scientific research areas: (1) atmospheric, earth and energy science, (2) biosciences and biotechnology, (3) nuclear and chemical sciences, (4) high energy density science, (5) advanced materials science, and (6) modeling and simulation.

2.1.3.3 *Computing*

Since LLNL's creation in 1952, computing has been essential to mission related R&D, basic science and technology, and supporting operations. The Computing Directorate has pioneered the development of computational tools and their application to complex scientific and engineering problems. Computing develops and deploys the world-class, next-generation machines and computational science expertise that enable the science and engineering critical to NNSA national security missions. This organization designs, develops, and deploys high-performance computing (HPC) capabilities to advance all the programmatic goals at LLNL under the direction of the Weapons Simulation and Computing Program in WCI. LLNL is currently home to some of the world's most powerful supercomputers. The addition of Exascale computing by approximately 2022 will support science and national security needs and provide LLNL programs with the next level of world-class computer science expertise required to solve challenging problems in the areas of massively parallel simulation, Web, mobile, software quality assurance, security, and product lifecycle management (LLNL 2019b, 2020b).

2.2 LLNL CAPABILITIES AND SUPPORTING INFRASTRUCTURE

The missions of the Laboratory represent an unprecedented challenge, requiring rigorous application of the scientific method to further the understanding of weapons phenomena, assess the condition of weapons, and pursue programs to extend the stockpile life of aging systems. The process of scientific and technical innovation must be supported by a viable and sustained capability and infrastructure foundation. LLNL's defining purpose is to sustain confidence in, and to maintain the U.S. strategic deterrent, as well as enhance national security. LLNL continues its strong tradition of scientific and technical excellence—anticipating, innovating, and delivering solutions for the nation's most challenging problems. NNSA has established infrastructure capability requirements to be executed by LLNL, as shown in Table 2-1, along with the LLNL infrastructure associated with each requirement.

Table 2-1. Definitions of LLNL Assets Supporting NNSA Infrastructure Capabilities

NNSA Infrastructure Capabilities	LLNL Assets Associated with NNSA Capabilities
Design and Certification	Weapons engineering, hydrodynamics, radiochemistry, and surveillance.
Tests and Experiments	Environmental tests, high energy density physics, radiography, radiation effects, subcritical experiments, material tests, and flight tests.
Simulation	Simulation, codes and models and high-performance computing.
Plutonium, enriched Uranium, depleted Uranium, Tritium, and Lithium	Strategic Defense Materials (including Special Nuclear Materials) infrastructure and capabilities, including assets for R&D, waste, and storage.
High Explosives	Infrastructure for development and testing of highly energetic materials, including assets for R&D, waste, and storage.
Non-Nuclear Components	Radiation hardened microelectronics, power sources, neutron generators, advanced manufacturing, manufacturing R&D, and multiple non-nuclear components.
IT/Communications	Information technology and voice and data services, including assets for data centers, communication systems, towers, and switching stations.
Security	Physical security of sites, including fencing, towers, ranges, guard houses, and security lights.
Mission Enabling Infrastructure	Power, water, emergency services, office and laboratory, roads and parking, storage, maintenance shops, and waste management.
Global Security	Counterterrorism and counterproliferation, nonproliferation, and incident and emergency response.
Strategic Partnership Projects	Work for federal agencies and non-federal entities that are outside of DOE and NNSA and involve broader national security, energy security, and scientific development missions.

Source: NNSA 2019b.

The following sections describe NNSA's defined capabilities executed by LLNL. Figure 2-2 presents a high-level display of facility layouts at the Livermore Site. Table 2-2 and Table 2-3 identify key buildings/facilities utilized by the Laboratory at the Livermore Site and Site 300, respectively, to accomplish its missions. Notable facilities are shown on Figure 2-3 (Livermore Site) and Figure 2-4 (Site 300).

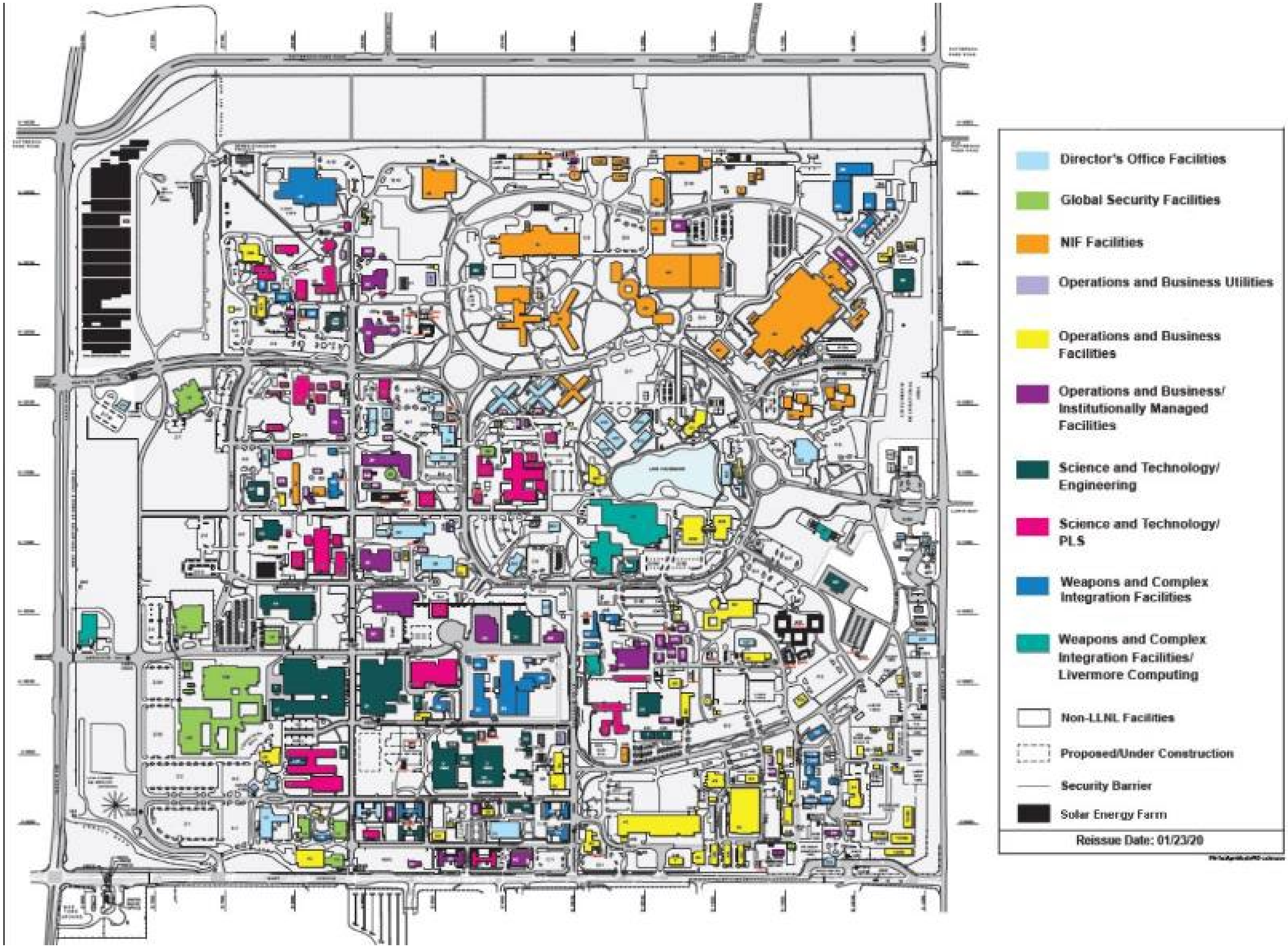


Figure 2-2. Top View of Existing Facilities at the Livermore Site

Table 2-2. Overview of Key Facilities at the Livermore Site

Facility Number	Facility Name	Gross Square Feet	NNSA Capability	Lab/ Research	Office/ Service/ Support	Hazards		
						Chemical	Radiological	Other[a]
131	Weapons Engineering	287,192	Design and Certification	Yes	Yes	Yes	Yes	Yes
132N	Defense Programs Research Facility	204,146	Global Security	Yes	Yes	Yes	Yes	Yes
132S	Global Security Research Facility	172,104	Global Security	Yes	Yes	Yes	Yes	Yes
141	Engineering Tech Development	47,342	Tests and Experiments	Yes	Yes	Yes	Yes	Yes
151 & 152	Analytical and Nuclear Chemistry Facility and Storage	96,030 (751)	Design and Certification	Yes	Yes	Yes	Yes	Yes
153	Microfabrication Laboratory	25,976	Non-Nuclear Components	Yes	Yes	Yes	Yes	Yes
154	Analytical and Radiochemistry Laboratory (part of B151 Complex)	9,138	Design and Certification	Yes		Yes	Yes	Yes
162 & 165	Crystal Growth and Optics/Development Labs	29,095	Tests and Experiments	Yes	Yes	Yes	Yes	Yes
166	Development Lab	13,266	Plutonium	Yes		Yes	Yes	Yes
170	National Atmospheric Release Advisory Center	43,760	Strategic Partnership Projects		Yes			
174	Jupiter Laser Facility	19,437	Tests and Experiments	Yes	Yes	Yes	Yes	Yes
190	Center for Accelerator Mass Spectrometry Lab Facility	10,252	Design and Certification	Yes		Yes	Yes	Yes
191	High Explosives Application Facility	121,031	High Explosives	Yes	Yes	Yes	Yes	Yes
194	Accelerator Tunnel Complex	41,544	Design and Certification	Yes	Yes	Yes	Yes	Yes
223	AME New Polymers Capability Facility	13,200	Tests and Experiments	Yes	Yes	Yes	Yes	Yes
225	Manufacturing Sciences Facility	15,900	Tests and Experiments	Yes		Yes		Yes
231	Development and Assembly Eng.	131,454	Weapons Engineering	Yes	Yes	Yes	Yes	Yes
B231V, OS232FA, B233GV	Vaults and Transportation	5,000 1,200 1,800	Weapons Engineering		Yes	Yes	Yes	Yes
235	Materials Science Division Offices and Labs	88,071	Tests and Experiments	Yes	Yes	Yes	Yes	Yes
239	Radiography Facility	12,905	Plutonium	Yes		Yes	Haz Cat 3 Nuclear	Yes
253	HC Dept Offices & Labs	30,932	Enabling Infrastructure	Yes	Yes	Yes	Yes	Yes
254	HC Bio Assay Lab	2,488	Enabling Infrastructure	Yes	Yes	Yes	Yes	Yes
255	HC SPD Labs and Offices	21,855	Enabling Infrastructure	Yes	Yes	Yes	Yes	Yes
262	Radiation Detector Development	10,815	Global Security	Yes		Yes	Yes	Yes
272	Materials Science Laboratory	10,124	Non-Nuclear Components	Yes		Yes	Yes	Yes
298	Target Development	47,987	Tests and Experiments	Yes	Yes	Yes	Yes	Yes
310	Nondestructive Evaluation Building	11,000	Tests and Experiments	Yes	Yes	Yes	Yes	Yes
321A	Materials Fabrication Shop	59,515	Tests and Experiments	Yes	Yes	Yes	Yes	Yes
321C	Materials Fabrication Shop	78,335	Tests and Experiments	Yes	Yes	Yes	Yes	Yes
321G	Manufacturing Building	13,000	Tests and Experiments	Yes	Yes	Yes	Yes	Yes
322	Plating Shop	5,704	Tests and Experiments	Yes	Yes	Yes	Yes	Yes
327	Radiography	19,101	Tests and Experiments	Yes	Yes	Yes	Yes	Yes

Facility Number	Facility Name	Gross Square Feet	NNSA Capability	Lab/ Research	Office/ Service/ Support	Hazards		
						Chemical	Radiological	Other[a]
331	Tritium Facility	30,484	Tritium	Yes	Yes	Yes	Haz Cat 3 Nuclear	Yes
332	Plutonium Facility	104,787	Plutonium	Yes	Yes	Yes	Haz Cat 2 Nuclear	Yes
334	Hardened Engineering Test Building	10,688	Plutonium	Yes		Yes	Haz Cat 2 Nuclear	Yes
335	Support Facility	11,988	Plutonium	Yes	Yes	Yes		Yes
341	Engineering Mechanical Testing	44,184	Tests and Experiments	Yes	Yes	Yes	Yes	Yes
361 & 362	Bio Research Cornerstone Facility	68,889	Global Security	Yes	Yes	Yes	Yes	Yes
364	Bio Research Support Facility	9,372	Global Security	Yes	Yes	Yes	Yes	Yes
365	Biosafety Level 2 Laboratory	8,972	Strategic Partnership Projects	Yes		Yes		Yes
368	Biosafety Level 3 Laboratory	1,590	Strategic Partnership Projects	Yes		Yes	No	Yes
381	Target Fabrication and Offices	95,478	Tests and Experiments	Yes	Yes	Yes	Yes	Yes
391	NIF Optics and Diagnostic Labs	197,842	Tests and Experiments	Yes	Yes	Yes	Yes	Yes
392	Optics Laboratory Facility	8,413	Tests and Experiments	Yes		Yes	Yes	Yes
431	Beam Research Labs	54,790	Tests and Experiments	Yes	Yes	Yes	Yes	Yes
432	NIF Target Fabrication Machining	33,575	Tests and Experiments	Yes	Yes	Yes	Yes	Yes
453	Livermore Computing Facility	253,000	Livermore Computing	Yes	Yes	Yes		Yes
490	NIF Engineering and Diagnostic Lab	216,789	Tests and Experiment	Yes	Yes	Yes	Yes	Yes
491	Development Lab	13,883	Tests and Experiment	Yes	Yes	Yes	Yes	Yes
511	Craft Shop	77,141	Tests and Experiment	Yes		Yes	Yes	Yes
581/582/681	NIF/Vacuum Systems Building, and Optics Assembly Building	700,907 2,927 46,818	Tests and Experiments	Yes	Yes	Yes	Yes	Yes
Area 612	RHWM Waste TSDF (B612, B614, B624, B624A/B, OS612A, Tent 6197B)	12,426	Plutonium		Yes	Yes	Yes	Yes
655	Advanced Manufacturing Laboratory	13,993	Strategic Partnership Projects	Yes		Yes		Yes
663	Health Services	24,786	Enabling Infrastructure		Yes	Yes		Yes
Area 625, 693 Yard, Area 696R	RHWM Radioactive Waste Storage Facilities	19,247 12,000 9,600	Plutonium			Yes	Haz Cat 2 Nuclear	Yes
695, 696S 697	RHWM Liquid Waste Processing/Decontamination and Waste Treatment Facility	46,504 11,781 4,118	Plutonium	Yes	Yes	Yes	Yes	Yes

Haz Cat 2 Nuclear = Hazard Category 2 facility (as defined by DOE-STD-1027); Haz Cat 3 Nuclear = Hazard Category 3 facility—all radionuclides below Cat 2 thresholds; hazard analysis shows potential for only significant localized consequences (10 CFR Part 830); NIF = National Ignition Facility; RHWM = radioactive and hazardous waste management; TSDF = Treatment, Storage, and Disposal Facility

a. Other hazards include biological materials, explosives, accelerators, x-ray machines, lasers, nuclear magnetic resonance, electrical, and collection and storage of compressed gas cylinders.

Table 2-3. Overview of Key Buildings and Facilities at Site 300

Facility Number	Facility Name	Gross Square Feet	NNSA Capability	Lab/ Research	Office Service/ Support	Hazards		
						Chemical	Radiological	Other[a]
801A/B/C	Contained Firing Facility	46,848	Design and Certification	Yes	Yes	Yes	Yes	Yes
805	Inert Machining/Explosives Waste	6,830	High Explosives	Yes	Yes	Yes	Yes	Yes
806A/B	HE Machining	7,505	High Explosives	Yes	Yes	Yes	Yes	Yes
807	HE Machining	1,575	High Explosives	Yes	Yes	Yes	Yes	Yes
809A/B/C	HE Pressing and Oven Facility	3,794	High Explosives	Yes	Yes	Yes	Yes	Yes
810A/B/C	HE Assembly and Storage	5,200	Design and Certification	Yes	Yes	Yes	Yes	Yes
816, M2-5	Explosives Waste Storage Facility	1,223	High Explosives		Yes	Yes	Yes	Yes
817A/B/C/E/ F/G/H	HE Pressing and Oven Facility	3,102	High Explosives	Yes	Yes	Yes	Yes	Yes
823A/B	LINAC Radiography	2,748	Design and Certification	Yes	Yes	Yes	Yes	Yes
825	Chemistry	1,547	High Explosives	Yes	Yes	Yes	Yes	Yes
826	Chemistry	1,547	High Explosives	Yes	Yes	Yes	Yes	Yes
827A/B/C/D/ E	Chemistry Control and Process Facility	18,709	High Explosives	Yes	Yes	Yes	Yes	Yes
832A/C/E, OSM832B/D	Storage Facilities	2,456	High Explosives		Yes	Yes	Yes (A, E)	Yes
834A/B/C/D E/F/H/M	Thermal Test Facilities HE Storage	11,199	Enabling Infrastructure, Tests and Experiments	Yes	Yes	Yes	Yes	Yes
834L	HE Additive Manufacturing	1,000	High Explosives	Yes	Yes	Yes	Yes	Yes
836A/B/C/D	Dynamic Test Facility	13,023	Tests and Experiments	Yes	Yes	Yes	Yes (B, C, D)	Yes
845A/B	Explosives Waste Treatment Facility	722	High Explosives		Yes	Yes	Yes	Yes
850	Firing Facility	5,095	Enabling Infrastructure	Yes	Yes	Yes		Yes
851A	Outdoor Firing Facility	13,176	Design and Certification	Yes	Yes	Yes	Yes	Yes
855A/B/C	HE Machining	1,700	High Explosives	Yes	Yes	Yes	Yes	Yes

HE = high explosives; LINAC = Linear Accelerator; EWSF = Explosives Waste Storage Facility; EWTF = Explosives Waste Treatment Facility.
a. Other hazards include biological materials, explosives, accelerators, x-ray machines, lasers, nuclear magnetic resonance, electrical, and collection and storage of compressed gas cylinders.

Figure 2-3. Notable Facilities at the Livermore Site

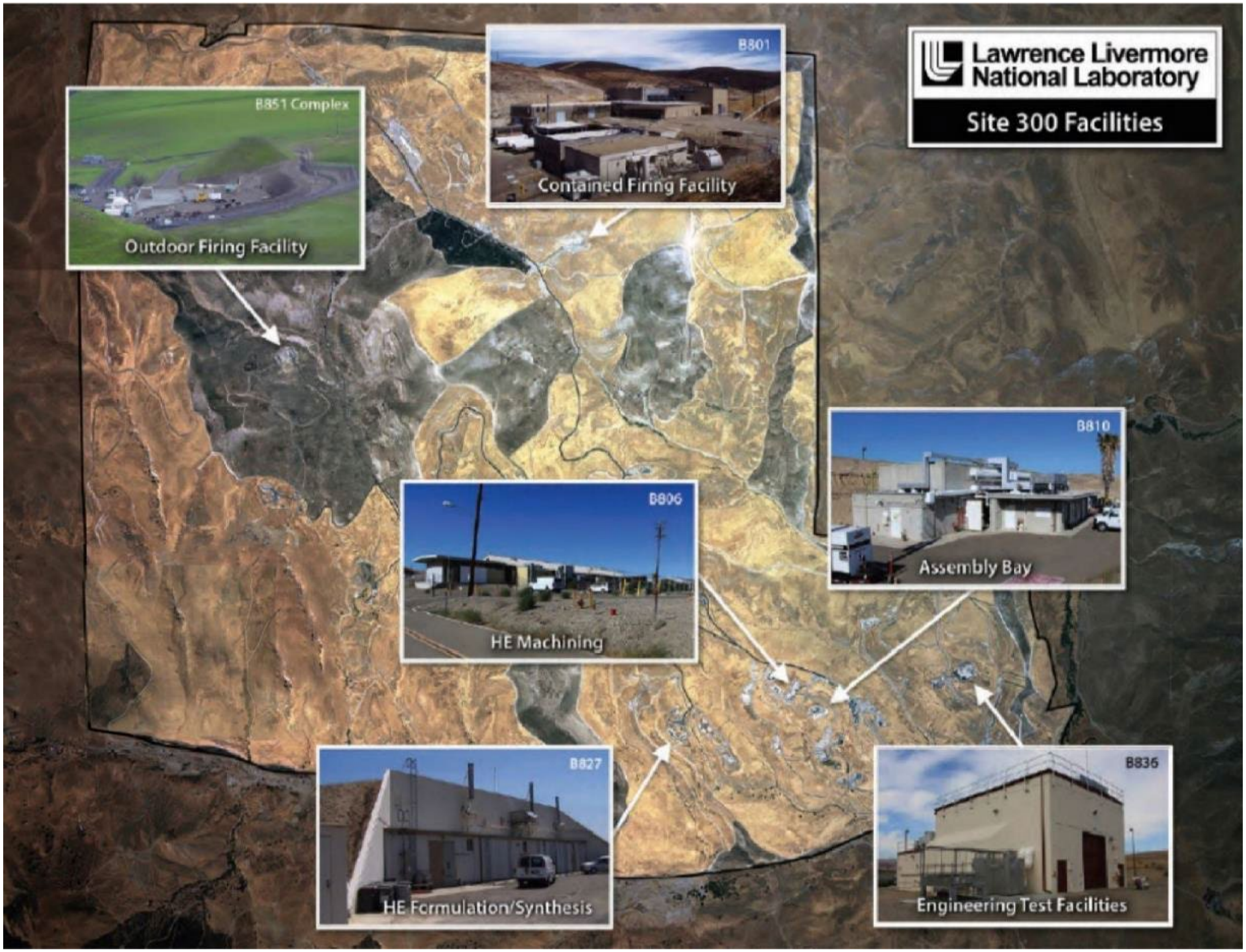


Figure 2-4. Notable Facilities at Site 300

2.2.1 Design and Certification

LLNL's design and certification capability includes site activities that enable the conceptualization and sustainment of the nuclear stockpile, including data for qualifying weapons design, confirming system performance requirements, and surveilling the stockpile. It also includes assets for hydrodynamics, radiochemistry, and surveillance, and integrates closely with the weapons engineering capability to support radiation effects testing on weapons program devices and components. LLNL's historic, current, and anticipated future mission work provides the nation with safe, secure, and reliable nuclear weapons systems. LLNL is responsible for maintaining three of the seven active stockpile weapons systems through the annual weapon certification process and for enabling the future stockpile. For example, LLNL designs and certifies components to extend the life of the W80-4 warhead (LLNL 2017a).

2.2.1.1 *Current Research Capabilities*

Weapons Engineering. LLNL is responsible for ensuring the safety, reliability, and performance of weapons nuclear explosives packages (NEP), without nuclear testing. Weapons Engineering plays a key role in ensuring that the design of the NEP meets the DoD's requirements specified by the weapon's military characteristics.

LLNL annually assesses and certifies the B83, W87, and W80-1 warheads to ensure that they continue to meet DoD requirements. The confidence basis for the annual weapon certification process is built on a foundation of historical tests, along with the annual monitoring (formally called surveillance) and design agency stockpile tests. This important test data allows the Laboratory to assess and communicate to the Secretary of Energy, Secretary of Defense, and the Nuclear Weapons Council the health of the stockpile.

Another of LLNL's primary responsibilities is to support life extension programs (LEPs), modification programs (Mods), and alteration programs (Alts) which extend the service life and enhance the safety, security, and reliability of nuclear weapons. Weapons Engineering activities are key to the success of annual assessments (including surveillance), LEPs, Mods, and Alts.

Weapons Engineering activities supporting annual assessments, LEPs (W80-4), and Mods (W87-1) include design, development, systems integration, testing, production, and surveillance. Weapons Engineering also includes activities and infrastructure related to the weapons lifecycle, including concept exploration, requirements satisfaction, design, and certification and qualification. Weapons Engineering utilizes assets for environmental tests, high energy density physics, radiography, radiation effects, subcritical experiments, material tests, and flight tests.

Weapons Engineering tests also require advanced material deposition and joining capabilities, such as welding or brazing. These joints are then applied to assemblies used in hydrodynamic and environmental tests to determine how materials are affected by the welding process. When a material is welded, its crystalline structure changes and these microstructural changes can affect a material's strength, corrosion resistance, ductility, and mechanical properties. The changes could either enhance the quality of the weld or reduce the weld's integrity. The welding process is better understood by modeling it and then predicting the changes that may occur in the joined component (LLNL 2017a).

Hydrodynamic. The Hydrodynamic subgroup includes activities and infrastructure related to hydrodynamic testing for validating models within multi-physics design codes and predicting nuclear weapon performance. Hydrodynamic testing at Site 300 is used to study the behavior of surrogate primary-stage materials in response to extremely high temperatures and pressures. These tests are essential for the continued refining of computational models that simulate nuclear weapon performance. Hydrodynamic tests involve explosive detonations that create temperatures and pressures so great that solids behave like liquids. The components in these integrated weapon experimental devices are equivalent to those used in the stockpile except for the use of surrogate materials in place of nuclear materials. Hydrodynamic tests compare the phases of hydrodynamic flow from non-nuclear explosives experiments with computational data. These tests are conducted at Site 300's Contained Firing Facility (CFF) and Building 851. With its diagnostic capabilities, the CFF/flash x-ray (FXR), in combination with other hydrodynamic testing capabilities in the complex, provides designers and engineers working on non-weapons programs with the experimental capability necessary to develop and evaluate counterterrorism and counterproliferation tools (LLNL 2019b).

Radiochemistry. The Radiochemistry subgroup includes activities and infrastructure related to the study of radioactive materials and their interactions, including evaluating data from legacy underground testing and modeling problems in nuclear forensics and attribution. LLNL researchers use radiochemistry (the study of radioactive isotopes) and nuclear chemistry (which focuses on the properties of atomic nuclei and the processes involved in element transformation) to further understand the nation's stockpile. Since the moratorium on underground nuclear testing, radiochemical research at the Laboratory continues to support the weapons program through stockpile stewardship and other national security and scientific missions. Many of LLNL's radiochemistry efforts are carried out in Building 151, where scientists perform radiochemical analyses, to provide support to LLNL's stockpile certification effort. Radiochemistry research provides an array of materials handling capabilities and isotope research and production facilities, to support, for example, the Center for Accelerator Mass Spectrometry (CAMS) and the NIF. CAMS also measures radioactive isotopes for a variety of chemistry experiments. These laboratories also support NIF diagnostics and pre- and post-detonation forensics and provide a unique capability to support nonproliferation and treaty verification programs.

Surveillance. The Surveillance subgroup includes activities related to diagnostics and measurement of the current state of the stockpile and stockpile aging. Advanced surveillance techniques were instituted to help maintain existing stockpile weapons components for as long as possible without the need for nuclear testing. Surveillance has three primary goals: detect stockpile defects, assess and document stockpile conditions, and uncover precursors of aging early enough to implement corrective action (LLNL 2017a). These surveillance activities are done at various LLNL facilities.

2.2.1.2 *Supporting Infrastructure*

The major physical infrastructure supporting the Design and Certification capabilities includes large office buildings, such as Buildings 121, 131, 151, and 235, that house scientists, engineers, and other staff. Other facilities for Design and Certification include Building 801 (CFF/FXR) used to conduct hydrodynamic tests that evaluate and test weapon components; B851 open detonation table; Building 810 high explosives (HE) assembly and storage; Building 154 (Radiochemistry

Laboratory); Building 190 (CAMS); and B194 (Accelerator Complex). The CFF (*see* Figure 2-9 in Section 2.2.5.2) allows the Laboratory to conduct explosives tests indoors, as the facility has the largest indoor firing chamber in the nation, capable of containing explosive detonations of 60 kilograms (132 pounds). The CFF provides distinct experimental capabilities in support of annual assessments, LEPs and Mods, for both NEP performance and nuclear safety. The CFF also supports the development of weapon design and engineering skills at the Laboratory, delivers experiments in support of broader national security efforts, and provides a venue to mature technologies that enable required future radiographic capabilities.

Engineering R&D occurs at LLNL's Applied Materials and Engineering (AME) facility, Building 231, which is the largest complex of engineering research, development, test, and evaluation (RDT&E) facilities at the Laboratory. Building 231 is 140,000 square feet and houses crucial weapons engineering capabilities required to execute NNSA's missions for the stockpile, particularly LEPs, Mods, and the annual assessment. This building supports many capabilities, including applied materials work in areas of characterization, specialty fabrication, joining, physical vapor deposition, and mechanical testing. Materials include metals (both radiological and nonradiological), polymers, and powders. At present, the building poses a risk to personnel safety and programmatic execution due to failing facility conditions. LLNL has already begun to move its staff and capabilities out of the building to mitigate potential risks (LLNL 2019b, 2017a). As discussed in Chapter 3, Section 3.2, of this SWEIS, LLNL is in the process of building replacement AME facilities.

2.2.2 Tests and Experiments

Tests and experiments infrastructure houses the activities that provide data to determine weapon performance characteristics, understand material properties under extreme conditions, and contribute to formation and validation of models. It includes assets for environmental tests, high energy density (HED) physics, radiography, radiation effects, subcritical experiments, material tests, and flight tests. The NIF's experimental capabilities are essential components of LLNL's test and experimental strategy because NIF provides the only means by which scientists may access the pressure and temperature conditions relevant to thermonuclear burn. NIF is the NNSA's preeminent HED stockpile stewardship experimental facility (LLNL 2019b, 2020b).

2.2.2.1 *Current Research Capabilities*

Environmental Tests. This includes those capabilities that simulate environmental and functional conditions, such as shock, vibration, radiation, acceleration, temperature, electrostatic, and pressure conditions (*see* Figure 2-6 below). At times, these experimental tests may identify failures in systems or components which may require further material testing. These tests allow the engineer to assess whether the failure was due in part to a material's structure or property. This testing is applied to all proposed modifications for any weapon component.

High Energy Density Physics. This capability includes infrastructure to support HED physics, the study of matter and radiation under extreme conditions, and assist in the formation and validation of models. This experimental data helps to inform and validate sophisticated, three-dimensional (3D) weapons-simulation computer codes and facilitate a broader understanding of weapons physics.

Radiography. The Radiography subgroup includes activities and infrastructure that supports radiography for certification, recertification, and assessment of the stockpile. Advanced scientific diagnostics, such as high-energy FXR radiography and high-speed optics, capture data from hydrodynamic tests that are used to assess the science and operation of non-nuclear weapon components for LEPs and Mods. Radiography of weapons components and HE components are also conducted in several radiography facilities, including Building 239 and Building 337 at the Livermore Site, and Building 823 at Site 300.

LLNL is a leader in x-ray non-destructive evaluation (NDE) within the NNSA complex. The Laboratory maintains several dedicated facilities on site that house a broad spectrum of unique NDE hardware and software systems. Building 327 is a four-story structure that houses six subsurface, shielded x-ray bays that can handle classified parts. Facility personnel provide capabilities and services to satellite NDE facilities that support missions across the Laboratory.

NDE is used for the stockpile stewardship program to understand the internal structure and makeup of a variety of individual parts, subcomponents, and full assemblies. X-ray imaging methods and technologies are used for various industrial and stockpile stewardship missions, such as highly detailed, multidimensional x-ray images of weapons parts, engine parts, and the molds that cast them. Current NDE capabilities allow for highly detailed, multidimensional x-ray images that can be used for reverse engineering, quality assurance, or surveillance testing to characterize the health of nuclear weapons components. Three-dimensional x-ray computed tomography can be used to measure the dimensions of a wide range of components and materials (explosives, foams, and metals) for assessment without taking the component apart, with inspected object sizes ranging from small (sub micrometer) to large (several meters) (LLNL 2017a).

Radiation Effects. The Radiation Effects subgroup includes infrastructure to support radiation effects testing on components and weapons program devices. Much of this work involves HED physics from both an experimental and modeling perspective and utilizes the HED capabilities described above.

Subcritical Experiments. The Subcritical Experiments subgroup includes capability and infrastructure to support subcritical experiments, instead of underground nuclear explosive testing, for validating models within multi-physics design codes and predicting nuclear weapon performance. The NIF's experimental capabilities are essential components of the nation's stockpile assessment and certification strategy because NIF provides the only means by which scientists may access the pressure and temperature conditions relevant to thermonuclear burn (LLNL 2019b, 2020b). NIF users and collaborators include researchers from DOE national laboratories, universities, and other U.S. and foreign research centers. LLNL conducts some subcritical experiments at the Nevada National Security Site (NNSS).

Material Tests. Material testing includes capabilities that support the study of how materials in a nuclear weapon behave under conditions of temperature and pressure. When a refurbishment (or change) is proposed to a weapon component or subassembly, testing is conducted to determine whether the design changes will meet required specifications. Required test capabilities consist of material characterization and mechanical testing of polymers and metals, including radioactive materials. In addition, key environmental test capabilities help understand what happens when a weapon component or subassembly design is subjected to thermal-mechanical environments.

Environmental testing also includes the capability to perform new high explosive formulation experiments in test cells.

Flight Tests. This activity includes capabilities related to flight testing for stockpile weapon system surveillance and qualification. Flight testing involves the preparation of the part or assembly to be used in the flight test. Many potential technical issues involving flight tests can be simulated and evaluated within the LLNL facilities.

2.2.2.2 *Supporting Infrastructure*

To support the mission needs, LLNL has designed, operated, and maintained an infrastructure network that includes the primary NIF, Building 581, and many support facilities for target fabrication; optics processing and development; and target diagnostic development, assembly, and refurbishment. NIF, shown in Figure 2-5, is the world's largest and highest-energy laser. NIF's 192 laser beams routinely create temperatures and pressures similar to those that exist only in the cores of stars and giant planets, and inside nuclear weapons. As such, NIF provides the only means by which scientists may access the pressure and temperature conditions relevant to thermonuclear burn. This allows access to HED regimes that are essential for the nation's stockpile assessment and certification strategy. For example, the physical properties of plutonium can be examined under the most extreme conditions reached during detonation of a nuclear weapon. NIF is also a premier international center for experimental science. The extreme temperatures and pressures created inside the NIF target chamber allow scientists from around the world to conduct unprecedented experiments in HED science and gain new insights into such mysterious astrophysical phenomena as supernovae, giant planets, and black holes (LLNL 2017a).

The NIF itself must meet infrastructure requirements to ensure tight, accurate laser pointing and timing to the target, protect the workers and public from radiation and contamination, ensure unimpeded high-power laser propagation, protect the unique NIF optical components by providing an environment with required levels of cleanliness and humidity, and power the world's largest capacitor bank that feeds the NIF laser amplifiers. NIF has a specialized set of requirements and associated facilities and equipment needed to support stockpile stewardship. The NIF has been well maintained since operations began in 2009, but many systems will need to be replaced over the next decade. Conditions such as temperature stability, pointing stability, and room cleanliness directly impact NIF's ability to execute its mission (LLNL 2017a). Proposed upgrades to NIF are discussed in Chapter 3, Section 3.3, of this SWEIS.

Figure 2-5. The National Ignition Facility

Environmental testing is also performed in several Site 300 facilities. These facilities allow for the largest HE loading of all environmental test facilities within the NSE. To validate warhead component performance, LLNL also uses Site 300's outdoor firing facility (at Building 851). Additionally, at Site 300's environmental test area, several facilities subject prototype HEs, detonators, and other energetic materials, as well as nonnuclear stockpile components, to conditions such as vibration, shock, impact, acceleration, twisting, and various combinations of heat and cold.

2.2.3 Simulation

Simulation and computing capabilities and infrastructure at LLNL support activities for computer modeling, and the prediction of weapon performance and material properties not accessible through experimentation. This includes assets for simulation, codes and models, and HPC applicable to the entire LLNL mission space for NNSA, as well as the broader DOE and Strategic Partnership Projects (SPP) sponsor base. The Advanced Simulation and Computing (ASC) Program (formerly known as the Accelerated Strategic Computing Initiative) was launched to address this need. ASC is capable of integrating the vast amount of scientific knowledge of nuclear weapons processes and materials with the accumulated experimental data from hundreds of nuclear tests.

ASC simulations offer a computational surrogate for nuclear testing. Major advances in hardware and software have made possible a clearer understanding of the issues involved with nuclear weapon performance by accurately simulating much of the extraordinary complexities of nuclear weapons systems. Full 3D, high-fidelity simulations allow physicists to observe phenomena nanosecond by nanosecond, with a level of spatial resolution and physics realism previously unobtainable. LLNL's HPC ecosystem (i.e., the hardware, software, facility infrastructure, and computer support staff) empowers scientific discovery and technology development in areas such as counterterrorism, medical countermeasures, drug discovery, and climate modeling (LLNL 2019b, 2020b). LLNL's most powerful computers are used primarily for stockpile stewardship efforts. As weapons age, it is important for national security to simulate weapons behavior and performance with the highest level of confidence. Often, this means running numerous iterations of complex simulations of weapon performance and behavior (LLNL 2017a).

Additionally, other internally funded projects are already using these HPC capabilities across an increasing number of disciplines. One such effort, Cardioid (an LDRD-funded program), is the world's most detailed model of the electrophysiology of the human heart. Developed in partnership with IBM, the code depicts the activation of each heart muscle cell and the cell-to-cell voltage transfer of up to three billion cells. It does so in near-real time and with unprecedented accuracy and resolution. For the first time, scientists are seeing how potentially fatal arrhythmias develop and are influenced by the administration of drugs and medical devices (LLNL 2017a). A second effort is the Accelerating Therapeutics for Opportunities in Medicine (ATOM), which is a public-private consortium with the mission of transforming drug discovery by accelerating the development of more effective therapies for patients. The goal is to transform drug discovery from a slow, sequential, and high-failure process into a rapid, integrated, and patient-centric model. This requires integrating HPC, diverse biological data, and emerging biotechnologies to create a new pre-competitive platform for drug discovery. These tools are actively applied to address the COVID-19 pandemic and continue to support potential new public health threats.

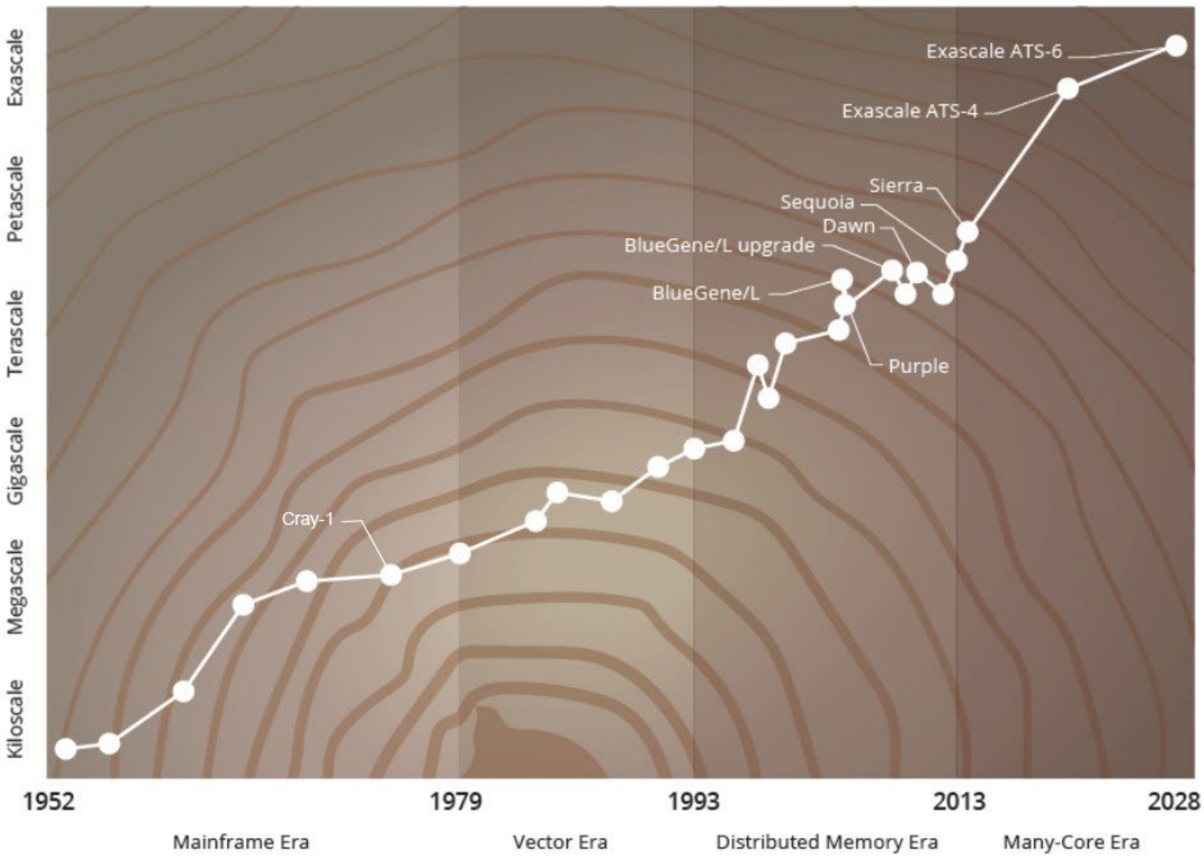
2.2.3.1 *Current Research Capabilities*

Simulation Codes and Models. The Simulation Codes and Models subgroup includes capabilities and infrastructure used to support the advanced computer codes and models used to simulate the behavior of nuclear weapons and enable certification of the stockpile to assess multiple threats that could be posed by adversaries over the next decade. A factor of 100 to 1,000 improvement in capability over what is available today is needed within just a few years to ensure confidence in assessments, reduce risks of surprise, and meet expected military requirements to counter these threats. This drives the need for new codes, Exascale platforms to run them on, and advanced facilities capable of hosting these platforms efficiently.

High Performance Computing. This subgroup includes capabilities and infrastructure related to HPC, including software, hardware, and facilities of sufficient power for modeling the performance of weapon systems and components and physical processes critical to nuclear operation as well as the other critical national security mission areas for CBRNE counterterrorism, medical countermeasures, drug discovery and climate modeling, among others (LLNL 2019b). The most accurate simulations can reduce design iterations in comparison to constructing prototypes and conducting tests. Therefore, HPC has become essential for numerous scientific and engineering research areas at LLNL. For stockpile stewardship, research focuses on the need for uncertainty quantification. HPC simulations must be executed many times with slightly different variables to better quantify the uncertainty in possible outcomes and the accuracy of LLNL's codes.

Exascale computing is the newest capability supporting the advanced computer codes and models used to simulate the behavior of nuclear weapons and enable certification of the stockpile as well as other critical national security mission areas. Exascale computing, at speeds of one quintillion

(10^{18}) floating point operations per second (flops) and memory of 10^{16} to 10^{17} bytes, is the next step in HPC (Figure 2-6 depicts computational advancements) (LLNL 2017a).



Source: LLNL 2017a.

Figure 2-6. Computational Advancements

2.2.3.2 *Supporting Infrastructure*

LLNL's Livermore Computing Complex houses some of the world's fastest and most powerful computers, including Top 500 computer systems: the 125 petaflop Sierra system, the 19 petaflop Lassen system, the 5.9 petaflop Ruby system, the 4.9 petaflop Magma system, and the Jade and Quartz systems at 3 petaflops each. Livermore Computing also contains smaller systems including the 970-teraflop Zin system and additional large multi-core, multi-socket Linux clusters with various processor types. Building 453 serves as the main facility and has more than 51,000 square feet of open machine floor space, supporting both classified and unclassified national security programs. These computers require infrastructure support such as large quantities of electrical power, cooling systems, and office space. LLNL is continuing to modernize its computing infrastructure to continue to accommodate HPC (LLNL 2017a). Currently, the infrastructure is being upgraded to support Exascale computers in the near future and to support operation of a 24/7 data center.

Sierra, LLNL's latest advanced technology HPC system, joined LLNL's line up of supercomputers in 2018 to support Exascale computing. The new system provides computational resources that are essential for nuclear weapon scientists to fulfill NNSA's stockpile stewardship mission through simulation in lieu of underground nuclear explosive testing. ASC Program scientists and engineers use Sierra to assess the performance of nuclear weapon systems, nuclear weapon science, and engineering calculations. These calculations are necessary to understand key issues of physics, the knowledge of which later makes its way into the integrated design codes. This work on Sierra has important implications for other global and national challenges, such as nonproliferation and counterterrorism. In 2016, LLNL completed Building 654, a modular and sustainable supercomputing facility, to help meet the growing need for unclassified computing at LLNL, and to accommodate a variety of HPC architectures (LLNL 2017a). Ongoing upgrades to the Laboratory's computing are discussed in Chapter 3, Section 3.2, of this SWEIS.

2.2.4 Strategic Defense Materials (Plutonium, Uranium, Tritium, and Lithium)

Stockpile Stewardship and Management Program activities at the Superblock include material characterization and analytical chemistry of plutonium and highly enriched uranium components of U.S. stockpile weapons to ensure that current weapons function as designed; fabrication of plutonium targets for NIF to determine dynamic plutonium properties (to update and refine material property models); and plutonium aging studies to determine when current weapons need to be remanufactured. The Superblock also performs certification activities for remanufactured pit components to ensure they meet design intent, testing, and certification activities for LEP and Mod nuclear material components. Since Security Category I and II SNM were de-inventoried in 2012, LLNL continues this mission with Security Category III quantities of SNM, including plutonium isotopes and enriched uranium. (Note: Security categories are different from hazard categories.)

Special Nuclear Materials (SNM) and SNM Security Categories

Section 11 of the Atomic Energy Act defines SNM as: "(1) plutonium, uranium enriched in the isotope 233 or in the isotope 235, and any other material which the U.S. Nuclear Regulatory Commission determines to be special nuclear material, or (2) any material artificially enriched by any of the foregoing."

There are four designated SNM security categories (Categories I, II, III, and IV), determined by the quantity and type of SNM or a designation of an SNM location based on the type and form of the material and the amount of nuclear material present. The greatest quantities are included under Security Category I, and lesser quantities are included in descending order under Categories II, III, and IV. DOE/NNSA uses a graded approach to provide safeguards and security for SNM.

LLNL also has the capabilities for working with depleted uranium, tritium, and lithium. Since the end of underground nuclear explosive testing in 1992, LLNL's annual assessment efforts have been predicated on a fundamental understanding of the nuclear weapons stockpile, which involves a deep understanding of the properties of plutonium and how plutonium performs in weapons. Researchers must grasp the physics of how plutonium material ages and its behavior under extreme conditions, such as ultrahigh temperatures and pressures. Since its discovery, plutonium has constantly surprised researchers and engineers with its unique and unprecedented properties; thus, developing accurate physics models for plutonium is not easily accomplished merely by extrapolating models of other materials. Instead, LLNL has focused on understanding plutonium through a combination of unique experimental and computational tests (LLNL 2017a).

LLNL researchers run state-of-the-art, HPC calculations to predict the properties of plutonium in conditions unachievable by experiment. These calculations are validated and benchmarked with high-fidelity experiments at ambient conditions and elevated pressures. LLNL continuously pushes the frontiers of high-pressure science to develop new platforms that can reach more extreme conditions and interrogate material properties in those new regimes. These new experiments help refine theoretical models, more accurately predict observed phenomena in plutonium, and connect those phenomena to performance (LLNL 2017a).

2.2.4.1 *Current Research Capabilities*

Plutonium. The capability and infrastructure for this strategic defense material includes assets for R&D, waste, and storage. R&D activities include stockpile surveillance, process development, certification for Production Agencies, long-term aging, fabrication of small test objects, material characterization testing, and recovery of material from residues. Planning the future needs of the U.S. nuclear weapons stockpile and complex depends on plutonium R&D work by LLNL scientists to maintain confidence in new manufacturing methods, changes in metallurgy, and the long-term stability of the plutonium residing inside weapons. Scientists and engineers who ensure the safety and reliability of the nation's stockpile have long been concerned that the damage accumulated over decades from plutonium self-irradiation could eventually compromise weapon performance.

Enriched Uranium. The capability and infrastructure for this strategic defense material includes assets for R&D, waste, and storage. The majority of R&D with enriched uranium is centered on development of detectors for nonproliferation in support of the Nuclear Nonproliferation Treaty (NPT).

Depleted Uranium. The capability and infrastructure for this strategic defense material includes assets for R&D, waste, and storage. Depleted uranium is used in many R&D activities since it is not only a component in nuclear weapons but can be used as a surrogate for enriched uranium. R&D activities include process development and material characterization. LLNL has robust R&D capabilities for depleted uranium, which includes radiographic analysis, machining and inspection, metallographic analysis, microstructural characterization, chemical sampling, and mechanical testing. Other capabilities include performance of specialized heat treatments, chemical analysis, and electron microscopy and advanced microstructural analyses.

Tritium. The infrastructure houses supporting activities for this radioactive form of hydrogen gas, including assets for R&D, waste, and storage. Tritium R&D work in support of enduring nuclear weapon stockpile activities is conducted in conjunction with Sandia National Laboratories, along with basic research applicable to fusion-energy tritium issues. The number and complexity of experiments using tritium will continue to increase in support of stockpile experiments, fusion energy, neutron generation, and other R&D activities. With the NIF's expected long lifetime and continued inertial confinement fusion (ICF) program target needs, LLNL will need to maintain target fill and other tritium support capabilities. Tritium recovery operations, mostly from obsolete illumination devices, are expected to continue, as are container maintenance and surveillance activities. Most of the tritium that is used at NIF is recovered in molecular sieves and is disposed of as low-level radioactive waste.

Lithium. The capability and infrastructure is needed for nuclear weapon components and radiation detection, and includes assets for R&D, waste, and storage. R&D assets are developed in conjunction with the Y-12 National Security Complex in Oak Ridge, Tennessee (Y-12), to support aging studies, long-term sustainment goals, and NNSA's lithium production strategy. The collaborative work between LLNL and Y-12 scientists and engineers supports modernization and simplification of lithium processing through consideration of alternatives and technology maturation. LLNL is also supporting the ongoing planning, review, and conceptual design of the new Lithium Processing Facility that is scheduled for completion in 2031 at Y-12.

2.2.4.2 *Supporting Infrastructure*

LLNL's work with nuclear materials—including highly enriched uranium, plutonium, and tritium—is primarily conducted at the Superblock facilities (Figure 2-7), one of just two defense plutonium R&D facilities in the nation. LLNL's Superblock facilities include Buildings 239, 331, 332, 334, 334O, and 335. The Superblock supports a wide variety of NNSA-, DOE-, and DoD-sponsored activities. However, stockpile stewardship encompasses the majority of the Superblock's programmatic activities. These efforts contribute to the annual process of providing the President of the United States with the technical basis of an assessment of the safety and reliability of nuclear components for which LLNL is responsible. Superblock facilities house modern equipment for research and engineering testing of nuclear materials. Facilities have been upgraded over time to ensure it meets the latest nuclear safety requirements (LLNL 2017a).

Figure 2-7. Aerial View of Superblock Facilities

Plutonium processing and characterization equipment and other associated capabilities in Building 332 support pit certification, environmental testing, and materials processing missions. These are all essential to assuring that LLNL can meet current and anticipated stockpile stewardship needs (LLNL 2017a). Specific infrastructure related to waste and storage needs are discussed in Section 2.2.9. Ongoing upgrades to support and maintain these facilities are discussed in Chapter 3, Section 3.2, of this SWEIS.

2.2.5 High Explosives

HE capabilities and infrastructure support programmatic activities for highly energetic materials, including assets for R&D, waste, and storage. LLNL's HE R&D program is an integral element of the NNSA's design and development effort that supports nuclear weapons stewardship and broad national security missions. The HE program has the capability to conduct RDT&E activities using a multidisciplinary approach to synthesis, formulation, characterization, processing, and testing of energetic materials, components, and warhead subassemblies. RDT&E activities directly support stockpile stewardship for energetic materials with weapons assessments, stockpile maintenance, sustainment through LEPs, weapons surveillance, significant findings investigations, and technical guidance for weapon dismantlement and disposition. These activities are collectively conducted at the HEAF at the Livermore Site and the Contained Firing Facility (CFF) at Site 300. The use of existing and planned capabilities at both of these sites is key to meeting mission objectives.

LLNL is the lead design agency for the W80-4 LEP and the W87-1 Mod. Replacement of the HE and insensitive HE (IHE) detonator, booster, and main charge are included in design options. The R&D work requires synthesis, formulation, processing, test, and evaluation of newly manufactured explosives materials. This requires significant effort to develop, down-select, and qualify explosives, binders, and explosive components.

2.2.5.1 *Current Research Capabilities*

Research and Development. The formulation and processing capability includes R&D activities for HE and the infrastructure related to the production and manufacturing of HE, including additive manufacturing methods.

Not all types of explosive materials and formulations react the same to a given stimulus condition. In particular, IHEs require extremely high stimulus levels before reacting violently. The probability of accidental initiation or transition from burning or deflagration-to-detonation is negligible for this particular class of explosive when subjected to unplanned heat, shock, fragment or bullet impact, electrostatic discharge, or other unplanned stimuli. Using an IHE offers many benefits to the stockpile by improving safety and security, allowing robust use control, and facilitating production efficiencies. LLNL's unique expertise for IHE explosive formulations is continually being utilized to achieve performance and operational requirements while also improving safety margins.

An additive manufacturing method capability provides for developing methods and cultivating expertise in additive manufacturing techniques to make polymer-bonded explosive (PBX) components. This material is a composite, predominately consisting of explosive crystals bonded together with a small amount of polymer. Additive manufacturing methods, in which layers of material are built up as prescribed in a digital file, are used to quickly and precisely create objects with highly tailored material properties and performance. Additive manufacturing provides an opportunity to gain more control over the sensitivity, safety, and performance of the explosive (LLNL 2017a).

Test and Evaluation. In support of stockpile stewardship, explosives test and evaluation RDT&E efforts at LLNL provide the scientific understanding for ensuring that the warhead initiation train functions as designed and is safe, secure, and reliable. RDT&E conducts experiments and modeling activities to qualify and predict behavior of explosives under a variety of operating conditions. The work also involves a range of activities to understand the properties, engineering, and physics performance of the energetic materials, explosive components, and warhead-level assemblies. Performance and safety tests are conducted to assess and ensure that the explosives used in nuclear warheads remain functional and reliable over their expected lifetime and beyond. They also assess how newer and safer explosives may perform as replacements. Regularly occurring stockpile stewardship surveillance tests examine the physical, chemical, detonation, and mechanical properties of HE reclaimed from the nuclear stockpile and help determine the safety and performance of aging explosive components (LLNL 2017a).

2.2.5.2 *Supporting Infrastructure*

LLNL's unique experimental facilities supporting the HE R&D program are the HEAF (Livermore Site) and the CFF (Site 300). HEAF (Figure 2-8) is a DOE/NNSA complex-wide Center of Excellence for HE R&D. CFF (Figure 2-9) has the largest indoor firing chamber in the nation, capable of containing detonations of explosives up to 60 kilograms (132 pounds). It features a wide field-of-view radiography capability for imaging integrated experiments. Collectively, these key facilities have enabled a better understanding of energetic materials. Scientists apply expertise in explosives synthesis and formulation, material characterization techniques, and detonation sciences, and integrate experimental data with computer simulations to understand and predict the safety and performance of energetic materials.

Figure 2-8. The HEAF at the Livermore Site

Figure 2-9. The CFF at Site 300

HEAF is a centralized, fully contained, HE facility with office and meeting spaces, explosives-rated laboratories, assembly areas, storage magazines, and seven firing tanks capable of detonating up to 10 kilograms (22 pounds) of explosives while using advanced diagnostics to characterize energetic materials and detonation phenomena. The facility also has a research gun with a 100-millimeter bore diameter. The gun fires into a specially designed tank for high-velocity impact studies. Most energetic materials R&D is performed with relatively small quantities of explosives in this facility (LLNL 2017a).

Explosives capabilities at Site 300 support stockpile stewardship, nuclear nonproliferation, and nuclear counterterrorism missions through explosives, warhead components/ assembly processing, fabrication, test and evaluation, diagnostics development, and disablement technologies. The Site 300 HE capabilities at CFF exceed those at HEAF and can handle and test larger quantities of explosives and warhead-level components and assemblies for technology maturation, prototyping, proof-of-concept design testing, certification, and surveillance activities. Additionally, outdoor testing at Site 300 is important for formulation development and testing. The infrastructure at Site 300 consists of more than 50 facilities and storage magazines supporting large-charge explosives work. This infrastructure includes pilot-scale synthesis, formulation and casting capabilities, inert and explosives machining capabilities, radiography, assembly areas, storage, outdoor test areas with supporting bunkers, and explosives waste treatment facilities. These HE capabilities provide core competencies for the weapons program's annual assessment of energetic materials, components, and subassemblies (LLNL 2017a).

Specific infrastructure related to waste and storage needs are discussed below in Section 2.2.9. Proposed upgrades to HE capabilities are discussed in Chapter 3, Section 3.3.

2.2.6 Non-Nuclear Components

2.2.6.1 *Current Research Capabilities*

Non-nuclear component activities support the parts and processes that do not involve nuclear or high explosive materials, including assets for radiation hardened microelectronics, power sources, neutron generators, advanced manufacturing, manufacturing R&D, and multiple non-nuclear components. Discussion on LLNL's non-nuclear infrastructure is included in various sections earlier as their NNSA capabilities are generally included in Design and Certification (Weapons Engineering) and Tests and Experiments.

2.2.6.2 *Supporting Infrastructure*

LLNL's AME facility, Building 231, is the largest complex of engineering RDT&E facilities at the Laboratory. Building 231 is 140,000 square feet and houses several non-nuclear weapons engineering capabilities required to execute NNSA's missions for the stockpile, particularly LEPs, Mods, and the annual assessment. This building supports many capabilities, including applied materials work in areas of characterization, specialty fabrication, joining, physical vapor deposition, and mechanical testing. Materials include non-nuclear metals, polymers, and powders (LLNL 2019b). Building 231 is currently being replaced by the AME facilities, Buildings 223 and 224. A Manufacturing Science Facility, Building 225, conducts R&D activities on non-nuclear components. An AML, Building 654, also conducts manufacturing activities on non-nuclear parts.

2.2.7 IT/Communications

2.2.7.1 *Current Capabilities*

Communications/information technology capabilities and infrastructure support information technology and voice and data services, including assets for data centers, communications systems, towers, and switching stations. Mission-enhancing scientific computing and networking capabilities need to be robust and reliable. Networking capabilities must include first-in-class core and distribution layers and pervasive indoor and outdoor wireless access. Not all buildings support network speeds that are fast enough for today's scientific computing. The networking and telecommunications hub for LLNL is a single-point-of-failure risk. The facility assets are insufficient to support modern, robust, and reliable network and telecommunications equipment. Projects that will enhance these capabilities are included in both the No-Action Alternative and the Proposed Action, described in Sections 3.2 and 3.3 of this SWEIS. The following section describes legacy telephone and cabling infrastructure. A replacement facility would leverage architectural, structural, and systems designs that emphasize sustainability features.

2.2.7.2 *Supporting Infrastructure*

LLNL currently has over 465 miles of telecommunications lines. The central networking and telecommunications facility, Building 317, is currently inadequate to be effectively updated to meet LLNL's growing needs. Continued investment is needed in the network communications systems to support the need for telecommuting server access. IT and communications networks for classified networks exist to support discussions with NNSA and other sponsors. Additionally, networks are available to support communications at higher security levels in Sensitive Compartmented Information Facility (SCIF) locations.

2.2.8 Security

2.2.8.1 *Current Capability*

LLNL's capabilities include those activities that contribute to the physical security of the Livermore Site and Site 300, including fencing, towers, ranges, guard houses, and security lights. This provides protection against a broad range of threats. Security threats include unauthorized access, cyber threats and electronic intrusion, theft or diversion of nuclear material, sabotage, espionage, loss or theft of classified matter and proprietary information, destruction of government-owned and Laboratory-managed property, and other hostile acts.

LLNL operates and maintains a number of site infrastructure facilities and systems capable of providing security. The capability to protect LLNL against these threats rests with the Security Organization (SO).

2.2.8.2 *Supporting Infrastructure*

LLNL is home to a broad spectrum of national research and is responsible for its protection, which requires enhanced security measures. To execute its safeguards and security mission, the SO operates and maintains a number of site infrastructure facilities and systems. Building 275 is a new armory and Building 274 is the main administrative support building for security. These include protective force training and operations facilities; physical protection elements (fences, gates, access control and intrusion detection systems, video surveillance systems, and barriers); and systems supporting security clearance and badging functions (Figure 2-10).

Figure 2-10. West Gate Badge Office

A primary aspect of the LLNL protection strategy is a sophisticated, information technology access control and intrusion detection system. This system, which was designed and engineered at LLNL and is continually being upgraded and enhanced, meets such stringent security requirements that the NNSA's Office of Defense Nuclear Security has cited it as the standard for physical security systems protecting facilities. As it monitors and controls entry into buildings requiring enhanced security, this system is simultaneously monitoring both the Livermore Site and Site 300 for security threats and can alert and direct security forces to those threats. The Laboratory's sensitive information, materials, and facilities are thoroughly protected, intruders can be detected in real time, and intrusions and emergencies receive prompt response from police and investigative personnel. The Laboratory is provided with continuous forms of security 24 hours a day, 7 days a week. The SO operates three vehicle entry gates into LLNL's Livermore Site property protection area (one of which is shared with SNL/CA) and two additional gates within LLNL itself, all staffed by protective force officers (LLNL 2017a).

2.2.9 Mission Enabling Infrastructure

Mission-enabling infrastructure supports all Laboratory programmatic needs and is foundational to making sites habitable, including assets for communications, power, water, emergency services, offices, site roads and parking, storage, maintenance shops, and waste management. LLNL is comparable to a small city, providing utility services to nearly 700 buildings, roads, and basic support services for its population. The Livermore Site and Site 300 have their own electric, gas, water, communications, and sewage collection systems, and fire stations (staffed by Alameda County Fire Department personnel). At the Livermore Site, three additional sitewide utilities support scientific endeavors, including low-conductivity water, deionized water, and compressed air. Mission support assets also include cafeterias, maintenance shops, analytical laboratories, and business functions. The enabling infrastructure supports the execution of LLNL's missions, including bioscience, counterterrorism, defense, energy, intelligence, nonproliferation, science, and weapons (LLNL 2019b). These facilities demand 24-hour, highly reliable utilities and support services.

2.2.9.1 *Current Capabilities*

Power. Electrical, mechanical, and civil utilities including current firm-substation electrical utility capacity at the Livermore Site is approximately 125 megawatts (MW), and demand is approximately 63.6 MW. With the anticipated addition of Exascale computing, programmatic loads, and other new demands, electricity demand is expected to increase to 65.5 MW by 2023. Currently there are 316 electrical distribution substations/transformers. At Site 300, 2019, the monthly peak demand has averaged two megawatts and is projected to remain consistent over the next several years (LLNL 2019l). LLNL is dual sourced by the Western Area Power Administration (WAPA) and Pacific Gas & Electric (PG&E) with automatic transfer.

Water. LLNL drinking water is provided from Hetch Hetchy reservoir and delivered by the San Francisco Public Utility Commission. Backup water service is provided by the Zone 7 Water Agency. Currently, there are 70 miles of underground water distribution pipelines. The southern part of Site 300 is supplied from a system of wells. Sanitary waste from the Livermore Site is disposed of through the LLNL sewer system to the city of Livermore sanitary system. Site 300 sanitary waste is disposed of on-site using evaporation and percolation ponds. There are additional site-wide utilities that support scientific endeavors, including low-conductivity water and deionized water. Cooling towers at the Central Utility Station were recently replaced, revitalizing a critical part of the site-wide low-conductivity water system. Cooling tower wastewater from various Site 300 operations is currently discharged in accordance with prescribed permit conditions to septic systems, the sewage evaporation and percolation ponds, and engineered percolation systems.

Remediation. The Livermore Site and Site 300 are designated Superfund sites and have significant capabilities in conducting the soil and groundwater remediation activities that are requirements of both the *Resource Conservation and Recovery Act* (RCRA) and the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA). The Livermore Site came under CERCLA in 1987 when it was placed on the National Priorities List. The major contamination source areas were identified by an extensive network of soil vapor and groundwater monitoring wells. The primary soil and groundwater contaminants [Contaminants of Concern (COCs)] are common volatile organic compounds (VOCs), primarily trichloroethylene (TCE) and perchloroethylene (PCE). Site 300 became a CERCLA site in 1990, when it was placed on the National Priorities List. The major contamination source areas were identified by extensive soil and rock sampling and analysis and the installation of an extensive network of groundwater and soil vapor monitoring wells. Primary COCs at Site 300 include VOCs, HE compounds, tritium, depleted uranium, organosilicate oil, nitrate, perchlorate, and metals. As a result of the of the many years of characterization, monitoring, and cleanup at the two sites, LLNL has developed an advanced DOE capability for assessing and remediating soil and groundwater contamination. This includes extensive hydrogeological modeling expertise, as well as soil extraction and groundwater treatment technologies. LLNL has utilized treated water from Livermore Site remediation activities for irrigation uses as appropriate. LLNL continues to have an active program in this area, which is coordinated with key local, state, and federal stakeholders.

Emergency Services. This capability and infrastructure includes onsite and offsite emergency response to fires, medical emergencies, regional earthquakes, and other significant onsite incidents that may require a collaborative response by LLNL with the city, county, state, and federal agencies. Coordinated operations will take place in a new Emergency Operations Center. The existing center has many functional gaps; Chapter 3, Section 3.2, of this SWEIS discusses consolidation of emergency management, communications, and response teams and assets into the new Emergency Operations Center to meet DOE and state requirements, to provide a self-sustained protective environment for a minimum of 72 hours post event. A proposed new fire station for the Livermore Site is discussed in Chapter 3, Section 3.3, of this SWEIS.

Office, Laboratory, and Storage Space. The Livermore Site includes 1,449,820 square feet of office and storage space, 3,477,092 square feet of laboratory space, and 449,426 square feet of computing space. At Site 300, there are 21,787 square feet of office and storage space, 70,161 square feet of laboratory space, and 3,352 square feet of computing space. The majority of these buildings are aging and have been used longer than expected due to limited capital to rebuild.

LLNL must also provide safety-compliant retrofits of enduring facilities. The Livermore Site is located in a seismically active region, and there is a relatively high probability that one or more earthquakes of a 6.7 magnitude or greater will occur within a 30-year period (*see* Section 4.4 for details). LLNL has many enduring facilities that are in need of a seismic retrofit, which are discussed in Chapter 3 of this SWEIS.

Roads and Parking. LLNL manages and maintains more than 51 miles of roads. This includes pathways and parking areas.

Waste Management. LLNL provides onsite waste treatment, storage, and disposal of radioactive and hazardous waste in permitted facilities (LLNL 2017a). LLNL operates radioactive and hazardous waste management (RHWM) facilities that are permitted by the California Environmental Protection Agency (Cal EPA), Department of Toxics Substances Control (DTSC). The waste management facilities collect wastes from laboratory facilities and provide treatment and disposal activities to approved disposal sites. LLNL's RHWM organization manages and disposes of low-level radioactive waste (LLW), transuranic (TRU) waste, mixed LLW (MLLW), mixed TRU waste, hazardous waste, and biological waste.

Additionally, a DOE Environmental Management (EM) Review Team concluded that LLNL's legacy-process contaminated facilities are aligned with EM's transfer and stabilization criteria, and that the identified high-priority facilities represent significant risk and should be high priorities for decontamination, decommissioning, and demolition (DD&D). For example, Building 280 is an experimental reactor decommissioned in 1980 and scheduled for decontamination and demolition; many other contaminated legacy buildings fall into the same category. Demolishing legacy facilities will increase waste production in the short term, but help clear the sites for redevelopment, eliminate maintenance backlog and ES&H and security risks, reduce surveillance and maintenance costs, support sustainability goals by eliminating the energy and water usage of excess facilities, and improve the sites appearance to attract and retain the next-generation workforce. While the facilities await final demolition funding, the following transition, disposition, and stewardship actions have been implemented: (1) reduction of operating and maintenance costs by achieving an inactive state; (2) maintenance of required safety controls; and (3) execution of monitoring and surveillance activities.

2.2.9.2 *Supporting Infrastructure*

Like many government agencies, cities, and counties, LLNL is operating some facilities and infrastructure longer than expected. Support utilities and infrastructure are the foundation of all mission facilities. These systems were installed in 1944 when the Livermore site was a Naval Air Station. This infrastructure has been modified over time as the Laboratory has expanded to keep pace with increasing program missions. Much of this infrastructure is beyond its useful life, increasing maintenance costs and reliability risks. Aging infrastructure and the need for reliable, code-compliant systems create gaps that require ongoing investment. Existing infrastructure capacity must also be increased to meet the projected load demands of the future. Many facilities and equipment are beyond expected service life, and there are tremendous opportunities for modernization, integration, and streamlining. Investments must be made to replace and upgrade electrical systems—including life-safety, mechanical, and civil utilities—to ensure reliability and allow for preventive maintenance without major planned outages and interruptions to mission-significant facilities (LLNL 2017a).

As discussed in Chapter 3, Section 3.3, of this SWEIS, NNSA is proposing the following infrastructure improvement projects: facility DD&D, utility valves and water distribution piping replacements, Site 300 erosion control systems installation, paving replacements, facilities fire protection and life-safety system replacements, and domestic water supply treatment plant upgrades.

2.2.10 Global Security

Global security capability and infrastructure is aimed at reducing CBRNE dangers by preventing, countering, and responding to persistent and evolving threats, including assets for counterterrorism and counterproliferation, nonproliferation, and incident and emergency response. LLNL uses these capabilities to analyze nuclear technologies; develop nuclear detection and countermeasures strategies and hardware; provide expertise, analysis, and disablement technologies in support of emergency response; and perform the full range of nuclear materials analysis and pre- and post-detonation nuclear forensics to support attribution and consequence management. LLNL also has the capabilities to support activities for the broader national security missions involving chemical and biological weapons (LLNL 2017a).

The Global Security capability includes nuclear threat reduction and response to support the U.S. government's efforts to defend against the threat posed by the malicious use of weapons of mass destruction and support DOE/NNSA emergency operations mission by providing critical technical capabilities and scientific expertise during radiological/nuclear incidents, in collaboration with the interagency preparedness and response community. These capabilities support three principal areas: nuclear counterterrorism and counterproliferation, nonproliferation, and incident and emergency response (LLNL 2017a).

2.2.10.1 *Current Capabilities*

Counterterrorism and Counterproliferation. LLNL supports combatting the threat of nuclear terrorism and securing nuclear weapons, materials, related technology, and knowledge to prevent their malicious use. The Laboratory provides the methodologies and tools to deny, deter, and dissuade potential actors from acquiring the materials or technologies needed to execute such an event. LLNL also supports efforts for detecting (and if possible, countering) the development of any device or capability that may lead to an event. The Laboratory is also working on technologies to detect uranium and plutonium, ranging from high-end, high-purity germanium detectors to new, lower-cost, portable scintillator detectors. The Laboratory is also working on methods to enhance the effectiveness of searches for radioactive materials in urban areas. LLNL's work to counter nuclear weapons is focused on its capability to develop tools that could be used to prevent rogue use of a nuclear weapon against the United States or its allies (LLNL 2017a).

Nonproliferation. LLNL's current capability and infrastructure supports activities related to preventing or limiting the spread of materials, technology, and expertise for nuclear and radiological threats; developing technologies to detect nuclear proliferation worldwide; eliminating or securing inventories of surplus weapons-usable materials and infrastructure; and reducing the risk that hostile nations or terrorists could acquire nuclear weapons or weapons-usable material. LLNL applies its capabilities in computing, materials development, and sensor technologies as well as its nuclear weapons expertise to enable the nonproliferation mission. The Laboratory also supports the International Atomic Energy Agency's (IAEA's) nuclear safeguards mission by developing new technologies and providing expert advice to the agency and to U.S. policy makers. LLNL personnel not only work with international partners to strengthen safeguards implementation, but also take leaves of absence to serve as IAEA staff members. The goal is to prevent proliferation and reduce the global risk posed by inadequately secured nuclear and radiological materials in support of the NPT, the Comprehensive Test Ban Treaty (CTBT) and other bilateral and multilateral agreements. For instance, an aspect of LLNL's nonproliferation effort is to determine whether a seismic event was actually an underground nuclear explosion (LLNL 2017a).

Incident and Emergency Response. The Incident and Emergency Response subgroup includes capabilities and infrastructure related to responding to nuclear incidents, locating and disabling nuclear devices, and managing consequences of nuclear detonation. LLNL provides key technical capabilities and scientific expertise during radiological and nuclear incidents, in collaboration with the interagency preparedness and response community. LLNL partners with other national laboratories and sites to support emergency response capabilities, including the nuclear Accident Response Group, the Joint Technical Operations Team, the Disposition and Forensic Analysis Team (DFEAT), the DOE Forensics Operations (DFO), the Radiological Assistance Program, the DOE Radiological Triage, and nuclear/radiological Consequence Management. Livermore experts have played important roles preparing for major national events that could attract terrorists bent on detonating a nuclear device. LLNL enhances NNSA's incident and emergency response programs by providing both pre- and post-event response and reach-back support for CBRNE. LLNL provides key technical capabilities and scientific expertise during radiological and nuclear incidents in collaboration with the interagency preparedness and response community. For example, LLNL develops computer models that track the transport and deposition of hazardous materials released into the atmosphere.

The Laboratory's chemical threat reduction and response capabilities include extensive collections of analytical instrumentation, including a variety of mass spectrometers (coupled with gas, liquid, and ion chromatographs), nuclear magnetic resonance spectrometers, and infrared and Raman spectrometers. The Forensic Science Center (FSC) uses emerging technologies to increase LLNL's understanding of chemical agents, and their persistence in, and interactions with, materials in the environment. As part of LLNL's national security mission, FSC staff plays a primary role in international efforts to develop new forensic methods aimed at discouraging the trafficking of illicit and counterfeit materials (LLNL 2017a). The FSC has been a leader in supporting the Chemical Weapons Convention Treaty (CWC) by developing many of the procedures used internationally to support routine and challenge inspections. LLNL is one of only two rigorously accredited laboratories in the U.S. designated by the Organisation for the Prohibition of Chemical Weapons (OPCW) to provide technical assistance in matters of CWC treaty compliance. To retain this accreditation, the FSC is allowed to synthesize small amounts of chemical warfare agents for defensive purposes, required to maintain ISO-17025 certification, and required to participate in annual proficiency tests conducted by OPCW. This involves extremely challenging, time-sensitive analyses of complex samples. Maintaining state-of-the-art facilities is key to the success of this effort.

LLNL's biological threat reduction and response capabilities provide support through its rapid detection and characterization capabilities for emerging and unknown threats, by enabling a global disease surveillance system that will significantly reduce the time it takes to detect and characterize an emerging or unknown pathogen; faster development of new medical countermeasures for new pathogens by addressing key scientific barriers in the drug discovery and development process; and improved threat characterization, simulation, and intelligence analysis. LLNL is able to work at Biosafety Level (BSL)-2 and BSL-3—a key requirement for handling pathogens that could be potential terrorist threats as well as the ability to respond to a global pandemic, such as COVID-19.

LLNL's base capability is to use HPC to develop a suite of predictive analytics that will expedite the characterization of biological threats, predict the paths of diseases through the population, and help accelerate the development of technologies and treatments (LLNL 2017a).

LLNL's coupling of medical countermeasures development with HPC tools is an advanced capability in the DOE complex. Additionally, LLNL operates the Biodefense Knowledge Center (BKC), a classified asset that can provide threat assessment capabilities for the U.S. government. LLNL operates the only BSL-3 facility permitted by the Centers for Disease Control and Prevention (CDC) in the DOE complex. Issues with potential emerging pathogens have outpaced our current available capability to support collaborative research efforts. Proposed upgrades to the BSL-3 facility are discussed in Chapter 3, Section 3.3, of this SWEIS.

2.2.10.2 *Supporting Infrastructure*

LLNL's nuclear, chemical, and biological threat reduction and response programs rely heavily on the capabilities provided from NNSA-funded activities at LLNL and other sites. Specifically, infrastructure projects, including the recapitalization of radiochemistry laboratories and the Livermore Advanced Simulation and Computing Complex, directly support nonproliferation mission activities.

The National Atmospheric Release Advisory Center (NARAC) is a national support and resource center for planning, real-time assessment, emergency response, and detailed studies of incidents involving a wide variety of hazards, including nuclear, radiological, chemical, biological, and natural emissions. The Center, currently located in Building 170, provides the government with tools and expert services that map the probable spread of hazardous material accidentally or intentionally released into the atmosphere to help protect the public and the environment. NARAC has limited classified capabilities (LLNL 2017a).

Currently, the infrastructure includes the International Security Research Facility (Building 140), the FSC (Building 132N), the Biosciences complex (Building 361 complex area and supporting BSL-2 and BSL-3 facilities), and the Animal Care Facility. A proposed replacement for the Animal Care Facility is discussed in Chapter 3, Section 3.3, of this SWEIS.

2.2.11 Strategic Partnership Projects

Strategic Partnership Projects (SPP) capabilities support federal and non-federal entities that are outside of DOE and NNSA, and involve broader national security, energy security, and scientific development missions. LLNL engages in partnerships with academia, industry, and government entities that support LLNL's mission and need to utilize the Laboratory's capabilities as a federally funded R&D center for national needs. The strategy for partnering includes entering into agreements with external partners and sponsors and obtaining long-term investments in LLNL capabilities.

LLNL's SPP includes a broad portfolio of projects in three areas: nuclear security, national security, and energy and environmental security. The SPP program leverages the Laboratory's core competencies, infrastructure, and technical staff to deliver practical solutions. The three primary national security agencies with Laboratory SPP interagency agreements include the DoD, the intelligence community, and the U.S. Department of Homeland Security (DHS). In turn, these activities have circled back to the NNSA for use as test diagnostics in support of stockpile stewardship as well as deployable units for defense nuclear nonproliferation missions.

2.2.11.1 *Current Capabilities*

Partnering with Other Federal Agencies and Non-federal Entities. LLNL's support to entities outside of DOE and NNSA, through SPP agreements, is one of many contracting mechanisms that extend the Laboratory’s impact. Cooperative R&D agreements, agreements for commercializing technology and interagency agreements, offer alternative ways in which LLNL’s core capabilities and technical staff engages with researchers external to DOE/NNSA. In turn, sponsors receive access to world-class science and technology capabilities and benefit from a multidisciplinary approach to tackling problems that can only be done at a DOE Federally Funded Research and Development Center (FFRDC).

Notable examples of partnering have included the HPC for Manufacturing Program, the High-Repetition Rate Advanced Petawatt Laser System, and the Joint Design of Advanced Computing Solutions for Cancer Program. Additionally, as previously described, many medical and bio-computational partnerships for new capabilities are ongoing. Below is a description of some of the LLNL capabilities that can be employed in the SPP program. The LVOC on the east side of the Livermore Site is an area designated to conduct unclassified collaborative research that facilitates research with industry, government, and academia in various fields including HPC, energy and environmental security, biosecurity, cybersecurity, and nonproliferation. The LVOC concept is modeled after R&D campuses at major industrial research parks and other DOE laboratories, with campus-like security, a set of business and operating rules devised to enhance and accelerate international scientific collaboration and partnerships with U.S. government agencies, industry and academia (LLNL 2019b). Currently, the LVOC is in early development with only limited capabilities. Ultimately, the LVOC is anticipated to grow to an approximately 110-acre parcel along the eastern edge of the Livermore Site and will house additional conference space, collaboration facilities, and a visitor’s center to support educational and research activities. New facilities that would be constructed at LVOC are identified in Chapter 3, Tables 3-1 and 3-4.

The HPC Innovation Center (Figure 2-11) would be part of the LVOC and has the capability to boost the development of modeling and simulation, data analytics, and cyber programming models and methods that can then be applied to national security missions and other uses. In addition, public-private partnerships help drive the computer industry to develop new hardware and software with capabilities that benefit NNSA, DOE, and other government agencies. This capability brings together world-class computing resources, and the expertise of DOE national laboratories with U.S. manufacturers to deliver solutions that offer the potential to revolutionize manufacturing (LLNL 2017a).

Figure 2-11. Conceptual Plan for the HPC Innovation Center

NNSA is currently investing in advanced manufacturing initiatives that support the modernization of its manufacturing infrastructure, ultimately reducing time to product, decreasing manufacturing footprint, and minimizing waste. To that end, in 2019, LLNL completed its new Advanced Manufacturing Laboratory (AML) in the LVOC. The AML provides a space in which LLNL researchers can collaborate with outside researchers to advance the state of the art of additive and other advanced manufacturing technologies. LLNL anticipates that researchers will produce breakthroughs and lead development of new technologies that strengthen advanced manufacturing companies and enhance the domestic supply of machines and materials. These efforts support NNSA missions that include stockpile stewardship, energy security, and intelligence, as well as other DOE thrusts, including economic competitiveness and SPP support to the broader government mission areas of the DoD and other sponsors. The AML's cutting-edge capabilities and public-access location provide a space for LLNL employees to expand this work with industry and academic partners.

Broader National Security Mission. Biosecurity capabilities are built on the Laboratory's biological threat and response capabilities, but with a broader mission, including drug discovery and medical countermeasures requiring collaborations with commercial partners and universities. The capabilities in genome biology, computational biology, molecular toxicology, host-pathogen biology, structural biology, biological detection, and microbial systems are used to answer biosecurity questions. LLNL capabilities include experimental and simulation infrastructure to develop innovative bioassays to rapidly detect infectious agents and other pathogens; investigate microbes and microbial communities as they respond to different perturbations to address environmental problems; understand the mechanisms of action of the effects of chemicals and drugs in humans; examine host-pathogen interactions with a focus on biothreat viruses and bacteria; and develop advanced bioanalytical and molecular imaging instruments (LLNL 2020b).

Chemical security capabilities built off of the Laboratory's chemical threat and response capabilities include broader research in the areas of analytical science and instrument development, nuclear forensic analysis, and the synthesis of new molecular and tailored nanostructured materials and applies those capabilities to national security needs for a variety of sponsors. LLNL capabilities support law enforcement and government agencies to assist in cases involving compounds that have not been previously identified and whose chemical structure cannot be easily determined. LLNL capabilities in chromatography/mass spectrometry, nuclear magnetic resonance, and other advanced spectrometric techniques use this analytical data to suggest chemical structures for these "unknown unknowns." In-house synthesis experts then generate the suspected material to confirm the proposed chemical structure. These efforts are uncommon in traditional forensic science laboratories but play an ever more critical role in combating illicit drug use, counterfeit pharmaceutical development, and acutely toxic chemical threats (LLNL 2020b).

The CAMS is the world's most versatile and productive accelerator mass spectrometer facility. The center operates around the clock, performing up to 25,000 measurements annually. The research made possible by CAMS covers areas as diverse as archaeology, atmospheric chemistry, biomedicine, carbon-cycle dynamics, earth system processes, cell biology, alternative fuels, forensic dating, and forensic reconstruction of radiation doses. Accelerator mass spectrometry is an exceptionally sensitive technique for measuring concentrations of isotopes in small samples, typically less than one milligram, and the relative abundance of isotopes at low levels. For example, it can identify one carbon-14 isotope among a quadrillion other carbon atoms. By measuring the carbon-14 isotopes in various samples, CAMS researchers have helped solve cold cases and probe the mysteries of the human brain and eye, tested the efficacy of cancer drugs, and established the age of a potential Mayan codex (LLNL 2017a).

Energy Security. LLNL's capability to support energy security has enabled the advancement of engineering solutions for the carbon economy. HPC has been enhanced for manufacturing and materials development to meet national energy security challenges. This includes the capability for development of technologies for cleaner fossil energy consumption and enhancing energy alternatives (geothermal, solar, wind). LLNL has significant capabilities for subsurface modeling, instrumentation, and both laboratory and field experimentation. Additionally, LLNL has advanced capabilities for combustion research and engineering to include reaction models, simulation software, and prediction tools to illuminate the complexities of combustion chemistry and assist designers in their quest for engine efficiency.

Scientific Development Missions. LLNL also conducts scientific research for DOE's Office of Science. These projects often are multi-year efforts that enable remarkable discoveries and transform LLNL's basic understanding of fundamental science. This research frequently pushes the limits of LLNL's computational and experimental capabilities and builds deeper knowledge within LLNL's core competencies. For example, efforts to support COVID-19 collaborative requests with the Office of Science outpaced the Laboratory's BSL-2 and BSL-3 capabilities, with regard to space and manpower. As the only BSL-3 laboratory in the DOE complex, demand for this type of expertise is growing. During the current pandemic, a COVID-19 response team of LLNL researchers from various disciplines developed a preliminary set of predictive 3D protein structures of the virus to aid research efforts to combat the disease. In addition, the LLNL researchers used modeling and simulation, along with machine learning, to identify about 20 initial, yet promising, antibody designs from a nearly infinite set of potentials and to examine millions of small molecules that could have anti-viral properties.

2.2.11.2 *Supporting Infrastructure*

SPP utilizes much of the infrastructure across the entire Laboratory, with some additional unique facilities. The International Security Research Facility (Building 140) and the FSC (Building 132N) are two such examples. The laboratories for chemical security research support a broad sponsor base, which is conducted in Building 132N laboratories that are currently at capacity. This includes the Laboratory's capability to handle chemical weapons-related materials under the Chemical Weapons Convention treaty as well as other materials of national interest. Due to space limitations, additional laboratories are spread out across the Livermore Site, limiting the Lab's ability to optimize research. Biology research at LLNL is currently conducted in a group of biosecurity and bioscience buildings that support a diverse sponsor base and other national laboratories. Most of these buildings are more than 50 years old and require significant infrastructure investment, particularly Building 361, LLNL's Biosciences complex, which houses the nation's resource for biomedical accelerator mass spectrometry. Of key importance are BSL-2 and BSL-3 and the Animal Care Facility. As previously mentioned, BSL-3 is a unique facility, as it is the only BSL-3 within the DOE/NNSA complex.

The newest facilities at LLNL include the High Performance Computing Innovation Center (HPCIC) and the AML. The HPCIC is housed in Building 642, which is an almost 25,000 square foot facility containing 105 offices, two double-size "hotel" offices, two conference rooms, and collaboration spaces. The adjacent 2,975-square-foot conference annex can accommodate about 90 people and includes a lobby, kitchen, restrooms, utility rooms, and storage. The AML's reconfigurable layout allows rapid response to dynamic mission requirements and sponsor needs and supports the NNSA program as previously described. Proposed upgrades to the supporting facilities for SPPs are identified in Chapter 3, Section 3.3 of this SWEIS.

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CHAPTER 3

Proposed Action and Alternatives

3.0 PROPOSED ACTION AND ALTERNATIVES

3.1 INTRODUCTION

This chapter describes the two alternatives that NNSA is evaluating for continued operation of LLNL: (1) the No-Action Alternative, described in Section 3.2; and (2) the Proposed Action, described in Section 3.3. To evaluate the potential environmental impacts, NNSA developed construction and operational parameters for both the No-Action Alternative and the Proposed Action, as described in Section 3.4. This chapter also discusses alternatives that were considered but eliminated from detailed study (Section 3.5); identifies NNSA's preferred alternative (Section 3.6); and provides a comparison of the potential consequences for the two alternatives (Section 3.7). Chapter 5 provides more detailed analyses on potential consequences of the alternatives. A Record of Decision (ROD) will be prepared by the NNSA with decisions on the projects and activities that will go forward through 2035.

Decontamination, Decommissioning, and Demolition (DD&D)

DD&D are those actions taken at the end of the useful life of a building or structure to reduce or remove substances that pose a substantial hazard to human health or the environment, retire it from service, and ultimately eliminate all or a portion of the building or structure.

The No-Action Alternative reflects the use of existing facilities to continue operations at levels consistent with those experienced since 2005, as well as those anticipated by NEPA analyses and agency decisions that have been made since 2005. As described in Section 3.2, the No-Action Alternative includes the construction of new facilities, modernization/ upgrade/utility projects, and DD&D of excess and aging facilities through 2022. It is important to note that the data and information developed in support of this document is based on the best available data at the end of calendar year 2019. Therefore, it is expected that many of the No-Action Alternative projects will have been completed by the time the Draft SWEIS is issued for public comment and certainly by the time the ROD is issued. This is a complex SWEIS with many projects and supporting infrastructure capabilities and has required a detailed environmental analysis requiring over two years to complete. The Proposed Action includes the actions described for the No-Action Alternative, as well as the additional actions through 2035, which are described in detail in Section 3.3. Figure 3-1 provides a high-level illustration of the level of operations under both the No-Action Alternative and the Proposed Action.

Operational Changes

Operational changes may include:

- An increase/decrease of materials/emissions/ waste generation limits;
- Changes to previously described operational parameters in the 2005 SWEIS and 2011 SA; and
- Other changes that are relative to environmental concerns.

There are no new operational changes under the No-Action Alternative. Section 3.3 describes the operational changes for the Proposed Action.

The analysis in this LLNL SWEIS considers ongoing activities and proposed activities that could occur over approximately the next 15 years (2020-2035). To assess the potential environmental impacts that could occur as a result of the alternatives, NNSA developed site-wide estimates of construction and operational parameters, such as the potential area of land disturbance or the amount of utilities that may be required. NNSA incorporated these site-wide estimates, along with information on ongoing and future activities, into the analysis of impacts. For example, estimated areas of land disturbance for proposed activities were used in determining impacts on resources such as soils (area of disturbance and erosion), cultural resources (number of sites potentially affected), and biological resources (vegetation/habitat loss).

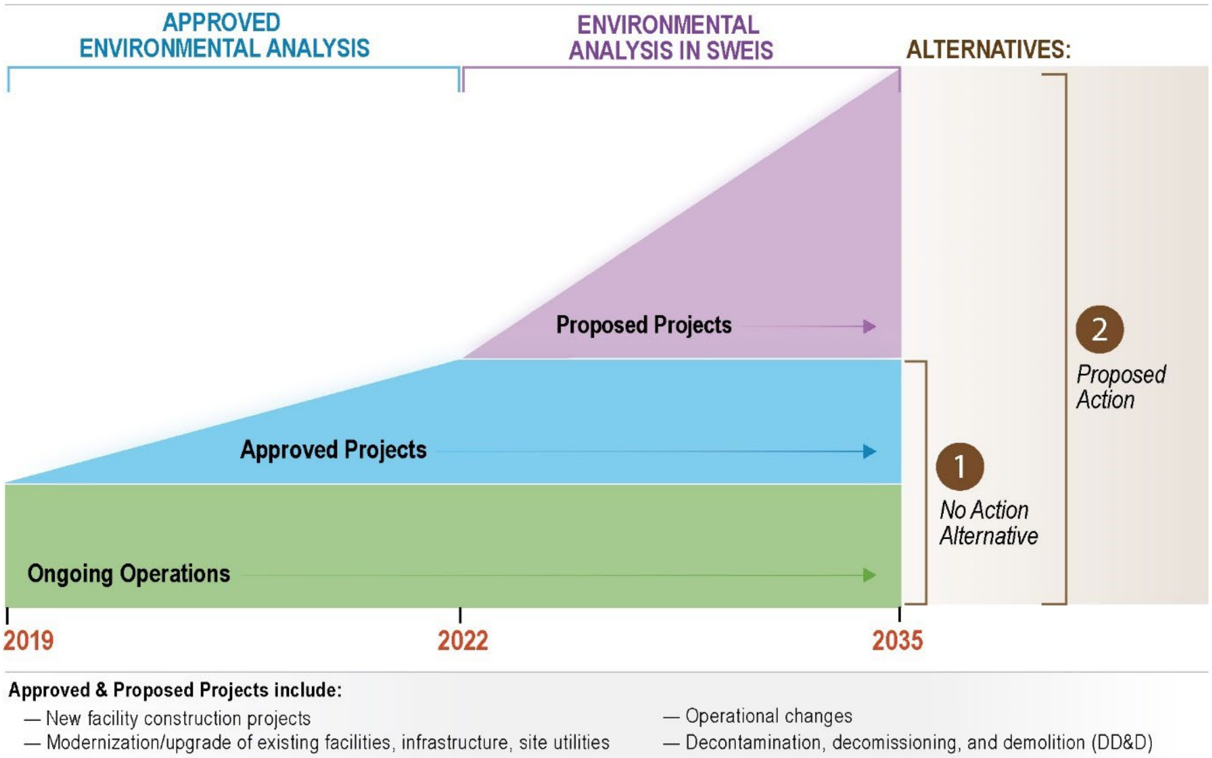


Figure 3-1. Level of Operations for the No-Action Alternative and the Proposed Action

3.2 NO-ACTION ALTERNATIVE

NNSA analyzed the No-Action Alternative to comply with the CEQ's NEPA implementing regulations (40 CFR Parts 1500–1508), and to provide a baseline against which the impacts of the Proposed Action can be compared. The No-Action Alternative reflects implementation of decisions NNSA made based on the 2005 LLNL SWEIS and its 2011 Supplement Analysis, and implementation of decisions made on actions evaluated in other relevant NEPA documents completed since 2005. For example, the removal of Security Category I/II special nuclear materials (SNM)[1] from LLNL, which was completed in 2012, LLNL would continue with Security Category III quantities of materials under the No-Action Alternative (*see* Section 4.13.6). The No-Action Alternative also includes projects/actions through 2022, for which NEPA has or will be

[1] Per DOE Order 474.2, "Nuclear Material Control and Accountability," quantities of SNM stored at each DOE site are categorized into Security Categories I, II, III, and IV, with the greatest quantities included under Security Category I and lesser quantities included in descending order under Security Categories II through IV. Types and compositions of SNM are further categorized by their "attractiveness" to saboteurs, alphabetically, with the most attractive materials for conversion of such materials into nuclear explosive devices being identified by the letter "A" and less-attractive materials being designated progressively by the letters "B" through "E."

completed by 2022. These projects are identified in the most recent 2021 LLNL Site Development Plan, which was published in January 2021 (LLNL 2021b).

The projects identified in Table 3-1 and Table 3-2, and described in Sections 3.2.1 and 3.2.2, define the No-Action Alternative projects that are expected to be implemented at the Livermore Site and Site 300 over the next several years. Implementation of these projects would result in changes to some of the environmental parameters at the Laboratory. Table 3-8, which is located at the end of this chapter, identifies the operational parameters associated with the No-Action Alternative. As discussed earlier, all of the No-Action Alternative projects have either completed their separate NEPA documentation or would complete their documentation before their startup through 2022.

Under the No-Action Alternative, LLNL would use existing and enhanced capabilities through 2022 to continue to support major DOE/NNSA capabilities/programs described in Chapter 2 of this LLNL SWEIS. This would involve projects that have been approved, or are in the process of being approved, for implementation. As defined in this SWEIS, the No-Action Alternative reflects the use of existing facilities and ongoing projects to meet national security and other laboratory mission requirements. The No-Action Alternative also includes: (1) construction of new facilities; (2) modernization/upgrade of existing facilities and infrastructure projects (includes utility projects); and (3) DD&D of excess and aging facilities for which NEPA analysis/documentation already exists or would be completed by 2022. For example, as a result of continued operation at LLNL, NNSA has issued categorical exclusions for activities that would not result in significant impacts (e.g., routine maintenance, remediation actions, and a broad range of R&D activities performed within existing LLNL facilities) (see Appendix A, Section A.3). Therefore, as shown on Figure 3-1, the No-Action Alternative includes a level of operation for LLNL greater than ongoing operations. Under the No-Action Alternative, operations would continue at a steady-state into the future, but at a lower level than would be needed to support overall NNSA growing mission requirements.

The major capabilities, key facilities, and operations included in the No-Action Alternative are described in Chapter 2. In addition, Table 3-1, Table 3-2, and Table 3-3 identify new facilities, modernization/upgrade/utility projects, and DD&D projects associated with the No-Action Alternative. Figure 3-2 provides a map for locating the new facilities for the No-Action Alternative at the Livermore Site.[2] Under the No-Action Alternative, only one new facility, the Small Firearms Training Facility (SFTF), would occur at Site 300, at the Small Arms Training Area (*see* Figure 3-3 for the relevant facilities at Site 300 for the SWEIS). Baseline impacts associated with the No-Action Alternative were estimated based on historical operations since 2005, such as the number of experiments performed at the NIF and the number of HE tests at Site 300, as well as any notable changes in operations resulting from the actions identified in Table 3-1, Table 3-2, and Table 3-3. Baseline data for all environmental resource areas was collected for 2019 as part of the Existing Environment (Chapter 4).

[2] Figure 3-2 can be used to find the approximate location of new facilities for the No-Action Alternative using the grid coordinates in Table 3-1.

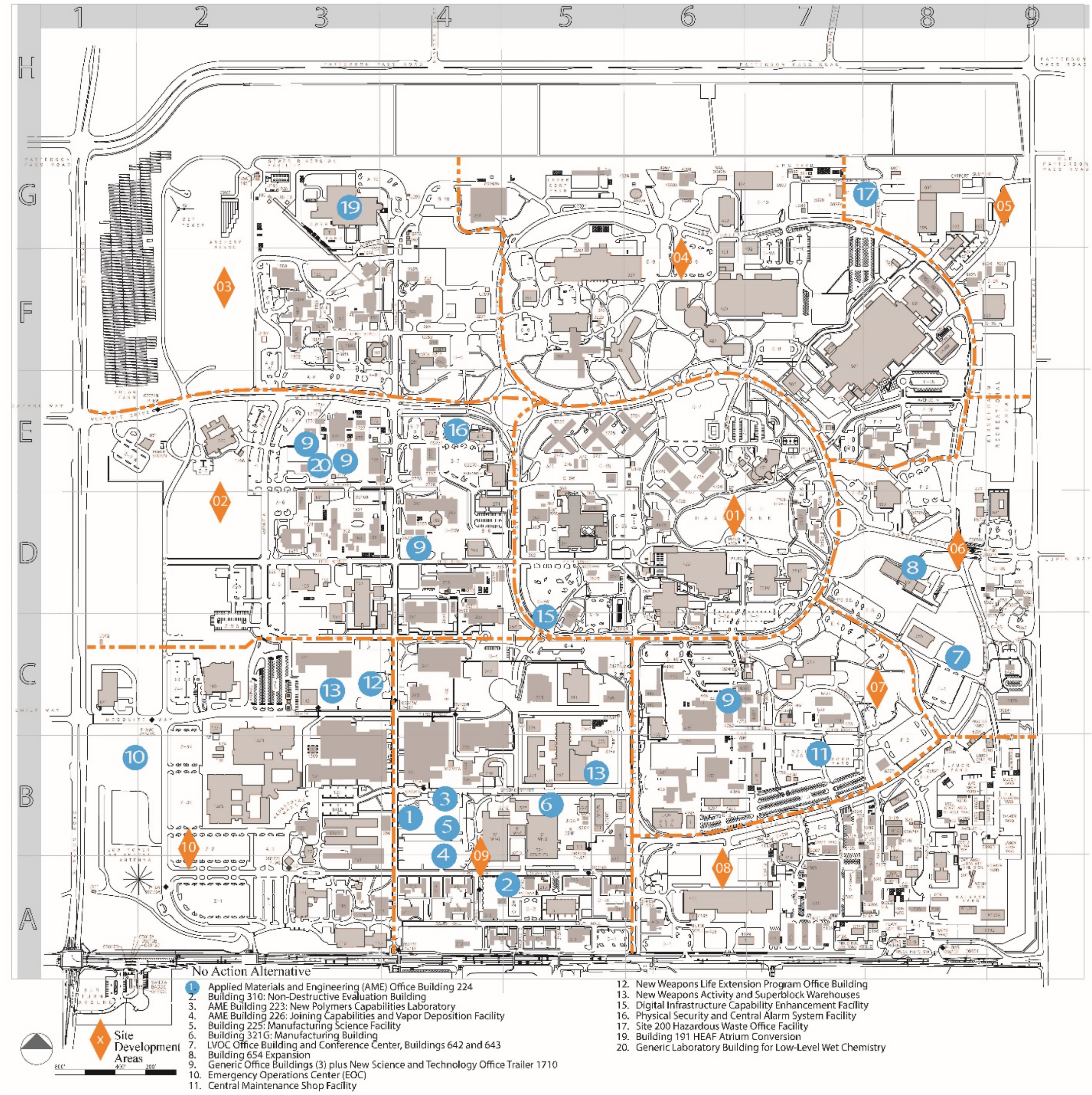


Figure 3-2. No-Action Alternative Projects at the Livermore Site

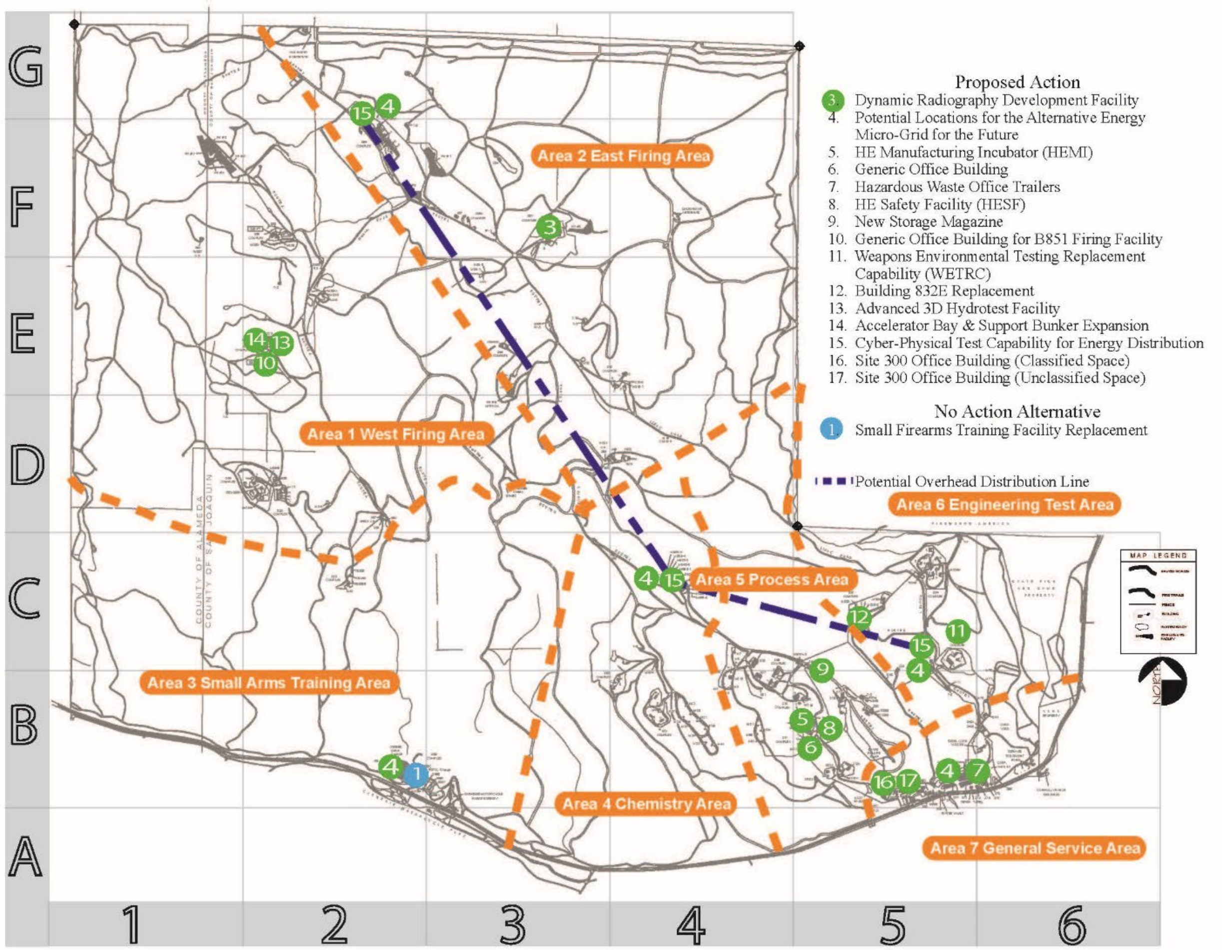


Figure 3-3. Map for No-Action Alternative and Proposed Action Projects at Site 300

Table 3-1. No-Action Alternative: New Facilities (2020–2022)

Map ID #	Name[a]	Site; Grid Location[b]	Size (ft^2)/ Facility Type	Year	NNSA Capability[d]
1	**Applied Materials and Engineering (AME) Office Building 224[c]**	Livermore Site; B-4	22,000 Office	2020	Tests and Experiments; Enabling Infrastructure;
2	**Building 310: Non-Destructive Evaluation Building**	Livermore Site; A-5	11,000 Lab	2020	Tests and Experiments
3	**AME Building 223: New Polymers Capabilities Laboratory**	Livermore Site; B-4	13,200 Lab	2020	Tests and Experiments
4	**AME Building 226: Joining Capabilities and Vapor Deposition Facility**	Livermore Site; B-4	15,400 Lab	2021	Tests and Experiments
5	**AME Building 225: Manufacturing Science Facility**	Livermore Site; B-4	15,400 Lab	2020	Tests and Experiment
6	**Building 321G: Manufacturing Building**	Livermore Site; B-5	13,000 Lab	2020	Tests and Experiments
7	**LVOC Office Building and Conference Center, Buildings 642 and 643**	Livermore Site; C-8	25,000 Office	2020	Strategic Partnership Projects

Map ID #	Name[a]	Site; Grid Location[b]	Size (ft^2)/ Facility Type	Year	NNSA Capability[d]
8	Building 654 Expansion	Livermore Site; D-8	18,000 Office	2020	Simulation
9	**Generic Office Buildings (3) plus New Science and Technology Office Trailer 1710**	Livermore Site; E-3; D-4	72,000 Office	2020-2022	Enabling Infrastructure; Tests and Experiments
Fig 3-3: 1	**Building 899 Small Firearms Training Facility (SFTF) Replacement**	Site 300; Figure 3-3, B-2	4,000 Support	2020	Security/Enabling Infrastructure
10	**Emergency Operations Center (EOC)**	Livermore Site; B-1	20,000 Support	2021	Enabling Infrastructure
11	**Central Maintenance Shop Facility**	Livermore Site; B-7	60,000 Support	2021	Enabling Infrastructure
12	New Weapons Life Extension Program Office Building	Livermore Site; C-3	35,000 Office	2021	Design and Certification
13	New Weapons Activity and Superblock Warehouses	Livermore Site; A-6, B-5	25,000 Support	2022	Enabling Infrastructure; Plutonium
15	Digital Infrastructure Capability Enhancement Facility	Livermore Site; C-5	7,000 Support	2022	Communications/ Enabling Infrastructure
16	**Physical Security and Central Alarm System Facility**	Livermore Site; E-4	22,000 Lab	2022	Security/ Enabling Infrastructure
17	Livermore Site Hazardous Waste Office Facility	Livermore Site; F-9	16,000 Office	2022	Plutonium
19	**Building 191 HEAF Atrium Conversion**	Livermore Site; G-3	2,300 Lab	2022	Tests and Experiments
20	**New Generic Laboratory Building for Low-Level Wet Chemistry**	Livermore Site; E-3	20,000 Lab	2022	Design and Certification
Total			**416,300**		

a. Throughout this SWEIS, NNSA acknowledges that facility names are subject to change in the future.
b. In general, for each new facility at the Livermore Site, alphabetical-numerical grid coordinates are provided to aid in locating the facility on Figure 3-2. For Site 300, Figure 3-3 shows the locations of any new facilities.
c. **Bolded** projects in this table and Table 3-2 are described in Section 3.2.1.
d. NNSA Infrastructure capabilities as defined in Chapter 2.
Sources: LLNL 2021b, 20201c, 2021d.

Table 3-2. No-Action Alternative: Modernization/Upgrade/Utility Projects (2020–2022)[a]

Name	Site	Building Number(s)	NNSA Capability[b]
Exascale Computing Facility Modernization (Project ID 4169)	Livermore Site	453	Simulation
Livermore Site Miscellaneous Facility/Laboratory Repairs, Replacements, and Upgrades (Project ID 446, 472, 3044, 4000, 5735, 6096, 225, 3789, 4574, 458, 3061, 3913, 3993, 4394, 4412, 5006, 5731, 5733, 5744, 6638, 6684, 6686, 6753)	Livermore Site	131, 132N, 151, 170, 174, 197, 232, 235, 239, 253, 254, 256, 321, 321A, 327, 361, 391, 411, 439, 442, 453, 490, 581, 681, Block 1300 LEP Offices, 15SWCS	Design and Certification; Global Security; Tests and Experiments
Utility Replacements and Upgrades (valves, control systems, piping, etc.) (Project ID 5911, 5649, 4757)	Livermore Site	Not applicable	Enabling Infrastructure
Arroyo Mocho Pump Station Upgrades (control center, pumps, etc.) (Project ID 6859, 6795)	Arroyo Mocho	Not applicable	Enabling Infrastructure
Livermore Site Storm Drain Upgrades (Project ID 3920)	Livermore Site	Not applicable	Enabling Infrastructure
Generator Replacements and Fuel Tank (underground and above ground) Replacements	Livermore Site, Site 300	132, 241, 251, 291, 313, 325, 331, 332, 431, 432, 435, 611 834A, 836, 875	Global Security; Enabling Infrastructure; Plutonium
Low Pressure Air System Upgrade (Project ID 4745)	Livermore Site, Site 300	Not applicable	Enabling Infrastructure
Seismic Risk Reduction (Project ID 5006, 5728, 6066)	Livermore Site, Site 300	235, 321A, 411	Tests and Experiments
Site 300 Miscellaneous Facility/Laboratory Repairs, Replacements, and Upgrades (Project ID 5727, 6685)	Site 300	836, 865	Enabling Infrastructure
Site 300 Utility Replacements and Installations (transformers, water supply piping, valves, wells) (Project ID 4751, 4746, 6792)	Site 300	Not applicable	Enabling Infrastructure
Site 300 Limited Area Fence Replacements (Project ID 3930)	Site 300	Not applicable	Enabling Infrastructure
3D Flash Computed Tomography (CT) System upgrades	Livermore Site, Site 300	310, 327, 810, 823	Tests and Experiments
Building 850 Revitalization Project (Project ID 6798)	Site 300	850	Global Security; Tests and Experiments

a. Modernization/Upgrades list only comprises of large projects greater than $1million; there are many hundreds of smaller upgrade projects less than $1 million that are not included in this list.
b. NNSA Infrastructure capabilities as defined in Chapter 2.
Sources: LLNL 2021b, 20201c, 2021d.

Table 3-3. No-Action Alternative: DD&D Projects (2020–2022)

Buildings to Undergo DD&D	Site	Size (ft^2)	Year
1736, 175, 280, 4302, 4377, 4378, 4382, 4383, 4384, 4385, 4387 (11 facilities)	Livermore Site	~60,000	2020
2632, 616 (2 facilities)	Livermore Site	~2,000	2021
194A, 1601, 1602, 1678, 182, 1927, 241, 243, 251, 2525, 2552, 2554, 2728, 2806, 280A, 281A, 292, 2925, 293, 312A, 343, 3526, 3555, 3751, 3775, 406, 4926, 532 (28 facilities), plus Legacy Slabs (LS) 212, 377, and 412	Livermore Site	~165,000	2022
8806	Site 300	~1,000	2022
Total		**~228,000**	

Sources: LLNL 2021b, 20201c, 2021d.

Brief descriptions of new facilities and modernization/upgrade/utility projects (Section 3.2.1), DD&D projects (Section 3.2.2), and operational changes (Section 3.2.3) are presented below for the No-Action Alternative.

3.2.1 No-Action Alternative Project Descriptions: New Facilities and Modernization/ Upgrade/Utility Projects

As shown on Table 3-1, approximately 19 new projects, totaling about 416,300 square feet, would begin construction through 2022. All but one of those projects would be located at the Livermore Site. The only facility to be constructed at Site 300 is the 4,000-square-foot SFTF. In addition, as shown in Table 3-2, there would be approximately 13 categories of modernization/upgrade/ utility projects, many involving multiple facilities. With regard to NNSA missions, most of the projects are related to Tests and Experiments or Enabling Infrastructure. Brief descriptions of notable new facilities and modernization/upgrade/utility projects for the No-Action Alternative are presented below.

3.2.1.1 *Tests and Experiments Projects*

The Tests and Experiments infrastructure houses the activities that provide data to determine weapon performance characteristics, understand material properties under extreme conditions, and contribute to formation and validation of models. For Tests and Experimentation, NNSA would implement the following notable projects:

- **Applied Materials and Engineering (AME) Buildings 223, 224, and 226.** AME capabilities are vital to the certification, design, and testing of stockpile systems under the LEPs and Mods and other programs. The current AME facility is Building 231, a 60-year-old, approximately 130,000-square-foot facility. It is a 1950s-era facility with deteriorating facility conditions, seismic deficiencies, process contamination, and a high level of deferred maintenance. Building 231 is too costly to modernize and therefore there is a need to move its operations to modern facilities. To ensure long-term support for nuclear stockpile stewardship and LEPs and Mods, NNSA has developed a multi-year area plan that will replace and upgrade the existing AME facilities, increase operational efficiency, and reduce the area's footprint by 40 percent (LLNL 2019b). The plan calls for recapitalization of four existing facilities (Buildings 131, 341, 233, and 321A), and construction of two new laboratory buildings (each approximately 13,000 to 16,000 square feet) and an office building (approximately 22,000 square feet). As shown on Figure 3-4, the new facilities would be Building 224 (Office building), Building 223 (Polymers Laboratory), and Building 226 (Vapor Deposition and Joining Lab). Because operations would be similar to the operations in Building 231, there would be no change in wastes, emissions, hazards, or accidents (LLNL 2017b).

Note: Relocation of Building 231 activities shown in different colors; Building 231 would undergo DD&D.
Source: LLNL 2019b.

Figure 3-4. Applied Materials and Engineering Consolidation

- **AME Building 225 Manufacturing Science Building**. The new AME Manufacturing Science Facility would be a non-nuclear process development facility bridging a gap between design and production agencies. The facility would conduct process development work to modernize and improve production methods and efficiencies for classified parts containing mostly plastic (polymer) materials. These modernized manufacturing techniques would support modernization (LEPs and Mods) programs by improving current manufacturing methods at the production agency. Building 225 would be an all-inclusive facility, where raw materials (batches of powders) are used to make parts, and then the parts would be subjected to various inspections for required density measurements, radiography (non-destructive evaluation), and dimensional measurements. Process development manufacturing equipment would include large mixers (multiple liters per batch), syringe fillers for additive manufacturing printers, curing ovens (~150 degrees Celsius), machining equipment, and cleaning stations. Compared to traditional methods, these techniques would produce better quality parts and less waste. Similar work is currently being done in Building 132N but at a smaller scale. The process development techniques would eventually be transferred to the production agency where they can be scaled up for production. Waste would be generated from part trimming and machine cutting (approx. 1 to several liters per day). Additionally, the facility would generate 100 milliliters/day of solvent waste and laboratory trash. There would be minor solvent emissions from toluene, silicon elastomers, and acetone. Manufactured parts would be either sent to the production agency or declassified for disposal. Solvent emissions would be exhausted through a facility stack.

- **Building 321G Manufacturing Building.** The new Building 321G would add institutional high bay manufacturing space (from 7,000 to 10,000 square feet) in support of NNSA's growing national security programs and Strategic Partnership Projects (SPP), including DoD and DHS projects. The expanded secure spaceshop capacity would address the increased need for the combination of precision and classified manufacturing required by these multi-programmatic missions across the Laboratory. The new building would be sited in the 3200 block, adjacent to the existing Building 321 Complex to gain more efficient workflow. The project would also include the removal of a facility to accommodate the construction of the new manufacturing facility in the same footprint (LLNL 2019).

- **Building 310 Non-Destructive Evaluation Building.** This project would relocate the primary low-energy operations of the Non-Destructive Evaluation (NDE) group, currently housed in Building 327, to a new 11,000-square-foot above-ground facility. NDE group staff operate specialized radiography systems in basement and sub-basement shielded laboratories and perform complementary ultrasound, dye penetrant, magnetic particle, and microwave investigations in other laboratories on the main floor. Key NNSA missions such as weapon design, certification, engineering, surveillance, and high energy density physics all require NDE capability. The quality of programmatic NDE work can be improved by relocating Building 327 low-energy capabilities to a new facility with modern, flexible, open labs. Light and open lab space can be constructed since low-energy NDE equipment uses self-shielded cabinets for personnel safety. The proposed plan would relocate NDE inspection capabilities of less than one million electron volts (MeV). Engineer and technician offices would be relocated to the new office building being built in the AME campus (LLNL 2019d).

- **Building 191 HEAF Atrium Conversion to Shot-Ready Workspace Project.** The purpose of the proposed project is to convert the existing first floor 2,000 square feet atrium at HEAF, Building 191, into experimental space to accommodate safe and compliant work with explosives. The construction scope of work would include the following:

  - Demolition of existing construction as required for the new facility;
  - New construction of blast resistant, concrete walls, foundation, and roof system;
  - New access plates over concrete wall openings at the east side of the HE test area;
  - Modification/addition of new mechanical, electrical, plumbing and fire protection systems;
  - New interior finishes.

  In preparation for design of the proposed project, a structural study was prepared, with a focus on the options for demolition of the existing structure in the atrium area and the layout of the new structure in relation to blast loading. The new structure would be designed as a containment structure to protect occupants, equipment, supplies and stored explosives from fragment impact and blast pressures based on a 500-gram TNT weight limit explosive rating. There is also a potential for laser experiments in the future for this area (LLNL 2020d).

3.2.1.2 *Design and Certification Projects*

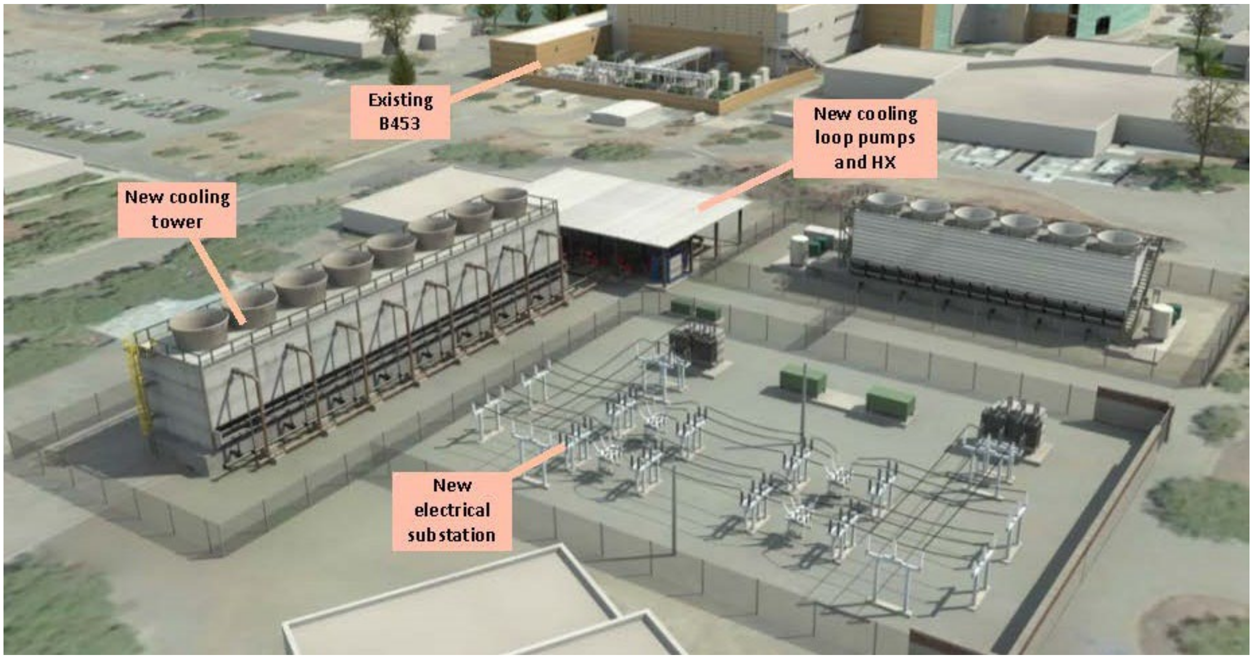
As a design agency for NNSA, LLNL is responsible for maintaining three of the seven active stockpile weapon systems through the annual weapon assessment process and for enabling the future stockpile.

- **New Generic Laboratory Building for Low-Level Wet Chemistry.** This facility would replace Building 197, which provides small-scale laboratory space for the Center for Accelerator Mass Spectrometry (CAMS), Building 190. The new facility would have generic laboratory capabilities, including wet labs that produce target materials for CAMS. The Cosmo Chemistry clean laboratory in Building 151 would also relocate to this new facility. Office personnel from Building 197 would also relocate to this new facility. Equipment would include microwaves, high-pressure digesters, baking ovens, drying ovens, glassware, and furnaces. The facility would use mineral acids and digesters. This facility would generate small quantities of hazardous materials as waste, as well as wipe cleaning wastes. There would be no work with radioactive materials (LLNL 2021c).

3.2.1.3 *Simulation Projects*

Simulation capability and infrastructure at LLNL support activities for computer modeling and the prediction of weapon performance and material properties not accessible through experimentation. Under the No-Action Alternative, NNSA would implement the Exascale Complex Facility Modernization (ECFM).

- **Exascale Complex Facility Modernization (ECFM).** NNSA has completed facility upgrades in Building 453 for the Sierra supercomputer (the next step toward exascale) and is planning for the next two advanced HPC computers (expected to be delivered in 2023 and 2028). The ECFM project would provide capable facilities and infrastructure to site an exascale-class system in 2022, with full operations initiating in 2023 (LLNL 2017a). To implement the ECFM, NNSA would modify Building 453 by strengthening the facility foundation, increase electrical power service to 85-110 megawatts by constructing a new electrical substation, and install new cooling towers and cooling loop pumps to accommodate an additional 18,000 to 28,000 tons of cooling (Figure 3-5) (LLNL 2019b).



Source: LLNL 2019b.

Figure 3-5. ECFM Project

3.2.1.4 *Strategic Partnership Projects*

Strategic Partnership Projects (SPP) capabilities support federal and non-federal entities that are outside of DOE and NNSA, and involve broader national security, energy security, and scientific development missions. NNSA would construct the following notable facilities: LVOC Office Building and Conference Annex, Building 642 and Building 643. This project is discussed below.

- **LVOC Office Building and Conference Center, Buildings 642 and 643.** This project involves the construction of approximately 28,000 square feet on the 110-acre LVOC, which provides modern office and meeting space for LLNL researchers in predictive biology, materials and manufacturing, the Laboratory's Innovation & Partnerships Office and High Performance Computing Innovation Center. At nearly 25,000 square feet, Building 642 contains 105 offices, two double-size "hotel" offices, two conference rooms, and collaboration spaces. The adjacent 2,975-square-foot conference annex can accommodate about 90 people and includes a lobby, kitchen, restrooms, utility rooms and storage.

3.2.1.5 *Global Security Projects*

Global Security R&D at LLNL supports a broad range of national security missions for a wide sponsor base, which includes DOE/NNSA, as well as other federal, state, local agencies, private industry and academia. This includes capabilities for counterterrorism, nonproliferation, intelligence, and energy security. NNSA provides technical and programmatic support to help prevent and mitigate catastrophic incidents arising from CBRNE materials.

- **Building 850 Revitalization Project.** This project would revitalize Building 850 at Site 300 and would mainly involve utility upgrades/replacements, including the electrical, water, sanitary, and septic systems. The project started in 2021. The work involves reconnecting the electrical, water, and sanitary septic systems in year one of the construction changes. The sanitary septic system would need to be replaced, requiring a permit from San Joaquin County. The surface soil and subsurface soil in this area have been remediated, and the integrity of the remedy in this area (consolidated and solidified soil) would continue to be protected. After the revitalization portion of this project, the facility would support LLNL programs, which may include small-scale explosives experiments, counterterrorism, counter proliferation, training area, continuity of operations facility, and classified communications area. The projects would involve the use of HE, shaped charges, projectiles, directed energy, and propellant deflagration. Various types of radiography would also be conducted. The facility would be a radiological facility and would remain below Hazard Category (HC)-3 thresholds. Less than HC-3 facilities are classified in accordance with DOE-STD-1027. It would have small quantities of chemicals (including metallics, acids and bases), BSL-1 biologicals, and radiological materials as a low-hazard/radiological facility. The facility would use Category 3 and 4 lasers and RGD hazards. Small quantities of sealed sources would also be present in Building 850. Waste generated from the facility and firing table would include solid wastes, HE wastes, radiological mixed waste, and wipe cleaning waste (LLNL 2021c).

3.2.1.6 *Enabling Infrastructure Projects*

Mission-enabling infrastructure supports all Laboratory programmatic needs, and is foundational to making sites habitable, including assets for communications, power, water, emergency services, offices, site roads and parking, storage, maintenance shops, and waste management. NNSA would implement several new projects related to Enabling Infrastructure, including the following notable projects:

- **Emergency Operations Center.** NNSA is in the process of constructing a building of approximately 20,000 square feet to house emergency management and response capabilities. The permanent facility (Figure 3-6) would be in an area that is part of the previously undisturbed west buffer zone in the southwest quadrant of the Livermore Site, south of Mesquite Way and west of West Perimeter Drive. No hazardous operations would take place in the facility. Operation of the building would generate municipal wastes consistent with office facility use, and wastes would be recycled or otherwise managed in accordance with LLNL procedures. The building has been designed to Leadership in Energy and Environmental Design (LEED) Gold criteria. In addition, renewable energy credits would be claimed by utilizing some of the power from the LLNL solar farm during operations of the facility (LLNL 2017c).

Source: LLNL 2017a.

Figure 3-6. Conceptual View of the New Emergency Operations Center

- **Small Firearms Training Facility Replacement.** This project involves construction of a new facility at Site 300, Small Arms Training Area. The new facility would replace the 35-year-old classroom that concurrently operates as an office, kitchen, and classroom, which limits and obstructs training. The 4,000-square-foot facility would contain a functional classroom, restrooms, kitchenette, locker area, and two offices. The current classroom would be modified for storage of firearms, ammunition, and supplies, and for the cleaning and maintenance of firearms.

- **Physical Security and Central Alarm System (CAS) Facility**. The CAS is currently housed in the basement of Building 271, a 45+ year-old facility with outdated data infrastructure with no room for future equipment needs such as servers. The building operates at 85 - 95 percent of power capacity and no additional equipment can be added. This project would involve construction of a new 2-story facility totaling 22,000 square feet in an existing developed area of the Livermore Site. The proposed facility site would be prepared by removing existing old trailers 2726, 2727, 2728, and 2775. These trailers, which are more than 40 years old, would be disposed of as solid wastes. The proposed facility would house multiple security groups including the CAS facility that operates 24 hours a day and seven days a week, a shop for locks and keys, several conference rooms, and approximately 60 offices. The facility would include multiple types of spaces including offices, conference rooms, shops and related stock rooms, facilities for continuous monitoring and server rooms (LLNL 2021c).

- **Central Maintenance Shop Facility.** A new 60,000-square-foot facility would be constructed in the southeast portion of the Livermore Site (LLNL 2021c). This modern new facility would replace the current seismically deficient maintenance shop, Building 511.

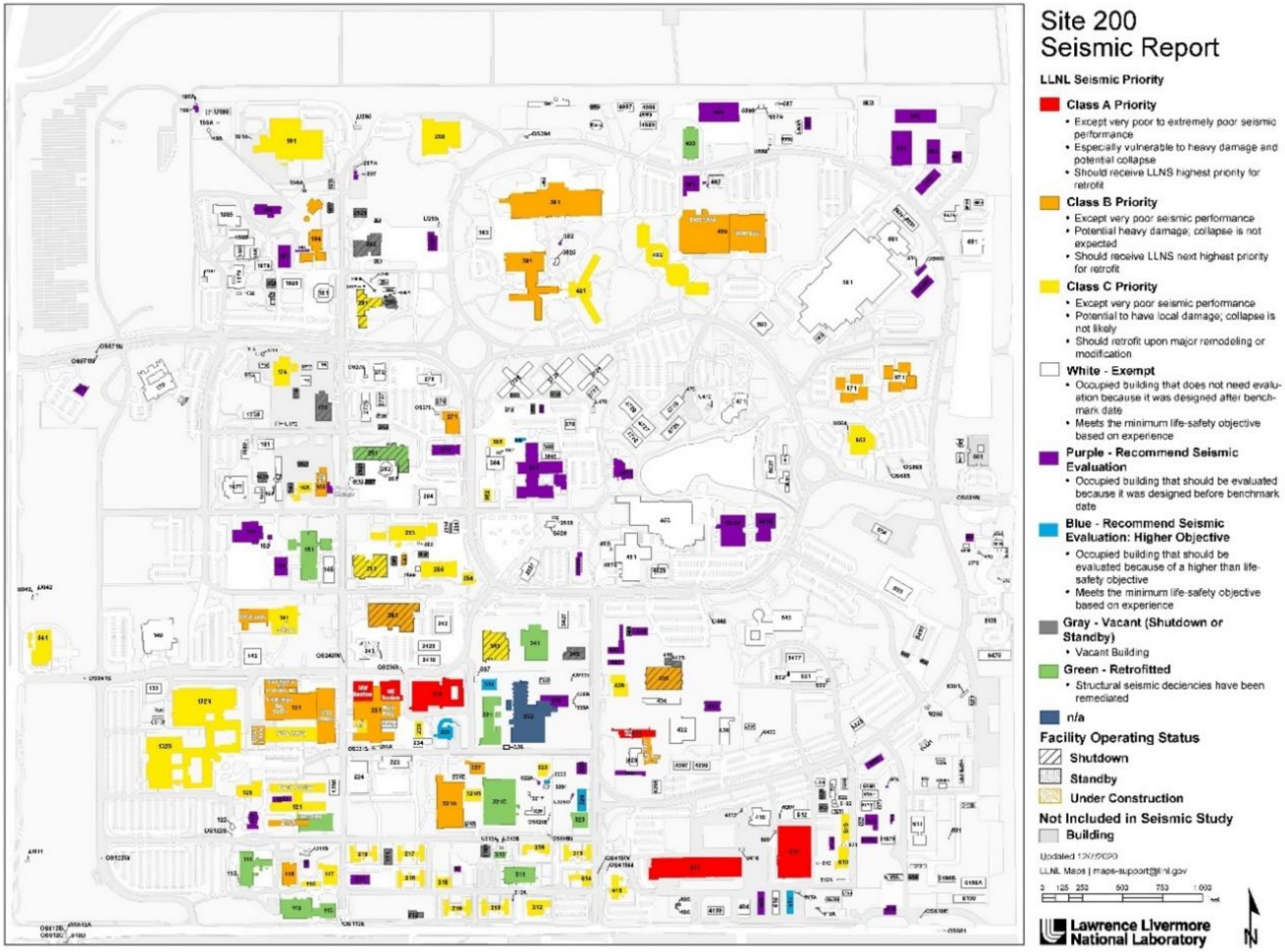
- **Replacement of Existing Office Buildings/Laboratory Facilities.** The No-Action Alternative includes the construction of three generic office buildings (two at 22,000 square feet and one at 8,000 square feet) at the Livermore Site (*see* Table 3-1), as well as modernization/upgrade to several facilities at both the Livermore Site and Site 300 (*see* Table 3-2). Timely infrastructure modernization is critical to long-term success in science-based stockpile stewardship to support NNSA's national missions.

- **Seismic Risk Reduction.** NNSA must provide safety-compliant retrofits of enduring facilities. LLNL is located in a seismically active region and there is a 72-percent probability that one or more earthquakes of magnitude 6.7 or greater will occur within a 30-year period. LLNL has many enduring facilities that are in need of a seismic retrofit. This will be accomplished through the Seismic Risk Reduction Project (LLNL 2017a). The Seismic Risk Reduction Project includes the continuation of designing and installing seismic upgrades to mitigate life-safety hazards for building occupants during earthquakes. Figure 3-7 depicts LLNL facilities that still have seismic deficiencies. As indicated on that figure, four facilities are rated as having poor to extremely poor seismic performance. Of those four, Buildings 231, 511, and 431 are proposed for DD&D (*see* Table 3-6), and the fourth facility (Building 411) would be seismically upgraded (*see* Table 3-2**).**

- **Utility Projects.** LLNL's utilities infrastructure must be fully reliable 24/7 to ensure NNSA meets its programmatic mission requirements. Most of LLNL's utility system infrastructure is underground where it cannot be readily seen, monitored for condition degradation, nor preventatively maintained. More often than not, repairs and upgrades are only made after system failures occur. Those system failures impact programmatic missions. Many of LLNL's utility systems are the original systems installed when LLNL was a Naval Air Station over 65 years ago and are well beyond useful life (LLNL 2019b).

  Some projects, such as replacing over 100 of LLNL's most critical utility system valves, are ongoing and nearing completion. NNSA also has projects underway at both the Livermore Site and Site 300 to provide filtration and chloramination[3] treatment to the water supplied from the Hetch Hetchy reservoir. Other projects under the No-Action Alternative include storm drain upgrades at the Livermore Site, generator and generator fuel tank replacements, upgrades to the low-pressure air system, Site 300 replacements and installations of transformers, water supply piping, valves, and wells. These projects would provide protection from shutdowns and improve system reliability and redundancy (LLNL 2019b).

[3] Chloramination is the process of adding chloramine to drinking water to disinfect it and kill germs.



Note: Buildings 231, 511, and 431 are proposed for DD&D in approximately 2027, 2030, and 2032, respectively. Seismic upgrades are planned for Buildings 235, 321A and 411 as part of the No-Action Alternative. Seismic upgrades for Buildings 490, 391B, 271, 381B, 431, and 298 are planned as part of the Proposed Action.
Source: LLNL 2020ac.

Figure 3-7. LLNL Facilities with Seismic Deficiencies

- **Ongoing Remediation Activities.** Groundwater and soils at both the Livermore Site and Site 300 are contaminated from historical operations; the contamination is mostly confined to within the boundaries of each site. Ongoing remedial investigations and cleanup activities for legacy contamination of environmental media at LLNL fall under CERCLA. The Livermore Site and Site 300 came under CERCLA in 1987 and 1990, respectively, when they were each placed on the National Priorities List. NNSA complies with provisions specified in Federal Facility Agreements (FFAs) (DOE 1988, DOE 2002) entered into by USEPA, DOE, the California EPA Department of Health Services (now Department of Toxic Substances Control [DTSC]), and the San Francisco Bay Regional Water Quality Control Board (RWQCB; for Livermore Site) and the Central Valley RWQCB (for Site 300). Chapter 4, Section 4.15, of this SWEIS discusses ongoing pending remediation efforts. Those remediation efforts would continue under both the No-Action Alternative and the Proposed Action. Any future remediation actions would be conducted in accordance with the FFAs.

- **Arroyo Mocho Utility Upgrades.** The primary source of domestic water for the Livermore Site is the City of San Francisco's Hetch Hetchy Regional Water System. The Hetch Hetchy water travels to the Livermore Site from a tunnel located 800 feet underground, about seven miles from the Livermore Site at Arroyo Mocho (*see* Figure 4-1 in Chapter 4). NNSA owns and operates three wells, each with a pump to pull the water from the tunnel to aboveground tanks, which then gravity feeds to the LLNL supply tanks located at SNL/CA. This then becomes the source of water for the Livermore Site and SNL/CA. Two of the three pumps are more than 40 years old, and a third is 28 years old, well past their expected service life. Under the No-Action Alternative, NNSA would replace these pumps at the Arroyo Mocho Pump Station (LLNL 2021c).

3.2.2 No-Action Alternative: DD&D Projects

Since 2003, approximately 600,000 square feet of facilities have undergone DD&D at the Livermore Site (LLNL 2019b). Under the No-Action Alternative, DD&D actions would continue. As shown in Table 3-3, over the period 2020–2022, NNSA expects to DD&D approximately 42 excess facilities, totaling approximately 228,000 square feet. All but one of the facilities scheduled for DD&D are at the Livermore Site (41 facilities, totaling approximately 227,000 square feet). The only facility at Site 300 that would undergo DD&D is Building 8806 (1,000 square feet). On an annualized basis, NNSA would DD&D approximately 76,000 square feet of excess/aging facilities over the No-Action Alternative planning period (2020–2022). Figure 3-8 shows notable contaminated facilities at the Livermore Site that would undergo DD&D under the No-Action Alternative. There would be LLW and potentially TRU waste associated with DD&D of these contaminated facilities.

3.2.3 No-Action Alternative: Operational Changes

There are no new operational changes for the No-Action Alternative. The prior operational changes described in the 2011 SA (NNSA 2011) examined changes in programs, projects, or operations since the 2005 SWEIS; new and modified plans, projects, and operations for the period 2010–2015; and new information that was not available for consideration when the 2005 SWEIS was prepared. The 2010–2015 projections for each resource area included consideration of the proposed new and modified projects and modifications in site operations at LLNL that were likely to be implemented through the year 2015. For most environmental resources, the 2010–2015 projections remained consistent with impacts analyzed in the 2005 SWEIS (*see* Table A-8 in Appendix A). For the few instances where the 2010–2015 projections differed from the 2005 SWEIS analysis, the changes in environmental impact were not significant (NNSA 2011). A notable operational change that has occurred since 2011 is the de-inventory of Security Category I/II Special Nuclear Materials (SNM), which was completed in 2012. Another operational change— a proposed increase in weights of explosives detonated at the Building 851 firing table—has not been implemented during the writing of this SWEIS.[4]

[4] Detonation of explosives is currently limited to less than 100 pounds per day and less than 1,000 pounds per year.

Source: LLNL 2015a.

Figure 3-8. No-Action Alternative: Notable Facilities to Undergo DD&D

3.3 PROPOSED ACTION

In January 2021, LLNL published the 2021 Site Development Plan (Plan) (LLNL 2021b), which provides a framework for future development at both the Livermore Site and Site 300. The Plan was undertaken to guide planning for the facilities and infrastructure needed to best support the NNSA mission at LLNL. The Plan, which identifies critical needs and articulates a vision to meet those needs, is guided by the following principal goals:

- Create an approach for physical development of the Laboratory over time;
- Confirm the phasing of projects with mission needs and priorities; and
- Support future project requests for direct and indirect funding.

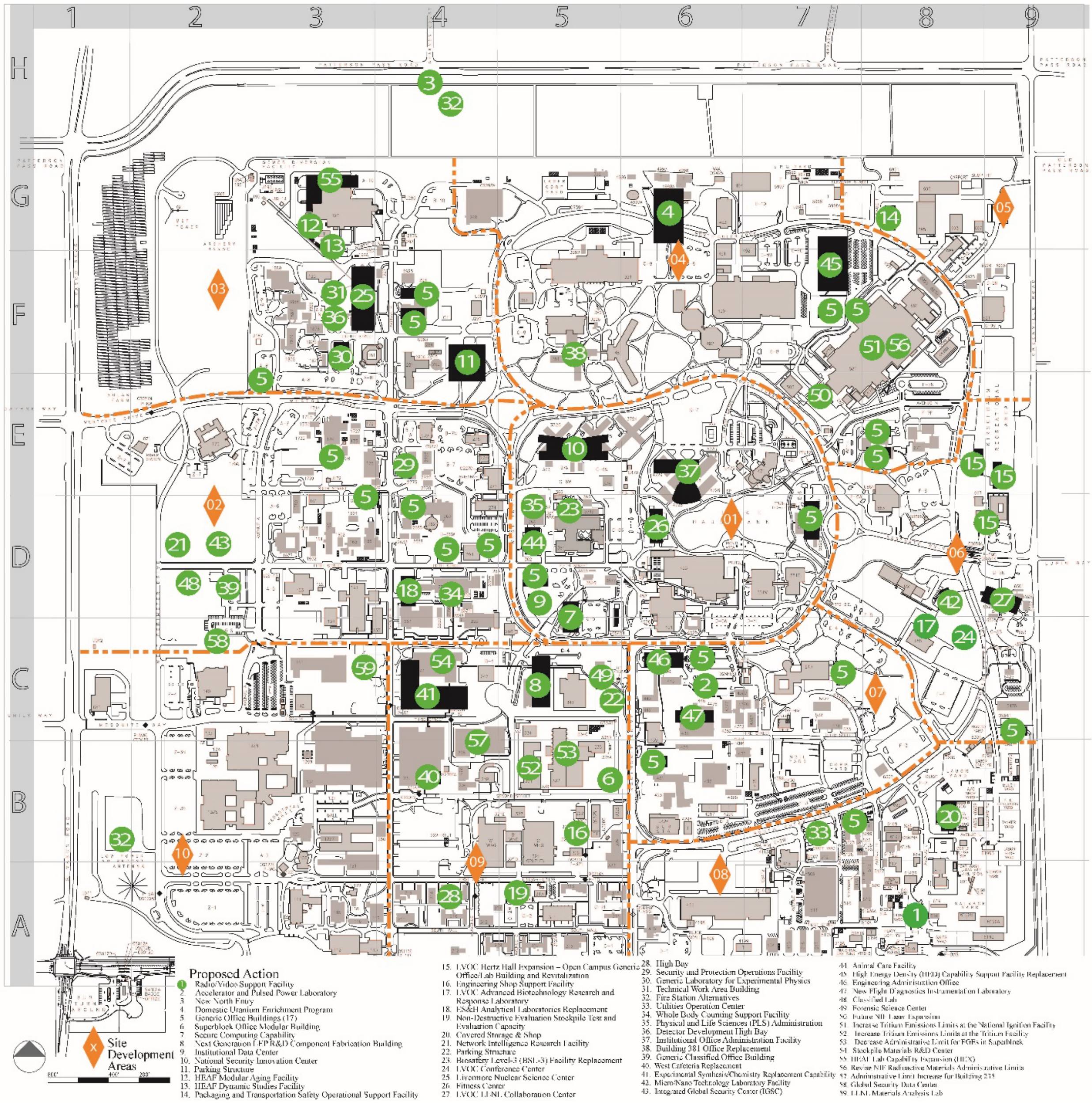
The Proposed Action described in this section embraces the framework, principles, goals, and vision expressed in the 2021 Site Development Plan. The Proposed Action supports the need to replace many aged facilities with consolidated new construction that offers conservation of resources with closer connection in an identifiable "Campus Center." The Proposed Action also promotes pedestrian scale development, creates public space, and is intended to enhance environmental quality, improve connections across the Lab, and create a strong, collaborative center. With regard to Site 300, the 2021 Site Development Plan and this SWEIS recognize decentralization as a prevailing condition and the roadway system that connects the Site 300 operational areas. As such, the Proposed Actions for Site 300 focuses on improving the infrastructure and operations within the seven operational areas identified in Figure 3-3.

Under the Proposed Action, NNSA would continue to support national security and the other laboratory mission requirements described in Chapter 2 of this LLNL SWEIS. As defined in this SWEIS, the Proposed Action reflects the use of existing facilities and ongoing projects described for the No-Action Alternative, as well as additional new facility construction, modification/upgrade/utility projects, DD&D of excess/aging facilities, and operational changes. Therefore, the Proposed Action includes a level of operation at LLNL that is greater than both current operations and under the No-Action Alternative (*see* Figure 3-1 for a graphical representation of the operational difference between the Proposed Action and the No-Action Alternative).

Table 3-4, Table 3-5, and Table 3-6 identify new facilities, modernization/upgrade/utility projects, DD&D projects, and operational changes associated with the Proposed Action. Figure 3-9 provides a map for locating the new facilities for the Proposed Action at the Livermore Site.[5]

For new facilities at Site 300 under the Proposed Action, refer to Figure 3-3 above. The tables below list all the Proposed Actions by category. Those highlighted in bold are described in more detail in the following sections. Chapter 5 describes in detail the environmental impacts associated with the Proposed Action.

[5] Figure 3-9 can be used to find the approximate location of new facilities for the Proposed Action using the grid coordinates in Table 3-4.



Note: Some project locations have been approximated pending detailed design requirements.

Figure 3-9. Proposed Action Projects at the Livermore Site

Table 3-4. Proposed Action: New Facilities/Operational Changes (2023–2035)

Map ID #	Name[a]	Site; Grid Locations[b]	Size (ft^2)/ Facility Type	Year	NNSA Capability[d]
1	Radio/Video Support Facility	Livermore Site; A-8	8,000 Support	2023	Enabling Infrastructure
2	**Accelerator and Pulsed Power Laboratory[c]**	Livermore Site; C-6	50,000 Lab	2023	Tests and Experiments. Strategic Partnerships
5	**Generic Office Buildings (17)**	Livermore Site; Various	404,000 Office	2023-2035	Enabling Infrastructure
Figure 3-14	**Extend city of Livermore Reclaimed Water Distribution System for Cooling Tower Use**	Livermore Site; Figure 3-14	Not applicable	2023-2024	Enabling Infrastructure
Figure 3-3: 4	**Alternative Energy Micro-Grid for the Future**	Site 300; Fig. 3-3	Not applicable	2023	Global Security
6	Superblock Office Modular Building	Livermore Site; B-5	6,000 Lab	2024	Global Security
7	Secure Computing Capability	Livermore Site; C-5	40,000 Office	2024	IT and Communications
8	**Next Generation LEP R&D Component Fabrication Building**	Livermore Site; C-5	60,000 Lab	2024	Tests and Experiments
9	Institutional Data Center	Livermore Site; D-5	10,000 Office	2024	IT and Communications
10	**National Security Innovation Center**	Livermore Site; F-4	225,000 Office	2024	Design and Certification
11	**Parking Structure**	Livermore Site; F-4	90,000	2024	Enabling Infrastructure
12	**HEAF Modular Aging Facility**	Livermore Site; G-3	2,000 Lab	2024	Tests and Experiments
13	**HEAF Dynamic Studies Facility**	Livermore Site; G-3	2,000 Lab	2024	Tests and Experiments
14	**Packaging and Transportation Safety Operational Support Facility**	Livermore Site; G-8	11,000 – 14,000 Office and Support	2024	Enabling Infrastructure, Plutonium
54	**Stockpile Materials R&D Center**	Livermore Site; C-4	50,000 Lab	2024	Non-Nuclear Components
15	**Hertz Hall Expansion – Open Campus Generic Office/Lab Building and Revitalization**	Livermore Site; C-9, D-8, E-8, E-9	20,000 Office, Lab	2024-2028	Strategic Partnership Projects
Figure 3-3: 5	**HE Manufacturing Incubator (HEMI)**	Site 300; Fig 3-3, B-5	10,000 Lab	2024	High Explosives
Fig 3-3: 15	**Cyber-Physical Test Capability for Energy Distribution**	Site 300; Figure 3-3, various	NA	2024	Global Security
Figure 3-3: 6	**Generic Office Building**	Site 300; Fig. 3-3, B-5	14,000 Office	2024	Enabling Infrastructure
Figure 3-3: 7	Hazardous Waste Office Trailers	Site 300; Fig. 3-3, B-5	5,000 Office	2024	Enabling Infrastructure
Figure 3-3:17	**Site 300 Office Building (unclassified space)**	Site 300; Fig. 3-3	24,000 (unclassified)	2024	Enabling Infrastructure
Figure 3-3:16	**Site 300 Office Building (classified space)**	S300; Fig. 3-3	50,000 (classified)	2024	Enabling Infrastructure
16	Engineering Shop Support Facility	Livermore Site; B-5	10,000 Support	2025	Tests and Experiments
17	**LVOC Advanced Biotechnology Research and Response Laboratory**	Livermore Site; C-8	Up to 13,000 Lab	2025	Strategic Partnership Projects

Map ID #	Name[a]	Site; Grid Locations[b]	Size (ft^2)/ Facility Type	Year	NNSA Capability[d]
18	**ES&H Analytical Laboratories Replacement**	Livermore Site; D-4	40,000 Lab	2025	Enabling Infrastructure
55	**HEAF Lab Capability Expansion (HEX)**	Livermore Site; G-3	40,000 Lab; 10,000 Office	2025	Tests and Experiments
3	**New North Entry**	Livermore Site; H-4	N/A	2025	Enabling Infrastructure
Figure 3-3: 8	**HE Safety Facility (HESF)**	Site 300; Fig. 3-3, B-5	10,000 Lab	2025	High Explosives
Figure 3-3: 9	New Storage Magazine	Site 300; Fig. 3-3, B-5	400 Support	2025	High Explosives
19	**Non-Destructive Evaluation Stockpile Test and Evaluation Capacity**	Livermore Site; A-5	11,000 Lab	2026	Tests and Experiments, Global Security, Strategic Partnerships
20	Covered Storage & Shop	Livermore Site; B-8	20,000 Support	2026	Enabling Infrastructure
21	**Network Intelligence Research Facility**	Livermore Site; C-2	80,000 Office	2026	Global Security
22	Parking Structure	Livermore Site; C-5	250,000	2026	Enabling Infrastructure
23	**Biosafety Level 3 (BSL-3) Facility Replacement**	Livermore Site; D-5	5,000 Lab	2026	Strategic Partnership Projects; Global Security
24	**LVOC Conference Center**	Livermore Site; D-8	20,000 Office	2026	Strategic Partnership Projects
25	**Livermore Nuclear Science Center**	Livermore Site; F-3	100,000 Lab	2026	Design and Certification
Figure 3-3: 10	**Generic Office** (for Building 851 Firing Facility)	Site 300; Fig 3-3, E-2	10,000 Office	2026	Enabling Infrastructure
26	Fitness Center	Livermore Site; D-6	22,000 Support	2027	Enabling Infrastructure
27	**LVOC LLNL Collaboration Center**	Livermore Site; D-9	111,000 Office	2027	Strategic Partnership Projects
59	**Materials Analysis Laboratory**	Livermore Site	20,000	2027	Global Security
28	**High Bay**	Livermore Site; A-4	100,000	2028	Design and Certification
29	Security and Protection Operations Facility	Livermore Site; E-4	22,000 Lab	2028	Security
30	**Generic Laboratory for Experimental Physics**	Livermore Site; F-3	15,000 Lab	2028	Tests and Experiments
31	Technical Work Area Building	Livermore Site; F-3	4,000 Lab	2028	Enabling Infrastructure
32	**Fire Station Facility**	Livermore Site; H-4	30,000 Support	2028	Enabling Infrastructure
39	**Generic Classified Office Building**	Livermore Site	15,000	2028	Global Security
Figure 3-3: 3	**Dynamic Radiography Development Facility[c] (DRDF)**	Site 300; Fig. 3-3, F-3	60,000-Lab 60,000 to 80,000-Shed	2028-2032	High Explosives
33	Utilities Operation Center	Livermore Site; B-7	10,000 Office	2029	Enabling Infrastructure
Figure 3-3: 11	**Weapons Environmental Testing Replacement Capability (WETRC)**	Site 300; Fig. 3-3, C-5	40,000 Lab	2029	Tests and Experiments
Figure 3-3: 12	**Building 832E Replacement**	Site 300; C-5	2,000 Office/ Storage	2029	Enabling Infrastructure
34	**Whole Body Counting Support Facility**	Livermore Site; D-4	2,000 Lab	2030	Enabling Infrastructure
35	Physical and Life Sciences (PLS) Administration	Livermore Site; D-5	22,000 Office	2031	Simulation

Map ID #	Name[a]	Site; Grid Locations[b]	Size (ft^2)/ Facility Type	Year	NNSA Capability[d]
36	**Detector Development High Bay**	Livermore Site; F-3	15,000 Lab	2031	Test and Experiments
4	**Domestic Uranium Enrichment Program**	Livermore Site; G-6	150,000 Lab	2031	Global Security
37	Institutional Office Administration Facility	Livermore Site; E-6	110,000 Office	2032	Enabling Infrastructure
38	Building 381 Office Replacement	Livermore Site; F-5	70,000 Office	2032	Test and Experiments. HED Experiments
Figure 3-3: 13	**Advanced 3D Hydrotest Facility**	Site 300; Fig 3-3, E-2	75,000 Lab	2032	High Explosives
39	Secure Training and Communications Center	Livermore Site; D-2	8,000 Support	2033	Global Security
Figure 3-3: 14	**Accelerator Bay & Support Bunker Expansion**	Site 300; Fig 3-3, E-2	10,000 Lab	2033	High Explosives
40	West Cafeteria Replacement	Livermore Site; B-4	15,000 Support	2034	Enabling Infrastructure
41	**Experimental Synthesis/Chemistry Replacement Capability**	Livermore Site; C-4	160,000 Lab	2034	Tests and Experiments. Global Security, Strategic Partnerships
42	**Micro/Nano Technology Laboratory Facility**	Livermore Site; C-6	20,000 Lab	2034	Non-Nuclear Components
43	Integrated Global Security Center (IGSC)	Livermore Site; D-2	75,000 Office	2034	Global Security
44	**Animal Care Facility**	Livermore Site; D-5	20,000 Lab	2034	Strategic Partnership Projects. Global Security
45	**High Energy Density (HED) Capability Support Facility Replacement**	Livermore Site; F-7	145,000 Lab	2034	Tests and Experiments
46	Engineering Administration Office	Livermore Site; C-6	50,000 Office	2035	Design and Certification
47	**Flight Diagnostics Instrumentation Laboratory (STAR)**	Livermore Site; C-6	22,000 Lab	2035	Tests and Experiments
48	**Classified Lab**	Livermore Site; D-2	15,000 Lab	2035	Global Security
49	**Forensic Science Center**	Livermore Site; C-5	60,000 Lab	By 2035	Global Security
Figure 3-13	**Rebalance Site-wide Parking**	Livermore Site; Figure 3-13	Not applicable	By 2035	Enabling Infrastructure
Figure 3-15	**Remove Limited Area Fencing**	Livermore Site; Figure 3-15	Not applicable	By 2035	Enabling Infrastructure
Figure 3-16	**Expand Pedestrian Walkways**	Livermore Site; Figure 3-16	Not applicable	By 2035	Enabling Infrastructure
Figure 3-17	**Expand Bicycle Circulation**	Livermore Site; Figure 3-17	Not applicable	By 2035	Enabling Infrastructure
50	**Future NIF Laser Expansion**	Livermore Site; E-7	50,000	Unknown	High Energy Density Physics
N/A	**Lake Haussmann Enhancements**	Livermore Site; D-6	Not applicable	By 2035	Enabling Infrastructure
Total			**3,328,400**		
Operational Changes					
51	**Increase Tritium Emissions Limits at the National Ignition Facility**	Livermore Site; F-8	N/A	2023	Tests and Experiments
52	**Increase Tritium Emissions Limits at the Tritium Facility**	Livermore Site; B-5	N/A	2023	Tritium
53	**Decrease Administrative Limit for Fuels-Grade**	Livermore Site; B-5	N/A	2023	Plutonium

Map ID #	Name[a]	Site; Grid Locations[b]	Size (ft^2)/ Facility Type	Year	NNSA Capability[d]
	Equivalent (FGE) Plutonium, Enriched Uranium, and Depleted Uranium Radioisotopes in Superblock				
56	**Revise National Ignition Facility Radioactive Materials Administrative Limits**	Livermore Site; F-8	N/A	2023	Tests and Experiments
57	**Increase Administrative Limit for Building 235**	Livermore Site; C-6	N/A	2024	Tests and Experiments; Plutonium

a. Throughout this SWEIS, NNSA acknowledges that facility names are subject to change in the future.
b. In general, for each new facility at the Livermore Site, alphabetical-numerical grid coordinates are provided to aid in locating the facility on Figure 3-9. For Site 300, Figure 3-3 shows designated areas to aid in locating any new Site 300 facility.
c. **Bolded** projects in this table and Table 3-5 are described in Section 3.3.1.
d. NNSA Infrastructure capabilities as defined in Chapter 2.
Sources: LLNL 2021b, 20201c, 2021d.

Table 3-5. Proposed Action: Modernization/Upgrade/Utility Projects (2023–2035)[a]

Name[b]	Site	Building Number(s)	NNSA Capability[c]
NIF Upgrades and Infrastructure Modernization (Project ID 4368, 460, 5644, 6622, 4761, 4798, 385, 3047, 3060, 3066, 4390, 3983, 4097, 4590, 5561, 6623, 433, 3078, 3936, 4107, 4184, 4582, 4583, 4584, 4587, 4593, 5724, 593, 3036, 3056, 3059, 4586, 4588, 4589, 4595, 4596, 4597, 4598, 6132, 6131, 6130, 6129, 6136, 6128)	Livermore Site	298, 391, 392, 490, 581, 582, 684	Tests and Experiments
Enhanced Capability at NIF	Livermore Site	581	Tests and Experiments
132N Complex Revitalization (Project ID 4576, 5650, 5652, 4793, 4794, 457, 5576, 6971, 5575)	Livermore Site	132N	Global Security
132S Complex Revitalization (Project ID 4393, 5657, 5583, 484, 4408, 3897, 6970, 6972)	Livermore Site	132S	Global Security
Building 151 Laboratory Upgrades and Revitalization (Project ID 3976, 5528, 6071, 6077, 6068, 6072, 6078, 3776, 6079)	Livermore Site	151	Design and Certification
Superblock Upgrades (Glovebox System, Support Systems) (Project ID 3045, 4156, 540, 3046, 3049, 5648, 545, 6137, 6168, 6847, 6848, 387, 3054, 6139, 6138)	Livermore Site	239, 331, 332, 334, 3340, 335	Tritium, Plutonium
Livermore Site Miscellaneous Facility/Laboratory Upgrades (Project ID 3989, 5522, 2823, 3019, 4267, 4756, 5519, 6111, 3052, 3350, 4085, 4158, 6109, 4046, 4157, 4172, 5627, 374, 384, 3895, 3928, 4066, 4090, 4189, 5517, 6030, 6075, 425, 3345, 4007, 4045, 4407, 5536, 5549, 5552, 5554, 5624, 6073, 3058, 4330, 5620, 6027, 6074, 6076, 6087, 6100, 6112, 6093, 6097, 6106, 6033, 6107, 6089, 6094, 6101, 6113, 6110, 6812). Includes industrial gas (i.e., liquid nitrogen) centralization for site facilities.	Livermore Site	131, 140, 141, 170, 191, 194, 197, 231, 233, 235, 253, 255, 262, 282, 321C, 327, 341, 361, 381, 391, 439, 443, 451, 453, 551W, 654, 663, 681, 695, 696	Design and Certification; High Explosives; Tests and Experiments; Enabling Infrastructure
Seismic Risk Reduction (Project ID 6790, 6791, 3349)	Livermore Site	490, 391B, 271, 381B, 431, 298	Enabling Infrastructure

Name[b]	Site	Building Number(s)	NNSA Capability[c]
Miscellaneous Office and Computing Building Revitalization (Project ID 4072, 4105, 5977, 246, 4766, 5970, 4402, 4071, 5511, 6163, 597)	Livermore Site, Site 300	111, 112, 113, 123, 1677, 271, 324, T4727, 490, 651	Enabling Infrastructure
High Explosives Process Area Revitalization (Project ID 537, 500, 594, 596)	Site 300	805, 806, 807, 809, 810, 817, 823, 855	High Explosives
Site 300 Firing Control System Modernization/Upgrade (Project ID 445, 732, 6034)	Site 300	851	Design and Certification
Site 300 Miscellaneous Facility/Laboratory Upgrades (Project ID 3901, 4754, 5651, 4074, 6028, 6029, 6635, 556, 509, 590, 6032, 526, 542, 562, 532). Includes industrial gas (i.e., liquid nitrogen) centralization for site facilities.	Site 300	801, 807, 810, 823, 825, 826, 827, 834, 836, 850, 851, 865	Design and Certification; High Explosives
Running Track Installation	Livermore Site	Not applicable	Enabling Infrastructure
Site 300 Erosion Control Projects	Site 300	Not applicable	Enabling Infrastructure
Site 300 Road Upgrades	Site 300	Not applicable	Enabling Infrastructure
Domestic Water/Low Conductivity Water Supply and Distribution System Upgrades, including Cooling Tower Replacements/Upgrades	Livermore Site, Site 300	Includes U291, OS454, and other upgrades at both sites	Enabling Infrastructure
Sanitary Sewer, Septic and Stormwater System Upgrades and Replacements, including Wastewater Reuse Projects	Livermore Site, Site 300	Not applicable	Enabling Infrastructure
Security Fencing and Security Upgrades	Livermore Site, Site 300	Not applicable	Enabling Infrastructure
Arroyo Mocho Water Pumping Facility and Associated Pipelines Refurbishment and Upgrades	Livermore Site, Site 300, Arroyo Mocho	Not applicable	Enabling Infrastructure
Mechanical and Electrical System (including High Voltage and Emergency System) Replacements and Upgrades, including upgrades and expansion for Electric Vehicle Charging[d]	Livermore Site, Site 300	Not applicable	Enabling Infrastructure

a. Modernization/Upgrades list only comprises of large projects greater than $1 million; there are many hundreds of smaller upgrade projects less than $1million are not included in this list.
b. Actions identified in Table 3-5 have been combined and summarized.
c. NNSA Infrastructure capabilities as defined in Chapter 2.
d. Electric Vehicle charging capabilities would be increased such that fleet acquisitions for light-duty vehicles approach 100% zero emissions by 2025. Charging capability for employee personal vehicles would also be expanded.
Sources: LLNL 2021b, 20201c, 2021d.

Table 3-6. Proposed Action: DD&D Projects (2023–2035)

Buildings to Undergo DD&D	Site	Size (ft^2)	Year
1726, 2632, 2685, 2687, 3180, 343, 345, 3724, 3725, 3726, 373, 376, 379, 3982, 5125, 5225 (16 facilities)	Livermore Site	~ 37,000	2023
1739, 2726, 2727, 2775, 312A, 446, 4475, 6127, 6178, 6179 (10 facilities)	Livermore Site	~ 95,000	2024
8724, 8726	Site 300	~ 1,300	2024
231, 261, 263, 3203, 3204, 321F, 322A, 3527, 435 (9 facilities)	Livermore Site	~ 196,000	2025
802A, 828A/B/C (4 facilities)	Site 300	~ 4,000	2025
4675, 510, 6475, 6501, 651, 652, 6525, 6526, 6527, 653, 6575 (11 facilities)	Livermore Site	~ 35,000	2026
830	Site 300	~ 1,800	2026
1714, 1730, 1735, 231A, 3427, 378, 4525, 6206 (8 facilities)	Livermore Site	~ 24,000	2027
856	Site 300	~ 1,600	2027
1277, 1280, 197, 198, 294, 327, 5626, 5627, 5675 (9 facilities)	Livermore Site	~ 60,000	2028
848	Site 300	1,300	2028
115, 116, 117, 118, 2580, 314, 315, 362, 571 (9 facilities)	Livermore Site	~ 119,000	2029
Other Structure (OS) 858B Drop Tower Storage	Site 300	N/A	2029
1878, 1886, 1887, 1888, 1925, 214, 217, 218, 317, 318, 319, 404, 405, 418, 5105, 511, 514A, 515, 516, 519, 520, 522, 5226, 523, 525, 5299, 622, 6325, 6925, 6926 (30 facilities), plus LS431	Livermore Site	~ 260,000	2030
812A, 812D, OS812B, OS812C (4 facilities)	Site 300	~ 4,000	2030
1826, 1884, 1885, 252, 4725, 4726, 4727, 4728, 4729, 473, 512 (11 facilities)	Livermore Site	~ 65,000	2031
834B, 834C, 834G, 834J (4 facilities)	Site 300	~ 3,000	2031
253, 365, 423, 431, 509, 517, 517A (7 facilities)	Livermore Site	~ 110,000	2032
1632, 254, 671 (3 facilities)	Livermore Site	~ 49,000	2033
255	Livermore Site	~ 22,000	2034
1677, 1680, 216, 316, 366, 6929, 6930 (7 facilities), plus OS394	Livermore Site	~ 81,000	2035
Total		**~ 1,170,000**	

Source: LLNL 2021b, 20201c, 2021d.

3.3.1 Proposed Action Project Descriptions: New Facilities and Modernization/Upgrade/ Utility Projects

As shown on Table 3-4, approximately 75 new projects, totaling approximately 3.3 million square feet, are proposed over the period 2023–2035. Of this, 61 projects, totaling approximately 2.9 million square feet, are proposed at the Livermore Site; 14 projects, totaling approximately 385,000 square feet, are proposed at Site 300. The proposed locations for new facilities are primarily based on land availability and synergies/efficiencies with respect to existing facilities/operations. The proposed locations would also support NNSA's vision for the Proposed Action end state (*see* Section 3.3.4). In addition to new projects, as shown in Table 3-5, NNSA proposes 20 modernization/upgrade/utility projects, many involving multiple facilities. The following sections provide brief descriptions of the notable new facilities/projects and modernization/upgrade/utility projects proposed.

3.3.1.1 *Design and Certification and LEPs and Mods Support Projects*

As a design agency for NNSA, LLNL is responsible for maintaining three of the seven active stockpile weapon systems through the annual weapon assessment process and for enabling the future stockpile. Weapons issues that could lead to future degradation, such as aging effects, include parts that may need to be replaced or refurbished as part of LEPs and Mods to meet safety, security, and reliability requirements. In this way, LEPs and Mods extend the lifetime of the weapons by an additional 20 to 30 years and are carried out without conducting underground nuclear tests. To accomplish the annual weapon assessment process and LEPs and Mods certification, NNSA is proposing to construct several new facilities, including the following notable facilities: (1) National Security Innovation Center; (2) Next Generation LEP R&D Component Fabrication Building; (3) Livermore Nuclear Science Center; and (4) High Bay. Each of these proposed new facilities is discussed below.

- **National Security Innovation Center.** This project involves construction and operation of a three-story building (or four smaller buildings) of approximately 225,000 square feet to co-locate the Weapons Program offices (Weapons Physics and Design, Weapon Simulation and Computing, and Weapon Technology and Engineering) currently spread out in several facilities into one central campus and optimize the mix of classified and unclassified space. This building would provide classified space that includes approximately 1,000 offices, meeting rooms, server rooms, training rooms, strategically located collaboration areas throughout the building, and utility connections. Approximately 1,100 personnel from Buildings 132N, 131, 111, and 381 would relocate to this facility. The project would also include the demolition of several trailers located at that footprint (LLNL 2020g, 2021c).

- **Next Generation LEP R&D Component Fabrication Building.** The scope of this project is the construction and operation of a 60,000-square-foot R&D complex for increasing capacity and capability in support of current and future LEPs and Mods. The new facility would provide the precision required in manufacturing weapons parts and assemblies while increasing efficiencies and safety by adding automation and advanced technologies. Manufacturing innovations and process modernization that will be developed cannot enter the stockpile without being qualified. The qualification process itself requires a level of precision that is approximately ten times higher than typical production components and, thus, requires modern manufacturing and inspection capabilities (note: manufacture of components for LEPs and Mods will take place at other NNSA sites). The new facility would consist of flexible secure manufacturing high bay space and office space, including state-of-the-art manufacturing tools. The facility would include medium energy x-ray bays with shielding, a high bay with a temperature-controlled environment, and a 32-inch foundation to control vibration. There would be an increase over current Building 321C waste streams because of the qualification process. Hazards would include flammability and explosivity. The project may be located at the footprint of Building 231 or Building 343, after those facilities undergo DD&D (LLNL 2020h, 2021c).

- **Livermore Nuclear Science Center.** This facility, which would replace the existing above-ground nuclear physics building (Building 194), would be located in the northeast portion of the Livermore Site and connect directly to the underground accelerator bays, which would remain. The Nuclear Science Center is a centerpiece of NNSA's strategy at LLNL to centralize and improve the existing capabilities for (1) generating nuclear data used as input to the design community's computer simulations; (2) acquiring and interpreting data from nuclear explosion debris to enable decisions about historic nuclear explosion tests; and (3) providing a platform where new experimental techniques, such as neutron interrogation and diagnostics, can be developed. The facility would be about 100,000 square feet over multiple floors, with laboratories making up half of the total building area. The remaining area would consist of 100 offices, a conference facility to accommodate 250 people, and utility/support space. The work planned for this facility can be divided into three categories: (1) handling nuclear and radioactive samples; (2) material characterization and analytical chemistry; and (3) nuclear physics and chemistry experiments using a high-intensity pulsed beam mono-energetic neutron source. The new facility would be a multi-level nuclear chemistry facility with radionuclide inventories below HC-3 thresholds. Operations would utilize high-level, short-lived nuclear isotopes (minutes to hours half-life). The facility would include gloveboxes and hot cells. The dissolver wing from Building 151 would also move to this facility, but Building 151 would remain a low-level radiological facility. The existing Building 194 Control Room and underground accelerator tunnels would also stay, and no new accelerators are expected as part of this proposal. The facility would generate approximately 20 to 40 drums of LLW and MLLW wastes annually. No new accidents would be introduced compared to existing operations (LLNL 2020j, 2021c).

- **High Bay.** The new High Bay would replace the existing Building 131 High Bay, which is now experiencing seismic issues due to its 60+ year-old age. The new High Bay would be a 100,000-square-foot industrial shop-type building housing 20 occupants. This facility would provide workshop, machine shop, and storage capabilities for experiments and operations in engineering evaluations, primarily in support of the Stockpile Stewardship and Management Program, although other programs are supported as well. It would be classified as a low-hazard radiological facility. The work would cover a range of operations including fabricating parts, assembling hardware, gauging, calibrating, bonding, potting, and testing parts and assemblies-using mechanical shock, acceleration, and vibration. Facility space would be dedicated to the storage of components, material stock, fixtures, tooling, and equipment. Materials Management would move classified and controlled materials in and out of the building. Some storage, handling, cleaning, assembly/disassembly, and testing operations involve hazardous materials (beryllium and lithium hydride/lithium deuteride), non-dispersible radioactive material (DU), and toxic chemicals, generally in a non-dispersible form. Small quantities of powdered metals and glass/ceramic microspheres would be handled using pressure and vacuum transport systems. Operations may require cryogens such as liquid nitrogen or liquid argon. Explosives in limited quantities would be present in the facility. RGDs would be used for radiography and testing operations. Hazardous and radiological wastes would be generated (LLNL 2021c).

3.3.1.2 *High Explosives Infrastructure Revitalization Projects*

This NNSA program relies on HE devices and advanced manufacturing process development capabilities currently at Site 300 and in the HEAF (at the Livermore Site) to complete mission activities. The HE enterprise across NNSA is aging as the mission areas are increasing. Capabilities and capacities are inadequate to meet current stockpile research, development, test, and evaluation (RDT&E) demands. HEAF is a centralized, fully contained HE facility with office and meeting spaces, explosives-rated laboratories, assembly areas, storage magazines, and seven firing tanks capable of detonating up to 22 pounds of explosives while using advanced diagnostics to characterize energetic materials and detonation phenomena. The facility also has research gas guns that fires into specially designed tanks for high velocity. In addition, environmental testing is performed in several Site 300 facilities. These existing LLNL test facilities are, on average, 50 years old and are exhibiting signs of significant deterioration and loss of some capabilities. Site 300's HE processing facilities, also over 50 years old, have many infrastructure gaps and deficiencies in both utilities and real property.

Additional space for chemical synthesis of explosives, formulation of HE, advanced manufacturing of explosives charges, HE pressing, HE machining, device characterization, and labs evaluating abnormal environments for HE articles is needed to create increased capacity to support LEPs and Mods mission requirements. NNSA is proposing investments to sustain and modernize the equipment and utilities at HEAF and existing facilities at Site 300. Laboratory-specific projects proposed for the HE Infrastructure Revitalization are described below.

- **Dynamic Radiography Development Facility (DRDF).** This 60,000-square-foot facility (plus a 60,000 to 80,000-square-foot shed-like structure) would be used to conduct radiography of HE targets using Dense Plasma Focus (DPF), Linear Induction Accelerator (LIA), and/or NIF-like laser-based application technologies. The DPF technology generates neutrons, while the LIA and laser systems generate x-rays. For the LIA, this would involve a 16- to 20-MeV accelerator. Use of DPF technology would require use of tritium, which would result in a LLW stream of approximately 1,000 pounds every two years. This facility could require electrical upgrades for the additional 5 MW requirement. If the facility is built on the north side of Building 801, it would require extensive excavation of the hillside. Additionally, the upper few feet of the soil could be contaminated with beryllium, DU, and other components from historical outdoor tests in this area. Thousands of tons of soil may be excavated from the hillside. If located on the south side, the excavation would be much less. The laser-based technology would use two NIF-like laser beamlines requiring 60,000 to 80,000 square feet. This would be in place where the shed would be. Waste generation would also include wipe cleaning using solvents (LLNL 2021c).

- **HE Manufacturing Incubator (HEMI).** This proposed 10,000-square-foot facility would allow the manufacturing processes for HE developed by the Design Agency to be seamlessly passed to the Pantex Production Agency. To accomplish this, the facility would conduct process development work for new manufacturing techniques (proof of concept) in collaboration with the Pantex Production Agency. The processes would be validated and approved for manufacturing at the Pantex Plant, including additive manufacturing and other techniques. There would be a new facility and renovation of some existing facilities in the Building 817 Complex. These facilities would undergo modernization of current activities and would utilize identical materials currently used in this Building 817 Complex. There would be no new waste streams from this facility (LLNL 2021c).

- **High Explosives Application Facility (HEAF) Laboratory Capability Expansion (HEX).** This project includes construction of a 30,000 - 40,000-square-foot laboratory at the Livermore Site for scientific and laboratory space for HE R&D, as well as 5,000-10,000 square feet of office space on the second floor. The location would be adjacent to the existing HEAF, Building 191. The proposed approach would leverage an existing, large NNSA investment by adding the HEX to HEAF to capitalize on the existing structure, equipment, and workforce. This facility could double the work currently conducted at HEAF. The HE limits for the firing tanks would be less than 10 kilograms of HE. Waste generated would include hazardous waste contaminated with HE and non-hazardous waste and managed in accordance with DTSC permit requirements. The facility could double the existing waste stream from HEAF. There is also a potential for air emissions; the tanks would be connected to an exhaust system with HEPA filters and cyclone separators. There would be a 21-foot stack from the second-floor mechanical room (approximately 50 feet from the ground). The facility would have similar air emissions and permits as the HEAF. There are currently five air emission sources at HEAF: four of those sources are permitted as miscellaneous, chemical, and explosives sources and are authorized to emit a maximum of 0.0001 ton per hour. One source, the Two Stage Large Gas Gun, is exempt. Foundations for this new facility would be up to 10 to 15 feet deep, with no basement. This facility would provide enhanced capabilities to respond to emerging threats from an energetic materials perspective (LLNL 2020c, 2021c).

- **HE Safety Facility (HESF).** This facility would allow the life-cycle evaluation of HE process safety. Process evaluations would focus on formulation, transportation, assembly, disassembly, and final disposition of HE. NNSA does not have a dedicated facility to study the safety of HE processes. The facility would perform studies to define science-based HE process safety limits, specifically for use at Pantex in assembly and disassembly activities. These studies would answer life-cycle safety questions such as the consequence of dropping tools or having equipment fall on a part (e.g., screw drivers). The high bay facility would conduct a full range of explosives process safety tests within tanks ranging from 1 kilogram to 20 kilograms in size, similar to the one at HEAF for these dynamic experiments. Waste streams would include small HE wastes, which would be treated at the existing Explosives Waste Treatment Facility. There would be no other chemical hazards in the facility (LLNL 2021c).

- **HEAF Modular Aging Facility.** This would be a thermal aging laboratory that would use modified transport containers for construction. The facility would be approximately 2,000 square feet, with a two-tiered foundation that utilizes the existing outside retaining wall, which would be left in place. Pressed HE parts (with an average mass of approximately one gram) would be put in ovens for approximately three to six months for aging studies. The facility would include up to 10 ovens. The facility would have a 500-gram HE limit. A small chemical fume hood would also be installed. The facility would also be used to receive HE (received from magazines at Site 300 via USDOT-approved trucks) (LLNL 2021c).

- **HEAF Dynamic Studies Facility.** This would be another Environmental Testing Facility for HE. It would be constructed in the courtyard of Building 191 and would be of a modular structure consisting of two shipping containers joined together with added concrete wall thickness based on HE limits. It would contain a 45-foot-long bar, which would hit the center of small quantities of HE for dynamic testing. The facility would have a 1 kg HE limit and would generate explosives wastes (LLNL 2021c).

- **Advanced 3D Hydrotest Facility.** The proposed 75,000-square-foot Advanced 3D Hydrotest Facility would deliver a unique cinematographic capability for understanding vital weapons physics and validating an array of high-fidelity simulations. This testbed would serve as a basis for future upgrades to other hydrotest facilities, such as the Dual Axis Radiographic Hydrodynamic Test (DARHT) facility at LANL and Flash X-ray (FXR) at Building 801. The proposed project would include radiographic facilities using the N-pulse (20 pulses per 10 nanoseconds) solid-state driven 8-10 MeV linear accelerator capable of imaging weapons physics configurations over a range of densities. Another technology under this project potentially includes a DPF technology currently being developed in Building 391. The DPF technology would use deuterium and deuterium-tritium mixtures and would generate approximately 0.5 to 0.75 cubic meters of LLW every 1-2 years. Use of the gases would also involve gas handling systems. Waste generation would also involve cleaning solvents and rags. Peak electrical power needs would increase by about 5 MW and would involve the installation of local modular offices and septic leach fields. Hazards would include x-ray and neutron generation from the accelerator, and the use of localized lead shielding (LLNL 2021c).

- **Building 832E Replacement.** This 2,000-square-foot facility would replace existing materials management functions from Building 832E at Site 300, to be conducted safely and efficiently into a modern facility. These functions include administrative activities with office space and shipping, receiving, and storage of non-explosive controlled chemical and radioactive materials required by the programs (LLNL 2021c).

- **Accelerator Bay and Support Bunker Expansion.** This 10,000-square-foot facility, which would be a variation of the LIA for HE diagnostics, would generate flash x-rays videos for diagnostics of HE. The proposed project would include radiographic facilities using the N-pulse (20 pulses over a relevant time) solid-state 8- to 10-MeV linear accelerator capable of imaging weapons physics configurations over a range of densities. It would remain below the 10-MeV threshold for an accelerator. The facility would fulfill the gap for deep-penetrating x-ray systems between the 17-MeV FXR (in the CFF) and the smaller 1-MeV systems. It would not irradiate the target materials at the firing table and there would not be any additional radiological waste generated at the firing table. Maintenance of the equipment might require some oils and wipe cleaning wastes (LLNL 2021c).

3.3.1.3 *Tests and Experiments Projects*

For Tests and Experimentation, NNSA is proposing to construct many new projects, including the following notable projects: (1) Generic Laboratory for Experimental Physics; (2) Weapons Environmental Testing Replacement Capability (WETRC); (3) Accelerator and Pulsed Power Laboratory; (4) HED Capability Support Facility Replacement; (5) Micro/Nano Technology Laboratory Facility; (6) Experimental Synthesis/Chemistry Replacement Capability; (7) Detector Development High Bay; (8) Flight Diagnostics Instrumentation Laboratory (STAR); (9) Stockpile Materials R&D Center; and (10) NIF Expansion and Upgrades. Each of these proposed projects is discussed below.

- **Generic Laboratory for Experimental Physics**. This would be a 15,000 square-foot generic physics dry laboratory, including a high-pressure lab that supports the two-stage gas gun facility at JASPER at the Nevada National Security Site (NNSS). The work would involve physics-type experiments and would involve relocation of existing activities from Building 197. This facility would conduct similar work as conducted in Building 197, but at a larger scale. Other existing operations would also relocate here, including the Electron-beam ion trap (EBIT) facility in Building 194; some physics labs from Building 132S; and Quantum computing work and Scanning Electron Microscopy labs from Building 282. The facility would have radiological hazards from EBIT operations (LLNL 2021c).

- **Weapons Environmental Testing Replacement Capability (WETRC).** This project would construct up to 40,000 square feet of new facilities to consolidate activities that are currently housed in Buildings 834, 836, and the OS858 Complexes at Site 300. The existing prefabricated facilities are old (1960s-era) and unable to address new environments for future stockpile LEPs and Mods with new delivery platforms. The new facilities would be constructed based on HE standoff distance requirements and would consolidate the 834 and 836 complexes which encompass 14 cells. The facilities would also include a small conference/office area, control rooms, and large high bay rooms with 5-ton cranes and roll up doors to house large pieces of programmatic test equipment. These test facilities must be rated for explosives operations, meet electrical supply requirements, have a reaction mass in one test cell facility floor, have cooling systems for a shaker in another test cell, and have ducting into certain test cells to accommodate external thermal condition units. This project would also include procurement of environmental test equipment. The project would also upgrade the OS858 Complex capability, which houses the drop tower. The scope includes seismic retrofit of the 100-foot drop tower, a new cable lift system, improvements to the existing drop table platform, improvements to earth berm protecting control building area and a new control building with sensor lines between it and the drop tower (LLNL 2021c).

- **Accelerator and Pulsed Power Laboratory**. The proposed Pulsed Power Laboratory would replace existing capabilities in Buildings 423 and 431. The facility would be approximately 50,000 square feet, and would have two bays, one for accelerator testing and the other for pulse power testing. These would be RGDs that involve electron accelerators with x-ray and neutron generation hazards. Hazards in the facility include RGD hazards with x-ray, alpha, gamma, beta, deuteron, and neutron generation. The facility would use sealed radioactive sources. The facility would also conduct high voltage testing and testing with radiofrequency sources. Experiments would also involve linear induction accelerators. The energies used in these accelerators would be less than 10 MeV. The new facility would be constructed with 2 to 3 feet thick concrete walls. Lead shielding would be provided in the RGD experiments, and dielectric fluids would be used for insulation purposes. All accelerator work would be performed remotely, and workers would follow ALARA guidelines to minimize exposure. The facility would develop next-generation accelerators, which would be capable of conducting multi-probe radiography in the future. Waste generated from the facility would include oil and oily rags, metal dust, and beryllium. All other accelerator parts would be discarded as non-hazardous waste. Waste generated would be one drum/year for oil and rags; 1 drum/year of PPE with lead contamination; and 1 cubic meter per year of electronic waste (e.g., discarded electrical or electronic devices). Small quantities of SF_6 are used in the RGD equipment – the facility would be installed with recovery system for SF_6. The facility would require an air permit for wipe cleaning involving cleaning solvents (LLNL 2021c).

- **HED Capability Support Facility Replacement.** This new 145,000 square-foot facility would house fabrication of targets, target diagnostics, and optics. The facility would consolidate operations currently conducted in Buildings 298, 381, 391, 490, and at several vendor locations. Some operations currently conducted in Building 331 could also be relocated to this facility. The new facility would provide advanced clean room and laboratory facilities for the next generations of targets and diagnostics for HED physics. The facility would have a 16,000 Ci tritium limit as a low-hazard, radiological facility (DOE-STD-1027); and 1,500 Ci tritium limit for reservoir operations. Tritium emissions would be the same as for Building 298 (approximately 10 Ci/year). Waste amounts would be similar to combination of wastes currently generated in Buildings 391, 298, and 490. Hazardous waste generation in these facilities is usually small (approximately 2 drums per month) and consists of mostly PPE waste (LLNL 2020k, LLNL 2021c).

- **Micro/Nano Technology Laboratory Facility.** This proposed facility would duplicate the micro/nano electronic technology work conducted in Building 153. This facility, which would be located closer to the LVOC but within the Property Protection Area, would expand external collaboration work while keeping Building 153 for ongoing mission-critical work. The building would be approximately 20,000 square feet with laboratory facilities (including a Class 100 Clean Room), offices, and utility areas. The building would involve similar operations (e.g., clean rooms, similar chemicals, hazards, and waste) as Building 153. There would also be a tall stack. There would be some visual impacts from Greenville Road as the facility would be located near the LVOC; however, there are few homes in that area (LLNL 2021c).

- **Experimental Synthesis/Chemistry Replacement Capability.** This project would replace Building 235 with a modern 160,000 square-foot facility to conduct metallography on small samples of radiological and hazardous materials. The facility would have approximately the same number of offices and laboratories as the existing building (approximately 130 offices and 60 laboratories). Additionally, this facility must meet tight vibrational and electrical noise requirements for analytical and characterization instrumentation as well as hazardous, radioactive and nanomaterials laboratory controls. The facility would generate radiological and hazardous wastes in similar quantities as are generated in Building 235 (LLNL 2021c).

- **Detector Development High Bay.** This 15,000 square-foot high bay facility would replace the high bay in Building 432. It will be used for building detectors for physics experiments. The work involves design, construction, testing, and scale-up of detectors which can get quite large and heavy thus requiring the high bay and cranes. Low activity sealed sources may be used for calibration and testing. Pre-moistened wipes would be used for wipe cleaning.

- **Flight Diagnostics Instrumentation Laboratory.** The new 22,000 square-foot facility would replace Building 442 and 443 to provide light laboratories, secure video teleconferencing, and some office space. The replacement would be equipped with a high bay. The facility would be used to develop diagnostic sensors and assembly of ocean-worthy rafts with these sensors. Wastes generated would consist of typical office trash.

- **Stockpile Materials R&D Center (SMRDC).** NNSA is developing a number of new materials and pilot manufacturing processes for several active stockpile weapon systems. The proposed SMRDC, at approximately 50,000 square feet, would be a nonradiological facility with large open laboratory space. The facility would conduct R&D to develop customized feedstock for the AML. Five different types of materials would be used: (1) glass, (2) ceramics, (3) polymers, (4) metals, and (5) nanomaterials. Initial work would generate gram-level products. Later, the facility would scale up the work to include kilogram-level products. Chemical hazards would include carcinogens, sub-micron materials, and toxic chemicals. Facility equipment hazards would include radiation generating devices (RGDs), including x-ray diffraction (XRD), x-ray florescence (XRF), baking ovens, tube furnaces, and ultraviolet curing lamps. The facility would generate mostly hazardous waste at a rate of 10 to 20, 55-gallon drums per year. Most work would be done in walk-in hoods. Any use of dry nanomaterials would be conducted in gloveboxes. The facility would use solvents such as alcohol and formaldehyde. The feedstock products would be shipped to Kansas City National Security Campus (NSC), and R&D technology would eventually be transferred to the Kansas City NSC (LLNL 2020i, 2021c).

- **NIF Upgrades, Infrastructure Modernization, and Enhanced Capability.** NIF is approaching 20 years of operation and some of its infrastructure will need to be replaced or upgraded. Additionally, improving NIF's laser energy and power could enable higher-yield experiments that further increase the fidelity of weapons physics experiments and enable the continued progress in support of ignition (LLNL 2020l, LLNL 2021c). Enhanced capability at NIF would include 4 major actions:

  (1) Sustain NIF operations for the next 3 decades: This will include refurbishment and upgrades to conventional facility infrastructure such as boilers, chillers, and transformers as well as systems supporting main laser operations, such as control, alignment, and optical systems. These activities would generate mostly industrial wastes.

  (2) Increase Capability at NIF: The power and energy delivery could increase by 50 percent to support increased yield and to potentially achieve ignition.

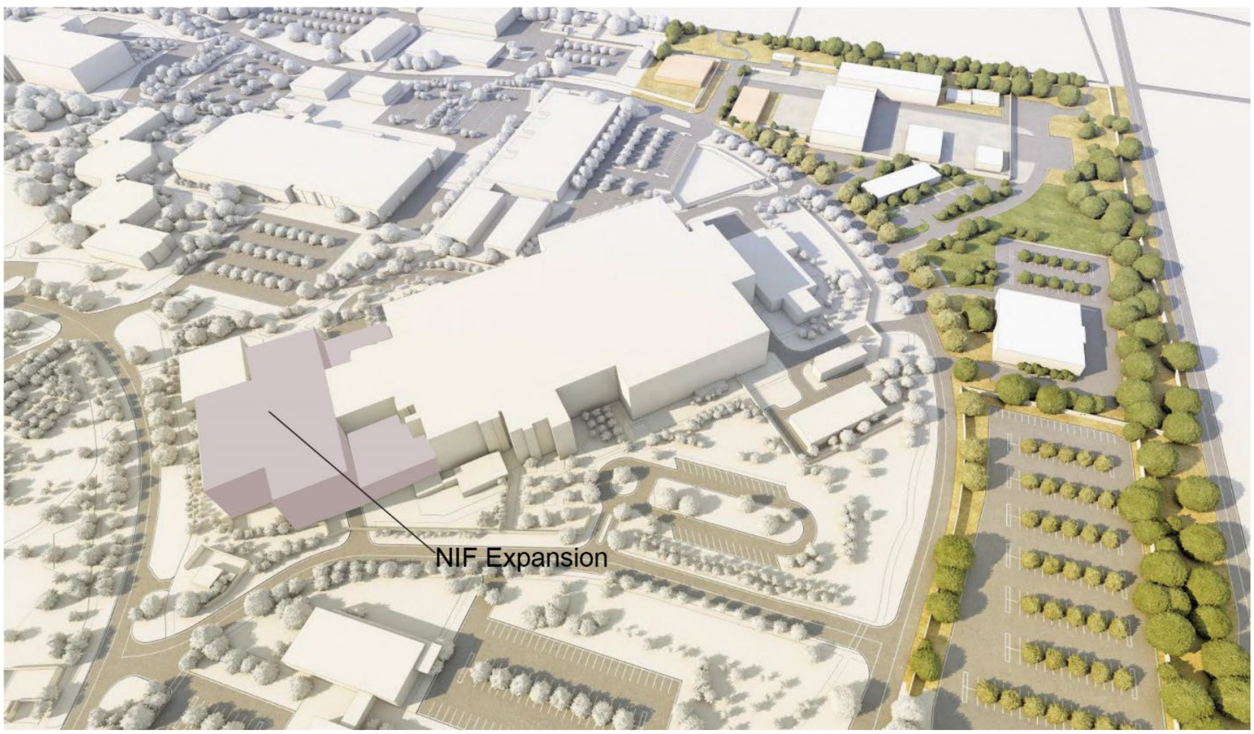
  (3) Step towards doing direct drive experiments: This would be polar direct drive with smooth laser beam to target (as opposed to current indirect drive experiments where the laser beam shines inside of the hohlraum to create x-rays). This will involve beam smoothing technology and modifications to the two ends of the laser systems.

  (4) Increase the rate of experiments from 400 shots per year to 600 shots per year. There would be no change in NIF limits as described in the operational changes under the Proposed Action. Increases in the number of shots would increase LLW

by two transportainers per year. Total yearly shot yield would remain at 1,245 megajoules; therefore, the skyshine.[6]

(5) estimates from the 2005 SWEIS/2011 SA would not increase.

- **Future NIF Laser Expansion.** NIF has the potential for adding a second Switchyard/Target Bay/Target Chamber to conduct experiments using the NIF beam lines. Among other things, this expansion would allow for shielding design to support higher yields, the division of yield/non-yield experiments, direct-drive architecture, and enhanced shot rate. The expansion would be approximately 50,000 square feet as shown on Figure 3-10, and could disturb approximately 3 acres of land located southwest adjacent to the NIF. A new target chamber would require excavation to approximately 50-feet-deep. If the currently defined operational envelope for NIF is insufficient to support operations envisioned for the second target chamber, appropriate NEPA actions would be initiated at a later date (LLNL 2021b, LLNL 2021c).



Source: LLNL 2021b.

Figure 3-10. Potential Expansion of the NIF

3.3.1.4 *Strategic Partnership Projects*

NNSA is proposing to construct several new SPP facilities, including the following notable facilities: (1) Hertz Hall Expansion – Open Campus Generic Office/Lab Building and Revitalization and other Proposed New Facilities; (2) LVOC Advanced Biotechnology Research

[6] Skyshine refers to the dose from neutrons (and the gamma rays produced) that collide with molecules in the air and scatter to the ground.

and Response Facility; (3) LVOC LLNL Collaboration Center; (4) Biosafety Level 3 (BSL-3) Facility Replacement; and (5) Animal Care Facility (includes Forensic Science Center interface and R&D activities described in 3.3.1.5). Each of these proposed facilities is discussed below.

- **Hertz Hall Expansion – Open Campus Generic Office/Lab Building and Revitalization and other Proposed New Facilities.** The Hertz Hall expansion would be a UC funded project, and would consist of light laboratories, offices, and a guest house facilities for visitors from UC campuses. The light labs would use solvents such as isopropyl alcohol (IPA) and soldering equipment, which is expected to generate soldering wastes wipe cleaning wastes. There would also be a 3D printing station. Most other spaces would be offices and computer desktops. The facility would generate soldering waste and wipe cleaning wastes (LLNL 2019e, 2021c).

- **LVOC Advanced Biotechnology Research and Response Facility**. This project involves construction and operation of a 13,000 square-foot laboratory building adjacent to the Advanced Manufacturing Laboratory (AML). The facility would be designed with reconfigurable biological wet lab space for state-of-the-art bioscience, and flexible dry-lab space devoted to building engineering platform prototypes and measurement instrumentation. There is currently a gap in DOE/NNSA capabilities at LLNL to address future pandemics, and this facility would fill those gaps. The proposed building would be similar in size, layout, and overall design to the recently completed AML facility, which includes some chemical fumehoods. The proposed building would also contain biological and biological engineering labs and include BSL-2 labs, with stand-alone biosafety cabinets and safety procedures. No select agents would be present. Environmental impacts would be similar to operations conducted in existing Building 361. Medical, biological, non-biological, hazardous, and municipal waste would be generated. The operations would use Risk Group 2 agents and below that can be handled at the BSL-2 level. The facility would support both near and long-term bioscience, biotechnology, and biosecurity programs across NNSA, DOE, and multiple federal agencies. Locating the facility within the LVOC would aid NNSA's collaboration with outside industry, partners, and academia (LLNL 2020e, 2020f).

- **LVOC LLNL Collaboration Center**. This project involves construction and operation of a 111,000 square-foot 4-story office and conference center with approximately 350 offices.

- **Animal/Biosafety Level 3 Facility Replacement.** LLNL's Animal/BSL-3 Facility, Building 368, is the only such laboratory within the DOE complex. The facility is experiencing an increased demand for many DOE laboratory collaborators and other government and industry strategic partners as well as ongoing and expanding programs. Additionally, there is a need for modern approaches to enhance safety, but these require additional space to implement. The facility supports new work in medical countermeasures (medical prophylactics [e.g., vaccines] and therapeutics [e.g., antibody therapy, antibiotics, drugs]) and is specific to providing risk reduction for public health-related incidents (i.e., COVID-19). Much of this work is important for NNSA's collaborative efforts with university and industrial partners. The Animal/BSL-3 Facility is an aging modular, double-wide facility, containing separate laboratories of approximately 1,560 square feet and 853 square feet, a mechanical room outside of the laboratory space, and change rooms designed for work with select agents at the Animal/BSL-3 level. This facility is nearing its end of life and would need to be replaced or significantly upgraded during this timescale (LLNL 2020m, 2020n, 2021c).

The Proposed Action involves construction of a new modernized replacement facility, with upgraded safety systems and storage capability, which would be approximately 5,000 square feet with laboratory, equipment, and small animal preparation and holding space. Some procedures with the new instrumentation would benefit from the additional of a Class III biosafety cabinet for which space is a current limitation. Currently, due to new regulatory requirements, an extensive inactivation and viability testing program is needed to safely bring inactivated select agent materials out of the BSL-3 to lower containment where instrumentation is available. The facility would allow for a dedicated instrument laboratory to increase the efficiency and reduce the cost of the research by removing all of these extra safety procedures for removing materials outside of the Animal/BSL-3 that are currently needed. The proposed replacement facility would be located within the Building 361 Complex, which is an existing disturbed area within the Livermore Site. The proposed replacement facility would also include a small Animal BSL-3 (ABSL-3) facility which would allow temporary housing of small animals while conducting research requiring an ABSL-3 facility. The facility would be operated under Centers for Disease Control and Prevention (CDC) registration, US Animal Welfare regulations, Public Health Service Policy, "The Guide for the Care and Use of Laboratory Animals" Biosafety in Microbiological and Biomedical Laboratories," and the Association for Assessment and Accreditation of Laboratory Animal Care (AAALAC) International accreditation standards (LLNL 2020m, 2020n, 2021c).[7]

- **Animal Care Facility.** LLNL directly supports NNSA's national security missions targeted at responding to global biological threats from terrorism, weapons of mass destruction (including biological and chemical), protecting the warfighter and countering existing and emerging biothreats. Key to understanding and responding to these threats is the ability to use animal models. In addition, there is an increased need for added capabilities, including the ability to understand and counter exposures to aerosolized toxins and infectious agents, as well as conducting experiments in a secure environment. With respect to the proposed Animal Care Facility, LLNL has an existing capability for conducting R&D activities with small animals in bioscience laboratories. The proposed replacement facility would be located within the Building 361 Complex, which is an existing disturbed area within the Livermore Site. This would be a replacement for work done in the Building 364 and Building 365 areas. The majority of the animal research and most of the animal housing is currently located in Building 364. Animal husbandry, following strict governmental regulations is required to support R&D activities (LLNL 2020m, 2020n, 2021c).

[7] AAALAC International is a private, nonprofit organization that promotes the humane treatment of animals in science through voluntary accreditation and assessment programs.

The Proposed Action would involve construction of a modern 20,000-square-foot replacement Animal Care Facility with state-of-the-art air-handling units and other safety and environmental features. All work would continue at the A/BSL-1 to A/BSL2 in this facility. The facility would be operated U.S. Animal Welfare regulations, Public Health Service Policy, "The Guide for the Care and Use of Laboratory Animals", "Biosafety in Microbiological and Biomedical Laboratories", and AAALAC International accreditation standards. Most of the ongoing work is focused on developing and using models of human disease to develop countermeasures, and testing and validating treatments for exposure to chemical and biological agents. Animals are humanely used in these research protocols and tissues are harvested for molecular analysis. Other chemicals and some radionuclides are also used in this research. The proposed facility would also house secure labs to conduct forensic science work with classified materials in the animal care facility. Some procedures with the new instrumentation would benefit from the addition of a Class III biosafety cabinet. Waste generation includes medical waste as defined by the California Medical Waste Management Act (California Health and Safety Code Sections 117600 – 118360 [California 2017]). No select agents would be used in the animal care facility and therefore no select agent waste would be generated. Small quantities of hazardous waste and LLW would also be generated, which would be collected and disposed of by the RHWM to a disposal site in Utah. After completion, Building 364 would be demolished (LLNL 2020m, 2020n, 2021c).

3.3.1.5 *Global Security*

Global Security capability and infrastructure is aimed at reducing chemical, biological, radioactive, nuclear and explosive (CBRNE) dangers by preventing, countering, and responding to persistent and evolving threats, including assets for counterterrorism and counter-proliferation, nonproliferation, and incident and emergency response. In support of this mission, NNSA is proposing the following new facilities:

- **Domestic Uranium Enrichment Program.** NNSA has a need for domestic uranium enrichment using U.S.-developed technologies in support of the Stockpile Stewardship and Management Program and advanced civilian and defense reactor systems. As experts in the previous uranium-atomic vapor laser isotope separation (Uranium-AVLIS) work at LLNL, the laboratory is well-suited to conduct pilot-scale laser-based technology development work and to use these systems to enrich depleted uranium inventories. Once selected and successfully developed, this LLNL technology would then be transferred to one of the NNSA production agencies where it can be scaled up to support NNSA uranium enrichment programs. The facility would be a radiological facility and would remain below Hazard Category (HC)-3 threshold. Less than HC-3 facilities are classified in accordance with DOE-STD-1027. The proposed project would require an approximately 150,000 square feet laboratory facility in the north-central portion of the Livermore Site. The first year of this 5- to 10-year project would define the sizes for equipment and materials for this facility. It is expected that the facility would use modern dye-pumped solid-state laser systems, and isotope separators to conduct this technology development work. The facility would also house optics systems, cleaning, optics development work, computer systems, dye pump support systems, ethanol tanks, and ethanol recovery system. The facility would also utilize the existing LLNL dye-pump facility, Building 491. Hazards in the facility would include laser systems, dye systems, and the use of radioactive materials. The facility's operational parameters are as follows:

- Ethanol usage up to 500 gallons per year. This would be 95 percent ethanol and 5 percent water;
- Solid dye usage of up to 300 grams per year. These are generally Rhodamine-class dyes, which are classified as hazardous by OSHA;
- Ethanol solvent recovery system capable of processing up to 500 gallons per year would only be needed if it helped with reducing disposal of dye ethanol waste. Solvent recovery was also previously done during the uranium-AVLIS work in the 1990's, and the dye/ethanol mixtures were disposed of as waste (LLNL 2021h).

- **Classified Lab**. This 15,000-square-foot classified laboratory would be used to conduct electromechanical work, as well as work involving test assembly, clean room activities (optics), and small wet and dry chemical capability. It would be a low-hazard radiological facility just like Building 132N, and the waste and emissions would also be like Building 132N. There would be a fume hood and an exhaust stack. Emissions would be from the use of solvents for wipe cleaning (LLNL 2021c).

- **Forensic Science Center.** This 60,000-square-foot facility would replace Forensic Science laboratory spaces in Building 132N with a new state-of-the-art classified laboratory space, including 30 new chemistry and biology laboratories and 80 offices. The biological laboratories would be at BSL-2 (with potential select agents) or below. The facility would support U.S. compliance with the Chemical Weapons Convention, as well as the ongoing and expanding work for the U.S. Federal Bureau of Investigation, the intelligence community, and other U.S. government organizations. The Forensic Science Center laboratory would provide the unique capability to accept and analyze samples that are potentially contaminated with CBRNE materials. The generated wastes and safety basis for the proposed facility would be similar to that which currently exists for Building 132N (LLNL 2021c).

- **Network Intelligence Research Facility.** There is a need to expand support for emergency response, forensics, nuclear counterterrorism, and other intelligence-related projects. Specifically, NNSA requires expanding support to Defense Programs (NA-10), Defense Nuclear Nonproliferation (NA-20), Research and Development (NA-22), Nonproliferation and International Security (NA-24), and Emergency Response/Counter-terrorism and Counter-proliferation (NA-40/80). Current LLNL sensitive compartmented information facility (SCIF) space needs and expected growth for the next 10 years would require an additional 140 SCIF offices and associated support areas. The proposed action would construct an 80,000 square foot facility encompassing offices, light electrical laboratories, server rooms, communications rooms and other support space; and would double the amount of SCIF square footage at LLNL. The office/lab facility would house analysts, engineers, and technicians working on a variety of intelligence-related projects focused on international threats and corresponding countermeasures.

- **Cyber-Physical Test Capability for Energy Distribution.** The Site 300 Cyber-physical test capability for energy distribution would install renewable power generation and distribution systems at Site 300 to enable cyber-physical testing and demonstration focused on enhancing the resilience of the US energy production and distribution infrastructure. The proposed project is anticipated to begin in FY 2022. This effort will involve installing electrical generation and storage equipment consisting of ground mounted solar arrays, battery storage, and diesel generators (three 200 kVA generators) as well as power distribution equipment connected by a dedicated overhead distribution line system. A construction trailer will also be used to house monitoring and control equipment. It is anticipated that about 2.25 acres of previously undisturbed area of the land will be used for equipment installation and the new distribution line. The locations will be in the vicinity of Building 837, northwest of Building 865 and Building 847/Water Tank 1, and a distribution line connecting these areas. Generated waste is expected to be minimal from commercial energy storage equipment and solar photovoltaic generation systems. The installed equipment will allow NNSA to evaluate limited but useful resilience capabilities to provide backup power to support other activities at S300.

- **Alternative Energy Micro-Grid for the Future.** The Site 300 alternative energy micro-grid for the future will both provide a pilot location for demonstrating resilient power solutions from renewable sources as well as provide some power for Site 300 using primarily renewable sources thereby enhancing LLNL's ability to provide uninterrupted NNSA mission support even during grid-wide power outages. The initial stage of this proposed effort will begin in FY 2023 and will include implementation of grid-of-the-future solutions at the General Services Area (GSA) and the Small Arms Training Area of Site 300 by installation of additional solar photovoltaic (PV), advanced energy storage solutions and integration with advanced technologies such as building management system and sensors for energy efficiency and resilience improvement. In FY 2024, the proposed project will utilize solar PV, new advanced renewable power technologies including energy storage capabilities to provide some site backup power through microgrid technologies. This capability will allow NNSA and other sponsors to evaluate integrated alternative energy technologies for US grid resilience. A new bladeless wind technology will be piloted that is expected to be minimally invasive to bird species. It is anticipated that about 9.4 acres of previously undisturbed area of the land would be used for equipment installation, a significant portion of which would be ground mounted solar PV arrays. About 11 acres of previously disturbed ground would be used for installing rooftop solar PV and parking lot canopy PV. These would include the surrounding areas of Buildings 837, 865, and 847/Water Tank 1, GSA, and SFTF.

- **Materials Analysis Laboratory.** This facility (approximately 20,000 square feet) would support LLNL's expanding nuclear forensics work. In short, this facility would be similar to Building 151 but on a smaller scale. The facility would have the ability to do high sensitivity and high-resolution chemical and nuclear analysis but would remain a low-level radiological facility with similar emissions, hazards, and waste streams as Building 151. Currently, LLNL is at capacity in Building 151, and are limited to support the growing NNSA mission requirements. The facility would generate LLW and MLLW in small quantities, and the generations rates are included projections for the Proposed Action. This facility would support programmatic requirements for Defense Nuclear

Nonproliferation (NA-20), and Counterterrorism and Counter-proliferation (NA-80). This is a growing area for which LLNL capabilities are sought after and our technical expertise highly valued. This facility would be submitted using the ENERGY STAR method for design.[8]

- **Generic Classified Office Building**. LLNL is experiencing a shortage of classified office space. This office building is planned to be near LLNL's proposed Classified Lab Facility and would be approximately 15,000 square feet and house 40-50 staff. There is a need to expand support for emergency response, forensics, nuclear counterterrorism, and other intelligence-related projects. Specifically, NNSA requires expanding support to Defense Programs (NA-10), Defense Nuclear Nonproliferation (NA-20), Research and Development (NA-22), Nonproliferation and International Security (NA-24), and Counterterrorism and Counter-proliferation (NA-80). This facility would be submitted using the ENERGY STAR method for design.

3.3.1.6 *Enabling Infrastructure Projects*

NNSA is proposing to construct many new projects related to Enabling Infrastructure, including the following notable projects: (1) ES&H Analytical Laboratories Replacement; (2) Packaging and Transportation Safety and Operational Support Facility; (3) Whole-Body Counting Support Facility; (4) Non-Destructive Evaluation Stockpile Test and Evaluation Capacity Expansion; (5) Generic Office Buildings/Modernization of Existing Office Buildings/Miscellaneous Laboratory Facilities; (6) New Parking Structures and Rebalance of Site-Wide Parking; (7) Upgrades of Electrical, Mechanical, and Civil Utilities at the Livermore Site and Site 300; (8) Fire Station; (9) New North Entry at Livermore Site; (10) Extend city of Livermore Reclaimed Water Distribution System for Cooling Tower Use; (11) Seismic Risk Reduction Projects; (12) Removal of Limited Area Fencing; (13) Arroyo Mocho Utility Upgrades; (14) Expand Pedestrian Walkways; (15) Expand Bicycle Circulation; and (16) Lake Haussmann Enhancements. Each of these proposed projects is discussed below.

- **ES&H Analytical Laboratories Replacement.** This 40,000-square-foot laboratory is a proposed replacement for ES&H analytical laboratory functions within Buildings 253, 254, and 255, and a small lab in Building 151 at the Livermore Site. Operations would include wet chemistry and instrumentation for analyzing environmental samples, bioassay samples and personal dosimetry; radiological and industrial hygiene calibration; and respirator program activities. The new building would contain shielded cells housing radiation sources. Fully contained Risk Group 1-3 agents would be occasionally irradiated in the facility. In addition, experiments would be performed to determine the aging effects to small explosives samples due to exposure to radiation fields generated by radiation sources. These quantities are considered non-detonable by abnormal stimuli or environment. No explosives waste is generated from the experiments. The new building would be classified as a Low Hazard Facility based on the inventory of radiological materials. Operations in

[8] ENERGY STAR is a joint program of the USEPA and DOE. Its goal is to help consumers, businesses, and industry save money and protect the environment through the adoption of energy-efficient products and practices.

the new building would generate the same types and quantities of wastes as the current buildings (LLNL 2021c).

- **Packaging and Transportation Safety and Operational Support Facility.** This new facility would serve as a replacement for office space in Building 234, Building 231 Vault, Building 233 Garage Area and Building 233 Fenced Area. Primary operations at this 11,000- to 14,000-square-foot facility would include 20 offices and 8,000 square feet of operational space. The office space would be divided into a Vault Type Room (VTR) space that would house 8 individuals and classified terminals; while the other portion of the building would house 12 to 20 people, break room, and a conference room. The packaging and shipping operational space has special requirements as it would be the main shipping and receiving area for radioactive materials and classified materials shipments. This type of work requires that the space be both a Radioactive Materials Area (RMA) and a VTR. Due to the classified materials and documents associated with this work scope, there will need to be four classified data lines and a classified phone line within the RMA VTR. The RMA VTR portion of the building would be a high-bay area (25- to 30-foot-tall ceilings) with reinforced concrete structure with large vault-type steel doors for access from the exterior and a lighter-weight interior door for access from the attached office areas; it will require HEPA filtration. Operations would include shipping, receiving, and storage of controlled materials. These operations include handling, lifting, loading, inspecting, weighing, measuring, surveying, swiping, packing, and re-packing. Equipment necessary to perform these operations include an overhead crane, fume hood and drum opening station. Related tasks would include certifying nuclear explosive-like assembly (NELA)/non-fissile material (measuring/surveying) and handling radioactive/hazardous/ mixed waste in satellite accumulation areas. Controlled materials typically encountered in these facilities would consist of accountable nuclear materials, sealed sources and other radioactive materials, classified parts and assemblies (including their hazardous/ radioactive materials), mock explosives, small quantities of explosives, and precious metals. As part of the shipping/receiving function of the facility, RGDs (up to Class IV) may be temporarily received in the facility before they are sent to their final destinations within LLNL (LLNL 2021c).

- **Whole-Body Counting Support Facility.** This would be a 2,000-square-foot facility at the Livermore Site. When Building 253 is demolished (which is scheduled for approximately 2031), the Whole-Body Counting facility on the side of Building 253 would remain. This new support facility would be built to provide offices and labs near the whole-body counting facility (LLNL 20201c). This appears to be the most cost-effective solution to providing employee health monitoring capabilities.

- **Non-Destructive Evaluation Stockpile Test and Evaluation Capacity Expansion**. The current non-destructive evaluation facilities would be expanded to support the growing LEPs and Mods work. Building 327 low-energy capabilities would be relocated to this new 11,000 square feet facility with modern, flexible open labs LEP and Mods work. The facility would utilize similar equipment as in Building 321G, and would include RGDs with radiation hazards. The facility would not generate any hazardous or radioactive wastes (LLNL 2021c).

- **Generic Office Buildings/Modernization of Existing Office Buildings/Miscellaneous Laboratory Facilities.** As previously discussed, LLNL facilities are old and aging. Modernization is critical to long-term goals to support NNSA's national security missions. As shown in Table 3-4 and Table 3-5, NNSA plans to construct/modernize many generic/miscellaneous office buildings/laboratory facilities by 2035. Per Table 3-4, approximately 17 new generic office buildings are proposed at the Livermore Site, totaling approximately 374,000 square feet (each generic office building is expected to be approximately 22,000 square feet in size); two new office buildings, totaling approximately 24,000 square feet, are proposed to be located at Site 300. In addition to these generic office buildings, several specific office buildings are proposed, such as the Institutional Office Administration Facility and the Engineering Administration Office (LLNL 2021b, 2021c).

- **New Parking Structures and Rebalance of Site-wide Parking.** Current Livermore Site parking count identifies more than 17,000 spaces overall. Available area, changing programs, and shifts in staff population have resulted in a situation in which the Livermore Site is over-parked by space-count, but poorly balanced by the location of those spaces. Recognizing convenience in access as a reasonable priority, new surface parking is proposed to be located in smaller lots near buildings. This reduced area carries visual benefit, limiting the visual potential for a "sea of parking" with improved opportunities for screening and shading. With this, consolidated parking would be accomplished in a few large lots at the Livermore Site perimeter or in parking structures to support increased worker population near the central portion of the Livermore Site. For the Proposed Action, NNSA is proposing to construct two new parking structures: (1) a two-level 90,000-square-foot garage with 300 parking spaces located close to the National Security Innovation Center; and (2) a multi-level 250,000-square-foot parking structure east of Building 341 (LLNL 2020g, 2021c). The Proposed Action assigns about 1,500 spaces to the two new parking structures, increasing total space count to more than 2,500 spaces in the central portion of the site. Figure 3-11 reflects this proposed new parking balance.

Source: LLNL 2021b.

Figure 3-11. Parking Distribution for the Proposed Action

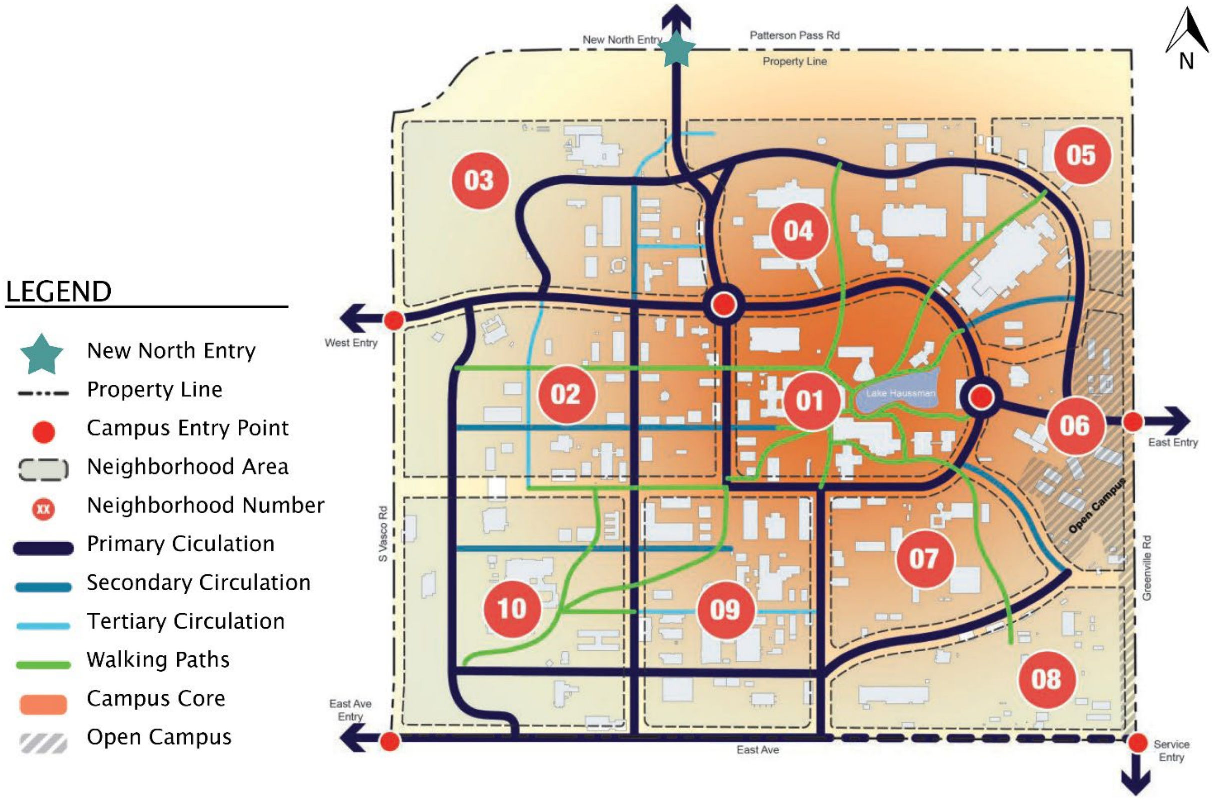
Existing parking lots on site would be preserved when not in conflict with proposed construction sites. New surface parking lots are proposed for site areas that are currently unoccupied or that may become available through progressive building replacement process. In addition, while new construction projects at LLNL include charging stations near building entrances for government vehicles, the demand for electric vehicle charging stations for employee's personal vehicles has significantly outpaced supply. The existing program that allows staff to charge their vehicles for a monthly fee has a substantial waiting list. Increasing the number of charging stalls in the larger parking lots is included under the Proposed Action.

- **Upgrades of Electrical, Mechanical, and Civil Utilities at the Livermore Site and Site 300.** LLNL is comparable to a small city— it provides utility services to hundreds of buildings, roads, and basic support services for its population. The Livermore Site and Site 300 have their own electric, gas, water, communications, sewage collection systems, security force, and fire stations. Components within LLNL's utility systems are more than 50 years old, have aged to the point of unreliability, and/or can no longer be maintained cost effectively. Leaks and system failures are impacting mission facility availability. Aging of LLNL's utilities and need for reliable, code-compliant systems create gaps that require ongoing investment. In addition, existing capacity must be adjusted to meet the projected load increases demanded by future NNSA requirements and strategic plans. Investments must be made to replace and upgrade electrical systems—including life-safety, mechanical, and civil utilities—to ensure reliability and allow for preventive maintenance without major planned outages and interruptions to mission-significant facilities. Infrastructure projects include utility valves and water distribution piping replacements, domestic water system treatment plant upgrades, Site 300 erosion control systems installation, paving systems replacements, facilities fire protection and life-safety systems replacement, and electrical system upgrades (LLNL 2017a).

- **Fire Station.** A new 30,000-square-foot Fire Station is proposed to be constructed in approximately 2028 (LLNL 2021c). The existing single-story fire station was built in 1959 and expanded in 1990 to house additional vehicles and consolidate management offices. The original part of the building was retrofitted in 1994 to meet seismic requirements and to modernize the living quarters for the fire crews. The building is now inadequate for many reasons including, poor insulation, high energy consumption, and antiquated HVAC controls. In addition, restrooms need modernization and expansion, and sleeping areas need modernization. The facility no longer meets its goal of providing a fully functional fire station with administrative offices meeting the needs of a modern professional fire department. A replacement for this building is needed to provide the quarters needed for the firefighting crews, provide space for housing fire vehicles, and provide administrative space. The scope of work includes constructing a new Fire Station with administrative offices at a location that will provide desirable emergency response routes to onsite and offsite locations. The preferred location for the new Fire Station would be south of the EOC in the west buffer zone. In addition, this SWEIS analyzes an alternate location west of the New North Entry in the north buffer zone.

- **New North Entry at Livermore Site.** As shown on Figure 3-12 and Figure 3-12, a New North Entry to the Livermore Site is proposed for 2025. This site entry would provide quick employee access to the center of the laboratory where several new facilities and office buildings are being proposed under both the No-Action Alternative and the Proposed Action. The New North Entry would alleviate traffic backups and delays/wait times (some up to 15 minutes long) that occur during the morning commute at the West Gate entrance. Approximately 1,500 lineal feet of roadway construction and approximately four acres of land would be disturbed for this project. The roadway would cross the approximately 500-foot-wide north buffer zone, and an approximately 100-foot-long bridge would be constructed across the existing Arroyo Las Positas (LLNL 2021b).

- **Extend City of Livermore Reclaimed Water Distribution System for Cooling Tower Use.** NNSA is proposing to improve LLNL's water resource sustainability practices by working with multiple local water agencies to extending the supply of city of Livermore Water Reclamation Plant (WRP) reclaimed water for use in cooling towers at the Livermore Site. As shown on Figure 3-14, this proposal would require construction of approximately 6,000 linear feet of 6-inch-diameter piping on the Livermore Site, buried to a depth of approximately 3 feet. Approximately 2.5 acres of land would be disturbed during construction activities, but would be restored after construction. The reclaimed water would be used by existing cooling towers U291 and OS454 and a future cooling tower serving the ECFM project (Stantec 2019). To facilitate this extension, replacements/upgrades to the individual cooling towers would be necessary.

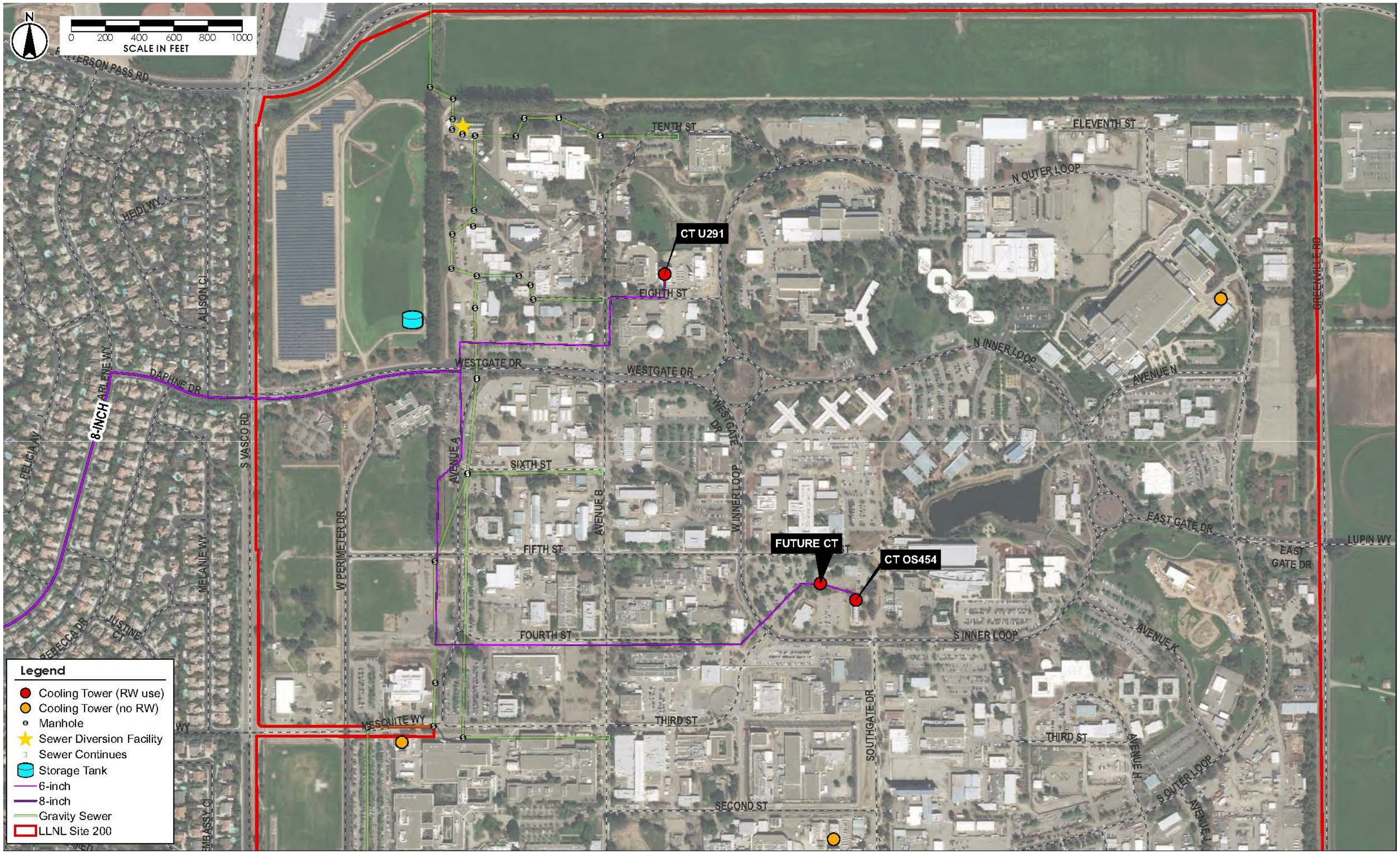


Source: LLNL 2021b.

Figure 3-12. Location of New North Entry to Livermore Site

Source: LLNL 2021b.

Figure 3-13. Details of New North Entry to Livermore Site



Note: The purple line shows the pipeline extensions on the Livermore Site and the near vicinity.
Source: Stantec 2019.

Figure 3-14. Extend City of Livermore Reclaimed Water Distribution System for Cooling Tower Use

- **Seismic Risk Reduction**. The Proposed Action includes seismic upgrades to several facilities, as identified in Table 3-5. These buildings are Class B Priority or lower. Class B Priority indicates that they would have poor seismic performance in a design basis earthquake and would potentially receive heavy damage but collapse not likely. Several of these facilities are large (about 200,000 square feet) and routinely occupied. The buildings would be upgraded to meet Life Safety performance objectives.

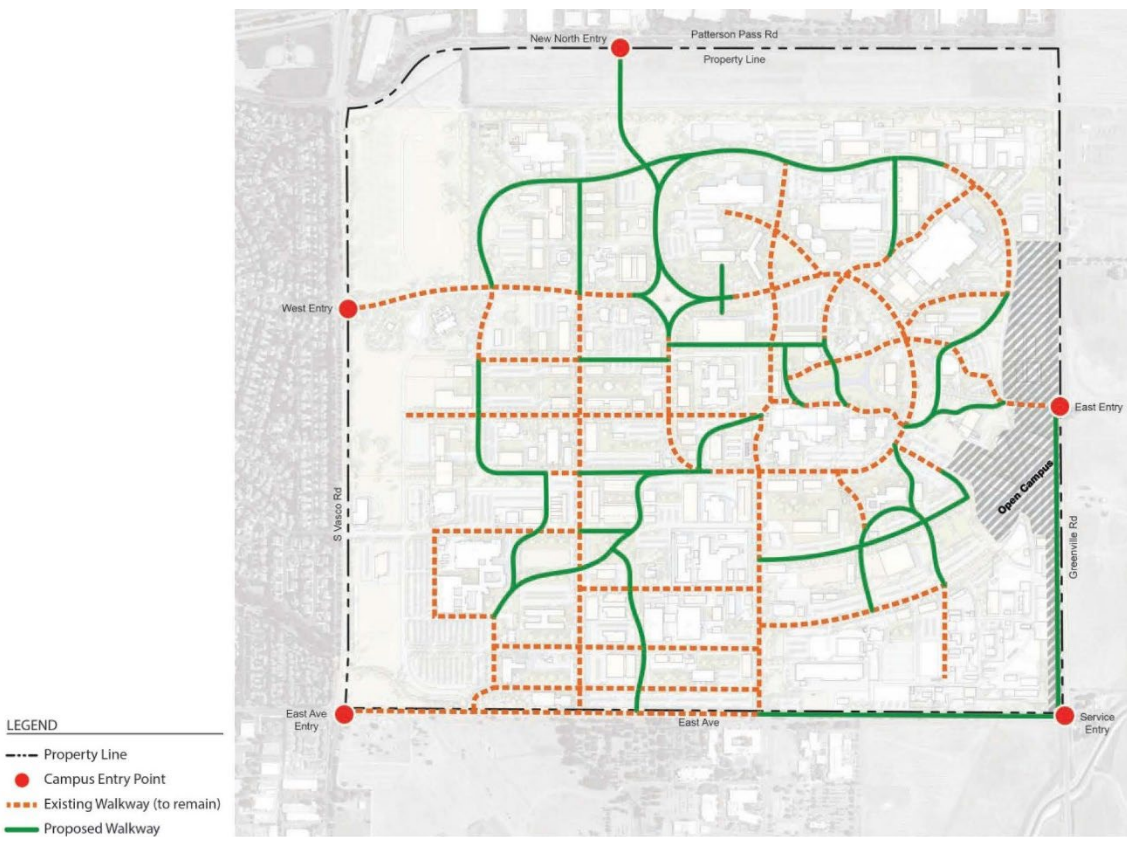
- **Removal of Limited Area Fencing.** The Proposed Action also includes operational Limited Area fencing located throughout the Livermore Site to provide a layer of physical security external to buildings. Over time, the position and extent of these barriers have changed in response to evolving security requirements. Today, these fences are concentrated in the southwest corner of the laboratory and present a significant challenge to redevelopment. Gradually removing and relocating Limited Area fencing and the associated legacy posts and turnstiles would allow more fluid pedestrian movement and thereby greater collaborative potential. In addition, general access areas (GAA) around the LVOC and along Vasco Road would be expanded as collaborative projects are built on the edges of the Livermore Site. Figure 3-15 displays proposals related to removing the Limited Area fencing and expanding the GAA at the Livermore Site.

Source: LLNL 2021b.

Figure 3-15. Removal of Limited Area Fencing and Expanding General Access Areas

- **Arroyo Mocho Utility Upgrades.** NNSA proposes the following upgrades to the Arroyo Mocho water supply system: (1) installation of a second telemetry control system; (2) replacement of the pump control systems and associated electrical switchgear; and (3) refurbishment of the seven-mile-long pipeline. These projects would improve the reliability and life of the supply system. Telemetry control systems, which are used to monitor pressure and flow, detect leaks, and control pumps and valves, are critical for reliable primary water supply to the Livermore Site and SNL/CA. With regard to the electrical switchgear for the pumps, NNSA would install a backup generator, as the site only has one source of power. Because failure or break in the seven-mile-long pipeline that supplies Hetch Hetchy water from the Arroyo Mocho pump station to the Livermore Site would undermine the water supply, NNSA would refurbish the pipeline to reduce the risk of losing the water supply (LLNL 2021c).

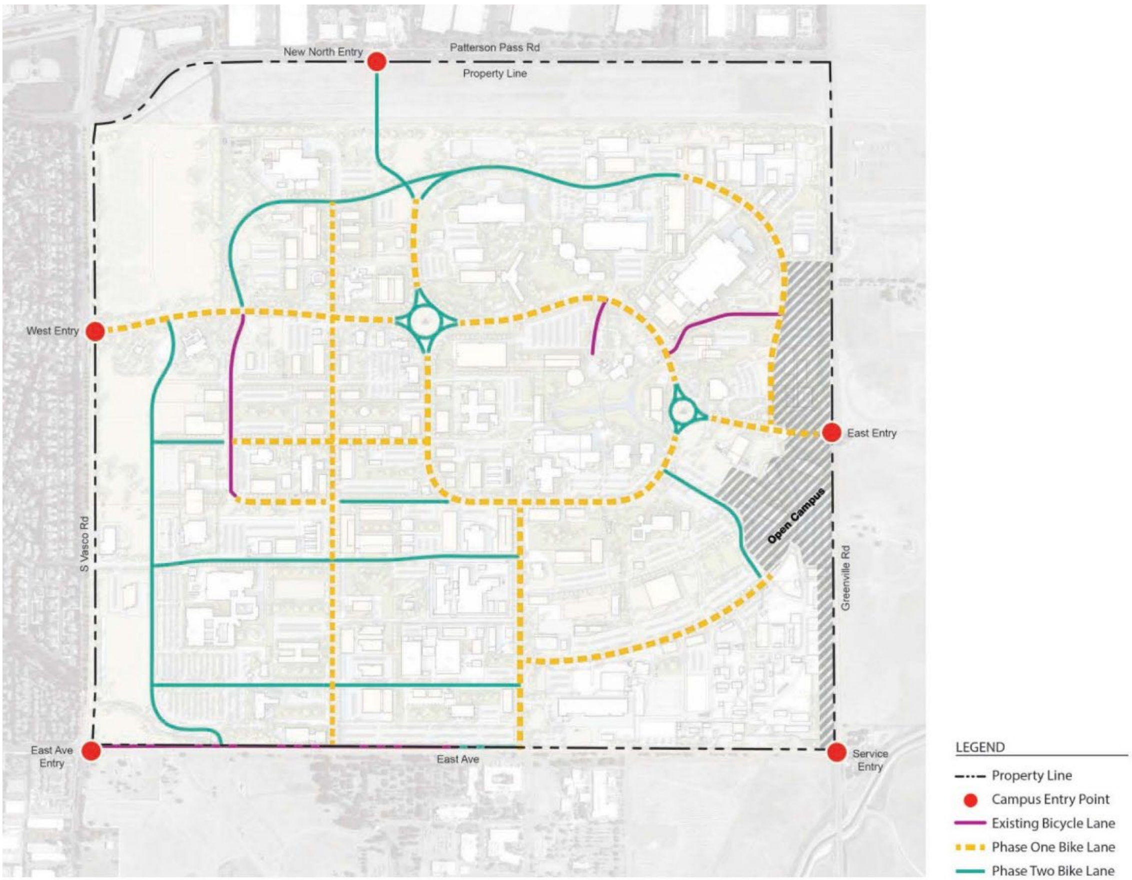
- **Expand Pedestrian Walkways.** Pedestrian routes are typically located adjacent to roadway or parking areas on the Livermore Site. The SWEIS identifies opportunities for dedicated pedestrian circular networks throughout the Livermore Site, as depicted in Figure 3-16. Approximately six miles of new pedestrian walkways would be constructed, disturbing approximately six acres of land (LLNL 2021b).



Source: LLNL 2021b.

Figure 3-16. Expanded Pedestrian Walkways at the Livermore Site

- **Expand Bicycle Circulation.** The one-square-mile Livermore Site is easily traveled by bicyclists if there are adequate considerations made for their safety along the vehicle roadways. Consequently, as depicted in Figure 3-17, NNSA is proposing to stripe 4-foot-wide bike lanes on existing roads that are generous enough in width to provide safe passage for vehicles and bicyclists simultaneously.



Source: LLNL 2021b.

Figure 3-17. Expanded Bicycle Circulation at the Livermore Site

- **Two Site 300 Office Buildings (unclassified and classified spaces).** LLNL is experiencing a shortage of office space and is planning to lease spaces offsite. Specifically, Site 300 has a critical shortage of office space, particularly in the GSA. Two office buildings are separate projects proposed for this area: the first office building (approximately 24,000 square feet) would house 100 personnel, and the second office building (approximately 50,000 square feet) would house 200 personnel. The buildings would provide modern office space based on ENERGY STAR initiative floor plans. Both buildings would provide needed space for new hires and serve as a "Site 300 Hub," creating hoteling/short-term office space for LLNL commuters coming from the Central Valley and beyond, while also providing a home base for classified computing and IT. A master planning study is underway to identify the current capacity of the electrical, water, and sewage systems as well as to determine the future utility requirements of the GSA and forward areas. The study would also quantify the classified and unclassified office needs of Site 300. This office space supports programmatic requirements for NNSA.

- **Lake Haussmann Enhancements.** Although not a native or natural water body, Lake Haussmann is a feature element and is located in the geographic center of the Livermore Site. In addition to its aesthetic value, Lake Haussmann is a conveyance channel for both stormwater runoff and treated groundwater that is discharged off site into Arroyo Las Positas. NNSA is proposing additional landscaping around Lake Haussmann to facilitiate a collaborative environment while retaining a significant water feature. Lake Haussmann would continue to serve as a conveyance channel.

3.3.2 Proposed Action: DD&D Projects

Under the Proposed Action, NNSA would DD&D about 150 facilities, totaling approximately 1,170,000 square feet; 98 percent of these facilities are at the Livermore Site (131 facilities, totaling about 1,153,000 square feet) and 2 percent (18 facilities, totaling about 17,000 square feet) are at Site 300. On an annualized basis, NNSA would DD&D approximately 90,000 square feet of excess facilities over the SWEIS Proposed Action planning period (2023–2035).

3.3.3 Proposed Action: Operational Changes

NNSA is proposing to increase the tritium emissions limits at the NIF (Building 581) and the Tritium Facility (Building 331). Emissions from the Tritium Facility and NIF may not increase; however, increased reservoir tritium loading (up to 1,500 Ci) presents the potential for higher emissions during reservoir handling and associated system operations or maintenance. Engineered solutions to tritium emissions, including the Tritium Processing System, are expected to continue to operate with high efficiency (>99 percent) but some equipment/operations fall out of the control umbrella of these engineered systems. These larger quantities of tritium would be required to fill the larger target gas capsules to higher pressures anticipated in new experimental platforms. The fill systems are complex and operated manually, and could release part or all of the tritium from the target or reservoir to the NIF or Building 331 environmental stacks instead of the intended tritium recovery systems. Additionally, programmatic and maintenance tasks required during tritium processing (e.g., changing fill and source vessels during processing operations and maintenance of valves, pipes, pumps, and molecular sieves may increase the likelihood of incidental tritium emissions. This SWEIS analyzes the potential impacts from increased tritium emissions limits (*see* Section 5.14 of this LLNL SWEIS).

In addition, NNSA is proposing to decrease the administrative limit for fuels-grade-equivalent (FGE) plutonium in the Superblock (Building 332). The 2005 LLNL SWEIS ROD established an administrative limit for all isotopes of plutonium in the Superblock to 1,400 kilograms, enriched uranium to 500 kilograms, and depleted or natural uranium to 3,000 kilograms. In this SWEIS, NNSA is proposing to reduce that administrative limit to 300 kilograms of FGE (see text box below) plutonium; 200 kilograms of enriched uranium; and 1,000 kilograms of natural or depleted uranium.

> **Administrative Limits**
>
> Administrative limits are defined as the maximum amount of the referenced material allowed at a facility. The actual inventory for some materials at LLNL for which there is an administrative limit may be classified.

Fuels-Grade-Equivalent (FGE) Plutonium

The Building 332 Documented Safety Analysis (DSA) uses 30-year-old fuels-grade plutonium for material-at-risk (MAR) in accident scenarios. Most of plutonium handled in Building 332 is weapons- or fuels-grade-plutonium, that comprise of a variety of different isotopes. The major difference between the two is the presence of americium-241 (Am-241), which has a higher potential radiological dose than any of the plutonium isotopes. Because the 30-year-old fuels-grade plutonium has approximately three percent Am-241, versus 0.45 percent in weapons-grade, the fuels-grade is used as a standard to compare with all other radionuclides. This is done by the method of Equivalent Mass Multiplier (EMM), where the EMM for fuels-grade is defined as 1.00. The EMM for weapons-grade is 0.47 and for Pu-238 is 80.9. For example, 10 kilograms of fuels-grade plutonium is equivalent to 10 divided by 80.9, or 0.12 kilograms of Pu-238. In other words, 0.12 kilograms of Pu-238 has a FGE of 10 kilograms. This method is used to determine a FGE plutonium value for all other materials used in Building 332 that have different isotopes than the specified 30-year-old fuels-grade plutonium. The FGE value is also used in the inventory control process to ensure that the facility operates within the envelope of analyzed conditions. The FGE values represent the amount of an isotope giving an offsite dose equivalent to 30-year-old fuels-grade plutonium as analyzed in the Building 332 DSA.

Source: LLNL 2016a.

The Administrative limits for enriched uranium (greater than one percent enrichment for SWEIS purposes) are proposed at 200 kilograms; and for depleted and natural uranium (less than one percent enrichment for SWEIS purposes) at 1,000 kilograms. NNSA notes that the Building 334 administrative limits for plutonium, enriched uranium, and natural and depleted uranium are included in the Building 332 administrative limits. After de-inventory of Security Category I and II materials were completed in 2012, LLNL designated material areas would remain below Security Category II material limits. This SWEIS analyzes whether the proposed decrease would impact operations and accidents involving the Superblock (*see* Section 5.16).

The National Ignition Facility would revise its radioactive materials administrative limits for all isotopes in accordance with the applicable hazard categorization standard. The facility would increase the tritium inventory limit from the No-Action Alternative (8,000 Ci) to below the HC-3 limits (16,000 Ci) under the Proposed Action. The facility would also increase the plutonium-239 administrative limits to below 38.2 grams per DOE-STD-1027-2018 when approved for use at LLNL. These changes would maintain the existing facility limit of less than HC-3 in accordance with DOE-STD-1027 revisions approved for use at LLNL. For purposes of this document, radiological hazard categorization primarily uses DOE-STD-1027-92, which is the currently applicable standard at LLNL per the terms of the prime contract. Because the SWEIS is a forward-looking document, some proposed projects will use the more recent revision, DOE-STD-1027-2018 (DOE 2018), which NNSA expects to implement at LLNL in the future. Use of either of these revisions is acceptable by the guidance provided by DOE. These limits are presented in Chapter 4 (*see* Table 4-39) and analyzed in Appendix C and Chapter 5. The bounding radiological impacts from accidents at LLNL are not related to NIF operations; therefore, neither the current nor proposed tritium inventory limits in NIF would change the bounding radiological impacts from accidents.

NNSA is also proposing to increase the administrative limits for plutonium mixtures at Building 235 from less than 8.4 grams plutonium-239 under the No-Action Alternative to less than 38.2 grams under the Proposed Action. This increase would maintain the existing facility limit of less than HC-3 in accordance with DOE-STD-1027 revisions approved for use at LLNL. The increased limits in B235 would lead to expanding the laboratory space dedicated to the preparation of plutonium samples for experimental work conducted outside of B235. This would enable the preparation of experimental samples for critical high-pressure experiments at NIF, JASPER facility at Nevada Nuclear Security Site, HPCAT and DCS facilities at Argonne National Laboratory, Z Pulsed Power Facility at Sandia National Laboratories, and other facilities. Building 235 would also conduct characterization of aged and newly manufactured actinide materials; small scale benchtop experiments evaluating engineering property changes as a function of age; and new manufacturing processes and methods of mitigating the effects of aging. NNSA Programs require this information to support mission critical requirements which cannot be obtained at Building 332 due to capacity limitations. This work scope currently has funding to support these operational changes and enhances the experimental facilities to allow the work to be done safely at LLNL. Approximately 600 square feet of existing laboratory space would be repurposed to plutonium operations, and three additional glove boxes would be installed to accommodate diamond turning, sample polishing, diamond wire saw cutting, and other experimental sample preparation operations along with a dedicated focused ion beam mill. All of the equipment would enable NNSA to better characterize plutonium samples and to prepare plutonium metal into the proper geometry to support critical experimental efforts across the weapons complex.

3.3.4 The Proposed Action End State

The planned removal or replacement of aged facilities creates an opportunity to shift population and intensity of use toward a central location within the Livermore Site. Because Lake Haussmann is a feature element and the geographic center of the Livermore Site, the Proposed Action would consolidate many new facilities near this location to create opportunities for collaboration, introduce employee amenities, and enhance the image of the site. Enhancing the landscaping with additional vegetation and walkways would facilitate this proposed vision. Figure 3-18 depicts a "heat map" that visually illustrates the concentration of employees in an identifiable central area (Area "01") while reducing the concentration of worker population in the surrounding collaborative loop (Areas "02-10").

The size of the Livermore Site also places a premium on the value of an effective, site-wide network of pedestrian links and bicycle paths. While the loop road system is currently geared to vehicles, the original master planning concept envisioned a pedestrian network, converging on Lake Haussmann. In addition, changing security protocols would allow for removal of significant fencing of Limited Areas, removing additional barriers to cross-site pathways. The Proposed Action also addresses this approach for pedestrians and leverages the width of the loop road system to introduce dedicated lanes for bicycle travel.

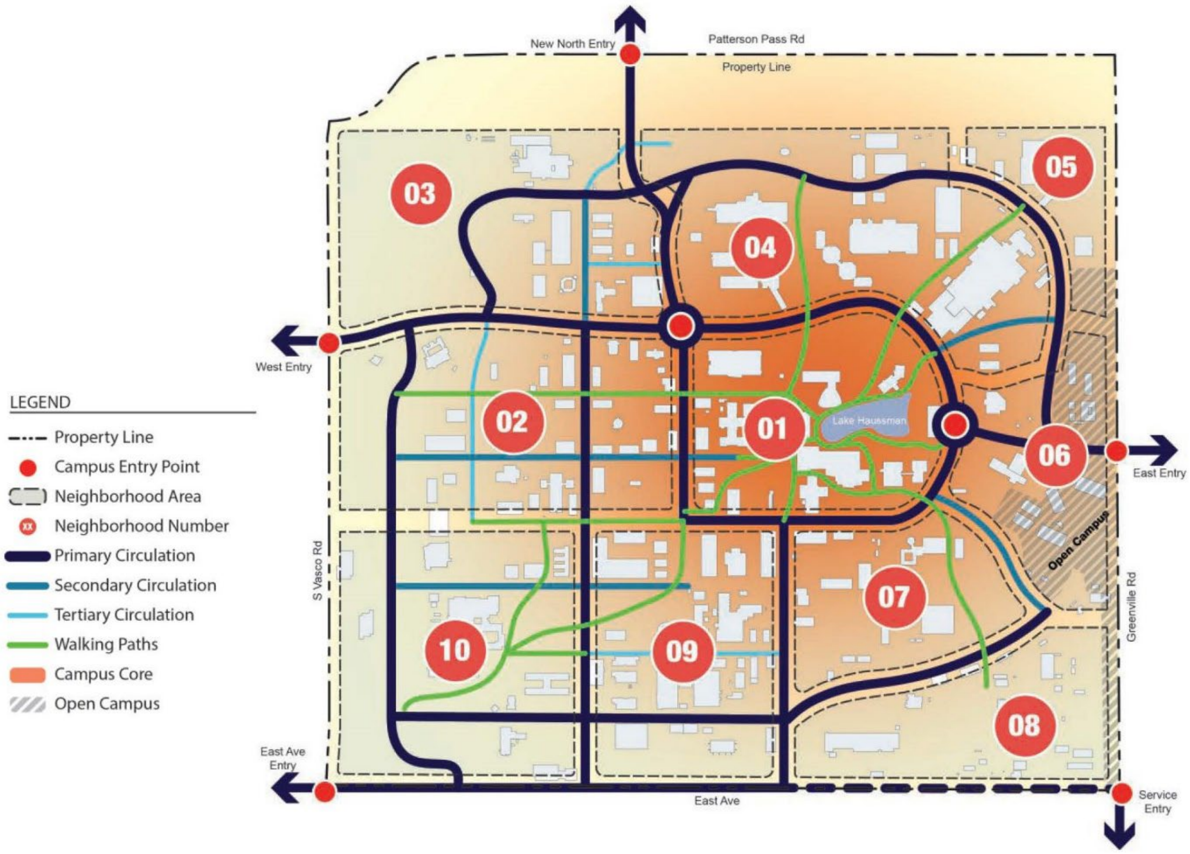


Figure 3-18. Illustration of the Concentration of Employees in Central Area

3.3.5 New Hybrid Work Environment for the Proposed Action and No-Action Alternative

Although teleworking was not discussed in the scoping meetings, this SWEIS includes analysis of an implementation option in which NNSA would maximize telework at LLNL. This new hybrid work environment is a DOE/NNSA initiative at the Administrator-level involving all NNSA laboratories, including LLNL. The new hybrid work environment would represent a different approach to conducting operations at LLNL but would not change the fundamental NNSA mission requirements or overall facility operations. Under this option, approximately 20 to 30 percent of the LLNL workforce could telework a maximum of 2.5 days per week without detriment to NNSA mission requirements.

Section 5.18 of this SWEIS provides an analysis of the potential environmental impacts associated with a new hybrid work environment at LLNL, and quantifies the impacts where possible. The new hybrid work environment could be implemented for both the No-Action Alternative and the Proposed Action as discussed in Section 5.18:

- Although consolidation of personnel could help accelerate DD&D and construction activities, the number of facilities and offices would not change; potential decreases in office space would be countered by COVID-19 distancing requirements that may be required/accommodated for in the future. Reduced worker commuting and reduced travel would decrease air emissions. However, some of this decrease would be offset by workers using their home heating and air conditioning systems.

- Reduced worker commuting would result in positive impacts on the level-of-service (LOS) of area roads.
- Reduced onsite worker population would reduce onsite vehicle circulation, parking, and domestic water use.
- There would be no net change in safety, health, and waste generation because facility and laboratory personnel would continue to operate facilities and conduct the same types and amounts of experiments and tests.

3.4 Analytical Parameters for the Alternatives

As discussed in Sections 3.2 and 3.3, both the No-Action Alternative and the Proposed Action encompass a multitude of discreet projects/actions that could give rise to environmental impacts. By addressing all of these projects/actions in a site-wide analysis, NNSA is able to:

- Consolidate impact analyses and public participation activities, which streamlines the NEPA process to make it more efficient and useful;
- Present impact information so decisionmakers and the public have a clear understanding of the totality of impacts from past, present, and reasonably foreseeable future activities at a site;
- Avoid segmentation (division of actions with significant impacts into smaller actions, thereby hiding significance); and
- Effectively and efficiently respond to stakeholders by presenting information on past, present, and future activities at DOE sites in order to better understand the impacts that DOE's activities have had or may have on their health and environmental quality (DOE 1994).

A primary challenge in preparing a site-wide analysis is to address the impacts of the individual projects/actions while also addressing the totality of impacts. To accomplish those dual goals, NNSA defined and accumulated data for each of the projects/actions defined by the No-Action Alternative and the Proposed Action. For each project/action, NNSA consulted with subject matter experts from LLNL to quantify key parameters. The accumulated parameters are shown in Table 3-7 (for construction) and Table 3-8 (for operations) for both the No-Action Alternative and the Proposed Action. For example, for both the No-Action Alternative and the Proposed Action, construction activities associated with new facilities (Table 3-1 and Table 3-4), modernization/ upgrade/utility projects (Table 3-2 and Table 3-4), and DD&D activities (Table 3-3 and Table 3-5) have the potential to result in land disturbance. Table 3-7 shows the results of accumulating those land disturbances for all of the projects/actions.

This same process was utilized to develop parameters such as workforce, water use, and waste generation, as examples. In some instances, the accumulated parameters presented in Table 3-7 and Table 3-8 are largely driven by the contribution of one or two projects/actions. For example, as shown in Table 3-8, increased water usage at the Livermore Site after 2023 would be primarily associated with cooling water usage for Exascale computing. As these examples illustrate, in developing the key parameters for the SWEIS analysis, NNSA is able to account for projects/actions both individually and in totality, and the analysis in this SWEIS addresses each of these aspects.

As shown in Table 3-7, for most construction parameters associated with the Proposed Action, NNSA developed estimates for both the average year and the peak year of construction/DD&D.[9]

The analysis in Chapter 5 addresses the potential impacts associated with peak year of construction/DD&D. This approach acknowledges the non-linear characteristics of construction/DD&D (i.e., unlike steady-state operations, construction/DD&D projects often ramp up to a peak level of effort) and provides a conservative analysis to account for future uncertainties. This approach also affords NNSA flexibility with respect to scheduling and conducting future construction/DD&D projects. For example, if NNSA decides to conduct a greater amount of DD&D in a given year than currently planned, the peak year analysis would be expected to bound those potential impacts.

Because operations are based on steady-state conditions, most parameters in Table 3-8 were estimated to reflect operations at a given level. One exception to this is waste generation, which includes construction/DD&D wastes in Table 3-8 as "nonroutine" wastes. Once the key construction and operational parameters were developed, resource experts utilized those parameters to conduct the impact analysis presented in Chapter 5 of this SWEIS.

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[9] Because construction associated with the No-Action Alternative is more well defined, less uncertain, and has occurred/is occurring over a relatively short period (i.e., 2019–2022), a peak-year analysis is less meaningful and was not developed.

Table 3-7. Key Construction Parameters for the No-Action Alternative and the Proposed Action

	Baseline Data (2019)	No-Action Alternative (3 years: 2020–2022)	Proposed Action (13 years: 2023–2035)
Land disturbance[a]	**Livermore Site:** 821 acres in size; approximately 80-90% developed	**Livermore Site** • 13.6 acres total (9.6 acres for new projects, 2 acres for ECFM, and 2 acres of laydown areas); • average of 4.5 acres/yr	**Livermore Site** • 85.5 acres total (69 acres for new projects, 4 acres for New North Entry, 2.5 acres for cooling tower pipeline, 6 acres for sidewalks, and 4 acres of laydown areas); • average of 6.4 acres/yr; peak year: 12.8 acres
	Site 300: 7,000 acres in size; less than 5% developed	**Site 300** • 0.6 acres total including 0.5-acre laydown area; • average of 0.2 acres/yr	**Site 300** • 36 acres total (12.3 acres for new facilities, 2.3 acres for Cyber-physical test capability for energy distribution, 20.4 acres for alternative energy micro-grid for the future, and 1 acre of laydown areas); • average of 2.8 acres/yr; peak year: 5.6 acres
Land restored by DD&D	As of 2019, approximately 481,166 square feet of facilities (11 acres total, 0.8 acre/yr) have undergone DD&D at LLNL since completion of 2005 SWEIS	**Livermore Site** • 5.2 acres total; average of 1.7 acres/yr	**Livermore Site** • 26.5 acres total; average of 2.0 acres/yr; peak year: 4.0 acres
		Site 300 • 0.02 acres total; average of 0.007 acre/yr	**Site 300** • 0.4-acre total; average of 0.03 acre/yr; peak year: 0.06 acre
Net land	Not applicable	**Livermore Site** • 6.4 acres disturbed (assumes DD&D land is reclaimed and laydown areas are restored)	**Livermore Site** • 52.5 acres disturbed (assumes DD&D land is reclaimed and cooling tower pipeline and laydown areas are restored)
		Site 300 • 0.1 acre disturbed (assumes DD&D land is reclaimed and laydown areas are restored)	**Site 300** • 34.6 acres disturbed (assumes DD&D land is reclaimed and laydown areas are restored)
Workforce	Total LLNL employment: 7,909, consisting of 7,208 employees at Livermore Site, 477 supplemental workers, and 224 workers at Site 300	210 construction workers/yr	Average: 350 construction workers/yr; peak year: 700 construction workers
Electricity use	**Livermore Site**: 402.4 million kilowatt-hours/year **Site 300**: 11 million kilowatt-hours/year	No notable change associated with construction	No notable change associated with construction

	Baseline Data (2019)	No-Action Alternative (3 years: 2020–2022)	Proposed Action (13 years: 2023–2035)
Natural gas use	**Livermore Site and Site 300**: 12,361 therms/day	No notable change associated with construction	No notable change associated with construction
Fuel	**Livermore Site and Site 300**: 102,000 gallons/yr of petroleum	No notable change associated with construction	No notable change associated with construction
Concrete	Not applicable	25,000 yd^3	250,000 yd^3 (of this, approximately 50,000 yd^3 could be associated with future NIF expansion)
Water use	**Livermore Site and Site 300**: 267 million gallons/yr	Increase of 3.7 million gallons/yr	Increase of 3.9 million gallons/yr; increase of 6.8 million gallons in peak year
Wastewater	**Livermore Site and Site 300**: 328,000 gallons/day	Increase of 5,250 gallons/day (based on 25 gallons/day per construction worker)	Increase of 8,250 gallons/day; increase of 16,500 gallons/day in peak year (based on 25 gallons/day per construction worker)

a. Land disturbance includes new parking lots associated with rebalancing parking on the Livermore Site.
Source: LLNL 2021c, LLNL 2021d.

Table 3-8. Key Operational Parameters for the No-Action Alternative and the Proposed Action

Resources	Baseline Data (2019)	No-Action Alternative (Operations by end of 2022)	Proposed Action (Operations by 2035)
Land occupied by new projects after restoration of laydown areas and other project areas	**Livermore Site:** 821 acres in size; approximately 80-90% developed	**Livermore Site** • 11.6 acres total	**Livermore Site** • 79 acres total
	Site 300: 7,000 acres in size; less than 5% developed	**Site 300** • 0.1 acre total	**Site 300** • 35 acres total
Land no longer occupied as a result of DD&D	As of 2019, approximately 481,166 square feet of facilities (11 acres total, 0.8 acre/yr) have undergone DD&D at LLNL since completion of 2005 SWEIS	**Livermore Site** • 5.2 acres total	**Livermore Site** • 26.5 acres total
		Site 300 • 0.02 acre total	**Site 300** • 0.4 acres total
Net change in land use	Not applicable	**Livermore Site** • 6.4 acres disturbed	**Livermore Site** • 52.5 acres disturbed
		Site 300 • 0.1 acre disturbed	**Site 300** • 34.6 acres disturbed
Operational workforce	**Total LLNL employment**: 7,909, consisting of 7,208 employees at Livermore Site, 477 supplemental workers, and 224 workers at Site 300	**Livermore Site** • 8,810 workers **Site 300** • 320 workers Total: 9,130 workers (increase of 1,221 workers over 2019 baseline of 7,909 workers)	**Livermore Site** • 9,654 workers **Site 300** • 406 workers Total: 10,060 workers (increase of 2,151 workers over No-Action Alternative 9,130 workers)
Electricity	**Livermore Site**: 402.4 million kilowatt-hours/year	**Livermore Site** • 475 million kilowatt-hours/year • 65.5 MW/month (peak)	**Livermore Site** • 535 million kilowatt-hours/year • 81.9 MW/month (peak)
	Site 300: 12.2 million kilowatt-hours/year	**Site 300** • 12.6 million kilowatt-hours/year • 2 MW/month (peak)	**Site 300** • 24.7 million kilowatt-hours/year • 5 MW/month (peak)
Natural gas usage	**Livermore Site and Site 300**: 12,361 therms/day	12,750 therms/day	13,500 therms/day
Fuel (oil, gasoline) usage[a]	**Livermore Site and Site 300**: 102,000 gallons/yr of petroleum	96,000 gallons/yr. by 2022 75,300 gallons/yr. by 2035	85,000 gallons/yr
Water use[b]	**Livermore Site and Site 300**: 281 million gallons/yr	Increases to 447 million gallons/yr in 2030; 400 million gallons/yr by 2035	503 million gallons/yr

Resources	Baseline Data (2019)	No-Action Alternative (Operations by end of 2022)	Proposed Action (Operations by 2035)
Wastewater	**Livermore Site and Site 300**: 328,000 gallons/day	358,000 gallons/day (based on 25 gallons/day per additional worker)	412,000 gallons/day (based on 25 gallons/day per additional worker)
Radiological air emissions (curies/year)	**Livermore Site** • Tritium Facility: 126.4 Ci tritium • NIF: 2.8 Ci tritium Miscellaneous other diffuse emissions	**Livermore Site** • Tritium Facility limit: 210 Ci tritium • NIF limit: 80 Ci tritium • Building 298: 10 Ci tritium • Miscellaneous other diffuse emissions	**Livermore Site** • Tritium Facility limit: 2,000 Ci tritium[c] • NIF limit: 1,600 Ci tritium[c] • HED Capability Support Facility Replacement (replacement for Building 298): 10 Ci tritium • Miscellaneous other diffuse emissions
	Site 300 CFF: 1.2×10^{-7} U-234; 1.7×10^{-8} U-235; 9.2×10^{-7} U-238	**Site 300** • CFF: 1.2×10^{-7} U-234; 1.1×10^{-8} U-235; 8.9×10^{-7} U-238	**Site 300** • CFF: 1.2×10^{-7} U-234; 1.1×10^{-8} U-235; 8.9×10^{-7} U-238
Radiation workers[h]	123	575	615
Average dose to radiation worker	69.6 mrem/yr	180 mrem/yr	173.5 mrem/yr
Waste Projections[d]			
Hazardous waste	Routine: 510 metric tons/yr Nonroutine:1,700 tons/yr	Routine: 510 metric tons/yr Nonroutine: 1,700 metric tons/yr	Routine: 510 metric tons/yr Nonroutine: 1,700 metric tons/yr
Nonhazardous solid waste	Routine: 2,780 metric tons/yr Nonroutine: 2,570 metric tons/yr	Routine: 3,050 metric tons/yr Nonroutine: 900-5,500 metric tons/yr	Routine: 3,400 metric tons/yr Nonroutine: 5,500 metric tons/yr
LLW	Routine: 850 m^3/yr Nonroutine: 710 m^3/yr[e]	Routine: 850 m^3/yr Nonroutine: 4,000-8,000 m^3/yr[e]	Routine: 1,000 m^3/yr Nonroutine: 7,000 m^3/yr[e]
MLLW	Routine: 88 m^3/yr Nonroutine: 725 m^3/yr	Routine: 88 m^3/yr Nonroutine: 725 m^3/yr[e]	Routine: 88 m^3/yr Nonroutine: 3,170 m^3/yr[e]
TRU and mixed TRU wastes	Routine: 52.8 m^3/yr Nonroutine: 60 m^3/yr	Routine TRU: 50 m^3/yr Nonroutine TRU: 60 m^3/yr[e] Routine Mixed TRU: 2.8 m^3/yr Nonroutine Mixed TRU: 0 m^3/yr[e]	Routine TRU: 50 m^3/yr Nonroutine TRU: 60-120 m^3/yr[e] Routine Mixed TRU: 2.8 m^3/yr Nonroutine Mixed TRU: 0-2.8 m^3/yr[e]
LLW/MLLW shipments	40-50 annually of LLW 10-15 annually of MLLW	Routine shipments: 120/yr (85% to NNSS, 15% to Energy*Solutions*)[f] Nonroutine shipments: 160/yr (10% to NNSS, 90% to Energy*Solutions*)[f]	Routine shipments: 120/yr (85% to NNSS, 15% to Energy*Solutions*)[f] Nonroutine shipments: 160-384/yr (10% to NNSS, 90% to Energy*Solutions*)[f]
TRU waste shipments to WIPP	2-4 annually[g]	Up to 8 annually[g]	Up to 8 annually[g]

a. In 2019, LLNL used 102,000 gal/yr of petroleum. NNSA has a goal to reduce petroleum usage at LLNL by approximately 2 percent year-over-year. By the end of 2022, petroleum usage is expected to be 96,000 gal/yr and LLNL would strive to continue reducing usage by 2 percent year-over-year going forward. For the Proposed Action, NNSA has assumed that the goal to reduce petroleum usage by 2 percent annually would continue and by 2035 petroleum usage would decline to 85,000 gal/yr.

b. In 2019, LLNL used approximately 261 million gallons/yr of water. Increased usage until 2023 would be primarily associated with increased personnel. Increased water usage after 2023 would be primarily associated with cooling water usage for Exascale computing. Under the No-Action Alternative, water usage is expected to peak in 2030, when approximately 447 million gallons/yr would be used. Steady-state water usage of approximately 400 million gallons/yr would occur under the No-Action Alternative. Water use for the Proposed Action would increase to approximately 503 million gallons/year as new facilities become operational.
c. Emissions from the Tritium Facility and NIF may not increase; however, increased reservoir tritium loading (up to 1,500 Ci) presents the potential for higher emissions during reservoir handling and associated system operations or maintenance. Engineered solutions to tritium emissions, including the Tritium Processing System, are expected to continue to operate with high efficiency (>99 percent) but some equipment/operations fall out of the control umbrella of these engineered systems.
d. In general, English units are used throughout this SWEIS. However, for most waste types, metric units are used as that is the normal convention used by LLNL in measuring and reporting these wastes.
e. Estimates for nonroutine radiological wastes (i.e., LLW, MLLW, TRU waste) are not intended to reflect annual occurrences. Nonroutine radiological wastes would not be generated in all years.
f. Small quantities of shipments could also be made to other commercial facilities (see Section 5.11.3).
g. Past shipments to the WIPP were done through “Campaigns,” in which several years of generated waste drums/boxes were stored onsite until a campaign was initiated to move these drums to WIPP. In the future, NNSA intends to develop an enduring program to make annual shipments from LLNL to WIPP. This would result in less waste drum storage onsite, thereby reducing any accident scenarios involving multiple stored drums.
h. Number of radiation workers that receive a measurable dose.

Source: LLNL 2021c; LLNL 2021d.

3.5 ALTERNATIVES CONSIDERED BUT ELIMINATED FROM DETAILED STUDY

NNSA considered public input and comments received during the scoping process in determining the range of alternatives in this Draft LLNL SWEIS. NNSA only considered reasonable alternatives that would meet the purpose and need described in Chapter 1 of this SWEIS. The following alternatives were considered in developing this Draft SWEIS, but were eliminated from detailed analysis because they did not allow LLNL to fulfill the NNSA mission requirements. The specific reasons for elimination are detailed below.

Complete Closure of LLNL (Livermore Site and/or Site 300). This alternative is inconsistent with the LLNL mission defined by NNSA. Such a possibility was considered as recently as 2008 when NNSA prepared the Complex Transformation SPEIS (NNSA 2008). In that document, NNSA concluded that, "as a result of the continuing challenges of certification [of nuclear weapons] without underground nuclear testing, the need for robust peer review, benefits of intellectual diversity from competing physics design laboratories, and uncertainty over the details [of] future stockpiles, NNSA does not consider it reasonable to evaluate laboratory consolidation [or elimination] at this time" (NNSA 2008). That conclusion has not changed today. In addition, as one of only three nuclear weapons laboratories, LLNL contributes significantly to the core intellectual and technical competencies of the U.S. related to nuclear weapons. These competencies embody more than 50 years of weapons knowledge and experience. The laboratories perform the basic research, design, system engineering, development testing, reliability and assessment, and certification of nuclear weapon safety, reliability, and performance. From a broader national security perspective, the core intellectual and technical competencies of LLNL (as well as LANL and SNL, NNSA's other nuclear weapons laboratories) provide the technical basis for the pursuit of U.S. arms control and nuclear nonproliferation objectives.

Transfer of Current Missions/Operations from LLNL to Other Sites. The Complex Transformation SPEIS also considered and evaluated the transfer of missions/operations to and/or from LLNL, and NNSA has implemented, as appropriate, decisions that followed preparation of that document. NNSA has not identified any new proposals for current missions/operations that are reasonable for transfer to and/or from LLNL (NNSA 2008; 85 FR 47362).

Conversion of LLNL to an Academic Laboratory and/or an Environmental Research Laboratory. Under this alternative, LLNL would cease nuclear weapons-related work and instead perform academic/environmental research work. Under this alternative, NNSA would remove nuclear materials from LLNL and remove all waste. LLNL would use existing facilities and staff for academic research and/or environmental research. Such an alternative would not allow NNSA to meet the purpose and need discussed in Chapter 1, Section 1.3, of this LLNL SWEIS (85 FR 47362).

Relocation of All Nuclear Materials and Nuclear Research to Another Site. Under this alternative, LLNL would cease its work involving nuclear materials and would relocate all nuclear materials to another DOE/NNSA site. Such an alternative would not allow NNSA to meet the purpose and need discussed in Chapter 1, Section 1.3, of this LLNL SWEIS (85 FR 47362).

Reduced Operations at LLNL. Under this alternative, LLNL would reduce operations to a level below the operations defined under the No-Action Alternative. Such an alternative would not allow NNSA to meet the purpose and need discussed in Chapter 1, Section 1.3, of this LLNL SWEIS.

Shift Funding from Weapons Work to Environmental Cleanup. Such an alternative would not allow NNSA to meet the purpose and need discussed in Chapter 1, Section 1.3, of this LLNL SWEIS (85 FR 47362).

Analyze Alternatives for Elimination of Outdoor Detonations with Hazardous Materials at Site 300. During the scoping period, a commenter stated that NNSA should analyze an alternative to eliminate outdoor detonations with hazardous materials at Site 300. As discussed in Section 2.2.5, LLNL's HE R&D program is an integral element of the NNSA's design and development effort that supports nuclear weapons stewardship and broad national security missions. The infrastructure at Site 300 consists of more than 50 facilities and storage magazines supporting HE work. These HE capabilities provide core competencies for the weapons program's annual assessment of energetic materials, components, and subassemblies (LLNL 2017a). Outdoor testing at Site 300 with hazardous material such as HE is important for formulation development and testing. If that testing were eliminated, NNSA would not be able to meet the purpose and need discussed in Chapter 1, Section 1.3, of this LLNL SWEIS.

No W87-1 Warhead Development. During the scoping period, a commenter stated that NNSA should analyze an alternative that did not include development of the W87-1 warhead. Decisions concerning whether the U.S. should possess nuclear weapons and the type and number of those weapons are made by Congress and the President. As discussed in Section 1.3.3, over the next 15 years, one of LLNL's primary responsibilities will be to continue to support LEPs and Mods, which modify the existing weapons packages for new delivery systems and extend the service life and enhance the safety, security, and reliability of nuclear weapons. One specific such project is the W87-1 LEP and Mods. The alternative requested by the commenter would not allow NNSA to meet the purpose and need discussed in Chapter 1, Section 1.3, of this LLNL SWEIS (85 FR 47362).

3.6 PREFERRED ALTERNATIVE

CEQ NEPA regulations require that an agency identify its preferred alternative, if one or more exists, in a Draft EIS and identify such an alternative in the Final EIS (40 CFR 1502.14 [e]). The preferred alternative is the alternative that NNSA believes would fulfill its statutory missions and responsibilities, considering economic, environmental, technical, and other factors. This LLNL SWEIS provides information on the potential environmental impacts under the No-Action Alternative and the Proposed Action. NNSA prepares cost, schedule, and technical analyses separately, and NNSA will consider all relevant factors in preparation of its ROD. NNSA had determined that LLNL is critical to its Stockpile Stewardship and Management Program, which is best supported by the Proposed Action. Therefore, NNSA has identified the Proposed Action as the preferred alternative for the continuing operations of LLNL.

3.7 COMPARISON OF THE POTENTIAL CONSEQUENCES OF THE ALTERNATIVES

A summary comparison of the environmental consequences for the continued operation of LLNL is provided in Table 3-9 (note: Table 3-10 and Table 3-11 provide additional details regarding infrastructure and accidents, respectively). The table compares the potential impacts to environmental resources associated with the continued operation of LLNL under the No-Action Alternative and the Proposed Action. The information in Table 3-9 includes data for both construction and operations. Detailed analyses supporting the summary comparisons in Table 3-9 are contained in Chapter 5 of this SWEIS. Table 3-12 provides information regarding the new hybrid work environment.

Table 3-9. Summary Comparison of Environmental Impacts of the Alternatives

Baseline Data (2019)	No-Action Alternative (2020-2022)	Proposed Action (2023-2035)
Land Use		
Both Sites: The Livermore Site is 821 acres in size and is approximately 85 percent developed. Site 300 is approximately 7,000 acres in size and less than 5 percent developed. Activities at both sites continue to be compatible with existing land uses, approved land-use designations surrounding the site, and open space policies applicable to areas near the site. Since 2005, approximately 166,741 square-feet of new facilities have been added to LLNL and 659,755 square-feet of facilities have undergone DD&D.	Both Sites: Operations would be consistent with current land use designations and historic uses of LLNL land. Livermore Site: Land disturbance of 13.6 acres; 5.2 acres of land reclaimed as a result of DD&D; and 2 acres of laydown areas restored. Net change in land use would be disturbance of 6.4 acres. Site 300: Land disturbance of 0.6 acres; 0.02 acres of land reclaimed as a result of DD&D; and 0.5 acre of laydown areas restored. Net change in land use would be disturbance of 0.1 acres.	Both Sites: Operations would be consistent with current land use designations and historic uses of LLNL land. Livermore Site: Land disturbance of 85.5 acres; 26.5 acres of land reclaimed as a result of DD&D; 2.5 acres restored for cooling tower pipeline; and 4 acres of laydown areas restored. Net change in land use would be disturbance of 52.5 acres. Removal of limited area fencing, expanded bicycle network, expanded pedestrian walkways, rebalanced vehicle parking, and Lake Haussmann enhancements would create an end state with more green space. Site 300: Land disturbance of 36 acres; 0.4 acres of land reclaimed as a result of DD&D; and 1 acre of laydown areas restored. Net change in land use would be disturbance of 34.6 acres.
Aesthetics and Scenic Resources		
Both Sites: The Livermore Site has a campus-like setting with buildings, internal roadways, pathways, and open space. Portions of the Livermore Site along the western and northern boundaries are largely undeveloped and serve as buffer zones between the laboratory and adjacent industrial and residential development. Site 300 is predominately grasslands and low shrubs in areas ranging in topography from gently rolling hills to steeply sloping ridges and valleys. Viewsheds in the area around Site 300 are severely constrained by topography.	Both Sites: Construction activities would result in temporary changes to the visual appearance of both sites due to the presence of cranes, construction equipment, demolition, facilities in various stages of construction/DD&D, and possibly increased dust. Livermore Site: Replacing some aging facilities would improve the overall visual appearance, but site would remain highly developed with a campus-style or business park appearance. Site 300: Due to site boundary distances and intervening topography, minimal visual impacts expected.	Both Sites: Construction activities would result in temporary changes to the visual appearance of both sites due to the presence of cranes, construction equipment, demolition, facilities in various stages of construction/DD&D, and possibly increased dust. Livermore Site: Net land disturbance for new projects would be 52.5 acres, but modernizations and land use initiatives would add green space and improve visual appeal. Site would remain highly developed with a campus-style or business park appearance. New North Entry and Fire Station in north buffer zone would be the most notable visual change. Site 300: Net land disturbance for new projects would be 34.6 acres. Changes would occur in the site interior and would be consistent with existing visual character of the site.

Baseline Data (2019)	No-Action Alternative (2020-2022)	Proposed Action (2023-2035)
Geology and Soils		
Both Sites: There is no prime farmland at either the Livermore Site or Site 300. Ongoing remediation efforts would continue to improve soil conditions at both sites. The Livermore Site and Site 300 are located near the boundary between the North American and Pacific tectonic plates, and the structural geology of the area is the result of the interaction between these two plates. The structural conditions of the region around Livermore are largely defined by the major active faults within the region. Potential impacts from geologic hazards (i.e., seismic events) are discussed under "accidents."	Both Sites: Soil disturbances would be minimal; no prime farmland exists. Ongoing remediation efforts would continue to improve soil conditions at both sites. Major regional faults exist, but no active faults underlie the sites. No historical record of surface rupturing or faulting, although there is potential for surface faulting at Site 300. Any new facility would be designed and constructed to meet seismic design criteria commensurate with the risk category requirements. Potential impacts from geologic hazards (i.e., seismic events) are discussed under "accidents."	Both Sites: Soil disturbances would be minimal; no prime farmland exists. Ongoing remediation efforts would continue to improve soil conditions at both sites. Major regional faults exist, but no active faults underlie the sites. No historical record of surface rupturing or faulting, although there is potential for surface faulting at Site 300. Any new facility would be designed and constructed to meet seismic design criteria commensurate with the risk category requirements. Potential impacts from geologic hazards (i.e., seismic events) are discussed under "accidents."
Water Resources		
Both Sites: Groundwater quality has improved because of ongoing remediation at treatment facilities. Water use at LLNL is approximately 267 million gallons per year. Livermore Site: Surface drainage and natural surface infiltration at the Livermore Site are generally good, but drainage decreases locally with increasing clay content in surface soils. Arroyo Las Positas is an intermittent stream that drains from the hills directly east of the Livermore Site with a watershed area of approximately 3,300 acres. The arroyo enters the Livermore Site from the east, is diverted to a storm ditch along the northern edge of the site, and exits at the northwest corner. Nearly all of the surface-water runoff at the Livermore Site is discharged into Arroyo Las Positas. There are a total of 25.9 acres of floodplain on the Livermore Site. Floodplains are associated with the Arroyo Las Positas (23.5 acres) and the Arroyo Seco (2.4 acres). Wetlands at the Livermore Site include seasonal wetlands and freshwater marsh wetlands in intermittent streams which total 1.85 acres and 4,332 linear feet. Site 300: Surface water at Site 300 consists of	Both Sites: New facilities would increase impervious surfaces, which could increase stormwater runoff. LLNL meets stormwater compliance monitoring requirements and implementation of a Stormwater Pollution Prevention Plan (SWPPP) would minimize any pollution that might leave the site by stormwater. Ongoing remediation efforts would continue to improve groundwater conditions at both sites. There are no construction and operations projects under the No-Action Alternative that would affect the floodplains at the Livermore Site or Site 300. Water use is addressed in "Infrastructure."	Both Sites: New facilities would increase impervious surfaces, which could increase stormwater runoff. LLNL meets stormwater compliance monitoring requirements and implementation of a SWPPP would minimize any pollution that might leave the site by stormwater. Ongoing remediation efforts would continue to improve groundwater conditions at both sites. Livermore Site: New North Entry would cross approximately 0.9 acres (approximately 2 percent) of the 500-year floodplain (critical action floodplain) in the north buffer zone and approximately 0.1 acres (approximately 0.4 percent) of the 100-year floodplain (base floodplain) along Arroyo Las Positas. New Fire Station (alternate location) could disturb approximately 0.7 acres (approximately 1.6 percent) of the 500-year floodplain (critical action floodplain) but would not disturb any acres of the 100-year floodplain (base floodplain). The enhancements in Lake Haussmann would not involve wetlands or affect impoundment-waters. Even with enhancements, Lake Haussmann would continue to serve as a conveyance channel.

Baseline Data (2019)	No-Action Alternative (2020-2022)	Proposed Action (2023-2035)
seasonal runoff, seeps, and natural and man-made ponds. There are no perennial streams at or near Site 300. The floodplain associated with the Corral Hollow intermittent stream in the southeast corner is 9.6 acres. Perennial and seasonal wetlands total 8.4 acres. Waters include intermittent and ephemeral streams which total 10.54 acres and 108,066 linear feet.		Water use is addressed in "Infrastructure." However, implementation of city of Livermore wastewater reclamation plant (LWRP) would enable LLNL to use approximately 200 million gallons per year of treated wastewater from the LWRP for cooling tower cooling water instead of using Hetch Hetchy or Zone 7 waters, and effectively would reduce potable water usage at LLNL by 200 million gallons per year.
Air Quality		
<u>Both Sites</u>: Based on actual emission data for the past five years (2015-2019), the Livermore Site has emitted approximately 38.7-41.4 tons/year of pollutants. The Livermore Site's nonradioactive air emissions have been approximately: • 16.9 tons/year of carbon monoxide • 14.7 tons/year of nitrogen oxides • 1.8 tons/year of particulate matter • 0.7 tons/year of sulfur oxides • 6.1 tons/year of precursor organic compounds. Air pollutants are much lower at Site 300 than the Livermore Site. Emissions estimates are well below the applicable conformity thresholds for air quality; therefore, the SWEIS projected air emissions and the actual emissions are still in conformance with Clean Air Act requirements. In 2019, LLNL emitted approximately 147,332 metric tons of carbon dioxide equivalent. The Livermore Site has reduced Scope 1 and 2 Greenhouse gas (GHG) emissions by 32 percent since 2008. Radiological air emissions of tritium at the Livermore Site are approximately 129.2 curies. Site 300 emits small quantities of depleted uranium.	<u>Both Sites</u>: Fugitive dust would be generated during clearing, grading, and other earth-moving operations. Construction and operational emissions would not: (1) result in a considerable net increase (i.e., greater than the *de minimis* thresholds) of any criteria pollutant for which the project region is non-attainment; (2) expose sensitive receptors to substantial pollutant concentrations; (3) conflict with or obstruct implementation of the applicable air quality plan; or (4) violate any air quality standard or contribute substantially to an existing or projected air quality violation. contribute to an exceedance of an ambient air quality standard. GHG emissions would increase by approximately 5,237 metric tons annually compared to 2019 levels. The GHG emissions associated with the No-Action Alternative would represent 0.03 percent of the State of California GHG emissions. Radiological air emissions of tritium at the Livermore Site would be 300 curies based on emissions limits. There would be minimal radiological air emissions at Site 300. Impacts associated with radiological air emissions are addressed in "Human Health and Safety."	<u>Both Sites</u>: Fugitive dust would be generated during clearing, grading, and other earth-moving operations. Construction and operational emissions would not: (1) result in a considerable net increase (i.e., greater than the *de minimis* thresholds) of any criteria pollutant for which the project region is non-attainment; (2) expose sensitive receptors to substantial pollutant concentrations; (3) conflict with or obstruct implementation of the applicable air quality plan; or (4) violate any air quality standard or contribute substantially to an existing or projected air quality violation. GHG emissions would increase by approximately 5,239 metric tons annually compared to the No-Action Alternative. This GHG emissions associated with the Proposed Action would represent 0.03 percent of the State of California GHG emissions. Radiological air emissions of tritium at the Livermore Site would be 3,610 curies based on emissions limits. There would be minimal radiological air emissions at Site 300. Impacts associated with radiological air emissions are addressed in "Human Health and Safety."
Noise		
<u>Livermore Site:</u> Existing sources of noise at the	<u>Livermore Site</u>: Although construction and DD&D	<u>Livermore Site</u>: Although construction and DD&D

Baseline Data (2019)	No-Action Alternative (2020-2022)	Proposed Action (2023-2035)
Livermore Site are common to any industrial/commercial setting, although on a somewhat larger scale. Sources include various industrial facilities, equipment, and machines, vehicles, as well as the use of small arms and demolitions. Noise sources from industrial facilities and operations at the Livermore site are predominantly inaudible at the property boundary. Site 300: NNSA conducts explosive testing at the CFF and on open firing tables. The overall average sound levels are completely compatible with all land uses outside of the Site 300 property boundary.	activities would cause temporary noise impacts, almost all activities would be confined to areas more than 500 feet from the Livermore Site property boundaries. Including the EOC, there would be five projects constructed within a distance of approximately 800 feet of the Livermore Site boundary. Site 300: The SFTF is located within 500 feet of the southern site boundary. However, because there are no residences or other noise receptors within several miles of this facility, there would be no offsite noise impacts. Explosive testing conducted at the CFF and on open firing tables at Site 300 would be unchanged when compared to current operations. The 57-dBC, 62-dBC, and 70-dBC CDNL contours would remain completely contained within the Site 300 property boundary, and the testing activities would continue to be neither loud enough nor frequent enough to generate areas of incompatible land use. LLNL continues to monitor testing activities to ensure that noise levels remain below its self-imposed limit of 126 dB in nearby residential areas. LLNL would continue to monitor during testing to limit noise levels in nearby residential areas.	activities would cause temporary noise impacts, most activities would be confined to areas more than 500 feet from the Livermore Site property boundaries. There would be 15 projects constructed within a distance of approximately 800 feet of the Livermore Site boundary. Six of the new projects would be constructed within approximately 500 feet of a site boundary. Site 300: Four facilities would be located within 500 feet of the southern site boundary. However, because there are few residences/businesses, but no schools, within several miles of this facility. offsite noise impacts would be minimal. Explosive testing noise impacts would be the same as discussed for the No-Action Alternative. LLNL would maintain its self-imposed 126 dB limits for offsite populated areas.
Biological Resources		
Both Sites: There are 10 protected and sensitive species known or expected to occur in the vicinity of the Livermore Site and 11 at Site 300. Through monitoring and compliance activities, NNSA has been able to avoid significant impacts on special status wildlife and plants. Habitat enhancement, avian protection, and invasive species control efforts resulted in benefits to protected and sensitive species. NNSA continues to monitor and maintain several restoration sites, habitat enhancements, and conservation set asides that are beneficial to native plants and animals at the Livermore Site or Site 300 and ensures the protection of protected and sensitive	Both Sites: The net land disturbance would be 6.4 acres at the Livermore Site and net disturbance of 0.1 acres at Site 300. Construction would have no appreciable impact on native vegetation, plant species of concern, wetlands or waters of the U.S. viability of federally or state-listed species, or modification of USFWS-designated critical habitat. Operations would be consistent with current activities and would have no appreciable impact on biological resources.	Both Sites: The net land disturbance would be 52.5 acres (Livermore Site) and 34.6 acres (Site 300). Construction would have no appreciable impact on native vegetation, plant species of concern, wetlands or waters of the U.S. viability of federally or state-listed species, or modification of USFWS-designated critical habitat. The roadway for the New North Entry would not be expected to impact biological resources. Operations would be consistent with current activities and would have no appreciable impact on biological resources.

Baseline Data (2019)	No-Action Alternative (2020-2022)	Proposed Action (2023-2035)
species. Surveys and monitoring activities through 2019 show no indications of substantial changes in general site conditions, ecology, and species compositions at the Livermore Site and Site 300 since the 2005 SWEIS was completed.		
Cultural and Paleontological Resources		
Livermore Site: No archaeological resources have been previously recorded at the Livermore Site. No cultural resources of religious or cultural significance to Native American tribes have been identified on the Livermore Site. Fossil resources within the area include fragmented fossils of mammoth, extinct bison, horses, camels, boney fish, rodent, turtle, and bird. Four late Pleistocene vertebrate fossils were discovered in the peripheral parts of the excavation for the NIF. No facilities at the Livermore Site retain National Register eligibility. Site 300: Archaeological surveys undertaken at Site 300 over the past 40 years inventoried all accessible areas of Site 300 and resulted in the recordation of 31 prehistoric and historic archaeological sites and isolated artifacts. It is likely that currently unknown, intact archaeological deposits exist at Site 300 because such resources have been recorded at the site and approximately 95 percent of the site's 7,000 acres is undeveloped. There have been no recorded paleontological finds on Site 300. However, several vertebrate fossil deposits have been found on Site 300 in the vicinity of Corral Hollow.	Both Sites: The probability of impacting archaeological resources would be low because field and archival research have not identified any such resources. Because fossils and/or fossil remains have been discovered at both sites, any excavations have the potential to impact similar fossils/fossil remains. Both sites have undergone a comprehensive review to identify significant historic buildings, structures, and objects, and those that were determined eligible for the National Register have already been mitigated and are no longer eligible.	Both Sites: The probability of impacting archaeological resources would be low because field and archival research have not identified any such resources. Because fossils and/or fossil remains have been discovered at both sites, any excavations have the potential to impact similar fossils/fossil remains. Both sites have undergone a comprehensive review to identify significant historic buildings, structures, and objects, and those that were determined eligible for the National Register have already been mitigated and are no longer eligible. Because there would much more construction and associated excavation under the Proposed Action, the likelihood for discoveries of fossils/fossil remains would be greater than under the No-Action Alternative. Livermore Site: Construction planned in the vicinity of the 1997-1998 fossil discoveries, which includes the NIF Laser Expansion, HED Capability Support Facility Replacement, and some generic office buildings, would have higher potential for such discoveries if excavation extends to those depths. Of note is the planned addition to the southwestern end of the NIF for the laser expansion, as many of the original fossil discoveries occurred in this area during construction of the NIF; thus, the probability for further discoveries during the expansion of the facility is high. Site 300: For the DRDF, excavation of the hill north or south of Building 801 could be as deep as 50 feet, which would have a higher potential to impact cultural resources.

<table>
<tr><th>Baseline Data (2019)</th><th>No-Action Alternative (2020-2022)</th><th>Proposed Action (2023-2035)</th></tr>
<tr><td colspan="3">Socioeconomic Characteristics</td></tr>
<tr><td><u>Both Sites</u>: As of 2019, there were 7,909 full-time employees at LLNL consisting of 7,208 employees at the Livermore Site, 477 supplemental workers, and 224 workers at Site 300. (Note: at any given time there are also additional construction workers at LLNL. Due to fluctuations, those workers are assumed to be within the accuracy of the estimated total employment). The 2019 labor force in the region of influence (ROI) is 1,976,800 persons. Direct onsite employment at LLNL accounts for approximately 0.4 percent of employment in the four-county ROI.</td>
<td>Key socioeconomic impacts are presented in the table below.
<table>
<tr><th>Resource/Metric</th><th>Construction</th><th>Operations</th></tr>
<tr><td>Additional direct employment</td><td>210</td><td>1,221</td></tr>
<tr><td>Additional indirect employment</td><td>81</td><td>1,016</td></tr>
<tr><td>Additional direct earnings (millions of dollars)</td><td>18.6</td><td>206.0</td></tr>
<tr><td>Additional value added from LLNL (millions of dollars)</td><td>31.6</td><td>376.1</td></tr>
</table>

Socioeconomic impacts associated with construction would be minimal/temporary and much lower than operational impacts. Once steady-state operations are reached in 2023, employment at LLNL is projected to increase to 9,340 workers (9,020 workers at the Livermore Site and 320 workers at Site 300). This would represent an increase of 1,431 workers over the 2019 workforce, resulting in an estimated 1,097 indirect jobs in the four-county ROI.

Due to the low potential for impacts on the ROI population, steady-state operations would not affect fire protection, police protection services, or medical services. The number of school-age children associated with the additional workforce potentially migrating into the ROI would be 1,011 children. The increase in school enrollment would represent 0.4 percent of the projected 2021-2022 school enrollment for the ROI. This minimal increase in school enrollment would have a negligible effect on school services in the ROI.</td>
<td>Key socioeconomic impacts are presented in the table below.
<table>
<tr><th>Resource/Metric</th><th>Construction</th><th>Operations</th></tr>
<tr><td>Additional direct employment</td><td>700</td><td>710</td></tr>
<tr><td>Additional indirect employment</td><td>270</td><td>590</td></tr>
<tr><td>Additional direct earnings (millions of dollars)</td><td>62.1</td><td>119.8</td></tr>
<tr><td>Additional value added from LLNL (millions of dollars)</td><td>104.4</td><td>218.7</td></tr>
</table>

Socioeconomic impacts associated with construction would be minimal/temporary and much lower than operational impacts. Once steady-state operations are reached in 2035, employment at LLNL is projected to increase to 10,750 workers (10,344 workers at the Livermore Site and 406 workers at Site 300). This would represent an increase of 1,410 workers over the No-Action Alternative workforce, resulting in an estimated 860 indirect jobs in the four-county ROI workforce.

Due to the low potential for impacts on the ROI population, operations by 2035 would not affect fire protection, police protection services, or medical services. The number of school-age children associated with the additional workforce potentially migrating into the ROI would be 908 children. The increase in school enrollment would represent 0.1 percent of the projected 2034-2035 school enrollment for the ROI. This minimal increase in school enrollment would have a negligible effect on school services in the ROI.</td></tr>
<tr><td colspan="3">Environmental Justice</td></tr>
<tr><td><u>Both Sites</u>: The average minority population percentage of the counties surrounding the Livermore Site and Site 300 is approximately 59.6 percent The low-income population percentage of the counties surrounding the Livermore Site and Site 300 is 10.8 percent. LLNL operations have continued to result in</td>
<td>No high and adverse impacts from construction and operation activities at LLNL are expected. Consequently, there would be no disproportionately high and adverse impacts to minority or low-income populations.</td>
<td>No high and adverse impacts from construction and operation activities at LLNL are expected. Consequently, there would be no disproportionately high and adverse impacts to minority or low-income populations.</td></tr>
</table>

Baseline Data (2019)	No-Action Alternative (2020-2022)	Proposed Action (2023-2035)
minimal impacts, including human health effects to offsite residents and onsite workers, and there are no disproportionately high and adverse impacts to minority or low-income populations.		
Traffic and Transportation		
Both Sites: LLNL is surrounded by a system of freeways, major streets, and collector streets. The freeways and major streets in the vicinity of the Livermore Site include I-580, South Vasco Road, Greenville Road, East Avenue, and Patterson Pass Road, most of which are primarily located within the city limits of Livermore. Recent traffic studies in the vicinity of the Livermore Site indicate that the standards on roads and intersections in the vicinity of the Livermore Site vary between level-of-service (LOS) C and LOS D, which is not considered deficient.	Both Sites: By 2023, employment at LLNL is projected to increase by 1,431 over the current 2019 baseline of 7,909 workers. If all 1,431workers were to commute to the Livermore Site (which is a bounding assumption for the transportation analysis), local traffic would increase by an average of approximately 2.4 percent (note: traffic on specific roads in the vicinity of the Livermore Site would increase by 1.6 – 3.4 percent). The increase in traffic would not affect the LOS on roads in the vicinity of LLNL.	Both Sites: By 2035, employment at LLNL is projected to increase by 1,410 workers over the No-Action Alternative workforce. If all 1,410 workers were to commute to the Livermore Site (which is a bounding assumption for the transportation analysis), local traffic would increase by an average of approximately 2.3 percent (note: traffic on specific roads in the vicinity of the Livermore Site would increase by 1.6 – 3.2 percent). The increase in traffic would not affect the LOS on roads in the vicinity of LLNL. The New North Entry to the Livermore Site is expected to be operational in approximately 2025. This site entry would reduce the ADT volumes on Vasco Road and Greenville Road, and increase the ADT volume on Patterson Pass Road in the vicinity of the Livermore Site. The net effect would be a reduction in traffic backups and delays in the mornings on Vasco Road at the West Gate entrance.
Radiological and Hazardous Material Transportation		
Both Sites: LLNL transports the following hazardous and radiological materials: LLW/MLLW shipments: 40-50 annually. TRU shipments: 2-4 annually. Radiological Material shipments: about 600 shipments annually. In 2019, there were approximately 11 shipments of special nuclear material (primarily plutonium and uranium), about 84 shipments of small quantities of highly enriched uranium, about 5 shipments of tritium, and about 470 shipments of sealed sources and miscellaneous isotopes. Explosives shipments: 730 annually. Hazardous waste shipments: about 80 to 240	Both Sites: No radiological or hazardous waste materials/shipments are expected to be performed in support of construction activities. During operations, LLNL would regularly transport radiological waste, SNM, and other radiological materials to and from the LLNL site (which includes Site 300). Modeling all 645 potential offsite shipments resulted in the following impacts: Dose to transport-crews: 61.6 person-rem per year; LCF Risk to transport crews: 0.037 LCFs; Incident-free dose to general public: 21.6 person-rem; LCF Risk to Public: 0.013 LCFs; Accident Risk to Public: 1.9 x 10^{-6} LCFs;	Both Sites: As a result of increased nonroutine shipments of LLW/MLLW associated with DD&D, there could be more total shipments of radiological materials for the Proposed Action compared to the No-Action Alternative. However, potential impacts would not be notable higher because the LLW/MLLW shipments only account for a small fraction of the total impacts. Modeling all 888 potential offsite shipments resulted in the following impacts: Dose to transport-crews: 69.2 person-rem per year; LCF Risk to transport crews: 0.042 LCFs; Incident-free dose to general public: 24.7 person-rem; LCF Risk to Public: 0.015 LCFs; Accident Risk to Public: 2.9 x 10^{-6} LCFs;

Baseline Data (2019)	No-Action Alternative (2020-2022)	Proposed Action (2023-2035)
annually.	Number of Traffic Fatalities from Accidents: 0.025.	Number of Traffic Fatalities from Accidents: 0.038.
Infrastructure		
See Table 3-10 for a discussion of total capacity and available capacity.	Both Sites: Existing infrastructure would be adequate to meet all requirements (*see* Table 3-10).	Both Sites: Existing infrastructure would be adequate to meet all requirements (*see* Table 3-10).
Waste Management and Materials Management		
Both Sites: Operations (including construction and DD&D) generate the following annual quantities of waste (upper numbers are projections): LLW (cubic meters/year): 1,022-1,560 MLLW (cubic meters/year): 207-813 TRU/mixed TRU waste (cubic meter/year): 8-112.8 Hazardous (metric tons/year): 269-2,210 Nonhazardous (metric tons/year): 5,350	Operations (including construction and DD&D) would generate the following projected annual quantities of waste: LLW (cubic meters/year): 4,850 – 8,850 MLLW (cubic meters/year): 813 TRU/mixed TRU waste (cubic meter/year): 112.8 Hazardous (metric tons/year): 2,210 Nonhazardous (metric tons/year): 3,950-8,550	Operations (including construction and DD&D) would generate the following projected annual quantities of waste: LLW (cubic meters/year): 8,000 MLLW (cubic meters/year): 3,258 TRU/mixed TRU waste (cubic meter/year): 112.8-175.6 Hazardous (metric tons/year): 2,210 Nonhazardous (metric tons/year): 8,900
Human Health and Safety		
Both Sites: Lost days due to injury/illness per year: 65 Number of occupational fatalities per year: 0.13	Both Sites: Lost days due to injury/illness per year: 77.5 Number of occupational fatalities per year: 0.15	Both Sites: Lost days due to injury/illness per year: 92.5 Number of occupational fatalities per year: 0.18
Radiological Impacts: (see below)	Radiological Impacts: (see below)	Radiological Impacts: (see below)

Baseline Data (2019) – Radiological Impacts:

Receptor/Dose/Risk	Livermore Site	Site 300
Public		
Collective dose to 50-mile population (person-rem)	0.26	3.7×10^{-5}
Population LCFs	1.6×10^{-4}	2.0×10^{-8}
Offsite MEI dose (millirem)	4.004[a]	1.7×10^{-4}
MEI LCF risk	2.4×10^{-6}	1.0×10^{-10}
Workers		
Number of radiological workers[a]	123	
Average annual dose to radiological worker (millirem)	69.6	
Average annual radiological worker risk (LCFs)	4.2×10^{-5}	
Collective annual dose to radiological workers (person-rem)	8.45	
Total Annual Radiological Worker Risk (LCFs)	0.005	

a. Modelled doses as reported in the 2020 Annual Site Environmental Report (LLNL 2020r). Also includes maximum of 4 mrem/year in skyshine dose from NIF operations.

No-Action Alternative (2020-2022) – Radiological Impacts:

Receptor/Dose/Risk	Livermore Site	Site 300
Public		
Collective dose to 50-mile population (person-rem)	0.60	5.0×10^{-5}
Population LCFs	3.6×10^{-4}	3.0×10^{-8}
Offsite MEI dose (millirem)	4.01[a]	1.7×10^{-4}
MEI LCF risk	2.4×10^{-6}	1.0×10^{-10}
Workers		
Number of radiological workers	575	
Average annual dose to radiological worker (millirem)	180	
Average annual radiological worker risk (LCFs)	1.1×10^{-4}	
Collective annual dose to radiological workers (person-rem)	103.5	
Total Annual Radiological Worker Risk (LCFs)	0.06	

Modelled doses from radiological air emissions. Includes maximum of 4 mrem/year in skyshine dose from NIF operations.

Proposed Action (2023-2035) – Radiological Impacts:

Receptor/Dose/Risk	Livermore Site	Site 300
Public		
Collective dose to 50-mile population (person-rem)	7.1	5.0×10^{-5}
Population LCFs	4.3×10^{-3}	3.0×10^{-8}
Offsite MEI dose (millirem)	4.21[a]	1.7×10^{-4}
MEI LCF risk	2.5×10^{-6}	1.0×10^{-10}
Workers		
Number of radiological workers	615	
Average annual dose to radiological worker (millirem)	173.5	
Average annual radiological worker risk (LCFs)	1.0×10^{-4}	
Collective annual dose to radiological workers (person-rem)	106.7	
Total Annual Radiological Worker Risk (LCFs)	0.06	

a. Modelled doses from radiological air emissions. Includes maximum of 4 mrem/year in skyshine dose from NIF operations.

Baseline Data (2019)	No-Action Alternative (2020-2022)	Proposed Action (2023-2035)
Site Contamination and Remediation		
Both Sites: Remediation of groundwater and soil contamination at both the Livermore Site and Site 300 is ongoing. NNSA complies with provisions specified in the two FFAs entered into by USEPA, DOE, the California EPA Department of Health Services (now DTSC), and the San Francisco Bay or Central Valley Regional Water Quality Control Boards.	Both Sites: Remediation of groundwater and soil contamination at both the Livermore Site and Site 300 would continue. NNSA complies with provisions specified in the two FFAs entered into by USEPA, DOE, the California EPA Department of Health Services (now DTSC), and the San Francisco Bay or Central Valley Regional Water Quality Control Boards. Any future remediation actions would be conducted in accordance with these FFAs, and NNSA is not proposing any specific future remediation activities in this SWEIS. None of the activities associated with the No-Action Alternative would complicate or delay any of the monitoring or cleanup activities at the Livermore Site or Site 300.	Both Sites: Remediation of groundwater and soil contamination at both the Livermore Site and Site 300 would continue. NNSA complies with provisions specified in the two FFAs entered into by USEPA, DOE, the California EPA Department of Health Services (now DTSC), and the San Francisco Bay Regional Water Quality Control Board. Any future remediation actions would be conducted in accordance with the FFA, and NNSA is not proposing any specific future remediation activities in this SWEIS. None of the activities associated with the Proposed Action would complicate or delay any of the monitoring or cleanup activities at the Livermore Site or Site 300.
Accidents		
Both Sites: Bounding accidents and potential bounding impacts would be the same as the No-Action Alternative (see Table 3-11). With regard to non-bounding accidents, the only notable difference in accident impacts involves a Tritium Processing System Fire in the NIF (B581). Under both the No-Action Alternative and the Proposed Action, that accident would have higher impacts than the current baseline due to an increase in the tritium inventory in the NIF (*see* Appendix C, Section C.3.2.2).	Both Sites: Bounding accidents and potential bounding impacts are presented in Table 3-11.	Both Sites: Bounding accidents and potential bounding impacts are presented in Table 3-11.
Intentional Destructive Acts (IDA)		
Both Sites: The baseline conditions would have the same IDA results as presented for the No-Action Alternative (see Table 3-11).	NNSA has prepared an IDA appendix to support this LLNL SWEIS that analyzes the potential impacts of intentional destructive acts (e.g., sabotage, terrorism). That appendix contains Official Use Only information related to security concerns and is not publicly releasable. All of the IDA consequences would be similar to, and consistent with, the accident consequences.	The Proposed Action would have the same IDA results as presented for the No-Action Alternative.

Source: LLNL 2021c; LLNL 2021d.

a. Workers receiving measurable radiation dose.

Table 3-10. Summary Comparison of Infrastructure Requirements of the Alternatives

		Current			Projected Requirements			
Resource	**Site**	**Use**	**Total Capacity**	**Available Capacity**	**Construction: No-Action Alternative**	**Construction: Proposed Action**	**Operations: No-Action Alternative**	**Operations: Proposed Action**
Electricity–power consumption (million kilowatt-hours per year)	Livermore Site	402.4	Not Applicable	Not Applicable	No notable change	No notable change	475	535
	Site 300	12.2	ND	ND	No notable change	No notable change	12.6	24.7
Electricity–Monthly Peak Load (MW)	Livermore Site	63.6	125	61.4	No notable change	No notable change	65.5	81.9
	Site 300	2	ND	ND	No notable change	No notable change	2	5
Natural Gas (million therms/year)	Livermore Site	4.51	8.94	4.43	No notable change	No notable change	4.65	4.91
	Site 300	None	None	None	None	None	None	None
Petroleum Fuel (gallons per year)	Both Sites	102,014	Not Applicable[a]	N/A	No notable change	No notable change	75,300[b]	85,000[b]
Domestic water (million gallons per year)	Livermore Site	267	1,051	784	3.33	3.51 (6.12 peak year)	386	482
	Site 300	14	473	459	0.37	0.39 (0.68 peak)	14	21
Wastewater (million gallons per year)	Livermore Site	132.5	3,467 [c]	3,335	1.5	2.2 (4.5 peak year)	134.1	147.8
	Site 300	1.46	2.73	1.27	0.5	0.8 (1.5 peak year)	1.6	1.9

ND = no available data
a. fuel delivered by truck
b. estimated usage in year 2035 for the No-Action Alternative and the Proposed Action.
c. Capacity of the Livermore Wastewater Reclamation Plant (LWRP), 9.5 MGD
Source: CWB 2016; CRWQCB 2008; LLNL2020b; Stantec 2019.

Table 3-11. Potential Accident and Intentional Destructive Acts Impacts for the Alternatives

Accidents Applicable to the No-Action Alternative and the Proposed Action	Potential Impact
Livermore Site Facility Radiological Accidents—Bounding MEI Impact	
Conservative Meteorology: B693 – Waste Storage Facility Fire	Frequency: $\leq 1\times10^{-4}$ to 1×10^{-6} **MEI Dose: 17 rem; MEI LCF: 0.01** Population Dose: 160 person-rem; Population LCF: 0.096
Average Meteorology: A625 Yard TRUPACT-II Crane Drop and Fire	Frequency: $\leq 1\times10^{-4}$ to 1×10^{-6} **MEI Dose: 0.85 rem; MEI LCF: 5.1×10^{-4}** Population Dose: 5 person-rem; Population LCF: 0.003
Livermore Site Facility Radiological Accidents—Bounding Population Impact	
Conservative Meteorology: B625 Aircraft Crash	Frequency: 6.3×10^{-7} MEI Dose: 4.5 rem; MEI LCF: 0.0027 **Population Dose: 4,300 person-rem; Population LCF: 2.6**
Average Meteorology: B625 Aircraft Crash	Frequency: 6.3×10^{-7} MEI Dose: 0.041 rem; MEI LCF: 2.5×10^{-5} **Population Dose: 610 person-rem; Population LCF: 0.37**
Site 300 Radiological Accidents	Site 300 facilities are below HC-3 and have no offsite impacts.
Other Accidents	
Livermore Site Site-wide Earthquake	Frequency: $\leq 1\times10^{-4}$ to 1×10^{-6} MEI Dose: 0.97 rem; MEI LCF: 5.8×10^{-4} **Population Dose: 220 person-rem; Population LCF: 0.013**
Chemical Accidents	Average Meteorology: For the Livermore Site,_MEI chemical concentrations are each below their respective PAC-1 levels, except for accidents with chlorine and hydrogen chloride/hydrochloric acid, all of which are below their PAC-2 level. For Site 300, the MEI chemical concentrations are each below their respective PAC-1 levels. Conservative Meteorology: For the Livermore Site,_MEI chemical concentrations are each below their respective PAC-2 levels, except for the chlorine accident, which is below its PAC-3 level at the fenceline. For the chlorine accident scenario at 240 meters distance beyond the site boundary, concentrations are below PAC-2. For Site 300, the bounding chemical accident is a lithium hydride fire scenario, with a distance of 35 meters beyond the site boundary where concentrations are below PAC-2.
Livermore Site and Site 300 High Explosives Accidents	No offsite accident impacts.
Biological Accidents	No credible risk to the offsite population from escape of the bounding biological agent, even under the worst-case meteorological conditions at the Livermore Site.
Intentional Destructive Acts	
Theft, Sabotage, Others	The accident analyses done in the SWEIS represents the bounding accidents relative to environmental concerns for the IDA analysis.

Table 3-12. Environmental Impacts of the New Hybrid Work Environment

Resource	Potential Impacts
Land use, visual and aesthetic resources, geology and soils, water resources, biological resources, cultural resources, socioeconomics and Environmental Justice, human health, and accidents	Although consolidation of personnel could help accelerate DD&D and construction activities, the number of facilities and offices would not change; potential decreases in office space would be countered by COVID-19 distancing requirements that may be required/accommodated for in the future. There would be no net change in safety, health, and waste generation because facility and laboratory personnel would continue to operate facilities and conduct the same types and amounts of experiments and tests. As a result, for both the No-Action Alternative and the Proposed Action, there would be no change in the following resources
Air Quality	Reduced worker commuting and reduced travel would decrease air emissions. However, some of this decrease would be expected to be offset by workers using their home heating and air conditioning systems. NNSA estimates that onsite traffic could be reduced by up to 10 percent on any given day, which could reduce emissions by a maximum of approximately one percent. Because LLNL operations do not violate any air quality standard or contribute substantially to an existing or projected air quality violation, a reduction of one percent in emissions would be inconsequential. Effects on air quality from construction would be the same with or without the implementation of this option.
Transportation	Reduced worker commuting would result in positive impacts on the level-of-service (LOS) of area roads. Compared to the current baseline, which assumes 7,909 workers would use area roads daily to commute to LLNL, average daily traffic as a result of LLNL workers would decrease by 150 vehicles for both the No-Action Alternative and the Proposed Action. Reduced onsite worker population would also reduce onsite vehicle circulation and parking.
Infrastructure	Reduced onsite worker population would reduce domestic water use by a maximum of approximately 7.4 million gallons annually. Because steady-state water usage is expected to be approximately 400-503 million gallons annually, the reduction would amount to approximately 1.5-1.9 percent of the LLNL usage.

CHAPTER 4

Existing Environment

4.0 EXISTING ENVIRONMENT

4.1 INTRODUCTION

In accordance with the Council on Environmental Quality (CEQ) NEPA implementing regulations (40 CFR Parts 1500–1508) for preparing an EIS, the existing environment is "interpreted comprehensively to include the natural and physical environment and the relationship of people with that environment." The existing environment descriptions in this chapter provide the context for understanding the environmental consequences described in Chapter 5. They serve as a reference from which any environmental changes that could result from implementing the alternatives can be evaluated. The existing conditions for each environmental resource area were determined for ongoing operations from information provided in previous environmental studies and other reports and databases.

This SWEIS evaluates the environmental impacts of the alternatives within defined regions of influence (ROIs). The ROIs are specific to the type of effect evaluated and encompass geographic areas within which any significant impact would be expected to occur. For example, human health risks to the general public from exposure to airborne contaminant emissions are assessed for an area within a 50-mile radius of the centers of the Livermore Site and Site 300.

Most LLNL operations are conducted at the Livermore Site or Site 300. LLNL also conducts limited activities at several leased properties, including but not limited to storage facilities, and office space. Other offsite properties where LLNL conducts activities include the Arroyo Mocho Pump Station, located 7 miles south of the Livermore Site, and several offsite environmental monitoring locations. Due to the New Hybrid Work Initiative, LLNL plans to lease more office space in or near Livermore and Tracy, California. Offsite locations may include limited activities on Federal, State, and private properties, such as imaging technology development to determine road and bridge conditions, monitoring activities in the Marshall Islands, conducting airflight studies, atmospheric studies, and other national security projects throughout the United States and overseas.

In addition, missions of the LLNL programs are fulfilled through collaborations, both onsite and offsite, with scientific and institutional support organizations throughout the world. LLNL also provides support and guidance nationally and internationally for emergency assessments in response to chemical, nuclear, and biological incidents, joining with other similar teams across the DOE complex. This support may include providing training, collaborating, and responding as necessary with federal, state, and local agencies to assist in emergency responses. Several deployable teams are available to meet the DOE/NNSA emergency response mission under the umbrella of the NNSA Nuclear Emergency Support Team (NEST), including but not limited to the Radiological Assistance Program (RAP), Joint Technical Operations Team (JTOT), Accident Response Group (ARG), Disposition and Forensic Analysis Team (DFEAT), and DOE Forensics Operations (DFO). These teams may be deployed to any location, foreign or domestic, as requested by the DOE/NNSA.

Brief descriptions of the ROIs are provided in Table 4-1. Descriptions of the methodology used to evaluate impacts are presented in Appendix B of this SWEIS.

Table 4-1. General Regions of Influence for the Existing Environment

Environmental Resource	Region of Influence
Land use	Livermore Site, Site 300, Arroyo Mocho, and nearby offsite areas
Aesthetics and scenic resources	Livermore Site, Site 300, Arroyo Mocho, and nearby offsite areas
Geology and soils	Livermore Site, Site 300, and nearby offsite areas
Water resources	Onsite and adjacent surface water and groundwater
Air quality	Livermore Site, Site 300, and nearby offsite areas
Noise	Livermore Site, Site 300, and nearby offsite areas
Biological resources	Livermore Site, Site 300, Arroyo Mocho, and nearby offsite areas
Cultural and paleontological resources	Livermore Site, Site 300, Arroyo Mocho, and nearby offsite areas
Socioeconomics	Counties where approximately 90 percent of LLNL employees reside
Environmental justice	Minority and low-income populations within 50 miles of Livermore Site and Site 300
Traffic and transportation	Transportation corridors between LLNL and other sites where wastes/materials are transported
Infrastructure	Livermore Site, Site 300, and Arroyo Mocho
Waste management and materials management	Livermore Site and Site 300
Human health and safety	Livermore Site, Site 300, offsite areas within 50 miles of those sites
Environmental remediation	Livermore Site and Site 300

4.2 LAND USE

This section summarizes existing onsite and surrounding land uses at the Livermore Site, Site 300, and offsite leased properties, as well as adopted land-use plans applicable to surrounding areas. It also describes local land-use plans, and city and county programs. City or county organizations have no planning jurisdiction at the site because LLNL is a DOE-owned federal facility. Nevertheless, LLNL does consider local planning policies, to the extent practicable, in its land-use decisions as a good neighbor policy. Figure 4-1 shows the location of the Livermore Site, Site 300, and the Arroyo Mocho pump station.

Source: Apple Maps 2020.

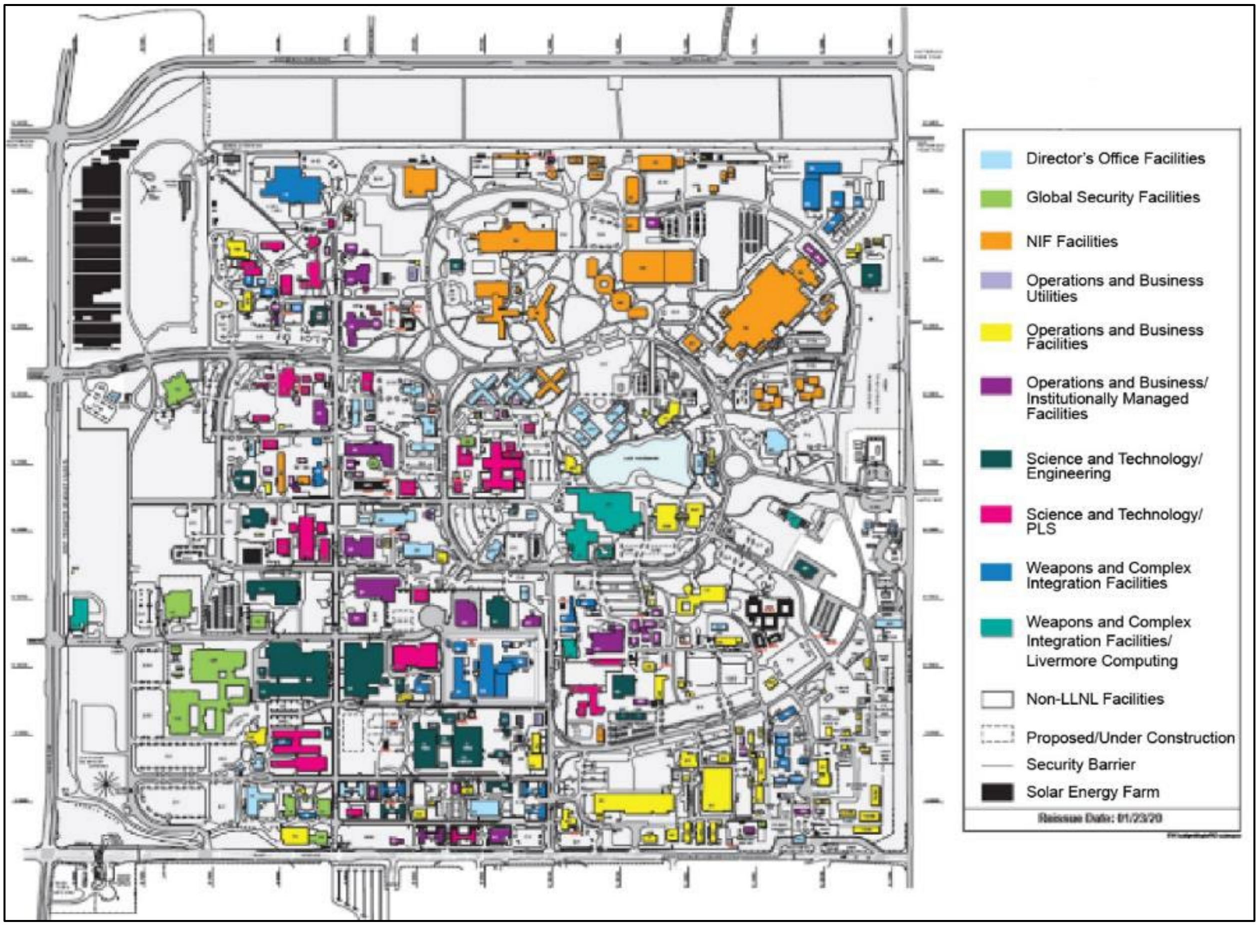
Figure 4-1. Location of the Livermore Site, Site 300, and the Arroyo Mocho Pump Station

4.2.1 Livermore Site

4.2.1.1 *Existing Onsite Land Uses*

The Livermore Site sits on 821 acres in eastern Livermore, California. The Livermore Site offers a campus-like setting with offices, laboratory buildings, support facilities such as cafeterias, storage areas, maintenance yards, and a fire station. There are roadways, shared paths for pedestrians and bicycles, parking areas, buffer zones, and landscaping. The Livermore Site is slightly larger than one square mile and lies entirely within the eastern perimeter of the city of Livermore's limits. The northern and western portions of the Livermore Site feature a 500-foot-wide security buffer zone. The northern buffer zone abuts land zoned and developed industrial, while the western portion borders residential single-family developments. The southern portion of the Livermore Site is adjacent to Sandia National Laboratories/California (SNL/CA), and the eastern portion lies next to agricultural land outside Livermore city limits.

Figure 4-2 depicts the development of the Livermore Site. There are approximately 490 buildings on the Livermore Site, ranging from small facilities of less than 100 square feet (such as security kiosks) to facilities of more than 500,000 square feet (such as the three interconnected structures that comprise Building 581, and the 700,907 square-foot National Ignition Facility [NIF]). The majority of the buildings (88 percent) are smaller than 20,000 square feet, resulting in an average building size of 14,000 square feet. There are 16 buildings larger than 100,000 square feet and seven "anchor" buildings greater than 150,000 square feet (*see* Table 4-2).



Source: LLNL 2020o.

Figure 4-2. Livermore Site Development

Table 4-2. Livermore Site Buildings Larger than 150,000 Square Feet

Building	Square Footage
Building 581 (NIF)	700,907
Building 131 (Engineering Facility)	287,192
Building 453 (Livermore Computing Facility)	253,000
Building 490 (NIF Engineering and Diagnostic Lab)	216,789
Building 132N (Defense Programs Research Facility)	204,146
Building 391 (NIF Optics and Diagnostic Labs)	197,842
Building 132S (Global Security Research Facility)	172,104

Over the past 15 years, NNSA has constructed 123,126 square feet of new facilities and demolished 554,728 square feet of excess facilities at LLNL (LLNL 2020p). NNSA is committed to sustainable development and community engagement at LLNL. To that end, NNSA has developed a site sustainability plan that lays out the future growth of the Laboratory. As the Livermore Site continues to be developed, new facility construction is primarily infill projects replacing aging facilities. Per DOE Orders 413.3B and 430.1C, new construction at LLNL will be built to either Leadership in Energy and Environmental Design (LEED) Building Design and Construction certification at the Gold rating level and DOE's guiding principles (GPs), as outlined in Table 4-3 (DOE Order 413.3B, LLNL 2021b). Since 2005, NNSA has added five LEED-certified facilities and an additional 14 buildings adhering to the GPs (LLNL 2019j). NNSA will continue to commit new construction to either LEED or GPs standards as new energy-efficient facilities replace the aging and functionally obsolete structures.

Table 4-3. Applicability of either LEED or DOE Guiding Principles for New Construction

Criteria	LEED Building Design and Construction Gold and Guiding Principles	Guiding Principle
Total project cost	≥$50M	Any
Individual building size	≥1,000 gross square feet	>5,000 gross square feet
Real property trailers	No	Yes
Human occupants	Yes	Yes or No
Individual building cost	Any	Any

LEED = Leadership in Energy and Environmental Design
Sources: LLNL2019j.

In addition to the replacement of legacy facilities with more efficient new facilities, NNSA has made other strides in improving the efficiency and sustainability of the Livermore Site. There is infrastructure in place for electrical vehicle charging. The landscaping on site is also being modernized to reduce water usage; LLNL is reducing turf, planting native species, installing bioswales, and utilizing smart irrigation. The Lab is also adding additional open space as shown in Figure 4-3. Future building and development of the facilities and the site will be human-scaled to maximize the potential for walking and bicycle trips between facilities (LLNL 2019j).

To better integrate and partner with the statewide research community, in 2005 NNSA partially opened the 200-acre Livermore Valley Open Campus (LVOC) on the east side of the Livermore Site. Located outside of the Livermore Site main security perimeter, the LVOC currently contains a visitor center (Discovery Center), a press room trailer, legacy office facilities, an advanced manufacturing facility and the High Performance Computing (HPC) Innovation Center (located in Building 642). LVOC includes an office building (Building 642) and conference facility (Building 643). It also includes an approximately 10-acre parcel that since 1975 has been leased to the University of California (UC) and which contains three UC-owned buildings known as the Hertz Hall complex. LVOC offers LLNL and external stakeholders an opportunity to collaborate and share the lab's resources in areas such as green transportation, energy, advanced technologies, and HPC.

Source: LLNL 2021b.

Figure 4-3. Existing and Potential Future Green Space

4.2.1.2 *Livermore Site Surrounding Land Uses*

All designations used in this section are from the relevant municipal or county general plan and zoning maps. Figure 4-4 displays the land uses around the Livermore Site.

The Livermore Site is bordered on the east by Greenville Road. The property east of Greenville Road is mostly agricultural with a few scattered rural residences and businesses, and is used primarily for grazing. The businesses include a veterinarian office, a construction contractor, an equestrian facility/wedding venue, and a winery across Greenville from the Laboratory. A DOE Western Area Power Administration electrical substation is near the southeast corner of Greenville

Road and Patterson Pass Road. The South Bay Aqueduct, a branch of the California Aqueduct, traverses the land east of the Livermore Site in a north-south direction. The Patterson Reservoir and filtration plant for the South Bay Aqueduct are northeast of the Livermore Site along Patterson Pass Road.

Source: Livermore 2020a.

Figure 4-4. Land Uses Around the Livermore Site

Patterson Pass Road runs along the northern boundary of the Livermore Site. An industrial park and warehouse complex lie across Patterson Pass Road to the north. The area is largely developed with a variety of commercial operations. A Union Pacific Railroad line runs in an east-west direction along the northern boundary of the industrial park. The Vasco Road Station located near the intersection of Vasco and Patterson Pass Roads carries rail passengers via the Altamont Corridor Express (ACE) and Amtrak lines. Land uses farther north include more commercial and industrial enterprises, logistics centers, office parks, small pockets of residential developments, and Interstate 580 (I-580). Land northeast of the site is agricultural and used primarily for grazing. Wind turbines are installed on the hills of the Altamont Pass, northeast of the Livermore Site.

Vasco Road borders the Livermore Site to the west. A low-density, single-family residential subdivision begins at the southwest corner of Patterson Pass Road and Vasco Road and extends south and west. Medium-density residential areas, mainly apartment complexes, exist on the west side of this development, approximately 2,000 feet west of Vasco Road.

East Avenue borders the Livermore Site to the south. SNL/CA, which has land uses similar to those at the Livermore Site, is south of East Avenue. The primary land uses to the south and west of SNL/CA are low-density residential developments, and agricultural (mainly grazing and viticulture). Public access to the section of East Avenue common to the Livermore Site is administratively controlled. There is a small residential development on the southwest corner of East Avenue and Vasco Road. Along the southwest side of Vasco Road is a light industrial park. To the south and west of this industrial park is low density detached housing.

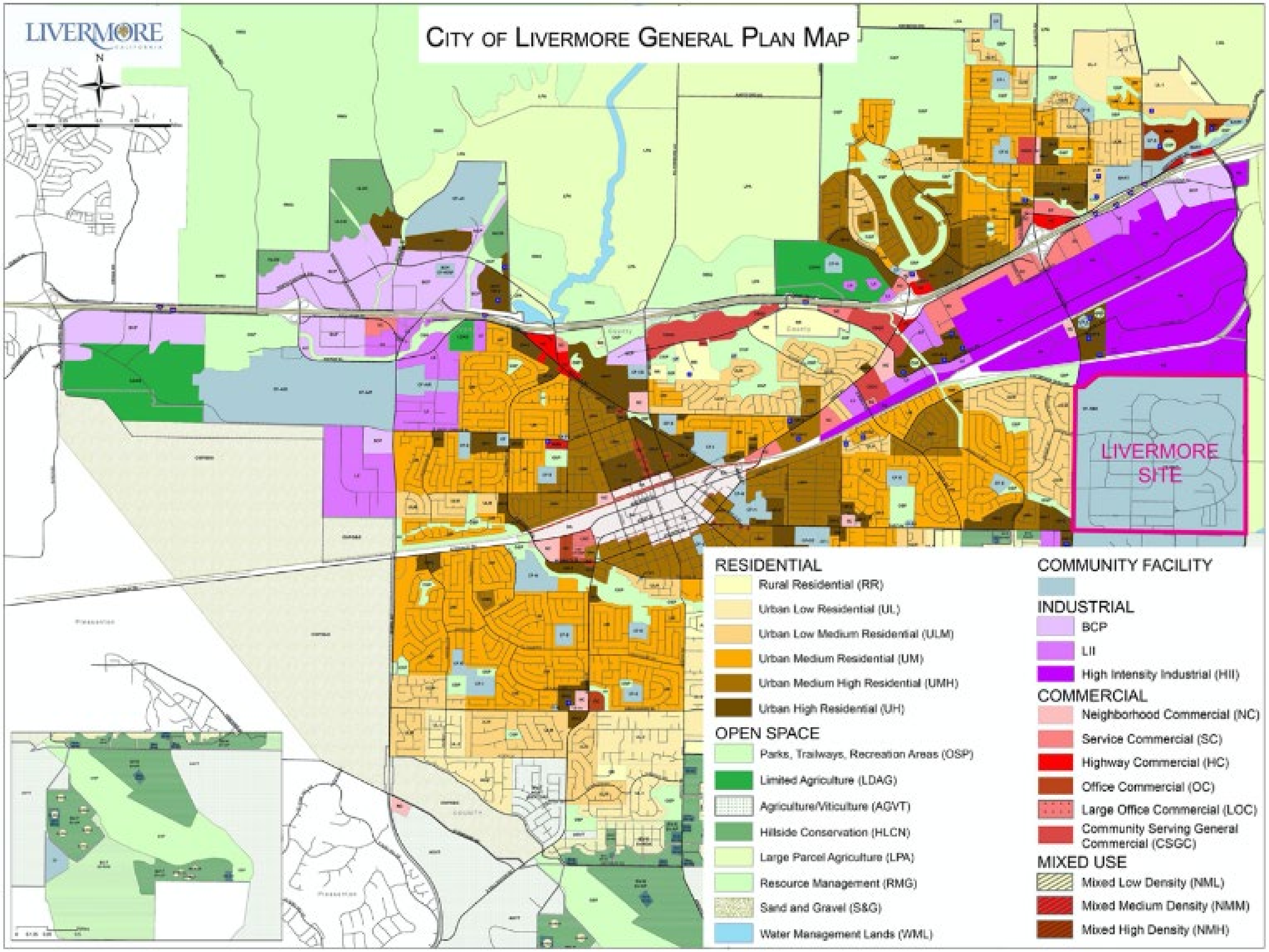
4.2.1.3 *Land Use Plans and Programs*

The Livermore Site is a federally owned facility, and the city of Livermore does not have planning jurisdiction. However, for purposes of this evaluation, this section presents local land-use planning in the vicinity of the Livermore Site.

City of Livermore

Annexation of LLNL. In 2011, the city of Livermore's planning commission voted unanimously to annex LLNL and SNL/CA to correct a disparity that existed between Livermore's city limits and the urban growth boundary. Now, both Livermore's city limits and the urban growth boundary align to encompass the entire Livermore Site. (LLNL 2011a).

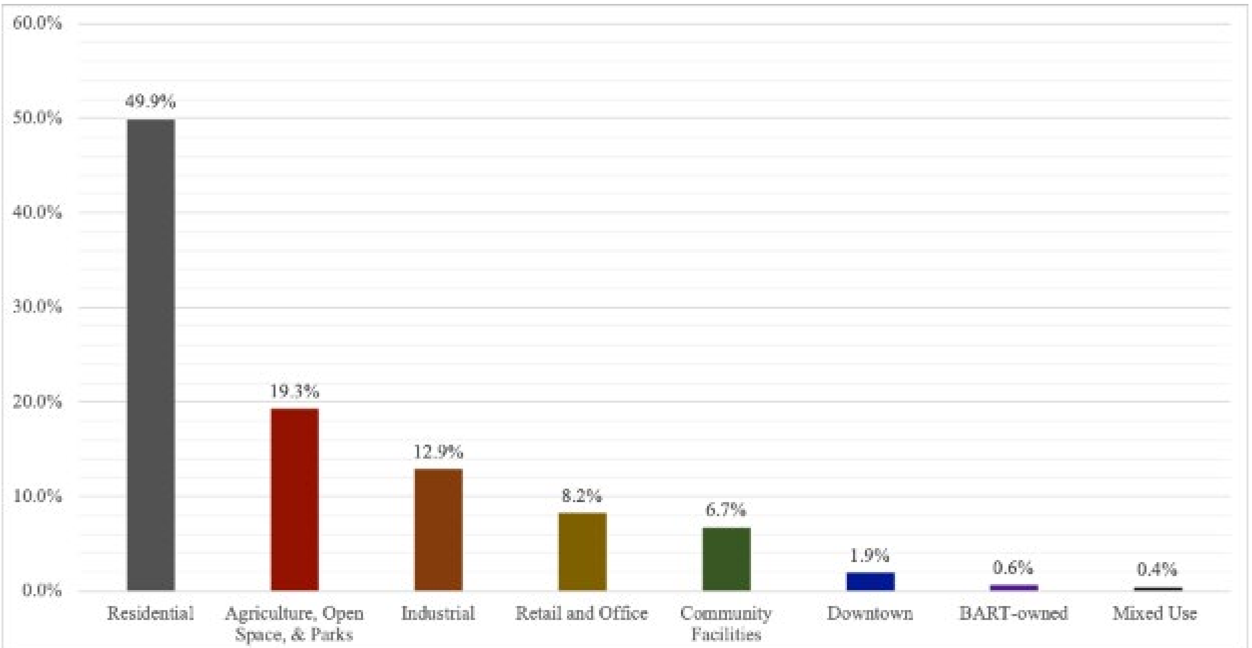
City of Livermore General Plan. The Livermore City Council adopted the *City of Livermore General Plan, 2003–2025*, on February 9, 2004, and last amended it in December 2014 (Livermore 2014). The planning area for the city of Livermore encompasses approximately 139 square miles and is bordered on the north by the Alameda County line, on the east by the ridgeline of the Altamont Hills, on the south by a line eight miles south of the Livermore City Hall, and on the west by the Murray-Pleasanton Township. Figure 4-5 shows land uses for the city of Livermore. The largest single land use within the city of Livermore planning area is open space (83 percent), mostly grassland.



Source: Livermore 2014.

Figure 4-5. Land Uses in the City of Livermore

Figure 4-6 displays the breakdown of land-use categories within the city of Livermore. Of the urban developed area within the city of Livermore's limits, 50 percent is devoted to residential uses; 19 percent to agriculture, open space, and parks; 13 percent to industrial; 8 percent to retail and office; 7 percent to community facilities; and the remainder is either downtown, owned by the Bay Area Rapid Transit (BART), or mixed use.



Source: Livermore 2014.

Figure 4-6. Comparative Acreage of General Plan Land Use Categories

The following list relevant land-use policies in the City of Livermore General Plan (Livermore 2014):

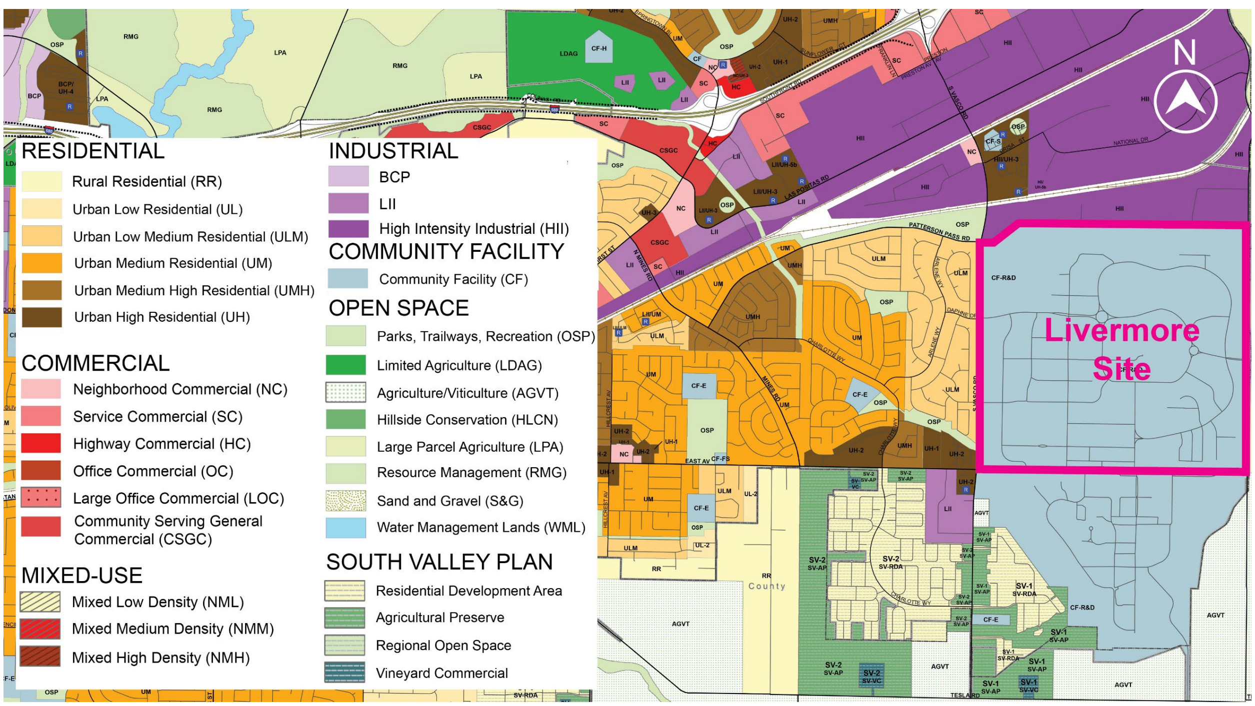
- The City shall make industrial development subject to design principles and performance standards that prevent negative impacts on the health, safety, and welfare of residents and are consistent with General Plan policies.
- The City shall apply regulations that reserve large tracts for exclusive industrial use to encourage development of an industrial community and prevent encroachment by incompatible uses.
- The City shall encourage the formation of an Industrial Park Foundation for purposes of establishing an industrial park as an added inducement in attracting new industries.
- Use open space to protect and enhance local community character and identity, to preserve rural characteristics, and to provide an edge to urban growth. Open space shall be used as a buffer between incompatible land uses within urban or essentially undeveloped areas.

The city of Livermore has also adopted specific policies of Alameda County's South Livermore Valley Area Plan under its own South Livermore Valley Policies, including (Livermore 2004):

- Using economic incentives to facilitate the expansion of cultivated agriculture
- Creating permanent urban/rural boundaries to protect the long-term viability of agriculture/viticulture

These policies are directed at development within the Livermore city limits and include specific area designations and policies to encourage preserving agricultural lands and limiting commercial and residential development that may reduce agricultural lands.

Figure 4-7 illustrates the land-use designations for the Livermore Site and surrounding areas as determined by the city of Livermore's General Plan (Livermore 2014). The Livermore Site is designated as Community Facility – Research and Development (CF – R&D). The Livermore Community General Plan designates the areas north of the Livermore Site as High Intensity Industrial, with areas west as Urban Low Medium Residential. Small areas within the residential areas are designated as open-space parks, which include parks, trail ways, recreation corridors, and protected areas. The area directly south of the Livermore Site is the SNL/CA, also designated CF – R&D. The areas to the east are outside the city of Livermore's city limits and urban growth boundary. The land is primarily in use as open space and agriculture.

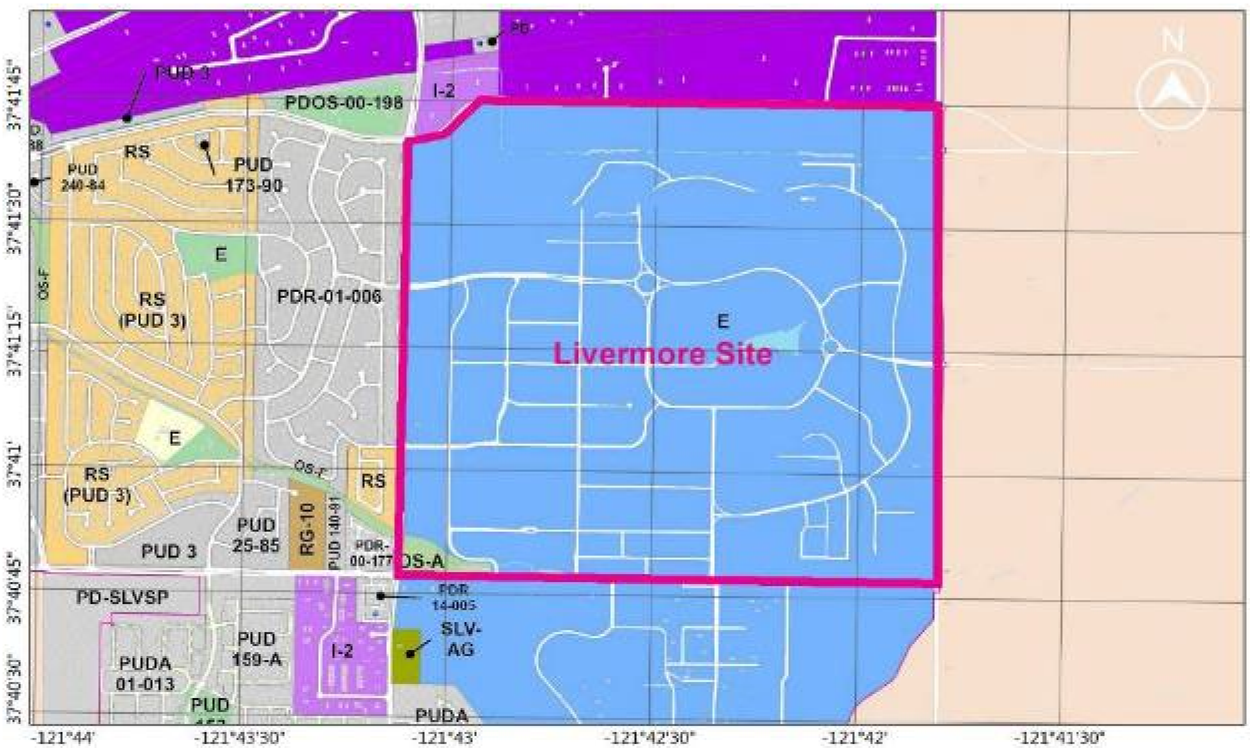


Source: Livermore 2020a.

Figure 4-7. City of Livermore Land Use Designations Around Livermore Site

North Livermore Area General Plan Amendment. The Livermore City Council adopted the *North Livermore Area General Plan Amendment* in March 1988 (Livermore 2002). The north Livermore area is bordered on the west by the unincorporated Springtown community, on the north and east by the base of the Livermore foothills, and on the south by I-580. The *North Livermore Area General Plan Amendment* revised the pattern of residential land uses and densities, and provided for supporting neighborhood commercial facilities, community facilities, and open-space uses. The amendment provided for a 35-percent increase in residential land use, a 54-percent increase in commercial use, a 32-percent decrease in public facility use, and a 51-percent decrease in open-space and agriculture use over a 20- to 25-year planning horizon. This amendment allowed for approximately 3,000 more dwelling units and approximately 170 more commercial acres to be built in the Springtown Community. Most development permitted by this amendment has been completed (Livermore 2002).

City of Livermore Zoning. Figure 4-8 presents zoning designations of the Livermore Site and adjacent properties. The entire Livermore Site is zoned as "E" (education and institutions) (*see* Table 4-4). The northern perimeter area is primarily zoned "I-3" for heavy industrial use, and a small parcel in the northwest perimeter area is zoned "I-2" for light industrial use. Areas west of the Livermore Site are designated as "PDR" for planned-development residential. The entire southern border is zoned as "E" and comprises the SNL/CA. Areas east are rural and outside of the city of Livermore's zoning influence.



Source: LLNL 2020a.

Figure 4-8. Zoning Designations of the Livermore Site and Adjacent Properties

Table 4-4. Zoning Descriptions of Livermore Site and Adjacent Properties

Zone	Purpose
E, Education and Institutions	The E zone is applied to areas of the city that are appropriate for the development of public and private educational institutions wherein all directly related types of uses may be located. The E zone is also applied to areas for publicly owned park and recreation facilities and areas for governmental buildings and facilities.
I-2, Light Industrial	The I-2 zone is applied to areas of the city that are appropriate for professional and administrative facilities, research institutions, manufacturing operations, and green technology facilities not proposed to be located in a "campus"-type environment. It is intended to provide an optimum general industrial environment by providing an alternate choice for industrial land uses that are compatible with adjacent residential uses and buffered from them.
I-3, Heavy Industrial District:	The I-3 zone is applied to areas of the city that are appropriate for a range of industrial activities including manufacturing, assembly and processing, storage and distribution of raw materials, and related industrial uses that are neither objectionable nor detrimental to adjacent properties because of hazards, noise, or other disturbance. The I-3 zone also accommodates professional and administrative facilities accessory to research and manufacturing operations. The I-3 zone provides a sound heavy industrial environment by providing and protecting areas within the city for such development.
OS-A, Open Space-Agricultural	The OS-A zone is applied to areas of the city that are appropriate for permanent or semi-permanent open space. Lands shall be zoned to the OS zone where the open space designation meets one or more of the following criteria: (A) represents the actual use of the land; (B) establishes the best use of the land; (C) indicates land not to be converted to urban use in the foreseeable future; (D) indicates land having resources found to be in the public interest to preserve; or (E) indicates land found not suitable for urban use due to natural or other hazards associated with the land.
PDR, Planned Development Residential	The PDR zone is applied to areas of the city appropriate for residential, commercial, and industrial planned development projects that require more flexible design standards. The flexibility allows a developer to address geologic, topographical, and environmental factors. A PDR zone allows projects to be developed with open space and neighborhood amenities. A PDR zone shall conform to the requirements of the General Plan and the intent of the Municipal Code in requiring adequate standards necessary to protect the public health, safety, and general welfare.
R-S, Suburban Residential	The R-S zone is applied to areas of the city that are appropriate for low-density residential dwellings of a single-family dwelling type. The R-S zone preserves and protects a single-family residential character but allows flexible subdivision design and development that encourages a variety of lot sizes, housing types, and housing opportunities for all income groups.

Source: Livermore 2019a.

4.2.2 Site 300

4.2.2.1 *Existing Onsite Land Uses*

Site 300 is located in western San Joaquin County with a small portion in Alameda County. Site 300 is 16 miles east of LLNL, 11 miles southwest of downtown Tracy, California, and 4 miles from I-580, which acts as a barrier between most of the developing areas of Tracy and the grasslands adjacent to Site 300. The site is located in California's interior Coast Range and is characterized by low rugged mountains and intervening valleys. It is bordered to the south by Corral Hollow Road, which provides primary entry and egress to the site. Access along Corral Hollow Road lies in a valley, and the site rises in elevation from 500 to 1,750 feet above sea level along north-south ridges. While the southern portion of the site features steep slopes and valleys, in the north, these harsh grades give way to more gentle hills.

Site 300 is approximately 7,000 acres in area, with less than five percent developed. Many of the developed areas with buildings are fenced for access control, and few of these developed areas provide habitat for native flora and fauna. Of the 7,000 acres, more than 95 percent are undisturbed save for annual prescribed burns, 803 acres are in a conservation set-aside study area, and 160 acres have been set aside as the *"Amsinckia grandiflora Reserve"* to protect this species' natural habitat. Eighty percent of the site is covered in California annual grassland, primarily pine bluegrass and purple needlegrass.

Site 300 is primarily a test facility for nonnuclear explosives and other nonnuclear weapons components. Site 300 is divided into seven areas (Figure 4-9): General Service Area (GSA), Engineering Test Area, Process Area, Chemistry Area, Small Arms Training Area, West Firing Area, and East Firing Area. The main entrance is located on Corral Hollow Road. The Small Arms Training Area is accessible by a separate entrance on Corral Hollow Road.

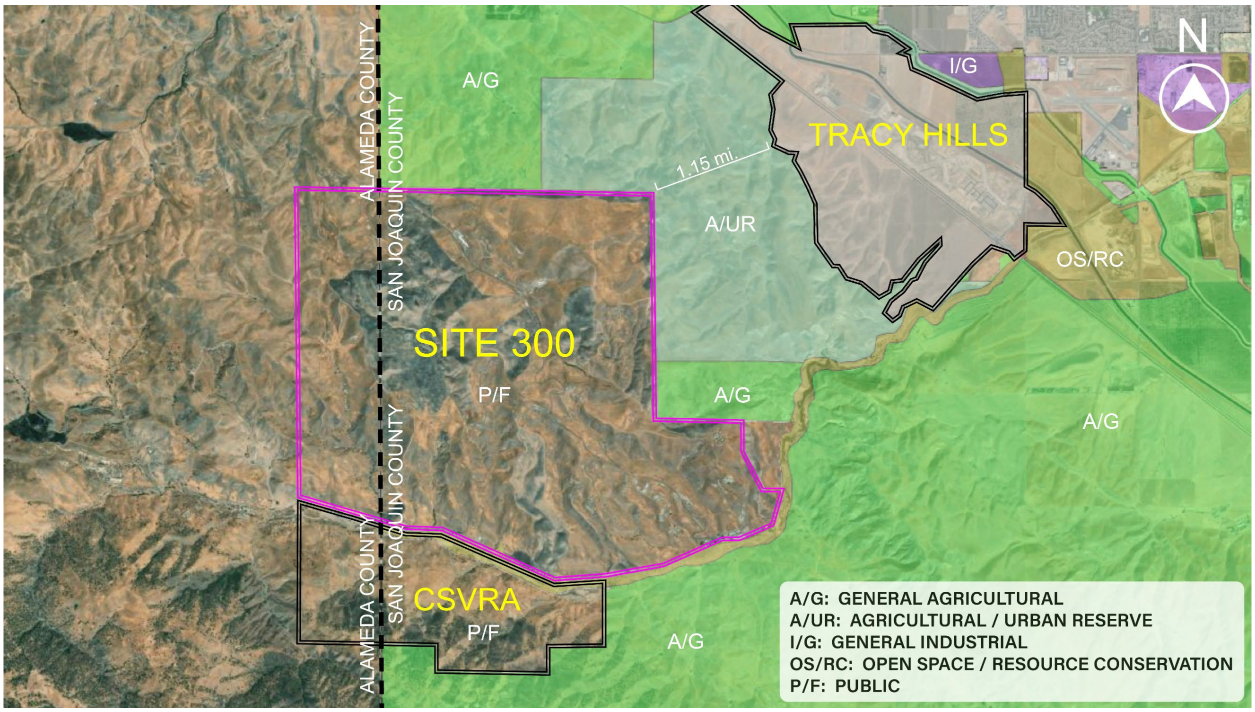
Source: LLNL 2020q.

Figure 4-9. Site 300 Area Designations

There are approximately 150 buildings on Site 300. Of these, fewer than 15 are considered large facilities (i.e., more than 10,000 square feet). The largest facilities are the Contained Firing Facility (CFF) (Building 801) and the Advanced Test Accelerator (Building 865). The majority of the 150 buildings on Site 300 are small (less than 2,000 square feet) support facilities, such as storage buildings, offices, maintenance shops, and training facilities. There are approximately 45 small storage magazines, almost all of which are less than 1,000 square feet.

4.2.2.2 *Site 300 Surrounding Land Uses*

Figure 4-10 shows the existing land uses surrounding Site 300. The majority of land immediately surrounding Site 300 is native grassland that is either undeveloped or utilized for agricultural purposes, primarily for grazing cattle and sheep.



Source: San Joaquin 2020.

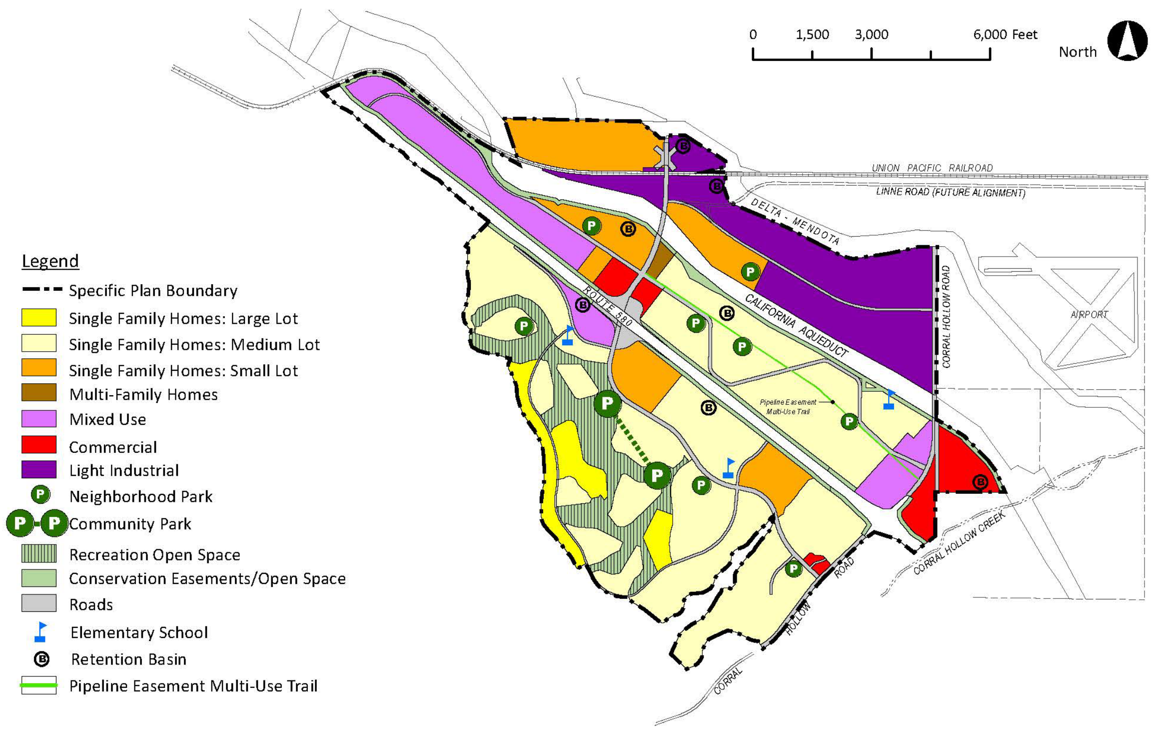
Figure 4-10. Land Use Designations for Site 300 and Surrounding Area

Corral Hollow Road borders Site 300 on the south. It is the sole artery providing access to Site 300 and the surrounding properties. From Livermore, Tesla Road becomes Corral Hollow Road at the Alameda-San Joaquin county line. Tesla Road features low-density residential development, equestrian facilities, and local viticulture enterprises. As Corral Hollow Road nears Site 300, these rural activities give way to even more rural, agrarian endeavors, i.e., equestrian facilities and a scattering of homesteads supporting ranching and livestock grazing activities.

The Carnegie State Vehicular Recreation Area (CSVRA) is located south of the western portion of Site 300, across Corral Hollow Road. It covers approximately 5,000 acres and is operated by the California Department of Parks and Recreation, Off-Highway Motor Vehicle Recreation Division, for the exclusive use of off-highway vehicles. Power-generating wind turbines occupy the land northwest of Site 300. The land uses to the east resemble the low-density grazing and agriculture of those to the west.

There are two other smaller, privately operated commercial facilities located near Site 300. The property east of and adjacent to Site 300 is now owned by Fireworks America and is currently being used to store pyrotechnics. A portion of the property is leased to Teledyne RISI and is used to manufacture initiators, which are agents that cause a chemical reaction to commence.

Site 300 lies outside any defined city limits. The nearest urban area is the city of Tracy. Tracy's city limits are approximately 1 mile from Site 300. Undeveloped agricultural land lies between Tracy and Site 300. The closest housing development to Site 300 is Tracy Hills, which is currently being developed by Integral Communities. As shown in Figure 4-11, Tracy Hills could be as close as approximately 1.15 miles from Site 300. Over the next 12 years, approximately 4,700 housing units will be developed at Tracy Hills, at a density of 2.6 dwelling units per acre (Tracy 2019a). The denser development will occur east of I-580, while the land west of I-580 is reserved for estates (approximately 0.5 to 2.0 dwelling units per acre), and low-density housing (2.1 to 5.8 dwelling units per acre). Figure 4-11 shows the specific plan for Tracy Hills and its development densities.



Source: Tracy 2019a.

Figure 4-11. Tracy Hills Development

4.2.2.3 *Site 300 Land Use Plans and Regulations*

The bulk of Site 300 is in San Joaquin County, with a small portion in Alameda County. The city of Tracy boundary is located approximately one mile northeast of Site 300. Planning programs of these three government entities are addressed below to provide a basis for evaluating Site 300's compatibility with future surrounding land uses. San Joaquin County, Alameda County, and the city of Tracy do not have planning jurisdiction over Site 300 because it is a federal facility, owned by US DOE.

San Joaquin County

San Joaquin County General Plan. The San Joaquin County Board of Supervisors adopted the *San Joaquin County 2035 General Plan* in December 2016 (San Joaquin 2016). The land use/circulation element of the General Plan contains goals, objectives, and principles for land-use development and circulation and transportation within San Joaquin County. Figure 4-12 shows the land-use designations for Site 300 and the surrounding areas. Table 4-5 describes the San Joaquin County General Plan land-use designations.

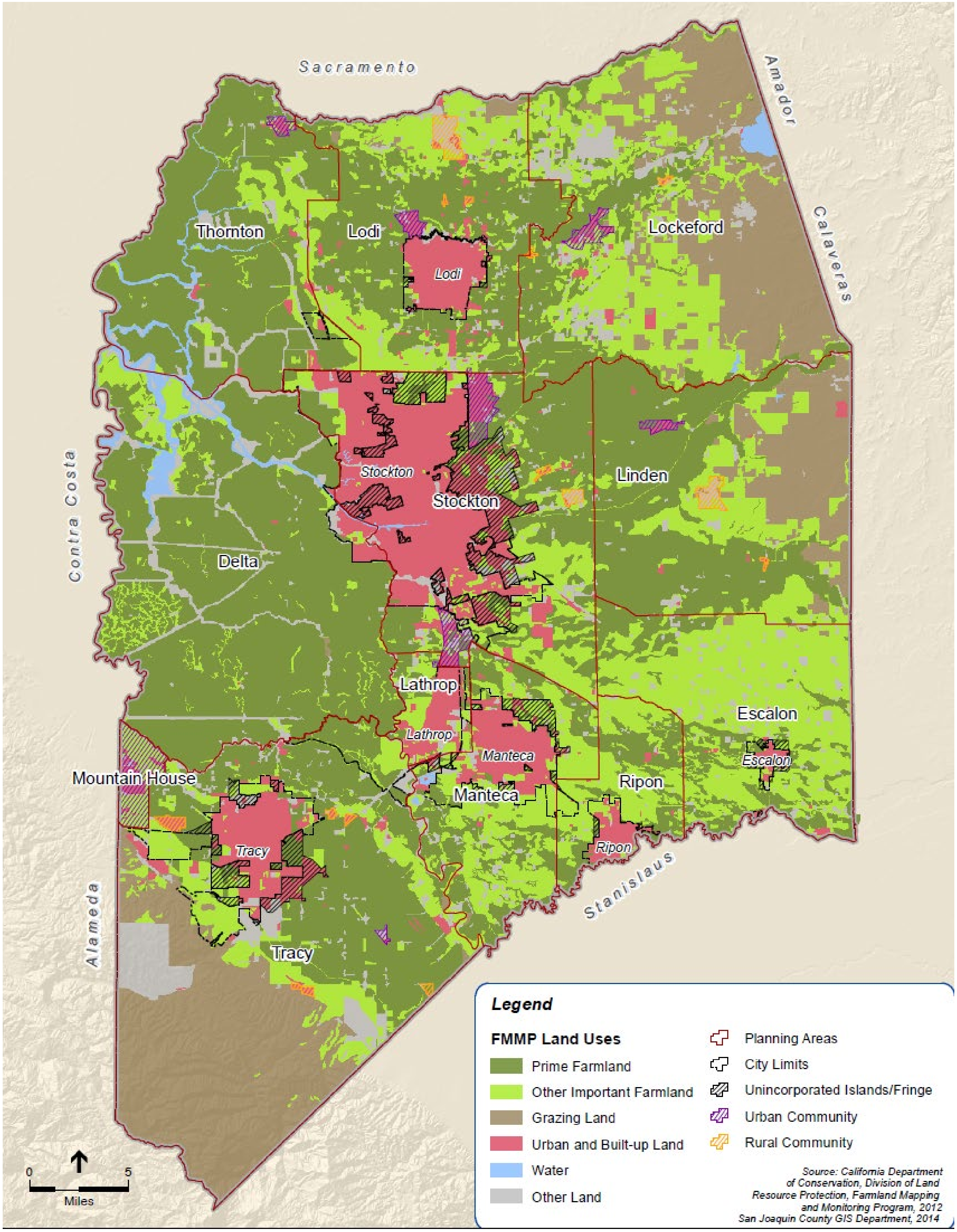
The portion of Site 300 in San Joaquin County is designated public and quasi-public. Areas north of Site 300 are designated as general agricultural. Areas northeast of Site 300 are designated agricultural/urban reserve. Areas south of Site 300 along Corral Hollow Road are designated as public and in use as recreation and conservation areas. Areas west fall in Alameda County and are discussed in that section below.

The following are policies of the *San Joaquin County General Plan* that could be relevant to a public facility in or near an agricultural and agricultural-urban reserve areas (San Joaquin 2016):

- The county shall ensure that residential and other noncompatible uses are separated and buffered from major public facilities, such as landfills, airports, and wastewater treatment facilities, using location-appropriate measures (e.g., distance, screens, berms).

- The county shall preserve areas designated agricultural-urban reserve for future urban development by ensuring that the operational characteristics of the existing uses does not have a detrimental impact on future urban development or the management of surrounding properties, and by generally not allowing capital-intensive facility improvements or permanent structures that are not compatible with future urban development.

- The county shall require new agricultural support development and non-farm activities to be compatible with surrounding agricultural operations. New developments shall be required to demonstrate that they are locating in an agricultural area because of unique site area requirements, operational characteristics, resource orientation, or because it is providing a service to the surrounding agricultural area. The operational characteristics of the use may not have a detrimental impact on the operation or use of surrounding agricultural properties. Developments must be sited to avoid any disruption to the surrounding agricultural operations.



Source: San Joaquin 2016.

Figure 4-12. San Joaquin County Land Use Designations

Table 4-5. San Joaquin County Land Use Designations of Adjacent Properties

Zone	Purpose
A/G, General Agriculture	This designation provides for large-scale agricultural production and associated processing, sales, and support uses. The A/G generally applies to areas outside areas planned for urban development, where soils are capable of producing a wide variety of crops and/or support grazing. Typical building types include low-intensity structures associated with farming and agricultural processing and sales.
A/UR, Agricultural-Urban Reserve	This designation provides a reserve for urban development but is not necessary to accommodate development projected during the planning period of the General Plan (i.e., 2035). The A/UR designation generally applies to areas currently undeveloped or used for agricultural production that are in the logical path of development around an urban community or city fringe area. This designation may be applied to areas adjacent to cities and in city fringe areas if (1) the area identified is designated for urban development in a city general plan, and (2) the county determines that the area represents a reasonable expansion of a city.
P/F, Public Facilities	This designation provides for location of services and facilities that are necessary to the health and welfare of the community. The P/F designation may be applicable to any area of the county in which a public or quasi-public use is appropriate or a public agency owns property. Building types vary based on use.
I/G, General Industrial	This designation provides for industrial employment-generating uses that may produce loud noise or vibration, high heat, glare, or noxious odors and tend to have a high volume of truck traffic. The I/G designation is limited to areas served by, or planned to be served by, a public water, wastewater, and drainage system. Developments must be located on a county-defined minor arterial or higher classification roadway. Typical building types include industrial structures limited to 100 feet in height.
OS/RC, Resource Conservation	This designation provides for areas with significant natural resources that should remain in open space, used for recreation, or preserved and used for resource production (e.g., mining). The OS/RC designation may be applicable to any area of the county that is essentially unimproved and planned to remain open in character, improved for recreational uses, managed in the production of resources, protected from development-related impacts, or restricted from access for the protection of the community (e.g., floodplains).

Source: San Joaquin 2016.

- The county shall ensure non-agricultural land uses at the edge of agricultural areas incorporate adequate buffers (e.g., fences and setbacks) to limit conflicts with adjoining agricultural operations.

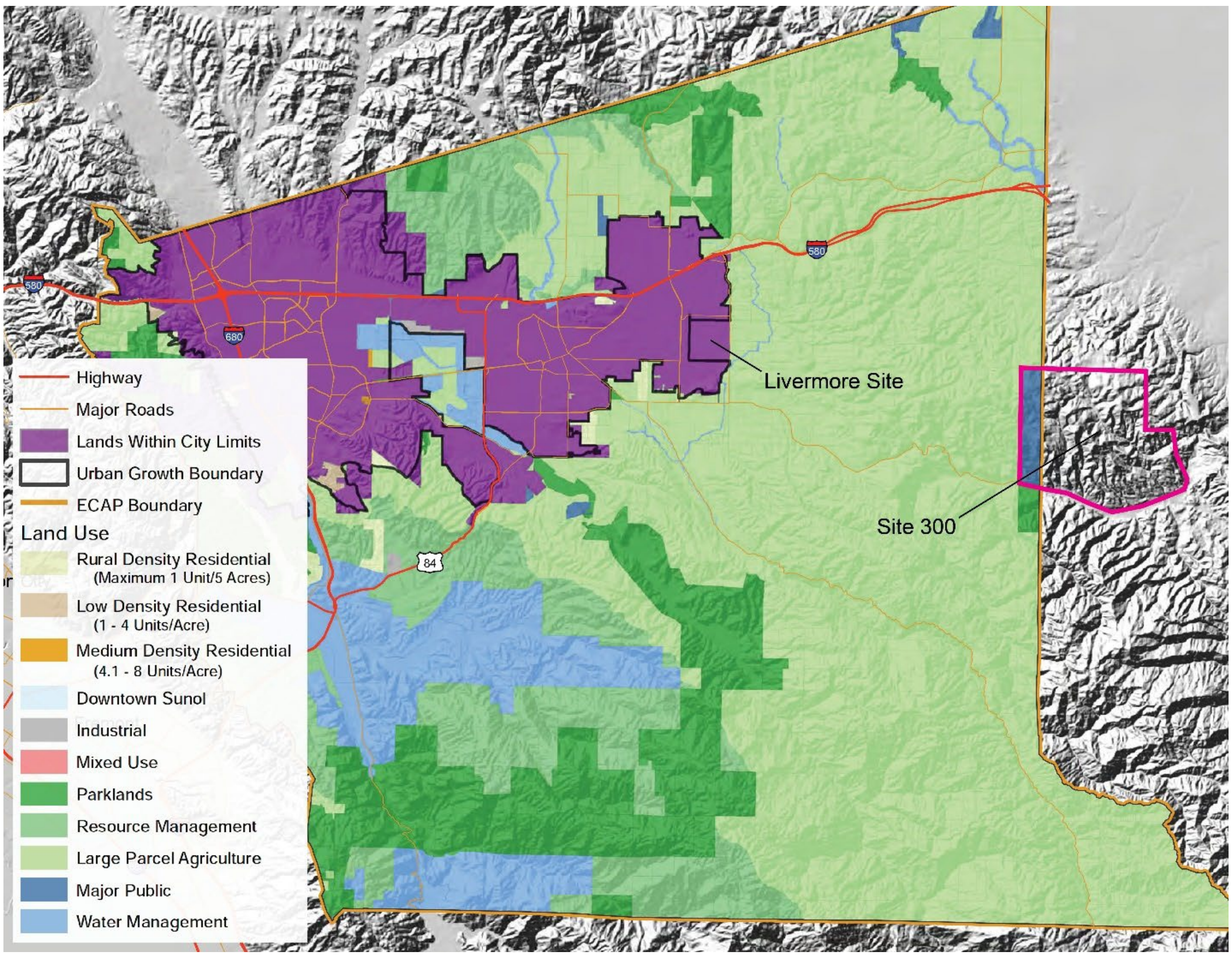
- Agriculture shall be protected from nuisance complaints from non-agricultural land uses by appropriate regulatory and land-use planning mechanisms.

- Agricultural areas shall be used principally for crop production, ranching, and grazing. All agricultural support activities and non-farm uses shall be compatible with agricultural operations.

San Joaquin County Zoning. The portion of Site 300 in San Joaquin County is zoned “P-F” for public facilities. All activities on Site 300 are consistent with applicable zoning requirements and are compatible with existing land-use designations surrounding Site 300. No prime or unique farmland protected by the *Farmland Protection Policy Act* (7 U.S.C. §§ 4201–4209) exists at Site 300. No grazing or other agricultural activities occur on Site 300.

Alameda County

Alameda County General Plan, East County Area Plan. Figure 4-13 shows the land uses in the eastern portion of Alameda County. This encompasses the entire city of Livermore, including the Livermore Site and a slice of Site 300 on the eastern edge of the county. Both sites abut county land designed as Large Parcel Agriculture. The East County Area Plan designates Site 300 in Alameda County as Major Public (Figure 4-13). The East County Area Plan, Policy 138, states that Alameda County shall allow development and expansion of major public facilities (e.g., hospitals, research facilities, landfill sites, jails) in appropriate locations inside and outside the urban growth boundary, consistent with the policies and land-use diagram of the East County Area Plan (Alameda 2000).



Source: Alameda 2000.

Figure 4-13. Alameda County: East County Area Plan Land Uses

Alameda County Zoning. The portion of Site 300 in Alameda County is zoned "A" as Major Public. The Alameda County ordinance code specifies "remote testing facilities" as a conditional use within the "A" district, subject to approval by the zoning administrator for Alameda County (Title 17, Chapter 6, Section 40, Conditional Uses) (Alameda 2019).

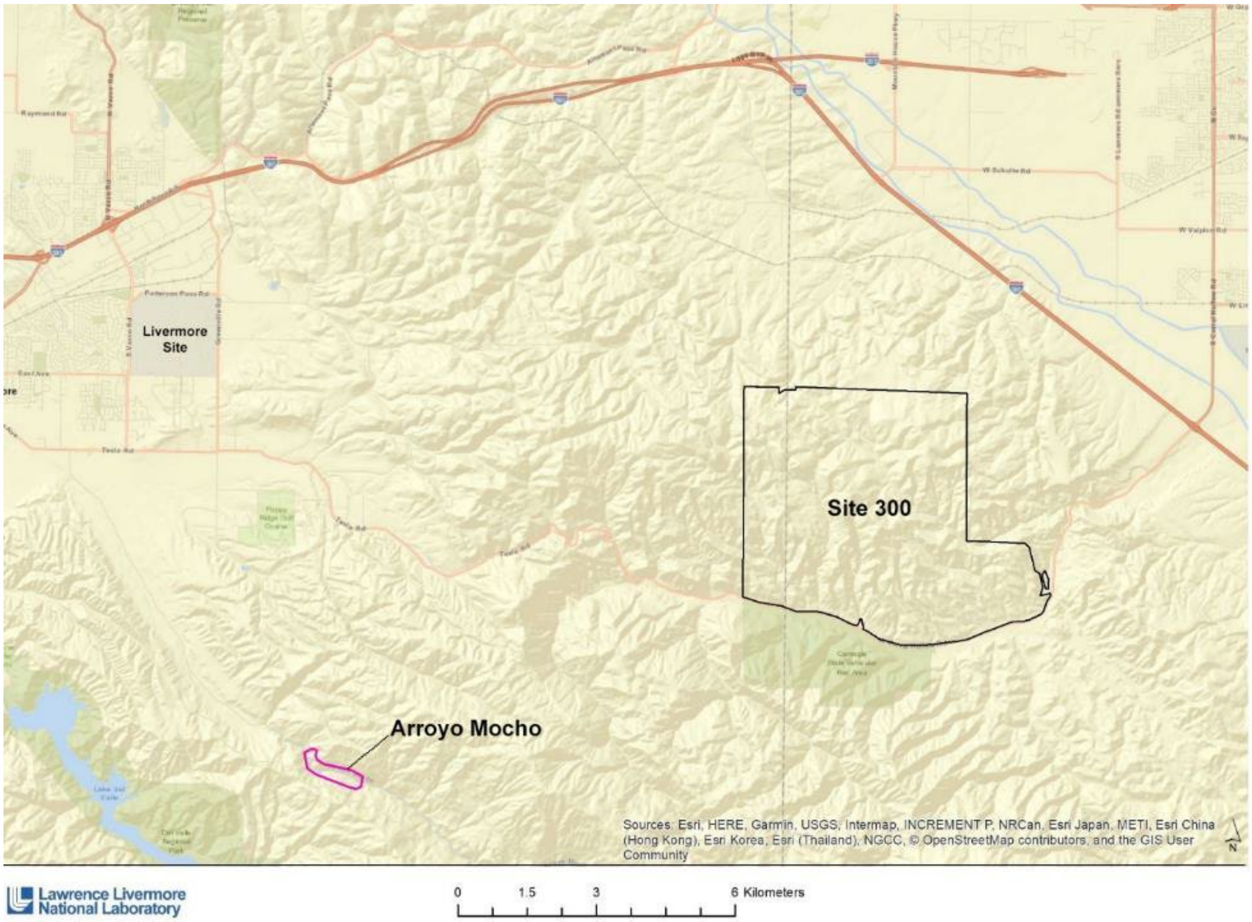
City of Tracy. Site 300 is approximately eleven miles from downtown Tracy, CA, and one mile southwest of Tracy Hills area. Although Site 300 is outside of the city of Tracy's urban growth boundary, it abuts Tracy's sphere of influence. The city of Tracy adopted its updated general plan in February 2011. The land immediately east of Site 300 area is designated on the city of Tracy Community Areas Map as federal reserve/open space. The city of Tracy General Plan (Tracy 2011) defines open space within the sphere of influence as "planned as permanent open space for habitat conservation and managed grazing." Site 300 borders the city of Tracy's sphere of influence, which is designated as the Tracy Hills area.

4.2.3 Offsite Lease Property

LLNL also conducts limited activities at various leased properties near the Livermore Site, as well as an office in Washington D.C. These include a storage warehouse on Research Drive in the city of Livermore and LLNS offsite office space on First Street. Also, LLNL has right-of-way entry to access the Arroyo Mocho pump station for pipeline maintenance and repair, located six miles south of the Livermore Site (*see* Section 4.2.4). There is also a similar, but not identical, arrangement for Site 300 at the Thomas Shaft. These nearby offsite-leased properties are shown on Figure 1-2 in Chapter 1 of this SWEIS.

4.2.4 Arroyo Mocho

Figure 4-14 shows the Arroyo Mocho pump station relative to the Livermore Site. The pump station is the primary source of water to the Livermore Site. The pump station lifts water 850 feet from the city of San Francisco's Hetch Hetchy Aqueduct to the surface. This water then flows by gravity to the Livermore Site via storage tanks located at SNL/CA. A chloramination station located at SNL/CA and operated by LLNL provides disinfection for the Hetch Hetchy water from Arroyo Mocho. Since publication of the 2005 LLNL SWEIS, NNSA has completed two substantial projects at Arroyo Mocho—a boulder removal project and a new stream crossing in 2004. The boulder project removed two large upstream rock formations in the Arroyo Mocho that were threatening the gabion-style retaining wall supporting the pump housing. The new stream crossing is a steel structure, erected higher than the 100-year flood mark. This replaced the existing 160-foot-long by 80-foot-wide low-flow concrete crossing. The concrete crossing was past its useful life and in danger of failure and obstructing fish passage.



Source: LLNL 2019af.

Figure 4-14. Relative Location of the Arroyo Mocho Pump Station

4.3 AESTHETICS AND SCENIC RESOURCES

The scenic quality or character of an area consists of the landscape features and social environment from which they are viewed. The landscape features that define an area of high visual quality may be natural, such as mountain views, or man-made, such as city skyline. To assess the quality of visual resources in the project area, this section describes the overall visual character and distinct visual features on or in the viewshed of the Livermore Site and Site 300.

Locations of visual sensitivity are defined in general terms as areas where high concentrations of people may be present or areas that are readily accessible to large numbers of people. They are further defined in terms of several site-specific factors, including:

- Areas of high scenic quality (i.e., designated scenic corridors or locations)
- Recreation areas characterized by high numbers of users with sensitivity to visual quality (i.e., parks, preserves, and private recreation areas)
- Important historic or archaeological locations

No visually sensitive locations are defined on the Livermore Site or Site 300.

4.3.1 Livermore Site and Surrounding Area

The Livermore Site is located entirely within the city of Livermore and sited in the Livermore Valley. Hills and mountains define the regional viewshed and provide open space around the development on the valley floor. The terrain in the near vicinity of the Livermore Site ranges from relatively flat land to gently rolling hills. The hills east and south of the Livermore Site gradually become steeper as they trend eastward to form the Altamont Hills of the Diablo Range. Wind turbines north and south of the Altamont Pass punctuate the eastern horizon and have become part of the eastern valley landscape identity.

As shown on Figure 4-15, the Livermore Site has a campus-like setting with buildings, internal roadways, pathways, and open space. Portions of the Livermore Site along the western and northern boundaries are largely undeveloped and serve as buffer zones between the laboratory and adjacent industrial and residential development. The southern portion of the Livermore Site borders SNL/CA, which has comparable land uses. The eastern border of the Livermore Site is adjacent to low-density agricultural lands.

A row of eucalyptus and poplar trees surrounds much of the developed portion of the Livermore Site and screens most ground-level views of the facility. Onsite buildings range in height from 10 feet to approximately 110 feet. A nine-foot-high chain-link and barbed-wire security fence surrounds the Livermore Site. The most prominent buildings in the public viewshed are the administrative buildings off East Avenue in the southwest corner of the Livermore Site, Building 041 in the western portion of the site, and the NIF in the northeast corner. These facilities are visible from locations along adjacent roads.

In February 2016, NNSA added a 10-acre fixed-tilt photovoltaic array in the northwest portion of the west buffer zone (Figure 4-16). The solar array is generally concealed to adjacent residences, drivers, and pedestrians along Vasco Road and Patterson Pass Road during the spring, summer, and autumn months because the landscaping along the roads screen this buffer zone area. As the landscaping thins in the winter, the visibility of the modules is increased. The solar panels are treated with an anti-reflective coating and positioned to ensure any potential reflective glare is directed away from traffic or the residences on the opposite side of Vasco Road.

The Livermore Valley Open Campus (LVOC) opened in 2005. This campus is roughly 200 acres located on the east side of the Livermore Site, outside of the main security perimeter. The LVOC has a similar campus-like feel to the Livermore Site and SNL/CA.

Figure 4-15. Panoramic View of the Livermore Site, Looking North and East with the Diablo Range in the Background

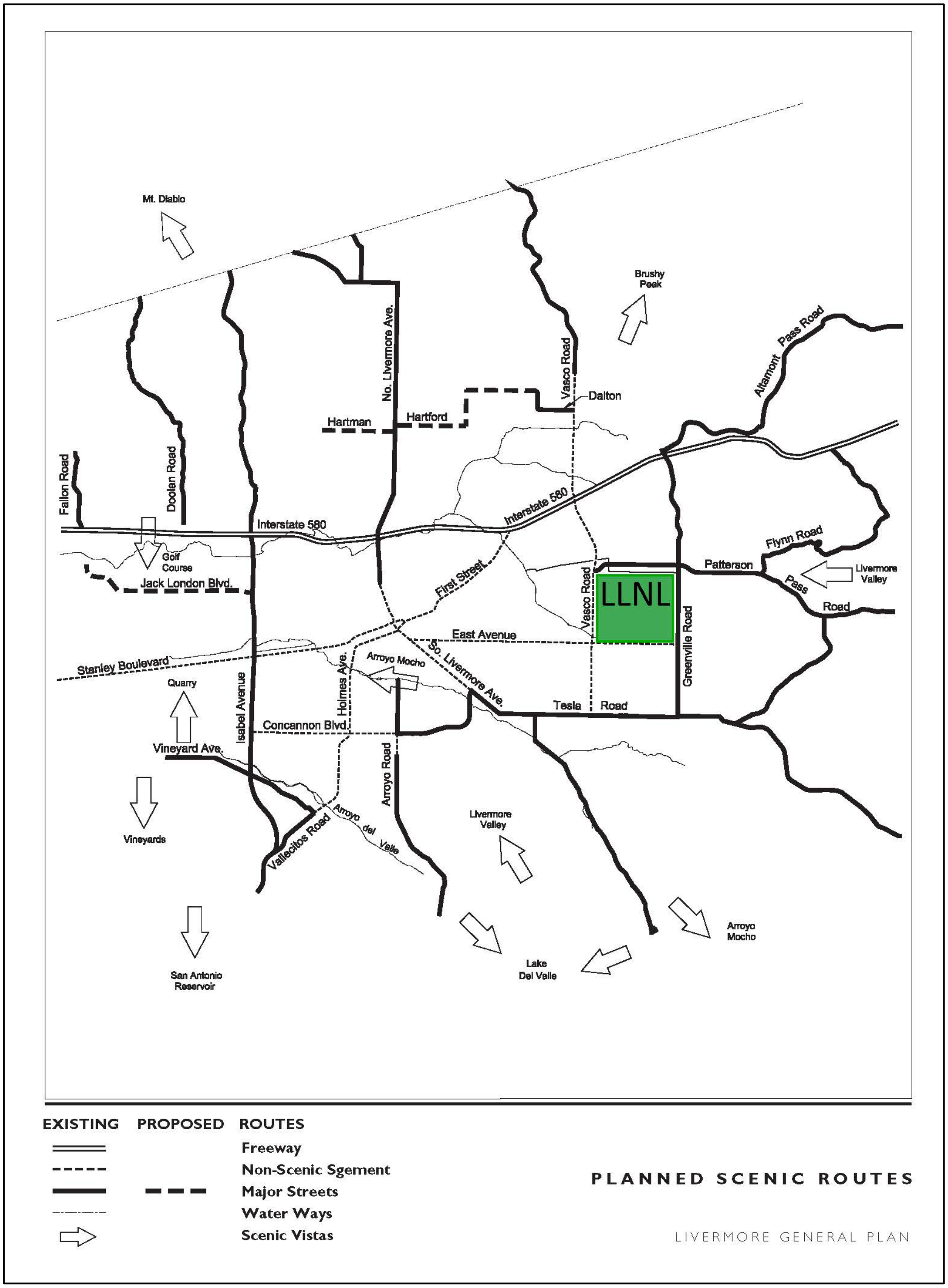
Figure 4-16. View of Solar Array from Outside Fence Line

The area surrounding the Livermore Site is a mixture of rural and pastoral uses and urban development (Figure 4-17). SNL/CA is located immediately south of the Livermore Site. Rural residences and grazing land are the primary visual features to the east. Detached residences occupy the area west of the Livermore Site, giving the area a suburban character. A small area of commercial and light industrial use occupies lands southwest of the Livermore Site. A mixture of vineyards and residential uses surrounds the commercial and light-industrial area, although residential development has shifted the visual character of the area from pastoral to suburban. The area north of the Livermore Site to I-580 is commercial and industrial, containing primarily one- and two-story industrial buildings, business parks, hotels, detached housing, apartment buildings, and the Union Pacific railroad line that traverses the area. This area is visually similar with the research, business, and industrial character of the Livermore Site.

Figure 4-17. Livermore Site (outlined in yellow)

Sensitive Views in the Surrounding Area. The Livermore Site is not visible from several designated scenic resource areas (e.g., Wente and Concannon wineries, Tesla historical town site, Altamont Pass Road, Cross Road, and Mines Road) and is only minimally visible from several other designated scenic resource areas as a result of distance or intermittent topography.

The Livermore Site is adjacent to two dedicated scenic routes in the city of Livermore: Patterson Pass Road and Greenville Road (Figure 4-18). The I-580 Scenic Corridor is of particular importance to the city of Livermore and is heavily regulated in planning documents. The corridor is defined as the area within 3,500 feet of the freeway centerline and visible from the roadway (Livermore 2014). The closest portions of LLNL are more than 5,300 feet from I-580, well outside of the protected corridor. Views from I-580 are obstructed by vegetation and development. Only the tallest onsite buildings on the Livermore Site are intermittently visible from this highway.



Source: Livermore 2014.

Figure 4-18. City of Livermore Scenic Routes in Vicinity of the Livermore Site

The Livermore Site is not visible from most of Flynn Road but does occupy the middle-ground views from the western end of Flynn Road. As a result of distance, the facilities are visually indistinct and are consistent with surrounding development. The view of the Livermore Site from Tesla Road is almost completely obstructed by intervening topography. The Livermore Site is prominently visible from residences near and motorists traveling along Patterson Pass Road and Vasco Road (Figure 4-19). Vegetation that surrounds the Livermore Site obstructs or partially screens most views of the facilities from this area. The buffer zone and solar array provide visual separation between the Livermore Site and surrounding viewers.

The Livermore Site is also visible from residences and vineyards to the southwest and to motorists traveling north on Vasco Road (Figure 4-20). The security buffer area and vegetation provide partial screening of the Livermore Site from this view. In addition, residential and vineyard development in this area is currently taking place and will further screen views of the facilities. The Livermore Site is prominent in views from most of Greenville Road (Figure 4-21). Although Greenville Road follows the eastern boundary of the Livermore Site, views from this portion of the road are heavily screened by vegetation. Views from Greenville Road south of the Livermore Site are more panoramic due to the elevated viewing perspective but are partially screened by the rolling topography. The Livermore Site is visually distinct in the fore- and middle ground but is visually consistent with the overall pattern of development in the viewshed.

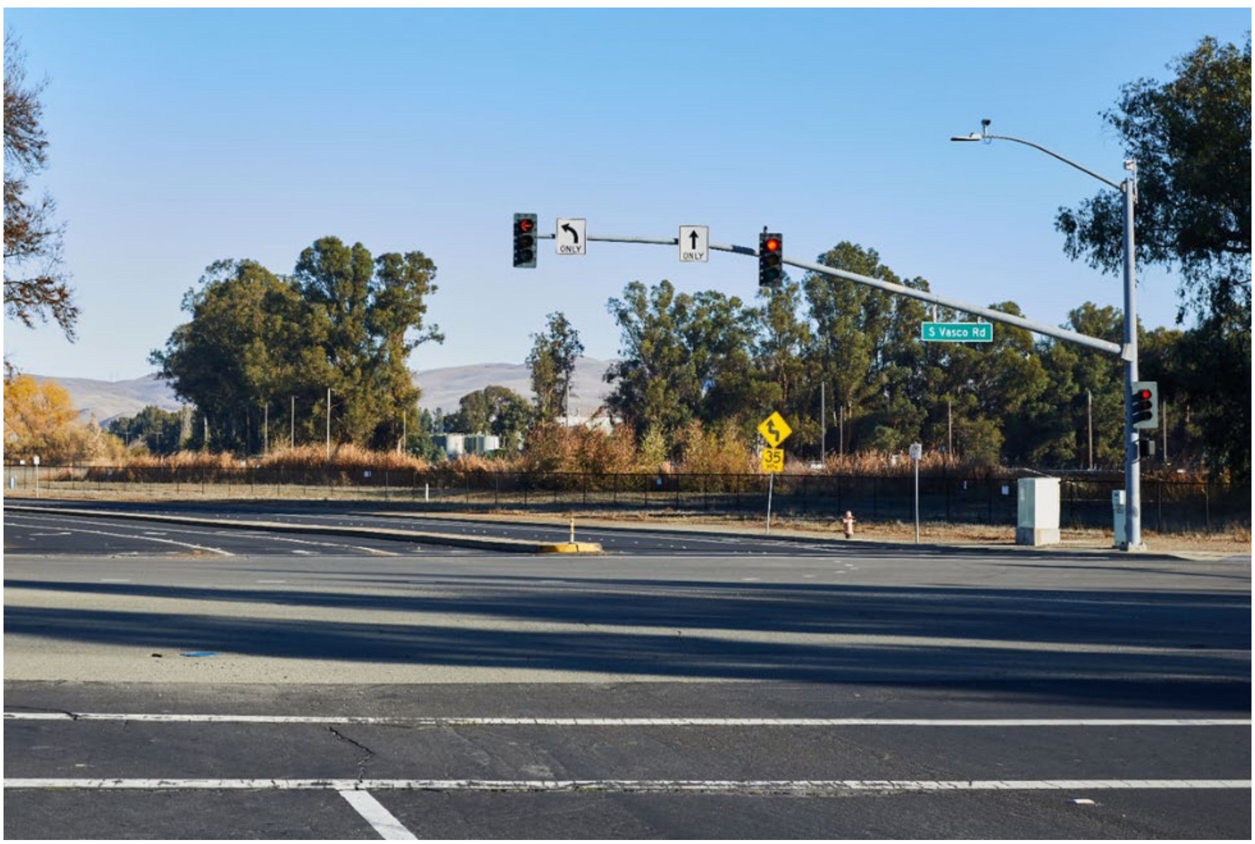


Figure 4-19. View of the Livermore Site, Looking Southeast from Patterson Pass and Vasco Roads

Figure 4-20. View of the Livermore Site, Looking Northeast from Vasco Road

Figure 4-21. View of the Livermore Site and SNL/CA (to the left), Looking Northwest from Greenville Road

The Livermore Site is also prominent in views from the western portions of Patterson Pass Road, from Flynn Road to Vasco Road. Views from Patterson Pass Road adjacent to the Livermore Site, similar to those described for Vasco Road, are largely screened by vegetation and are separated from viewers by a security buffer area. Views toward the west from the lower reaches of Patterson Pass Road are similarly obstructed by vegetation. Views of the facilities from the higher reaches of Patterson Pass Road are obstructed by topography. The NIF, which is located in the northeast portion of the Livermore Site, is visible from Patterson Pass Road and Greenville Road (Figure 4-22).

Figure 4-22. View of the NIF Looking Northeast

4.3.2 Site 300 and Surrounding Area

Site 300 is located in the Altamont Hills of the Diablo Range (Figure 4-23). This area is predominately grasslands and low shrubs in areas ranging in topography from gently rolling hills to steeply sloping ridges and valleys. Viewsheds in the area around Site 300 are severely constrained by topography. The main gate and the GSA of Site 300, including a number of buildings, roads, and infrastructure, are foreground and middle-ground features in view from Corral Hollow Road, which forms the southern boundary of Site 300. Vegetative screening and topography partially obscure many of the features associated with the GSA. The majority of Site 300 is obscured from view by topography.

Figure 4-23. Typical Aerial View of Site 300 Area

The surrounding area is primarily undeveloped open space or rural, with some exceptions. Fireworks America is adjacent to and northeast of Site 300. Although the sign at the entrance to the facility is visible from Corral Hollow Road, structures associated with this facility are obscured by topography.

The CSVRA, located south of the western portion of Site 300, is used by off-road vehicles. The park includes dirt trails on the surrounding hillsides and a ranger station, picnic areas, and several contoured riding areas in the valley floor adjacent to Corral Hollow Road. These features are all visible from Corral Hollow Road. The high degree of modification is substantially out of character with the surrounding open space and rural features of the area.

Sensitive Views in the Surrounding Area. Site 300 is not within the viewshed of any of the designated scenic corridors except for a short section of Tesla Road at the eastern end of Alameda County. Tesla Road becomes Corral Hollow Road at the San Joaquin County boundary. Corral Hollow Road follows the southern boundary of Site 300 and affords views of the site but is not designated a scenic corridor. Corral Hollow Road, which is adjacent to and south of Site 300, is the nearest public roadway with a view of Site 300. The view of Site 300 from Corral Hollow Road is of parking areas and several single-story structures in the GSA (Figure 4-24 and Figure 4-25). The Small Firearms Training Facility is also visible from Corral Hollow Road. The GSA portion of Site 300 at Corral Hollow Road features vegetation screening and a barbed-wire security fence. The remainder of the view of Site 300 from Corral Hollow Road consists of rolling hillsides and a few scattered small structures on the hilltops. Other than the GSA, the facilities of Site 300 are not apparent in landscape views from publicly accessible viewpoints; however, a 3-foot-high wire fence surrounding Site 300 is visible along the site's southern boundary at Corral Hollow Road.

Figure 4-24. View of Site 300 GSA Entrance from Corral Hollow Road, Looking West

Figure 4-25. View of Site 300 GSA Entrance from Corral Hollow Road, Looking East

Site 300 can be seen from the CSVRA, which lies directly south. From the picnic area near the park entrance, the view of Site 300 consists primarily of undeveloped hillsides.

4.3.3 Arroyo Mocho Pump Station

The Arroyo Mocho pump station is located six miles south of LLNL at the lower end of the Arroyo Mocho canyon. Arroyo Mocho is approximately 10 miles long and empties into Arroyo de la Laguna. The infrastructure at the pump station is unobtrusive and partially visible from Mines Road. In 2004, LLNL replaced a dated low flow cement crossing with a modern steel bridge that allows the water and wildlife to pass uninhibited. LLNL also removed boulders from the creek that were threatening both the creek flow and the gabion retaining walls of the pump station infrastructure. Figure 4-26, Figure 4-27, and Figure 4-28 depict the visual conditions at the Arroyo Mocho pump station.

Figure 4-26. Arroyo Mocho Pump Station

Figure 4-27. Gabion Retaining Walls

Figure 4-28. Steel Bridge to Arroyo Mocho Pump Station

4.4 GEOLOGY AND SOILS

This section provides an overview of the affected physical environment, including discussions of the local and regional geologic setting including geomorphology, structural geology, stratigraphy (rock and sediment types), soil contamination, soil types and geological hazards including seismicity and landslides. Information regarding remediation is included in Section 4.15.

4.4.1 Geologic and Topographic Settings

The general understanding of geology and topography for the Livermore Site and Site 300 has not changed to any great degree from that presented in the 2005 LLNL SWEIS (NNSA 2005). This SWEIS discusses the most recent research and references.

4.4.1.1 *Topography and Geomorphology*

The Livermore Site and Site 300 are located in the geologic province of the California Coast Ranges (Dibblee 1980a, 1980b), which is characterized by low rugged mountains and relatively narrow intervening valleys. Figure 4-1 in Section 4.2 show the locations of the Livermore Site and Site 300 relative to the surrounding area, respectively.

Livermore Site

The Livermore Site is located in the southeastern portion of the Livermore Valley within the Central California Diablo Range (Carpenter 1984a). The Livermore Valley, the most prominent valley within the Diablo Range, is an east-west trending structural and topographic trough, bounded on the west by Pleasanton Ridge and on the east by the Altamont Hills. The valley is approximately 16 miles long and varies in width generally between 2.5 and 7 miles. The highest elevation of the valley floor is 720 feet above sea level along its eastern margin near the Altamont Hills; it descends gradually to 300 feet at the southwestern corner. The valley forms an irregularly shaped lowland area about 16 miles long east to west, and 7 to 10 miles wide north to south (LLNL 2019f). The floor of the valley slopes to the west at about 20 feet per mile. The Livermore Site slopes gently to the north-northwest at an inclination of less than one degree (USDA 1966). The Livermore Site property ranges in elevation from 676 feet in the southeast corner to 571 feet in the northwest corner. Altamont Hills are several miles from the Livermore Site to the east and south.

Site 300

Site 300 is located in the Altamont Hills, which separates the Livermore Valley to the west from the San Joaquin Valley to the east. Site 300 consists of steep ridges and canyons with a decrease in elevation toward the southeast. Slopes vary greatly in the canyons and can exceed 45 degrees in places. The slopes are much gentler in the GSA, located in the southeastern portion of the site, and can be as low as two or three degrees (USDA 1990). The elevation of Site 300 ranges from about 1,740 feet above sea level at the northwestern corner of the site to approximately 490 feet in the southeastern portion (LLNL 2019f).

4.4.1.2 *Structural Geology*

A generalized map of the regional structural geology of the San Francisco Bay Area is presented in Figure 4-29. The Livermore Site and Site 300 are located near the boundary between the North American and Pacific tectonic plates, and the structural geology of the area is the result of the interaction between these two plates. The Pacific Plate moves northwestward relative to the North American Plate at a rate of about two inches per year. In the San Francisco Bay region, this motion is accommodated primarily by strike-slip motion along the San Andreas fault system. The San Andreas Fault system includes several major fault zones (San Andreas, Hayward, Calaveras, and Greenville) as well as other smaller active and potentially active faults, including the Las Positas Fault (BART 2017). The San Gregorio, Hayward, Calaveras, Greenville, and other faults in the region also accommodate the relative motion between these major faults (Tri-Valley 2018).

The Diablo Range, which includes the Altamont Hills, is part of the northwest-trending Coast Ranges that parallels the San Andreas Fault system. These ranges are intensely uplifted, folded, and faulted. The structural conditions of the region around Livermore are largely defined by the major active faults within the region. The San Andreas Fault system accommodates the majority of the motion between the North American and Pacific tectonic plates. Over most of its extent in central California, the San Andreas Fault is a relatively simple, linear fault trace. Across the San Francisco Bay Area, however, the fault splits into a number of branch faults or splays (AEG 2018).

The Hayward Fault, located about 17 miles west of the Livermore Site, extends on land for about 62 miles from east of San Jose to Point Pinole on San Pablo Bay and forms the western boundary of the East Bay Hills. At Point Pinole, the Hayward Fault continues beneath San Pablo Bay and connects with the Rodgers Creek Fault. The southern end of the Hayward Fault has recently been shown to be more directly linked to the Calaveras Fault than previously thought (AEG 2018).

The Calaveras Fault traverses the Hollister Plain and the Diablo Range east of the Santa Clara Valley, forming a structural boundary between the Diablo Range and the San Francisco Bay structural depression (Page 1981). The Calaveras Fault Zone trends northwest-southeast through the San Ramon Valley, which borders the Livermore Valley to the west.

The Greenville Fault Zone extends southeast from Mt. Diablo for about 56 miles to San Antonio Valley. Strands of the Greenville Fault Zone are located about 1,400 feet northeast of the northeastern corner of the Livermore Site (Carpenter 1984a).

The Las Positas Fault Zone is an active Holocene fault that trends northeast along the southeastern margin of the Livermore Valley. The north branch of the Las Positas Fault passes just southeast of the southeastern corner of the Livermore Site (Carpenter 1984a).

The principal faults in the vicinity of Site 300 are the Corral Hollow-Carnegie, Black Butte, and Midway (*see* Figure 4-36). The Corral Hollow-Carnegie Fault system passes through the southern portion of Site 300 (LLNL 2007a). The Elk Ravine Fault, a complex structure composed of pre-Holocene strike-slip faults, reverse faults, normal faults, and local folds, crosses Site 300 from the northwest corner to the southeast corner (Dibblee 1980a).

The two regional structural features located closest to the Livermore Site are the Greenville and Las Positas fault zones. Geologic maps of the vicinities of the Livermore Site and Site 300 shown in Figure 4-30 and Figure 4-31. Additionally, a detailed surface geology map is provided for Site 300, Figure 4-32.

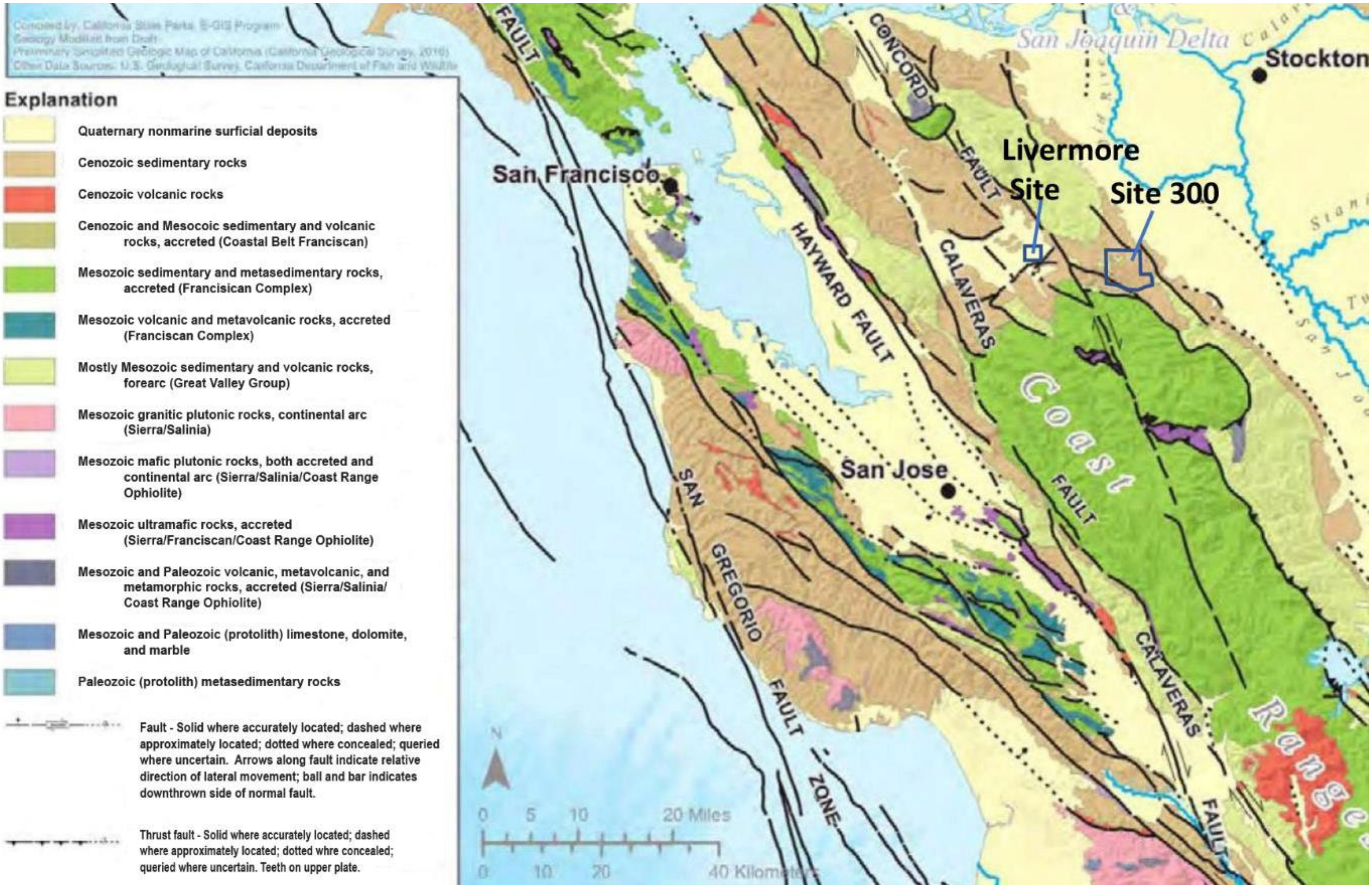
4.4.1.3 *Stratigraphy*

The oldest bedrock exposed in the stratigraphic assemblages in the area of Livermore and Site 300 consists of the Jurassic to Cretaceous Franciscan Complex and the Cretaceous Great Valley sequence. The Franciscan Complex is made up of weakly to strongly metamorphosed, locally highly sheared graywacke, metagraywacke, shale, argillite, blueschist, and greenstone, with minor limestones, cherts, and assorted igneous rocks.

Overlying the Franciscan Complex, the Great Valley sequence is made up of sandstone, siltstone, shale, and graywacke. Outcrops of the Great Valley Sequence are seen in the Altamont Hills east of Livermore, immediately north and south of Site 300, and especially along the eastern edge of the Coast Ranges. The contact between the Great Valley Sequence and the Franciscan Assemblage is defined by the Coast Range thrust, which occurs along the eastern margin of the Coast Ranges.

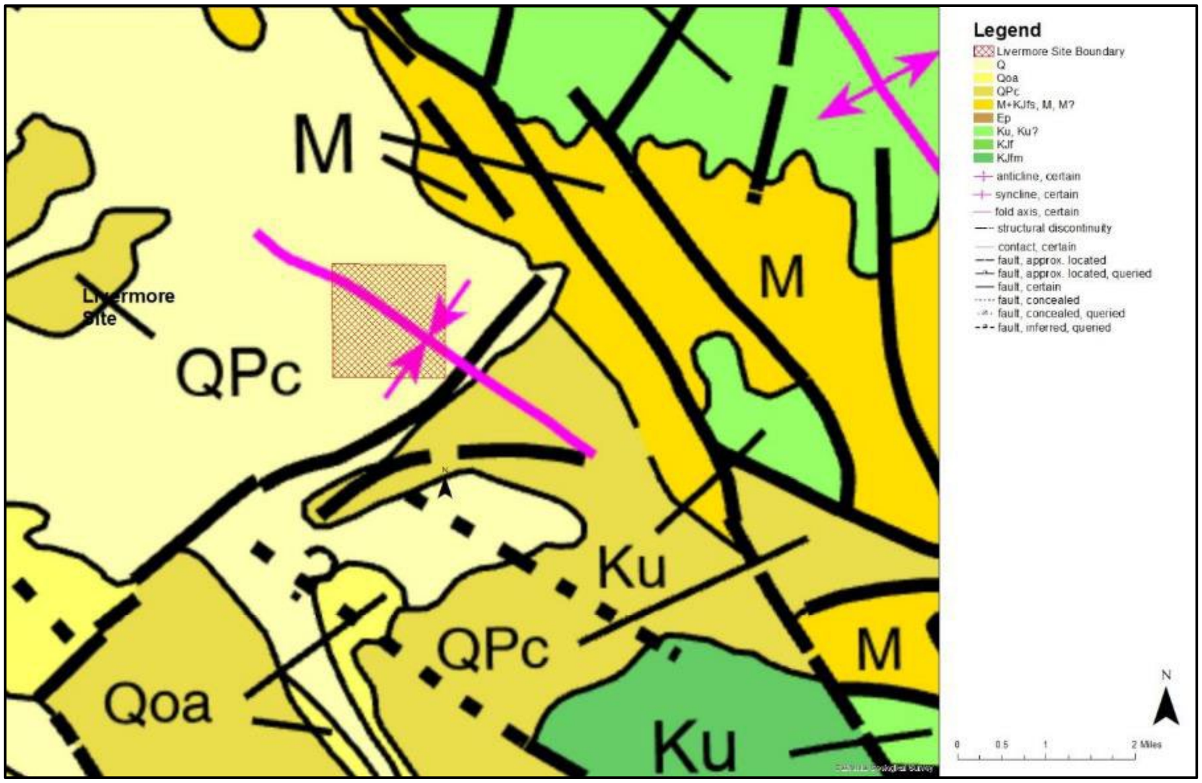
These stratigraphic units are unconformably overlain in some of the assemblages by Eocene to Miocene marine and brackish water sandstone, siltstone, and claystone belonging to the Tesla Formation, Cierbo Formation (dominated by sandstone), and the Neroly Formation (principally sandstone with siltstone, claystone, and conglomerate). In turn, these units are overlain in some of the assemblages by Miocene and Pliocene nonmarine sandstone, siltstone, and conglomerate of the Green Valley/Tassajara Formation, silt, sand, and gravels of the Oro Loma Formation, and Plio-Pleistocene cobble conglomerate, sandstone, and siltstone of the Livermore Gravels (DOC 2009).

Figure 4-33 presents a schematic stratigraphic column of geologic units outcropping or underlying at the Livermore Site and Site 300.



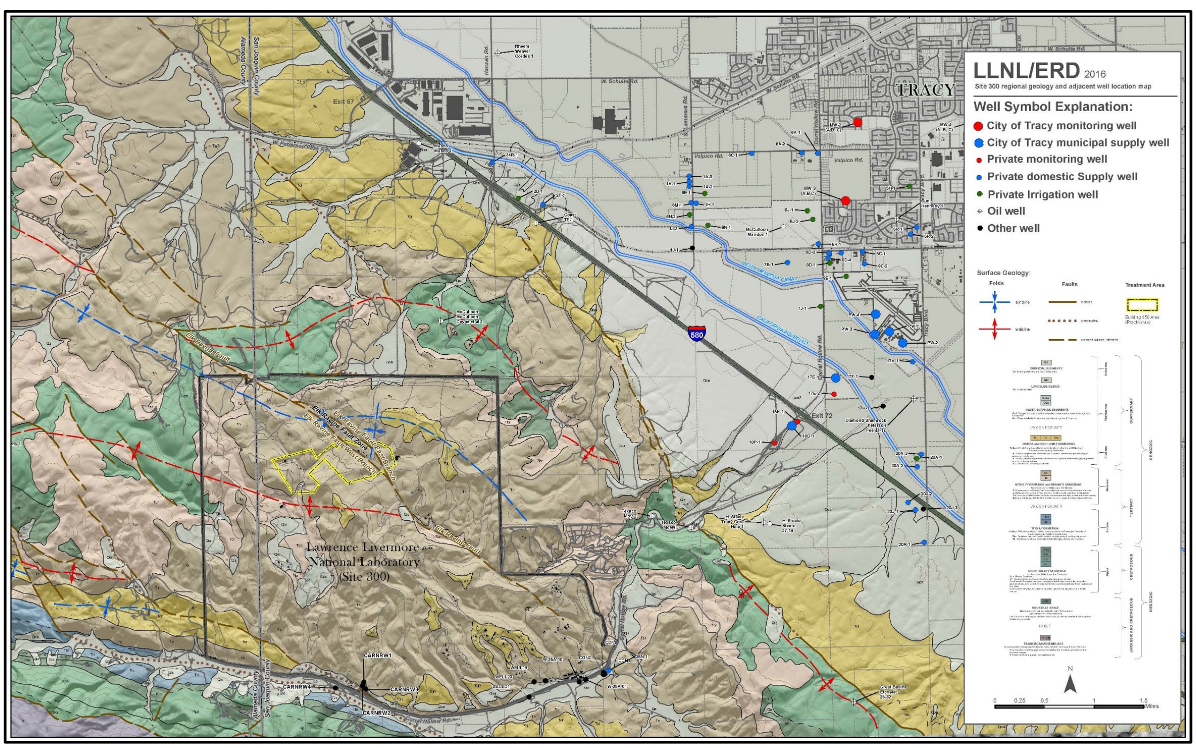
Source: AEG 2018.

Figure 4-29. Generalized Geologic Map of the San Francisco Bay Area Showing the Location of the Livermore Site



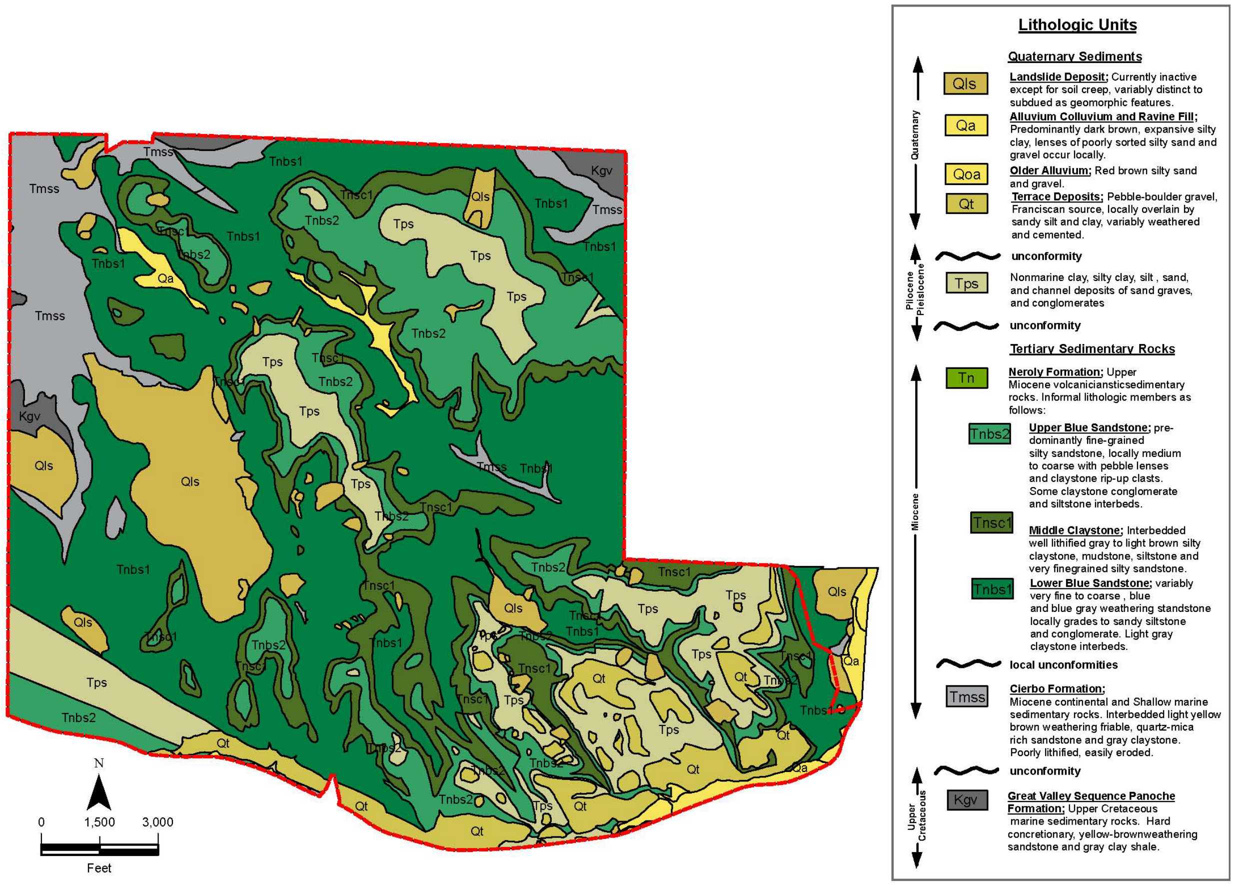
Source: DOC 2020.

Figure 4-30. Geological Map of the Southeast Livermore Valley



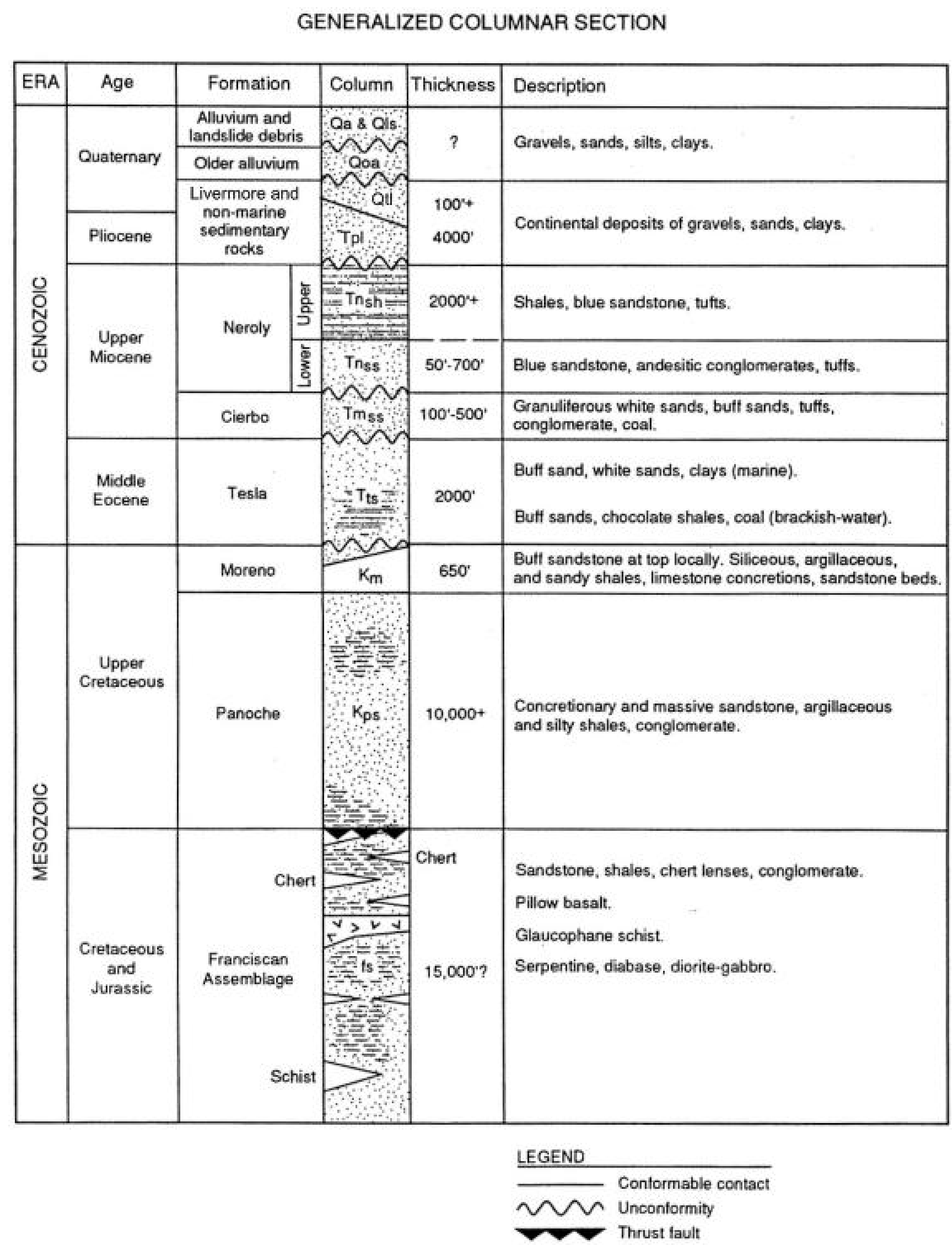
Source: LLNL 2021m.

Figure 4-31. Geological Map of Site 300 and Surrounding Area



Source: LLNL 2021n.

Figure 4-32. Site 300 Detailed Surface Geology



Source: Adapted from Carpenter 1984b and Huey 1948.

Figure 4-33. Stratigraphic Column for the Livermore Site and Site 300

Livermore Site

The rocks underlying the Livermore Site are late Tertiary and Quaternary age sediments comprising the Livermore Formation (Figure 4-34) (Carpenter 1984b; Huey 1948), which has a maximum thickness of approximately 4,000 feet. This formation has been divided into Upper and Lower Members. Massive gravel beds mixed with sand, silt, and clay characterize the Upper Member. The Lower Member is dominated by greenish- to bluish-grey silt and clay, with lenses of gravel and sand (Huey 1948; Thorpe et al. 1990). For additional information on the local stratigraphic units and hydrogeology at the Livermore Site, *see* Section 4.5.

Site 300

Sedimentary rocks on Site 300 are generally older than the alluvial sediments that underlie the Livermore Site in the eastern Livermore Valley. This hilly terrain contains sedimentary units that generally dip five degrees or more to the northeast, east or southeast. Some older formations, including the Upper Cretaceous Panoche Formation (part of the Great Valley Sequence), are exposed in limited areas of the northwest and northeast corners of Site 300. A majority of the exposed strata on site are of Tertiary age, including the Miocene Cierbo and Neroly Formations. The Miocene Neroly Formation is exposed and directly underlies the greatest areal extent of all the bedrock onsite. Locally overlying nonmarine sedimentary rocks of Pliocene age occupy a similar position in the local stratigraphy (*see* Figure 4-32), and possibly formed simultaneously, with the lower-portion Livermore Formation rocks in the Livermore Valley. Figure 4-32 coordinates with the detailed surface geology map depicted previously in Figure 4-31. Additionally, younger Quaternary alluvial landslide deposits are present on site in limited areas. Additional information on the local Site 300 stratigraphy and hydrogeology is presented in Section 4.5.

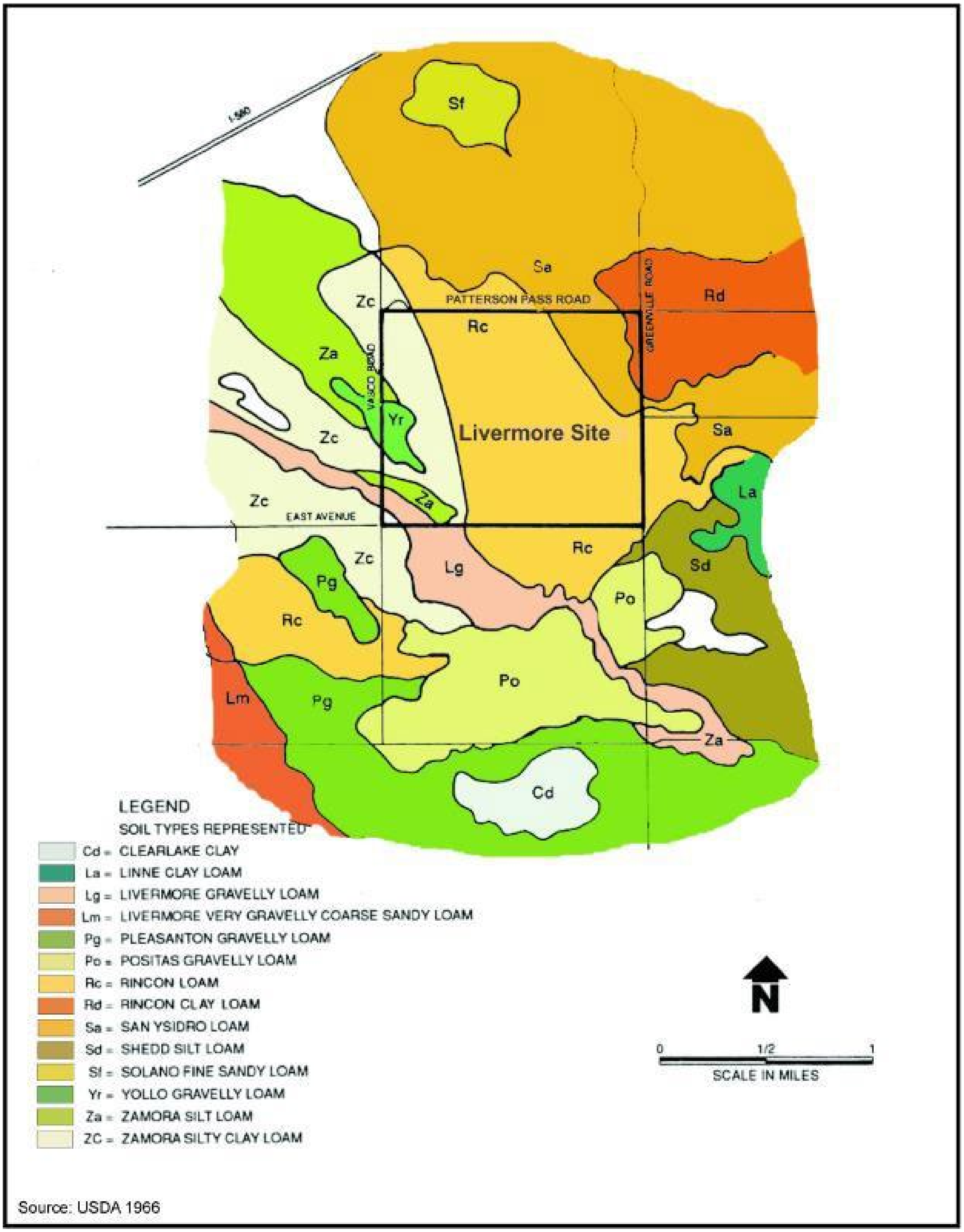


Figure 4-34. Soil Map of the Southeast Livermore Valley

4.4.1.4 *Soils*

While the discussion below includes soils that are designated prime farmland soils by the U.S. Department of Agriculture National Resources Conservation Service, the land at the Livermore Site and Site 300 is not currently considered prime farmland suitable for agriculture under the *Farmland Protection Policy Act* for the following reasons:

- The Livermore Site is classified as urban land (not suitable for agriculture).
- The *Farmland Protection Policy Act* exempts any use of farmland for national defense purposes (7 USC 73 § 4208[b]).
- The Livermore Site and Site 300 were established in 1952 and 1955, respectively, predating the passage of the *Farmland Protection Policy Act* in 1984.

Soil properties and extent are important factors in evaluating potential transport of contaminants. A discussion of the distribution of soil and sediment contamination at the Livermore Site is presented in Section 4.4.1.5.

Livermore Site

A soil map of the Livermore Site area is shown in Figure 4-34. Four soils cover most of the Livermore Site vicinity: Rincon loam (64.7 percent), Zamora silty clay loam (13.1 percent), San Ysidro loam (13.0 percent), and Rincon clay loam (2.7 percent). Remaining soil types include Yollo gravelly loam (2.3 percent), Livermore gravely loam (2.1 percent), and Zamora silt loam (2.1 percent). With the exception of the San Ysidro loam, all of these soils are rated as "prime farmland if irrigated." The soils can be used for crop production when provided with sufficient water and nutrients or minerals.

Almost 75 percent of the soil series on the Livermore Site meet criteria for prime farmland. The U.S. Department of Agriculture defines prime farmland as "land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is also available for these uses" (USDA 2022).

The Livermore Gravelly loam and Yolo Gravelly loam are rated as "not limited" for purposes of construction. The Rincon clay loam is rated as "very limited." The rest of the soils are rated as "somewhat limited" (NRCS 2020).

The soils in the Livermore Valley beneath the Livermore Site are formed primarily upon sediments deposited by local streams. These soils are primarily Alfisols, or moderately developed soils, and grade into Mollisols, which are grassland soils (Brady 1990). Most of the deposits in the eastern part of the valley are relatively young, and thus, the soils are only moderately developed. These soils, generally loam, have minimal horizon or development of layers and can be locally several meters thick (Brady 1990; USDA 1966).

A soil map of Site 300 is provided in Figure 4-35. As Site 300 is within both Alameda and San Joaquin counties, the demarcation of soil taxa, which can vary by county, identifies the Alameda County soil names in italics. The Wisfiat-Arburnia-San Timoteo Complex soils cover most of Site 300 (66 percent). This complex differs slightly depending upon slope, with *Linne clay loam* (33.2 percent) on 30 to 50 percent slopes, and *Los Gatos-Osos Complex/Altamont clay* (32.8 percent) on 50 to 75 percent slopes. The rest of Site 300 is mostly covered by the Alo-Vaquero Complex (13.1 percent), Vaquero-Carbona Complex/*Diablo clay* (11.5 percent), and Carbona clay loam/*Rincon clay loam* (2.3 percent), with Rock land (3.1 percent) having no soil. With the exception of the Carbona clay loam/*Rincon clay loam*, which is rated as "prime farmland if irrigated," all of the other soils on Site 300 are rated as "not prime farmland." All of the soils on Site 300 are rated as "very limited" for purposes of construction (NRCS 2020).

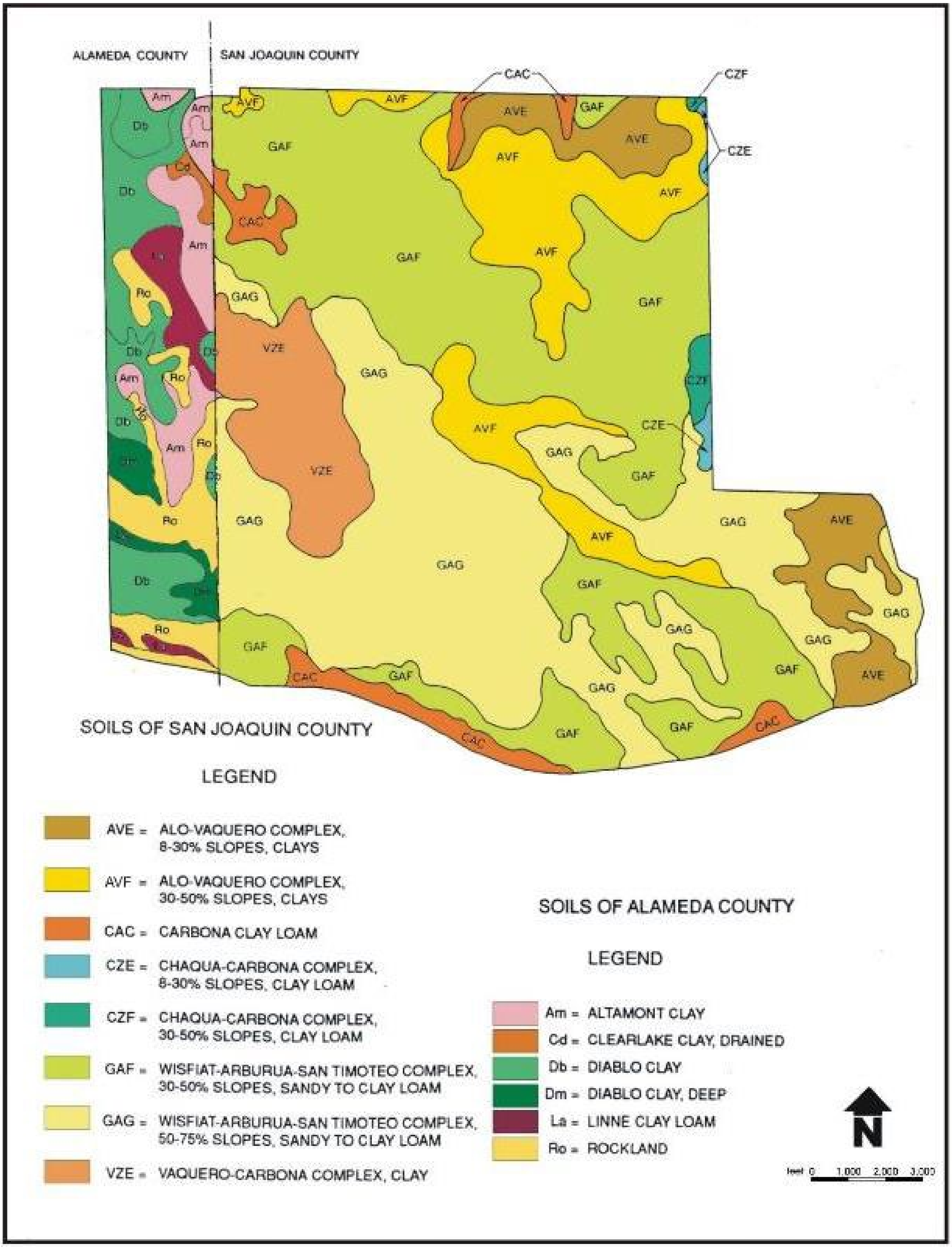
Site 300 soils have developed on fluvial, estuarine, and shallow marine shales and sandstones and uplifted river terraces, and fluvial deposits. They are classified as loamy Entisols. Entisols are young soils that have little or no horizon development. Clay-rich soils, known as Vertisols, are also present and have been mapped as the Alo-Vaquero Complex. Vertisols are mineral soils characterized by high clay content that display shrink/swell capability. Vertisols exhibit low permeability and are susceptible to moderate erosion. Wildlife habitat and limited grazing by livestock are the best uses of these soils. The remaining soil types identified on Site 300 occur only in limited areas. These units are mixtures of the soils described and are not readily separable, including grassland Mollisols, or are poorly developed Inceptisols (USDA 1966, 1990).

4.4.1.5 *Contamination in Soils*

Past releases of hazardous materials have impacted soil and groundwater beneath portions of both the Livermore Site and Site 300. The contamination, for the most part, is confined to each site; however, NNSA acknowledges that some contamination has migrated offsite.

At the Livermore Site, contaminants of concern (COCs) in soil include volatile organic compounds (VOCs), primarily trichloroethylene (TCE) and perchloroethylene (PCE), fuel hydrocarbons, metals, and tritium. Only the VOCs in groundwater and saturated and unsaturated soils are in concentrations that need remediation. In 2019, concentrations continued to decrease in most of the Livermore Site VOC plumes due to active remediation and the removal of more than 41 kg of VOCs from both groundwater and soil vapor. Groundwater concentration and hydraulic data indicate subtle but consistent declines in the VOC concentrations and areal extent of the contaminant plumes in 2019 (LLNL 2020r).

COCs in soil at Site 300 include VOCs (primarily TCE), nitrate, perchlorate, tritium, high explosives, depleted uranium, silicone-based oils, polychlorinated biphenyls, dioxins, furans, and metals. Site 300 restoration activities in 2019 related to soil contamination were focused on enhancing and optimizing ongoing operations at treatment facilities, continuing bioremediation treatability studies, and ongoing characterization in the Building 812 OU. Groundwater concentration data indicate general declines in contaminant concentrations in 2019 and progress toward off-site and on-site plume and source area cleanup (LLNL 2020r).



Source: USDA 1966, 1990.

Figure 4-35. Soil Map of Site 300

LLNL measures the radioactivity present in soil and vegetation in the vicinities of both the Livermore Site and Site 300. Soil is analyzed for plutonium, gamma-emitting radionuclides, and tritium. Plutonium concentrations in soil at the Livermore Water Reclamation Plant continued to be high relative to other sampled locations, but even this concentration was significantly below the screening level for cleanup recommended by the National Council on Radiation Protection (NCRP) (LLNL 2020r). The highest detected value for plutonium was 7.70 ±0.75 mBq/dry gram (0.208 pCi/dry gram),[1] at sampling location L-WRP1. The detected concentration (activity) is 1.6 percent of the NCRP-recommended screening limit of 470 mBq/g (12.7 pCi/g) for property used for commercial purposes (LLNL 2020r).

Except for a sampling location in the central eastern portion of Livermore Site (L-ESB), all reported tritium concentrations (activities) were within the range of previous data. At that location, tritium was detected at 5.0 ±1.5 Bq/L (135 ±40 pCi/L). In 2018, tritium was detected in a L-ESB at 14.0 Bq/L (378 pCi/L) (LLNL 2020r).

Off-site vegetation and Livermore Valley wine were sampled for tritium. In 2019, the median of concentrations in all offsite vegetation samples was below the lower limit of detection of the analytical method. For Livermore Valley wines purchased in 2019, the highest concentration of tritium was just 0.34 percent of the U.S. Environmental Protection Agency's (USEPA) standard for maximal permissible level of tritium in drinking water (LLNL 2020r). (*See* also Section 4.8.1.4 for additional information on tritium levels in vegetation and commodities near the Livermore Site.)

At Site 300, soils are analyzed for gamma-emitting radionuclides and beryllium. In 2019, uranium-235 and uranium-238 concentrations in soils at Site 300 were below NCRP-recommended screening levels (LLNL 2020r). The levels of tritium in the groundwater, and therefore soils, have significantly decreased from their historical maximum, and modeling and continued monitoring indicate that the tritium plume will not migrate off site in the period of time it takes to naturally attenuate to cleanup standards (Taffet et al. 2016).

4.4.2 Geologic Resources

The geologic resources found on or near the Livermore Site and Site 300 include aggregate deposits, mineral deposits, and petroleum. These resources are described below.

4.4.2.1 *Aggregate Deposits*

The Livermore Valley is underlain by alluvial deposits that contain substantial reserves of sand and gravel suitable for use in the production of Portland cement. Most of the valley floor south of I-580 is classified as an area of significant mineral resources by the California Geological Survey (formerly the California Division of Mines and Geology). This portion of the valley floor includes areas classified as Mineral Resource Zone (MRZ)-2 and MRZ-3. MRZ-2 is an area where adequate information indicates that significant mineral deposits are present. MRZ-3 areas contain

[1] In general, this SWEIS presents information in English units. However, radiological information is more commonly presented in metric units, as they are more widely used in scientific publications. In some instances, both English and metric units are provided, such as those related to radiological contamination levels, as in this section and Section 4.5.

mineral deposits, but the significance of the deposits cannot be determined on the basis of available information (Livermore 2014). The areas north of I-580 and within and immediately surrounding the Livermore Site are classified as having no significant mineral deposits or areas where information is inadequate to indicate the presence of significant mineral resources (Livermore 2014).

The city of Livermore planning area (*see* Section 4.2.1.3) contains several MRZ-2 areas where mineral extraction is occurring and areas where current land uses are similar. These areas are two miles to the south and five miles to the west of the Livermore site, respectively. Aggregate resources within these areas are estimated to be approximately 100 million tons (Livermore 2014).

The areas classified as MRZ-2 for reserves and resources of gravel in western San Joaquin County occur east of Site 300, to the south and southwest of Tracy (San Joaquin 2016). This area contains one large-scale gravel quarry. No sand or gravel resources have been assessed within the drainage basin of Corral Hollow Creek; specifically, Corral Hollow and Site 300 (CDMG 1988).

4.4.2.2 *Mineral Deposits*

Clay, coal, and silica have been mined or have the potential to be mined in the vicinity of the Livermore Site and Site 300 (CDMG 1950). Clays found in this region have been used for brick, sewer pipe, and roofing tile. Substantial clay deposits are associated with outcrops of the Eocene Tesla Formation near the old settlement of Tesla in Corral Hollow, and some clay has been excavated from the perimeter of the Livermore Valley (CDMG 1950). The clay beds near Tesla were mined from 1897 to 1912. Extensive clay deposits still remain, but the need for and cost of subsurface mining prevents the economic exploitation of these deposits (CDMG 1957).

Lignite coal was discovered near the settlement of Tesla before 1857. This coal was often found layered with clay in the Eocene Tesla Formation, and was mined between 1897 and 1902. The Tesla Formation is present immediately south of Site 300 in the Carnegie State Vehicle Recreation Area (SVRA). More than 70,000 tons per year of lignite coal were produced during that time (CDMG 1950). Silica was mined in an unspecified location in the hills north and west of Corral Hollow from high silica Tesla Formation sandstone. The extent of this resource is presently unknown. Silica was mined only intermittently for use in manufacturing machine parts and for furnace linings (CDMG 1950).

Several occurrences of other potentially economically valuable mineral deposits are within a 10-mile radius of the Livermore Site. These include deposits of manganese, chromium, clay, gemstones, pyrite, dimension stone, sand and gravel, and natural gas. Past production statistics and the current development status of these mineral resources are unknown. No commercially exploitable mineral deposits are known to exist within the boundaries of the Livermore Site and Site 300.

4.4.2.3 *Petroleum Production*

The Livermore oil field, just east of the Livermore Site, was discovered in 1967 and is the only oil field in the Livermore-San Ramon Valley area to date (California Division of Oil and Gas 1982). The Livermore oil field originally consisted of 10 producing wells. These wells are located east of the northeastern corner of the Livermore Site. There were six active wells and two inactive petroleum wells in Alameda County in 2018. These wells produced a total of 4,918 barrels and 456 million cubic feet of natural gas that year (DOC 2019). In July 2018, the Alameda County supervisors voted to not extend the Livermore field's operator's conditional use permit. No oil or gas exploration is being conducted in the hills to the east of the Livermore Site.

4.4.3 Geologic Hazards

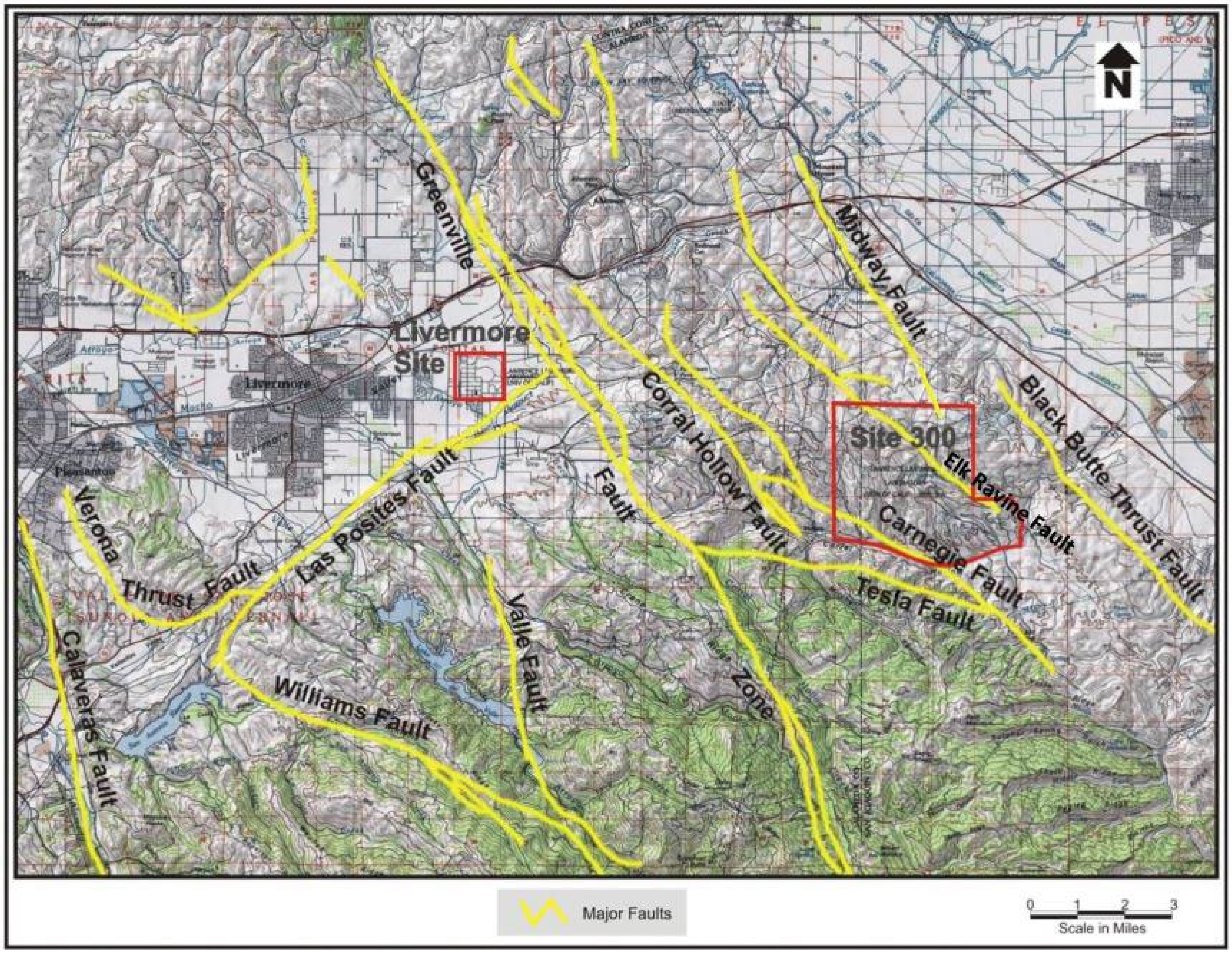
Geologic hazards from earthquakes are mainly due to seismically induced ground motion. Assessment of ground motion includes measurement of the acceleration and the frequency of the shaking. The acceleration is expressed in units of *g*, or the acceleration due to gravity (i.e., 9.8 meters/sec^2). The frequency is in units of hertz or one full cycle back and forth per second.

The intensity of ground motion or shaking that could occur at LLNL or Site 300 as a result of an earthquake is related to the size of the earthquake, its distance from LLNL or Site 300, and the response of the geologic materials beneath the two sites. Ground shaking generally causes the most widespread effects, not only because it propagates considerable distances from the earthquake source, but also because it may trigger secondary effects from ground failure.

4.4.3.1 *Tectonic Characteristics*

The Livermore Site and Site 300 are located near the northwest-southeast trending boundary separating the North American and Pacific tectonic plates, or San Andreas Fault system (*see* Figure 4-29 in Section 4.4.1.2). Local plate interaction generally results in the accumulation of strain along fault structures, which may be released during an earthquake event. The high level of seismicity active locally has resulted in the area's classification of Seismic Risk Zone 4, the highest risk zone in the California Building Code (Livermore 2014).

Regionally significant structures are associated with the San Andreas Fault system, including synclines, anticlines, and faults (*see* Figure 4-30). The San Andreas, Hayward, and Calaveras faults have produced the majority of significant historical earthquakes in the Bay Area and accommodate the majority of slip along the North American and Pacific tectonic plate boundary. These structures will likely continue generating moderate to large earthquakes more frequently than other faults in the region (LLNL 2002a). The closest structures to the Livermore Site associated with the San Andreas Fault system are the Calaveras Fault situated approximately 15 miles west of the Livermore Site, and the Greenville Fault, located approximately 1,400 feet northeast of the northeastern corner of the Livermore Site. These faults are also among the closer active faults to Site 300. Locally significant fault structures include the Greenville, Mount Diablo (thrust fault which underlies the Livermore Valley), Los Positas (one mile southeast of the Livermore Site), and Corral Hollow (two miles east of the Livermore Site) faults (Figure 4-36).



Source: modified Carpenter 1984a.

Figure 4-36. Location of the Major Faults Adjacent to the Livermore Site and Site 300 Seismicity and Earthquakes

<u>Faults</u>

Major earthquakes have occurred in the region in the past and can be expected to occur again in the future. The greatest probability for large earthquakes is associated with the San Andreas Fault zone, approximately 38 miles to the west of the Livermore Site. However, the large earthquakes that have occurred in the San Francisco Bay Area, such as the 1906 Great San Francisco Earthquake, with an estimated magnitude of 8.3 on the Richter Scale, have produced limited structural damage in the Livermore Valley.

The Livermore Site and Site 300 are in the region of, but somewhat removed from, the largest and most active earthquake faults in California. However, both sites are located close to lesser active and potentially active faults. The most important of these are the Calaveras and Greenville faults, which are the easternmost active members of the San Andreas Fault system in the San Francisco Bay region (LLNL 2007a).

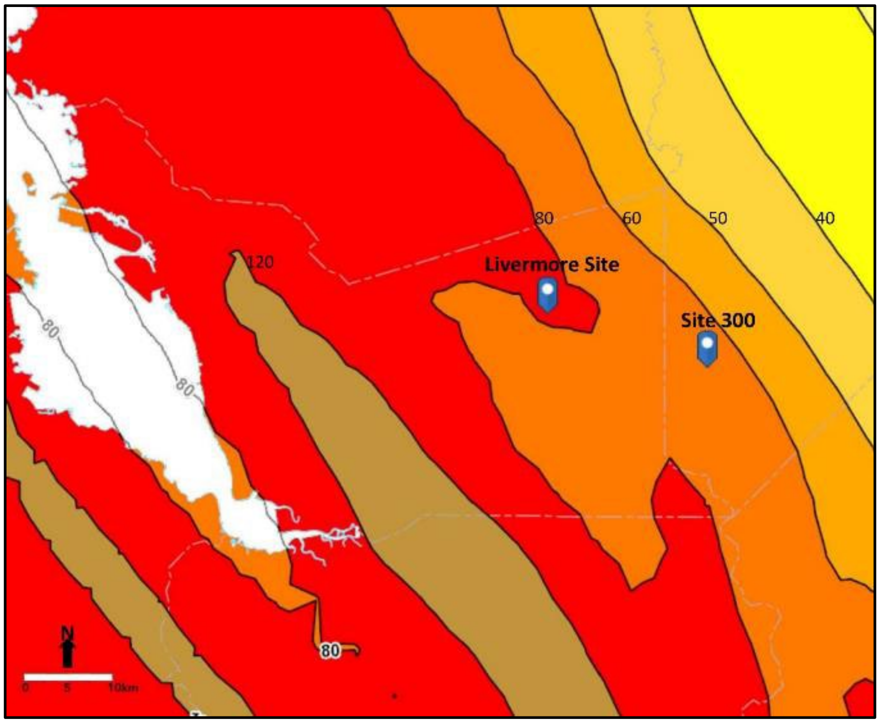
The Calaveras and Greenville faults are both estimated to be capable of producing earthquakes in the magnitude 6.5 to 7 range (i.e., similar to the size of the 1989 Loma Prieta earthquake). These two faults make the greatest contribution to the seismic hazard at the Livermore Site due to ground motion, particularly at low frequencies of ground shaking of about one Hertz and above that would be the most damaging to buildings at the sites. For example, a magnitude 5.8 earthquake (followed by a magnitude 5.4 aftershock) on the Greenville Fault in 1980 produced high-frequency shaking with an estimated peak acceleration of about 0.3*g* and some instances of significant structural damage at the Livermore site. Comparable high-frequency shaking would not be experienced from earthquakes on larger faults of the San Andreas Fault system (i.e., San Andreas, Hayward-Rogers Creek, San Gregorio) due to distance from the epicenter. Rather, these faults would produce relatively large low-frequency ground motions of longer duration. For example, the 1989 magnitude 7 Loma Prieta earthquake on the San Andreas Fault produced a peak ground acceleration (PGA) of 0.1*g* at the Livermore Site but no damage (LLNL 2007a).

The Mount Diablo Thrust Fault, postulated to underlie the Livermore and Sycamore valleys on the basis of seismic reflection data, is related to the development of fold structures in the area. The Las Positas Fault passes within one mile southeast of the Livermore Site and is considered capable of generating relatively infrequent moderate earthquakes. Additionally, the Corral Hollow Fault zone passes approximately two miles east of the Livermore Site.

Potential sources for future ground motion at the Livermore Site include the major regional faults, as well as the local faults. Faults that show evidence of Holocene and earlier activity in Quaternary time comprise the source of potential seismic hazard to the Livermore Site and Site 300. Historical records indicate that about once every 20 years the Livermore Site is subject to an earthquake that can at least knock books off shelves, overturn furniture, cause lighting fixtures to fall, and the like. No active faults are known to underlie the site, and there is no historical record of surface rupturing or faulting at the site (LLNL 2007a).

Geologic hazard and seismic safety studies have been conducted for the Livermore Site and Site 300 facilities for over 40 years. These studies are used to help design, construct, and retrofit these facilities. The unmodified PGA at the project site based on the 1991 Geomatrix study were 0.567*g*, 0.682*g*, and 0.983*g* for 500, 1,000, and 5,000 years, respectively. This compares to unmodified surface PGAs derived in the current probabilistic seismic hazards assessment of 0.532*g*, 0.668*g*, and 0.9711*g* for the same three return periods, which are comparable (Menchawi and Fernandez 2016).

In 2014, the U.S. Geological Survey issued a report (Petersen et al. 2014) that updates the *2008 United States National Seismic Hazard Maps* (Petersen et al. 2008). The 2014 report provides updated seismic hazard maps for the entire country and is updated roughly every five to six years to account for new evidence and improvements in the field of seismology. The 2014 report showed the Livermore Site in an area with a predicted PGA due to earthquake of 0.6*g* to 0.8*g* (Figure 4-37). The PGA values cited are based on a two-percent probability of exceedance in 50 years. This corresponds to an annual occurrence probability of about 1 in 2,500. The 2018 update of the United States National Seismic Hazard Model included basin depths, new earthquake data, and shaking estimates for the San Francisco Bay Area Region and resulted in changes to predicted PGA of only one percent (Petersen et al. 2020).



Source: Petersen et al. 2014.

Figure 4-37. Peak Ground Accelerations (as a percentage of standard gravity [32.2 ft per sq. sec])

The local faults in the Livermore Valley region are still the main seismic hazard to the Livermore Site (Scheimer 1985). The potential for local, damaging earthquakes was highlighted by the January 1980 Livermore earthquake sequence on the Greenville Fault, which produced two earthquakes of magnitudes 5.5 and 5.6 on the Richter Scale (Bolt et al. 1981). The first earthquake caused discontinuous surface displacements along 3.9 miles of the fault and produced a maximum PGA of 0.26*g* at nearby Lake Del Valle. The earthquake caused some structural and nonstructural damage to the Livermore Site, mostly to the old buildings/modular structures on site and the general lack of site seismic safety considerations due to the knowledge of the time.

The most recent probabilistic seismic hazards update for LLNL (Menchawi and Fernandez 2016) found that the Greenville Fault is the largest contributor to high-frequency seismic hazard at the Livermore Site, followed by the Calaveras and the Corral Hollow fault systems; then, by an order of magnitude less, it is followed by the Springtown and Mount Diablo thrust, and finally by the Las Positas Fault. This is primarily due to the distance of these faults from the Livermore Site (LLNL 2002a). At lower frequencies, the more distant Hayward and San Andreas faults are substantial contributors to the total hazard.

The evaluation of seismic hazards for Site 300 was based on a review of the literature, an aerial photographic analysis of the faults and landslides prior to field reconnaissance mapping, and a review of features identified in detailed studies of faulting and geology at the site (Carpenter et al. 1991; Dugan et al. 1991).

Site 300 is located near the eastern edge of the geologic province of the California Coast Ranges, which is characterized by northwest trending, strike-slip faults of the San Andreas Fault system. The boundary between the Coast Ranges and the San Joaquin Valley lies immediately east of Site 300 and is characterized by east-northeast compression, resulting in reverse and thrust faulting and folding (Wong et al. 1988; Wentworth and Zoback 1989).

The principal faults in the vicinity of Site 300 are the Corral Hollow-Carnegie, Black Butte, and Midway (*see* Figure 4-36). The Corral Hollow-Carnegie Fault system passes through the southern portion of Site 300 (LLNL 2007a). LLNL geoscience field investigations in 1991 and 1992 determined that this system should be considered potentially active. The Elk Ravine Fault, a complex structure composed of pre-Holocene strike-slip faults, reverse faults, normal faults, and local folds, crosses Site 300 from the northwest corner to the southeast corner (Dibblee 1980a). No significant recorded earthquakes have occurred on any of the local faults.

Potential for surface faulting exists at Site 300. The areas adjacent to the active Carnegie Fault portion of the fault system could experience ground deformation in the event of a major earthquake on the fault. A 10- to 13-foot-wide zone of faulting is present in Holocene and late Pleistocene deposits within the Corral Hollow-Carnegie Fault zone, attesting to the potential for surface rupture. Carpenter et al. (1992) state that surface wave magnitude (M_s) = 6.3–6.7, with 7.1 as the upper limit, has been estimated as the range of maximum earthquake magnitudes that could be generated in this fault zone. The only structures located adjacent to the Holocene strand of the Corral Hollow-Carnegie Fault, and, therefore, subject to the hazard of surface faulting, are Buildings 899A and 899B at the Small Firearms Training Facility (*see* Figure 4-36). In addition to the principal Holocene strike-slip Carnegie Fault strand, the subsidiary Elk Ravine Fault could produce minor amounts of surface rupture (Dugan et al. 1991) although evidence of Holocene movement has not been observed on strands of this fault at Site 300.

4.4.3.2 *Other Geologic Hazards*

Other geologic hazards due to earthquakes include landslides, surface rupture of faults, and liquefaction of soils. Landslides are evaluated by slopes and soil and rock characteristics. The potential for fault rupture is discussed in terms of location of faults and associated earthquake activity. Liquefaction is assessed in terms of soil character and water content.

Landslides

There is some overlap between the definitions of landslides and debris flows, also known as mudslides. For this SWEIS, landslides are defined as movement of rock, earth, or debris down a slope at any speed. Mudslides and debris flows are a type of fast-moving landslide that tends to flow in channels (CDC 2018). The Livermore Site consists of a relatively flat land surface that slopes gently to the northwest. Ground surface elevations within the Livermore Site range from a low of 571 feet at the northwest corner of the site to 676 feet at the southeast corner. Little potential for slope instability exists at the Livermore Site because of the low relief.

At Site 300, the topography ranges from gently sloping to nearly vertical in places, and numerous landslide features have been mapped with the largest landslide covering approximately 0.5 square miles. The potential for non-seismically initiated landslides is great along the canyon walls, especially where soils consist of deep loams and clay loams. During periods of extended wet weather, the saturated soils can become structurally weakened and expand, resulting in slope failure. Small landslides and mudflows have occurred in the recent past causing closures of Corral Hollow Road (ABC7 2015). The potential for localized slope instability greatly increases if slopes are made steeper by road cutting or building excavation. The presence of landslide deposits and colluvium or other historic evidence of slope failure increases the probability of a failure in the future. The potential exists for seismically induced landslides on Site 300. The potential for slope instability is greater on northeast-facing slopes that have exposed strata of the Cierbo Formation. Buildings 825, M825, 826, M51, 847, 851A, 851B, 854, 855, and 856 are located on old landslides. The potential for ground deformation beneath these buildings is considered to be moderate to high.

Surface Rupture

Surface rupture is the displacement of the ground surface along both sides of the surface expression of an earthquake fault. There are no faults within the Livermore Site; therefore, the potential for surface rupture within the Livermore Site is low, although there is potential for surface rupture south of the Livermore Site.

As previously stated, the Corral Hollow-Carnegie Fault system passes through the southern portion of Site 300, and there is potential for surface rupture along the fault.

Liquefaction

Liquefaction is a type of soil failure in which a horizontal mass of partially saturated or saturated soil is transformed from a solid to a fluid state in response to earthquake shaking. The liquefaction potential of a soil deposit is controlled by several factors, including the depth to groundwater, the type and density of the soil, and the intensity and duration of ground shaking. Depths to groundwater range from about 30 to 130 feet beneath the Livermore Site (Carpenter 1984b). Based on the fairly deep groundwater levels, the uniformly distributed, poorly sorted sediments beneath the site, and a relatively high degree of sediment compaction, the potential for damage from liquefaction at the Livermore Site is low. The Association of Bay Area Governments map of liquefaction susceptibility in the Bay Area shows a low susceptibility for the majority of the Livermore Site, with a moderate susceptibility in the southwestern 20 percent of the site (Association of Bay Area Governments 2017).

Site 300 is underlain largely by coherent Tertiary bedrock, which is not liquefiable. The Quaternary alluvium at the site is limited to valley bottoms and is generally partially saturated to unsaturated except during the rainy seasons. Pleistocene gravel-bearing terrace deposits occur above Corral Hollow and periodically saturated younger alluvium and weathered bedrock occur in canyon bottoms (LLNL 1983). Based on the presence of bedrock beneath Site 300 and the age, composition, and unsaturated condition of the terrace deposits, the potential for liquefaction at Site 300 is low. Buildings completed within landslide deposits may be an exception.

4.5 WATER RESOURCES

This section provides an overview of surface water and groundwater at the Livermore Site and Site 300. Additionally, this section describes water use and floodplains at these sites. Wastewater is discussed in Section 4.12.4. Groundwater quality and surveillance monitoring results are presented in Sections 4.5.2.3 and 4.5.2.4. Information regarding remediation is included in Section 4.15.

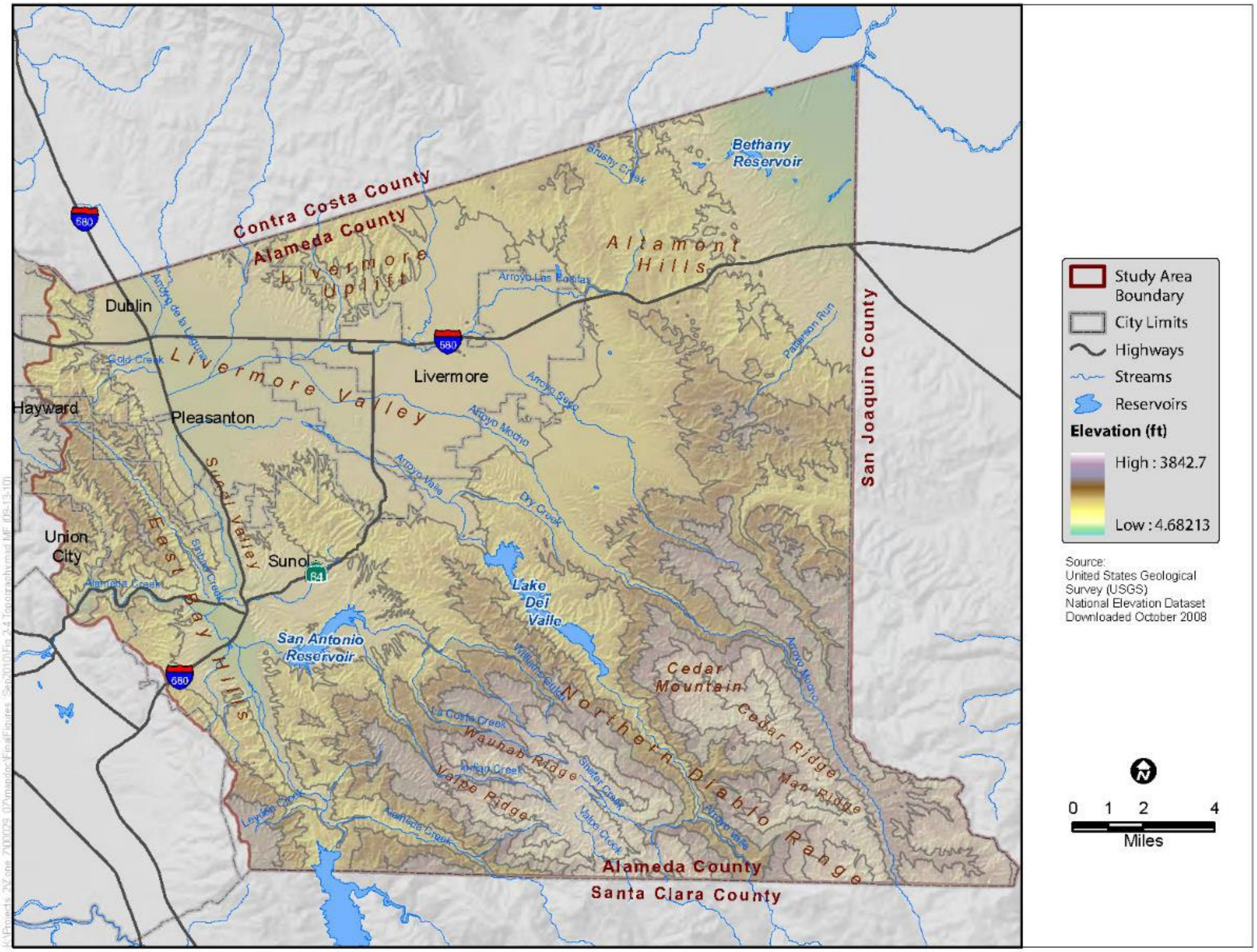
4.5.1 Surface Water

4.5.1.1 *Livermore Site*

Surface drainage and natural surface infiltration at the Livermore Site are generally good, but drainage decreases locally with increasing clay content in surface soils. Surface flow may occur intermittently from October to April, during the Livermore Valley's wet season. Only intermittent streams flow into the eastern valley from the surrounding uplands and low hills, where they merge on the valley floor. The four major intermittent streams that drain into the eastern Livermore Valley are Arroyo Mocho, Arroyo Seco, Arroyo Las Positas, and Altamont Creek (Figure 4-38). Arroyo Seco and Arroyo Las Positas pass through the Livermore Site, while Altamont Creek and Arroyo Mocho flow off site to the north and southwest, respectively. Recharge to sediments underlying the Livermore Valley is primarily from the arroyos that originate in the eastern foothills and flow across the valley. When surface flow occurs in these channels, water infiltrates into the underlying alluvium and eventually percolates to the aquifers within the Livermore Valley (LLNL 2020r).

The headwaters of the Arroyo Seco drainage are in the hills southeast of the Livermore Site. Arroyo Seco has a drainage length of approximately 12 miles and a watershed area of approximately 8,960 acres upstream of SNL/CA. The Arroyo Seco flows through SNL/CA before crossing over the southwest corner of the Livermore Site and continuing northwesterly. Flow only occurs in the arroyo during rainfall because discharge to the stream is from storm runoff only. The channel is well defined in the section that passes directly through the Livermore Site and is dry for at least six months of the year. The majority of the Arroyo Seco channel remains dry year-round except when rainfall creates drainage runoff. The last 20 feet of the channel on site and at least a few hundred feet of the channel downstream of the Livermore Site flow year-round due to treated groundwater discharge operated from the Livermore Site regulated under the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) (42 U.S.C. § 9601) (LLNL 2019g).

Arroyo Las Positas is an intermittent stream that drains from the hills directly east of the Livermore Site with a watershed area of approximately 3,300 acres. The arroyo enters the Livermore Site from the east, is diverted to a storm ditch along the northern edge of the site, and exits at the northwest corner. Arroyo Las Positas receives discharge from Lake Haussmann (formerly identified as the onsite drainage retention basin). Additionally, water from springs and runoff in the nearby hills feeds into Arroyo Las Positas. Before 1992, it was determined that stormwater was infiltrating and dispersing contaminated groundwater in the area of what is currently Lake Haussmann. Therefore, Lake Haussmann was constructed with a liner in 1992 to prevent this infiltration of stormwater. Lake Haussmann collects about one-fourth of the surface-water runoff from the site and a portion of the Arroyo Las Positas drainage. Lake Haussmann discharges north to a culvert that leads to Arroyo Las Positas. The water level of Lake Haussmann is controlled by a weir that also acts as an overflow mechanism during moderate rainfall periods, releasing water to an underground culvert that eventually discharges along the bank of Arroyo Las Positas.



Source: EAC 2010.

Figure 4-38. Livermore Valley Site Surface Water Features

During wet weather, the majority of the discharge from Lake Haussmann to Arroyo Las Positas is stormwater, but a substantial amount of the flow is also discharged from groundwater treatment facilities. Just east of Building 591, Arroyo Las Positas receives treated water from the Livermore Site Groundwater Project (GWP) as part of CERCLA activities. Additional groundwater treatment facility discharges enter the arroyo from other drainage ditches and culverts further west. Water flows year-round in the lower two-thirds reach (LLNL 2019g).

Nearly all of the surface water runoff at the Livermore Site is discharged into Arroyo Las Positas; only surface runoff along the southern boundary and storm drains in the southwest corner of the Livermore Site drains into Arroyo Seco. Regional drainage flows through the southwestern part of the Livermore Valley into the San Francisco Bay through Alameda Creek.

There are more than 27 ponds located in and around the eastern Livermore Valley. The majority of the small ponds are used for private water storage for livestock watering; some have other uses, such as ornamental. The Patterson Reservoir is located 0.8 miles northeast of the Livermore Site. This reservoir covers 3.23 acres and contains about 100 acre-feet. The South Bay Aqueduct is an open canal that circles the Livermore Valley and delivers drinking water to the southeast San Francisco Bay Area, as well as to portions of Livermore through Zone 7 (EAC 2010).

LLNL conducts surface water surveillance monitoring in support of DOE Order 458.1. Surface and drinking water near the Livermore Site and in the Livermore Valley were sampled at the locations shown in Figure 4-39 in 2018. Offsite sampling locations DEL, ALAG, SHAD, and ZON7 are surface waterbodies; of these, DEL and ZON7 are also drinking water sources. GAS and TAP are drinking water outlets. LLNL sampled the two drinking water outlets semiannually and the other locations annually in 2018. All locations were sampled for tritium, gross alpha, and gross beta. The median activity for tritium in all water location samples was estimated to be below the analytical laboratory's minimum detectable activities or minimum quantifiable activities. The maximum tritium activity detected in any sample collected in 2018 was 40.3 picocuries per liter (pCi/L), which is less than one percent of the drinking water maximum contaminant level (MCL) of 20,000 pCi/L for tritium. Median activities for gross alpha and gross beta radiation in all water samples were less than eight percent of their respective MCLs. Historically, concentrations of gross alpha and gross beta radiation in drinking-water sources have fluctuated around the laboratory's minimum detectable activities (LLNL 2019f).

Because air moisture containing HTO (tritiated water) is rapidly entrained and washed out locally during rain events, rainwater is collected in rain gauges at fixed locations at both the Livermore Site and Site 300 to provide information about storms that are sampled for runoff. The tritium activity of each sample is measured and the analytical results compared to the USEPA drinking water MCL for tritium. In calendar year 2018, the rain gauges were placed at the sample locations SALV, MET, DWTF, and SECO at the Livermore Site (Figure 4-39). The samples for calendar year 2018 were collected after the January, February, and March storm events. The highest measured tritium activity was for the March 1 storm and was measured at the SECO location. This activity is less than one percent of the USEPA established drinking water standard (LLNL 2019f).

Source: LLNL 2020r.

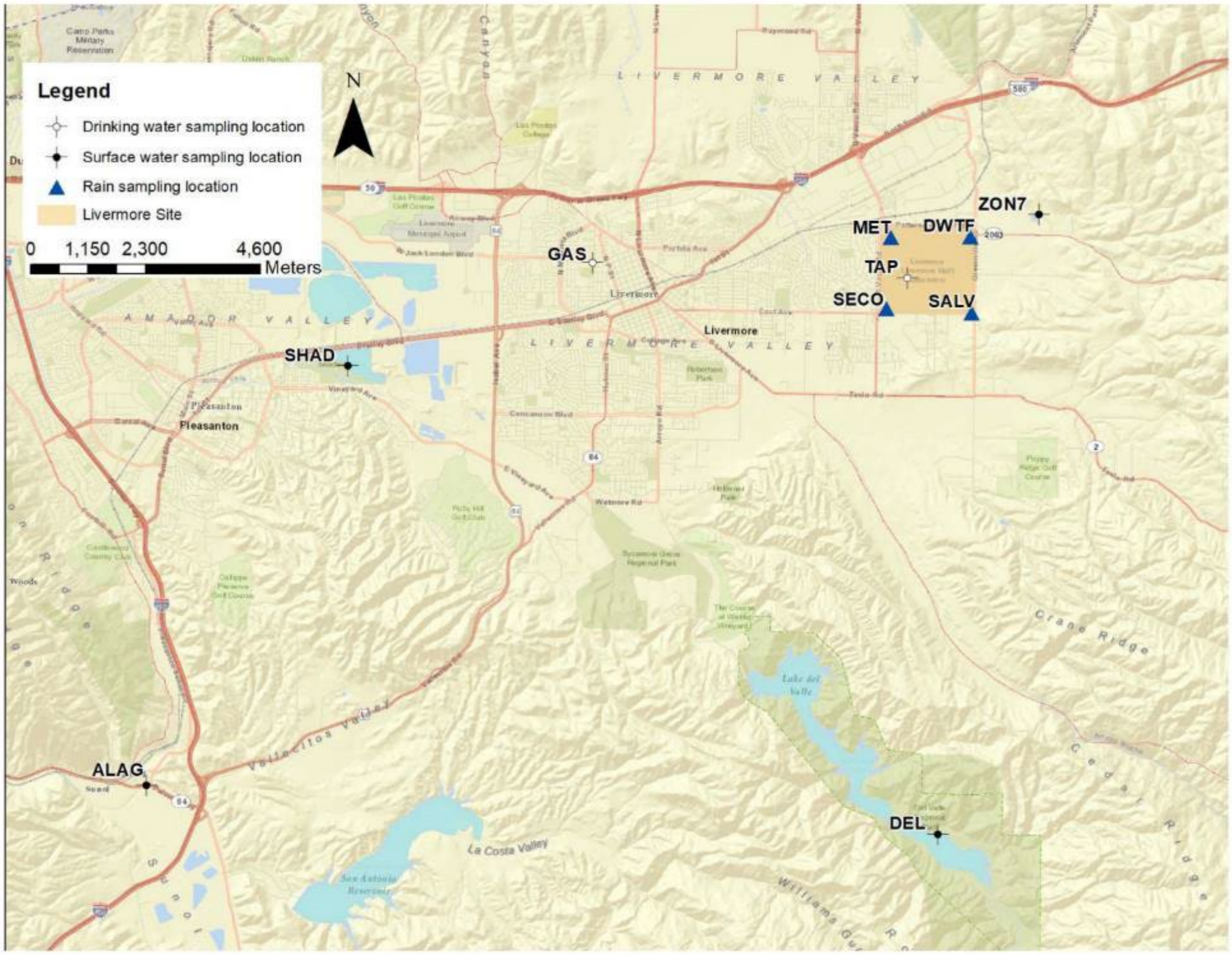
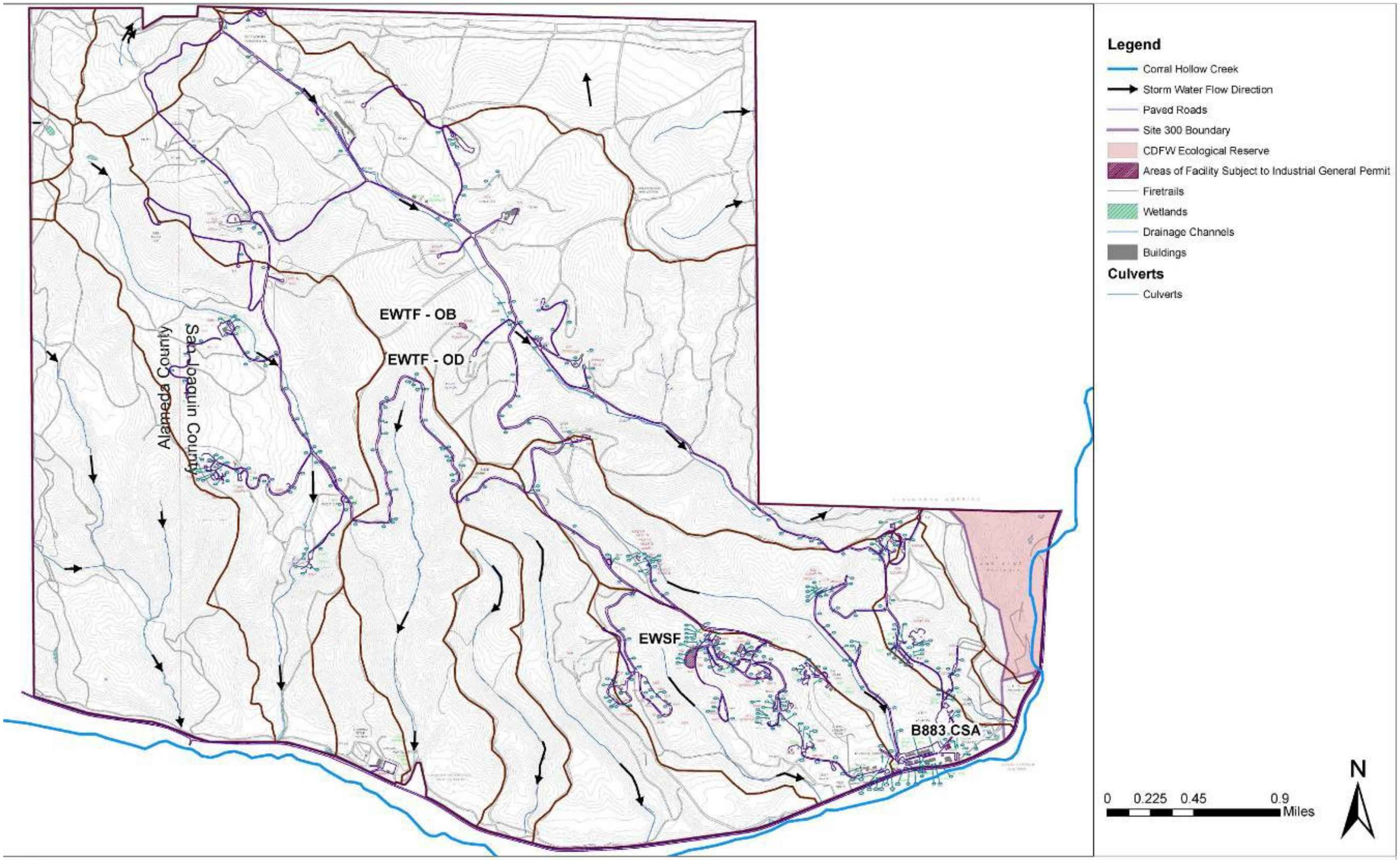


Figure 4-39. Livermore Site and Livermore Valley Sampling Locations for Rain, Surface Water, and Drinking Water

4.5.1.2 *Site 300*

Surface water at Site 300 consists of seasonal runoff, seeps, and natural and man-made ponds (Figure 4-40). There are no perennial streams at or near Site 300. The canyons that dissect the hills and ridges on Site 300 drain into intermittent streams. The majority of the intermittent streams within the site drain south to Corral Hollow Creek, also intermittent, which runs along the southern boundary of Site 300 toward the east into the San Joaquin Valley. Elk Ravine, a major drainage channel for most of Site 300, extends from the northwest portion of the site to the east-central area and drains the center and eastern portion of the site into Corral Hollow Creek. Some of the canyons in the northeast section of Site 300 drain to the north and east toward the city of Tracy in the San Joaquin Valley. Downstream of the GSA, Corral Hollow Creek contains flow from Groundwater Treatment Facilities (Nomad Ecology 2020). Discharge water from cooling towers and mechanical equipment is collected in 10 percolation pits at Site 300. A sewage evaporation pond and an associated sewage percolation pond for overflow conditions are located in the southeast corner of the site in the GSA (CRWQCB 2008).



Source: LLNL 2019h.

Figure 4-40. Site 300 Surface Water Features

Groundwater seeps are evident as by the presence of flowing water or wet soils where the water table is close to the surface and by the presence of distinct hydrophytic vegetation (cattails, willow). There are 45 groundwater seeps feeding seasonal wetlands at Site 300, most having low flow rates and only recognized by small marshy areas, pools of water, or vegetation (Nomad Ecology 2020).

In 2018, LLNL maintained coverage under General Order R5-2016-0076-025, National Pollutant Discharge Elimination System (NPDES) Permit No. CAG995002 for occasional large-volume discharges from the Site 300 drinking water system that may reach surface-water drainage courses. The monitoring and reporting program that LLNL developed for these discharges was approved by the Central Valley Regional Water Quality Control Board (CVRWQCB). Discharges with the potential to reach surface waters that are subject to these sampling and monitoring requirements are:

- Drinking water storage tank discharges
- System-flush and line-dewatering discharges
- Dead-end flush discharges

All 2018 releases from the Site 300 drinking water system quickly percolated into the drainage ditches or dry streambeds and did not reach Corral Hollow Creek, the potential receiving water (LLNL 2019f).

In calendar year 2018, LLNL collected rainwater samples at three locations on Site 300 for the January storm. None of the sample locations for the storm detected tritium (LLNL 2019f).

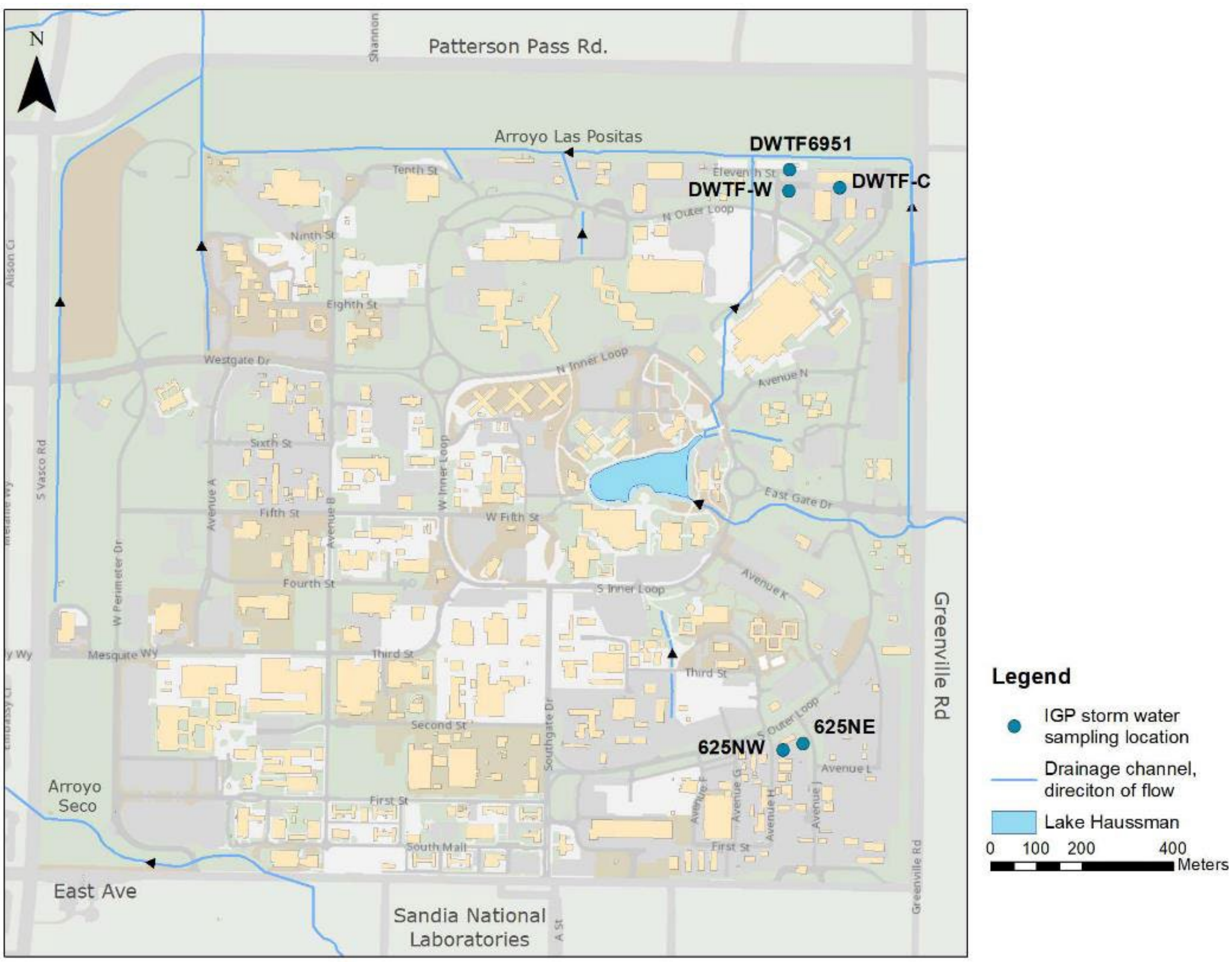
4.5.1.3 *Stormwater Compliance and Surveillance Monitoring at the Livermore Site and Site 300*

The California State Water Resources Control Board issued a Storm Water Industrial General Permit (2014-0057-DWQ) that took effect July 1, 2015. LLNL modified the stormwater monitoring plan for both the Livermore Site and Site 300 to comply with this new permit. Stormwater monitoring at both sites also follows the requirements in *Environmental Radiological Effluent Monitoring and Environmental Surveillance* (DOE 2015) and meets the applicable requirements of DOE Order 458.1 (LLNL 2020r).

For construction projects that disturb one acre of land or more, LLNL also meets stormwater compliance monitoring requirements of the California NPDES General Permit for Storm Water Discharges Associated with Construction Activity (Order Number 2009-0009-DWQ). Section 438 of the *Energy Independence and Security Act* specifically calls for federal development that has a footprint that exceeds 5,000 square feet to maintain or restore predevelopment hydrology (LLNL 2020r).

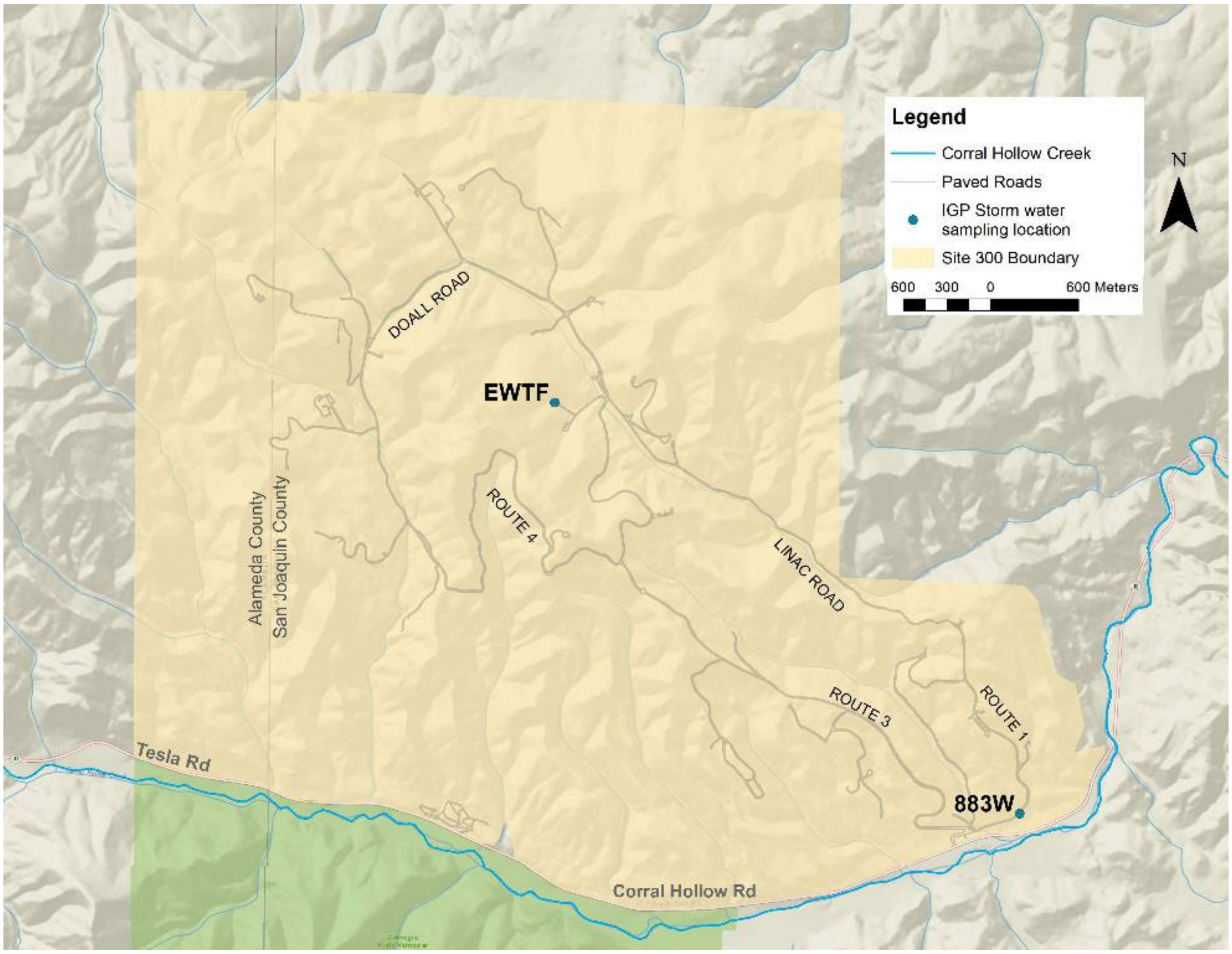
Under the industrial stormwater permit, LLNL is required to collect and analyze samples at specified locations two times during the period from July 1 to December 31 and two times during the period from January 1 to June 30 if specific criteria are met and the sampling window coincides with regular working hours (Figure 4-41 and Figure 4-42). The state stormwater reporting period is offset from the reporting period in this SWEIS. In 2018, runoff samples were collected for 3 events from all five required stormwater locations at the Livermore Site. One location was sampled once at Site 300 during 2018. Runoff samples were collected for two storm events at the Livermore Site and two storm events at Site 300 in 2019. Samples were collected from all five required stormwater locations at the Livermore Site and both required locations at Site 300. Samples were collected at the Livermore Site on January 16, 2019, February 8, 2019, and at Site 300 on February 13, 2019 and December 2, 2019. LLNL is required to visually inspect the storm drainage system during up to four qualifying storm events to observe runoff quality and once each month during dry periods to identify any dry weather flows. Annual facility inspections are performed to ensure that the adequate best management practices (BMPs) for controlling stormwater pollution are implemented. Each principal directorate at LLNL conducts an annual inspection of its facilities to verify implementation of BMPs and to ensure that those measures are adequate (LLNL 2020r).

For stormwater sample analytical results, both the Livermore Site and Site 300 remain at Exceedance Response Action Level 2 for magnesium. LLNL has provided data and analysis that show the exceedance of magnesium is due to aerial deposition from natural sources not industrial activities at LLNL (LLNL 2020r).



Source: LLNL 2020s.

Figure 4-41. Stormwater Sampling Locations, Livermore Site



Source: LLNL 2020s.

Figure 4-42. Stormwater Sampling Locations, Site 300

The Central Valley Regional Water Quality Control Board (CVRWQCB) issued a *Water Code Section 13267 Order for Submittal of Technical and Monitoring Reports for the Active Building 851 Firing Table, Lawrence Livermore National Laboratory Site 300, San Joaquin County*. This order requested a sediment and stormwater runoff monitoring program for the Building 851 Firing Table during the operational period at Site 300 (CVRWQCB 2020).

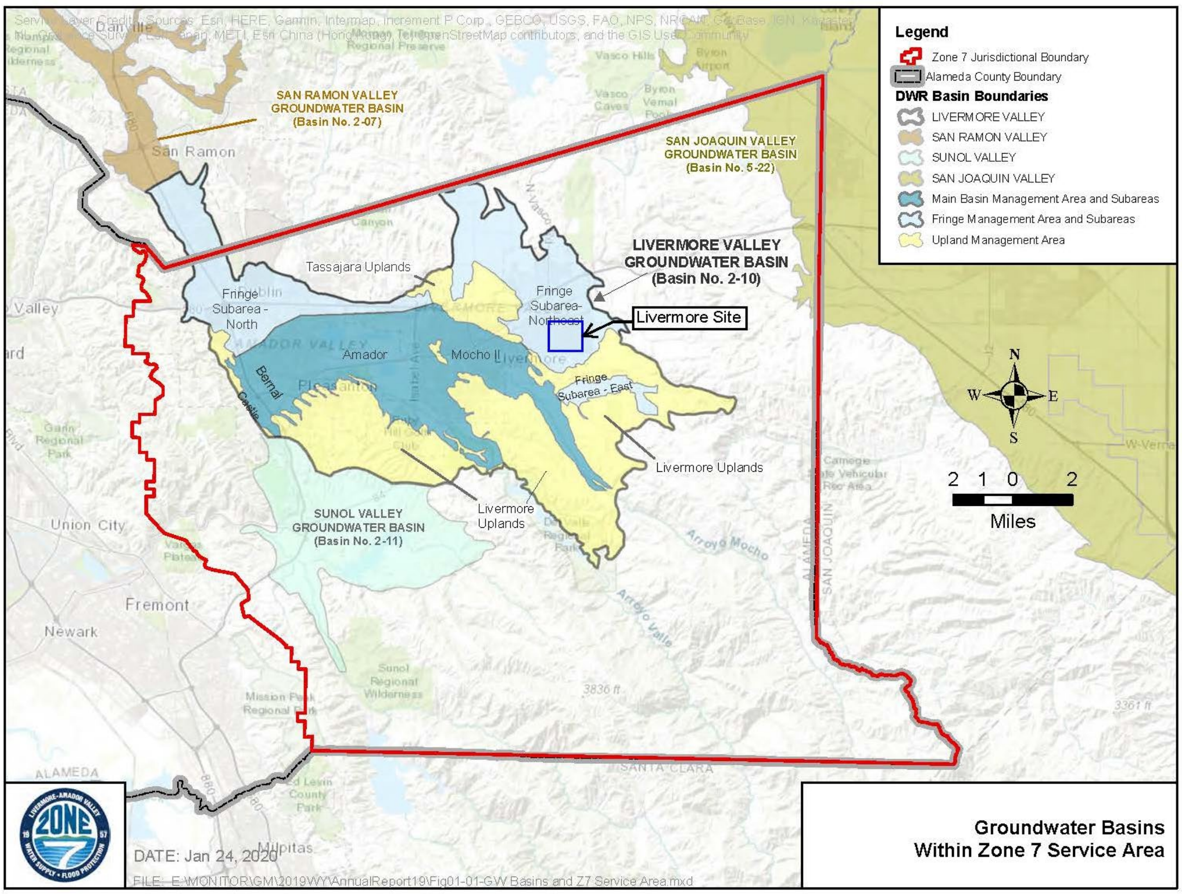
CVRWQCB subsequently approved a *Work Plan for Building 851 Firing Table Stormwater Runoff and Sediment Monitoring and Reporting*, dated March 2021. The Work Plan identified constituents of concern at the Building 851 Firing Table area, and described how LLNL will collect a stormwater runoff sample and a sediment sample annually, analyze samples for constituents of concern, and report the sampling results to the CVRWQCB. No stormwater runoff samples have been collected as of June 17, 2021 (LLNL 2021i). Sediment samples have been collected but no results have been received (LLNL 2021j).

4.5.2 Groundwater

4.5.2.1 *Regional Hydrogeology*

Livermore Site

Most of the sediments within the Livermore Valley are water bearing, though hydraulic conductivity values vary depending on lithology. In contrast, the uplands generally do not yield groundwater in sufficient quantities to constitute a groundwater resource. The Livermore Valley has been divided into a series of seven groundwater subbasins based on the locations of faults, topography, and other hydrogeological barriers that affect groundwater occurrence, movement, and quality (Figure 4-43) (Zone 7 Water Agency 2020a). In general, depth to groundwater or the water table varies from about 35 to 125 feet under the Livermore Site (LLNL 2020r).



Source: Zone 7 Water Agency 2020a.

Figure 4-43. Location of Subbasins and Physiographic Features of the Livermore Valley Groundwater Basin

The Livermore Site lies primarily within the Fringe Subarea-Northeast subbasin. The water-bearing sediments in the Livermore Valley include late-Pleistocene to Holocene-age alluvial sediments, generally less than 200 feet thick, which overlie Plio-Pleistocene alluvial and lacustrine Livermore Formation sediments, up to 4,000 feet thick. The Livermore Formation consists of beds of gravel, sand, silt, and clay of varying permeabilities. Sandy gravelly layers alternate with fine-grained, relatively impermeable layers, and groundwater can be both confined and semiconfined (LLNL 2020r).

Stream runoff from precipitation, controlled releases from the South Bay Aqueduct, direct rainfall, irrigation, and treated groundwater infiltration recharge the Livermore Valley groundwater basin. In addition, stream channels, ditches, and gravel pits west of the city of Livermore are important sources for shallow, alluvial aquifer recharge. Groundwater is naturally discharged from the basin at Arroyo de la Laguna, located over 11 miles southwest of the Livermore Site. Some minor discharges also occur at springs, including those along Arroyo Las Positas near its confluence with Altamont Creek. Natural recharge occurs primarily along the fringes of the Livermore Valley groundwater basin and through the arroyos during periods of winter flow. Artificial recharge, if needed to maintain groundwater levels, is accomplished by releasing water from the Chain of Lakes, Lake Del Valle, or from the South Bay Aqueduct into arroyo channels in the east (Zone 7 Water Agency 2020a; EAC 2010).

Groundwater generally moves east to west within the Livermore Valley, westward through the Amador Subbasin, eventually terminating in a large groundwater depression near two gravel mining areas located west of the city of Livermore. A former gravel mining company had extracted deep groundwater, causing the large groundwater depression. Current gravel mining is not as deep as in the past, decreasing the need for deep groundwater pumping. Subsequently, the groundwater depression has decreased. At the eastern edge of the Livermore Site, groundwater gradients are relatively steep, but under most of the site and farther to the west, the contours flatten (LLNL 2020s; Zone 7 Water Agency 2020a).

Pumping of groundwater for agricultural uses has historically accounted for the major withdrawal of groundwater from the Livermore Valley groundwater basin. As the valley has become increasingly urbanized, a shift in groundwater users has caused the amount of pumping for municipal use to exceed agricultural withdrawals. Agricultural use and golf courses account for approximately 135 acre-feet per year of groundwater used annually in the Livermore Site vicinity. During 2019, a total of 14,000 acre-feet of groundwater was used in the Livermore Valley primarily for municipal use and minor amounts for agriculture and domestic use. The use of surface water from the State Water Project (SWP) is fundamental to the maintenance of the Alameda County Flood and Water Conservation District (Zone 7 Water Agency) basin measurable objectives with regard to sustainable groundwater levels and storage, avoidance of subsidence, and protection of groundwater dependent eco-systems (Zone 7 Water Agency 2020a).

Site 300

Site 300 lies on the eastern flank of the Diablo Range. Most surface runoff and groundwater flows toward the San Joaquin Valley or Corral Hollow Creek. Stormwater runoff that concentrates for short periods in the Elk Ravine, Corral Hollow Creek, and lesser tributary drainages can recharge local bedrock aquifers. Regional groundwater beneath Site 300 largely occurs within sandstone and conglomerate beds of the lower Neroly Formation, and groundwater flows through both interconnected pores and fractures. A deep confined aquifer (400 to 500 feet deep) is present beneath the southern part of Site 300 within the lower Neroly Formation sandstones. This confined aquifer provides backup for the potable Site 300 water supply, which is now provided by the Hetch

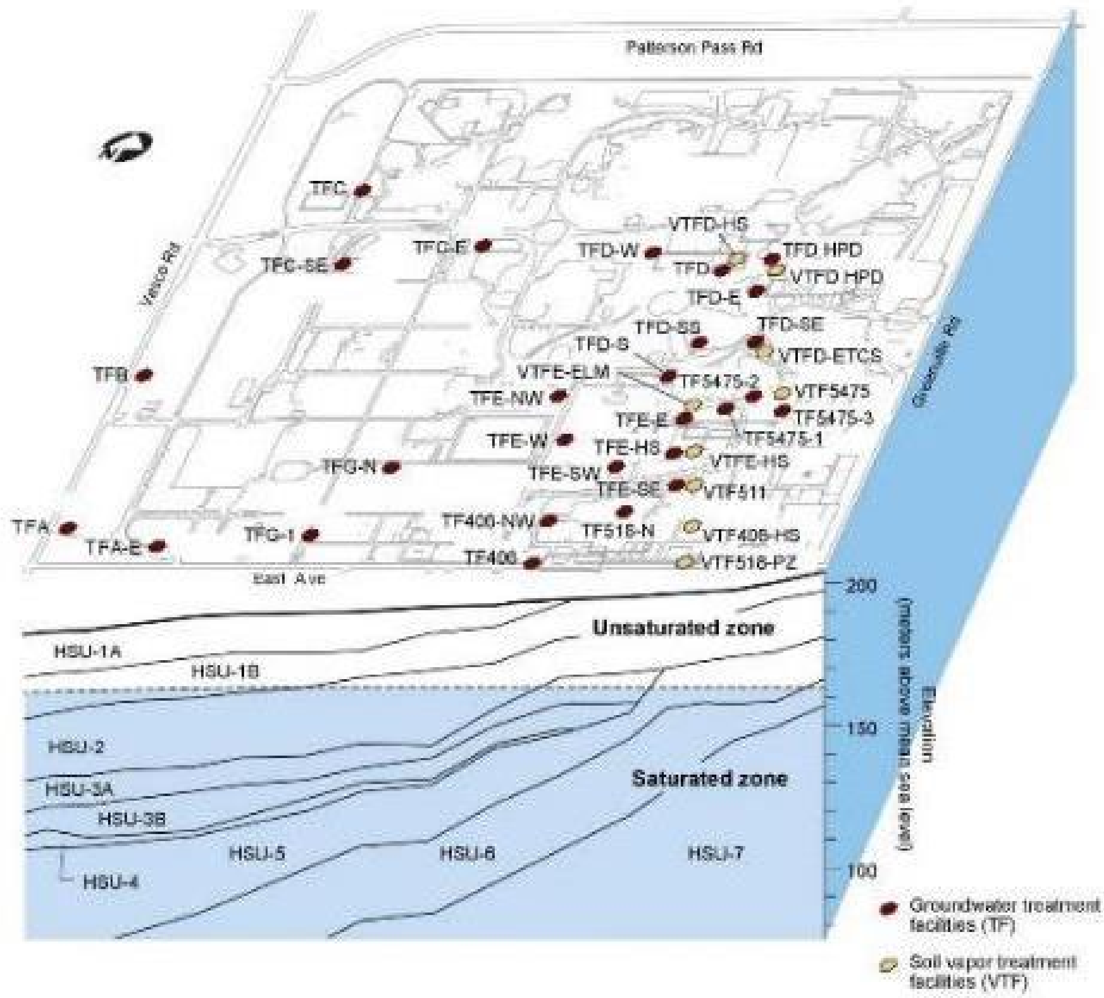
Hetchy aqueduct. The Small Firearms Training Facility gets its water from a well on the CSVRA property on the north side of Corral Hollow Road. Pumping tests performed on Site 300 water supply wells affirm the integrity of the aquitard separating the shallow and deeper aquifers within the lower Neroly Formation. In addition to the regional aquifers, local aquifers containing lesser quantities of water occur in stratigraphically higher deposits within the Neroly Formation and in a perched zone within an unnamed perched Pliocene unit and the underlying marine Tertiary Cierbo Formation. Because the water quality is generally poor and yields are lower, these lesser water-bearing zones generally do not meet the state of California criteria for aquifers that are potential water supplies (Webster-Scholten et al. 1994).

4.5.2.2 *Local Hydrogeology*

The following section describes the local hydrogeology for the Livermore Site and Site 300.

Water-Bearing Units

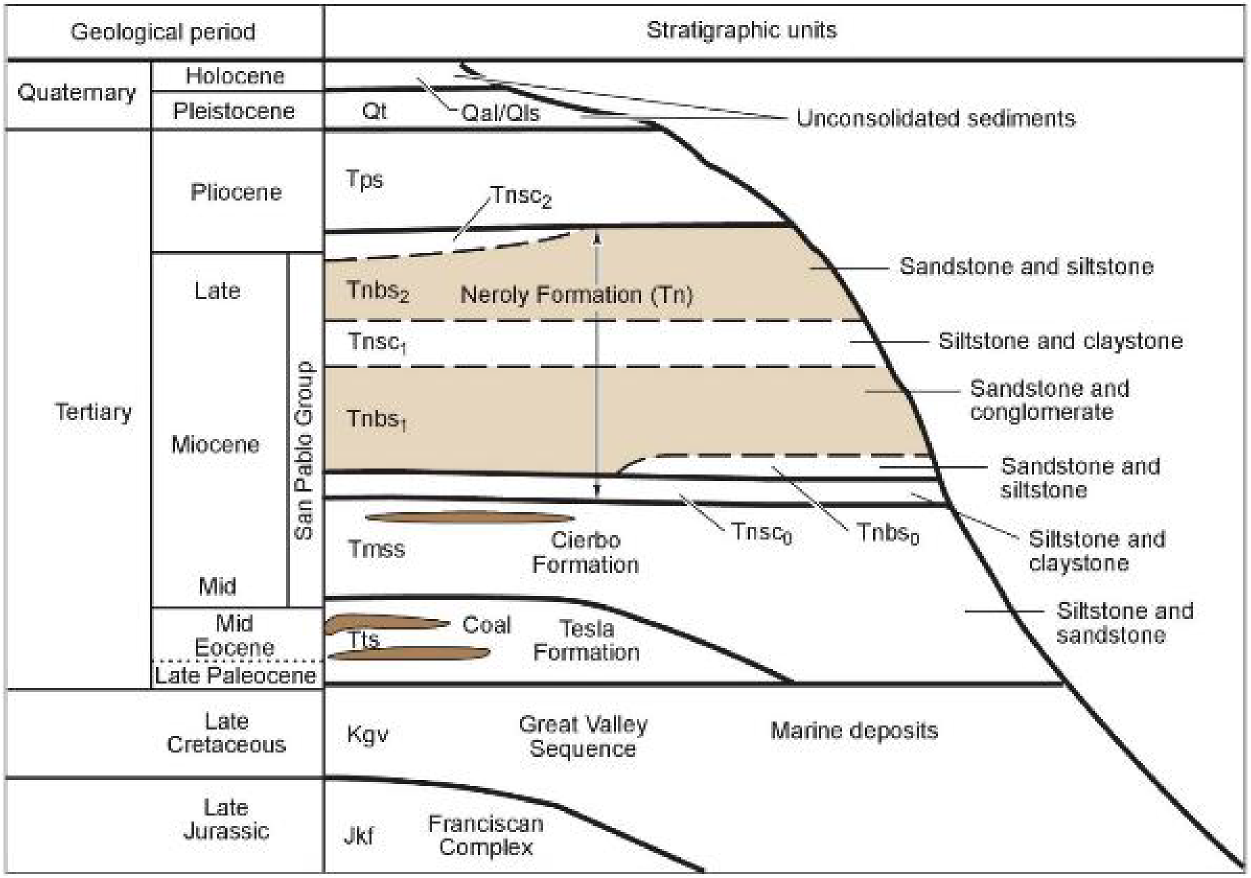
Livermore Site. In order to implement groundwater cleanup at the site under the CERCLA (*see* Section 4.15), the alluvial sediments have been divided into nine hydrostratigraphic units (HSUs) each consisting of a sequence of sediments grouped together based on hydraulic properties, geologic data, and chemical data (Berg et al. 1994; Blake et al. 1995). The nine HSUs dip gently westward. Figure 4-44 shows the major water-bearing HSUs beneath the Livermore Site. These water-bearing units include deposits formed during the late Pleistocene to Holocene age and are composed of shallow, heterogeneous, unconsolidated alluvium and deep fluvial and lacustrine sediments. The hydraulically-interconnected network of permeable sediments that transport water within each unit are separated paleosols, or ancient soil horizons, that form the boundaries between HSUs and act as confining layers. Screened intervals (depth range from which groundwater is drawn) for site monitoring wells typically range from the shallow HSU-1B to the deeper HSU-5. Unit 6 consists of a regional confining layer that slopes westward and varies in depth from about 110 feet beneath the eastern edge of the Livermore Site to about 350 feet near the western site boundary.



Source: LLNL 2007b.

Figure 4-44. Hydrogeologic Cross Section of the Livermore Site

Site 300. Two principal regional aquifers or major water-bearing zones have been identified at Site 300: an upper water table aquifer in the sandstones and conglomerates of the Neroly Formation and a deeper confined aquifer located in Neroly sandstones just above the Neroly/Cierbo Formation contact. There is also a deeper regional aquifer that has been encountered in deep wells within the sandstones of the Cierbo Formation. Both Neroly aquifers have permeable zones layered with lower permeability claystones, siltstones, or tuffs. Many of the sandstones are fine grained and silty and contain fractures. Groundwater flow is both within pores and in fractures. In addition to the two regional aquifers, several perched aquifers have been identified, some of which give rise to springs. Extensive perched aquifers are present beneath the Pit 7 area and the Building 834 complex. In addition, shallow Quaternary alluvium and undifferentiated Tertiary nonmarine sediments are locally water bearing, such as under the GSA (Figure 4-45). These local aquifers are generally unconfined or water table aquifers (LLNL 2007b).



Source: LLNL 2007b.

Figure 4-45. Schematic Stratigraphic Section for Site 300

In order to implement groundwater cleanup at Site 300 under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (*see* Section 4.15), nine environmental restoration OUs have been designated (*see* Figure 4-99 in Section 4.15) based on the nature and extent of contamination (LLNL 2017i):

- OU 1: GSA, including the central and eastern GSA
- OU 2: Building 834
- OU 3: Pit 6 landfill
- OU 4: HE Process Area, including Building 815, the HE Lagoons, and HE Burn Pit
- OU 5: Building 850/Pit 7 Complex
- OU 6: Building 854
- OU 7: Building 832 Canyon, including Buildings 830 and 832
- OU 8: Site-Wide, including Buildings 801, 833, 845, 851, Pit 2, 8, and 9 landfills
- OU 9: Building 812

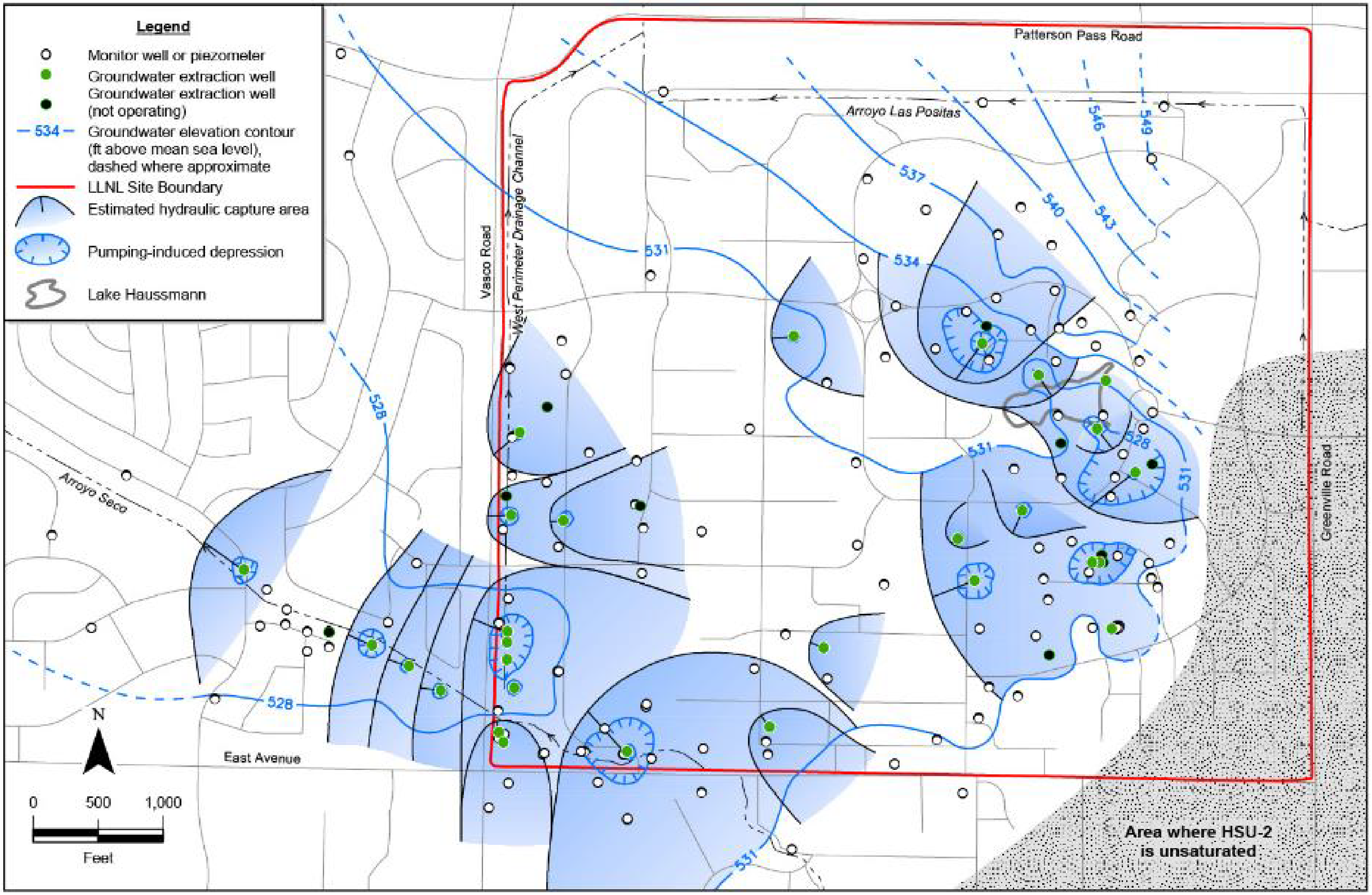
Occurrence and Flow of Groundwater

Livermore Site. Water table depth at the Livermore Site varies from about 35 to 125 feet (LLNL 2020r). Figure 4-46 presents a groundwater elevation contour map for the HSU-2 in 2019. Water table elevations vary slightly with seasonal and year-to-year differences in natural and artificial recharge and pumping (LLNL 2020s).

Groundwater at the Livermore Site and vicinity generally flows to the southwest in the northeastern part of the site and to the west in the western portion of the site. This differs from the generally westward regional flow observed in the 1980s. The shift in flow direction is a consequence of groundwater recovery and remediation in the southwestern and eastern portions of the site. Groundwater from the northern half of the Livermore Site eventually discharges to Arroyo Las Positas near First Street, about 1.5 miles to the northwest. Groundwater from the southern half of the Livermore Site may flow westward through the mapped gap between the Fringe Subarea-Northeast and Mocho subbasins (*see* Figure 4-43), about 1.5 miles west of the Livermore Site, where it may continue to flow westward toward the municipal well field near central Livermore. The majority of sediments are hydraulically continuous between the Fringe Subarea-Northeast and Mocho subbasins. Although the magnitude and direction of groundwater flow in the Fringe Subarea-Northeast I-Mocho gap are uncertain, it is conservatively assumed that at least some groundwater from the Livermore Site exits the Fringe Subarea-Northeast Subbasin in this area (Zone 7 Water Agency 2020a). The groundwater flow direction between the Fringe Subarea-Northeast and Mocho subbasins depends on the recharge conditions at each subbasin, which is impacted seasonally.

The average groundwater gradient across the Livermore Site is estimated to be 0.005 feet per feet (ft/ft) with a range of between 0.001 and 0.01 ft/ft. Hydraulic heads in wells at the Livermore Site decrease with increasing depth, indicating downward vertical gradients. Based on the results of extensive long-term hydraulic testing, the hydraulic conductivity of sediments beneath the site average about 3.7 ft/day, with a range of 2.4 to 5.6 ft/day. Aquifers in the southwest quadrant of the Livermore Site and the adjacent offsite area tend to have the highest average hydraulic conductivity. There is a greater abundance of coarse-grained deposits in the area, possibly the location of ancient channels of Arroyo Seco.

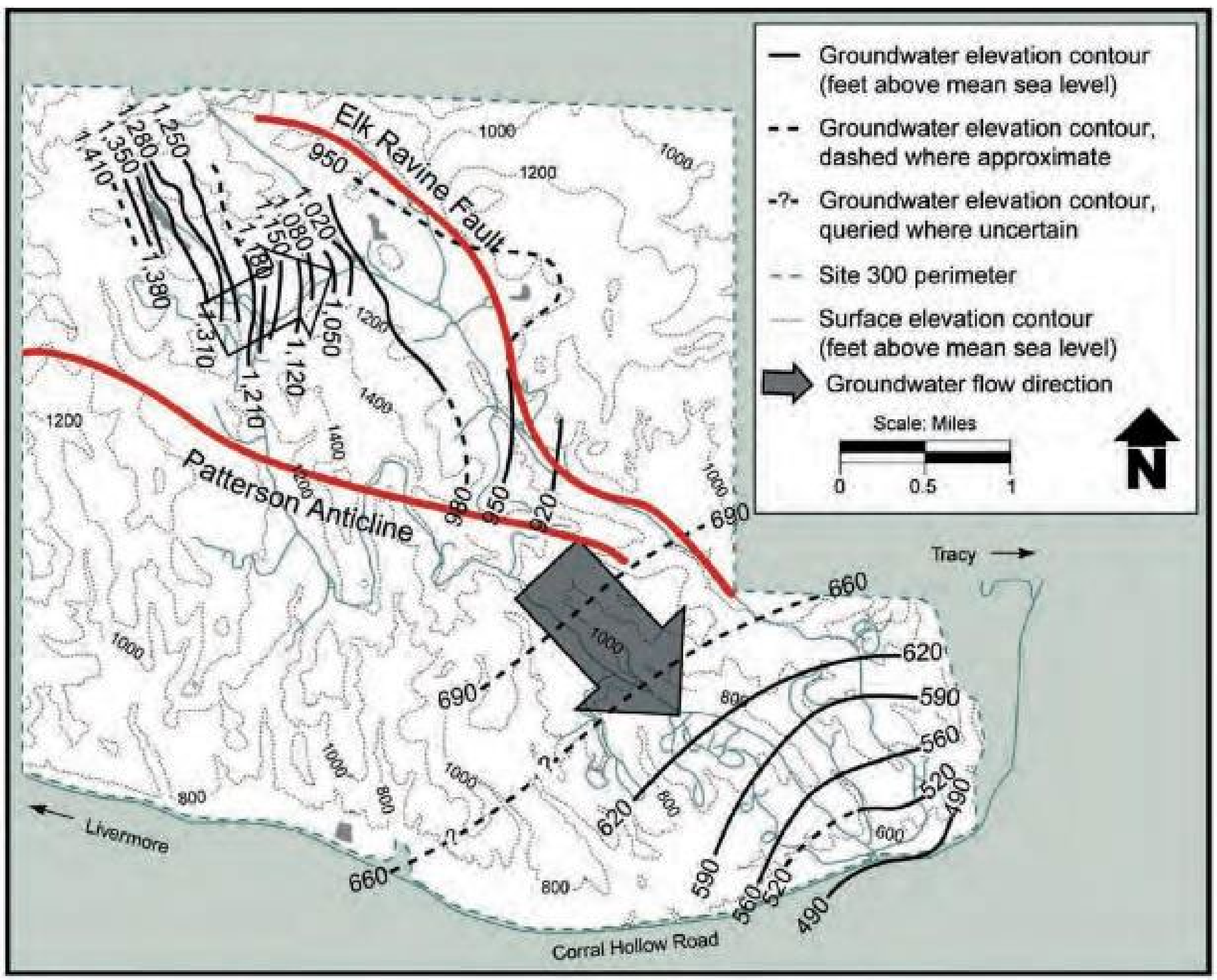
The estimated average groundwater velocities beneath the Livermore Site for the Upper Member of the Livermore Formation, the main water-bearing unit, average 20 feet per year (using a porosity of 0.3) and range from about 4 to 35 ft/year under ambient conditions (Thorpe et al. 1990).



Source: LLNL 2020s.

Figure 4-46. Livermore Site Groundwater Elevation Contour Map within Hydrostratigraphic Unit-2

Site 300. Site 300 is a large and hydrogeologically complex site in which groundwater occurs in both bedrock and alluvium/weathered bedrock aquifers. Due to steep topography and structural complexity, the geologic units are often discontinuous across the site. Consequently, locally unique hydrogeologic conditions govern the occurrence and flow of groundwater and the fate and transport of contaminants. Groundwater potentiometric surface contours for the lower Neroly aquifer at Site 300 are shown in Figure 4-47. North of the Patterson Anticline, groundwater occurs under unconfined-to-confined conditions, primarily within the lower Neroly and Cierbo bedrock aquifers. General groundwater flow in the lower Neroly aquifer in this area is principally to the northeast, east, and southeast and is controlled primarily by the stratigraphic dip. Perched water bearing zones also occur within the Quaternary alluvial sands and gravels and underlying decomposed bedrock as well as in fractured siltstones and claystones. Laterally-extensive saturated stratigraphic units at Site 300 have been grouped into HSUs.



Source: LLNL 2007b.

Figure 4-47. Approximate Groundwater Surface Elevations and Flow Direction in the Principal Site 300 Water-Bearing Zones

Throughout most of the southeastern portion of Site 300, the lower Neroly bedrock aquifer is a continuous, regional water-bearing zone. Groundwater in this aquifer in southeastern Site 300 occurs under confined-to-flowing artesian conditions. As indicated by the contours in Figure 4-47, groundwater generally flows to the south-southeast in the southern and southeastern parts of Site 300 (LLNL 2007b). Estimated groundwater velocities in the shallow Quaternary alluvial gravels at the GSA range from 1 foot to 10 feet per day (or about 365 to 3,650 feet per year). The estimated groundwater flow rates for bedrock aquifers at Site 300 range from about less than 0.01 to 1 foot per day (3.6 to 365 feet per year). The wide range of estimated seepage velocities reflects the diverse Site 300 hydrostratigraphy arising from both porous and fracture flow and a range of permeabilities (Webster-Scholten et al. 1994).

4.5.2.3 *General Groundwater Quality*

Livermore Site

Groundwater near the Livermore Site is generally suitable for use as a domestic, municipal, agricultural, and industrial supply; however, use of some shallower groundwater may be limited by its marginal quality. Groundwater less than 300 feet deep is usually unsuitable for domestic use without treatment (Zone 7 Water Agency 2020a).

Groundwater in the vicinity of the Livermore Site is mostly a calcium-bicarbonate type with sodium-chloride waters to the northeast (Zone 7 Water Agency 2020a). The four main constituents of concern (COCs) that are monitored by Zone 7 and have set minimum thresholds are total dissolved solids, nitrate, boron, and chromium. In addition, per- and polyfluoroalkyl substances were added to the list of COCs for all municipal supply wells and select monitoring wells in 2019. Elevated concentrations of total dissolved solids, nitrate, boron, and chromium were identified within or in the vicinity of the Livermore Site from groundwater samples collected in 2019 (Zone 7 Water Agency 2020a).

Site 300

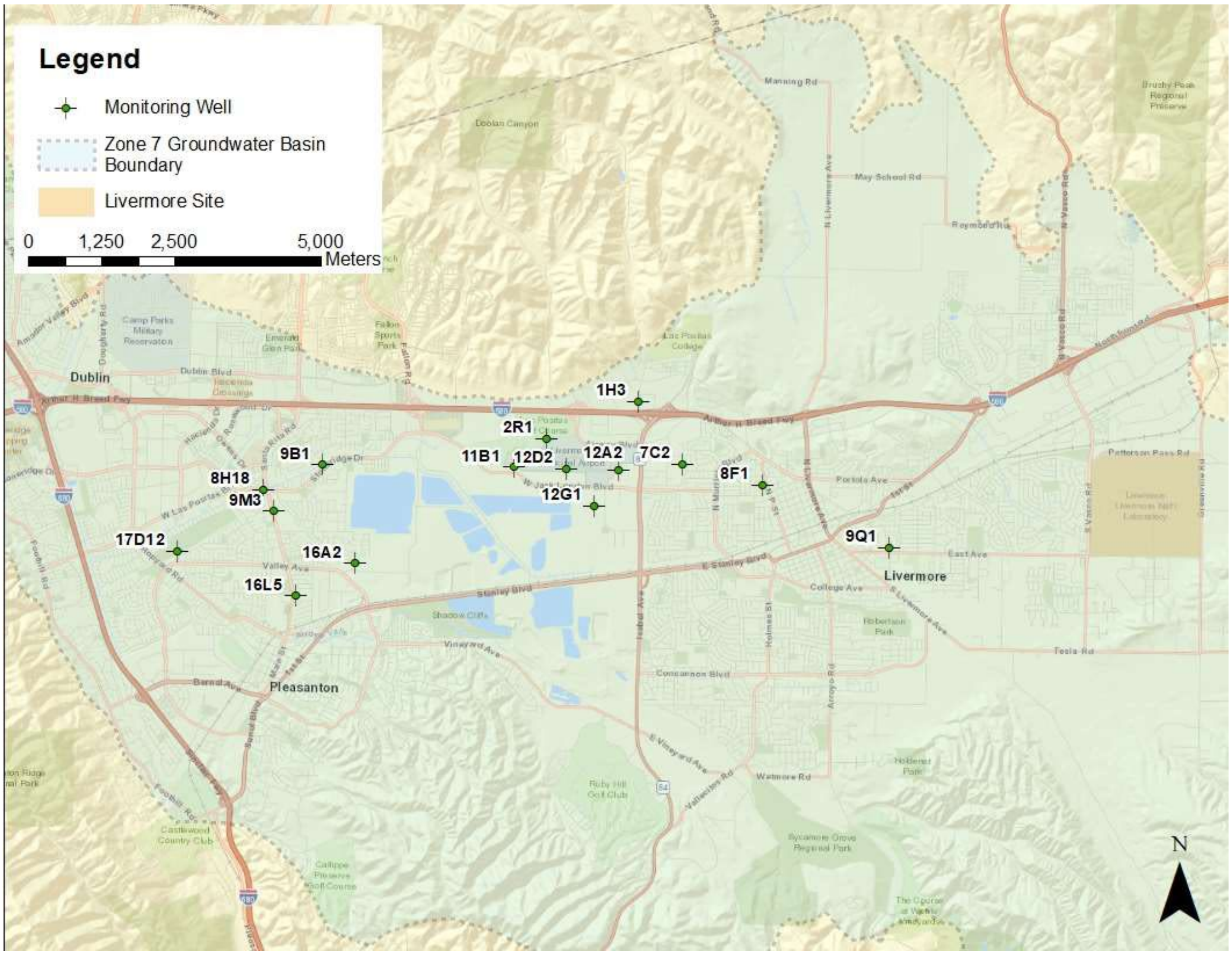
The background groundwater quality at Site 300 generally has a relatively high concentration of total dissolved solids, though variability in natural water quality has been observed. Sodium bicarbonate water is most common in water supply wells. The amount of total dissolved solids ranges from 400 parts per million to 4,000 parts per million in local groundwater. Naturally occurring elements such as arsenic, barium and uranium in rocks and sediments have contributed to elevated levels (Webster-Scholten et al. 1994).

4.5.2.4 *Groundwater Surveillance Monitoring*

Livermore Site

LLNL conducts surveillance monitoring of groundwater in the Livermore Valley through networks of wells and springs that include offsite private wells and onsite DOE CERCLA wells. Because surveillance monitoring is geared to detecting substances at low concentrations in groundwater, contamination can be detected before it significantly impacts groundwater resources. Surveillance results from groundwater monitoring wells at the Livermore Site and in the Livermore Valley are included in LLNL's Environmental Monitoring Plan (LLNL 2019f). A discussion of groundwater cleanup under CERCLA is presented in Section 4.15.

LLNL continues to monitor groundwater for VOCs and tritium. LLNL has monitored tritium in water hydrologically downgradient of the Livermore Site since 1988. HTO (tritiated water) is potentially the most mobile groundwater contaminant from LLNL operations. Groundwater samples were obtained during 2018 from 16 of 17 municipal water wells in the Livermore Valley (Figure 4-48) and measured for tritium activity; well 16B1 was out of service and could not be sampled (LLNL 2019f). Fourteen wells were sampled in 2019 (LLNL 2020r).

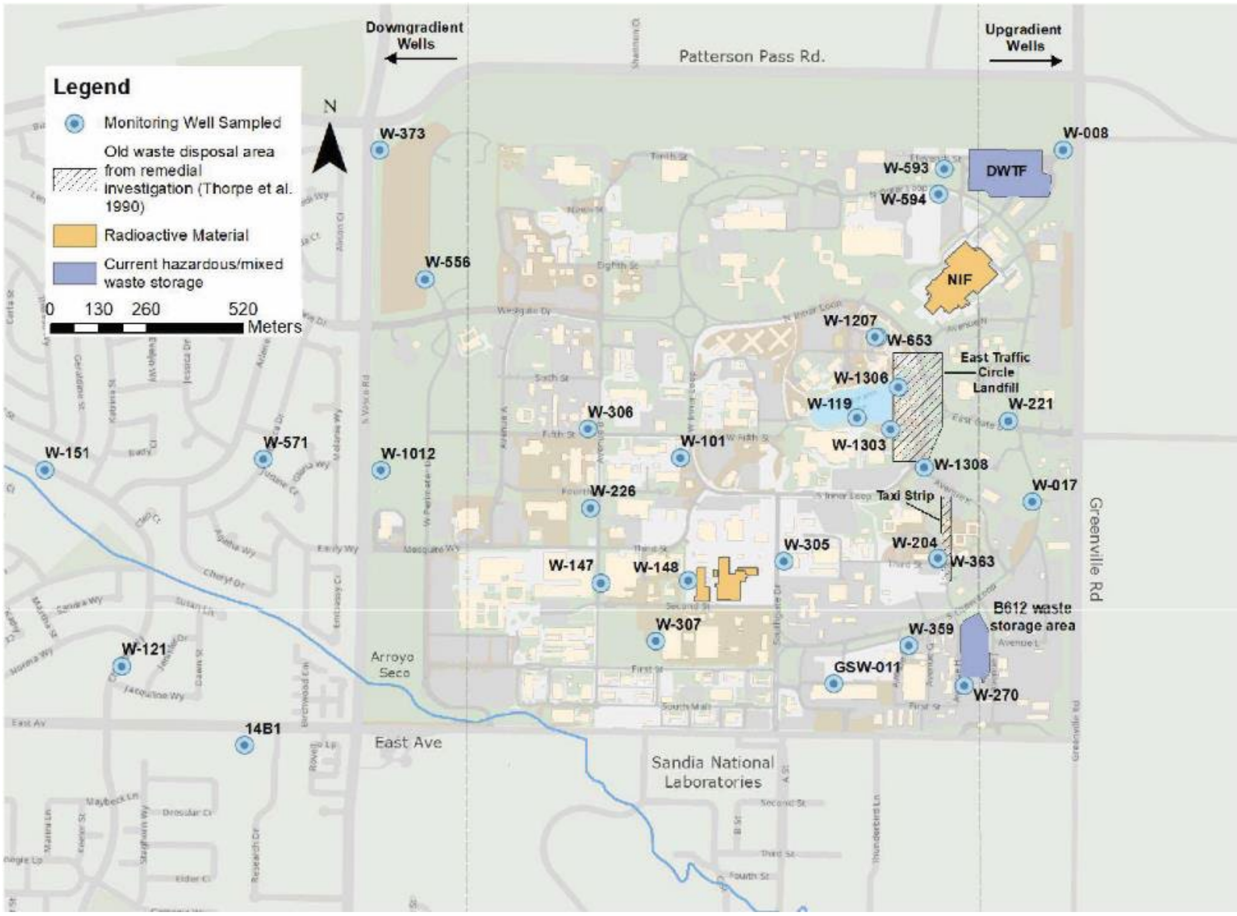


Source: LLNL 2020r.

Figure 4-48. Offsite Tritium Monitoring Wells in the Livermore Valley (2018 and 2019)

In 2018 and 2019, the tritium measurements continued to show low activities compared with the 20,000 pCi/L MCL established for drinking water in California. In 2018, the maximum tritium activity estimated off site was in the groundwater at well 12A2, located about 5.6 miles west of LLNL (Figure 4-48). The estimated activity at well 12A2 was less than 83.8 pCi/L in 2018, less than 0.5 percent of the MCL (LLNL 2019f). In 2019, the maximum tritium activity estimated off-site was in the groundwater at well 9M3, located about 8.7 miles west of LLNL. The estimated activity at well 9M3 was 29.7 pCi/L in 2019, less than 0.5 percent of the MCL (LLNL 2020r).

In addition, LLNL's groundwater surveillance monitoring program was designed to complement the Livermore Site GWP. The intent of the program is to monitor for potential groundwater contamination from LLNL operations. The perimeter portion of the surveillance groundwater monitoring network uses three upgradient (background) monitoring wells near the eastern boundary of the site and seven downgradient monitoring wells located near the western boundary (Figure 4-49).



Source: LLNL 2020r.

Figure 4-49. Routine Surveillance Groundwater Monitoring Wells

Historically, natural background levels of chromium (VI) had been detected above the MCL (50 µg/L) in groundwater samples from western perimeter well W-373; however, concentrations of this analyte first dropped below the MCL in 2002. The 2018 and 2019 samples from this location showed a concentration of 36 µg/L and 28 µg/L; a value consistent with the range of chromium (VI) concentrations (5 µg/L to 52 µg/L) detected at well W-373 since 2002. Groundwater samples collected in 2018 from nearby wells W-556 and W-1012, also along the western perimeter of the Livermore Site, showed chromium (VI) concentrations of 20 µg/L and 10 µg/L, respectively (LLNL 2019f, 2020r).

From 1996 through 2004, concentrations of nitrate detected in groundwater samples from downgradient well W-1012 were greater than the MCL of 45 mg/L. The nitrate concentrations detected in the 2018 and 2019 samples from this well (21 mg/L and 20 mg/L) were again, as in the past 12 years, below the MCL. During 2018 and 2019, concentrations of nitrate in the onsite shallow background well W-221 were 54 mg/L and 53 mg/L. During 2018 and 2019, detected concentrations of nitrate in western perimeter wells ranged from 14 mg/L (in well W-373) to 50 mg/L (in well W-151), a range consistent with results reported in previous years and consistent with natural background levels (LLNL 2019f, 2020r).

During 2018 and 2019, gross alpha, gross beta, and tritium were detected occasionally in the Livermore Site's perimeter wells at levels consistent with the results from recent years; however, the concentrations again were below drinking water MCLs (LLNL 2019f, 2020r).

Groundwater sampling locations within the Livermore Site include areas in which releases to the ground may have occurred in the recent past, where previously detected COCs have low concentrations that do not require CERCLA remedial action, and where baseline information needs to be gathered for the area near a new facility or operation. Wells selected for monitoring are screened in the uppermost aquifers and are downgradient from and as near as possible to the potential release locations (LLNL 2019f).

The Taxi Strip and East Traffic Circle Landfill areas (*see* Figure 4-49) are two potential sources of historical groundwater contamination. Samples from monitoring wells screened in HSU-2 (W-204) and HSU-3A (W-363) downgradient from the Taxi Strip area were analyzed in 2018 for copper, lead, zinc, and tritium. Samples from monitoring wells screened at least partially in HSU-2 (W-119, W-1207, W-1303, W-1306, and W-1308) within and downgradient from the East Traffic Circle Landfill were analyzed for the same elements as the Taxi Strip area. Concentrations of tritium remained well below the drinking water MCLs at all seven locations, and none of the trace metals (copper, lead, zinc) were detected in any of these seven monitoring wells during 2018 (LLNL 2019f). In 2019, tritium remained well below the drinking water MCLs at all seven locations, and zinc was the only metal detected in the seven monitoring wells (LLNL 2020r).

Near the NIF, LLNL measures pH, conductivity, and tritium concentration of nearby groundwater to establish a baseline. During 2018 and 2019, tritium analyses were conducted on groundwater samples collected from wells W-653 and W-1207 (screened in HSU-3A and HSU-2, respectively) downgradient of the NIF. Samples were also obtained downgradient from the DWTF from wells W-593 and W-594 (screened in HSU-3A and HSU-2, respectively) and were analyzed for tritium. Monitoring results from the wells near the NIF and DWTF showed no detectable concentrations of tritium, above the limit of sensitivity of the analytical method, in the groundwater samples collected during 2018 and 2019 (LLNL 2019f, 2020r).

The former storage area around Building 514 and the hazardous waste/mixed waste storage facilities around Building 612 are also potential sources of contamination. The area and facilities are monitored by wells W-270 and W-359 (both screened in HSU-5) and well GSW-011 (screened in HSU-3A). During 2018 and 2019, groundwater from these wells was sampled and analyzed for gross alpha, gross beta, and tritium. No significant contamination was detected in the groundwater samples collected downgradient from these areas in 2018 and 2019 (LLNL 2019f, 2020r).

Groundwater samples are obtained annually from monitoring well W-307 (screened in HSU-1B), downgradient from Building 322. Soil samples previously obtained from this area showed concentrations elevated above the Livermore Site's background levels for total chromium, copper, lead, nickel, zinc, and occasionally other metals. LLNL removed contaminated soils near Building 322 in 1999 and replaced them with clean fill. The area was then paved over, making it less likely that metals would migrate from the site. In 2018 and 2019, concentration of metals at well W-307 were within typical concentrations reported in recent years. The concentration of manganese in 2018 (which had shown some questionable fluctuations in 2012 and 2013) remained below the analytical reporting limit (LLNL 2019f, 2020r).

Groundwater samples were obtained downgradient from a location where sediments containing metals (including cadmium, chromium, copper, lead, mercury, and zinc) had accumulated in a stormwater catch basin near Building 253. In 2018 and 2019, the samples obtained from monitoring wells W-226 and W-306 (screened in HSU-1B and HSU-2, respectively) again contained dissolved chromium at concentrations above the analytical reporting limit, but these concentrations remained low and essentially unchanged from recent years (LLNL 2019f, 2020r).

Established in 1999, additional surveillance groundwater sampling locations are in areas surrounding the Plutonium Facility and Tritium Facility. Potential contaminants include plutonium and tritium from these facilities, respectively. Plutonium is much more likely to bind to the soil than migrate into the groundwater. Tritium, as HTO, can migrate into groundwater if spilled in sufficient quantities. Upgradient of these facilities, well W-305 is screened in HSU-2. Downgradient wells W-101, W-147, and W-148 are screened in HSU-1B; however, as in 2012–2017, well W-101 was dry and could not be sampled in 2018. In August 2000, elevated tritium activity was detected in the groundwater sampled at well W-148 (3100 ± 135 pCi/L). The activity was most likely related to local infiltration of stormwater containing elevated tritium activity. Tritium activities in groundwater in this area had remained at or near the same level through 2005, but samples collected from well W-148 in 2006–2019 have shown significantly lower values—a downward trend ranging from approximately one-fifth to one-half of the August 2000 value due to the natural decay and dispersion of tritium. LLNL continues to collect groundwater samples from these wells periodically for surveillance purposes, primarily to demonstrate that tritium concentrations remain below MCLs (LLNL 2020r).

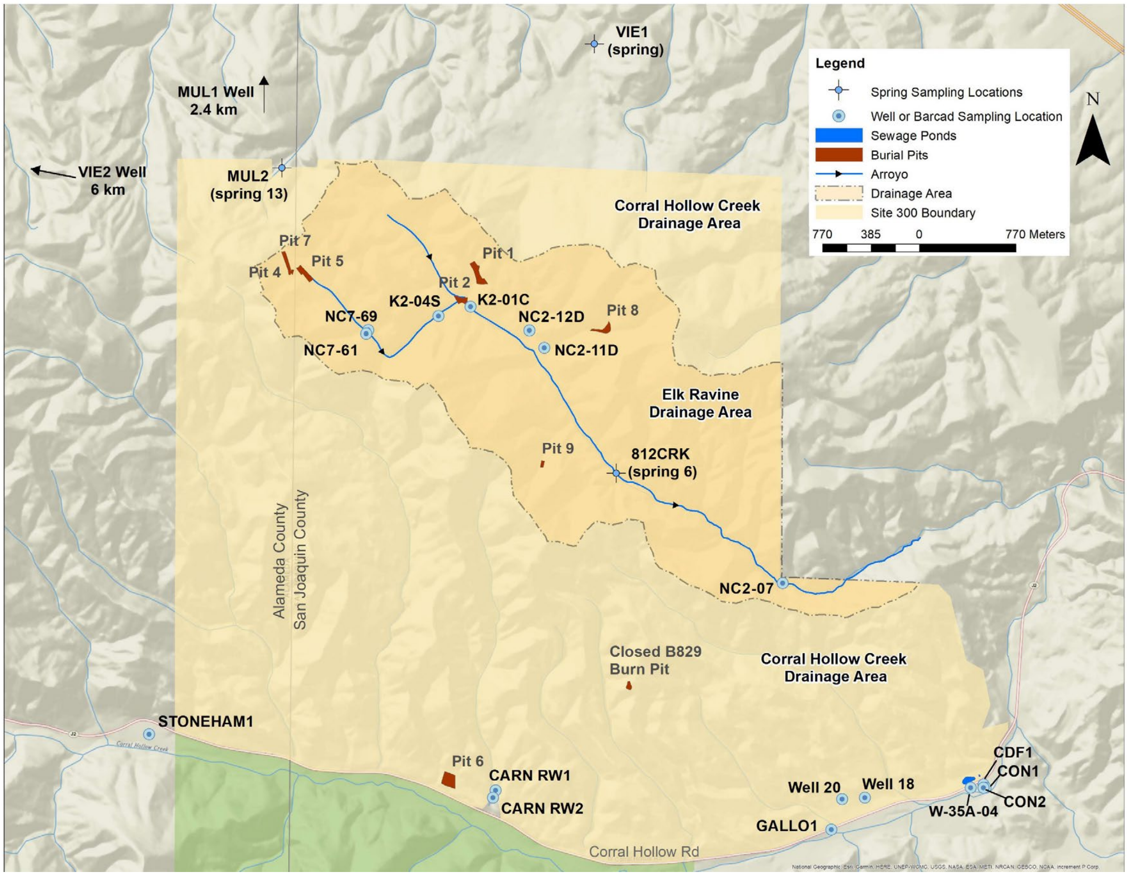
Site 300

LLNL conducts surveillance monitoring of groundwater for Site 300, through networks of wells and springs that include offsite private wells and onsite DOE CERCLA wells. However, it should be noted that a number of contaminants were released to the environment during past Site 300 operations, including from waste fluid disposed in dry wells, surface spills, piping leaks, buried explosive test debris in unlined pits and landfills, leaching of materials associated with explosive tests at firing tables, and discharge of rinse water to unlined lagoons. Environmental investigations at Site 300 began in 1981 and Site 300 was placed on the USEPA National Priorities List in 1990. As a result of these investigations, VOCs, high explosive (HE) compounds, tritium, depleted uranium, organosilicate oil, nitrate, perchlorate, polychlorinated biphenyls (PCBs), dioxins, furans, and metals were identified as COCs in soil, rock, groundwater, or surface water. This contamination is confined to within Site 300 boundaries, except for VOCs which are present in offsite monitoring wells near the southern Site 300 boundary. Cleanup activities begun at Site 300 are ongoing (LLNL 2020r, LLNL 2020aa). A discussion of groundwater cleanup and monitoring activities under CERCLA is presented in Section 4.15.

LLNL conducts detection and surveillance monitoring to supplement the CERCLA compliance monitoring in the CMP/CP and provide additional data to characterize potential impacts from

LLNL operations. Representative groundwater samples are obtained at least once per year at every monitoring location; groundwater samples are routinely measured for general physical and chemical parameters (pH, total dissolved solids/electrical conductivity, and principal anions and cations), metals, a wide range of volatile organic compounds, general radioactivity (gross alpha and gross beta), nitrate, perchlorate, high explosives compounds, uranium activity concentration, and tritium activity concentration. Groundwater from the shallowest water-bearing zone is the target of most of the monitoring because it would be the first to show contamination from LLNL operations at Site 300 (LLNL 2020r). The regional aquifers and any water-bearing zones that contain contaminants are also extensively monitored.

The Elk Ravine drainage area, a tributary to the Corral Hollow Creek drainage system, includes most of northern Site 300 (Figure 4-50). Stormwater runoff in the Elk Ravine drainage area collects in arroyos and quickly infiltrates into the ground. Groundwater from wells in the Elk Ravine drainage area is monitored for COCs to determine the impact of current LLNL operations on local groundwater. The area contains eight closed landfills, known as Pits 1 through 5 and 7 through 9, and firing tables where explosives tests are conducted. The only active outdoor firing table is at Building 851. None of these closed landfills have a liner, which is consistent with the disposal practices when the landfills were constructed (LLNL 2020r). The following descriptions of surveillance and detection monitoring networks within Elk Ravine are organized, in order, from the headwaters area in the northwest and proceed downstream (southeast). These surveillance data supplement the CERCLA monitoring of confirmed and potential chemical release sites in the area. They do not necessarily reflect the highest chemical concentrations defined in recent monitoring data for upgradient chemical release sites.



Source: LLNL 2020r.

Figure 4-50. Principal Channels of the Elk Ravine Drainage System Showing Selected Wells and Springs Used for Surveillance Monitoring

Pit 7 Complex. The Pit 7 landfill was closed in 1992 in accordance with the USEPA and California EPA Department of Health Services (now DTSC)-approved RCRA closure and post-closure plans using the LLNL CERCLA FFA process. From 1993 to 2009, monitoring requirements were specified in Waste Discharge Requirement (WDR) 93-100, administered by the CVRWQCB, and in Site 300 RCRA closure and post-closure plans for Landfill Pits 1 and 7. An amendment to the interim record of decision for the Pit 7 Complex was signed in 2007 under CERCLA. The remedial actions specified in the interim record of decision—including a hydraulic drainage diversion system, extraction and treatment of groundwater, and monitored natural attenuation for tritium in groundwater—were implemented in 2008. In 2010, detection monitoring and reporting for the Pit 7 Complex was transferred to CERCLA. Analytes and frequencies of sampling are documented in the CERCLA CMP/CP for Site 300. The objective of this monitoring continues to be the early detection of any new release of COCs from Pit 7 to groundwater (LLNL 2019f).

For compliance purposes, during 2018 and 2019 (and continuing every year), LLNL obtained annual or more frequent groundwater samples from the Pit 7 detection monitoring well network. Samples were analyzed for tritium, VOCs, fluoride, HE compounds, nitrate, perchlorate, uranium (isotopes or total), metals, lithium, and PCBs. A detailed account of Pit 7 compliance monitoring conducted during 2018, including well locations, maps of the distribution of COCs in groundwater, and analytical data tables, is summarized in the CERCLA Site 300 annual compliance monitoring report (CMR) (LLNL 2020aa), that the LLNL Environmental Restoration Department submitted to the regulatory agencies.

During 2019, tritium activity concentrations in routine and duplicate groundwater samples collected from the Pit 7 Complex detection monitor well K7-03 exceeded the 20,000 pCi/L MCL cleanup standard, with a maximum activity concentration of 42,800 pCi/L (May), a decrease from the 2018 maximum of 47,600 pCi/L. K7-01 exhibited a minor increase from 15,300 pCi/L in 2018 to 18,600 pCi/L (November) in 2019. Overall, tritium activity concentrations in the Pit 7 Complex detection monitoring wells have remained stable. None of the Pit 7 detection monitoring wells exhibited uranium activity concentrations above the 20 pCi/L MCL cleanup standard. Groundwater samples collected in 2019 from the Pit 7 Complex detection monitoring wells K7-01 and NC7-47 exceeded the 45 mg/L MCL cleanup standard, at concentrations of 51 mg/L (April) and 63 mg/L (November), respectively. Groundwater samples from well NC7-47 have never contained any other COCs in excess of background concentrations. Overall, nitrate concentrations in the detection monitoring wells have remained stable since 2017. In 2019, only K7-01 contained perchlorate above the reporting limit of 7 µg/L (April). Overall, nitrate concentrations in the detection monitoring wells have remained stable or declined since 2017. During 2019, VOCs were detected in samples from a single detection monitoring well at concentrations above reporting limits. Monitoring well K7-03 exhibited 1.3 µg/L of TCE (May) in groundwater; no other VOCs were detected in the Pit 7 Complex detection monitoring wells. The historical maximum VOC concentration in samples from monitoring well K7-03 was 15.2 µg/L (1985), composed of 8.7 TCE, 0.8 PCE, 1.2 1,1,1-TCA, and 4.5 µg/L 1,2-DCE. VOC concentrations have generally been declining in samples from these wells since these 1985 maxima. During 2019, Title 22 metals (antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, mercury, molybdenum, nickel, selenium, silver, thallium, vanadium, and zinc) and lithium were not detected in groundwater samples from the Pit 7 Complex Area detection monitoring wells at concentrations in excess of background. During 2019, HE compounds were not detected in groundwater samples from the Pit 7 Complex Area detection monitoring wells at concentrations in excess of individual compound detection limits of 1 to 2.5 µg/L. During 2019, PCB compounds were not detected in groundwater samples from the Pit 7 Complex Area detection monitoring wells at concentrations in excess of the individual compound detection limits of approximately 0.5 µg/L. The 2019 data are not indicative of a release of any of the detection monitoring constituents from any of the landfills or underlying vadose zone during the reporting period (LLNL 2020aa).

Elk Ravine. Groundwater samples were obtained on various dates in 2018 and 2019 from the widespread Elk Ravine surveillance monitoring network (NC2-07, NC2-11D, NC2-12D, NC7-61, NC7-69, 812CRK [SPRING6], K2-04S, K2-01C) (*see* Figure 4-50). Monitoring at well K2-04D ceased in 2014 due to a pump becoming stuck in the well, and LLNL has since decommissioned well K2-04D and is using another well as a replacement. Samples from NC2-07 were analyzed for inorganic constituents (mostly metals), general radioactivity (gross alpha and beta), tritium and uranium activity/concentration, and HE compounds (cyclotetramethylenetetranitramine [HMX] and hexahydro-1,3,5-trinitro-1,3,5-triazine [RDX]). Samples from the remaining wells were analyzed only for general radioactivity (LLNL 2019f, 2020r). HMX and RDX were not detected at well NC2-07 in 2018 and 2019.

The chemical and radioactivity data obtained during 2018 and 2019 indicated no new release of COCs to the groundwater from LLNL operations in Elk Ravine. The major source of contaminated groundwater beneath Elk Ravine is from historical operations in the Building 850 firing table area (LLNL 2019f, 2020r).

The tritium activity for well NC7-61 was 470 ± 91 Bq/L (12,704 ±2,460 pCi/L)in 2018, compared to the higher value of 580 ±110 Bq/L (15,677 ±2,973 pCi/L) in 2017. The tritium activity for well NC7-61 was 530 ±100 Bq/L (14,326 ±2,703 pCi/L) in 2019. This tritium activity remains elevated with respect to the background concentrations. Tritium, as HTO, has been released in the past in the vicinity of Building 850. The majority of the Elk Ravine surveillance-network tritium measurements made during 2018 and 2019 support earlier CERCLA studies showing that the tritium in the plume is diminishing over time because of natural decay, and dispersion CERCLA modeling studies indicate that the tritium will decay to background levels before it can reach a site boundary (LLNL 2019f, 2020r).

Groundwater surveillance measurements of gross alpha, gross beta, and uranium radioactivity in Elk Ravine are low and are indistinguishable from background levels. Additional detections of nonradioactive elements, including arsenic, barium, chromium, selenium, and vanadium, are all within the natural ranges of concentrations typical of groundwater elsewhere in the Altamont Hills (LLNL 2019f, 2020r).

Pit 1. The Pit 1 landfill was closed in 1993 in accordance with a DTSC-approved RCRA closure and post-closure plan using the LLNL CERCLA FFA process. Monitoring requirements are specified in WDR 93-100, which is administered by the CVRWQCB (1993, 1998, and 2010). The main objective of this monitoring is the early detection of any release of COCs from Pit 1 to groundwater. LLNL obtained groundwater samples quarterly during 2018 from the Pit 1 monitoring well network. Samples were analyzed for inorganic COCs (mostly metallic elements), general radioactivity (gross alpha and beta), activity of certain radioisotopes (tritium, radium, uranium, and thorium), explosive compounds (HMX and RDX), and VOCs. Additional annual analyses were conducted on groundwater samples for extractable organics, pesticides, and PCBs. Compliance monitoring showed no new releases at Pit 1 in 2018 and 2019 (LLNL 2019f, 2020r); a detailed account of Pit 1 compliance monitoring during 2018, including well locations and tables and graphs of groundwater COC analytical data, can be found in the CERCLA Site 300 annual CMR (LLNL 2020aa). In 2020, the CVRWQCB issued a letter rescinding the Pit 1 monitoring under WDR 93-100 and transferring the monitoring to CERCLA (CVRWQCB 2020).

Pit 6. Two Pit 6 groundwater monitoring programs, which operate under CERCLA, ensure compliance with all regulations. They are (1) the Detection Monitoring Plan (Dibley et al. 2009), designed to detect any new release of COCs to groundwater from wastes buried in the Pit 6 landfill, and (2) the Corrective Action Monitoring Plan (MacQueen et al. 2013), which monitors the movement and fate of historical releases. To comply with monitoring requirements, LLNL collected groundwater samples monthly, quarterly, semiannually, and annually during 2018 and 2019 from specified Pit 6 monitoring wells. Groundwater wells were analyzed for VOCs, tritium, beryllium, mercury, total uranium, gross alpha/beta, perchlorate, and nitrate (LLNL 2019f, 2020r).

During 2018 and 2019, no new contaminant releases from Pit 6 were detected. A detailed account of Pit 6 compliance monitoring conducted during 2018, including well locations, tables of groundwater analytical data, and maps showing the distribution of COC plumes, is summarized in the Site 300 annual CMR (LLNL 2020aa).

In 2019, the January, April, July, and December samples from well EP6-08 contained small concentrations of four VOCs, all below MCLs except for PCE, which was detected at 6.2 µg/L in January. Except for well K6-19, tritium activity concentrations in all detection monitoring wells were below reporting limits (<100 pCi/L). Total uranium was detected at 15.92 pCi/L (January) then declined slightly to 11.39 pCi/L (March) to 9.71 pCi/L (July) to 10.1 pCi/L (December). None of these activity concentrations exceeded the 20 pCi/L MCL (LLNL 2020aa).

Building 829 Closed High Explosives Burn Facility. As planned for compliance purposes, LLNL obtained groundwater samples during 2018 from the three wells in the Building 829 monitoring network. Groundwater samples from these wells, screened in the deep regional aquifer, were analyzed for inorganics (mostly metals), turbidity, high explosive compounds (HMX, RDX, and trinitrotoluene), VOCs, extractable organics, and general radioactivity (gross alpha and gross beta).

In 2018 and 2019, no organic or explosive COCs were detected above reporting limits in any samples. All results for the radioactive COCs (gross alpha and gross beta) were below their statistical limit values (LLNL 2019c, 2020r). Statistical limit values represent the threshold below which the result is considered within the range of background concentration and not indicative of a new release, as calculated from onsite baseline datasets.

During 2018, the only COC detections above their respective statistical limits were manganese and zinc detected in well W-829-22 and zinc detected in well W-829-15; however, LLNL concluded that these detections were not evidence of release from the closed burn pit. The zinc data for the routine sample and two independent retests were inconclusive due to zinc being present in the field blanks during all three sampling events. For the manganese detected at well W-829-22, one of the two independent retests exceeded the statistical limit for manganese, which validated the initial detection of manganese. However, given the natural presence of manganese in the deep regional aquifer beneath the B-829 Facility, as well as the history of W-829-22 showing no previous detections of this constituent, LLNL concluded that the detection of manganese is from naturally occurring sources and not evidence of a release from the closed burn pit (LLNL 2019f). During 2019, the only COC detections above their respective statistical limits were manganese detected in wells W-829-15 and W-829-22 and barium detected in well W-829-1938; however, LLNL concluded that these detections were not evidence of release from the closed burn pit (LLNL 2020r). LLNL will continue annual monitoring of zinc and manganese.

Among the inorganic constituents, perchlorate was not detected above its reporting limit in any sample in 2018 and 2019. The metal concentrations are not significantly different from background concentrations for the deep aquifer beneath the High Explosives Process Area. The 2019 manganese detections at wells W-829-15 and W-829-22 are likely the result of local background variability and not an actual manganese release from the B829 burn pit. For barium detected at well W-829-1938, one of the two independent retests exceeded the SL, which validated the initial detection of barium. However, the concentrations are within the range of local background variability and therefore LLNL has concluded that the exceedances do not indicate an actual barium release from the B829 burn pit (LLNL 2020r). LLNL will continue to track these results as additional data become available.

Water Supply Well. Water supply well 20, located in the southeastern part of Site 300 (*see* Figure 4-50), is a deep, high-production well now used as a backup water supply. The well is screened in the Neroly lower sandstone aquifer and can produce potable water at a rate of up to 396 gallons per minute. As planned for surveillance purposes, LLNL obtained groundwater samples quarterly during 2019 from well 20. Groundwater samples were analyzed for inorganic COCs (mostly metals), high explosives compounds (HMX and RDX), general radioactivity (gross alpha and gross beta), and tritium activity. Quarterly measurements of groundwater from well 20 do not differ significantly from previous years. As in past years, the primary potable water supply well at Site 300 showed no evidence of contamination. High explosive compounds were not detected over reporting limits and gross alpha, gross beta, and tritium activities were low and indistinguishable from background activity/concentrations (LLNL 2019f). In 2019, LLNL determined that surveillance monitoring for well 20 was no longer necessary because the well is sampled and analyzed for COCs under a monitoring program defined in Domestic Water Supply Permit Amendment No. 01-10-16PA-003.

Offsite Surveillance Wells and Springs

As planned for surveillance purposes, during 2018 and 2019, LLNL obtained groundwater samples from two offsite springs (MUL2 and VIE1) and ten offsite wells (MUL1, VIE2, CARNRW1, CARNRW2, CDF1, CON1, CON2, GALLO1, STONEHAM1, and W35A-04) (*see* Figure 4-50). VIE1, an offsite spring that is sampled for surveillance purposes, was dry in 2018 but was sampled in 2019. Except for one well, all offsite monitoring locations are near Site 300. The exception, well VIE2, is located at a private residence 6 kilometers west of the site. It represents a typical potable water supply well in the Altamont Hills (LLNL2019f, 2020r). One stock watering well (MUL1) and two stock watering springs (MUL2 and VIE1) are adjacent to the site on the north. Eight wells—CARNRW1, CARNRW2, CDF1, CON1, CON2, GALLO1, STONEHAM1, and W35A-04—are adjacent to the site on the south (LLNL 2019b). Seven of these wells are privately owned and were constructed to supply water for drinking, stockwatering, and fire suppression. Well W35A-04 was installed for site monitoring purposes only (LLNL 2003a).

In 2018 and 2019, samples from CARNRW2 and GALLO1 were analyzed at least quarterly for inorganic constituents (mostly metals), general radioactivity (gross alpha and beta), tritium activity, HE compounds (HMX and RDX), and VOCs. Additional annual analyses were conducted for uranium activity and extractable organic compounds for samples collected from CARNRW2 only. In addition, CARNRW1 and CON2 samples were analyzed for VOCs; samples from well CARNRW1 were also sampled for perchlorate and tritium (LLNL 2019f, 2020r).

Groundwater samples were obtained once (annually) during 2018 and 2019 from the remaining offsite surveillance monitoring locations: MUL1, MUL2, and VIE1 (north of Site 300); VIE2 (west of Site 300); and STONEHAM1, CON1, CDF1, and W-35A-04 (south of Site 300). Samples were analyzed for inorganic constituents (metals, nitrate, and perchlorate), general radioactivity (gross alpha and gross beta), tritium and uranium activity, HE compounds (HMX and RDX), VOCs, and extractable organic compounds.

Generally, no constituents attributable to LLNL operations at Site 300 were detected in the offsite surveillance groundwater samples in 2018 and 2019. Radioactivity measurements in samples collected from offsite groundwater wells are generally indistinguishable from naturally occurring activities (LLNL 2019f, 2020r). However, CERCLA monitoring of groundwater downgradient of the Site 300 GSA identified contamination in offsite wells.

4.5.4 Floodplains

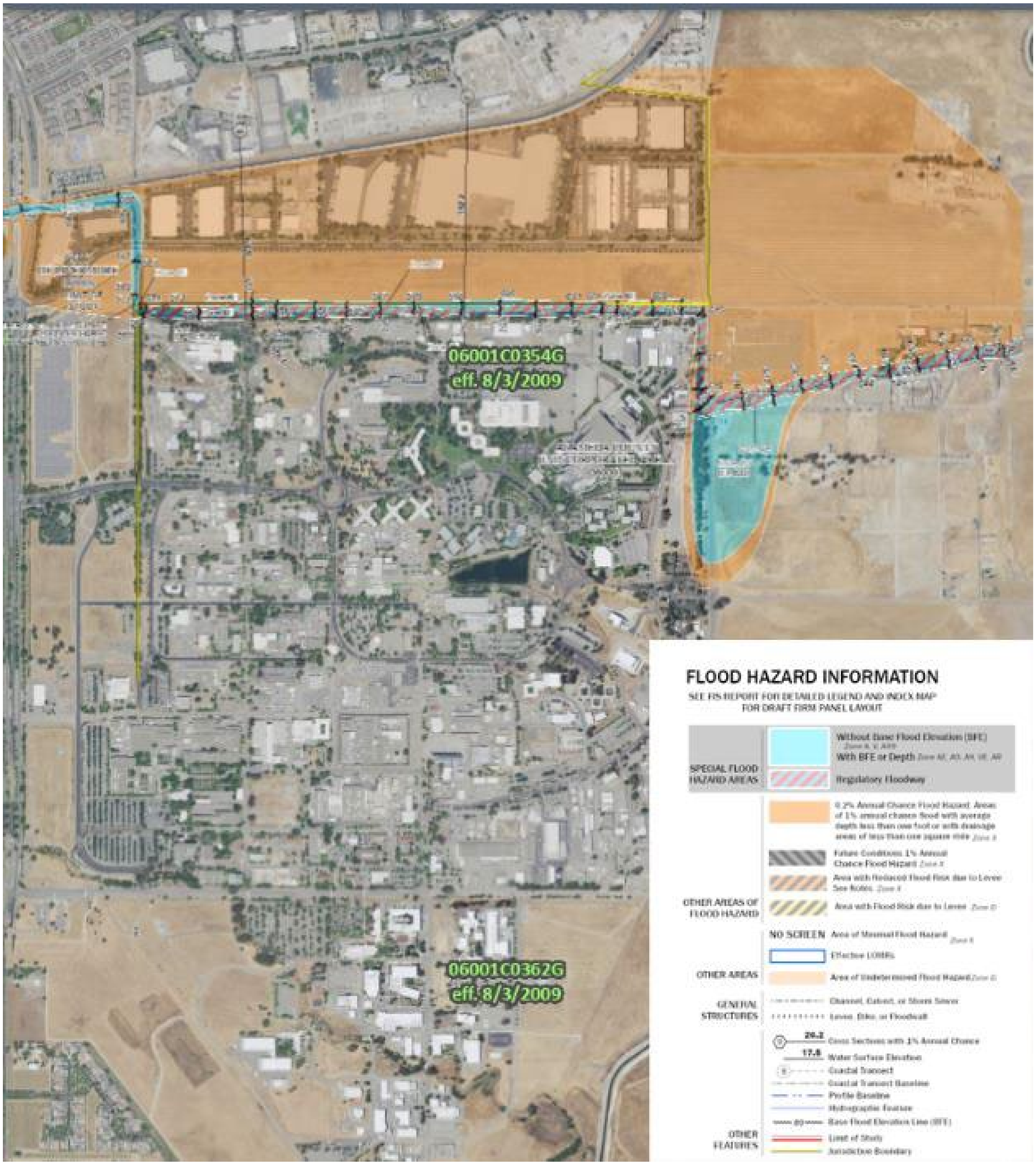
4.5.4.1 Livermore Site

A floodplain is defined as the valley floor adjacent to a streambed or arroyo channel that may be inundated during high water. Arroyo Las Positas and Arroyo Seco are the only potential sources of flooding on the Livermore Site. Localized flooding is most likely to occur during the rainy season from October to April. At the site, open ditches and storm drains are designed for a 10-year storm event. Most of the Livermore Site ultimately drains to the north into Arroyo Las Positas, and a small percentage of land in the southwest corner drains southward to Arroyo Seco.

The original course of Arroyo Las Positas was through what is now the Livermore Site. In the 1940s, the U.S. Navy diverted the arroyo to its current location. It now approaches the Livermore Site from the east, runs north along the eastern boundary of the Livermore Site for approximately 1,000 feet, then turns west and flows adjacent to the northern boundary of the Livermore Site until it exits the site in the far northwest corner.

The Federal Emergency Management Agency (FEMA) performed flood insurance studies to determine flood hazards in Alameda County and to identify the approximate limits of the 100-year floodplain (FEMA 2020). These floodplains were incorporated into Flood Insurance Rate Maps (FEMA 2020). The 100-year and 500-year floodplains for the Livermore Site are presented in Figure 4-51.

Arroyo Las Positas is an intermittent stream that drains approximately 3,300 acres in the northeastern and eastern hills above the Livermore Site. Flow has increased in the arroyo over the past several years downstream of the outfall of Lake Haussmann, due to discharge of treated groundwater as part of the Livermore Site CERCLA process. This arroyo has a maximum predicted 100-year base flood peak flow adjacent to the Livermore Site of 822 cubic feet per second (DOE 1992a). The 100-year floodplain broadens as it approaches the Livermore Site from the east, from 100 feet wide to approximately 800 feet wide, covering Greenville Road along the northeastern boundary of the Livermore Site. The spreading is due to the shallow channel that cannot contain the 100-year flood. As the arroyo flows westward along the northern boundary of the Livermore Site and approaches the northwest corner of the site, the 100-year flood flow exceeds the channel banks to a width of approximately 120 feet. Storm flow within the northern perimeter channel combines with the western area drainage at the northwest corner of the site. The flow is conveyed to the north, beyond the site, within a drainage easement (the north buffer zone) managed and maintained by LLNL. The 500-year floodplain extends approximately 2,000 feet to the north and is generally bounded by the Union Pacific Railroad right of way (Figure 4-51).



Source: FEMA 2020.

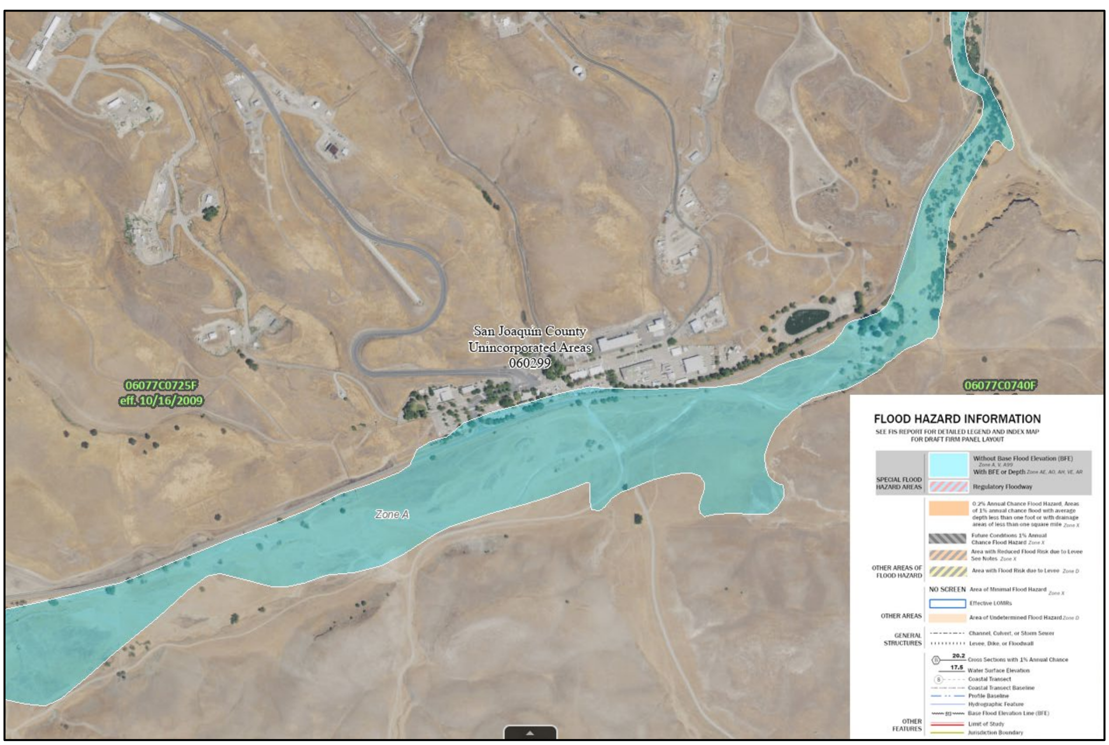
Figure 4-51. 100- and 500-Year Floodplains at the Livermore Site

The Arroyo Las Positas Management Project has been implemented annually from 2000 through 2006 and from 2014 to the present to protect the Livermore Site from the 100-year flood by ensuring that the arroyo would be capable of handling a 10-year storm event and using the north buffer zone as a floodplain for storm events exceeding the capacity of the arroyo. The DOE has consulted with the U.S. Fish and Wildlife Service regarding this project, and the SFBRWQCB has annual oversight of this project. A two-foot-high berm was constructed along portions of the southern bank of the arroyo to ensure that the 100-year flood event would not inundate the Livermore Site. Maintenance activities undertaken to ensure that the channel can handle the 10-year storm event included a phased project to desilt portions of the arroyo on LLNL property, remove vegetation that impedes flow, and conduct bank stabilization/erosion control activities (LLNL 2006a).

Arroyo Seco is an intermittent stream that drains approximately 8,960 acres in the foothills to the southeast of the Livermore Site. In 2005, an extensive erosion control and restoration project was completed in the LLNL reach of Arroyo Seco. This project included measures to repair existing erosion damage, prevent future erosion, and restore the stream banks to a more natural topography. The channel was narrow and deeply incised where it is present for about 900 linear feet in the far southwest corner of the Livermore Site (LLNL 2011b). The 100-year flood event is contained within the channel at the Livermore Site (FEMA 2020).

4.5.4.2 Site 300

FEMA flood mapping indicates that the 100-year floodplain for Corral Hollow Creek overlaps with the southern boundary of the GSA, which is currently used for vehicle parking (FEMA 2020) (Figure 4-52). Elsewhere on Site 300, the land is undeveloped and characterized by steep hills and ravines. There are no floodplains because the 100-year flood event would be contained within the drainage channels. However, due to the steep slopes and high runoff potential, velocities within these channels could be high during a peak flood event.



Source: FEMA 2020.

Figure 4-52. 100-Year Floodplain for Corral Hollow Creek at Site 300 near the GSA

4.6 AIR QUALITY

Air pollution is the presence in the atmosphere of one or more contaminants (e.g., dust, fumes, gas, mist, odor, smoke, vapor) that are harmful to humans, plants, or animal life. Air quality as a resource incorporates several components that describe the levels of overall air pollution within a region, sources of air emissions, and regulations governing air emissions. The following sections discuss the criteria pollutants and attainment status, regulations, climate and greenhouse gases (GHGs), and radiological air emissions.

4.6.1 Criteria Pollutant and Attainment Status

USEPA Region 9 and the California Air Resources Board (CARB) regulate air quality in California. CARB has delegated the authority to administer both federal and state air programs to the Bay Area Air Quality Management District (BAAQMD) for Alameda County, including the Livermore Site and part of Site 300, and the San Joaquin Valley Air Pollution Control District (SJVAPCD) for San Joaquin County and most of Site 300. With regard to conformity to state implementation plans, *see* Section 4.6.2.3.

The *Clean Air Act* (CAA) (42 U.S.C. 7401–7671q), as amended, assigns USEPA the responsibility to establish primary and secondary National Ambient Air Quality Standards (NAAQS) (40 CFR Part 50) that specify acceptable concentration levels of six criteria pollutants: particulate matter (measured as both particulate matter less than 10 microns in diameter [PM_{10}] and particulate matter less than 2.5 microns in diameter [$PM_{2.5}$]), sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), and lead (Table 4-6). Short-term NAAQS (1-, 8-, and 24-hour periods) have been established for pollutants contributing to acute health effects, while long-term NAAQS (annual averages) have been established for pollutants contributing to chronic health effects.

Table 4-6. National and California Ambient Air Quality Standards

Pollutant	Air Quality Standard		
	NAAQS	CAAQS	Averaging Period
CO			
1-hour (ppm)	35	20	Not to be exceeded more than once per year
8-hour (ppm)	9	9	
NO_2			
1-hour (ppb)	100	180	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
O_3			
1-hour (ppm)	No Standard	0.09	3-year average of the fourth highest daily maximum
8-hour (ppm)	0.07	0.07	
SO_2			
1-hour (ppm)	75	250	98th percentile, averaged over 3 years
3-hour (ppb)	0.5	No Standard	Not to be exceeded more than once per year
24-hour (ppb)	No Standard	40	Not to be exceeded more than once per year
$PM_{2.5}$			
24-hour (µg/m^3)	35	No Standard	98th percentile, averaged over 3 years
Annual mean (µg/m^3)	12	12	Averaged over 3 years
PM_{10}			
24-hour (µg/m^3)	150	50	Not to be exceeded more than once per year over 3 years

Pollutant	Air Quality Standard		
	NAAQS	CAAQS	Averaging Period
Annual mean (µg/m^3)	No Standard	20	Not to be exceeded more than once per year over 3 years
Lead			
Rolling 3-month average (µg/m^3)	0.15	No Standard	Not to be exceeded

µg/m^3 = micrograms per cubic meter; CAAQS = California Air Quality Standards; CO = carbon monoxide; NAAQS = National Ambient Air Quality Standards; NO_2 = nitrogen dioxide; O^3 = ozone; PM*n* = particulate matter less than or equal to *n* microns in aerodynamic diameter; ppb = parts per billion; ppm = parts per million; SO_2 = sulfur dioxide
Note: California also has CAAQS for visibility reducing particles, sulfates, hydrogen sulfide, and vinyl chloride.
Source: CARB 2020.

California has adopted the stricter California Ambient Air Quality Standards (CAAQS). In addition, California also maintains air quality standards for visibility-reducing particles, sulfates, hydrogen sulfide, and vinyl chloride (CARB 2020).

Federal regulations designate Air Quality Control Regions (AQCRs) in violation of the NAAQS as nonattainment areas and AQCRs with levels below the NAAQS as attainment areas. Maintenance areas are AQCRs that have previously been designated as nonattainment, but have been re-designated to attainment for a probationary period through implementation of maintenance plans. Alameda County, including the Livermore Site, is within the San Francisco Bay Area Intrastate AQCR, and San Joaquin County and Site 300 are within the San Joaquin Valley Intrastate AQCR (40 CFR 81.21 and 40 CFR 81.165). The USEPA has designated Alameda County as a marginal nonattainment area for the 8-hour ozone NAAQS, a moderate nonattainment area for the 2006 $PM_{2.5}$ NAAQS, and an attainment area for all other criteria pollutants (USEPA 2020). The USEPA has designated San Joaquin County as an extreme nonattainment area for the 2008 and 2015 8-hour ozone NAAQS, a serious nonattainment area for the 1997 and 2006 $PM_{2.5}$ NAAQS, a moderate nonattainment area for the 2012 $PM_{2.5}$ NAAQS, a maintenance area for the 1987 PM_{10} NAAQS, and an attainment area for all other criteria pollutants (USEPA 2020).

4.6.2 Air Permitting and Regulatory Review

Air permitting is required for industries and facilities that emit regulated pollutants authorizing building and operating of stationary sources of emissions. BAAQMD issues air permits for sources at the Livermore Site and parts of Site 300, and SJVAPCD issues air permits for sources at Site 300. The permitting process begins with the application for an authority-to-construct permit (a pre-construction permit outlining construction, pre-operations and start-up requirements), followed by a permit to operate (a post-construction permit allowing the holder to operate all equipment or activities listed on the permit).

Each project with stationary sources of emissions is evaluated to ensure air permitting requirements are met. This evaluation is based on the manufacture date, size, material throughput, and amount and type of pollutants emitted. In addition, excavation activities, underground storage tank removal, and prescribed burning require notification to the air district prior to the start of operation. Depending on the size and type of air emissions source, the pre-construction permitting requirements may include the following:

- Best Available Control Technology review for qualifying criteria pollutants
- Lowest Achievable Emissions Rate review for qualifying nonattainment pollutants

- Maximum Achievable Control Technology review for hazardous air pollutants
- Predictive air dispersion modeling
- Acquiring emissions offsets for emissions increases
- A public involvement process

In addition, the Livermore Site holds a synthetic minor operating permit, which limits the Livermore Site actual annual emissions to levels beneath the major source thresholds by including federally enforceable limitations in its permit (40 CFR 52.21). These limitations are implemented via specific practices according to material type and process. Primary stationary sources of air emissions at the Livermore Site and Site 300 include:

- Internal combustion engines/generators greater than 50 horsepower
- Boilers and steam generators
- Mixing, blending, or processing of any organic solvents, adhesives, or coatings
- Operations creating dust or smoke or involving incineration of any material
- Metal reclamation or refining of any liquids or solids
- Storage or use of solvents or motor fuels (except diesel)
- Operations involving chemical reactions
- Use of solvents for cleanup (wipe cleaning)

As discussed in Chapter 1, Section 1.5.1, in January 2018, NNSA prepared an EA (NNSA 2018a) to evaluate the potential environmental consequences of the Proposed Action to increase the explosives weight for outdoor explosives tests (otherwise known as open detonations) at Site 300. The increase in detonation size has not yet been implemented at Building 851 during the writing of this SWEIS.

Permit requirements include periodic inventories of all significant stationary sources of air emissions for each of the criteria pollutants. Table 4-7 lists the existing and historical facility-wide air emissions from all significant stationary sources at the Livermore Site and Site 300. Emissions levels have both declined over time and remained relatively low at both sites from 2005 to 2019-2020.

Table 4-7. Annual Emissions for the Livermore Site and Site 300

Pollutant	Annual Emissions (tons per year)					
	Livermore Site			Site 300		
	2019	5-Year Maximum	5-Year Average	2019	5-Year Maximum	5-Year Average
Carbon monoxide	16.3	17.4	16.9	0.1	0.3	0.2
Nitrogen oxides	14.2	15.1	14.6	0.3	1.4	0.9
Fine particulate matter (PM_{10}/$PM_{2.5}$)	1.8	1.9	1.8	0.1	0.2	0.2
Sulfur dioxide	0.7	0.8	0.7	0.0	0.1	0.0
Volatile organic compounds	6.9	6.9	6.1	0.1	0.1	0.1

PM_n = particulate matter less than *n* microns in diameter.
Source: LLNL 2019k, LLNL 2021d.

In addition to the permitting requirements to construct and operate new or modified emissions sources, numerous other regulations, plans, and programs apply to activities at the Livermore Site and Site 300, including:

- **New Source Performance Standards –** New Source Performance Standards dictate the level of pollution that a new stationary source may produce. These standards are authorized by Section 111 of the CAA, and the regulations are published in 40 CFR Part 60. New Source Performance Standards have been established for a number of individual industrial or source categories such as boilers and generators.

- **National Emission Standards for Hazardous Air Pollutants (NESHAPs)** – NESHAPs (40 CFR Part 61) are the federal standards that apply to the emissions of hazardous air pollutants. Hazardous air pollutants are those that cause cancer, serious health effects, or adverse environmental effects.

- **Air Emissions Offsets Management Plan –** Governs LLNL's management of air emissions to keep them below the BAAQMD pollutant-specific threshold of 10 tons per year for nitrogen oxides and VOCs and 100 tons per year for particulate matter and sulfur oxides and the SJVAPCD pollutant-specific threshold of 10 tons per year for Nitrogen Oxides and VOCs.

- **Integrated Air Pollution Prevention Programs** – Several pollution prevention efforts at the Livermore Site benefit air resources, including transportation demand management, reduced precursor organic solvent use and recycling programs, energy conservation, and programs to reduce the use of ozone-depleting substances.

These regulations, plans, and programs are specifically designed to meet or exceed the intent of the *California Clean Air Act*, provide for timely permitting of new projects, and avoid the necessity for additional permitting associated with major source programs.

4.6.2.1 *Hazardous Air Pollutants*

The CAA requires the USEPA to regulate hazardous air pollutants (HAPs) which include more than 200 compounds known to cause cancer and other serious health effects. The National Emission Standards for Hazardous Air Pollutants (NESHAPs) are the federal standards that apply to the emissions of HAPs. In particular, beryllium (metal, alloys, and compounds) used at the Livermore Site are governed by NESHAP requirements (40 CFR Part 61, Subpart C). HAPs emissions rates at both LLNL sites are less than 10 tons per year for a single hazardous air pollutant, or 25 tons per year for a combination of hazardous air pollutants which are the major source thresholds under NESHAPs (LLNL 2020t). The Livermore Site's air operating permit limits emissions for a single HAP to less than 9 tons per year, or 23 tons per year for all HAPs combined (BAAQMD 2019). Although, LLNL is not a major facility in terms of HAPs emissions rates, specific NESHAPs programs apply for beryllium (discussed in Radiological Air Quality below).

4.6.2.2 *Toxic Air Contaminants*

Programs regulating toxic air contaminants differ from those regulating criteria air pollutants. Rather than establishing standards, regulating air toxics is based on managing risk (i.e., a probability of harm), which can be determined for any air toxicant based on its toxicity, airborne concentration, and exposure rate. The California Office of Environmental Health Hazard Assessment classifies and determines the toxicity for both carcinogenic and noncarcinogenic air toxics.

LLNL compiles an inventory of toxic air contaminants under the California Air Toxics "Hot Spots" program. Of the more than 300 listed chemicals, only a few are emitted from LLNL processes at levels exceeding the *de minimis* reporting thresholds. Air districts monitor toxic air contaminant levels and use the data to estimate background risk. The BAAQMD monitors a number of air contaminants throughout the Bay Area and has compiled a composite cancer risk for exposure to air toxics. On the basis of the air toxics inventories, BAAQMD and SJVAPCD have ranked LLNL as a low-risk facility for nonradiological air emissions (CARB 2018). The Livermore Site does not currently have a reporting requirement under the California Air Toxics "Hot Spots" Program, while Site 300 is currently preparing a plan to meet SJVAPCD's request.

4.6.2.3 *General Conformity*

To implement Section 176(c) of the CAA and to ensure the federal government does not interfere with a state's timely attainment of the NAAQS, the USEPA promulgated the general conformity rules (GCR). The GCR require federal agencies to fully offset all direct and indirect emissions from their actions in nonattainment areas for which the total emissions exceed *de minimis* (of minimal importance) thresholds outlined in the regulation. This includes both direct emissions and indirect emissions over which the federal agency has some control (40 CFR 93.153). The GCR are not applicable to certain federal actions, such as those which would result in total emission levels below applicability thresholds, or those that would result in no emissions increase or an increase that would be clearly *de minimis*. In addition, general conformity determinations are not required for portions of actions that include major new or modified stationary sources that require a permit under the New Source Review program (40 CFR 93.153).

The general conformity regulations were specifically designed to ensure actions taken by federal agencies, such as those at LLNL, do not interfere with a state's plans to attain and maintain national standards for air quality. Both the Livermore Site and Site 300 are within areas the USEPA has designated nonattainment for the NAAQS, and applicability analysis has been performed to determine whether the general conformity rule applies. This assessment is provided in Section 5.6.2 of this SWEIS.

4.6.2.4 *California Environmental Quality Act*

The BAAQMD guidelines for addressing air quality in the *California Environmental Quality Act* (CEQA) contain instructions on how to evaluate, measure, and mitigate air quality impacts from land development construction and operation activities. The DOE and LLNL have used these guidelines in this SWEIS to better address the effects of the proposed action. The Guidelines focus on criteria air pollutants, GHGs, toxic air contaminants, and potential odors generated at the project level. The environmental consequences sections of this SWEIS include an assessment to determine if the action exceeds any of the screening criteria outlined in the BAAQMD guidelines for assessing air quality effects under CEQA.

4.6.3 Climate and Greenhouse Gases

Livermore's average high temperature is 89.1 degrees Fahrenheit (°F) in the hottest month of July, and an average low temperature of 36.9 °F in the coldest month of December. Livermore has average annual precipitation of 14.8 inches per year. The wettest month of the year is January, with an average rainfall of 3.0 inches (Idcide 2020).

GHGs are components of the atmosphere that trap heat relatively near the surface of the earth, and, therefore, contribute to the greenhouse effect and climate change. Most GHGs occur naturally in the atmosphere; increases in their concentration result from human activities such as the burning of fossil fuels. Global temperatures are expected to continue to rise as human activities continue to add carbon dioxide, methane, nitrous oxide, and other GHGs, such as sulfur hexafluoride, to the atmosphere. Whether or not rainfall will increase or decrease remains difficult to project for specific regions (USEPA 2016a; IPCC 2014).

DOE must submit "the status of the implementation by the agency of initiatives to improve 34 energy efficiency metrics, reduce energy cost, and reduce emissions of greenhouse gases" (42 U.S.C. § 17143). DOE sites are required to track and reduce GHG emissions each year and report these metrics to the DOE Sustainability Performance Office.

EO 14008, "Tackling the Climate Crisis at Home and Abroad," outlines policies to reduce GHG emissions and to bolster resilience to the impacts of climate change. The EO directs CEQ to review, revise, and update its 2016 final guidance entitled, "Final Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in National Environmental Policy Act Reviews." When considering GHG emissions and their significance, agencies should use appropriate tools and methodologies for quantifying GHG emissions and comparing GHG quantities across alternative scenarios. The CEQ guidance specifically requires agencies within the DoD to quantify GHG emissions in NEPA assessments and review federal actions in the context of future climate scenarios and resiliency (EO 14008).

The GHG emissions generated directly and indirectly by an entity such as a federal agency can be classified into three "scopes" based on the source of the emissions:

- **Scope 1** emissions are direct GHG emissions from sources that are owned or controlled by the entity. Scope 1 includes emissions from fossil fuels burned on site, from owned or leased vehicles, and from other direct sources.

- **Scope 2** emissions are indirect GHG emissions resulting from the generation of electricity, heating and cooling, or steam generated off site but purchased by the entity.

- **Scope 3** emissions include indirect GHG emissions from sources not owned or directly controlled by the entity but related to the entity's activities. Scope 3 GHG emissions sources currently required for federal GHG reporting include employee travel and commuting, contracted solid waste disposal, and contracted wastewater treatment.

Table 4-8 outlines the Livermore Site's facility-wide GHG emissions for 2008 (baseline year), 2019, and 2020. The Livermore Site's Scope 1 and Scope 2 emissions include natural gas boilers and furnaces, fleet vehicles, fugitive emissions of refrigerants, operation of the sewage lagoon at Site 300, and indirect emissions from electricity consumption. The Livermore Site has reduced Scope 1 and 2 GHG emissions by 32 percent since 2008. Reduction efforts at the Livermore Site focuses on continued management of sulfur hexafluoride usage, the offsets of purchased renewable energy credits, purchased renewable electric energy from incremental hydroelectric power, and minimizing electrical energy use.

Table 4-8. Site-Wide Greenhouse Gas Emissions (Livermore Site and Site 300)

Category	2008 Baseline	2018	2019
Facility Energy	156,688	103,704	111,110
Fleet Vehicles	1,773	1,204	1,021
Fugitive Emissions	34,947	16,065	7,839
Wastewater Treatment	7.2	15.2	16.6
Renewables	0.0	0.0	0.0
Renewable Energy Credits	0.0	(505)	(468)
Total	**193,415**		**119,519**
T&D Losses	8,624	5,239	4,085
T&D RECs Credit	0.0	2,468	1,850.5
Air Travel	9,709	9,675	10,975
Ground Travel	1,218	1,615	1,575
Commute	25,708	21,400	25,013
Offsite MSW	730	660	859.5
Offsite WWT	19.6	17.8	19
Total	46,008	**41,077**	44,377

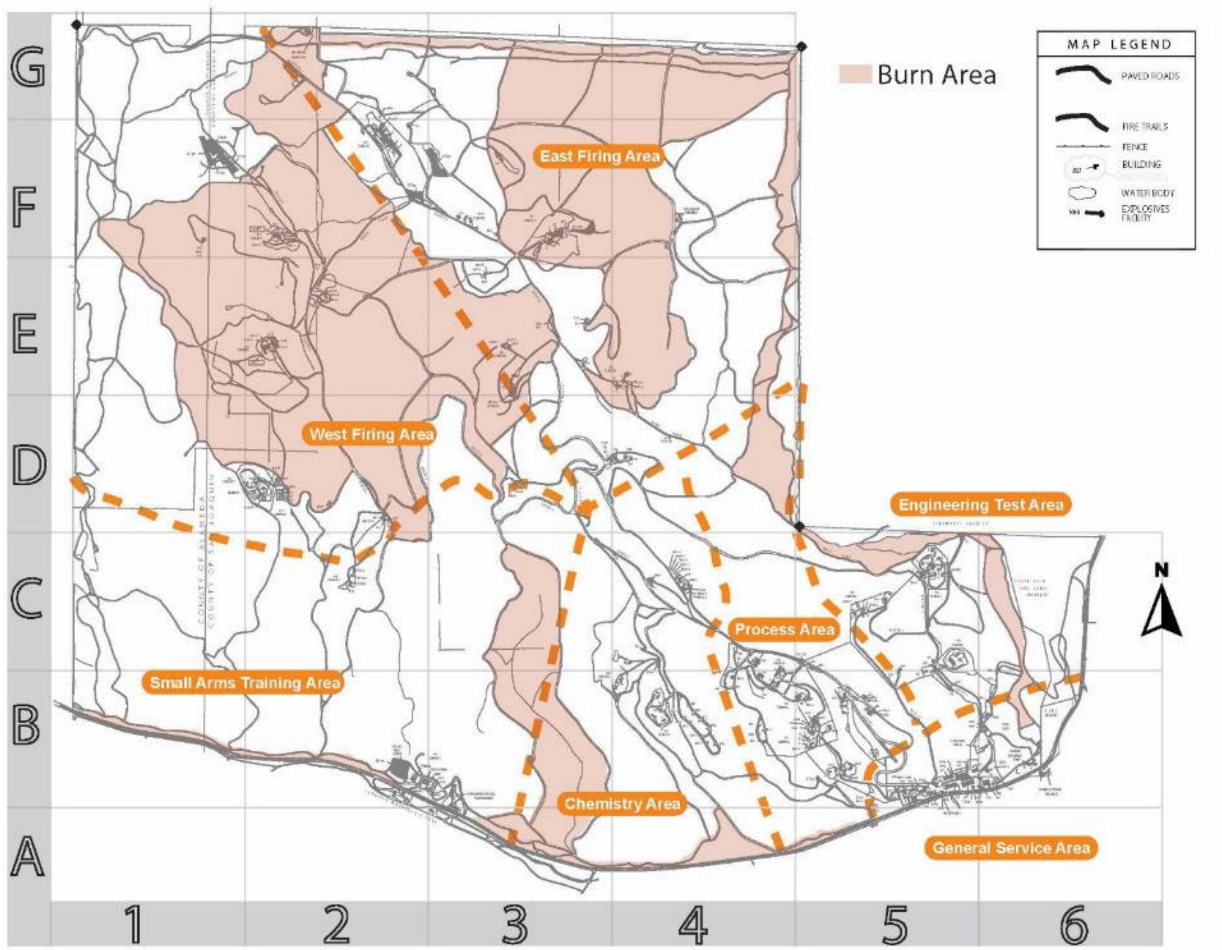
GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent.
Source: LLNL 2019j.

In FY 2019, the Laboratory maintained an overall reduction of 3.5 percent in Scope 3 GHG emissions from the FY 2008 baseline, but increased Scope 3 GHG emissions by 8 percent year over year from FY 2018 (*see* Table 4-8). This 8 percent increase was most likely due to an increase in Lab population and work activities resulting in more GHG emissions from air travel, commuting, and municipal waste disposal. (LLNL 2019j, 2021d).

4.6.4 Prescribed Burning Operations at Site 300

Site 300 annually conducts prescribed burns- on up to 2,500 acres, which is divided into burn plots ranging from less than 1 acre to about 600 acres. Daily prescribed burn acreage can range between approximately 10 acres and 700 acres. Prescribed burning at Site 300 typically occurs each year from mid-May through July, when the grass (i.e., fuel) has dried enough and the wind conditions are typically more ideal than later in the summer. Figure 4-53 generally depicts the annual prescribed burn areas for Site 300.

Prior to the prescribed burn each year, LLNL submits a prescribed burn/smoke management plan to both the SJVAPCD and BAAQMD and meets each air district's planning and reporting requirements (LLNL 2015b). Each district imposes stringent review and approval requirements before allowing prescribed burn activities to take place to meet their smoke management objectives. In addition, each air district prioritizes burn activities requested within their air basin and provides daily burn allocations to the requesting entity based on air quality, weather conditions, declared burn days, and other scheduled burn activities. In addition, LLNL conducts prescribed burns to meet DOE land management requirements and follows BMPs to minimize the creation of smoke and ensure safe burn conditions (LLNL 2015b).



Source: LLNL 2021d.

Figure 4-53. Current Site 300 Annual Prescribed Burn Areas

In 2022 LLNL will revise some of the annual prescription burn plots onsite by including additional polygons along the northeastern perimeter (Figure 4-54) and retiring several polygons currently treated in the interior of the property. Of the roughly 2,500 acres burned annually, no net increase in annual acreage is anticipated as a result of this action. The added northeastern burn plots will provide a higher standard of fire protection against wildfire, especially along this boundary.

The additional burn polygons consist primarily of non-native, annual grassland vegetation which is identical to the current fuels in the other burn plots onsite. The same environmental best management practices and procedures will apply and be followed in these areas.

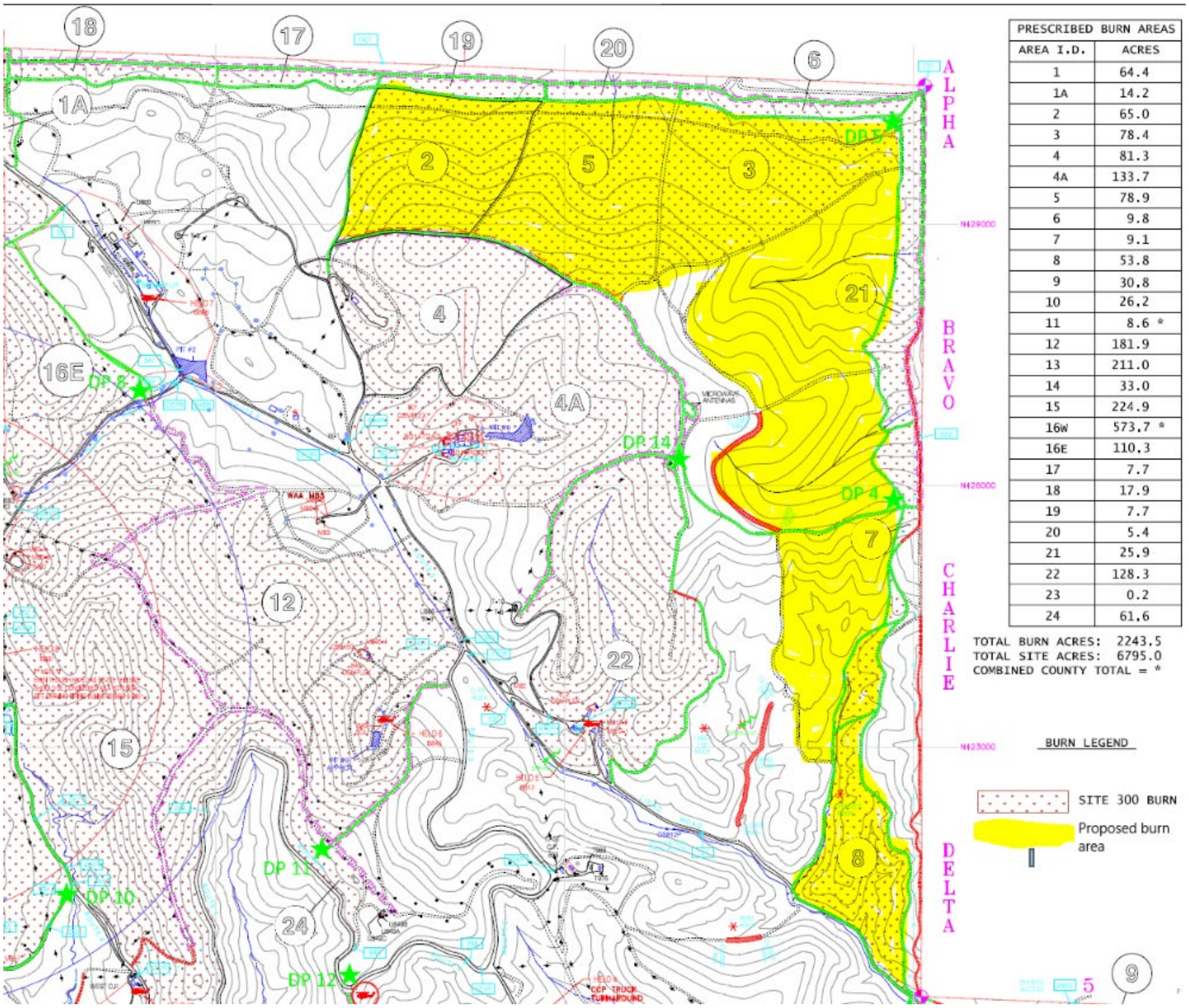


Figure 4-54. Proposed 2022 Replacement Burn Polygons, Northeastern Perimeter, Site 300

4.6.5 Radiological Air Quality

LLNL operates facilities in which radionuclides are handled and stored, and radiological emissions to the air are possible. These facilities are subject to the USEPA NESHAPs in 40 CFR Part 61, Subpart H, which regulates radionuclide emissions to air from DOE facilities. The USEPA Region IX has enforcement authority for LLNL compliance with radiological air emission regulations (LLNL 2020r, 2020t).

In accordance with 40 CFR Part 61, Subpart H, LLNL performs air effluent monitoring of atmospheric discharge points to evaluate its compliance with local, state, and federal laws and regulations and to ensure that human health and the environment are protected. That monitoring is used to determine the actual radionuclide releases from individual facilities during routine and nonroutine operations and to confirm the operation of facility emission control systems. Subpart H requires continuous monitoring of facility radiological air effluents if the potential off-site (fence-line) dose equivalent is greater than 0.1 millirem/year, as calculated using the USEPA-mandated air dispersion dose model, CAP88-PC, without credit for emission control devices. The results of monitoring air discharge points provide the actual emission source information for modeling, which is used to ensure that the NESHAPs standard of 10 millirem/year total site-effective-dose equivalent from the airborne pathway is not exceeded (LLNL 2020o, 2020p).

Many different radioisotopes were present at LLNL in 2019 including biomedical tracers, tritium, mixed fission products, transuranic isotopes, and others. Radioisotope handling procedures and work enclosures are determined for each project or activity, depending on the isotopes, the quantities being used, and the types of operations being performed. Work enclosures include glove boxes, exhaust hoods, and laboratory bench tops. Exhaust paths to the atmosphere include High Efficiency Particulate Air (HEPA) filtered ventilation systems, roof vents and stacks without abatement devices, resuspension of deposited depleted uranium in the soil from previous open-air explosives testing at Site 300, and releases to ambient air from a variety of non-monitored sources (LLNL 2020p).

LLNL groups radionuclide emission sources into two categories: major sources or minor sources. Major sources are defined as those that have the potential to emit radionuclides that could result in an annual potential effective dose of 0.1 millirem or more to a member of the public at an off-site location; the radionuclide NESHAPs regulation requires continuous monitoring of the stack effluent when the annual potential effective dose exceeds 0.1 millirem to an off-site member of the public. Minor sources are defined as sources that do not have the potential to cause an annual effective dose of 0.1 millirem to an off-site member of the public. At LLNL, all major sources of emissions are point sources, i.e., stack emission points; however, minor sources include both point sources and diffuse sources (LLNL 2020p).

In 2019, there were five facilities at the Livermore Site and one facility at Site 300 that had radionuclide air effluent continuous monitoring systems. These facilities are listed in Table 4-9, along with the number of samplers, the types of samplers, and the analytes of interest. Some of these facilities have the potential to emit radionuclides that would cause an annual effective dose greater than the 0.1 millirem NESHAPs standard; these sources are major sources following the definition given above. Other facilities have had the potential from radioactive air emissions in the past requiring monitoring, and the monitoring continues to be maintained to assure that the potential impact to the public and the environment is well understood. Additionally, monitoring may be in place for site-wide environmental impact statement commitments made to the public regarding the potential for radioactive air emissions (LLNL 2020p).

Many of the monitored stacks at LLNL have effluent controls, such as HEPA filters, to collect materials before they are emitted to the atmosphere. Air samples for particulate emissions are extracted downstream of HEPA filters and prior to the discharge point to the atmosphere. Particles are collected on high efficiency cellulose membrane filters. The sample filters are removed and analyzed for radioactive particulate activity on a weekly or bi-weekly frequency depending on the facility. In all cases, continuous passive filter aerosol collection systems are used. At some facilities, continuous air monitors also sample the stack air exhaust for radionuclide activity. Continuous air monitors have an alarm capability in the event of an unplanned release of radionuclide activity. Continuous air monitors are used for facility personnel safety; they are not used for NESHAPs compliance demonstration (LLNL 2020p).

Table 4-9. Radiological Air Effluent Sampling Systems and Locations

Building	Facility	Analytes	Sample Type	Number of Samples
231 Vault	Engineering Development and Assembly Facility	Gross alpha, beta on particles	Filters	3 to 4
235	Building in Physical and Life Sciences Directorate	Gross alpha, beta on particles	Filter	1
331	Tritium Facility	Gaseous tritium/ tritiated water vapor	Ionization Chamber[a]	4
		Gaseous tritium/ tritiated water vapor	Glycol Bubblers	2
332	Plutonium Facility	Gross alpha, beta on particles	Filters	15
		Gross alpha, beta on particles	CAM[a]	14
581	National Ignition Facility	Gross alpha, beta on particles, Gamma suite on particles	Filter	1
		Radioiodine (volatile)	TEDA cartridge	1
		Gaseous tritium/ tritiated water vapor	Glycol Bubbler	1
		Gaseous tritium/ tritiated water vapor	Ionization Chamber[a]	1
695/696	Decontamination and Waste Treatment Facility	Gross alpha, beta on particles	Filter	1
801A	Contained Firing Facility (Site 300)	Gross alpha, beta on particles	Filter	1

CAM = continuous air monitor; TEDA = triethylenediamine.
a. Alarmed systems used for notification for any unplanned release.
Source: LLNL 2020p.

Gas flow proportional counters and gamma spectroscopy are used to detect radioactive particulate activity collected on the filters. For verification of the operation of the counting system, calibration sources, and background samples are interspersed among the sample filters for analysis. The Radiological Measurements Laboratory (RML) in LLNL's Radiation Protection Functional Area and the Environmental Monitoring Radioanalytical Laboratory (EMRL) in the Physical and Life Sciences Directorate perform the analyses (LLNL 2020p).

When the result for gross alpha or gross beta on a particulate filter is greater than the minimum detectable concentration (MDC), the filter is recounted. If the second result is also above the MDC, the filter is submitted to the EMRL for isotopic analysis to determine whether the activity on the filter is the result of naturally occurring radionuclides or is reportable as a radionuclide emission from the facility (LLNL 2020p).

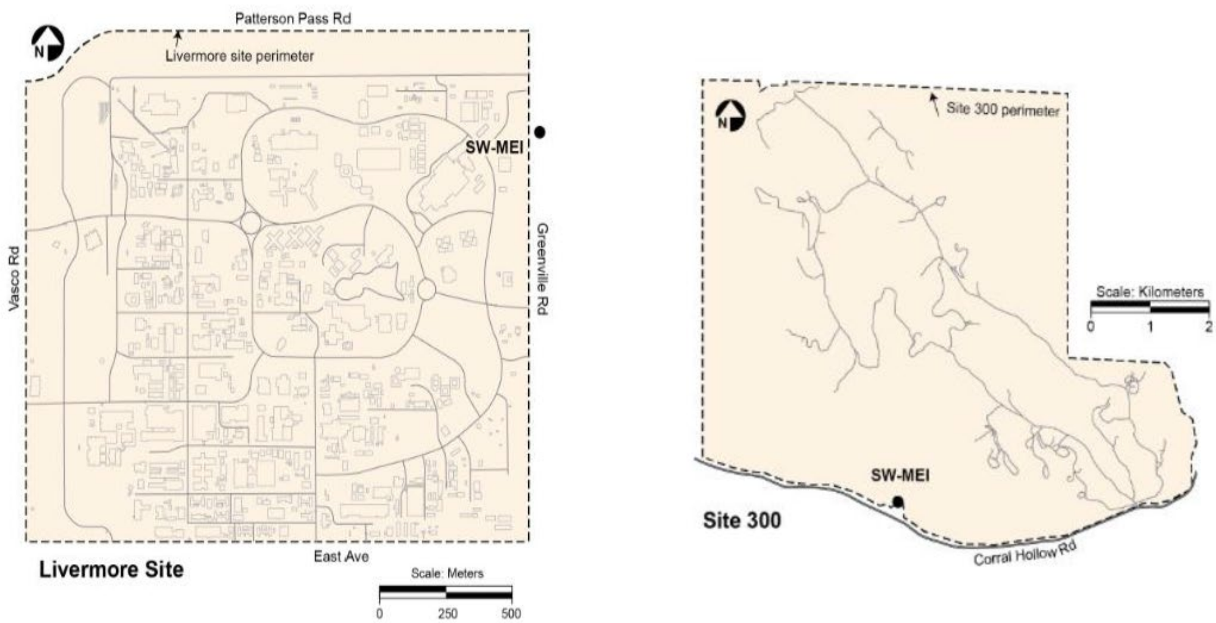
Glycol bubblers are used to monitor for tritium releases from the two Tritium Facility (Building 331) stacks, and the NIF stack. In addition to this NESHAPs compliance monitoring, the two Tritium Facility stacks, and the NIF stack are monitored using ion chambers. The ion chamber monitors are set to alarm at designated tritium concentrations to identify accidental or off-normal releases. Ion chambers are in place for notification only so that any unplanned release may be detected and responded to real-time; all the stack samplers monitor continuously (LLNL 2020p).

Because tritium can be released in the form of either tritiated water (HTO) vapor or tritiated hydrogen gas (HT), glycol bubblers employ a two-stage glycol impinging process to capture both physical forms. Stack air to be sampled enters the instrument and flows through the first stage impingers, capturing the HTO present. Next, the sampled air is directed through a heated palladium catalyst where oxidation of any HT in the sample takes place, converting gaseous tritium to HTO, which is then collected in the second stage impingers. The impingers are analyzed by the RML using liquid scintillation analysis. This type of sampling quantifies the amount of tritium for both species, HT and HTO (LLNL 2020p).

Tritium in particulate form is monitored when required using high efficiency (better than HEPA grade) cellulose membrane filters. Measurements indicate that tritium exchange (adsorption of tritium in HTO and/or HT captured in the filter medium via a binding reaction) occurs; this was verified by placing two particulate filters in series and comparing the results (applying 2-sigma error) on each filter. If tritiated particulate were present, then the pre-stream filter (the filter that comes into contact with stack air first) would have a higher amount of tritium than the post-stream filter (the filter that comes into contact with stack air immediately after the pre-stream filter). This is because the pre-stream filter would have significantly filtered out tritiated particles prior to the post-stream; this would result in less tritium on the post-stream filter. The pre-stream filter and post-stream filter showed the same amount of tritium (within analytical error) indicating tritium exchange (LLNL 2020p).

Triethylenediamine (TEDA) cartridges are used to sample for radioactive iodines in gaseous or vapor state. The TEDA is impregnated into carbon (activating the carbon) by the manufacturer and is housed in a plastic cartridge of standard industry size 2 ¼ inch diameter by 1inch thick. Stack air is directed through the TEDA cartridge, which is the second stage of the two-stage filter housing. Both the particulate filter (first stage) and the TEDA cartridge (second stage) are counted by gamma spectroscopy by the EMRL (LLNL 2020p).

For LLNL to comply with the NESHAPs regulations, the site-wide maximally exposed individual (MEI) cannot receive an effective dose equivalent greater than 10 millirem/year per site. A site-wide MEI is defined as a *hypothetical* member of the public at a single residence, school, business, church, or other such facility who receives the greatest LLNL induced dose from the combination of all evaluated radionuclide source emissions, as determined by modeling. At the Livermore Site, the 2019 site-wide MEI is located at the Integrative Veterinary Care facility, which is approximately 115 feet outside the eastern fence line of the site. At Site 300, the 2019 site-wide MEI is located at the Site 300 boundary with the CSVRA, managed by the California Department of Parks and Recreation, approximately 1.9 miles south-southeast of the firing table at Building 851 (LLNL 2020p). The locations of the site-wide MEIs for both the Livermore Site and Site 300 are shown in Figure 4-55.



Source: LLNL 2020p.

Figure 4-55. Location of Site-Wide MEI at Livermore Site and Site 300

LLNL operations involving radioactive materials have minimal impact on ambient air. Releases of radioactivity to the environment from LLNL operations occur through stacks and from diffuse area sources. In 2019, radioactivity released to the atmosphere was monitored at five facilities on the Livermore Site and one at Site 300. In 2019, 126.4 Curies (Ci) of tritium was released from the Tritium Facility, and 2.8 Ci (of tritium was released from the NIF. The CFF at Site 300 had measured stack emissions in 2019 for depleted uranium. A total of 1.2×10^{-7} Ci of uranium-234, 1.7×10^{-8} Ci of uranium-235, and 9.2×10^{-7} Ci of uranium-238 was released in particulate form (LLNL 2020o). Table 4-10 presents tritium emissions for the Tritium Facility and NIF for 2015–2019.

Table 4-10. Tritium Air Emissions from Tritium Facility and NIF (2015–2019)

Location	2015 (Ci)	2016 (Ci)	2017 (Ci)	2018 (Ci)	2019 (Ci)	Average (Ci)
Tritium Facility	43.7	75.3	43.8	183.5	126.4	94.5
NIF	1.44	1.11	1.15	8.6[a]	2.8	3.0

Ci = curies.
a. Includes release of 5.53 Ci from unplanned event on June 11, 2018 (LLNL 2019f).
Source: LLNL 2016b, 2017d, 2018a, 2019f, 2020r.

There were two unplanned radioactive air releases from the Livermore Site in 2019. On October 11, 2019, the Physical and Life Sciences Directorate (B235) had a uranium fire as a result of material transfer when one ball valve was accidently left open on a two-valve system. When the container was moved out of alignment, approximately 0.00002 Ci of depleted uranium dropped into a photo tray under the ball valve of the machine. The material began to spark and was placed inside a fume hood. The fire was extinguished with a spray bottle and the sash was lowered. Work was suspended until a Group Management Concerns/Issues process was completed. This included the Environmental Functional Area Health Physicist and facility management that implemented proper corrective actions to reduce the possibility of an accidental valve misalignment from becoming a reoccurring event. The unplanned release of 0.00002 Ci of depleted uranium is less than one-tenth of a percent of the USEPA Reportable Quantities (40 CFR Part 302) (LLNL 2020o).

On October 26, 2019, the Physical and Life Sciences Directorate (B235) had a second uranium fire that occurred during the cleaning of a plasma-based particle spheroidizer.[2] Approximately 0.000004 Ci of uranium dropped onto a contamination barrier and began to smolder. The beginning fire was extinguished with a Metal-X extinguisher. The work was suspended with no routine access allowed in the room until a Group Management Concerns/Issues process was completed. This included the Environmental Functional Area Health Physicist and facility management that implemented proper corrective actions to reduce the possibility of an accidental uranium release from maintenance activities becoming a reoccurring event. The unplanned release of 0.000004 Ci of depleted uranium is less than one-tenth of a percent of the USEPA Reportable Quantities (40 CFR Part 302) (LLNL 2020o).

The degree of hazard to the public is directly related to the type and quantity of the radioactive materials released. Section 4.14 of this SWEIS provides estimates of the doses received by individuals in the vicinity of the Livermore Site and Site 300 from releases of radionuclides to the environment from LLNL operations. The 2019 doses presented in Section 4.14 include the doses associated with the two unplanned releases discussed above.

4.7 NOISE

Sound is a physical phenomenon consisting of vibrations that travel as acoustic waves through a medium, such as air, and are sensed by the human ear. Noise is defined as any sound that is undesirable because it interferes with communication, is intense enough to damage hearing, or is otherwise intrusive. Human response to noise varies depending on the type and characteristics of the noise, distance between the noise source and the receptor, receptor sensitivity, and time of day. Noise is often generated by activities essential to a community's quality of life, such as construction or vehicular traffic.

Sound varies by both intensity (or amplitude) and frequency. Sound pressure level, described in decibels (dB), is used to quantify sound intensity. The dB is a logarithmic unit that expresses the ratio of a sound pressure level to a standard reference level. Hertz (number of sound vibrations in one second) are used to quantify sound frequency. The human ear responds differently to different frequencies. A-weighting, measured in A-weighted decibels (dBA), approximates a frequency response expressing the perception of loudness of sound in air by human ear. Sounds encountered in daily life and their dBA levels are provided in Table 4-11. C-weighting, described in C-weighted decibels (dBC), is similar to A-weighting except that C-weighting incorporates more low-frequency noise. C-weighting is predominately used to describe noise that has a component of rumble or the potential for noise-induced vibrations. It is used to describe impulse-type sounds, such as demolitions and explosive events.

[2] A spheroidizer is used to create spherical products.

Table 4-11. Common Sounds and Their Levels

Outdoor	Sound Level (dBA)	Indoor
Motorcycle	100	Subway train
Tractor	90	Garbage disposal
Noisy restaurant	85	Blender
Downtown (large city)	80	Ringing telephone
Freeway traffic	70	TV audio
Normal conversation	60	Sewing machine
Rainfall	50	Refrigerator
Quiet residential area	40	Library

dBA = A-weighted decibel.
Source: Harris 1998.

The sound pressure level noise metric describes steady noise levels, although few noises are, in fact, constant; therefore, additional noise metrics have been developed to describe noise, including:

- **Equivalent Sound Level (L_{eq})** – the average sound level in decibels of a given event or period of time.
- **Day-Night Sound Level (DNL) –** the average sound level in a 24-hour period with a 10-dB penalty added to noise events occurring between 10 p.m. and 7 a.m. DNL is a useful descriptor for noise because: (1) it averages ongoing yet intermittent noise, and (2) it measures total sound energy over a 24-hour period. DNL provides a measure of the overall acoustical environment but does not directly represent the sound level at any given time. C-weighted DNL is often used for impulsive noise (e.g., detonations and explosive testing), as it accounts for the low-frequency components of the noise.
- **Peak Sound Level (dBP) –** the maximum instantaneous sound level that occurs during an acoustic event. Although not a good descriptor of the overall noise environment, peak levels relate well to the level of concern and possibility of complaints among people after an individual impulsive noise event.

4.7.1 Livermore Site

This section provides an overview of the federal, state, and local noise regulations and guidance that may apply to activities at the Livermore Site, and a description of the existing noise environment at and around the site.

4.7.1.1 *Regulatory Overview*

The *Noise Control Act of 1972* (42 U.S.C. § 4901 et seq., Public Law 92-574) directs federal agencies to comply with applicable federal, state, and local noise control regulations. In 1974, the USEPA provided information suggesting continuous and long-term noise levels in excess of 65 dBA DNL are normally not recommended for noise-sensitive land uses such as residences, schools, churches, and hospitals (USEPA 1974).

The state of California has land-use compatibility guidelines for transportation noise, particularly near airports and roadways (CAOPR 2017). These guidelines set standards for new developments to provide adequate protection from nearby noise sources. The city of Livermore general plan outlines acceptable noise levels based on these state land-use guidelines (Table 4-12). In addition, Table 4-13 outlines the strict not-to-exceed noise limits outlined in Alameda County's municipal code. These limits are based on the cumulative time a noise is present in any given hour. Construction is exempt weekdays 7 a.m.–7 p.m. and Saturdays 8 a.m.–5 p.m. Notably, the city of Livermore's municipal code includes a nuisance noise ordinance that does not contain specific noise limits (Livermore 2021a).

Table 4-12. City of Livermore Land Use Compatibility Guidelines

Land Use	**Sound Level (dBA DNL)**			
	Normally Acceptable	**Conditionally Acceptable**	**Normally Unacceptable**	**Clearly Unacceptable**
Single Family Residential	<60	55–70	70–75	>75
Multi-family Residential	<65	60–70	70–75	>75
School, library, church, or hospital	<70	60–70	70–80	>80
Recreational	<75	70–80		>80
Administrative	<70	70–75	>75	
Industrial	<75	70–80	>75	

dBA = A-weighted decibel; DNL = day-night sound level.
Note: Where dBA levels overlap between categories, determination of noise level acceptability will be made on a project-by-project basis.
Source: Livermore 2014.

Table 4-13. Alameda County – Maximum Allowable Sound Levels

Duration (minutes/hour)	Maximum Allowable Sound Levels Daytime (Nighttime) [dBA]	
	Residential	**Commercial**
30	55 (50)	50 (65)
15	60 (55)	55 (70)
5	65 (60)	60 (75)
1	70 (65)	65 (80)
0	75 (70)	70 (85)

dBA = A-weighted decibel.
Notes: Daytime is 7 a.m.–10 p.m., and nighttime is 10 p.m.–7 a.m.
Residential land use includes schools, hospitals, churches, and public libraries.
Source: Alameda 2021.

4.7.1.2 *Existing Conditions*

Existing sources of noise at the Livermore Site are common to any industrial/commercial setting, although on a somewhat larger scale. Sources include various industrial facilities, equipment, and machines, vehicles, unmanned aircraft systems (UAS) in outdoor drone pen, as well as the use of small arms and demolitions. Noise sources from industrial facilities and operations at the Livermore site are predominantly inaudible at the property boundary. There is no measurable noise from the High Explosives Application Facility (B191, HEAF) outside except for air handlers and other mechanical equipment. There are no audible sounds from HEAF at the fence line. (Cracchiola 2020).

Sources of noise in areas surrounding the Livermore Site include roadway traffic, high-altitude aircraft and helicopter overflights, rail operations, yard maintenance equipment, and natural sources of noise such as wind and animal vocalizations. The Union Pacific and Southern Pacific rail lines, located just north of the Livermore Site, produce noise from train operations and warning whistles and horns at local roadway crossings. The Livermore Municipal Airport is six miles to the west, and other than an occasional midlevel overflight, does not contribute appreciably to the ambient noise levels at the Livermore Site.

Background Noise

Existing noise levels (L_{eq} and DNL) were estimated for the surrounding areas using the techniques specified in the American National Standard *Quantities and Procedures for Description and Measurement of Environmental Sound Part 3: Short-term measurements with an observer present* (ANSI 2013). Table 4-14 outlines the land-use category and the estimated background noise levels for nearby areas. Residential land-use categories with estimated DNL above 50 dBA have an uncertainty of approximately 10 dB (ANSI 2013). Residential land-use categories with estimated DNL below 50 dBA only provide an indication of what range of DNL they might span. Rural and remote areas may have background sound levels substantially lower than those shown, particularly in isolated areas or at night.

Table 4-14. Estimated Background Sound Levels Near the Livermore Site

Closest Noise Sensitive Area			Estimated Existing Sound Levels (dBA)		
Distance (feet)	Direction	Land Use Category	DNL Range	L_{eq} Daytime	L_{eq} Nighttime
800	North/South	Normal suburban Residential/ Industrial	50 to 55	50	44
650	West	Quiet Suburban Residential	45 to 50	40	34
200	East	Rural/Remote	<45	<40	<34

dBA = A-weighted decibel; DNL = day-night sound level; Leq = equivalent sound level.
Source: ANSI 2013.

Traffic Noise

The Federal Highway Administration (FHWA) Traffic Noise Model, Version 2.5 (FHWA 2004), was used to estimate the existing traffic noise for areas adjacent to the Livermore Site. Specifically, the average noise level during the peak traffic hour (L_{eq} [1 hour]) was determined for areas along Vasco Road, Patterson Pass Road, and Greenville Road. Table 4-15 outlines traffic noise levels for varying distances from the roadway centerlines. Notably, FHWA and California Department of Transportation guidance suggests that an average hourly sound level (i.e., L_{eq} [1 hour]) of 66 dBA would be a clear source of annoyance for residential uses (23 CFR 772.5; Caltrans 2020). These modeled levels are consistent with a 2003 noise survey that measured the traffic noise to be between 68 and 73 dBA in areas adjacent to the roadways examined (Sculley 2003).

Table 4-15. Existing Peak Period Traffic Noise Levels Adjacent to the Livermore Site

Distance (feet)	Sound Level (L_{eq} [1 hour])		
	Vasco Road	Patterson Pass Road	Greenville Road
25	71.5	69.8	66.6
50	68.5	66.8	63.5
100	65.6	63.9	60.7
200	62.5	60.8	57.6
400	59.0	57.3	54.0

Leq = equivalent sound level.
Source: FHWA 2004.

4.7.2 Site 300

This section provides an overview of the federal, state, and local noise regulations and guidance that may apply to activities at Site 300, and a description of the existing noise environment at and around the site.

4.7.2.1 *Regulatory Overview*

The federal and state regulatory requirements and guidance outlined under the Livermore Site, such as the Noise Control Act and the California land-compatibility guidance, also apply to Site 300. Site 300 is outside of Tracy city limits so the city of Tracy's noise ordinance is not applicable. Performance standards in the San Joaquin County Development Title (Section 9-1025.9) prohibit excessive noise that is incompatible with nearby sensitive land use.

- Projects that will result in new stationary noise sources must not create daytime (7:00 a.m. to 10:00 p.m.) noise levels over 50 dBA L_{eq} or nighttime (10:00 p.m. to 7:00 a.m.) noise levels over 45 dBA L_{eq} at the nearest location of offsite outdoor activity (i.e., the property line of the nearest sound receiver).

- Maximum sound levels (L_{max}) must not exceed 70 dBA in the daytime or 65 dBA in the nighttime. For single-tone noise (such as hum), impulsive noise, or noise from speech or music, these standards are reduced by five dBA.

- Construction activities conducted between 6:00 a.m. and 9:00 p.m. on any day are exempt from noise standards. Furthermore, construction/DD&D of structures or infrastructure and vibration caused by motor vehicles or trains are exempt from vibration standards.

4.7.2.2 *Existing Conditions*

Existing noise sources at Site 300 include various industrial facilities, equipment, and machines, as well as the use of small arms and explosive detonations. Existing sources of noise near Site 300 include off-road vehicles using the CSVRA to the south, vehicular traffic along Corral Hollow Road, and occasional high-level aircraft overflights. The city of Tracy Municipal Airport is somewhat distant and a relatively minor source of noise.

Background Noise

Similar to the Livermore Site, existing noise levels (L_{eq} and DNL) were estimated for the surrounding areas. Table 4-16 outlines the land-use category and the estimated background noise levels for nearby areas. These rural and remote areas may have background sound levels substantially lower than those shown, particularly in isolated areas or at night.

Traffic Noise

The FHWA Traffic Noise Model, Version 2.5 (FHWA 2004), was used to estimate the existing traffic noise for areas adjacent to Site 300. Specifically, the average noise level during the peak traffic hour (L_{eq} [1 hour]) was determined for areas along Corral Hollow Road. Table 4-17 outlines traffic noise levels for varying distances from the roadway centerline. These modeled levels are consistent with a 2003 noise survey that measured the traffic noise to be 66 dBA in areas adjacent to the roadway (Sculley 2003).

Table 4-16. Estimated Background Sound Levels Near Site 300

Closest Noise Sensitive Area			Estimated Existing Sound Levels (dBA)			
Distance (feet)	Direction	Type	Land Use Category	DNL	L_{eq} Daytime	L_{eq} Nighttime
10,100	South	Residential	Rural/Remote	<45	<40	<34
14,750	East					
10,650	North					
20,900	West					

dBA = A-weighted decibel; DNL = day-night sound level; Leq = equivalent sound level.
Source: ANSI 2013.

Table 4-17. Existing Peak Period Traffic Noise Levels Adjacent to the Site 300

Distance (feet)	Sound Level (L_{eq} [1 hour]) Corral Hollow Road
25	65.7
50	62.6
100	59.8
200	56.7
400	53.1

Leq = equivalent sound level.
Source: FHWA 2004.

Explosive Testing Noise

Explosive testing conducted on open firing tables may be audible beyond the Site 300 property boundary. In addition to regulatory requirements, this section includes guidelines for assessing land-use compatibility and the risk of concern and complaint from the explosive testing at Site 300. Noise modeling was conducted using BNOISE2 demolition noise model to estimate C-weighted DNL (CDNL) for land-use planning and peak levels to evaluate the potential for concern and complaint from these activities. Explosive type, detonation characteristics, atmospheric attenuation, topography, ground surface roughness, and meteorological conditions were included in the assessment.

Community annoyance and land-use compatibility from repeated explosive events is typically assessed using the CDNL noise metric, which averages noise levels over a protracted period and incorporates low-frequency sounds that are characteristic of these types of events. Table 4-18 outlines the recommended CDNL noise levels for compatibility with noise sensitive land uses such as housing, schools, and medical facilities.

Table 4-18. Compatibility of Explosive Noise with Sensitive Land Uses

Compatibility with Noise Sensitive Land Uses	Demolition Site Noise (CDNL)
Acceptable	<62 dBC
Normally not recommended	62–70 dBC
Not recommended	>70 dBC

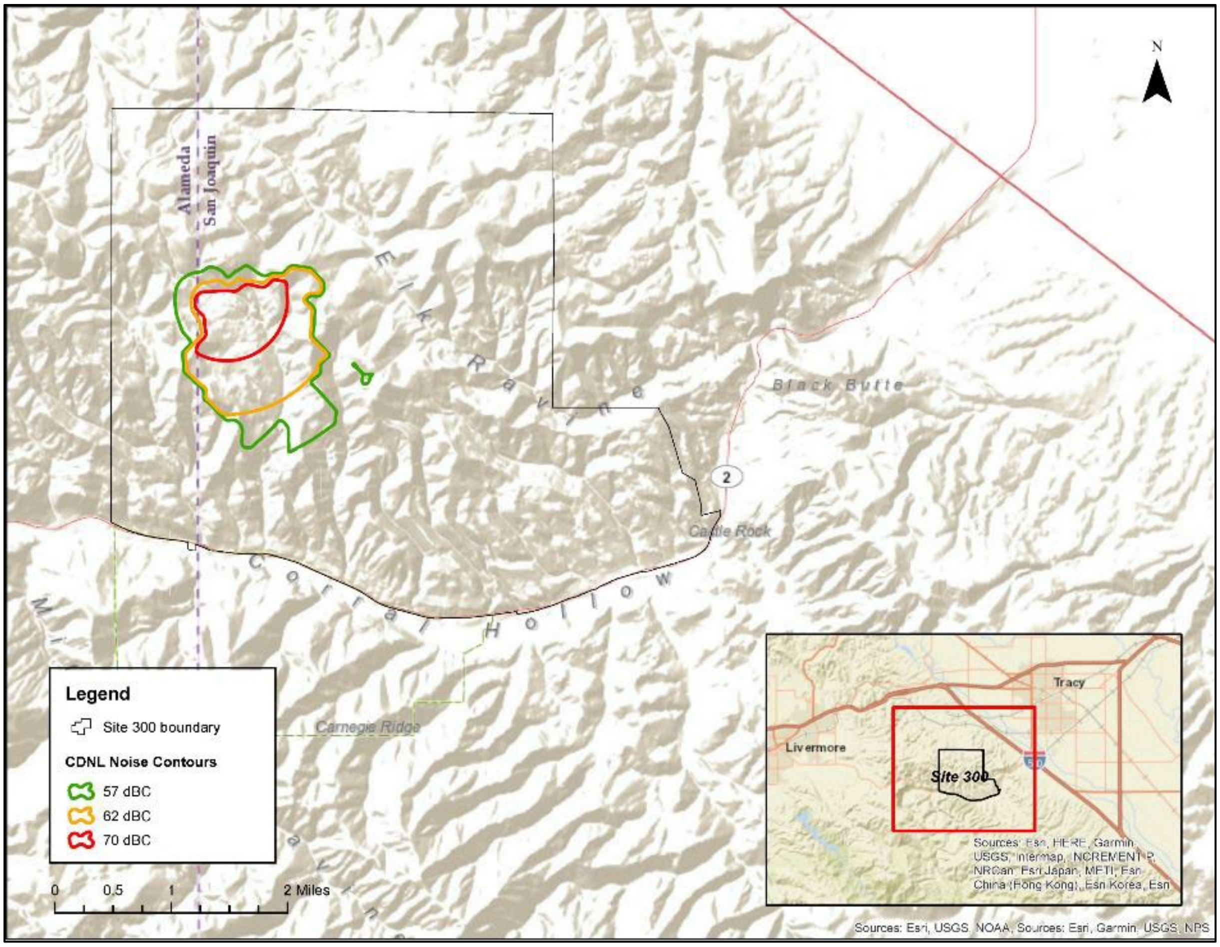
dBC = C-weighted decibel; CDNL = C-weighted Day-Night Sound Level.
Source: Army 2007.

The existing CDNL contours associated with explosive testing are shown in Figure 4-56. The 57-dBC, 62-dBC, and 70-dBC CDNL contours are completely contained within the Site 300 property boundary. As shown in Table 4-18, the overall average sound levels (i.e., CDNL) are completely compatible with all land uses outside of the Site 300 property boundary. The testing activities are neither loud enough nor frequent enough to generate areas of incompatible land use. Currently, outdoor detonations at Site 300 are limited to less than 100 pounds per day, and any contours would be less than shown here.

In addition to land-use compatibility, the use of explosives and detonation events are common causes of concern and complaint among individuals. The peak level is the absolute maximum sound level for an individual acoustical event, not an average over several events or over a period of time like CDNL. Although not a good descriptor of the overall noise environment like CDNL, peak levels relate well to the level of concern and possibility of complaints among people living nearby after an individual event. Table 4-19 outlines level of concern and complaint for an individual impulsive noise using peak noise levels.

Increase in Weights of Explosives Detonated at Site 300. In January 2018, NNSA prepared an environmental assessment (NNSA 2018a) to evaluate a proposal to test explosive materials up to 1,000 pounds per day and no more than 7,500 pounds per year at Site 300.[3] The most notable environmental impact of the proposal was an increase in peak sound pressure levels; although not a significant impact, NNSA determined that sound pressure levels with the potential to generate public concern would extend off site into unpopulated areas. LLNL's self-imposed one-second sound pressure level of 126 dB would not be exceeded in populated areas or at sensitive receptors (e.g., schools, hospitals, daycare facilities). Implementation of the proposal was not anticipated to result in noise levels greater than 57 dB in residential areas. As a result of the assessment, NNSA issued a Finding of No Significant Impact in March 2018 (NNSA 2018b). The proposed increase in detonation weights has not yet been implemented, and B851 will continue R&D experiments within the current Site 300 limits of less than 100 pounds per day and less than 1,000 pounds per year.

[3] Detonation of explosives is currently limited to less than 100 pounds per day and less than 1,000 pounds per year.



Note: Figure depicts open air detonation at Building 851 of 100 lbs/day, 1,000 lbs/yr as the primary source of detonation noise at Site 300.
Source: LLNL 2018a.

Figure 4-56. Noise (CDNL) Contours for Open Air Detonation at Site 300

Table 4-19. Level of Concern and Possibility of Complaint by Level of Noise

Level of Concern and Possibility of Complaint	Peak Noise Level from a Demolition or Explosive Event (dBP)
Low	<115 dBP
Medium	115–130 dBP
High	130–140 dBP

dBP = Peak Sound Level.
Source: Army 2007.

4.8 BIOLOGICAL RESOURCES

This section summarizes the existing environment for vegetation, fish and wildlife special status species, and wetlands at the Livermore Site, Site 300, and the Arroyo Mocho Pumping Station. According to the *California State Wildlife Action Plan* (CDFW 2015), the project areas are in the Bay Delta and Central Coast Province and the relevant conservation units are Central California Coast and Central California Coast Ranges ecoregions.

Several biological resource surveys were previously conducted to provide supporting information for the 2005 LLNL SWEIS (NNSA 2005). Flora and fauna studies were conducted in 1982, 1986, 1987, 1990, 1991, 1992, 2001, 2002, and 2004 in support of this previous effort. Wetland delineations were conducted at the Livermore Site in 1992 and 1997. Site-wide wetland delineations were conducted at Site 300 in 1991 and 2002. Project-specific wetland delineations were conducted in localized areas at both sites from 2005 through 2019. Wetland/delineations were conducted in June 2020 for the Livermore Site, Site 300, and Arroyo Mocho Pumping Station as supporting information for this SWEIS (Nomad Ecology 2020).

LLNL has conducted annual monitoring of known Site 300 rare plant and wildlife populations from 2005 through 2021. Annual monitoring was conducted at Site 300 for the federally threatened California red-legged frog and California tiger salamander from 2005 through 2021. Annual monitoring for the California red-legged frog was conducted at the Livermore Site from 2005 through 2021. Periodic annual monitoring for nesting raptors, including white-tailed kites and western burrowing owls, has been conducted at the Livermore Site and Site 300 from 2005 through 2021.

The information in this section is a summary of the more detailed information presented on the 2020-2021 biological studies and wetlands delineations in Appendices I and E of this SWEIS, respectively. This information was supplemented with the results of annual monitoring surveys. The scientific names of species mentioned in this section are provided in Appendix I. Specifically, for this SWEIS, several key supporting investigations were completed. These are described in more detail in the following sections, and include:

- Botanical Resource Survey Report, Arroyo Mocho, Lawrence Livermore National Laboratory, Alameda County, California. June 2021 (Nomad Ecology 2021b).

- Final Site 300 Sensitive Botanical Resource Report, Alameda and San Joaquin Counties, California. June 2021 (Nomad Ecology 2021a).

- California Red-legged Frog USFWS Protocol Survey Report, Lawrence Livermore National Laboratory, Site 200 – Livermore Campus, Livermore, California. May 2021 (Sequoia 2021a).

- Valley Elderberry Longhorn Beetle Surveys at the Lawrence Livermore National Laboratory - Site 300, California. December 2020 (Shepard 2020).

- Valley Elderberry Longhorn Beetle Surveys at the Lawrence Livermore National Laboratory - Site 300, California. June 2021 (Shepard 2021).

- Wetland/Aquatic Resources Delineation for the 2021 Sitewide Environmental Impact Statement. Lawrence Livermore National Laboratory Facilities, Alameda and San Joaquin Counties, California. September 2020 (Nomad Ecology 2020).
- Arroyo Mocho Habitat Suitability Assessment for Sensitive Reptiles, Amphibians, and Fish. Lawrence Livermore National Laboratory, California. September 2021 (Sequoia 2021b).
- Carnivore Survey Results for the Lawrence Livermore National Laboratory Site 300, Alameda and San Joaquin Counties, California. August 2021 (ECORP 2021b).
- Bat Survey for the Lawrence Livermore National Laboratory Experimental Test Site 300, Alameda and San Joaquin Counties, California. August 2021 (ECORP 2021c).
- Small Mammal Trapping Survey for the Lawrence Livermore National Laboratory Site 300, Alameda County, California. August 2021 (ECORP 2021d).
- Herpetological Survey for the Lawrence Livermore National Laboratory Site 300, Alameda County, California. August 2021 (ECORP 2021e).
- FY19 and FY20 Report for the Lawrence Livermore National Laboratory Experimental Test Site (Site 300) Natural Resources Management Plan. September. 2021 (LLNL 2021o).
- 2019-2021 Nesting Bird Survey Summary Report for the Lawrence Livermore National Laboratory Site 200, Alameda County, California. September. 2021 (LLNL 2021p).
- Passerine Bird Surveys for the Lawrence Livermore National Laboratory Site 200, Alameda County, California. August 2021 (ECORP 2021a).
- Avian Surveys Report for the Lawrence Livermore National Laboratory Arroyo Mocho Pumping Station, Alameda County, California. August 2021 (ECORP 2021f)
- 2021 Alameda Whipsnake Surveys for the Lawrence Livermore National Laboratory Site 300, Alameda and San Joaquin Counties, California. September 2021 (LLNL 2021q).
- Scat Detection Dog Surveys for the San Joaquin Kit Fox on the Lawrence Livermore National Laboratory's Experimental Test Site (Site 300) and the Corral Hollow Ecological Reserve: 2020 Deployment. Alameda and San Joaquin Counties, California (Woollett 2021).
- 2020 Mitigation and Monitoring Report for the Arroyo Las Positas Management Project. Lawrence Livermore National Laboratory, Livermore, California (LLNL 2021t).

4.8.1 Vegetation

Land use, with respect to habitat availability and development, has not changed significantly since the 2005 LLNL SWEIS although some areas that were considered undeveloped in 2005 have been developed recently as part of construction associated with the Livermore Valley Open Campus and the Emergency Operations Center. Surveys and monitoring activities through 2019 show no indications of substantial changes in vegetation conditions (LLNL 2020p).

4.8.1.1 *Livermore Site*

The Livermore Site was founded in 1952 and is in the Livermore Valley in southeastern Alameda County. The Livermore Site is an urban developed site within the city of Livermore. Some remnants of natural vegetation occur within the buffer zones and adjacent to two creeks that cross the site: Arroyo Las Positas and Arroyo Seco. As of 2019, approximately 80 percent to 90 percent of the 821-acre Livermore Site is developed. The northern and western portions of the Livermore Site have a 500-foot-wide security buffer zone. The buffer zones have been leveled and disturbed by historical land uses. The vegetation in the buffer zones is dominated by non-native annual grasses similar to what is found in the adjacent agricultural land. The buffer zones are generally mowed twice a year (LLNL 2013a).

Livestock grazing began on a large scale in the Central Valley and surrounding areas of California in the 1800s. It is likely that grazing and other agricultural activities adversely altered the perennial grasslands and riparian plant communities in the Central Valley (Warner 1981). The U.S. Navy acquired the land that is now the Livermore Site in 1942 and built runways, roads, and buildings throughout the site. Aerial photographs show that by the 1950s, large portions of the Livermore Site had been leveled and cleared of vegetation to construct runways and roads. In addition, Arroyo Las Positas was channelized and now traverses part of the eastern and northern boundaries of the site. Although a botanical inventory of the Livermore Site has not been completed, Appendix I provides a list of plant species that are found in naturalized portions of the Livermore site that were identified during 2020 wetland delineations and previous surveys.

Surveys in 2002 confirmed that site conditions and species composition have changed relatively little during the previous 10 years (Jones and Stokes 2002). In 2002, the developed areas on the Livermore Site were landscaped with ornamental vegetation and lawns. There were also small areas of disturbed ground with early successional plant species. The undeveloped land in the buffer zones was an annual grassland plant community dominated by non-native grasses such as wild oat, brome grasses, foxtail barley, curly dock, and wild radish (Jones and Stokes 2002).

The 2020 aquatic resources delineation report described vegetation communities on the Livermore Site as ornamental landscape plantings, ruderal vegetation, coastal and valley freshwater marsh, seasonal wetlands, and great valley willow scrub. Most of Livermore Site is dedicated to office and laboratory buildings and associated walkways and roads; native vegetation is generally lacking. Tree species in the landscaped areas include scarlet oak, eucalyptus, Monterey pine, Fremont cottonwood, London plane tree, Peruvian pepper tree, she-oak, and Gooding’s willow. Ruderal vegetation is present on the banks of drainage ditches and streams, and in buffer zones. Ruderal vegetation includes slender oats, soft chess, brome fescue, Bermuda grass, English plantain, and other species. Freshwater marsh vegetation is dominated by cattails; other species include California bulrush, willow herb, and umbrella sedge. Seasonal wetland vegetation is present in drainage ditches and includes Italian wildrye, dallis grass, curly dock, and other species. Willow scrub vegetation, including narrow-leaved willow, arroyo willow, red willow, and scattered coast live oak is present along Arroyo Seco and Arroyo Las Positas (Nomad Ecology 2020).

In 2002, the tree canopy of Arroyo Seco consisted of both native and non-native species including willows, oaks, California buckeye, glossy privet, and black locust. Vegetation along the arroyo's channel included perennial peppergrass, sweet fennel, and common cocklebur (Jones and Stokes 2002).

In 2005, an extensive erosion control and restoration project was completed in the LLNL reach of Arroyo Seco. Prior to this project, Arroyo Seco flowed through a steep incised channel as it crossed the Livermore Site. Erosion was also occurring in locations where stormwater flowed over the banks of the arroyo. This project included measures to repair existing erosion damage, prevent future erosion, restore the stream banks to a more natural topography, and plant native riparian species. Where space allowed, the stream banks were cut back to decrease their slope and meanders were added to the channel to decrease the rate of flow through the site. Space did not allow the addition of meanders in the upstream portion of the project site, so vegetated geogrids were installed in this area to prevent future erosion. The vegetated geogrids were constructed of folds of soil held in place on the stream banks by erosion control fabric, and further stabilized with willow plantings. Restoration of native vegetation included arroyo willow, Fremont cottonwood, coast live oak, and valley oak (LLNL 2011b).

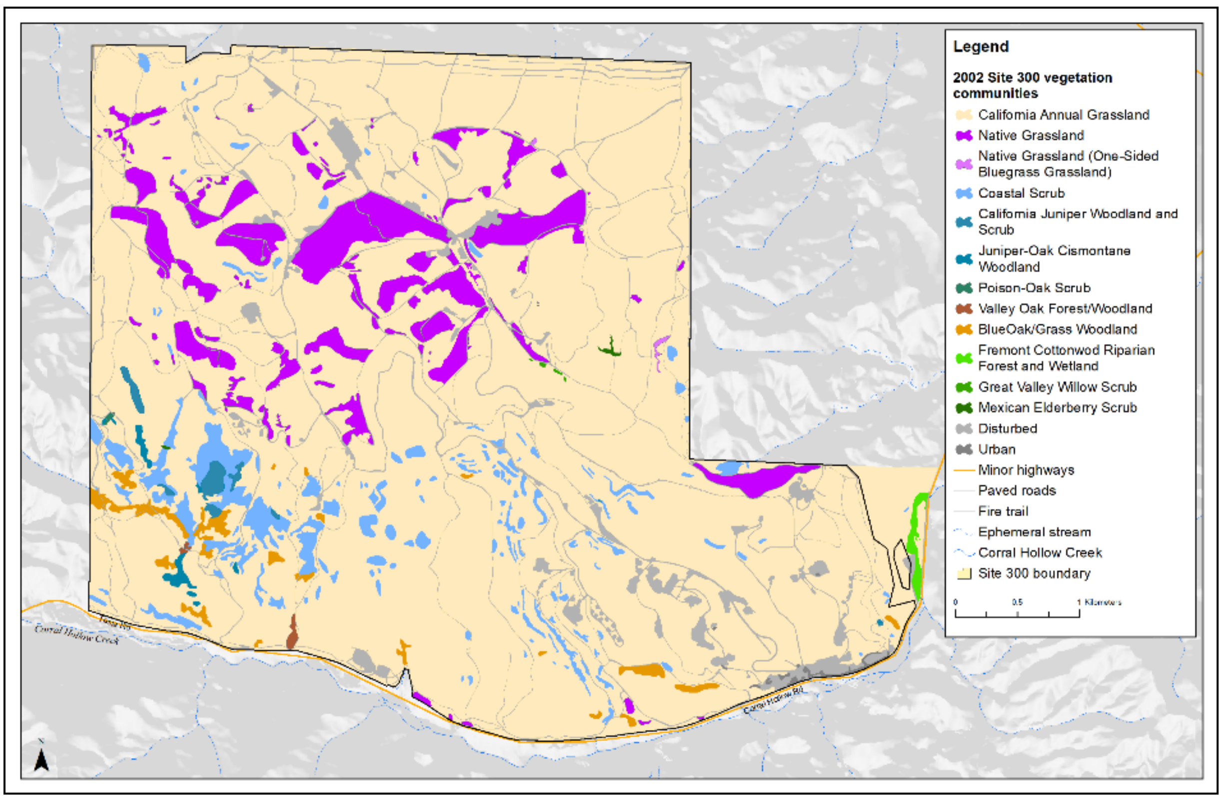
In 2020, great valley willow scrub vegetation type was found along the upstream portion of Arroyo Seco. It is characterized by stands of narrow leaved willow, arroyo willow, red willow, and scattered coast live oak. Non-native species along Arroyo Seco include black locust and Chinese privet. Shrubs include elderberry and coyote brush. Herbaceous cover is sparse to absent in this willow scrub community (Nomad Ecology 2020).

A vegetation survey along Arroyo Las Positas in 2002 found essentially the same species as those found during a 1997 survey. Common species in the annual grassland along the upper channel bank of the arroyo include wild oats, brome grasses, alkali mallow, and yellow starthistle. Wetland plants observed along Arroyo Las Positas are indicative of plant species associated with disturbed lands, such as tall flatsedge and barnyard grass, cattails and bulrushes in freshwater marsh, and willows in riparian scrub (Jones and Stokes 2002). During the 2020 wetland delineation, Coastal and Valley Freshwater Marsh vegetation was found along Arroyo Las Positas. These vegetation communities are dominated by cattails. Other species observed in 2020 include California bulrush, rabbitsfoot grass, willow herb, watercress, umbrella sedge, and Bermuda grass (Nomad Ecology 2020). The vegetation in and adjacent to Arroyo Las Positas from the outfall of Lake Haussmann to the location where Arroyo Las Positas exits the Livermore Site is monitored each year as part of the annual flood control maintenance conducted in this location. In 2020, five vegetation community or substrate types were identified within the Arroyo Las Positas: areas dominated by the invasive ornamental tree she-oak; emergent wetland vegetation dominated by watercress and cattails; willow dominated areas which include arroyo willow, Goodding's black willow, and narrow-leafed willow; open water areas with greater than 50 percent open water; and concrete lined channels (LLNL 2021t). A summary of the 2020 Mitigation and Monitoring Report for the Arroyo Las Positas Management Project is presented in Appendix I.

4.8.1.2 *Site 300*

Site 300, approximately 8 miles (approximately 16 miles driving distance) east of the Livermore Site, was acquired in 1955 covering approximately 7,000 acres of land in eastern Alameda County and western San Joaquin County. The northern portion is characterized by rolling hills with the southern portion by steep, deep canyons. Approximately five percent of the site (350 acres) has been developed for LLNL activities; with the exception of prescribed burning, the remainder is undisturbed. Appendix I provides a list of plant species on Site 300.

Three site-wide vegetation surveys have been conducted and 406 plant species have been identified at Site 300. A 1986 survey identified four upland plant community types: (1) introduced grassland, (2) native grassland, (3) coastal sage scrub, and (4) oak woodlands. A more detailed 2002 survey identified 18 community types in six general categories: scrub and chaparral, grassland and herb dominated, bog and marsh, riparian and bottomland habitat, broad leafed upland tree dominated, and coniferous upland forest and woodland, based primarily on the California Natural Diversity Database's List of California Terrestrial Natural Communities (Figure 4-57). The expanded list also included disturbed and urban habitat. Some of the vegetation communities identified in 2002 include annual grassland, native grassland, coastal scrub, coastal sage scrub oak, poison oak scrub, cottonwood riparian forest/woodland, Great Valley willow scrub, Mexican elderberry, blue oak woodland, valley oak forest/woodland, juniper-oak woodland/scrub, juniper-oak cismontane woodland, disturbed land, and urban habitat (Jones and Stokes 2002).



Source: Jones and Stokes 2002.

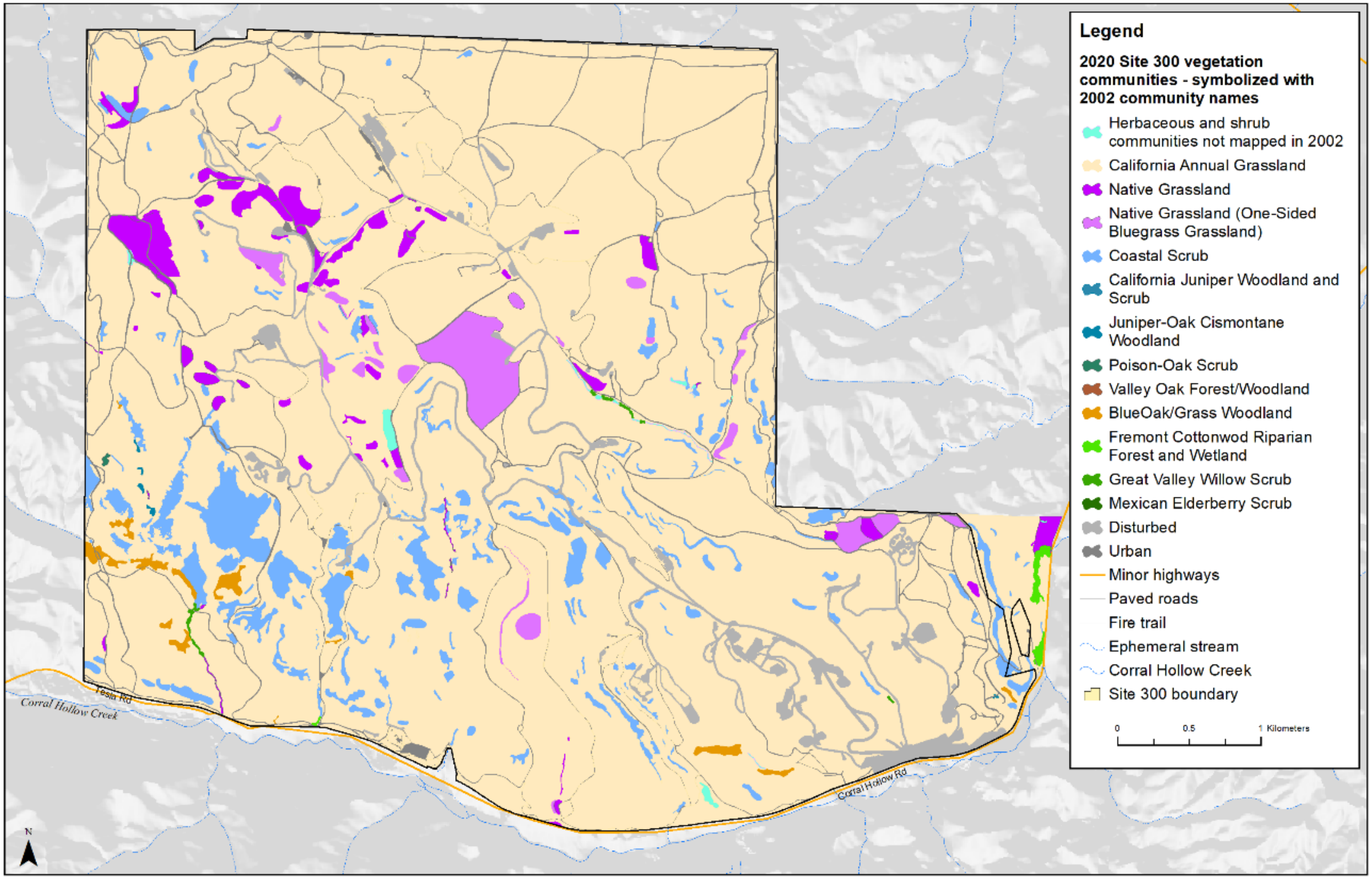
Figure 4-57. Vegetation Communities Mapped in 2002 on Site 300

In 2002, annual grassland covered 5,534 acres on Site 300. This community is dominated by species introduced from Mediterranean Europe during the Spanish Colonial Era (e.g., slender oat and ripgut brome). Native grassland, dominated primarily by one-sided bluegrass and purple needlegrass, covered 480 acres in 2002. Oak woodland dominated by blue oak covered approximately 56 acres in 2002 in scattered areas on steep slopes in the southern half of the site. The oak woodland understory is dominated by grassland species such as brome grass and slender oat. Less common community types identified in 2002 include coastal scrub, dominated by California matchweed, California sagebrush, California buckwheat, black sage, and several wetland communities (LLNL 2011c; Jones and Stokes 2002).

Vegetation classification and mapping efforts conducted in 2020 and 2021 (Nomad Ecology 2021a) on Site 300 resulted in four tree-overstory, 14 shrubland, and 11 herbaceous alliances (i.e., uniform group of plant associations). Most were assigned further into associations resulting in five tree-overstory, 15 shrubland, and 10 herbaceous associations (i.e., vegetation classification units based on overall species composition). The vegetation mapping units are depicted in Figure 4-58. A summary of the 2020-21 surveys is presented in Appendix I.

The 2020 aquatic resources delineation report described vegetation communities on Site 300 as primarily of grassland dominated by non-native annual grasses with patches of native grasslands and scattered open woodlands. Non-native annual grasslands are dominated by slender oats, ripgut brome, soft chess, brome fescue, and red brome. Native grassland patches are dominated by one sided bluegrass, purple needlegrass, creeping wildrye, squirrel tail, and other species. Scrub communities previously mapped as coastal scrub more accurately fit the Diablan Sage Scrub vegetation type, which includes California sagebrush, California matchweed, California buckwheat, and other species. Central coast cottonwood riparian forest, dominated by Fremont's cottonwood, is restricted to a few riparian corridors along Corral Hollow Creek. Central coast riparian scrub, dominated by red willow, is a scrubby streamside thicket restricted to a few drainages. Blue oak woodland is characterized as dominated by blue oak with scattered valley oak in the canopy. Freshwater seeps are seasonal wetlands dominated by creeping wildrye, cobwebby hedgenettle, iris-leaved rush, Mexican rush, stinging nettle, perennial pepperweed, rabbitsfoot grass, and other species (Nomad Ecology 2020).

Fire history and grazing regime for Site 300 is related to the vegetation occurrence at Site 300. Portions of Site 300 are regularly burned as part of a fuel-suppression strategy, prescribed burning, in explosives testing zones. No grazing or farming has taken place since the site was acquired. Site 300 vegetation naturally becomes dry and dormant during the hot dry summer months presenting a risk of uncontrolled wildfire. Prescribed burns have been conducted on up to approximately 2,500 acres of the site since it was acquired to control for this risk of wildfire. Prescribed burning is a recognized land management practice for reducing non-native annual grass cover and sustaining rare habitat types (USFS 2021). The presence of native grassland is strongly correlated with the burn areas (Carlsen et al. 2017). The requirements and coordination of activities for all individuals and organizations necessary to perform the prescribed burn are presented in the Site 300 Prescribed Burn Management Procedure (LLNL 2015b). Burns are permitted between May 1 to August 1. Annual permitting is required for burns in both San Joaquin County (per the SJVAPCD) and Alameda County (per the BAAQMD). The 2020 plan for prescribed burning on Site 300 was 2,244 acres (*see* Figure 4-53).



Source: Nomad Ecology 2021a.

Figure 4-58. Vegetation Communities Mapped in 2020 on Site 300

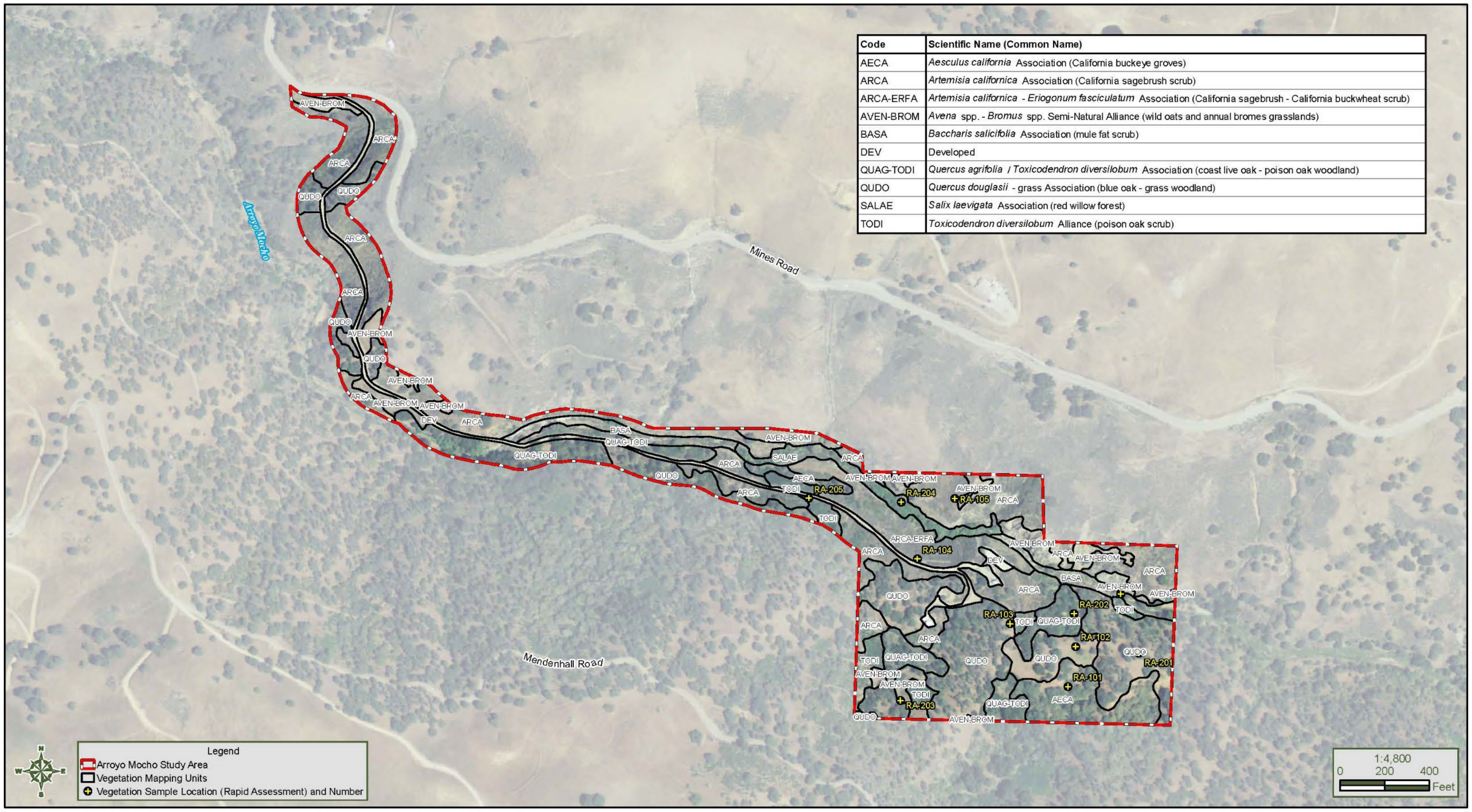
In 2017, LLNL and U.S. Department of Agriculture researchers explored how the frequency of controlled burns can affect the relative abundance of native and exotic species in grassland environments over a 15-year study period, using LLNL's Site 300 as a model grassland system. Yearly burns were most effective at maintaining the population of the native perennial grass one-sided blue grass, considered a foundation grassland species. Other local native species benefited from burning approximately every three years, which also preserved one-sided blue grass. Both annual and every three years fire frequencies reduced exotic grass species. However, an endangered plant species, large-flowered fiddleneck, performed best in the control treatment that did not have prescribed burns (Carlsen et al. 2017).

Ongoing practices at Site 300 that affect site vegetation include the exclusion of grazing and other agricultural uses; annual maintenance of fire roads and breaks; annual controlled burns; weed control along roads, power poles, and security fences; planned minor construction in or adjacent to existing facilities; and road-widening projects. The maintenance of fire roads and fire breaks and weed control measure have resulted in sparse vegetative cover dominated by early successional plant species including introduced grass species. Facilities development sites and adjacent landscaping are considered urban habitat, while these activities for fire roads, perimeter fences, and power poles are considered disturbed habitat (LLNL 2011c).

4.8.1.3 *Arroyo Mocho*

LLNL maintains the Arroyo Mocho Pumping Station, the access road, water tanks, and erosion control structures at these facilities and adjacent to Arroyo Mocho. In addition, LLNL maintains the water line that delivers water from the pumping station to the Livermore Site. The Arroyo Mocho Pumping Station is owned by the City of San Francisco Public Utilities Commission. The pump station has been the primary water source for the Livermore Site since the 1960s. Arroyo Mocho is relatively undisturbed and supports mature riparian woodland with cottonwood, sycamore, and alder (Livermore 2014). The approximately 10-mile-long Arroyo Mocho is an important tributary in the Alameda Creek watershed. The pump station is in the lower end of the Arroyo Mocho canyon before Arroyo Mocho flows onto the Livermore Plain in Livermore. With the exception of the footprint of the pump station and associated structures, the area surrounding the pump station is largely undeveloped. The Arroyo Mocho watershed is characterized by steep canyon walls composed of coastal scrub and riparian woodlands. Upland vegetation in the Arroyo Mocho canyon is dominated by coastal shrub species on southwest-facing slopes and oak woodland on northeast-facing slopes. Dominant coastal shrub species are California coastal sage, toyon, and sticky monkey flower. Oak woodland is dominated by an overstory of blue oak, coastal live oak, and buckeye with an understory of shrubs and grasses (LLNL 2008a).

Vegetation classification and mapping efforts conducted in 2020 (Nomad Ecology 2021b) at the Arroyo Mocho Pumping Station resulted in four tree, three shrub, and one herbaceous alliance. Most were assigned further into associations resulting in four tree and four shrub associations. The vegetation mapping units are depicted in Figure 4-59. A summary of the 2020-21 surveys is presented in Appendix I.



Source: Nomad Ecology 2021b.

Figure 4-59. Vegetation classifications from the 2020 surveys for the Arroyo Mocho Pumping Station

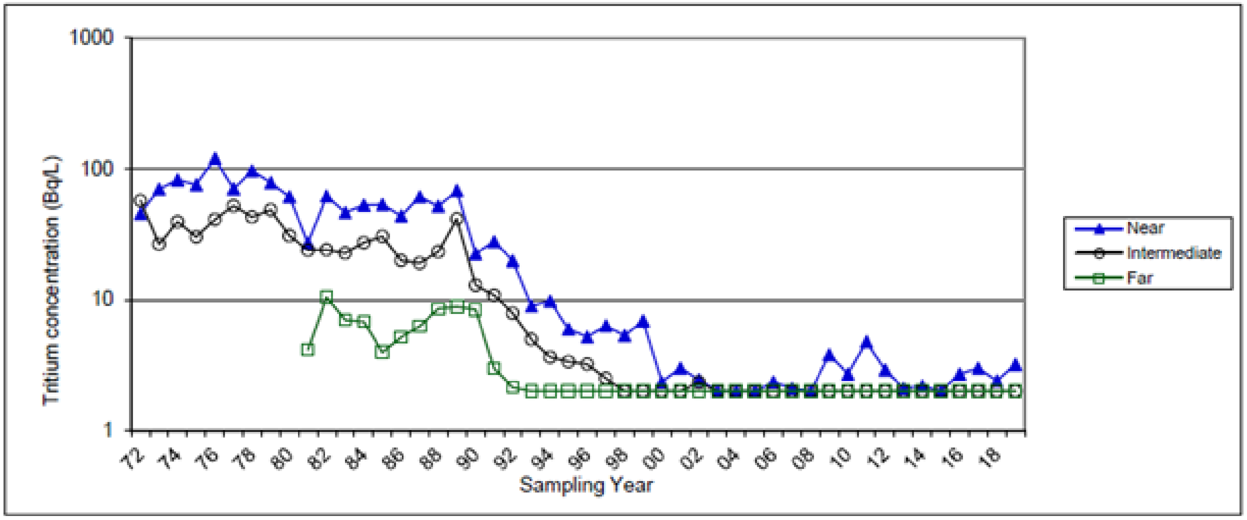
The 2020 aquatic resources delineation report described vegetation communities on the Arroyo Mocho Pumping Station as blue oak woodland, California buckeye groves, Diablan sage scrub, white alder riparian forest, central coast riparian scrub, coast live oak woodland, and non-native annual grassland. Blue oak woodland is present on the north facing slopes above the creek. California buckeye groves are present in the southeast corner of the pumping station on a gradual north facing slope. Diablan sage scrub, dominated by California sagebrush, poison oak, golden yarrow, sticky monkeyflower, and California buckwheat, occurs on the slopes above the creek. White alder riparian forest and central coast riparian scrub are restricted to the narrow riparian corridor. Coast live oak woodland occurs in a stand on a north facing slope above the creek. Non-native grassland is present in upland areas and is dominated by slender oats, ripgut brome, soft chess, red brome, brome fescue, and other species (Nomad Ecology 2020).

4.8.1.4 *Tritium Levels in Vegetation and Commodities*

LLNL monitors several aspects of the terrestrial environment at the Livermore Site, Site 300, and in the vicinity of both sites. Measures include the radioactivity present in soil, vegetation, and wine, and the gamma radiation exposure at ground-level receptors from terrestrial and atmospheric sources. Terrestrial pathways from LLNL operations leading to potential radiological dose to the public include potential ingestion doses from radionuclides in vegetation and wine. Vegetation and foodstuff monitoring have been conducted since 1971. Location monitoring sites classified as “near” are onsite or less than 0.6 mile from the Livermore Site perimeter; “intermediate” monitoring locations are in the Livermore Valley and 0.6 to 3.1 miles from the Livermore Site perimeter; and “far” monitoring locations are more than 3.1 miles from the Livermore Site perimeter. Site 300 has four monitoring locations for vegetation. Vegetation is sampled and analyzed quarterly. Wines for sampling are purchased from a supermarket in Livermore and represent wines from the Livermore Valley, other regions of California, and France (LLNL 2020r).

Tritium in vegetation due to LLNL operations is most likely to be detected at the near and intermediate locations and is highly unlikely to be detected at the far locations. Median concentrations of tritium in vegetation at sampling locations at the Livermore Site and in the Livermore Valley have decreased noticeably since 1989 (Figure 4-60). Median concentrations at the far locations have been below the detection limit since 1993. Median concentrations at the intermediate locations have been below the detection limit since 1998, except in 2002. Median concentrations at the near locations have been at or slightly above the detection limit since 2012. At Site 300, the median concentrations of tritium in vegetation were less than the detection limit at three of the four monitoring sites. Vegetation at the site with median concentration above the detection limit is likely due to occasional uptake of contaminated groundwater by the roots (LLNL 2020r).

Tritium concentrations in wines purchased in 2019 were highest (slightly above the detection limit) in a Livermore Valley wine that was made from grapes harvested in 2016. The highest measured concentration for a California wine (other than the Livermore Valley) was below the detection limit and was made from grapes harvested in 2018 from Mendocino County. The highest measured concentration in a French wine was above the detection limit and from Rhone Valley wine grapes harvested in 2015. Analyses of the wines purchased annually since 1977 have typically demonstrated that tritium concentrations in the Rhone Valley wines are typically higher than tritium concentrations in the Livermore Valley wines. Tritium concentrations in the California wines (other than the Livermore Valley) are typically lower than tritium concentrations in the Livermore Valley wines. This relationship was observed in the 2019 monitoring results (LLNL 2020r).



Note: Median values at or below the lower limit of detection (2.0 Bq/L [54 pCi/L]) are plotted as 2.0 Bq/L (54 pCi/L).
Source: LLNL 2020r.

Figure 4-60. Median Tritium Concentrations in Plant Water Samples at Livermore Site and Livermore Valley (1972–2019)

The hypothetical annual ingestion doses for mean concentrations of tritium in vegetation from LLNL operations for 2019 was approximately 1/35,000 of the average annual background dose in the United States from all-natural sources and about 1/120 the dose from a panoramic dental x-ray. Ingestion doses for Site 300 vegetation were not calculated because neither people nor livestock ingest vegetation from Site 300. For Livermore Valley wines purchased in 2019, the highest concentration of tritium was 0.34 percent of the USEPA standard for maximal permissible level of tritium in drinking water. The potential dose from drinking Livermore Valley wines in 2019 would be about 1/400 of a single dose from a panoramic dental x-ray (LLNL 2020r).

Potential dose to biota resulting from LLNL operations was calculated for 2019 using the sum of the fractions of radionuclide in soil, sediment, and surface water for the aquatic and terrestrial systems. The maximum concentration of each radionuclide measured, considering both the Livermore Site and Site 300, were used in the dose screening calculations for the terrestrial and aquatic fractions. For 2019, the total sum of the fractions for the aquatic ecosystem animals and terrestrial ecosystem animals and plants was well below the screening limit, showing that LLNL's impacts on biota are minimal (LLNL 2020r).

4.8.2 Fish and Wildlife

4.8.2.1 *Livermore Site*

The Livermore Site has a campus-like or business park-like setting with buildings, roadways, pathways, and open space. The area surrounding the Livermore Site is a mixture of rural and pastoral (grazing) uses and urban development. Consequently, wildlife habitat is limited on the Livermore Site. Wildlife includes species that live in the undeveloped grassland in addition to a number of species that live in the developed areas of the site or along the arroyos. Seven amphibian and reptile species, 81 bird species, and 14 mammal species were observed during biological surveys between 1986 and 2021 at the Livermore Site (NNSA 2005; ECORP 2021a). Appendix I provides a list of fish and wildlife species on the Livermore Site.

Invasive species, bullfrog and largemouth bass, are known predators of the federally threatened California red-legged frog. In 1997, bullfrogs were noted in the southern sediment basin, a sediment trap south of Lake Haussmann. A bullfrog management program was coordinated with the USFWS and a fish management plan was coordinated with the California Department of Fish and Wildlife to minimize adverse impacts on the California red-legged frog. Through these management efforts, largemouth bass have been eliminated from Lake Haussmann, although bullfrogs still occur on the Livermore Site (NNSA 2005; LLNL 2013a).

The 2013 *Lawrence Livermore National Laboratory, Livermore Site, Natural Resources Management Plan* describes focal species found in three general habitat types (wetlands and aquatic habitat, security buffer zones, and developed areas) at the Livermore Site. Focal species are the species of primary management concern and can be native or non-native. Focal species in wetlands and aquatic habitats include the California red-legged frog, the American bullfrog, Canada geese, various waterfowl and songbirds, and red-winged blackbirds. Focal species in the security buffer zones around the perimeter of the Livermore Site include California ground squirrels and other small mammals, native reptiles and amphibians, and raptors such as white-tailed kites and red-shouldered hawks. Focal species in the developed areas of the Livermore Site include a variety of migratory and resident birds (e.g., cliff swallows, white throated swifts, and great horned owls) that nest in trees, shrubs, and buildings across the site, and mammals (e.g., striped skunk, raccoon, red and gray foxes, bobcats, and feral cats) that forage and hunt in the developed landscapes (LLNL 2013a).

Passerine bird and waterfowl surveys were conducted in 2021 at the Livermore Site (ECORP 2021a). Avian point-count surveys were conducted at seven stations along the perimeter of the Livermore Site. There were 81 species recorded at the point-count stations. A summary of the 2021 surveys is presented in Appendix I.

Routine nesting bird surveys and nest monitoring conducted at the Livermore Site document that multiple avian species successfully nest and fledge young at this developed site (ECORP 2021a). Surveys within the buffer zones and open fields for burrowing owls did not observe any burrowing owls or sign of presence. Special status species observed during these surveys are discussed in Section 4.8.3.

4.8.2.2 *Site 300*

Large areas of wildland vegetation, interspersion of various plant community types, and availability of water at springs provide habitat for a diversity of wildlife on Site 300. Twenty-nine reptile and amphibian species, 118 bird species, and 48 mammal species have been observed during biological surveys conducted on Site 300 between 1986 and 2021 (LLNL 2021u, ECORP 2021c and 2021d, NNSA 2005). Special status species are discussed in Section 4.8.3.

The 2011 *Natural Resources Management Plan for Site 300* categorizes Site 300 into four broad focal community types, grassland, oak woodland, coastal sage scrub, and wetland/riparian, and defines focal species within these four communities. The Site 300 Natural Resources Management Plan describes focal species as species of ecological value and deemed of priority interest to the long-term management and sustainability of Site 300 natural communities. Grasslands support an abundance of wildlife species that utilize both aboveground and below-ground features. California ground squirrels, considered a keystone species, occur throughout the grassland habitats where they create burrow systems that provide refuge for many species. A variety of grassland passerine birds occur at Site 300 such as loggerhead shrike, grasshopper sparrow, lark sparrow, and horned lark, all of which are protected under the MBTA. Oak woodlands provide islands of food and shelter for a variety of species such as black-tailed deer, red-tailed hawk, and American kestrel. The coastal sage scrub habitat supports wildlife adapted to this hot arid habitat, such as coyote, greater roadrunner, and the common side-blotched lizard. Many of the wildlife species that occur at Site 300 use the wetland/riparian habitats, especially special status species (LLNL 2011c).

Avian point count and raptor migration surveys were conducted at Site 300 in between 2014 and 2016 (Garcia and Associates 2016). A total of 20 large bird species were observed during point counts and the most common species included raven, red-tailed hawk, turkey vulture, northern harrier, rough-legged hawk, golden eagle, and prairie falcon. A total of 28 small bird species was observed during point counts and the most common species included white-crowned sparrow, savannah sparrow, Brewer’s blackbird, western meadowlark, rock wren, horned lark, and Say’s phoebe. The most common species observed during raptor migration surveys included red-tailed hawk, turkey vulture, golden eagle, northern harrier, and American kestrel.

Results of scat detection dog surveys conducted in 2020, and subsequent DNA analysis, do not support the presence of kit foxes at Site 300 or the Corral Hollow Ecological Reserve (Woollett 2021). Carnivore surveys using camera stations and spotlighting were conducted at Site 300 in the spring of 2021 (ECORP 2021b). The surveys were designed to document carnivores and other animals present on Site 300, with a focus on documenting the presence of San Joaquin kit fox, American badger, and mountain lion on Site 300. Bat surveys using acoustic detectors/recorders for passive monitoring were conducted at Site 300 in the spring of 2021 (ECORP 2021c). Summaries of the 2020 and 2021 surveys are presented in Appendix I.

Small mammal (rodents) trapping surveys were conducted in the spring of 2021 to document small mammal occurrence at Site 300 and the adjacent Corral Hollow Ecological Reserve (ECORP 2021d). Herpetological (reptiles and amphibians) surveys using visual observations and cover boards were conducted at Site 300 in 2021 (ECORP 2021d). Summaries of the 2021 survey are presented in Appendix I.

4.8.2.3 *Arroyo Mocho*

The Arroyo Mocho pump station is within the valley-foothill riparian habitat designated in the California Wildlife Habitat Relationships System. The valley-foothill riparian habitat provides food; water; migration and dispersal corridors; and escape, nesting, and thermal cover for an abundance of wildlife. Although the Arroyo Mocho pump station is a small area along the riparian corridor, it contributes to connecting wildlife habitats and increasing the likelihood of sustaining viable wildlife populations in the area (CDFG 1988).

Coordination in January 2021 with LLNL staff confirmed that the cliff swallow colony present in 2008 still exists on the canyon wall below the pump station. In accordance with the biological assessment for the Arroyo Mocho erosion control maintenance projects, activities below the pump station apron are limited to the period outside the nesting season of May 1 to August 15 to protect the swallow colony (LLNL 2008a).

Passerine bird and raptor surveys were conducted in 2021 at six point-count stations to document the presence and abundance of avian species at the Arroyo Mocho Pumping Station (ECORP 2021f). A total of 59 species were recorded during the avian point counts and raptor nesting surveys. A summary of the 2021 survey is presented in Appendix I.

4.8.3 Special Status Species and Habitats

This section includes a description of special status species found at the Livermore Site, Site 300, and the Arroyo Mocho Pumping Station. For the purposes of this analysis, special status species are defined as:

- Species classified as candidate, threatened, or endangered under the federal or California Endangered Species Acts (ESA/CESA);
- U.S. Fish and Wildlife Service (USFWS) Birds of Conservation Concern (USFWS 2021d);
- California Fully Protected Species (CAFPS) (California Fish and Game Code §3511);
- California Species of Special Concern (CASSC) (CNDDB 2022a);
- Bald and Golden Eagle Protection Act (16 U.S.C. 668-668c); and
- Rare plants with a California Rare Plant Rank (CRPR) of 1 or 2 (California Native Plant Society [CNPS] 2021).

Protected habitats described in this section included critical habitat protected under the federal Endangered Species Act, Conservation Areas and Reserves protected through consultations between DOE/NNSA and the USFWS and other agreements, and Sensitive Natural Communities. Sensitive Natural Communities are Natural Communities identified by the CDFW Vegetation Classification and Mapping Program (VegCAMP) as having a rarity rank of S1-S3.

The federal *Endangered Species Act* (ESA) (16 U.S.C. §1531 et seq) provides protection for threatened and endangered species and their habitat. Section 3 of ESA defines endangered species as any animal or plant species in danger of extinction throughout all or a significant portion of its range. This Act further defines threatened species as any species likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. The California ESA (California Fish and Game Code §§ 2050–2089.25) includes provisions intended to protect threatened and endangered species that may be affected by development projects subject to the *California Environmental Quality Act* (CEQA) (California Public Resource Code §21000 et seq). The term "listed species" is used throughout the remainder of this section to refer to species listed as threatened or endangered under the federal or state ESA.

CEQA requires an initial review by state and local agencies, called an Initial Study (IS), of projects by a public agency or a private activity which must receive some discretionary approval from a State of California agency which may cause either a direct physical change in the environment or a reasonably foreseeable indirect change in the environment. The IS a checklist that includes specific questions about the project's level of environmental impacts on 18 resource categories and issues. The CEQA checklist includes the following six questions regarding the level of impacts to biological resources:

1. Would the project have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Wildlife or U.S. Fish and Wildlife Service?

2. Would the project have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Wildlife or US Fish and Wildlife Service?

3. Would the project have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the *Clean Water Act* (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?

4. Would the project interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?

5. Would the project conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?

6. Would the project conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?

If the IS checklist has a finding of "No Impact" or "Less Than Significant Impact" for all categories and questions, then it qualifies for a negative declaration, which is a written statement describing the reasons that a proposed project will not have a significant effect on the environment. If the IS checklist has a finding of "Less Than Significant with Mitigation Incorporated" for at least one of the questions (but no greater impacts), then it qualifies for a "mitigated" negative declaration. CEQA defines a mitigated negative declaration as a negative declaration for a project when the IS has identified potentially significant effects on the environment, but (1) revisions in the project plans or proposals made by, or agreed to by, the applicant before the proposed negative declaration and IS are released for public review would avoid the effects or mitigate the effects to a point where clearly no significant effect on the environment would occur, and (2) there is no substantial evidence in light of the whole record before the public agency that the project, as revised, may have a significant effect on the environment. If biological resources are the reason for the mitigation, typically a biological resources technical study is completed to justify the findings and proposed mitigation.

If the IS checklist has a finding of "Potentially Significant Impact" for at least one of the questions, then an environmental impact report (EIR) must be prepared. CEQA defines an EIR as a detailed statement prepared under CEQA describing and analyzing the significant effects of a project and discussing ways to mitigate or avoid the effects.

The California Natural Diversity Database (CNDDB) is an inventory of the status and locations of rare plants and animals in California. The 2022 CNDDB of animal taxa lists a total of 177 state and federally listed threatened, endangered, or candidate/proposed animal taxa which occur throughout the state of California (CNDDB 2022a). The list includes 43 state listed species, 82 federally listed species, and 52 state and federally listed species (CNDDB 2022a). State listing is pursuant to the *California Endangered Species Act* of 1984 (CESA; California Code of Regulations, Title 14, Chapter 6, §§783.0-787.9; Fish and Game Code Chapter 1.5, §§ 2050-2115.5). Federal listing is pursuant to the Federal Endangered Species Act of 1973, as amended (16 USC §§1531-1544; 50 CFR §§17.1-17.108). The 2022 CNDDB plant taxa lists a total of 285 state and federally listed threatened, endangered or candidate/proposed plant taxa which occur throughout the state of California (CNDDB 2022b). The list includes 100 state listed species, 63 federally listed species, and 122 state and federally listed species (CNDDB 2022b). State listing is pursuant to the Native Plant Protection Act of 1977 (Fish and Game Code Chapter 10 §§1900-1913) and the CESA; California Code of Regulations, Title 14, Chapter 6, §§783.0-787.9; Fish and Game Code Chapter 1.5, §§2050-2115.5). The official California listing of Endangered and Threatened species is contained in the California Code of Regulations, Title 14, §670.5. Federal listing is pursuant to the Federal Endangered Species Act of 1973. The official federal listing of Endangered and Threatened animals is published in the Federal Register, 50 CFR §17.11.

The *California State Wildlife Action Plan* (CDFW 2015) identifies species of greatest conservation need in the Bay Delta and Central Coast Province that are the focus of the CDFW conservation strategies. There are no invertebrate species in the list of focal species for the province, and fish species do not include species associated with the project areas. Amphibian focal species in the California Wildlife Action Plan that are associated with the project area include the California tiger salamander, western spadefoot, foothill yellow-legged frog, and California red-legged frog. Reptile focal species associated with the project area include western pond turtle, San Joaquin coachwhip, Blainville's horned lizard, California legless lizard, California glossy snake, and Alameda whipsnake. Avian focal species associated with the project area include, but are not limited to, bald and golden eagles, Swainson's hawk, northern harrier, white-tailed kite, long-eared owl, burrowing owl, loggerhead shrike, least Bell's vireo, bank swallow, Swainson's thrush, yellow warbler, and tricolored blackbird. Mammal focal species associated with the project area include pallid bat, Yuma myotis, western mastiff bat, long-legged myotis, western red bat, and American badger. The state's action plan identifies stressors on conservation targets as habitat loss and degradation from population growth and development; non-native and invasive species; row crops, vineyards, and orchards; wildfire and fire suppression; and climate change.

Critical habitat designations for species that may occur in the project area have changed multiple times since completion of the 2005 LLNL SWEIS. A biological assessment for the 2005 SWEIS was prepared in 2004 and revised in 2007. Due to the potential for impacts on protected species and their habitats, LLNL has conducted multiple consultations with USFWS. These consultations have resulted in several biological opinions and associated amendments. The USFWS issued an amendment to the existing biological opinion for maintenance activities at the Livermore Site in

December 2010 and an amendment to the existing biological opinion for maintenance activities at Site 300 in August 2007. The most recent formal consultations for the Livermore Site and Site 300 were completed in 2013 and 2018 respectively. In 2013, the USFWS issued a biological opinion for Infill Construction and Redevelopment at the Livermore Site (USFWS 2013), and in 2018, the USFWS and the DOE/NNSA completed a formal consultation on continued operation and maintenance of Site 300 (USFWS 2018). A biological opinion on the maintenance of the Arroyo Mocho Pumping Station was completed in 2004 and amended in 2008 (LLNL 2008a).

4.8.3.1 *Livermore Site*

A list of special status species with the potential to occur at the Livermore Site was derived using the USFWS' Information for Planning and Consultation (IPaC) tool (USFWS 2021a) and onsite studies (LLNL 2020p; ECORP 2021a; LLNL 2021a) of species known or expected to occur in the vicinity of the Livermore Site. The IPaC list includes one mammal (San Joaquin kit fox), one reptile (Alameda whipsnake), two amphibians (California red-legged frog and California tiger salamander), one fish (delta smelt), two insects (monarch butterfly and valley elderberry longhorn beetle), two crustaceans (conservancy fairy shrimp and vernal pool fairy shrimp), and one plant (palmate-bracted bird's beak). The IPaC also includes 12 bird species that are protected under the *Migratory Bird Treaty Act* (MBTA) or the *Bald and Golden Eagle Protection Act* (BGEPA), or occur in the USFWS Birds of Conservation Concern (BCC). Species include the bald eagle, Nuttall's woodpecker, tricolored blackbird, and yellow-billed magpie. There is no USFWS-designated critical habitat at the Livermore Site.

Many of these federal special status species are also considered rare, threatened or endangered by the State of California (Table 4-20). Livermore Site special status species include two amphibians (California red-legged frog and California tiger salamander), one reptile (western pond turtle), 11 birds (five passerine and six raptor species), and two mammals (American badger and Mountain lion) that are considered threatened, endangered, or rare. The special status species observed, or with potential to occur at the Livermore Site, are presented in Table 4-20. The confirmed occurrence is based on observations made between 1986 and 2021. Observations have been conducted by botanists and zoologists with training and experience in conducting surveys consistent with federal and state guidelines.

Table 4-20. List of Special Status Species Observed or with Potential to Occur at the Livermore Site

Common Name	Scientific Name	Regulatory Status	Occurrence[a]
Mammals			
San Joaquin Kit Fox	*Vulpes macrotis mutica*	ST, FE	Not observed, no habitat present
American Badger	*Taxidea taxus*	CDFW:SSC	Confirmed
Mountain lion	*Puma concolor*	Candidate CESA	Confirmed
Birds			
Bald Eagle	*Haliaeetus leucocephalus*	SE, BGEPA	Confirmed
Bullock's Oriole	*Icterus bullockii*	BCC, MBTA	Confirmed
Burrowing owl	*Athene cunicularia*	CDFW:SSC, BCC, MBTA	Confirmed
Clark's Grebe	*Aechmophorus clarkii*	BCC, MBTA	Not observed

Common Name	Scientific Name	Regulatory Status	Occurrence[a]
Salt Marsh Common Yellowthroat	*Geothlypis trichas sinuosa*	BCC, CDFW: SSC, MBTA	Not observed[c]
Golden Eagle	*Aquila chrysaetos*	CDFW:FP, BGEPA	Confirmed
Lawrence's Goldfinch	*Spinus lawrencei*	BCC, MBTA	Not observed
Loggerhead Shrike	*Lanius ludovicianus*	CDFW:SSC, MBTA	Confirmed
Marbled Godwit	*Limosa fedoa*	BCC, MBTA	Not observed
Nuttall's Woodpecker	*Dryobates nuttallii*	BCC, MBTA	Confirmed
Oak Titmouse	*Baeolophus inornatus*	BCC, MBTA	Confirmed
Peregrine Falcon	*Falcon peregrinus anatum*	CDFW:FP, MBTA	Confirmed
Short-billed Dowitcher	*Limnodromus griseus*	BCC, MBTA	Not observed
Modesto Song Sparrow, Suisun Song Sparrow, Alameda Song Sparrow, San Pablo Song Sparrow	*Melospiza melodia*	CDFW:SSC, MBTA	Not observed[d]
Swainson's Hawk	*Buteo swainsoni*	ST, MBTA	Confirmed
Tricolored Blackbird	*Agelaius tricolor*	CDFW:SSC, ST, BCC, MBTA	Not observed
White-tailed Kite	*Elanus leucurus*	CDFW:FP, MBTA	Confirmed
Wrentit	*Chamaea fasciata*	BCC, MBTA	Not observed
Yellow-billed Magpie	*Pica nuttalli*	BCC, MBTA	Not observed
Yellow Warbler	*Setophaga petechia*	CDFW:SSC, MBTA	Confirmed
Reptiles			
Alameda Whipsnake	*Masticophis lateralis euryxanthus*	ST, FT	Not observed, no habitat present.
Western Pond Turtle	*Actinemys marmorata*	CDFW:SSC	Confirmed
Amphibians			
California Red-legged Frog	*Rana draytonii*	CDFW:SSC, FT	Confirmed
California Tiger Salamander	*Ambystoma californiense*	ST, FT	Confirmed[b]
Fishes			
Delta Smelt	*Hypomesus transpacificus*	SE, FT	Not observed, no habitat present
Insects			
Valley Elderberry Longhorn Beetle	*Desmocerus californicus dimorphus*	FT	Not observed, the Livermore Site is west of the known range
Monarch butterfly	*Danaus plexippus*	FC	Species not surveyed for
Crustaceans			
Conservancy Fairy Shrimp	*Branchinecta conservatio*	FE	Not observed, no vernal pool habitat present
Vernal Pool Fairy Shrimp	*Branchinecta lynchi*	FT	Not observed, no vernal pool habitat present
Plants			
Palmate-bracted Bird's Beak	*Chloropyron palmatum*	FE	Not observed, no alkali habitat present

Special Status Codes: BCC = USFWS Bird of Conservation Concern (USFWS 2021d BCC lists); BGEPA = Protected under the *Bald and Golden Eagle Protection Act*; CDFW:SSC = California Department of Fish and Wildlife-Species of Special Concern (CDFW Special Animals List, January 2022); FC = Federally listed as a candidate species for listing; FT = Threatened under the Federal *Endangered Species Act*; MBTA = Protected under the *Migratory Bird Treaty Act*; SE = Endangered under the *State Endangered Species Act*; ST = Threatened under the *California Endangered Species Act*

a. Species observed at the Livermore Site between 1986 and 2021. See Appendix I for observation date.

b. The California Natural Diversity Database contains a record of California tiger salamander on Greenville Road adjacent to the Livermore Site.

c. While the common yellowthroat *(Geothlypis trichas)* was observed at the Livermore Site in 2021, the rare subspecies *Geothlypis trichas sinuosa* has not been confirmed at the Livermore Site
d. While the song sparrow *(Melospiza melodia)* was observed at the Livermore Site in 2021, rare subspecies or populations have not been observed at the Livermore Site

Source: NNSA 2005, Appendix E – Ecology and Biological Assessment; LLNL 2020p; ECORP 2021a; LLNL 2021p; CNDDB 2022a, USFWS 2020, USFWS 2021d.

Surveys for the California red-legged frog were conducted using standard visual encounter survey techniques during the non-breeding season between 1 July and 30 September 2020 and during the breeding season between 1 January and 28 February 2021 in accordance with methods provided in the USFWS Revised Guidance on Site Assessments and Field Surveys for the California Red-Legged Frog (Sequoia 2021a). Passerine bird and waterfowl surveys were conducted in 2021 at the Livermore Site 200 (ECORP 2021a). Annual nesting bird surveys were conducted from 2019 to 2021 for the Livermore Site (LLNL 2021p). Summaries of the 2021 surveys are presented in Appendix I.

4.8.3.2 *Site 300*

A list of special status species with the potential to occur at Site 300 was derived using the IPaC tool (USFWS 2021b) and onsite studies (LLNL 2020r; ECORP 2021c; ECORP 2021e) of species known or expected to occur in the vicinity of the Site 300 (Table 4-21). The Site 300 IPaC list includes one mammal (San Joaquin kit fox), two reptiles (Alameda whipsnake and giant garter snake), two amphibians (California red-legged frog and California tiger salamander), one fish (delta smelt), two insects (monarch butterfly and valley elderberry longhorn beetle), two crustaceans (vernal pool fairy shrimp and vernal pool tadpole shrimp), and one plant (large-flowered fiddleneck). The IPaC also includes 11 bird species that are protected under the MBTA or the BGEPA. Species include the bald eagle, California thrasher, Nuttall's woodpecker, oak titmouse, and wrentit.

Many of these federal special status species are also considered rare, threatened or endangered by the State of California (Table 4-21). Site 300 special status species include three amphibians (California tiger salamander, California red-legged frog, and western spadefoot toad), six reptiles (western pond turtle, Alameda whipsnake, California glossy snake, San Joaquin Coachwhip, Blainville's (coast) Horned Lizard, and Northern California Legless Lizard), six mammals (pallid bat, western red bat, western mastiff bat, Townsend's big-eared bat, American badger, and mountain lion), 17 birds (white pelican, raptors, and passerines), and seven plants (large-flowered fiddleneck, big tarplant, Diamond-petaled California Poppy, adobe navarretia, California androsace, stinkbells, hogwallow starfish) that are considered threatened, endangered, or species of special concern by the state of California. The special status species observed or with potential to occur at the Site 300 are presented in Table 4-21. The confirmed occurrence is based on observations made between 1986 and 2021. Observations have been conducted by botanists and zoologists with training and experience in conducting surveys consistent with federal and state guidelines.

In addition, LLNL maintains a list of special status wildlife species known to occur at Site 300 in the Site Annual Environmental Report (SAER). The SAER list was originally based on the results of biological surveys conducted for the 2005 SWEIS and has been periodically updated as additional surveys were conducted and through the CERCLA five-year ecological review process (LLNL 2019ac).

Table 4-21. List of Special Status Species Observed or with Potential to Occur at Site 300

Common Name	Scientific Name	Regulatory Status	Occurrence Status[a]
Mammals			
San Joaquin Kit Fox	*Vulpes macrotis mutica*	ST, FE	Not observed
Mountain lion	*Puma concolor*	Candidate CESA	Confirmed
American Badger	*Taxidea taxus*	CDFW:SSC	Confirmed
Pallid Bat	*Antrozous pallidus*	CDFW:SSC	Confirmed
Towsend's Big-eared Bat	*Corynorhinus townsendii*	CDFW:SSC	Confirmed
Western Red Bat	*Lasiurus blossevillii*	CDFW:SSC	Confirmed
Western Mastiff Bat	*Eumops perotis*	CDFW:SSC	Confirmed
Birds			
American White Pelican	*Pelecanus erythrorhynchos*	CDFW:SSC	Confirmed
Bald Eagle	*Haliaeetus leucocephalus*	SE, BGEPA	Confirmed
Burrowing Owl	*Athene cunicularia*	CDFW:SSC, BCC, MBTA	Confirmed
California Thrasher	*Toxostoma redivivum*	BCC, MBTA	Confirmed
Salt Marsh Common Yellowthroat	*Geothlypis trichas sinuosa*	BCC, CDFW: SSC, MBTA	Not observed[b]
Golden Eagle	*Aquila chrysaetos*	CDFW:FP, BGEPA, MBTA	Confirmed
Grasshopper Sparrow	*Ammodramus savannarum*	CDFW:SSC, MBTA	Confirmed
Lawrence's Goldfinch	*Spinus lawrencei*	BCC, MBTA	Not observed
Loggerhead Shrike	*Lanius ludovicianus*	CDFW:SSC, MBTA	Confirmed
Long-eared Owl	*Asio otus*	CDFW:SSC, BCC, MBTA	Confirmed
Northern Harrier	*Circus cyaneus*	CDFW:SSC, BCC, MBTA	Confirmed
Nuttall's Woodpecker	*Dryobates nuttallii*	BCC, MBTA	Confirmed
Oak Titmouse	*Baeolophus inornatus*	BCC, MBTA	Confirmed
Olive-sided Flycatcher	*Contopus cooperi*	CDFW:SSC, BCC, MBTA	Not observed
Peregrine Falcon	*Falcon peregrinus anatum*	CDFW:FP, MBTA	Confirmed
Short-eared Owl	*Asio flammeus*	CDFW:SSC, BCC, MBTA,	Confirmed
Song Sparrow “"Modesto” population	*Melospiza melodia*	CDFW:SSC, MBTA	Confirmed
Swainson’s Hawk	*Buteo swainsoni*	ST, MBTA	Confirmed
Tricolored Blackbird	*Agelaius tricolor*	CDFW:SSC, ST, BCC, MBTA	Confirmed
White-tailed Kite	*Elanus leucurus*	CDFW:FP, MBTA	Confirmed
Willow Flycatcher	*Empidonax traillii*	SE, MBTA	Confirmed
Wrentit	*Chamaea fasciata*	BCC, MBTA	Not Observed
Yellow-billed Magpie	*Pica nuttalli*	BCC, MBTA	Not Observed
Reptiles			
Alameda Whipsnake	*Masticophis lateralis euryxanthus*	ST, FT	Confirmed
California Glossy Snake	*Arizona elegans occidentalis*	CDFW:SSC	Confirmed
Giant Garter Snake	*Thamnophis gigas*	ST, FT	Not observed, no habitat present
Western Pond Turtle	*Actinemys marmorata*	CDFW:SSC	Confirmed
San Joaquin Coachwhip	*Masticophis flagellum ruddocki*	CDFW:SSC	Confirmed

Common Name	Scientific Name	Regulatory Status	Occurrence Status[a]
Blainville's (coast) horned lizard	*Phrynosoma blainvillii*	CDFW:SSC	Confirmed
Northern California Legless Lizard	*Anniella pulchra*	CDFW:SSC	Confirmed
Amphibians			
California Red-legged Frog	*Rana draytonii*	CDFW:SSC, FT	Confirmed
California Tiger Salamander	*Ambystoma californiense*	ST, FT	Confirmed
Western Spadefoot Toad	*Spea hammondii*	CDFW:SSC	Confirmed
Foothill Yellow-legged Frog	*Rana boylii*	CDFW:SSC, SE, FC	Not observed
Fishes			
Delta Smelt	*Hypomesus transpacificus*	SE, FT	Not observed, no habitat present
Insects			
Valley Elderberry Longhorn Beetle	*Desmocerus californicus dimorphus*	FT	Confirmed
Monarch butterfly	*Danaus plexippus*	FC	Surveys not conducted for this species
Crustaceans			
Vernal Pool Tadpole Shrimp	*Lepidurus packardi*	FE	Not observed
Vernal Pool Fairy Shrimp	*Branchinecta lynchi*	FT	Not observed
Plants			
Large-flowered Fiddleneck	*Amsinckia grandiflora*	FE, SE, CRPR 1B	Confirmed
Big Tarplant	*Blepharizonia plumosa*	CRPR 1B	Confirmed
Diamond-petaled California Poppy	*Eschscholzia rhombipetala*	CRPR 1B	Confirmed
Adobe Navarretia	*Navarretia nigelliformis* ssp. *radians*	CRPR 1B	Confirmed
California Androsace	*Androsace elongata* ssp. *acuta*	CRPR 4	Confirmed
Stinkbells	*Fritillaria agrestis*	CRPR 4	Confirmed
Hogwallow Starfish	*Hesperevax caulescens*	CRPR 4	Confirmed

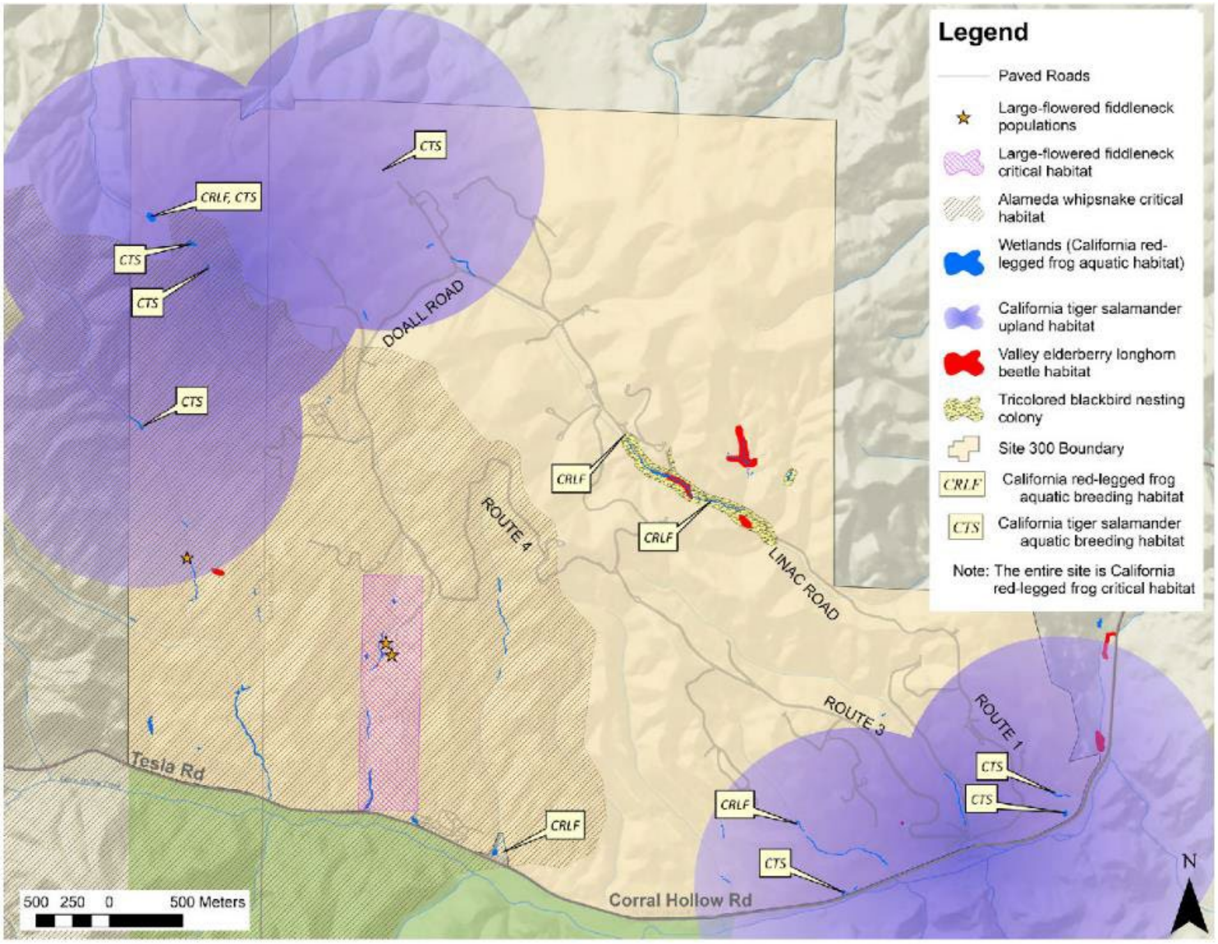
Special Status Codes: BCC = USFWS Bird of Conservation Concern (USFWS 2021d BCC lists); BGEPA = Protected under the *Bald and Golden Eagle Protection Act*; CDFW:SSC = California Department of Fish and Wildlife-Species of Special Concern (CDFW Special Animals List, January 2022); CRPR 1B = California Rare Plant Rank 1B, species are considered rare and endangered throughout their range (CNPS 2021); CRPR 4 = California Rare Plant Rank 4, plants of limited distribution that are not considered rare or endangered (CNPS 2021); FC = Federally listed as a candidate species for listing; FT = Threatened under the Federal *Endangered Species Act*; MBTA = Protected under the *Migratory Bird Treaty Act*; SE = Endangered under the State *Endangered Species Act*; ST = Threatened under the *California Endangered Species Act*

a. Species observed at the Livermore Site between 1986 and 2021. See Appendix I for observation date.

b. While the common yellowthroat *(Geothlypis trichas)* has been observed at Site 300, the rare subspecies *Geothlypis trichas sinuosa* has not been confirmed at Site 300.

Source: NNSA 2005, Appendix E – Ecology and Biological Assessment; USFWS 2020; USFWS 2021b; USFWS 2021d; LLNL 2020r; ECORP 2021c; ECORP 2021e.

Site 300 is within critical habitat designated by USFWS for the Alameda whipsnake (71 FR 58176) and California red-legged frog (75 FR 12816). These critical habitats extend far beyond the boundaries of Site 300. The USFWS-designated critical habitat for the large-flowered fiddleneck (50 FR 19374) is within the boundaries of Site 300. The protected natural resources at Site 300 are depicted in Figure 4-61.



Note: All of Site 300 is critical habitat for California red-legged frog. California red-legged frog and California tiger salamander aquatic breeding locations are called out along with aquatic non-breeding habitat. All areas within one mile of aquatic habitat are upland habitat for the California red-legged frog; this includes the entire site. California tiger salamander upland habitat is symbolized on the map.
Source: LLNL 2020p.

Figure 4-61. Protected Natural Resources at Site 300

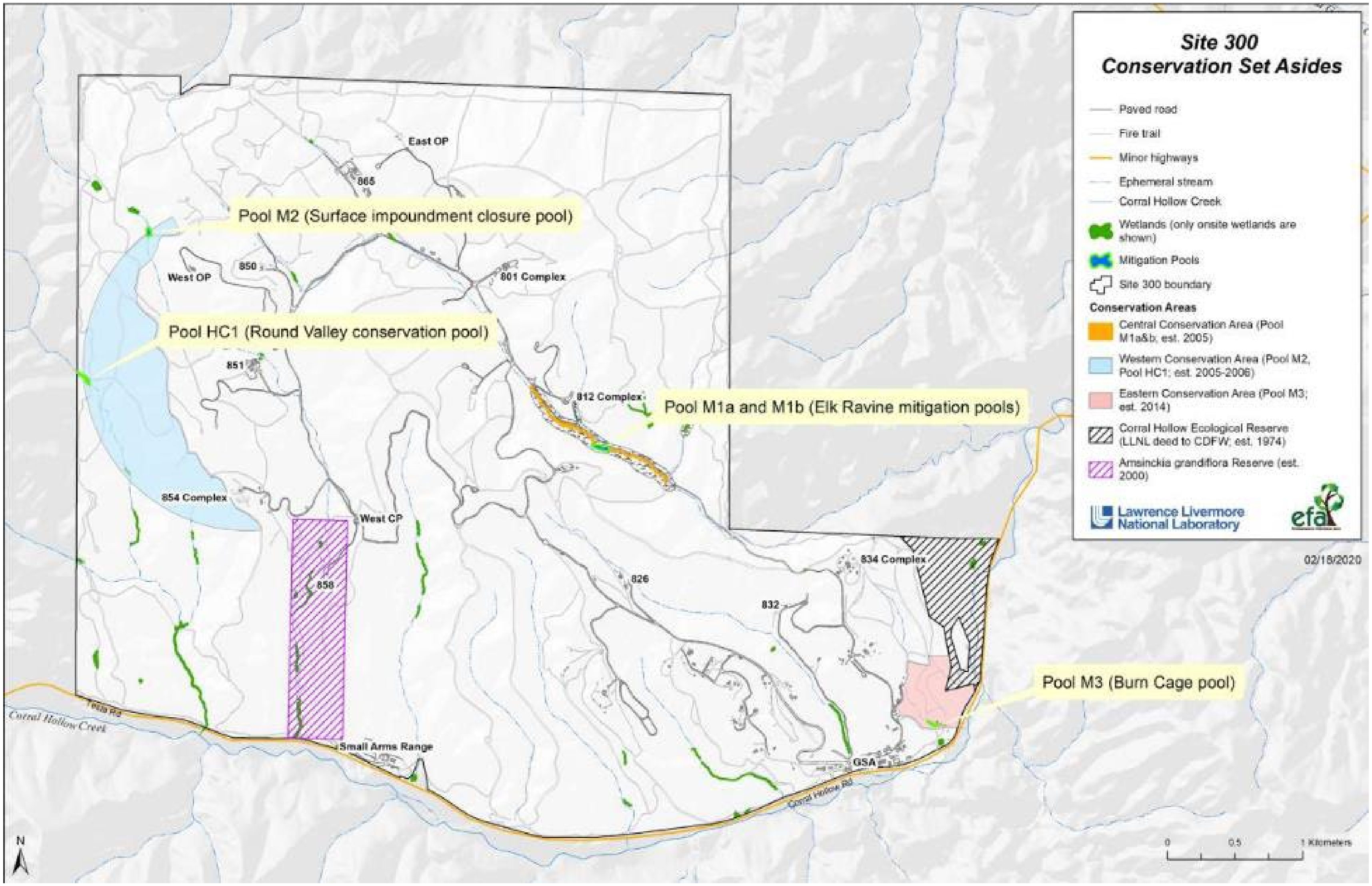
Five conservation areas are maintained at Site 300 as compensation for projects included in ESA consultations with USFWS between 2002 and 2018: Pool M2 (2005), Pool HC1 (2002), the Central Conservation Area (including Pools M1a and b) (USFWS 2002), the Eastern Conservation Area (including Pool M3) (2014), and the Western Conservation Area (including Pools HC1 and M2) (2018) (LLNL 2021b). These five areas combined include approximately 920 acres at Site 300. Two additional reserves have been created by DOE for the protection of natural ecosystems and special status species: the *Amsinckia grandiflora* Reserve and the Corral Hollow Ecological Reserve. The Corral Hollow Ecological Reserve has been deeded to the CDFW, and LLNL maintains a small inholding within the Reserve. Development is restricted within the five conservation areas and the *Amsinckia grandiflora* Reserve. Conservation set asides at Site 300 are depicted in Figure 4-62.

Sensitive botanical resource surveys, and vegetation mapping and classification were conducted in April-June, and August 2020, and February and March 2021 on the 7,000-acre LLNL Site 300 (Nomad Ecology 2021a). A visual survey was conducted in October and November 2020 to determine the potential presence of the valley elderberry longhorn beetle and the quantity and quality of its host plant, blue elderberry on Site 300 and CDFW land southeast of Site 300 (Shepard 2020). Presence-absence surveys were conducted, along with inspections of elderberry plants, at Site 300 and CDFW land southeast of Site 300 for signs of past infestation as evidenced by exit holes in April and May 2021 (Shepard 2021). Summaries of the 2020 and 2021 surveys are presented in Appendix I.

Surveys for protected fairy shrimp were conducted in 2002, 2003, 2010 and 2016. During these surveys, no special status branchiopods were found at Site 300 (LLNL 2019ac).

Carnivore surveys conducted in 2021 detected one California Species of Special Concern (American badger). San Joaquin kit fox were not detected at Site 300 during 2021 surveys or any previous surveys. Although mountain lions were not detected on Site 300 during 2021 survey, this species is known to occur occasionally at Site 300 (ECORP 2021b). Bat surveys conducted in 2021 identified species that are designated as California Species of Special Concern, including the western red bat, pallid bat, Townsend's big-eared bat, and western mastiff bat (ECORP 2021c). Small mammal (rodent) trapping surveys conducted in 2021 identified common species found throughout Alameda and San Joaquin counties but did not document the presence of the federally listed (endangered) riparian woodrat (ECORP 2021d). Herpetological (reptiles and amphibians) surveys using visual observations were conducted at Site 300 in 2021 (ECORP 2021e). The surveys targeted three California Species of Special Concern reptile species, including Blainville's (coast) Horned Lizard, Northern California Legless Lizard, and San Joaquin Coachwhip. All three target species were documented. Special status avian and amphibian monitoring were conducted between October 2018 and September 2020 (LLNL 2021c) to fulfill management recommendations described in the Site 300 Natural Resources Management Plan (LLNL 2011c). Summaries of these surveys are presented in Appendix I.

Nesting raptors and raven locations were monitored in 2019 and 2020 at Site 300 (LLNL 2021c). Focused monitoring was conducted for burrowing owl, red-tailed hawk, great horned owl, barn owl and common raven. Monitoring for California red-legged frog and California tiger salamander was conducted in 2019 and 2020 (LLNL 2021o). Nine seasonal pools that support California tiger salamander breeding were monitored in 2019 and 2020 (LLNL 2021o). Fire trail surveys were conducted in 2019 and 2020 for approximately 85 miles of dirt fire trails on Site 300 in preparation for annual fire trail grading (LLNL 2021o). Alameda whipsnake surveys were conducted in 2021 (LLNL 2021q). A summary of the surveys is presented in Appendix I.



Source: LLNL 2021b.

Figure 4-62. Conservation Set Asides at Site 300

4.8.3.3 *Arroyo Mocho*

A list of special status species was derived using the IPaC tool and onsite studies (USFWS 2021c, LLNL 2020r, Sequoia 2021b, ECORP 2021f) of species known or expected to occur in the vicinity of the Arroyo Mocho Pumping Station. The IPaC list includes one mammal (San Joaquin kit fox), one reptile (Alameda whipsnake), two amphibians (California red-legged frog and California tiger salamander), one bird (California least tern), one fish (delta smelt), one insect (monarch butterfly), and one crustacean (vernal pool fairy shrimp). The IPaC also includes 14 bird species that are protected under the MBTA or the BGEPA, or occur in the BCC. Species include the bald and golden eagles, oak titmouse, and yellow-billed magpie. The pumping station is within critical habitat designated by USFWS for the Alameda whipsnake and California red-legged frog (LLNL 2008a). These critical habitats extend far beyond the boundaries of the pumping station.

Based on a review of available databases and literature, familiarity with the regional flora, and presence of specific vegetation types, four California Native Plant Society special status (rare and watch list) species were determined to be targets of the 2020 and 2021 rare plant surveys at Arroyo Mocho (Nomad Ecology 2021b). A habitat suitability assessment was conducted in 2021 for special-status reptiles, amphibians, and fish within the Arroyo Mocho Pumping Station (Sequoia 2021b). Passerine bird and raptor surveys were conducted in 2021 at six point-count stations to document the presence and abundance of avian species at the Arroyo Mocho Pumping Station (ECORP 2021f). Summaries of these studies are presented in Appendix I.

Many of these federal special status species are also considered rare, threatened or endangered by the State of California (Table 4-22). Arroyo Mocho special status species include three amphibians (California tiger salamander, California red-legged frog, and foothill yellow-legged frog), three reptiles (western pond turtle, Alameda whipsnake, and San Joaquin coachwhip), two mammals (pallid bat and western red bat), and six birds (bald eagle, golden eagle, olive-sided flycatcher, tricolored blackbird, willow flycatcher, and yellow warbler), and three plants (Jepson's woolly sunflower, hospital canyon larkspur, Michael's piperia) that are considered threatened, endangered, or species of special concern by the state of California. The special status species observed or with potential to occur at the Livermore Site are presented in Table 4-22. The confirmed occurrence is based on observations made between 1986 and 2021. Observations have been conducted by botanists and zoologists with training and experience in conducting surveys consistent with federal and state guidelines.

Table 4-22. List of Special Status Species Observed or with Potential to Occur at the Arroyo Mocho Pumping Station

Common Name	Scientific Name	Regulatory Status	Occurrence[a]
Mammals			
Mountain Lion	*Puma concolor*	Candidate CESA	Expected, surveys not conducted for this species
San Joaquin Kit Fox	*Vulpes macrotis mutica*	FE, ST	Poor habitat quality, surveys not conducted for this species
Pallid Bat	*Antrozous pallidus*	CDFW:SSC	Bat surveys not conducted
Western Red Bat	*Lasiurus blossevillii*	CDFW:SSC	Bat surveys not conducted
Birds			
Bald Eagle	*Haliaeetus leucocephalus*	BGEPA, SE	Not observed
Bullock's Oriole	*Icterus bullockii*	BCC, MBTA	Confirmed
California least tern	*Sternula antillarum browni*	FE, SE, MBTA	Not observed
California Thrasher	*Toxostoma redivivum*	BCC, MBTA	Confirmed
Clark's Grebe	*Aechmophorus clarkii*	BCC, MBTA	Not observed
Salt Marsh Common Yellowthroat	*Geothlypis trichas sinuosa*	BCC, CDFW: SSC, MBTA	Not observed
Golden Eagle	*Aquila chrysaetos*	BGEPA, CDFW:FP	Confirmed
Lawrence's Goldfinch	*Spinus lawrencei*	BCC, MBTA	Not observed
Nuttall's Woodpecker	*Dryobates nuttallii*	BCC, MBTA	Confirmed
Oak Titmouse	*Baeolophus inornatus*	BCC, MBTA	Confirmed
Olive-sided flycatcher	*Contopus cooperi*	CDFW:SSC, BCC, MBTA	Confirmed
Short-billed Dowitcher	*Limnodromus griseus*	BCC, MBTA	Not observed
Tricolored Blackbird	*Agelaius tricolor*	CDFW:SSC, ST, BCC, MBTA	Not observed
Willow Flycatcher	*Empidonax traillii*	SE, MBTA	Confirmed
Willet	*Tringa semipalmata*	BCC, MBTA	Not observed
Wrentit	*Chamaea fasciata*	BCC, MBTA	Confirmed
Yellow-billed Magpie	*Pica nuttalli*	BCC, MBTA	Not observed
Yellow Warbler	*Setophaga petechia*	CDFW:SSC, MBTA	Not observed
Reptiles			
Alameda Whipsnake	*Masticophis lateralis euryxanthus*	FT, ST	Expected, Surveys not conducted for this species
Blainville's (coast) horned lizard	*Phrynosoma blainvillii*	CDFW:SSC	Not observed, moderate potential for occurrence, Surveys not conducted for this species
Western Pond Turtle	*Actinemys marmorata*	CDFW:SSC	Confirmed
San Joaquin Coachwhip	*Masticophis flagellum ruddocki*	CDFW:SSC	Expected, Surveys not conducted for this species
Amphibians			
California Red-legged Frog	*Rana draytonii*	CDFW:SSC, FT	Confirmed
California Tiger Salamander	*Ambystoma californiense*	ST, FT	Not observed, low potential for occurrence, Surveys not conducted for this species
Foothill Yellow-legged Frog	*Rana boylii*	CDFW:SSC, SE, FC	Confirmed

Common Name	Scientific Name	Regulatory Status	Occurrence[a]
Fishes			
Delta Smelt	*Hypomesus transpacificus*	SE, FT	Not observed, only occurs in the San Francisco Bay estuary
Steelhead	*Oncorhynchus mykiss*	FT, CASSC	No likely to occur, Surveys not conducted for this species
Crustaceans			
Vernal Pool Fairy Shrimp	*Branchinecta lynchi*	FT	Not observed, no vernal pool habitat present
Plants			
Jepson's woolly sunflower	*Eriophyllum jepsonii*	CRPR 4.3	Confirmed
Hospital Canyon larkspur	*Delphinium californicum subsp. Interius*	CRPR 1B.2	Confirmed
Michael's piperia	*Piperia michaelii*	CRPR 4.2	Confirmed

Special Status Codes: BCC = USFWS Bird of Conservation Concern (USFWS 2021d BCC lists); BGEPA = Protected under the *Bald and Golden Eagle Protection Act*; CDFW:SSC = California Department of Fish and Wildlife-Species of Special Concern (CDFW Special Animals List, January 2022); CRPR 1B = California Rare Plant Rank 1B, species are considered rare and endangered throughout their range (CNPS 2021); CRPR 4 = California Rare Plant Rank 4, plants of limited distribution that are not considered rare or endangered (CNPS 2021); FC = Federally listed as a candidate species for listing; FT = Threatened under the *Federal Endangered Species Act*; MBTA = Protected under the *Migratory Bird Treaty Act*; SE = Endangered under the *State Endangered Species Act*; ST = Threatened under the *California Endangered Species Act*

a. Species observed at Site 300 between 1986 and 2021. See Appendix I for observation date.

Source: NNSA 2005, Appendix E – Ecology and Biological Assessment; USFWS 2020; USFWS 2021c; USFWS 2021d; LLNL 2020r.Sequoia 2021b; ECORP 2021f.

4.8.4 Wetlands

Wetland/aquatic resource delineations were completed in June 2020 (Nomad Ecology 2020) for the Livermore Site, Site 300, and the Arroyo Mocho Pumping Station in support of the LLNL SWEIS (Appendix E). A summary of the wetland/aquatic resource delineations is presented in Appendix I. The delineation report presents the results of the field evaluations conducted in June 2020 and provides a preliminary determination of (1) jurisdictional waters of the United States and California (including wetlands) and (2) wetlands and floodplains as defined by 10 CFR Part 1022, *Department of Energy Floodplain and Wetland Environmental Review Requirements*. These preliminary determinations have not been verified by the USACE or the Regional Water Quality Control Board.

At the time of the 2020 wetland delineation report, the scope of waters and wetlands regulated under the federal *Clean Water Act* (waters of the U.S.) was defined by the April 2020 Navigable Waters Protection Rule (85 FR 22250). As a result of recent rulings by the U.S. District Court in August 2021, the USACE and the USEPA have halted the implementation of the Navigable Waters Protection Rule and are interpreting waters of the US consistent with the pre-2015 regulatory regime. Further revisions to the definition of waters of the US are expected prior to the finalization of this SWEIS.

The USACE defines wetlands as "those areas that are inundated or saturated with ground or surface water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted to life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas." EO 11990, "Protection of Wetlands," requires analyses of potential impacts to wetlands related to proposed federal actions. Additionally, Section 404 of the *Clean Water Act* (33 U.S.C. § 1344) authorizes the Secretary of the Army, acting through the Chief of Engineers, to issue permits for the discharge of dredged or fill materials into the waters of the United States, including wetlands (USACE 1987).

California EO W-59-93, "State Wetland Conservation Policy," established the state's "No Net Loss" policy for wetlands, established a State Wetland Conservation Policy, and provided comprehensive direction for the coordination of state-wide activities for the preservation and protection of wetland habitats. The *State Wetland Definition and Procedures for Discharges of Dredged or Fill Material to Waters of the State* was adopted by the State Water Resources Control Board in April 2019 to clarify what is considered a wetland for the entire state and establishes permitting procedures for discharged materials from or to areas considered a wetland (CWB 2019).

The definition of wetlands included in the *Department of Energy Floodplains and Wetlands Review Requirements* mirrors the federal definition. This regulation defines a wetland as "an area that is inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions, including swamps, marshes, bogs, and similar areas." (10 CFR § 1022.4).

4.8.4.1 *Livermore Site*

Two creeks, Arroyo Seco and Arroyo Las Positas, are present on the Livermore Site. Both arroyos are part of the Alameda Creek Watershed and have been artificially modified as a result of historic use. Arroyo Las Positas is in a trapezoidal channel. Naturally, Arroyo Las Positas would have intermittent flow and become completely dry during the summer months. Arroyo Seco is ephemeral and typically only flows during rain events. An artificial impoundment, Lake Haussmann, is centrally located at the Livermore Site. All three waters bodies, Arroyo Seco, Arroyo Las Positas, and Lake Haussmann, receive water from natural run off and artificial sources. Intermittent and ephemeral streams are regulated by the state and may be regulated by the USACE.

As part of the CERCLA process, groundwater at the Livermore Site is pumped, treated, and released to Lake Haussmann and several surface drainages that flow into Lake Haussmann, Arroyo Seco, and Arroyo Las Positas. This release results in a perennial water flow through a 4,500-foot reach of Arroyo Las Positas within the Livermore Site. This artificial perennial water source has resulted in the growth of dense wetland vegetation downstream of the groundwater discharges. Upstream of the discharges, Arroyo Las Positas has an intermittent flow and is vegetated by annual and perennial grasses.

Numerous artificial linear drainage ditches cross the Livermore Site and connect to Arroyo Las Positas either above ground or through underground culverts. Many of the ditches are perennial due to continuous inputs from LLNL groundwater treatment facilities (Nomad Ecology 2020).

Wetlands identified during the 2020 wetland delineation of the Livermore Site total 1.8 acres. These wetlands include seasonal wetlands and freshwater marsh wetlands found within the channel of intermittent and ephemeral streams. Lakes, rivers, and streams that do not include wetlands are referred to as other waters (waters). At the Livermore Site, waters include those portions of intermittent and ephemeral drainages and Lake Haussmann that do not support wetlands. The 2020 wetland delineations identified waters including intermittent and ephemeral streams and Lake

Haussmann at the Livermore Site which together total 5.3 acres. Wetlands and waters combined total 7.1 acres and 9,685 linear feet. The FEMA floodplain maps show a total of 25.9 acres of floodplain on the Livermore Site (Nomad Ecology 2020). The wetlands and waters on the Livermore Site are presented in Figure 4-63 and Figure 4-64.

Intermittent streams include Arroyo Las Positas, the two aboveground outlet segments of Lake Haussmann, and the channel immediately upstream of Lake Haussmann. Wetland portions of Arroyo Las Positas were characterized by dense freshwater marsh vegetation. Ephemeral streams on the Livermore Site include Arroyo Seco and East Gate Drainage.

Three seasonal wetlands were identified on the Livermore Site that receive runoff from the hills east of the installation. The seasonal wetlands are found within a ditch that is parallel to the west side of Greenville Road and within the East Gate Drainage and may be considered waters of the state and DOE wetlands. All of the drainage ditches that receive only artificial water input were determined to be non-regulated features (Nomad Ecology 2020).

4.8.4.2 *Site 300*

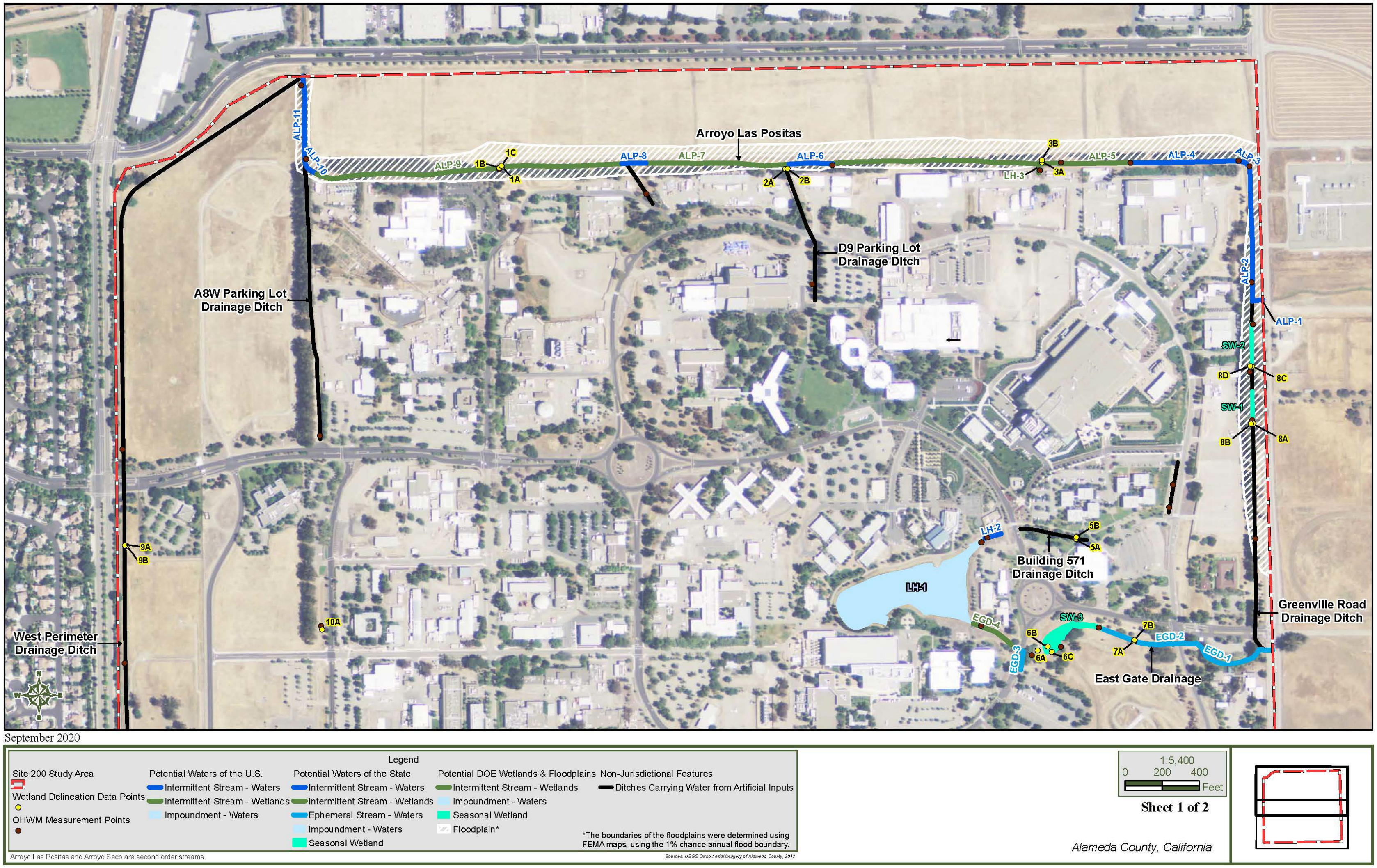
The 2020 delineation identified 10.5 acres and 108,066 linear feet of intermittent and ephemeral streams at Site 300. Wetlands identified in 2020 include 49 seasonal and perennial wetlands totaling 8.4 acres. Seasonal wetlands at Site 300 are primarily fed by seeps, although some seasonal wetlands on the site appear to be fed by direct precipitation. In 2002, 46 wetland features with a combined area of 8.6 acres, including three vernal pool features and five seasonal pond features, were identified at Site 300. The area and distribution of wetlands at Site 300 has remained relatively constant from 2002 to 2020. Intermittent and ephemeral streams were not evaluated in 2002. Wetlands, intermittent streams, and ephemeral streams identified at Site 300 in 2020 total 18.9 acres and 108,066 linear feet. The FEMA floodplain maps show the Corral Hollow floodplain on Site 300 is 9.6 acres (Nomad Ecology 2020). The wetlands and waters on Site 300 are presented in Figure 4-65. Intermittent and ephemeral streams and associated wetlands are regulated by the state and may be regulated by the USACE.

Corral Hollow is the only intermittent stream on Site 300. There were 30 ephemeral stream segments identified in Site 300. The ephemeral streams averaged 2-3 feet in width, and some contained wetlands in the channels. Ephemeral streams on Site 300 are waters of the state and may be waters of the U.S. Four perennial wetlands containing freshwater marsh vegetation were identified in Draney Canyon, Elk Ravine, and near Corral Hollow. The wetlands were fed by seeps and had sufficient water to flow year-round. These perennial wetlands meet the DOE wetland definition and are regulated by the state. A total of 45 seasonal wetlands were mapped on Site 300. These wetlands are primarily fed by seeps and are in drainages. The seasonal wetlands meet the DOE wetland definition and are regulated by the state (Nomad Ecology 2020). Some of the seasonal and perennial wetlands may also be waters of the U.S. if they are found within streams that are federally regulated.

4.8.4.3 *Arroyo Mocho*

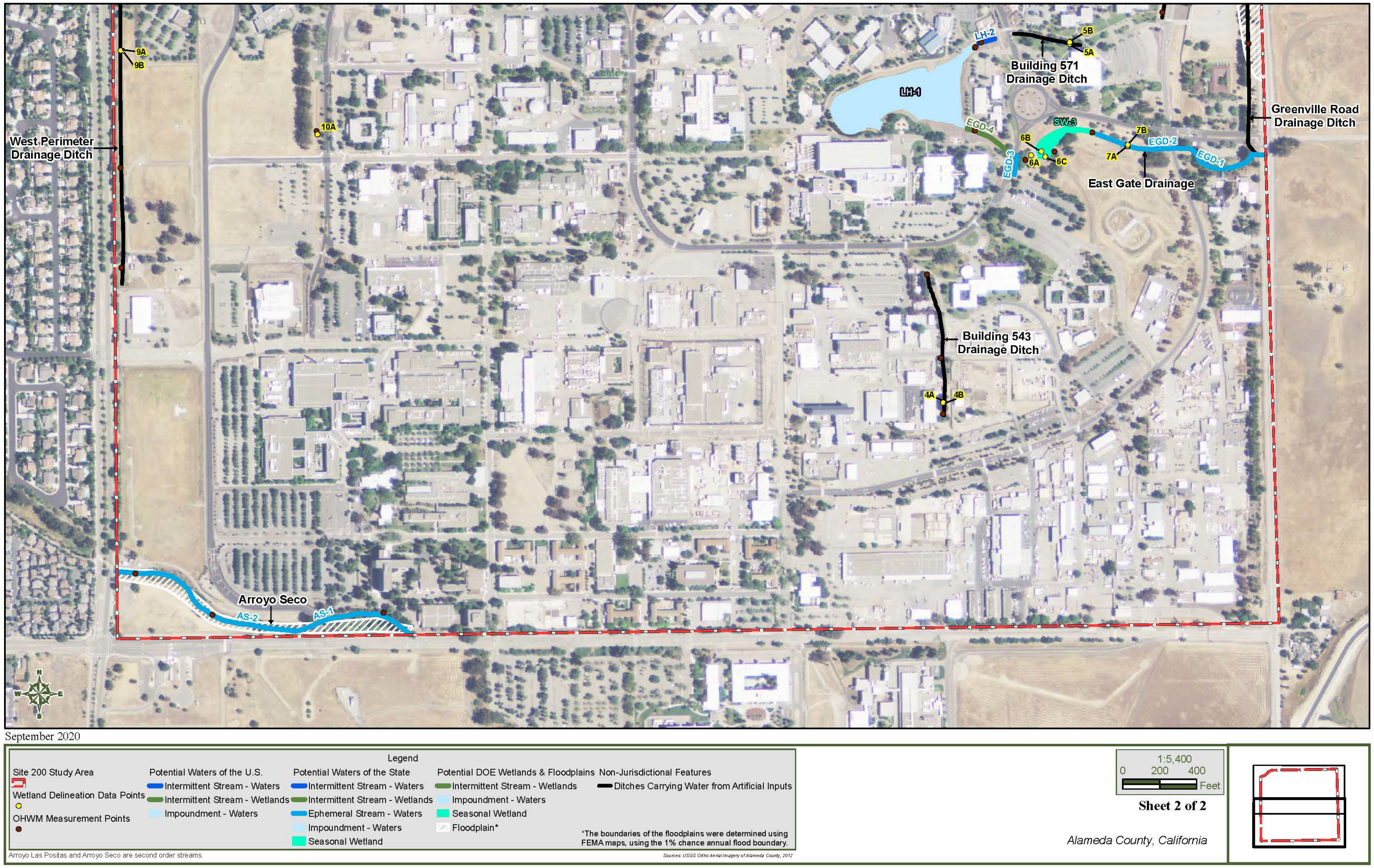
Potential waters of the U.S. identified in the 2020 delineation in the areas operated and maintained by LLNL (i.e., pump station and access road) at Arroyo Mocho include open water which totals

3.5 acres and 3,865 linear feet. Arroyo Mocho is also a water of the state. No wetlands were identified in the 2020 delineation at Arroyo Mocho. The only jurisdictional feature identified in the 2020 delineation of the Arroyo Mocho Pumping Station was Arroyo Mocho, an intermittent steam. At the time of the June site visit, the stream was mostly dry with some pools of standing water. The averages width of the stream was 40 feet (Nomad Ecology 2020). The waters of the U.S. at Arroyo Mocho Pumping Station are presented in Figure 4-66.



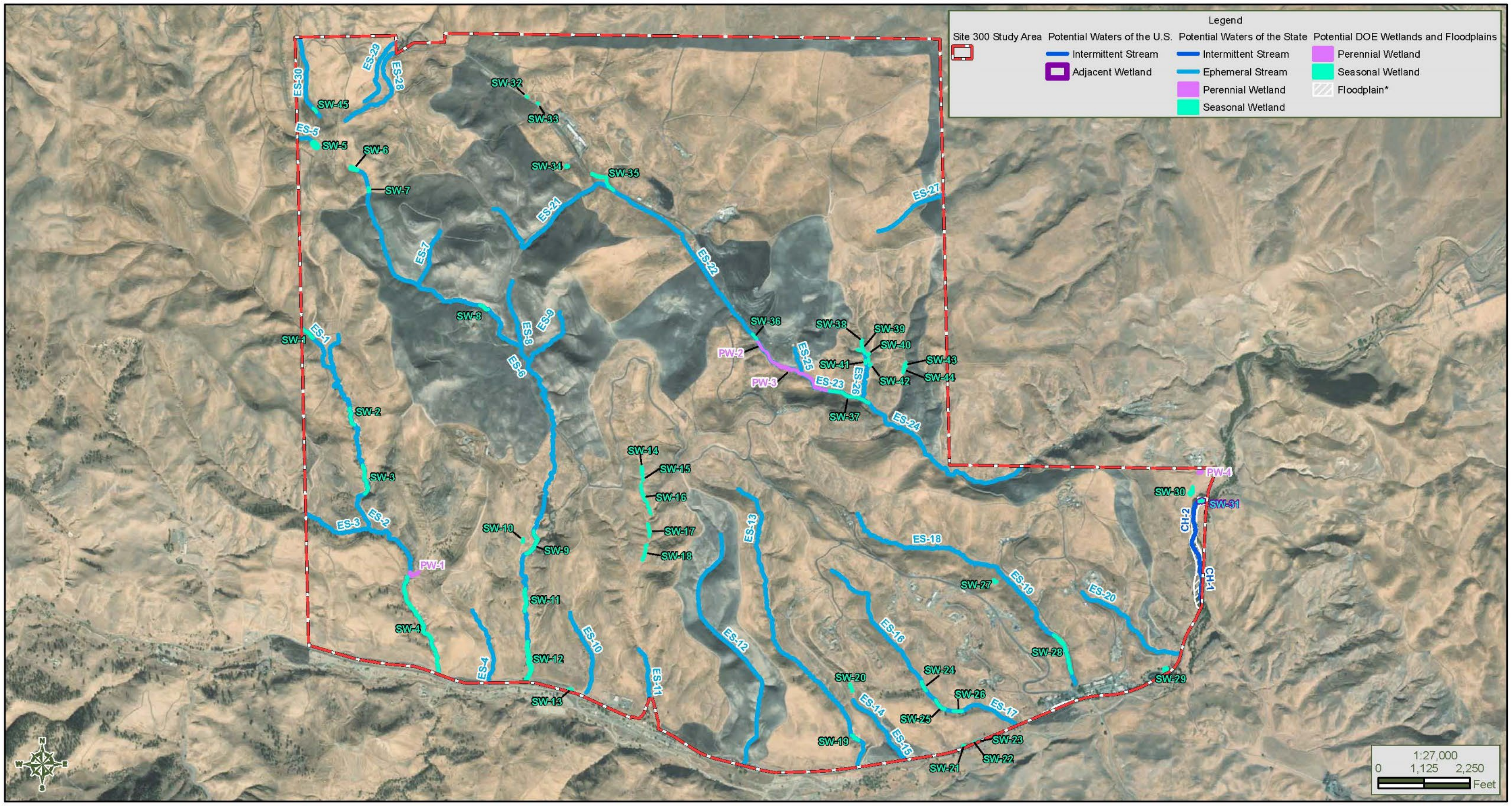
Source: Nomad Ecology 2020.

Figure 4-63. Wetland and Aquatic Resources Delineation at the Livermore Site (sheet 1 of 2)



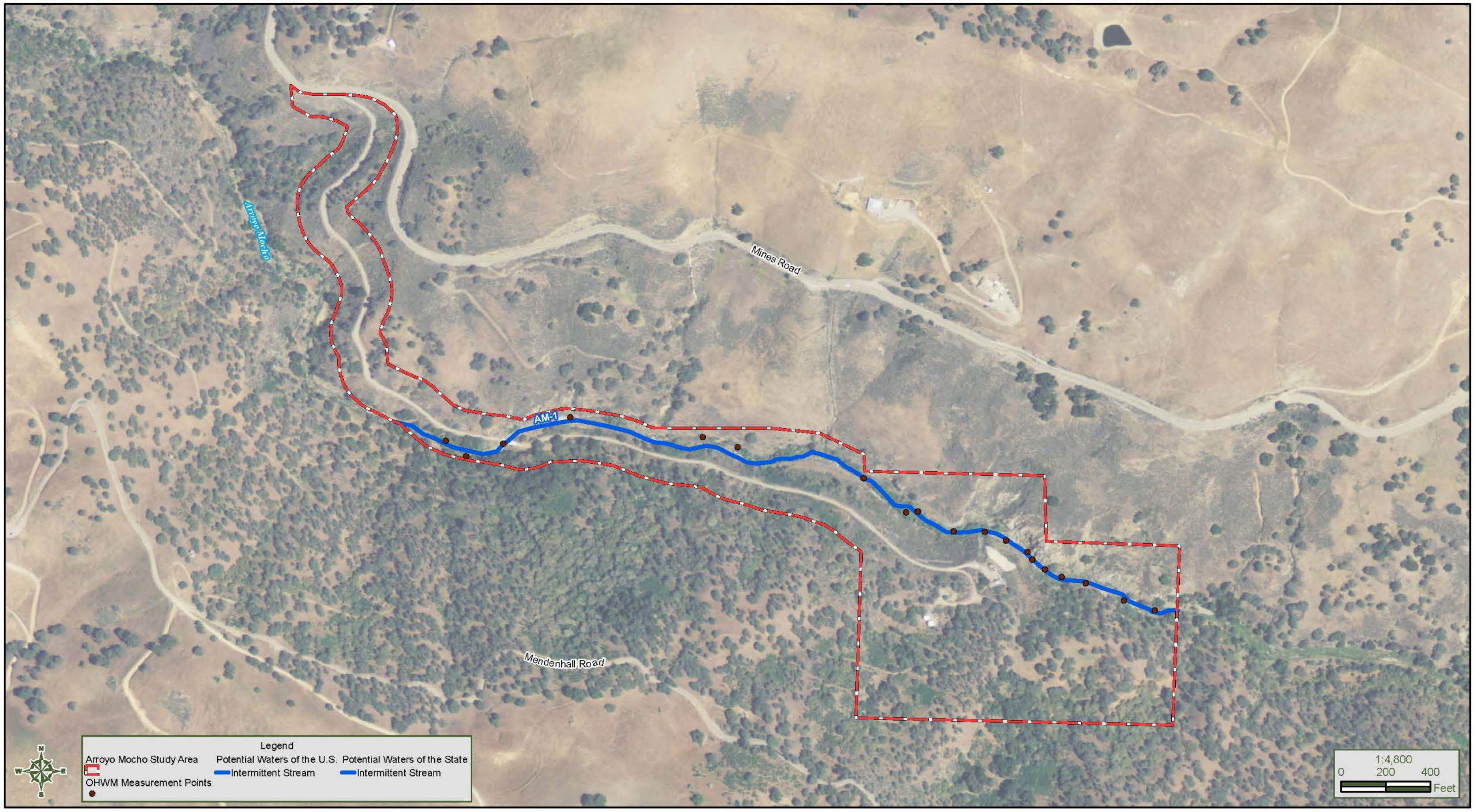
Source: Nomad Ecology 2020.

Figure 4-64. Wetland and Aquatic Resources Delineation at the Livermore Site (sheet 2 of 2)



Source: Nomad Ecology 2020.

Figure 4-65. Wetland and Aquatic Resources Delineation at Site 300



Source: Nomad Ecology 2020.

Figure 4-66. Wetland and Aquatic Resources Delineation at the Arroyo Mocho Pumping Station

4.9 CULTURAL AND PALEONTOLOGICAL RESOURCES

4.9.1 Definition of the Resources

4.9.1.1 *Cultural Resources*

Cultural resources are physical manifestations of culture, specifically archaeological sites, architectural properties, ethnographic resources, and other historical resources relating to human activities, society, and cultural institutions that define communities and link them to their surroundings. They include expressions of human culture and history in the physical environment, such as prehistoric and historic archaeological sites, buildings, structures, objects, and districts, considered important to a culture or community. Cultural resources also include locations of important historic events and aspects of the natural environment, such as natural features of the land or biota, that can be part of traditional lifeways and practices.

The National Register of Historic Places (National Register) is a listing maintained by the federal government of prehistoric, historic, and ethnographic buildings, structures, sites, districts, and objects that are considered significant at a national, state, or local level. Listed resources can have significance in the areas of history, archaeology, architecture, engineering, or culture. Cultural resources listed on the National Register, or determined eligible for listing, have been documented and evaluated according to uniform standards, found in 36 CFR 60.4, and have been found to meet criteria of significance and integrity. Generally, resources evaluated for eligibility are at least 50 years old; there are exceptions to this standard, particularly resources associated with the Cold War era. Cultural resources that meet the criteria for listing on the National Register, regardless of age, are called historic properties. Resources that have undetermined eligibility are treated as historic properties until a determination otherwise is made.

4.9.1.2 *Paleontological Resources*

Paleontology is the study of life in past geological time and the chronology of Earth's history. Paleontological resources are the fossilized remains of past life forms and the remains of once-living organisms such as plants, animals, fungi, and bacteria that have been replaced by rock material. Fossils also include imprints or traces of organisms preserved in rock, such as impressions, burrows, and trackways. In general, fossils are greater than 5,000 years old (middle Holocene) and are typically preserved in sedimentary rocks. Although rare, fossils can also be preserved in volcanic rocks and low-grade metamorphic rocks under certain conditions.

Paleontological resources are considered a fragile and nonrenewable scientific record of the history of life on Earth, and therefore represent an important component of America's natural heritage. Significant paleontological resources are defined as “identifiable” vertebrate fossils and uncommon invertebrate, plant, and trace fossils that provide important data (SVP 2010). These data are important because they are used to examine evolutionary relationships, provide insight on the development of and interaction between biological communities, establish time scales for geologic studies, and for many other scientific purposes (SVP 2010).

The potential for paleontological resources depends on the geological formations present, which determines the age, type, abundance, and distribution of fossils, and the topography of the area under scrutiny, which determines the access to those formations. The paleontological resource potential of the geologic unit(s) (or members thereof) underlying a particular area can be assigned to one of four categories defined by the Society of Vertebrate Paleontology (SVP 2010). These categories include high, undetermined, low, and no potential. Table 4-23 summarizes the criteria for each sensitivity classification.

Table 4-23. Paleontological Sensitivity Categories

Sensitivity	Criteria
High	Rock units from which vertebrate or significant invertebrate, plant, or trace fossils have been recovered are considered to have a high potential for containing additional significant paleontological resources. Rocks units classified as having high potential for producing paleontological resources include, but are not limited to, sedimentary formations and some volcaniclastic formations (e.g., ashes or tephras), some low-grade metamorphic rocks that contain significant paleontological resources anywhere within their geographical extent, and sedimentary rock units temporally or lithologically suitable for the preservation of fossils (e.g., middle Holocene and older, fine-grained fluvial sandstones, argillaceous and carbonate-rich paleosols, cross-bedded point bar sandstones, fine-grained marine sandstones). Rock units that contain potentially datable organic remains older than late Holocene, including deposits associated with animal nests or middens, are also classified as having high potential.
Undetermined	Rock units for which little information is available concerning their paleontological content, geologic age, and depositional environment are considered to have undetermined potential. Further study is necessary to determine if these rock units have high or low potential to contain significant paleontological resources.
Low	Reports in the paleontological literature or field surveys by a qualified professional paleontologist may allow determination that some rock units have low potential for yielding significant fossils. Such rock units will be poorly represented by fossil specimens in institutional collections, or, based on general scientific consensus, only preserve fossils in rare circumstances and the presence of fossils is the exception not the rule (e.g., basalt flows or recent colluvium).
No	Some rock units have no potential to contain significant paleontological resources because they were formed under or exposed to immense heat and pressure, for instance high-grade metamorphic rocks (such as gneisses and schists) and plutonic igneous rocks (such as granites and diorites).

Source: Modified from SVP 2010.

4.9.2 Regulatory and Compliance Setting

4.9.2.1 *Cultural Resources*

Federal laws, regulations, and EOs address cultural resources and the associated federal responsibilities. Foremost among these statutory provisions, and most relevant to the current analysis, is the *National Historic Preservation Act* (NHPA) (54 U.S.C. § 300101 et seq.). Section 106 of the NHPA requires federal agencies to consider the effects of their undertakings on historic properties. The Advisory Council on Historic Preservation regulations that implement Section 106 (36 CFR Part 800) describe the processes for identifying and evaluating historic properties; assessing effects of federal actions on historic properties; and consulting to avoid, minimize, or mitigate any adverse effects. The NHPA does not mandate preservation of historic properties, but it does ensure that federal agency decisions concerning the treatment of these properties result from meaningful consideration of cultural and historical values, and identification of options available to protect the properties. As part of the Section 106 process, agencies are required to consult with the State Historic Preservation Officer (SHPO) on their determinations and decisions. Coordination with the SHPO in California occurs via the Office of Historic Preservation in the California Department of Parks and Recreation.

Other prominent cultural resource laws pertinent to LLNL include the *Archaeological Resources Protection Act of 1979* (16 U.S.C. §§ 470aa–mm), which makes it a federal offense to excavate, remove, damage, alter, or otherwise deface archaeological resources on federal lands without authorization. Permits allowing for professional archaeological excavations can be granted by the land-managing agency pursuant to 32 CFR Part 229.8.

The *Native American Graves Protection and Repatriation Act of 1990* (NAGPRA) (25 U.S.C. § 3001 et seq.) establishes a process for federal agencies to return human remains, associated and unassociated funerary objects, sacred objects, and objects of cultural patrimony to federally recognized Indian Tribes and Native Hawaiian organizations. NAGPRA applies equally to items already in the possession of federal agencies and those encountered during current actions and undertakings on federal or tribal lands. NAGPRA consultation is required in the event of the planned excavation or unexpected discovery of such items on federal lands.

DOE Policy 141.1, "Department of Energy Management of Cultural Resources" (May 2001), ensures that DOE programs integrate cultural resource management into their missions and activities, and raises the awareness of the importance of the Department's cultural resource-related legal and trust responsibilities. The policy directs that all DOE programs and missions will be implemented in a manner consistent with federal laws, regulations, orders, DOE Orders, and implementation guidance protecting cultural resources.

As a federal agency, DOE has a trust responsibility to Indian Tribes to protect tribal cultural resources and to consult with Tribes on a government-to-government basis regarding those resources. Section 101(d)(6) of the NHPA mandates that federal agencies consult with Tribes and other Native American groups who either historically occupied the project area or may attach religious or cultural significance to historic properties in the region. The NEPA implementing regulations link to the NHPA, as well as to the *American Indian Religious Freedom Act* (42 U.S.C. § 1996), EO 13007, "Indian Sacred Sites" (61 FR 26771), EO 13175, "Consultation and Coordination with Indian Tribal Governments" (65 FR 67249), and the *Executive Memorandum on Government-to-Government Relations with Native American Tribal Governments* (59 FR 22951). These requirements call on agencies to consult with tribal leaders and others knowledgeable about cultural resources important to them. In November 2009, DOE updated "American Indian and Alaska Native Tribal Government Policy" (DOE Order 144.1, Administrative Change 1), which provides guidance for consulting and coordinating with tribal governments in compliance with federal statutes and regulations. The policy sets forth the principles that DOE must follow to ensure effective implementation of a government-to-government relationship with Tribes, and directs all DOE officials, staff, and contractors regarding fulfilling trust obligations and responsibilities arising from Departmental actions that may potentially affect tribal traditional, cultural, and religious values and practices; natural resources; and treaties and other federally recognized and reserved rights.

4.9.2.2 *Paleontological Resources*

Paleontological resources that have significant research potential are protected under the *Antiquities Act of 1906* (16 U.S.C. § 431–433). This law establishes a penalty for the unlawful appropriation, excavation, or injury to any "historic or prehistoric ruin or monument, or any object of antiquity" that is situated on federal lands or federally controlled lands.

4.9.3 Resource Management at LLNL

Following the 2005 LLNL SWEIS, DOE/NNSA, the University of California, and the California SHPO initiated development of a Programmatic Agreement to guide the identification, evaluation, and treatment of historic properties at LLNL (reference). This effort was terminated in 2014 when the California SHPO requested that these efforts be conducted on an undertaking-by-undertaking basis in accordance with the 36 CFR Part 800 regulations (LLNL 2020p).

DOE/NNSA has conferred with the California Native American Heritage Commission to identify tribes with traditional ties to the LLNL region. Various bands of the Ohlone/Costanoan Nation have traditional ties to the region. DOE has consulted with 11 representatives of this potentially interested Tribe concerning the continued operation of the Livermore Site and Site 300. To date, no federally recognized American Indian tribes have claimed strong cultural affiliation to lands operated by LLNL (LLNL 2020p).

Institutional processes are in place to review any proposed earth-disturbing activities at LLNL. Archaeological sensitivity maps have been created for the Livermore Site and Site 300. When projects involving ground-disturbing activities are proposed, the LLNL subject matter expert or designee consults these maps and additional information, assesses the potential for effects to cultural resources, and provides guidance prior to permit approval. Any necessary field investigations, consultation with the California SHPO, or mitigation activities are completed prior to project implementation (LLNL 2020p).

Inadvertent discoveries and unanticipated effects to resources can occur when previously unknown resources (e.g., subsurface archaeological remains) are discovered during ground-disturbing activities. If such remains are encountered during ground-disturbing activities, work within the immediate vicinity of the discovery ceases and the LLNL subject matter expert is notified. If the LLNL subject matter expert determines that the find is potentially significant, DOE/NNSA and the SHPO are notified, and consultation is initiated pursuant to 36 CFR 800.13. Through that consultation, a determination is made of the resource's significance, the extent of any adverse effect, and the appropriate actions required to avoid, reduce, or mitigate further adverse effects. The inadvertent discovery of Native American human remains or funerary objects (associated or unassociated) at LLNL requires adherence to 43 CFR 10.4 of the NAGPRA implementing regulations.

Similar LLNL procedures occur to review proposed project locations for paleontological resource potential. Standard LLNL practice requires that if any previously unknown resources are discovered during ground-disturbing activities, all work will be halted and a qualified paleontologist will assess the resources.

4.9.4 Cultural Resources at LLNL

4.9.4.1 *Livermore Site*

No archaeological resources have been previously recorded at the Livermore Site. Field surveys conducted in the undeveloped areas of the campus, including a 500-foot-wide buffer, did not reveal the presence of archaeological resources. The potential for intact archaeological deposits to be present at the Livermore Site is low due to the lack of recorded archaeological sites on the campus and the extensive modern horizontal and vertical development that has disturbed much of the site. However, the possibility remains that previously unknown sites may lay buried beneath the modern landscaping.

Development of detailed historic contexts for LLNL, and an inventory and assessment of all historic (50 years old or older) buildings, structures, and objects at LLNL under those contexts, was conducted and each recorded resource was evaluated for National Register of Historic Places (NRHP, or National Register) eligibility (Sullivan and Ullrich 2007). DOE/NNSA, in consultation with the California SHPO, determined that four Livermore Site buildings (194, 280, 332, and 391) and select objects within Building No. 174 were eligible for listing in the National Register because of their association with important research and development that was undertaken within the context of the Cold War (OHP 2005a). All of the eligible buildings and select objects at the Livermore Site have been mitigated and no longer retain National Register eligibility.

The Programmatic Agreement described in Section 4.9.3 required a review and re-evaluation of the eligibility of laboratory properties for the National Register every five years following publication of the 2007 Historic Context report. The first five-year re-evaluation was prepared in 2012, while the Programmatic Agreement was still in draft form. The 2012 report included consideration of changes within LLNL to management, to mission, and to the built environment (Heidecker and Ullrich 2012). The re-evaluation report determined the status of those buildings, objects, and districts that were recommended as NRHP-eligible in the 2007 report and that had received concurrence from DOE/NNSA and the California SHPO. The re-evaluation report also included buildings that were omitted from the earlier building list, those that had reached 50 years of age since the 2007 report, and new buildings. The 2012 report concluded that no buildings should be added to the list of individual buildings eligible for the NRHP. As noted above, the Programmatic Agreement effort was terminated in 2014.

A review of LLNL's Facilities Information Management System (FIMS) database (LLNL 2021x) for Livermore Site facilities confirmed that all have been: a) reviewed in the 2007 Historic Context and/or the 2012 NRHP Re-evaluation reports; b) dismissed from further review because they were not eligible, based on criteria consistent with those applied in the 2007 and 2012 reports; or c) dismissed from further review because they had not reached 50 years of age.

To date, no cultural resources of religious or cultural significance to Native American tribes have been identified on the Livermore Site. In 2002, DOE/NNSA sent letters to 10 Native American contacts identified by the California Native American Heritage Commission, inquiring if they wished to participate in developing plans to improve cultural resource planning at LLNL. None of the Tribes expressed interest in DOE/NNSA's plans, although one Ohlone/Costanoan contact indicated that he would like to continue to receive correspondence referencing the programmatic agreement and would welcome an opportunity to tour the prehistoric sites at Site 300 (LLNL 2005). TBD – add results of current SWEIS tribal consultation; in progress

4.9.4.2 *Site 300*

Archaeological surveys undertaken at Site 300 over the past 40 years inventoried all accessible areas of Site 300 and resulted in the recordation of 31 prehistoric and historic archaeological sites and isolated artifacts (LLNL 2005). In 2003, these resources were revisited to assess their condition, update documentation, and be evaluated for National Register eligibility. The eight prehistoric archaeological resources indicate that the area was used by early populations for hunting and for collecting and processing seasonal plant foods. This use is evidenced by small lithic scatters and rock shelters that contain bedrock mortars and possible small midden deposits. DOE/NNSA, in consultation with the California SHPO, determined that two of the prehistoric sites, both rock shelters, were eligible for listing on the National Register because of their potential to yield information important in prehistory (OHP 2005b; LLNL 2005). These sites have been and will continue to be avoided by Site 300 activities and remain eligible for listing on the National Register. The remaining six prehistoric resources were determined not eligible for the National Register; the California SHPO concurred with these determinations (OHP 2005b).

Twenty-three of the 31 archaeological resources are historic archaeological sites and isolated artifacts (including one that is multi-component, i.e., prehistoric and historic). These resources provide evidence that homesteading, ranching, and mining were the predominant activities in the area during the historic period (circa 1846–1930). The historic archaeological resources include an early 20th century homestead site, a sheepherder's shack (since burned down), possible remnants of a small bridge, two small trash dumps, a power-telegraph line, and a mine adit and associated features (LLNL 2005). Site 300 also contains the archaeological remains of the residential section of the former town of Carnegie. At the turn of the 20th century, Carnegie hosted a population of approximately 2,500 inhabitants and supported churches, schools, company stores, a hotel, saloons, pool halls, laundries, ice cream parlors, barber and beauty shops, bunkhouses for the single men, and company housing for the married men and their families who worked at the Carnegie Brick and Pottery Plant (LLNL 2005). Of the 23 historic archaeological resources recorded on Site 300, DOE/NNSA determined that three were eligible for listing on the National Register because of their potential to yield information important to history. These sites include an early 20^{th} century homestead, a historic mining entrance and associated structures, and the historic Carnegie Town Site. The Carnegie Town Site is also eligible for its association with the brick and pottery industry at the beginning of the 20th century, an event that has made a significant contribution to the broad patterns of our history (LLNL 2005). The California SHPO concurred with these determinations (OHP 2005b). These sites have been and will continue to be avoided by Site 300 activities and remain eligible for the National Register. The remaining 20 historic resources were determined not eligible for the National Register; the California SHPO concurred with these determinations (OHP 2005b).

It is likely that currently unknown, intact archaeological deposits exist at Site 300 because such resources have been recorded at the site and approximately 95 percent of the site's 7,000 acres is undeveloped.

As described in Section 4.9.4.1, development of detailed historic contexts for LLNL were completed in 2007 and 2012. These contexts included an inventory and assessment of all historic (50 years old or older) buildings, structures, and objects at LLNL under those contexts, was conducted and each recorded resource was evaluated for National Register eligibility (Sullivan and Ullrich 2007; Heidecker and Ullrich 2012). Following completion of the 2007 report, DOE/NNSA, in consultation with the California SHPO, determined that one individual building (Building No. 865A), the High Explosives Process Area Historic District (encompassing Building Nos. 805, 806A, 806B, 807, 817A, 817B, 817F, 825, 826, 827A, and 827C), and the Hydrodynamic Test Facilities Historic District (encompassing Building Nos. 850 and 851A) at Site 300 were eligible for listing in the National Register because of their association with important research and development that was undertaken within the context of the Cold War (OHP 2005a). All of the eligible buildings and districts at Site 300 have been mitigated and are no longer eligible for listing on the National Register.

A review of LLNL's FIMS database (LLNL 2021a) for Site 300 facilities confirmed that all have been: a) reviewed in the 2007 Historic Context and/or the 2012 NRHP Re-evaluation reports; b) dismissed from further review because they were not eligible, based on criteria consistent with those applied in the 2007 and 2012 reports; or c) dismissed from further review because they had not reached 50 years of age.

To date, no cultural resources of religious or cultural significance to Native American tribes have been identified on Site 300. In 2002, DOE/NNSA sent letters to 10 Native American contacts identified by the California Native American Heritage Commission, inquiring if they wished to participate in developing plans to improve cultural resource planning at LLNL. None of the Tribes expressed interest in DOE/NNSA's plans, although one Ohlone/Costanoan contact indicated that he would like to continue to receive correspondence referencing the programmatic agreement and would welcome an opportunity to tour the prehistoric sites at Site 300 (LLNL 2005).

4.9.4.3 *Arroyo Mocho Pump Station*

No archaeological resources have been previously recorded at the Arroyo Mocho pump station. The potential for intact archaeological deposits to be present is low due to the extensive modern horizontal and vertical development that has disturbed much of the site. However, the possibility remains that previously unknown sites may lay buried in the few areas left undisturbed.

4.9.5 Paleontological Resources at LLNL

4.9.5.1 *Livermore Site*

As described in Sections 4.4 and 4.5 of this SWEIS, the geology underlying the Livermore Site consists of late-Pleistocene to Holocene alluvial sediments, generally less than 200 feet thick, that overlie Plio-Pleistocene alluvial and lacustrine Livermore Formation sediments, up to 4,000 feet thick, which have filled the trough between the Altamont Hills on the east and the Pleasanton Ridge to the west. This late Tertiary to Quaternary formation has been divided into Upper and Lower members. Massive gravel beds mixed with sand, silt, and clay characterize the Upper Member. The Lower Member is dominated by greenish- to bluish-grey silt and clay, with lenses of gravel and sand.

The surficial exposures (i.e., less than 5 feet below ground surface) of Quaternary alluvium are composed of relatively recently deposited sediments, thus surficial exposures are generally considered to have low potential for paleontological resources. The potential for paleontological resources increases with depth below ground surface as the age of the sediments increases with depth (BART 2017). More than 533 fossil localities are recorded for Alameda County in the University of California Museum of Paleontology database (UCMP 2020a). Of the 341 localities with information on the geologic formation, only four have been tied to the Livermore Gravels Formation. Vertebrate fossil resources within the Livermore Formation are known from various localities in central Alameda County, including fragmented fossils of mammoth, extinct bison, horses, camels, boney fish, rodent, turtle, and bird (California Department of Conservation 2015). The distribution of fossil localities and the location of corresponding geologic units indicate that most of the vertebrate paleontological resources in Alameda County are located southeast of I-680 in the upland foothills of the Diablo Range and in the Livermore Valley (BART 2017). Due to the presence of vertebrate fossils, the Livermore Formation is considered to be of high sensitivity for paleontological resources.

A search of the UCMP database revealed no recorded paleontological finds at the Livermore Site in that database (UCMP 2020b). However, four late Pleistocene vertebrate fossils were discovered in the peripheral parts of the excavation for the NIF: two of the locations yielded fragmentary remains of Equus or horse; the third location included remains of proboscidean or elephant order, probably Mammuthus or mammoth; and the fourth location yielded remains of Columbian Mammoth or *Mammuthus columbi,* including a jawbone, partial skull, tusks, and some vertebrae. The geologic unit in which all four localities occur is fluvial valley fill deposit 20 to 30 feet below the present ground surface (Hanson 2000; LLNL 2005). Fossils of land-dwelling vertebrates, their environment, and associated geological, stratigraphical, taphonomical, and geographical data are considered significant paleontological resources (BART 2017). Such fossils typically are found in river, lake, and bog deposits, although they may occur in nearly any type of sedimentary sequence.

The only vertebrate fossil deposits in the vicinity of the Livermore Site, other than those from the NIF excavation mentioned above, are in the Quaternary deposits of the surrounding low hills of the east Livermore Valley. These fossils are few in number and scattered. They have been tentatively identified as of Pleistocene age, specifically Rancho La Brean and Blancan, and consist of bone fragments of mammoth and giant sloth (Hanson 2000). Invertebrate shells and leaf and stem fossils have also been found. These appear to be randomly dispersed, mainly within the Neroly Formation. No invertebrate or botanical fossil deposits of significance are believed to be present in the eastern Livermore Valley (Hanson 2000).

4.9.5.2 *Site 300*

The hilly terrain of Site 300 contains older formations, including the Upper Cretaceous Panoche Formation, exposed in limited areas of the northwest and northeast corners of the site. A majority of the exposed strata on the site are of Tertiary age, including the Miocene Cierbo and Neroly Formations. The sandstone and conglomerate beds of the Neroly Formation are exposed over the greatest areal extent of all sedimentary units on Site 300.

Invertebrate paleontological resources occur throughout the Altamont Hills (BART 2017). Over 100 fossil localities are recorded for San Joaquin County in the UCMP database (UCMP 2020c). Of the 68 localities with information on the geologic formation, five have been tied to the Neroly Formation and none to the Cierbo Formation. However, numerous invertebrate and vertebrate localities are known from within the Cierbo Formation, including unspecified vertebrate fossil specimens, as well as coral, echinoderm, gastropod, and bivalve (Hanson 2000). Due to the presence of vertebrate fossils, both the Cierbo and Neroly formations are considered to be of high sensitivity for paleontological resources.

A search of the UCMP database revealed no recorded paleontological finds on Site 300 (UCMP 2020b). However, several vertebrate fossil deposits have been found on Site 300 in the vicinity of Corral Hollow. Most finds have been a result of road improvement or erosion along stream banks. Nearly all bone fragments found are considered to be Miocene in age, specifically Clarendonian, and are scattered within the Neroly Formation. An assortment of mammalian groups is represented: camelids, mastodon, assorted early horses, shrews, beavers, and squirrels. Fossil finds were generally widely scattered and none consisted of more than one or a few fragments of bone. The eroded terraces of exposed Neroly Formation rocks on the south side of Corral Hollow Creek adjacent to Site 300 are also known to contain fossil localities (Hanson 2000). In May 1991, numerous fossil bones and bone fragments were found on the fire trail and road improvement areas along the ridge south of Building 827. The locale has since been protected from ground disturbances. The fossils were within the Neroly Formation and were tentatively identified as mastodon, horse, and an extinct predator. Invertebrate shells, primarily oysters, have been recovered on Site 300 from the Cierbo Formation. Stem and leaf fossils are found in many places within the finer-grained sediments of the Lower Neroly Formation. The fossils are generally scattered, and no significant invertebrate or botanical fossil locales have been identified on Site 300 or in the surrounding area (Hanson 2000).

4.9.5.3 *Arroyo Mocho Pump Station*

A search of the UCMP database was performed in September 2020 and revealed no recorded paleontological finds at the Arroyo Mocho pump station (UCMP 2020b). NNSA has no recorded discoveries of paleontological resources in this location.

4.10 SOCIOECONOMIC CHARACTERISTICS AND ENVIRONMENTAL JUSTICE

Socioeconomics considers the attributes of human social and economic interactions of a proposed action and alternatives and the impacts that such action may have on the ROI. The socioeconomic ROI is defined on the basis of current residential location of full-time LLNL workers directly involved in LLNL activities, and encompasses the area in which most of these workers spend their wages and salaries. This section discusses regional and local economy, local demographics, local housing, and community services. This section also discusses the presence of environmental justice populations. Socioeconomic impacts may be defined as the environmental consequences of a proposed action in terms of potential demographic and economic changes. Environmental justice impacts may be defined as environmental impacts that proposed actions may have on minority and low-income populations, and whether such impacts are disproportionate to those on the population as a whole in the potentially affected area.

The following sections provide information on the area surrounding LLNL, focusing primarily on Alameda, San Joaquin, Contra Costa, and Stanislaus counties, i.e., where most of the LLNL workforce resides (Figure 4-67).

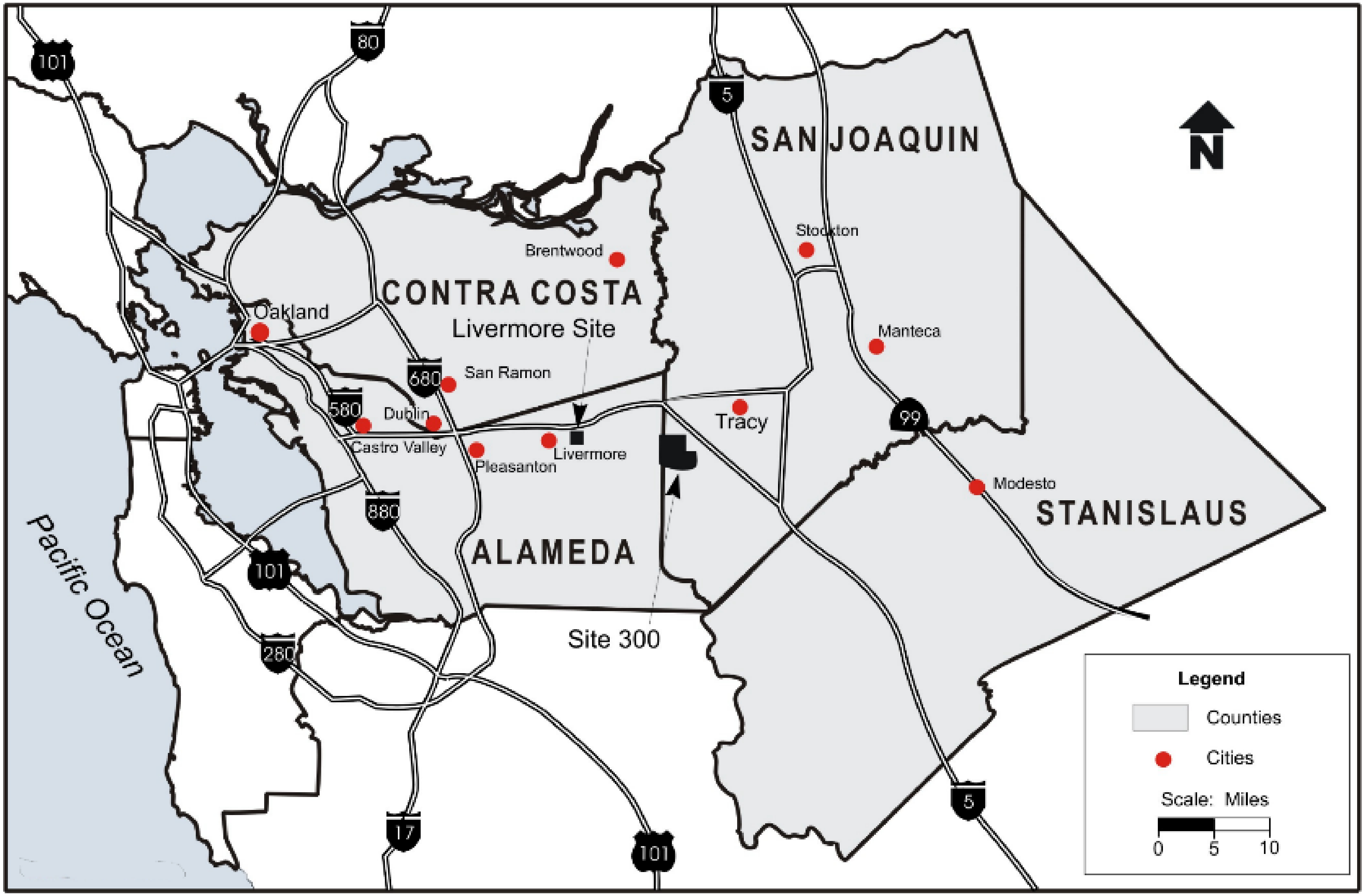
4.10.1 Employment and Economic Characteristics

As of 2019, there were 7,909 full-time employees at LLNL consisting of 7,208 employees at the Livermore Site, 477 supplemental workers, and 224 workers at Site 300 (Table 4-24) (LLNL 2019i, 2019z). The largest percentage of personnel reside in Alameda County (approximately 3,546 personnel). Approximately 1,416 employees reside in San Joaquin County, with the remaining 2,947 employees residing in surrounding counties. Direct onsite employment accounts for approximately 0.4 percent of employment in the four-county ROI. Employment at LLNL is projected to increase five percent every year until 2025. Employment is projected to hold steady between 2025 and 2035 (LLNL 2019i).

Table 4-24. Geographic Distribution of Lawrence Livermore National Laboratory Employee Residences by County, 2019

County	Number of Employees	Percent of Total Site Employment[a]
Alameda	3,546	44.8
San Joaquin	1,416	17.9
Contra Costa	1,000	12.6
Stanislaus	356	4.5
Other counties	1591	20.1
Total	**7,909**	**100.0**

a. Percentages may not total 100 due to rounding.
Source: LLNL 2019i, 2019z.



Source: NNSA 2005.

Figure 4-67. Four-County Lawrence Livermore National Laboratory Region of Influence

From 2010 through 2019, the labor force in the ROI increased 6.1 percent to 1,976,800 persons. During the same period, employment in the ROI increased by 15.8 percent to 1,900,900 persons, and the number of unemployed decreased by 65.1 percent, reflecting the economic recovery after the recession of 2008–2010. Over that same period, the unemployment rate declined from 12.6 percent to 3.8 percent. California experienced similar trends in unemployment rates, decreasing from 12.2 percent to 4.0 percent in 2019 (EDD 2020a). Table 4-25 presents the employment profile in the ROI and California for 2010 and 2019.

Table 4-25. Employment Profile in the Four-County Region of Influence

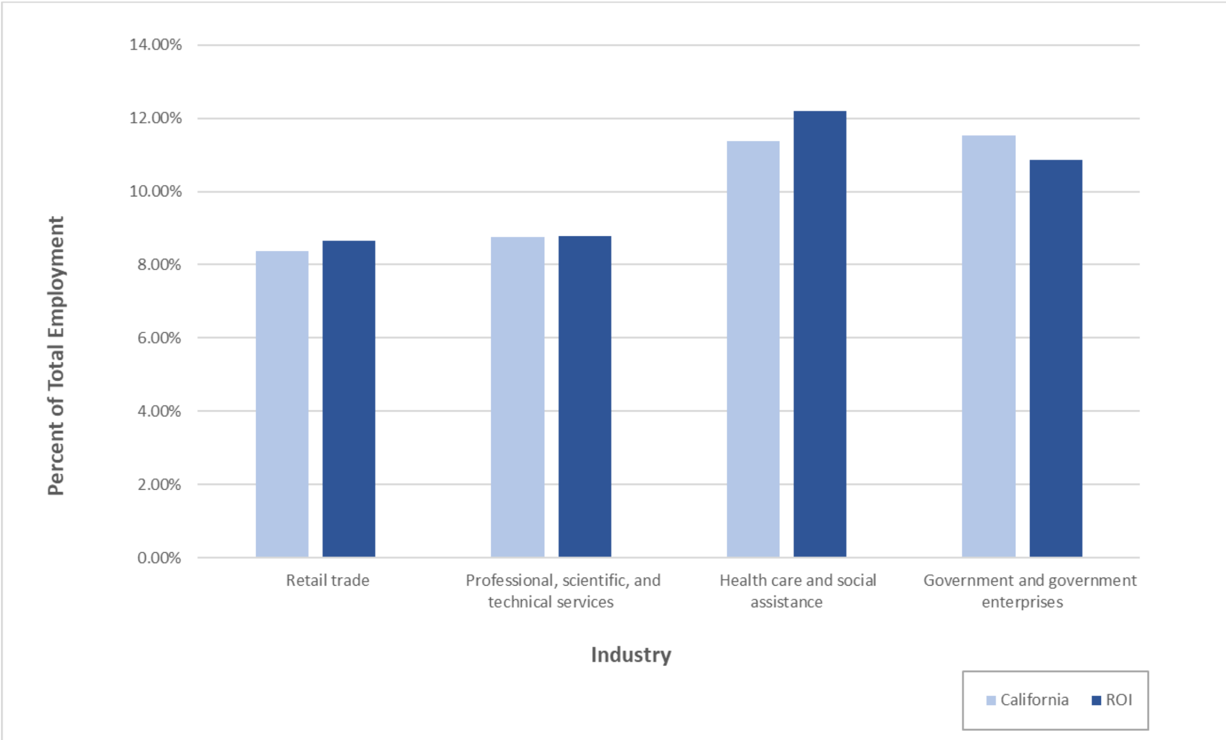
Area	Labor Force		Employed		Unemployed		Percent Unemployed	
	2010	2019	2010	2019	2010	2019	2010	2019
Alameda	782,500	844,400	697,100	819,700	85,400	24,700	11.0	2.9
San Joaquin	311,400	327,100	260,000	307,900	51,400	19,200	16.5	5.9
Contra Costa	525,500	561,800	467,900	544,500	57,600	17,300	11.0	3.1
Stanislaus	243,300	243,500	202,200	228,800	41,100	14,700	16.9	6.0
ROI	**1,862,700**	**1,976,800**	**1,627,200**	**1,900,900**	**235,500**	**75,900**	**12.6**	**3.8**
California	**18,336,300**	**19,411,600**	**16,091,900**	**18,627,400**	**2,244,300**	**784,200**	**12.2**	**4.0**

ROI = region of influence.
Source: EDD 2020a.

From 2010 to 2019, the average per capita income of the ROI increased 60.4 percent to $64,844. Of the counties within the ROI, Alameda County experienced the highest increase in per capita income (68.6 percent), while Stanislaus County experienced the lowest increase (42.4 percent). state-wide, California experienced a lower increase than the ROI, increasing approximately 52.7 percent, to $66,619 (BEA 2020b).

In 2019, the health care and social assistance industry accounted for approximately 12.2 percent of the total employment in the ROI, government enterprises accounted for approximately 10.9 percent of employment, followed by professional, scientific, and technical services (8.8 percent). The distribution of employment in California was generally similar (BEA 2020d). The major employment sectors in the ROI and California are presented in Figure 4-68.

As of the last quarter of fiscal year FY 2019, LLNL had monthly payroll of approximately $81 million. The total annual LLNL payroll for FY 2019 was approximately $973 million (LLNL 2019i). This amount represents 1.2 percent of the total combined payroll generated by all business establishments in the ROI.



Source: BEA 2020d.

Figure 4-68. Major Employment Sector Distribution for the LLNL Region of Influence and the State of California in 2019

Alameda County. The California Employment Development Department (EDD) reported a total labor force of 844,400 persons in Alameda County for 2019 (*see* Table 4-25). This represents a 7.9-percent increase over the 2010 annual average of 782,500 persons. The average annual unemployment rate for 2019 was 2.9 percent (24,700 persons), which was lower than the statewide average of four percent for the same period (EDD 2020a).

In 2019, the health care and social assistance industry accounted for approximately 11.6 percent of the total employment in Alameda County, followed by health care and social assistance for approximately 11.6 percent and professional, scientific, and technical services for approximately 11.4 percent of employment in the county (BEA 2020d). Employment projections through 2026 estimate health care and social assistance, construction, and manufacturing industries to experience the greatest percent job growth, while government enterprises are estimated to decrease (EDD 2020b).

The 2019 per capita personal income was $81,171 and ranked sixth in the state. The 2019 per capita personal income reflected an increase of 5.1 percent from 2018. The 2009–2019 compound annual growth rate of per capita personal income was 5.8 percent (BEA 2020a). Total business establishments reported in the county for 2019 was 64,372, with a combined annual payroll of $54 billion (EDD 2020c). The health care and social assistance industry was the largest employment sector, with $9 billion in total compensation (BEA 2020c).

San Joaquin County. The California EDD reported a total labor force of 327,100 persons in San Joaquin County for 2019 (*see* Table 4-25). This represents a five-percent increase over the 2010 annual average of 311,400 persons. The average annual unemployment rate for 2019 was 5.9 percent (19,200 persons), which was higher than the state-wide average of four percent for the same period (EDD 2020a).

In 2019, government enterprises accounted for approximately 13.2 percent of the total employment in San Joaquin County, followed by transportation and warehousing for approximately 12.4 percent and health care and social assistance for approximately 11.1 percent (BEA 2020d). Employment projections through 2026 estimate educational services, health care and social assistance, and transportation and warehousing industries to experience the greatest percent job growth (EDD 2020b).

The 2019 per capita personal income was $47,139 and ranked 41st in the state. The 2019 per capita personal income reflected an increase of 5.5 percent from 2018. The 2009–2019 compound annual growth rate of per capita personal income was 4.7 percent (BEA 2020a). Total business establishments reported in the county for 2019 was 17,715, with a combined annual payroll of $10 billion (EDD 2020c). Government and government enterprises was the largest employment sector, with $4 billion in total compensation (BEA 2020c).

Contra Costa County. The California EDD reported a total labor force of 561,800 persons in Contra Costa County for 2019 (*see* Table 4-25). This represents a 6.9-percent increase over the 2010 annual average of 525,500 persons. The average annual unemployment rate for 2019 was 3.1 percent (17,300 persons), which was lower than the state-wide average of four percent for the same period (EDD 2020a).

In 2019, the health care and social assistance industry accounted for approximately 13.1 percent of the total employment in Contra Costa County, followed by professional, scientific, and technical services for approximately 8.5 percent and retail trade for approximately 9.1 percent and of employment in the county (BEA 2020d). Employment projections through 2026 estimate health care and social assistance, construction, and manufacturing industries to experience the greatest percent job growth, while government services are estimated to decrease (EDD 2020b).

The 2019 per capita personal income was $85,324 and ranked fifth in the state. The 2019 per capita personal income reflected an increase of 4.8 percent from 2018. The 2009–2019 compound annual growth rate of per capita personal income was 4.7 percent (BEA 2020a). Total business establishments reported in the county for 2019 was 32,968, with a combined annual payroll of $23 billion (EDD 2020c). The health care and social assistance industry was the largest employment sector, with $6 billion in total compensation (BEA 2020c).

Stanislaus County. The California EDD reported a total labor force of 243,500 persons in Stanislaus County in 2019 (*see* Table 4-25). This represents a 0.1-percent increase over the 2010 annual average of 243,300 persons. The average annual unemployment rate for 2019 was six percent (14,700 persons), which was lower than the state-wide average of four percent for the same period (EDD 2020a).

In 2019, the health care and social assistance industry accounted for approximately 14 percent of the total employment in Stanislaus County, followed by government enterprises for approximately 12.4 percent and retail trade for approximately 10.8 percent of employment in the county (BEA 2020d). Employment projections through 2026 estimate educational services; health care and social assistance; and arts, entertainment, and recreation industries to experience the greatest percent job growth (EDD 2020b).

The 2019 per capita personal income was $45,742 and ranked 43rd in the state. The 2019 per capita personal income reflected an increase of 4.8 percent from 2018. The 2009–2019 compound annual growth rate of per capita personal income was 4.5 percent (BEA 2020a). Total business establishments reported in the country for 2019 was 15,800, with a combined annual payroll of $8 billion (EDD 2020c). The health care and social assistance industry was the largest employment sector, with $3 billion in total compensation (BEA 2020c).

4.10.2 Population

In 2019, the population in the ROI was estimated to be 4,084,802 people. From 2010 to 2019, the total population in the ROI increased at an average annual rate of 0.9 percent, which was higher than the state-wide growth rate. Over the same period, the total population of California increased at an average annual rate of 0.6 percent, to 39,283,497 people (USCB 2019a).

Population projections for California are drawn from the California Department of Finance (DOF) forecasts of population produced by the Demographic Research Unit (DOF 2020a). Using this data, population growth is projected to be slow and steady. From 2020 to 2030, the total population in the ROI is projected to increase at an average annual rate of approximately 0.9 percent, which is higher than the projected state-wide growth rate. From 2030 and 2035, the ROI population is projected to continue to grow, with a projected increase of 4.0 percent in 2035. From 2020 to 2030, the state-wide population is projected to increase at an average annual rate of 0.5 percent (DOF 2020a), with a projected increase of 2.2 percent between 2030 and 2035. The populations of each county in the ROI are summarized in Table 4-26, followed by brief descriptions.

Table 4-26. Historic and Projected Population within the Four-County Region of Influence

County	2010	2015	2019	2020	2025	2030	2035
Alameda	1,510,271	1,584,983	1,656,754	1,685,886	1,756,709	1,832,576	1,903,253
San Joaquin	685,306	708,554	742,603	782,545	832,480	879,055	923,437
Contra Costa	1,049,025	1,096,068	1,142,251	1,160,099	1,203,635	1,252,891	1,296,603
Stanislaus	514,453	527,367	543,194	562,303	584,055	606,900	629,634
Total ROI	**3,759,055**	**3,916,972**	**4,084,802**	**4,190,833**	**4,376,879**	**4,571,422**	**4,752,927**
Average annual % growth	1.0	0.8	1.1	2.6	0.9	0.9	0.8
California	37,253,956	38,421,464	39,283,497	40,129,160	41,176,614	42,263,654	43,195,093
Average annual % growth	N/A	0.6	0.6	2.2	0.5	0.5	0.4

ROI = region of influence.
Source: USCB 2010, 2015, 2019a; DOF 2020a.

Alameda County. In 2010, the population of Alameda County was 1,510,271 (USCB 2010), 229,046 of which lived within the communities of Livermore, Pleasanton, and Dublin, near the Livermore Site. From 2010 to 2019, the population increased by 9.7 percent. The DOF estimates that the Alameda County population will increase to 1,685,886 residents in 2020 (DOF 2020a).

From 2020 to 2035, Alameda County is expected to grow by approximately 217,367 residents, an increase of 12.9 percent (DOF 2020a).

San Joaquin County. In 2010, the population of San Joaquin County was 685,306 (USCB 2010). From 2010 to 2019, the population increased by 8.4 percent. The DOF estimates that the San Joaquin County population will increase to 782,545 residents in 2020 (DOF 2020a). From 2020 to 2035, San Joaquin County is expected to grow by approximately 140,892 residents, an increase of 18 percent (DOF 2020a).

Contra Costa County. In 2010, the population of Contra Costa County was 1,049,025 (USCB 2010). From 2010 to 2019, the population increased by 8.9 percent. The DOF estimates that the Contra Costa County population will increase to 1,160,099 in 2020 (DOF 2020a). From 2020 to 2035, Contra Costa County is expected to grow by approximately 136,504 residents, an increase of 11.8 percent (DOF 2020a).

Stanislaus County. In 2010, the population of Stanislaus County was 514,453 (USCB 2010). From 2010 to 2019, the population increased be 5.6 percent. The DOF estimates that the Stanislaus County population will increase to at 562,303 in 2020 (DOF 2020a). From 2020 to 2035, Stanislaus County is expected to grow by approximately 67,331 residents, an increase of 12.0 percent (DOF 2020a).

4.10.3 Housing

From 2010 to 2020, the number of housing units in the ROI increased by 4.8 percent to 1,462,287 units (DOF 2020b). The number of housing units in California also increased by 4.8 percent, resulting in a total number of 14,329,863 units state-wide.

The most recent housing stock statistics from the California DOF estimates 2020 housing occupancy by type (occupied or vacant). As of January 2020, there were 1,462,287 housing units in the ROI, of which 94.6 percent were occupied and 5.4 percent were vacant. This value is lower than the state-wide estimate of 7.4 percent vacancy.

From 2010 to 2019, the median value of owner-occupied housing units in the ROI increased by 11.7 percent to $483,950 (USCB 2019b). In 2019, the median housing values in the ROI were lower than the median value in California. Housing occupancy data for the ROI are summarized in Table 4-27, followed by brief descriptions.

Table 4-27. Housing Units and Vacancy Rates Within the Four-County Region of Influence and Selected Cities, 2010 and 2020

Location	2010			2020			Percent Housing Unit Growth
	Housing Units	Occupied	Percent Vacant	Housing Units	Occupied	Percent Vacant	
California	13,670,304	12,568,167	8.1	14,329,863	13,272,939	7.4	4.8
County							
Alameda	581,372	544,046	6.4	611,752	579,058	5.3	5.2
San Joaquin	233,755	215,007	8.0	249,058	234,766	5.7	6.5
Contra Costa	400,263	375,364	6.2	418,409	396,099	5.3	4.5
Stanislaus	179,503	165,180	8.0	183,068	173,951	5.0	2.0
Total ROI	**1,394,893**	**1,299,597**	**6.8**	**1,462,287**	**1,383,874**	**5.4**	**4.8**

Location	2010			2020			Percent Housing Unit Growth
	Housing Units	Occupied	Percent Vacant	Housing Units	Occupied	Percent Vacant	
City							
Livermore	30,342	29,134	4.0	32,728	31,696	3.2	7.9
Tracy	25,963	24,331	6.3	27,843	27,281	2.0	7.2
Pleasanton	26,053	25,245	3.1	28,508	27,283	4.3	9.4
Manteca	23,132	21,618	6.5	27,667	26,510	4.2	19.6
Modesto	75,044	69,107	7.9	76,641	74,139	3.3	2.1
Brentwood	17,523	16,494	5.9	20,954	20,067	4.2	19.6
San Ramon	26,222	25,284	3.6	29,267	28,004	4.3	11.6
Stockton	99,637	90,605	9.1	101,235	95,015	6.1	1.6
Dublin	15,782	14,913	5.5	23,567	22,021	6.6	49.3
Oakland	169,710	153,791	9.4	175,457	164,296	6.4	3.4

ROI = region of influence.
Source: DOF 2020b.

Alameda County. The Alameda County housing stock (all units) totaled 611,752 units as of January 2020 (*see* Table 4-27). The vacancy rate in Alameda County was 5.3 percent, indicating a low percentage of available housing. The total number of housing units increased by 5.2 percent between 2010 and 2020 (DOF 2020b). The median value of owner-occupied housing units increased by 30.2 percent between 2010 and 2019 to $769,300 (USCB 2019b).

San Joaquin County. The San Joaquin County housing stock (all units) totaled 249,058 units as of January 2020 (*see* Table 4-27). The vacancy rate in San Joaquin County was 5.7 percent, indicating a low percentage of available housing. The total number of housing units increased by 6.5 percent between 2010 and 2020 (DOF 2020b). The median value of owner-occupied housing units decreased by 7.4 percent between 2010 and 2019 to $342,100 (USCB 2019b).

Contra Costa County. The Contra Costa County housing stock (all units) totaled 418,409 units as of January 2020 (*see* Table 4-27). The vacancy rate in Contra Costa County was 5.3 percent, indicating a low percentage of available housing. The total number of housing units increased 4.5 percent between 2010 and 2020 (DOF 2020b). The median value of owner-occupied housing units increased by 14.2 percent between 2010 and 2019 to $625,800 (USCB 2019b).

Stanislaus County. The Stanislaus County housing stock (all units) totaled 183,068 units as of January 2020 (*see* Table 4-27). The vacancy rate in Stanislaus County was five percent, indicating a low percentage of available housing. The total number of housing units increased by two percent between 2010 and 2020 (DOF 2020b). The median value of owner-occupied housing units decreased by 2.2 percent between 2010 and 2019 to $291,600 (USCB 2019b).

4.10.4 Community Services

This section describes the existing demands on fire protection services, police protection services, public education, and health care. Providers of these services in the ROI are fire and police departments, hospitals and clinics, and public school districts.

4.10.4.1 *Fire Protection*

Fire protection for the ROI is provided by county fire departments, consolidated fire districts, and incorporated city fire departments.

Alameda County. There are 114 fire departments in Alameda County serving a population of over 1.6 million people in an area covering approximately 739 square miles. The Alameda County Fire Department (ACFD) provides fire protection services to the unincorporated areas of Alameda County and LLNL. The ACFD is made up of 30 fire stations, 26 engine companies, seven ladder truck companies, and is staffed by over 400 personnel and 100 reserve firefighters. In 2019, the ACFD provided service to a daytime population of approximately 394,000 people in an area covering approximately 508 square miles (ACFD 2020).

The ACFD has mutual aid agreements with the Livermore-Pleasanton Fire Department (LPFD), the San Ramon Valley Fire Department, and the Camp Parks Fire Department to ensure service is sent based on the shortest response times. The LPFD is the fire, emergency response, and community service organization serving the city of Livermore. The LPFD operates 10 fire stations, 8 engine companies, 2 truck companies, and is staffed is by 121 full-time employees (Dublin 2019).

The existing fire protection and emergency services at LLNL are provided by the LLNL Emergency Management Department and by a contract with the ACFD. The Emergency Management Department is the parent organization for fire protection consisting of the Alarms Division, the Emergency Programs Division, and the Fire Protection Division. The Fire Protection Division is responsible for administering the contract with ACFD (LLNL 2020u). The Emergency Management Department at the Livermore Site occupies two facilities: a fire station at Building 323 (ACFD Fire Station No. 20) and an emergency dispatch center at Building 313. Emergency response services are provided pursuant to a contract with the ACFD. As part of that contract the ACFD personnel assigned to LLNL fire stations are required to meet certain training and certificate requirements to achieve the comprehensive fire protection program. ACFD also responds to emergencies in the surrounding area outside of LLNL. The ACFD is also responsible for monitoring the LLNL Fire and Emergency Voice Alarm system, answering emergency telephone calls, tracking emergency and non-emergency response resources, providing emergency pager notification for hearing-impaired employees, and coordinating response with LLNL and SNL/CA protective forces (LLNL 2020u). The ACFD also operates the Alameda County Regional Emergency Call Center (also known as the 911 dispatch center) located in Building 313.

For emergency response, ACFD provides three shifts, each lead by a Battalion Chief. Each shift is divided into three companies. Each shift is staffed to provide a Battalion Chief, two three-person and one four-person companies (two companies are assigned to the Livermore Site and one company is assigned to Site 300). Minimum staffing is two three-person and one four-person companies and a Battalion Chief (LLNL 2020u).

San Joaquin County. There are 67 fire department in San Joaquin County serving a population of over 762,000 people in an area covering approximately 1,391 square miles. Fire protection services for the unincorporated areas of San Joaquin County are provided by independent special district fire departments, the California Department of Forestry and Fire Protection, and city fire departments. There are 22 fire protection districts in San Joaquin County, which are staffed with paid firefighters, reserve firefighters, volunteer firefighters, and administrative staff. Additional fire districts provide fire protection within unincorporated areas and outlying small communities. City fire departments in Tracy, Stockton, Manteca, and Lodi provide fire protection within their respective incorporated areas (San Joaquin 2016).

The South San Joaquin County Fire Authority consists of 60 professional firefighters, 12 reserve firefighters, a fire chief, three division chiefs, emergency medical service manager, two civilian fire inspections and two administrative support staff. The fire authority serves the city of Tracy, as well as all of the surrounding rural areas from the Stanislaus County line to the Alameda County line. The response area is protected by six staffed engine companies and one truck company operating out of six fire stations (San Joaquin 2016).

The Emergency Management Department at Site 300 occupies Building 890 (ACFD Fire Station No. 21). ACFD also provides emergency response services at Site 300 pursuant to the same contract mentioned above. For emergency response, ACFD provides three shifts each lead by a Battalion Chief. Each shift is divided into three companies (two companies are assigned to the Livermore Site and one company is assigned to Site 300) and staffed to provide a Battalion Chief, two three-person and one four-person companies. Minimum staffing is two three-person and one four-person companies and a Battalion Chief (LLNL 2020u).

Contra Costa County. There are 87 fire departments in Contra Costa County serving a population of over 1.1 million people in an area covering approximately 715 square miles. Fire protection services within Contra Costa County are provided by six fire protection districts. The Contra Costa Consolidated Fire Protection District fire protection service area covers the majority of the central part of Contra Costa County. The Contra Costa Consolidated Fire Protection District consists of 26 fire stations, 27 fire companies, and is staffed by 288 firefighters (CCCFPD 2018).

Stanislaus County. There are 57 fire departments in Stanislaus County serving a population of over 550,000 people in an area covering approximately 1,494 square miles. There are six municipal fire departments and 14 special districts that provide fire protection services. The Stanislaus Consolidated Fire District is the largest fire district within the county and serves the unincorporated areas of Stanislaus County. The district is made up of nine fire stations staffed by 80 full time personnel, two part-time personnel, and 10 intern firefighters (SCFPD 2020).

4.10.4.2 *Police Protection Services*

Police protection in the ROI is provided by county sheriff's departments and various local police departments. Each station provides law enforcement services in conjunction with other law enforcement agencies, including the California Highway Patrol.

Alameda County. There are 31 police departments in Alameda County serving a population of over 1.6 million people in an area covering approximately 739 square miles. The Alameda County Sheriff's Office provides patrol and investigation services to the city of Dublin and unincorporated areas of the county. The Sheriff's Office has over 1,500 authorized positions, both sworn and professional staff. In addition to the Sheriff's Office, the California Highway Patrol has jurisdiction over public roadways in unincorporated areas of the county. The Livermore Police Department has 90 officers and 45 full-time personnel (Dublin 2019).

LLNL participates in emergency response agreements with the Livermore Police Department, the Alameda County Sheriff's Department, and the California Highway Patrol. The Protective Force Division of the LLNL Security Organization provides police protection and security services at LLNL. It is the function of the Protective Force Division to provide protection for LLNL personnel and assets. This protection is provided through several channels, including access control, fixed access and surveillance points, random vehicle and foot patrols, response elements, and special response team elements.

San Joaquin County. There are 16 police departments in San Joaquin County serving a population of over 762,000 people in an area covering approximately 1,391 square miles. The Tracy Police Department provides police protection within the Tracy city limits and is staffed by 93 sworn staff and uniform patrol officers (Tracy 2020).

LLNL participates in emergency response agreements with the San Joaquin County Sheriff's Department and the California Highway Patrol. Site 300 is within Patrol District 8 of the San Joaquin County Sheriff's Department.

Contra Costa County. There are 37 police departments in Contra Costa County serving a population of over 1.1 million people in an area covering approximately 715 square miles. Public protection services in Contra Costa County are provided by various city police departments and the Contra Costa County Sheriff's Office. The Sheriff's Office is the largest law enforcement agency in the county and employs 720 sworn personnel and 332 general employees for a total of 1,052 staff (Contra Costa 2020).

Stanislaus County. There are 14 police departments in Stanislaus County serving a population of over 550,000 people in an area covering approximately 1,494 square miles. The Stanislaus County Sheriff's Department provides public protection services in Stanislaus County. Its Operations Division has principal jurisdiction in all unincorporated areas serving a population of more than 200,000. Of the nine cities in the county, Stanislaus County Sheriff's Department provides contract law enforcement services to four: Patterson, Riverbank, Hughson, and Waterford. The cities of Ceres, Modesto, Newman, Oakdale, and Turlock maintain their own municipal police departments (ICF 2016).

4.10.4.3 *Medical Services*

Medical services with the ROI include 57 full-service hospitals and clinics. These facilities provide a wide array of medical services, including physical examinations; treatment of illness; emergency, intensive, and coronary care; internal medicine; x-ray and laboratory; infertility, obstetrics, and gynecology; neonatal intensive care; inpatient and outpatient surgery; pharmaceuticals; optometry; dental; respiratory therapy; and skilled nursing and long-term care.

Alameda County. There are 26 medical services facilities in Alameda County. Medical services facilities in the vicinity of LLNL include Stanford Health Care–ValleyCare Livermore, Stanford Health Care–ValleyCare Pleasanton, Eden Medical Center, and STAT MED Urgent Care. Stanford Health Care–ValleyCare Livermore is an urgent care facility and also provides comprehensive range of specialties and services. Stanford Health Care–ValleyCare Pleasanton is a general acute-care, 167-bed facility (ORNL 2019).

San Joaquin County. There are nine medical services facilities in San Joaquin County. Hospitals in the vicinity of Site 300 include Sutter Tracy Community Hospital, and the Manteca Medical Center. Sutter Tracy Community Hospital in Tracy is a full-service, acute-care, 81-bed hospital in Tracy. The Manteca Medical Center, located in the city of Manteca, is an acute-care, 99-bed hospital that provides an array of medical services including 24-hour emergency care (ORNL 2019).

Contra Costa County. There are 11 medical services facilities in Contra Costa County. The largest hospital in the county is the John Muir Health, Walnut Creek Medical Center, a 554-bed hospital designated as the only trauma center for Contra Costa County (ORNL 2019). John Muir Health, Concord Medical Center is the second major hospital in this County, a 244 bed facility.

Stanislaus County. There are 11 medical services facilities in Stanislaus County. The largest hospital in the county is Memorial Hospital Medical Center in Modesto, a 423-bed hospital that provides an array of medical services including 24-hour emergency care (ORNL 2019).

Onsite Medical Services. There is a Health Services Department located in Building 663 on the Livermore Site. The Health Services Department provides comprehensive occupational health services to ensure a safe and healthful work environment for employees. The department is accredited by the Accreditation Association for Ambulatory Health Care and meets regulatory requirements and professional standards to assist in providing health care services (LLNL 2020v).

4.10.4.4 *School Services*

There are 83 school districts in the ROI for a total of 1,148 schools serving 667,493 students during the 2018–2019 school year (Table 4-28). There are no schools within one-quarter mile of any Livermore Site or Site 300 facilities. Total students within the ROI comprise approximately 10.8 percent of the state student population. Alameda County has the greatest number of schools (409) and the largest student population (228,125) within the ROI, while Stanislaus County has the least number of schools (200) and smallest student population (110,405) within the ROI. The ROI has an average student-to-teacher ratio of 21 to 1.

Table 4-28. School Enrollment in the Four-County Region of Influence,

County	School Districts	Schools	Students	Student-to-Teacher Ratio
Alameda	22	409	228,125	1:19
San Joaquin	15	248	151,023	1:22
Contra Costa	20	291	177,940	1:22
Stanislaus	26	200	110,405	1:21
Total ROI	**83**	**1,148**	**667,493**	**1:21**

ROI = region of influence.
Source: CDOE 2020.

4.10.5 Environmental Justice

Under EO 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," federal agencies are responsible for identifying and addressing the possibility of disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations in the United States and its territories and possessions, the District of Columbia, the Commonwealth of Puerto Rico, and the Commonwealth of the Mariana Islands. In January 2021, Executive Order 14008, "Tackling the Climate Crisis at Home and Abroad" was issued. The order formalizes the commitment to make environmental justice a part of the mission of federal agencies to develop programs, policies, and activities to address the disproportionate health, environmental, economic, and climate impacts on disadvantaged communities and required federal agencies to "make achieving environmental justice part of their missions." Minority populations refer to persons of any race self-designated as Asian, Black, Native American, or Hispanic. Low-income populations refer to households with incomes below the federal poverty thresholds.

Environmental justice concerns the environmental impacts that proposed actions may have on minority and low-income populations, and whether such impacts are disproportionate to those on the population as a whole in the potentially affected area. The potentially affected area for this SWEIS includes parts of 19 counties throughout California that comprise an area within a 50-mile radius of the Livermore Site and Site 300. To be consistent with the human health analysis in this EIS, the population distributions of the potentially affected area are calculated using data at the block-group level of spatial resolution from U.S. Census Bureau population estimates.

The threshold used for identifying minority and low-income communities surrounding specific sites was developed consistent with CEQ guidance (CEQ 1997) for identifying minority populations using either the 50-percent threshold or a "meaningfully greater" percentage of minority or low-income individuals in the general population. Meaningfully greater is defined in this SWEIS as 20 percentage points above the population percentage in the general population.

The average minority population percentage of California is 62.8 percent, and the average minority population percentage of the counties surrounding the Livermore Site and Site 300 is approximately 59.6 percent (USCB 2019a). Comparatively, a meaningfully greater minority population percentage relative to the general population of the state and the surrounding counties would exceed the 50-percent threshold defined by CEQ. Therefore, the CEQ threshold of 50 percent is used to identify areas with minority populations surrounding the Livermore Site and Site 300.

Meaningfully greater low-income populations are identified using the same methodology described above for identifying meaningfully greater minority populations. The low-income population in California is 13.4 percent, and the low-income population percentage of the counties surrounding the Livermore Site and Site 300 is 10.8 percent. Comparatively, a meaningfully greater low-income population percentage using these statistics would be 20 percentage points greater than the low-income population for counties surrounding the Livermore Site and Site 300 (or 30.8 percent). Therefore, the county threshold was used to identify areas that have meaningfully greater low-income populations within a 50-mile radius of the Livermore Site. Table

4-29 shows the demographic composition of the counties surrounding LLNL and Site 300 within a 50-mile radius.

Table 4-29. Estimated Population in the Potentially Affected Area within a 50-Mile Radius of the Livermore Site and Site 300

Population Group	Livermore Site		Site 300	
	Population	Percent of Total	Population	Percent of Total
Nonminority	3,143,364	37.2	2,696,695	36.2
Hispanic	2,224,905	26.3	2,064,754	27.7
Black or African American	508,081	6.0	445,978	6.0
American Indian or Alaska Native	20,035	0.2	18,241	0.2
Asian	2,138,937	25.3	1,864,099	25.0
Pacific Islander	50,221	0.6	44,329	0.6
Other Race	26,695	0.3	22,000	0.3
Two or More Races	345,297	4.1	297,511	4.0
Total Minority	5,314,171	62.8	4,756,912	63.8
Total Population[a]	8,457,535	100.0	7,453,607	100.0
Low-Income Population (percent)[b]		9.6		9.9

a. Population estimates are based on Census Burau 2019 American Community Survey 5-year estimates (2014–2019). Populations of Census tracts that intersect or were within the 50-mile radius were wholly included in population counts. Such a methodology is conservative, in that it could include high populations than may actually exist within the 50-mile radius.
b. Poverty status is determined for all persons except institutionalized persons, persons in military group quarters and in college dormitories, and unrelated individuals under 15 years old.
Source: USCB 2019c, 2019d.

4.10.5.1 *Livermore Site*

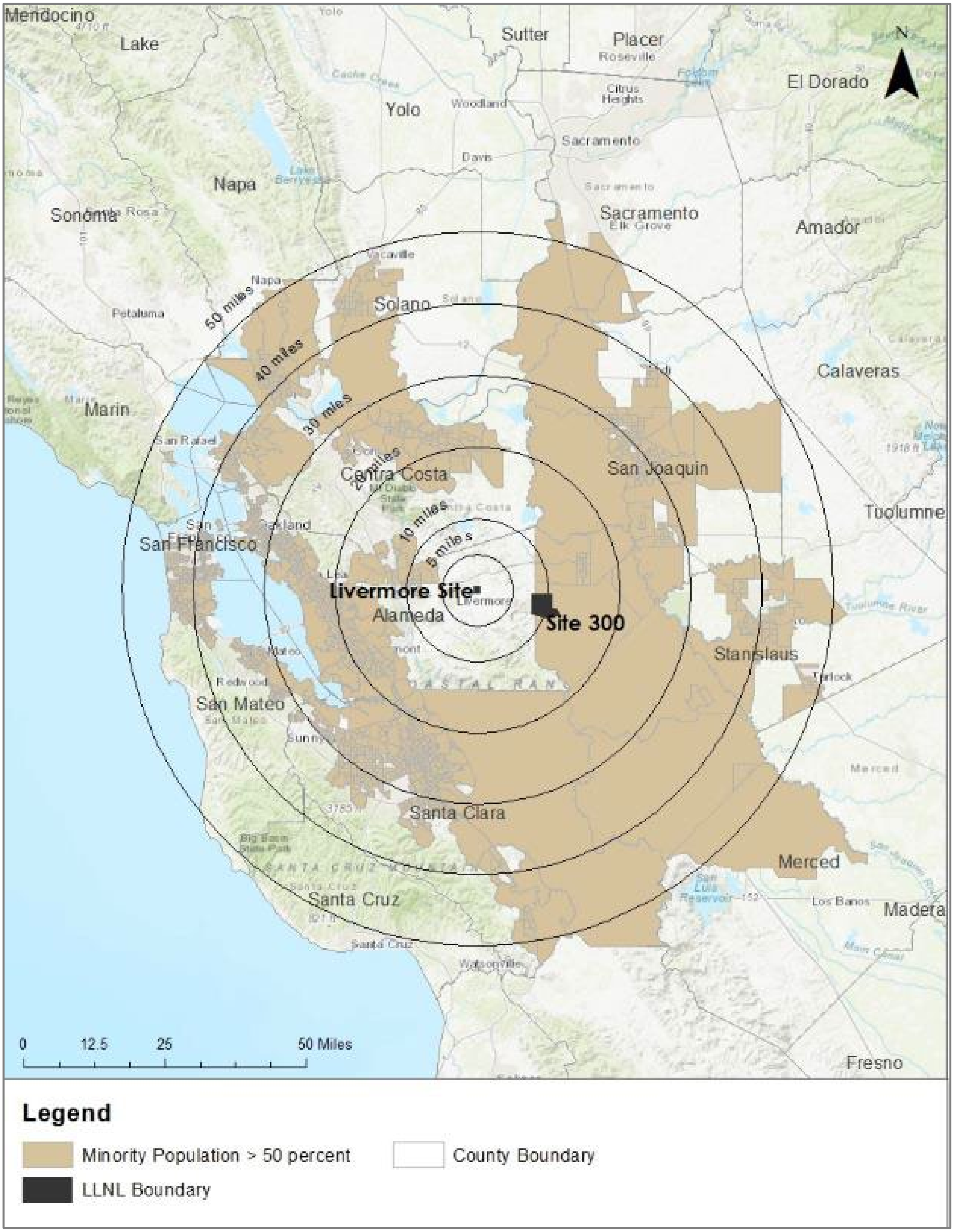
The current estimated population residing within a 50-mile radius of the Livermore Site is approximately 8,457,535 people, of which 62.8 percent are minority (USCB 2019c). This percentage is equal to the state of California as a whole (62.8 percent). The Hispanic population is the largest minority group and makes up 26.3 percent of the population within this area. Figure 4-69 shows minority populations within the 50-mile radius of the Livermore Site.

Of the current estimated population residing within a 50-mile radius of the Livermore Site for whom poverty status is determined, 9.6 percent are low-income (USCB 2019d). This percentage is less than the state of California as a whole (13.4 percent). Figure 4-70 shows low-income populations within the 50-mile radius of the Livermore Site.

4.10.5.2 *Site 300*

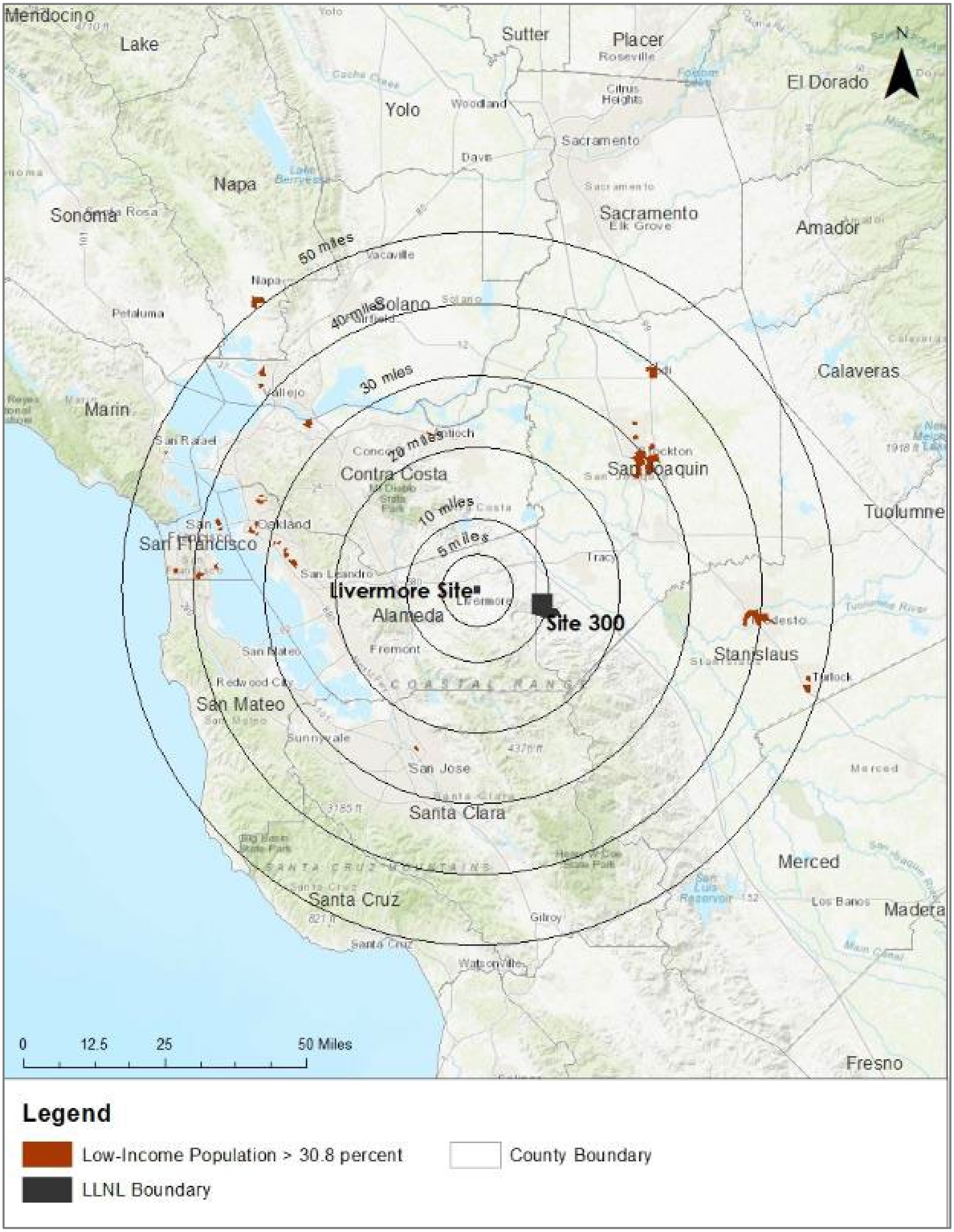
The current estimated population residing within a 50-mile radius of Site 300 is 7,353,150 people, of which 63.8 percent are minority (USCB 2019c). This percentage is higher than the state of California as a whole (62.8 percent). The Hispanic population is the largest minority group and makes up 27.7 percent of the population within this area. Figure 4-71 shows minority populations within the 50-mile radius of Site 300.

Of the current estimated population residing within a 50-mile radius of Site 300 for whom poverty status is determined, 9.9 percent are low-income (USCB 2019d). This percentage is less than the state of California as a whole (13.4 percent). Figure 4-72 shows low-income populations within the 50-mile radius of Site 300.



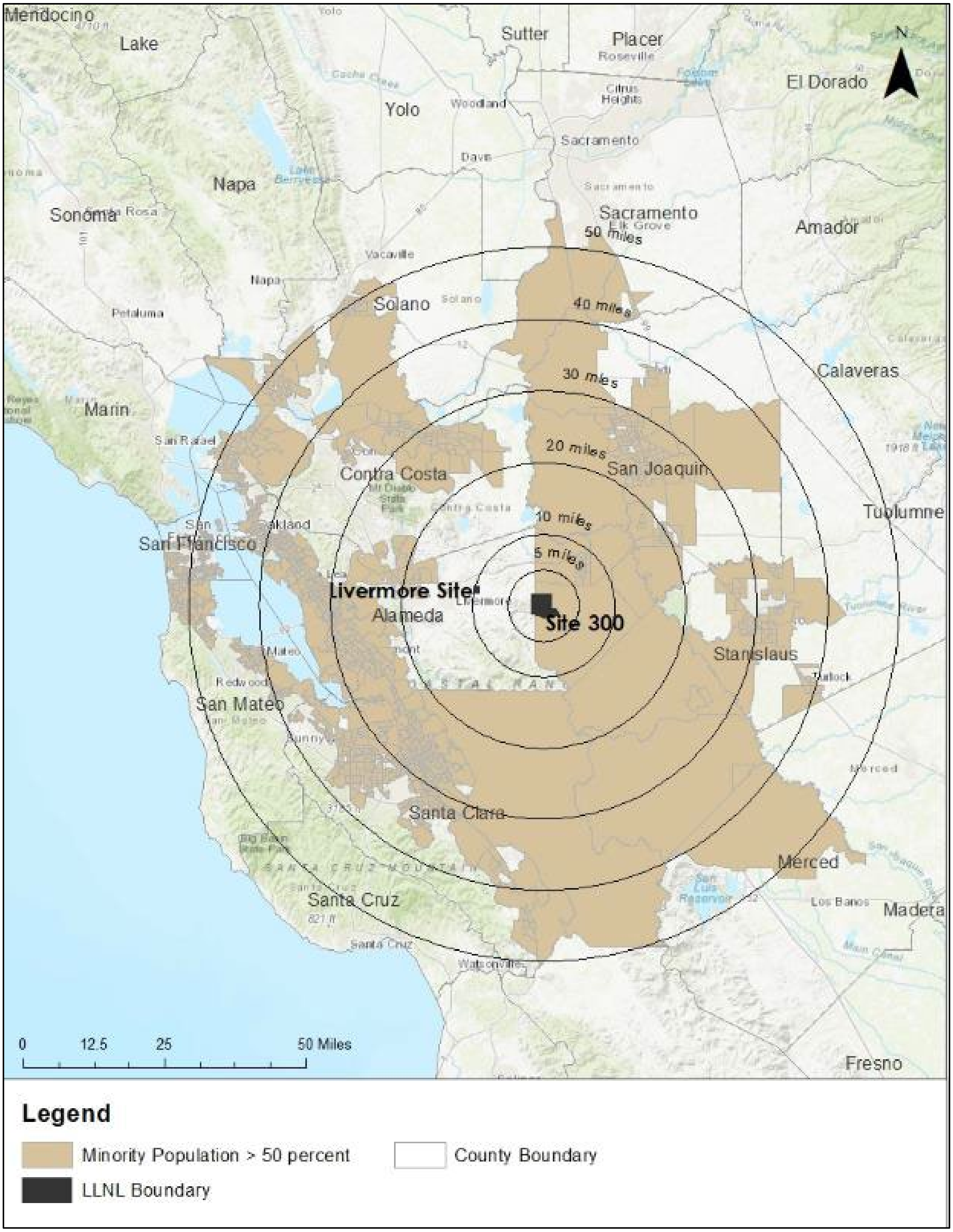
Source: USCB 2019c.

Figure 4-69. Minority Populations within 50 Miles of the Livermore Site



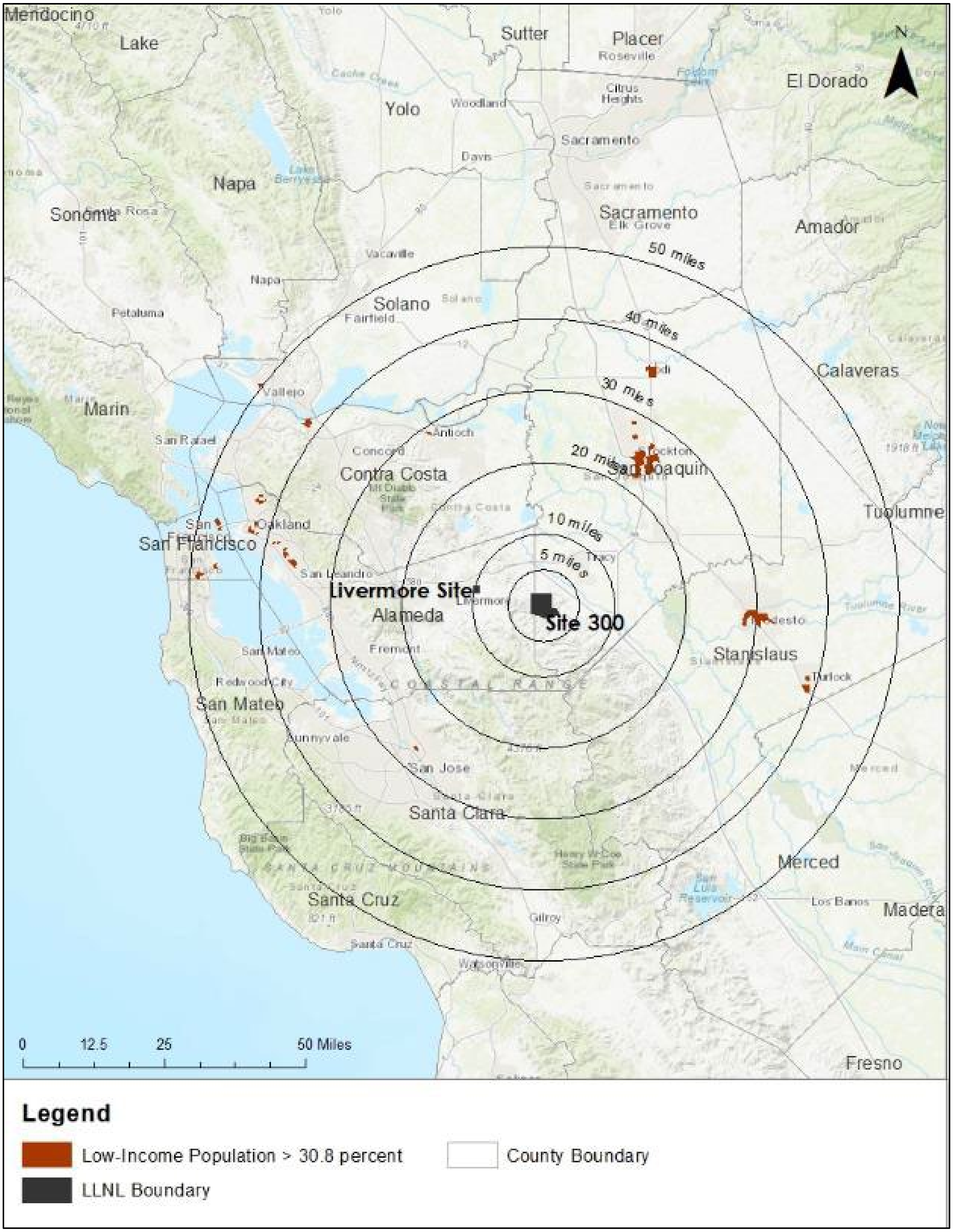
Source: USCB 2019d.

Figure 4-70. Low-Income Populations within 50 Miles of the Livermore Site



Source: USCB 2019c.

Figure 4-71. Minority Populations within 50 Miles of Site 300



Source: USCB 2019d.

Figure 4-72. Low-Income Populations within 50 Miles of Site 300

4.11 Traffic and Transportation

4.11.1 Transportation Infrastructure

4.11.1.1 *Livermore Site*

The Livermore Site is surrounded by a system of freeways, major streets, and collector streets (Figure 4-73). The freeways and major streets in the vicinity of the Livermore Site include I-580, South Vasco Road, Greenville Road, East Avenue, and Patterson Pass Road, most of which are primarily located within the city limits of Livermore.

I-580 is an east-west, eight-to-ten-lane freeway with four mixed-flow lanes, one auxiliary lane, and one express lane in each direction near LLNL's Livermore Site. I-580 connects the Bay Area with San Joaquin County and is a major inter-regional route for commuting, truck commerce, and recreational travel. Regional access to the Livermore Site by motor vehicle is from I-580, which runs east and west approximately one mile north of the Livermore Site. As depicted in Figure 4-73, the Vasco Road/I-580 interchange provides access to the western Livermore Site boundary, and the Greenville Road/I-580 interchange provides access to the eastern Livermore Site boundary.

In the vicinity of the Livermore Site, I-580 carries an average daily traffic volume of 165,000 to 220,000 vehicles (Alameda CTC 2018). I-580 experiences significant congestion during extended peak commute hours. In the morning, the westbound lanes of I-580 are congested from east of the Vasco Road/Greenville Road area (and beyond). In the evening, the eastbound lanes of I-580 are congested from west of Vasco Road to the Altamont Pass and eastward. Because of the congestion on I-580, the three parallel roads that connect the area with the Livermore Site—Patterson Pass Road, Tesla Road, and Altamont Pass Road—are increasingly used by commuters.

South Vasco Road is an important north-south roadway with four to six lanes and a median between East Avenue and I-580, with a continuation north of I-580. This roadway serves as a major route for traffic to the Livermore Site, with an estimated 37 percent of incoming traffic using this road to access the site (LLNL 2021d).

In addition to serving the Livermore Site and existing residential districts located west of the Livermore Site, South Vasco Road provides key access to the large industrial/business parks located north of the area, between Greenville Road to west of South Vasco Road. South Vasco Road also provides access to the existing Altamont Commuter Express (ACE) train station located near the southwest quadrant of the intersection of South Vasco Road and Brisa Street. The northern section of South Vasco Road, generally between I-580 and Las Positas Road, experiences the greatest degree of congestion in this corridor due to higher traffic volumes and a greater density of intersections with traffic signals.

Greenville Road is the other major north-south roadway serving the Livermore Site. Portions of Greenville Road, which is a divided arterial street, are two-, three-, four-, and six-lanes wide, with the wider sections to the north near I-580. It is estimated that 33 percent of all Livermore Site traffic uses Greenville Road for access (LLNL 2021d).

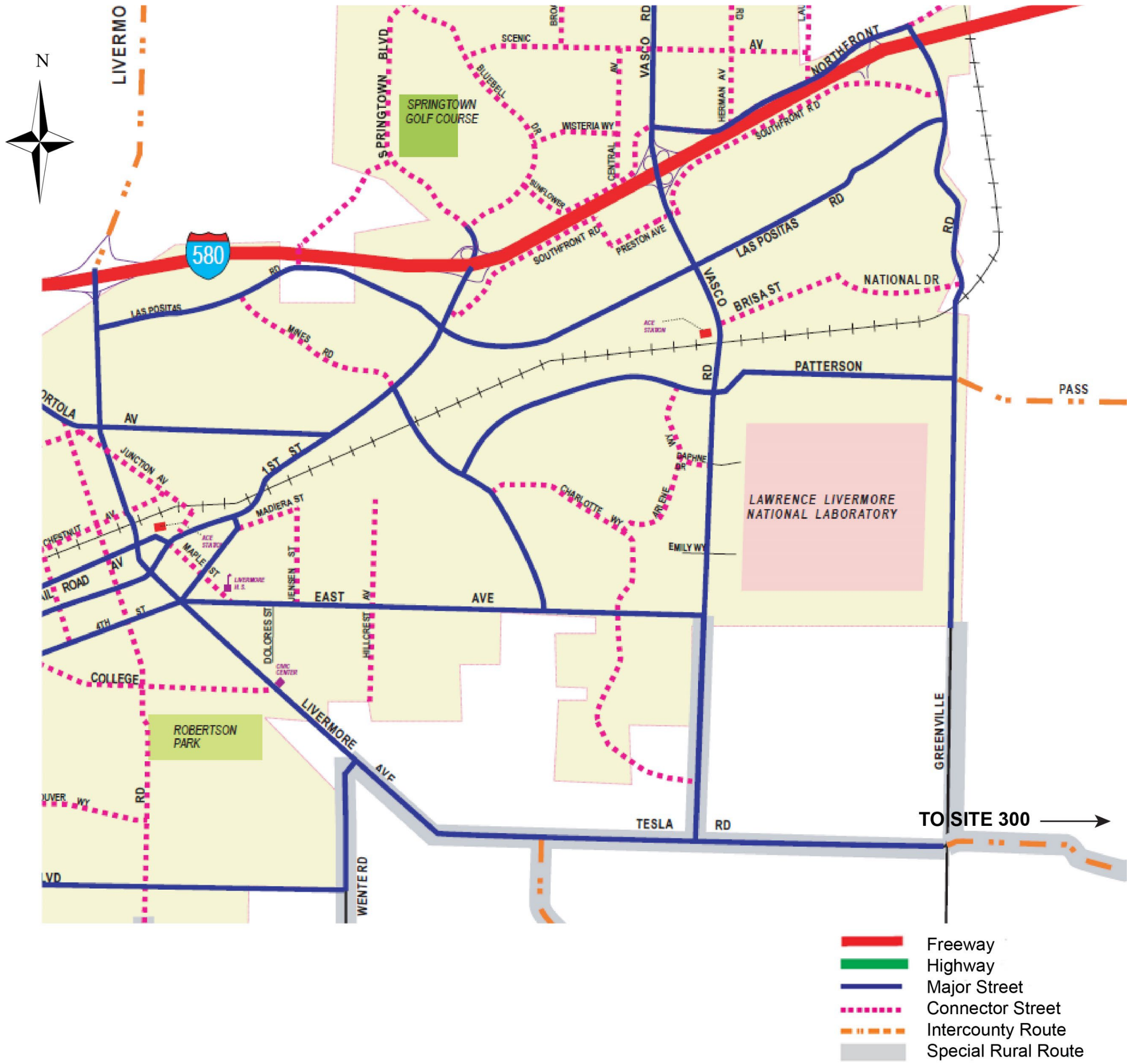


Figure 4-73. Road Network Surrounding the Livermore Site

East Avenue is the major east-west roadway serving the Livermore Site. An estimated 30 percent of all Livermore Site traffic uses East Avenue for access (LLNL 2021d). It also serves as an entry point for a sizable number of Sandia personnel. Along the southern boundary of the Livermore Site, between South Vasco Road and Greenville Road, East Avenue is four lanes wide on the western half and two lanes wide on the eastern half. However, the eastern half of the roadway was closed and gated in 2003 and is no longer usable for non-LLNL and SNL/CA Site traffic.

Patterson Pass Road is a four-lane divided arterial street with bike lanes between South Vasco Road and Greenville Road, located just north of the Livermore Site. Industrial buildings occupy the north side of the street; the south side of the street is an undeveloped buffer for the Livermore Site.

Speed limits for the roads surrounding the Livermore Site are depicted in Figure 4-74. According to the city of Livermore's adopted General Plan, the intersection level of service (LOS) standard is mid-level D, except in the downtown area and near freeway interchanges (Baker 2019a). The upper limit of acceptable LOS at selected intersections near freeway interchanges is LOS E. Therefore, any intersection operating at LOS E or LOS F is considered deficient for the purposes of this SWEIS analysis, with the exception of intersections near I-580 interchanges, where LOS F is considered deficient. Recent traffic studies in the vicinity of the Livermore Site indicate that the standards on roads and intersections in the vicinity of the Livermore Site vary between LOS C and LOS D (Baker 2019a, 2019b; Raney 2019a, 2019b). Under existing conditions, the I-580 freeway interchange intersections operate within applicable City of Livermore standards (Baker 2019a, 2019b; Raney 2019a, 2019b).

Level of Service

The LOS is a qualitative measure that describes operational conditions as they relate to the traffic stream and perceptions by motorists and passengers. The LOS generally describes these conditions in terms of such factors as speed and travel time, delays, freedom to maneuver, traffic interruptions, comfort, convenience, and safety. The operational LOS are given letter designations from A to F, with A representing the best operating conditions (free-flow) and F the worst (severely congested flow with high delays). Intersections generally are the capacity-controlling locations with respect to traffic operations on arterial and collector streets.

Approximately 39 percent of the Livermore Site employees live within 12 miles of the site (LLNL 2021d). The remaining employees travel from greater distances, mostly from Alameda, San Joaquin, Contra Costa, and Stanislaus counties. Many of these commuters travel in personal vehicles and arrive either via local roads or I-580. Approximately 73 percent of Livermore Site personnel commute to work alone. Alternate modes of commuter transportation include carpools/vanpools (11 percent of employees) and bicycles and/or public transit (10 percent). Under previous normal operating conditions (before COVID-19 teleworking), approximately six percent of employees worked from home on any given day (LLNL 2021d). This has changed in the last 1.5 years because of the COVID-19 pandemic, although LLNL has recently established a Return to New Normal (RTNN) program for employees to return safely back to the Laboratory.

Because the Bay Area suffers from heavy traffic congestion, LLNL has established programs to help commuters find alternative means to get to work. LLNL's Transportation Systems Management Program maintains a database that commuters can use to advertise for new riders or to find an appropriate carpool. There are approximately 250 carpools/vanpools in use. LLNL provides preferential parking for those willing to use carpools. Vans are either leased or privately owned. An LLNL incentive program provides gasoline at reduced prices for vanpools (LLNL 2021d).

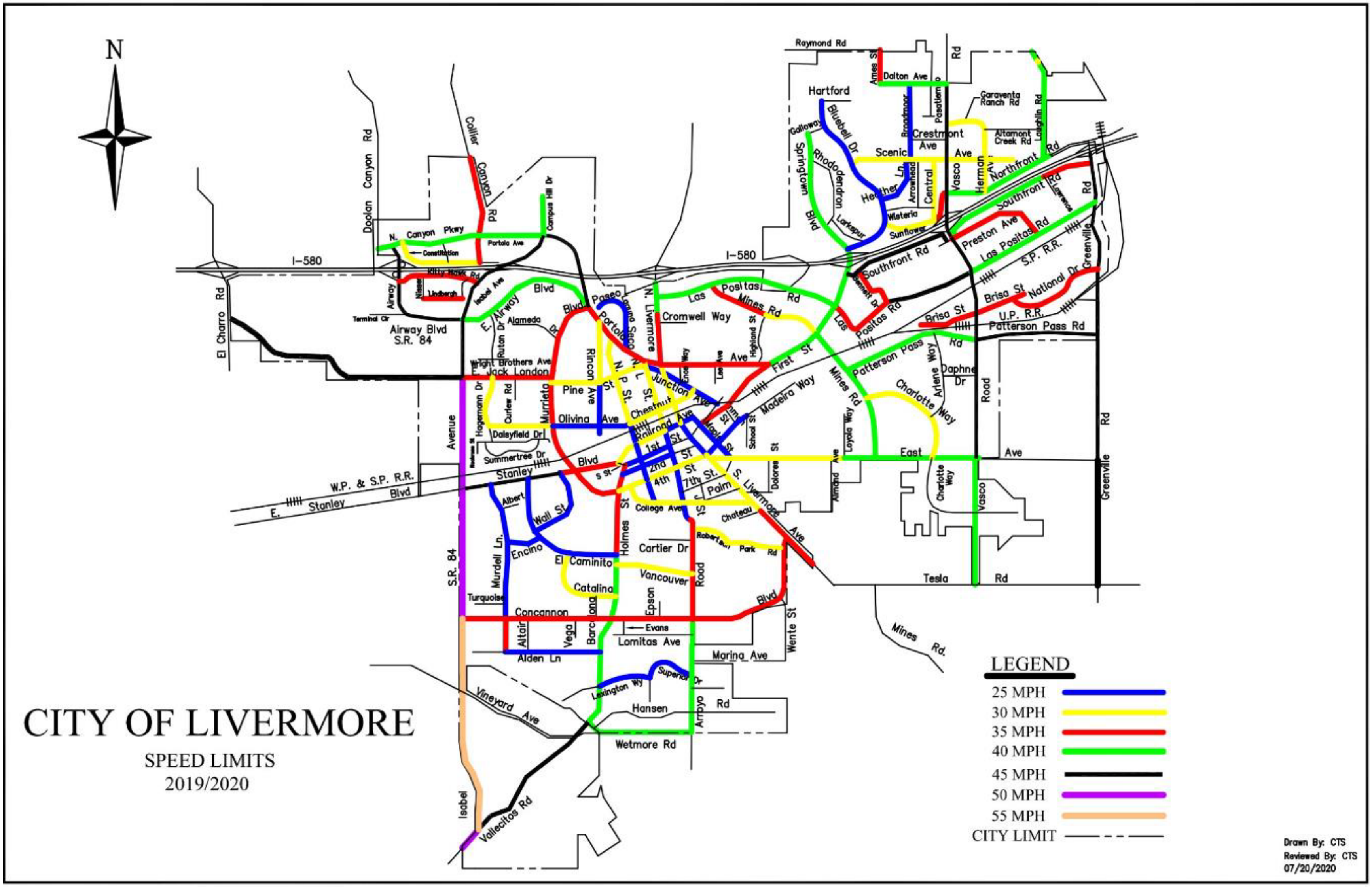


Figure 4-74. City of Livermore Speed Limits

Road Improvements Near the Livermore Site. Since publication of the 2005 SWEIS, notable improvements have been implemented for roads in the vicinity of the Livermore Site. Most notably, the Vasco Road/I-580 interchange has been improved with signals and off-ramp changes to reduce the speed of traffic exiting the freeway and increase the distance between the off-ramps and local roads. There have also been improvements on Greenville Road, including road straightening and widening. Currently, the city of Livermore is evaluating a Corridor Study on East Avenue that will enhance mobility and safety for all modes of transportation, with a focus on East Avenue between S. Livermore Avenue and S. Vasco Road. The study will evaluate existing conditions, identify issues, and provide alternatives to mitigate traffic-related issues with the help of extensive community participation (Livermore 2021b)

Mass Transit. Mass transit opportunities include the ACE, BART, Livermore Amador Valley Transit Authority, and commuter buses. ACE is a rail service between Stockton and San Jose, passing through Livermore, Pleasanton, and other points along the route. The LLNL taxi service provides free shuttle service between the ACE Train South Vasco Station and the Livermore Site. BART provides rapid transit rail service from San Francisco, Oakland, and other points in the Bay Area to a station in Pleasanton/Dublin. WHEELS is a service of the Livermore Amador Valley Transit Authority and provides public transportation for the Tri-Valley communities of Dublin, Livermore, and Pleasanton, with stops at the Livermore Site. Commuter buses from points in San Joaquin and Contra Costa counties provide service directly to the Livermore Site.

The BART to Livermore Extension Project was a proposal to extend the BART rail line by 5.5 miles along I-580 from the existing Dublin/Pleasanton Station (the eastern terminus of the route) to a new station in the vicinity of the Isabel Avenue interchange. The Project also incorporated improvements to the local bus system and connections with key activity centers in Livermore and inter-regional rail service. The proposed extension would have provided an alternative to traffic congestion on the busy I-580 corridor, reduced GHG emissions and other pollutants, and expanded opportunities for transit-oriented development. At its May 24, 2018, meeting, the BART Board voted to certify the BART to Livermore Extension Project Final Environmental Impact Report, but to not advance the Proposed Conventional BART Extension to Livermore. The Board also voted to not advance the Diesel Multiple Unit or Electric Multiple Unit Alternative, Express Bus/Bus Rapid Transit Alternative, or the Enhanced Bus Alternative (BART 2018).

Currently, the Tri-Valley-San Joaquin Valley Regional Rail Authority is considering a plan that would deliver cost-effective and responsive transit connectivity between the BART and ACE systems in the Tri-Valley to meet the goals and objectives of the communities it would serve. To date, a project feasibility report has been completed, which identifies a proposed project (Valley Rail) that is currently undergoing further design and environmental review. That project would consist of two phases (Valley Link 2020):

- **Phase 1:** Rail service from the existing Dublin/Pleasanton BART Station to the proposed North Lathrop/ACE station, utilizing existing transportation rights of way where feasible.
- **Phase 2:** Rail service extended from the North Lathrop ACE station to the existing Stockton ACE/San Joaquin stations.

The Valley Rail project would implement two new daily round-trips for the Amtrak San Joaquin service to better connect San Joaquin Valley travelers with the Sacramento Area, as well as an extension of ACE between Sacramento and Merced. In addition, Valley Rail would convert the entire fleet including the thruway bus network to renewable diesel fuel, providing GHG benefits across the entire existing (449 track miles) and proposed expansion (119 track miles) of San Joaquin and ACE services (Acerail 2021).

4.11.1.2 *Site 300*

Regional access to Site 300 is via I-580 to Corral Hollow Road. Alternatively, travel between the Livermore Site and Site 300 is via Tesla Road (*see* Figure 4-73). Tesla Road becomes Corral Hollow Road east of the Alameda-San Joaquin county line. There is one primary access gate to Site 300 from Corral Hollow Road with another gate for the Small Arms Training Facility. The LLNL Transportation Systems Management Program also provides services for setting up carpools and vanpools for employees of Site 300. Neither public transportation nor LLNL shuttle service are available to Site 300.

Road Improvements Near Site 300. These improvements will widen Corral Hollow Road by 12 feet to accommodate installation of a left-hand turn lane and a median acceleration lane on eastbound Corral Hollow Road, along with associated rumble strips and striping. The improvements will also include slurry seal for the existing roadway, as well as installation of speed limit signs and solar powered radar signs on both eastbound and westbound Corral Hollow Road and right-hand turn pocket delineators on westbound Corral Hollow Road (NNSA 2021a).

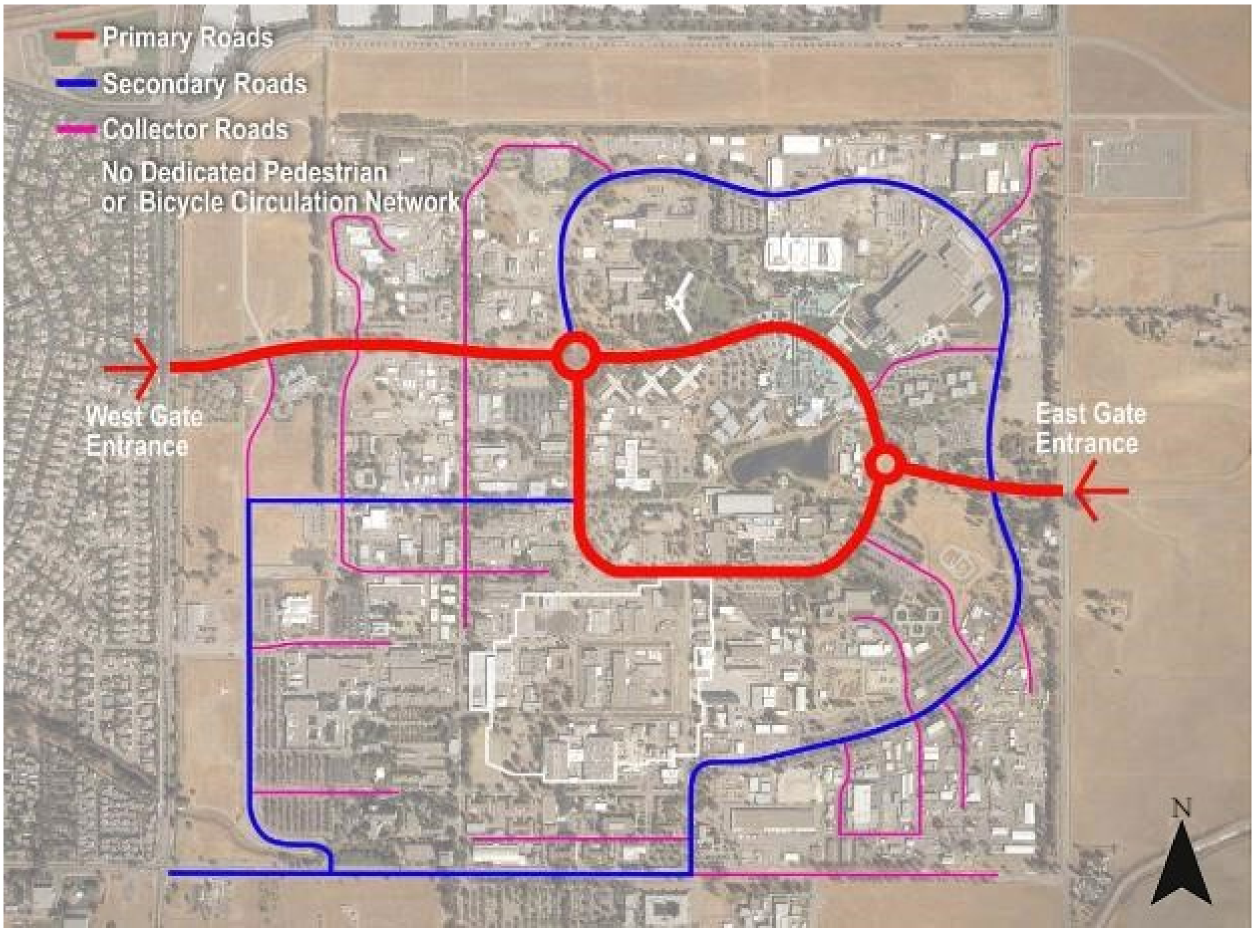
4.11.2 Aviation

The Livermore Municipal Airport, located just south of I-580 at Airway Boulevard, is the only airport in the Tri-Valley area and is the fourth busiest airport in the Bay Area. The airport occupies 644 acres and has been in operation at its existing location since 1965. As a general aviation airport, most aircraft served by the airport are small, privately owned, single- and twin-engine propeller, and turbo-propeller aircraft. As of 2018, these smaller aircraft comprised approximately 98 percent of all aircraft served by the airport; the remaining two percent are small- and medium-sized corporate jets (e.g., Challenger 601, Lear 35, Hawker 25) and helicopters. Current discussions are underway for possible airport expansions. In 2018, the airport experienced approximately 148,000 total aircraft flights (Livermore 2020b). The airport does not provide commercial airline service. LLNL leases aircraft for research and also conducts research from aircraft managed by others. Aircraft operations include the use of manned aircraft, which fly in the Livermore Valley and around Site 300, as well as other sites outside of the area. Unmanned aircraft systems (UAS) are also used for research at both the Livermore Site and Site 300. The Livermore Site has a dedicated UAS pen for contained research flights.

4.11.3 Onsite Circulation and Parking

4.11.3.1 *Livermore Site*

Vehicle access to the Livermore Site is provided through four security gates and one shipping and receiving gate. The two principal access gates are the West Gate Entrance from South Vasco Road and the East Gate Entrance from Greenville Road (Figure 4-75). There are also two additional access gates for site personnel from East Avenue. Following the 2005 SWEIS, NNSA placed the section of East Avenue between South Vasco Road and Greenville Road under enhanced security control. That roadway is now closed to public traffic and has become a Property Protection Security Area known as the East Avenue Corridor Property Protection Area, with guard kiosks at both ends and additional traffic lane modifications. The three original East Avenue gates continue to provide secure access to the Livermore Site. A truck inspection station for deliveries was constructed at the northwest corner of Greenville Road and East Avenue and is only accessible from the Greenville Road intersection.



Source: LLNL 2011d.

Figure 4-75. Looped Circulation Traffic System on the Livermore Site

The existing circulation and transportation network within the Livermore Site consists of primary and secondary roads organized in a looped pattern (Figure 4-75). Once vehicles enter the site, traffic flow is dominated by an inner and outer circular loop road system. Two roundabouts (traffic circles) facilitate flow of traffic into and out of the loops. The onsite transportation system is also characterized by roads and streets, meandering bike and pedestrian pathways, and parking lots. Even during peak traffic periods, traffic at the Livermore Site is light. Improvements in pavement markings, signage, lane widths, and crosswalk locations, and elimination of angle parking are continually being implemented.

Expected traffic counts at the Livermore Site gates are shown in Table 4-30. Those traffic counts have been adjusted from the most recent Site Circulation Study (LLNL 2011d) to reflect conditions that would be expected under non-COVID-19 pandemic conditions, in which approximately six percent of employees worked from home on any given day. This has changed in the last 1.5 years because of the COVID-19 pandemic, although LLNL has recently established a RTNN program for employees to return safely back to the Laboratory. The sum of all the entrance counts represents the external traffic expected at the site under non-COVID-19 pandemic conditions. Likewise, the sum of all the exit counts represents the external traffic generated by all the zones during the day under non-COVID-19 pandemic conditions. Although car usage is estimated at 0.71 vehicle per employee, the total daily vehicles entering the site is computed as 9,000 (based on non-COVID-19 pandemic conditions) to include visitors, suppliers, and multiple trips by some employees (e.g., offsite -activities).

Table 4-30. Estimated Traffic Counts at Livermore Site Gates[a]

Gate Entrance	Entering Trips	Exiting Trips
West Gate	3,660	3,330
East Gate	2,530	2,630
East Avenue/Vasco Road Gate (southwest)	1,470	1,310
East Avenue/Greenville Road Shipping and Receiving Gate (southeast)	1,340	1,430
Total	**9,000**	**8,700**

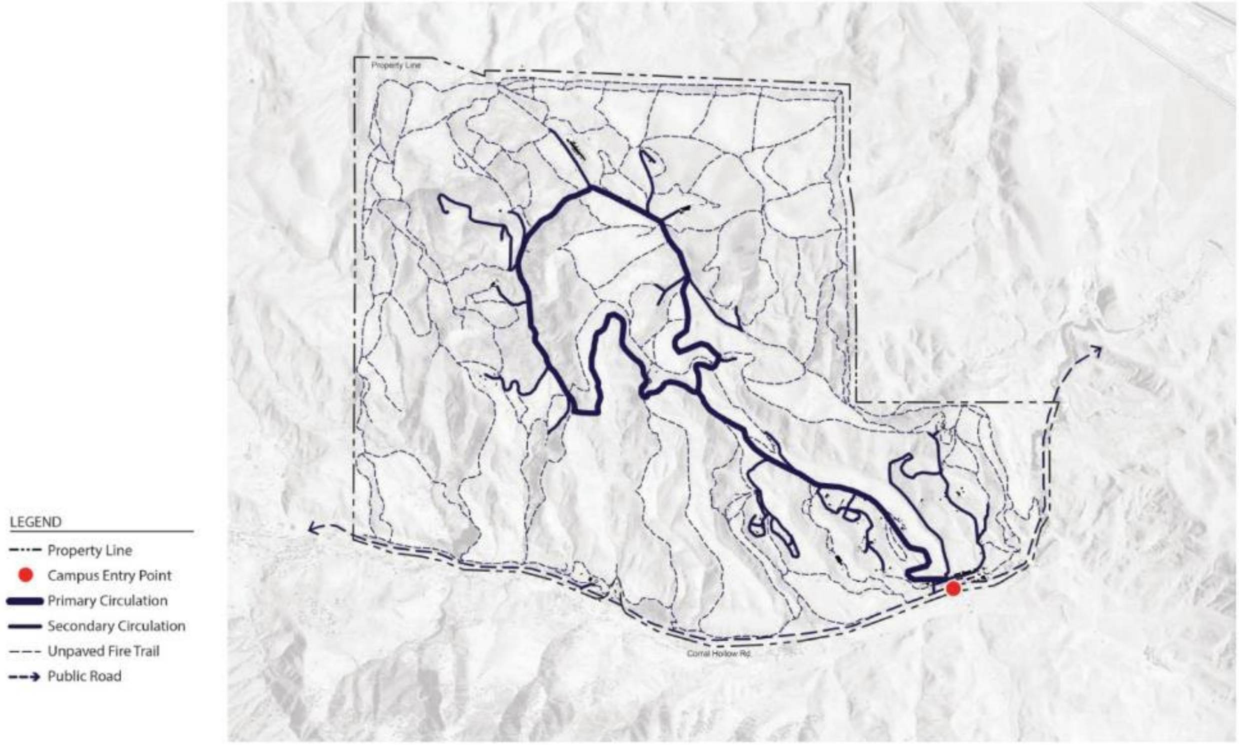
a. Estimates are based on non-COVID 19 pandemic conditions.
Source: LLNL 2011d, as modified based on employment of 7,685 employees at the Livermore Site.

An analysis of the Livermore Site road network, which was based on a population of approximately 9,000 site workers, concluded that the current primary and secondary road network on site is well below capacity and can readily handle doubling (or more) of traffic (LLNL 2011d). Given the current total of 7,685 workers at the Livermore Site, that conclusion remains valid.

There are approximately 8,200 parking stalls at the Livermore Site to serve current and future employees (i.e., LLNL employees, contract employees, DOE personnel, visitors with LLNL offices, and others, not including construction workers and consultants with sporadic presence). These stalls were provided in more than 70 designated institutional parking lots distributed across the Livermore Site and placed with a goal of limiting walking distance from vehicle to work location to 540 feet. Some of the parking lots have a surplus of stalls, and some have a deficit, but the overall parking stall supply and demand is balanced for the site.

4.11.3.2 *Site 300*

Access to Site 300 is through a single gate from Corral Hollow Road. There is a separate gate for the Small Firearms Training Facility. Personal vehicles are only allowed in the parking area in the GSA just beyond the gate. Only government and contractor company vehicles are allowed on Site 300 roads. The parking stall availability is adequate to meet demand. Traffic on Site 300 roads is extremely light. The existing circulation and transportation network within Site 300 consists of primary and secondary roads as shown in Figure 4-76.



Source: LLNL 2021b.

Figure 4-76. Existing Vehicle Circulation on Site 300

4.11.4 Hazardous and Radiological Materials Shipments

LLNL packages and transports hazardous and radiological materials and wastes to support many of its programs. These packaging and transportation activities must meet stringent regulatory requirements which are designed to protect persons and property, ensure hazardous materials or waste is contained in the package during routine transportation and off-normal events, provide material identification to first responders, and provide security protection during transit, as applicable. Appendix E, Section E.3 describes these regulations and federal agency enforcement responsibilities. The *Radioactive Material Regulations Review* (USDOT 2008) document provides additional details regarding the regulation of radioactive materials shipments. Appendix E, Section E.4 describes the responsibilities and coordination activities associated with emergency response to transportation incidents.

4.11.4.1 *Livermore Site*

With the exception of local deliveries from the Bay Area, trucks carrying radioactive or hazardous material almost exclusively arrive from or depart to the east on I-580 and I-5. Majority of hazardous waste shipments are from LLNL to San Jose. In an average year, LLNL conducts between about 80 to 240 separate shipments of hazardous waste per year. Additionally, as discussed below, LLNL sends or receives about 1,400 shipments per year of explosive or radioactive materials involved in LLNL's mission (LLNL 2021d).

LLNL transports about 40 to 60 low-level radioactive waste (LLW) shipments per year, with approximately 85 percent going to the Nevada National Security Site (NNSS) near Las Vegas, Nevada, and 15 percent to the Energy*Solutions* commercial disposal facility in Clive, Utah. About 10 to 15 mixed low-level waste (MLLW) shipments are made to commercial treatment, storage and disposal facilities (Energy*Solutions* in Clive, Utah, and Perma-Fix in Kingston, Tennessee) annually. Contact-handled transuranic (TRU) waste is shipped to the Waste Isolation Pilot Plant (WIPP) in Carlsbad, New Mexico. About 2 to 4 TRU shipments are made to WIPP annually, although LLNL made 21 shipments of legacy TRU waste in 2020 (LLNL 2021d).

Radioactive materials are also shipped to and from the Livermore Site as part of its mission, resulting in about 600 shipments annually. These include plutonium metals and oxides, uranium metals and oxides, tritium, and other radioactive materials. In 2019, there were approximately 11 shipments of special nuclear material (primarily plutonium and uranium), about 84 shipments of small quantities of highly enriched uranium, about 5 shipments of tritium, and about 470 shipments of sealed sources and miscellaneous isotopes.

Radioactive wastes and materials are routinely transferred between Livermore Site facilities. In the event of an accident, the operational transfers have the potential to release radioactivity to the employees and the public and are analyzed in Appendix C. LLNL has carefully examined onsite transfers of radioactive materials and has established engineered and administrative controls to minimize the impact and frequency of such accidents.

Onsite transfers at LLNL are defined as the movement of materials by programmatic organizations on the Livermore Site and Site 300. LLNL radioactive waste transfer operations begin when the vehicle leaves the boundary of the originating facility and ends when the transfer vehicle enters the boundary of Radioactive and Hazardous Waste Management's (RHWM) receiving facility. Materials transfers include radionuclides within the Superblock (i.e., between B331, B332, and B334) and between the Superblock and B239. Onsite transportation at Site 300 is limited to activities related to materials within the geographically contiguous property of Site 300.

Two documents describe the envelope within which hazardous and/or radioactive materials transportation operations must occur to meet safety objectives: (1) *Transportation Safety Basis Document for Nonnuclear Onsite Transfer Activities at Lawrence Livermore National Laboratory– Main Site* (LLNL 2017e) prescribes operational requirements for smaller-quantity transfers; and (2) *Lawrence Livermore National Laboratory Transportation Safety Document* (LLNL 2018e), prescribes the requirements for the larger-quantity transfers. Section 5.11 and Appendix C discusses accidents and potential impacts involving transportation of hazardous and radiological materials.

4.11.4.2 *Site 300*

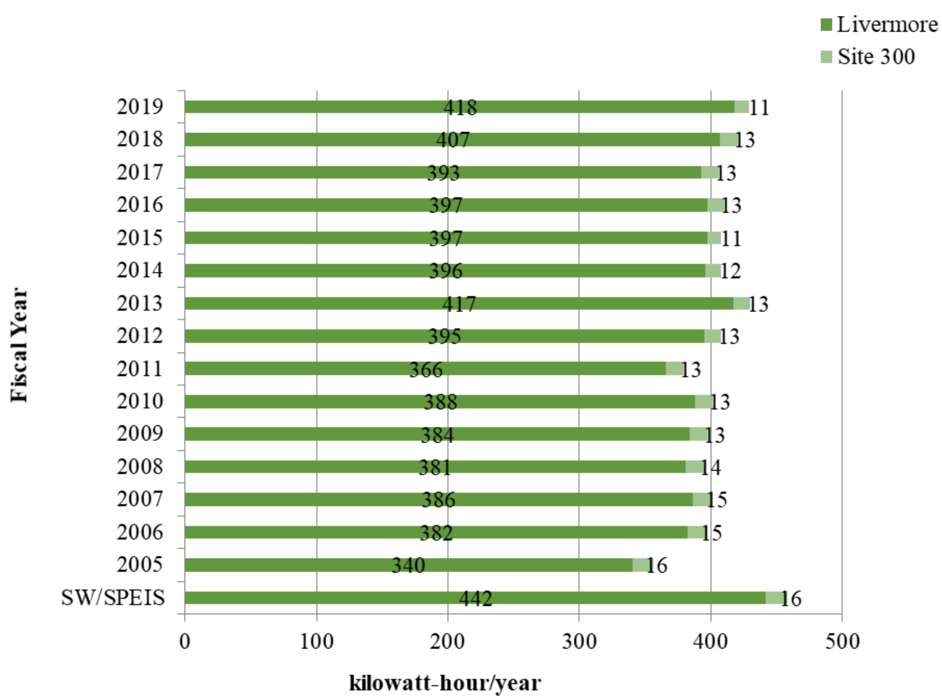
LLNL makes about 22 shipments per year of depleted uranium to and from Site 300. Radiological shipments, such as those containing depleted uranium, are infrequent and contain little radioactivity. Most of the hazardous shipments to and from Site 300 are explosives shipments. In 2019, there were about 730 explosives shipments, consisting of 610 outgoing shipments and approximately 120 receivals. A small number (1-2) of the outgoing shipments include explosives waste that cannot be treated at the EWTF at Site 300 and is shipped to the Clean Harbors facility in Colfax, Louisiana. Explosives waste shipments follow the same controls and regulations as all other hazardous material shipments. The Occupational Safety and Health Administration (OSHA) enforces regulations under 29 CFR Part 1926.902 that are applicable to the surface transport of explosives. U.S. Department of Transportation (USDOT) regulations that are applicable to the transport of explosives are under 49 CFR Parts 173 and 176, and 49 CFR Parts 390–397 (applicable to motor carriers).

LLNL has analyzed the hazards of explosives transport and prepared procedures for safe operations (LLNL 2017f). LLNL has carefully examined onsite transfers of hazardous materials and has established engineered and administrative controls to minimize the impact and frequency of such accidents. The *Transportation Safety Basis Document for Nonnuclear Onsite Transfer Activities at Lawrence Livermore National Laboratory–Site 300* (LLNL 2017f) describes the envelope within which hazardous materials transportation operations must occur to meet safety objectives. All Site 300 shipment operations are conducted in accordance with USDOT regulations. There have been no explosions or fires resulting from accidents with explosive shipments (LLNL 2021d).

4.12 INFRASTRUCTURE

4.12.1 Electricity

Electricity consumption for the Livermore Site and Site 300 was consistent with the relatively stable trend in recent years at both sites (Figure 4-77) (LLNL 2020p).



Note: SW/SPEIS = 2005 SWEIS projection

Figure 4-77. Annual Electricity Consumption for the Livermore Site and Site 300 (2005–2019)

Electricity consumption at the Livermore Site averaged 402.4 million kilowatt-hours per year over the five-year period 2015–2019 with a standard deviation of 9.1 million kilowatt-hours. This standard deviation represents a 2.2-percent variation from the average. At Site 300, electricity consumption averaged 12.2 million kilowatt-hours per year over the same five-year period, with a standard deviation of 0.98 million kilowatt-hours. This standard deviation represents an 8-percent variation from the average. The total consumption for both sites was 414.6 million kilowatt-hours per year with a standard deviation of 8.7 million kilowatt-hours. This standard deviation represents a 2.1-percent variation from the average (LLNL 2020p).

4.12.1.1 *Livermore Site*

An existing Western Area Power Administration transmission line substation located off site at Patterson Pass Road and Greenville Road provides power to the Livermore Site (NNSA 2019b). Pacific Gas and Electric Company also provides electric power to parts of the site. The electrical energy used at the Livermore Site is devoted almost entirely to the operation of office buildings and research laboratory facilities. Under DOE guideline definitions of “building” and “metered process,” the Livermore Site space is classified as approximately 50 percent “building” and 50 percent “metered process” load (NNSA 2005). The peak electrical load in 2019 was 59 megawatts and is projected to increase to 83 megawatts in 2022 (LLNL 2019l) as other site projects become operational.

4.12.1.2 *Site 300*

Pacific Gas and Electric Company supplies electrical power to Site 300. From 2015 to 2019, Site 300 consumed an average of 12.2 million kilowatt-hours per year. Electricity consumption rates at Site 300 have remained stable over the past five years and reflect a 23.8-percent decrease from the 2005 average of 16 million kilowatt-hours per year (LLNL 2020p).

In 2019, the monthly peak demand at Site 300 averaged two megawatts and is projected to remain consistent over the next several years (LLNL 2019l).

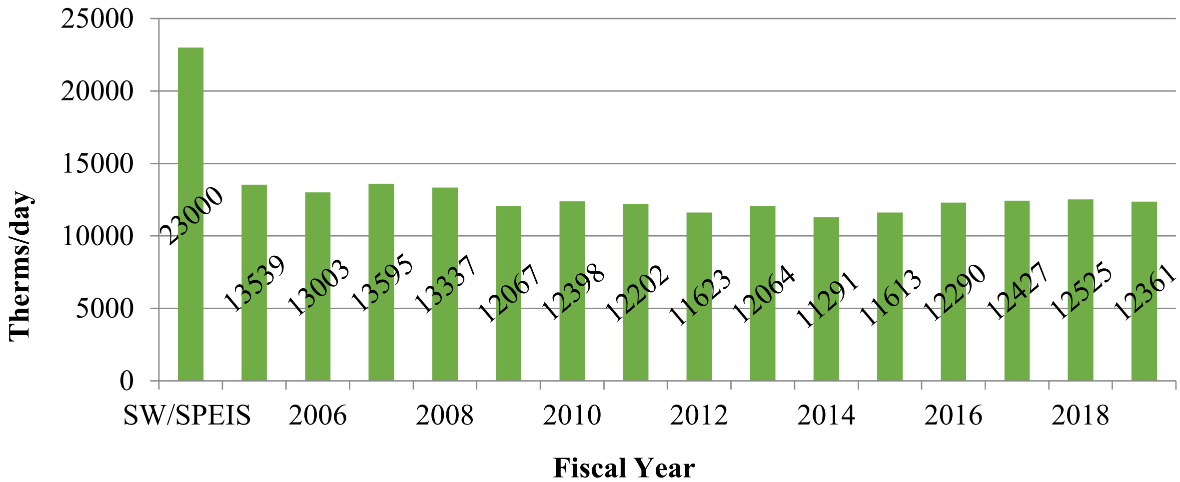
4.12.2 Fuel

4.12.2.1 *Natural Gas*

Livermore Site. Pacific Gas and Electric Company supplies natural gas to the Livermore Site via the meter station at the south end of Southgate Drive. Natural gas is used mostly for comfort heating in the building category. In the metered process category, natural gas is used mostly for programmatic experiments and comfort heating. Continuing efforts to decrease energy use include modification to heating, ventilation, and air conditioning controls, the design of more efficient buildings, conducting boiler tune-ups, and making other site energy conservation efforts (LLNL 2019j).

Natural gas consumption rates at the Livermore Site have slightly increased during the past five years, reflecting a 6.1-percent increase since 2015 (Figure 4-78). The current capacity of the natural gas system is 24,500 therms per day (NNSA 2005). In addition, the 2005 LLNL SWEIS projected natural gas consumption at 23,000 therms/day for the Livermore Site. Actual natural gas consumption during 2018 was 12,525 therms/day and during 2019 was 12,361 therms/day (LLNL 2020f, 2020p).

Site 300. There is no natural gas service at Site 300 (LLNL 2020p).



Note: SW/SPEIS = 2005 SWEIS projection.

Figure 4-78. Annual Natural Gas Consumption at the Livermore Site and Site 300 (2005-2019)

4.12.2.2 *Petroleum Fuel*

Petroleum fuel is used in vehicles and heavy equipment and for backup electrical power generation in the building category. In FY 2020, LLNL decreased its petroleum fuel consumption by 74 percent relative to the FY 2005 baseline about the same as FY 2019, which was nearly 10 percent less than FY 2018. About 102,685 gallons of petroleum was dispensed in FY 2020. This exceeded the goal of a 20-percent reduction in annual petroleum consumption by FY 2015 relative to a FY 2005 baseline, but did not meet the goal of maintaining a 2-percent year-over-year reduction (LLNL 2020ab). Fuel oil is no longer used at the Livermore Site or Site 300 (LLNL 2019k).

4.12.3 Domestic Water

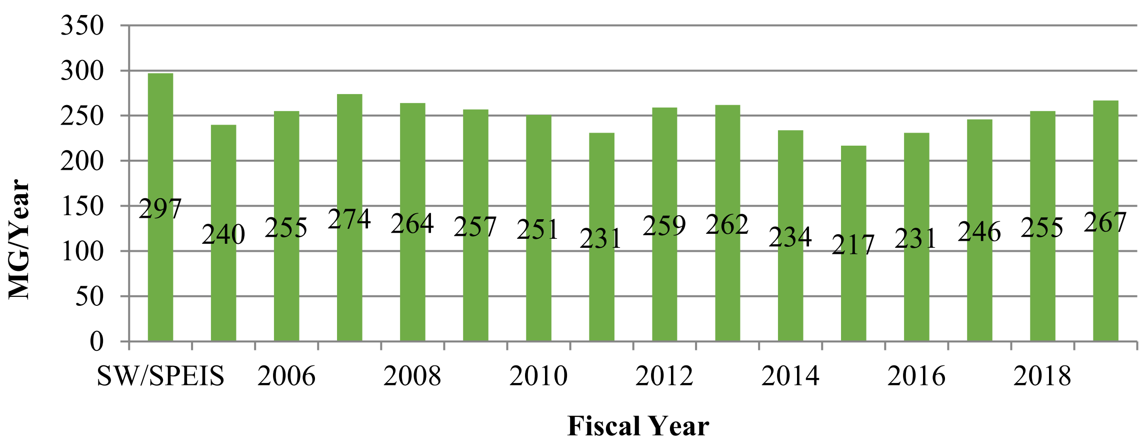
4.12.3.1 *Livermore Site*

The Livermore Site's primary water source is San Francisco Public Utilities Commission's (SFPUC) Hetch Hetchy Regional Water System. This system obtains its water from a reservoir in the Hetch Hetchy Valley of Yosemite National Park. Water from Hetch Hetchy is treated at a newly built chloramination facility located at SNL/CA but owned and operated by LLNL. The secondary water source for the Livermore Site is from Zone 7 Water Agency. This water is a mixture of both groundwater and water from the South Bay Aqueduct of the SWP. The Livermore Site domestic water system capacity is approximately 2.88 million gallons per day, or 1,051 million gallons per year. The 2005 LLNL SWEIS projected annual water consumption of approximately 297 million gallons per year. Actual water consumption at LLNL was 267 million gallons in 2019 (LLNL 2020p).

Water at the Livermore Site is primarily used for cooling towers, facility processes, domestic use, and irrigation (LLNL 2019j). The largest portion of LLNL's current water demand at the Livermore Site can be attributed to the cooling facilities, which account for over 50 percent of total potable water use on site. Currently, there are five cooling towers at the Livermore Site, with plans to add a sixth large tower[4] to serve the Exascale Computing Facility Modernization project (Stantec 2019).

Water consumption in 2019 was consistent with the gradually increasing trend in recent years at both the Livermore Site and Site 300. However, for all years since publication of the 2005 LLNL SWEIS, consumption has remained within stated projections. The annual switch from Hetch Hetchy to Zone 7 water supply has usually lasted for two to three months during maintenance periods. However, the amount of time on Zone 7 water supply has increased in recent years. The Livermore Site drew from Zone 7 water supply for 30 weeks in 2016, 50 weeks in 2017, and 39 weeks in 2018. This increased reliance on Zone 7 water supply was due to concerns regarding adequate chlorination in the normal Hetch Hetchy supply (LLNL 2019k). This problem was fixed with the new chloramination plant built at SNL/CA in 2020 and operated by LLNL.

Water consumption at LLNL averaged 243.2 million gallons over the five-year period from 2015 through 2019 with a standard deviation of 17.6 million gallons (Figure 4-79). This standard deviation represents a 7.2-percent variation from the average (LLNL 2020p).



Note: SW/SPEIS = 2005 SWEIS projection.

Figure 4-79. Annual Water Consumption at the Livermore Site (2005–2019)

Livermore Site Vicinity. LLNL is within in the Livermore-Amador Valley. Freshwater supplies in this area are limited and the average annual rainfall is only about 14-inches. No major rivers flow through the area; therefore, groundwater and imported surface waters are the primary sources

[4] The sixth cooling tower is now operational.

of freshwater serving the area. The availability of SWP supplies is fundamental to Zone 7's maintenance of its basin measurable objectives with regard to sustainable groundwater levels and storage, avoidance of subsidence, and protection of groundwater dependent eco-systems. Zone 7 ensures that local groundwater supplies are not depleted by importing an average of 75 percent of the Valley's water demand (61 percent in Water Year 2019). This imported water is delivered to Zone 7 through the South Bay Aqueduct and is used for municipal and agricultural supplies and for recharging the Main Basin aquifers (artificial recharge) (Stantec 2019). Overall, groundwater conditions in the Livermore Basin are stable and have recovered from the 2011–2015 drought. However, management of the long-term water supply is an important issue/concern requiring monitoring and mitigation efforts, especially as water demand is projected to increase in the coming years (Zone 7 Water Agency 2020a).

Potable water and raw water for agricultural irrigation is provided to the city of Livermore from a variety of sources. Zone 7 is the water wholesaler. California Water Service Company (Cal Water) and Livermore Municipal Water provide retail service (Zone 7 Water Agency 2020a). In 2019, 51,805 acre-feet of water were consumed in the Livermore Valley for municipal use (79 percent), agricultural use (21 percent), and domestic use (0.2 percent). Imported surface water from the SWP supplied about 61 percent of the water demand with a combination of groundwater (27 percent), and recycled water (12 percent) (Zone 7 Water Agency 2020a). Land use in the vicinity of the Livermore Site consists primarily of residential use (to the west) and agricultural (vineyard) to the south. The water used in these areas is primarily acquired from municipal or imported sources, though limited areas south of the Livermore Site use groundwater wells (Zone 7 Water Agency 2020a).

In April 2019, Zone 7 released a memorandum report, *2019 Water Supply Evaluation Update*, which forecasted a growing potable water supply deficit over the coming years in the Tri-Valley Area unless additional water conservation measures and/or new water resource supplies are developed (Zone 7 Water Agency 2019). The water supply planning goals associated with this forecast include: (1) maximize reuse of available treated wastewater, (2) import more water (from the Central Valley), (3) minimize use of water by existing area residents, and (4) maximize storage of surplus water for times of need. Because of the forecasted shortage in potable water in the coming year, LLNL is evaluating the feasibility of additional wastewater reuse to meet the projected water requirements. LLNL is evaluating the feasibility of using non-potable water in place of potable water in its primary cooling towers. Potential alternatives under evaluation include extending the Livermore Water Reclamation Plant (LWRP) distribution system, conducting onsite wastewater treatment, and reusing cooling tower blowdown directly (Stantec 2019).

4.12.3.2 *Site 300*

The Site 300 domestic water system has three sources. Starting in March 2020, the primary water source is purchased surface water from the San Francisco Public Utility Commission's (SFPUC) Hetch Hetchy Aqueduct System (HHAS) through the Thomas Shaft pumping station. Water from the HHAS is supplied throughout the year, except during maintenance activities (LLNL 2019m). Additionally, Site 300 has two deep wells: well 20 (the primary water supply well) and well 18 (the backup water supply well). The water system's capacity is estimated to be 648,000 gallons per day, with expansion capability of 1.2 million gallons per day (NNSA 2011). The maximum capacity of the treated purchased water source is 300 gallons per minute. The capacity of well 18 is approximately 200 gallons per minute and the capacity of well 20 is approximately 400 gallons per minute. The water is subject to the Safe Drinking Water Act of 1974 regulations and the system operates under Water Supply Permit No. 01-10-16PA-003 (CWB 2016).

The Site 300 drinking water system consists of the three water sources, 10 storage tanks, booster pumps, and a distribution network. In addition, the Small Firearms Training Facility gets its water (up to 500 gallons per day) from a well located on adjacent CSVRA property. From 2010 through 2014, annual groundwater usage ranged between 10.09 and 14.10 million gallons (CWB 2016). Due to the low water usage, a measurement plan for water use at Site 300 has not been in place since 2007 (LLNL 2019j).

In 2014, 10.09 million gallons of groundwater were produced. From 2010 through 2013, annual groundwater usage ranged between 11.35 and 14.10 million gallons. The combined capacity of the treated purchased water source and two active wells is approximately 900 gallons per minute, compared to the highest maximum day demand (203 gallons per minute) experienced during the 2010–2014 time period (CWB 2016). The three sources (Hetch Hetchy, well 18, and well 20) are each capable of supplying the required maximum daily demand of potable and fire protection water for the entire site.

The HHAS supply contains elevated levels of natural organic matter (NOM). Because of added chlorine quantities to counteract this NOM, there are high levels of disinfection byproducts (DBPs), such as total trihalomethanes (TTHMs) and haloacetic acids (five) (HAA5) in the purchased surface water. To reduce DBP formation, a granular activated carbon (GAC) filtration system began operating in March 2020 to filter out the incoming NOM. Since the GAC also removes any chlorine in the water, a 12.5 percent sodium hypochlorite (NaClO) feed system chlorinates the water as it exits the filtration plant. The GAC can also lower the pH of the water, so a 25 percent sodium hydroxide (NaOH) injection system raises the pH of the water into the neutral range if needed. Additionally, LLNL disinfects well water with 12.5 percent NaClO at the well pump station. Chlorine can be added again at each booster station to maintain the necessary residual chlorine level in the pipeline. LLNL reviews monitoring data to ensure that drinking water standards are met and the Site 300 drinking water analyst submits the required reports to the California State Water Resources Control Board Division of Drinking Water (CWB 2016).

4.12.4 Sanitary Wastewater

4.12.4.1 *Livermore Site*

In 2019, the Livermore Site discharged an average of 119.6 million gallons per year (327,616 gallons per day) of wastewater to the city of Livermore sewer system, or 6.7 percent of the total flow into the City's system. This volume includes SNL/CA-generated wastewater and a small quantity from Site 300. In 2019, SNL/CA generated approximately 7 percent of the total effluent discharged from the Livermore outfall. Wastewater from SNL/CA and Site 300 is discharged to the LLNL collection system and combined with LLNL sewage before it is released at a single point to the municipal collection system (LLNL 2020r).

LLNL's effluent contains both domestic waste and process wastewater and is discharged in accordance with Wastewater Discharge Permit (Permit #1250) requirements administered by the City of Livermore Water Resources Division and the City of Livermore Municipal Code. Most of the process wastewater generated at the Livermore Site is collected in retention tanks and discharged to LLNL's collection system following characterization and approval from LLNL's Wastewater Discharge Authorization Record approval process (LLNL 2020r).

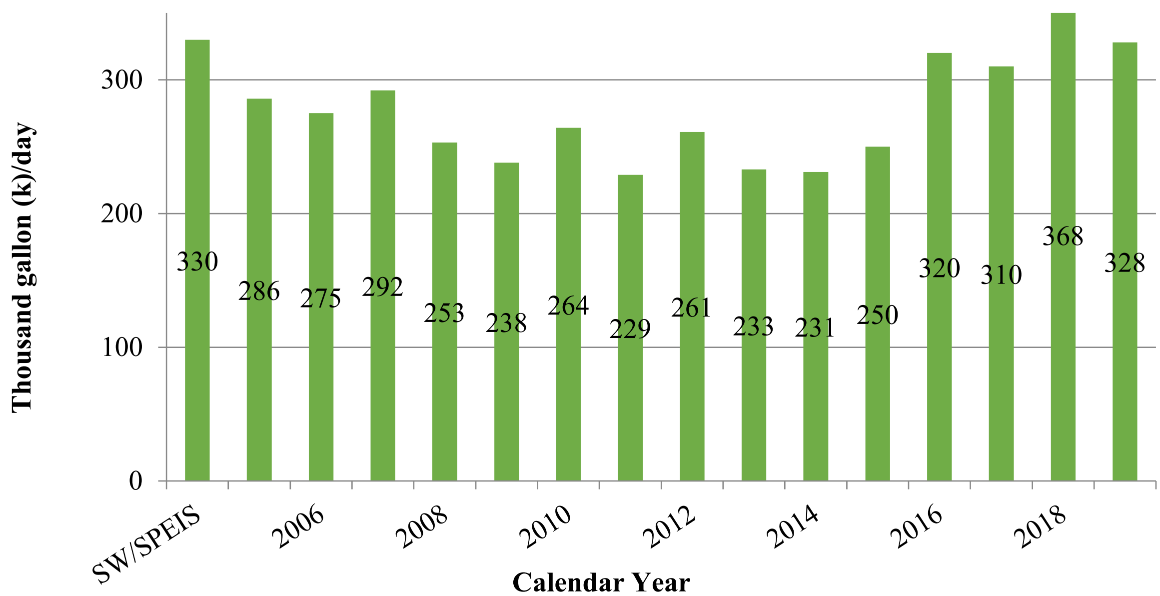
The LWRP handles sewage from the Livermore Site. Sewage flows through two main laterals on the east and west sides of the site, combines in a flow-measuring flume near Building 196 (located at the northwest corner of the Livermore Site), then leaves the site and enters the city of Livermore's sewer system. The western lateral includes wastewater from SNL/CA. From 2015 to 2019, Livermore Site and SNL/CA daily flows averaged a total of 315,200 gallons per day (LLNL 2019k).

LLNL maintains a sewer monitoring complex to protect the LWRP against accidental contamination. The Sewer Monitoring Complex incorporates the online monitoring capabilities of Building 196 and Building 193, which detect conditions that could cause upset or pass through to the LWRP treatment processes. Building 196 monitors 24 hours a day, 365 days a year for pH, flow, metals, and gamma-emitting radioisotopes, with periodic downtime for system maintenance. The Upstream Trigger Monitoring Station at Building 193 monitors for pH from 7 a.m.–7 p.m. during LLNL workdays, allowing LLNL to detect and capture anomalous pH releases during peak LLNL operational periods. Due to the design of the system and the quick response time of the pH probes, it is able to divert the effluent waste stream to the Sewer Diversion Facility before any discharge leaves the LLNL sewer system, which has greatly reduced the risks of pH exceedances. Up to 205,000 gallons of potentially contaminated sewage can be held pending analysis to determine the appropriate handling method (LLNL 2018c). The LWRP's capacity is 9.5 million gallons per day (average dry weather flow) (Stantec 2019).

Sewer discharges at the Livermore Site have increased over the past five years (Figure 4-80). For 2016, 2017, and 2019 the overall sewer flow was within the 2005 LLNL SWEIS projections; however, for 2018, the overall sewer flow exceeded projections. The Livermore Site drew from Zone 7 water supply for 39 weeks in 2018. Water supplied from Zone 7 has substantially higher dissolved solids than Hetch Hetchy water, and cooling tower consumption and blow down increased substantially during this switch in supply. Subsequently, the sanitary sewer flow also increased, as 6 to 20 percent of sanitary sewer flow is cooling tower blow down (LLNL 2019f).

Most discharges to the sanitary sewer system at the Livermore Site are considered batch discharges since they occur on a sporadic basis. Because these discharges occur randomly and as necessary, there is considerable variation both in the number of discharges per month and in the time of day of the discharges. One exception is the cleaning of cooling towers. Generally, each tower is emptied once a year usually during the winter months, when demand on the towers is lower, and on weekends, when more capacity is available in the Livermore Site sewer system. Air washers, cooling towers, boilers, and wastewater retention systems are the principal sources of large-volume batch discharges from the Livermore Site, of which, discharges from the wastewater retention systems have the greatest potential to impact the strength of the sewer effluent (LLNL 2018b).

Discharges to the sanitary sewer are from sanitary water, process water, boilers, cooling water, washing water, irrigation, deionized water, low-conductivity water system filter, and fire hydrant test/water quality flush. In 2017, an estimated 280,450 gallon per day of water was discharged to the sanitary sewer, discussed below (LLNL 2018b).



Note: SW/SPEIS = 2005 SWEIS projection.
Source: LLNL 2020p.

Figure 4-80. Average Daily Amount of Wastewater Generated per Calendar Year from the Livermore Site (2005-2019)

Sanitary Wastewater

The calculation for sanitary wastewater is based on an estimated 7,909 employees. The daily sanitary sewage estimate is adjusted to reflect the average for a 7-day week. In 2019, 176,210 gallons per day of sanitary water were discharged to the sanitary sewer (LLNL 2019aa).

Process Water

Process water includes rinse water discharges from both non-regulated and regulated wastewater generating processes, wet-chemistry laboratories, and all other discharges that have not been specifically identified in the other water-use categories. In 2019, 3,570 gallons per day of process water were discharged to the sanitary sewer (LLNL 2019aa).

Boilers

There are approximately 16 steam boilers and 98 hot water boilers on the Livermore Site. Discharge volumes are estimated for once-through use for steam, steam-boiler blow down, and annual draining of the units for cleaning. In 2019, 7,650 gallons per day of boiler water were discharged to the sanitary sewer (LLNL 2019aa).

Cooling Water

The largest portion of LLNL's current water demand at the Livermore Site can be attributed to the cooling facilities, accounting for over 50 percent of total potable water use on site. Currently, there are five cooling towers at the Livermore Site, with plans to Currently, there are five cooling towers at the Livermore Site, with plans to add a sixth large tower[5] to serve the Exascale Computing Facility Modernization project (Stantec 2019).

Almost all cooling water is recirculated through one of five sets of cooling towers, with little water used on site for once-through cooling. More than 98 percent of the cooling water is for makeup to the two large tower complexes serving the entire site (Buildings 291 and 325), two large towers serving the Livermore Computing Complex (Building 453), large tower complex serving the NIF, and one small cooling tower system (Building 133). The cooling tower water volume is based on meter readings for the makeup water of the aforementioned cooling towers. The blow down volume is based on a cooling tower water balance for all the cooling tower complexes. In 2019, 94,750 gallons per day of cooling water were discharged to the sanitary sewer (LLNL 2019aa).

Washing Water

The washing water usage estimate includes cafeteria dishwashing, car washing, steam cleaning, and the cleaning of equipment, buildings, and shop floors. In 2019, approximately 14,660 gallons per day of washing water were discharged to the sanitary sewer (LLNL 2019aa).

Deionized Water

Deionized water is used for replenishment of the deionized water and low-conductivity water systems used in certain onsite operations, including deionized water going to Building 391 and the Laser and Target Area Building for use in NIF optics cleaning. In 2019, approximately 10,990 gallons per day of deionized water were discharged to the sanitary sewer (LLNL 2019aa).

Low-Conductivity Water System Filter

This volume includes the NIF central plant boilers and cooling towers and is based on estimates from the operators familiar with the system. In 2019, approximately 1,400 gallons per day of low-conductivity water were discharged to the sanitary sewer (LLNL 2019aa).

Fire Hydrant Test/Water Quality Flush

This category contains an estimate of the water that is used to flow test LLNL's 170 fire hydrants and for flushing piping for water quality issues or concerns. The flow test discharges by the LPFD will continue to be estimated. In 2019, there was no hydrant test water discharged to the sanitary sewer (LLNL 2019aa).

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[5] The sixth cooling tower is now operational.

The LLNL Wastewater Discharge Permit #1250 requires continuous monitoring of the effluent flow rate and pH. Samplers at the Sewer Monitoring Station collect flow-proportional composite samples and instantaneous grab samples that are analyzed for metals, radioactivity, total toxic organics, and other water quality parameters (LLNL 2020r). The DOE Order 458.1 sanitary sewer discharge numerical limits include the following annual discharge limits for radioactivity: tritium, 5 Ci; carbon-14, 1 Ci, and all other radionuclides combined, 1 Ci. LLNL determines the total radioactivity contributed by tritium, gross alpha emitters, and gross beta emitters from the measured radioactivity in the monthly effluent samples. The 2019 combined release of alpha and beta sources was 0.304 GBq (0.008 Ci), which is 0.8 percent of the corresponding DOE Order 458.1 limit (37 Gbq [1.0 Ci]). The tritium total was 5.5GBq (0.15 Ci), which is 3.0 percent of the DOE Order 458.1 limit (185 GBq [5 Ci]). Cesium and plutonium results are from monthly composite samples of LLNL and LWRP effluent and from quarterly composites of LWRP sludge. For 2019, the annual total discharges of cesium-137 and plutonium-239 were far below the DOE-derived concentration standards (LLNL 2020r).

LLNL also compares annual discharges with historical values to evaluate the effectiveness of ongoing discharge control programs. During 2018, a total of 0.15 Ci of tritium was discharged to the sanitary sewer. While this is moderately higher than tritium activities discharged during the past 10 years (Table 4-31), this amount is in a similar range to historical values, well within regulatory limits, and fully protective of the environment.

Table 4-31. Historical Radioactive Liquid Effluent Releases from the Livermore Site (2009–2019)

Year	Tritium (Ci)	Plutonium-239+240 (Ci)
2009	0.03	1.60E-07
2010	0.04	1.42E-07
2011	0.04	5.41E-08
2012	0.04	1.89E-07
2013	0.05	1.60E-06
2014	0.04	8.68E-07
2015	0.06	2.97E-07
2016	0.02	2.54E-07
2017	0.12	3.89E-07
2018	0.15	2.35E-07
2019	0.15	5.43E-07

Ci – curies.
Source: LLNL 2020r.

Grab samples of LLNL's sanitary sewer effluent are collected monthly for total toxic organics analysis (permit limit = 1.0 mg/L total of the sum of the concentrations for each of the priority pollutant compounds found in the discharge at a concentration greater than 10 µg/L) and quarterly for cyanide and metals analysis. In 2019, LLNL did not exceed any of these discharge limits. Results from the monthly total toxic organics analyses for 2019 show that no priority pollutants, listed by the USEPA as toxic organics, were identified in LLNL effluent above the 10-µg/L permit-specified reporting limit.

The USEPA has established pretreatment standards for categories of industrial processes that it has determined are major contributors to point-source water pollution. Only processes that discharge to the sanitary sewer require semiannual sampling, inspection, and reporting. During 2019, two processes discharged wastewater to the sanitary sewer: semiconductor processes located in the Building153 (microfabrication facility), and the abrasive jet machining located in Building 321C. In 2019, LLNL analyzed compliance samples for all regulated parameters from both processes and demonstrated compliance with all federal categorical and local discharge limits. During 2019, no discharges exceeded any discharge limits for either radioactive or nonradioactive materials to the sanitary sewer (LLNL 2020r).

4.12.4.2 *Site 300*

Sanitary effluent (nonhazardous wastewater) generated from buildings at the Site 300 GSA is managed in a catalytically blown asphalt lined evaporation pond. During winter rains, diligent monitoring of the sewage pond freeboard depth is performed to ensure a minimum of 12 inches is maintained to prevent overflow into the unlined percolation pond. Although this potential exists, it did not occur during 2019 (LLNL 2020r). Design capacity of the sewage evaporation pond is 250 people per day at 30 gallons per day per person. The sewage evaporation pond receives approximately 4,000 gallons per day of wastewater. Normal usage is lower than the design capacity (CRWQCB 2008). Site 300 sanitary sewage generated outside the GSA is disposed of through septic systems (consisting of a septic tank and leach field or filter bed) or percolations pits at individual building locations (CRWQCB 2008).

Cooling tower wastewater from various Site 300 operations is currently discharged in accordance with prescribed permit conditions to septic systems, the sewage evaporation and percolation ponds, and engineered percolation systems. Wastewater from mechanical equipment, other than cooling towers, is discharged to septic systems, the sewage evaporation and percolation ponds, and engineered percolation systems. Other industrial wastewater generated at Site 300 is stored in retention tanks and hauled to the Livermore Site by tanker trucks for reprocessing and/or disposal (CRWQCB 2008).

In September 2008, WDR 96-248 was replaced by WDR R5 2008-0148, a new permit issued by the CVRWQCB for discharges to ground at Site 300 (LLNL 2020r). Under the terms of the Monitoring and Reporting Program, LLNL submits semiannual and annual monitoring reports detailing its Site 300 discharges of domestic and wastewater effluent to sewage evaporation and percolation ponds in the GSA, as well as cooling-tower blow down to percolation pits and septic systems and mechanical equipment discharges to percolation pits located throughout the site (LLNL 2020r). The monitoring data collected for the 2019 semiannual and annual reports shows compliance with all Monitoring and Reporting Program conditions and permit limits. All networks were in compliance with the permit requirements (LLNL 2020r).

There were no discharges from the Site 300 sewage evaporation pond to the percolation pond. Groundwater monitoring related to this area indicated there were no measurable impacts to the groundwater from the sewage pond operations (LLNL 2020r).

Wastewater from Site 300 is occasionally transported to the Livermore Site for discharge to the sanitary sewer or for treatment prior to discharge. Wastewater from Site 300 could include process rinse water from the Site 300 Chemistry Area operations, Process Area operations, miscellaneous operations that support the outdoor or indoor detonation facilities, and other small miscellaneous sources of water. During calendar year 2019, no wastewater was transported from Site 300 to the Livermore Site for onsite treatment, shipment off site, or discharge to the sanitary sewer system (LLNL 2019aa).

Site 300 wastewater intended for shipment to the Livermore Site for discharge to the sanitary sewer system is characterized prior to transport. Wastewater that does not meet the sanitary sewer discharge criteria is managed through RHWM facilities (LLNL 2018b).

4.12.5 Resource Conservation and Waste Minimization

LLNL strives to be a leader in responsible environmental stewardship and sustainability and incorporates sustainability and environmental management into the planning and performance of day-to-day operations and nonroutine activities. LLNL's Environmental Management System (EMS) provides a framework for integrating environmental considerations into daily work processes—based on an international standard (ISO 14001)—to guide efforts toward achieving this goal and continually improving environmental performance. EMS comprises four main elements: environmental policy, planning, implementation, and review and improvement. Under the EMS, LLNL has established environment, safety, and health (ES&H) action plans that detail the objectives and track progress toward meeting environmental goals focused on decreasing climate impacts, conserving water, and reducing waste. The action plans are directly aligned with the goals of the Site Sustainability Plan (LLNL2021h).

The *FY 2020 Site Sustainability Plan* for LLNL was developed consistent with DOE/NNSA guidance as a deliverable under DOE Order 436.1, "Departmental Sustainability" (LLNL 2021h).

LLNL's vision for site sustainability encompasses many objectives:

- Supply its programs with optimal conditions for success while undergoing continual improvement to existing energy infrastructure.
- Collaborate with growing mission areas to identify ways of innovating toward more energy- and water-efficient solutions for energy/water-intensive facilities.
- Pursue innovative renewable energy generation—both for onsite use and as an ongoing research area.
- Incorporate energy- and water-efficiency improvements into the ongoing energy management and facility operations of LLNL.
- The goal category targets, along with the status, for each DOE Strategic Sustainability Performance Plan goal are listed below in Table 4-32.

Table 4-32. Summary of Site Sustainability Goals and Performance Status in FY 2020

DOE Goal	Performance Status	Risk of Non-Attainment
Energy Management		
30% energy intensity (Btu per gross square foot) reduction in goal-subject buildings by FY 2015 from	In FY 2020, a 28.29% reduction from FY 2003 baseline was	High

DOE Goal	Performance Status	Risk of Non-Attainment
an FY 2003 baseline and 1% year over year thereafter.	achieved; and a 5.68% reduction from FY 2019.	
Energy Independence and Security Act (EISA) Section 432 energy and water evaluations.	LLNL has completed 100% of its EISA audit portfolio for the fourth round as of FY 2020. Desk audits were performed on sixteen (16) facilities in FY 2020.	Medium
Meter all individual buildings for electricity, natural gas, steam, and water, where cost-effective and appropriate.	In FY 2020, 90% of electricity achieved (some loss of meters has been experienced - 50 of 305 meters have failed since 2012). 60% of natural gas achieved.	Medium
Water Management		
20% potable water reduction from an FY 2007 baseline and 0.5% year over year thereafter.	In FY 2020, LLNL's water intensity is estimated at +6.2% relative to the FY 2007 baseline. Gain from FY 2019 is +2.7% versus a target of -0.5%. This is primarily due to the unavoidable switch to Zone 7 water supply in mid-July of 2016.	Medium
Non-potable freshwater consumption (Gal) reduction of industrial, landscaping, and agricultural (ILA). Year over year reduction; no target.	LLNL uses potable water for ILA (non-potable water is not used for ILA).	Low
Waste Management		
Reduce at least 50% of nonhazardous solid waste, excluding construction and demolition debris, sent to treatment and disposal facilities.	LLNL consistently diverts over 70% of nonhazardous solid waste from landfill.	Low
Reduce construction and demolition materials and debris sent to treatment and disposal facilities. Year over year reduction; no set target.	LLNL consistently diverts over 50% of construction and demolition materials and debris.	Low
Fleet Management		
20% reduction in annual petroleum consumption by FY 2015 relative to an FY 2005 baseline, and 2% year over year thereafter.	In FY 2020, LLNL's petroleum fuel consumption was similar to last year's - over 70% from the FY 2005 baseline; data will be reported in Federal Automotive Statistical Tool (FAST).	Low
10% increase in annual alternative fuel consumption by FY 2015 relative to FY 2005 baseline. Maintain 10% increase thereafter.	FY 2020 alternative fuel consumption decrease, but this is attributed to less miles driven due to COVID-19 pandemic and many employees not being on-site. Overall decrease compared to the FY 2005 baseline will be calculated in FAST.	Low
75% of light-duty vehicle acquisitions must consist of AFVs.	LLNL continues to meet the required 75% replacement of fossil	Low

DOE Goal	Performance Status	Risk of Non-Attainment
	fuel light-duty vehicles with AFVs. Data will be entered in FAST.	
Clean and Renewable Energy		
"Renewable Electric Energy" requires that renewable electric energy account for not less than 7.5% of total agency electric consumption by FY 2013, and each year thereafter.	FY 2020 requirement was exceeded with the 73% allotment of renewable power generated by the 3.3 megawatt (MW) solar plant and with the purchase of 83,572 MWh of renewable electric energy and 1,272 MWh of renewable energy credits (RECs) through Western Area Power Administration (WAPA).	Low
Continue to increase non-electric thermal usage. Year over year increase; no set target but an indicator in the Office of Management and Budget (OMB) scorecard.	Non-electric thermal usage was 402 million cubic feet of natural gas in FY 2020 compared to 440 million in FY 2019.	N/A
Sustainable Buildings		
At least 15% (by building count) of owned existing buildings to be compliant with the revised Guiding Principles for HPSB by FY 2021, with annual progress thereafter.	9% (60% towards goal of 15%) by building count of existing occupied buildings greater than 10,000 gsf have been HPSB assessed and certified. New buildings completed in FY 2020 received LEED certified (B223) and LEED silver (B224) certification.	High
Acquisition and Procurement		
Promote sustainable acquisition and procurement to the maximum extent practicable, ensuring BioPreferred and biobased provisions and clauses are included in all applicable contracts.	Sustainable Acquisition clauses have been incorporated into all eligible LLNL general provisions (GPs) for purchase orders and subcontracts. LLNL is 100% compliant with the requirement to include sustainable acquisition clauses in all eligible contract actions. LLNS had 22,066 contract actions with a sustainability clause.	Low
Measures, Funding, and Training		
Site set annual targets for sustainability investment with appropriated funds and/or financed contracts to be implemented.	In FY 2016, LLNL evaluated the merits of the recommended four ECMs proposed in the IGA estimated at a cost of $2 million, not including the third-party financing cost and LLNL support costs. No activity in FY 2020 due to manpower and resources.	
Travel and Commute		
Year over year scope 3 GHG reduction from an FY 2008 baseline.	GHG emissions in this category decreased by 43% from FY 2008 and 44% from last year due to	Medium

DOE Goal	Performance Status	Risk of Non-Attainment
	decreased travel activity due to the COVID-19 pandemic.	
Fugitives and Refrigerants		
Year over year Scope 1 & 2 GHG reduction from an FY 2008 baseline.	GHG emissions in this category were reduced by 36% from FY 2008 and increased 186% from last year due to increased purchases of sulfur hexafluoride (SF_6).	Medium
Electronic Stewardship		
100% of eligible (i.e., not classified) used electronics are reused or recycled using environmentally sound disposition options each year.	LLNL has a process to evaluate excess electronics for either reuse or recycling options.	Low
Establish a power usage effectiveness target for new data centers; discuss efforts to meet targets.	Continued efforts in evaluating options to further optimize, consolidate or close remaining 16 LLNL unclassified data centers by: · Adoption of a Cloud Smart policy to the furthest extent practicable based on cost, security requirements and application needs. · Migrating to available inter-agency co-located data centers. · Migrating to more optimized data centers within the LLNL inventory.	Medium
Climate Resilience		
Discuss overall integration of climate resilience in emergency response, workforce, and operations procedures and protocols.	Through LLNL's existing environmental policy, the Lab commits to continuously improve environmental performance.	Low

Source: LLNL 2021h.

4.13 NNSA WOULD ALSO STRIVE TO MEET THE SUSTAINABILITY GOALS ANNOUNCED IN EXECUTIVE ORDER 14057 ON DECEMBER 8, 2021.WASTE MANAGEMENT AND MATERIALS MANAGEMENT

This section discusses existing waste management and materials management activities within LLNL. Discussions are grouped by the following general waste categories: (1) radioactive waste, (2) hazardous waste, (3) mixed waste, (4) biohazardous/medical waste, (5) other wastes; and (6) nuclear materials management. These categories are further divided into subcategories in a few cases to better address activities. As appropriate, the discussions differentiate between the Livermore Site and Site 300; however, for over-arching LLNL actions and waste generation rates, operations at the two sites are combined.

4.13.1 Radioactive Waste

The *Atomic Energy Act of 1954* gave DOE regulatory authority for the management of its own radioactive waste. Subsequent rulings have limited or clarified that this authority is specific only to the radioactive component of its waste, and other elements of waste streams are subject to other regulatory requirements as applicable. A common example of this clarification is that DOE-generated LLW that also qualifies as hazardous waste under RCRA is subject to both DOE waste management rules and those established pursuant to RCRA.

> **Radioactive Waste Categories at LLNL**
>
> **Low-Level Radioactive Waste (LLW)** – Radioactive waste that is not classified as high-level radioactive waste, spent nuclear fuel, transuranic waste, by-product material, or naturally occurring radioactive material.
> **Mixed Low-Level Waste (MLLW)** – Waste that contains both hazardous components regulated under RCRA, and radioactive components regulated under DOE.
>
> **Combined Waste:** – Waste that contains both radioactive constituents and constituents that are hazardous under State of California regulations, but not under RCRA. Combined waste is managed through a combination of DOE LLW requirements and certain provisions of the California waste regulations.
>
> **Transuranic (TRU) Waste** – Radioactive waste containing more than 100 nanocuries of alpha-emitting transuranic isotopes per gram of waste, with half-lives greater than 20 years, except for: (1) high-level radioactive waste; (2) waste DOE has determined, with USEPA concurrence, does not need the degree of isolation required by 40 CFR Part 191 disposal regulations; or (3) waste that the U.S. Nuclear Regulatory Commission has approved for disposal on a case-by-case basis in accordance with 10 CFR Part 61.
> **Mixed TRU Waste** – waste that contains both hazardous wastes, regulated under RCRA, and TRU waste.

Two categories of radioactive waste are generated within LLNL: LLW and TRU waste. LLNL is not involved in reprocessing spent nuclear fuel and, accordingly, does not generate high-level radioactive waste. With respect to LLW, this section addresses the management of waste that has only radionuclides as its regulated component. LLW also containing a RCRA hazardous component is characterized as mixed low-level waste (MLLW) and is addressed in a separate section below. The discussion of TRU waste, however, addresses both TRU waste and mixed TRU waste because the quantity of mixed TRU waste generated is small and both types are managed similarly and are disposed of at the same location. The overriding set of requirements LLNL must meet in its management of LLW and TRU waste is established in DOE Order 435.1, "Radioactive Waste Management." Waste transported off site must also be packaged and shipped in accordance with USDOT regulations, and the waste itself must meet the waste acceptance criteria of the receiving waste management facility, whether a commercial or government facility.

4.13.1.1 *Low-Level Radioactive Waste*

<u>Overview of LLNL Management of LLW</u>

LLNL LLW is generated from research and development, facility operations, maintenance and decontamination; facility deactivation and demolition; and removal of contaminated soil and debris from remedial activities (LLNL 2020w). The RHWM Program has primary responsibility for management of LLW, including storage, treatment and arranging for offsite disposal. The facilities that generate LLW (i.e., the generators) have responsibility for appropriately collecting and packaging their waste. RHWM personnel assist generators in characterizing, packaging, and labelling waste, and provide training and guidance on waste management. RHWM works proactively with LLNL waste generators to ensure waste has a disposal path prior to generation. In this manner, potential waste management problems can be addressed at a project stage where operational changes might be practical that could lessen or even eliminate such problems (LLNL 2020w).

As LLW is generated, it is typically stored at or near the site of generation. Waste is then transferred into RHWM managed facilities, although in some cases waste may be shipped for off-site disposal directly from the generating location. The waste management process and the RHWM facilities for LLW are the same as those used to manage hazardous waste and are described below in section 4.13.2.1.

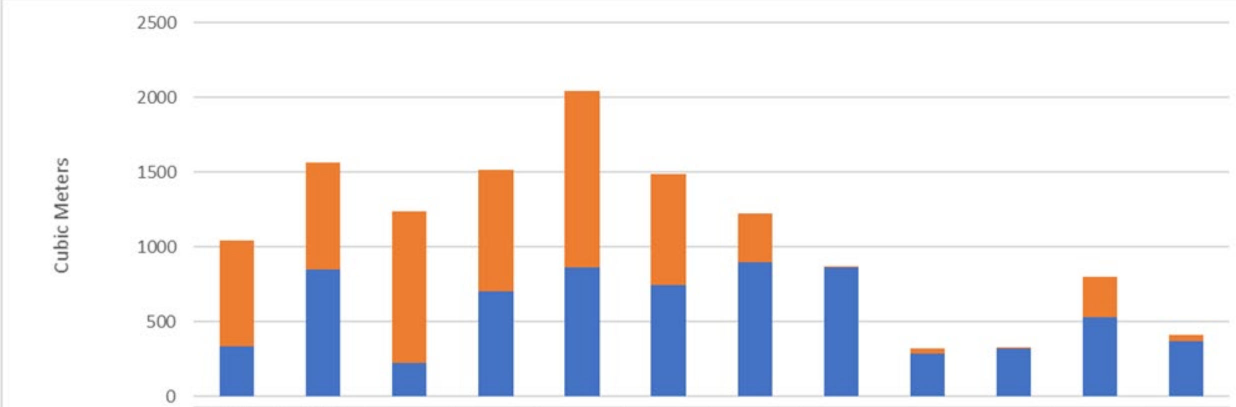
RHWM LLW activities at the Livermore Site facilities include handling, storage, treatment, and packaging of LLW. LLW is frequently staged in several available storage areas to collect sufficient materials to reduce the number of shipments, or to collect wastes of a similar type for treatment. Some types of radioactive wastes, typically liquids, are treated to put them in a form meeting offsite disposal criteria or to reduce volume to improve the efficiency of offsite shipment. Additionally, waste treatment capabilities (discussed in more detail in section 4.13.2.1 below) are used to treat aqueous radioactive solutions by removing contaminants, intended to make disposition of at least a portion of the waste stream simpler or even to allow its disposal as nonhazardous waste by discharge to the sanitary sewer system.

RHWM sends LLW to two main disposal sites: NNSS or the Energy*Solutions* commercial facility in Clive, Utah. It is estimated that about 85 percent of LLNL's LLW goes to NNSS (LLNL 2020x). LLNL does not perform onsite disposal of radioactive waste either at the Livermore Site or Site 300 (LLNL 2020w).

LLW Generation Rates

LLNL tracks its waste generation as "routine" or "nonroutine." Routine wastes are those generated during normal operations, and nonroutine wastes are those generated during decontamination, deactivation, and demolition (DD&D) activities; during construction; and from environmental restoration actions (LLNL 2019k). The nonroutine category represents waste sources that can be large and can vary greatly from year to year; the Livermore Site has deemed it of value to maintain the data as a separate subset.

Figure 4-81 provides a graphical and numeric summary of the LLW volumes generated within LLNL over the last 10 years of record. For comparison, Figure 4-81 also shows the volume of routine and nonroutine LLW projected for the Proposed Action evaluated in the 2005 SWEIS. The notable increases in the volume of routine LLW generated starting in FY 2011 were attributed to changes in operations that resulted in increases in cleaning wastes and personnel protective equipment wastes as well as an increase in shot activities at Site 300. Subsequent program improvements resulted in reductions in routine LLW generation beginning in FY 2016 that continues to the present. The increase in nonroutine LLW generation occurring in the early years was attributed to several DD&D-type projects (specifically Buildings 419, 391, and 321C), a reroofing project on Building 801, and a campaign to dispose of several tons of gravel from Site 300 (LLNL 2020p). The 2011 SA projected an increase in LLW generation for the years 2010 through 2015 as compared to the projections in the 2005 SWEIS. The total LLW generated in FY 2012 exceeded even the higher projection, but no existing waste management capacities were exceeded. Total LLW generated in each of the last five years (i.e., FY 2015–FY 2019) was below the level projected in the 2005 SWEIS.



	2005 SWEIS	2011 SA[a]	FY 10	FY 11	FY 12	FY 13	FY 14	FY 15	FY 16	FY 17	FY 18	FY 19
Nonroutine	710	710	1,014	809	1,178	746	328	6	38	7	272	43
Routine	330	850	219	704	862	741	896	860	284	318	526	369
Totals (cubic meters)	1,040	1,560	1,233	1,513	2,040	1,487	1,224	866	322	325	798	412

a. The Supplemental Analysis to the 2005 LLNL SWEIS (NNSA 2011) projected larger volumes of LLW would be generated from 2010 to 2015. Specifically, the SA projected and evaluated generation rates of 850 and 710 cubic meters per year for routine and nonroutine LLW, respectively, for a total of 1,560 cubic meters per year.
b. In FY12, non-routine waste increase was from re-roof of B801 and removal of several tons of gravel from S300.
To convert cubic meters to cubic yards, multiply by 1.3079.
Source: NNSA 2005; LLNL 2020p.

Figure 4-81. LLNL Low-Level Radioactive Waste Generation, FY 2010–FY 2019, Compared to Projections from the 2005 SWEIS

4.13.1.2 *Transuranic Waste and Mixed Transuranic Waste*

Overview of LLNL Management of TRU Waste and Mixed TRU Waste

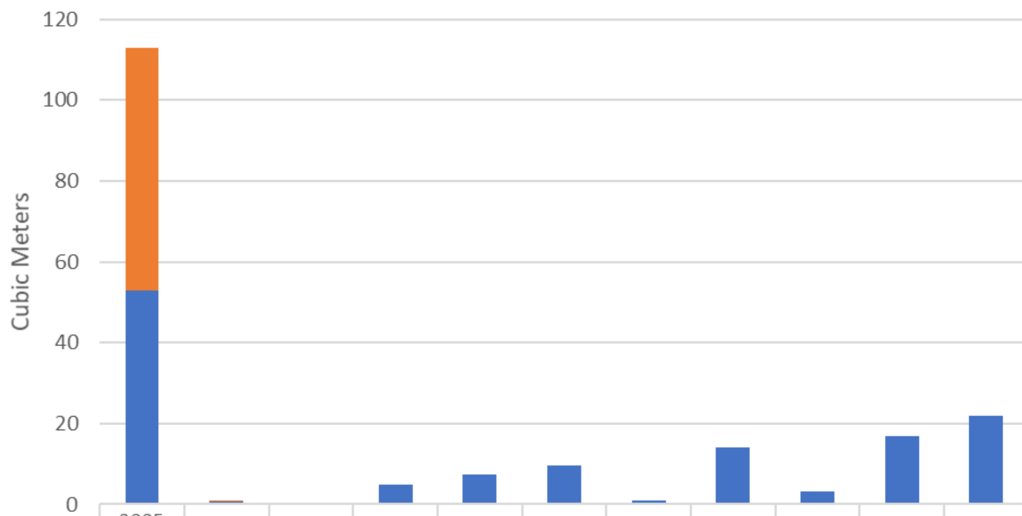
The total amount of TRU waste generated at LLNL is notably smaller than the amount of LLW generated. Mixed TRU waste comprises a small fraction of the total TRU waste generated, so the following discussion includes both TRU and mixed TRU waste. LLNL TRU waste is generated primarily in laboratory experiments and component tests. TRU waste is managed similarly to LLW, although the requirements for identifying waste constituents and waste generating processes are more stringent for TRU waste. RHWM personnel work with generators to ensure the waste is managed appropriately and applicable waste characterization data is collected. Once it accepts the waste, RHWM is responsible for subsequent storage and eventual shipment off site for disposal. Differences in waste management beyond these common elements are driven by the unique requirements of the waste acceptance criteria of the offsite disposal facility.

TRU wastes are transported to the DOE's Waste Isolation Pilot Plant (WIPP) in Carlsbad, NM for disposal. WIPP is the nation's only deep geologic repository established and authorized for the permanent disposal of TRU waste. WIPP requires generators to perform specific, rigorous waste characterization and certification actions before it will accept waste. Because there are many steps to getting waste approved for shipment to WIPP and because LLNL does not produce large amounts of TRU waste, LLNL's past management of TRU waste has been in campaigns. TRU waste would accumulate in onsite storage for a period of time, then RHWM would contract with the WIPP Central Characterization Program to perform characterization and certification on a relatively large group of containers for transport to WIPP. The last two campaigns, in 2004 and 2009–2010, resulted in a combined 892 drums being disposed of at WIPP (LLNL 2020y). A problem with such campaigns is the magnitude of effort required to restart a characterization and certification campaign after being dormant for several years.

Beginning in 2019, LLNL has changed its approach to managing TRU waste to an ongoing enduring operation. Waste characterization equipment (e.g., radiography, nondestructive assay, and headspace gas sampling and analysis equipment) and trained personnel are maintained in a ready condition at the Livermore site under the management of the WIPP Central Characterization Program and operations are conducted under LLNL's certification program which has been approved by DOE's Carlsbad Field Office. Trained and certified LLNL personnel perform elements of the waste characterization and certification process as TRU waste is generated and packaged; Central Characterization Program contractors are deployed to LLNL once a year to perform other required elements of the process. LLNL plans on making at least one shipment to WIPP per year so the activity can be considered ongoing and not subject to restart requirements. The first shipment of LLNL TRU waste to WIPP under this new approach occurred in the mid-2020 timeframe, although this campaign included over 600 containers as it had been some time since the last shipment (LLNL 2020k).

TRU Waste Generation Rates

Figure 4-82 provides a graphical and numeric summary of the TRU waste volumes managed by the programmatic organization (RHWM) over the last 10 years of record. For comparison, Figure 4-82 also shows the volume of routine and nonroutine TRU waste projected for the Proposed Action evaluated in the 2005 SWEIS. The same generation rates were projected in the 2011 SA. Generation rates for TRU waste have remained below those projected in the 2005 SWEIS.



	2005 SWEIS[a]	FY 10[b]	FY 11[b]	FY 12	FY 13	FY 14	FY 15	FY 16	FY 17	FY 18	FY 19
Nonroutine	60	0.22	0	0	0	0	0	0	0	0	0
Routine	52.8	0.66	0.4	4.8	7.5	9.5	0.9	14	3.2	17	22
Totals (cubic meters)	112.8	0.88	0.4	4.8	7.5	9.5	0.9	14	3.2	17	22

a. The 2005 LLNL SWEIS entry in the figure shows an arrow rather than a total in order to keep other entries at a more readable scale.
b. Quantity shown is the only TRU waste received by RHWM during the fiscal year.
To convert cubic meters to cubic yards, multiply by 1.3079.
Source: NNSA 2005; LLNL 2020p.

Figure 4-82. LLNL TRU Waste Received by RHWM FY 2009–FY 2019, Compared to Projections from the 2005 SWEIS

4.13.2 Hazardous Waste

4.13.2.1 *Overview of LLNL Hazardous Waste Management*

In California, RCRA is implemented by the California Hazardous Waste Control Law and CCR Title 22. The processes for managing hazardous waste described in this section also apply to PCB waste, although PCB waste is regulated under the *Federal Toxic Substances Control Act* (15 U.S.C. § 2601 et seq).

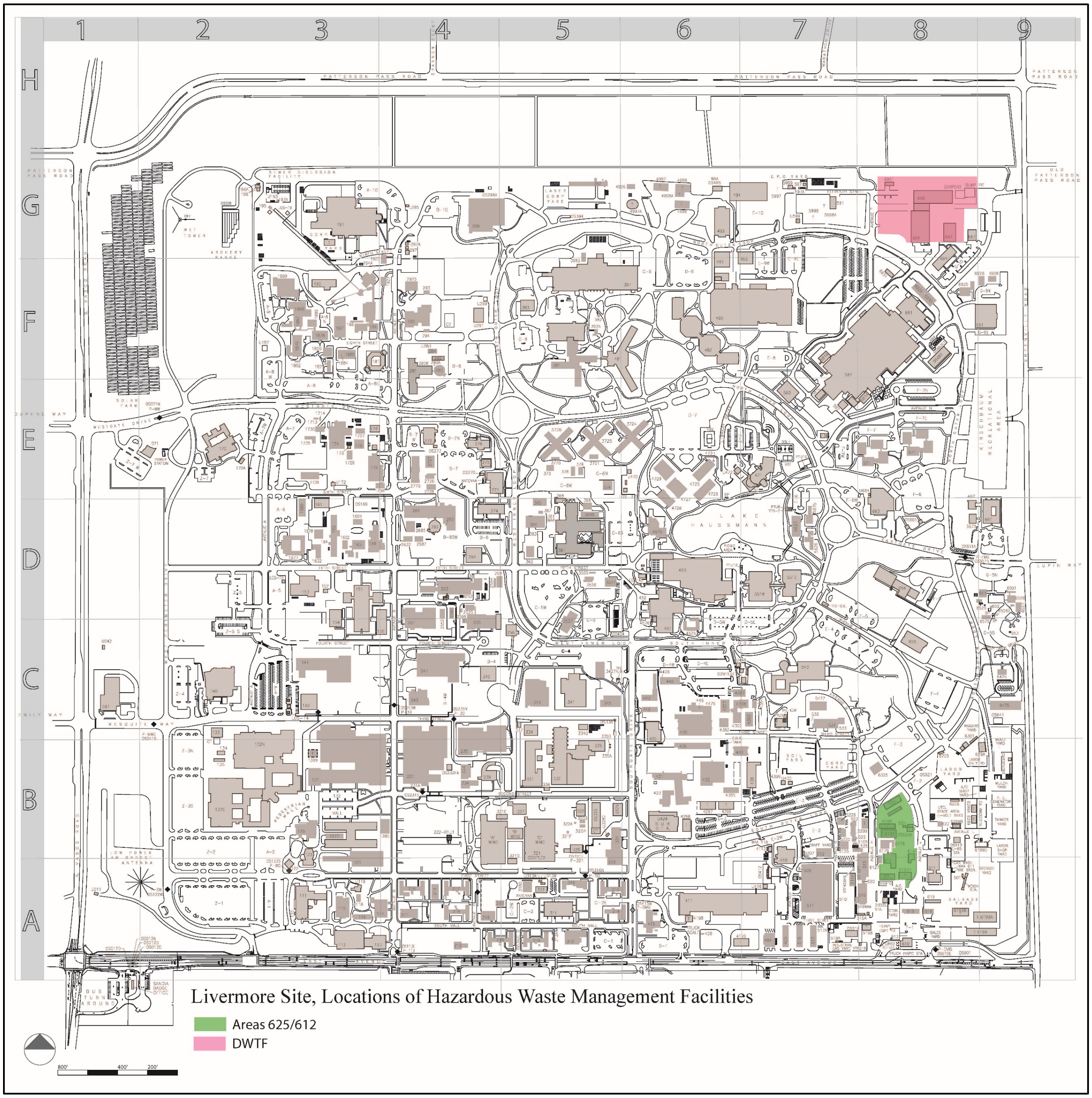
LLNL performs a broad range of research activities that can generate a variety of waste materials. Additionally, LLNL's research and chemical laboratories use many chemicals that may require disposition as hazardous waste once they are used, no longer needed, determined to be off-specification, or residues in containers, as well as if they contaminate cleanup materials or protective gear. The nature of the LLNL mission is also such that research activities often change over time, either by small amounts or in their entirety, and the wastes produced can likewise change. As a result, LLNL's approach to managing hazardous waste, particularly at the Livermore Site, is designed to accommodate a wide variety of waste generators and waste types. This is also reflected in LLNL's hazardous waste permits with the California DTSC.

Primary responsibility for management of Livermore Site hazardous waste lies with the RHWM Program. Hazardous waste is typically stored at or near the site of generation in a satellite accumulation area (SAA), although in some facilities waste from multiple generators is stored in centralized waste accumulation areas (WAA). SAAs are managed by the waste generator while WAAs are managed by a combination of the facility and RHWM. Waste is then transferred into RHWM managed facilities, although rarely waste may be shipped for off-site disposal directly from the generating location. Before being accepted into a RHWM facility, the generator provides information on the waste's constituents and waste generating process and the waste is verified to meet the RHWM waste acceptance criteria. RHWM collects and maintains data on each of the containers it accepts in a waste management database. This information is used to track wastes from cradle to grave, and includes elements such as (LLNL 2020w):

- Waste generation process and location
- Physical characteristics (e.g., waste volume and weight, container type and volume)
- Characterization information
  - Chemical constituents (for hazardous wastes)
  - Radiological constituents (for radioactive wastes)
- Any other information required for safe storage of the waste.

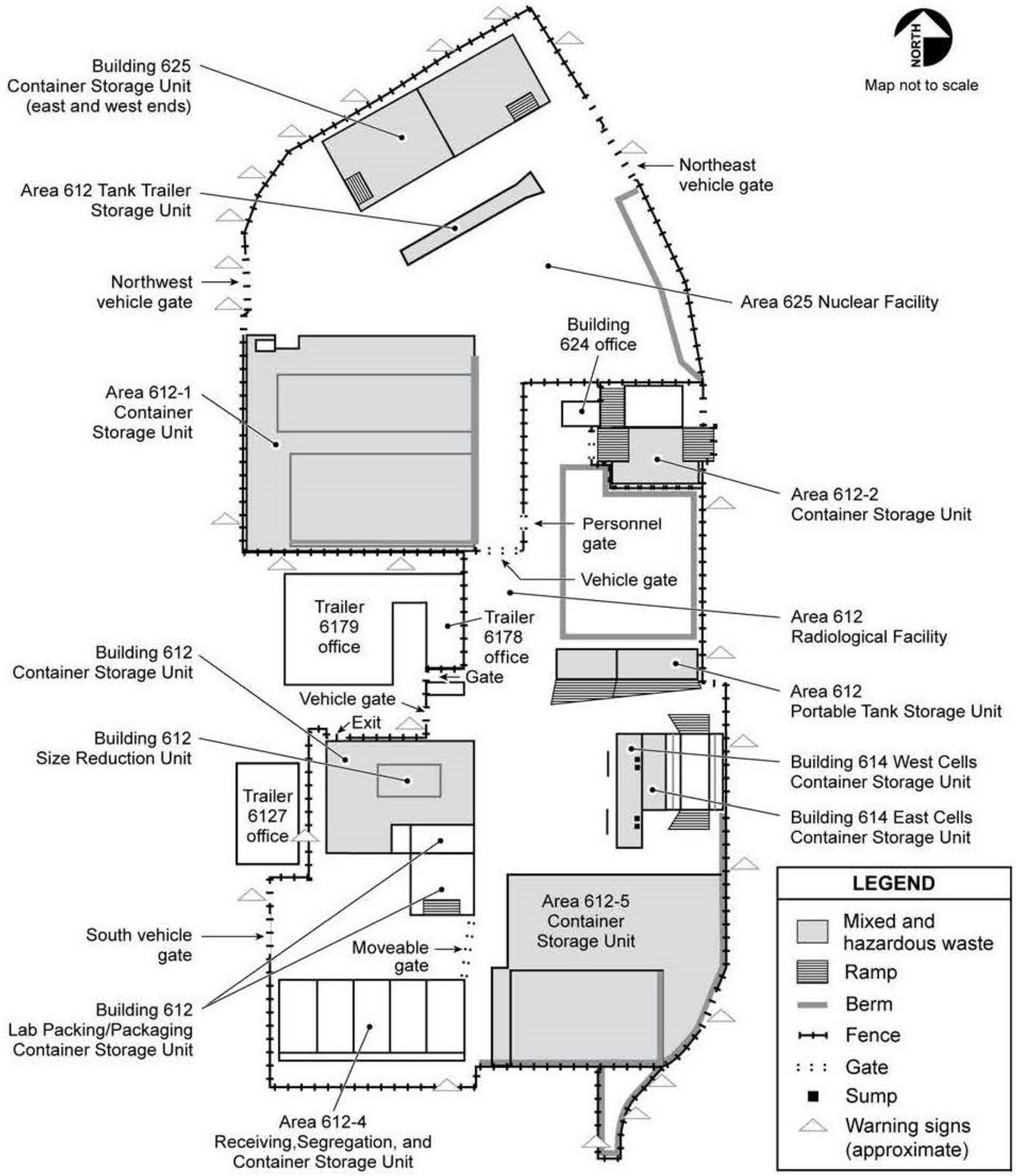
Livermore Site

When waste is accepted by RHWM, it generally goes first into a waste accumulation area. From there it is transferred to one of RHWM's two Waste Management Unit Areas (WMUAs) at the Livermore Site: Area 625/612 or the Decontamination and Waste Treatment Facility (DWTF) (LLNL 2020w). Area 625/612 is in the southeast section of the Livermore Site; the DWTF is in the northeast corner. Figure 4-83 shows the locations of Area 625/612 and the DWTF. Figure 4-84 and Figure 4-85 show the facilities in Area 625/612 and the DWTF, respectively.



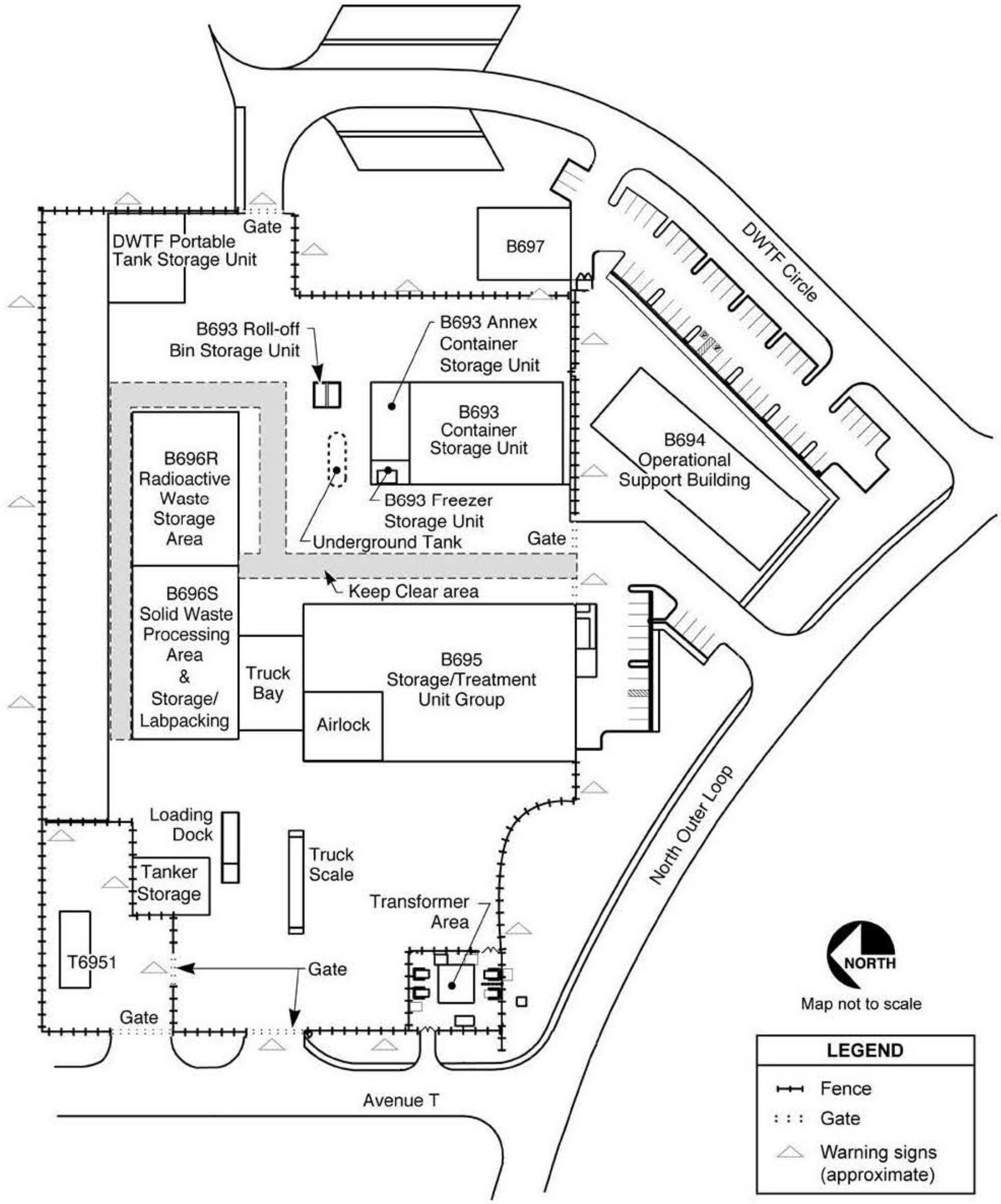
Source: LLNL 2021k.

Figure 4-83. Livermore Site Showing Locations of the DWTF and Area 625 (Area 612—not shown—abuts the south side of Area 625)



Source: LLNL 2021l.

Figure 4-84. Map of Area 625/612, Showing Fence, Access Gates, and Warning Signs



Source: LLNL 2021l.

Figure 4-85. Map of DWTF Complex Showing Fence, Access Gates, and Warning Signs

Both WMUAs contain multiple hazardous waste management units (WMUs) and are operated under Permit No. CA2890012584. In addition to waste from within the Livermore Site, the WMUAs occasionally receive waste from Site 300. No hazardous waste is accepted from other sites (LLNL 2019m).

RHWM activities in the Livermore Site WMUAs include handling, storage, treatment, and packaging of hazardous waste, although the majority of hazardous waste is typically only staged in storage areas prior to being shipped off site to commercial, permitted facilities for subsequent treatment or disposal (LLNL 2019u). When wastes are treated in the DWTF, it is often to put them in a form meeting offsite disposal criteria or to reduce volume to improve the efficiency of offsite shipment. Additionally, DWTF treatment capabilities (discussed in more detail below) are used to treat aqueous solutions by removing contaminants, intended to make disposition of at least a portion of the waste stream simpler or even to allow its disposal as nonhazardous waste by discharge to the sanitary sewer system.

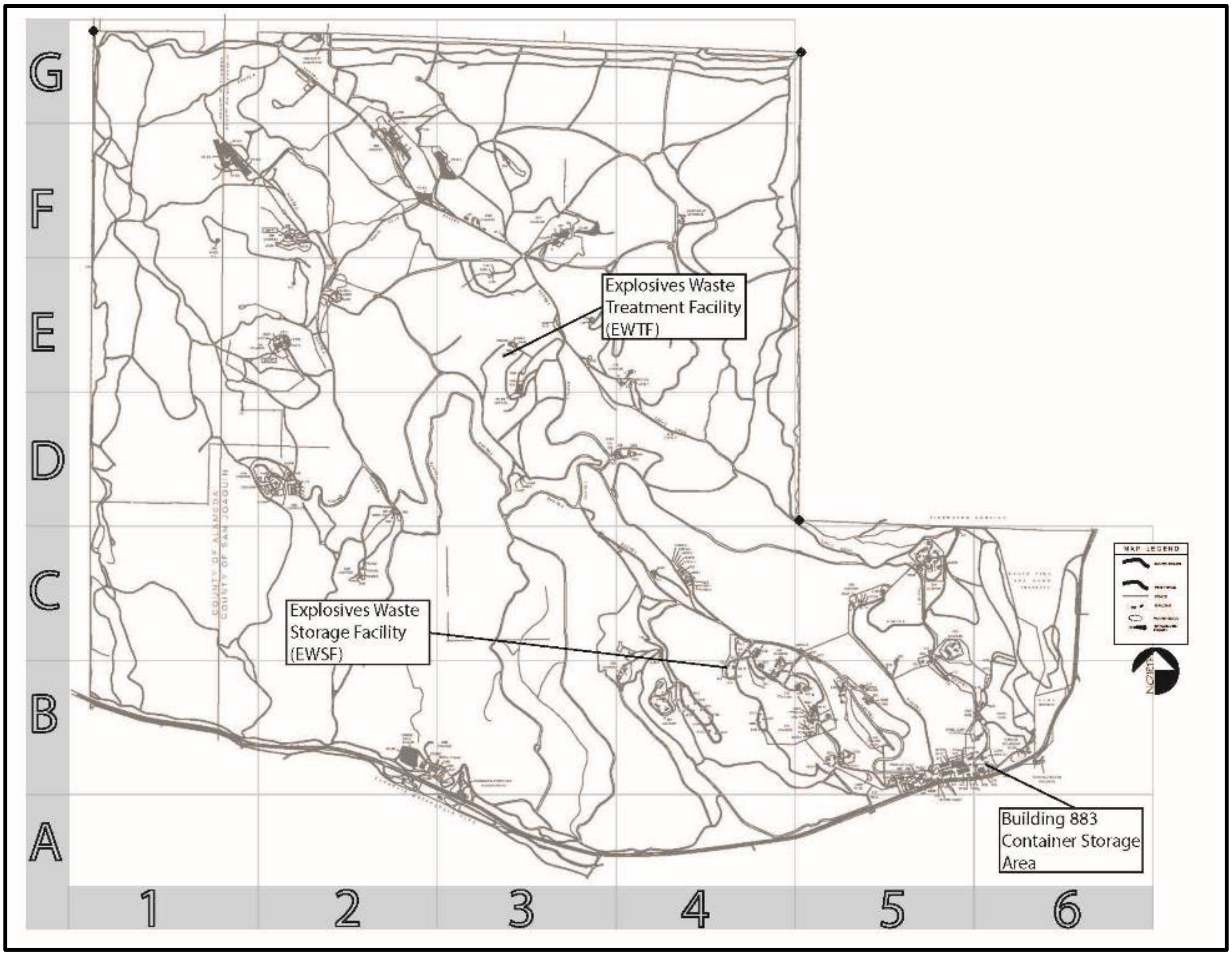
RHWM sends hazardous waste to a variety of offsite commercial Treatment, Storage, and Disposal Facilities (TSDFs). In any given year, it is likely that waste is sent to more than 10 different commercial facilities (LLNL 2020x). This is attributed, in a large part, to the varied, often unique, nature of the LLNL waste, which requires a correspondingly broad range of treatment and disposal capabilities in commercial facilities.

Waste Management Process and Facilities at Site 300

Hazardous waste management activities at Site 300 are similar to those described for the Livermore Site. RHWM personnel work with generators of all types of hazardous wastes to ensure that the waste is appropriately managed and characterized before being accepted into a RHWM unit for storage or treatment. Unlike the Main Site, RHWM permitted treatment capabilities at Site 300 include the ability to burn or detonate explosives waste. The permit for operational hazardous waste management actions at Site 300 (Permit No. CA2890090002) covers units within three separate facilities: (1) the Building883 Container Storage Area (B883 CSA); (2) the Explosives Waste Storage Facility (EWSF); and (3) the Explosives Waste Treatment Facility (EWTF). The relative locations of the three hazardous waste facilities within Site 300 are shown in Figure 4-86.

RHWM personnel are responsible for coordinating and overseeing the transportation of hazardous waste from Site 300. These shipments typically go to offsite, permitted, commercial TSDFs with the appropriate capacity and capabilities (LLNL 2019v); and on few occasions shipments could also be to the Livermore Site. The offsite commercial TSDFs receiving Site 300 hazardous waste are included in the variety of facilities described for the Livermore Site. The exception is offsite shipments of explosives wastes, which currently go only to the Clean Harbors facility in Colfax, Louisiana (LLNL 2020x).

When necessary, explosives waste is transported from the Livermore Site to Site 300 for storage and treatment or subsequent offsite disposition.



Source: LLNL 2019t.

Figure 4-86. Location of the Three Operational Hazardous Waste Facilities on Site 300

4.13.2.2 *Permitted Hazardous Waste Management Units*

Livermore Site

The Livermore Site's permitted WMUs, listed in Table 4-33, are within two WMUAs: Areas 625/612 (*see* Figure 4-84) and the DWTF (*see* Figure 4-85), which includes Buildings 693, 695, and 696 (Note that the first WMUA was referred to as Area 612 in the 2005 LLNL SWEIS. In the permit application currently under review with the DTSC, the area is now referred to as Area 625). The WMUs in the table are grouped by their function: 20 container storage units (including two packaging or receiving units); one unit used for both tank storage and treatment; and nine miscellaneous treatment units. The maximum capacity and a brief description (as identified in the current hazardous waste permit) is included for each unit. The last unit at the bottom of the table (i.e., the Building 696 Macroencapsulation Unit) is not in the current hazardous waste permit, but is included in the permit renewal application (*see* Section 4.13.2.4). The 2005 LLNL SWEIS identified Area 514 and Building 233 as other Livermore Site WMUAs, but they have since been formally closed in 2007 and 2008, respectively. Building 419, which was an interim status unit, was also closed in 2013.

Table 4-33. Waste Management Units Used for Hazardous and Mixed Waste at the Livermore Site

Unit Name[a]	Maximum Permitted Capacity	Unit Description
Container Storage Units		
Area 612 Tank Trailer Storage Unit	5,000 gallons	**Area 612 Tank Trailer Storage Area** is located in the north portion of the Area 612 Facility. It is an uncovered recessed loading dock designed to store tank trailers (e.g., vacuum tankers) as well as portable tanks on flatbed trailers.
Area 612 Portable Tank Container Storage Unit	10,000 gallons	**Area 612 Portable Tank Storage Unit** is located on the east side of the Area 612 Facility across from the Area 612 office (Trailer 6179). It is an uncovered concrete pad. This unit is scheduled for closure upon renewal of the HWFP.
Building 612 Container Storage Unit	7,150 gallons	**Building 612 Container Storage Unit** is located within Rooms 100 and 110. This area is also shared with the Size Reduction Unit. This unit is scheduled for closure upon renewal of the HWFP.
Bldg 612 Lab packing Unit	N/A	**Building 612 Lab Packing/Packaging Container Storage Unit** is located in Rooms 104, 105, and 107, this area is currently operated as a 90-day accumulation area under delayed closure. This unit is scheduled for closure upon renewal of the HWFP
Area 612-1 Container Storage Unit	38,400 ft^3	**Area 612-1 Container Storage Unit** is located on the west side of the facility, on the north side of the Area 612 office. The Unit has a covered storage area consisting of the two tents (Tent 6197 and Tent 6198) as well as an open, asphalt-surfaced storage area
Area 612-2 Container Storage Unit	10,560 gallons	**Area 612-2 Container Storage Unit** is a concrete pad located in the east side of the facility. This unit is scheduled for closure upon renewal of the HWFP.
Area 612-4 Receiving, Segregation and Container Storage Unit	N/A	**Area 612-4 Receiving, Segregation, and Container Storage Unit** is located in the southwest corner of the facility. This area is currently operated as a 90-day accumulation area under delayed closure. This unit is scheduled for closure upon renewal of the HWFP
Area 612-5 Container Storage Unit	23,900 ft^3	**Area 612-5 Container Storage Unit** in the southeast portion of the facility is an open, asphalt surfaced storage area with a tent. This unit is scheduled for closure upon renewal of the HWFP.
Building 614 East Cells Container Storage Unit	3,520 gallons	**Building 614 East Cells Container Storage Unit** is located in the southeastern section of the facility, immediately adjacent to Building 614 West Cells Container Storage Unit. This unit is scheduled for closure upon renewal of the HWFP.
Building 614 West Cells Container Storage Unit	672 gallons	**Building 614 West Cells Container Storage Unit** is located in the southeastern section of the facility, immediately adjacent to the Building 614 East Cells Container Storage Unit. This unit is scheduled for closure upon renewal of the HWFP.
Building 625 Container Storage Unit	42,416 gallons	**Building 625 Container Storage Unit** is a steel-frame, roofed structure occupying Building 625.
Building 693 Container Storage Unit	141,240 gallons	Building 693 is a structural steel frame building divided into four cells where wastes are segregated according to compatibility.
Building 693 Annex Classified Waste Storage	3,060 ft^3	The B693 Annex is a separate structure attached to Building 693 with shared exterior siding.

Unit Name[a]	Maximum Permitted Capacity	Unit Description
Building 693 Freezer Unit	30 gallons	The outside area just west of the B693 Annex is used as a storage location and includes an industrial-grade freezer unit used primarily to store laboratory animal carcasses (rats, rabbits, etc.).
Building 693 Roll off Bin Storage	2,160 ft^3	The outside area just north of Building 693 is used as a storage location for two vendor-supplied roll-off bins.
Building 695 Airlock Container Storage Unit	12,000 gallons	Occupies the majority of the area of Building 695. The area is divided into room 1028, where the majority of liquid wastes are processed, and numerous smaller solid waste processing rooms (1036 through 1041). The Building 695, Room 1027 Airlock occupies the northwest corner of the building.
Building 695 Reactive Waste Storage Unit	12,400 gallons	These four equally sized storage rooms are positioned along the northeast wall of Building 695.
DWTF Portable Tank Storage Pad	22,000 gallons	The DWTF Portable Tank Storage Unit is approximately 60 ft by 70 ft.
Building 696 Rooms 1010 and 1011 Container Storage Unit	18,140 ft^3	B696R is divided into two rooms (1010 from 1011).
Building 696 Rooms 1001, 1007, 1008 & 1009 Storage Unit	3,000 ft^3	B696S includes the Waste Storage and Lab-packing room (1001), Solid Waste Processing room (1009), the Radioactive Waste Repackaging room (1008), and the airlock (1007). Containerized waste can be handled, staged, and stored in these areas.
Tank System with Treatment and Storage		
Bldg 695 Tank Farm	45,000 gal. storage, 325,000 gal/year	Unit consists of nine 5,000-gallon, closed-top storage/treatment tanks inside Building 695. It includes transfer systems (intra-tank and building), chemical feed system, and other ancillary equipment and is used primarily for aqueous-based liquids with dilute concentrations of varying contaminants.
Miscellaneous Treatment Units		
Building 695 Cold Vapor Evaporation Unit	Included with Tank Farm treatment	The **Cold Vapor Evaporator** (Room 1028) operates under vacuum at low temperatures to evaporate water which results in the concentration of dissolved and suspended solids.
Building 695 Centrifuge Unit	55,000 gal/year	The **Centrifuge** (Room 1028) uses centrifugal force to separate varying densities of multiphasic liquid wastes and/or solid particulates.
Building 695 Solidification Unit	115 tons/year	The **Solidification System** (Room 1028) is used to solidify free liquids and to immobilize waste constituents by drum mixing, and/or hand mixing.
Building 695 Shredding Unit	183 tons/year	The **Shredding Unit** (Rooms 1039, and 1040) is used to size-reduce solid waste for subsequent treatment or packaging for off-site shipment.
Building 695 Drum Rinsing Unit	180 ton/year	The **Bulking/Drum Rinsing Station** (Room 1028) uses water or water with detergent(surfactant) or inorganics to rinse or triple rinse empty drums and containers.
Building 695 Debris Washer Unit	45 tons/year – included with Macro-encapsula-tion Unit	The **Debris Washer** (Room 1036) uses water or a solvent (e.g., acid, surfactant, organic, etc.) to chemically extract hazardous and/or radioactive contaminants from debris.

Unit Name[a]	Maximum Permitted Capacity	Unit Description
Building 695 Small Scale Treatment Laboratory	0.23 ton/day	**Small Scale Treatment** takes place in the RWP area (Rooms 1023 and 1025) and the SST Laboratory (Room 1017) and consists of a variety of treatment methods, including chemical, physical separation, and physical removal.
Building 695 Wastewater Filtration Unit	2,700 gal/year	The **Wastewater Filtration Unit** is used to remove solids such as precipitates, suspended solids, or particulates from liquid hazardous and/or mixed wastes before or after waste treatment or storage at the B695 Wastewater Treatment Tank Farm. After removing these hazardous constituents (in the form of filterable solids), the liquid effluent may be discharged to the sanitary sewer in accordance with the City of Livermore Water Reclamation Plant (LWRP) requirements.
Building 696 Drum/ Container Crushing Unit	600 short ton/year	A **Container Crushing Unit** is located in room 1009, along the northeastern wall. This Unit is for processing hazardous and mixed waste. (Another drum crusher is also in room 1009 and is used for radioactive waste only.) The compactor uses hydraulic force to flatten waste containers, liners, or solid debris (such as lab trash).
Building 696 Macro-encapsulation Unit	45 tons/year – included with Debris Washer Unit	The **Macroencapsulation Controller Unit** is in B696 room 1009 along the northern wall. This unit is included as a treatment unit in the permit renewal application

ft = feet/foot; ft^3 = cubic foot; ft^2 = square foot; Bldg = building; DWTF = Decontamination and Waste Treatment Facility; gal = gallon.
a. Source: LLNL 2021i, DTSC 2008.

Consistent with the nature of the Livermore Site operations, the hazardous waste permit identifies a broad range of EPA and state hazardous waste codes as authorized for management in one or more of the WMUs in Table 4-33. The hazardous waste permit also specifically identifies each of the WMUs in Table 4-34 as being used in the management of both hazardous waste and MLLW (LLNL 2019u).

Site 300

Site 300 has 11 permitted WMUs within its three operational waste management facilities (i.e., B883 CSA, EWSF, and EWTF). The WMUs, grouped by facility, are listed in Table 4-34. The maximum capacity and a brief description are included for each unit, as identified in the current Site 300 Part A/B Permit Application (LLNL 2019v). The B883 CSA unit is for storage of general waste pending offsite shipment and is located in the GSA of Site 300 in the southeastern corner of site (*see* Figure 4-86). The EWSF consists of explosives storage magazines located roughly one mile northwest of the main entrance. The EWTF contains two operational areas separated by about 600 feet: one for the open burning cage and pan, the other for the open detonation pad and nearby earth-covered control bunker, and is located roughly 2.5 miles northwest of the main entrance, in the central area of the site.

Historically, Site 300 had an Interim Status treatment unit, the High Explosives Burn Pits (Building 829), that was formally closed and currently operates under a post-closure permit issued by DTSC. The DTSC post-closure permit effective and expiration dates for Building 829 are April 27, 2017 and April 27, 2027, respectively.

Table 4-34. Waste Management Units Used for Hazardous Waste at Site 300

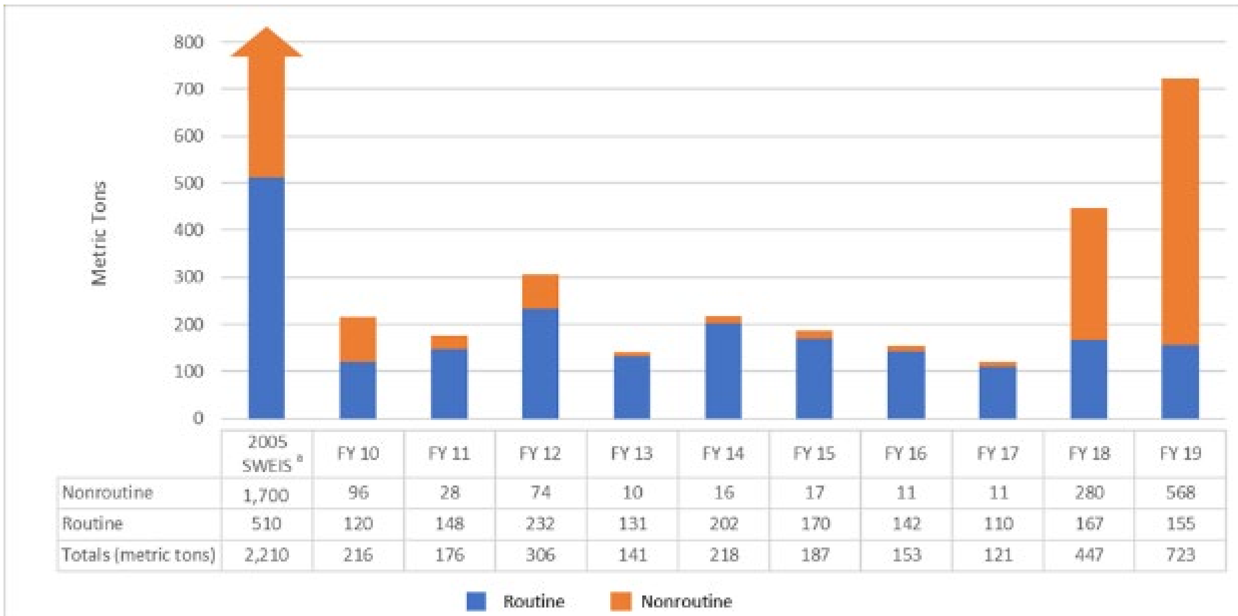
Unit Name	Maximum Permitted Capacity	Unit Description
Building 883 Container Storage Area		
B883 CSA	5,500 gal 330 gal (Chemical Storage Locker)	This is a concrete pad with a metal roof and enclosed by a fence used to store containerized waste.
Explosives Waste Storage Facility		
EWSF Magazine 2	3,209 lb	This is a semi-cylindrical corrugated metal structure overlain with earth berms. Solid and liquid wastes may be stored here, where liquid waste would be solid explosive fines with water from machining operations.
EWSF Magazine 3	5,592 lb	This a reinforced concrete structure overlain with earth. Solid and liquid wastes (as for Magazine 2) may be managed here.
EWSF Magazine 4	4,291 lb	This a reinforced concrete structure overlain with earth. Solid and liquid wastes (as for Magazine 2) may be managed here.
EWSF Magazine 5	2,744 lb	This is a semi-cylindrical corrugated metal structure overlain with earth berms. Solid and liquid wastes (as for Magazine 2) may be managed here.
EWSF Magazine 816	9,240 gal	This is an enclosed metal building, used to store explosives-contaminated wastes.
Explosives Waste Treatment Facility		
EWTF Open Burn Cage	260 lb (50 lb NEW)/event/day - no more than 100 events/year.	This is a burn cage installed on a concrete base used to treat wastewater sludges from machining operations, explosives-contaminated packing material, laboratory waste, and small quantities of explosive powders. Materials are ignited remotely, and after a 24-hour cooling period, explosives technicians inspect the residues for any unburned explosives and residues are collected.
EWTF Open Burn Pan	100 lb/event/day - no more than 100 events/year	This is a burn pan mounted on steel legs with a remotely controlled cover. Small pieces of explosives are put in the pan along with materials such as paper and kerosene to facilitate burning. Ignition is done remotely from inside an earth-covered bunker (Building 845A). Once a burn is complete, the pan is covered and after a 24-hour cooling period, explosives technicians inspect the residues for any unburned explosives and treatment residues are collected.
EWTF Open Detonation Unit	100 lb/event/day - no more than 1,000 lb/year	This is a clay-lined gravel pad where waste explosives may be detonated from inside a nearby earth-covered bunker (Building 845A). After detonation, explosives technicians search for any unexploded explosive pieces and perform further detonation as needed. Treatment residues are collected following a 24-hour cool-down period.
EWTF Residue Storage Unit 1	275 gal	This is a metal chemical storage cabinet for the storage of treatment residues located near the Open Burn Units.
EWTF Residue Storage Unit 2	110 gal	This is a plastic storage cabinet for the storage of solid ash residues located near the Open Detonation Pad.

EWSF = Explosives Waste Storage Facility; EWTF = Explosives Waste Treatment Facility; ft = feet/foot; lb = pounds; gal = gallons; NEW = net explosive weight.
Source: LLNL 2019v; DTSC 2019.

The Site 300's hazardous waste permit (DTSC 2017) identifies a broad range of USEPA and state hazardous waste codes as potentially being managed in the B883 CSA. The EWSF and EWTF waste codes are tailored to management of explosives waste, explosives waste assemblies, cased explosives waste, explosives processing lab waste (e.g., PPE, paper, wipes, mixing utensils) and explosives waste residue.

4.13.2.3 *Hazardous Waste Generation Rates*

Figure 4-87 provides a graphical and numeric summary of the hazardous waste quantities, routine and nonroutine, generated within LLNL over the last 10 years of record. For comparison, Figure 4-87 also shows the volume of routine and nonroutine hazardous waste projected for the Proposed Action evaluated in the 2005 SWEIS. The same generation rates were projected in the 2011 SA. Generation rates for hazardous waste have remained below those projected in the 2005 SWEIS.



	2005 SWEIS [a]	FY 10	FY 11	FY 12	FY 13	FY 14	FY 15	FY 16	FY 17	FY 18	FY 19
Nonroutine	1,700	96	28	74	10	16	17	11	11	280	568
Routine	510	120	148	232	131	202	170	142	110	167	155
Totals (metric tons)	2,210	216	176	306	141	218	187	153	121	447	723

a. The SWEIS entry in the figure shows an arrow rather than a total in order to keep other entries at a more readable scale.
To convert metric tons to tons, multiply by 1.1023.
Source: NNSA 2005; LLNL 2020p.

Figure 4-87. LLNL Hazardous Waste Generation, FY 2009–FY 2019, Compared to Projections from the 2005 SWEIS

LLNL periodically generates TSCA PCB waste from DD&D type activities or from taking equipment such as transformers, capacitors, and light ballasts out of service. For example, during the three years of 2016 through 2018, LLNL reported that 328, 5,890, and 659 pounds of PCB-containing items were generated (LLNL 2017d, 2018a, 2019f), but there are also years when no items are generated. This waste is sent off site to commercial facilities for treatment. Specifically, this waste was sent either to the Clean Harbors facility in Argonite, Utah, or to the Energy Solutions facility in Clive, Utah.

4.13.2.4 *Compliance Status Overview*

Hazardous waste operations at both LLNL sites are performed under permits issued by DTSC. The Livermore Site is currently in the Hazardous Waste Facility Permit (HWFP) renewal process and is operating under the timely renewal provision of the regulations until the Final Permit Renewal is issued. The Livermore Site was granted interim status in the early 1980s through submittal of a Part A application. In 1999, DTSC authorized the Livermore Site's continued hazardous waste management operations under a full RCRA-equivalent Hazardous Waste Facility Permit (99-NC-006). Modifications to the permit have been submitted to the DTSC throughout the lifetime of the permit to ensure it remained reflective of current operations. In 2009, the Livermore Site submitted a timely application for a permit renewal. Since that time, and through March 2021, that application has been in the state's review and approval process, which has included analysis by DTSC, public hearings and comments, comment responses, a permit decision, and then an appeal for the review of the permit decision. The issuance of the permit was stayed until the DTSC appeals officer could review the petitioner's arguments. In December 2016, three of the issues raised by the petitioners were granted review by the DTSC appeals officer, staying the permit. In July of 2018, the final appeal decision and order was issued, and the permit was remanded back to the DTSC permitting division to resolve the comments. The LLNL permit application referenced is the permit currently issued by DTSC, Permit 99-NC-006, and the source of much of its hazardous waste management information for the Livermore Site. From an operational perspective the permit renewal will not have a major impact on day-to-day waste management operations. The only significant operational change will be that upon renewal LLNL will begin the phased closure of nine permitted waste storage units located in Area 612.

Site 300 is operating under a Final Hazardous Waste Facility Permit (renewal) issued by DTSC in June 2017 with an effective date in August 2017 (DTSC 2020b). The original permit (DTSC 2017) was subsequently reissued in 2019 (DTSC 2019) with minor modifications. The permit application referenced in this document for Site 300 (i.e., LLNL 2019t), and the source of much of the hazardous waste management information for Site 300, is the version prepared to incorporate the 2019 modifications.

As permitted hazardous waste facilities, both the Livermore Site and Site 300 are subject to periodic inspection from the applicable regulatory agencies, specifically USEPA and California DTSC, or their representatives. California operates a unified program, whereby local agencies can become certified to oversee compliance in six environmental programs, including hazardous waste (in non-permitted areas). A local agency meeting the necessary qualifications and receiving state-level approval is designated a Certified Unified Program Agency (CUPA) (DTSC 2020c). At the Livermore Site, the LPFD is the CUPA approved to inspect hazardous waste generator activities and, as such, performs periodic inspections of the Livermore Site facilities. At Site 300, the San Joaquin County Environmental Health Department is the CUPA. Table 4-35 provides a summary of the inspections performed on the Livermore Site and Site 300 from 2014 through 2019.

Table 4-35. Inspections of Hazardous Waste Generators and Hazardous Waste Facilities (2014–2019)

Inspecting Agency	Inspection Dates	Findings/Resolution
Livermore Site Inspections		
USEPA	6/23/2014 – 6/24/2014	Unannounced Compliance Evaluation Inspection of hazardous waste facilities. No violations issued. Seven potential violations all resolved through corrective actions and documentation submittals.
CUPA-LPFD	9/3/2014 – 9/5/2014	Three Class II violations[a] identified. Resolved with added training and change in specific waste stream management approach.
CUPA-LPFD	8/17/2015 – 8/20/2015	Four Minor violations[a] dealing with waste characterization, container labeling and management, and a training deficiency.
CUPA-LPFD	7/25/2016 – 7/28/2016	One Minor violation for improper container labeling which was immediately remedied.
USEPA	9/1/2016 – 9/2/2016	One noncompliance issue identified on maintenance of secondary containment which was subsequently fixed.
CUPA-LPFD	7/24/2017 – 7/27/2017	One violation issued for an improper container label.
USEPA	5/14/2018	Compliance Evaluation Inspection – No violations.
CUPA-LPFD	6/18/2018 – 7/27/2018	No violations.
DTSC	4/23/2019 – 4/25/2019; 5/3/2019	Compliance Evaluation Inspection – Two Class II violations; one for cracks in the surface of a container containment area and another for failure to note the cracked surface and rainwater accumulation in the inspection log.
CUPA-LPFD	9/23/2019 – 9/26/2019	No violations.
Site 300 Inspections		
USEPA	9/4/2014 & 9/8/2014	Compliance Evaluation Inspection of Hazardous Waste Facilities – No violations issued, but two potential violations were resolved with equipment repairs and documentation submissions.
CUPA-SJCEHD	9/30/2015, 10/1/2015, 10/5/2015, 10/15/2015, & 10/19/2015	Nineteen violations issued; two were rescinded after additional information was provided; and 17 remaining violations were addressed through a Return to Compliance Certificate from the Site.
CUPA-SJCEHD	10/31/2016 & 11/2/2016	Eight violations issued dealing with record maintenance, container management and labeling, and storage of hazardous waste greater than 90 days.
CUPA-SJCEHD	11/28/2017 – 11/30/2017	Two violations were issued for improper container management and labeling.
USEPA	6/5/2018	Compliance Evaluation Inspection – No violations.
CUPA-SJCEHD	11/13/2018, 11/14/2018, & 11/26/2018	One violation issued for an incorrect waste container label.
DTSC	1/23/2019 – 1/24/2019	Compliance Evaluation Inspection – Two violations; one Class II violation for not removing treatment ash from the Open Burn Cage and one Minor violation for failure to update the Contingency Plan emergency coordinator list.

DTSC = California Environmental Protection Agency Department of Toxic Substances Control; CUPA = Certified Unified Program Agency; LPFD = Livermore Pleasanton Fire Department; SJCEHD = San Joaquin County Environmental Health Department; USEPA = U.S. Environmental Protection Agency.

a. Class II Violation – A deviation from regulatory or permit requirements that warrants a formal enforcement action but does not rise to the level of a significant threat (to health, safety, or the environment) or a chronic violation as would warrant a Class I Violation. Minor violations are a subset of Class II Violations that are not willful, beneficial to the violator, or chronic and are not generally included in enforcements actions provided they are corrected in a timely manner (DTSC 2009).

Source: LLNL 2015c, 2016b, 2017d, 2018a, 2019f, 2020r.

As can be seen in Table 4-35, the local CUPA performs site inspections on an annual, or near annual basis; USEPA and DTSC less frequently. During the six years covered in the table, inspections of both sites identified violations, but none warranting a Class I violation (i.e., associated with a significant threat to health, safety, or the environment) or a chronic violation.

4.13.3 Mixed Waste

4.13.3.1 *Overview of LLNL Mixed Waste Management*

Mixed waste is subject to the regulatory requirements for both hazardous waste and radioactive waste, and is managed at LLNL in the same manner as described for hazardous waste with the exception of modified storage time limits for certain wastes with no or limited off-site treatment options. Before RHWM workers take custody of MLLW, they work with generators to characterize the waste to ensure they have sufficient information to properly manage the waste. MLLW is then managed in many of the same WMUs as hazardous waste. The only exception is for Site 300, for which RHWM must either arrange for its offsite disposition or ship the MLLW to the Livermore Site, since the B883 CSA is not approved for mixed waste storage (the Site 300 permit application identifies the B883 CSA as being used for the storage of hazardous waste only (DTSC 2019).

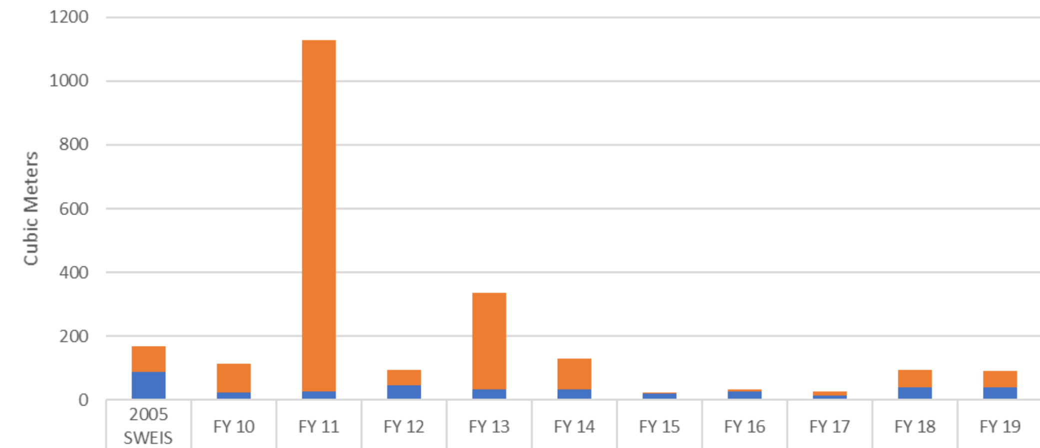
Another difference in the management of mixed waste is the added measures taken if mixed waste is treated in any of the DWTF treatment units in Table 4-35. According to the Livermore Site's Part B permit application, treatment equipment would be decontaminated as needed after treatment of mixed waste batches to prevent subsequent batches of hazardous wastes from becoming mixed waste (LLNL 2019m).

As with hazardous waste, RHWM is responsible for sending mixed wastes to appropriately permitted offsite commercial TSDFs for necessary treatment and disposal actions. Most recently, LLNL's mixed waste has been going to the Energy*Solutions* facility in Clive, Utah, and a PermaFix facility in Kingston, Tennessee (LLNL 2020w). As recently as 2018, LLNL mixed waste was also sent to NNSS for disposal (NNSS 2018).

Compliance status described in Section 4.13.2.4 for hazardous waste actions at the Livermore Site is also applicable to the management of mixed waste.

4.13.3.2 *Mixed Waste Generation Rates*

Figure 4-88 provides a graphical and numeric summary of the mixed waste volumes, routine and nonroutine, generated by LLNL over the last 10 years of record. For comparison, Figure 4-88 also shows the corresponding volume of mixed waste projected for the Proposed Action evaluated in the 2005 SWEIS. The same generation rates were projected in the 2011 SA. The notably large quantity of nonroutine mixed waste generated in FY 2011 was attributed to DD&D activities on Buildings 419, 391, and 321C (LLNL 2020p). Although much less, the volume of nonroutine mixed waste generated was also high in FY 2013. Other than those two years (i.e., FY 2011 and FY 2013), the total mixed waste generated each year has been below the amount projected in the 2005 SWEIS.



	2005 SWEIS	FY 10	FY 11	FY 12	FY 13	FY 14	FY 15	FY 16	FY 17	FY 18	FY 19
Nonroutine	81	91	1102	47	302	97	4	7	13	56	49
Routine	88	22	27.4	46	32	31	19	25.5	14	38	40
Totals (cubic meters)	169	113	1129.4	93	334	128	23	32.5	27	94	89

To convert cubic meters to cubic yards, multiply by 1.3079.
In FY 2011 the spike was from DD&D of B419.
Source: NNSA 2005; LLNL 2020p.

Figure 4-88. LLNL Mixed Low Level Waste Generation, FY 2009–FY 2019, Compared to Projections from the 2005 SWEIS

4.13.4 Biohazardous/Medical Waste

Medical waste, including biohazardous waste, is generated at several Livermore Site facilities. Medical waste is regulated by the California Department of Public Health and, at the Livermore Site, the program is enforced by the Alameda County Department of Environmental Health (ACDEH) (LLNL 2019f). LLNL is registered with ACDEH as a generator of medical wastes and is required to renew those registrations on an annual basis. LLNL's most recent registration applications (at the time of document preparation) were completed in August 2019 and include one application for 11 facilities at Biosafety Level (BSL)-2 or lower (LLNL 2019n) and a separate application for one facility at BSL-3 (LLNL 2019o). The Centers for Disease Control and Prevention uses a four-level system to characterize facilities working with potentially infectious microbes in order to establish appropriate standards for those facilities, including protective measures and equipment. BSL-2 facilities deal with microbes that pose moderate hazards, while BSL-3 facilities deal with microbes that can cause serious or potentially lethal disease through respiratory transmission (CDC 2020).

LLNL is registered with DTSC as a "large quantity generator with onsite treatment," indicating that it generates 200 pounds or more of medical/biohazardous waste in any month of a year. LLNL generates approximately 540 pounds per month of regulated medical waste (LLNL 2019n, 2019o). The two registration applications identify the same types of medical waste being generated and the same types of onsite and offsite treatment being employed. Table 4-36 provides a summary of the types of medical waste generated at the Livermore Site and the alternative treatment methods used.

Minor differences in treatment alternatives between the BSL-2 facilities and the BSL-3 facility are described in the table's footnotes.

Table 4-36. Types of Medical Waste Generated and Alternative Treatment Methods

Medical Waste Type	Waste Form	Treatment Alternatives
Biohazardous	Solids	• (Primary) Autoclave on site, then dispose as Municipal Solid Waste, OR • Send off site for incineration[a]
	Liquids	• (Primary) Chemical disinfection on site, then discharge to the sanitary sewer, OR • Autoclave on site, then discharge to the sanitary sewer[b]
Pathology	Solids	• (Primary) Send off site for incineration[c], OR • For animal carcasses meeting the definition of pathology waste: o Autoclave on site, then send off site for incineration, or o Treat on site in the medical waste-permitted tissue digester[b]
	Liquids	• (Primary) Chemical disinfection on site, then discharge to the sanitary sewer, OR • Autoclave on site, then discharge to the sanitary sewer[b]
Pharmaceutical	All	• (Primary) Send off site for incineration
Sharps	All	Without trace chemotherapeutic contamination • (Primary) Autoclave on site to render non-infectious, then send off site for incineration With trace chemotherapeutic contamination • Send off site for incineration
Trace chemotherapeutic	Solids	• (Primary) Send off site for incineration
	Liquids	• (Primary) Send off site for incineration
Trauma scene (rarely generated)	All	• Send to offsite hospital as soon as safe to do so

a. LLNL's registration for its BSL- 3 facility does not list offsite incineration as an alternative for biohazardous solids.
b. After successful treatment cycles, liquid from the large-capacity autoclave and the tissue digester is discharged to a waste retention tank system along with other treated wastewater from laboratory sinks and floor drains. Water in the waste retention tank system is routinely analyzed and, based on the results, is either managed by RHWM or chlorinated and released to the sanitary sewer.
c. LLNL's registration for its BSL- 3 facility only addresses carcasses as pathology solids produced as waste and lists the tissue digester as the primary treatment alternative with offsite incineration as the alternative.
Source: LLNL 2019n, 2019o.

Medical/biohazardous waste sent off site for treatment (incineration) is managed by RHWM personnel, either by staging the waste through their facility or coordinating shipment directly from the generating laboratory. Currently, LLNL disposes of medical/biohazardous waste at the Clean Harbors Environmental Services, Inc. facility in Aragonite, Utah (LLNL 2019n, 2019o).

Each registration application includes, as integral and required elements, a medical waste management plan, an emergency action plan for all facilities, and a medical waste closure plan for treatment units. Accordingly, ACDEH has considerable information on the manner in which medical/biohazardous waste is managed and how requirements are being met and provides some concurrence on those elements when registration is granted. In addition, ACDEH routinely makes onsite inspection visits of the Livermore Site's medical/biohazardous waste management program. Table 4-37 provides a summary of the last six inspections performed; no record was found of a 2014 inspection. The entries are chronological and include a brief description of the findings from each inspection.

Table 4-37. ACDEH Inspections of Medical/Biohazardous Waste Activities (2013–2019)

Inspection Dates	Findings/Resolution
7/25/2013	Three areas of concern identified: (1) inappropriate packaging of a small bag of biohazardous waste; (2) missing biohazardous symbol on another package, which was immediately corrected; and (3) the runtime of an autoclave calibration was questioned. No violations.
7/29/2015	Medical waste facility inspection – no violations.
8/17/2016	Medical waste facility inspection – no violations.
8/23/2017	Medical waste facility inspection – no violations.
8/22/2018 & 9/5/2018	Medical waste facility inspection – no violations.
10/29/2019	Medical waste facilities inspection – no violations

ACDEH = Alameda County Department of Environmental Health
Source: LLNL 2014b, 2016b, 2017d, 2018a, 2019f, 2020r.

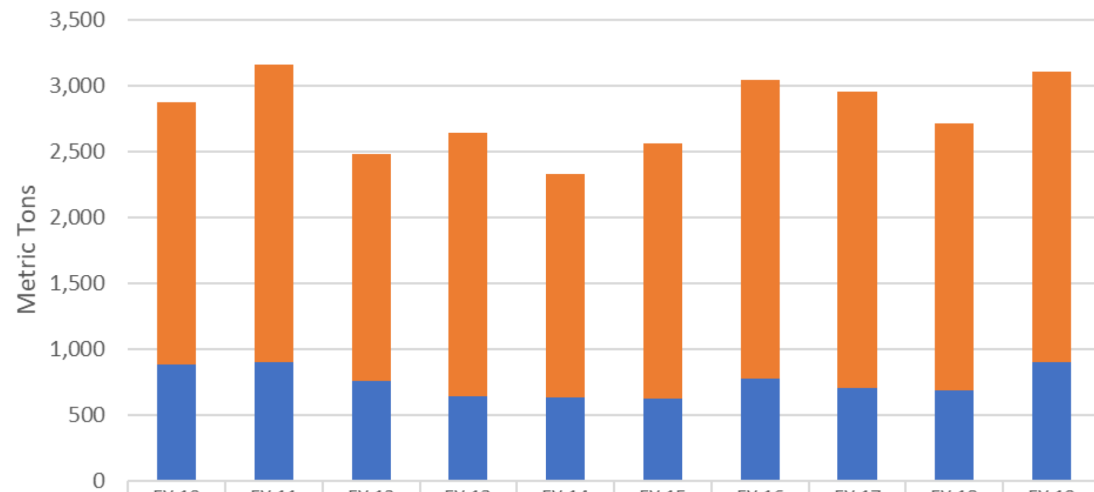
4.13.5 Other Wastes

4.13.5.1 *Municipal Solid Waste*

LLNL uses several different approaches to manage waste materials that are not hazardous or radioactive or any other category discussed above. First, LLNL has an active Pollution Prevention/Sustainability Program that includes efforts to evaluate materials used on site to determine if there are alternatives that generate less waste or waste that is easier to manage or that involves fewer adverse impacts. Programs have also been established to recycle, often for reuse, items such as computers, monitors, laptops, tablets, batteries, and cell phones. Onsite food services promote the use of compostable products and provide means for employees to support material separation. Several other categories of waste materials are segregated and diverted from landfill disposal, with paper and cardboard, metals, and green waste (e.g., chips, compost, mulch, and clean wood) as larger-quantity contributors (LLNL 2019f).

Waste materials not diverted for reuse or recycling are collected through a normal trash collection system operated by LLNL personnel. Filled garbage trucks take the waste to offsite commercial landfills that have the appropriate permits to receive the waste. At the Livermore Site, waste is taken to either the Altamont Landfill or the Vasco Road Landfill (LLNL 2020x). The Altamont Landfill, located about five miles northeast of the Livermore Site, is owned and operated by Waste Management of Alameda County (CalRecycle 2020a). The Vasco Road Landfill, located about four miles north of the Livermore Site, is owned and operated by Republic Services of California (CalRecycle 2020b). At Site 300, collected waste is taken to the Tracy Material Recovery and Transfer Station in Tracy, California. This facility, a little more than five miles northeast of the Site 300 main entrance, is owned and operated by a local entity (CalRecycle 2020c). The Tracy facility includes separating green waste for its compositing operation and using a combination of mechanical and manual sorting to remove materials for recycling (Tracy MRF 2020). Waste not amenable to recovery is sent through the facility's transfer station to another facility with disposal capabilities.

LLNL tracks the amount of municipal solid waste that it sends (from both the Livermore Site and Site 300) to landfills for disposal. It also tracks the amount of waste materials diverted for recovery or recycling before it goes to a landfill. Figure 4-89 provides a summary of the amounts of municipal-type solid waste sent to landfill disposal over the last 10 years and the amount diverted by reuse, recovery, or recycling. During the 10-year period, 73 percent of the waste managed was diverted away from landfill disposal.



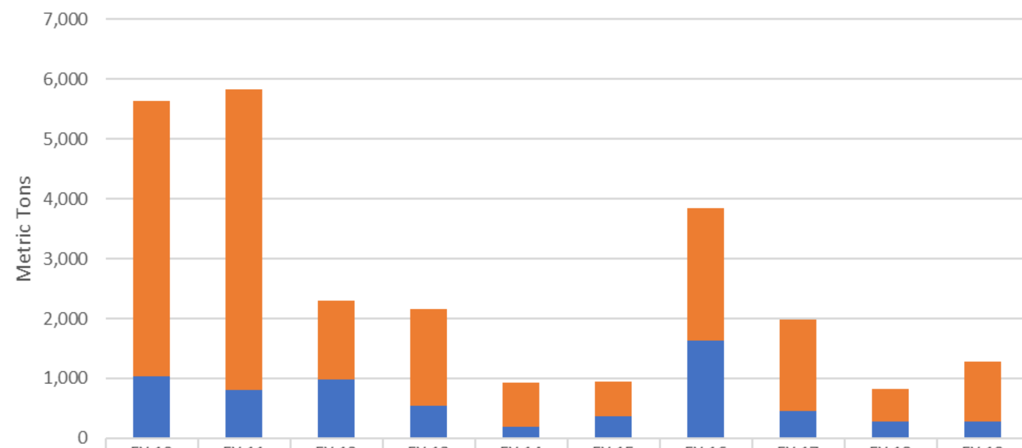
	FY 10	FY 11	FY 12	FY 13	FY 14	FY 15	FY 16	FY 17	FY 18	FY 19
Diverted	1,991	2,261	1,728	1,994	1,697	1,934	2,263	2,244	2,019	2,204
Landfilled	884	898	755	644	634	623	776	704	689	897
Total (metric tons)	2,875	3,159	2,483	2,638	2,331	2,557	3,039	2,948	2,708	3,101

To convert metric tons to tons, multiply by 1.1023.
Source: LLNL 2011b, 2012, 2013b, 2014b, 2015c, 2016b, 2017d, 2018a, 2019f, 2020r.

Figure 4-89. LLNL Municipal Waste Generation FY 2010–FY 2019

4.13.5.2 *Construction and Demolition Waste*

LLNL also segregates and tracks construction and demolition waste, which is generated by those activities plus associated decontamination actions. Construction and demolition waste typically consists of soils, broken up concrete, scrap metals, and various building material waste or rubble. As was described for the municipal waste category, LLNL has implemented actions to reuse or recycle these materials where feasible rather than send them for landfill disposal. Scrap metals are sent for recycling; soils are reused on site or arrangements are made for the landfill to use it as cover; and broken up concrete is used at the landfill for roads, pads, or cover. Figure 4-90 provides a summary of the amounts of construction and demolition waste sent to landfill disposal and diverted for reuse or recycling over the last 10 years. During the 10-year period, 75 percent of the waste was diverted away from landfill disposal.



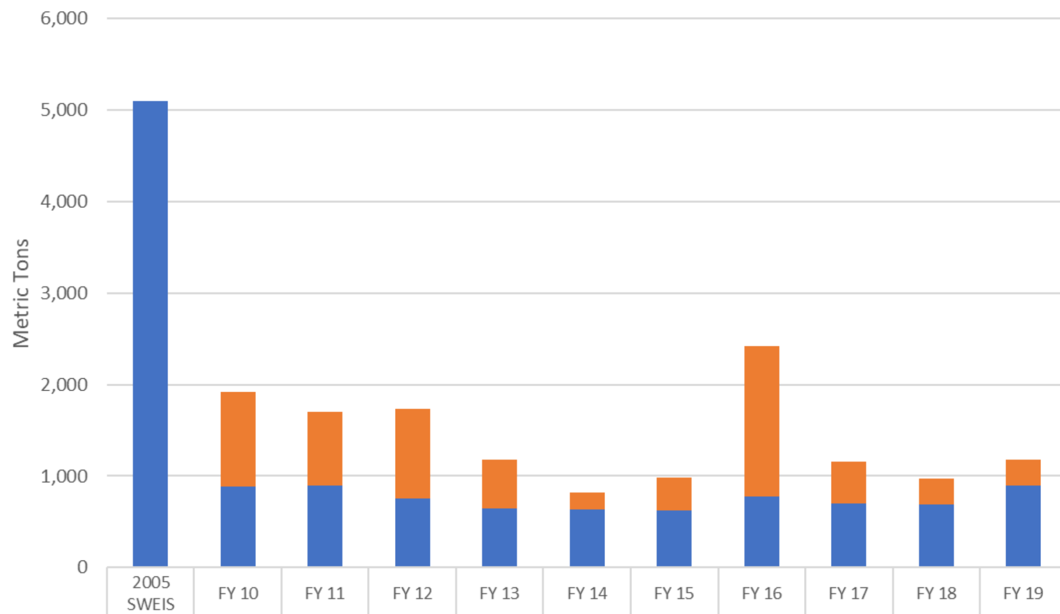
	FY 10	FY 11	FY 12	FY 13	FY 14	FY 15	FY 16	FY 17	FY 18	FY 19
Diverted	4,601	5,015	1,317	1,626	749	593	2,200	1,537	546	996
Landfilled	1,037	806	979	535	184	360	1,639	451	283	280
Total (metric tons)	5,638	5,821	2,296	2,161	933	953	3,839	1,988	829	1,276

To convert metric tons to tons, multiply by 1.1023
Source: LLNL 2011b, 2012, 2013b, 2014b, 2015c, 2016b, 2017d, 2018a, 2019f, 2020r

Figure 4-90. LLNL Construction and Demolition Waste Generation FY 2010–FY 2019

4.13.5.3 *Sanitary Solid Waste (Combination Municipal and Construction & Demolition)*

The waste management evaluation in the 2005 LLNL SWEIS and in the subsequent Supplemental Analysis of 2011 considered a sanitary solid waste category with routine and nonroutine components similar to other LLNL waste groupings. The routine component consists of the portion of the municipal waste described above which goes to landfill disposal. The nonroutine component consists of the portion of the C&D waste going to landfill disposal. Figure 4-91 provides a summary of the combined category of sanitary solid waste sent to landfills over the ten-year period of FY 2010 through FY 2019. For comparison, the figure also presents the annual generation rate for the sanitary waste category as projected in the 2005 SWEIS. The same generation rates were projected in the 2011 SA. As can be seen in the figure, sanitary solid waste generated within LLNL has remained well within the amount projected in the 2005 SWEIS.



	2005 SWEIS	FY 10	FY 11	FY 12	FY 13	FY 14	FY 15	FY 16	FY 17	FY 18	FY 19
Nonroutine[a]	b	1,037	806	979	535	184	360	1,639	451	283	280
Routine[a]	5,100	884	898	755	644	634	623	776	704	689	897
Total (metric tons)	5,100	1,921	1,704	1,734	1,179	818	983	2,415	1,155	972	1,177

a. The "routine" category is municipal waste going to landfill disposal. The "nonroutine" category is C&D waste going to landfill disposal.
b. The SWEIS projection for the nonroutine category is included in the value shown for the routine category.
To convert metric tons to tons, multiply by 1.1023
Source: LLNL 2011b, 2012, 2013b, 2014b, 2015c, 2016b, 2017d, 2018a, 2019f, 2020r

Figure 4-91. LLNL Sanitary Solid Waste Generation, FY 2010–FY 2019, Compared to Projections from the 2005 SWEIS

4.13.6 Materials Management

4.13.6.1 *Regulatory Setting*

LLNL's materials management operations are conducted pursuant to DOE orders and to various applicable federal, state, and local laws and regulations. Regulatory oversight lies with various federal, state, and local agencies. Major laws, regulations, and orders are summarized in Table 4-38.

Table 4-38. Summary of Major Laws, Regulations, and Orders Associated with Materials Management

Laws, Regulations, and Orders	Description
Emergency Planning and Community Right-to-Know Act of 1986 (42 U.S.C. § 11001)	This Act includes emergency planning, notification requirements for unplanned releases of extremely hazardous substances, annual chemical inventory/material safety data sheet reporting, and annual toxic release inventory reporting requirements. LLNL has assisted DOE in preparing toxic release inventory reports consistent with the directive of EO 13834.
Efficient Federal Operations (EO 13834)	This EO directs all federal agencies to meet energy and environmental performance statutory requirements in a manner that increases efficiency, optimizes performance, eliminates unnecessary use of resources, and protects the environment.
Atomic Energy Act (42 U.S.C. § 2011)	The *Atomic Energy Act of 1954* makes the federal government responsible for regulatory control of the production, possession, and use of three types of radioactive material: source, special nuclear, and byproduct (including waste).
29 CFR 1910.1200, *Hazard Communication*	This regulation requires employers to keep a list of the hazardous chemicals maintained in the workplace and to maintain workplace copies of safety data sheets for each hazardous chemical. Safety data sheets must be readily accessible during each work shift to employees.
40 CFR Part 302, *Designation, Reportable Quantities, and Notification*, and 40 CFR Part 370, *Hazardous Chemical Reporting: Community Right to Know*	This regulation requires the reporting of hazardous chemicals in quantities exceeding federally prescribed thresholds to safety and health officials in the state and local community.
California Health and Safety Code Division 20, Chapters 6.7 and 6.75, Sections 25280-25299.7	This regulation establishes standards for concentration, maintenance, inspection, and testing of underground storage tanks.
California Health and Safety Code Division 20, Chapter 6.95, Section 25500	This regulation establishes a state-wide environmental reporting system requirement for business plans that address the type, quantity, and health risks of hazardous materials managed in the state.
DOE O 440.1B, *Worker Protection Program*, for DOE (including NNSA) federal employees	This order requires DOE elements to comply with requirements of Title 49 CFR Part 1910, *Occupational Safety and Health Standards*, that provide worker protection for hazards applicable to their facility. This includes 29 CFR Part 1910, Subpart Z, *Toxic and Hazardous Substances*.
DOE O 460.2A, *Departmental Materials Transportation and Packaging Management*	This order establishes DOE (including NNSA) requirements and responsibilities for the safe, secure, efficient packaging and transportation of hazardous and nonhazardous materials.
DOE O 460.1D, *Packaging and Transportation Safety*	This order establishes DOE (including NNSA) safety requirements for the proper packaging and transportation of offsite shipments and onsite transfers of hazardous materials including radioactive materials. (Offsite is any area within or outside a DOE site to which the public has free and uncontrolled access; onsite is any area within the boundaries of a DOE site or facility to which access is controlled.)
California Accidental Release Prevention (CalARP) Program	This regulation requires that specific chemical stationary sources with more than a threshold quantity of a regulated substance shall be evaluated to determine the potential for and impacts of accidental releases from that covered process.

U.S.C. = United States Code; CFR = Code of Federal Regulations; DOE = U.S. Department of Energy; EPCRA = Emergency Planning and Community Right-to-Know Act; NNSA = National Nuclear Security Administration.

4.13.6.2 *Radioactive, Controlled, and Hazardous Materials Management*

Radionuclide Inventories

LLNL uses radioactive materials in a wide variety of operations including scientific and weapons R&D, diagnostic research, research on the properties of materials, and isotope separation. Before discussing radioactive materials in general, it should be noted that some LLNL activities include the presence and use of special nuclear materials (that is, uranium enriched in the uranium-235 isotope, uranium-233, or plutonium, but may include other nuclear material determined to warrant similar consideration). The Nuclear Regulatory Commission categorizes quantities of special nuclear material (SNM) into three main levels according to the risk and potential for its use in a fissile explosive or in production of nuclear material for use in a fissile explosive. These safeguard categories are: SNM Category I designating strategic quantities; SNM Category II designating quantities of moderate strategic significance; and SNM Category III designating quantities of low strategic significance (NRC 2017). DOE/NNSA uses a different, though similar, approach to categorize the SNM managed at its locations. These groupings, again based on the mass and form of SNM present, are designated Security Categories I through IV, and are used to establish the types and levels of security, control, and accounting measures required in the management of these materials.

DOE/NNSA SNM Security Categories

DOE uses a cost-effective, graded approach to provide special nuclear material safeguards and security. Quantities of special nuclear material stored at each DOE site are categorized into Security Categories I, II, III, and IV, with the greatest quantities included under Security Category I, and lesser quantities included in descending order under Security Categories II through IV.

Although it has already occurred, a notable operational change at LLNL since publication of the 2005 LLNL SWEIS was the removal of Security Category I/II nuclear materials from LLNL, which was completed in 2012. Given its significance related to continued operations at LLNL under the No-Action Alternative (and the Proposed Action), this section provides a more detailed discussion of that project. The removal of Security Category I/II nuclear materials from LLNL was an outcome of "Complex Transformation," (NNSA 2008, NNSA 2019b) which represented NNSA's vision for a smaller, safer, more secure, and less expensive nuclear weapons complex to meet national security requirements. One of the goals of Complex Transformation was to decrease the number of Security Category I/II nuclear material operations to a minimum number of sites.

LLNL processed and packaged Security Category I/II items for offsite transfer to other DOE/NNSA sites. The effort of processing, packaging, and shipping the Security Category I/II nuclear material from LLNL was performed over a five-year period, from 2008 to 2012, all of which was accomplished while maintaining programmatic operations at LLNL (LLNL 2013c). Upon completion of material transfer operations, LLNL declared conversion to Security Category III operations at the end of FY 2012 and has been executing the LLNL Security Category III operational plan. With regard to the general management of radioactive materials, LLNL evaluates the quantities of these materials in individual facilities using the DOE Standard *Hazardous Categorization of DOE Nuclear Facilities* (DOE-STD-1027). For purposes of this document, radiological hazard categorization primarily uses DOE-STD-1027-92 Change Notice 1 (DOE 1997), which is the currently applicable standard at LLNL per the terms of the prime contract. Since the SWEIS is a forward-looking document, some proposed projects use the more recent revision, DOE-STD-1027-2018, which NNSA expects to implement at LLNL in the future. Use of either of these revisions is acceptable by the guidance provided by DOE.

This Standard designates three categories of facility (*see* text box) for which a safety basis must be established and maintained in accordance with 10 CFR Part 830, *Nuclear Safety Management*, Subpart B, *Safety Basis Requirements*. The categories are based on an extensive list of radionuclides with quantities (in curies or grams) for both Hazard Category 2 and Category 3 thresholds. Criteria for the category representing the lowest safety hazard (i.e., Hazard Category 3) are often set as administrative limits on facilities. Facilities maintaining radioactive materials at levels below Hazard Category 3 still require appropriate safety and hazard evaluations, but they are recognized as being at risk levels not requiring the extensive and formal requirements of 10 CFR Part 830. An administrative limit is thus the total inventory of radioactive materials allowed in a specific building at LLNL and is generally based on the facility design and operations, which determine the inventory of radioactive materials that can be safely and reasonably managed. Hazardous material inventories or administrative limits for Livermore Site and Site 300 facilities are provided in Table 4-39. The inventories or administrative limits in the tables are primarily for radioactive materials, but include explosives in the case of Site 300.

Nuclear Hazard Categories

(not to be confused with Special Nuclear Materials Categories)
Category 1 – DOE nuclear facility with the potential for significant off-site consequences. An example would be a nuclear reactor, 20 megawatt or greater in size.
Category 2 – DOE nuclear facility with the potential for significant on-site consequences beyond localized consequences. An example would be a facility with sufficient hazardous material and energy that an unmitigated release would require an emergency plan for on-site evacuation.
Category 3 – DOE nuclear facility with the potential for only local consequences. Examples would include lab operations, low level waste handling facilities, or research machines with Category 3 levels of materials (per DOE-STD-1027), but less than Category 2 levels.
Source: DOE-STD-1027

Table 4-39. Facilities Managing Radionuclides at Livermore Site and Site 300

Facility Number	Facility Description	Material/Emission/ Waste Description	Current Inventory[a] and/or Admin Limits[b]	Facility Classification[c]
131HB	Weapons Engineering	Depleted Uranium (DU)	10,000[a] to less than 30,000 kg[c] cumulative with no more than 1,000 kg in powder	Radiological Facility
		Total radiological inventory	Inventory maintained below Category 3 thresholds	
		Radiation-Generating Devices (RGDs)[d]	Up to Class IV	
132N	Defense Programs Research Facility	Sealed sources	Inventory maintained below Cat 3 thresholds[f]	Radiological Facility
		Other radiological inventory	Inventory maintained below Cat 3 thresholds[e]	
132S	Global Security Research Facility	Sealed sources	Inventory maintained below Cat 3 thresholds	Radiological Facility
		Total radiological inventory	Inventory maintained below Cat 3 thresholds	
		RGDs	Class I and II	
141	Engineering Tech Development	Total radiological inventory	Less than 1/20th of Category 3 thresholds	Radiological Facility
		RGDs	Up to Class IV	
151, 152	Analytical and Nuclear Chemistry Facility and Storage	Total radiological inventory	Less than Cat 3 thresholds	Radiological Facility
		RGDs	Class I	
154	Analytical and Radiochemistry Laboratory	Total radiological inventory	Less than Cat 3 thresholds	Radiological Facility
162/164	Crystal Growth/ Machine Shop	Total radiological inventory	Less than 1/20th of Category 3 thresholds	Radiological Facility
		RGDs	Up to Class III	
165	Optics/ Development Lab	Other radiological inventory	Less than 1/20th of Category 3 thresholds	Radiological Facility
166	Development Lab	Sealed sources	Less than 1/20th of Category 3 thresholds	Radiological Facility
174 Complex	Jupiter Laser Facility (B174, 173, 174, T1727)	RGD (up to Class IV; X-rays, Accelerators, etc.)	Up to Class IV Less than 1/20 of Cat 3 thresholds	Radiological Facility
190	Center for Accelerator Mass Spectrometry (CAMS) Lab Facility	Pu-239	0.186 Ci	Radiological Facility
		Sealed source Pu-238	12.1 Ci[f]	
		Three accelerators (Largest is 11 MV)	Hazards within Low Hazard Accelerator Facility Safety Envelope	
		RGDs	Up to Class IV	

Facility Number	Facility Description	Material/Emission/ Waste Description	Current Inventory[a] and/or Admin Limits[b]	Facility Classification[c]
		Other radiological inventory	Less than Cat 3 thresholds	
		Other sealed sources	Less than Cat 3 thresholds	
191	High Explosives Application Facility (HEAF)	DU/Natural Uranium/other compounds containing these materials	Less than 1/20th of Cat 3 thresholds	Radiological Facility
		Sealed sources/encapsulated radiological materials	Less than 1/20th of Cat 3 thresholds	
194	Accelerator Tunnel Complex	Total radiological inventory	Less than Cat 3 thresholds	Radiological Facility
		Sealed sources	Less than Cat 3 thresholds	
		RGDs (facility includes four Accelerators)	Up to Class IV	
231	Engineering Development and Assembly Facility	Natural thorium	3 kg[a]	Radiological Facility
		Natural uranium	242 kg[a]	
		DU	5,425 kg[a]	
		Total radiological inventory	Less than Cat 3 thresholds[e]	
		RGDs	Up to Class III	
B231V, OS232FA, B233GV	Building 231 Vault, Other Structure 232 Fenced Area, Building 233 Garage Vault	DU	1000 kg[a]	Radiological Facility
		Total radiological inventory	Less than Cat 3 thresholds	
		Sealed sources	Inventory maintained below Cat 3 thresholds[f]	
		RGDs	Up to Class IV	
235	Materials Science Division Offices and Labs	Accelerator (4 MV)	Hazards within Low Hazard Accelerator Facility Safety Envelope	Radiological Facility
		Total radiological inventory	Less than Cat 3 thresholds	
		RGDs	Up to Class III	
		Plutonium	Less than 38.2 g Cat 3 threholds[c, i]	
239	Radiography Facility	Natural uranium	2.5 kg[b]	Category 3 Nuclear Facility
		Plutonium, fuel grade equivalent	3.3 kg[b]	
		Highly enriched uranium (HEU)	50 kg (bulk solid)[b]	
		DU	500 kg (bulk solid or powder)[b]	
		Radiological Waste	80 g of fuel-grade equivalent plutonium[b]	
		Total radiological inventory	Inventory maintained below Cat 2 thresholds	
253	HC Dept Offices and Labs	Total radiological inventory	Less than 1/20th of Category 3 thresholds	Radiological Facility
254	HC Bio Assay Lab	Sealed sources	Less than 1/20th of Category 3 thresholds	Radiological Facility
255	HC SPD Labs and Offices	Total radiological inventory	Inventory maintained below Cat 3 thresholds	Radiological Facility

Facility Number	Facility Description	Material/Emission/ Waste Description	Current Inventory[a] and/or Admin Limits[b]	Facility Classification[c]
		Sealed sources	Inventory maintained below Cat 3 thresholds[f]	
		RGDs	Up to Class IV	
262	Radiation Detector Development	U-235	Approximately 1,220 g[a]	Radiological Facility
		Total radiological inventory	Inventory maintained below Cat 3 thresholds	
		Sealed sources	Inventory maintained below Cat 3 thresholds [f]	
		RGDs	Up to Class IV	
272	Material Science Laboratory	RGDs	Up to Class III	Radiological Facility
		Total radiological inventory	Less than 1/20th of Category 3 Thresholds	
298	Target Fabrication	Tritium	1500 Ci[b]	Radiological Facility
		Other radiological inventory	Less than Cat 3 thresholds	
		RGDs	Up to Class III	
		Tritium Air Emissions	10 Ci/yr.	
321A	Materials Fabrication Shop	Natural thorium/Natural uranium	Less than 1/20th of Cat 3 thresholds	Radiological Facility
		DU	Less than 1/20th of Cat 3 thresholds; typically <100 kg[a]	
321C	Materials Fabrication Shop	DU	About 3,500 kg[a] (less than Cat 3 thresholds)	Radiological Facility
		Natural thorium/Natural uranium	Less than Cat 3 thresholds	
		RGDs	Up to Class III	
322 322A	Plating Shop	DU	Less than 1/20th of Category 3 thresholds	Radiological Facility
		Total radiological inventory	Less than 1/20th of Category 3 thresholds	
327	Radiography	DU	Less than Cat 3 thresholds	Radiological Facility
		Sealed sources	Less than Cat 3 thresholds	
		Other radiological inventory	Less than Cat 3 thresholds	
		RGDs	Up to Class IV	
329	Laser Weld Shop	DU	150 kg limit[b]; Less than 1/20th of Cat 3 thresholds	Radiological Facility
		Total radiological inventory	Less than 1/20th of Category 3 Thresholds	
331	Tritium Facility	Tritium	35g across two increments; 30 g maximum in increment[b]	Category 3 Nuclear Facility

Facility Number	Facility Description	Material/Emission/ Waste Description	Current Inventory[a] and/or Admin Limits[b]	Facility Classification[c]
		Other radiological inventory	Pu-239 < 450 g, U-233 < 500 g, U-235 < 700 g in each increment[b]; All other radionuclides below Cat 2 thresholds	
		Tritium Emissions	210 Ci/yr.[h]; Max. 2,000 Ci/yr.[i] tritium emissions	
		Emissions from Maintenance Activities		
332	Plutonium Facility	Plutonium	300 kg fuels-grade plutonium equivalent [b]	Category 2 Nuclear Facility.
		Enriched Uranium	200 kg [b]	
		Natural or DU	1000 kg [b]	
		Waste	No limit	
334	Hardened Engineering Test Building	Tritium	1.6 g[b]	Category 2 Nuclear Facility
		Enriched Uranium	Included in B332 limit	
		Plutonium	Included in B332 limit	
		Natural or DU	Included in B332 limit	
341	Engineering Mechanical Testing	DU	Less than 1/20th of Cat 3 thresholds	Radiological Facility
		RGDs	Up to Class IV	
361, 362	Bio Research Cornerstone Facility	Total radiological inventory	Less than 1/20th of Cat 3 thresholds	Radiological Facility
		RGDs	Class I	
364	Bio Research Support Facility	Cesium-137 (Sealed source)	2.25 x 10^3 Ci ("Excluded Inventory")[f]	Radiological Facility
		Total radiological inventory	Less than 1/20th of Cat 3 thresholds	
366	Bio Research Facility	Total radiological inventory	Less than 1/20th of Cat 3 thresholds	Radiological Facility
381	Target Fabrication and Offices	Total radiological inventory	Less than 1/20th of Cat 3 thresholds	Radiological Facility
		RGDs	Less than Class III	
391	NIF Optics and Diagnostic Labs	Total radiological inventory	Less than 1/20th of Cat 3 thresholds	Radiological Facility
		RGDs	Up to Class IV	
392	Optics Laboratory Facility	Total radiological inventory	Less than 1/20th of Cat 3 thresholds	Radiological Facility
431	Beam Research Labs	Total radiological inventory	Less than 1/20th of Cat 3 thresholds	Radiological Facility
		RGDs	Up to Class IV	
432	NIF Target Fabrication Machining	Total radiological inventory	Less than 1/20th of Cat 3 thresholds	Radiological Facility
442	WCI Facility/Flight Test Group	Total radiological inventory	Less than 1/20th of Cat 3 thresholds	Radiological Facility
490	NIF Engineering & Diagnostics Labs	Heavy water (D_2O)	60,000 kg	Radiological Facility
		Total radiological inventory	Less than 1/20th of Cat 3 thresholds	
		RGDs	Up to Class IV	
491	Development Lab	Total radiological inventory	Less than 1/20th of Cat 3 thresholds	Radiological Facility

Facility Number	Facility Description	Material/Emission/ Waste Description	Current Inventory[a] and/or Admin Limits[b]	Facility Classification[c]
OS495	Consolidation Waste Accumulation Area	All radionuclides in radiological waste	Less than Cat 3 thresholds	Radiological Facility
581/582, 684	National Ignition Facility	Tritium	8,000 Ci[h]/ less than Cat 3 thresholds (16,000 Ci)[i]	Radiological Facility
		Total radiological inventory	Less than Cat 3 threshold quantity	
		Routine tritium Emissions including emissions from tritium reservoir operations	80 Ci/yr.[h]. 1,600 Ci/yr.[i] tritium emissions	
		RGDs	Up to Class IV	
		Plutonium	Less than 38.2 g Cat 3 thresholds[c, i]	
612 Area	RHWM Waste TSDF	All radionuclides in radiological waste	Less than Cat 3 threshold quantity	Radiological Facility
681	Optics Assembly Building (OAB)	Total radiological inventory	Less than 1/20th of Category 3 Thresholds	Radiological Facility
Area 625 and Yard Area	RHWM Radioactive Waste Storage Facilities	Radiological waste	Currently, approx. 1210 PE-Ci. Allowed Cat 2 Nuclear Facility quantities	Category 2 Nuclear Facility
		Tritium	Currently, approx. 232 Ci[a]; B625 tritium limit is 15,000 Ci[b]; 625 Yard tritium limit is 40,000 Ci[b]	
B693 and Yard Area	RHWM Radioactive Waste Storage Facilities	Radiological waste	Currently, approx. 1 PE-Ci[a]; Yard allowed to have Cat 2 Nuclear Facility quantities	Category 2 Nuclear Facility
		Tritium	Currently, approx. 70 Ci[a]; B693 tritium limit is 15,000 Ci[b]; 693 Yard tritium limit is 40,000 Ci[b]	
B696R	RHWM Radioactive Waste Storage Facilities	Radiological waste	Currently, approx. 41 PE-Ci[a]; allowed to have Cat 2 Nuclear Facility quantities	Category 2 Nuclear Facility
		Tritium	Currently, approx. 4958 Ci[a]; B696R tritium limit is 15,000 Ci[b]	
695, 696S, 697	RHWM Liquid Waste Processing/ Decontamination and Waste Treatment Facility (DWTF)	All radionuclides in radiological waste	Less than Cat 3 threshold quantity	Radiological Facility
S300 Firing Operations:				
801A	Building 801 Complex--Contained Firing Facility	Accelerator (18 MeV)	Hazards within Low Hazard Accelerator Facility Safety Envelope	Radiological Facility
		Tritium	20 mg; 192 Ci/experiment	

Facility Number	Facility Description	Material/Emission/ Waste Description	Current Inventory[a] and/or Admin Limits[b]	Facility Classification[c]
	(CFF) and Flash X-ray Accelerator (FXR)	DU	10,400 kg	
		Total radiological inventory	Less than Cat 3 thresholds	
804	Low-Level Waste Staging Area	All radionuclides in radiological waste	Less than 1/20th of Cat 3 thresholds	Radiological Facility
812E	Radiography Storage, Repair and Testing	RGDs	Up to Class IV	Radiological Facility
851A	Outdoor Firing Facility	Tritium	20 mg (192 Ci)/experiment	Radiological Facility
		Total radiological inventory	Less than Cat 3 thresholds	
		Air emissions		
Process Area Facilities:				
806A/B	HE Machining	Total radiological inventory	Less than Cat 3 thresholds	Radiological Facility
810A/B/C	HE Assembly and Storage	DU	10,400 kg	Radiological Facility
		Thorium-232 (Th-232)	910 kg/1 x 10^{-3}Ci	
		Tritium	1.6 g	
		Total radiological inventory	Less than Cat 3 thresholds	
823A/B	LINAC Radiography	DU	10,400 kg	Radiological Facility
		Sealed sources	Less than Cat 3 thresholds	
		Total radiological inventory	Less than Cat 3 thresholds	
		RGDs	Up to Class IV	
Engineering Test Area Facilities:				
836A/B/C/D	Dynamic Test Facility	Total radiological inventory	Less than Cat 3 thresholds	Radiological Facility
		DU	10,400 kg	
		Tritium	20 mg/192 Ci	
Forensic Receival Facility:				
858	Forensic Receival Facility	Total radiological inventory	Less than Cat 3 thresholds	Radiological Facility
Waste Facilities:				
OS 883	RHWM Other Structure	All radionuclides in radiological waste	Less than Cat 3 thresholds	Radiological Facility
Materials Management Facilities:				
	B832 Complex: M832-1, M832-2, B832A, B832B, B832C, M832-D, B832-E, M1, M7, M8, M52, B854 Complex (B854A, M854H, M854V), V822A-D	Total radiological inventory	Less than Cat 3 thresholds	Radiological Facility

a. Current inventory is a snapshot in time; this is not a limit.

b. Administrative limit as proposed by LLNL programs or from safety documentation (safety basis document, etc.).

c. Facility classification, as defined in DOE-STD-1027: 1) A Hazard Category 2 Nuclear Facility is one with the potential for nuclear criticality events, or, with sufficient quantities of hazardous materials and energy, could require on-site emergency planning activities; 2) A Hazard Category 3 Nuclear Facility is one with the potential for significant but localized consequences, and has quantities of hazardous radioactive materials which meet or exceed Table A.1 values in the standard; 3) Facilities that do not meet or exceed Category 3 threshold criteria but still possess some amount of radioactive material may be considered Radiological Facilities. Some facilities may increase inventories per DOE-STD-1027 revisions approved for use at LLNL, as long as consequences remain localized to the site.

d. Radiation-Generating Devices (RGDs) are particle accelerators or photon emitters that produce ionizing radiation (e.g., X-rays, electrons, neutrons). RGDs may be grouped by class. RGDs not covered by DOE O 420.2C would not require additional safety documentation. RGDs covered by DOE O 420.2C (Accelerators) would have additional safety assessment documentation.

e. Exceeds the criticality thresholds described in DOE-STD-1027-92, or later revisions approved for use at LLNL. Storage and use is permitted only when a criticality safety evaluation determines that a criticality is not credible.

f. B132N, B190, B231V/OS232FA/B233GV, B255, B262, and B364 contain several high activity sealed sources that qualify for exclusion from inventory per DOE-STD-1027-92, or later revisions approved for use at LLNL. Attachment 1. Qualification for exclusion includes packaging in specific types of robust capsules or containers and a demonstration that the hazards in the facility will not create a condition that will exceed the criteria under which the capsules or containers were tested against.

g. LLNL is currently working on removing the inventory of DUF_6 in B165.

h. No-Action Alternative

i. Proposed Action Alternative

With regard to radiological material inventories, Hazard Categories 2 and 3 represent the highest (or worst) potential risk consequences posed by LLNL facilities; No Hazard Category 1 facilities are located at LLNL. As shown in Table 4-39, only a limited number of Hazard Category 2 and 3 facilities are located at the Livermore Site. Specifically, there are seven facility entries in the Table 4-39 with Hazard Category 2 or 3 designations. The number of Hazard Category 2 and 3 nuclear facilities currently shown for LLNL remains basically unchanged from the number identified in the 2005 SWEIS, with a couple of notable changes. Building 251 was identified as a Category 2 facility in the 2005 SWEIS, but is not shown in the current listing and is scheduled for DD&D (*see* Table 3-3). Also, Building 239 is now a Category 3 facility and was shown as a "less than Category 3" facility in the 2005 SWEIS.

Explosives represent a significant portion of the entries in Table 4-39 for Site 300, but many entries are also designated as radiological facilities. None of the Site 300 facilities, however, contain or are allowed to contain sufficient radiological material to warrant as much as a Hazard Category 3 Nuclear Facility designation.

Chemical Inventories

As indicated in the discussion of hazardous waste (*see* Section 4.13.2.1), LLNL performs a broad range of research activities. These activities and the associated research and chemical laboratories use a broad range of hazardous chemicals and in both small and large quantities. The nature of LLNL activities is also such that chemical inventories can change significantly over time and from facility to facility as programs change or research findings dictate changes in direction. The general following chemical types, many using DOE designations, are used and stored at LLNL (LLNL 2019p):

- corrosives (liquids, solids, and gases);
- toxic substances (including gases);
- flammables and combustibles (including solids, liquids, and gases);
- nonflammable gases;
- water reactives/pyrophorics/spontaneously combustibles;
- oxidizing substances;
- organic peroxides; and
- explosives.

Consistent with information in the 2005 SWEIS, some of the toxic substances used within LLNL are considered to be carcinogens and some of the gases, both flammable and nonflammable, are asphyxiants.

A key element of LLNL's strategy in managing its chemical inventory is to ensure chemicals are used safely and appropriately. For new or planned actions, this is done largely through implementing the following hierarchy of controls, in order of preference: (1) select materials and process designs that avoid or minimize use of hazardous materials; (2) use engineered controls to confine, shield, or remove hazards; (3) use administrative or procedural controls; and (4) use personal protective equipment (LLNL 2019q, 2019r). Concurrently and consistent with requirements of 29 CFR Part 1910, Subpart Z, *Toxic and Hazardous Substances*, and other standards, the LLNL ES&H program includes measures and requirements to inform workers of the hazards posed by chemicals in their workplace and to provide training so that they can perform their work in a manner that minimizes the risk of adverse effects from those chemicals (LLNL 2019q, 2019r).

LLNL Classifications of Hazardous Materials

Based on the level of security classification and whether the material is considered waste, the hazardous material types are:

Type 1 – Controlled hazardous materials also fitting the definition of hazardous materials in 49 CFR 171.8 (e.g., hazardous classified material, non-waste quantities of radioactive materials, accountable nuclear materials, explosives, and nuclear components and special assemblies)

Type 2 – Unclassified hazardous or radioactive materials substances, and wastes of negligible economic value (i.e., hazardous, biological, and radioactive wastes)

Type 3 – Consisting mainly of chemicals and industrial materials, this is all hazardous materials and substances other than those identified as Type 1 or 2.

Source: LLNL 2015d.

As noted in the 2005 SWEIS, another key element of LLNL's strategy in managing its chemical inventory is to minimize its size. Efforts to this end include actions taken whenever hazardous materials are ordered for the site. Such requests are reviewed by subject specialists to determine if there are less hazardous materials available to accomplish the same need. Another review is performed to determine if the hazardous chemical is already available onsite as determined through the LLNL ChemShare program (LLNL 2015d). Once chemicals have been ordered, all hazardous materials coming to the Livermore Site from commercial vendors or other DOE sites are received by the Receiving Section of the Supply Chain Management Department; that is, unless prior approval has been given, or is already in place, for a specific, direct delivery. Supply Chain Management Department personnel are then responsible for bar coding containers and entering record of the receipt into the ChemTrack system or requesting the ChemTrack Group to enter the data (LLNL 2015d). Similar container bar-coding and inventory data entry in the ChemTrack system are performed by receiving organization at Site 300. The ChemTrack system is LLNL's centralized chemical inventory database for tracking hazardous chemicals and represents the site's means of determining whether goals of inventory reduction are being achieved. ChemTrack allows RFID-tagged chemical containers to be tracked by location and usage information from receipt through disposal. It also links each chemical to data on its properties and hazards, including the safety data sheets if available. Measures to maintain and validate ChemTrack chemical inventory data include performing, at least on an annual basis, a wall-to-wall inventory and reconciliation at each facility where tracked items are used (LLNL 2015d).

ChemTrack also provides inventory data in support of LLNL's Hazardous Materials Business Plans (Livermore Site, Site 300, and supporting leased facilities) which must be prepared and updated periodically in compliance with California law (specifically, the Health and Safety Code sections 25500–25519). In addition to an inventory of hazardous chemicals, the Hazardous Materials Business Plans include the sites' emergency response plans and procedures in the event of a hazardous material release, along with descriptions of employee training to respond to releases, and other key response information. The Plans are made available and are intended to provide basic information to first responders in the community and satisfy *Federal Emergency Planning and Community Right-to-Know Act* reporting and state Community Right-To-Know requirements (CalOES 2014).

In 2019, approximately 122,000 chemical containers, ranging from tanks to 55-gallon drums to small-quantity vials, as well as bags and boxes, were in use or stored at LLNL; roughly 115,000 of the containers were in Livermore Site facilities, the other 7,000 were at Site 300 (LLNL 2019s). For comparison, it was reported in the 2005 SWEIS that there were more than 166,000 chemical containers being used or stored at LLNL in 2001. Table 4-40 presents a representative list of 2018/2019 hazardous chemicals at the Livermore Site.

Table 4-40. Representative List of Hazardous Chemicals in Use at the Livermore Site

Chemical	Chemical Abstract Number	Maximum/Average Quantity
Paints/Thinners		
Paint (variety)	Not Available	8,750/5,810 gallons
Thinner, lacquer	Not Available	100/60 gallons
Methylene chloride	75-09-2	750/500 gallons
Methyl alcohol	67-56-1	700/470 gallons
Acetone	67-64-1	1,250/820 gallons
Metals		
Lead bricks or ingots	7439-92-1	750,000/750,000 pounds
Tantalum	7440-25-7	950/640 pounds
Boron, powder	7440-42-8	350/210 pounds
Aluminum	7429-90-5	500/ 320 pounds
Chrome or chromium	7440-47-3	1,650/ 1,090 pounds
Beryllium	7440-41-7	2,100/1,380 pounds
Copper, powder	7440-50-8	350/230 pounds
Nickel, powder	7440-02-0	450/280 pounds
Tungsten	7440-33-7	11,300/7,510 pounds
Acids/Bases/Oxidizers		
Oxygen, compressed	7782-44-7	70,000/50,000 cubic feet
Hydrogen peroxide <52%	7722-84-1	700/440 gallons
Ammonium hydroxide	1336-21-6	2,750/1,820 pounds
Sodium hydroxide	1310-73-2	500/320 pounds
Sulfuric acid	7664-93-9	15,000/10,000 pounds
Nitric acid (70% solution and fuming)	7697-37-2	12,100/6,070 pounds
Phosphoric acid	7664-38-2	200/120 gallons
Hydrofluoric acid	7664-39-3	700/450 pounds
Hydrochloric acid	7647-01-0	600/390 gallons
Industrial Gases		
Argon, compressed	7440-37-1	230,000/160,000 cubic feet
Helium, compressed	7440-59-7	330,000/220,000 cubic feet
Hydrogen, compressed	1333-74-0	100,000/70,000 cubic feet
Nitrogen, compressed	7727-37-9	250,000/170,000 cubic feet
Carbon dioxide	124-38-9	160,000/110,000 cubic feet
Acetylene	74-86-2	24,000/16,000 cubic feet
Methane	74-82-8	12,000/8,000 cubic feet
Sulfur hexafluoride	2551-62-4	70,000/52,000 cubic feet
Refrigerants (note 1)		

Chemical	Chemical Abstract Number	Maximum/Average Quantity
Freon 113 (1,1,2-Trichloro-1,2,2-trifluorethane) Refrigerant 123 (2,2-Dichloro-1,1,1-trifluoroethane) Freon 22 (chlorodifluoromethane) Freon 11 (trichlorofluoromethane) Freon 12 (dichlorodifluoromethane) Freon 14 (tetrafluoromethane) Refrigerant 134A (1,1,1,2-tetrafluorethane)	76-13-1 306-83-2 75-45-6 75-69-4 75-71-8 75-73-0 811-97-2	750/500 gallons 6,000/4,740 gallons 250,000/210,000 cubic feet 1,550/1,030 gallons 30,000/22,000 cubic feet 1,300/850 cubic feet 220,000/180,000 cubic feet
Explosives		
Explosives, various	Not Available	Max/Avg pounds 750/500

Note 1. The USEPA has issued regulations to implement certain provisions of the American Innovation and Manufacturing Act, to mandate the phasedown of hydrofluorocarbons, which are highly potent greenhouse gases, by 85 percent over a period ending in 2036 (see 86 FR 55116, November 4, 2021).
Source: LLNL 2019p.

A representative listing of chemical inventories in 2018/2019 for Site 300 is presented in Table 4-41. Site 300 operations generally require smaller chemical inventories than the Livermore Site due in part to fewer operations and programs.

Table 4-41. Representative List of Hazardous Chemicals in Use at Site 300

Chemical	Chemical Abstract Number	Maximum/Average Quantity
Paints/Thinners		
Paint (variety)	Not Available	400/225 gallons
Acetone	67-64-1	300/100 gallons
Metals		
Lead bricks or ingots	7439-92-1	60,000/50,000 pounds
Acids/Bases/Oxidizers		
Oxygen, compressed	7782-44-7	6,000/4,000 cubic feet
Sulfuric acid	7664-93-9	1,200/760 pounds
Cyanuric acid	108-80-5	600/400 pounds
Ammonium nitrate	6484-52-2	1,000/500 pounds
Industrial Gases		
Argon, compressed	7440-37-1	10,200/6,800 cubic feet
Helium, compressed	7440-59-7	290,000/193,000 cubic feet
Hydrogen, compressed	1333-74-0	400/240 cubic feet
Nitrogen, compressed	7727-37-9	300,000/185,000 cubic feet
Carbon dioxide	124-38-9	1,000/600 cubic feet
Acetylene	74-86-2	7,500/5,000 cubic feet
Methane	74-82-8	2,000/1,300 cubic feet
Refrigerants		
Freon 22 (chlorodifluoromethane)	75-45-6	11,000/7,000 cubic feet
Freon 12 (dichlorodifluoromethane)	75-71-8	5,000/3,300 cubic feet
Freon 13 (chlorotrifluoromethane)	75-72-9	2,500/1,650 cubic feet
Explosives		
High explosives, various	Not Available	70,000/60,000 pounds

Source: LLNL 2019t.

Explosive Materials

As described in Chapter 2, LLNL uses explosives in various R&D and test applications. These applications involve a wide range of activities including synthesis and formulation, characterizations, and machining as well as detonations. Most of this work is performed within the controlled-access area that is Site 300, but multiple facilities within the Livermore Site include explosives in their inventory of hazardous materials. However, the Livermore Site has inventories or administrative limits for explosives that are low in comparison to quantities managed in Site 300 facilities.

LLNL uses a comprehensive explosives safety program to manage explosives, with DOE Explosives Safety Standard (DOE-STD-1212) as the controlling document (LLNL 2018c). The program uses the internationally recognized United Nations hazard classification system for classifying explosives materials and components as does the U.S. Department of Defense and USDOT. This classification system is used for activities such as labeling, storage, transportation, facility siting, and weight limits (LLNL 2018c). Another major component of the explosive safety program is the LLNL Explosives Safety Committee, an institutional committee with approval authority for a variety of LLNL's programmatic activities (e.g., the development of explosives programs, initial classification and reclassification of explosives, and developing and administering training) and an advisory role to organizations that conduct the activities. In both roles, the LLNL Explosives Safety Committee has a primary objective to ensure that operations are conducted safely (LLNL 2018c). All work with explosives within LLNL must be reviewed and approved through an appropriate work control document.

LLNL's management of explosives also includes its own facility-based inventory control system. It is required for both storage magazines (designed and designated for long-term storage of explosives or ammunition) and service magazines (an auxiliary building or suitable designated room [vault] for intermediate storage in support of operations) where materials cannot be stored for longer than 180 days. A running inventory is to be maintained for each magazine, updated at a minimum of every three months for service magazines and annually for storage magazines. Storage locations and explosives containers are also to be inspected at least once a year to ensure continued safe storage (LLNL 2018c).

Onsite Receipt and Distribution

All hazardous materials coming to the Livermore Site from commercial vendors or other DOE sites are received at Building 411, Shipping/Receiving, by the Receiving Section of the Supply Chain Management Department. Radioactive materials are generally received at Building 411 and then transferred to the Building 231 Vault or the Materials Management Vaults and Transportation Group (V&TG) Operational area, unless prior arrangements have been made with V&TG and appropriate authorizations have been obtained allowing the radioactive materials to be delivered directly to the LLNL designated facility. Explosives from commercial vendors or other DOE sites are not received at the Livermore Site; rather they are received at Site 300 (LLNL 2017e). Explosives shipments going to, or coming from Site 300 go through Building 191, the High Explosives Applications Facility (LLNL 2008b).

Chemicals going to Site 300 are received at Building 876, Stores and Reclamation, where applicable inventory information is also entered into the ChemTrack database. Radiological materials going to Site 300 are received at Building 832, HE Storage Facility, and subsequently transferred to the designated facility by the Materials Management Controlled Materials Group (CMG). Explosive materials from offsite vendors or DOE contractors are also received at Building 832 for processing by CMG. In some cases, CMG may determine that a shipment's processing should be done at another facility. Explosives from the Livermore Site are delivered to Building 832 or to the authorized destination facility (LLNL 2017f, 2008b).

4.13.6.3 *Nonhazardous Materials*

Nonhazardous materials delivered to LLNL are received at the same locations described above for deliveries of hazardous chemicals. Inbound shipments of nonhazardous materials to the Livermore Site, meeting applicable USDOT requirements, are received at Building 411. After receipt, the unopened shipment continues on to its designated facility (LLNL 2017e). Nonhazardous materials going to Site 300, and meeting USDOT requirements, are received at Building 876. After being received, each shipment continues on to its designated facility (LLNL 2017f).

4.13.6.4 *Excess Properties Salvage and Reclamation*

LLNL property items determined to be excess and verified to meet requirements for unrestricted release are:

- Donated to interested state agencies, federal agencies, or universities;
- Redeployed to other on-site users; or
- Released to LLNL's Donation, Utilization and Sales group.

Property with residual radioactivity above limits set in DOE Order 458.1 is not released to the public. Written procedures are in place that require a process knowledge evaluation to be conducted to verify the property has not been contaminated or activated, or that it be surveyed prior to being released to the public. In some cases, both the process knowledge evaluation and the survey are performed. If property is determined to have residual radioactivity above the DOE Order 458.1 limits, it is either transferred to other DOE facilities for reuse or transferred to RHWM for disposal as radioactive waste (LLNL 2020r).

4.14 HUMAN HEALTH AND SAFETY

In accordance with DOE Order 450.2 and DOE Order 440.1B NNSA and LLNL are required to operate in a manner that protects the health and safety of workers and the public, preserves the quality of the environment, and prevents property damage. ES&H is a priority consideration in the planning and execution of all work activities at LLNL. DOE Order 452.3 requires LLNL to comply with applicable ES&H laws, regulations, and requirements and with directives promulgated by DOE/NNSA regarding occupational safety and health. Operations at LLNL are conducted in accordance with an Integrated Safety Management System (ISMS) and EMS, an Operational Health and Safety Management System (OHSMS), a Worker Safety and Health Program, and Work Planning and Control (WP&C). These systems protect the health and safety of workers and the public, preserve the quality of the environment, and prevent property damage. The ISMS, OHSMS, Worker Safety and Health Program, and WP&C minimize the occurrence and mitigates the consequences of worker impacts by identifying and analyzing potential hazards during the planning stages of work activities. Site workers conduct work in accordance with established site-wide and project-specific programs. The EMS provides a framework that integrates environmental protection into all work planning processes. LLNL established its EMS to meet the requirements of the International Organization for Standardization (ISO) 14001:1996 in June 2004 and has remained certified since that time, updating to revised standards in June 2006 (14001:2004) and May 2018 (14001:2015). Every three years LLNL identifies, documents, and updates its environmental aspects and each year plans actions to address the most significant aspects identified (LLNL 2019f).

LLNL's ISMS, EMS, and OHSMS are periodically audited by external, independent third-party organizations. In addition, LLNL performs internal assessments and reviews. As a result of these audits/reviews, specific practices and recommendations for corrective and preventive measures are identified and implemented, demonstrating the Laboratory's commitment to environmental compliance (LLNL 2019f).

The success of these systems and programs is evidenced by LLNL's certification to the ISO 14001:2015 and ISO 45001:2018 standards, coupled with a consistent record of good environmental stewardship and compliance. The combination of surveillance and effluent monitoring, source characterization, and dose assessment show that the radiological dose to the hypothetical, maximally exposed member of the public from LLNL over the past five years was substantially less than the dose from natural background. Potential dose to biota was well below DOE screening limits. LLNL complied with permit conditions for releases to air and to water, and analytical results and evaluations of air and various waters potentially impacted showed minimal contributions from LLNL operations. Remediation efforts at both the Livermore Site and Site 300 further reduced concentrations of contaminants of concern in groundwater and soil vapor (LLNL 2019f).

Current activities associated with routine operations at LLNL have the potential to affect worker and public health. Air emissions at LLNL can lead to exposure to radioactive and nonradioactive materials. Liquid effluents discharged into nearby waterbodies may affect downstream populations using the water for drinking or recreation. Additionally, workers are exposed to occupational hazards similar to those experienced at most industrial work sites. Monitoring of materials released from LLNL and environmental monitoring and surveillance on and around the site are discussed in Sections 4.5 and 4.6 of this SWEIS. This section characterizes the human health impacts from current releases of radioactive and nonradioactive materials at LLNL. It is against this baseline that the potential incremental and cumulative impacts associated with the alternatives are compared and evaluated.

4.14.1 Public Health

4.14.1.1 *Radiological*

Table 4-42 shows the major sources and levels of background radiation doses to an average individual in the U.S. population. Background radiation in the environment is attributed to naturally occurring radiation such as cosmic radiation from space and terrestrial gamma radiation from radionuclides naturally in the environment, including radon. In addition, members of the

U.S. population receive radiation doses from medical and dental uses of radiation and from man-made products. These sources and background radiation doses are unrelated to LLNL operations. Table 4-42 also shows the doses that the collective population around LLNL receives from these background sources, based on the assumption that individuals in the vicinity of LLNL receive the same dose as those to an average individual in the U.S. population. Annual background radiation doses to individuals are expected to remain constant over time.

Table 4-42. Background Radiation Exposure Unrelated to LLNL Operations

Source[a]	Individual Dose[b] (millirem per year)	Collective Dose[c] (person-rem per year)
Natural Background Radiation[d]		
Cosmic radiation	33	257,000
Terrestrial radiation	21	164,000
Internal (food and water consumption)	29	226,000
Radon and Thoron in homes (inhaled)	228	1,780,000
Other Background Radiation		
Diagnostic x-rays and nuclear medicine	300	2,340,000
Consumer products	13	101,000
Industrial plus occupational	0.8	6,240
Total	**625**	**4,874,240**

a. From National Council on Radiation Protection and Measurements, Report No. 160, Table 8.1 (NCRP 2009).
b. This dose is an average over the U.S. population.
c. The collective dose is the combined dose for all individuals residing within a 50-mile radius of the Livermore Site (approximately 7.8 million people [LLNL 2019f]).
d. These values vary with location.
Source: LLNL 2019f.

Releases of radionuclides to the environment from LLNL operations are another source of radiation exposure to individuals in the vicinity of LLNL. The environment potentially affected by radiological site releases includes air, water, and soil. These transport pathways (the environmental medium through which a contaminant moves) require an associated exposure pathway (e.g., inhaling air, drinking water, or dermal contact with soil) to affect human health. The specific resource sections in this LLNL SWEIS (e.g., air quality and water) describe the existing conditions of the environmental media. A radiation dose is calculated to determine the health impact from exposure to radiation. Health impacts (latent cancer fatalities [LCFs]) are calculated from the risk factor of 0.0006 LCF to the general population expected per rem (or person-rem) of radiation dose (DOE 2003). Table 4-43 provides the various exposure limits set for exposure pathways by DOE and the USEPA for radiation workers and members of the public.

Radiation Dose Measurement

In this SWEIS, radiation doses are measured in units of either “person-rem” or “rem.”

Person-rem is used to measure the total collective radiation dose for a group of people. To determine the population dose, this SWEIS sums up the individual dose of every person within a 50-mile radius of the Livermore Site. Statistically, approximately 1,667 person-rem would result in one LCF.

Rem is used to measure the radiation dose for a single individual. Individual doses are converted to LCFs by multiplying the dose by 0.0006. For example, an individual who receives a dose of 1.5 rem would have a 0.0009 chance of developing an LCF.

Table 4-43. Exposure Limits for Members of the Public and Radiation Workers

Guidance Criteria (organization)	Public Exposure Limit at the Site Boundary	Worker Exposure Limit
10 CFR Part 835 (DOE)	--	5,000 millirem per year [a,b]
DOE Order 458.1 (DOE) [c]	10 millirem per year (all air pathways) 4 millirem per year (drinking water pathways) 100 millirem per year (all pathways)	--
40 CFR Part 61 (USEPA)	10 millirem per year (all air pathways)	--
40 CFR Part 141 (USEPA)	4 millirem per year (drinking water pathways)	--

DOE = U.S. Department of Energy; USEPA = U.S. Environmental Protection Agency; N/A = not applicable.

a. Although this is a limit (or level) that is enforced by DOE, worker doses must be managed in accordance with ALARA principles. Refer to footnote b.

b. The regulatory dose limit for an individual worker is 5,000 millirem/year (10 CFR Part 835). At LLNL, administrative control levels are multi-tiered, meaning they can vary between 500 millirem/year and up to 5,000 millirem/year with appropriate management approval (LLNL 2019c).

c. Derived from 40 CFR Part 61, 40 CFR Part 141, and 10 CFR Part 20.

Table 4-44 presents the annual exposures to the public from LLNL emissions of radioactive materials to the air from 2015 to 2019. Doses are presented for a MEI[6] and the population within a 50-mile radius of the Livermore Site and Site 300 (Figure 4-92 and Figure 4-93, respectively, for the location of the MEIs). These doses fall within radiological limits presented in Table 4-43 and are much lower than the background radiation dose presented in Table 4-42.

Table 4-44. Annual Radiation Exposures to Public from LLNL Operations (2015–2019)

Members of the Public	Year	Livermore Site	Site 300	Total
MEI (millirem)	2015	1.7×10^{-3}	4.8×10^{-4}	N/A[a]
	2016	2.8×10^{-3}	2.2×10^{-4}	N/A[a]
	2017	1.9×10^{-3}	4.8×10^{-5}	N/A[a]
	2018	6.7×10^{-3}	9.6×10^{-5}	N/A[a]
	2019	4.3×10^{-3}	9.5×10^{-8}	N/A[a]
	2015–2019 Average	$\mathbf{3.5\times10^{-3}}$	$\mathbf{1.7\times10^{-4}}$	**N/A[a]**
Population within 50 miles (person-rem)[b]	2015	0.13	2.4×10^{-5}	0.13[c]
	2016	0.22	3.0×10^{-5}	0.22[c]
	2017	0.13	7.2×10^{-5}	0.13[c]
	2018	0.47	2.8×10^{-5}	0.47[c]
	2019	0.33	2.9×10^{-5}	0.33[c]
	2015–2019 Average	**0.26**	$\mathbf{3.7\times10^{-5}}$	**0.26[c]**
Average annual dose to a person within 50 miles (millirem)	2015	1.7×10^{-5}	1.0×10^{-8}	1.7×10^{-5}
	2016	2.8×10^{-5}	4.2×10^{-9}	2.8×10^{-5}
	2017	1.7×10^{-5}	1.0×10^{-8}	1.7×10^{-5}
	2018	6.0×10^{-5}	3.0×10^{-9}	6.0×10^{-5}
	2019	4.2×10^{-5}	4.1×10^{-9}	4.2×10^{-5}
	2015–2019 Average	$\mathbf{3.3\times10^{-5}}$	$\mathbf{6.3\times10^{-9}}$	$\mathbf{3.3\times10^{-5}}$

MEI = site-wide maximally exposed individual member of the public.

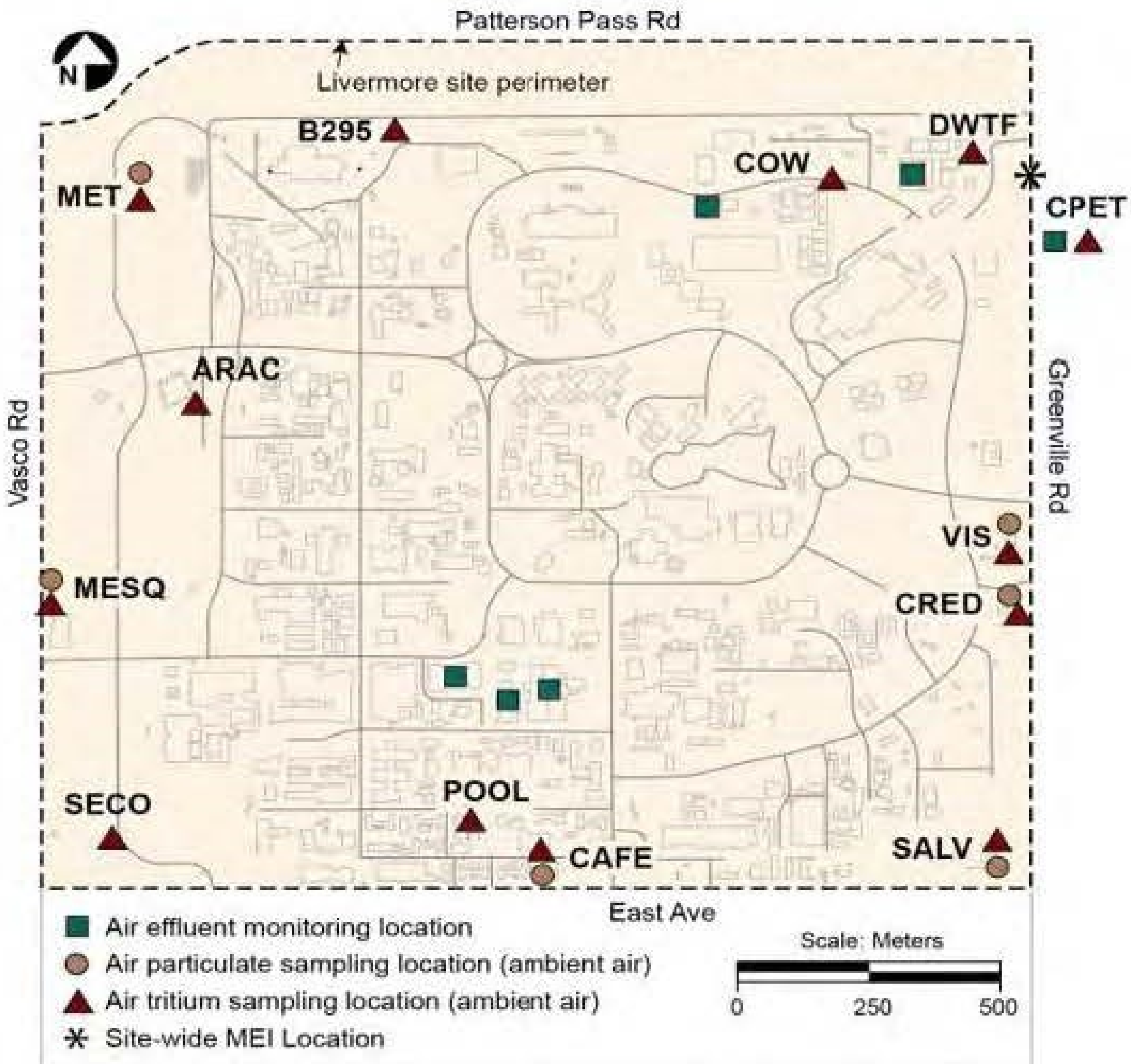
a. MEI at Livermore Site and Site 300 are different people; therefore, their doses are not additive. If the MEI were additive, the MEI dose for the Livermore Site would account for approximately 97 percent of the combined dose.

b. The population dose is the combined dose for all individuals residing within a 50-mile radius of LLNL (approximately 7.8 million people for the Livermore Site and 7.1 million for Site 300), calculated with respect to distance and direction from each site.

[6] The MEI is a hypothetical individual located offsite who could potentially receive the maximum dose of radiation. In 2018, the MEI at the Livermore Site was located at the Integrative Veterinary Care facility, just under a quarter mile outside the site's eastern perimeter. The MEI at Site 300 was located on the site's south-central perimeter, which borders the CSVRA.

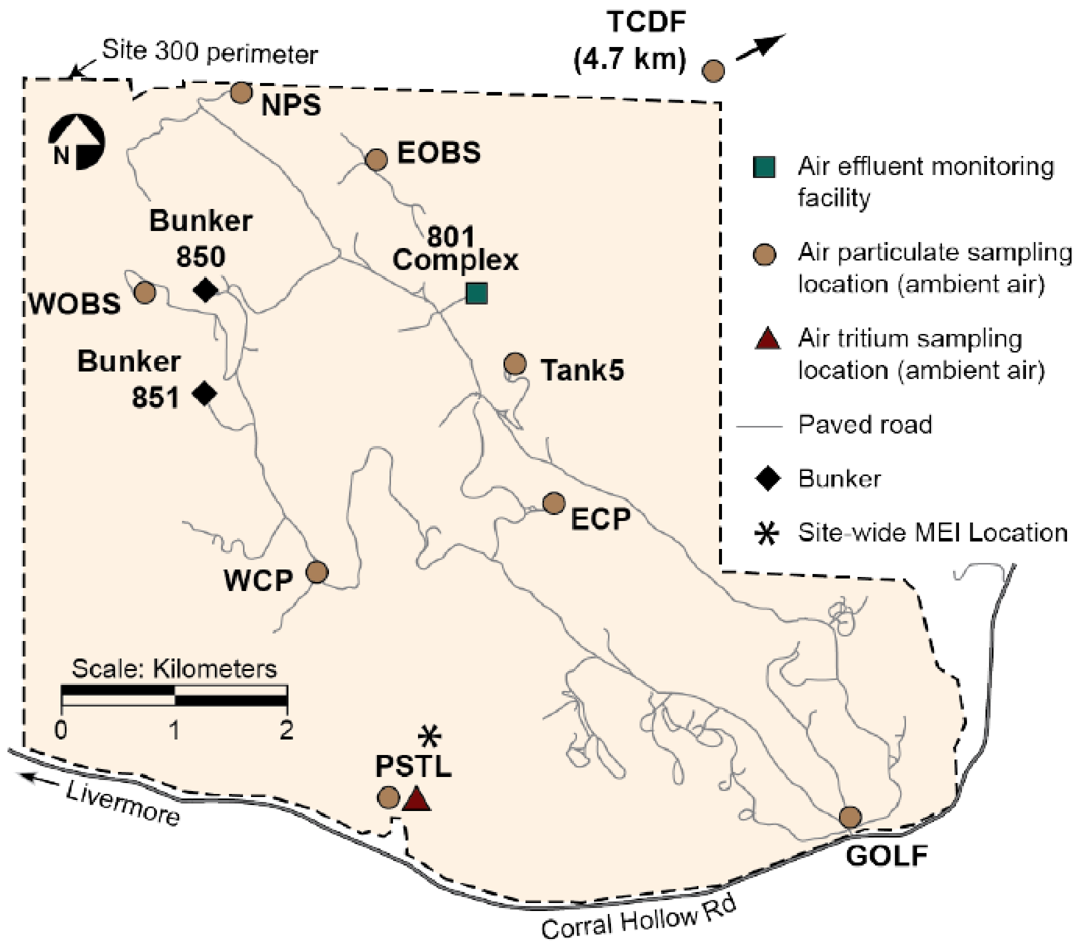
c. Although the 50-mile population surrounding the Livermore Site and Site 300 are different, the population dose from Site 300 is insignificant compared to the population dose from the Livermore Site; therefore, the total population dose equals the population dose for the Livermore Site.

Source: LLNL 2016b, 2017d, 2018a, 2019f, 2020r.



Source: LLNL 2019f.

Figure 4-92. Location of the MEI at the Livermore Site



Source: LLNL 2019f.

Figure 4-93. Location of the MEI at Site 300

Based on the information presented in Table 4-44, the risk of the hypothetical site-wide MEI member of the public developing an LCF from exposure to Livermore Site radiological air emissions would be a maximum of 2.1×10^{-9} (or about 1 chance in 500 million).[7] The projected number of LCFs to the population within a 50-mile radius of the Livermore Site would be a maximum of 1.6×10^{-4} (or about 1 chance in about 6,400).[8] For perspective, this number may be compared with the number of fatal cancers expected in the same population from all causes. The average annual mortality rate associated with cancer for the entire U.S. population from 2012 through 2016 (the last five years for which final data are available) was 161 per 100,000 people (USCSWG 2019).[9] Based on this national mortality rate, the number of fatal cancers that would be expected to occur in 2018 in the population of approximately 7.8 million people living within 50 miles of LLNL is 12,558.

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[7] In 2018, the risk of an LCF to the MEI at Site 300 is approximately 100 times less than at the Livermore Site.

[8] In 2018, the number of LCFs for the 50-mile population of Site 300 is approximately 6,300 times less than the Livermore Site.

[9] The number of cancer deaths was 163.5 per 100,000 men and women per year (based on 2011–2015 deaths) (NCI 2018). In 2016, the latest year for which incidence data are available, for every 100,000 people, 156 died of cancer (USCSWG 2019).

As shown in Table 4-44, the annual radiological doses from the Livermore Site and Site 300 are well below the applicable standards for radiation protection of the public. The doses to the site-wide MEIs resulting from Livermore Site and Site 300 operations are less than one percent of the NESHAPs (10 millirem/year) standard. For all five years, the measured radionuclide particulate and tritium concentrations in ambient air at the Livermore Site and Site 300 were all less than one percent of the DOE primary radiation protection standard for the public (LLNL 2016b, 2017d, 2018a, 2019f, 2020r). The MEI doses from both the Livermore Site and Site 300 are much less than one-tenth of one percent of the total dose from sources of natural radioactivity shown in Table 4-42.

4.14.1.2 *Nonradiological*

The background chemical environment important to human health consists of the atmosphere, which may contain hazardous chemicals that can be inhaled; drinking water, which may contain hazardous chemicals that can be ingested; and other environmental media through which people may come in contact with hazardous chemicals (e.g., surface water during swimming or food through ingestion). Hazardous chemicals can cause cancer and noncancerous health effects. Sections 4.5 and 4.6 of this SWEIS present the baseline data for assessing potential health impacts from the chemical environment.

Effective administrative and design controls that decrease hazardous chemical releases to the environment and help achieve compliance with permit requirements (e.g., via NESHAP and NPDES permits) contribute to minimizing health impacts on the public. The effectiveness of these controls is verified through the use of environmental monitoring information and inspection of mitigation measures. Health impacts on the public may occur through inhalation of air containing hazardous chemicals released to the atmosphere during normal LLNL operations. Risks to public health from other pathways, such as ingestion of contaminated drinking water or direct exposure, are lower than those from inhalation (LLNL 2016b, 2017d, 2018a, 2019f, 2020r).

Section 4.6 of this SWEIS addresses the baseline air emission concentrations and applicable standards for hazardous chemicals. The baseline concentrations are estimates of the highest existing offsite concentrations and represent the highest concentrations to which members of the public could be exposed. These concentrations are in compliance with applicable guidelines and regulations.

Beryllium metal, alloys, and compounds are used at LLNL. Although LLNL is not a major facility in terms of hazardous air pollutant emission rates, specific NESHAP requirements (40 CFR Part 61[c]) apply for beryllium. Beryllium is identified with respiratory and immune system toxicity and is regulated under both state and federal programs. Beryllium is the only nonradiological emission from LLNL that is monitored in ambient air. LLNL requested and was granted a waiver by the BAAQMD for source-specific monitoring and recordkeeping for beryllium operations, provided that LLNL can demonstrate that monthly average beryllium concentrations in air are well below regulatory limits of 10,000 picograms per cubic meter (pg/m^3). LLNL meets this requirement by sampling biweekly for a monthly composite sample for airborne beryllium at perimeter locations at the Livermore Site and Site 300. The highest value recorded at the Livermore Site perimeter in 2015–2019 for airborne beryllium was 62 pg/m^3. This value is 0.62

percent of the BAAQMD ambient concentration limit for beryllium (10,000 pg/m^3) (LLNL 2016b, 2017d, 2018a, 2019f, 2020r).

There is no regulatory requirement to monitor beryllium in San Joaquin County; however, LLNL analyzes samples from three Site 300 perimeter locations as a BMP. The highest value recorded at the Site 300 perimeter in 2018 was 22 pg/m^3. These data are similar to data collected from previous years. Beryllium is naturally occurring and has a soil concentration of approximately 1 part per million. The sampled results are believed to be from naturally occurring beryllium that was resuspended from the soil and collected by the samplers. Even if the concentrations of beryllium detected were from LLNL activities, the amount is still less than one percent of the BAAQMD ambient air concentration limit (LLNL 2019f).

4.14.1.3 *Cancer Incidences*

The National Cancer Institute publishes national, state, and county incidence rates of various types of cancer (NCI 2019). However, the published information does not provide an association of these rates with their causes, (e.g., specific facility operations and human lifestyles). Table 4-45 presents incidence rates for the United States, California, and the five counties surrounding LLNL (Alameda County, San Joaquin County, Stanislaus County, Santa Clara County, and Contra Costa County). As shown in Table 4-45, cancer incident rates in Alameda County and San Joaquin County (the two counties in which the Livermore Site and Site 300 are located), are generally less than the cancer incident rates in California and the United States.

Table 4-45. Cancer Incidence Rates[a] for the United States, California, and Counties Adjacent to LLNL (2012–2016)

Location	All Cancers	Thyroid	Breast	Lung and Bronchus	Leukemia	Prostate	Colon and Rectum
United States	**448.0**	**14.5**	**125.2**	**59.2**	**14.1**	**93.8**	**38.7**
California	**404.8**	**13.0**	**121.0**	**42.1**	**12.6**	**104.1**	**35.5**
Alameda County[b]	392.8	10.4	120.9	41.5	11.7	95.7	34.5
San Joaquin County[c]	413.2	12.7	117.7	51.7	12.3	88.0	36.9
Stanislaus County	416.5	12.6	117.1	48.7	11.6	82.2	39.2
Santa Clara County	390.4	12.3	121.5	39.3	12.2	90.4	33.0
Contra Costa County	427.0	12.3	128.4	42.7	12.9	108.4	37.1

a. Age-adjusted incidence rates; cases per 100,000 persons per year.
b. Livermore Site is located primarily in Alameda County.
c. Site 300 is located in Alameda County and San Joaquin County.
Source: NCI 2019.

4.14.2 Worker Health

Each employee at LLNL, from Director to laboratory worker, is required to know and understand the ES&H requirements of his or her assignment, the potential hazards in the work area, and the controls necessary for working safely. Employees must participate in all required ES&H training and health monitoring programs. All work assignments must be performed in full compliance with applicable ES&H requirements as published in LLNL manuals and guidelines and established in safety procedures. All employees are responsible for working in a manner that produces high-quality results, preserves environmental quality, and protects the health and safety of workers and members of the public.

The LLNL ISMS addresses the identification of workplace hazards, control measures, safe work practices, and feedback and continuous improvement functions necessary to perform work safely at LLNL. This program articulates the institutional requirements for all LLNL operations, whether at the Livermore Site, Site 300, or at any other sites where LLNL personnel and contractors are working.

When the LLNL mission is fulfilled through collaborations, both onsite and offsite, potential impacts could also include worker exposure to electrical, low-level radiological, and transportation hazards. However, work activities would be performed in accordance with federal and state regulations, and the personnel safety exposures to radiological sources would be maintained as low as reasonably achievable (ALARA). Additionally, offsite transport of sealed sources would be performed in accordance with Department of Transportation (DOT) regulations, as well as LLNL procedures, including the Transportation Safety Manual.

Title 10, Code of Federal Regulations (CFR), Part 835 (10 CFR 835) establishes radiation protection standards, limits, and program requirements for protecting workers from ionizing radiation resulting from the conduct of DOE activities and requires DOE contractors to develop and maintain a DOE-approved Radiation Protection Program (RPP). LLNL has a single RPP, which governs radiological activities at the Livermore Site, Site 300, and off-site locations. As noted in the RPP, LLNL's radiological support operations may include, when requested by DOE, support of offsite activities or events involving radiation-generating devices and sealed radioactive sources.

Additionally, DOE Order 458.1 establishes requirements to protect the public and the environment against undue risk from radiation associated with DOE conducted radiological activities. Public radiological doses at the Livermore Site and Site 300, as well as for offsite DOE/NNSA directed activities, are reported in the LLNL Site Annual Environmental Report (SAER). Radiological doses generated by these operations are consistently found to be well below the applicable standards for radiation protection of the public.

In 2013, LLNS began developing a new WP&C process featuring a computer-based tool and a task-based hazard analysis process. LLNS designed the new process for implementation across the laboratory for all work activities (i.e., research and laboratory, maintenance, service provider, and subcontracted work). The WP&C process integrates input from safety and health subject matter experts using established protocols to identify hazards. LLNS industrial hygienists use a well-developed and systematic risk assessment approach to identify industrial hygiene hazards, assess the risk of exposure, and establish the level of control necessary to reduce exposure risk to an acceptable level (DOE 2020a).

4.14.2.1 *Radiological*

LLNL workers receive the same dose as the general public from background radiation, but also receive an additional dose from working in facilities with nuclear and radiological materials and RGDs. Table 4-46 presents the annual average individual and collective worker doses from LLNL operations from 2015 to 2019. These doses fall within the regulatory limits presented in Table 4-43. Using the risk estimator of 0.0006 LCF per 1 person-rem, the annual average LCF risk to a representative member of the LLNL workforce due to radiological releases and direct radiation exposure from LLNL operations from 2015 to 2019 is estimated to be 4.2×10^{-5}. That is, the estimated probability of a worker developing a fatal cancer at some point in the future from radiation exposure associated with one year of LLNL operations is about 1 in 24,000. No excess fatal cancers are projected in the total worker population from one year of normal operations during the period 2014–2018.

Table 4-46. Radiation Doses to LLNL Workers from Operations (2015–2019)

Occupational Personnel	From Outside Releases and Direct Radiation by Year					
	2015	2016	2017	2018	2019	Average
Number of workers receiving a measurable dose	105	98	115	145	152	123
Total (collective) worker dose (person-rem)	7.57	8.215	7.134	8.691[b]	10.648[b]	8.45
Average radiation worker (millirem)[a]	72.1	83.8	62.0	59.9	70.0	69.6

a. No standard is specified for an "average radiation worker"; however, the maximum dose to a worker is limited as follows: the radiological limit for an individual worker is 5,000 millirem per year (10 CFR Part 835). However, DOE's goal is to maintain radiological exposure as low as reasonably achievable. At LLNL, administrative control levels are multi-tiered, meaning they can vary between 500 millirem/year and up to 5,000 millirem/year with appropriate management approval (LLNL 2019c)
b. The small number of workers with measurable dose below 0.01 are included with the workers not receiving a measurable dose in the totals in 2018. (*See* also footnote "a" in Table 4-47.)
Source: DOE 2021b.

Table 4-47 presents the worker dose distribution of annual radiation doses (external + internal) received by LLNL workers for the recent five-year period 2015–2019. As shown in Table 4-47, only two workers received a dose greater than 500 millirem during 2019. Most worker doses were less than 10 millirem. LLNL provides data to DOE for occupational radiation exposure reports every year. Often times, LLNL will provide updates to previous years' data, revising such values. As a result, there may be slight differences in Tables 4-46 and 4-47 regarding the number of workers who received measurable doses. For example, Table 4-46 shows that 145 workers received a measurable dose in 2018, while Table 4-47 shows that 128 workers received a measurable dose in 2018.

Table 4-47. Distribution of Worker Doses (2015–2019)

Dose Range (rem)	Number of Workers				
	2015	2016	2017	2018[a]	2019
≥2	0	0	0	0	0
1.5–1.999	0	0	0	0	0
1.000–1.499	1	1	0	0	0
0.5–0.999	1	2	3	2	2
0.1–0.499	15	12	9	15	20
0.01–0.099	77	53	79	111	115
<0.01	7,196	7,784	7,209	2,769[a]	2,868

a. In July 2017, LLNL changed its dosimetry issue policy from universal issuance to targeted issuance; consequently, the number of monitored workers in 2018 dropped considerably from prior years.
Source: LLNL 2019ab.

4.14.2.2 *Nonradiological*

LLNL is a research site in which a large variety of hazardous materials are used. LLNL operations represent a potential for exposure of some workers to hazardous materials (such as solvents, metals, and carcinogens). Typically, operations are controlled through specific WP&C documents so that those workers may be exposed to low levels of a wide variety of chemicals that are below a threshold of concern throughout the duration of their research.

Workers are provided with information and training on identified hazards and follow requirements in specific WP&C documents to protect them and minimize hazards and exposures. LLNL has several programs and procedures in place to provide direction for monitoring, handling, storing, and using these materials. These programs and safety procedures include the Hazard Communication Program, Chemical Hygiene Program, Respiratory Protection Program, and written safety procedures (such as the WP&C documents) for the handling and use of carcinogens and biohazard materials. Work activities are periodically monitored with measurements performed at personal breathing zones and general work areas. ES&H monitoring records indicate that personnel exposure to hazardous materials is maintained well below established regulatory requirements and exposure guidelines (LLNL 2017d, 2018a, 2019f).

Biohazards. Biological operations at LLNL include using and safely handling biohazardous materials, agents, or their components (e.g., microbial agents, bloodborne pathogens, recombinant deoxyribonucleic acid, and human or primate cell cultures), and research proposals and activities concerning animal or human subjects. Biological materials can cause illness and infection. Examples of potential sources of exposure to biological hazards are as follows:

- Human fluids, secretions, or feces
- Class II and III etiologic agents
- Infectious agents from animal infestation or droppings
- Biological toxins
- Human cell and tissue culture systems
- Research involving animals
- Research involving allergens of biological origin (e.g., certain plants and animal products, danders, urine, and some enzymes)
- Laundry soiled with blood or other potentially infectious materials
- Contaminated sharps
- Unfixed human tissues or organs

Personnel exposure to biological hazards is minimized by use of administrative controls, engineered controls, and personal protective equipment. By analyzing the hazards for each specific operation, LLNL personnel develop and implement the appropriate controls to protect themselves, the community, and the environment from potential exposure.

Carcinogens. Carcinogens are only used in LLNL operations when it is not possible to use a noncarcinogenic material. Any use of carcinogens requires stringent controls to be in place to prevent exposures to workers, the public, and the environment. Examples of operations where carcinogenic materials may be encountered include:

- Work with cadmium-containing alloys
- Work that generates or involves contact with soot and tar
- Use of mineral oil products that may contain polyaromatic hydrocarbons
- Electric arc discharge machining
- Discharging of gas propellants in a vacuum
- Handling refractory ceramic fibers
- Welding stainless steels (due to the formation of hexavalent chromium compounds and nickel oxide)
- Chromium plating and other operations that disperse hexavalent chromium compounds or irritatingly strong concentrations of sulfuric acid into the air
- Generating hardwood dust, including carpentry and cabinet-making activities
- Spraying hexavalent chromium compounds, including, but not limited to, primers, paints, and sealants containing barium, calcium, sodium, strontium, or zinc chromate
- Handling inorganic arsenic compounds and arsenic metal, including gallium arsenide, in a manner that can result in exposure to arsenic
- Handling animals in research activities involving carcinogens
- Using or synthesizing carcinogens in laser chemistry or biochemistry laboratories
- Using asbestos, beryllium, laser dyes, or lead and lead compounds

At LLNL, employees use chemical carcinogens only when required by a specific research project. As described above, the LLNL programs and safety procedures, including the Chemical Hygiene Plan and the ES&H Manual (LLNL 2019x) outline requirements for the safe handling and use of carcinogenic materials. The program addresses control and storage of chemicals, work plan preparation, worker safety, personnel protective measures, engineering controls, and waste management. Worker exposures to certain hazardous materials are monitored by industrial hygiene staff and tracked using an occupational exposure database and the WP&C program. Likewise, personnel may be monitored for certain chemical agents by way of routine medical examinations performed by the LLNL Health Services Department. All employees who work with carcinogens must receive sufficient information and training so that they may work safely and understand the relative significance of the potential hazard they may encounter.

Special Illness Prevention Program. Site 300 workers and visitors face the potential of contracting coccidioidomycosis, a respiratory disease commonly known as Valley Fever, caused by the fungus *Coccidioides immitis*. The disease is common in warm, dry, alkaline areas including the entire San Joaquin Valley. Coccidioidomycosis is acquired from the inhalation of spores (arthroconidia). Once in the lungs, the arthroconidia transform into spherical cells called "spherules." An acute respiratory infection occurs 7 to 21 days after exposure and typically resolves rapidly. However, the infection may alternatively result in a chronic pulmonary condition or disseminate to the meninges, bones, joints, and subcutaneous and cutaneous tissues. About 25 percent of the patients with disseminated disease have meningitis (DrFungus 2020). The LLNL requires annual Valley Fever awareness training for any individual going to Site 300 as a visitor or worker.

4.14.2.3 *Occupational Injuries*

LLNL's occupational health and safety performance is measured by injury and illness rates (Total Recordable Case [TRC] and Days Away with Restricted Time [DART]) pursuant to DOE orders that use OSHA criteria. As shown on Table 4-48, the TRC rate at LLNL has varied between 0.99 and 1.29 over the past five years; this means that for every 100 workers at LLNL, there is approximately one work-related injury or illness annually that results in either death, days away from work, or days of restricted work activity or job transfer. In 2019, the TRC rate was the lowest in the past five years. DART represents severe injuries per 100 workers annually. As shown in Table 4-48, the DART rate at LLNL has varied between 0.28 and 0.58 over the past five years; this means that for every 100 workers at LLNL, there is less than one work-related severe injury or illness annually that results in days away from work or days of job restriction or transfer.

Table 4-48. Occupational Injury Statistics for LLNL (2015–2019)

Year	TRC Rate[a]	DART Rate[b]	Number of TRCs[c]	DART Cases[d]	Workdays Lost[e]	Number of DART Days[f]
2015	1.02	0.39	45	17	691	1,191
2016	1.22	0.41	57	19	515	1,103
2017	1.19	0.32	59	16	381	1,304
2018	1.29	0.58	64	29	171	1,194
2019	0.99	0.28	53	15	84	616

DART = Days Away, Restricted Time; TRC = Total Recordable Case.

a. TRC Rate: Total Recordable Cases per 200,000 work-hours (approximately 100 person-years).

b. DART Rate: Days Away, Restricted or on Job Transfer per 200,000 work-hours (approximately 100 person-years).

c. Number of TRCs: The total number of work-related injuries or illnesses that resulted in either death, days away from work, days of restricted work activity, or days of job transfer.

d. DART Case: An injury or illness case where the most serious outcome of the case resulted in days away from work or days of job restriction or transfer.

e. Workdays Lost: The number of days away from work (consecutive or not) on which the employee would have worked but could not because of occupational injury or illness.

f. Number of DART days: The total number of work-related injuries or illnesses that resulted in days away from work or days of job restriction or transfer.

Source: DOE 2020b.

During normal operations, LLNL workers may be exposed to hazardous conditions that can cause injury or death. The potential for health impacts varies among facilities and workers. In 2018, work-related injuries included eye exposure to hazardous chemicals while not wearing eye protection, skin burns from flash powder, trips and falls that resulted in wrist/leg/foot fractures, concussions, serious cuts from machining operations, and electric shocks (DOE 2020b). No work-related fatalities occurred at LLNL between 2015 and 2019 (LLNL 2021d).

Workers are protected from workplace hazards through appropriate training, protective equipment, monitoring, materials substitution, and engineering and management controls. Under 10 CFR Part 851, DOE lists the requirements for a worker safety and health program to ensure that DOE contractors and their workers operate a safe workplace. DOE establishes procedures for investigating whether a violation of a requirement of this part has occurred, for determining the nature and extent of any such violation, and for imposing an appropriate remedy. In addition, 10 CFR Part 851 incorporates many OSHA requirements and other protections. Appropriate monitoring that reflects the frequency and quantity of chemicals used in the operational processes ensures that these standards are not exceeded. DOE also requires that conditions in the workplace minimize hazards that cause, or are likely to cause, illness or physical harm.

4.15 ENVIRONMENTAL REMEDIATION

Lawrence Livermore National Laboratory (LLNL) samples and analyzes groundwater from areas of known or suspected contamination. Portions of the two sites where soil or groundwater contains or may contain chemicals of concern are actively investigated to define the hydrogeology, nature, and extent of the contamination and its source. Where necessary, remediation strategies are developed and evaluated through preparation of a Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) removal action or through the CERCLA feasibility study process. An approved remedy for each area is developed in consultation with the regulatory agencies and the community.

The detailed contamination history of LLNL is described in Section 4.17 of the 2005 LLNL SWEIS. Groundwater and soils at both the Livermore Site and Site 300 are contaminated from historical operations. The contamination, for the most part, is confined to each site; however, NNSA acknowledges that some contamination has migrated offsite. Sections 4.4 and 4.5 describe the historical contamination found in soils and groundwater, respectively. This section describes the ongoing remediation activities at LLNL. The status of the ongoing operations is presented for both the Livermore Site (Section 4.15.1) and Site 300 (Section 4.15.2). Section 4.15.3 presents a summary of the major environmental restoration activities/accomplishments since publication of the 2005 LLNL SWEIS. A history of accomplishments on CERCLA projects can be found in the *First through Fifth Five-Year Reviews for the Livermore Site (*LLNL 1997, LLNL 2002c, LLNL 2007d, LLNL 2012b, LLNL 2017h) and in the *2015-2019 Annual Compliance Monitoring Reports for Site 300* (LLNL 2017k, LLNL 2018g, LLNL 2019ac LLNL 2020aa, LLNL 2021e).

4.15.1 Livermore Site

Initial releases of hazardous materials occurred at the Livermore Site in the mid-to-late 1940s during operations at the Livermore Naval Air Station (Thorpe et al. 1990). There is also evidence that localized spills, leaking tanks and impoundments, and landfills contributed volatile organic compounds (VOCs), fuel hydrocarbons, metals, and tritium to the unsaturated zone and groundwater in the post-Navy era. The Livermore Site was placed on the USEPA National Priorities List in 1987. Remedial activities are overseen by the USEPA, the CVRWQCB, and DTSC under the authority of a Federal Facility Agreement (FFA) under CERCLA Section 120 (DOE 1988). The Record of Decision was issued in July 1992 (DOE 1992b).

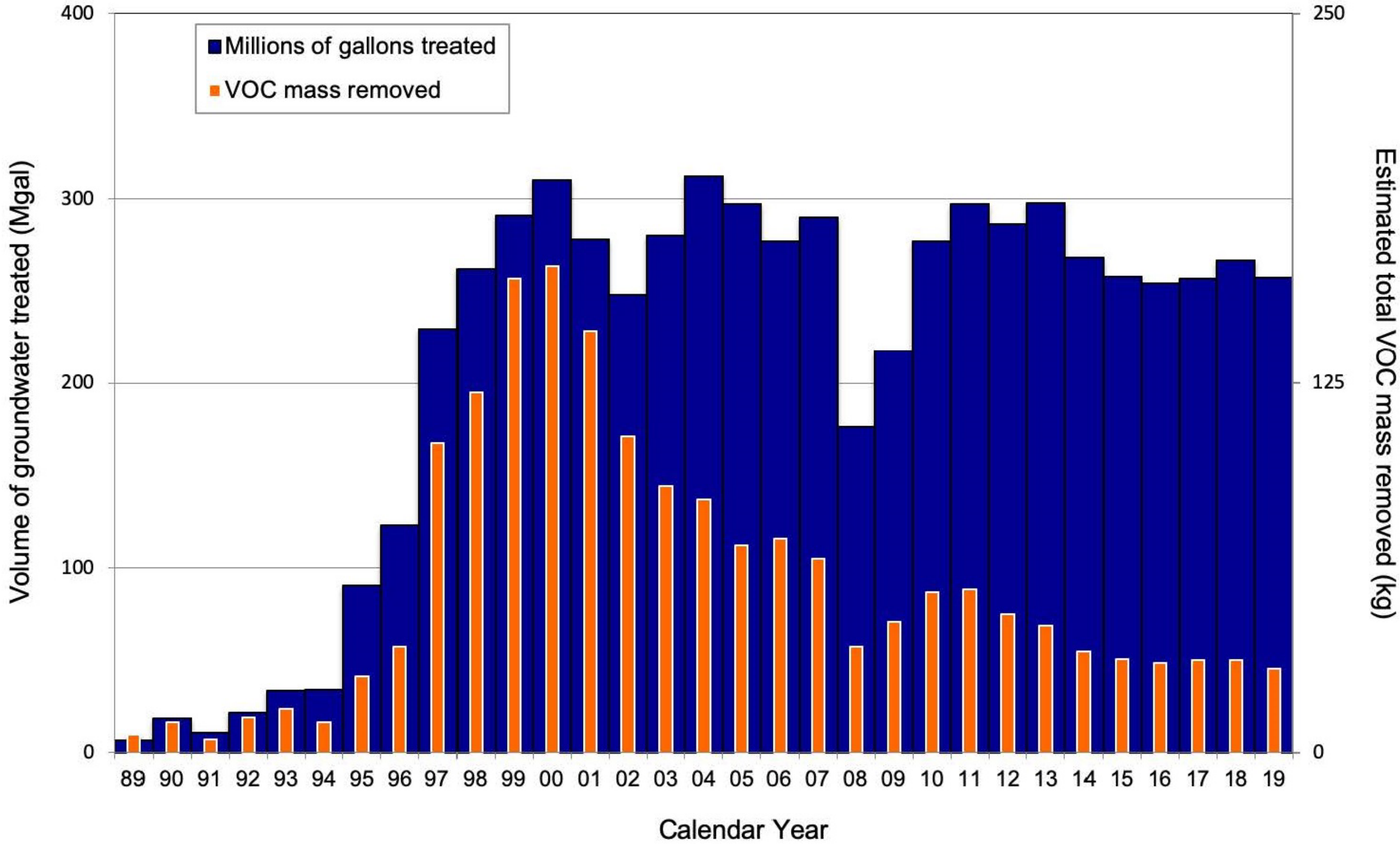
An analysis of all environmental media showed that groundwater and both saturated and unsaturated soils are the only media that require remediation (Thorpe et al. 1990). Compounds that currently exist in groundwater at various locations beneath the site at concentrations above drinking water standards (maximum contaminant level [MCLs]) are trichloroethylene (TCE), tetrachloroethene (PCE), 1,1-dichloroethylene, cis-1,2-dichloroethylene, 1,1-dichloroethane, 1,2-dichloroethane, and carbon tetrachloride. PCE is also present at low concentrations slightly above the MCL in off-site plumes that extend from the southwestern corner of the Livermore Site. LLNL operates groundwater extraction wells in both on-site and off-site areas. In addition, LLNL maintains an extensive network of groundwater monitoring wells in the off-site area west of Vasco Road. Ongoing remedial actions are removing contaminants and monitoring LLNL's progress towards CERLCA cleanup goals. The Livermore Site has had many remedial actions implemented since the ROD was issued in 1992 and is primarily in a "pump and treat" mode with major accomplishments having been successful in the removal of groundwater and soil contaminants.

The Livermore Valley groundwater system consists of several semiconfined aquifers. Rainfall from the surrounding hills and seasonal surface water in the arroyos recharge the groundwater system, which flows toward the east-west axis of the valley. Sediments at the Livermore Site are grouped into four grain-size categories: clay, silt, sand, and gravel. Groundwater flow beneath the site occurs primarily in alluvial sand and gravel deposits, which are bounded by lower permeability clay and silt deposits. The alluvial sediments have been subdivided into nine hydrostratigraphic units (HSUs) beneath the Livermore Site. HSUs are defined as sedimentary sequences whose permeable layers show evidence of being hydraulically interconnected and geochemically similar. Six of the nine HSUs contain contaminants at concentrations above their MCLs: HSU-1B, -2, -3A, -3B, -4, and -5 (Blake et al. 1995; Hoffman et al. 2003). HSU-1A, -6, and -7 do not contain contaminants of concern above action levels. These HSUs are the designations used for all groundwater regulatory remedial activities. Significant progress has been made in contaminant removals from each of these HSUs.

As of 2019, LLNL maintained and operated 27 groundwater treatment facilities. During 2019, the groundwater extraction wells and dual (groundwater and soil vapor) extraction wells produced 973 million L of groundwater and the treatment facilities (TFs) removed about 29 kg of VOCs. Since remediation began in 1989, approximately 24.6 billion L of groundwater have been treated, resulting in removal of more than 1,772 kg of VOCs. Figure 4-94 shows the annual groundwater removals by year through 2019. Additional detailed information concerning flow and mass removal by treatment facility area within each HSU is presented in Noyes et al. (LLNL 2020s). LLNL also maintained and operated eight soil vapor treatment facilities (VTFs) in 2019. During 2019, the soil vapor extraction wells and dual extraction wells produced more than 3.0 million m^3 of soil vapor and the treatment facilities removed approximately 12 kg of VOCs. Since initial operation, nearly 29.1 million m^3 of soil vapor has been extracted and treated, removing more than 1,621 kg of VOCs from the subsurface. Figure 4-95 shows the annual soil VOC removals through 2019. Additional information concerning flow and mass removal by treatment facility area is presented in Noyes et al. (LLNL 2020s). Figure 4-96 shows all the current treatment facilities at the Livermore Site.

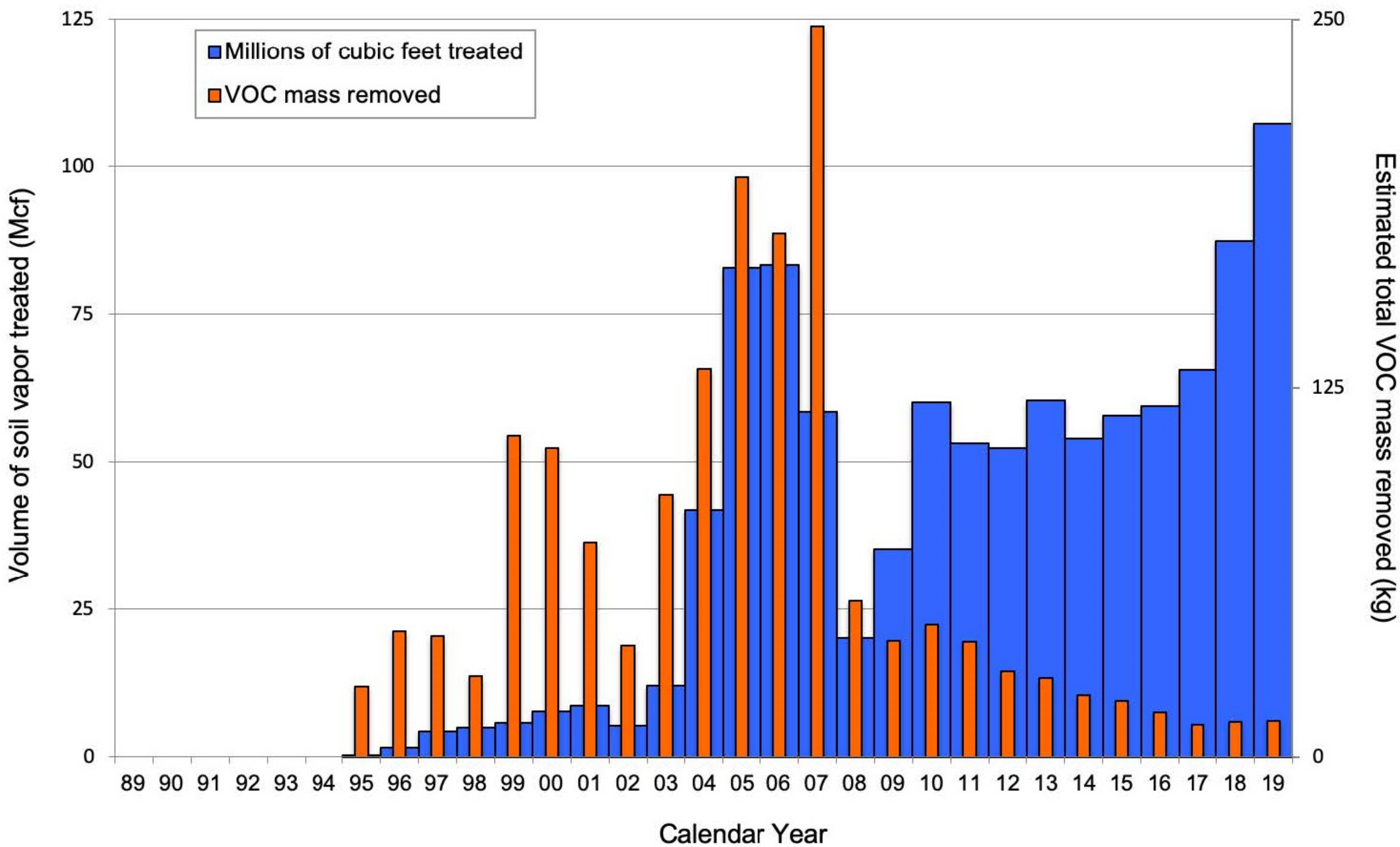
Five treatment facilities remained offline in 2019:

- Vapor Treatment Facility D (VTFD) Helipad
- TF5475-1
- TF5475-3
- VTF5475
- TF518 North



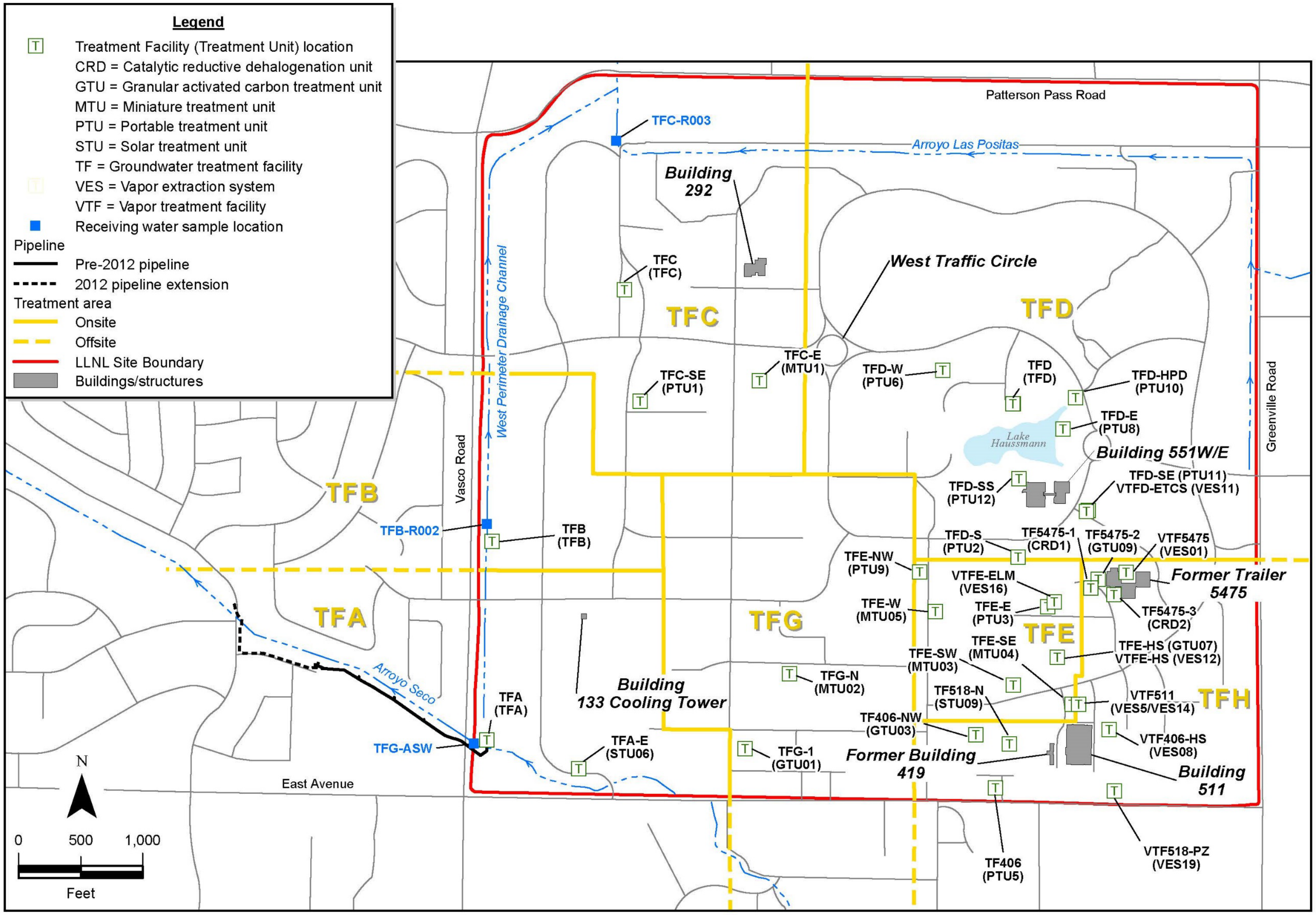
Source: LLNL 2020s.

Figure 4-94. Estimated Total VOC Mass Removed from Livermore Site Groundwater since 1989



Source: LLNL 2020s.

Figure 4-95. Estimated Total VOC Mass Removed from Livermore Site Soil Vapor since 1989



Source: LLNL 2020s.

Figure 4-96. Livermore Site Treatment Areas and Treatment Facility Locations

The VTFD Helipad remained offline in support of the *in situ* bioremediation Enhanced Source Area Remediation (ESAR) treatability test at the TFD Helipad Source area. The four remaining facilities were discussed in *Radioactive Waste Management Basis*, June 2009 (LLNL 2009). With the U.S. EPA concurrence, restart of these four facilities has been deferred, pending the results of ESAR treatability tests. LLNL continues to monitor groundwater for VOCs and tritium. See Noyes et al. (LLNL 2020s) for more detailed information on the Livermore Site groundwater and soil vapor treatment facilities.

Restoration activities in 2019 at the Livermore Site continued to be primarily focused on enhancing and optimizing ongoing operations at treatment facilities, while continuing to evaluate technologies that could be used to accelerate cleanup of the Livermore Site source areas. In particular, LLNL is working to address the mixed-waste management issue discussed in the *Draft Focused Feasibility Study of Methods to Minimize Mixed Hazardous and Low-Level Radioactive Waste from Soil Vapor and Ground Water Treatment Facilities at the Lawrence Livermore National Laboratory Site* (Bourne et al. 2010).

In 2019, the Enhanced Source Area Remediation (ESAR) treatability tests continued at the TFD Helipad (*in situ* bioremediation), the TFE Eastern Landing Mat (thermally-enhanced remediation), and the TFC Hotspot (emplacement of zero valent iron [ZVI] for *in situ* VOC destruction). A yearly status update for the ESAR treatability tests is provided in Noyes et al. (LLNL 2020s). Groundwater concentration and hydraulic data indicate subtle but consistent declines in the VOC concentrations and areal extent of the contaminant plumes in 2019. Tritium in soil moisture and groundwater continues to decay on site, reducing tritium activity in both Livermore Site soil and groundwater. Hydraulic containment along the western and southern boundaries of the site was fully maintained in 2019, and progress was made toward interior plume and source area clean up. See Noyes et al. for the current status of cleanup progress (LLNL 2020s).

LLNL strives to reduce risks arising from chemicals released to the environment, to conduct all its restoration activities to protect environmental resources, and to preserve the health and safety of all site workers. LLNL's environmental restoration project is committed to preventing present and future human exposure to contaminated soil, soil vapor, and groundwater, preventing further contaminant migration of concentrations above drinking water standards, reducing concentrations of contaminants in groundwater and soil vapor, and minimizing contaminant migration from the unsaturated zone to the underlying groundwater. Remedial solutions that have been determined to be most appropriate for individual areas of contamination are and continue to be implemented. The selected remedial solutions, which include groundwater and soil vapor extraction and treatment, have been agreed upon by DOE and the regulatory agencies with public input and are designed to achieve the goals of reducing risks to human health and the environment and satisfying remediation objectives, and of meeting regulatory standards for chemicals in water and soil, and other state and federal requirements.

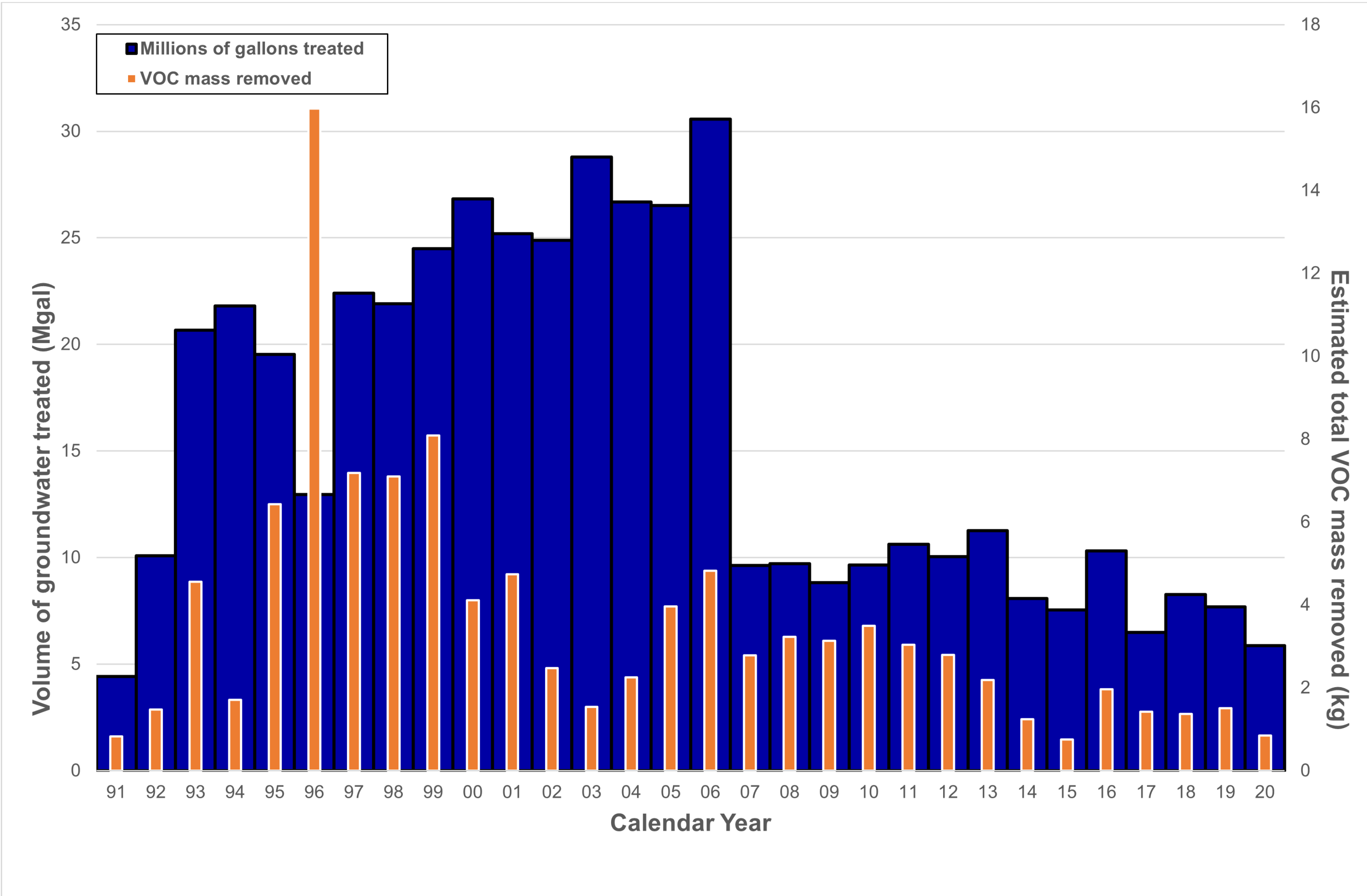
4.15.2 Site 300

Environmental Restoration Project remedial activities are ongoing at Site 300, which became a CERCLA site in 1990 when it was placed on the National Priorities List. Remedial activities are overseen by the USEPA, the CVRWQCB, and DTSC, under the authority of an FFA for the site (DOE 1992c). LLNL's cleanup remedies at Site 300 are designed and implemented to achieve the goals of reducing risks to human health and the environment and satisfying remediation action objectives, meeting cleanup standards for chemicals and radionuclides in water and soil, and preventing contaminant migration in groundwater to the extent technically and economically feasible. The initial Record of Decision was issued in February 2001 (DOE 2001). A second Record of Decision was issued in 2008 (LLNL 2008c).

As discussed in Section 4.5.2.4, LLNL maintains an extensive network of onsite and offsite wells to monitor this contamination (LLNL 2019f). Groundwater concentration and hydraulic data collected and analyzed for Site 300 during 2018 and 2019 provide evidence of continued progress in reducing contaminant concentrations in Site 300 soil vapor and groundwater, controlling and cleaning up contaminant sources, and mitigating risk to onsite workers (LLNL 2019f, 2020r). Tritium in groundwater continues to decay on site, reducing tritium activities in Site 300 groundwater (LLNL 2019f, 2020r). Since groundwater remediation began at Site 300 in 1991, approximately 1,763 million liters of groundwater and 37 million cubic meters of soil vapor have been treated, resulting in removal of approximately 630 kg of VOCs, 1.8 kg of perchlorate, 21,000 kg of nitrate, 2.8 kg of RDX, 9.5 kg of silicone oils, and 0.098 kg of uranium. (LLNL 2020r). Figure 4-97 and Figure 4-98 show the estimated total VOCs removed since 1991 from Site 300 groundwater and soil vapor, respectively (LLNL 2021r).

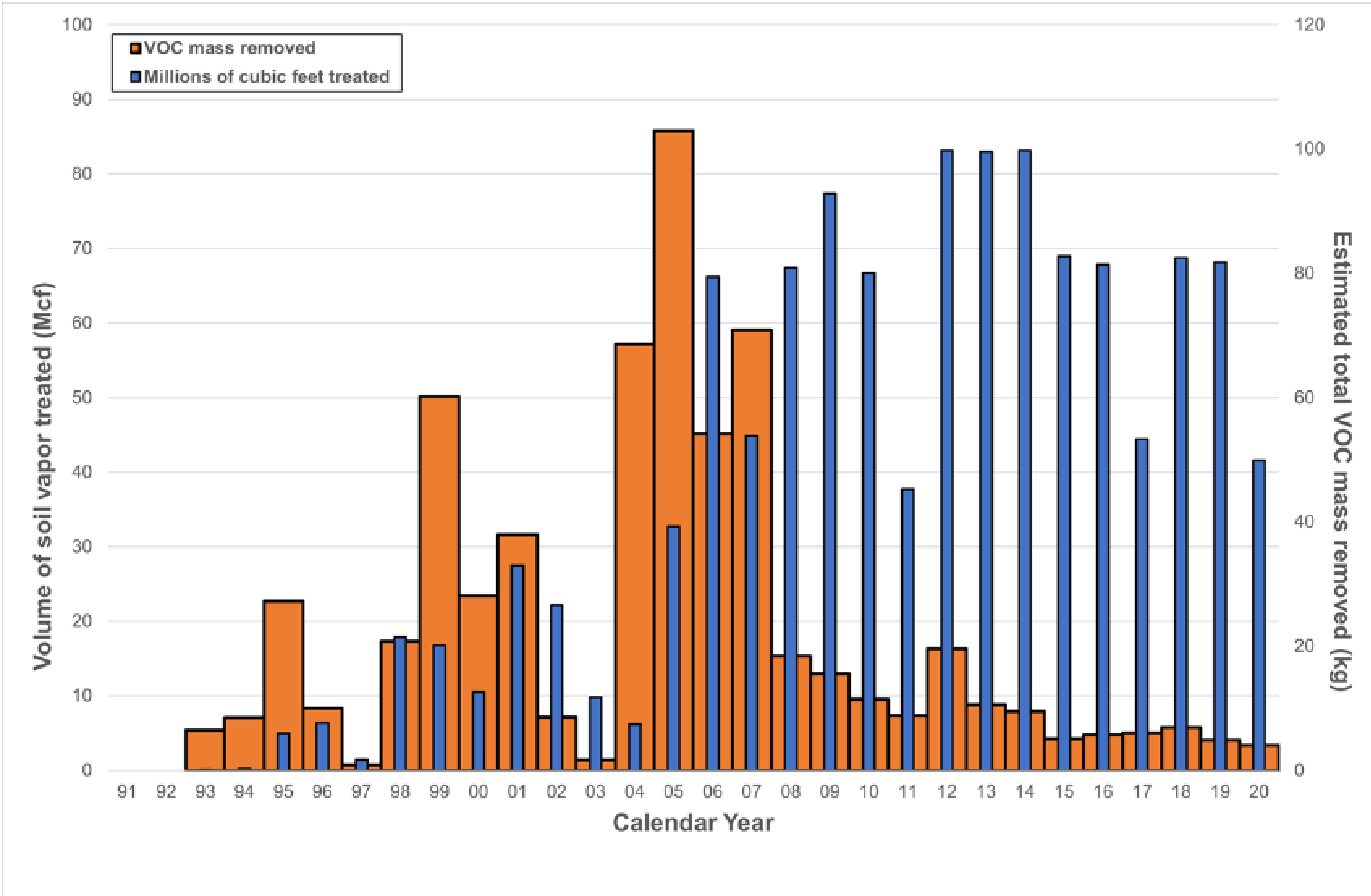
Contamination at Site 300 is confined within the site boundaries with the exception of VOCs that are present in offsite monitoring wells near the southern site boundary (LLNL 2019f). Background information for LLNL environmental characterization and restoration activities at Site 300 can be found in the *Site-Wide Remedial Investigation Report* (Webster-Scholten et al. 1994), *Final Remedial Investigation/Feasibility Study for the Pit 7 Complex at Lawrence Livermore National Laboratory Site 300* (Taffet et al. 2005), and the *Site-Wide Remediation Evaluation Summary Report for Lawrence Livermore National Laboratory Site 300* (LLNL 2006b).

To effectively manage site cleanup, nine environmental restoration OUs have been designated at Site 300 (Figure 4-99) based on the nature and extent of contamination (LLNL 2017i). All characterized contaminant release sites that have a CERCLA pathway have been assigned to one of nine OUs based on the nature, extent, and sources of contamination, as well as topographic and hydrologic considerations. Site 300 is a large and hydrogeologically diverse site. Due to the steep topography and structural complexity, stratigraphic units and groundwater contained within many of these units are discontinuous across the site. Consequently, site-specific hydrogeologic conditions govern the occurrence and flow of groundwater and the fate and transport of contaminants beneath each OU. Beginning in 2009, LLNL implemented an updated comprehensive CERCLA compliance monitoring plan/contingency plan (CMP/CP) at Site 300 that adequately covers the DOE and other agency regulatory requirements for onsite groundwater surveillance (Dibley et al. 2009). The current operating treatment facilities are shown in Figure 4-100.



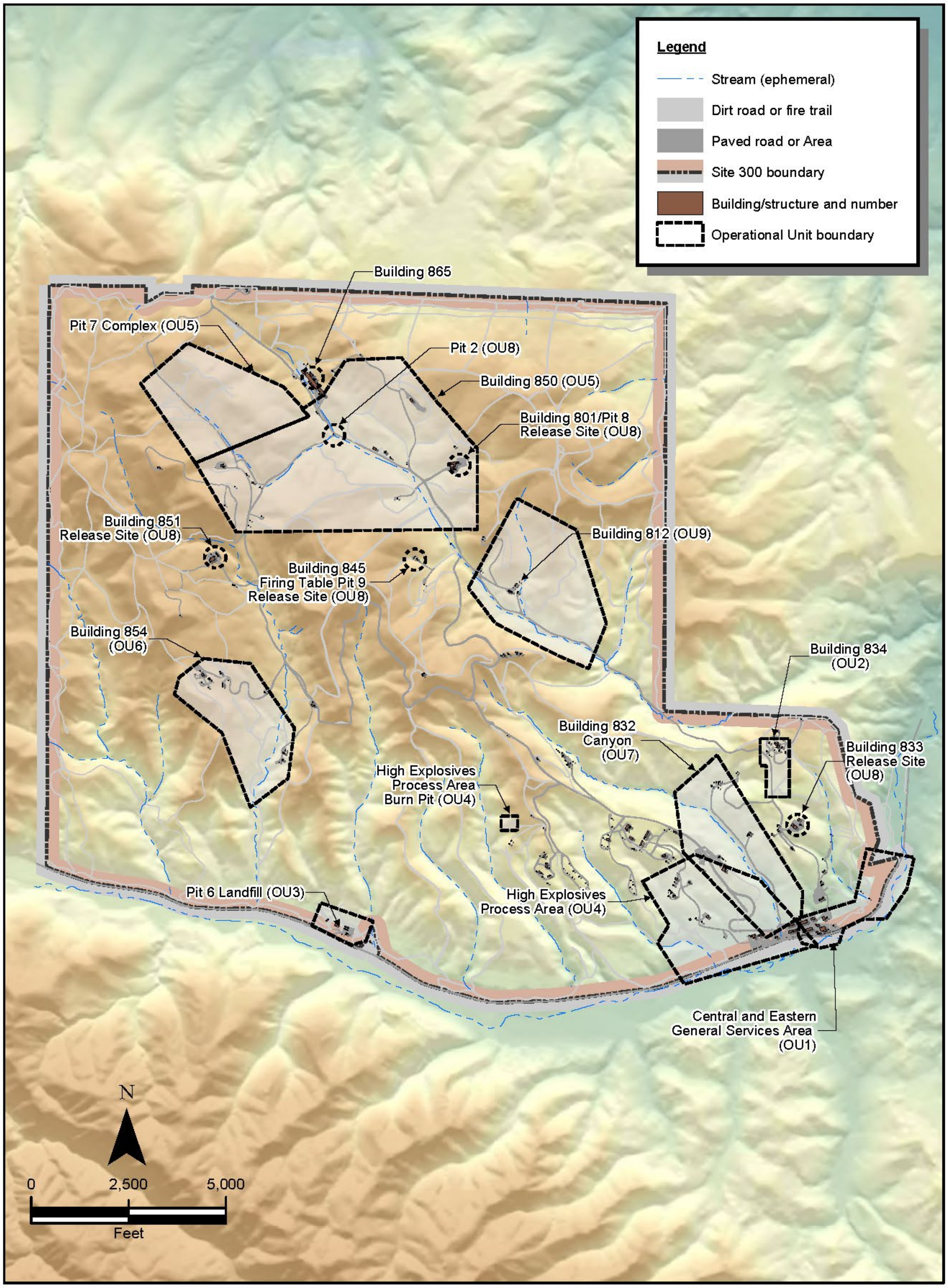
Source: LLNL 2021r.

Figure 4-97. Estimated Total VOC Mass Removed from Site 300 Groundwater since 1991



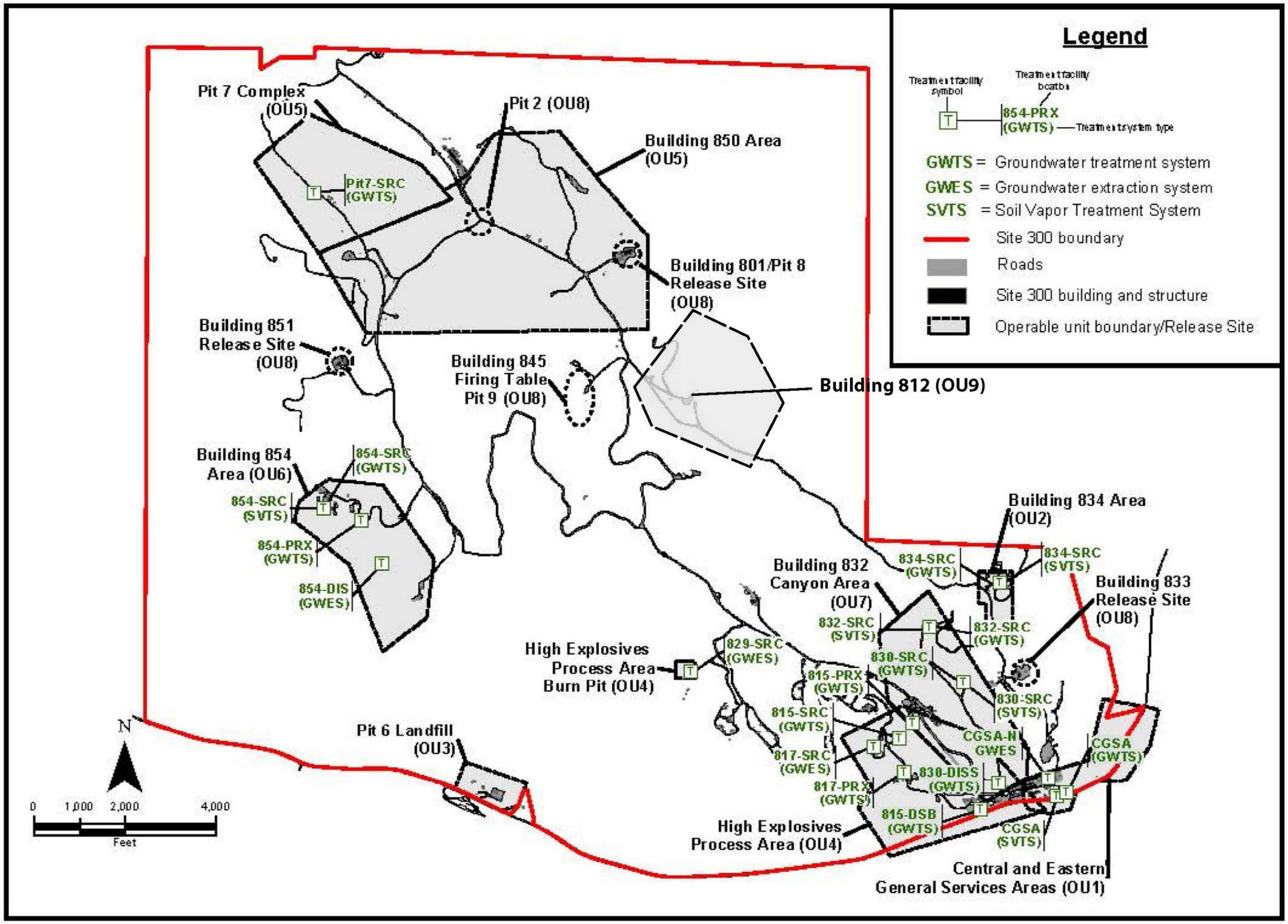
Source: LLNL 2021r.

Figure 4-98. Estimated Total VOC Mass Removed from Site 300 Soil Vapor since 1991



Source: LLNL 2017i.

Figure 4-99. Environmental Restoration Operable Units at Site 300



Source: LLNL 2021s.

Figure 4-100. Active Treatment Facilities and Operable Unit Locations at Site 300

Details of the distribution of contaminants in groundwater and current related cleanup activities in OUs 1 through 9 of Site 300 are provided below.

OU 1: GSA, including the central and eastern GSA. Chlorinated solvents, mainly TCE, were used as degreasing agents in craft shops in the Central GSA. As a result, subsurface soil and groundwater was contaminated with VOCs. Groundwater cleanup began in the Central GSA in 1992 and soil vapor extraction started in 1994 as removal actions. In 1997, a Final ROD for the GSA OU was signed and groundwater and soil vapor extraction and treatment continued as a remedial action. Operation of the groundwater and soil vapor extraction and treatment systems to remove VOCs from the subsurface are ongoing.

General trends of VOCs in OU 1 groundwater and soil vapor include the following:

- TVOCs decreased from a historical maximum of 272,000 µg/L in March 1992 to a current maximum of 1,065 µg/L in December 2019, detected in dual extraction well W-7I;
- TVOCs decreased from a historical maximum of 603 ppmv/v to a current maximum of 8.4 ppmv/v in October 2019 in dual extraction well W-7I (LLNL 2020aa).

OU 2: Building 834. From 1962 to 1978, intermittent spills and piping leaks resulted in contamination of the subsurface soil and rock and groundwater with VOCS and silicone oils (TBOS/TKEBs). Nitrate in groundwater results from septic-system effluent but may also have natural sources. There are no COCs in surface soil.

Remediation has reduced VOC concentrations in groundwater from a historical maximum of 1,060,000 µg/L to a maximum of 190,000 µg/L in 2008. TBOS in groundwater has also been reduced from a maximum historical concentration of 7,300,000 µg/L in 1995 to a 2008 maximum concentration of 780 µg/L. While nitrate concentrations have decreased from a historic maximum of 749 milligrams per liter (mg/L) in 2000 to 310 mg/L in 2008, the continued elevated nitrate concentrations indicate an ongoing source of groundwater nitrate (Dibley et. al. 2009). Although the overall extent of VOCs in Building 834 OU groundwater and soil vapor have not changed significantly in recent years, the maximum concentrations have decreased by more than one order of magnitude since remediation began in the mid-1990s.

OU 3: Pit 6 landfill. From 1964 to 1973, approximately 1,900 cubic yards of waste from the Livermore Site and the Lawrence Berkeley National Laboratory was buried in nine unlined trenches and at the Pit 6 Landfill. Infiltrating rainwater leached contaminants from pit waste resulting in tritium, VOCs, and perchlorate contamination in groundwater. Nitrate contamination in groundwater resulted from septic-system effluent. No COCs were identified in surface or subsurface soil. The extent of contamination at the Pit 6 Landfill is limited and continues to decrease with concentrations/activities near and below cleanup standards. Natural attenuation has reduced VOCs in groundwater from a historical maximum of 250 µg/L in 1988 to a maximum concentration of 10 µg/L in 2008. Tritium activities are well below cleanup standards and continue to decrease towards background levels. Perchlorate is not currently detected in any wells above cleanup standards. Nitrate concentrations exceeding cleanup standards continue to be limited to one well. Installation of the landfill cap mitigated the onsite worker inhalation risk (Dibley et al. 2009).

In 2019, VOC concentrations in groundwater near Pit 6 continued to exhibit decreasing trends. Except for three low detections in a single well (EP6-08), CFORM was below the reporting limit in all Pit 6 Landfill OU wells. During 2019, except for two detections in one well (EP6-09) that slightly exceeded the 5 µg/L MCL cleanup standard, TCE concentrations were below the cleanup standard in all Pit 6 Landfill OU wells. Tritium activity concentrations in groundwater continue to remain far below the 20,000 pCi/L MCL cleanup standard. During 2019, tritium activity concentrations remained low, slightly exceeding the 100 pCi/L reporting limit in only four wells. Perchlorate concentrations in OU 3 groundwater have decreased from a maximum of 65 µg/L in well K6-19 (following the 1998 El Niño) to below the 4 µg/L perchlorate reporting limit in all but two wells. Nitrate continues to be consistently detected in well K6-23 above its 45 mg/L MCL cleanup standard. Since this well is located near the Building 899 septic system, that appears to be the likely source of the nitrate at this location (LLNL 2020aa).

OU 4: HE Process Area, including Building 815, the HE Lagoons, and HE Burn Pit. From 1958 to 1986, surface spills at the drum storage and dispensing area for the former Building 815 steam plant resulted in the release of VOCs to groundwater and subsurface soil and bedrock. HE compounds, nitrate, and perchlorate detected in groundwater are attributed to wastewater discharges to former unlined rinsewater lagoons that occurred from the 1950s to 1985. VOCs, nitrate, and perchlorate have also been identified as COCs in groundwater near the former HE Burn Pits. HE compounds are COCs in surface soil. HE compounds and VOCs are COCs in subsurface soil. VOCs are COCs at Spring 5 (Dibley et al. 2009). In 1999, DOE implemented a CERCLA removal action to extract groundwater at the site boundary and prevent offsite TCE migration.

Groundwater remediation efforts have reduced VOC concentrations from a historical maximum of 450 µg/L in 1992 to a maximum of 50 µg/L in 2008. RDX in groundwater has also been reduced from a maximum historical concentration of 350 µg/L to a maximum concentration of 99 µg/L in 2008. Natural denitrification processes are reducing nitrate concentrations in groundwater to background levels. Perchlorate concentrations have decreased from a historic maximum of 50 µg/L in 1998 to 29 µg/L in 2008. Remediation has also mitigated risk to onsite workers in the HE Process Area OU (Dibley et al. 2009). In 2019, VOCs (mainly TCE) are the primary COCs detected in groundwater; RDX, HMX, 4-amino-2,6-dinitrotoluene (4-ADNT), perchlorate, and nitrate are secondary COCs. Some COCs (TCE, RDX, HMX, perchlorate, and nitrate) have also been detected in perched groundwater within the Tpsg-Tps HSU in the vicinity of Buildings 815 and 817. Minor concentrations of VOCs, perchlorate, and nitrate are also present in perched groundwater located beneath the former Building 829 WAA (LLNL 2020aa).

OU 5: Building 850/Pit 7 Complex. HE experiments were conducted at the Building 850 Firing Table from 1958 to 2008. Tritium was used in some of these experiments, primarily between 1963 and 1978. As a result of the destruction and dispersal of test assembly debris during detonations, surface soil was contaminated with metals, PCBs, dioxins, furans, HMX, and depleted uranium. Leaching from firing table debris has resulted in tritium and depleted uranium contamination in subsurface soil and groundwater. Nitrate and perchlorate are also COCs in groundwater. Tritium is the only COC in surface water (Well 8 Spring) (Dibley et al. 2009). A new remedial design was completed and implemented in 2009 for the excavation and solidification of PCBs-, dioxin-, and furan-contaminated soil and sand pile.

Natural attenuation has reduced tritium activities from a historical maximum of 566,000 pCi/L in 1985 to a 2008 maximum of 56,100 pCi/L. Uranium concentrations are below the cleanup standard and are within the range of natural background levels. The extent of nitrate with concentrations above cleanup standards is limited and does not pose a threat to human health or the environment. The historic maximum perchlorate concentration in the OU of 75.2 mg/L in 2005 has declined slightly to 69 µg/L in 2008. The metals, HMX, and uranium in surface soil do not pose a risk to human or ecological receptors or a threat to groundwater (Dibley et al. 2009).

The Pit 3, 4, 5, and 7 Landfills are collectively designated as the Pit 7 Landfill Complex. Firing Table debris containing tritium, depleted uranium, and metals was placed in the pits in the 1950s through the 1980s. The Pit 4 and 7 Landfills were capped in 1992. During years of above-normal rainfall (i.e., the 1997–1998 El Niño), groundwater rose into the bottom of the landfills and the underlying contaminated bedrock. This resulted in the release of tritium, uranium, VOCs, perchlorate, and nitrate to groundwater. There are no COCs in surface water or surface soil (Dibley et al. 2009). Tritium and depleted uranium are COCs in subsurface soil. Natural attenuation has reduced tritium activities in groundwater from a historical maximum of 2,660,000 pCi/L in 1998 to a 2008 maximum of 291,000 pCi/L and has mitigated risk to onsite workers from inhalation of tritium vapors. Uranium activities have also decreased from a historical maximum of 781 pCi/L in 1998 to a 2008 maximum of 140 pCi/L. VOC concentrations are currently near or below Maximum Contaminant Levels (MCLs). Nitrate concentrations in groundwater remain relatively stable, while perchlorate concentrations have decreased (Dibley et al. 2009).

In 2019, tritium activity concentrations in the Building 850 area did not exceed the 20,000 pCi/L MCL cleanup standard. The maximum 2019 total uranium activity concentration was 22.5 pCi/L (November) in monitoring well W-850-2315, a decrease from the 2018 maximum of 25.4 pCi/L from the same well. Nitrate was detected at concentrations at or above the 45 mg/L MCL cleanup standard in 12 wells in the Building 850 area during 2019. During 2019, perchlorate concentrations exceeding the 6 µg/L MCL cleanup standard were detected in 22 wells located east and south (downgradient) of Building 850, east (downgradient) of Pit 1, and southeast of Pit 2 in Elk Ravine. Perchlorate concentrations were similar to or deviated slightly from 2018 concentrations. During 2019, groundwater samples from 38 wells located in and around the Building 850 Area were analyzed for HE compounds at typical reporting limits of 1 µg/L or 2 µg/L. Only HMX and RDX were detected at concentrations exceeding these reporting limits. The source of HMX and RDX is the Building 850 Firing Table (LLNL 2020aa).

OU 6: <u>Building 854</u>. TCE was released to soil and groundwater through leaks and discharges of heat exchange fluid, primarily between 1967 and 1984. Nitrate and perchlorate are also COCs in groundwater. HE compounds, PCBs, dioxins, furans, tritium, and metals were identified as COCs in surface soil. No further action was selected as the remedy for metals, HMX, and tritium in surface soil (Dibley et al. 2009).

Groundwater remediation has reduced VOC concentrations from a historical maximum of 2,900 µg/L in 1997 to a maximum of 40 µg/L in 2008. Nitrate concentrations have decreased from a historical maximum of 260 mg/L in 2003 to a 2008 maximum of 230 mg/L. Perchlorate concentrations in groundwater have also decreased from 27 µg/L to a 2008 maximum concentration of 22 µg/L. Risks to onsite workers from inhalation of VOC vapors and from exposure to PCBs, dioxins, and furans in surface soil have been mitigated (Dibley et al. 2009). In

2019, at the Building 854 OU, TCE and perchlorate are the primary COCs detected in groundwater; nitrate is the secondary COC (LLNL 2020aa).

OU 7: Building 832 Canyon, including Buildings 830 and 832. Contaminants were released from Buildings 830 and 832 through piping leaks and surface spills during past activities at these buildings. VOCs, nitrate, and perchlorate are COCs in groundwater. VOCs, nitrate, and HMX are COCs in subsurface soil. HMX is also a COC in surface soil. VOCs are COCs in surface water at Spring 3 (Dibley et al. 2009).

Remediation has reduced VOC concentrations from a historical maximum of 30,000 µg/L in 1997 to a 2008 maximum of 4,700 µg/L. Perchlorate concentrations have been reduced from a historical maximum of 27 µg/L in 2003 to a 2008 maximum of 15 µg/L. Nitrate concentrations in groundwater remain fairly stable and are possibly the result of the ongoing contribution of nitrate from septic systems and natural bedrock sources. However, natural denitrification processes continue to reduce nitrate concentrations to background levels towards the site boundary. Remediation has also mitigated risk to onsite workers in several locations in the Building 832 Canyon OU (Dibley et al. 2009).

In 2019, VOCs detected in Building 832 area groundwater consist primarily of TCE. During 2019, VOCs, other than TCE, present above reporting limits in the Building 832 source area were cis-1,2-DCE, CFORM, 1,1,2-TCA, and Freon 11. Of these VOCs, only TCE and cis-1,2-DCE were present in the Building 832 area at concentrations above their MCL cleanup standards of 5 µg/L and 6 µg/L, respectively. VOCs detected in the Building 830 area (including 830-SRC and 830-DISS areas) groundwater consist primarily of TCE. During 2019, the other VOCs present above the reporting limit in the Building 830 area were PCE, cis-1,2-DCE, trans-1,2-DCE, CFORM; 1,2-DCA, 1,1-DCE, 1,1,2-TCA, and Freon 11. Of these VOCs, only TCE and 1,2-DCA were detected at concentrations above their MCL cleanup standards of 5 µg/L and 0.5 µg/L, respectively (LLNL 2020aa).

Including 2019, HE compounds have never been detected in groundwater in any Building 832 Canyon OU well (LLNL 2020aa). In 2019, maximum nitrate concentrations in groundwater remained high both in the vicinity of the Buildings 832 and 830 source areas, and low or below the 0.5 mg/L reporting limit in the downgradient, deeper parts of all Building 832 Canyon (LLNL 2020aa).

OU 8: Site-wide, including Buildings 801, 833, 845, 851, Pit 2, 8, and 9 landfills. Operable Unit 8 includes the contaminant release sites that have a monitoring-only remedy: the Building 801 Dry Well and Pit 8 Landfill, Building 833, Building 845 and Pit 9 Landfill, the Building 851 Firing Table, and the Pit 2 Landfill. OU 8 release sites have a monitoring-only interim remedy because (1) contaminants in surface and subsurface soil/bedrock do not pose a risk to humans or plant and animal populations or a threat to groundwater, (2) there is no groundwater contamination, (3) contaminant concentrations in groundwater do not exceed regulatory standards, and/or (4) the extent of contamination in groundwater is limited (Dibley et al. 2009). These release sites are summarized below (LLNL 2020aa).

The *Building 801 Firing Table* was used for explosives testing, and operations resulted in contamination of adjacent soil with metals and uranium (Dibley et al. 2009). In 2019, the 2018 maximum TVOC concentration (5.1 µg/L) in the area was observed in well K8-01 (composed of 3.5 µg/L of TCE and 1.6 µg/L of 1,2-DCA). These concentrations are well within the range observed since 1990. During 2019, perchlorate was not detected above its 4 µg/L reporting limit in any Building 801/Pit 8 Landfill area wells. The 2019 maximum nitrate concentrations were 73 and 72 mg/L in well K8-04 (routine and duplicate samples, respectively, detected in May), similar to recent results.

The *Building 833 Area* used TCE as a heat-exchange fluid from 1959 to 1982 which was released through spills and rinse water disposal, resulting in TCE-contamination of subsurface soil and shallow perched groundwater. No contamination has been detected in the deeper regional aquifer. No COCs were identified in surface soil at Building 833. In 2019, the VOCs, TCE, and cis-1,2-DCE were the primary COCs in shallow, perched groundwater; there are no secondary COCs. The historical maximum TVOC concentration was 2,100 µg/L, detected in 1993 (consisting entirely of TCE) in well W-833-03; TVOCs decreased to a current 2019 maximum of 19 µg/L, detected in May (consisting entirely of TCE) in well W-833-12.

The *Building 845 Firing Table* was used from 1958 until 1963 to conduct explosives experiments. Leaching from firing table debris resulted in minor contamination of subsurface soil with depleted uranium and HMX; however, no unacceptable risk to human or ecological receptors or threat to groundwater was identified. No contaminants have been detected in surface soil or in groundwater at the Building 845 Firing Table. Debris generated at the Building 845 Firing Table was buried in the Pit 9 Landfill. There has been no evidence of contaminant releases from the Pit 9 Landfill. In 2019, no groundwater COCs were identified in Building 845/Pit 9 Landfill area groundwater.

The *Building 851 Firing Table* has been used for HE research since 1962. VOCs and uranium-238 were identified as COCs in subsurface soil, and RDX, uranium-238, and metals as surface soil COCs. Uranium-238 was identified as a COC in groundwater. However, it poses no risk to human or ecological receptors, and uranium activities are well below cleanup standards and are within the range of background levels. The historical maximum uranium activity concentration was 7.9 pCi/L, detected in 2016 in well W-851-3207; uranium activity concentrations have decreased over time, remaining relatively stable since 1998. The current 2019 maximum of 3.6 pCi/L in May, was detected in well W-851-3207. The spatial extent has generally remained unchanged; however, uranium activity concentrations have decreased since 2016 at well W-851-3207.

The *Pit 2 Landfill* was used from 1956 until 1960 to dispose of firing table debris from Buildings 801 and 802. No contaminants were identified in surface or subsurface soil at the Pit 2 Landfill. No risk to human or ecological receptors has been identified at the Pit 2 Landfill. Overall, tritium activity concentrations in the Pit 2 Landfill detection monitoring wells are stable. The 2019 maximum uranium activity concentration in the Pit 2 area was 3.9 pCi/L (May) detected in monitoring well K2-01C, below the 20 pCi/L MCL cleanup standard and within the range of natural background. Uranium activity concentrations in the Pit 2 area continue to decrease from the 27.4 pCi/L maximum measured in a 1994 groundwater sample collected from well K2-01C.

OU 9: *Building 812*. The Building 812 Complex was built in the late 1950s-early 1960s and was used to conduct explosives tests and diagnostics until 2008. The Building 812 Complex was designated as OU 9 in March 2007 based on characterization results that indicated the presence of depleted uranium, VOCs, HE compounds, nitrate, and perchlorate in environmental media. The

CERCLA pathway for the last OU, Building 812, was negotiated with the regulatory agencies in 2011. Characterization activities were initiated in 2011 and have continued in subsequent years. A remedy has not yet been selected or implemented for this OU.

Building 865 Complex: The Building 865 Complex housed the former Advanced Testing Accelerator, where high-energy laser tests and diagnostics were conducted in support of national defense programs from 1980 to 1995. Freon 113, Freon 11, and tetrachloroethene (PCE) were identified as COCs in groundwater. Concentrations of Freon 113 and Freon 11 are below MCLs and PCE exists in a limited area with maximum concentrations slightly above its 5 µg/L MCL. A remedy has not yet been selected or implemented for this study area.

Site 300 remedial projects and the associated documentation and investigations continue to meet regulatory milestones. Site 300 remediation/restoration activities, since publication of the 2005 SWEIS, have focused on enhancing and optimizing ongoing removal operations and implementing the selected remedial strategies detailed in the 2008 ROD (LLNL 2008c). LLNL strives to reduce elevated risks arising from chemicals released to the environment at Site 300, to conduct its activities to protect ecological resources, and to protect the health and safety of site workers. LLNL's cleanup remedies at Site 300 are designed and implemented to achieve the goals of reducing risks to human health and the environment and satisfying remediation action objectives, meeting cleanup standards for chemicals and radionuclides in water and soil, and preventing contaminant migration in groundwater to the extent technically and economically feasible. These remedies are selected by DOE and the regulatory agencies with public input (LLNL 2008c).

4.15.3 Environmental Restoration Activities/Accomplishments Since 2005

A summary of the detailed environmental restoration activities/accomplishments is documented in the 5-year and annual compliance monitoring reports since initial CERCLA regulatory actions have begun (Livermore Site: LLNL 1997, LLNL 2002c, LLNL 2007d, LLNL 2012b, LLNL 2017h) (Site 300: LLNL 2017k, LLNL 2018g, LLNL 2019ac LLNL 2020aa, LLNL 2021e). As stated above, LLNL continues to meet all negotiated regulatory milestones and has successfully implemented remedial actions.

Livermore Site. As discussed above, at the Livermore Site, since remediation began in 1989, approximately 24.6 billion liters of groundwater have been treated, resulting in removal of more than 1,772 kg of VOCs. Since initial operation, nearly 29.1 million cubic meters of soil vapor has been extracted and treated from soil vapor extraction and dual extraction wells, removing more than 1,621 kg of VOCs from the subsurface (LLNL 2020r). Groundwater concentration and hydraulic data indicate subtle but consistent declines in the VOC concentrations and areal extent of the contaminant plumes in 2019. Hydraulic containment along the western and southern boundaries of the site was fully maintained in 2019, and progress was made toward interior plume and source area clean up (LLNL 2020r).

The major Livermore Site environmental accomplishments since the 2005 LLNL SWEIS have been:

1) The completed buildout of treatment facilities agreed to with the regulatory agencies in the Remedial Action Implementation Plan (RAIP) was achieved;

2) Significant contaminant mass removal from soils and groundwater on a yearly basis;

3) The 2012 Treatment Facility A offsite pipeline extension that significantly accelerated groundwater cleanup of the offsite TFA groundwater contaminant plumes;

4) Enhanced Source Area Remediation (ESAR) treatability tests being performed to accelerate cleanup of the Livermore Site source areas to avoid generating mixed waste at treatment facilities where both tritium and VOCs are present in the subsurface;

5) Implementation of treatment facility upgrades and remedial wellfield expansions to further optimize extraction rates, mass removal from the subsurface, and improve treatment facility up times.

Site 300. At Site 300, since groundwater remediation began in 1991, approximately 1,763 million liters of groundwater and 37 million cubic meters of soil vapor have been treated, resulting in removal of approximately 630 kg of VOCs, 1.8 kg of perchlorate, 21,000 kg of nitrate, 2.8 kg of RDX, 9.5 kg of silicone oils, and 0.098 kg of uranium. Tritium in groundwater continues to decay on-site, reducing tritium activities in Site 300 groundwater (LLNL 2020r). Groundwater concentration and hydraulic data collected and analyzed for Site 300 during 2019 provided evidence of continued progress in reducing contaminant concentrations in Site 300 soil vapor and groundwater, controlling and cleaning up contaminant sources, and mitigating risk to on-site workers (LLNL 2020r). Detailed groundwater volume and contaminant mass removal totals, by OU, are presented in the *2019 Annual Compliance Monitoring Report for Site 300* (LLNL 2020aa). In 2019, two documents summarizing the nature and extent of contamination, risk assessment, and remedial alternatives for contaminants in environmental media at two areas of Site 300 were submitted to the regulatory agencies. These documents are the *Focused Remedial Investigation Feasibility Study for Perchlorate at the Building 850 Area LLNL Site 300* (LLNL 2019ad) and the *Remedial Investigation/Feasibility Study, Part 1 for the LLNL Site 300 Building 865 Area* (LLNL 2019ae).

Current detailed information on remediation efforts at Site 300 are provided in the *Annual 2019 Compliance Monitoring Report Lawrence Livermore National Laboratory Site 300* (LLNL 2020aa). All calendar year 2019 Site 300 milestones were met or renegotiated with the regulatory agencies. The major Site 300 accomplishments since the 2005 SWEIS are:

1) The elimination of risk to onsite workers from contaminant exposure at eight locations throughout Site 300;

2) Reductions in maximum concentrations of the primary contaminant (VOCs) in Site 300 groundwater from 50 percent to 99 percent;

3) Cleanup remedies have been fully implemented and are operational in eight of the nine OUs at Site 300 to date (the General Services Area, Building 834, Pit 6 Landfill, High Explosives Process Area, Building 850/Pit 7 Complex, Building 854, Building 832 Canyon OUs, and OU 8, which is comprised of four site-wide subareas). The CERCLA pathway for the last OU, Building 812, was negotiated with the regulatory agencies in 2011 and is underway, pending completion of a soil background concentration study for Site 300;

4) Remediation of VOCs in groundwater in the eastern GSA to meet cleanup standards and subsequent closeout of groundwater treatment in the eastern GSA.

5) A reduction of maximum tritium activities in groundwater emanating from the Building 850 area to below cleanup standards (LLNL 2019f).

6) Excavation of approximately 29,000 yd^3 of PCB-bearing soil from the area surrounding the Building 850 firing table (OU 5) and adjacent consolidation, solidification, and isolation within a CAMU (Corrective Action Management Unit).

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CHAPTER 5

Environmental Consequences

5.0 ENVIRONMENTAL CONSEQUENCES

5.1 INTRODUCTION

In this chapter, NNSA discusses the potential direct and indirect environmental impacts of the No-Action Alternative and the Proposed Action, based on the descriptions of those alternatives in Chapter 3. The potential impacts are presented using the methodologies described in Appendix B to this SWEIS. The potential impacts (Sections 5.2 through 5.15) are presented in the same order as the resource descriptions in Sections 4.2 through 4.15.

The impact analysis in this chapter is based on the information regarding the projects defined by the No-Action Alternative and the Proposed Action. As discussed in Sections 3.2 and 3.3, there are hundreds of discrete projects associated with the No-Action Alternative and the Proposed Action. To assess the potential environmental impacts from all such projects, it was necessary for NNSA to define and accumulate data for each of the projects in the No-Action Alternative and the Proposed Action (*see* Section 3.4, and specifically Table 3-7 and Table 3-8). NNSA incorporated these site-wide estimates, along with more detailed information for specific projects, into the analysis of impacts. The analysis in this SWEIS addresses the construction of new facilities, modernization/upgrade/utility projects, DD&D of excess and aging facilities, operational changes, and continued operations through approximately 2035.

As discussed in Section 3.4, for construction parameters, NNSA developed conservative estimates for construction and DD&D activities based on a “peak year” approach. Such an approach acknowledges the non-linear characteristics of construction and DD&D and provides a conservative analysis to account for future uncertainties. This approach also affords NNSA flexibility with respect to scheduling and conducting future construction and DD&D projects. For example, if NNSA decides to conduct a greater amount of construction and/or DD&D in a given year than currently planned (such as DD&D of two major facilities), the peak-year analysis would be expected to bound those potential impacts. For each resource, NNSA analyzes construction, DD&D, and operational impacts concurrently, which acknowledges that any construction and DD&D activities would occur simultaneously with operations.

In addition to the resource analyses of the alternatives, this chapter presents the potential impacts associated with accidents and intentional destructive acts (Section 5.16); presents the potential environmental impacts of the alternatives at the Arroyo Mocho Pump Station (Section 5.17); presents the potential environmental impacts of implementing a New Hybrid Work Initiative for each of the alternatives (Section 5.18); discusses design features, best management practices (BMPs), and administration/engineering controls that would be implemented to avoid or mitigate potential environmental impacts (Section 5.19); discusses DD&D activities associated with any new facilities (Section 5.20); presents the unavoidable adverse impacts (Section 5.21); explains the relationship between short-term uses of the environment and the enhancement of long-term productivity (Section 5.22); presents the irreversible and irretrievable resource commitments (Section 5.23); and identifies the statutory requirements and environmental standards (i.e., regulations and permits) applicable to the activities addressed in this SWEIS (Section 5.24). Potential cumulative impacts are presented in Chapter 6 of this SWEIS.

5.2 LAND USE

The analysis in this section presents the potential land use impacts for the alternatives due to construction, DD&D, modernization/upgrade/utility projects, and operations. Key metrics in this analysis are: (1) amount of land disturbance; (2) number of new facilities; and (3) a qualitative analysis of consistency with current land use plans, classifications, and policies.

5.2.1 No-Action Alternative

Under the No-Action Alternative, the ongoing DOE/NNSA activities described in Chapter 2 and Chapter 4 would continue at LLNL. In addition, the new facility construction, DD&D, modernization/upgrade/utility projects, and operational changes described in Section 3.2 would occur. Table 5-1 summarizes the impacts that would occur under the No-Action Alternative.

Table 5-1. Land Use Impacts for the No-Action Alternative

Resource/Metric	Baseline (Existing Environment)	Change to Baseline as a Result of the No-Action Alternative			Net Percentage Change Over Baseline
		Construction[a]	DD&D[a]	Net Change	
Livermore Site (821 Acres)					
Land Disturbance	~700 acres	13.6 acres disturbed	5.2 acres reclaimed	6.4[b] acres permanently disturbed	0.9%
Square Footage of Facilities	7,000,000 ft^2	412,300 ft^2 (18 facilities)	227,000 ft^2 (41 facilities)	185,300 ft^2 added	2.6%
Land Use	The Livermore Site is approximately 85% developed. The No-Action Alternative activities would be consistent with current land use plans, classifications, and policies.				
Site 300 (7,000 Acres)					
Land Disturbance	~350 acres	0.6 acres disturbed	0.02 acres reclaimed	0.1[c] acre permanently disturbed	0.03%
Square Footage of Facilities	380,000 ft^2	4,000 ft^2 (1 facility)	1,000 ft^2 (1 facility)	3,000 ft^2 added	0.8%
Land Use	Site 300 is less than 5% developed. The No-Action Alternative activities would be consistent with current land use plans, classifications, and policies.				

a. Data from Tables 3-1, 3-3, and 3-7.
b. Assumes 2 acres of laydown area restored; (13.6 – 5.2 - 2 = 6.4).
c. Assumes 0.5 acre of laydown area restored; (0.6 – 0.02 – 0.5 = 0.1).

Livermore Site

As discussed in Section 4.2, the Livermore Site (821 acres) is largely developed as a contained, campus-like setting. The land surrounding the Livermore Site is generally a mixed use of industrial, laboratory, agricultural and residential. As discussed below, the No-Action Alternative activities would be consistent with current land use plans, classifications, and policies.

The land disturbance from construction activities would total 13.6 acres, and 5.2 acres would be reclaimed as a result of DD&D. The net change in land use at the Livermore Site would be 6.4 acres of disturbance after two acres of laydown areas are restored. Because of the historic development activities at the Livermore Site, any land disturbance is expected to occur on previously disturbed land. The 6.4-acre site disturbance represents an increase of approximately 0.9 percent compared to existing land disturbance on the Livermore Site.

Except for the Emergency Operations Center (EOC), no new types of land uses would be introduced in the buffer and perimeter areas. Therefore, no change in the site's compatibility with existing and approved future land uses would result from the No-Action Alternative Onsite changes, including increased employment (discussed in Section 5.10) at the Livermore Site would not result in any notable onsite or offsite land use changes.

Site 300

During the No-Action Alternative planning period, one new project is planned for Site 300: the Small Firearms Training Facility (SFTF) replacement (approximately 4,000 square feet), would be constructed in the Small Arms Training Area (see Figure 3-3). One building (Building 8806), totaling approximately 1,000 square feet, is scheduled for DD&D. Overall, Site 300 would maintain the same number of buildings and increase its square footage by approximately 3,000. The land disturbance from construction activities would total 0.6 acres, and 0.02 acres would be reclaimed as a result of DD&D. The net change in land use at the Livermore Site would be 0.1 acres of disturbance after 0.5 acres of laydown areas are restored. The 0.1-acre site disturbance represents an increase of approximately 0.03 percent compared to existing land disturbance on Site 300.

The types of land uses at Site 300 would not change, and the open space character of the site would be retained. Land uses at Site 300 are compatible with the existing uses and approved designations at and surrounding the site and with policies regarding open space resources near the site. Because activities under the No-Action Alternative represent a continuation of existing land uses, they would be compatible with existing onsite land uses and no additional impacts are expected to occur. Onsite changes, including increased employment (discussed in Section 5.10) at Site 300 would not result in any notable onsite or offsite land use changes.

5.2.2 Proposed Action

Under the Proposed Action, the ongoing activities described in Chapter 2 and Chapter 4 would continue at LLNL. In addition, the Proposed Action includes the use of facilities and projects described for the No-Action Alternative, as well as new facility construction, DD&D, modernization/upgrade/utility projects, and operational changes described in Section 3.3, as well as operational workforce increases. Table 5-2 summarizes the impacts that would occur under the Proposed Action.

Table 5-2. Land Use Impacts for the Proposed Action

Resource/Metric	No-Action Alternative	Change to No-Action Alternative as a Result of the Proposed Action			Net Percentage Change Over No-Action Alternative
		Construction[a]	DD&D[a]	Net Change	
Livermore Site (821 Acres)					
Land Disturbance	~706.4 acres	84.5 acres disturbed	26.5 acres reclaimed	52.5 acres[b] disturbed	7.4%
Square Footage of Facilities	7,185,300 ft^2	2,943,400 ft^2 (61 projects)	1,153,000 ft^2 (131 facilities)	1,790,400 ft^2 added	24.9%
Land Use	The Livermore Site is approximately 85% developed. The Proposed Action activities would be consistent with current land use plans, classifications, and policies.				
Site 300 (7,000 Acres)					
Land Disturbance	~350.1 acres	36 acres disturbed	0.4 acres reclaimed	34.6 acres[c] disturbed	9.9%
Square Footage of Facilities	383,000 ft^2	385,000 ft^2 (14 projects)	17,000 ft^2 (18 facilities)	368,000 ft^2 added	96.0%
Land Use	Site 300 is less than 5% developed. The Proposed Action activities would be consistent with current land use plans, classifications, and policies.				

a. Data from Tables 3-4, 3-5, and 3-7.
b. Assumes restoration of laydown areas (4 acres) and cooling tower pipeline disturbance (2.5 acres); (84.5– 26.5 – 4 – 2.5 = 51.5).
c. Assumes 1 acre of laydown area restored; (36 – 0.4 – 1 = 34.6).

Livermore Site

As discussed in Section 1.3 of this SWEIS, the long-term plan for LLNL is to improve operational efficiencies by modernizing its footprint and infrastructure to meet national security requirements and other mission needs. The ongoing mission would continue for the foreseeable future. The scope of the Proposed Action builds on, and is in addition to, those activities planned under the No-Action Alternative.

The land disturbance from construction activities would total 85.5 acres, with an additional 26.5 acres reclaimed as a result of DD&D. The net change in land use at the Livermore Site would be 52.5 acres of disturbance after laydown and pipeline areas are restored. Because of the historic development activities at the Livermore Site, most land disturbance is expected to occur on previously disturbed land. The 52.5-acre site disturbance represents an increase of approximately 7.4 percent compared to land disturbance on the Livermore Site above the No-Action Alternative.

The New North Entry (*see* Figures 3-11, 3-12) would connect Patterson Pass Road and North Outer Loop, providing better traffic circulation and reduced congestion with direct vehicle and bicycle access. Construction of the 1,500-foot long road would permanently disturb approximately four acres of land. No land would be conveyed, transferred, annexed, or otherwise acquired or disposed of as part of the project. After construction, temporary laydown areas would be restored in accordance with applicable regulations. The construction of the New North Entry would be consistent with current industrial land use. In addition, if the alternate location is selected, the new Fire Station could be located in the north buffer zone near the North Entry and could disturb approximately 0.7 acres.

The Livermore Site is largely developed with a structural footprint of approximately 7,000,000 square feet. While the Livermore Site would add approximately 2,943,400 square feet of new facilities, a significant amount of that new development would be encompassed by 11 facilities. As shown in Table 5-3, the 11 largest proposed facilities account for approximately 1,521,000 square feet or 52 percent of the new space that would be added under the Proposed Action. Section 3.3.1 provides descriptions of the specific projects during the Proposed Action planning period. The proposed construction projects and upgrades would be dispersed throughout the site and tie into the existing campus-like atmosphere of the Livermore Site.

Table 5-3. Largest Proposed Action Facilities at the Livermore Site[a]

Proposed Facilities	Size (ft^2)	Year	Location[b]
Parking Structure	250,000	2026	22
Nuclear Security Innovation Center	225,000	2024	10
Experimental Synthesis/Chemistry Replacement Capability (ESCRC)	160,000	2034	41
Domestic Uranium Enrichment Project	150,000	2031	4
High Energy Density (HED) Capability Support Facility Replacement	145,000	2034	45
LVOC LLNL Collaboration Center	111,000	2027	27
Institutional Office Administration Facility	110,000	2032	37
Livermore Nuclear Science Center	100,000	2026	25
High Bay	100,000	2028	28
Parking Structure	90,000	2024	11
Network Intelligence Research Facility	80,000	2026	21
Total:	**1,521,000**		

a. Facilities equal or greater than 80,000 ft^2.
b. "Location" refers to the numerical area identified in Figure 3-9.

As discussed in Section 3.3, expanding opportunities for connection and collaboration is a key driver of future land use at the Livermore Site. To that end, the Proposed Action lays out plans for rebalanced vehicle parking (Figure 3-11), removal of limited area fencing (Figure 3-15), expanded pedestrian walkways (Figure 3-16), expanded bicycle network (Figure 3-17), a more centralized core (Figure 3-18), and an "end state" site plan with more green space (Figure 4-3).

The confluence of these designs is intended to advance LLNL's mission and create a framework for physical development of the grounds. Removal of the limited area fencing would serve to enhance pedestrian movement, especially in the southwest quadrant of the site which currently houses the greatest concentration of workers. Expanding the bicycle network would allow employees taking non-vehicular trips a greater reach across the Livermore Site. Adding six miles of pedestrian walkways would help to usher employees between buildings and open green spaces. Currently, there are seven identified green spaces (*see* Figure 4-3), the largest being the landscape surrounding Lake Haussmann. As the Livermore Site becomes more connected on a pedestrian scale, NNSA would add 28 new green spaces. This collection of smart growth projects would enable NNSA to utilize the Livermore Site land in a more deliberate and sustainable manner.

The existing land use designation of Research and Development (R&D) would be maintained with the proposed construction and development projects. Furthermore, not all new projects would affect land use; many would involve actions within or modifications to existing structures or construction of new facilities, all of which lie within previously developed areas of the Livermore Site. Therefore, the Proposed Action would not represent a change in land uses, nor lead to a conflict with existing and approved future land uses adjacent to the site.

The Proposed Action reflects proposals that would expand the overall operations levels at LLNL beyond those established for the No-Action Alternative. Many of the facilities would replace existing aging facilities. The proposed operational changes described in Section 3.3.3 would have no impact on land use. Onsite changes at the Livermore Site, including increased employment (discussed in Section 5.10) would not result in any notable onsite or offsite land use changes.

Site 300

The Proposed Action at Site 300 would also include new facility construction, modernization/ upgrade/utility projects, operational changes, and DD&D activities. These projects are described in Section 3.3. No land acquisitions would occur. Land uses at Site 300 are compatible with the existing land uses and approved land use designations and policies surrounding the site. The types of land uses at Site 300 are not proposed to change, and the open space character of the site would be retained. No major alterations in the types of land uses would result.

The primary effect on land uses at Site 300 would be from the new facilities included in the Proposed Action. While 385,000 square feet of new facilities are proposed at Site 300, the bulk of new development would be contained in three facilities (Table 5-4) which would encompass approximately 255,000 square feet, or 66 percent of the new space added during the Proposed Action planning period. Because Site 300 is located on approximately 7,000 acres of largely undeveloped land, and the fact that the three major facilities would be dispersed in different areas throughout the site, they would not represent a substantial change of land uses, and the existing open character of the site would remain unaltered.

Table 5-4. Largest Proposed Action Facilities at Site 300[a]

Proposed Facilities	Size (ft^2)	Year	Location[b]
Dynamic Radiography Development Facility (DRDF)	140,000	2028-2032	3
Weapons Environmental Testing Replacement Capability (WETRC)	40,000	2029	11
Advanced 3D Hydrotest Facility	75,000	2032	13
Total:	**255,000**		

a. Facilities equal or greater than 40,000 ft^2.
b. "Location" refers to the numerical area identified in Figure 3-3.

Aside from new facility development, the most notable land use changes at Site 300 would be the potential installation of electrical infrastructure to support the Alternative Energy Micro-Grid for the Future (AEMGF) and construction of the Cyber-Physical Test Capability for Energy Distribution. The AEMGF would disturb up to 20.4 acres (9.4 acres of undisturbed land) for ground mounted solar photovoltaic (PV) arrays and 11 acres of previously disturbed land for rooftop and parking lot canopy PV arrays. Although the electrical power system upgrades are not expected to have a major effect on existing land uses, they would traverse a long path to reach the facility's proposed location in the interior of the Area 2 East Firing Area (*see* Figure 3-3). Construction and operations activities of new electrical infrastructure would be consistent and compatible with all existing land uses along the project's route, and these land uses would likely continue.

The Cyber-Physical Test Capability for Energy Distribution would involve installing electrical generation and storage equipment consisting of ground mount solar arrays, battery storage, and diesel generators (three 200 kVA generators) as well as power distribution equipment connected by a dedicated overhead distribution line system. A construction trailer would also be used to house monitoring and control equipment. It is anticipated that about 2.25 acres of previously undisturbed area of the land would be used for equipment installation and the new distribution line.

The two office buildings (unclassified and classified spaces) would increase the Site 300 construction by 74,000 square feet, with total acreage disturbed estimated at 5 acres. Overall, approximately 36 acres of land would be disturbed by new construction, and 0.4 acres would be reclaimed as a result of DD&D. Following restoration of the one acre laydown area, the net land disturbance would be 34.6 acres. The 34.6-acre disturbance represents an increase of approximately 9.9 percent compared to land disturbance on Site 300 above the No-Action Alternative.

Site 300 is predominately open space, and the minimal site disturbance would not change the current or future land use designation. Because activities under the Proposed Action represent a continuation of existing land uses, they would be compatible with existing and approved future land uses at and surrounding the site and no additional impacts are expected to occur. In addition, operational changes at Site 300, including increased employment (discussed in Section 5.10) would not result in any notable onsite or offsite land use changes.

5.2.3 Summary of Land Use Impacts for the Alternatives

Table 5-5 summarizes the potential land use impacts for the alternatives. Although there would be land disturbances at both the Livermore Site and Site 300, land uses would be consistent with historical and current uses. At the Livermore Site, operations would occur within the developed area, and at Site 300, operations would be dispersed throughout the site. Operational changes at each site would not change their current or future land use designations.

Table 5-5. Potential Land Use Impacts for the Alternatives

Resource/Metric	Existing Environment	No-Action Alternative End State	Proposed Action End State
Livermore Site (821 Acres)			
Land Disturbance	~700 acres[a]	706.4 acres[c]	758.9 acres[d]
Square Footage of Facilities	7,000,000 ft^2	7,185,300 ft^2	8,975,700 ft^2
Site 300 (7,000 acres)			
Land Disturbance	~350 acres[b]	350.1 acres[e]	384.7 acres[f]
Square Footage of Facilities	380,000 ft^2	383,000 ft^2	751,000 ft^2

a. Based on 85% of the total acreage (821).
b. Based on 5% of the total acreage (7,000).
c. Land disturbance of 6.4 acres would occur on previously disturbed land.
d. Land disturbance of 52.5 acres would occur on previously disturbed land, except for portions of the New North Entry and the alternate location of the Fire Station, which could disturb a total of 4.7 acres in the north buffer zone.
e. Land disturbance of 0.1 acre would occur on previously disturbed land.
f. Land disturbance of 34.6 acres would occur on previously disturbed land, except for approximately 20.4 acres associated with the AEMGF and 2.25 acres associated with the Cyber-Physical Test Capability for Energy Distribution.

5.3 Aesthetics and Scenic Resources

The analysis in this section presents the potential impacts to aesthetics and visual resources for the alternatives due to construction, DD&D, modernization/upgrade/utility projects, and operations. The key metric in this analysis is visual compatibility (i.e., whether actions would be consistent with existing landscapes; or obscure views; or increase the visibility of structures or otherwise detract from the scenic perspectives of existing and planned residential developments adjacent to the sites; or cause glare).

5.3.1 No-Action Alternative

Under the No-Action Alternative, the ongoing DOE/NNSA activities described in Chapter 2 and Chapter 4 would continue at LLNL. In addition, the new facility construction, DD&D, modernization/upgrade/utility projects, and operational changes described in Section 3.2 would occur.

Livermore Site

Figure 3-2 depicts the locations of facilities that would be constructed at the Livermore Site under the No-Action Alternative. The land disturbed by new projects at the Livermore Site would be 13.6 acres. Most of the new facilities (such as the AME, EOC, and office buildings) would be replacements for older facilities. Land reclaimed as a result of DD&D would be 5.2 acres. Overall, approximately 6.4 acres of additional land would be occupied by facilities, or 0.8 percent of the land at the Livermore Site. Development and modifications would largely occur within the developed portion of the site, would be similar in character to surrounding uses, and would be largely screened from public view by the fencing, buffer areas, and vegetation.

Construction and demolition activities would result in temporary changes to the visual appearance due to the presence of construction equipment, facilities in various stages of construction/DD&D, and possibly increased dust. As modern facilities replace the aging stock of buildings and trailers, the overall visual appearance of the Livermore Site is expected to improve. Although there would be some reduction in the number of facilities as a result of modernization activities, the Livermore Site would remain a highly developed area with a campus-style or business park appearance. Based on previous landscaping and development practices, it is anticipated that new facilities would be consistent with the existing character of the Livermore Site.

Views of the Livermore Site resemble a campus-like setting, including buildings, internal roadways, non-vehicular pathways, and open space. Although construction or modifications under the No-Action Alternative may alter these views to some degree, these changes would have no notable impact on the overall visual character of the site. Views of the site from public viewing areas, or existing viewsheds of the surrounding environment, would not notably change. Because the Livermore Site is largely developed, operations would occur within the developed area and would not change the Livermore Site's visual character. None of the changes would create a new source of substantial light or glare that would adversely affect day or nighttime views in the area. The additional workforce would have no observable effects on aesthetics at the Livermore site.

Site 300

Activities under the No-Action Alternative would include a limited amount of new facility construction, modernization/upgrade/utility projects, operational changes, and DD&D activities. The only new No-Action Alternative facility would be the SFTF. It would be similar in character to existing infrastructure and surrounding uses. This project would be visible from the Corral Hollow Road, but would be consistent with existing buildings and infrastructure in the Small Arms Training Area. Total land occupied by new facilities (i.e., the SFTF) would be 0.1 acre. Land reclaimed as a result of DD&D would be 0.02 acre. Overall, an additional 0.1 acre of land would be disturbed at Site 300 beyond the current baseline.

Views of Site 300 resemble a business park-like setting in the General Service Area (GSA), and natural undeveloped areas elsewhere. In general, views of Site 300 from Corral Hollow Road are limited due to distance and intervening topography and consist primarily of buildings and infrastructure in the GSA. Consequently, no visual impacts of Site 300 would occur to the built environment, to views of the site from public viewing areas, or to existing viewsheds of the surrounding environment under the No-Action Alternative.

None of the changes would create a new source of substantial light or glare that would adversely affect day or nighttime views in the area. The additional workforce and disturbed land would have no observable effects on aesthetics at Site 300.

5.3.2 Proposed Action

Under the Proposed Action, the ongoing activities described in Chapter 2 and Chapter 4 would continue at LLNL. In addition, the Proposed Action includes the use of facilities and projects described for the No-Action Alternative, as well as new facility construction, DD&D, modernization/upgrade/utility projects, and operational changes described in Section 3.3, as well as operational workforce increases.

Livermore Site

Figure 3-9 depicts the locations of facilities that would be constructed at the Livermore Site under the Proposed Action. Developments and modifications would occur within the developed portion of the site, would be similar in character to existing infrastructure, and would be largely screened from public view by the buffer zone, fences, and vegetation.

A notable visual change at the Livermore Site would be the addition of a New North Entry. The road would cut through the presently undeveloped 500-foot northern buffer between the Livermore Site and the private industrial development to the north. From Patterson Pass Road, there would be a bridge crossing Arroyo Las Positas followed by a gate and guardhouse inside the security buffer. The entry road and low-profile bridge would present a weak degree of contrast and would not attract attention as the site and surrounding landscape is largely developed. Although there would be short-term adverse visual impacts from construction activities, long-term impacts are expected to be minimal. In addition, if the alternate location is selected, the new Fire Station would be located in the north buffer zone near the North Entry and would be visible from offsite locations.

Another facility with potential for visual impact would be a tall stack for the Micro/Nano Technology Laboratory Facility. There would be some visual impacts from Greenville Road as the facility would be located near the LVOC; however, there are few homes in that area. Similarly, the Materials Analysis Laboratory would include small stacks (approximately 10 meters high), but would not be visible from Vasco Road due to the proposed interior location for this facility.

Most other new facilities would not affect the visual environment because they would be located near existing facilities or would be modifications to existing structures. Table 5-3 in Section 5.2.2 lists the 11 largest facilities (equal to or greater than 80,000 square feet) scheduled for development under the Proposed Action. Of the 11, five are tied to the replacement of existing facilities. The largest of these facilities would be located within the interior of the Livermore Site, which would have the highest density of employees. The remaining large facilities would be scattered across the site. As modern facilities replace the aging buildings and trailers (78 percent of existing facilities are greater than 30 years old), the Livermore Site would gradually become more cohesive, with more dedicated open green space.

Facility construction and DD&D activities would result in short-term impacts to the visual environment due to the presence of construction and demolition equipment, facilities in various stages of construction/DD&D, and possibly increased dust. Heavy equipment used during construction would create short-term visual impacts but would not be out of character for an industrial site such as Livermore. The construction laydown areas, temporary parking, and temporary construction office trailers would also be typical. After construction and DD&D activities are complete, heavy equipment temporary construction office trailers would be removed, and construction laydown areas would be incorporated back into the greater campus plan. The buildings would be visually compatible with nearby office, R&D, and computing structures. Removal of old structures would improve the general appearance of the Livermore Site in the long term.

The proposed removal or replacement of aged facilities with more modern facilities creates an opportunity to shift worker population and intensity of use toward a central campus location. Because Lake Haussmann is a feature element and the geographic center of the Livermore Site, implementation of the Proposed Action would consolidate many new facilities in this location to create opportunities for collaboration. This collection of smart growth projects would have a positive impact on visual resources. Implementation of the Proposed Action would also result in rebalanced vehicle parking (*see* Figure 3-11), the removal of limited area fencing (*see* Figure 3-15), expanded pedestrian walkways (*see* Figure 3-16), expanded bicycle network (*see* Figure 3-17), a more centralized core (*see* Figure 3-18), and an end-state site plan with more green space (*see* Figure 4-3). These actions are expected to improve the overall visual character of the Livermore Site.

The Livermore Site is visible in the middle ground and background viewsheds from the surrounding residential and rural areas and designated scenic routes. While viewers in these areas might perceive a slight increase in the built space at the facility because of the development described above, the development would occur within a context of similar development. No additional impacts to aesthetic and scenic resources are expected.

Once steady-state operations are reached in approximately 2035, 61 new facilities, totaling approximately 2,943,400 square feet, would have been constructed at the Livermore Site. About 131 facilities totaling approximately 1,153,000 square feet would have undergone DD&D. Overall, the building stock at the Livermore Site would decrease by about 70 buildings, which would decrease the density of facilities on the site. None of the changes would create a new source of substantial light or glare that would adversely affect day or nighttime views in the area.

The proposed operational changes described in Section 3.3.3 would have no impact on visual resources. Additionally, the increased workforce would not change the aesthetics at the site.

Site 300

The Proposed Action at Site 300 would also include new facility construction, modernization/ upgrade/utility projects, operational changes, and DD&D activities. Developments and modifications would be dispersed throughout the site, would be similar in character to existing infrastructure, and would be largely screened from public view by distance and topography. Total land occupied by new facilities at Site 300 would be 36 acres. Land reclaimed through DD&D under the Proposed Action would be 0.4 acre. In addition, the 1.0 acre laydown area would be restored following construction. Overall, the net disturbance of land would be approximately 34.6 acres, or 0.4 percent of the land at Site 300.

Under the Proposed Action, the location, type, and extent of improvement activities at Site 300 would be additive to those of the No-Action Alternative. The three largest facilities proposed for development under the Proposed Action would be the DRDF, the Advanced 3D Hydrotest Facility, and the WETRC. As shown on Figure 3-3, all three facilities would be located within different areas at Site 300 and no one area would experience a substantial increase in density or construction activities. Based on previous LLNL development practices, development of these projects at Site 300 would be consistent with the existing restrained character of the site. The two office buildings (unclassified and classified spaces) would be located within or near the GSA. The character of the buildings would be similar to existing buildings within the GSA and would be located north of the existing buildings and would not be visible from Coral Hollow Road.

In general, public viewpoints of Site 300 are from Corral Hollow Road and are limited due to distance and intervening topography. The views consist primarily of buildings and infrastructure in the GSA and Small Arms Training Area. Changes proposed at Site 300 under the Proposed Action would either occur in the interior of Site 300, which is not visible from the surrounding area, would have minor effects on aesthetics such as modification of existing facilities or utility upgrades, or would occur in the GSA where such changes would be consistent with the existing visual character of the site. Construction and facility improvement activities in the GSA are especially visible from public viewpoints along Corral Hollow Road. Apart from two facilities-- the Hazardous Waste Office Trailers (5,000 ft^2) and the AEMGF-- all the projects scheduled during the Proposed Action planning period would occur outside the GSA. The AEMGF would consist of a mix of PV arrays and bladeless wind turbines disturbing 20.4 acres (9.4 acres of previously disturbed and 11 acres of previously undisturbed) of land.

The Cyber-Physical Test Capability for Energy Distribution would involve installing electrical generation and storage equipment consisting of ground mount solar arrays, battery storage, and diesel generators (three 200 kVA generators) as well as power distribution equipment connected by a dedicated overhead distribution line system. About 2.25 acres of previously undisturbed area of the land would be used for equipment installation and the new distribution line. This facility would be sited in an interior area of Site 300 (see Figure 3-3).

Views of Site 300 from the Carnegie State Vehicular Recreation Area (Carnegie SVRA) consists primarily of undeveloped hillsides. Due to the large size of the site, the construction and maintenance activities planned for the interior of the site would not be visible from the recreation area and would not change the middle ground and background views of the site. Overall, Site 300 would remain compatible with local and county scenic resource plans and policies.

None of the changes would create a new source of substantial light or glare that would adversely affect day or nighttime views in the area. Onsite changes at Site 300 would not give rise to any notable visual changes. Additionally, the increased workforce would not change the aesthetics at the site.

5.3.3 Summary of Aesthetics and Scenic Resource Impacts for the Alternatives

Table 5-6 summarizes the potential visual and aesthetics impacts for the No-Action Alternative and the Proposed Action.

Table 5-6. Potential Visual and Aesthetics Impacts for the Alternatives

Resource	No-Action Alternative	Proposed Action
Livermore Site		
Increased Operational Footprint (acres)	6.4	52.5
Site 300		
Increased Operational Footprint (acres)	0.1	34.6
Both Sites		
Visual Compatibility	Actions would be consistent with current landscape, would not obscure views, would not detract from the existing scenic perspectives, and would not cause glare.	

5.4 GEOLOGY AND SOILS

The analysis in this section presents the potential impacts on geology and soils for the alternatives due to construction, DD&D, modernization/upgrade/utility projects, and operations. Key metrics in this analysis include: (1) the amount of soil disturbance; (2) the potential for causing erosion, soil loss, or impacts to prime farmland; and (3) analysis of whether soils and geologic features would support new facilities (e.g., potential for landslides and karst). In addition, the analysis identifies and discusses seismic requirements for new facilities.

5.4.1 No-Action Alternative

Under the No-Action Alternative, the ongoing activities described in Chapter 2 and Chapter 4 would continue at LLNL. In addition, new facility construction, DD&D, and modernization/upgrade/utility projects described in Section 3.2 would also occur. With regard to construction and DD&D, potential impacts were estimated for constructing approximately 19 new projects, totaling approximately 416,300 square feet, and DD&D of approximately 42 facilities, totaling approximately 228,000 square feet.

Livermore Site

Under the No-Action Alternative, approximately 13.6 acres of land would be disturbed for construction. Disturbances would occur within previously developed/disturbed areas. Utility replacements/upgrades also have the potential to disturb soils. Most would involve soils that were disturbed when the utilities were originally installed. Some projects, such as storm drain upgrades at the Livermore Site, may involve minor amounts of new disturbance. However, none of the construction activities would affect the topography or geomorphology of the Livermore Site, nor alter the character of the landscape. Approximately 5.2 acres would be reclaimed as a result of DD&D and the net land disturbance for construction of new facilities would be approximately 6.4 acres of previously developed land. This equates to approximately 0.8 percent of the total acreage at the Livermore Site.

As a result of prior activities at the Livermore Site (*see* Section 4.4.1.4), contaminated soils and possibly other media could be encountered during excavation and other site activities. Prior to commencing any new ground disturbance, NNSA would survey planned areas of disturbance to determine the extent and nature of any contaminated media and required remediation in accordance with LLNL's regulatory-approved procedures including the Soil Screening and Management Plan (Bergeron 2021). Any contaminated soils and associated media would be managed in accordance with existing waste management practices. Depending on the nature and extent of any newly discovered contamination, remediation and cleanup could be conducted under existing CERCLA environmental restoration agreements, including the Livermore Site FFA (DOE 1988). Under the No-Action Alternative, ongoing remediation efforts would continue, which would continue to improve soil and subsurface conditions at the Livermore Site (*see* Sections 4.15.1 and 5.15.1).

As discussed in Section 4.4.1.4, the soils at the Livermore Site are not considered prime farmland under the *Farmland Protection Policy Act*; therefore, the disturbance would not impact farmland soils. At all areas on the Livermore Site where construction or facility modifications would occur, adherence to BMPs for soil erosion and sediment control during land-disturbing activities would minimize soil erosion and loss. In general, limiting the amount of time soils are exposed, limiting the area disturbed during any phase of a construction project, and applying protective coverings to denuded areas during construction (e.g., mulching and/or geotextiles) until such time as disturbed areas could be revegetated or otherwise covered by facilities would reduce the potential for soil loss. Soil loss would be further reduced by the use of appropriate sedimentation and erosion control measures as weather conditions dictate. Stockpiles of soil removed during construction would be covered with a geotextile or temporary vegetative covering and enclosed by a silt fence to prevent loss by erosion.

No known geologic resources (i.e., aggregate, clay, coal, or mineral resources) would be adversely affected by construction activities related to the No-Action Alternative. None of the ongoing or planned projects or activities proceeding under the No-Action Alternative would take place near or upon known or exploitable mineral resources, unique geologic outcrops, or other unique geologic features. The construction activities would include the consumption of aggregate materials from offsite resources.

The geologic hazards associated with the Livermore Site are part of the character of that region. The hazards exist regardless of the presence of human activities, buildings, or facilities. Potential sources for future ground motion at the Livermore Site include the major regional faults, as well as the local faults. No active faults are known to underlie the site, and there is no historical record of surface rupturing or faulting at the site (LLNL 2007a). As discussed in Section 4.4.3.2, the Livermore Site consists of a relatively flat land surface that slopes gently to the northwest. Consequently, there is minimal potential for slope instability because of the low relief. Based on depth to groundwater (of at least 30 feet), the uniformly distributed, poorly sorted sediments beneath the site, and a relatively high degree of sediment compaction, the potential for damage from liquefaction at the Livermore Site is also low.

Any new facility associated with the No-Action Alternative would be designed and constructed to meet seismic design criteria commensurate with the risk category requirements of the facility. Depending on the specific facility, the seismic design could be based on requirements such as DOE Order 420.1C and DOE-STD-1020-2016 and/or the International Building Code (IBC),[1] using a site-specific seismic hazard study to define the design earthquake ground motions. Potential impacts from geologic hazards (i.e., seismic events) on operations are discussed in Section 5.16.

For nonnuclear facilities, DOE Order 420.1C and DOE-STD-1020-2016 do not drive enhancements beyond the relevant IBC risk category requirements. Under the No-Action Alternative, three existing facilities (Buildings 235, 321A, and 411) would be modified for seismic risk reduction. Any potential impacts to geology and soils would occur in the construction phases of the projects at the Livermore Site under the No-Action Alternative. Following construction, operations would take place in areas already disturbed by previous activities. No impacts to geology or soils would occur from operations under the No-Action Alternative.

Site 300

Under the No-Action Alternative, approximately 0.6 acre of land/soils (includes 0.5 acre laydown area) would be disturbed for construction. Utility replacement/upgrades would also have the potential to disturb soils. Most would involve soils that were disturbed when the utilities were originally installed. Some projects, such as water supply piping, valves, and water supply wells at Site 300 may involve minor amounts of new disturbance. No other construction or excavation projects are planned that would alter these features of the landscape. The No-Action Alternative would not include project work that would impact the topography or geomorphology of Site 300. Approximately 0.02 acre of land/soils would be reclaimed as a result of DD&D. The net land disturbance for construction of new facilities would be approximately 0.1 acre, which represents approximately 0.001 percent of the land at Site 300.

Prior to commencing any new ground disturbance, NNSA would survey proposed areas of disturbance to determine the extent and nature of any contaminated media and required remediation in accordance with LLNL's regulatory-approved procedures including the Soil Screening and Management Plan (Bergeron 2021). Any contaminated soils and media would be managed in accordance with existing waste management practices. Depending on the nature and extent of any newly discovered contamination, remediation and cleanup could be conducted under existing CERCLA environmental restoration agreements, including the Site 300 FFA (DOE 1992c). Under the No-Action Alternative, ongoing environmental restoration program remediation

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[1] For nonnuclear facilities, the IBC establishes the minimum requirements to safeguard the public safety and safety to life and property from hazards and provides the classification of buildings based on the purpose or purposes for which they are used. The IBC assigns risk categories to buildings to account for consequences and risks to human life (building occupants) in the event of a building failure. The risk category serves as a threshold for a variety of code provisions related to earthquake, flood, snow, and wind loads, and even the magnitude of special inspections. The value of the importance factor generally increases with the importance of the facility. Structures assigned greater importance factors must be designed for larger forces. The result is a more robust structure that would be less likely to sustain damage under the same conditions than a structure with a lower importance factor. The intent is to enhance a structure's performance based on its use or need to remain in operation during and after a disaster. The impact of a higher risk category classification is not limited to increasing the design loads. Compared to Risk Category I, II or III for instance, a Risk Category IV classification can lead to a higher seismic design category classification that can, in turn, require more stringent seismic detailing and limitations on the seismic-force-resisting system. This can also affect seismic design requirements for architectural, mechanical, and electrical components (Froehling and Robertson 2020).

efforts would continue, which would continue to improve soil and subsurface conditions at Site 300 (*see* Sections 4.15.1 and 5.15.1).

As discussed in Section 4.4.1.4, the soils at Site 300 are not considered prime farmland under the *Farmland Protection Policy Act*; therefore, the disturbance would not impact farmland soils. As discussed above for the Livermore Site, BMPs would be employed for soil erosion and sediment control during land-disturbing activities, which would minimize soil erosion and loss.

No known aggregate, clay, coal, or mineral resources would be adversely affected by the No-Action Alternative. None of the activities that would proceed under the No-Action Alternative are near or on any known or exploitable mineral resources, unique geologic outcrops, or other unique geologic features. The construction activities would include the consumption of aggregate materials from offsite resources.

The geologic hazards associated with Site 300 are part of the character of that region. The hazards exist regardless of the presence of human activities, buildings, or facilities. As discussed in Section 4.4.3.1, there is a potential for surface faulting at Site 300. In addition, the topography ranges from gently sloping to nearly vertical in places, and numerous landslide features have been mapped with the largest landslide covering approximately 0.5 square mile. The potential for liquefaction at Site 300 is low. Potential impacts from geologic hazards (i.e., seismic events) on operations are discussed in Section 5.16.

Any potential impacts to geology and soils would occur in the construction phases of the projects at Site 300 under the No-Action Alternative. Following construction, operations would take place in areas already disturbed by previous activities. No impacts to geology or soils would occur from operations under the No-Action Alternative.

5.4.2 Proposed Action

Under the Proposed Action, the ongoing activities described in Chapter 2 and Chapter 4 would continue at LLNL. In addition, the Proposed Action includes the use of facilities and projects described for the No-Action Alternative, as well as new facility construction, DD&D, modernization/upgrade/utility projects and operational changes described in Section 3.3, as well as operational workforce increases.

Impacts were estimated for construction activities for approximately 75 new projects, totaling approximately 3.3 million square feet over the period 2023–2035. Of this, 61 projects with a total area of approximately 2.9 million square feet are proposed at the Livermore Site; 14 facilities with a total area of approximately 385,000 square feet are proposed at Site 300. NNSA would also DD&D about 150 facilities, totaling approximately 1,170,000 square feet; 98.5 percent of these facilities are at the Livermore Site (131 facilities, totaling about 1,153,000 square feet) and 1.5 percent (18 facilities, totaling about 17,000 square feet) are at Site 300.

Livermore Site

Under the Proposed Action, approximately 85.5 acres of the site would be disturbed. The 85.5-acres of disturbance represents 10.4 percent of the current acreage of the Livermore Site. Because of the historic development activities at the Livermore Site, any land disturbance is expected to occur on previously disturbed land. Approximately 26.5 acres would be reclaimed as a result of DD&D. The net land disturbance for construction of new projects would be approximately 52.5 acres of previously developed land. This equates to approximately 6.4 percent of the total acreage at the Livermore Site.

Although not a native or natural water body, Lake Haussmann is a feature water element. NNSA is proposing additional landscaping around Lake Haussmann to facilitate a collaborative environment while retaining a significant water feature. These soils were previously disturbed during the construction of the lake. Lake Haussmann would still fulfill its intended purpose as a stormwater runoff and treated groundwater conveyance channel.

Utility replacements/upgrades also have the potential to disturb soils. Most would involve soils that were disturbed when the utilities were originally installed. However, none of the construction activities would affect the topography or geomorphology of the Livermore Site, nor alter the character of the landscape. For example, the proposed project to extend the city of Livermore reclaimed water distribution system for cooling tower use would require construction of approximately 6,000 linear feet of six-inch-diameter piping, buried to a depth of approximately three feet. Approximately 2.5 acres of soils would be disturbed during construction but would be restored after construction.

As a result of prior contamination at the Livermore Site (*see* Section 4.4.1.4), contaminated soils and possibly other media could be encountered during excavation and other site activities. Prior to commencing any new ground disturbance, NNSA would survey potentially affected areas to determine the extent and nature of any contaminated media and required remediation in accordance with LLNL's regulatory-approved procedures including the Soil Screening and Management Plan (Bergeron 2021). Any contaminated soils and media would be managed in accordance with existing waste management practices. Under the Proposed Action, ongoing remediation efforts would continue, which would continue to improve soil and subsurface conditions at the Livermore Site (*see* Sections 4.15.1 and 5.15.1).

As discussed in Section 4.4.1.4, the soils at the Livermore Site are not considered prime farmland under the *Farmland Protection Policy Act*; therefore, the disturbance would not impact farmland soils. As discussed in Section 5.4.1, at all areas on the Livermore Site where construction or facility modifications would occur, adherence to BMPs for soil erosion and sediment control during land-disturbing activities would minimize soil erosion and loss.

No known geologic resources (i.e., aggregate, clay, coal, or mineral resources) would be adversely affected by construction activities related to the Proposed Action. None of the ongoing or planned projects or activities proceeding under the Proposed Action would take place near or upon known or exploitable mineral resources, unique geologic outcrops, or other unique geologic features. The construction activities would include the consumption of aggregate materials from off-site resources.

The geologic hazards associated with the Livermore Site discussed in Section 5.4.1 would be applicable to the Proposed Action and are not repeated here. Any new facility associated with the Proposed Action would be designed and constructed to meet seismic design criteria commensurate with the risk category requirements of the facility. Depending on the specific facility, the seismic design would comply with various requirements, such as DOE Order 420.1C, DOE-STD-1020-2016, and/or the IBC, using a site-specific seismic hazard study to define the design earthquake ground motions. Under the Proposed Action, three existing facilities (Buildings 271, 381B, and 431) would be modified for seismic risk reduction. Potential impacts from geologic hazards (i.e., seismic events) on operations are discussed in Section 5.16.

Any potential impacts to geology and soils would occur in the construction phases of the projects at the Livermore Site under the Proposed Action. Following construction, operations would take place in areas already disturbed by previous activities. No impacts to geology or soils would occur from operations under the Proposed Action.

Site 300

The land disturbance from construction activities would total 36 acres. Approximately 0.4 acre of land would be reclaimed as a result of DD&D. The net change in soil disturbance at Site 300 would be 34.6 acres after laydown areas are restored. The 34.6 acres of soil disturbance represents 0.5 percent of the total 7,000-acre footprint of Site 300; or a 9.9 percent increase from the 350 acre disturbed areas.

Utility replacement and upgrades have the potential to disturb soils. Most would involve soils that were disturbed when the utilities were originally installed. Some projects, such as water supply piping, valves, and wells at Site 300 may involve minor amounts of new disturbance. The Cyber-Physical Test Capability for Energy Distribution would include the construction of overhead power distribution; however, there is also a potential these electrical lines could be buried. Mitigation for ground disturbance would be applied as needed. No other construction or excavation projects are planned that would alter these features of the landscape.

With regard to potential soil impacts, one notable facility proposed for construction at Site 300 is the DRDF. This 60,000 square foot facility (plus a 60,000 to 80,000 square foot open air shed) would be constructed adjacent to Building 801 in the Area 2 East Firing Area of Site 300 (*see* Figure 3-3). Although the exact footprint of the proposed facility has not been established, if the facility is built on the north side of Building 801, it would require extensive excavation of the hillside. Additionally, the upper few feet of the soil could be contaminated with beryllium, depleted uranium, metals, and other components from historical outdoor use of this area. Thousands of tons of soil may be excavated from the hillside. If located on the south side, the excavation is expected to be much less. However, prior to commencing any new ground disturbance, NNSA would survey potentially affected areas to determine the extent and nature of any contaminated media and required remediation in accordance with LLNL's regulatory-approved procedures including the Soil Screening and Management Plan (Bergeron, 2021). Any contaminated soils and media would be managed in accordance with existing waste management practices. Uncontaminated excavated soils would be used as grade and fill around the construction area. Under the Proposed Action, ongoing remediation efforts would continue, which would continue to improve soil and subsurface conditions at Site 300 (*see* Sections 4.15.1 and 5.15.1).

As discussed in Section 4.4.1.4, the soils at Site 300 are not considered prime farmland under the *Farmland Protection Policy Act*; therefore, the disturbance would not impact farmland soils. As discussed in Section 5.4.1.1, at all areas on Site 300 where construction or facility modifications would occur, adherence to BMPs for soil erosion and sediment control during land-disturbing activities would minimize soil erosion and loss.

No known aggregate, clay, coal, or mineral resources would be adversely affected by the Proposed Action. None of the activities that would proceed under the Proposed Action are near or on any known or exploitable mineral resources, unique geologic outcrops, or other unique geologic features. The construction activities would include the consumption of aggregate materials from off-site resources.

The geologic hazards associated with Site 300 discussed in Section 5.4.1 would be applicable to the Proposed Action and are not repeated here. Any new facility associated with the Proposed Action would be designed and constructed to meet seismic design criteria commensurate with the risk category requirements of the facility. Depending on the specific facility, the seismic design would comply with various requirements, such as DOE Order 420.1C, DOE-STD-1020-2016, and/or the IBC, using a site-specific seismic hazard study to define the design earthquake ground motions. Potential impacts from geologic hazards (i.e., seismic events) are discussed in Section 5.16.

Any potential impacts to geology and soils would occur in the construction phases of the projects at Site 300 under the Proposed Action. Following construction, operations would take place in areas already disturbed by previous activities. No impacts to geology or soils would occur from operations under the Proposed Action.

5.4.3 Summary of Geology and Soils Impacts for the Alternatives

Table 5-7 summarizes the potential geology and soils impacts for the No-Action Alternative and the Proposed Action.

Table 5-7. Potential Impacts to Geology and Soils for the Alternatives

Resource	No-Action Alternative	Proposed Action
Livermore Site		
Soil Disturbance during Construction (acres)	13.6	85.5
DD&D and Laydown Areas Restoration (acres)	5.2	26.5
Increased Operational Footprint (acres)	6.4	52.5
Site 300		
Soil Disturbance during Construction (acres)	0.6	36.0
DD&D and Laydown Areas Restoration (acres)	0.5	1.4
Increased Operational Footprint (acres)	0.1	34.6
Both Sites		
Prime Farmland	Soils are not classified as prime farmland. No potential impacts.	
Erosion Potential	Erosion controls and BMPs would be used to minimize soil erosion during construction and operations. Significant impacts would not be expected.	
Mineral Resources	No known geologic resources (i.e., aggregate, clay, coal, or mineral resources) would be adversely affected by construction and operations.	

Resource	No-Action Alternative	Proposed Action
Existing Soil Contamination	Prior to ground disturbance, NNSA would determine the extent and nature of any contaminated media and required remediation in accordance with the procedures established under LLNL's soils program. Contaminated soils and media would be managed in accordance with existing waste management practices.	
Geologic Hazards	Facilities would be designed and constructed to meet seismic design criteria commensurate with risk category requirements for the facility.	

5.5 WATER RESOURCES

The analysis in this section presents the potential impacts on water resources for the alternatives due to construction, DD&D, modernization/upgrade/utility projects, and operations. The water resources section analyzes both surface and groundwater. Key metrics presented in this analysis include: (1) increases in impervious areas and stormwater effects; (2) analysis of effluents and the potential for surface/groundwater contamination; and (3) potential floodplain impacts. Potential impacts to wetlands are discussed in Section 5.8 (Biological Resources). Potential impacts associated with water use are discussed in Section 5.12 (Infrastructure).

5.5.1 No-Action Alternative

Under the No-Action Alternative, the ongoing activities described in Chapter 2 and Chapter 4 would continue at LLNL. In addition, new facility construction, modernization/upgrade/utility projects, and DD&D activities described in Section 3.2 would also occur. Water resource impacts were estimated for constructing approximately 19 new facilities, totaling approximately 416,300 square feet, and DD&D of approximately 42 facilities, totaling approximately 228,000 square feet over the period 2020–2022.

Livermore Site

The addition of new facilities under the No-Action Alternative would create soil disturbance and increase impervious surfaces at the Livermore Site, which could lead to an increase in stormwater runoff. As discussed in Section 5.2.1, a total of approximately 13.6 acres of land would be disturbed by construction, approximately 5.2 acres of land would be reclaimed as a result of DD&D, and 2 acres of laydown area would be restored. Therefore, net land disturbance would be approximately 6.4 acres, which is about 0.8 percent of the Livermore Site area. The Livermore Site is approximately 85 percent developed; however, the new facilities would be constructed of impervious materials, and therefore the potential for stormwater impacts could increase.

Surface Water. For construction projects that disturb one acre of land or more, LLNL meets stormwater compliance monitoring requirements of the California National Pollutant Discharge Elimination System (NPDES) General Permit for Storm Water Discharges Associated with Construction Activity (Order Number 2009-0009-DWQ). As part of the NPDES permit, the development and implementation of a Stormwater Pollution Prevention Plan (SWPPP) would be required to help minimize any pollution that might leave the site by stormwater. The SWPPP would contain a detailed site plan and schematics for the installation of temporary and permanent stormwater and erosion control devices to effectively manage the site during construction and facility operation. Additionally, Section 438 of the *Energy Independence and Security Act* specifically calls for federal development that has a footprint that exceeds 5,000 square feet to maintain or restore pre-development hydrology. As such, facility design would incorporate permanent controls for the proper management of stormwater.

Surface water resources would be protected from potential contaminant releases during construction and operation of facilities under the No-Action Alternative. Potential contaminant sources could include construction materials; hydraulic fluid, oil, and diesel fuel; and releases from transportation or waste-handling accidents. LLNL would follow mitigation steps outlined in its Spill Prevention, Control, and Countermeasure (SPCC) Plan and ES&H Action Plan in the event of a spill of petroleum product. Implementation of spill prevention and response plans would minimize any impacts from spills during construction and operations.

Surface water monitoring would continue in accordance with DOE guidelines to determine whether any radioactive or nonradioactive constituents released by LLNL might have a negative impact on public health and the environment. Stormwater monitoring would continue in accordance with Storm Water Industrial General Permit (2014-8-0057-DWQ) requirements. Wastewater monitoring would continue as discussed in Section 4.12.4 in accordance with Wastewater Discharge Permit (Permit #1250) requirements administered by the City of Livermore Water Resources Division and the City of Livermore Municipal Code. Because of the extensive monitoring program and capability to divert and hold potentially contaminated wastewater through the sewage diversion facility, no impacts to the Livermore Water Reclamation Plant (LWRP) or downstream receiving surface waters would be expected.

Groundwater. Groundwater resources would be protected from potential contaminant releases during construction and operations of facilities under the No-Action Alternative. Potential contaminant sources could include construction materials; spills of hydraulic fluid, oil, and diesel fuel; and releases from transportation or waste handling accidents. The potential for spills of hazardous materials to impact groundwater largely depends on the depth to groundwater where the spill occurs. LLNL would follow prevention and mitigation steps from its SPCC Plan and ES&H Action Plan in the event of a hazardous material spill. Because the minimum depth to groundwater at the Livermore Site is approximately 30 feet and employees are trained in spill response procedures, spills would likely be cleaned up before they reach the water table.

At the Livermore Site, the primary soil and groundwater contaminants of concern are volatile organic compounds (VOCs), primarily trichloroethylene (TCE) and perchloroethylene (PCE). During operations, groundwater monitoring would continue under the No-Action Alternative to ensure that remediation of contamination already present continues to be effective and that contaminant fate and transport is fully understood. Groundwater quality should continue to improve because extracted groundwater would be collected and treated at the onsite treatment facilities. During operations, impacts to groundwater from leaking underground storage tanks would not be expected since LLNL complies with applicable underground storage tank regulations which enforce the use of tank and piping primary and secondary containment, detection and monitoring systems, and corrosion protection.

Impacts to groundwater at the Livermore Site are not expected under the No-Action Alternative because there would be no discharges to groundwater. Impacts to groundwater quality from surface water recharge would be minimized by complying with NPDES and Wastewater Discharge Permit limits and requirements.

Floodplains. The 100-year floodplain, as defined by the Federal Emergency Management Agency (FEMA), at the Livermore Site is presented in the 2020 Wetland/Aquatic Resources Delineation (Nomad Ecology 2020). The FEMA floodplain map shows a total of 25.9 acres of floodplain on the Livermore Site (*see* Figures 4-61 and 4-62). Floodplains are associated with the Arroyo Las Positas (23.5 acres) and the Arroyo Seco (2.4 acres). As indicated in Appendix E, there are no construction and operations projects under the No-Action Alternative that would affect the floodplains at the Livermore Site.

<u>Site 300</u>

Under the No-Action Alternative, project construction would create soil disturbance and increase impervious surfaces, which could lead to an increase in stormwater runoff. During construction, a total of approximately 0.6 acres (including 0.5 acre for laydown) of land would be disturbed. Meanwhile, approximately 0.02 acre of impervious land would be reclaimed as a result of DD&D. Therefore, net land disturbance would be approximately 0.1 acre, which is 0.001 percent of the land area at Site 300. This equates to a 0.03 percent increase over the existing Site 300 disturbed areas.

Surface Water. A California NPDES General Permit for Storm Water Discharges Associated with Construction Activity (Order Number 2009-0009-DWQ) would be required. As part of the NPDES permit, the development and implementation of a SWPPP would be required to help minimize any pollution that might leave the site by stormwater. Additionally, Section 438 of the *Energy Independence and Security Act* requires that facility design incorporate permanent controls for the proper management of stormwater. These mitigation requirements would help to minimize impacts to surface water during construction and operations.

Surface water resources would be protected from potential contaminant releases during construction of the new facility. Potential contaminant sources could include construction materials, spills of oil and diesel fuel, and releases from transportation or waste-handling accidents. During operations, spills of oil and diesel fuel, and releases from transportation or waste-handling accidents could occur. LLNL would follow mitigation steps outlined in its SPCC Plan and ES&H Action Plan in the event of a spill of petroleum products. Because employees are trained in emergency spill response procedures, surface spills would be unlikely to impact surface water bodies or groundwater.

During operations, surface water monitoring would continue in accordance with DOE guidelines to determine whether any radioactive or nonradioactive constituents released by LLNL might have a negative impact on public health and the environment. Stormwater monitoring would continue in accordance with Storm Water Industrial General Permit (2014-8-0057-DWQ) requirements. Wastewater monitoring would continue as discussed in Section 4.12.4. Wastewater discharges to the ground would be subject to the requirements of permit WDR-R5 2008-0148, issued by the CRWQCB (CRWQCB 2008). Under the terms of the Monitoring and Reporting Program, LLNL submits semi-annual and annual monitoring reports detailing its Site 300 discharges of domestic and wastewater effluent to sewage evaporation and percolation ponds in the GSA, as well as cooling tower blowdown to percolation pits and septic systems and mechanical equipment discharges to percolation pits located throughout the site. Potential impacts to groundwater quality from surface water recharge would be minimized because Site 300 would continue to comply with NPDES and WDR permit requirements.

Groundwater. Groundwater resources would be protected from potential contaminant releases during construction. Potential contaminant sources could include construction materials; spills of hydraulic fluid, oil, and diesel fuel; and releases from transportation or waste handling accidents. LLNL would follow mitigation steps outlined in its SPCC Plan and ES&H Action Plan in the event of an oil or hazardous material spill. The potential for spills of hazardous materials to affect groundwater largely depends on the depth to groundwater where the spill occurs. Depth to groundwater at Site 300 ranges from approximately 30 to 130 feet. Because the minimum depth to groundwater at Site 300 in areas where activities are expected under the No-Action Alternative is approximately 30 feet and employees are trained in spill response procedures, spills would likely be cleaned up before they reach the water table based on the local hydrogeology characteristics.

Groundwater contaminants of concern at Site 300 include VOCs, HE compounds, tritium, depleted uranium, organosilicate oil, nitrate, perchlorate, and metals. This contamination is confined within the site boundaries with the exception of VOCs that are present in offsite monitoring wells near the southern site boundary. Cleanup activities began at Site 300 in 1982 and are ongoing (LLNL 2020r). During operations, groundwater quality would continue to improve as remediation activities continue at Site 300.

During operations, impacts to groundwater from leaking underground storage tanks would not be expected since LLNL complies with applicable underground storage tank regulations which enforce the use of tank and piping primary and secondary containment, detection and monitoring systems, and corrosion protection.

Floodplains. The FEMA 100-year floodplain at Site 300 is presented in the 2020 Wetland/Aquatic Resources Delineation (Nomad Ecology 2020). The FEMA floodplain map shows that the floodplain associated with the Corral Hollow intermittent stream in the southeast corner of Site 300 is 9.6 acres (*see* Figure 4-63). Construction would not occur within the 100-year floodplain (Corral Hollow Creek) or areas susceptible to flash flooding (i.e., drainage channels with steep slopes). Therefore, no impacts to the floodplain or from flooding would be expected at Site 300 from construction. In addition, there would be no operational activities associated with the No-Action Alternative that would impact floodplains at Site 300.

5.5.2 Proposed Action

Under the Proposed Action, the ongoing activities described in Chapter 2 and Chapter 4 would continue at LLNL. In addition, the Proposed Action includes the use of facilities and projects described for the No-Action Alternative, as well as new facility construction, modernization/upgrade/utility projects, operational changes, and DD&D activities described in Section 3.3. Impacts were estimated for construction activities for approximately 75 new projects, totaling approximately 3.3 million square feet over the period 2023–2035. Of this, 61 projects with a total area of approximately 2.9 million square feet are proposed at the Livermore Site; 14 facilities with a total area of approximately 385,000 square feet are proposed at Site 300. NNSA would also DD&D about 150 facilities, totaling approximately 1,170,000 square feet; 98.5 percent of these facilities are at the Livermore Site (131 facilities, totaling about 1,153,000 square feet) and 1.5 percent (18 facilities, totaling about 17,000 square feet) are at Site 300.

Livermore Site

The construction of new facilities, and demolition of aged, excess facilities under the Proposed Action would create soil disturbance at the Livermore Site, which could potentially lead to an increase in stormwater runoff. During construction, a total of approximately 85.5 acres of land would be disturbed. Meanwhile, approximately 26.5 acres of land would be reclaimed as a result of DD&D. Therefore, net land disturbance would be approximately 52.5 acres, which is approximately 6.4 percent of the land area at the Livermore Site. The Livermore Site is extensively developed; however, the new facilities would generally be constructed of impervious materials, which could increase stormwater.

As shown on Figures 3-12 and 3-13, a New North Entry to the Livermore Site would be constructed in approximately 2025. This site entry would provide quick employee access to the center of the laboratory where several new facilities and office buildings are being considered. Approximately 1,500 linear feet of roadway construction and 4 acres of land would be disturbed for this project. The roadway would cross the 500-foot-wide north buffer zone, and an approximately 100-foot-long bridge would be constructed across the existing Arroyo Las Positas (LLNL 2021d). A SWPPP would be required to help minimize any pollution that might leave the site by stormwater. Additionally, requirement of Section 438 of the Energy Independence and Security Act specifically would be met. As such, the roadway design would incorporate permanent controls for the proper management of stormwater to minimize impacts to receiving waters.

Surface Water. During construction, LLNL would comply with California NPDES General Permit for Storm Water Discharges Associated with Construction Activity and would develop and implement a site-specific SWPPP to help minimize any pollution that might leave the site by stormwater. Additionally, LLNL would comply with Section 438 of the *Energy Independence and Security Act*, and facility design would incorporate permanent controls for the proper management of stormwater and minimize any impacts to receiving waterbodies during construction and operations.

Protection of surface water resources would be the same as discussed in Section 5.5.1. Surface water monitoring would continue in accordance with DOE guidelines. Stormwater monitoring would continue in accordance with Storm Water Industrial General Permit (2014-8-0057-DWQ) requirements. Wastewater monitoring would continue as discussed in Section 4.12.4 in accordance with Wastewater Discharge Permit (Permit #1250) requirements. Because of the extensive monitoring program and capability to divert and hold potentially contaminated wastewater through the sewage diversion facility, no impacts to the LWRP or downstream receiving surface waters would be expected.

Groundwater. Protection of groundwater resources would be the same as discussed in Section 5.5.1. Groundwater monitoring would continue under the Proposed Action to ensure that remediation of contamination already present continues to be effective and that contaminant fate and transport is fully understood. Groundwater quality should continue to improve because extracted groundwater would be collected and treated at the onsite treatment facilities.

No negative impacts to groundwater at the Livermore Site are expected from operations under the Proposed Action because there would be no discharges to groundwater. Impacts to groundwater quality from surface water recharge would be minimal because LLNL would continue to comply with NPDES and Wastewater Discharge Permit limits and requirements.

Floodplains. Two proposed projects under the Proposed Action (the New North Entry and the new Fire Station [alternate location]) could be located in the north buffer zone and could potentially affect floodplains (*see* Figure 3-9). The north buffer zone is mostly an undeveloped area located north of Arroyo Las Positas and south of Patterson Pass Road. The entire north buffer zone is within the 500-year flood plain of Arroyo Las Positas and the 100-year flood plain occurs immediately north and south of Arroyo Las Positas. The area has been previously used for soil storage, so the elevation is not uniform. The north buffer zone is vegetated by non-native annual grassland and annual maintenance includes mowing.

Based on the 2020 delineations (Nomad Ecology 2020) and Appendix E, the New North Entry would cross approximately 0.9 acres (approximately 2 percent) of the 500-year floodplain (critical action floodplain) in the north buffer zone and approximately 0.1 acres (approximately 0.4 percent) of the 100-year floodplain (base floodplain) along Arroyo Las Positas. The New North Entry is not considered a critical action because a small chance of flooding is not significant for this new roadway. Additionally, with regard to ingress and egress, the Livermore Site has three alternative entrances that can be used in the event of flooding. The proposed bridge would span the Arroyo Las Positas and would not be expected to result in significant impacts to the associated intermittent stream-wetlands. Prior to the start of the construction of the New North Entry, wetland delineations would be conducted at the location of the crossing. Appropriate permits would be obtained from the Army Corps of Engineers and the state Regional Water Quality Control Board if jurisdictional waters or wetlands may be impacted by this project. The proposed roadway would continue through previously developed land onto the Livermore Site. The Floodplain and Wetlands Assessment (Appendix E) concluded that no alternatives were identified for a New North Entry that would avoid crossing the north buffer area floodplain and the Arroyo Las Positas floodplain; therefore, no practicable alternative is required. Once operational, the roadway would result in negligible effects on the floodplain storage capacity and stormwater quality. Section 5.8.1 discusses any potential impacts to sensitive biological resources associated with the floodplain.

If the alternate location is selected, the new Fire Station could disturb approximately 0.7 acres (approximately 1.6 percent) of the 500-year floodplain (critical action floodplain) but would not disturb any acres of the 100-year floodplain (base floodplain). Additional analysis of surface elevations and hydrology is required to determine the potential for flooding at the proposed location. The north buffer zone has been used for soil storage and exact elevations and flood potential may differ from what is presented in the FEMA Flood Hazard Map. The facility would not store materials that are highly volatile, toxic, or water reactive that could cause significant adverse impacts in the event of a flood, which is indicative of a non-critical action.

If the alternate location for the Fire Station is selected, an analysis would be conducted prior to construction to determine the potential of flooding at the location. This analysis would be based on hydrological modeling of potential surface flow and an analysis of historic flood data for this location. Based on the results of this analysis, the design of the new Fire Station would include features to mitigate against flooding impacts. Design considerations could include raising the elevation of the Fire Station construction site as well as other mitigations.

Site 300

The construction of new facilities under the Proposed Action would create soil disturbance and increase impervious surfaces, which could potentially lead to increased amounts of runoff. The land disturbance from construction activities would total 36 acres. Approximately 0.4 acre of land would be reclaimed as a result of DD&D. The net change in soil disturbance at Site 300 would be 34.6 acres after laydown areas are restored. The 34.6 acres of soil disturbance represents 0.5 percent of the total 7,000-acre footprint of Site 300; or a 9.9 percent increase over the 350 acre disturbed areas.

Surface Water. A California NPDES General Permit for Storm Water Discharges Associated with Construction Activity (Order Number 2009-0009-DWQ) would be required. As part of the NPDES permit, the development and implementation of a SWPPP would be required to help minimize any pollution that might leave the site by stormwater. Additionally, Section 438 of the *Energy Independence and Security Act* requires that facility design incorporate permanent controls for the proper management of stormwater. These mitigation requirements would help to minimize impacts to surface water during construction and operations.

Protection of surface water resources would be the same as discussed in Section 5.5.1. Surface water monitoring would continue under the Proposed Action. Stormwater monitoring would continue in accordance with Storm Water Industrial General Permit (2014-8-0057-DWQ) requirements. Wastewater monitoring would continue as discussed in Section 4.12.4. Potential impacts to groundwater quality from surface water recharge would be minimal because Site 300 would continue to comply with NPDES and Wastewater Discharge Permit requirements.

Groundwater. Protection of groundwater resources would be the same as discussed in Section 5.5.1. Groundwater monitoring would continue under the Proposed Action to ensure that remediation of contamination already present continues to be effective and that contaminant fate and transport is fully understood. Under the Proposed Action, groundwater quality would continue to improve as remediation activities continue at Site 300.

Floodplains. Construction would not occur within the 100-year floodplain (Corral Hollow Creek) or areas susceptible to flash flooding (i.e., drainage channels with steep slopes), and therefore no impacts to the floodplain or from flooding would be expected.

5.5.3 Summary of Water Resources Impacts for the Alternatives

Table 5-8 summarizes the potential impacts to water resources for the No-Action Alternative and the Proposed Action.

Table 5-8. Potential Impacts to Water Resources for the Alternatives

Resource	No-Action Alternative	Proposed Action
Livermore Site		
Impervious Surfaces Created from Construction (acres)	13.6	85.5
Impervious Surfaces Reclaimed from DD&D and Restoration of Laydown Areas (acres)	7.2	33
Net Increase in Operational Impervious Footprint (acres)	6.4	52.5
Potential for Contaminant Releases during Construction, DD&D, and Operations	Minimal	Minimal
Potential Impacts to Floodplains	No Impact	New North Entry would cross approximately 0.9 acres (approximately 2 percent) of the 500-year floodplain (critical action floodplain) in the north buffer zone and approximately 0.1 acres (approximately 0.4 percent) of the 100-year floodplain (base floodplain) along Arroyo Las Positas. If sited at the alternate location, the New Fire Station could disturb approximately 0.7 acres (approximately 1.6 percent) of the 500-year floodplain (critical action floodplain) but would not disturb any acres of the 100-year floodplain (base floodplain).
Site 300		
Impervious Surfaces Created from Construction (acres)	0.6	36.0
Impervious Surfaces Reclaimed from DD&D and Restoration of Laydown Areas (acres)	0.5	1.4
Net Increase in Operational Impervious Footprint (acres)	0.1	34.6
Potential for Contaminant Releases during Construction, DD&D, and Operations	Minimal	Minimal
Potential Impacts to Floodplains	Negligible	Negligible

5.6 AIR QUALITY

The analysis in this section presents the potential air quality impacts for the alternatives due to construction, DD&D, modernization/upgrade/utility projects, and operations. Key metrics presented in the air quality analysis include: (1) quantities of air emissions and comparisons to air quality standards; (2) quantities of greenhouse gas (GHG) emissions and comparison to state-wide emissions; and (3) quantities of radiological emissions (note: potential human health impacts from radiological emissions are presented in Section 5.14). The analysis considers air emissions associated with land disturbance, use of construction equipment, heating and cooling of facilities, and worker commuting.

5.6.1 No-Action Alternative

Under the No-Action Alternative, the ongoing activities described in Chapter 2 and Chapter 4 would continue at LLNL. In addition, new facility construction, DD&D, and modernization/upgrade/utility projects described in Section 3.2 would also occur. Operational changes (e.g., increases in the number of workers) could also affect air quality impacts.

The general conformity regulations were specifically designed to ensure actions taken by federal agencies, such as those at LLNL, do not interfere with a state's plans to attain and maintain national standards for air quality. The general conformity regulations define *de minimis* levels (of minimal importance) below which the general conformity rules do not apply. General conformity was developed with NEPA in mind, and it is understood that activities and actions that have emissions below the *de minimis* levels would not interfere with the state's timely attainment of the NAAQS, cause or contribute to new violations of NAAQS, or worsen existing violations of the NAAQS.

The analysis used the Air Conformity Applicability Model (ACAM)[2] to determine whether emissions from new sources would exceed the general conformity rule's *de minimis* threshold values for assessing effects to air quality. Emissions were estimated for constructing approximately 416,300 square feet of new facilities. All but one of project would be located at the Livermore Site; the only facility to be constructed at Site 300 is the 4,000-square-foot SFTF. Over the period 2020–2022, NNSA expects to DD&D approximately 42 excess facilities, totaling approximately 228,000 square feet. All but one of the facilities scheduled for DD&D are at the Livermore Site (41 facilities, totaling approximately 227,000 square feet). The only facility at Site 300 that would undergo DD&D is Building 8806 (1,000 square feet). On an annualized basis, NNSA would DD&D approximately 76,000 square feet of excess/aging facilities over the No-Action Alternative planning period (2020–2022).

Land disturbance associated with construction and DD&D would generate particulate matter and fugitive dust. In addition, emissions were estimated for on- and off-road diesel equipment and vehicles, worker trips, and paving off-gasses. Exhaust emissions from these latter sources would result in releases of sulfur dioxide, nitrogen oxide, particulate matter, total suspended particulates, volatile organic compounds, and carbon monoxide. Operational emissions were estimated for heating and cooling of buildings, use of worker vehicles, and the addition of a back-up generator at the Arroyo Mocho Pump Station.

Table 5-9 presents the estimated additional annual emissions from construction, DD&D, modernization/upgrade/utility projects, and operational activities under the No-Action Alternative at both the Livermore Site and Site 300 (note: emissions from the Livermore Site and Arroyo Mocho were combined, as they are in the same non-attainment region). In addition, the least restrictive *de minimis* thresholds were carried forward for attainment pollutants to determine the level of effects under NEPA. Operational emissions include both heating of buildings and new worker commutes and are not directly comparable to the existing emissions from stationary

[2] As described in Appendix B, Section B.3.6, the ACAM model was specifically designed to estimate air emission from the construction and operation of facilities. The ACAM model uses stationary and mobile source emission factors to estimate emissions for projects that require the construction and operation of multiple facilities phased in over several years. As such, this model was considered ideal for this SWEIS.

sources, as existing commuter emissions are substantially greater for some pollutants such as carbon monoxide. This assessment also conservatively assumes that all new employees would commute to work 5 days per week for 20 miles. An estimate of future stationary source emissions under the No-Action Alternative are provided below.

Table 5-9. Estimated Additional Annual Emissions from the No-Action Alternative

Pollutant	Emissions (tons/year)				*De Minimis* Thresholds[a] (tons/year)	Exceeds *De Minimis* Threshold?
	Livermore Site and Arroyo Mocho		Site 300			
	Construction	Operations	Construction	Operations		
VOC	0.6	1.9	0.3	0.2	100(10)	No
NO_x	3.6	2.5	1.9	0.2	100(10)	No
CO	3.9	22.5	2.1	2.3	100	No
SO_x	<0.1	<0.1	<0.1	<0.1	100(70)	No
PM_{10}	7.9	0.1	0.2	<0.1	100	No
$PM_{2.5}$	0.2	0.1	0.1	<0.1	100(70)	No
Pb	<0.1	<0.1	<0.1	<0.1	25	No

CO = carbon monoxide; NO_x = nitrogen oxides; Pb = lead; PM_{10} = particulate matter less than or equal to 10 microns in aerodynamic diameter; $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in aerodynamic diameter; SO_x = sulfur oxides

a. Least restrictive *de minimis* threshold carried forward for attainment pollutants to determine the level of effects under NEPA. *De minimis* thresholds for Site 300 are 10 tons/year for VOCs and NOx and 70 tons/year for SOx and $PM_{2.5}$.

Sources: USEPA 2021a; USAF 2020.

As shown in Table 5-9, the estimated additional annual emissions would be below the *de minimis* threshold values; therefore, the general conformity rules would not apply and these activities would not expose sensitive receptors (e.g., elderly, asthmatics, and others whose are at a heightened risk of negative health outcomes due to exposure to air pollution) surrounding LLNL or Site 300 to substantial pollutant concentrations; conflict with or obstruct implementation of the applicable air quality plan; or violate any air quality standard or contribute substantially to an existing or projected air quality violation. Detailed emissions calculations are included in the administrative record of this SWEIS (Tetra Tech 2021).

Table 5-10 presents the total annual emissions from stationary sources expected at the Livermore Site and Site 300 for the No-Action Alternative compared to the 5-year average (2015-2019) emissions. The change in emissions was estimated based on the total change in building area (i.e., square footage) at the two sites. Ultimately, for the permitting of stationary sources, emission's would be evaluated based on the actual equipment selected during the facility design stage.

Table 5-10. Estimated Stationary Source Emissions for the Livermore Site and Site 300 under the No-Action Alternative

Pollutant	Annual Stationary Source[a] Emissions (tons per year)			
	Existing Environment (2015 – 2019 Average)		No-Action Alternative	
	Livermore Site	Site 300	Livermore Site	Site 300
Carbon monoxide	16.9	0.2	17.3	0.2
Nitrogen oxides	14.6	0.9	15.0	0.9
Fine particulate matter (PM_{10}/$PM_{2.5}$)	1.8	0.2	1.8	0.2
Sulfur dioxide	0.7	0.0	0.7	0.0
Volatile organic compounds	6.1	0.1	6.3	0.1

a. Because air permitting requirements apply to stationary sources of emissions, those emissions are presented in this table.

PMn = particulate matter less than n microns in diameter.

Source: LLNL 2019k, LLNL 20201d; USEPA 2021a; USAF 2020.

DD&D projects may also involve the disturbance of asbestos-containing materials (ACM). LLNL and all contractors would be certified and employ engineering controls and work practices to isolate the source of asbestos and prevent fiber migration. These include using physical barriers (e.g., plastic sheeting) to separate asbestos work areas, keeping the work area at a negative pressure, and using exhaust fans and vacuum cleaners with HEPA filters for asbestos control and cleanup. The local air district would be notified of asbestos-related demolition, renovation, and maintenance work. The No-Action Alternative does not include any activities that would have the potential for exposing humans to naturally occurring asbestos either on or off the Livermore Site or Site 300.

Activities associated with the No-Action Alternative were reviewed to determine if objectionable odors would be created either on or off the Livermore Site or Site 300. Because future operations would be similar to existing operations, and no objectionable odors are currently created, NNSA concluded that objectionable odors would not be created.

All new stationary sources of air emissions (e.g., boilers and generators) would be reviewed for compliance with all federal, state, and local permitting requirements. All required permits would be obtained prior to construction or operation. LLNL would continue to comply with all regulations and programs outlined in Section 4.6.

The No-Action Alternative would not: (1) result in a considerable net increase (i.e., greater than the *de minimis* thresholds) of any criteria pollutant for which the project region is in non-attainment; (2) expose sensitive receptors to substantial pollutant concentrations; (3) conflict with or obstruct implementation of the applicable air quality plan; or (4) violate any air quality standard or contribute substantially to an existing or projected air quality violation. As a result, no mitigation would be required; however, the following BMPs would be implemented to reduce these already-limited effects:

- All persons responsible for any operation, process, handling, transportation, or storage facility that could result in fugitive dust would take reasonable precautions to prevent such dust from becoming airborne. Reasonable precautions might include using water to control dust from building construction and demolition, road grading, or land clearing.
- Construction equipment and vehicles would be inspected routinely for leaks of fuel, engine coolant, and hydraulic fluid.
- LLNL personnel would routinely inspect construction sites to ensure adherence to project-specific requirements.

The No-Action Alternative includes an increase in the LLNL workforce of approximately 1,431 workers (210 construction workers and 1,221 operational workers) compared to the existing 2019 baseline of 7,909 workers. LLNL has a transportation management program that promotes environmentally responsible options for commuting, assists LLNL in complying with transportation-related *Clean Air Act* legislation, while relieving traffic congestion at and around its sites. LLNL is committed to continuing this program, which provides the following:

- A pre-tax benefit program for transit and vanpool commuters, which enables employees to set aside a fixed amount of their pre-tax salary each month to reduce transportation costs;
- Participation in the local air quality districts' Healthy Air Living program; and
- Interface with local and regional transportation planners and stakeholders to mitigate transportation-related air pollution and congestion-management issues.

As discussed in Section 4.6.1, NNSA has previously evaluated increasing the explosives weight for outdoor explosives tests at Site 300. In the EA (NNSA 2018a) for that action, NNSA performed a detailed air quality evaluation. As of the writing of this SWEIS, the increase in explosives testing weight has not been implemented and LLNL continues to perform outdoor explosives tests under the current weight limits.

Greenhouse Gases and Climate Change. Consistent with DOE Order 436.1, LLNL strives to be a leader in responsible environmental stewardship and sustainability and incorporates sustainability and environmental management into the planning and performance of day-today operations and non-routine activities. LLNL's Environmental Management System (EMS) provides a framework for integrating environmental considerations into daily work processes, based on an international standard (ISO 14001), to guide efforts to continually improve environmental performance. A goal of EMS and LLNL's Site Sustainability Plan is to reduce GHG emissions (LLNL 2019j). On a state-level, California Executive Order B-55-18 mandates that the state achieve carbon neutrality by 2045 and maintain net negative emissions thereafter (California 2018).

This SWEIS examines GHGs as a category of air emissions. This SWEIS does not attempt to measure the actual incremental impacts of GHG emissions from the development at LLNL. There is a lack of consensus on how to measure such impacts. Existing climate models have substantial variation in output and do not have the ability to measure the actual incremental impacts of a project on the environment. There also are no established criteria identifying monetized values that are to be considered significant for NEPA purposes.

Table 5-11 presents the estimated GHG emissions from all activities under the No-Action Alternative compared to similar 2019 GHG emissions at LLNL. The No-Action Alternative would increase the total annual LLNL GHG emissions by approximately 5,237 metric tons per year, which would be an increase of 2.6 percent when compared to 2019 GHG emissions from LLNL activities. In California, state-wide GHGs are estimated to be approximately 363.5 million metric tons per year (EIA 2016). GHG emissions associated with the No-Action Alternative at LLNL would account for less than 0.03 percent of those emissions. LLNL would continue efforts to reduce hydrofluorocarbon emissions in accordance with the USEPA mandate to phasedown hydrofluorocarbons by 85 percent over a period ending in 2036 (see 86 FR 55116, November 4, 2021).

Table 5-11. Estimated Annual Site-wide GHG Emissions for the No-Action Alternative

CO_2e Emissions (metric tons/year)		
	Existing Environment (2019)	**No-Action Alternative**
Scope 1 and 2 GHG Emissions	131,323	134,737
Scope 3 GHG Emissions	16,009	17,832

Total	147,332	152,569

Notes: Estimated increase in Scope 1 and 2 emissions based on change in the building areas (i.e., square footage). Estimated increase in Scope 3 emissions based on change in personnel at LLNL.
Sources: USAF 2021.

Radiological Air Emissions. There would be no radiological emissions during construction activities for the No-Action Alternative. Several facilities (most notably Buildings 251 and 280) have used or stored radiological materials and are known to contain residual contamination. Consequently, there is a potential for short-term radiological air emissions for these DD&D actions. Prior to the initiation of DD&D activities, LLNL would prepare a detailed DD&D plan for NNSA approval. The DD&D plan would contain a detailed description of the project-specific DD&D activities to be performed and would be sufficient to allow an independent reviewer to assess the appropriateness of the decommissioning activities; the potential impacts on the health and safety of workers, the public, and the environment; and the adequacy of the actions to protect health and safety and the environment.

With regard to operations, as discussed in Section 4.6.5, LLNL operations release radioactivity to the environment through stacks and from diffuse sources. Table 5-12 presents the radiological air emissions at the Livermore Site for both the No-Action Alternative and existing environment (baseline). As shown in Table 5-12, radiological emissions could increase at the Livermore Site under the No-Action Alternative due to increased activities at the Tritium Facility and the NIF. Radiological emissions at Site 300 are not projected to change compared to the 2019 baseline. The potential radiological impacts on the public from these No-Action Alternative radiological emissions are presented in Section 5.14.1.2. As discussed in that section, all doses to members of the public would be less than the 10 millirem per year limit from airborne emissions of radionuclides, per DOE Order 458.1.

Table 5-12. Estimated Annual Radiological Air Emissions for the No-Action Alternative

Radiological Air Emissions[a] (curies/year)			
2019 Baseline		**No-Action Alternative**	
Livermore Site	**Site 300**	**Livermore Site**	**Site 300**
Tritium Facility: 126.4 Ci tritium (210 Ci limit) NIF: 2.8 Ci tritium (80 Ci limit) Building 298: 10 Ci Tritium Miscellaneous other diffuse emissions	CFF: 1.2×10^{-7} Ci U-234; 1.7×10^{-8} Ci U-235; 9.2×10^{-7} Ci U-238	Tritium Facility Limit: 210 Ci tritium[b] NIF Limit: 80 Ci tritium[b] Building 298: 10 Ci tritium Miscellaneous other diffuse emissions	CFF: 1.2×10^{-7} Ci U-234; 1.7×10^{-8} Ci U-235; 9.2×10^{-7} Ci U-238

a. Data from Table 3-8.
b. Tritium Facility and NIF limits from the 2005 SWEIS and 2011 SA

5.6.2 Proposed Action

Under the Proposed Action, the ongoing activities described in Chapter 2 and Chapter 4 would continue at LLNL. In addition, the Proposed Action includes the use of facilities and projects described for the No-Action Alternative, as well as new facility construction, DD&D, modernization/upgrade/utility projects described in Section 3.3, as well as operational workforce increases.

As was done for the No-Action Alternative, the analysis used the ACAM model to determine whether emissions from new sources would exceed the general conformity rule's *de minimis* threshold values for assessing effects to air quality. Emissions were estimated for construction activities for approximately 3.3 million square feet of new construction over the period 2023–2035. Of this, approximately 2.9 million square feet are proposed at the Livermore Site; approximately 385,000 square feet are proposed at Site 300. NNSA would DD&D about 150 facilities, totaling approximately 1,170,000 square feet; 98 percent of these facilities are at the Livermore Site (131 facilities, totaling about 1,153,000 square feet) and 2 percent (18 facilities, totaling about 17,000 square feet) are at Site 300. On an annualized basis, NNSA would DD&D approximately 90,000 square feet of excess facilities over the SWEIS Proposed Action planning period (2023–2035).

Land disturbance associated with construction and DD&D would generate particulate matter and fugitive dust. In addition, emissions were estimated for on- and off-road diesel equipment and vehicles, new worker trips, and paving off-gasses. Exhaust emissions from these latter sources would result in releases of sulfur dioxide, nitrogen oxide, particulate matter, total suspended particulates, volatile organic compounds, and carbon monoxide. Operational emissions were estimated for heating and cooling of buildings and use of vehicles for new workers.

Table 5-13 presents the estimated additional annual emissions from construction, DD&D, and operational activities under the Proposed Action at both the Livermore Site and Site 300 (note: emissions from the Livermore Site and Arroyo Mocho were combined, as they are in the same non-attainment region). In addition, the least restrictive *de minimis* thresholds were carried forward for attainment pollutants to determine the level of effects under NEPA. Operational emissions include both heating of buildings and new worker commutes and are not directly comparable to the existing emissions from stationary sources, as existing commuter emissions are substantially greater for some pollutants such as CO. This assessment also conservatively assumes that all new employees would commute to work 5 days per week for 20 miles. An estimate of future stationary source emissions under the Proposed Action are provided below.

Table 5-13. Estimated Additional Annual Emissions from the Proposed Action

Pollutant	Emissions (tons/year)				*De Minimis* Thresholds[a] (tons/year)	Exceeds *De Minimis* Threshold?
	Livermore Site and Arroyo Mocho		Site 300			
	Construction	Operations	Construction	Operations		
VOC	0.7	4.2	0.6	0.5	100(10)	No
NO_x	4.7	14.7	3.4	3.3	100(10)	No
CO	4.9	51.9	3.7	3.6	100	No
SO_x	<0.1	0.1	<0.1	<0.1	100(70)	No
PM_{10}	26.6	1.0	2.5	1.0	100	No
$PM_{2.5}$	0.2	1.0	0.2	0.1	100(70)	No
Pb	<0.1	<0.1	<0.1	<0.1	25	No

CO = carbon monoxide; NO_x = nitrogen oxides; Pb = lead; PM_{10} = particulate matter less than or equal to 10 microns in aerodynamic diameter; $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in aerodynamic diameter; SO_x = sulfur oxides

a. Least restrictive *de minimis* threshold carried forward for attainment pollutants to determine the level of effects under NEPA. *De minimis* thresholds for Site 300 are 10 tons/year for VOCs and NOx and 70 tons/year for SOx and $PM_{2.5}$.

Sources: USEPA 2021a; USAF 2020.

As shown in Table 5-13, the estimated additional annual emissions would be below the *de minimis* threshold values; therefore, the general conformity rules would not apply and these activities would not expose sensitive receptors to substantial pollutant concentrations; conflict with or obstruct implementation of the applicable air quality plan; or violate any air quality standard or contribute substantially to an existing or projected air quality violation. Detailed emissions calculations are included in the administrative record of the SWEIS (Tetra Tech 2021).

For purposes of analysis, this SWEIS assesses peak annual emissions for the construction and DD&D activities associated with the Proposed Action. Therefore, regardless of the ultimate implementation schedule of any phase of development, annual emissions would be less than those specified herein. Small changes in facilities site and ultimate design, and moderate changes in quantity and types of equipment used would not substantially change these emission estimates and would not change the determination under the general conformity rule or level of effects under NEPA.

Table 5-14 presents the total estimated stationary source emissions expected at the Livermore Site and Site 300 for the Proposed Action compared to the 5-year average (2015-2019) emissions. The change in emissions was estimated based on the total change in building area (i.e., square footage) at the two sites. Ultimately, for the permitting of stationary sources, emissions would be evaluated based on the actual equipment selected during the facility design stage.

The potential air emissions from the Materials Analysis Laboratory would be similar to, and in lesser quantities, to Building 151 because of the smaller size of the facility. Emissions generated from the facility fume hoods would be appropriately filtered before releasing to the environment. Use of solvents would require a wipe-cleaning permit with the air district. More than one small stack would be required.

Table 5-14. Estimated Stationary Source Emissions for the Livermore Site and Site 300 under the Proposed Action

Pollutant	Annual Stationary Sources[a] of Emissions (tons per year)			
	No-Action Alternative		Proposed Action	
	Livermore Site	Site 300	Livermore Site	Site 300
Carbon monoxide	17.3	0.2	21.0	0.4
Nitrogen oxides	15.0	0.9	18.2	1.6
Fine particulate matter (PM_{10}/$PM_{2.5}$)	1.8	0.2	2.2	0.4
Sulfur dioxide	0.7	0.0	0.9	0.0
Volatile organic compounds	6.3	0.1	7.6	0.2

a. Because air permitting requirements apply to stationary sources of emissions, those emissions are presented in this table.
PM_n = particulate matter less than *n* microns in diameter.
Source: LLNL 2019k, LLNL 2021d; USEPA 2021a; USAF 2020.

As was discussed for the No-Action Alternative, DD&D projects may also involve the disturbance of ACM. Given that the Proposed Action includes significantly more DD&D compared to the No-Action Alternative, such disturbances would be more likely. BMPs associated with construction, such as controlling dust and the handling of ACM, would be the same as those identified under the No-Action Alternative. The Proposed Action does not include any activities that would have the potential for exposing humans to naturally occurring asbestos either on or off the Livermore Site or Site 300.

Activities associated with the Proposed Action were reviewed to determine if objectionable odors would be created either on or off the Livermore Site or Site 300. Because future operations would be similar to existing operations, and no objectionable odors are currently created, NNSA concluded that objectionable odors would not be created.

As with the No-Action Alternative, all new stationary sources of air emissions (e.g., boilers and generators) would be reviewed for compliance with all federal, state, and local permitting requirements. All required permits would be obtained prior to construction or operation. LLNL would continue to comply with all regulations and programs outlined in Section 4.6.

The Proposed Action would not: (1) result in a considerable net increase (i.e., greater than the *de minimis* thresholds) of any criteria pollutant for which the project region is in non-attainment; (2) expose sensitive receptors to substantial pollutant concentrations; (3) conflict with or obstruct implementation of the applicable air quality plan; or (4) violate any air quality standard or contribute substantially to an existing or projected air quality violation. As a result, no mitigation would be required; however, the following BMPs would be implemented to reduce these already-limited effects:

- All persons responsible for any operation, process, handling, transportation, or storage facility that could result in fugitive dust would take reasonable precautions to prevent such dust from becoming airborne. Reasonable precautions might include using water to control dust from building construction and demolition, road grading, or land clearing.
- Construction equipment and vehicles would be inspected daily for leaks of fuel, engine coolant, and hydraulic fluid.
- LLNL personnel would routinely inspect construction sites to ensure adherence to project-specific requirements.

The Proposed Action includes a total workforce of approximately 10,060 operational workers and 700 construction workers. LLNL has a transportation management program that promotes environmentally responsible options for commuting, assists LLNL in complying with transportation-related *Clean Air Act* legislation, while relieving traffic congestion at and around its sites. LLNL is committed to continuing this program, which provides the following:

- A pre-tax benefit program for transit and vanpool commuters, which enables employees to set aside a fixed amount of their pre-tax salary each month to reduce transportation costs;
- Participation in the local air quality districts' Healthy Air Living program; and
- Interface with local and regional transportation planners and stakeholders to mitigate transportation-related air pollution and congestion-management issues.

Greenhouse Gases and Climate Change. Table 5-15 presents the estimated GHG emissions from all activities under the Proposed Action compared to the No-Action Alternative GHG emissions at LLNL. The Proposed Action would increase the total annual LLNL GHG emissions by approximately 5,239 metric tons per year (3.4 percent increase) over the No-Action Alternative estimates. In California, state-wide GHGs are estimated to be approximately 363.5 million metric tons per year (EIA 2016). GHG emissions associated with the Proposed Action at LLNL would account for less than 0.03 percent of those emissions. LLNL would continue efforts to reduce hydrofluorocarbon emissions in accordance with the USEPA mandate to phasedown hydrofluorocarbons by 85 percent over a period ending in 2036 (see 86 FR 55116, November 4, 2021).

Table 5-15. Estimated Annual Site-wide GHG Emissions for the Proposed Action

CO_2e Emissions (metric tons/year)		
Type of GHG Emissions	**No-Action Alternative**	**Proposed Action**
Scope 1 and 2	134,737	138,241
Scope 3	17,832	19,567
Total	152,569	157,808

Notes: Estimated increase in Scope 1 and 2 emissions are based on change in the building areas (i.e., square footage). Estimated increase in Scope 3 emissions are based on change in personnel at LLNL.
Sources: USAF 2021.

Radiological Air Emissions. There would be no radiological emissions during construction activities for the Proposed Action. Several facilities (most notably Buildings 294, 327, and 378) have used or stored radiological materials and are known to contain residual contamination. Consequently, there is a potential for short-term radiological air emissions for these DD&D actions. As was discussed for the No-Action Alternative, prior to the initiation of DD&D activities, LLNL would prepare a detailed DD&D plan for NNSA approval.

Table 5-16 presents the radiological air emissions at the Livermore Site for both the Proposed Action and the No-Action Alternative. As shown in Table 5-16, tritium emissions limits from the Tritium Facility and NIF would increase to support loading and unloading operations involving higher-activity tritium reservoirs. Each reservoir would contain a maximum of 1,500 Ci of tritium, with the potential to release the entire contents of the reservoir during handling, operations, or maintenance activities. Engineered solutions to minimize tritium emissions, including the Tritium Processing System at NIF, are expected to continue to operate with high efficiency (>99 percent) but some handling and transport activities are outside these engineered systems. Therefore, there is a need to increase the emissions limits. Small (diffuse) radioactive emissions from the Materials Analysis Laboratory are possible and are included in the aggregate totals for radiological air emissions under the Proposed Action.

At Site 300, radiological emissions of depleted uranium from the CFF are estimated to be the same as the No-Action Alternative. The potential radiological impacts on the public from these Proposed Action radiological emissions are presented in Section 5.14.2.2. As discussed in that section, all doses to members of the public would be less than the 10 millirem per year limit from airborne emissions of radionuclides, per DOE Order 458.1.

Table 5-16. Estimated Annual Radiological Air Emissions for the Proposed Action

Radiological Air Emissions[a] (curies/year)			
No-Action Alternative		**Proposed Action**	
Livermore Site	**Site 300**	**Livermore Site**	**Site 300**
Tritium Facility Limit: 210 Ci tritium NIF Limit: 80 Ci tritium Building 298: 10 Ci tritium Miscellaneous other diffuse emissions.	CFF: 1.2×10^{-7} Ci U-234; 1.7×10^{-8} Ci U-235; 9.2×10^{-7} Ci U-238	Tritium Facility Limit: 2,000 Ci tritium[b] NIF Limit: 1,600 Ci tritium[b] HED Capability Support Facility Replacement (Building 298 replacement): 10 Ci tritium Miscellaneous other diffuse emissions.	CFF: 1.2×10^{-7} Ci U-234; 1.7×10^{-8} Ci U-235; 9.2×10^{-7} Ci U-238

a. Data from Table 3-8.
b. Actual operational emissions from the Tritium Facility and NIF are not expected to increase; however, the use of tritium reservoirs with substantially greater amounts of tritium could result in the potential for greater tritium releases from routine operations with these reservoirs. Although the potential for higher discharges are greater (within limits identified above), the facilities would continue to operate engineered systems that have proven to be highly effective at capturing tritium emissions.

5.6.3 Summary of Air Quality Impacts for the Alternatives

Table 5-17 summarizes the potential air quality impacts for the No-Action Alternative and the Proposed Action.

Table 5-17. Potential Air Quality Impacts for the Alternatives

Metric		**2019 Baseline**		**No-Action Alternative**		**Proposed Action**	
		Livermore Site	**Site 300**	**Livermore Site**	**Site 300**	**Livermore Site**	**Site 300**
Nonradiological Emissions (tons/year)	**CO** **NOx** **PM10/2.5** **SO_2** **VOC**	16.9 14.6 1.8 0.7 6.1	0.2 0.9 0.2 0.0 0.1	17.3 15.0 1.8 0.7 6.3	0.2 0.9 0.2 0.0 0.1	21.0 18.2 2.2 0.9 7.6	0.4 1.6 0.4 0.0 0.2
Air Quality Thresholds and Standards		• Emissions would be below *de minimis* threshold values. • No air quality standards exceeded.		• Emissions would be below *de minimis* threshold values. • No air quality standards exceeded.		• Emissions would be below *de minimis* threshold values. • No air quality standards exceeded.	
GHG Emissions: Scope 1, 2, and 3 (metric tons/year)		147,332		152,569		157,808	
Radiological Emissions		129.2 Ci tritium $<1.5\times10^{-7}$ Ci Uranium		300 Ci tritium $<1.5\times10^{-7}$ Ci Uranium		3,610 Ci tritium $<1.5\times10^{-7}$ Ci Uranium	
MEI Dose (millirem/yr) **MEI LCF Risk**		4.004 2.4×10^{-6}	1.7×10^{-4} 1.0×10^{-10}	4.01 2.4×10^{-6}	1.7×10^{-4} 1.0×10^{-10}	4.21 2.5×10^{-6}	1.7×10^{-4} 1.0×10^{-10}
Population Dose (person-rem/yr) **Population LCF Risk**		0.26 1.6×10^{-4}	3.7×10^{-5} 2.0×10^{-8}	0.60 3.6×10^{-4}	5.0×10^{-5} 3.0×10^{-8}	7.1 4.3×10^{-3}	5.0×10^{-5} 3.0×10^{-8}

5.7 NOISE

This section presents the potential noise impacts for the alternatives due to construction, DD&D, modernization/upgrade/utility projects, and operations. Key metrics presented in the noise analysis include: (1) identification of construction and operational noise sources; (2) identification of new projects within approximately 400-800 feet (122 – 244 meters) of site boundaries, which may cause offsite noise impacts; (3) qualitative analysis of potential noise levels offsite; and (4) traffic noise analysis.

5.7.1 No-Action Alternative

Under the No-Action Alternative, the ongoing activities described in Chapter 2 and Chapter 4 would continue at LLNL. In addition, new facility construction, modernization/upgrade/utility projects, and DD&D activities described in Section 3.2 would also occur. There would also be operational changes (e.g., increases in the number of workers) that could affect noise impacts. Noise impacts were estimated for constructing approximately 19 new projects, totaling approximately 416,300 square feet, and DD&D of approximately 42 facilities, totaling approximately 228,000 square feet over the period 2020–2022. Construction and DD&D activities would increase noise levels temporarily in the immediate construction area and in the vicinity of the site because of increased traffic. Construction equipment expected to be used includes the following, but is not limited to:

- backhoes
- excavators
- cranes
- soil compactors
- work trucks, four-wheel drive
- concrete delivery trucks
- concrete pump trucks
- water truck
- generators
- front end loader
- flatbed
- telescoping forklifts
- welder
- dump trucks
- skid steer
- fuel truck
- mini excavator

Table 5-18 shows the attenuation of construction noise over relatively short distances. At 400 feet from the construction site, construction noises would range from approximately 55 to 85 decibels. Golden et al. (1980) suggests that noise levels higher than 80 to 85 decibels are sufficient to startle or frighten birds and small mammals. Thus, there would be little potential for disturbing wildlife outside a 400-foot radius of the construction site. With multiple items of equipment operating concurrently, noise levels can be relatively high within 400 to 800 feet from the site of major equipment operations. Construction workers could be exposed to noise levels higher than the permissible exposure limit of 90 A-weighted decibels specified by the OSHA (29 CFR 1926.52). However, LLNL would implement appropriate hearing protection programs to minimize noise impacts to workers. These include the use of administrative controls, engineering controls, and personal hearing protection equipment.

Table 5-18. Peak Noise Levels Expected from Construction Equipment

Source	Noise level (dBA)					
	Peak	Distance from source (feet)				
		50	100	200	400	800
Heavy trucks	95	84–89	78–83	72–77	66–71	60-65
Dump trucks	108	88	82	76	70	64
Concrete mixer	105	85	79	73	67	61
Jackhammer	108	88	82	76	70	64
Scraper	93	80–89	74–82	68–77	60–71	54-65
Dozer	107	87–102	81–96	75–90	69–84	63-78
Generator	96	76	70	64	58	52
Crane	104	75–88	69–82	63–76	55–70	49-64
Loader	104	73–86	67–80	61–74	55–68	49-62
Grader	108	88–91	82–85	76–79	70–73	64-67
Dragline	105	85	79	73	67	61
Pile driver	105	95	89	83	77	71
Fork lift	100	95	89	83	77	71

Source: Golden et al. 1980.

Although construction and DD&D activities would cause temporary noise impacts, almost all activities would be confined to areas more than 500 feet from the Livermore Site property boundaries. No new projects would be constructed within approximately 500 feet of a site boundary.[3] As shown in Table 5-19, including the EOC, there would be five projects constructed within a distance of approximately 800 feet of the Livermore Site boundary. At Site 300, the SFTF would be located within 500 feet of the southern site boundary. However, because there are no residences or other noise receptors within several miles of this facility, there would be no offsite noise impacts.

Table 5-19. Projects within Approximately 800 Feet of Livermore Site Boundary

Facility/Project	Approximate Distance to Site Boundary (feet)
Livermore Site Hazardous Waste Office Facility	800 (north boundary)
Building 191 HEAF Atrium Conversion	800 (east boundary)
LVOC Office Building and Conference Center, Buildings 642 and 643	600 (east boundary)
Building 654 Expansion	750 (east boundary)
Emergency Operations Center	300 (west boundary)

Any construction or DD&D conducted within approximately 800 feet of the Livermore Site boundary could create construction noise impacts to offsite areas. The following BMPs would be performed to reduce noise effects:

- LLNL would remain compliant with all local noise regulations.
- Construction and demolition would primarily occur during daytime hours.
- Equipment mufflers would be properly maintained and in good working order.

[3] The Emergency Operations Center (EOC), which is currently under construction in the southwest portion of the Livermore Site, is located approximately 300 feet from the western boundary of the site. As of the publication of this SWEIS, most construction associated with the EOC has been completed.

- Onsite personnel, particularly equipment operators, would don hearing protection to limit exposure and ensure compliance with federal health and safety regulations.

Traffic noise associated with construction, DD&D, and operations would be another source of noise impacts. The No-Action Alternative would include an increase in the LLNL workforce of approximately 1,431 workers (210 construction workers and 1,221 operational workers) compared to the existing 2019 baseline. As discussed in Section 5.11.1, if 1,431 additional workers were to commute to the Livermore Site (which is a bounding assumption for both the transportation analysis and this noise analysis), local traffic would increase by an average of approximately 2.4 percent. Because noise is measured on a logarithmic scale, two line sources of equal level (e.g., traffic along a roadway) added together result in an increase of 3 dBA at all distances. Therefore, a doubling in traffic volume would increase the noise level by 3 dBA. For example, traffic generating 60 dBA plus the same amount of traffic on the same roadway would yield a total noise level of 63 dBA. Notably, a less-than-3-dBA change in noise levels would be barely perceptible to individuals with average hearing, and is considered negligible (FHWA 2011). A 2.4 percent increase in traffic on area roads would have an imperceptible effect on traffic noise in the vicinity of LLNL.[4]

Heavy equipment during construction and DD&D could generate minute ground-borne vibrations directly adjacent to (i.e., within a few feet) the equipment (Caltrans 2013). These effects would be confined to the immediate area of the equipment and completely within the project sites. There would be no blasting or associated ground-borne or airborne vibrations during construction and DD&D. There would be no offsite noise/vibrational effects from these activities.

Once operational, the operations associated with the No-Action Alternative would not introduce any machinery or equipment that would differ from the existing heating, ventilation and air conditioning (HVAC) systems, cooling towers, motors, pumps, fans, generators, air compressors, and loudspeakers currently on the Livermore Site and Site 300. At the Livermore Site, tests conducted in the High Explosives Application Facility (HEAF) would be unchanged when compared to existing conditions.

Some of the new facilities associated with the No-Action Alternative may include back-up generators that would be used only during power outages and periodic testing. Noise from facility support equipment internal to the sites would not normally be audible beyond the property boundaries; however, equipment adjacent to the property boundaries could be audible to nearby residences and other noise sensitive areas. This would be true more so at night when background noise levels are lower.

Given the proximity of residential areas to the Livermore Site, particularly to the west, extra precautions would be taken to incorporate noise controls into the final design of the facilities to ensure compliance with local noise regulations. Reductions by design (i.e., silencers, enclosures, and other engineering controls) may be required to ensure the noise from new facilities does not lead to a violation of the local noise regulations. To ensure compliance and mitigate noise impacts, LLNL would take the following actions:

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[4] Traffic noise is also dependent on the types and sizes of vehicles travelling on the roads. The analysis assumes that truck traffic would also increase by 2.4 percent compared to existing truck traffic on area roads.

- Require the building contractor and/or equipment manufacturer to design and guarantee the facility's HVAC systems and other sound producing equipment, through building and other equipment specifications (e.g., silencers, mufflers, and engineered sound enclosures), to ensure noise levels would not exceed thresholds outlined in any applicable federal, state, or local noise regulations; and
- Perform post-construction sound surveys, as necessary, to ensure compliance with these regulations.

At Site 300, as discussed in Section 4.7.2.2, explosive testing conducted at the open firing tables are audible beyond the Site 300 property boundary. The amount of explosive testing conducted at Site 300 would be unchanged under the No-Action Alternative, and would be similar to the existing environment described in Section 4.7.2.2. Those tests produce audible noises beyond the Site 300 property boundary (see Figure 4-54). As shown in Table 4-18, the overall average sound levels (i.e., C-weighted Day-Night Sound Level [CDNL]) are completely compatible with all land uses outside of the Site 300 property boundary. NNSA would continue open detonation at Site 300 facilities under the current levels of less than 100 pounds per day and less than 1,000 pounds per year.

The NNSA prepared the *Environmental Assessment for the Proposed Increase in the Weight of Explosives Detonated at Lawrence Livermore National Laboratory Experimental Test Site, Site 300* (NNSA 2018a), which included a Finding of No Significant Impact. As of the writing of this SWEIS, the increase in detonation testing weight has not been implemented. The EA described that the noise from activities which are more than current weight limits (less than 100 pounds per day and less than 1,000 pounds per year) would be audible and noticeably distinct at offsite locations; however, LLNL's self-imposed one second sound pressure level of 126 dB would not be exceeded in populated areas, or at the receptors of concern . The 57-dBC, 62-dBC, and 70-dBC CDNL contours would remain completely contained within the Site 300 property boundary, and the testing activities would continue to be neither loud enough nor frequent enough to generate areas of incompatible land use. LLNL continues to monitor testing activities to ensure that noise levels remain below its self-imposed limit of 126 dB in nearby residential areas.

5.7.2 Proposed Action

Under the Proposed Action, the ongoing activities described in Chapter 2 and Chapter 4 would continue at LLNL. In addition, the Proposed Action includes the use of facilities and projects described for the No-Action Alternative, as well as new facility construction, modernization/upgrade/utility projects, operational changes, and DD&D activities described in Section 3.3. There would also be increases in the number of workers with increased worker commute that could affect noise impacts. Noise impacts were estimated for constructing approximately 75 new projects, totaling approximately 3.3 million square feet, and DD&D of approximately 150 facilities, totaling approximately 1,170,000 square feet over the period 2023–2035. Most of the new projects (61 out of 75) and DD&D activities (approximately 98.5 percent [1,153,000 square feet out of 1,170,000]) would be located at the Livermore Site. Consequently, the noise analysis focuses on that site.

Although construction and DD&D activities would cause temporary noise impacts, most activities would be confined to areas more than 500 feet from the Livermore Site property boundaries. As shown in Table 5-20, there would be 15 projects constructed within a distance of approximately 800 feet of the Livermore Site boundary. Six of the new projects would be constructed within approximately 500 feet of a site boundary. At Site 300, four facilities would be located within 500 feet of the southern site boundary. However, because there are few residences/businesses, and no schools, within close proximity to Site 300, noise impacts from these facilities would be minimal.

As was discussed for the No-Action Alternative, construction/DD&D workers could be exposed to noise levels higher than the permissible exposure limit of 90 A-weighted decibels specified by the OSHA (29 CFR 1926.52). However, LLNL would implement appropriate hearing protection programs to minimize noise impacts to workers. These include the use of administrative controls, engineering controls, and personal hearing protection equipment.

Table 5-20. Projects within Approximately 800 Feet of Livermore Site Boundary

Facility/Project	Approximate Distance to Site Boundary (feet)
New North Entry	0 (north boundary)
Fire Station (Preferred Location)	300 (west boundary)
Fire Station (Alternate Location)	100 (north boundary)
HEAF Lab Capability Expansion (HEX)	700 (north boundary)
Domestic Uranium Enrichment Program	800 (north boundary)
Packaging and Transportation Safety Operational Support Facility	800 (north boundary)
Hertz Hall Expansion – Open Campus Generic Office/Lab Building and Revitalization	300 (east boundary)
Generic Office Buildings	300 (east boundary)
LVOC LLNL Collaboration Center	300 (east boundary)
LVOC Conference Center	500 (east boundary)
Micro/Nano Technology Laboratory Facility	600 (east boundary)
LVOC Advanced Biotechnology Research and Response Laboratory	800 (east boundary)
Network Intelligence Research Facility	800 (west boundary)
Secure Training and Communications Center	800 (west boundary)
Integrated Global Security Center (IGSC)	800 (west boundary)
High Energy Density (HED) Capability Support Facility Replacement	800 (west boundary)

Any construction or DD&D conducted within approximately 800 feet of the Livermore Site boundary could create construction noise impacts to offsite areas. To reduce noise effects, NNSA would utilize the same BMPs that were identified for the No-Action Alternative.

Traffic noise associated with construction, DD&D, and operations would be another source of noise impacts. Including construction and DD&D workers, the Proposed Action workforce is expected to increase from 9,340 workers under the No-Action Alternative to a total of 10,750 workers by the end of 2035 (*see* Section 5.10.1.2). This would represent a workforce increase of 1,410, or approximately 15.2 percent compared to the No-Action Alternative workforce. As discussed in Section 5.11.2, if all of the 1,410 additional workers were to commute to the Livermore Site (which is a bounding assumption for both the transportation analysis and this noise analysis), local traffic would increase by an average of approximately 2.3 percent. As was discussed under the No-Action Alternative, a doubling of traffic would be required to cause a perceptible increase in traffic noise. A 2.3 percent increase in traffic on area roads would have an imperceptible effect on traffic noise in the vicinity of LLNL.

Heavy equipment during construction and DD&D could generate minute ground-borne vibrations directly adjacent to (i.e., within a few feet) the equipment (Caltrans 2013). These effects would be confined to the immediate area of the equipment and completely within the project sites. There would be no blasting or associated ground-borne or airborne vibrations during construction and DD&D. There would be no offsite noise/vibrational effects from these activities.

The new Fire Station at the Livermore Site would be located in either: (1) the west buffer zone just south of the EOC within approximately 300 feet of the western site boundary (preferred location); or (2) west of the New North Entry in the north buffer zone within approximately 100 feet of the northern site boundary (alternate location). Operations associated with the Fire Station could cause intermittent offsite noise impacts from sirens and alarms, but these are typically located in residential areas. and allowed as per local noise ordinances. Once operational, the operations associated with the Proposed Action would not introduce any machinery or equipment that would differ from the existing HVAC systems, cooling towers, motors, pumps, fans, generators, air compressors, and loudspeakers currently on the Livermore Site and Site 300. Three new facilities at the Livermore Site— HEX, HEAF Modular Aging Facility and HEAF Dynamic Studies Facility— would perform HE experiments. HEAF Modular Aging Facility would have a 500-gram HE limit; and HEAF Dynamic Studies Facility would have a 1-kilogram HE limit; and. HEX would have a HE limit of less than 10 kg. These HE limits are within the current noise umbrella of HEAF.As with the No-Action Alternative, tests conducted in the HEAF at the Livermore Site would be unchanged when compared to existing conditions.

At Site 300, tests conducted at the CFF and on open firing tables at Site 300 would also remain unchanged. There would be six new HE-related facilities at Site 300 (DRDF, HE Manufacturing Incubator, HE Safety Facility, Advanced 3D Hydrotest Facility, Building 832E Replacement, and Accelerator Bay and Support Bunker Expansion), but operational noise impacts would not exceed current levels. LLNL would continue to monitor during testing to limit noise levels to less than 126 dB in nearby residential areas.

Some of the new facilities associated with the Proposed Action may include back-up generators that would be used only during power outages and periodic testing. Noise from facility support equipment internal to the sites would not normally be audible beyond the property boundaries; however, equipment adjacent to the property boundaries could be audible to nearby residences and other noise sensitive areas at acceptable levels from the Livermore Site. This would be true more so at night when background noise levels are lower. As was discussed under the No-Action Alternative, extra precautions would be taken to incorporate noise controls (including noise breaks or walls) into the final design of the facilities to ensure compliance with local noise regulations and BMPs would be employed to minimize noise effects.

5.7.3 Summary of Noise Impacts for the Alternatives

Table 5-21 summarizes the potential noise impacts for the No-Action Alternative and the Proposed Action.

Table 5-21. Potential Noise Impacts for the Alternatives

Metric	No-Action Alternative	Proposed Action
Number of New Projects within 800 Feet of Site Boundary	5 at Livermore Site; 1 at Site 300	15 at Livermore Site; 4 at Site 300

Metric	No-Action Alternative	Proposed Action
Noise Increase from Traffic Increases	2.4 percent increase in area road traffic compared to 2019 baseline; imperceptible effect on traffic noise	2.3 percent increase in area road traffic compared to No-Action Alternative; imperceptible effect on traffic noise
Exceedance of Noise Regulations	No	No

5.8 BIOLOGICAL RESOURCES

This section describes the potential impacts on biological resources associated with the construction, DD&D, modernization/upgrade/utility projects, and operations for the alternatives. Key metrics presented in the analysis include: (1) identify disturbances to land/vegetation and discuss impact on habitats, fish and wildlife, and special status species; (2) identify and discuss wetland impacts; and (3) quantify tritium levels and potential impacts on vegetation and commodities.

5.8.1 No-Action Alternative

Under the No-Action Alternative, the ongoing activities described in Chapter 2 and Chapter 4 would continue at LLNL. In addition, new facility construction, modernization/upgrade/utility projects, and DD&D activities described in Section 3.2 would also occur. With regard to construction and DD&D, potential impacts were estimated for constructing approximately 19 new projects, totaling approximately 416,300 square feet, and DD&D of approximately 42 facilities, totaling approximately 228,000 square feet.

Livermore Site

This section discusses potential impacts on biological resources versus the current information on biological resources presented in Section 4.8. The baseline data for analysis of the No-Action Alternative are that approximately 85 percent of the Livermore Site is developed and approximately 11 acres have been reclaimed as a result of DD&D since 2005. Updated biological survey data are presented in the 2020 and 2021 studies and reports conducted at the Livermore Site in support of this SWEIS (Appendix I).

Vegetation. The No-Action Alternative would affect vegetation by clearing land for construction projects. As stated in Section 4.8 of this SWEIS, site conditions and vegetation composition have changed relatively little since 2002. The 2020 aquatic resources delineation report described vegetation communities on the Livermore Site as mostly dedicated to office and laboratory buildings and associated walkways and roads; limited native wetland and riparian vegetation occurs adjacent to Arroyo Las Positas and Arroyo Seco (Nomad Ecology 2020). Undeveloped buffer zones comprise approximately 15 percent of the Livermore Site and are vegetated by non-native annual grasslands and ruderal species (LLNL 2013a). The vegetation in the buffer zones is dominated by non-native annual grasses similar to what is found on the adjacent agricultural land. The buffer zones are generally mowed twice per year (LLNL 2013a).

Under the No-Action Alternative at the Livermore Site, approximately 13.6 acres would be disturbed during construction. Approximately 5.2 acres would be reclaimed as a result of DD&D and the net land disturbance for construction of new facilities would be approximately 6.4 acres of previously developed land. The net land disturbance would be approximately 0.8 percent of the total acreage at the Livermore Site. Vacated land would primarily be used for the construction of new facilities. New drought tolerant landscaping would be installed around facilities. The No-Action Alternative also includes routine maintenance, remediation actions, and a broad range of operations that would have minimal effects on vegetation at the Livermore Site.

Fish and Wildlife. No changes in fish habitat would occur under the No-Action Alternative from construction or DD&D activities. Wildlife at the Livermore Site includes species found in grassland and riparian habitats and species adapted to life in urban areas. Seven amphibian and reptile species, 81 bird species, and 14 mammal species were observed during biological surveys between 1986 and 2021 at the Livermore Site (NNSA 2005; ECORP 2021a). Those surveys noted that the number of different bird species did not vary much according to the seasons and was attributable to the highly developed setting within and adjacent to the Livermore site. No unique wildlife habitat exists on the Livermore Site and any wildlife temporarily displaced by the proposed construction activities could occupy adjacent habitat. Future operations would be similar to ongoing operations and would not affect the distribution or abundance of fish and wildlife.

Special Status Species and Habitats. A list of special status species with the potential to occur at the Livermore Site was derived using the U.S. Fish and Wildlife's (USFWS) IPaC tool (USFWS 2021a) and onsite studies (LLNL 2020p; ECORP 2021a; LLNL 2021p) of species known or expected to occur in the vicinity of the Livermore Site (*see* Table 4-20). No critical habitat is designated by the USFWS at the Livermore Site. Livermore Site special status species confirmed to occur at the site that are considered rare, threatened or endangered include two amphibians, one reptile, 11 birds, and two mammals. The remaining species included in Table 4-20 are not expected to occur at the Livermore Site.

Six special status passerine bird species were observed in the 2021 surveys, including Bullock's oriole, Nuttall's woodpecker, oak titmouse, yellow warbler, white-breasted nuthatch, Swainson's hawk, white-tailed kite, and sharp-shinned hawk (ECORP 2021a). Four special status raptor species were observed in nesting bird surveys conducted from 2019 to 2021 (LLNL 2021a), including golden eagle (incidental observation), Swainson's hawk, white-tailed kite, and peregrine falcon.

Although bald and golden eagles are occasionally observed at the Livermore Site, nesting habitat for these species is not found at the Livermore Site. Disturbance of 19 acres within developed areas is not likely to harm, harass, kill, or injure species protected under the *Bald and Golden Eagle Protection Act* (BGEPA). Most of the bird species found at the Livermore Site are protected under the *Migratory Bird Treaty Act* (MBTA). Bird species protected by the MBTA are known to nest within developed areas at the Livermore Site. Nesting birds may be harmed by construction or DD&D projects. Impacts to nesting birds protected by the MBTA including special status species will be minimized through the implementation of avoidance measures including natural resources awareness training and pre-construction nesting bird surveys. In accordance with implementing EO 13186, "Responsibilities of Federal Agencies to Protect Migratory Birds," the Memorandum of Understanding (MOU) between DOE and USFWS identifies specific areas in which cooperation between the DOE and USFWS would substantially contribute to the conservation and management of migratory birds and their habitats. Implementation of the MOU would further minimize potential impacts on special status species and habitats.

Future operations under the No-Action Alternative would be similar to ongoing operations and would not be expected to impact the eight special status passerine bird species observed in the 2021 surveys (ECORP 2021a), four special status raptor species observed in the 2019 to 2021 nesting bird surveys (LLNL 2021a).

Federally listed species known or expected to occur at the Livermore Site include one reptile and two amphibians. The California red-legged frog (threatened) was the only federally listed species identified at the Livermore Site in the 2005 SWEIS (NNSA 2005). In its revised designation of critical habitat, the USFWS found that California red-legged frogs occur within developed areas adjacent to aquatic habitats (USFWS 2010). During the 2021 surveys (Sequoia 2021a), one California red-legged frog was observed in the northeastern-most corner of Arroyo Las Positas. The 2021 surveys concluded that California red-legged frogs are likely not abundant on the Livermore Site. Construction and DD&D activities at the Livermore Site have the potential to impact California red-legged frogs if present in nearby aquatic habitat including Arroyo Las Positas, Lake Haussmann, and associated drainage channels. DOE/NNSA has completed a formal consultation with the USFWS for infill construction and redevelopment at the Livermore Site (LLNL 2013b). The potential impacts would continue to be minimized by implementing conservation measures including natural resources awareness training, exclusion barriers, minimizing saturated soil or standing water at construction sites, and monitoring as specified in the consultation. In addition, LLNL maintains a Livermore Site Natural Resources Management Plan with the goals to include minimizing impacts to sensitive species and communities. Although the California tiger salamander (threatened) has not been observed at the Livermore Site, USFWS consultations include this species because of the proximity of observations to the Livermore Site. Potential impacts to the California tiger salamander would also be minimized through the implementation of conservation measures included in the consultation (LLNL 2013a, LLNL 2013b).

DOE/NNSA has completed multiple consultations with the USFWS for routine operations and maintenance of the Livermore Site. Conservation measures included in these consultations will be implemented to ensure impacts on the California red-legged frog and the California tiger salamander resulting from future operations under the No-Action Alternative are minimized.

Under the No-Action Alternative, LLNL would continue to fulfill its obligation to maintain Arroyo Las Positas and onsite tributaries for flood capacity. The management project involves removing vegetation and sediment from the channel of Arroyo Las Positas within the reach of Arroyo Las Positas that has a perennial water flow (LLNL 2018a). USFWS measures (USFWS 2010) to protect the California red-legged frog would be implemented per the Arroyo Las Positas Maintenance Plan. Implementation of the MOU between DOE and USFWS in accordance with EO 13186 would further minimize potential impacts to special status species and habitats. Therefore, the impacts of the No-Action Alternative on special status species, migratory birds, and habitats would be minimal.

Tritium Levels in Vegetation and Commodities. Vegetation and foodstuff monitoring have been conducted at LLNL since 1971. Median tritium concentrations at the sampling locations have been below or near the detection limit since 1993. LLNL continues to monitor tritium in vegetation and commodities in the Livermore Valley. Negligible tritium concentrations were detected in vegetation and wine monitoring (LLNL 2020aa). The actual tritium emissions in 2019 baseline year were 129.2 curies from the Livermore Site. In 2019, radionuclide particulate, tritium, and beryllium concentrations in air at the Livermore Site and in the Livermore Valley were well below the levels that would cause concern for the environment or public health.

The maximum estimated ingestion dose from LLNL operations for 2019 is 0.0086 millirem/year. This maximum dose is about 1/35,000 of the average annual background dose in the United States from all-natural sources and about 1/120 the dose from a panoramic dental x-ray. Ingestion doses of Site 300 vegetation were not calculated because neither people nor livestock ingest vegetation at Site 300. For Livermore Valley wines purchased in 2019, the highest concentration of tritium (68 pCi/L) was just 0.34 percent the U.S. Environmental Protection Agency (USEPA) standard for maximal permissible level of tritium in drinking water (20,000 pCi/L). Drinking one liter per day of the Livermore Valley wine with the highest concentration purchased in 2019 would have resulted in a dose of 0.0025 millirem/year (LLNL 2020r).

The tritium emissions limits would not change under the No-Action Alternative. These total approximately 300 Ci for the Tritium Facility, NIF, B298, and other miscellaneous diffuse sources (Table 3-8). Note that limits only apply to Tritium Facility and NIF and were established in the 2011 Supplement Analysis. The actual emissions in the 2019 baseline year were 129.2 Curies. If tritium emissions increased to approximately 300 Curies per year, the maximum estimated ingestion dose from LLNL operations would be 0.020 millirem/year. This maximum dose is about 1/15,000 of the average annual background dose in the United States from all-natural sources. For Livermore Valley wines, the highest concentration of tritium (156.4 pCi/L) would be just 0.78 percent the USEPA standard for maximal permissible level of tritium in drinking water (20,000 pCi/L). Drinking one liter per day of the Livermore Valley wine with the highest concentration would result in a dose of 0.001 millirem/year (based on LLNL 2020r). Therefore, the impacts of the No-Action Alternative on tritium levels in vegetation and commodities would be minimal.

Radiological Protection of Biological Resources. DOE Order 458.1, *Radiation Protection of the Public and the Environment*, requires radiological activities that have the potential to impact the environment to be conducted in a manner that protects populations of aquatic animals, terrestrial plants, and terrestrial animals in local ecosystems from adverse effects due to radiation and radioactive material released from DOE operations. This SWEIS focuses on potential impacts to humans, based on the concept endorsed by the International Commission on Radiation Protection (ICRP), which states, "if man is adequately protected then other living things are also likely to be sufficiently protected" (ICRP 1991). Such an approach uses human protection to infer environmental protection from the effects of ionizing radiation. Based on the analysis in this SWEIS, potential impacts to humans would be small, and no further evaluations of other biota are necessary to demonstrate protection.

In addition, DOE Standard, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota* (DOE-STD-1153-2019) (DOE 2019), provides dose evaluation methods that can be used to demonstrate protection of biota in accordance with DOE Order 458.1. Per that technical standard, biota dose rates below 1 rad/day (for aquatic animals and terrestrial plants), and below 0.1 rad/day (for riparian animals and terrestrial animals), are demonstrative that populations of plants and animals are adequately protected from the effects of ionizing radiation [note: the difference between a "rad" and "rem" is that the rad is a measurement of the radiation absorbed by the material or tissue, whereas the rem is a measurement of the biological effect of that absorbed radiation. For general purposes most physicists agree that rad and rem may be considered equivalent (DOE 2019).] As shown in Section 5.14 of this SWEIS, the potential impacts to workers and the public would be well below 0.1 rem per day, which is demonstrative that populations of plants and animals would be adequately protected from the effects of ionizing radiation.

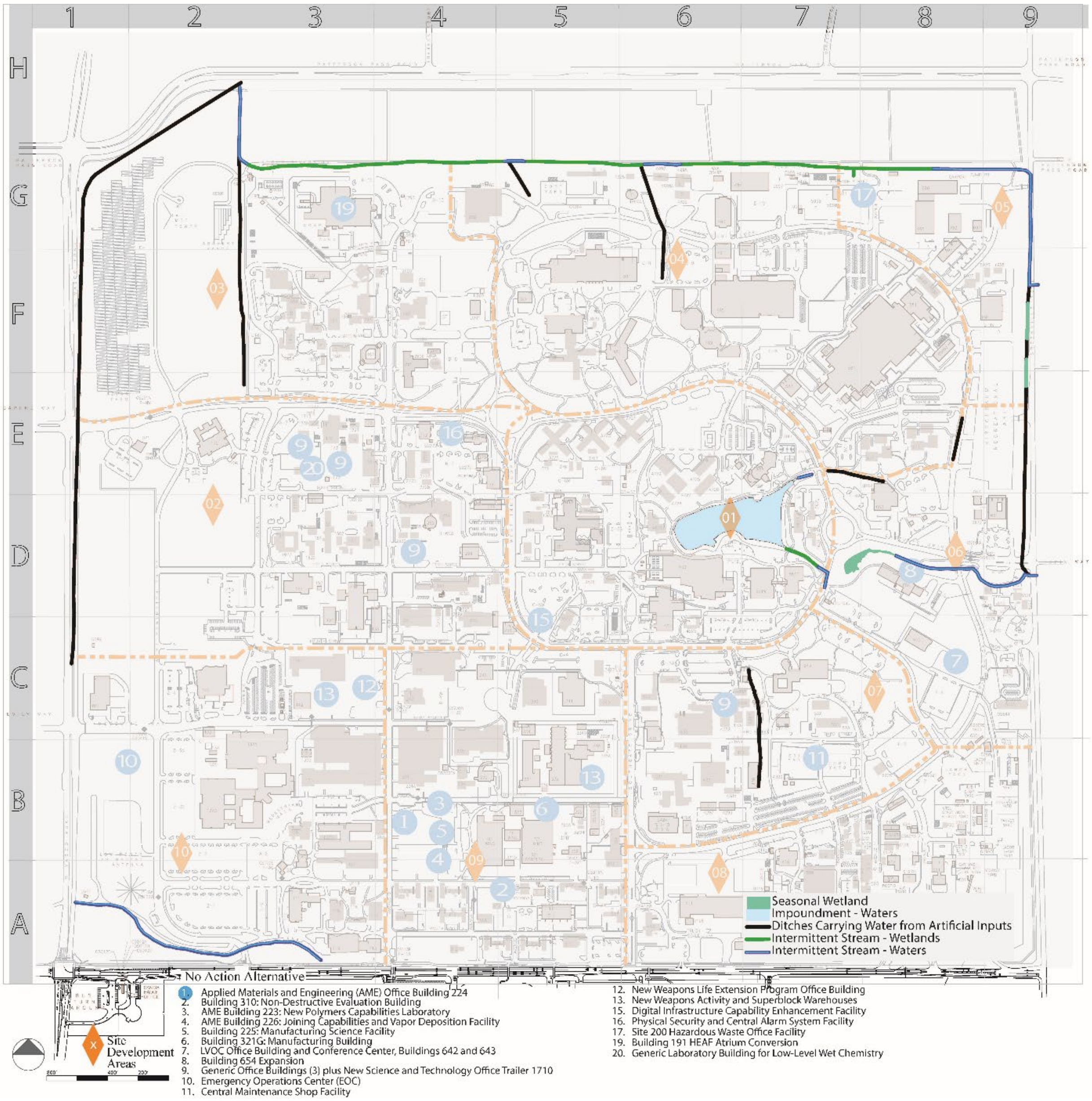
Wetlands. Construction activities would disturb approximately 13.6 acres at the Livermore Site. None of the new facilities and modernization/upgrade/utility projects for existing infrastructure would be located in or adjacent to wetlands or wetland buffer areas (Figure 5-1). In addition, modernization/upgrade projects sited near aquatic features would be implemented within the existing building footprints and not affect the nearby aquatic features. In accordance with the Livermore Site Natural Resources Management Plan (LLNL 2013a), vegetation buffers are maintained around Arroyo Las Positas and Arroyo Seco. Implementation of BMPs (e.g., silt fences) would also be employed to minimize impacts on wetlands and water features. Operations would be similar to existing operations and would have minimal effects on wetlands (Nomad Ecology 2020) at the Livermore Site.

Site 300

This section analyzes the potential impacts associated with the No-Action Alternative for construction and operational activities as they pertain to biological resources at Site 300, using data and information in Section 3.2, including information in Table 3-7 and Table 3-8. This section discusses potential impacts on biological resources versus the current information on biological resources presented in Section 4.8. The baseline data for analysis of the No-Action Alternative are that approximately 5 percent of Site 300 is developed and approximately 11 acres have been reclaimed as a result of DD&D since 2005. Updated survey data are presented in the 2020 and 2021 studies and reports that were conducted at Site 300 in support of this SWEIS (Appendix I).

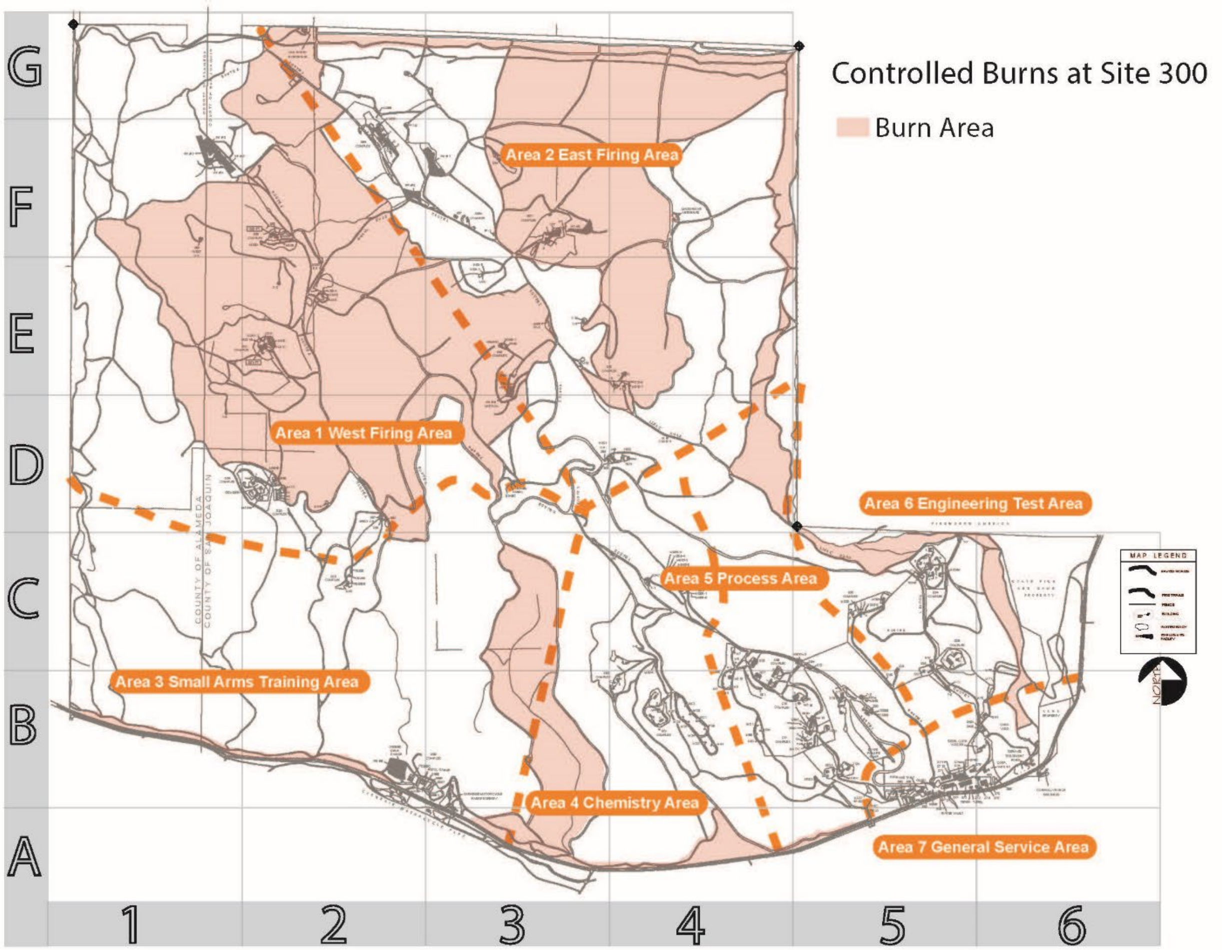
Vegetation. The No-Action Alternative would affect vegetation by clearing land for construction projects. One construction project would occur at Site 300: the SFTF. Approximately 0.6 acre would be disturbed by construction. Approximately 0.02 acre would be reclaimed as a result of DD&D and the 0.5-acre laydown area would also be restored. The net land disturbance would be approximately 0.1 acre, which equates to 0.001 percent of the total acreage at Site 300. The No-Action Alternative also includes routine maintenance, remediation actions, and a broad range of operations that would have minimal effects on vegetation at Site 300.

Prescribed burning would continue to be conducted in accordance with the Site 300 prescribed burn plans (LLNL 2015c). Up to 2,500 acres of land would continue to be control burned annually to maintain vegetation that could become an uncontrolled fire hazard and to provide the beneficial effects of sustaining and developing native grassland (Carlsen et al. 2017) (Figure 5-2). In addition, the controlled burning program may have an additional benefit by reducing the presence of invasive vegetation (Carlsen et al. 2017). The maintenance of fire roads and fire breaks would continue to facilitate the controlled burns (LLNL 2015c).



Sources: LLNL 2021d; Nomad Ecology 2020.

Figure 5-1. No-Action Alternative Projects and Wetland/Aquatic Resources Delineation at the Livermore Site

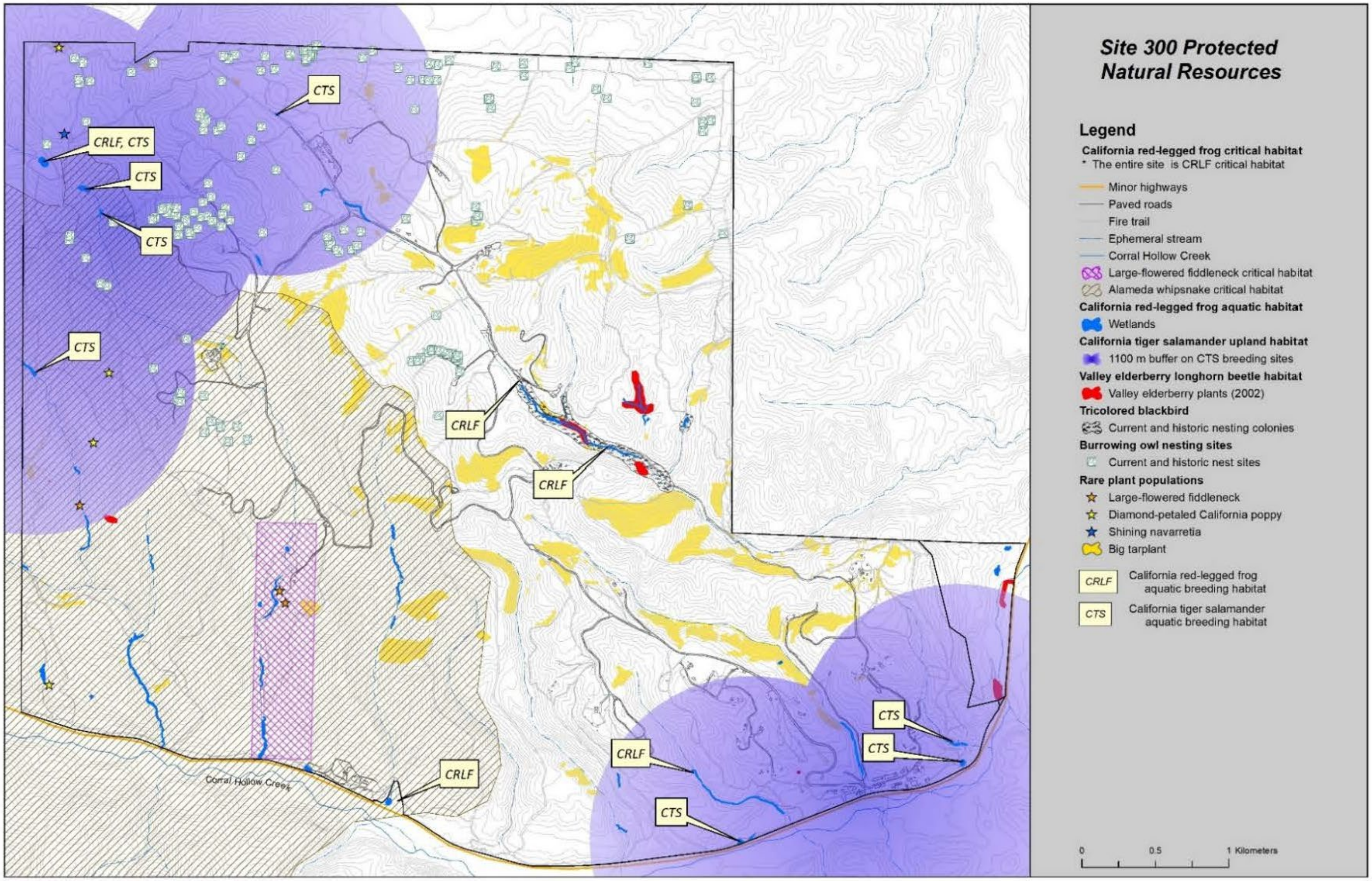


Source: LLNL 2021d.

Figure 5-2. Current Controlled Burns at Site 300

Fish and Wildlife. Construction of the SFTF would result in land disturbance and a change in wildlife habitat on approximately 0.1 acre. Because the disturbance amounts to 0.001 percent of the total acreage at Site 300, there would be minimal impacts on wildlife as any temporarily displaced animals could occupy adjacent habitat. No changes in fish habitat would occur under the No-Action Alternative. Future operations would be similar to ongoing operations and would not be expected to impact fish and wildlife at Site 300 beyond current impacts.

Special Status Species and Habitats. The protected natural resources at Site 300 are depicted in Figure 5-3. The entire site is within critical habitat designated for the California red-legged frog. Critical habitat for the Alameda whipsnake covers 2,492 acres of Site 300. Additionally, 160 acres within Site 300 are designated as critical habitat for the survival and recovery of large-flowered fiddleneck. The USFWS and LLNL are working on continued monitoring of native and experimental large-flowered fiddleneck populations and further development of habitat restoration and maintenance techniques.



Source: LLNL 2020p.

Figure 5-3. Protected Natural Resources at Site 300

Federally listed species known or expected to occur in the vicinity of Site 300 include one reptile two amphibians, one insect, and one plant. Although Site 300 is within the northern range of the San Joaquin kit fox, this species has not been observed onsite despite extensive survey efforts (LLNL 2020r; ECORP 2021b; Woollett 2021; Woollett 2019). The 2020 and 2021 surveys at Site 300 included surveys for carnivores; bats; small mammals; reptiles; sensitive botanical resources; special status wildlife populations; valley elderberry longhorn beetles and the quantity and quality of its host plant, blue elderberry; and Alameda whipsnake (Appendix I). In addition, 10 bird species are listed as Birds of Conservation Concern or protected by the BGEPA. State listed special status species confirmed to occur at Site 300 that are considered rare, threatened, or endangered include three amphibians, six reptiles, six mammals, 13 birds, and seven plants.

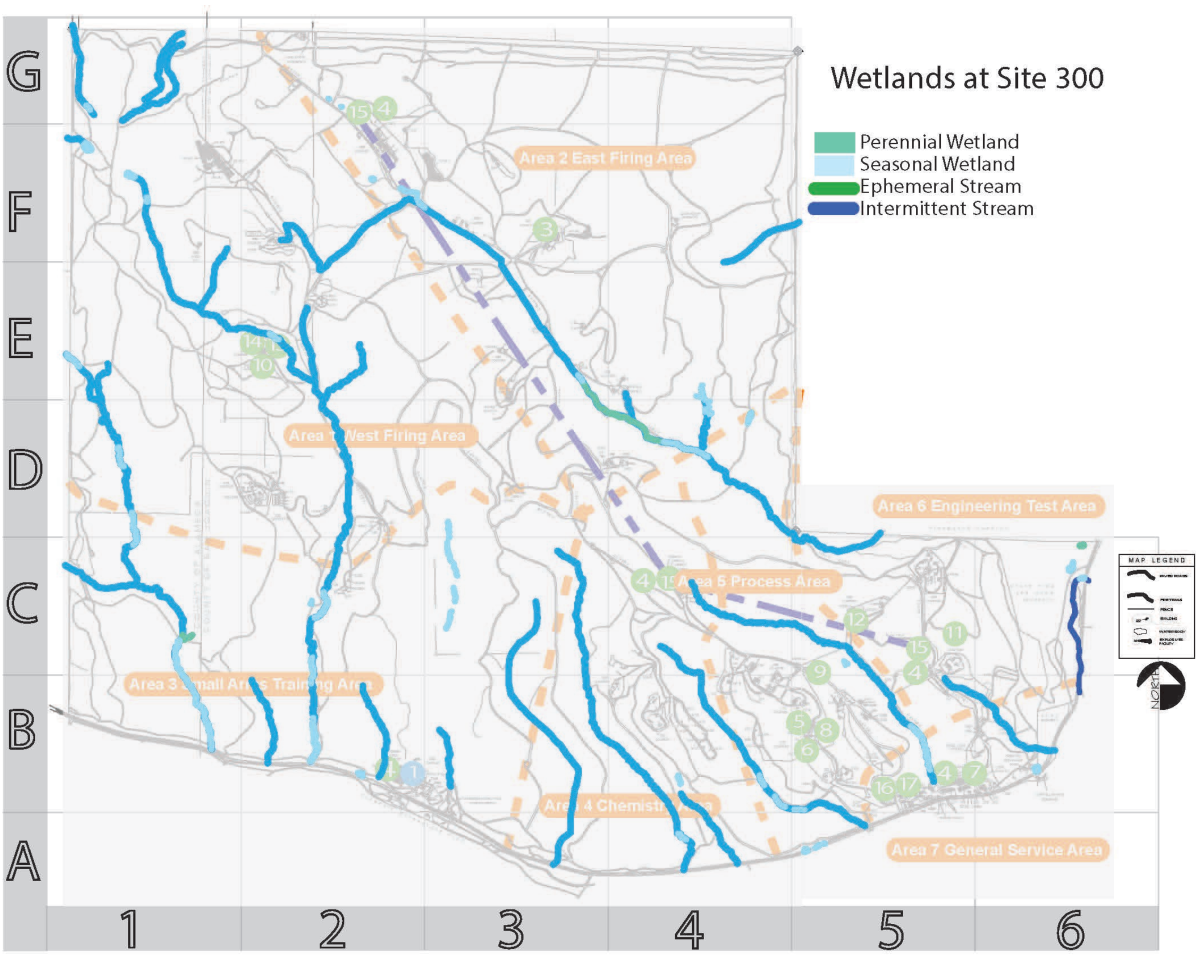
Five federally listed species (Alameda whipsnake, California red-legged frog, California tiger salamander, valley elderberry longhorn beetle, and large-flowered fiddleneck) are confirmed to occur on Site 300. Several of these federally listed species also are state listed. Two additional species protected under the California Endangered Species Act (ESA) (Swainson’s Hawk and Tricolored Blackbird) are confirmed to occur on Site 300. In addition to the federally endangered large-flowered fiddleneck, three rare plant species (big tarplant, diamond-petaled California poppy, and shining navarretia) and three uncommon plant species (California androsace, stinkbells, and hogwallow starfish) are known to occur at Site 300.

Conservation measures specified in the USFWS Biological Opinions since 2002 (LLNL 2002b; LLNL 2007c; LLNL 2018f) that are associated with facilities and infrastructure development activities at Site 300 would be implemented for conservation of special status species and habitats (LLNL 2011c). Consequently, the potential impacts from construction on special status species and habitats or critical habitats would be minimized.

Most of the bird species found at Site 300 are protected under the MBTA. Bird species protected by the MBTA are known to nest within developed and natural areas throughout Site 300. Golden eagles are frequently observed foraging at Site 300 but are not known to nest onsite. Several golden eagle nest sites are known to occur within 10 miles of Site 300. Construction disturbance of 0.6 acre has minimal the potential to impact species protected under the BGEPA or the MBTA. Nesting birds may be harmed by construction or DD&D projects. Impacts to nesting birds protected by the MBTA will be minimized through the implementation of avoidance measures including natural resources awareness training and pre-construction nesting bird surveys. In accordance with implementing EO 13186, “Responsibilities of Federal Agencies to Protect Migratory Birds,” the MOU between DOE and USFWS identifies specific areas in which cooperation between the DOE and USFWS would substantially contribute to the conservation and management of migratory birds and their habitats. Implementation of the MOU would further minimize potential impacts on special status species and habitats. Operations would be similar to past operations and would have minimal effects on special status species and habitats at Site 300.

Wetlands. Construction activities would not occur in wetlands (Figure 5-4) and would not directly affect wetlands or waters at Site 300. Wetland habitats (i.e., seeps and springs, vernal pools, seasonal ponds, and riparian woodlands) are scattered across Site 300 (Nomad Ecology 2020). Perennial and seasonal wetlands total 8.4 acres. The widely scattered pools provide aquatic breeding habitat for California red-legged frogs and California tiger salamanders. The Site 300 Natural Resources Management Plan (LLNL 2011c) recommends BMPs to protect wetland, riparian, and ephemeral water areas. Implementation of these BMPs would minimize potential impacts on wetlands.

The proposed operations of existing facilities and utilities under the No-Action Alternative would have minimal effects on wetlands at Site 300. As indicated in Appendix E, none of the operational changes would involve potential impacts on wetlands. Implementation of best management practices (e.g., silt fences) would minimize impacts on wetlands and waters features.



Sources: LLNL 2021d; Nomad Ecology 2020.

Figure 5-4. Projects and Wetland/Aquatic Resources Delineation at Site 300

5.8.2 Proposed Action

Livermore Site

This section analyzes the potential impacts associated with the Proposed Action construction and operational activities as they pertain to biological resources at the Livermore Site, using data and information in Section 3.3, including information in Table 3-7 and Table 3-8. This section discusses potential impacts that could occur from Proposed Action construction atop the new baseline established by the No-Action Alternative. Updated survey data are presented in the 2020 and 2021 studies and reports that were conducted in support of this SWEIS (Appendix I).

Vegetation. Under the Proposed Action at the Livermore Site, approximately 85.5 acres would be disturbed for construction of new facilities. Considering land reclaimed as a result of DD&D and restoration of laydown areas, the net amount of land disturbed would be approximately 52.5 acres. The net land disturbance would be approximately 6.4 percent of the total acreage at the Livermore Site. Revegetation of the vacated land, new cooling tower pipeline (2.5 acres) and laydown areas (4 acres) would be consistent with the vegetation in the surrounding developed areas.

NNSA is proposing additional landscaping around Lake Haussmann to facilitate a collaborative environment while retaining the lake's mission as a conveyance channel (LLNL 2021b). The Lake Haussmann enhancements would create more green space and result in beneficial impacts on the vegetation landscape at the Livermore Site.

The Proposed Action would affect vegetation by clearing land for the new construction projects; however, no new facilities would be constructed in undeveloped areas except for the New North Entry which will be constructed within the north buffer zone and crosses Arroyo Las Positas and the proposed new Fire Station, which could be constructed in a previously disturbed area in the west buffer zone (preferred location) or north buffer zone (alternate location). The impacts of the Proposed Action on changes to the existing ornamental vegetation and lawns, cleared areas, or recently disturbed sites would be minimal and similar to those for the No-Action Alternative. The construction of the New North Entry and the new Fire Station (in the alternate location) would result in the loss of 4.7 acres of annual grasslands in the north buffer zone. This represents 3.6 percent of the total acreage of the Livermore Site buffer zones.[5] Similar to the vegetation assessment for construction, conservation measures would continue to be implemented to minimize potential impacts from operational activities (LLNL 2013a; LLNL 2013b). The impacts of the Proposed Action for operations on changes to the existing ornamental vegetation and lawns, cleared areas, or recently disturbed sites would be minimal.

Fish and Wildlife. Under the Proposed Action at the Livermore Site, the proposed construction of new facilities and modernization/upgrade/utility projects would result in the clearing of vegetation on approximately 6.4 percent of the total acreage at the Livermore Site. No changes in fish habitat would occur under the Proposed Action.

Any wildlife temporarily displaced during construction activities could occupy adjacent habitats. Similar to the fish and wildlife impact analysis Under the No-Action Alternative at the Livermore Site, the potential impacts from construction under the Proposed Action would be minimal. Conservation measures would continue to be implemented to minimize potential impacts (LLNL 2013a; LLNL 2013b). The Proposed Action would occur in previously developed areas except for the New North Entry and Fire Station. Minimal changes to the existing ornamental vegetation and lawns, cleared areas, or recently disturbed sites would not diminish the existing wildlife habitat. Similar to the fish and wildlife assessment under the Proposed Action for construction, conservation measures would continue to be implemented to minimize potential impacts from operational activities (LLNL 2013a; LLNL 2013b).

[5] Livermore buffer zones total approximately 130 acres.

Special Status Species and Habitats. Under the Proposed Action at the Livermore Site, the proposed construction of new facilities and modernization/upgrade/utility projects would result in the clearing of vegetation on approximately 10.2 percent of the total acreage at the Livermore Site. Similar to the impact analysis for special status species and habitats under the No-Action Alternative at the Livermore Site, the potential impacts from construction under the Proposed Action would be minimal.

The proposed activities would be conducted in proximity to aquatic habitats. Future operations would be similar to ongoing operations. Impacts on special status raptor and passerine bird species (ECORP 2021a; LLNL 2021p), and the California red-legged frog (Sequoia 2021a) would be minimized through the implementation of avoidance measures including pre-activity surveys and natural resources education activities.

Construction related activities at the Livermore Site could impact California red-legged frogs if present in nearby aquatic habitat including Arroyo Las Positas, Lake Haussmann, and associated drainage channels. The 2020 and 2021 surveys indicated that California red-legged frogs are likely not abundant on the Livermore Site (Sequoia 2021a). The potential impacts would continue to be minimized by implementing conservation measures including natural resources awareness training, exclusion barriers, minimizing saturated soil or standing water at construction sites, and monitoring as specified in the formal consultation for infill construction and redevelopment and the Livermore Site Natural Resources Management Plan (LLNL 2013a; LLNL 2013b).

Construction associated with the Proposed Action would occur in previously developed areas with the exception of the New North Entry and Fire Station (alternate location). Minimal changes to the existing ornamental vegetation and lawns, cleared areas, or recently disturbed sites would not adversely affect special status species and habitats. The construction of the New North Entry and Fire Station (at the alternate location) would result in the loss of foraging habitat for special status bird species including the White-tailed Kite, and other birds protected under the MBTA. These birds will be displaced to adjacent rangeland for foraging. The construction of the New North Entry may also result in the loss of nest sites for the White-tailed Kite. Impacts to nesting White-tailed kites and other bird species protected by the MBTA would be minimized by conducting nesting bird surveys prior to construction, scheduling tree removal outside of the nesting season whenever possible, and implementing construction buffers around known nest sites when possible. The installation of a new road within the north buffer zone could present a barrier to upland movement of special status species including California red-legged frog and California tiger salamander. Traffic on the proposed North Entry road could increase potential road mortality during upland movement of special status species.

DOE/NNSA has previously completed a formal consultation with the USFWS for infill construction and redevelopment at the Livermore Site (LLNL 2013b). The 2013 formal consultation broadly analyzes impacts on listed species from construction within the Livermore Site buffer zones and the construction of crossings of the Arroyo Las Positas.

Conservation measures would continue to be implemented to minimize potential impacts from operational activities under the Proposed Action. Although the proposed development for new facilities would be conducted in proximity to aquatic habitats, operational activities would occur in previously developed areas and the minimal changes to the existing ornamental vegetation and lawns, cleared areas, or recently disturbed sites would not adversely affect special status species and habitats. Therefore, the impacts of the Proposed Action for operations on special status species and habitats would be minimal.

Tritium Levels in Vegetation and Commodities. LLNL continues to monitor tritium in vegetation and commodities in the Livermore Valley. Under the Proposed Action, radiological air emissions limits of tritium would be 12.0 times greater than limits under the No-Action Alternative. In 2019, radionuclide particulate, tritium, and beryllium concentrations in air at the Livermore Site and in the Livermore Valley were well below the levels that would cause concern for the environment or public health. The maximum estimated ingestion dose from LLNL operations for 2019 is 0.0086 millirem/year. This maximum dose is about 1/35,000 of the average annual background dose in the United States from all-natural sources and about 1/120 the dose from a panoramic dental x-ray. Ingestion doses of Site 300 vegetation were not calculated because neither people nor livestock ingest vegetation at Site 300. For Livermore Valley wines purchased in 2019, the highest concentration of tritium (68 pCi/L) was just 0.34 percent the USEPA standard for maximal permissible level of tritium in drinking water (20,000 pCi/L). Drinking one liter per day of the Livermore Valley wine with the highest concentration purchased in 2019 would have resulted in a dose of 0.0025 millirem/year (LLNL 2020r).

The potential impacts of increasing the tritium emissions limits under the Proposed Action may be calculated using a factor of 12.0 times the annual maximum ingestion dose calculated for the No-Action Alternative. These calculations assume a linear increase in tritium concentrations. If tritium emissions increased to approximately 3,600 Curies per year, the maximum estimated ingestion dose from LLNL operations would be 0.24 millirem/year. This maximum dose is about 1/1,250 of the average annual background dose in the United States from all-natural sources. For Livermore Valley wines, the highest concentration of tritium (1,876 pCi/L) would be just 9.4 percent the USEPA standard for maximal permissible level of tritium in drinking water (20,000 pCi/L). Drinking one liter per day of the Livermore Valley wine with the highest concentration would result in a dose of 0.012 millirem/year (based on LLNL 2020r). Therefore, the impacts of the No-Action Alternative on tritium levels in vegetation and commodities would be minimal.

Radiological Protection of Biological Resources. *See* the discussion in Section 5.8.1 for the No-Action Alternative, which discusses the correlation between radiation impacts to biological resources. As shown in Section 5.14 of this SWEIS, the potential impacts to workers and the public would be well below 0.1 rem per day, which is demonstrative that populations of plants and animals would be adequately protected from the effects of ionizing radiation.

Wetlands. Based on delineations in 2005 and 2020, small wetlands occur along Arroyo Las Positas and Arroyo Seco. In accordance with the Livermore Site Natural Resources Management Plan (LLNL 2013a), vegetation buffers are maintained around Arroyo Las Positas and Arroyo Seco. None of the proposed construction activities are sited in the wetland buffer areas or nearby aquatic features (Figure 5 5).

Two projects under the Proposed Action (the New North Entry and the enhancement of Lake Haussmann) would potentially affect wetlands or waters at the Livermore Site (*see* Appendix E, Figures E-1 and E-2). With regard to the New North Entry, the proposed bridge across the Arroyo Las Positas would span the Arroyo and would not impact the associated intermittent stream-wetlands. The proposed project would be consistent with the requirements in EO 11990. The proposed project would avoid the destruction or modification of wetlands and new construction in wetlands. DOE would implement best management practices for constructing the roadway and use a clear span bridge across the Arroyo Las Positas to avoid potential impacts to wetlands. No alternatives were identified for a New North Entry to the Livermore Site that would avoid crossing the Arroyo Las Positas floodplain and to avoid adverse impacts; therefore, no practicable alternative is required.

NNSA is proposing additional landscaping around Lake Haussmann to facilitate a collaborative environment while retaining the lake's mission as a conveyance channel. The proposed project would not involve planting additional landscaping within wetlands or waters of the U.S. Wetlands are present that meet the wetland definition included in the DOE Floodplain and Wetland Review Requirements (10 CFR 1022.4). The additional landscaping around Lake Haussmann would not affect DOE wetlands or intermittent stream waters adjacent to the lake. No alternatives were identified for Lake Haussmann enhancements to avoid adverse impacts; therefore, no practicable alternative is required.

Site 300

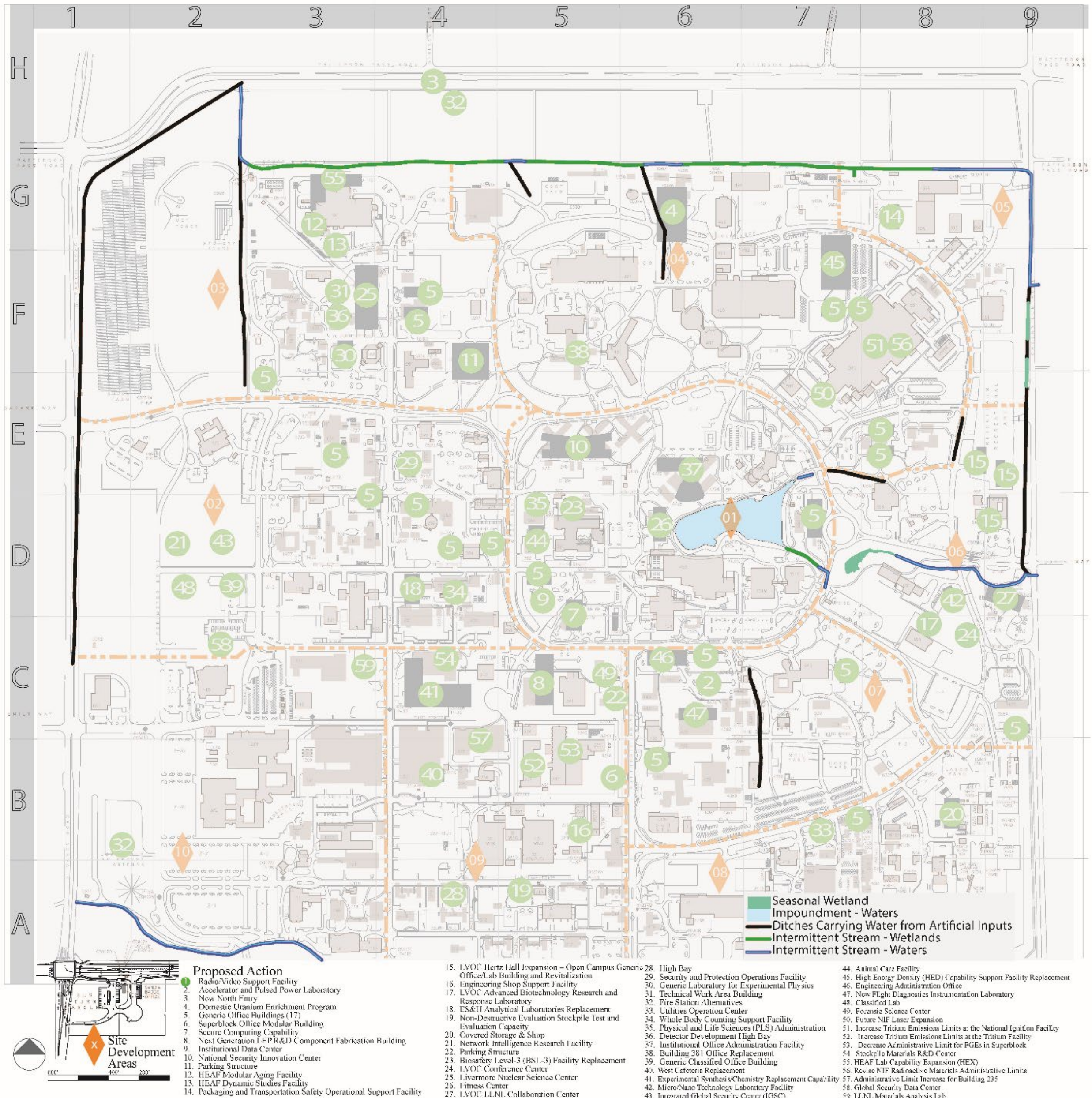
This section analyzes the potential impacts associated with the Proposed Action construction and operational activities as they pertain to biological resources at Site 300, using data and information in Section 3.3, including information in Table 3-7 and Table 3-8. This section discusses potential impacts that could occur from Proposed Action construction atop the new baseline established by the No-Action Alternative. Updated survey data are presented in the 2020 and 2021 studies and reports that were conducted at Site 300 in support of this SWEIS (Appendix I).

Vegetation. Under the Proposed Action at Site 300, approximately 36 acres would be developed for construction of new facilities. Considering land reclaimed as a result of DD&D and restoration of laydown areas, the net amount of land disturbed would be approximately 34.6 acres. The net land disturbance would be approximately 0.5 percent of the total acreage at Site 300. Revegetation of the vacated land would be consistent with the vegetation in the surrounding developed areas.

Construction associated with the Proposed Action would affect vegetation by clearing land for the new construction projects; however, new facilities would be constructed in associated developed areas when possible, conservation measures would be implemented (LLNL 2018a), and the disturbed area would be a small fraction of the total acreage at Site 300.

Similar to the vegetation assessment under the Proposed Action for construction, operations would be conducted in associated developed areas, conservation measures would be implemented (LLNL 2018a), and the disturbed area would be a small fraction of the total acreage at Site 300. Therefore, the impacts of the Proposed Action operations on vegetation would be minimal.

Similar to the No-Action Alternative, up to 2,500 acres of land would continue to be burned annually under the Proposed Action. This would control vegetation that could become an uncontrolled fire hazard and provides the beneficial effects of sustaining and developing native grassland. Prescribed burning would continue to be conducted in accordance with the Site 300 Prescribed Burn/Smoke Management Plans).



Sources: LLNL 2021d; Nomad Ecology 2020.

Figure 5-5. Proposed Action Projects and Wetland/Aquatic Resources Delineation at the Livermore Site

Fish and Wildlife. Under the Proposed Action at Site 300, the proposed construction of new facilities and implementation of modernization/upgrade/utility projects would result in vegetation disturbance and change in wildlife habitat on approximately 0.5 percent of the total acreage at Site 300. No changes in fish habitat would occur under the Proposed Action. The disturbance of 0.5 percent of Site 300 small fraction of the total acreage at Site 300 that would be disturbed would have minimal impacts on wildlife as some displaced animals could occupy adjacent habitat. Conservation measures would continue to be implemented to minimize potential impacts.

Revegetation of disturbed areas would be consistent with the vegetation in the surrounding areas to maintain natural communities to the greatest extent possible.

Common wildlife species are abundant at Site 300. Impacts on wildlife species would be minimized by planning construction activities in or adjacent to developed areas, implementing conservation measures (LLNL 2011c), and minimizing the area of disturbance as possible. Impacts resulting from the operation of new facilities would be minimized through the implementation of conservation measures such as natural resources awareness training and pre-activity surveys. In addition, new construction would be in, and adjacent to, existing areas disturbance when possible. No fish impacts would occur.

Special Status Species and Habitats. Under the Proposed Action at Site 300, the proposed construction of new facilities and implementation of modernization/upgrade/utility projects would result in development on approximately 0.5 percent of the total acreage at Site 300. The Proposed Action includes construction of new facilities in upland habitat for the California red-legged frog and California tiger salamander. Because all of Site 300 is within critical habitat designation for the California red-legged frog, surveys would be required for all new facilities prior to construction. These projects would be completed in consultation with the USFWS as required by Section 7 of the federal *Endangered Species Act*. The proposed action will not result in impacts to Alameda whipsnake or large-flowered fiddleneck critical habitat. Conservation measures specified in the USFWS Biological Opinions (LLNL 2002b; LLNL 2007c; LLNL 2018f) that are associated with facilities and infrastructure development activities at Site 300 would be implemented to minimize impacts to special status species and habitats. As described under the No-Action Alternative, avian species that are protected under the MBTA nest throughout developed and undeveloped portions of Site 300. This includes special status species such as the Burrowing Owl. In addition, the golden eagle is often observed foraging throughout Site 300. Conservation measures would continue to be implemented to minimize potential impacts. Revegetation of disturbed areas would be consistent with the vegetation in the surrounding areas to maintain natural communities to the greatest extent possible.

Open grasslands throughout Site 300 are foraging habitat for several species of raptors protected under the MBTA including special status species. Construction on 36 acres of Site 300 would result in the loss of foraging habitat for special status avian species. This represents 0.5 percent of Site 300, and extensive foraging habitat will remain at Site 300 and on adjacent properties.

The Cyber-Physical Test Capability for Energy Distribution would include the construction of overhead power distribution. Birds often utilize power poles for perching, hunting, and nesting. When birds contact power lines they may be electrocuted. To minimize adverse impacts to migratory birds, Site 300 implements an avian protection policy to support avian-friendly transmission lines, insulators, power poles, and other features that are designed to minimize collision and electrocution fatalities of birds of prey.

The operation of new facilities would occur on approximately 0.5 percent of the total acreage at Site 300. The Proposed Action would have minimal impacts on special status species and habitats because operational activities would be in associated developed areas, conservation measures would be implemented (LLNL 2011c), and the disturbed area would be a small fraction of the total acreage at Site 300.

Wetlands. As depicted in Figure 5-5 and indicated in Appendix E, none of the Proposed Action projects would be sited in wetlands. Implementation of BMPs would minimize potential impacts on wetlands. The Proposed Action would have minimal impacts on wetlands because construction activities would be in associated developed areas, conservation measures would be implemented (LLNL 2011c), and the disturbed area would be a small fraction of the total acreage at Site 300.

5.8.3 Summary of Biological Impacts for the Alternatives

Table 5-22 summarizes the potential impacts to biological resources for the alternatives.

Table 5-22. Potential Impacts to Biological Resources for the Alternatives

Resource/Metric	No-Action Alternative		Proposed Action	
	Livermore Site	Site 300	Livermore Site	Site 300
Land Disturbance (acres)	13.6	0.6	85.5	36
Land Reclaimed as a result of DD&D (acres)	5.2	0.02	26.5	0.4
Laydown Areas Restored after Construction (acres)	2.0	0.5	6.5[a]	1.0
Net Land Disturbed (acres)	6.4	0.1	52.5	34.6
Vegetation (potential impact)	Minimal	Minimal	New North Entry and new Fire Station (alternate location) would result in the loss of 4.7 acres of annual grasslands in the north buffer zone.	Minimal-- only 0.5 percent of site disturbed.
Fish and Wildlife (potential impact)	Minimal	Minor impacts to fish and wildlife species and their habitat will be minimized through the implementation of conservation measures.	Potential impacts to upland habitat that may result from the construction of the New North Entry and Fire Station (alternate location) in the north buffer zone would be minimized through the implementation of conservation measures.	Potential impacts to fish and wildlife species and their habitat will be minimized through the implementation of conservation measures.

Resource/Metric	No-Action Alternative		Proposed Action	
	Livermore Site	Site 300	Livermore Site	Site 300
Special Status Species and Habitats (potential impact)	Minor impacts to special status species and their habitat will be minimized through the implementation of conservation measures. Covered by existing consultation with the USFWS.	Minor impacts to special status species and their habitat will be minimized through the implementation of conservation measures. Covered by existing consultation with the USFWS.	Construction of the New North Entry and Fire Station (alternate location) in the north buffer zone could impact special status birds and upland habitat for the California red-legged frog.	Impacts to upland habitat for the California red-legged frog and California tiger salamander. Minor loss of foraging habitat for special status raptors.

a. Includes 4 acres of laydown areas and 2.5 acres of cooling tower pipeline.

5.9 Cultural and Paleontological Resources

This section presents the potential cultural and paleontological impacts for the alternatives due to construction, DD&D, modernization/upgrade/utility projects, and operations. Key metrics presented in the cultural and paleontological analysis include: (1) identification of land disturbances; and (2) qualitative analysis of the potential to impact cultural and paleontological resources.

5.9.1 No-Action Alternative

Under the No-Action Alternative, the ongoing activities described in Chapter 2 and Chapter 4 would continue at LLNL. In addition, new facility construction, modernization/upgrade/utility projects, and DD&D activities described in Section 3.2 would also occur. Operational changes, such as increases to the workforce, would not affect cultural and paleontological resources. Cultural and paleontological impacts were estimated for constructing approximately 19 new projects, totaling approximately 416,300 square feet, and DD&D of approximately 42 facilities, totaling approximately 228,000 square feet over the period 2020–2022.

Livermore Site

As discussed in Section 5.2.1, at the Livermore Site, a total of 13.6 acres would be disturbed during construction activities under the No-Action Alternative. Because approximately 85 percent of the Livermore Site is developed, this additional land disturbance would represent approximately 1.6 percent of the current land at the site. Although no archaeological resources were identified and no impacts to archaeological resources would be expected, unrecorded subsurface resources could be inadvertently discovered during new construction or other ground-disturbing activities undertaken on undisturbed land. The probability of impacting additional archaeological resources at the Livermore Site would be low because field and archival research have not identified any such resources and extensive modern horizontal and vertical development has disturbed much of the site. As discussed in Section 4.9, fossils were discovered in four localities at the peripheral parts of the excavation for the NIF. These finds were in the fluvial valley fill deposit at depths of

20 to 30 feet below the present surface. Because this valley fill is expected to occur throughout the Livermore Site, any excavation conducted under the No-Action Alternative to those depths would have the potential to impact similar fossils.

Site 300

As discussed in Section 5.2.2, at Site 300, a total of 0.6 acre would be disturbed during construction activities under the No-Action Alternative. The represents 0.001 percent of the current footprint at Site 300. The probability of impacting additional archaeological resources at Site 300 would also be low because the site has undergone assessments to identify such resources, the resources identified have been evaluated for their significance, and those that are significant would continue to be protected through implementation of current management practices that avoid and protect these sensitive areas and associated buffer zones from LLNL activities. Although no impacts to archaeological resources would be expected, unrecorded subsurface resources still could be inadvertently discovered during new construction or other ground-disturbing activities undertaken on undisturbed land. As discussed in Section 4.9, scattered fossil remains have been discovered in many locations at Site 300. Because the geological formations within which the finds have occurred (Neroly and Cierbo Formations) exist across Site 300 at the surface and to depth, it is reasonable to assume that ground disturbance conducted under the No-Action Alternative would have the potential to impact similar fossils.

Both Sites

As described in Section 4.9.4, the Livermore Site and Site 300 have undergone comprehensive reviews in 2007 and 2012 to identify significant historic buildings, structures, and objects, and those that were determined eligible for the National Register have already been mitigated and are no longer eligible. Additionally, a review of LLNL's Facilities Information Management System (FIMS) database (LLNL 2021a) for Livermore Site and Site 300 facilities confirmed that all have been: (1) reviewed in the 2007 Historic Context and/or the 2012 National Register of Historic Places (NRHP) Re-evaluation reports; (2) dismissed from further review because they were not eligible, based on criteria consistent with those applied in the 2007 and 2012 reports; or (3) dismissed from further review because they had not reached 50 years of age. Thus, there are currently no significant architectural properties at the Livermore Site or Site 300 and no impacts to these resources from new construction, modifications, or DD&D under the No-Action Alternative are expected.

As described in Section 4.9.3, any proposed ground-disturbing activities at the Livermore Site or Site 300 would be reviewed against archaeological and paleontological sensitivity maps and other information (such as prior field surveys or historical records) and assessed for the potential for effects to cultural resources, prior to permit approval. Any necessary field investigations, consultation with the California State Historic Preservation Officer (SHPO), or mitigation activities would be completed prior to project implementation. To address the inadvertent discovery of cultural material, LLNL would require its employees and contractors to report any evidence of cultural resources unearthed during ground-disturbing activities. Work within the immediate vicinity of the discovery would cease until a qualified archaeologist had the opportunity to assess the discovery. If the discovery were deemed potentially significant, work would be stopped until an appropriate treatment plan was developed according to DOE guidelines. Standard

LLNL practice would require work to be halted if any previously unknown resources were discovered during ground-disturbing activities, and that a qualified paleontologist be provided an opportunity to assess the materials.

5.9.2 Proposed Action

Under the Proposed Action, the ongoing activities described in Chapter 2 and Chapter 4 would continue at LLNL. In addition, the Proposed Action includes the use of facilities and projects described for the No-Action Alternative, as well as new facility construction, modernization/upgrade/utility projects, operational changes, and DD&D activities described in Section 3.3. Cultural and paleontological impacts were estimated for constructing approximately 75 new projects, totaling approximately 3.3 million square feet, and DD&D of approximately 150 facilities, totaling approximately 1,170,000 square feet over the period 2023–2035. Most of the new projects (61 out of 75) and DD&D activities (approximately 98.5 percent [1,153,000 square feet out of 1,170,000]) would be located at the Livermore Site.

Livermore Site

As discussed in Section 5.2.2, at the Livermore Site, a total of 85.5 acres would be disturbed under the Proposed Action over 2023-2035. This represents approximately 10.4 percent of the current land at the site. The probability of impacting archaeological resources from construction at the Livermore Site would also be low under the Proposed Action for the same reasons described above for the No-Action Alternative. However, along with the increase in the number of construction projects and acreage disturbed under the Proposed Action would come an increase in the number of opportunities to encounter inadvertent discoveries.

Under the Proposed Action, any excavations conducted at the Livermore Site to approximately 20 to 30 feet in depth would have the potential to impact fossils similar to those found during the original NIF construction. Because there would be more soil disturbance under the Proposed Action, the likelihood for discoveries of fossils would be greater than under the No-Action Alternative. Construction planned for the vicinity of the 1997-1998 fossil discoveries (*see* Figure 3-9), which includes the NIF Laser Expansion, HED Capability Support Facility Replacement, and some generic office buildings, would have higher potential for such discoveries if excavation extends to those depths.

Site 300

At Site 300, a total of 36 acres would be disturbed under the Proposed Action over 2023-2035. This represents approximately 0.5 percent of the current land at Site 300. The probability of impacting archaeological resources at Site 300 under the Proposed Action would be low for the same reasons described above for the No-Action Alternative. However, the increase in the number of construction projects at Site 300 under the Proposed Action would have an increased potential for inadvertent discoveries of archaeological resources. Any proposed ground-disturbing activities would be reviewed prior to permit approval and any inadvertent discoveries of archaeological material would be treated in accordance with existing LLNL procedures. Any ground disturbance conducted at Site 300 under the Proposed Action would have the potential to impact fossils similar to those previously found in the area. Because there would be more soil disturbance under the

Proposed Action, the likelihood for discoveries of fossils would be greater than under the No-Action Alternative.

Both Sites

Based on the comprehensive reviews conducted in 2007 and 2012, the completion of recommended mitigation documentation, and the recent review of the FIMS database described above, there are currently no significant architectural properties at the Livermore Site or Site 300. No impacts to these resources are expected under the Proposed Action from construction, modification, or DD&D projects undertaken during the SWEIS planning horizon. The 2007 comprehensive review of architectural resources (Sullivan and Ullrich 2007) and associated SHPO consultation under Section 106 (OHP 2005a) included those resources constructed prior to 1980, and the 2012 comprehensive review included those resources constructed prior to 1990. Therefore, buildings, structures, and objects that were built after 1990 and thus were not part of that comprehensive review may become eligible for listing on the National Register. An updated comprehensive review is planned consistent with the evaluation approach to identify significant (post-1990) historic buildings, structures, and objects, that was followed in 2007 and 2012. If post-1990 architectural resources planned for modifications or DD&D are eligible for the National Register, those activities could have an adverse effect on the properties. If it is found that there would be an adverse effect to an eligible resource, LLNL would complete consultation to plan and implement appropriate mitigation measures.

As described in Section 4.9.3, any proposed ground-disturbing activities at the Livermore Site or Site 300 would be reviewed against archaeological and paleontological sensitivity maps and other information (such as prior field surveys or historical records) and assessed for the potential for effects to cultural resources, prior to permit approval. Any necessary field investigations, consultation with the California SHPO, or mitigation activities would be completed prior to project implementation. To address the inadvertent discovery of cultural material, LLNL would require its employees and contractors to report any evidence of cultural resources unearthed during ground-disturbing activities. Work within the immediate vicinity of the discovery would cease until a qualified archaeologist had the opportunity to assess the discovery. If the discovery were deemed potentially significant, work would be stopped until an appropriate treatment plan was developed according to DOE guidelines. Particular attention would be paid to the report of the 1997-1998 fossil discoveries (Hanson 2000). Standard LLNL practice would require work to be halted if any previously unknown resources were discovered during ground-disturbing activities, and that a qualified paleontologist be provided an opportunity to assess the materials.

5.9.3 Summary of Cultural and Paleontological Impacts for the Alternatives

Table 5-23 summarizes the potential cultural and paleontological impacts for the No-Action Alternative and the Proposed Action.

Table 5-23. Potential Impacts to Cultural and Paleontological Resources for the Alternatives

Metric		Existing Environment Baseline	No-Action Alternative	Proposed Action
Archaeological and Paleontological Resources	Livermore Site	• No archaeological resources identified • Search of UCMP database revealed no recorded paleontological finds • 4 late Pleistocene vertebrate fossils were discovered in the peripheral parts of the excavation for the NIF • Unrecorded subsurface resources could exist	• No impacts expected • Unrecorded subsurface resources could be inadvertently discovered during construction/ground-disturbing activities undertaken on undisturbed land. • Any proposed ground-disturbing activities would be reviewed and assessed for the potential for effects prior to permit approval.	• No impacts expected • Unrecorded subsurface resources could be inadvertently discovered during construction/ground-disturbing activities undertaken on undisturbed land. • Any proposed ground-disturbing activities would be reviewed and assessed for the potential for effects prior to permit approval.
	Site 300	• 31 prehistoric and historic archaeological sites and isolated artifacts recorded • 23 of the 31 archaeological resources recorded are historic sites and isolated artifacts • 3 of the 23 historic archaeological resources are eligible • 2 prehistoric sites are eligible for listing in the National Register • Search of UCMP database revealed no recorded paleontological finds • Several vertebrate fossil deposits have been found on Site 300 in vicinity of Corral Hollow • Unrecorded subsurface resources could exist	• No impacts expected • NRHP eligible sites have been and would continue to be avoided by Site 300 activities • Unrecorded subsurface resources could be inadvertently discovered during new construction or other ground-disturbing activities undertaken on undisturbed land • Any proposed ground-disturbing activities would be reviewed and assessed for the potential for effects prior to permit approval	• No impacts expected • NRHP eligible sites have been and would continue to be avoided by Site 300 activities • Unrecorded subsurface resources could be inadvertently discovered during new construction or other ground-disturbing activities undertaken on undisturbed land. • Any proposed ground-disturbing activities would be reviewed and assessed for the potential for effects prior to permit approval
Architectural Resources	Livermore Site	• 4 buildings and select objects were previously eligible for listing in the National Register. Buildings and objects have been mitigated and no longer retain eligibility.	• No impacts expected • Periodic review of buildings over 50 years old	• No impacts expected • Periodic review of buildings over 50 years old
	Site 300	• 1 building and 2 districts eligible for listing in the National Register. Building and districts mitigated and no longer retain eligibility.	• No impacts expected • Periodic review of buildings over 50 years old	• No impacts expected • Periodic review of buildings over 50 years old
Cultural resources of significance to tribes	Livermore Site	• None identified	• No impacts expected • Review tribal consultation results	• No impacts expected • Review tribal consultation results
	Site 300	• None identified	• No impacts expected • Review tribal consultation results	• No impacts expected • Review tribal consultation results

Sources: LLNL 2005; OHP 2005b.

5.10 SOCIOECONOMICS AND ENVIRONMENTAL JUSTICE

The socioeconomic analysis (Section 5.10.1) presents the potential impacts from changes in employment and economic activity due to construction, DD&D, modernization/upgrade/utility projects, and operations associated with the alternatives. The Region of Influence (ROI), as described in Chapter 4, is a four-county area surrounding LLNL where more than 88 percent of LLNL employees and their families reside. Key metrics presented in the socioeconomics analysis are: (1) employment and population changes; (2) changes in economic activity (e.g., earnings/monetary value added); and (3) impacts to housing and community services. The environmental justice (EJ) analysis (Section 5.10.2) identifies and addresses any disproportionately high and adverse human health or environmental effects on minority or low-income populations.

5.10.1 Socioeconomics

5.10.1.1 *No-Action Alternative*

Under the No-Action Alternative, the ongoing activities described in Chapter 2 and Chapter 4 would continue at LLNL. In addition, new facility construction, modernization/upgrade/utility projects, and DD&D activities described in Section 3.2 and operational workforce increases would also occur. Table 5-24 shows the potential impacts on employment, population, and economic activity for the No-Action Alternative.

Employment and Economic Activity. As shown in Table 5-24, construction, modernization/upgrade/utility projects, and DD&D activities associated with the No-Action Alternative would require a peak level of approximately 210 workers per year[6] by the end of 2022. In addition, by the end of 2022, the operational workforce at LLNL is expected to increase from 7,909 workers to 9,130 workers (LLNL 2019i). Hence, the total workforce for the No-Action Alternative planning period (2020-2022) is expected to increase by 1,431 persons, from 7,909 persons to a total of 9,340 persons. Overall, direct employment at LLNL would increase by approximately 18.1 percent compared to the baseline 2019 workforce.

Increases in direct employment at LLNL would also cause increases in indirect employment and associated economic activity. These indirect increases were derived using multipliers provided from the BEA-developed Regional Input-Output Modeling System (RIMS II) for a select region. The multiplier of 1.8322 was used for indirect employment for operational workforce increases under the No-Action Alternative; and a multiplier of 1.3855 was used for construction/DD&D workforce increases (BEA 2021). These multipliers were developed for an aggregation of the four-county ROI. As a result, approximately 1,097 additional indirect jobs would be created in the ROI over the period 2020-2022. Overall, there would be an increase of 2,528 jobs (1,431 direct and 1,097 indirect), which would represent 0.12 percent of the total jobs in the ROI.

[6] For each project/action, NNSA consulted with subject matter experts from LLNL to quantify key parameters. Accumulated parameters are discussed in detail in Section 3.4.

Table 5-24. Socioeconomic Impacts from activities at LLNL Under the No-Action Alternative

Resource/Metric	Baseline (Existing Environment) 2019	Change to Baseline as a Result of the No-Action Alternative			No-Action Alternative (by end of 2022)	Percentage Increase Over Baseline (%)
		Construction and DD&D (Peak year)	Operations (by the end of 2022)	Total		
Jobs						
Direct jobs at LLNL (persons)	7,909[m]	210	1,221	1,431	9,340	18.1
Indirect jobs from LLNL (persons)	6,581[a]	81[b]	1,016[a]	1,097	7,678	16.7
Total Direct and Indirect employment	14,490	291	2,237	2,528	17,018	17.4
Total ROI labor force (persons)	1,976,800	-	-	-	2,039,210[c]	3.1[d]
Earnings/Value Added						
Earnings from direct jobs at LLNL (millions of dollars)	$1,334M[e]	$18.6M[f]	$206.0M[e]	$224.6M	$1,558.6M	16.8
Earnings from indirect jobs from LLNL in ROI (millions of dollars)[g]	$1,110M	$7.2M	$171.4M	$178.6M	$1,288.6M	16.1
Value added from LLNL (millions of dollars)	$2,436M[h]	$31.6M[i]	$376.1M[h]	$407.7M	$2,843.7M	16.7
Population						
Total ROI population	4,084,802	873[j]	6,711[j]	7,584	4,261,288[k]	4.3[l]

a. Indirect employment for operational workforce was estimated using a direct-effect employment multiplier of 1.8322 (BEA 2021).
b. Indirect employment for construction/DD&D was estimated using a direct-effect employment multiplier of 1.3855 (BEA 2021).
c. Calculated using the average labor force growth rate of historic labor force in the ROI (EDD 2020a).
d. ROI labor force increase of 3.1 percent would largely occur independent of LLNL activities. The direct and indirect employment increase from LLNL activities would only contribute a 0.12 percent increase.
e. Earnings were estimated using a final-demand earnings multiplier of 0.4374 applied to the change in jobs / change in final demand multiplier of 2.5926 (BEA 2021).
f. Earnings were estimated using a final-demand earnings multiplier of 0.4467 applied to the change in jobs / change in final demand multiplier of 5.0364 (BEA 2021).
g. Derived from earnings from directs jobs / direct jobs.
h. Value added was estimated using a final-demand value added multiplier of 0.7986 applied to the change in jobs / change in final demand multiplier of 2.5926 (BEA 2021).
i. Value added was estimated using a final-demand value added multiplier of 0.7584 applied to the change in jobs / change in final demand multiplier of 5.0364 (BEA 2021).
j. Based on an average of 3 persons per household for the ROI (USCB 2021) and the conservative assumption that new direct LLNL workers and indirect workers would move with their families.
k. Population projection for year 2022 for counties in the ROI from California's Department of Finance, Table P-1: State Population Projections (2010-2060) (DOF 2020a).
l. ROI population increase of 4.3 percent would largely occur independent of LLNL activities. The population increase from LLNL activities would contribute a 0.2 percent increase.
m. Values are for full time employees at LLNL and do not include construction workers, which vary annually. However, the percentage increase (18.1 percent) would not change significantly if baseline values were available for construction workers.

Sources: DOF 2020a; EDD 2020a; LLNL 2019i; USCB 2021; BEA 2021.

From 2020 to 2022, the total labor force in the ROI is expected to increase from 1,976,800 workers to 2,039,210 workers, which would equate to a 3.1 percent increase (EDD 2020a). More than 99 percent of the projected labor force increase would be associated with non-LLNL-related employment increases in the ROI. The total workers associated with the No-Action Alternative (17,018 total workers, consisting of 9,340 direct and 7,678 indirect) would increase by 17.4 percent from 2019 baseline and would account for 0.8 percent of the projected 2022 ROI labor force of 2.04 million workers.

The value added from the direct economic activity to the local economy includes employee compensation, tax on production and imports, and proprietary and other property income and indirect employment compensation. Total direct and indirect workforce increase by the end of 2022 under the No-Action Alternative would add approximately $407.7 million annually to the local economy. Approximately $224.6 million of the value added annually would be in the form of earnings ($18.6 million for construction/DD&D workers and $206 million for operational workforce). A portion of this increased payroll would enter the local economy as the new workers purchase additional goods and services. It is anticipated that some portion of construction and operational materials would be purchased locally and that most construction/DD&D and operational workers would be drawn from within the ROI, resulting in regional increases in jobs. The additional expenditures by workers would generate additional income and employment opportunities within the ROI as the expenditures filter throughout the economy.

Population and Housing. The population in the ROI in 2022 is projected to be 4,261,288 persons, which would be a 4.3 percent increase compared to the 2019 baseline population of 4,084,802 (DOF 2020a). Employment associated with the No-Action Alternative would be 17,018 workers (9,340 direct and 7,678 indirect workers), which would represent approximately 0.4 percent of the projected 2022 population in the ROI. The increase in direct and indirect jobs associated with the No-Action Alternative would be 2,528, which is less than 0.1 percent of the projected ROI population in 2022. Because the increase in direct and indirect jobs would be less than 0.1 percent of the projected population, a large influx of workers/families due to LLNL employment into the ROI is not expected. However, if these 2,528 new jobs were completely filled by workers migrating into the ROI, the maximum population increase in the ROI would be 7,584 persons (2,528 new jobs multiplied by 3 persons per household),[7] or 0.2 percent of the projected 2022 ROI population. The incremental population increase would be within growth projections for the ROI.

In 2020, there were 78,413 vacant housing units in the ROI (DOF 2020b). Because a large influx of workers/families into the ROI is not expected, the No-Action Alternative would not result in notable changes in vacant housing units. More likely, non-LLNL-related activities would be expected to cause reductions in vacant housing units. At most, the additional jobs associated with the No-Action Alternative would reduce the vacant housing units by 2,528, or approximately 3.2 percent.

Community Services and Schools. Due to the low potential for impacts on the population, the No-Action Alternative would not affect fire protection, police protection services, or medical services. As discussed above, the No-Action Alternative would result in a population increase in the ROI of 7,584 persons, or 0.2 percent of the projected 2022 ROI population of 4,261,288 (DOF

[7] Assumes one worker per household and an average of three persons per household for the ROI (USCB 2021).

2020a). This increase would not change demands for these services compared to current conditions. The Alameda County Fire Department (ACFD) located onsite and LLNL Safeguards and Securities Department currently provides adequate onsite service. The adequacy of these services would continue to be evaluated on an annual basis, and personnel, equipment, and facilities would be increased or upgraded as necessary.

With regard to schools, assuming an average of 0.4 school-age children per household (NAHB 2017), the maximum number of school-age children associated with the additional direct and indirect workforce of 2,528 potentially migrating into the ROI would be 1,011 children (2,528 multiplied by 0.4 average school-age children per household). The increase in school enrollment would represent 0.2 percent of the projected 2021-2022 school enrollment of 656,132 for the ROI (DOF 2021a). This minimal increase in school enrollment would have a negligible effect on school services in the ROI.

5.10.1.2 *Proposed Action*

Under the Proposed Action, the ongoing activities described in Chapter 2 and Chapter 4 would continue at LLNL. In addition, the Proposed Action includes the use of facilities and projects described for the No-Action Alternative, as well as new facility construction, modernization/upgrade/utility projects, and DD&D activities described in Section 3.3, as well as operational workforce increases. Table 5-25 shows the potential impacts on employment, population, and economic activity under the Proposed Action.

Employment and Economic Activity. As shown in Table 5-25, construction, modernization/upgrade/utility projects, and DD&D activities associated with the Proposed Action would require a maximum of approximately 700 workers per year. In addition, the operational workforce at LLNL is expected to increase from the No-Action Alternative baseline of 9,130 workers to 10,060 workers by the end of 2035. Hence, the total workforce for the Proposed Action planning period (2023-2035) is expected to increase from 9,340 workers under the No-Action Alternative to a total of 10,750 workers by the end of 2035. Overall, direct employment at LLNL would increase by approximately 15.2 percent compared to the No-Action Alternative workforce. A review of new facilities under the Proposed Action includes the following projects for housing workers:

- Seventeen generic office buildings totaling over 400,000 square feet would be constructed at the Livermore Site;
- The National Security Innovation Center, which involves construction and operation of a three-story building (or four smaller buildings) totaling approximately 225,000 square feet at the Livermore Site. Approximately 1,100 personnel from Buildings 132N, 131, 111, and 381 would relocate to this facility.
- Two Site 300 Office Buildings (unclassified and classified spaces) would be constructed in the GSA and would house approximately 300 personnel.

Table 5-25. Socioeconomic Impacts from Activities at LLNL Under the Proposed Action

Resource/Metric	No-Action Alternative (by end of 2022)	Change to No-Action Alternative as a Result of the Proposed Action			Proposed Action (by end of 2035)	Percentage Increase Over No-Action Alternative (%)
		Construction and DD&D (peak year)	Operations (by end of 2035)	Total		
Jobs						
Direct jobs at LLNL (persons)	9,340	700	710	1,410	10,750	15.2
Indirect jobs from LLNL (persons)	7,678	270[b]	590[a]	860	8,538	11.2
Total Direct and Indirect Employment	17,018	970	1,300	2,270	19,288	13.4
Total ROI labor force (persons)	2,039,210	-	-	-	2,238,799[c]	9.8[d]
Earnings/Value Added						
Earnings from direct jobs at LLNL (millions of dollars)	$1,558.6M	$62.1M[f]	$119.8M[e]	$181.9M	$1,740.5M	11.6
Earnings from indirect jobs from LLNL in ROI (millions of dollars)[g]	$1,288.6M	$24.8M	$99.5M	$124.3M	$1,412.9M	9.6
Value added from LLNL (millions of dollars)	$2,843.7M	$104.4M[i]	$218.7M[h]	$324.1M	$3,167.8M	11.4
Population						
Total ROI population	4,261,288	2,910[j]	3,900[j]	6,810	4,752,927[k]	11.5[l]

a. Indirect employment for operational workforce was estimated using a direct-effect employment multiplier of 1.8322 (BEA 2021).
b. Indirect employment for construction/DD&D was estimated using a direct-effect employment multiplier of 1.3855 (BEA 2021).
c. Calculated using the average labor force growth rate of historic labor force in the ROI (EDD 2020a).
d. ROI labor force increase of 9.8 percent would largely occur independent of LLNL activities. The direct and indirect employment increase from LLNL activities would only contribute a 0.11 percent increase.
e. Earnings were estimated using a final-demand earnings multiplier of 0.4374 applied to the change in jobs / change in final demand multiplier of 2.5926 (BEA 2021).
f. Earnings were estimated using a final-demand earnings multiplier of 0.4467 applied to the change in jobs / change in final demand multiplier of 5.0364 (BEA 2021).
g. Derived from earnings from directs jobs / direct jobs.
h. Value added was estimated using a final-demand value added multiplier of 0.7986 applied to the change in jobs / change in final demand multiplier of 2.5926 (BEA 2021).
i. Value added was estimated using a final-demand value added multiplier of 0.7584 applied to the change in jobs / change in final demand multiplier of 5.0364 (BEA 2021).
j. Based on an average of 3 persons per household for the ROI (USCB 2021) and the conservative assumption that new direct LLNL workers and indirect workers would move with their families.
k. Population projection for year 2035 for counites in the ROI from California's Department of Finance, Table P-1: State Population Projections (2010-2060) (DOF 2020a).
l. ROI population increase of 11.5 percent would largely occur independent of LLNL activities. The population increase from LLNL activities would contribute a 0.1 percent increase.
Sources: DOF 2020a; EDD 2020a; LLNL 2019i; USCB 2021; BEA 2021.

Increases in direct employment at LLNL would also cause increases in indirect employment and associated economic activity. As was done for the No-Action Alternative, these indirect increases were derived using the RIMS II multipliers for the four-county ROI. The multiplier of 1.8322 was used for indirect employment for operational workforce increases under the Proposed Action; and a multiplier of 1.3855 was used for construction/DD&D workforce increases (BEA 2021). Based on those multipliers, approximately 860 additional indirect jobs would be created in the ROI by the end of 2035. Overall, there would be an increase of 2,270 jobs (1,410 direct and 860 indirect), which would represent 0.10 percent of the total jobs in the ROI of 2.24 million by 2035.

The total labor force in the ROI is expected to increase from 2,039,210 workers in 2022 to 2,238,799 workers in 2035, which would equate to a 9.8 percent increase (EDD 2020a). The total workers associated with the Proposed Action (19,288 total workers, consisting of 10,750 direct LLNL workers and 8,538 indirect workers) would account for 0.9 percent of the projected 2035 ROI labor force of 2.24 million workers.

Additional value from construction/DD&D and operational activities under the Proposed Action is estimated to be approximately $324.1 million annually. Approximately $181.9 million of this annual value would be in the form of earnings ($62.1 million for construction/DD&D workers and $119.8 million for operational workers). A portion of this increased payroll would enter the local economy as the new workers purchase additional goods and services. It is anticipated that some portion of construction and operational materials would be purchased locally and that most construction/DD&D and operational workers would be drawn from within the ROI, resulting in regional increases in jobs. The additional expenditures by workers would generate additional income and employment opportunities within the ROI as the expenditures filter throughout the economy.

Population and Housing. The population in the ROI in 2035 is projected to be 4,752,927 persons, which would be a 11.5 percent increase compared to the 2022 population of 4,261,288 (DOF 2020a). Employment associated with the Proposed Action would be 19,288 total workers (10,750 direct and 8,538 indirect), which would represent approximately 0.4 percent of the projected 2035 population in the ROI. The increase in direct and indirect workers associated with the Proposed Action would be 2,270, which is which is less than 0.05 percent of the projected ROI population in 2035 of 2.24 million. Because the increase in direct and indirect jobs would be approximately 0.1 percent of the projected population, a large influx of workers/families into the ROI is not expected. However, if these 2,270 new jobs were completely filled by workers migrating into the ROI, the maximum population increase in the ROI would be 6,810 persons assuming 3 persons per household (or 2,270 multiplied by 3 persons per household),[8] or 0.1 percent of the projected 2035 ROI population of 4.75 million. The incremental population increase would be within growth projections for the ROI.

In 2020, there were 78,413 vacant housing units in the ROI (DOF 2020a). Because a large influx of workers/families into the ROI is not expected, the Proposed Action would not result in notable changes in vacant housing units. More likely, non-LLNL-related activities would be expected to

[8] Assumes one worker per household and an average of three persons per household for the ROI (USCB 2021).

cause reductions in vacant housing units. At most, the additional jobs associated with the Proposed Action would reduce the vacant housing units by 2,270, or approximately 2.9 percent.

Community Services and Schools. Due to the low potential for impacts on the population, the Proposed Action would not affect fire protection, police protection services, or medical services. As discussed above, the Proposed Action would result in a maximum population increase in the ROI of 6,810 persons, or 0.1 percent of the projected 2035 ROI population 4,752,927 (DOF 2020a). This increase would not change demands for these services compared to the No-Action Alternative. ACFD located onsite and LLNL Safeguards and Securities Department currently provides adequate onsite service. The adequacy of these services would continue to be evaluated on an annual basis, and personnel, equipment, and facilities would be increased or upgraded as necessary.

With regard to schools, assuming an average of 0.4 school-age children per household (NAHB 2017), the maximum number of school-age children associated with the additional direct and indirect workforce of 2,270 potentially migrating into the ROI would be 908 (2,270 multiplied by 0.4 average school-age children per household) children above the No-Action Alternative baseline. The increase in school enrollment would represent 0.1 percent of the projected 2034–2035 school enrollment of 643,318 for the ROI (DOF 2021a). This minimal increase in school enrollment would have a negligible effect on school services in the ROI.

5.10.1.3 *Summary of Socioeconomic Impacts for the Alternatives*

Both the No-Action Alternative and the Proposed Action would produce positive socioeconomic impacts in the ROI. Table 5-26 summarizes the impacts of both alternatives.

Table 5-26. Potential Socioeconomic Impacts for the Alternatives

Resource/Metric	Existing Environment (2019 Baseline)	No-Action Alternative (by end of 2022)	No-Action Increase over 2019 Baseline (%)	Proposed Action (by end of 2035)	Proposed Action increase over the No-Action Alternative (%)
Net Increase in Direct LLNL Jobs	7,909	9,340	18.2	10,750	15.2
Net increase in Indirect Jobs	6,581	7,678	16.7	8,538	11.2
Total ROI Labor Force	1,976,800	2,039,210	3.2	2,238,799	9.8
Annual Earnings from Direct Jobs at LLNL	$1,334M	$1,558.6	16.8	$1740.5M[a]	11.6
Annual Earnings from indirect jobs	$1,110M	$1,228.6M	10.5	$1,412.9M[a]	15.0
Total Annual Value Added to ROI Economy	$2,436M	$2,843.7M	16.7	$3,167.8M	11.4
Additional School Children from LLNL Added to ROI	3,164	3,736	18.1	4,300	15.2
Housing units occupied by LLNL Workforce[a]	7,909	9,340	18.2	10,750	15.2

a. Assuming one LLNL worker per household.

5.10.2 Environmental Justice

Under EO 12898, DOE is responsible for identifying and addressing disproportionately high and adverse human health or environmental effects on minority or low-income populations. Minority persons are those who identify as being Black or African American, Native American and Alaska Native, Asian, Native Hawaiian and other Pacific Islander, another non-White race, or persons of Hispanic or Latino ethnicity. Persons whose incomes are below the federal poverty threshold are designated low-income. Environmental justice concerns include the environmental impacts that proposed actions may have on minority and low-income populations, and whether such impacts are disproportionate to those of that population in the potentially affected area.

Section 4.10.5 presents the existing environmental justice characteristics of the ROI of census tracts within a 50-mile radius of the Livermore Site and Site 300. The 50-mile radius population surrounding the Livermore Site is 8,457,535, of which 62.8 percent is minority, and surrounding Site 300 is 7,453,607, of which 63.8 percent is minority. The average low-income population living within the 50-mile radius of the Livermore Site is 9.6 percent and of Site 300 is 9.9 percent.

Adverse health effects are measured in risks and rates that could result in LCFs and other fatal or nonfatal adverse impacts on human health. Adverse health effects may include bodily impairment, infirmity, illness, or death. Disproportionately high and adverse human health effects occur when the risk or rate of exposure to an environmental hazard on a minority or low-income population is significant and appreciably exceeds the risk or exposure rate for the general population or for another appropriate comparison group (CEQ 1997).

A disproportionately high environmental impact that is significant refers to an impact or risk of an impact on the natural or physical environment in a low-income or minority community that appreciably exceeds the environmental impact on the larger community (CEQ 1997). Such effects may include ecological, cultural, human health, economic, or social impacts. An adverse environmental impact is an impact that is determined to be both harmful and significant (CEQ 1997). In assessing cultural and aesthetic environmental impacts, LLNL considered impacts that uniquely affect geographically dislocated or dispersed minority or low-income populations or American Indian Tribes (CEQ 1997).

5.10.2.1 *No-Action Alternative*

Under the No-Action Alternative, the ongoing activities described in Chapter 2 and Chapter 4 would continue at LLNL. In addition, new facility construction, modernization/upgrade/utility projects, and DD&D activities described in Section 3.2 would also occur. Table 5-27 shows the potential impacts to environmental justice populations.

5.10.2.2 *Proposed Action*

Under the Proposed Action, the ongoing activities described in Chapter 2 and Chapter 4 would continue at LLNL. In addition, the Proposed Action includes the use of facilities and projects described for the No-Action Alternative, as well as new facility construction, modernization/upgrade/utility projects, and DD&D activities described in Section 3.3, as well as operational workforce increases. Table 5-27 shows the potential impacts to environmental justice populations.

5.10.2.3 *Summary of Environmental Justice Impacts for the Alternatives*

Based on the analysis of impacts for the resource areas in this SWEIS, and as shown in Table 5-27, there would be no disproportionately high and adverse environmental impacts on minority and low-income populations from construction, DD&D, modernization/upgrade/utility projects, and operational activities under the No-Action Alternative and Proposed Action at the Livermore Site and Site 300.

Table 5-27. Summary of Impacts to Minority and Low-income Populations for the Alternatives

Resource/Metric		No-Action Alternative	Proposed Action
Land Use (detailed discussion in Section 5.2)	Livermore Site	• Approximately 6.4 acres would be permanently disturbed, representing 0.8% of the current land. • Construction activities would be temporary and operations would be consistent with current land use designations and historic uses of LLNL land and would not result in any offsite land use changes; therefore, there would be no disproportionately high and adverse impacts to minority or low-income populations.	• Approximately 52.5 acres would be permanently disturbed, representing 6.4% of the current land. • Construction activities would be temporary and operations would be consistent with current land use designations and historic uses of LLNL land and would not result in any offsite land use changes; therefore, there would be no disproportionately high and adverse impacts to minority or low-income populations.
	Site 300	• Approximately 0.1 acre would be permanently disturbed, representing approximately 0.001% of the current land. • Construction activities would be temporary and operations would be consistent with current land use designations and historic uses of LLNL land and would not result in any offsite land use changes; therefore, there would be no disproportionately high and adverse impacts to minority or low-income populations.	• Approximately 34.6 acres would be permanently disturbed, representing approximately 0.5% of the current land. • Construction activities would be temporary and operations would be consistent with current land use designations and historic uses of LLNL land and would not result in any offsite land use changes; therefore, there would be no disproportionately high and adverse impacts to minority or low-income populations.
Aesthetics and Scenic Resources (detailed discussion in section 5.3)	Livermore Site	• Visual conditions would change, but site would remain highly developed with a campus-style or business park appearance. There would be no adverse impacts to aesthetics and scenic resources, therefore, there would be no disproportionately high and adverse impacts to minority or low-income populations.	• Visual conditions would change, but site would remain highly developed with a campus-style or business park appearance. There would be no adverse impacts to aesthetics and scenic resources, therefore, there would be no disproportionately high and adverse impacts to minority or low-income populations.
	Site 300	• Views of the site are limited, visual conditions would change, but would have minimal impacts on the aesthetics, views, or existing visual character of the site. There would be no adverse impacts to aesthetics and scenic resources, therefore, there would be no disproportionately high and adverse impacts to minority or low-income populations.	• Views of the site are limited, visual conditions would change, but would have minimal impacts on the aesthetics, views, or existing visual character of the site. There would be no adverse impacts to aesthetics and scenic resources, therefore, there would be no disproportionately high and adverse impacts to minority or low-income populations.

<table>
<tr><th>Resource/Metric</th><th></th><th>No-Action Alternative</th><th>Proposed Action</th></tr>
<tr><td>Geology and Soils (detailed discussion in Section 5.4)</td><td>Livermore Site and Site 300</td><td colspan="2">• Net soil disturbances would be 0.8 – 6.4% at the Livermore Site and 0.001 - 0.5% at Site 300, depending on the alternative. No prime farmland exists, no active faults are known to underlie the sites, and there is no historical record of surface rupturing or faulting at the sites. No known geologic resources would be adversely affected by construction activities. Operations would take place in areas already disturbed by previous activities. There would be no disproportionately high and adverse impacts to minority or low-income populations.</td></tr>
<tr><td rowspan="2">Water Resources (detailed discussion in Section 5.5)</td><td>Livermore Site</td><td colspan="2">• New facilities would increase impervious surfaces, which could increase stormwater runoff. There would be no significant adverse impacts to water resources, therefore, there would be no disproportionately high and adverse impacts to minority or low-income populations.</td></tr>
<tr><td>Site 300</td><td colspan="2">• New facilities would increase impervious surfaces, which could increase stormwater runoff. There would be no significant adverse impacts to water resources, therefore, there would be no disproportionately high and adverse impacts to minority or low-income populations.</td></tr>
<tr><td>Air Quality (detailed discussion in Section 5.6)</td><td>Livermore Site and Site 300</td><td colspan="2">• The alternatives would not (1) result in a considerable net increase (i.e., greater than the de minimis thresholds) of any criteria pollutant for which the project region is in non-attainment; (2) expose sensitive receptors to substantial pollutant concentrations; (3) conflict with or obstruct implementation of the applicable air quality plan; or (4) violate any air quality standard or contribute substantially to an existing or projected air quality violation. GHG emissions associated with the alternatives at the Livermore Site and Site 300 would account for less than 0.03 percent of California GHG emissions. Radiological emissions could increase at the Livermore Site due to increased activities at the Tritium Facility and the NIF (see "Human Health"). Any impacts to minority or low-income populations in the study area are expected to be similar to those that would be experienced by the general population; therefore, activities would not result in disproportionately high and adverse impacts on minority or low-income populations.</td></tr>
<tr><td>Noise (detailed discussion in Section 5.7)</td><td>Livermore Site</td><td>• 6 new projects within 800 feet of site boundary.
• Any construction or demolition project conducted within 400 to 800 feet of the north, east, or west property boundary of the Livermore Site would have minor adverse noise impacts on nearby residential areas. BMPs would be performed to reduce noise effects. There would be a 2.4 percent increase in area road traffic with an imperceptible effect on traffic noise and no exceedance of noise regulations. Impacts to minority or low-income populations in the study area are expected to be similar to those that would be experienced by the general population; therefore, activities would not result in disproportionately high and adverse impacts on minority or low-income populations.</td><td>• 15 new projects within 800 feet of site boundary.
• Any construction or demolition project conducted within 400 to 800 feet of the north, east, or west property boundary of the Livermore Site would have minor adverse noise impacts on nearby residential areas. BMPs would be performed to reduce noise effects. There would be a 2.3 percent increase in area road traffic with an imperceptible effect on traffic noise and no exceedance of noise regulations. Impacts to minority or low-income populations in the study area are expected to be similar to those that would be experienced by the general population; therefore, activities would not result in disproportionately high and adverse impacts on minority or low-income populations.</td></tr>
</table>

Resource/Metric		No-Action Alternative	Proposed Action
	Site 300	• 1 new project within 800 Feet of site boundary • Because there are no residences or other noise receptors within several miles of this facility, there would be no offsite noise impacts. Impacts to minority or low-income populations in the study area are expected to be similar to those that would be experienced by the general population; therefore, activities would not result in disproportionately high and adverse impacts on minority or low-income populations.	• 4 new projects within 800 Feet of site boundary • Because there are no residences or other noise receptors within several miles of this facility, there would be no offsite noise impacts. Impacts to minority or low-income populations in the study area are expected to be similar to those that would be experienced by the general population; therefore, activities would not result in disproportionately high and adverse impacts on minority or low-income populations.
Biological Resources (detailed discussion in Section 5.8)	Livermore Site and Site 300	• Impacts on native vegetation and special status plants and animals from construction and operations would be minimized through the implementation of conservation measures in consultation with the USFWS and CDFW when necessary. Construction is not expected to result in adverse modification of USFWS-designated critical habitat at the Livermore Site or Site 300. Site 300 projects are expected to impact a maximum of approximately 36 acres (Proposed Action) of upland habitat for the California red-legged frog and California tiger salamander that is critical habitat for the California red-legged frog. Livermore Site projects may result in impacts to habitat that is infrequently utilized as upland habitat by California red-legged frog.	
Cultural and Paleontological (detailed discussion in Section 5.9)	Livermore Site and Site 300	• No impacts are expected to archaeological and paleontological resources, architectural resources, or cultural resources of religious or cultural significance to Native American tribes. There would be no adverse impacts to cultural and paleontological resources, therefore, there would be no disproportionately high and adverse impacts to minority or low-income populations.	
Socioeconomic Characteristics (detailed discussion in Section 5.10.1)	Livermore Site and Site 300	• Increases in direct and indirect employment from construction and operation activities would increase regional population and housing needs and would produce positive socioeconomic impacts in the ROI. Increases in population would not affect public school services, fire protection, police protection services, or medical services. Any impacts to minority or low-income populations in the study area are expected to be similar to those that would be experienced by the general population; therefore, activities would not result in disproportionately high and adverse impacts on minority or low-income populations.	
Traffic and Transportation (detailed discussion in Section 5.11.1, 5.11.2)	Livermore Site and Site 300	• Increases in traffic would not affect LOS on roads or result in any changes to operations of the primary and secondary road network. Any impacts to minority or low-income populations in the study area are expected to be similar to those that would be experienced by the general population; therefore, activities would not result in disproportionately high and adverse impacts on minority or low-income populations	• Increases in traffic would not affect LOS on roads or result in any changes to operations of the primary and secondary road network. Any impacts to minority or low-income populations in the study area are expected to be similar to those that would be experienced by the general population; therefore, activities would not result in disproportionately high and adverse impacts on minority or low-income populations

Resource/Metric		No-Action Alternative	Proposed Action
Radiological and Hazardous Material Transportation (detailed discussion in Section 5.11.3)	Livermore Site and Site 300	• Potential offsite shipments would yield a bounding collective (i.e., cumulative) incident-free dose to the general public of 21.9 person-rem, with an associated increased risk of 0.013 LCF; and a bounding cumulative increased risk of 2.0×10^{-6} LCF to the general public from accidents that result in a container breach/release. Potential public impacts from a maximum foreseeable accident (involving the transport of plutonium oxide powder between LLNL and LANL [or LLNL and NNSS]) are estimated to be less than 4.3 rem (<0.003 LCF) to an MEI and less than 6,300 person-rem (<4 LCFs) to nearby populations. The No-Action Alternative would pose no disproportionately high and adverse safety risks to low-income or minority populations.	• Potential offsite shipments would yield a bounding collective (i.e., cumulative) incident-free dose to the general public of 24.7 person-rem, with an associated increased risk of 0.015 LCF; and a bounding cumulative increased risk of 2.0×10^{-6} LCF to the general public from accidents that result in a container breach/release. Potential public impacts from a maximum foreseeable accident (involving the transport of plutonium oxide powder between LLNL and LANL [or LLNL and NNSS]) are estimated to be less than 4.3 rem (<0.003 LCF) to an MEI and less than 6,300 person-rem (<4 LCFs) to nearby populations. The Proposed Action would pose no disproportionately high and adverse safety risks to low-income or minority populations.
Infrastructure (detailed discussion in Section 5.12)	Livermore Site and Site 300	• Water use and other utility use would increase, however LLNL's infrastructure has sufficient capacity to meet all requirements. There would be no disproportionately high and adverse impacts to minority or low-income populations.	
Waste Management and Materials Management (detailed discussion in Section 5.13)	Livermore Site and Site 300	• No adverse impacts to waste management and materials management are expected; therefore, there would be no disproportionately high and adverse impacts to minority or low-income populations.	• No adverse impacts to waste management and materials management are expected; therefore, there would be no disproportionately high and adverse impacts to minority or low-income populations.
Human Health and Safety (detailed discussion in Section 5.14)	Livermore Site	• The annual radiation dose to the offsite MEI would be less than the limit of 10 millirem per year set by both the USEPA (40 CFR Part 61, Subpart H) and DOE (DOE Order 458.1) for airborne releases of radioactivity under the No-Action Alternative. The risk of an LCF to the MEI from operations at the Livermore Site would be 2.4×10^{-6} per year. The projected number of LCFs to the population within a 50-mile radius of the Livermore Site would be 3.6×10^{-4} per year. The No-Action Alternative would pose no disproportionately high and adverse health and safety risks to low-income or minority populations surrounding the Livermore Site.	• The annual radiation dose to the offsite MEI would be less than the limit of 10 millirem per year set by both the USEPA (40 CFR Part 61, Subpart H) and DOE (DOE Order 458.1) for airborne releases of radioactivity under the Proposed Action. The risk of an LCF to the MEI from operations at the Livermore Site would be 2.5×10^{-6} per year. The projected number of LCFs to the population within a 50-mile radius of the Livermore Site would be 4.3×10^{-3} per year. The Proposed Action would pose no disproportionately high and adverse health and safety risks to low-income or minority populations surrounding the Livermore Site.

Resource/Metric		No-Action Alternative	Proposed Action
	Site 300	• The annual radiation dose to the offsite MEI would be much less than the limit of 10 millirem per year set by both the USEPA (40 CFR Part 61, Subpart H) and DOE (DOE Order 458.1) for airborne releases of radioactivity under the No-Action Alternative. The risk of an LCF to the MEI from operations at Site 300 would be 1.0×10^{-10} at Site 300 per year. The projected number of LCFs to the population within a 50-mile radius of Site 300 3.0×10^{-8} at Site 300 per year. The No-Action Alternative would pose no disproportionately high and adverse health and safety risks to low-income or minority populations surrounding Site 300.	• The annual radiation dose to the offsite MEI would be much less than the limit of 10 millirem per year set by both the USEPA (40 CFR Part 61, Subpart H) and DOE (DOE Order 458.1) for airborne releases of radioactivity under the Proposed Action. The risk of an LCF to the MEI from operations at Site 300 would be 1.0×10^{-10} at Site 300 per year. The projected number of LCFs to the population within a 50-mile radius of Site 300 3.0×10^{-8} at Site 300 per year. The Proposed Action would pose no disproportionately high and adverse health and safety risks to low-income or minority populations surrounding Site 300.
Environmental Remediation (detailed discussion in Section 5.15)	Livermore Site and Site 300	• Remediation efforts and natural attenuation would continue to reduce the contamination concentrations in both soils and groundwater at the Livermore Site and Site 300. Remediation efforts would continue to employ cleanup workers and generate hazardous and nonhazardous wastes that would be managed by the LLNL waste management system. There would be no adverse impacts to environmental remediation activities, therefore, there would be no disproportionately high and adverse impacts to minority or low-income populations.	
Accidents and Intentional Destructive Acts (detailed discussion in Section 5.16)	Livermore Site and Site 300	• New projects under the No-Action Alternative and Proposed Action do not impact the accidents that have been previously analyzed and also do not pose any additional significant radiological, chemical, biological, or HE accident threat. Impacts from intentional destructive acts would be similar to accidents.	

5.11 TRAFFIC AND TRANSPORTATION

The analysis in this section presents the potential impacts on traffic and transportation for the alternatives due to construction, DD&D, modernization/upgrade/utility projects, and operations. Key metrics presented in the traffic and transportation analysis include: (1) traffic changes on area roads; and (2) impacts to the public and transport crews from shipments of radiological and hazardous materials. Sections 5.11.1 and 5.11.2 present the potential traffic impacts for the No-Action Alternative and Proposed Action, respectively. The potential impacts associated with radiological and hazardous materials shipments are presented in Section 5.11.3.

5.11.1 No-Action Alternative

Under the No-Action Alternative, the ongoing activities described in Chapter 2 and Chapter 4 would continue. In addition, new facility construction, modernization/upgrade/utility projects, and DD&D activities described in Section 3.2 would occur. In addition, there would be operational workforce increases that would affect transportation.

Construction, DD&D, and operational activities associated with the No-Action Alternative would utilize the transportation infrastructure in the region and would have the potential to cause impacts as a result of commuting workers and construction vehicles. Because more than 95 percent of the construction, DD&D, and operational workforce traffic would occur at the Livermore Site, a quantitative transportation analysis was developed for that area. As discussed in Section 4.11.1, because traffic in the Site 300 area is generally not heavy (except during commuting times) due to its rural location and the relatively small workforce, a qualitative analysis is presented for that area.

Under the No-Action Alternative, NNSA estimates that approximately 210 additional construction workers per year would commute to LLNL (mostly to the Livermore Site, but some to Site 300). In addition, by the end of 2022, the operational workforce at LLNL is expected to increase from the current baseline of 7,909 workers to 9,130 workers, with 8,810 workers at the Livermore Site and 320 workers at Site 300. Consequently, over the No-Action Alternative planning period (2020-2022), the total workforce at LLNL is expected to increase by 1,431 persons, from 7,909 persons to a total of 9,340 persons.[9]

Traffic impacts were determined by comparing current traffic levels with projected traffic increases associated with the No-Action Alternative. The addition of 1,431 workers per year would represent an approximately 18.2 percent increase compared to the current workforce at both sites.[10] Table 5-28 displays how this increase would impact area roads. As shown on that table, if all 1,431workers were to commute to the Livermore Site (which is a bounding assumption for the transportation analysis), local traffic would increase by an average of approximately 2.4 percent (note: as Table 5-28 shows, traffic on specific roads in the vicinity of the Livermore Site would increase by 1.6 – 3.4 percent). The increase in traffic would not affect the LOS on roads in the vicinity of the Livermore Site, all of which operate at between level of service (LOS) C and LOS D at intersections, as described in Section 4.11.1, which is above the LOS E designation

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9 Construction and operational workforce numbers are from Table 3-7, Table 3-8, and Section 5.10.

10 Transportation analysis assumes traffic in the region returns to pre-pandemic conditions.

considered to be deficient. In general, traffic would need to increase by at least 20 percent to cause a LOS change (Traffic 2021).[11]

Table 5-28. Impacts to Area Roads for the No-Action Alternative

Road	Average Daily Traffic (ADT) Volume (Baseline) (vehicles/day)[a]	Percentage of LLNL Traffic Using Road	ADT Volume Due to Current LLNL Traffic (Baseline for LLNL) (vehicles/day)	Potential Increase in ADT Volume Due to No-Action Alternative[b] (vehicles/day)	Potential Percentage Increase in ADT Volume Due to No-Action Alternative
East Avenue	17,842	20%	1,582	286	1.6%
Patterson Pass Road	6,740	10%	791	143	2.1%
Greenville Road	13,944	33%	2,610	472	3.4%
Vasco Road	20,108	37%	2,926	530	2.6%
Total	**58,634**	**100%**	**7,909**	**1,431**	**2.4%**

a. Source: Livermore 2016.
b. Assumes that: (1) future traffic would be distributed across area roads in the same percentages as existing pre-pandemic traffic, and (2) each additional worker would commute to LLNL alone daily. Increase is presented in comparison to existing pre-pandemic ADT volumes on roads.

With regard to I-580, that interstate carries an average daily traffic (ADT) volume of 165,000 to 220,000 vehicles in the vicinity of the Livermore Site and experiences significant congestion during extended peak commute hours in the morning and evenings. If 70 percent of the additional LLNL employees were to utilize I-580 (based on 70 percent usage of Greenville Road and Vasco Road to access the Livermore Site—*see* Table 5-28), an increase of a maximum of 855 vehicles would increase the ADT volume on I-580 by less than one percent but would contribute to increased congestion. Given this increase, I-580 interchanges and associated intersections would continue to operate above LOS F (LOS F is considered the level at which these interchanges would become deficient; *see* Section 4.11.1) (Baker 2019a, 2019b; Raney 2019a, 2019b).

An analysis of the Livermore Site road network, which was prepared when the site workforce was approximately 9,000, concluded that the current primary and secondary road network on site is well below capacity and can readily handle doubling (or more) of traffic (LLNL 2010). An increase in the LLNL workforce from 7,909 persons to a total of 9,340 persons would not result in any changes to operations of the primary and secondary road network on LLNL. At Site 300, a small incremental increase in traffic from the addition of 96 workers could be readily accommodated by the local road system and no notable impacts are expected.

5.11.2 Proposed Action

Under the Proposed Action, the ongoing activities described in Chapter 2 and Chapter 4 would continue. In addition, the Proposed Action includes the use of facilities and projects described for the No-Action Alternative, as well as new facility construction, modernization/upgrade/utility

[11] The distinctions between LOS ratings are subjective, and many factors can affect how a given traffic change will affect the LOS on a given road, including road design, number of lanes, number of intersections, speed limit, and signalization. Consequently, the ability to make definitive conclusions about an LOS change on a given road is limited.

projects, operational changes, and DD&D activities described in Section 3.3. There would also be operational workforce increases that would affect transportation.

Construction, DD&D, and operational activities associated with the Proposed Action would utilize the transportation infrastructure in the region and would have the potential to cause impacts as a result of worker commuting and additional construction vehicles. During the 13-year Proposed Action planning period (2023–2035), NNSA estimates that a maximum of 700 additional construction workers per year would commute to LLNL annually (mostly to the Livermore Site, but some to Site 300). In addition, the operational workforce at LLNL is expected to increase from the No-Action Alternative baseline of 9,340 workers to 10,050 workers. Consequently, the LLNL workforce is expected to increase from 9,340 workers to a total of 10,750 workers. Overall, direct employment at LLNL would increase by approximately 1,410 workers compared to the No-Action Alternative workforce, which would be a 15.2 percent increase.[12]

As shown on Figures 3-12 and 3-13, under the Proposed Action, a New North Entry to the Livermore Site is expected to be constructed in approximately 2025. That entry would connect to Patterson Pass Road, which is a four-lane divided arterial street with bike lanes. Patterson Pass Road is heavily used during commuting hours, especially in the afternoon commute towards the Altamont Hills. The current speed limit is 45 miles per hour on Patterson Pass Road where the New North Entry would connect, and the average vehicle speed is approximately 42 miles per hour. There are no existing traffic signals on Patterson Pass Road between Vasco Road and Greenville Road. In the past three years, there have been 49 accidents on Patterson Pass Road in this area, which equates to approximately 4.7 accidents per million vehicle miles. This is notably higher than the state average of 1.7 accidents per million vehicle miles for this type of roadway (Livermore 2020c). Because of the 45 miles per hour speed limit on Patterson Pass Road, and the increased vehicle use expected for the new entry onto the Livermore Site, signalization would likely be required at the intersection of the New North Entry and Patterson Pass Road. The intersection/signalization of the New North Entry would be similar to the intersection/signalization that currently exists on Vasco Road and the West Gate entrance to the Livermore Site (Figure 5-6). Although new turn lanes on Patterson Pass Road are expected, NNSA would coordinate with the city of Livermore on the specifics of the intersection/signalization.

[12] Construction and operational workforce numbers are from Table 3-7, Table 3-8, and Section 5.10.

Source: Google Earth 2021.

Figure 5-6. Signalization/Intersection at Vasco Road and the West Gate entrance to the Livermore Site (typical of signalization/intersection for New North Entry)

The New North Entry would provide quick employee access to the center of the laboratory and would alleviate traffic backups and delays (some up to 15 minutes) that occur during the mornings on Vasco Road at the West Gate entrance. Once that North Entry is operational, it would be expected to reduce the ADT volumes on Vasco Road and Greenville Road adjacent to the Livermore Site, as presented in Table 5-28, and increase the ADT volume on Patterson Pass Road in the vicinity of the Livermore Site. The net effect would be a reduction in traffic backups and delays in the mornings on Vasco Road at the West Gate entrance. The New North Entry would not include any sharp curves or dangerous intersections. It would improve emergency access to the Livermore Site by providing a quick access from the north.

Traffic impacts were determined by comparing No-Action Alternative traffic levels with projected traffic increases associated with the Proposed Action. Table 5-29 displays how an increase of 1,410 workers would impact area roads. As shown on that table, if all 1,410 workers were to commute to the Livermore Site (which is a bounding assumption for the transportation analysis), local traffic would increase by an average of approximately 2.3 percent (note: as Table 5-29 shows, traffic on specific roads in the vicinity of the Livermore Site would increase by 1.6 – 3.2 percent). The increase in traffic would not affect the LOS on roads in the vicinity of the Livermore Site, all of which operate at between LOS C and LOS D at intersections, as described in Section 4.11.1, which is above the LOS E designation considered to be deficient. As discussed in Section 5.11.1, in general, traffic would need to increase by at least 20 percent to cause a LOS change (Traffic 2021).

The proposed New North Entry to the Livermore Site would alleviate traffic backups and delays (some up to 15 minutes) that occur during the mornings on Vasco Road at the West Gate entrance. That new entry would be expected to reduce the ADT volumes on Vasco Road and Greenville Road, as presented in Table 5-29, and increase the ADT volume on Patterson Pass Road in the vicinity of the Livermore Site.

Table 5-29. Impacts to Area Roads for the Proposed Action

Road	No-Action Alternative Average Daily Traffic (ADT) Volume (vehicles/day)[a]	Percentage of LLNL Traffic Using Road	ADT Volume Due to No-Action Alternative LLNL Traffic (vehicles/day)	Potential Increase in ADT Volume Due to Proposed Action[b] (vehicles/day)	Potential Percentage Increase in ADT Volume Due to Proposed Action
East Avenue	18,128	20%	1,868	282	1.6%
Patterson Pass Road	6,883	10%	934	141	2.0%
Greenville Road	14,416	33%	3,082	465	3.2%
Vasco Road	20,638	37%	3,456	522	2.5%
Total	**60,065**	**100%**	**9,340**	**1,410**	**2.3%**

a. Source: Livermore 2016.
b. Assumes that: (1) future traffic would be distributed across area roads in the same percentages as existing pre-pandemic traffic, and (2) each additional worker would commute to LLNL alone daily. Increase is presented in comparison to existing pre-pandemic ADT volumes on roads.

With regard to I-580, the ADT volume would increase by less than one percent, but would contribute to increased congestion. An increase in the Livermore Site workforce from 9,340 workers to a total of 10,750 workers would not increase traffic volumes that would challenge the primary and secondary road network on LLNL.

5.11.3 Transportation of Hazardous Material and Radiological Material (Offsite)

LLNL would regularly transport hazardous materials, including radiological waste, SNM, and other radiological materials from and to the LLNL site (which includes Site 300) under both the No-Action Alternative and the Proposed Action. Section 5.11.3.1 (No-Action Alternative) and Section 5.11.3.2 (Proposed Action) present the potential impacts of these shipments. Onsite transportation of hazardous and radioactive materials is presented in Appendix C (Section C.3.6).

5.11.3.1 *No-Action Alternative*

No radiological or hazardous waste materials/shipments are expected to be performed in support of construction activities under the No-Action Alternative at the Livermore Site or Site 300 unless contaminated soils are encountered and require offsite disposal. DD&D activities could generate radiological and hazardous wastes. Those wastes are included in the analysis below.

Radiological impacts would be caused by low levels of radiation emitted during incident-free transportation and from the release of radioactive materials in the event of an accident. These risks are expressed as a dose and additional latent cancer fatalities (LCFs). For the incident-free transport of radiological materials and wastes under the No-Action Alternative, radiological impacts were initially determined for crew members and the general population using the Radioactive Material Transportation Risk Assessment (RADTRAN) computer model as a baseline from which final estimates were then subsequently scaled. Such scaling was implemented through a compendium of published DOE/NNSA transportation assessment data including that used in support of the *Final Sitewide Environmental Impact Statement for the Continued Operation of the DOE/NNSA Nevada National Security Site and Offsite Locations in the State of Nevada* (DOE/EIS-0426) (NNSA 2013); the *Final Complex Transformation Supplemental Programmatic Environmental Impact Statement* (DOE/EIS-0236-S4) (NNSA 2008); and the *Final Surplus Plutonium Disposition Supplemental Environmental Impact Statement* (DOE/EIS-0283-S2) (NNSA 2015).

Radiation Dose Measurement

In this SWEIS, radiation doses are measured in units of either "person-rem" or "rem."

Rem is used to measure the radiation dose for a single individual. Individual doses are converted to LCFs by multiplying the dose by 0.0006. For example, an individual who receives a dose of 1.5 rem would have a 0.0009 chance of developing a latent cancer fatality (LCF).

Person-rem is used to measure the total collective radiation dose for a group of people. To determine the population dose, this SWEIS sums up the individual doses. Statistically, approximately 1,667 person-rem would result in one LCF.

Shipment crew members consist of a driver and a backup driver for each shipment vehicle. For the public dose analysis, the potentially exposed general population is defined as any persons residing within 0.50 mile of a transport vehicle's projected route (off-link), persons sharing the road with the vehicle (on-link), and nearby persons at the vehicle's rest-stops. The dose/LCF risks to the exposed population(s) under the No-Action Alternative are adjusted to represent the projected population(s) anticipated along transportation routes by the year 2030. A full description of the technical approach and supporting assumptions that were used for this SWEIS's radiological transportation analysis are provided in Appendix D.

Livermore Site

This subsection addresses the potential transportation impacts associated with radiological materials shipped from/to the Livermore Site. All radiological wastes associated with any potential DD&D undertakings or environmental restoration activities are included as part of the analyzed shipment streams below.

Under the No-Action Alternative, low-level radioactive waste (LLW) and mixed low-level waste (MLLW) would be primarily transported from the Livermore Site to two individual out-of-state treatment and disposal sites: Nevada National Security Site (NNSS) in southern Nevada and Energy*Solutions* in Clive, Utah. LLNL estimates that approximately 85 percent of the routine LLW and MLLW generated at the Livermore Site would be sent to the NNSS and 15 percent would be sent to Energy*Solutions.* For non-routine LLW and MLLW, approximately 90 percent of the waste would be sent to Energy*Solutions* and 10 percent would be sent to NNSS. In addition, approximately one to five shipments per year would be expected to be made to permitted/licensed treatment, storage and disposal facilities such as Perma-Fix Environmental Services in Oak Ridge, Tennessee; Perma-Fix in Richland, Washington; and Waste Control Specialists in Andrews County, Texas. Under the No-Action Alternative, approximately 120 routine shipments of LLW/MLLW and 160 nonroutine shipments of LLW/MLLW would occur annually. Table 5-30 shows the expected total annual number of LLW/MLLW shipments to the NNSS, Energy*Solutions*, and Perma-Fix or Waste Control Specialists,[13] with their associated estimated radiological impacts from incident-free transport and accident conditions.

As indicated in Section 4.11.4.1, the Livermore Site has the general capability to characterize and package contact-handled TRU waste for shipment directly to the Waste Isolation Pilot Plant (WIPP) facility in New Mexico; however, the possibility does also exist for packages to be first shipped to INL for any additional characterization or repackaging that may be required in order to meet WIPP's waste acceptance criteria. Shipments are made in TRUPACT-II packaging, with 3 TRUPACT-II containers assumed per shipment. As indicated in Table 3-8 and Table 5-30, up to eight (8) TRU waste shipments per year are realistically anticipated from the Livermore Site under the No-Action Alternative.

Shipments containing SNM are conducted by licensed commercial carriers; however, on occasion, NNSA's Office of Secure Transportation (OST) can also be employed in certain cases of material movement. Candidate SNM shipments are anticipated to include the following categories: plutonium oxides or metal (in the form of targets/coupons), highly enriched uranium oxides or metal (HEU), and miscellaneous pit parts/components that may contain various quantities of SNM. Associated origins and destinations of such materials, in addition to the Livermore Site, may potentially include the Los Alamos National Laboratory (LANL), NNSS, and the Savannah River Site (SRS) as a bounding-distance case. Transport of non-SNM radiological materials are exclusively conducted by licensed commercial carriers.

Tritium gas is often sent to and from SRS to LLNL in support of various research activities conducted at the site. Tritium does not emit radiation from its packaging; therefore, it does not have any incident-free radiological impacts. Section D.4 in Appendix D, however, addresses the consequences of a hypothetical transportation accident involving tritium gas. Up to 10 grams of gaseous tritium may be transported in Type B containers. Under accident conditions, the gaseous tritium is assumed to completely oxidize. Tritium in this quantity is anticipated to be shipped up to seven (7) times per year from the SRS to the Livermore Site.

The potential conveyance of sealed Am-241 sources (up to 100 mCi [0.0295 g] per package) between the Livermore Site and a host of possible locations across the United States is also assessed. Accordingly, this scenario's impacts are bounded in the analysis by assuming the maximum quantity shipped per package (100 mCi) along with the longest likely shipping distance travelled (i.e., to/from SRS). It was furthermore assumed that up to 200 shipments per year of "miscellaneous isotopes and sealed sources" would be sent to the Livermore Site from various locations across the United States; such transportation scenarios are similarly bounded by assuming that all shipments originate across the country at SRS and would representatively consist

[13] NNSA bounded the potential transportation impacts by modelling shipments to Perma-Fix Environmental Services in Oak Ridge, Tennessee. Shipments from LLNL to Oak Ridge, Tennessee would be more than 1,000 miles longer, and would transit through more heavily populated areas, than shipments from LLNL to Andrews County, Texas.

of 50 percent Am-241 (100 mCi) sealed sources and 50 percent Cs-137 (96 mCi [0.0011 g]) sealed sources.

Site 300

Under the No-Action Alternative, Site-300-related material transport scenarios are expected to include the local periodic movement of sealed Cs-137 sources and depleted-uranium (DU) between the Livermore Site and Site 300. LLNL also ships LLW and, to a much lesser extent, MLLW directly from Site 300 for disposal. In addition, there would be HE-related shipments to/from Livermore and other supplier facilities to Site 300.

Impact Discussion for Both Sites

Table 5-30 presents the entire compendium of potential incident-free and accident impacts associated with transporting radiological materials and wastes for the No-Action Alternative on an annualized basis. Accident risks in the tables represent a broad spectrum of accident severities and radioactive release conditions, as discussed in Appendix D, Section D.4.

The accident analyses associated with the aforementioned referenced documents (NNSA 2008, 2013, 2015) assessed original normalized probabilities and consequences from this spectrum of accident conditions, with the determined final risk values for this LLNL SWEIS being representative of the LCF risks to the public population within 50 miles of a/the hypothetical accident release location. Nonradiological risks are likewise provided for comparative perspective, and are expressed in terms of estimated traffic fatalities.

As shown in Table 5-30 for the No-Action Alternative, modeling of all 645 potential offsite shipments would yield a bounding collective (i.e., cumulative) incident-free dose to transport-crews of 61.6 person-rem per year, with an associated increased risk of 0.037 LCF; a bounding collective incident-free dose to the general public of 21.6 person-rem, with an associated increased risk of 0.013 LCF; and a bounding cumulative increased risk of 1.9×10^{-6} LCF to the general public from accidents that result in a container breach/release. As a point of comparison, the bounding cumulative increased risk of 0.025 additional traffic fatalities (due to traffic accidents) would result from all shipments conducted under the No-Action Alternative; this would be a factor of roughly 10,000 higher than the bounding incremental increase of 2.0×10^{-6} LCF estimated to the public from potential radiological impacts associated with such shipment accidents.

With regard to a potential annual bounding dose to a hypothetical MEI from incident-free transportation, a dose of 1.8×10^{-4} rem/yr is estimated, with an associated increased risk of an LCF to that individual of 1.1×10^{-7}/year (NNSA 2015, Table E-11). Moreover, as discussed in footnote "a" of Table 5-30, a maximally exposed crew member may receive up to 2 rem/year per DOE's administrative control level and a maximally exposed inspector would be expected to receive 0.019 rem per hour of inspection duty performed. Potential public impacts from a maximum foreseeable accident (involving the transport of plutonium oxide powder between LLNL and LANL [or LLNL and NNSS]) are estimated to be less than 4.3 rem (<0.003 LCF) to an MEI and less than 6,300 person-rem (<4 LCFs) to nearby populations within a 50-mile radius. Additional information associated with these scenarios is provided in Appendix D of this SWEIS.

Table 5-30. Annualized Transportation Impacts of Radiological Material/Waste– No-Action Alternative

				Incident-Free Dose				Accident	
Material or Waste Form	Origin	Destination	Shipments per Year	Crew Dose (person-rem)[a]	Crew Risk (LCF)	Population Dose (person-rem)	Population Risk (LCF)	Rad Risk (LCF)	Non-rad Risk (traffic fatalities)
LLW/MLLW - routine	LLNL	NNSS	102	1.8	1.1×10^{-3}	0.86	5.2×10^{-4}	4.8×10^{-7}	4.7×10^{-3}
LLW/MLLW – nonroutine	LLNL	NNSS	16	0.29	1.7×10^{-4}	0.14	8.1×10^{-5}	7.6×10^{-8}	7.4×10^{-4}
LLW/MLLW - routine	LLNL	Energy*Solutions*	18	0.25	1.5×10^{-4}	0.14	8.3×10^{-5}	8.1×0^{-8}	1.0×10^{-3}
LLW/MLLW – nonroutine	LLNL	Energy*Solutions*	144	2.0	1.2×10^{-3}	1.10	6.6×10^{-4}	6.5×10^{-7}	8.4×10^{-3}
LLW/MLLW - routine/nonroutine	LLNL	Perma-Fix (bounding)	5	0.33	2.0×10^{-4}	0.17	1.0×10^{-4}	9.5×10^{-8}	9.0×10^{-4}
Pu target material	LLNL or NNSS	NNSS or LLNL	4	0.027	1.6×10^{-5}	0.010	5.8×10^{-6}	2.9×10^{-9}	1.5×10^{-4}
Pu target material	LLNL	LANL	2	0.014	8.4×10^{-6}	1.6×10^{-3}	9.6×10^{-7}	1.5×10^{-9}	8.3×10^{-5}
Pu target material	LANL	LLNL	2	0.014	8.4×10^{-6}	1.6×10^{-3}	9.6×10^{-7}	1.5×10^{-9}	8.3×10^{-5}
HEU	LLNL or NNSS	NNSS or LLNL	2	0.038	2.3×10^{-5}	0.031	1.9×10^{-5}	3.6×10^{-10}	6.6×10^{-6}
HEU	LLNL or LANL	LANL or LLNL	2	0.040	2.4×10^{-5}	0.010	6.2×10^{-6}	3.8×10^{-10}	8.3×10^{-5}
Other Pu (metal/oxide)	LLNL or NNSS	NNSS or LLNL	5	0.47	2.8×10^{-4}	0.39	2.3×10^{-4}	1.1×10^{-9}	1.7×10^{-5}
Other Pu (metal/oxide)	LLNL	LANL	3	0.29	1.8×10^{-4}	0.078	4.7×10^{-5}	7.1×10^{-10}	1.2×10^{-4}
Other Pu (metal/oxide)	LANL	LLNL	2	0.20	1.2×10^{-4}	0.052	3.1×10^{-5}	4.7×10^{-10}	8.3×10^{-5}
TRU/Mixed TRU	LLNL	WIPP	8	0.88	5.3×10^{-4}	1.1	6.5×10^{-4}	4.9×10^{-8}	2.4×10^{-4}
Tritium	LLNL	SRS	5	NA	NA	NA	NA	3.0×10^{-10}	1.2×10^{-4}
Tritium	SRS	LLNL	7	NA	NA	NA	NA	4.1×10^{-10}	1.7×10^{-4}
Depleted U	Livermore Site	Site 300	15	NA	NA	NA	NA	NA	5.6×10^{-4}
Depleted U	Site 300	Livermore Site	5	NA	NA	NA	NA	NA	1.9×10^{-4}
HEU Metal	LLNL or SRS (bounding)	SRS (bounding) or LLNL	95	1.2	7.2×10^{-4}	1.8	1.1×10^{-3}	8.1×10^{-8}	2.3×10^{-3}
Cs-137 Sealed Source	Livermore Site or Site 300	Site 300 or Livermore Site	1	1.8×10^{-3}	1.1×10^{-6}	5.2×10^{-4}	3.1×10^{-7}	1.2×10^{-11}	3.7×10^{-5}
Am-241 Sealed Source	LLNL or SRS (bounding)	SRS (bounding) or LLNL	2	0.53	3.2×10^{-4}	0.16	9.4×10^{-5}	3.6×10^{-9}	4.8×10^{-5}
Miscellaneous Isotopes and Sealed Sources	SRS (bounding)	LLNL	200	53	0.032	16	9.4×10^{-3}	3.6×10^{-7}	4.8×10^{-3}
		Totals	**645**	**61.6**	**0.037**	**21.6**	**0.013**	**1.9×10^{-6}**	**0.025**

HEU = highly enriched uranium; LLW = low-level radioactive waste; MLLW = mixed low-level radioactive waste; NNSS = Nevada National Security Site; SRS = Savannah River Site; WIPP = Waste Isolation Pilot Plant; TRU = transuranic waste; LCF = latent cancer fatality; NA = *de minimis* dose or LCF risk; "(bounding)" = transport to/from SRS was evaluated as the bounding case for transport of HEU-metal, Am-241 sources, and other miscellaneous isotopes and sealed sources to/from LLNL.

a. A DOE employee would also need to comply with DOE regulations at 10 CFR Part 835 ("Occupational Radiation Protection"), which limits worker radiation doses to 5 rem/year. At LLNL, administrative control limits are multi-tiered, meaning they can vary between 100 millirem/year up to 500 millirem/year, depending on the situation (LLNL 2019w). This limit/guideline would apply to any non-TRU waste shipment conducted by DOE personnel. Drivers of TRU waste shipments to WIPP have an administrative exposure guideline of 1 rem/year. Commercial drivers are subject to OSHA regulations, which limit the whole-body dose to 5 rem/year (29 CFR 1910.1096), and to the USDOT requirement of 2 millirem/hour inside the truck cab (49 CFR 173.411).

It should be noted that due to DU's extremely low radiation levels (as well as the short distance travelled between LLNL and Site 300), radiological impacts (incident-free and accidents) due to DU transport would be expected to be roughly 1,000 to 10,000 times lower than those associated with any/all Pu or HEU transport scenarios assessed in this transportation evaluation and would therefore be of small magnitude compared to the latter; as such, DU accident impacts were not analyzed separately. This is discussed further in Appendix D.

In general, LLNL has carefully examined onsite transfers of radioactive materials and has established engineered and administrative controls to minimize the impact and frequency of related potential accidents. Three documents (two for the Livermore Site and one for Site 300) describe the envelope within which operations must occur to meet safety objectives: (1) *Transportation Safety Basis Document for Nonnuclear Onsite Transfer Activities at Lawrence Livermore National Laboratory– Main Site* (LLNL 2017e) prescribes operational requirements for smaller-quantity transfers; (2) *Lawrence Livermore National Laboratory Transportation Safety Document (*LLNL 2018e), prescribes the requirements for the larger-quantity transfers; and (3) *Transportation Safety Basis Document for Nonnuclear Onsite Transfer Activities at Lawrence Livermore National Laboratory–Site 300* (LLNL 2017f) describes the envelope within which hazardous materials transportation operations must occur to meet safety objectives. All offsite shipments under the No-Action Alternative would be conducted in accordance with DOT regulations.

With regard to the potential transportation of any materials that may contain varying amounts of HE, associated DOE/NNSA protocols and guidance to prevent or mitigate potential impacts to shipment crews and/or the public are provided in DOE Order 460.2A, DOE Order 460.1D, DOE Order 452.2F, and DOE Manual 440.1-1A. Therein DOE/NNSA specifies that before transporting explosive substances or articles fabricated by DOE (or alternatively under the direction or supervision of DOE) that the originating DOE organization must test the materials and obtain explosive hazard classification(s) from the NNSA's Office of Technical Services, and also that DOE must likewise provide two copies of the approval and supporting documentation for registration with the DOT. In addition, the following key criteria are furthermore mandated:

- Only qualified explosives handlers shall load and unload explosives aboard transport vehicles.
- Explosives shipped on common carriers shall be packaged, labelled, and shipped in accordance with DOT regulations.
- Explosives containing items transported by special agents in DOE-approved secure transporters are specifically governed by said DOE Orders 452.2F and 460.1D.
- Section 161.K of *The Atomic Energy Act of 1954* as amended and Title 18 USC, Chapter 40, section 845 govern security and emergency vehicles carrying explosives in support of approved contingency plans.
- The cargo on partly or completely loaded vehicles (including flatbed types) shall be blocked, braced, chocked, tied down, or otherwise secured to prevent shifting during transit.
- No explosives shall be loaded or unloaded from a transportation vehicle while the motor is running unless the motor is required to provide power to vehicle accessories used in loading and unloading operations, and is moreover equipped with an exhaust spark arrestor.

- DOT regulations govern commercial transport vehicle shipments on public highways. Shipments from a DOE installation that meet the DOT definition of "in commerce" must fully comply with the applicable portions of DOT regulations, and with state and municipal regulations.
- A qualified inspector shall inspect and approve for compliance with an approved checklist any transport vehicle that may be loaded with explosives and is designated for movement over public highways. After loading, the cargo shall be inspected and approved, which includes verification of proper labelling/placarding.
- Before transport vehicles loaded with explosive materials leave a DOE facility, drivers shall be informed of the nature of their cargo and appropriate measures to take if the vehicle or load becomes involved in a fire.
- Drivers of explosive-laden vehicles shall meet the pertinent requirements of 49 CFR Parts 390-397. Moreover, such drivers shall be provided special training that emphasizes caution, road courtesy, and defensive driving. Drivers shall also have proper training in general safety precautions for explosives handling.
- Explosive-laden vehicles shall avoid congested areas whenever possible and shall stop at all railroad crossings.
- No personnel shall ride in the cargo area. Loose items (e.g., handling gear) in the cargo compartments are prohibited.
- No smoking is allowed in or within 25 feet of any vehicle containing explosives. Matches, lighters, or other fire-, flame-, or spark-producing devices shall not be in the vehicle or carried by personnel in the vehicle.
- The vehicle shall be subjected to regular maintenance checks.
- Other than when opened for inspection, containers of explosives shall not be opened or repaired on any transportation vehicle.
- Except for emergency situations, fueling or maintenance of vehicles containing explosives is forbidden.

5.11.3.2 *Proposed Action*

No radiological or hazardous waste materials/shipments are expected to be performed in support of construction activities under the Proposed Action at the Livermore Site or Site 300 unless contaminated soils are encountered and require offsite disposal. DD&D activities could generate radiological and hazardous wastes. Those wastes are included in the analysis below.

As was the case for the No-Action Alternative discussed in Section 5.11.3.1, LLNL would regularly transport radiological waste, SNM, and other radiological materials to and from the LLNL site (including Site 300) under the Proposed Action. The potential incident-free and accident impacts associated with transporting radiological materials and wastes were determined for crew members and the general population using the RADTRAN computer model as a baseline from which final estimates were then subsequently scaled. Such scaling was implemented through a compendium of published DOE/NNSA transportation assessment data including that used in support of related NNSA NEPA documentation (NNSA 2008, NNSA 2013, NNSA 2015). Onsite transportation of hazardous and radioactive materials is presented in Appendix C (Section C.3.6).

As discussed previously in Section 5.11.3.1, crew members consist of a driver and a backup driver for each shipment vehicle, and the general population is defined as any persons residing within 0.50 mile of a vehicle's projected route (off-link), persons sharing the road with the vehicle (on-link), and nearby persons at vehicle rest-stops. The dose/LCF risks to the exposed population(s) under the Proposed Action are adjusted to represent the projected population(s) anticipated along transportation routes by the year 2030.

Livermore Site

This subsection addresses the Proposed Action for operations as it pertains to estimated transportation impacts associated with radiological materials shipped from/to the Livermore Site. All radiological wastes associated with any potential DD&D undertakings or environmental restoration activities are included as part of the analyzed shipment streams below.

As was the case under the No-Action Alternative, per the Proposed Action, LLW and MLLW would primarily be transported from the Livermore Site to either the NNSS in Nevada or Energy*Solutions* in Utah. LLNL estimates that approximately 85 percent of the routine LLW and MLLW generated at the Livermore Site would be sent to the NNSS and 15 percent would be sent to Energy*Solutions.* For non-routine LLW and MLLW, approximately 90 percent of the waste would be sent to Energy*Solutions* and 10 percent would be sent to NNSS. In addition, approximately one to five shipments per year would be expected to be made to permitted/licensed treatment, storage and disposal facilities such as Perma-Fix Environmental Services in Oak Ridge, Tennessee; Perma-Fix in Richland, Washington; and Waste Control Specialists in Andrews County, Texas. Under the Proposed Action, approximately 120 routine shipments of LLW/MLLW and up to 384 nonroutine shipments of LLW/MLLW would occur annually.[14] Table 5-31 shows the expected total annual number of LLW/MLLW shipments to the NNSS, Energy*Solutions*, and Perma-Fix facilities or Waste Control Specialists, with their associated estimated radiological impacts from incident-free transport and accident conditions.

As discussed in Section 5.11.3.1, the Livermore Site has the general capability to characterize and package contact-handled TRU waste for shipment directly to the WIPP facility; however, the possibility does also exist for packages to be first shipped to INL for any additional characterization or repackaging that may be required in order to meet WIPP's waste acceptance criteria. As was the case for the No-Action Alternative, shipments are to be made in TRUPACT-II packaging, with 3 TRUPACT-II containers assumed per shipment. As indicated in Table 3-8 and Table 5-31, up to eight (8) TRU waste shipments per year are realistically anticipated from the Livermore Site under the Proposed Action.

As was also the case under the No-Action Alternative, candidate SNM shipments are anticipated to include plutonium oxides or metal (in the form of targets/coupons), highly enriched uranium oxides or metal (HEU), and miscellaneous pit parts/components that may contain various quantities of SNM. Associated origins and destinations of such materials, in addition to the Livermore Site, may potentially include LANL, NNSS, and SRS as a bounding-distance case.

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[14] As shown in Table 5-31, the maximum number of nonroutine shipments (384) to NNSS and Energy*Solutions* is conservatively assumed.

The assumption that up to 10 grams of gaseous tritium may be transported in Type B containers is parallel to that assumed above under the No-Action Alternative. Furthermore, under accident conditions, it is also assumed that the gaseous tritium in question would completely oxidize, and that up to seven (7) shipments per year may occur from SRS to the Livermore Site.

Finally, the potential conveyance of sealed Am-241 sources (up to 100 mCi [0.0295 g] per package) between the Livermore Site and a host of possible locations across the United States was also assessed under the Proposed Action. Accordingly, this scenario's impacts are bounded in the analysis by assuming the maximum quantity shipped per package (100 mCi) along with the longest likely shipping distance travelled (i.e., to/from SRS). It was furthermore assumed that up to 215 shipments per year of "miscellaneous isotopes and sealed sources" will be sent to the Livermore Site from various locations across the United States; such transportation scenarios are similarly bounded by assuming that all shipments originate across the country at SRS and would representatively consist of 50 percent Am-241 (100 mCi) sealed sources and 50 percent Cs-137 (96 mCi [0.0011 g]) sealed sources.

<u>Site 300</u>

Under the Proposed Action, Site-300-related material transport scenarios are expected to include the local periodic movement of sealed Cs-137 sources and depleted-uranium (DU) between the Livermore Site and Site 300. LLNL also ships LLW and, to a much lesser extent, MLLW directly from Site 300 for disposal. As shown in Tables 5-30 and 5-31, the number of shipments, and potential impacts, would be the same for both the Proposed Action and the No-Action Alternative.

<u>Impact Discussion for Both Sites</u>

Table 5-31 presents the entire compendium of potential incident-free and accident impacts associated with transporting radiological materials and wastes for the Proposed Action on an annualized basis. Nonradiological risks are likewise provided for comparative perspective, and are expressed in terms of estimated traffic fatalities. Under the Proposed Action, modeling of all 888 potential offsite shipments would yield a bounding collective (i.e., cumulative) incident-free dose to transport-crews of 69.2 person-rem per year, with an associated increased risk of 0.042 LCF; a bounding collective incident-free dose to the general public of 24.7 person-rem, with an associated increased risk of 0.015 LCF; and a bounding cumulative increased risk of 2.9×10^{-6} LCF to the general public from accidents that result in a container breach/release. As a point of comparison, the bounding cumulative increased risk of 0.038 additional traffic fatalities (due to traffic accidents) would result from all shipments conducted under this alternative; this would be a factor of roughly 10,000 higher than the bounding incremental increase of 2.9×10^{-6} LCF estimated to the public from the potential radiological impacts associated with such shipment accidents.

The only quantifiable difference in radiological transportation characteristics between the No-Action Alternative and Proposed Action are the numbers of shipments (per year) of nonroutine LLW/MLLW to NNSS and Energy*Solutions* from LLNL. Because those shipments only account for a fraction of the total radiological transportation impacts, as shown in Table 5-30 and Table 5-31, the total radiological impacts for the Proposed Action would be only slightly higher across all categories as compared to the No-Action Alternative.

With regard to a potential annual bounding dose to a hypothetical MEI from incident-free transportation, a dose of 1.8×10^{-4} rem/yr is estimated, with an associated increased risk of an LCF to that individual of 1.1×10^{-7}/year (NNSA 2015, Table E-11). Moreover, as discussed in footnote "a" of Table 5-31, a maximally exposed crew member may receive up to 2 rem/year per DOE's administrative control level and a maximally exposed inspector would be expected to receive 0.019 rem per hour of inspection duty performed. Potential public impacts from a maximum foreseeable accident (involving the transport of plutonium oxide powder between LLNL and LANL [or LLNL and NNSS]) are estimated to be less than 4.3 rem (<0.003 LCF) to an MEI and less than 6,300 person-rem (<4 LCFs) to nearby populations within a 50-mile radius. Additional information associated with these scenarios is provided in Appendix D of this SWEIS.

As was the case in Section 5.11.3.1 above, due to DU's extremely low radiation levels, radiological impacts (incident-free and accidents) due to DU transport would be expected to be roughly 1,000 to 10,000 times lower than those associated with any/all Pu or HEU transport scenarios assessed in this transportation evaluation and would therefore be of small magnitude compared to the latter; as such, DU accident impacts are not analyzed.

Table 5-31. Annualized Transportation Impacts of Radiological Material/Waste – Proposed Action

				Incident-Free Dose				Accident	
Material or Waste Form	Origin	Destination	Shipments per Year	Crew Dose (person-rem)[a]	Crew Risk (LCF)	Population Dose (person-rem)	Population Risk (LCF)	Rad Risk (LCF)	Non-rad Risk (traffic fatalities)
LLW/MLLW - routine	LLNL	NNSS	102	1.8	1.1×10^{-3}	0.86	5.2×10^{-4}	4.8×10^{-7}	4.7×10^{-3}
LLW/MLLW nonroutine (max)	LLNL	NNSS	38	0.68	4.1×10^{-4}	0.32	1.9×10^{-4}	1.8×10^{-7}	1.7×10^{-3}
LLW/MLLW - routine	LLNL	Energy*Solutions*	18	0.25	1.5×10^{-4}	0.14	8.3×10^{-5}	8.1×10^{-8}	1.0×10^{-3}
LLW/MLLW nonroutine (max)	LLNL	Energy*Solutions*	346	4.83	2.9×10^{-3}	2.7	1.6×10^{-3}	1.6×10^{-6}	2.0×10^{-2}
LLW/MLLW - routine/nonroutine (max)	LLNL	Perma-Fix (bounding)	5	0.33	2.0×10^{-4}	0.17	1.0×10^{-4}	9.5×10^{-8}	9.0×10^{-4}
Pu target material	LLNL or NNSS	NNSS or LLNL	4	0.027	1.6×10^{-5}	0.010	5.8×10^{-6}	2.9×10^{-9}	1.5×10^{-4}
Pu target material	LLNL	LANL	2	0.014	8.4×10^{-6}	1.6×10^{-3}	9.6×10^{-7}	1.5×10^{-9}	8.3×10^{-5}
Pu target material	LANL	LLNL	2	0.014	8.4×10^{-6}	1.6×10^{-3}	9.6×10^{-7}	1.5×10^{-9}	8.3×10^{-5}
HEU	LLNL or NNSS	NNSS or LLNL	2	0.038	2.3×10^{-5}	0.031	1.9×10^{-5}	3.6×10^{-10}	6.6×10^{-6}
HEU	LLNL or LANL	LANL or LLNL	2	0.040	2.4×10^{-5}	0.010	6.2×10^{-6}	3.8×10^{-10}	8.3×10^{-5}
Other Pu (metal/oxide)	LLNL or NNSS	NNSS or LLNL	5	0.47	2.8×10^{-4}	0.39	2.3×10^{-4}	1.1×10^{-9}	1.7×10^{-5}
Other Pu (metal/oxide)	LLNL	LANL	3	0.29	1.8×10^{-4}	0.078	4.7×10^{-5}	7.1×10^{-10}	1.2×10^{-4}
Other Pu (metal/oxide)[b]	LANL	LLNL	5-6	0.60	3.6×10^{-4}	0.156	9.3×10^{-5}	1.4×10^{-9}	2.5×10^{-4}
TRU	LLNL	WIPP	8	0.88	5.3×10^{-4}	1.1	6.5×10^{-4}	4.9×10^{-8}	2.4×10^{-4}
Tritium	LLNL	SRS	5	NA	NA	NA	NA	3.0×10^{-10}	1.2×10^{-4}
Tritium	SRS	LLNL	7	NA	NA	NA	NA	4.1×10^{-10}	1.7×10^{-4}
Depleted U	Livermore Site	Site 300	15	NA	NA	NA	NA	NA	5.6×10^{-4}
Depleted U	Site 300	Livermore Site	5	NA	NA	NA	NA	NA	1.9×10^{-4}
HEU Metal	LLNL or SRS (bounding)	SRS (bounding) or LLNL	95	1.2	7.2×10^{-4}	1.8	1.1×10^{-3}	8.1×10^{-8}	2.3×10^{-3}
Cs-137 Sealed Source	Livermore Site or Site 300	Site 300 or Livermore Site	1	1.8×10^{-3}	1.1×10^{-6}	5.2×10^{-4}	3.1×10^{-7}	1.2×10^{-11}	3.7×10^{-5}
Am-241 Sealed Source	LLNL or SRS (bounding)	SRS (bounding) or LLNL	2	0.53	3.2×10^{-4}	0.16	9.4×10^{-5}	3.6×10^{-9}	4.8×10^{-5}
Miscellaneous Isotopes and Sealed Sources	SRS (bounding)	LLNL	215	57	3.4×10^{-2}	17.2	1.0×10^{-2}	3.9×10^{-7}	5.2×10^{-3}
		Totals	**888**	**69.2**	**0.042**	**24.7**	**0.015**	**2.9×10^{-6}**	**0.038**

a. A DOE employee would also need to comply with DOE regulations at 10 CFR Part 835 ("Occupational Radiation Protection"), which limits worker radiation doses to 5 rem/year; At LLNL, administrative control limits are multi-tiered, meaning they can vary between 100 millirem/year up to 500 millirem/year, depending on the situation (LLNL 2019w). This limit/guideline would apply to any non-TRU waste shipment conducted by DOE personnel. Drivers of TRU waste shipments to WIPP have an administrative exposure guideline of 1 rem/year. Commercial (i.e., non-DOE-employed) drivers are subject to OSHA regulations, which limit the whole-body dose to 5 rem/year (29 CFR 1910.1096), and to the USDOT requirement of 2 millirem/hour inside the truck cab (49 CFR 173.411).

b. Bounding value for 2023. Most years would have 2 shipments. Shipments expected to use Type B 0-160B cask loaded with pipe overpack containers that would contain some plutonium metals, oxides, and residues.

5.11.4 Summary of Transportation Impacts for the Alternatives

Table 5-32 summarizes the potential transportation impacts for the alternatives.

Table 5-32. Summary of Transportation Impacts for the Alternatives

Metric	No-Action Alternative	Proposed Action
Traffic Increase on Area Roads	1.6 - 3.4% (average of 2.4%)[a]	1.6 - 3.2% (average of 2.3%)[b]
Number of Annual Radiological Shipments	645	888
Crew Dose (person-rem)	61.6	69.2
Crew Radiological Risk (LCF)	0.037	0.042
Population Dose (person-rem)	21.6	24.7
Population Radiological Risk (LCF)	0.013	0.015

a. Increase over existing (2019) traffic baseline.
b. Increase over No-Action Alternative traffic projections.

5.12 INFRASTRUCTURE

This section discusses the potential impacts of the No-Action Alternative and Proposed Action on utilities and energy supplies. Utility and energy usage are discussed separately for the Livermore Site and Site 300. Key metrics presented in the infrastructure analysis are: (1) quantities of water, sanitary sewer (wastewater), electricity, and fuel (petroleum and natural gas) associated with construction, DD&D, modernization/upgrade/utility projects, and operations; and (2) analysis of the current infrastructure to meet demands.

5.12.1 No-Action Alternative

Under the No-Action Alternative, the ongoing activities described in Chapter 2 and Chapter 4 would continue at LLNL. In addition, new facility construction, DD&D, and modernization/upgrade/utility projects described in Section 3.2 would occur. In addition, there would be operational changes (e.g., operation of the Exascale Computing Facility Modernization [ECFM] project and increases in workforce) that would affect water use. Construction, DD&D, and operational activities associated with the No-Action Alternative would result in additional demands on the infrastructure in the region as discussed below. Table 5-33 summarizes the existing infrastructure capacities, current demands, and projected demands associated with the No-Action Alternative.

<u>**Livermore Site**</u>

Water Consumption. In 2019, the Livermore Site used approximately 267 million gallons of water. Construction and DD&D activities associated with the No-Action Alternative would require an additional 3.33 million gallons per year, and there would be increased demand associated with increased personnel at the Livermore Site. Increased water usage after 2023 would be primarily associated with cooling water usage for Exascale Computing Facility Modernization project. Under the No-Action Alternative, water usage is expected to peak in 2030, when approximately 433 million gallons per year would be used. Steady-state water usage of approximately 386 million gallons annually are expected in 2035. Under the No-Action Alternative, water demands would be 45 percent greater than current baseline demand. The capacity of the Livermore Site domestic water system is approximately 1,051 million gallons per year, which is adequate to meet demands. Any increase in water use at the Livermore Site would add to overall water demands and water supply issues in the region (see Chapter 6 for a discussion of potential cumulative impacts).

LLNL currently has a water supply contract with the San Francisco Public Utilities Commission (SFPUC) for water supplied from the Hetch Hetchy Aqueduct System. In addition, LLNL also has a water supply contract with Zone 7. Both contracts expire in 2024 (Stantec 2019). Hetch Hetchy water is primarily from Hetch Hetchy Reservoir with a "full" storage capacity of 117 billion gallons (Stantec 2019). Zone 7's future water supply reliability is significantly constrained by a supply deficit. The preliminary forecast of water supply yield in 2040 is approximately 55,500 acre-feet per year (AFY) (18.1 billion gallons). In 2019, 51,805 acre-feet (16.9 billion gallons) of water were consumed in the Livermore Valley for municipal use. Therefore, the best apparent regional water sustainability plan for LLNL is to maximize its use of Hetch Hetchy water at the Livermore Site (with resulting wastewater flowing into Zone 7's water reuse/water resource assets), with Zone 7 planning to provide water back to LLNL in times of drought when LLNL may need to reduce use of Hetch Hetchy water (Stantec 2019). For both water supply sources, water availability is dependent on annual precipitation rates. In the summer of 2019, Zone 7 management formally asked NNSA/LLNL to reduce Zone 7 water use as much as possible (NNSA 2021a). Potential future reductions in Zone 7 water use could impact LLNL, particularly during periods when the SFPUC supply system is down for maintenance.

Sanitary Sewer. From 2015 to 2019, the Livermore Site and SNL/CA daily wastewater flows averaged a total of 315,200 gallons per day (LLNL 2020r). In 2019, the Livermore Site discharged approximately 328,000 gallons of wastewater per day. Under the No-Action Alternative, construction and DD&D activities would increase discharges by an additional 3,940 gallons per day. Typically, portable toilets are used during construction and DD&D activities, which would mitigate the increased disposal of sanitary wastewater. During operations, as a result of increased personnel, wastewater discharge would increase to approximately 367,564 gallons per day. The overall increase in wastewater would be 12.1 percent above current baseline use. The LWRP currently receives a total of approximately 7.0 million gallons of effluent per day. The capacity of this facility is 9.5 million gallons of effluent per day (Stantec 2019); therefore, available capacity is approximately 2.5 million gallons per day. There is sufficient available capacity within the Livermore Site system to handle increased wastewater discharges.

Electricity Consumption. As discussed in Section 2.2.9.1, electricity for LLNL is dual sourced by the Pacific Gas and Electric (PG&E) Company and the Western Area Power Administration (WAPA), with automatic transfer. From 2015 to 2019, the Livermore Site used approximately 402.4 million kilowatt-hours per year of electricity (LLNL 2019ag). In 2019, the peak electrical demand varied between 53.4-63.6 MW (LLNL 2019ah).[15] Under the No-Action Alternative, there would be no notable changes in electricity consumption associated with construction and DD&D activities. During operations, electricity demand at the Livermore Site would be expected to increase to approximately 475 million kilowatt hours per year by 2028 (LLNL 2022a).[16] The

[15] Monthly peak electricity demand varies with seasons, due mainly to changes in air conditioning requirements.
[16] Based on electricity increase associated with ECFM and increase in square footage of facilities at Livermore Site.

expected increase in electrical consumption is largely attributed to the anticipated completion and operation of the ECFM project.

As a result of the ECFM project, electrical demand at the Livermore Site is expected to peak in 2028 at approximately 475 million kilowatt hours per year, which would represent a 18 percent increase over the 2019 baseline of 402.4 million kilowatt-hours per year of electricity (LLNL 2022a). By 2028, the peak electrical demand would rise to a maximum of 65.5 MW (LLNL 2022b). After 2028, as older, less efficient computer systems are phased out, electrical demand at the Livermore Site is decrease to approximately 428 million kilowatt hours per year (LLNL 2022a). The LLNL distribution system and the capacity of PG&E and the WAPA are anticipated to adequately meet the projected increase. Any increase in electricity use at LLNL would add to overall electricity demands and supply issues in the region (see Chapter 6 for a discussion of potential cumulative impacts).

Fuel Consumption. There would be no notable changes associated with natural gas during construction. Natural gas consumption for the Livermore Site averaged 12,361 therms per day in 2019. Under the No-Action Alternative consumption rates are expected to increase by 3.1 percent to approximately 12,750 therms per day as projects become operational. This demand would represent approximately 52 percent of the capacity of the natural gas system (24,500 therms per day).

About 102,014 gallons of petroleum was dispensed in FY 2019. LLNL has a goal to reduce petroleum usage by approximately two percent year-over-year. By 2023, petroleum usage is expected to be 96,000 gallons per year and LLNL would strive to continue reducing usage by two percent per year, with an expectation that petroleum usage would drop to approximately 83,300 gallons by 2030. By 2035, petroleum usage would drop to approximately 75,300 gallons.

Site 300

Water Consumption. Average water consumption at Site 300 ranges between 10 and 14 million gallons per year. Construction and DD&D activities would require about 0.37 million gallons of water per year. During operations, there would be no notable change in water consumption. The existing domestic water sources are two deep wells (Well 18 and Well 20) and the SFPUC Hetch Hetchy Aqueduct System (HHAS) through the Thomas Shaft Pumping Station. The No-Action Alternative also includes various utility installations and/or replacements to improve system reliability and redundancy at Site 300. Thus, water sources under the No-Action Alternative would also include the proposed Well 21. The primary source of domestic water to Site 300 is from the HHAS and is supplied throughout the year, except during maintenance activities at the Thomas Shaft or the Tesla Chlorination Facility. The SFTF draws up to 500 gallons of water a day from the Carnegie SVRA. The capacity of Site 300's water system exceeds 100 million gallons per year, which is adequate to meet demands associated with the No-Action Alternative. Any increase in water use at Site 300 would add to overall water demands and water supply issues in the region (see Chapter 6 for a discussion of potential cumulative impacts).

Sanitary Sewer. During construction and DD&D activities, wastewater generation would be approximately 1,310 gallons per day. There would be sufficient capacity to handle the increases in sanitary wastewater from construction activity at the GSA facility within Site 300. Typically, portable toilets are used during construction activity, which would also decrease the demand for onsite disposal of sanitary wastewater. Site 300 sanitary sewage generated outside the GSA is disposed of through septic tanks and leach fields or cesspools at individual building locations. Sanitary sewage generated within the GSA is piped into an asphalt-membrane-lined oxidation pond east of the GSA at an average rate of 4,000 gallons per day. During operations, sanitary wastewater would increase from 4,000 gallons per day to 4,436 gallons per day. There is sufficient capacity at Site 300 to handle the increase in sanitary wastewater. No offsite sewage treatment would be required, and no new impacts are expected.

Electricity. Electricity consumption at Site 300 is approximately 12.2 million kilowatt-hours per year and has remained stable over the past five years (LLNL 2019ag). In 2019, the peak electrical demand varied between 1.7-2.4 MW (LLNL 2019ah). During construction, there would be no changes associated with electricity. During operations, electrical consumption would increase to 12.6 million kilowatt-hours per year, which represents an increase of 3.3 percent over the 2019 baseline (LLNL 2022a).[17] Peak electrical demand is expected to remain about the same as the 2019 baseline (LLNL 2022b). The LLNL distribution system and the capacity of PG&E and the WAPA are anticipated to adequately meet the projected increase. Any increase in electricity use at Site 300 would add to overall electricity demands and supply issues in the region (see Chapter 6 for a discussion of potential cumulative impacts).

Fuel Consumption. During construction, there would be no notable changes associated with petroleum fuel consumption. By 2023, petroleum usage is expected to be 96,000 gallons per year and LLNL would strive to continue reducing usage by two percent per year. Based on that, petroleum usage at LLNL would drop to approximately 83,300 gallons by 2030, and further drop to approximately 75,300 gallons by 2035. Natural gas is not used at Site 300 (LLNL 2019f).

[17] Based on electricity increase associated with new facilities and increase in square footage of facilities at Site 300.

Table 5-33. Existing Capacity and Projected Use of Infrastructure Resources under the No-Action Alternative

Resource/Metric	Site	Existing Capacity	Existing Environment Baseline (2019)	Change to Baseline as a Result of the No-Action Alternative		No-Action Alternative	Percentage Change Over Baseline
				Construction/ DD&D	Operation		
Domestic water (million gallons per year)	Livermore Site	1,051	267	3.33	119	386	+44.5%
	Site 300	473	14	0.37	0.16	14.53	+3.7%
Wastewater (gallons per day)	Livermore Site	2,500,000 (a)	328,000	3,940	39,654	371,594	+12.1%
	Site 300	7,500	4,000	1,310	436	5,746	+43.6%
Electricity—Power Consumption (million kW-hr) per year	Livermore Site	Not Applicable	402.4(b)	No Notable Change	71.8	Peaks at 475 million kW-hr in 2028	+18%
	Site 300	Note Applicable	12.2(b)	No Notable Change	0.4	12.6	+3.3%
Electricity–Monthly Peak Load (MW)	Livermore Site	125	Maximum of 63.6	No Notable Change	1.9	Maximum of 65.5 MW in 2028	+3%
	Site 300	(c)	2	No Notable Change	No Notable Change	2	0%
Natural Gas (million therms per year)	Livermore Site	24,500	12,361	No Notable Change	389	12,750	+3.1%
	Site 300	None	None	No Notable Change	None	none	None
Petroleum Fuel (gallons per year)	Livermore Site Site 300	Not Applicable (d)	102,014	No Notable Change	-6,014 (e)	96,000 gallons/yr. by 2023; 75,300 gallons/yr by 2035	-5.9 to -26%

a. Capacity of the LWRP, 9.5 MGD.
b. Average value from 2015 to 2019
c. No available data.
d. Fuel delivered by truck.
e. In 2019, LLNL used 102,000 gal/yr of petroleum. NNSA has a goal to reduce petroleum usage at LLNL by approximately 2 percent year-over-year. By the end of 2022, petroleum usage is expected to be 96,000 gal/yr and LLNL would strive to continue reducing usage by 2 percent year-over-year going forward

Source: CWB 2016; CRWQCB 2008; LLNL 2020r; Stantec 2019.

5.12.2 Proposed Action

Under the Proposed Action, the ongoing activities described in Chapter 2 and Chapter 4 would continue. In addition, the Proposed Action includes the use of facilities and projects described for the No-Action Alternative, as well as new facility construction, modernization/upgrade/utility projects, operational changes, and DD&D activities described in Section 3.3. Table 5-34 summarizes the existing infrastructure capacities, current demands, and projected demands associated with the Proposed Action.

Livermore Site

Water Consumption. Construction and DD&D activities associated with the Proposed Action Alternative would require up to 6.1 million gallons of water annually. During operations, annual water consumption at the Livermore Site is estimated to increase as new facilities are brought into operation. Because the net square footage at the Livermore Site is expected to increase by approximately 25 percent, NNSA has estimated a nominal 25 percent increase in water use. Under the Proposed Action, steady-state water usage would increase from approximately 386 million gallons annually to 482 million gallons annually. The existing capacity of the Livermore Site domestic water system (approximately 1,051 million gallons per year) has adequate capacity to meet future water demand. Any increase in water use at LLNL would add to overall water demands and water supply issues in the region (see Chapter 6 for a discussion of potential cumulative impacts).

The largest portion of the current water demand at the Livermore Site is attributed to cooling towers, which account for over 50 percent of total potable water usage (Stantec 2019). Currently, there are five cooling towers at the Livermore Site, with an additional sixth large tower (already constructed) to serve the ECFM project. The two primary cooling towers at the Livermore Site are the U291 tower (7,700 tons of cooling capacity) and OS454 tower (7,200 tons of cooling capacity), both of which utilize potable water for cooling. The cooling tower that would support the ECFM project would provide approximately 17,400 tons of cooling capacity.

Under the Proposed Action, LLNL is preparing to receive reclaimed water from the City of Livermore's LWRP for use in cooling towers. This is a City of Livermore project. If completed, it will supply reclaimed water to cooling towers U291 and OS454 and the cooling tower serving the ECFM project at the Livermore Site.[18] As shown on Figure 3-18, this proposal would require construction of approximately 6,000 linear feet of 6-inch-diameter piping on the Livermore Site. The reclaimed water would be used by existing cooling towers U291 and OS454 and a future cooling tower serving the ECFM project at the Livermore Site. (Stantec 2019). The city of Livermore reclaimed water project would enable LLNL to use approximately 200 million gallons per year of treated wastewater for cooling tower cooling water instead of using fresh Hetch Hetchy water. Using reclaimed water would reduce Hetch Hetchy potable water usage at LLNL by approximately 200 million gallons per year. Consequently, potable water usage would not change under the Proposed Action, despite an increase in personnel and operations.

[18] Other cooling towers at the Livermore Site already utilize a non-potable water source or are not located in an area that would be cost-effective to use the reclaimed water from the LWRP (Stantec 2019).

Table 5-34. Existing Capacity and Projected Use of Infrastructure Resources under the Proposed-Action

Resource/Metric	Site	Existing Capacity	No-Action Alternative Demand	Change to No-Action Alternative as a Result of the Proposed Action		Proposed Action	Percentage Change Over No-Action Alternative
				Construction/ DD&D	Operation		
Domestic water (million gallons per year)	Livermore Site	1,051	386	6.12	90 (a)	482	25%
	Site 300	473	14.53	0.68	5.84	21.05	+44.9%
Wastewater (gallons per day)	Livermore Site	2,500,000 (b)	371,594	12,375	37,720	421,689	+13.5%
	Site 300	7,500	5,746	4,125	690	10,561	+83.8%
Electricity—Power Consumption (million kW-hr) per year	Livermore Site	Not Applicable	Peaks at 475 million kW-hr in 2028	No Notable Change	60	535 million kW-hr in 2032	12.6%
	Site 300	Not Applicable	12.6	No Notable Change	12.1	24.7	96%
Electricity–Monthly Peak Load (MW)	Livermore Site	125	Maximum of 65.5 MW in 2028	No Notable Change	16.4	Maximum of 81.9 MW in 2032	25%
	Site 300	(c)	2	No Notable Change	3	Maximum of 5 MW in 2028-2032	+150%
Natural Gas (million therms per year)	Livermore Site	24,500	12,750	No Notable Change	750	13,500	+5.9%
	Site 300	None	None	None	None	None	None
Petroleum Fuel (gallons per year)	Livermore Site Site 300	Not Applicable (d)	96,000 (e)	No Notable Change	-11,000	85,000(e)	-11.4%

a. Reclaimed water pipeline project would enable LLNL to use approximately 200 million gallons per year of treated wastewater for cooling tower use instead of using fresh Hetch Hetchy water.
b. Capacity of the LWRP, 9.5 MGD.
c. No available data.
d. Fuel delivered by truck.
e. In 2019, LLNL used 102,000 gal/yr of petroleum. NNSA has a goal to reduce petroleum usage at LLNL by approximately 2 percent year-over-year. By the end of 2022, petroleum usage is expected to be 96,000 gal/yr and LLNL would strive to continue reducing usage by 2 percent year-over-year going forward. For the Proposed Action, NNSA has assumed that the goal to reduce petroleum usage by 2 percent annually would continue and by 2035 petroleum usage would decline to 85,000 gal/yr.
Source: CWB 2016; CRWQCB 2008; LLNL 2020r; Stantec 2019.

The use of City of Livermore reclaimed water would require routine construction permits, possible environmental permits along the pipeline corridor, possible procurement of easements and rights-of-way, and development of Use Area reports for the State Department of Water Resources Division of Drinking Water approval to ensure no potable cross connections exist. In general, these processes are considered routine and not considered significant constraints to this proposal (Stantec 2019). A water service agreement between the city of Livermore and LLNL would also be required. This could include a new reclaimed water purchase agreement or an amendment to the existing agreement for sewer service (Stantec 2019).

Sanitary Sewer. Under the Proposed Action, construction workforce would discharge an additional 12,375 gallons per day of wastewater. Typically, portable toilets are used during construction activity, which would also decrease the demand for onsite disposal of sanitary wastewater. During operations for the Proposed Action, sewage discharges would increase at the Livermore Site by 37,720 gallons per day. The overall increase in sewage discharges would be 50,095 gallons per day, which would be an increase of 1.5 percent compared to the No-Action Alternative. The LWRP currently receives a total of approximately 7.0 million gallons of effluent per day. The capacity of this facility is 9.5 million gallons of effluent per day. Because of the sufficient available capacity, no adverse impacts would be expected from increased sewer discharges from the Livermore Site.

Electricity Consumption. There would be no changes associated with electricity consumption for construction and DD&D activities. During operations, electricity demand at the Livermore Site would be expected to increase as new facilities become operational. Because the net square footage at the Livermore Site is expected to increase by 25 percent, NNSA has estimated a nominal 25 percent increase in electricity use. Under the Proposed Action, steady-state electricity usage would increase from approximately 475 million kilowatt hours per year to approximately 535 million kilowatt hours per year by approximately 2032.[19] The monthly peak load is also expected to increase, from a maximum of 65.5 MW in 2028 to approximately 81.9 MW by approximately 2032. The proposed Enhanced Capability at NIF project would increase electrical energy usage at NIF by 50 percent. However, this increase is included in the estimates above. The LLNL distribution system would have sufficient capacity to adequately meet the electrical power requirements for the Proposed Action. Any increase in electricity use at the Livermore Site would add to overall electricity demands and supply issues in the region (see Chapter 6 for a discussion of potential cumulative impacts).

Fuel Consumption. During construction, there would be no notable changes associated with fuel (natural gas or petroleum) consumption. Compared to the No-Action Alternative natural gas consumption of 12,750 therms per day, the Proposed Action would increase natural gas consumption by 5.6 percent to approximately 13,500 therms per day. Because there is sufficient available capacity (24,500 therms per day), impacts would not be expected. For the Proposed Action, NNSA has assumed that the goal to reduce petroleum usage by 2 percent annually would continue, even with increased operations associated with the Proposed Action. Consequently, by 2035, petroleum usage at LLNL is expected to decline to 85,000 gallons per year.

[19] Based on electricity increase associated with new facilities and increase in square footage of facilities at Livermore Site.

Site 300

Water Consumption. Average water consumption at Site 300 is between 10 and 14 million gallons per year. Under the Proposed Action, construction would require approximately 0.39 million gallons per year. During construction, 0.68 million gallons of water would be required. Under the Proposed Action, water consumption would increase to approximately 20 million gallons per year. The capacity of Site 300's water system can safely exceed 100 million gallons per year. Because of the available water capacity, no significant impacts are expected from the increase in water usage. Any increase in water use at LLNL would add to overall water demands and water supply issues in the region (see Chapter 6 for a discussion of potential cumulative impacts).

Sanitary Sewer. During construction, an additional 4,125 gallons of wastewater per day would require disposal. However, portable toilets would likely be used during construction which would offset the demand for onsite treatment/disposal of sanitary wastewater. The excess capacity for wastewater disposal at the Site 300 GSA treatment system is approximately 3,500 gallons per day, so it may be necessary to transport excess wastewater to the Livermore Site for sampling, treatment and disposal. During operations, sewage discharge rates at Site 300 would increase by 690 gallons per day. The overall increase in sewage discharge would be 4,815 gallons per day, which would represent an increase of 83.8 percent above the No-Action Alternative. Wastewater treatment capacity at Site 300 at the GSA facility would be sufficient to handle the majority of the projected increase in sanitary wastewater. However, it may be necessary to transport excess wastewater to the Livermore Site for sampling, treatment and disposal. Additionally, septic tanks and leach fields for new facility locations would be constructed as appropriate. No offsite sewage treatment would be required, and no new impacts are expected.

Electricity Consumption. During construction, there would be no changes associated with electricity consumption at Site 300. During operations, electricity demand at Site 300 would be expected to increase as new facilities become operational. Because the net square footage at Site 300 is expected to increase by 96 percent, NNSA has estimated a nominal 96 percent increase in electricity use. Under the Proposed Action, steady-state electricity usage would increase from approximately 12.6 million kilowatt hours per year to approximately 24.7 million kilowatt hours per year by approximately 2032.[20] Peak electrical demand could also increase due to the operation of several new facilities. Most notably, both the DRDF and the Advanced 3D Hydrotest Facility would consume up to five megawatts of peak electrical power. Such demand is expected to be of short-duration and the Site 300 electrical distribution system would have sufficient capacity to adequately meet this increase in peak electrical demand. However, as these projects develop, NNSA would perform a Site 300 utility analysis to ensure this conclusion remains valid. Any increase in electricity use at LLNL would add to overall electricity demands and supply issues in the region (see Chapter 6 for a discussion of potential cumulative impacts).

Fuel Consumption. There would be no changes associated with fuel consumption during construction. Natural gas is not used at Site 300. Under the No-Action Alternative, petroleum usage at both the Livermore Site and Site 300 is expected to be 96,000 gallons per year by end of 2023, and 75,300 gallons per year by 2035. For the Proposed Action, petroleum usage is expected

[20] Based on electricity increase associated with new facilities and increase in square footage of facilities at Site 300.

to be 85,000 gallons per year by 2035; NNSA would strive to continue reducing usage by two percent year-over-year going forward.

5.13 Waste Management and Materials Management

The waste and materials management analysis presents the potential impacts from changes in waste generation rates and in quantities of hazardous materials managed due to construction, DD&D, modernization/upgrade/utility projects, and operations. NNSA does not expect waste or hazardous materials associated with these activities to be unique or substantially different from the types of waste and materials already managed within the LLNL, although quantities would increase. Key metrics for the waste analysis include: (1) the capacity of the existing LLNL waste management system to appropriately manage any expected increases in waste quantities, and (2) the capacity of offsite facilities to receive additional LLNL waste for subsequent treatment and/or disposal. Key metrics for the hazardous materials use analysis are the capacity and capability of the existing LLNL materials management system to accommodate any expected increases in hazardous material quantities.

5.13.1 No-Action Alternative

Under the No-Action Alternative, the ongoing activities described in Chapter 2 and Chapter 4 would continue at LLNL. In addition, new facility construction, DD&D, and modernization/upgrade/utility projects described in Section 3.2 would also occur. Waste projections present in this section thus include wastes from existing LLNL operations as well as those associated with No-Action Alternative Projects. The subsections that follow address waste and material categories in the same order as presented in Section 4.13. In most waste categories, wastes generated at Site 300 are not addressed separately from those of the Livermore Site because wastes from both areas are managed by the same groups, under the same procedures, and often by moving waste to the Livermore Site prior to any treatment or disposition. Also, most waste records maintained and published by LLNL are for combined (Livermore Site and Site 300) quantities.

5.13.1.1 *Radioactive Waste*

The discussion of radioactive waste includes the categories of low-level radioactive waste (LLW) and transuranic (TRU) waste, including mixed-TRU waste. Mixed low-level radioactive waste (MLLW), which contains both radioactive and hazardous constituents, is addressed later in its own section.

LLW. Under the No-Action Alternative, it is estimated that LLW would be generated within LLNL at the annual rate shown in Table 5-35. For comparison, the table also shows the average quantity of LLW generated within LLNL over ten years of record, as well as the projected waste quantities that were estimated when NNSA prepared the 2011 SA. The estimated generation rates for the No-Action Alternative include both routine LLW quantities (from normal operations) and nonroutine LLW quantities (from DD&D, construction, and environmental restoration actions), as well as totals. A review of new facilities with potential to generate routine LLW includes the Applied Materials and Engineering (AME) Buildings 223, 224, and 226; and the Building 310 Non-Destructive Evaluation Building. These buildings would generate small quantities of LLW.

The total routine LLW generation projections for the No-Action Alternative are provided in Table 5-35.

As indicated in Table 3-8, the estimate for the nonroutine LLW is not intended to reflect annual occurrences, as this quantity of waste would not be generated in all years. The nonroutine estimate reflects years when notable construction and/or DD&D actions would take place. For example, demolition of Buildings 251 and 280 (*see* Figure 3-8) would generate large amounts of LLW from decontamination activities. The nonroutine waste projection is based on the assumption that one or two large, contaminated facilities could be demolished in a single year, which provides a bounding value for this analysis.

Table 5-35. LLNL Generation of LLW Under the No-Action Alternative

LLW Category	Baseline/Existing Environment/Previous Projection (m^3/yr)		No-Action Alternative Projection[a] (m^3/yr)	Percent Increase Over 2011 SA Projection
	10-year Average (2010 to 2019)	2011 Supplement Analysis (SA) Projection		
Routine	578[b]	850	850	0%
Nonroutine	444[c]	710	4,000 - 8,000	463 – 1,025%
Total	**1,022**	**1,560**	**4,850- 8,850**	**210 - 467%**

m^3/yr = cubic meters per year
a. From Table 3-8.
b. From Figure 4-81. Lowest routine value during 10-year period was 219 m^3/year in 2010; highest routine value was 896 m^3/year in 2014.
c. From Figure 4-81. Lowest nonroutine value during 10-year period was 6 m^3/year in 2015; highest nonroutine value was 1,178 m^3/year in 2012.

As shown in Table 5-35, routine LLW quantities would be the same as the 2011 SA Projections. Nonroutine LLW quantities would increase as a result of increased DD&D activities. The large increase in non-routine waste generation should be seen in the context of a large decrease in long-term risks due to removal of legacy contaminated facilities and equipment. Radioactive and Hazardous Waste Management (RHWM) storage facilities at the Livermore Site have a combined capacity of 124,000 cubic feet or 3,520 cubic meters for permitted units; additional capacity is available for LLW and storage of DD&D LLW waste at the project locations. Although these waste storage facilities would never be expected to be used solely for LLW, this capacity (without considering capacity at project locations) represents less than 0.5 year of the estimated LLW generation. NNSA estimates that under the No-Action Alternative, there would be as many as 120 LLW/MLLW routine waste shipments per year and 160 LLW/MLLW nonroutine waste shipments per year (*see* Table 3-8). If 100 of these shipments were dedicated to LLW and were evenly distributed through the year, the average volume accumulated in storage would be about 50-90 cubic meters, or less than 3 percent of the storage capacity.

LLNL would continue to treat liquid LLW to put it in a form to meet offsite disposal criteria under the No-Action Alternative (as described in Section 4.13.1.1). The large waste storage capacity would allow any such waste to be accumulated, if necessary, until onsite treatment capacity was available or until there was sufficient volume to perform an efficient treatment process.

It is expected that final disposition of the LLW generated under the No-Action Alternative would be the same as described for current operations: approximately 85 percent of the routine LLW and MLLW generated at the Livermore Site would be sent to the NNSS and 15 percent would be sent to Energy*Solutions*. For non-routine LLW and MLLW, approximately 90 percent of the waste would be sent to Energy*Solutions* and 10 percent would be sent to NNSS (Table 3-8). From 2015 through 2019, the NNSS disposed of an average of 997,000 cubic feet (NNSS 2015, 2016, 2017, 2018, 2019), or 28,200 cubic meters of LLW per year in its land-based disposal cells. LLNL's current 10-year average LLW generation rate accounts for about 1.9 percent of the LLW sent to NNSS. Under the No-Action Alternative, the LLW contribution from LLNL could increase over the current 10-year average, and would account for approximately 4.0-5.4 percent of the average volume of LLW disposed of at NNSS (*see* Section 6.4.13). This increase would be well within the normal fluctuation reported in NNSA's annual waste disposal records. From 2015 through 2019, the difference between the NNSS' highest and lowest LLW disposal years was more than 11,000 cubic meters.

The Energy*Solutions* facility is a commercial facility licensed as a Class A LLW disposal facility by the Utah Department of Environmental Quality (UDEQ). UDEQ has this authority under agreement with the U.S. Nuclear Regulation Commission (NRC) (UDEQ 2020). During the five-year span from 2015 through 2019, Energy*Solutions* received an average of 3,420,000 cubic feet (96,800 cubic meters) of LLW per year. There was a marked increase in the volume of LLW received in the last three years of that span, resulting in a three-year average of 4,750,000 cubic feet (134,000 cubic meters) per year (NRC 2020). In either case, the LLNL LLW estimated under the No-Action Alternative would be 3,727 – 7,327 cubic meters per year and would account for approximately 2.8-5.4 percent of the waste managed by the Energy*Solutions*' Utah facility (*see* Section 6.4.13).

Relatively small amounts of LLW (one to five shipments per year) may also be sent to other offsite facilities such as Perma-Fix Environmental Services in Oak Ridge, Tennessee; Perma-Fix in Richland Washington; and Waste Control Specialists in Andrews County, Texas. These, or other offsite facilities, would only be utilized if they had appropriate permits/licenses and the capacity and capability to treat, store, and/or dispose of the specific LLW.

TRU and Mixed TRU Waste. LLNL generates TRU waste and, in smaller quantities, mixed TRU waste. Although both waste groups are shown in the waste projections in Table 3-8, the evaluation here considers a combined (TRU plus mixed TRU) waste volume. This is because all of the waste goes to the same offsite facility (i.e., DOE's WIPP facility) where it is all managed as if it were TRU waste. For ease of presentation, the combined waste is simply referred to as TRU waste. Under the No-Action Alternative, it is estimated that TRU waste could be generated within LLNL at the annual rate shown in Table 5-36. For comparison, the table also shows the average quantity of TRU waste generated within LLNL over ten years of record, as well as the projected waste quantities that were estimated when NNSA prepared the 2011 SA.

For the No-Action Alternative, the estimated generation rate is broken down into contributions from routine and nonroutine actions (as described previously), as well as totals. As indicated in Table 3-8 and described in more detail for LLW, the estimate for the nonroutine TRU waste is not intended to reflect annual occurrences, as this quantity of waste would not be generated in all years. The value presented is intended to bound years when nonroutine activities with high TRU waste generating rates would occur.

Table 5-36. LLNL Generation of TRU Waste Under the No-Action Alternative

TRU Waste Category	Baseline/Existing Environment/Previous Projection (m^3/yr)		No-Action Alternative Projection[a] (m^3/yr)	Percent Increase Over 2011 SA Projection
	10-year Average (2010 to 2019)	2011 SA Projection		
Routine	8.0[b]	52.8	52.8	0%
Nonroutine	0.022[c]	60	60.0	0%
Total	**8.0**	**112.8**	**112.8**	**0%**

m^3/yr = cubic meters per year

a. From Table 3-8. TRU and mixed TRU waste values from Table 3-8 are combined here for evaluation purposes.

b. From Figure 4-82. Lowest routine value during 10-year period was 0.4 m^3/year in 2011; highest routine value was 22 m^3/year in 2019.

From Figure 4-82. Lowest nonroutine value during 10-year period was 0 m^3/year in 2010-2019; highest nonroutine value was 0.22 m^3/year in 2010.

As shown in Table 5-36, the total volume of TRU waste projected for the No-Action Alternative would be the same as compared to 2011 SA projections. As described for LLW, RHWM would take management control of the containers of TRU waste it receives from generators and move the waste to one of its storage facilities. Once sufficient TRU waste was accumulated and verified to meet WIPP waste acceptance criteria, arrangements would be made to ship the waste to WIPP. NNSA estimates shipments to WIPP could occur up to eight (8) times per year under the No-Action Alternative (Table 3-8). With only two shipments per year, as much as 56 cubic meters could be in storage at the Livermore site, which would represent less than two percent of the combined 3,520-cubic-meter maximum storage capacity in RHWM's permitted waste storage units. More frequent shipments to WIPP would decrease the storage capacity needed for TRU waste.

Beginning in 2019, LLNL revised its approach to managing TRU waste to an ongoing enduring operation to improve the process of characterizing and certifying waste for shipment to WIPP (Section 4.13.1.2). This program involves significant characterization equipment and personnel training, but other than the ability to repackage waste if needed, does not include treatment of TRU waste.

TRU waste generated at LLNL is shipped to the WIPP facility near Carlsbad, New Mexico. In general, any increases in TRU waste generation (from any source) would have the potential to impact WIPP operations. WIPP is DOE's only authorized repository for TRU waste and also has a hazardous waste permit issued by the New Mexico Environment Department (NMED) for the management of mixed TRU waste. As of September 12, 2020, WIPP has disposed of approximately 69,600 cubic meters of TRU waste (NWP 2020) since it first received waste in March 1999. This disposed volume can be compared to a total capacity limit of 6.2 million cubic feet, or 175,564 cubic meters, established in the WIPP Land Withdrawal Act (Public Law 102-579, as amended by Public Law 104-201). Considering the total volume of waste now disposed of at WIPP and excluding the three years (2014 through 2016) waste emplacement operations were suspended, the facility has received an average of approximately 3,800 cubic meters per year since it started operations. While the volume of TRU waste projected for the LLNL No-Action Alternative represents an increase over what RHWM received from 2010 through 2019, it is consistent with LLNL's past projections of TRU waste generation, and it would remain a small contributor to the total TRU waste sent to WIPP (see Chapter 6 for a cumulative impact analysis of TRU disposal at WIPP).

5.13.1.2 *Hazardous Waste*

Under the No-Action Alternative, hazardous waste would be generated within LLNL at the annual rate shown in Table 5-37. That generation rate is broken down into contributions from routine operations and from nonroutine construction and DD&D projects. For direct comparison as a baseline, the table also shows the average quantity of hazardous waste generated at LLNL over ten years of record, as well as the projected waste quantities that were estimated when NNSA prepared the 2011 SA.

NNSA determined that the following new facilities under the No-Action Alternative would generate small quantities of routine hazardous waste:

- Building 321G Manufacturing Building;
- Building 310 Non-Destructive Evaluation Building;
- New Generic Laboratory Building for Low-Level Wet Chemistry;
- Building 850 Revitalization Project; and
- Central Maintenance Shop Facility

Hazardous waste from these facilities is included in the routine hazardous waste projections presented in Table 5-37.

Table 5-37. LLNL Generation of Hazardous Waste Under the No-Action Alternative

Hazardous Waste Category	Baseline/Existing Environment/Previous Projection (MT/yr)		No-Action Alternative Projection[a] (MT/yr)	Percent Increase Over 2011 SA Projection
	10-year Average (2010 to 2019)	2011 SA Projection		
Routine	158[b]	510	510	0%
Nonroutine	111[c]	1,700	1,700	0%
Total	**269**	**2,210**	**2,210**	**0%**

MT/yr = metric tons per year (Metric tons equals 1,000 kilograms. Metric tons multiplied by 1.1023 equals tons.)
a. From Table 3-8.
b. From Figure 4-87. Lowest routine value during 10-year period was 110 MT/year in 2017; highest routine value was 232 MT/year in 2012.
c. From Figure 4-87. Lowest nonroutine value during 10-year period was 10 MT/year in 2013; highest nonroutine value was 568 MT/year in 2019.

As shown in Table 5-37, the total volume of hazardous waste projected for the No-Action Alternative would be the same as 2011 SA projections. Generators of hazardous wastes generally accumulate their wastes in SAAs or WAAs. RHWM works with generators to ensure wastes are not held in these accumulation areas beyond applicable regulatory time limits. When waste containers are full, appropriately characterized, and turned over to RHWM, they are moved to one of the RHWM storage facilities in AREA625/612 or the DWTF. In some cases, RHWM might make arrangements to ship containers of hazardous waste directly from the generator's location to an offsite commercial treatment/disposal facility.

Using a rough approximation of one cubic yard of hazardous waste weighing 600 pounds (or about twice the density of typical uncompacted mixed municipal solid waste [USEPA 2016b]), the 2,210 metric tons (or 2,440 tons) per year of total hazardous waste equates to 8,130 cubic yards or about 220,000 cubic feet per year. (If it is assumed that the waste is heavier than 600 pounds per cubic yard, the amount of storage space required decreases.) If the hazardous waste were to be stored for an entire year, the space required would equate to about 180 percent of the combined 124,000 cubic feet maximum storage capacity of RHWM's permitted waste storage units. However, LLNL makes frequent hazardous waste shipments to the multiple commercial hazardous waste treatment/disposal facilities it has under contract. As described in Section 4.11.4.1, such shipments are made at a typical rate of between 80 and 240 per year. Even at the low end of this rate, and assuming each shipment removes all hazardous waste available, the storage requirement for hazardous waste drops to below three percent of the maximum storage capacity.

The preceding storage capacity evaluation does not take into consideration any hazardous waste treatment that might be performed in the DWTF. As with current operations, some hazardous waste generated under the No-Action Alternative will be amenable to such treatment. Many of the DWTF treatment units are intended for the treatment of aqueous wastewater solutions or to otherwise reduce the volume of waste requiring subsequent offsite treatment or disposal. As a result, the treatment process would often act to reduce demand on storage capacity.

LLNL manages its hazardous waste under contract with large commercial enterprises that must show adequate capacity and compliance with applicable permitting and regulatory requirements in order to be considered for the contract. As described in Section 4.13.2.1, LLNL utilizes a variety of commercial facilities in order to accommodate the varied and often unique nature of the hazardous waste generated from its operations. The quantities of hazardous waste associated with the No-Action Alternative are not large on a national, or even state level. Based on USEPA's biennial reports for hazardous waste, there were 35 million tons of hazardous waste generated nationally in 2017, with 322,000 tons generated in California the same year (USEPA 2018a). The 2,210 metric tons (or 2,440 tons) per year projected for LLNL represents a small portion (less than one percent) of these waste quantities.

Hazardous wastes that would be generated at Site 300 are included in the quantities addressed in the preceding discussion. However, the available hazardous waste storage at Site 300, specifically the B883 CSA (Table 4-33), was not considered in the total storage capacity. NNSA does not expect Site 300 to have capacity issues at the B883 CSA because hazardous waste at that storage unit can be shipped directly to offsite commercial facilities, as appropriate, or moved to the Livermore Site for longer storage, as needed.

Explosive Wastes. NNSA does not expect explosive waste activities under the No-Action Alternative to be different than described for the existing environment in Section 4.13.2. The No-Action Alternative would involve new or expanded facilities working with high explosives; specifically, the Building 191 HEAF Atrium Conversion to Shot-Ready Workspace Project as described in Section 3.2.1.1. This project would involve relatively small explosive weight limits. Another facility handling small quantities of HE with the potential to generate explosives waste is the Building 850 Revitalization Project. These wastes, however, are included in the hazardous waste quantity projected for the No-Action Alternative and evaluated in the preceding discussion. The discussion of existing hazardous waste activities presented in Section 4.13.2 includes descriptions of how explosive wastes are managed, stored, and treated within Site 300. The discussion identifies the explosive waste storage and treatment units included in the applicable hazardous waste permit (Table 4-33) and lists the maximum operating capacity for each unit as established in the permit. The same explosive waste management activities are expected to continue under the No-Action Alternative and within the established operating limits of the existing hazardous waste permit.

5.13.1.3 *Mixed Low-Level Radioactive Waste (MLLW)*

Under the No-Action Alternative, MLLW would be generated within LLNL at the annual rate shown in Table 5-38. For comparison, the table also shows the average quantity of MLLW generated within LLNL over ten years of record, as well as the projected waste quantities that were estimated when NNSA prepared the 2011 SA. The estimated generation rates for the No-Action Alternative include both routine MLLW quantities and nonroutine MLLW quantities, as well as totals. As indicated in Table 3-8, the estimate for the nonroutine MLLW is not intended to reflect annual occurrences, as this quantity of waste would not be generated in all years. The value presented is intended to bound years when nonroutine activities with high MLLW generating rates would occur. Under the No-Action Alternative, Building 850 Revitalization Project would generate small quantities of routine radiological mixed wastes.

Table 5-38. LLNL Generation of Mixed Low-Level Waste Under the No-Action Alternative

MLLW Category	Baseline/Existing Environment/Previous Projection (m^3/yr)		No-Action Alternative Projection[a] (m^3/yr)	Percent Increase Over 2011 SA Projection
	10-year Average (2010 to 2019)	2011 SA Projection		
Routine	30[b]	88	88	0%
Nonroutine	177[c]	725	725	0%
Total	**206[d]**	**813**	**813**	**0%**

m^3/yr = cubic meters per year
a. From Table 3-8.
b. From Figure 4-88. Lowest routine value during 10-year period was 14 m^3/year in 2017; highest routine value was 46 m^3/year in 2012.
c. From Figure 4-88. Lowest nonroutine value during 10-year period was 4 m^3/year in 2015; highest nonroutine value was 1,102 m^3/year in 2011.
d. This total is not the exact sum of the routine and nonroutine values due to rounding.

As shown in Table 5-38, there would no increase in the total MLLW generation rate estimated for the No-Action Alternative when compared to the 2011 SA projections. As shown in that table, the majority of MLLW would be nonroutine quantities associated with DD&D actions on inactive contaminated facilities.

As with other waste categories, RHWM would take management control of containers of MLLW once generated and either move the waste to one of its storage facilities (Area 625/612 or the DWTF) or make arrangements to ship containers directly from the generator's location to an offsite treatment/disposal facility. If the MLLW were to be stored for an entire year, the space required (i.e., 813 cubic meters) would equate to about 23 percent of the combined 3,521 cubic meters maximum storage capacity of RHWM's permitted waste storage units. Currently LLNL ships MLLW off site for disposition at a typical rate of 10 to 15 shipments per year, with combined LLW and MLLW shipments at 50 to 65 per year (see Table 3-8). Under the No-Action Alternative combined LLW and MLLW offsite shipments are estimated to be as high as 280 per year. Accordingly, accumulating MLLW for even as long as one year would be unlikely. If all MLLW accumulations were removed only 10 times per years, MLLW storage requirements would be less than 3 percent of the capacity.

As with current operations, some MLLW generated under the No-Action Alternative would be amenable treatment in the DWTF. Many of the DWTF treatment units are intended for the treatment of aqueous wastewater solutions or to otherwise reduce the volume of waste requiring subsequent offsite treatment or disposal. As a result, the treatment process would often act to reduce demand on storage capacity or offsite treatment/disposal. Having adequate storage capacity to accumulate and stage waste for treatment unit processing should ensure that treatment capacity is not adversely impacted.

LLNL manages its MLLW through a combination of on-site treatment followed by disposal as LLW, or shipment to commercial facilities for treatment and/or disposal. Use of commercial facilities is limited to those able to show adequate capacity and compliance with applicable permitting and regulatory requirements. As noted in Section 4.13.3.2, commercial facilities recently used by LLNL for MLLW include the Energy*Solutions* facility in Utah and a Perma-Fix facility (specifically Diversified Scientific Services Inc. or DSSI) in Tennessee. These two facilities, as well as the NNSS facility, have permits with their applicable states allowing them to receive MLLW for treatment and/or disposal. Perma-Fix describes its Tennessee facility as a treatment facility using a combustion process and dealing primarily with liquid waste, so the LLNL waste types (largely from DD&D-type activities) amenable to this facility would be expected to be limited.

In the five-year period from 2015 through 2019, NNSS received an average of 103,000 cubic feet of MLLW per year (NNSS 2015, 2016, 2017, 2018, 2019). In the biennial reporting required under RCRA for hazardous waste facilities, Energy*Solutions* and Perma-Fix reported receiving 2,060 tons (USEPA 2018b) and 212 tons (USEPA 2018c), respectively, of hazardous waste in 2017. Both commercial facilities describe their expertise as management of radiological waste materials, including MLLW. Using the rough approximation described previously of 600 pounds per cubic yard, the MLLW received by the Energy*Solutions* and Perma-Fix facilities in 2017 equate to about 185,000 and 19,100 cubic feet, respectively. The 813 cubic meters, or 28,700 cubic feet, of MLLW generated annually under the No-Action Alternative would represent only about nine percent of the total volume sent to all three facilities. However, if all or most of the No-Action Alternative MLLW were sent to either the NNSS or Perma-Fix facilities, their normal operations might have to be altered at times to accommodate the increased waste quantities. Other commercial treatment and/or disposal facilities such as Perma-Fix in Richland Washington and Waste Control Specialists in Andrews County, Texas, are also available and would be considered, as appropriate.

MLLW that might be generated at Site 300 is included in the estimated quantities addressed above. As noted in Section 4.13.3.1, however, should MLLW be generated at Site 300, RHWM would be required to take timely actions to get the waste shipped to an offsite facility or to be moved to the Livermore Site, as MLLW is not permitted for storage in the B883 CSA.

5.13.1.4 *Biohazardous/Medical Waste*

Current operations at LLNL generate approximately 13,000 pounds of biohazardous/medical waste annually (LLNL 2019n, 2019o). NNSA expects that under the No-Action Alternative, LLNL management of medical waste, which includes biohazardous waste, would remain unchanged from the existing operations described in Section 4.13.4 and, accordingly, would not be adversely impacted. The same types and quantities of waste described in Table 4-35 would be generated and the same treatment alternatives, including several onsite processes and offsite incineration, would be available and used. LLNL would be subject to the same regulatory oversight, including onsite inspections by the oversight agency.

5.13.1.5 *Other, Nonhazardous Solid Waste*

This section evaluates a nonhazardous solid waste category that combines municipal solid waste (Section 4.13.5.1) and construction and demolition waste (Section 4.13.5.2). As with the discussion of other waste types, routine and nonroutine segments are considered as being municipal solid waste and construction and demolition (C&D) waste, respectively. Under the No-Action Alternative, it is estimated that nonhazardous solid waste could be generated within LLNL at the annual rate shown in Table 5-39. For direct comparison, the table also presents a summary of the levels of nonhazardous solid waste generated at LLNL from 2010 through 2019.

Table 5-39. LLNL Generation of Nonhazardous Solid Waste Under the No-Action Alternative

Nonhazardous Solid Waste Category	Baseline/Existing Environment (10-year Average – 2010 to 2019)[a] (MT/yr)	No-Action Alternative[b] (MT/yr)	Percent Increase Over Baseline
Routine (Municipal Solid Waste)	2,780	3,050	10%
Nonroutine (Construction and Demolition Waste)	2,570	900-5,500	Up to 110%
Total	**5,360[c]**	**3,950-8,550**	**Up to 60%**

MT/yr = metric tons per year (1 metric ton = 1,000 kilograms). Metric tons multiplied by 1.1023 equals tons.
a. From Figures 4-89 and 4-90.
b. From Table 3-8.
c. This total is not the exact sum of the routine and nonroutine values due to rounding.

As shown in Table 5-39, the estimated total nonhazardous solid waste generation rate for the No-Action Alternative is represented by a range of values due to the range of values estimated for the nonroutine, C&D waste segment. The broad range is consistent with the nature of the C&D waste stream that varies greatly from year to year. The total estimated quantity of nonhazardous solid waste would be less than the ten-year average at the low end of the range, and 60 percent higher than the average at the high end.

The municipal solid waste segment is waste that is accumulated throughout the Livermore Site and manned areas of Site 300, and is routinely collected for transport to an offsite commercial landfill. Other than the accumulation bins and containers, there are no storage facilities for this waste, and it is expected that existing bins and containers would be adequate for waste generated under the No-Action Alternative. C&D waste also has no designated storage areas. Such waste is typically accumulated at the construction or demolition site and periodically removed as needed. Accordingly, there are no onsite storage facilities for nonhazardous solid waste that would be overloaded by additional waste from the No-Action Alternative.

As described in Section 4.13.5, nonhazardous solid waste generated from within the Livermore Site is taken to either the Altamont Landfill or the Vasco Road Landfill. Nonhazardous solid waste generated at Site 300 generally goes through the Tracy Material Recovery and Transfer Station, but unrecovered waste may go to one of the same landfills. Both the Altamont and Vasco Road facilities have appropriate permits to operate as solid waste landfills and the County of Alameda, Department of Environmental Health, is identified as the local enforcement agency for both landfills. The maximum permitted throughput for the Altamont Landfill is 11,150 tons per day (CalRecycle 2020a). The maximum permitted throughput for the Vasco Road Landfill is 2,518 tons per day (CalRecycle 2020b). The Tracy Facility is permitted for material recovery/processing, composting, and waste transfer; its local enforcement agency is the San Joaquin County Environmental Health Department; and its permitted maximum throughput is 1,800 tons per day (CalRecycle 2020c).

If it is assumed that the total nonhazardous solid waste associated with the No-Action Alternative is sent to an offsite landfill over five days per week, 50 weeks per year (i.e., 250 days per year), the range of 3,950 to 8,550 metric tons per year can be equated to 15.8 to 34.2 metric tons (or 17.4 to 37.7 tons) per day. This daily range of waste represents 0.16 to 0.34 percent of the Altamont Landfill's permit limit of 11,150 tons per day and 0.69 to 1.5 percent of the Vasco Road Landfill's permit limit of 2,518 tons per day. Contributing waste in these small percentages of the landfills' operating limits would not be expected to cause adverse impacts to those operations. Also, as described in Section 4.13.5, it has been LLNL practice to divert a significant portion of its nonhazardous solid waste from landfilling through various recycling or reuse efforts. During the past 10 years, more than 70 percent of both the municipal solid waste segment and the C&D segment have been diverted from landfill disposal. Accordingly, the actual amounts of waste that would go to either the Altamont or Vasco Road landfills should be lower than evaluated above.

A small portion of the LLNL nonhazardous solid waste generated at Site 300 could be processed at the Tracy Material Recovery and Transfer Station. That waste quantity would be small in comparison to its operating limit of that facility (1,800 tons per day).

5.13.1.6 *Hazardous Materials Management*

The No-Action Alternative would involve construction of new facilities (*see* Section 3.2), including some with new or expanded laboratory or research functions. As a result, it is expected that the use and presence of hazardous materials at LLNL would increase to some extent. The additional hazardous materials would likely be the same or similar to materials already used within LLNL (*see* Section 4.13.6); and any new hazardous materials would not be allowed onsite without appropriate equipment, facilities, procedures, and training necessary to safely manage those materials.

The new facilities under the No-Action Alternative with hazardous materials inventories include:

- Applied Materials and Engineering (AME) Buildings B223, B224, and B226;
- Building 225 Manufacturing Science Building;
- Building 321G Manufacturing Building;
- Building 310 Non-Destructive Evaluation Building;
- Building 191 HEAF Conversion to Shot Ready Workspace Project;
- New Generic Laboratory Building for Low-Level Wet Chemistry;
- Building 850 Revitalization Project; and
- Central Maintenance Shop Facility.

All of these facilities would handle small quantities of hazardous materials. Overall usage of hazardous materials under the No-Action Alternative for Livermore Site and Site 300 are described below.

Livermore Site. For purposes of this evaluation, increases in hazardous material usage are estimated based on increases in building area (square footage) where such materials would be most heavily used. As a baseline for the Livermore Site, Table 2-2 lists the key facilities within the site; the square footage of those facilities shown with laboratory or research functions totals approximately 3,530,000 square feet. This total Livermore Site building area is associated with existing conditions characterized, for example, as including roughly 115,000 chemical containers (per Section 4.13.6) and the quantities of representative hazardous chemicals listed in Table 4-40. Table 5-40 identifies facilities that would be constructed under the No-Action Alternative and which are described in Section 3.2.1 as involving expanded or new laboratory or research functions. That is, new construction intended to replace existing facilities and functions, or that is limited to office space or administrative-type functions, is not included in the table. Finally, the table provides a comparison of area between existing facilities and new facilities listed in the table.

Table 5-40. Expanded Laboratory/Research Functions at Livermore Site for No-Action Alternative

Facility Designation	Area (square feet)	Increase to Existing Facilities
Existing key facilities with laboratory or research functions – Total Area[a]	3,530,000	N/A
New No-Action Alternative facilities with expanded or new laboratory or research functions[b]	30,700	0.9%
Total R&D Facilities under the No-Action Alternative and Percentage Increase above the Current Baseline	**3,560,700**	0.9%

a. From Table 2-2.
b. Based on new No-Action Alternative facilities described in Section 3.2.1, such as the Building 321G Manufacturing Building, Building 191 HEAF Atrium Conversion, and Building 225 Manufacturing Science Facility.

Consistent with information in Table 5-40 and the assumption that hazardous material usage is related to the size of facilities, it is estimated that the Livermore Site's hazardous material usage under the No-Action Alternative would increase by 0.9 percent compared to current conditions.

Site 300. The evaluation described above for the Livermore Site was repeated for Site 300. As a baseline for the Site 300, Table 2-3 lists the key facilities within the site. In this case, the facilities-of-interest category was expanded to include every facility in the table. This is due to the nature of the work performed at Site 300 and because every facility shown in Table 2-3 is identified as having "chemical" and "other" hazards (with the "other" likely attributed primarily to HE) and most also have radiological hazards. The total square footage for the facilities in Table 2-3 is approximately 266,000 square feet. This Site 300 building area is associated with existing conditions characterized, for example, as including roughly 7,000 chemical containers (per Section 4.13.6) and the quantities of representative hazardous chemicals listed in Table 4-41. Table 5-41 identifies facilities and their square footage that would be constructed under the No-Action Alternative as described in Sections 3.2.1. As with the Livermore Site evaluation, only facilities involving expanded or new laboratory or research functions were considered; replacement facilities, office space, or administrative-type facilities are not included in the table. Finally, the table provides a comparison of area between existing facilities and new facilities listed in the table.

Table 5-41. Expanded Laboratory/Research Functions at Site 300 for the No-Action Alternative

Facility Designation	Area (square feet)	Increase to Existing Facilities
Existing key facilities with laboratory or research functions – Total Area[a]	266,000	N/A
New No-Action Alternative facilities with expanded or new laboratory or research functions[b]	0	No change
Total R&D Facilities under the No-Action Alternative and Percentage Increase above the Current Baseline	**266,000**	No change

a. From Table 2-3.
b. Based on the projects described in Section 3.2.1, there would be no change in the amount of hazardous materials at Site 300 under the No-Action Alternative.

Consistent with information in Table 5-41 and the assumption that hazardous material usage is related to the size of facilities, it is estimated that Site 300's hazardous material usage under the No-Action Alternative would not change compared to existing conditions.

Potential Impacts under the No-Action Alternative

The management of hazardous materials, either at the Livermore Site or Site 300, would not be directly affected by construction activities included in the No-Action Alternative. Typical construction activities would be expected to include hazardous materials (e.g., paints, thinners, cleaning solvents, adhesives, fuels, lubricants), but construction contractors would be responsible for management of those materials. This would include responsibility for bringing the materials onto the site; for their proper use and handling; and for removal and proper disposition of unused materials, residues, and wastes. LLNL's hazardous materials management system would not be involved and should not be adversely impacted by the actions.

Livermore Site. It is estimated that the quantity of hazardous materials managed within the Livermore Site could increase by roughly 0.9 percent as a result of the new facilities that would be constructed under the No-Action Alternative. That is, for example, the 115,000 chemical containers being managed within the site (Section 4.13.6.2) could increase to about 116,000 containers and each of the representative hazardous chemicals identified in Table 4-40 could have average quantities increased by about 0.9 percent. The number of chemical containers managed would still be well below past levels such as that described in the 2005 SWEIS, which was 166,000. Also, with respect to the hazardous chemicals in Table 4-40, in all but one instance, increasing the average values by 0.9 percent would result in quantities well below the maximum values shown in the same table. Because the Livermore Site has operated with these quantities on hand, it is unlikely that physical capabilities would be overtaxed by the additional materials. The single instance where an increase in a Table 4-40 average would cause the maximum to be exceeded is the entry for lead bricks or ingots. In this case, Table 4-40 shows the same value for both the maximum and average values indicating the same quantity of lead was onsite for the entire year of record. These are undoubtedly lead bricks or ingots being used for shielding or available for shielding. Because any shielding requirements for the new facilities would be part of their design, no storage capacity outside the new facilities would be needed. In summary, the small increase in hazardous materials associated with the new facilities would not be expected to adversely impact existing management capacity or capabilities.

Site 300. Hazardous material usage under the No-Action Alternative would not change compared to existing operations.

5.13.1.7 *Radioactive Materials Management*

LLNL uses radioactive materials in a wide variety of operations including scientific and weapons R&D, diagnostic research, and research on the properties of materials. Tables 2-2 and 2-3 in Chapter 2 list the facilities at the Livermore Site and Site 300, respectively, that manage/use radioactive materials. Based on facility design and operation, LLNL establishes administrative limits for fissile, special use, radioactive, and sealed materials. An administrative limit is the total amount of certain materials allowed in a specific building at LLNL. These limits are used in determining potential risks associated with accidents. A description of the key facilities at the Livermore Site and Site 300 that manage/use radioactive materials is contained in Appendix A. Those descriptions summarize the hazards and wastes from operation of the existing facilities.

DOE/NNSA requires LLNL to conduct its radiological activities in compliance with a documented, DOE-approved, radiation protection program (RPP). Table 5-42 lists the ES&H Manual documents that contain the requirements of LLNL's RPP and constitute LLNL's site-specific radiological control manual. Effective implementation of these documents ensures general employees, visitors, and LLNL are adequately protected and that LLNL achieves compliance with the DOE's rule on Occupational Radiation Protection (Part 10 CFR 835) and contractually-obligated orders and standards.

Table 5-42. ES&H Manual Documents that Implement LLNL's Radiation Protection Program

ES&H Manual Document	Title	Contains
Document 20.1	"Occupational Radiation Protection"	Technical requirements for the overall radiological protection program, including the ALARA program
Document 20.2	"LLNL Radiological Safety Program for Radioactive Materials"	Technical requirements for the handling, storage, or transportation of radioactive materials (including radioactively contaminated items)
Document 20.3	"LLNL Radiological Safety Program for Radiation-Generating Devices"	Technical requirements for operation of RGDs
Document 22.6	"Exposure to Radiation in an Emergency"	Provisions for responding to radiological emergencies

Source: LLNL 2017g.

The removal of Security Category I/II special nuclear materials (SNM) from LLNL, which was completed in 2012, represents one of the Laboratory's major actions since publication of the 2005 LLNL SWEIS ROD. LLNL's transformation from Security Category I/II operations to Security Category III operations required the completion of many activities, including:

1. Security Category I/II SNM removal
2. Transfer LLNL Security Category I/II operations
3. Transition the LLNL site to Security Category III operations (LLNL 2013c).

To reach Security Category III mass limits, LLNL needed to process and package approximately 1,700 items for offsite transfer. Approximately 87 percent of LLNL's starting inventory of Security Category I/II SNM was declared excess to NNSA mission needs. The effort of processing, packaging and shipping the Security Category I/II SNM from LLNL was performed over a five year period, all of which was accomplished while maintaining programmatic operations at LLNL (LLNL 2013c).

Under the No-Action Alternative, LLNL would continue to manage radioactive materials and conduct radiological operations at both the Livermore Site and Site 300. Operations involving radioactive materials have the potential to release radionuclides to the air (*see* Section 5.6.1), generate radioactive, hazardous, and nonhazardous waste (*see* Section 5.13.1), and impact human health through radiological exposures and occupational injuries (*see* Section 5.14.1) and accidents (*see* Section 5.16). The two projects involving radioactive materials under the No-Action Alternative are the Applied Materials and Engineering (AME) Project and the Building 850 Revitalization Project. These two projects are replacements or upgrades for existing facilities and would not introduce new hazards or waste streams compared to existing operations. For example, under the Building 850 Revitalization Project, the facility would remain a radiological facility below HC-3 thresholds. Neither of these two facilities would release radionuclides to the air under normal operations (*see* Section 5.6.1). Wastes generated by these two facilities are included in the No-Action Alternative wastes discussed in Section 5.13.1. Impacts to human health from these two facilities are included in the No-Action Alternative impacts discussed in Section 5.14.1. For a discussion on accidents associated with radioactive materials, see Section 5.16.

5.13.1.8 *Explosives Materials Management*

LLNL uses explosives in various R&D and test applications. Explosive quantities used per activity range from milligrams to several kilograms. Overall, the quantities of explosive material maintained onsite are restricted by the approved explosive capacity of various storage areas. Site 300 is the primary location for explosives storage. This site is designated as a limited area accessible to approved personnel only. Tables 2-2 and 2-3 in Chapter 2 list the facilities at the Livermore Site and Site 300, respectively, that manage/use explosives. A description of the key facilities at the Livermore Site and Site 300 that manage/use explosives is contained in Appendix A.

DOE's Explosives Safety Standard (DOE STD 1212-2012) is the controlling document for all explosives operations at LLNL. Document 17.1, "Explosives" (LLNL 2018c), is one of many ES&H Manual Documents that covers LLNL-specific work practices and local requirements and implements various sections of the DOE Explosives Safety Standard that applies to common operations involving explosives. LLNL also implements explosives safety standards through safety basis documents, facility safety plans, training programs, safety committees, peer reviews, and work control documents.

Based on a total mass size less than the critical diameter, primary explosives 1 mg or less and secondary explosives 10 mg or less are considered non-detonable by abnormal stimuli or environment. Therefore, operations involving quantities less than or equal to1 milligram of primary explosives or less than 10 milligrams of secondary explosives (i.e., *de minimus* or residual quantities) may be conducted in areas where explosives are not otherwise permitted. Activities with *de minimus* or residual quantities still require an approved work control document (LLNL 2018c).

Under the No-Action Alternative, LLNL would continue to manage explosives materials and conduct explosives operations at both the Livermore Site and Site 300. Operations involving explosives have the potential to cause noise impacts (*see* Section 5.7.1), generate hazardous and nonhazardous waste (*see* Section 5.13.1), and impact human health through occupational injuries (*see* Section 5.14.1) and accidents (*see* Section 5.16). The only project involving explosives under the No-Action Alternative is the Building 191 HEAF Atrium Conversion to Shot-Ready Workspace Project at the Livermore Site. That project would convert the existing first floor 2,000 square feet atrium at HEAF, Building 191, into experimental space to accommodate safe and compliant work with explosives. Noise impacts, wastes generated, and human health impacts would be similar to existing operations at HEAF.

5.13.2 Proposed Action

Under the Proposed Action, the ongoing activities described in Chapter 2 and Chapter 4 would continue at LLNL. In addition, the Proposed Action includes the use of facilities and projects described for the No-Action Alternative, as well as new facility construction, DD&D, modernization/upgrade/utility projects, and operational changes described in Section 3.3.

Waste projections presented in this section include wastes projected for Proposed Action activities (*see* Section 3.3). It includes the existing 2019 baseline LLNL operations as well as increases due to the No-Action Alternative Projects. NNSA does not expect additional waste associated with the Proposed Action to be unique or substantially different from the types of waste already managed within the LLNL, although a larger proportion of DD&D waste and construction debris is expected. In each waste stream discussion in this section, waste quantities projected for the Proposed Action are compared to the No-Action Alternative.

The subsections that follow address waste and material categories in the same order as presented in Section 4.13. As explained for the No-Action Alternative (Section 5.13.1), wastes generated at Site 300 are not generally addressed separately from those of the Livermore Site.

5.13.2.1 *Radioactive Waste*

The discussion of radioactive waste includes the categories of low-level radioactive waste (LLW) and transuranic (TRU) waste, including mixed-TRU waste. Mixed low-level radioactive waste (MLLW), which contains both radioactive and hazardous constituents, is addressed later in its own section.

The new facilities under the Proposed Action handling radioactive materials with the potential to generate routine radioactive waste include:

- Livermore Nuclear Science Center;
- High Bay;
- Generic Laboratory for Experimental Physics
- HED Capability Support Facility Replacement;

- Experimental Synthesis/Chemistry Replacement Capability;
- Enhanced Capability at NIF;
- Future NIF Laser Expansion;
- Domestic Uranium Enrichment Program;
- Forensic Science Center;
- ES&H Analytical Laboratories Replacement; and
- Packaging and Transportation Safety and Operational Support Facility.

The projections for radioactive waste for the Proposed Action are described.

LLW. Under the Proposed Action, LLW would be generated within LLNL at the annual rate shown in Table 5-43. As with the discussion of waste streams in Section 5.13.1, the estimated generation rate is broken down into contributions from operations (routine category) and from construction and DD&D projects (nonroutine category). For a comparison baseline, the table also shows the corresponding waste generation rates from the No-Action Alternative. As indicated in Table 3-8, the estimate for the nonroutine LLW is not intended to reflect annual occurrences, as this quantity of waste would not be generated in all years. As discussed in Section 5.13.1, the nonroutine estimate provides a bounding value for this analysis.

Table 5-43. LLNL Generation of LLW Under the Proposed Action

LLW Category	No-Action Alternative (m^3/yr)	Proposed Action[a] (m^3/yr)	Percent Increase Over No-Action Alternative
Routine	850	1,000	18%
Nonroutine	4,000 - 8,000	7,000[b]	17%[c]
Total	**4,850 - 8,850**	**8,000**	**17%[d]**

m^3/yr = cubic meters per year
a. From Table 3-8.
b. Nonroutine LLW is average for the 2023 to 2035 period, with a range of 315 to 21,600 m^3/year.
c. Increase of 17% is compared to No-Action Alternative average of 6,000 m^3/year.
d. Increase of 17% is compared to No-Action Alternative average of 6,850 m^3/year.

As shown in Table 5-43, LLW would increase by 17 percent compared to the No-Action Alternative average quantities. The potential increase in non-routine waste generation should be seen in the context of a large decrease in long-term risks due to removal of legacy contaminated facilities and equipment. RHWM storage facilities have a combined capacity of 124,000 cubic feet or 3,520 cubic meters. This capacity would not accommodate the annual quantities of LLW at the highest projected generation rate, although the vast majority of non-routine DD&D waste would ship directly from the project site, and would not require storage at the RHWM facilities. NNSA estimates that under the Proposed Action, there would be as many 280 to 504 waste shipments per year to remove accumulations of LLW and MLLW (Table 3-8). If 300 of these shipments were dedicated to LLW and were evenly distributed through the year, the average volume of LLW accumulated in storage under the highest generation rate would be about 27 cubic meters, or less than 1 percent of the storage capacity.

It is possible that some of the additional LLW generated under the Proposed Action would be amenable to the limited types of treatment currently being performed by RHWM (per Section 4.13.1.1); that is, treatment processes used to put LLW into a form to meet offsite disposal criteria or to reduce volume. The large waste storage capacity would allow any such waste to be accumulated, if necessary, until onsite treatment capacity was available or until there was sufficient volume to perform an efficient treatment process.

Disposition of LLW generated under the Proposed Action would be the same as described for current operations: approximately 85 percent of the routine LLW and MLLW generated at the Livermore Site would be sent to the NNSS and 15 percent would be sent to Energy*Solutions,* while approximately 90 percent of the nonroutine LLW and MLLW would be sent to Energy*Solutions* and 10 percent to NNSS (Table 3-8). From 2015 through 2019, the NNSS disposed of an average of 997,000 cubic feet (NNSS 2015, 2016, 2017, 2018, 2019), or 28,200 cubic meters of LLW per year in its land-based disposal cells. Under the Proposed Action, the LLW contribution from LLNL (1,550 cubic meters) would be an increase over the No-Action Alternative average (1,322 cubic meters), and would account for approximately 5.5 percent of the average volume of LLW disposed of at NNSS. This increase would be minimal compared to the No-Action Alternative and likely unnoticeable to NNSS waste management operations, as it would be within normal fluctuations reported in NNSA's annual waste disposal records. From 2015 through 2019, the difference between the NNSS' highest and lowest LLW disposal years was more than 11,000 cubic meters.

The commercial facility, Energy*Solutions*, received an average of 3,420,000 cubic feet (96,800 cubic meters) of LLW per year facility during the five-year span from 2015 through 2019. There was a marked increase in the volume of LLW received in the last three years of that span, resulting in a three-year average of 4,750,000 cubic feet (134,000 cubic meters) per year (NRC 2020). In either case, the 6,450 cubic meters per year of LLW estimated under the Proposed Action would be less than 7 percent of the waste managed by the Energy*Solutions*' Utah facility.

As noted for the No-Action Alternative, relatively small amounts of LLW may also be sent to other offsite facilities such as Perma-Fix Environmental Services in Oak Ridge, Tennessee; Perma-Fix in Richland Washington; and Waste Control Specialists in Andrews County, Texas. These, or other offsite facilities, would only be utilized if they had appropriate permits/licenses and the capacity and capability to treat, store, and/or dispose of the specific LLW.

TRU and Mixed TRU Waste. LLNL generates TRU waste and, in smaller quantities, mixed TRU waste, but as described in more detail in the No-Action Alternative, "TRU waste" as used here is a combination of TRU and mixed TRU. Under the Proposed Action, it is estimated that TRU waste could be generated within LLNL at the annual rate shown in Table 5-44. The estimated generation rate is broken down into contributions from routine and nonroutine actions (as described previously), as well as totals. For a comparison baseline, the table also shows the corresponding waste generation rates from the No-Action Alternative. As indicated in Table 3-8, the estimate for the nonroutine TRU waste is not intended to reflect annual occurrences, as this quantity of waste would not be generated in all years. The value presented is intended to bound years when nonroutine activities with high TRU waste generating rates would occur.

Table 5-44. LLNL Generation of TRU Waste Under the Proposed Action

TRU Waste Category	No-Action Alternative[a] (m^3/yr)	Proposed Action[a] (m^3/yr)	Percent Increase Over No-Action Alternative
Routine	52.8	52.8	0%
Nonroutine	60.0	60.0 – 122.8	0% - 105%
Total	**112.8**	**112.8 – 175.6**	**0% - 56%**

m^3/yr = cubic meters per year
a. From Table 3-8. TRU and mixed TRU waste values from Table 3-8 are combined here for evaluation purposes.

As shown in Table 5-44, routine TRU waste would remain at the baseline rate and nonroutine TRU waste would range from the baseline rate to a 105 percent increase, with an overall total ranging from the baseline to a 56 percent increase over the baseline. RHWM would take management control of the containers of TRU waste it receives from generators and move the waste to one of its storage facilities. Once sufficient TRU waste was accumulated and verified to meet WIPP waste acceptance criteria, arrangements would be made to ship the waste to WIPP. NNSA estimates shipments to WIPP would occur up to eight (8) times per year under the Proposed Action (Table 3-8). With only two shipments per year, as much as 88 cubic meters could be in storage at the Livermore Site, which would represent less than three percent of the combined 3,520-cubic-meter maximum storage capacity in RHWM's permitted waste storage units. More frequent shipments to WIPP would decrease the storage capacity needed for TRU waste. The estimated quantity of TRU waste generated under the Proposed Action would have minimal effect on the storage capacity of RHWM waste management facilities.

LLNL's recently revised approach to managing TRU waste and certifying the waste for shipment to WIPP (described in more detail in Section 4.13.1.2) involves significant characterization equipment, personnel training, and, if needed, the ability to repackage waste. The highest TRU waste quantity expected under the Proposed Action is estimated at 56 percent higher than found in other reference documents (e.g., the 2005 SWEIS and 2011 SA), but the increase is attributed to nonroutine sources, so that high rate would not be expected to occur each year.

As described in more detail in Section 5.13.1.1, WIPP receives an average of approximately 3,800 cubic meters of TRU waste per year. The volume of TRU waste projected for the LLNL Proposed Action represents an increase over LLNL's past operations, but it would remain a small contributor to the total waste sent to WIPP (see Chapter 6 for a cumulative impact analysis of TR disposal at WIPP). The 112.8 to 175.6 cubic meters per year of TRU waste shown in Table 5-44 represents about three to five percent of the average annual waste sent to WIPP.

5.13.2.2 *Hazardous Waste*

Under the Proposed Action, hazardous waste would be generated within LLNL at the annual rate shown in Table 5-45. The generation rate is broken down into contributions from routine operations and from nonroutine construction and DD&D projects. For a comparison baseline, the table also shows the corresponding waste generation rates from the No-Action Alternative.

Table 5-45. LLNL Generation of Hazardous Waste Under the Proposed Action

Hazardous Waste Category	No-Action Alternative[a] (MT/yr)	Proposed Action[a] (MT/yr)	Percent Increase Over No-Action Alternative
Routine	510	510	0%
Nonroutine	1,700	1,700	0%
Total	**2,210**	**2,210**	**0%**

MT/yr = metric tons per year (Metric tons equals 1,000 kilograms. Metric tons multiplied by 1.1023 equals tons.)
a. From Table 3-8.

As shown in Table 5-45, the total volume of hazardous waste projected for the Proposed Action is the same as projected for the No-Action Alternative. Expected impacts would be the same as described for the No-Action Alternative in Section 5.13.1.2; that is, existing LLNL waste management units would have adequate capacity to handle the increased volume of hazardous waste and offsite commercial hazardous waste treatment/disposal facilities would continue to be used as the means of final disposition.

Explosive Wastes. NNSA is proposing to construct several high explosives infrastructure revitalization projects, including the DRDF laboratory, HEX, HE Manufacturing Incubator, HE Safety Facility, HEAF Modular Aging Facility, HEAF Dynamic Studies Facility, Weapons Environmental Testing Replacement Capability, Advanced 3D Hydrotest Facility, and Accelerator Bay and Support Bunker Expansion. At Site 300, where most of these facilities would be located, approximately 205,000 square feet of new HE-related facilities would be constructed. Currently, the HE-related facilities at Site 300 encompass approximately 125,000 square feet. Although operation of these projects would involve relatively small explosive weight limits, additional HE wastes would be generated. NNSA estimates that HE wastes could increase by approximately 100 percent. The discussion of existing hazardous waste activities presented in Section 4.13.2 includes descriptions of how explosive wastes are managed, stored, and treated within Site 300. The discussion identifies the explosive waste storage and treatment units included in the applicable hazardous waste permit (Table 4-33) and lists the maximum operating capacity for each unit as established in the permit. The same explosive waste management activities are expected to continue under the Proposed Action and within the established operating limits of the existing hazardous waste permit.

5.13.2.3 *Mixed Low-Level Radioactive Waste (MLLW)*

Under the Proposed Action, MLLW would be generated within LLNL at the annual rate shown in Table 5-46. The estimated generation rates include both routine MLLW quantities and nonroutine MLLW quantities, as well as totals. For a comparison baseline, the table also shows the corresponding MLLW generation rates from the No-Action Alternative. As indicated in a footnote to Table 3-8, the estimate for the nonroutine MLLW is not intended to reflect annual occurrences, as this quantity of waste would not be generated in all years. The value presented is intended to bound years when nonroutine activities with high MLLW generating rates would occur.

Table 5-46. LLNL Generation of Mixed Low-Level Waste Under the Proposed Action

MLLW Category	No-Action Alternative[a] (m^3/yr)	Proposed Action[a] (m^3/yr)	Percent Increase Over No-Action Alternative
Routine	88	88	0%
Nonroutine	725	3,170	337%
Total	**813**	**3,258**	**300%**

m^3/yr = cubic meters per year
a. From Table 3-8. Nonroutine value is an average for 2023 – 2035 period, with a range of 143 to 9,800 m^3/year.

As shown in Table 5-46, routine MLLW would not change compared to the No-Action Alternative, while nonroutine MLLW would increase by approximately 337 percent. A primary driver for the estimates of nonroutine MLLW is the potential to perform multiple major DD&D actions on inactive contaminated facilities. As with other waste categories, RHWM would take management control of containers of MLLW once generated and either move the waste to storage or ship the waste to an offsite treatment/disposal facility. If the MLLW were to be stored for an entire year, the space required for the largest projected quantity (i.e., 3,258 cubic meters) would equate to about 90 percent of the combined 3,521 cubic meters maximum storage capacity of RHWM's permitted waste storage units. Under the Proposed Action, combined LLW and MLLW offsite shipments are estimated to be 280 to 504 per year. Accordingly, accumulation periods for MLLW would be expected to be relatively short. If all MLLW accumulations were removed 50 times per years, MLLW storage requirements at the highest generation rate would be less than two percent of the capacity.

As with current operations, some MLLW generated under the Proposed Action would be amenable treatment in the DWTF. Many of the DWTF treatment units are intended for the treatment of aqueous wastewater solutions or to otherwise reduce the volume of waste requiring subsequent offsite treatment or disposal. As a result, the treatment process would often act to reduce demand on storage capacity or offsite treatment/disposal. Having adequate storage capacity to accumulate and stage waste for treatment unit processing should ensure that treatment capacity is not adversely impacted.

LLNL manages its MLLW by sending it to NNSS for disposal or to a commercial facility for treatment and/or disposal. Use of commercial facilities is limited to those able to show adequate capacity and compliance with applicable permitting and regulatory requirements. As noted in Section 4.13.3.2, commercial facilities recently used by LLNL for MLLW include the Energy*Solutions* facility in Utah and a Perma-Fix facility (specifically Diversified Scientific Services Inc. or DSSI) in Tennessee, which are described in Section 5.13.1.3.

As detailed in Section 5.13.1.3, the NNSS facility receives an average of 103,000 cubic feet of MLLW per year, and the Energy*Solutions* and Perma-Fix facilities receive about 185,000 and 19,100 cubic feet of hazardous waste per year, respectively. The Proposed Action's maximum MLLW generation rate of 3,258 cubic meters, or 115,100 cubic feet, per year would represent about 37 percent of the total volume sent to all three facilities. Other commercial treatment and/or disposal facilities are also available and would be considered as appropriate.

MLLW that might be generated at Site 300 is included in the estimated quantities addressed above. As noted in Section 4.13.3.1, however, should MLLW be generated at Site 300, RHWM would be required to take timely actions to get the waste shipped to an offsite facility or to be moved to the Livermore Site, as MLLW is not permitted for storage in the B883 CSA.

5.13.2.4 *Biohazardous/Medical Waste*

LLNL management of medical waste/biohazardous waste under the Proposed Action would remain unchanged from the existing operations described in Section 4.13.4. The same types and quantities of waste described in Table 4-35 would be generated and the same treatment alternatives, including several onsite processes and offsite incineration, would be available and used. LLNL would be subject to the same regulatory oversight, including onsite inspections by the oversight agency (Table 4-36).

New facilities with the potential to generate medical/biohazardous waste include:

- LVOC Advanced Biotechnology Research and Response Facility;
- Animal/Biosafety Level 3 Facility Replacement;
- Whole-Body Counting Support Facility;
- Animal Care Facility; and
- Forensic Science Center.

Some of these facilities are replacement facilities and the medical/biohazardous waste generated under the Proposed Action would remain unchanged from the No-Action Alternative.

5.13.2.5 *Other, Nonhazardous Solid Waste*

This section evaluates a nonhazardous solid waste category that combines municipal solid waste (Section 4.13.5.1) and construction and demolition waste (Section 4.13.5.2). As discussed for other waste types, routine and nonroutine segments are considered as being municipal solid waste and construction and demolition (C&D) waste, respectively. Under the Proposed Action, nonhazardous solid waste could be generated within LLNL at the annual rate shown in Table 5-47. For a comparison baseline, the table also shows the corresponding nonhazardous solid waste generation rates from the No-Action Alternative.

Table 5-47. LLNL Generation of Nonhazardous Solid Waste Under the Proposed Action

Nonhazardous Solid Waste Category	No-Action Alternative[a] (MT/yr)	Proposed Action[a] (MT/yr)	Percent Increase Over No-Action Alternative
Routine (Municipal Solid Waste)	3,050	3,400	11%
Nonroutine (Construction and Demolition Waste)	900 - 5,500	5,500	0 - 511%
Total	**3,950 - 8,550**	**8,900**	**4% to 125%**

MT/yr = metric tons per year (1 metric ton = 1,000 kilograms). Metric tons multiplied by 1.1023 equals tons.
a. From Table 3-8. Nonroutine DD&D wastes are average over the 2023 - 2035, with a range of 150-8,830 MT per year.

As shown in Table 5-47, routine nonhazardous solid waste would increase by 11 percent over the No-Action Alternative, while nonroutine nonhazardous solid waste could vary from no change to an increase of approximately 511 percent. The large range in nonroutine nonhazardous solid waste is a function of nonroutine C&D wastes, which can vary greatly from year to year.

The municipal solid waste segment is waste that is accumulated throughout the Livermore Site and manned areas of Site 300, and is routinely collected for transport to an offsite commercial landfill. Other than the accumulation bins and containers, there are no storage facilities for this waste and it is expected that existing bins and containers would be adequate for waste generated under the Proposed Action. C&D waste also has no designated storage areas. Such waste is typically accumulated at the construction or demolition site and periodically removed as needed. Accordingly, there are no onsite storage facilities for nonhazardous solid waste that would be overloaded by additional waste from the Proposed Action.

As described in Section 4.13.5, nonhazardous solid waste generated from within the Livermore Site is taken to either the Altamont Landfill or the Vasco Road Landfill. Nonhazardous solid waste generated at Site 300 generally goes through the Tracy Material Recovery and Transfer Station, but unrecovered waste may go to one of the same landfills. The maximum permitted throughput for the Altamont Landfill is 11,150 tons per day (CalRecycle 2020a). The maximum permitted throughput for the Vasco Road Landfill is 2,518 tons per day (CalRecycle 2020b). The Tracy Facility is permitted for material recovery/processing, composting, and waste transfer and its permitted maximum throughput is 1,800 tons per day (CalRecycle 2020c).

If it is assumed that the total nonhazardous solid waste associated with the Proposed Action is sent to an offsite landfill over five days per week, 50 weeks per year (i.e., 250 days per year), the average of 8,900 metric tons per year would equate to 36.6 metric tons (or 40.3 tons) per day. This daily amount of waste represents 0.36 percent of the Altamont Landfill's permit limit of 11,150 tons per day and 1.6 percent of the Vasco Road Landfill's permit limit of 2,518 tons per day. Also, as described in Section 4.13.5, LLNL diverts a significant portion of its nonhazardous solid waste from landfilling through various recycling or reuse efforts. During the past 10 years, more than 70 percent of both the municipal solid waste segment and the C&D segment have been diverted from landfill disposal. Accordingly, the actual amounts of waste that would go to either the Altamont or Vasco Road landfills should be lower than evaluated above.

A small portion of the LLNL nonhazardous solid waste generated at Site 300 could be processed at the Tracy Material Recovery and Transfer Station. That waste quantity would be small in comparison to its operating limit of that facility (1,800 tons per day).

5.13.2.6 *Hazardous Materials Management*

The Proposed Action would involve construction of new facilities (*see* Section 3.3), including some with new or expanded laboratory or research functions and, as a result, it is expected that the use and presence of hazardous materials at LLNL would increase. The additional hazardous materials would likely be the same or similar to materials already used within LLNL (Section 4.13.6); and any new hazardous materials would not be allowed onsite without appropriate equipment, facilities, procedures, and training necessary to safely manage those materials.

Livermore Site. The projected increase in hazardous materials associated with the Proposed Action was estimated in the same manner as described for the No-Action Alternative. That is, it is assumed that increases in hazardous materials would correspond to increases in the building area (square footage) of new or expanded laboratory or research functions. For example, a five percent increase in the laboratory or research building area over baseline facilities would include a five percent increase in hazardous materials. In this case the baseline includes the 3,530,000 square feet of existing laboratory or research facility square footage from Table 2-2 (as used in the No-Action Alternative evaluation) plus the 30,700 square feet of laboratory or research facilities associated with the No-Action Alternative (*see* Table 5-40). This total building area for the Proposed Action baseline can then be related to 115,000 chemical containers for existing actions (per Section 4.13.6) plus an increase of about 0.9 percent for the No-Action Alternative increases, for a total of about 116,000 chemical containers. Table 5-48 identifies facilities that would be constructed under the Proposed Action and which are described in Section 3.3 as involving expanded or new laboratory or research functions. New construction intended to replace existing facilities and functions, or that is limited to office space or administrative-type functions, is not included in the table.

Table 5-48. Expanded Laboratory/Research Functions at Livermore Site for the Proposed Action

Facility Designation	Area (square feet)	Increase to No-Action Alternative Facilities
Total R&D Facilities under the No-Action Alternative[a]	3,560,700	N/A
New Proposed Action facilities with expanded or new laboratory or research functions[b]	412,600	11.6%
Total R&D Facilities under the Proposed Action and Percentage Increase above the No-Action Alternative	**3,973,300**	**11.6%**

a. From Table 5-40.
b. Based on facilities described in Section 3.3.1, such as the Domestic Uranium Enrichment Program, Next Generation LEP R&D Component Fabrication Building, Livermore Nuclear Science Center, HEX, SMRDC, and others.

Consistent with information in Table 5-48 and the assumption that hazardous material usage is related to the size of laboratory and research facilities, it is estimated that the Livermore Site hazardous material usage under the Proposed Action could increase by 11.6 percent compared to the No-Action Alternative. As a result, approximately 129,500 chemical containers could be managed at the Livermore Site under the Proposed Action.

Site 300. The evaluation described above for the Livermore Site was repeated for Site 300. As a baseline for Site 300, Table 2-3 lists the key facilities within the site which total approximately 266,000 square feet (as was used in the No-Action Alternative). The baseline for the Proposed Action also includes the 850 square feet of laboratory or research facility associated with the No-Action Alternative (*see* Table 5-41). This Site 300 baseline building area is still associated with existing conditions of roughly 7,000 chemical containers (per Section 4.13.6) and the quantities of representative hazardous chemicals listed in Table 4-4. Table 5-49 identifies Site 300 facilities that would be constructed under the Proposed Action and which are described in Section 3.2.2 as involving expanded or new laboratory or research functions. New construction intended to replace existing facilities and functions, or that is limited to office space or administrative-type functions, is not included in the table.

Table 5-49. Expanded Laboratory/Research Functions at Site 300 for the Proposed Action

Facility Designation	Area (square feet)	Increase to No-Action Alternative Facilities
Total R&D Facilities under the No-Action Alternative[a]	266,000	N/A
New Proposed Action facilities with expanded or new laboratory or research functions[b]	145,000	54.5%
Total R&D Facilities under the Proposed Action and Percentage Increase above the No-Action Alternative	**411,000**	**54.5%**

a. From Table 5-41.
b. Based on facilities described in Section 3.3.1, such as the Dynamic Radiography Development Facility, HE Manufacturing Incubator (HEMI), and Advanced 3-D Hydrotesting Facility.

Consistent with information in Table 5-49 and the assumption that hazardous material usage is related to the size of facilities, it is estimated that Site 300's hazardous material usage under the Proposed Action would increase by 54.5 percent compared to the No-Action Alternative. It is expected that this estimated increase is conservatively high. This is because the increase is attributed primarily to functions in two new facilities (i.e., the DRDF and the Advanced 3-D Hydrotesting Facility) that would both involve heavy use of various electronic equipment to perform their intended functions and would not be expected to involve using or processing large volumes of hazardous materials.

Potential Impacts under the Proposed Action

The management of hazardous materials, either at the Livermore Site or Site 300, would not be directly affected by construction activities included in the Proposed Action. Typical construction activities would be expected to include hazardous materials (e.g., paints, thinners, cleaning solvents, adhesives, fuels, lubricants), but construction contractors would be responsible for management of those materials. This would include responsibility for bringing the materials onto the site; for their proper use and handling; and for removal and proper disposition of unused materials, residues, and wastes. LLNL's hazardous materials management system would not be involved and should not be adversely impacted by the actions.

Livermore Site. As shown in Table 5-50, it is estimated that the average inventory of hazardous materials managed within the Livermore Site could increase by 11.6 percent as a result of the new facilities that would be constructed under the Proposed Action. That is, for example, the 116,000 chemical containers that would be managed under the No-Action Alternative (Section 5.13.1.6) could increase to about 129,500 containers and each of the representative hazardous chemicals identified in Table 4-40 could have average quantities increased by roughly 12 percent (0.9 percent under the No-Action Alternative compounded by 11.6 percent under the Proposed Action). The hazardous chemicals from Table 4-40 are repeated in Table 5-50, along with recent daily average inventories and the average quantities that could occur under the Proposed Action. Table 5-50 lists representative hazardous chemicals managed at Livermore Site. The number of chemical containers managed would remain below past levels such as that described in the 2005 SWEIS, which was 166,000. These are representative numbers and not limits and additional analysis for site impacts have been handled at the facility level in Appendix C, Accident Analysis.

Table 5-50. Representative Hazardous Chemicals Managed at Livermore Site[a] and No-Action Alternative and Proposed Action Quantities

Chemical	Chemical Abstract Number	Average Daily Inventory (2/2018 to 2/2019)[b]	No-Action Alternative Projected Average Inventory	Proposed Action Projected Average Inventory	From 2019 California TRI (where available)[c]
Paints/Thinners					
Paint (variety)	Not Available	5,810 gal	5,870 gal	6,500 gal	
Thinner, lacquer	Not Available	60 gal	61 gal	67 gal	
Methylene chloride	75-09-2	500 gal	505 gal	560 gal	296,000 gal[d]
Methyl alcohol	67-56-1	470 gal	475 gal	530 gal	1,840,000 gal[d]
Acetone	67-64-1	820 gal	828 gal	920 gal	
Metals					
Lead and lead compounds	7439-92-1	750,000 lb	757,500 lb	844,000 lb	32,100,000 lb
Tantalum	7440-25-7	640 lb	646 lb	720 lb	
Boron, powder	7440-42-8	210 lb	212 lb	240 lb	
Aluminum	7429-90-5	320 lb	323 lb	360 lb	5,270,000 lb
Chrome or chromium	7440-47-3	1,090 lb	1,100 lb	1,230 lb	5,550,000 lb
Beryllium	7440-41-7	1,380 lb	1,394 lb	1,550 lb	
Copper, powder	7440-50-8	230 lb	232 lb	260 lb	10,100,000 lb
Nickel, powder	7440-02-0	280 lb	283 lb	320 lb	8,310,000 lb
Tungsten	7440-33-7	7,510 lb	7,585 lb	8,450 lb	
Acids/Bases/Oxidizers					
Oxygen, compressed	7782-44-7	50,000 ft^3	50,500 ft^3	56,200 ft^3	
Hydrogen peroxide <52%	7722-84-1	440 gal	444 gal	500 gal	
Ammonium hydroxide	1336-21-6	1,820 lb	1,838 lb	2,050 lb	
Sodium hydroxide	1310-73-2	320 lb	323 lb	360 lb	
Sulfuric acid	7664-93-9	10,000 lb	10,100 lb	11,200 lb	1,370,000 lb
Nitric acid	7697-37-2	6,070 gal	6,130 gal	6,830 gal	1,680,000 lb
Phosphoric acid	7664-38-2	120 gal	121 gal	140 gal	
Hydrofluoric acid	7664-39-3	450 lb	455 lb	510 lb	1,190,000 lb
Hydrochloric acid	7647-01-0	390 gal	394 gal	440 gal	455,000 gal[d]
Industrial Gases					
Argon, compressed	7440-37-1	160,000 ft^3	161,600 ft^3	180,000 ft^3	
Helium, compressed	7440-59-7	220,000 ft^3	222,200 ft^3	248,000 ft^3	
Hydrogen, compressed	1333-74-0	70,000 ft^3	70,700 ft^3	78,800 ft^3	
Nitrogen, compressed	7727-37-9	170,000 ft^3	171,700 ft^3	191,000 ft^3	
Carbon dioxide	124-38-9	110,000 ft^3	111,100 ft^3	124,000 ft^3	
Acetylene	74-86-2	16,000 ft^3	16,160 ft^3	18,000 ft^3	
Methane	74-82-8	8,000 ft^3	8,080 ft^3	9,000 ft^3	
Sulfur hexafluoride	2551-62-4	52,000 ft^3	52,520 ft^3	58,500 ft^3	
Refrigerants					
Freon 113	76-13-1	500 gal	505 gal	560 gal	
Refrigerant 123	306-83-2	4,740 gal	4,787 gal	5,330 gal	
Freon 22	75-45-6	210,000 ft^3	212,100 ft^3	236,000 ft^3	
Freon 11	75-69-4	1,030 gal	1,040 gal	1,160 gal	
Freon 12	75-71-8	22,000 ft^3	22,220 ft^3	24,800 ft^3	

Chemical	Chemical Abstract Number	Average Daily Inventory (2/2018 to 2/2019)[b]	No-Action Alternative Projected Average Inventory	Proposed Action Projected Average Inventory	From 2019 California TRI (where available)[c]
Freon 14	75-73-0	850 ft^3	858 ft^3	960 ft^3	
Refrigerant 134A	811-97-2	180,000 ft^3	181,800 ft^3	202,000 ft^3	

a. This list of representative chemicals was developed by starting with the corresponding list (groupings and individual chemicals) presented in the 2005 SWEIS in order to facilitate comparisons by readers. This list was then updated by removing chemicals no longer in the inventory, if any, and adding updated inventory quantities to those remaining. This listing was also updated with additional chemicals from the recent inventory which belonged in the same groupings and which were managed in similar quantities to those chemicals already in the applicable grouping. This listing is only intended to be representative of the great number of hazardous chemicals managed within the LLNL site.
b. The current inventory reference (i.e., LLNL 2019p) reports maximum (not shown here) and daily average inventory quantities for a year of record. Data in the reference was last updated February 5, 2019.
c. Source: USEPA 2021a. The online TRI database was queried for State of California, Facilities Summary, Waste Managed.
d. The "pound" values reported in the TRI database for methylene chloride, methyl alcohol, nitric acid, and hydrochloric acid were converted to "gallons" using density values of 11.1, 6.6, 11.8, and 9.9 pounds per gallon, respectively.

With respect to the hazardous chemicals in Table 5-50, in all but one instance, increasing the average values by approximately 12 percent would result in quantities well below the maximum inventory values shown in Table 4-40. These maximum levels represent a capacity of sorts in that the site has operated with these quantities on hand, so it is unlikely that physical capabilities would be overtaxed by the additional materials. The single instance where an increase in Table 5-50 average would cause the maximum to be exceed is the entry for lead. In this case, Table 4-40 shows the same value for both the maximum and average values indicating the same quantity of lead was onsite for the entire year of record. These are lead bricks or ingots being used for shielding or available for shielding. Because any shielding requirements for the new facilities would be part of their design, no storage capacity outside the new facilities would be needed.

Table 5-50 also presents quantities from USEPA's Toxics Release Inventory for the State of California for 2019. TRI data is presented in instances where the California TRI entries matched with Livermore Site representative materials. The TRI data is presented as a reference point, similar to its description in the 2005 SWEIS. The TRI numbers are not directly comparable to the Livermore Site numbers. The TRI entries represent quantities of hazardous materials released to the environment or dispositioned as waste through recycling, energy recovery, treatment or disposal, as reported by companies meeting certain size and function specifications. The Livermore Site numbers represent items in the site's materials inventory—in use or being held for future use. Hence, the California TRI numbers are much larger than any corresponding values for the Livermore Site. The total quantity of toxic materials (releases and wastes) identified in the TRI for California in 2019 is about 288 million pounds with only 1,192 reporting facilities (USEPA 2021c). For Alameda County, where the Livermore Site is located, the total quantity of toxic materials identified in the TRI is about 1.2 million pounds with 46 facilities reporting (USEPA 2021d). These numbers demonstrate that toxic or hazardous materials are used widely in industry and regionally in much larger quantities than within the Livermore Site.

Site 300. As indicate in Table 5-51, the quantity of hazardous materials managed within Site 300 could increase by 54.5 percent as a result of the new facilities that would be constructed under the Proposed Action. As indicated previously, it is likely that this estimated increase is high because of the nature of the new buildings driving the estimate. Other than shielding materials (e.g., lead) and possibly cooling materials neither of the facilities may require large quantities of hazardous materials. Using the estimated increase, the 7,000 chemical containers being managed within Site

300 (Section 4.13.6.2) could increase to about 10,815 containers and each of the representative hazardous chemicals identified in Table 4-41 could have average quantities increased by 54.5 percent. The increased number of chemical containers may be similar to, or even greater than the number managed at the time the 2005 SWEIS was prepared.

The hazardous chemicals from Table 4-41 are repeated in Table 5-51 along with recent daily average inventories and the average quantities that could occur under the Proposed Action. The tables show that Proposed Action quantities could exceed maximum values in Table 4-41.

Table 5-51. Representative Hazardous Chemicals Managed at Site 300[a] and No-Action Alternative and Proposed Action Quantities

Chemical	Chemical Abstract Number	Average Daily Inventory (12/2017 to 12/2018)[b]	No-Action Alternative Projected Average Inventory	Proposed Action Projected Average Inventory	From 2019 California TRI (where available)[c]
Paints/Thinners					
Paint (variety)	Not Available	225 gal	225 gal	350 gal	
Acetone	67-64-1	100 gal	100 gal	150 gal	
Metals					
Lead and lead compounds	7439-92-1	50,000 lb	50,150 lb	77,200 lb	32,100,000 lb
Acids/Bases/Oxidizers					
Oxygen, compressed	7782-44-7	4,000 ft^3	4,012 ft^3	6,180 ft^3	
Sulfuric acid	7664-93-9	760 lb	762 lb	1,170 lb	1,370,000 lb
Cyanuric acid	108-80-5	400 lb	401 lb	620 lb	
Ammonium nitrate	6484-52-2	500 lb	501 lb	770 lb	27,800,000 lb[d]
Industrial Gases					
Argon, compressed	7440-37-1	6,800 ft^3	6,820 ft^3	10,500 ft^3	
Helium, compressed	7440-59-7	193,000 ft^3	193,580 ft^3	298,000 ft^3	
Hydrogen, compressed	1333-74-0	240 ft^3	241 ft^3	370 ft^3	
Nitrogen, compressed	7727-37-9	185,000 ft^3	185,555 ft^3	286,000 ft^3	
Carbon dioxide	124-38-9	600 ft^3	602 ft^3	930 ft^3	
Acetylene	74-86-2	5,000 ft^3	5,015 ft^3	7,700 ft^3	
Methane	74-82-8	1,300 ft^3	1,304 ft^3	2,000 ft^3	
Refrigerants					
Freon 22	75-45-6	7,000 ft^3	7,021 ft^3	10,800 ft^3	
Freon 12	75-71-8	3,300 ft^3	3,310 ft^3	5,100 ft^3	
Freon 13	75-72-9	1,650 ft^3	1,655 ft^3	2,540 ft^3	
Explosives					
High explosives	Not Available	60,000 lb	60,180 lb	92,400 lb	

a. This list of representative chemicals was developed by starting with the corresponding list (groupings and individual chemicals) presented in the 2005 SWEIS in order to facilitate comparisons by readers. This list was then updated by removing chemicals no longer in the inventory, if any, and adding updated inventory quantities to those remaining. This listing was also updated with additional chemicals from the recent inventory which belonged in the same groupings and which were managed in similar quantities to those chemicals already in the applicable grouping. This listing is only intended to be representative of the great number of hazardous chemicals managed within Site 300.
b. The current inventory reference (i.e., LLNL 2019t) reports maximum (not shown here) and daily average inventory quantities for a year of record. Data in the reference was last updated December 21, 2018.
c. Source: USEPA 2021b. The online TRI database was queried for State of California, Facilities Summary, Waste Managed.
d. The TRI database item listed is less specific; it is for "nitrate compounds (water dissociable)."

As with the discussion of the Livermore Site, Table 5-51 also presents quantities from USEPA's Toxics Release Inventory (TRI) for the State of California for 2019 in instances where the California TRI entries matched with Site 300 representative materials. The TRI numbers are not directly comparable to the Site 300 numbers because they represent quantities of hazardous materials released to the environment or dispositioned as waste through recycling, energy recovery, treatment or disposal. The Site 300 numbers represent materials in inventory; in use or being held for future use. Hence, the California TRI data, though few in number, are much larger than any corresponding Site 300 values. The total quantity of toxic materials (releases and wastes) identified in the TRI for California in 2019 is about 288 million pounds with only 1,192 reporting facilities (USEPA 2021c). For San Joaquin County, where Site 300 is located, the total quantity of toxic materials identified in the TRI is about 3.3 million pounds with 42 facilities reporting (USEPA 2021e). These numbers demonstrate that toxic or hazardous materials are used widely in industry and regionally in much larger quantities than within Site 300.

5.13.2.7 *Radioactive Materials Management*

The discussion of radioactive materials management in Section 5.13.1.7 is also applicable to the Proposed Action and is not repeated here. For the Proposed Action, LLNL would continue to manage radioactive materials and conduct radiological operations at both the Livermore Site and Site 300 using existing facilities, No-Action Alternative facilities, and many of the Proposed Action projects identified in Section 3.3.2. Proposed Action projects that would manage/use radioactive materials are as follows:

- Livermore Nuclear Science Center
- High Bay
- Accelerator and Pulsed Power Laboratory
- HED Capability Support Facility Replacement.
- Experimental Synthesis/Chemistry Replacement Capability
- Detector Development High Bay
- Domestic Uranium Enrichment Program
- Classified Lab
- ES&H Analytical Laboratories Replacement
- Packaging and Transportation Safety and Operational Support Facility
- Whole-Body Counting Support Facility
- Increase in Administrative limits in Building 235
- Materials Analysis Laboratory
- Increase in Administrative limits in NIF

The potential impacts associated with the construction and operation of the new facilities that would manage/use radioactive materials are addressed in Sections 5.2 through 5.16 of this chapter. The more relevant sections for potential impacts from radioactive materials management are specified in Section 5.13.1.7.

5.13.2.8 *Explosives Materials Management*

The discussion of explosives materials management in Section 5.13.1.8 is also applicable to the Proposed Action and is not repeated here. For the Proposed Action, LLNL would continue to manage explosives materials and conduct explosives operations at both the Livermore Site and Site 300 using existing facilities, No-Action Alternative facilities, and the proposed "High Explosives Infrastructure Revitalization Projects" identified in Section 3.3.1.2 (e.g., Dynamic Radiography Development Facility [DRDF], HE Manufacturing Incubator [HEMI], HEAF Laboratory Capability Expansion [HEX], HE Safety Facility [HESF], HEAF Modular Aging Facility, HEAF Dynamic Studies Facility, Advanced 3D Hydrotest Facility, and the Accelerator Bay and Support Bunker Expansion). The potential impacts associated with the construction and operation of the new explosives-related facilities are addressed in Sections 5.2 through 5.16 of this chapter. The more relevant sections for potential impacts from explosives materials management are specified in Section 5.13.1.8.

5.13.3 Summary of Waste Management Impacts for the Alternatives

Both the No-Action Alternative and the Proposed Action would result in increases to quantities of waste produced and hazardous materials managed. Table 5-52 summarizes impacts of both alternatives.

Table 5-52. Waste Management and Material Management Impacts for the Alternatives

Metric	Current/ Existing Conditions[a]	2011 SA Projections	No-Action Alternative Projections	Proposed Action Projections
Waste Management				
Total LLW Generated	1,022 m^3/yr	1,560 m^3/yr	4,850 – 8,850 m^3/yr	8,000 m^3/yr average
Total TRU/Mixed TRU Waste Generated	8.02 m^3/yr	112.8 m^3/yr	112.8 m^3/yr	112.8 to 175.6 m^3/yr
Total Hazardous Waste Generated	269 MT/yr	2,210 MT/yr	2,210 MT/yr	2,210 MT/yr average
Total Mixed LLW Generated	207 m^3/yr	813 m^3/yr	813 m^3/yr	3,258 m^3/yr average
Total Nonhazardous Solid Waste Generated	3,350 MT/yr	Not estimated	3,950 to 8,550 MT/yr	8,900 MT/yr average
Medical Waste	13,000 lbs/yr	Not estimated	13,000 lbs/yr	13,000 lbs/yr
Hazardous Material Management				
Livermore Site	115,000 chemical containers	Not estimated	0.9% general increase in hazardous materials, 116,000 chemical containers	11.6% general increase in hazardous materials over No-Action Alternative, 129,500 chemical containers
Site 300	7,000 chemical containers	Not estimated	No increase in hazardous materials	54.5% general increase in hazardous materials over No-Action Alternative,

Metric	Current/ Existing Conditions[a]	2011 SA Projections	No-Action Alternative Projections	Proposed Action Projections
				10,815 chemical containers

m^3/yr = cubic meters per year; MT/yr = metric tons per year (1 metric ton = 1,000 kilograms)
For waste quantities, the "current/existing conditions" is the average annual waste production from 2010 through 2019.

5.14 HUMAN HEALTH

The analysis in this section presents the potential human health impacts for the alternatives due to construction, DD&D, modernization/upgrade/utility projects, and operations. Key metrics presented in the human health analysis are: (1) radiological doses and potential latent cancer fatalities (LCF) to the public and workers from normal operations; (2) occupational injuries/deaths to workers; and (3) health impacts to workers and the public from normal operations involving chemical and biological materials.

5.14.1 No-Action Alternative

Under the No-Action Alternative, the ongoing activities described in Chapter 2 and Chapter 4 would continue at LLNL. In addition, new facility construction, DD&D, and modernization/upgrade/utility projects described in Section 3.2 would also occur. There would also be operational changes (e.g., increases in the number of radiation workers and higher yield experiments at NIF) that could affect human health impacts. LLNL would continue to utilize ongoing health and safety measures in an Environmental Management System (EMS), Integrated Safety Management System (ISMS), Operational Health and Safety Management System (OHSMS), and Work Planning and Control (WP&C). These systems protect the health and safety of workers and the public, and preserve the quality of the human environment. LLNL would also continue to comply with applicable ES&H laws, regulations, and requirements, and other DOE and NNSA directives regarding occupational safety and health. The following sections discuss the potential impacts associated with the No-Action Alternative.

Radiological Impacts. It is anticipated that new facility construction activities would not occur in areas that would pose radiological risks to workers or the public. However, prior to construction, soils in construction areas would be sampled and tested for any contaminants. If any contamination is found, remediation of the area would be conducted prior to constriction. Consequently, construction activities should not result in any radiological health impacts to the public or workers.

A review of the facilities that could undergo DD&D under the No-Action Alternative (*see* Table 3-3) was conducted. Several facilities (most notably Buildings 251 and 280) have used or stored radiological materials and are known to contain residual contamination. Prior to the initiation of DD&D activities, LLNL would prepare a detailed DD&D plan for NNSA approval. The DD&D plan would contain a detailed description of the project-specific DD&D activities to be performed and would be sufficient to allow an independent reviewer to assess the appropriateness of the decommissioning activities; the potential impacts on the health and safety of workers, the public, and the environment; and the adequacy of the actions to protect health and safety and the environment.

For any facility that has used or stored radiological materials, there is a potential for residual contamination and the potential for radiological impacts to workers. DD&D planning would implement "as low as reasonably achievable" (ALARA) objectives[21] and follow radiological protection guidelines to ensure that radiation doses to workers are kept below administrative guidelines and that airborne releases, which could impact the public, are kept to ALARA levels. Lessons learned from DD&D at LLNL and other DOE sites would be applied to minimize impacts to workers.

LLNL's ALARA Policy

It is the policy of LLNL to plan and conduct its radiological activities in a manner that protects the health and safety of all its employees, contractors, the general public, and the environment. In achieving this policy, LLNL shall ensure that efforts are taken to reduce radiological exposures and releases to as low as reasonably achievable (ALARA), taking into account social, technical, economic, practical and public policy considerations. The Laboratory is committed to implementing a high-quality radiological control program that reflects this policy.

Source: LLNL 2017g.

Releases of radiological materials to the environment from LLNL operations are a source of radiation exposure to worker and individuals in the vicinity of LLNL. NNSA regulates the releases of radiological materials for its facilities and the potential level of radiation doses to workers and the public. Environmental radiation protection is currently regulated by DOE Order 458.1, which sets annual dose standards from routine DOE operations of 100 millirem per year through all exposure pathways to members of the public. The order requires that no member of the public receive an effective dose in a single year greater than 10 millirem from airborne emissions of radionuclides and four millirem from ingestion of drinking water. In addition, the dose requirements in 40 CFR Part 61, Subpart H, limit exposure to the MEI from all air emissions to 10 millirem per year.

Under normal operations, public radiation doses would occur from airborne releases (*see* Section 4.6.5), plus the radiation dose from neutron interaction with air (skyshine) above the roof of the NIF. Skyshine dose is the largest contributor to the MEI dose at the Livermore Site. Table 5-52 lists incremental radiation doses estimated for the public (offsite MEI and collective population dose) and corresponding incremental LCFs at the Livermore Site and Site 300.

As shown in Table 5-53, at both the Livermore Site and Site 300, the annual radiation dose to the offsite MEI would be much less than the limit of 10 millirem per year set by both the USEPA (40 CFR Part 61, Subpart H) and DOE (DOE Order 458.1) for airborne releases of radioactivity.[22] The risk of an LCF to the MEI from operations would be 2.4×10^{-6} per year at the Livermore Site and 1.0×10^{-10} per year at Site 300. The projected number of LCFs to the population within a 50-mile radius would be 3.6×10^{-4} at the Livermore Site and 3.0×10^{-8} at Site 300.

[21] Per DOE Order 458.1, ALARA is "an approach to radiation protection to manage and control releases of radioactive material to the environment, and exposure to the work force and to members of the public so that the levels are as low as is reasonably achievable, taking into account societal, environmental, technical, economic, and public policy considerations." ALARA is not a specific release or dose limit but a process which has the goal of optimizing control and management of releases of radioactive material to the environment and doses so that they are as far below the applicable limits of the Order as reasonably achievable.

[22] As discussed in footnote "b" in Table 5-53, skyshine doses are not covered by USEPA limits (40 CFR Part 61, Subpart H), but are limited by DOE Order 458.1, which sets annual dose standards from routine DOE operations of 100 millirem through all exposure pathways to members of the public.

Table 5-53. Annual Radiological Impacts to the Public from Operational Radiological Emissions under the No-Action Alternative at the Livermore Site and Site 300

Receptor/Dose/Risk	Baseline (Existing Environment)		No-Action Alternative	
	Livermore Site	Site 300	Livermore Site	Site 300
Offsite MEI[a]				
Dose (millirem)	4.004[b]	1.7×10^{-4}	4.01[b]	1.7×10^{-4}
LCF risk[c]	2.4×10^{-6}	1.0×10^{-10}	2.4×10^{-6}	1.0×10^{-10}
Population Within 50 Miles[d]				
Collective dose (person-rem)[e]	0.26	3.7×10^{-5}	0.60	5.0×10^{-5}
LCF[c]	1.6×10^{-4}	2.0×10^{-8}	3.6×10^{-4}	3.0×10^{-8}

a As discussed in Section 4.14.1, the MEI is a hypothetical individual located offsite who could potentially receive the maximum dose of radiation. The MEI at the Livermore Site is located at the Integrative Veterinary Care facility, about 35 meters outside the site's eastern perimeter. The MEI at Site 300 is located on the site's south-central perimeter, which borders the CSVRA.
b. Includes maximum of four mrem/year in skyshine dose from NIF operations (LLNL 2021c). Skyshine doses are not covered by USEPA limits (40 CFR Part 61, Subpart H), but are limited by DOE Order 458.1, which sets annual dose standards from routine DOE operations of 100 millirem through all exposure pathways to members of the public.
c. Based on an LCF risk estimate of 0.0006 LCF per rem or person-rem.
d. Based on projection of 8,364,520 people living within 50 miles of the Livermore Site in the year 2030 and 7,613,858 people living within 50 miles of Site 300 in the year 2030.
e. Skyshine would not increase the overall population dose because exposure to skyshine would be limited to close proximity to the Livermore Site boundary near the NIF. Skyshine estimates are based on shot yields totaling 1,245 megajoules per year, which is considered a NIF practical operational constraint that would not be exceeded under the No-Action Alternative (LLNL 2021f).

Source: LLNL 2020p, 2020r, 2021a, 2021c, 2021v.

Operations at LLNL (including accelerators, sealed sources, and other radiation-generating devices) can result in radiological doses to workers. The estimates of annual radiological doses to workers for the No-Action Alternative are provided in Table 5-54. As shown in the table, the annual doses to individual workers would be well below the DOE limit of 5,000 millirem (10 CFR Part 835). At LLNL, administrative control levels are multi-tiered, meaning they can vary between 500 millirem/year and up to 5,000 millirem/year with appropriate management approval (LLNL 2019w).

Under the No-Action Alternative, NNSA has estimated that worker dose at the Livermore Site would increase as a result of higher yield experiments at NIF. Currently, NIF has approximately 450 radiation workers, most of whom receive no measurable dose (*see* Table 4-47). As a result of higher yield experiments at NIF, NNSA is estimating that all 450 radiation workers at NIF would receive a measurable dose. For the 100 primary operations workers, a maximum dose of 600 millirem per year could result. For 350 non-primary operations workers, a dose of 100 millirem per year is estimated (LLNL 2021w).

Operations at LLNL may result in an average individual worker dose of approximately 180 millirem annually. The total annual collective dose to all LLNL radiological workers would be 103.5 person-rem under the No-Action Alternative. Statistically, a total annual dose of 103.5 person-rem would result in 0.06 LCFs annually to the LLNL radiological workforce.

Table 5-54. Annual Radiological Impacts to Workers from Operations under the No-Action Alternative at the Livermore Site and Site 300

Receptor/Dose/Risk	Baseline (Existing Environment) (includes workers at both the Livermore Site and Site 300)	No-Action Alternative (includes workers at both the Livermore Site and Site 300)
Radiological Workers		
Number of radiological workers who receive a measurable dose[a]	123	575
Average annual dose to radiological worker (millirem)	69.6	180
Average annual radiological worker risk (LCFs)	4.2×10^{-5}	1.1×10^{-4}
Collective annual dose to radiological workers (person-rem)	8.45	103.5
Total Annual Radiological Worker Risk (LCFs)[b]	**0.005**	**0.06**

LCF = latent cancer fatality.
a. Radiological worker is defined as a general employee whose job assignment involves operation of radiation producing devices or working with radioactive materials, or who is likely to be routinely occupationally exposed above 100 millirem per year.
b. Based on a LCF risk estimator of 0.0006 LCF per rem or person-rem.
Note: Annual doses to individual workers would be well below the DOE limit of 5,000 millirem (10 CFR Part 835). At LLNL, administrative control levels are multi-tiered, meaning they can vary between 500 millirem/year and up to 5,000 millirem/year with appropriate management approval (LLNL 2019w).
Source: LLNL 2021a, LLNL 2021w.

Nonradiological Hazards and Occupational Health Impacts. Construction, DD&D, and operational activities would have the potential to adversely impact workers, but, as explained in this section, offsite health effects are not expected. Potential human health impacts to workers were evaluated using Bureau of Labor Statistics (BLS) occupational injury/illness/fatality rates. Injury/illness/fatality rates at DOE/NNSA sites are historically lower than BLS values due to the increased focus on safety fostered by ongoing health and safety processes and requirements at LLNL (i.e., adherence to EMS, ISMS, EMS, OHSMS, and WP&C requirements). Consequently, the potential risk of occupational injuries/illnesses and fatalities to workers engaged in construction, DD&D, and operations at LLNL would be bounded by injury/illness and fatality rates for general industrial construction and general manufacturing operations.

Table 5-55 lists the potential estimates of injuries/illnesses and fatalities estimated in an average year for the No-Action Alternative. As shown in the table, in an average year, approximately 77.5 days of lost work from illness/injury and 0.15 fatality would be expected from LLNL operations under the No-Action Alternative. For illness/injury, this would represent an increase of 19.2 percent compared to the existing baseline. For fatalities, the increase would be 15.4 percent above the existing baseline. These increases are associated with increases in the construction/DD&D and operational workforces.

Table 5-55. Occupational Injury/Illness and Fatality Estimates at LLNL for Construction, DD&D, and Operations under the No-Action Alternative

Injury, Illness, and Fatality Categories	Baseline (Existing Environment)			No-Action Alternative			Percent Change versus Baseline[f]
	Construction and DD&D[c]	Operations[c]	Total	Construction and DD&D[d]	Operations[e]	Total	
Lost days due to injury/illness[a]	1.5	63.5	65.0	3.2	74.3	77.5	19.2%
Number of fatalities[b]	0.006	0.12	0.13	0.01	0.14	0.15	15.4%

a. Based on 152.6 injuries in California per 10,000 workers for construction/DD&D and 81.4 injuries in California per 10,000 workers for manufacturing (operations)
b. Based on 6.5 fatalities in California per 100,000 workers for construction/DD&D and 1.5 fatalities in California per 100,000 workers for manufacturing (operations).
c. Existing workforce of 7,909 workers is assumed to have 7,809 operational workers and 100 construction workers.
d. Based on 210 construction workers annually.
e. Based on 9,130 operational workers annually.
f. Percent change is presented for the "Total."
Source: BLS 2021.

Nonionizing Radiation and Radiation Generating Devices (RGD). LLNL utilizes many types of technologies that can generate both ionizing and nonionizing radiation, including x-ray machines, lasers and electron beam devices, and accelerators. Potential health impacts associated with nonionizing radiation are discussed below. Potential health impacts associated with ionizing radiation are included in the "Radiological Impacts" section.

Non-ionizing radiation refers to any type of electromagnetic radiation that does not carry enough energy to ionize living material, that is, to completely remove an electron from an atom. Because non-ionizing radiation has lower energy than ionizing radiation, it has fewer health risks than ionizing radiation. Technologies used at LLNL that generate non-ionizing radiation include lasers, microwave-generating and radiofrequency devices, technologies that generate ultraviolet radiation, video displays and instrumentation, welding, and security-related devices. Devices that generate nonionizing radiation are regulated by the U.S. Food and Drug Administration, while worker exposures are regulated by the Occupational Safety and Health Administration. Public exposures are not expected as any non-ionizing radiation generated by site operations are localized in nature. Devices that can generate larger amounts of non-ionizing radiation, such as some lasers, can cause eye injury to anyone who looks directly into the beam or its mirror reflection, or skin burns. Worker exposures could occur because of equipment failure, improper use of equipment, or non-adherence to procedures. Mitigation measures include regular equipment maintenance and inspections, use of design measures such as interlocks that prevent laser operation unless the enclosure is secured, and administrative controls and training. Workers who operate more powerful lasers are required to have an eye examination, complete a laser safety training course, and understand and follow applicable procedures.

A review of new No-Action Alternative facilities with potential RGD hazards includes Building 310 Non-Destructive Evaluation (NDE) Building. This facility would present mostly RGD hazards to workers and will include NDE inspection capabilities of less than one million electron volts (MeV). Worker hazards from these specialized low-energy NDE capabilities would be mitigated by shielding equipment and laboratories. Workers would follow appropriate safety procedures documented in work control documents.

Chemical Health Impacts. Workers would be protected from overexposure to hazardous chemicals by adherence to regulatory occupational standards that limit concentrations of potentially hazardous chemicals and implementation of EMS, ISMS, OHSMS, and WP&C to identify hazards and minimize potential impacts through controls. Active systems (e.g., electric, water, telecommunications) would be identified and deactivated, as appropriate. Adaptive reuse of such infrastructure would be considered, and recyclable materials would be sorted and managed separately, to the extent practicable.

A review of new facilities with potential chemical hazards includes the Applied Materials and Engineering (AME) Joining laboratory (B226). This facility would include vapor deposition and joining capability with associated materials hazards to workers. Another facility, the AME Polymers Laboratory (B223), would include plastics and polymer materials hazards to workers. Workers would follow appropriate safety procedures documented in work control documents.

For DD&D activities, all buildings and systems would require regulatory planning, document preparation, and characterization and deactivation before any DD&D activities would be allowed to commence. Facilities would be characterized to identify waste types (e.g., radiological and hazardous waste), construction material types (e.g., steel, roofing, concrete), presence of equipment, levels of contamination, expected waste volumes, and other information that would be used to support safe demolition and clarify requirements for developing facility-specific plans. Because of the age of some facilities that would undergo DD&D, regulated ACM may be present. Proper pre-demolition surveys would be conducted to identify any ACM present and all potential ACM in the facilities would be handled and disposed of according to applicable federal, state, and local regulations.

Overall site usage of chemicals would increase under the No-Action Alternative as activity levels increase at existing facilities and as new facilities are constructed and begin operation. As discussed in Section 5.13.2, the square footage associated with new facilities with expanded or new laboratory or research functions could increase by approximately 0.9 percent for the No-Action Alternative compared to existing operations at the Livermore Site. At Site 300, there would be no increase. However, no notable chemical-related health impacts are associated with normal operations at LLNL. Initial screens for the hazard analyses did not result in the identification of any additional controls necessary to protect the public from direct chemical exposures during normal operations. Facility design features that minimize worker exposures during facility operations act as defense-in-depth controls. In addition to these controls, worker protection is augmented by ISMS, EMS, OHSMS, a Worker Safety and Health Program, WP&C, chemical hygiene, industrial hygiene personnel monitoring, and emergency preparedness. Potential impacts from chemical accidents are presented in Section 5.16.

The new Central Maintenance Shop Facility would replace the aging maintenance shop, B511. The new shop would have mostly industrial and chemical hazards. The chemicals used in the facility include cleaning solvents, lubricants, and other industrial chemicals. Heavy maintenance equipment presents mostly industrial hazards. Workers would follow appropriate safety procedures documented in work control documents.

Biological Materials Health Impacts. The hazards associated with working with biological materials (agents) range from personal exposure to accidental environmental releases.[23] Biological agents are categorized into the following four risk groups (RGs) based on their relative risk to human health (LLNL 2019x):

- Risk Group 1 (RG1): Agents not associated with disease in healthy adult humans.
- Risk Group 2 (RG2): Agents associated with human disease that is rarely serious and for which preventive or therapeutic interventions are often available.
- Risk Group 3 (RG3): Agents associated with serious or lethal human disease for which preventative or therapeutic interventions may be available.
- Risk Group 4 (RG4): Dangerous and exotic agents that pose high individual risk of aerosol-transmitted laboratory infections and life-threatening disease that are frequently fatal, for which there are no vaccines or treatments; and related agents with unknown risk of transmission. [Note: LLNL does not work with RG4 agents].

Biosafety Level 1 (BSL-1) standard practices, safety equipment, and facility specifications are generally appropriate for undergraduate and secondary educational training and teaching laboratories and for other laboratories that work with defined and characterized strains of viable biological agents not known to consistently cause disease in healthy adult humans. Work is typically conducted on open bench tops using standard microbiological practices. Special containment equipment or facility design is not required nor generally used. Laboratory personnel have specific training in the procedures conducted in the laboratory and are supervised by a scientist with general training in microbiology or a related science.

Biosafety Level 2 (BSL-2) standard practices, safety equipment, and facility specifications are applicable to laboratories in which work is performed using a broad-spectrum of biological agents and toxins that are associated with causing disease in humans of varying severity. It differs in that laboratory personnel have specific training in handling pathogenic agents and are directed by competent scientists, access to the laboratory is limited when work is being conducted, extreme precautions are taken with contaminated sharp items, and certain procedures in which infectious aerosols or splashes may be created are conducted in biological safety cabinets or other physical containment equipment (NNSA 2002; DOE 2008). DOE has determined that operations involving BSL-1 and BSL-2 facilities would not result in significant impacts to workers or the public (10 CFR Part 1021, Subpart D, Appendix B). Consequently, the analysis in this section focuses on potential human health impacts from BSL-3 operations.

Biosafety Level 3 (BSL-3) standard practices, safety equipment, and facility specifications are applicable to laboratories in which work is performed using indigenous or exotic biological agents with a potential for respiratory transmission and those that may cause serious and potentially lethal infection. BSL-3 operations up to RG3 are conducted in the existing BSL-3 facility located at the Livermore Site. Under the No-Action Alternative, operations in the BSL-3 facility would continue at levels similar to current baseline levels.

[23] Potential impacts associated with accidental releases of biological materials are presented in Section 5.16.

The 1,500 square-foot BSL-3 facility has three BSL-3 lab rooms and is designed for a normal occupancy of up to six workers. All air-handling systems were designed as required by the Centers for Disease Control and Prevention (CDC) guidelines. Thus, the facility has a HEPA air filtration system, in which all laboratory room air passes through two HEPA filters in series before being vented outside. The efficiency of each filter is at least 99.97 percent for 0.3-micron particles (NNSA 2002). One room within the facility has a ventilated cage rack with negative-pressurized HEPA-filtered cages to hold up to 960 rodents. Further, the facility operates at negative air pressure (i.e., with an air pressure less than that of outside air, drawing air into the facility.). In the event of main power loss, a backup power (generator) system would enable workers to safely shut down any work occurring in the BSL-3 facility. In the event all power was lost, the air supply would shut down, and the laboratories should go to static air flow.

The CDC and National Institutes of Health (NIH) have established standards for operating BSL-3 labs. These require that before infectious microorganisms may be handled, a risk analysis must be prepared, and the local medical community informed of the agent, how to identify it, and treat its associated diseases. Prior to using a CDC designated select agent, the facility must register with the CDC and show it meets biosafety level requirements for working with that agent. Only personnel registered with the CDC may handle such agents. The CDC conducts periodic inspections of the facility operations every three years for the CDC site-registration and unannounced inspection between registration renewals. Under NIH regulations, operations at the BSL-3 laboratory would be conducted in accordance with guidance from the LLNL Institutional Biosafety Committee and approval of research protocols. The Institutional Biosafety Committee is constituted in accordance with the *NIH Guidelines for Researching Involving Recombinant or Synthetic Nucleic Acid Molecules* (NIH Guidelines) and the LLNL Institutional Biosafety Committee charter. Voting members of the Institutional Biosafety Committee, must comprise no fewer than five members so selected that they collectively have experience and expertise in recombinant or synthetic nucleic acid molecule technology and the capability to assess the safety of recombinant or synthetic nucleic acid molecule research and to identify any potential risk to public health or the environment. At least two members shall not be affiliated with the institution (apart from their membership on the Institutional Biosafety Committee) and who represent the interest of the surrounding community with respect to health and protection of the environment. Meetings are regularly attended by the DOE/NNSA Livermore Field Office personnel. All pathogen experiments must be first reviewed and approved by the Institutional Biosafety Committee.

The BSL-3 facility does not use radioactive materials, propellants, or HE materials, and the quantities of hazardous chemicals stored in the facility at any one given time are just a few liters each of chemical disinfectants (such as sodium hypochlorite) and biologic stabilizers (phenol). The facility also conducts periodic fumigation by LLNL facility staff using vaporous hydrogen peroxide as a fumigant. Chemicals such as paraformaldehyde are not stored in the facility but brought in only when required for fumigation by outside contractors for certification or repair of the biosafety cabinets.).

In general, personal exposure may result from the direct handling of biological materials which may enter the body, cause infection/intoxication, and result in an illness. Illness may occur from direct inhalation (however personnel wear a powered air purifying respirator (PAPR) with HEPA filtration which should prevent exposure from an accidental release outside of a containment device), ingestion, skin or parenteral contact through the mucous membranes and/or by indirect exposure from aerosol-generating equipment. The degree of exposure or injury will depend on the source, the individual's immune or health status, and the efficiency of transmission. Personal exposure may have benign results or may cause a disease requiring medical treatment. Personal injury may have benign results or may cause bodily harm (LLNL 2019x).

Workers are protected by a combination of microbiological safety practices, safety equipment acting as primary barriers, and facilities that provide secondary barriers to preclude contamination or infection by biohazardous material. In the 2002 BSL-3 EA (NNSA 2002), NNSA concluded the potential for injuries and illnesses involving routine laboratory operations presents a greater health risk to workers than does the potential for injury and illnesses associated with handling infectious substances. NNSA believes those conclusions remain valid today.

LLNL has more than 50 years of experience with biological research laboratories, including operation of the BSL-3 laboratory since January 2010. Prior to commencing operations in the BSL-3 facility, LLNL had operated BSL-1- and BSL-2-equivalent laboratories without any infections associated with their operation (NNSA 2002). Also, there were no unintentional releases to the environment or to the public associated with the LLNL biological research laboratories. LLNL has maintained a good track record of no infections associated with operations, and no unintentional releases to the environment or to the public (LLNL 2020z).

5.14.2 Proposed Action

Under the Proposed Action, the ongoing activities described in Chapter 2 and Chapter 4 would continue at LLNL. In addition, the Proposed Action includes the use of facilities and projects described for the No-Action Alternative, as well as new facility construction, modernization/upgrade/utility projects, operational changes, and DD&D activities described in Section 3.3, as well as operational workforce increases.

Radiological Impacts. As was discussed for the No-Action Alternative, it is anticipated that new facility construction activities would not occur in areas that would pose radiological risks to workers or the public. However, prior to construction, soils in construction areas would be sampled and tested for any contaminants. If any contamination is found, remediation of the area would be conducted prior to construction. Consequently, construction activities should not result in any radiological health impacts to the public or workers.

A review of new facilities with radiological hazards includes the Packaging and Transportation Safety and Operational Support Facility, ES&H Analytical Laboratory, Whole Body Counting Support Facility, Future NIF Laser Expansion, NIF Upgrades and Modernization, and HED Capability Support Facility Replacement. All these facilities present radiological hazards to workers. The facilities would conduct research experiments, transportation, and packaging with either remote operations or with appropriate controls to protect workers. The HED Capability Support Facility Replacement would replace B298 for target fabrication, target diagnostics, and optics. This facility would have a 16,000 Ci tritium limit for a radiological facility and a 1,500 Ci reservoir tritium limit. Tritium emissions would be similar to B298 (approximately 10 Ci/yr.). Radiological impacts to the public from all LLNL sources are presented in Table 5-56 below. Workers would follow appropriate safety procedures documented in work control documents.

A review of the facilities that could undergo DD&D under the Proposed Action (*see* Table 3-6) was conducted. Several facilities (most notably Buildings 294, 327, and 378) have used or stored radiological materials and could contain residual contamination. Prior to the initiation of DD&D activities, LLNL would prepare a detailed DD&D plan for NNSA approval. The DD&D plan would contain a detailed description of the project-specific DD&D activities to be performed and would be sufficient to allow an independent reviewer to assess the appropriateness of the decommissioning activities; the potential impacts on the health and safety of workers, the public, and the environment; and the adequacy of the actions to protect health and safety and the environment. As was discussed for the No-Action Alternative, DD&D planning would implement ALARA objectives and follow radiological protection guidelines to ensure that radiation doses to workers are kept below administrative guidelines and that airborne releases, which could impact the public, are kept to ALARA levels.

As was true for the No-Action Alternative, under normal operations, public radiation doses would occur from airborne releases, plus the radiation dose from neutron interaction with the atmosphere (skyshine) above the roof of the NIF. Under the Proposed Action, skyshine dose would remain the largest contributor to the MEI dose at the Livermore Site. Table 5-56 lists incremental radiation doses estimated for the public (offsite MEI and collective population dose) and corresponding incremental LCFs at the Livermore Site and Site 300.

As shown in Table 5-56, at both the Livermore Site and Site 300, the annual radiation dose to the offsite MEI would be much less than the limit of 10 millirem per year set by both the USEPA (40 CFR Part 61, Subpart H) and DOE (DOE Order 458.1) for airborne releases of radioactivity.[24] The risk of an LCF to the MEI from operations would be 2.5×10^{-6} per year at the Livermore Site and 1.0×10^{-10} per year at Site 300. The projected number of LCFs to the population within a 50-mile radius would be 4.3×10^{-3} at the Livermore Site and 3.0×10^{-8} at Site 300.

[24] As discussed in footnote "b" in Table 5-52, skyshine doses are not covered by USEPA limits (40 CFR Part 61, Subpart H), but are limited by DOE Order 458.1, which sets annual dose standards from routine DOE operations of 100 millirem through all exposure pathways to members of the public.

Table 5-56. Annual Radiological Impacts to the Public from Operations under the Proposed Action at the Livermore Site and Site 300

Receptor/Dose/Risk	No-Action Alternative		Proposed Action	
	Livermore Site	Site 300	Livermore Site	Site 300
Offsite MEI[a]				
Dose (millirem)	4.01[b]	$1.7×10^{-4}$	4.21[b]	$1.7×10^{-4}$
LCF risk[c]	$2.4×10^{-6}$	$1.0×10^{-10}$	$2.5×10^{-6}$	$1.0×10^{-10}$
Population Within 50 Miles[d]				
Collective dose (person-rem)[e]	0.60	$5.0×10^{-5}$	7.1	$5.0×10^{-5}$
LCF[c]	$3.6×10^{-4}$	$3.0×10^{-8}$	$4.3×10^{-3}$	$3.0×10^{-8}$

a. As discussed in Section 4.14.1, the MEI is a hypothetical individual located offsite who could potentially receive the maximum dose of radiation. The MEI at the Livermore Site is located at the Integrative Veterinary Care facility, about 35 meters outside the site's eastern perimeter. The MEI at Site 300 is located on the site's south-central perimeter, which borders the CSVRA.
b. Includes maximum of four mrem/year in skyshine dose from NIF operations (LLNL 2021c). Skyshine doses are not covered by USEPA limits (40 CFR Part 61, Subpart H), but are limited by DOE Order 458.1, which sets annual dose standards from routine DOE operations of 100 millirem through all exposure pathways to members of the public.
c. Based on an LCF risk estimate of 0.0006 LCF per rem or person-rem.
d. Based on projection of 8,364,520 people living within 50 miles of the Livermore Site in the year 2030 and 7,613,858 people living within 50 miles of Site 300 in the year 2030.
e. Skyshine would not increase the overall population dose because exposure to skyshine would be limited to close proximity to the Livermore Site boundary near the NIF. Skyshine estimates are based on shot yields totaling 1,245 megajoules per year, which is considered a NIF practical operational constraint that would not be exceeded under the Proposed Action (LLNL 2021f).
Source: LLNL 2020p, 2021a, 2021c, 2021v.

In comparing the Proposed Action against the No-Action Alternative, the MEI and public dose at Site 300 would be the same for both the Proposed Action and the No-Action Alternative. This is due to the fact that the estimated radiological air emissions from Site 300 activities would be the same under both alternatives. In contrast, at the Livermore Site, the public doses would be higher for the Proposed Action (7.1 person-rem) than under the No-Action Alternative (0.60 person-rem). This is largely due to the proposal described in Section 3.3.3 to increase the tritium emissions limits at the NIF (Buildings 581–582) and the Tritium Facility (Building 331). Under that proposal, annual tritium emissions from the Tritium Facility could increase from 210 curies to 2,000 curies tritium, and annual tritium emission from the NIF could increase from 80 curies to 1,600 curies.[25] The tritium emission increases would occur as a result of the need to support NIF's Stockpile Stewardship and National Security missions as well as basic science investigations.

While the increase in the tritium emissions limits at the NIF and the Tritium Facility could also increase the MEI dose for the Proposed Action compared to the No-Action Alternative at the Livermore Site, that increase is minimized by the fact that skyshine dose accounts for approximately 99 percent of the MEI dose for the No-Action Alternative and 95 percent of the MEI dose for the Proposed Action. As a result of the proposed increases in tritium emissions, the annual MEI dose would increase from 4.01 millirem to 4.21 millirem, an insignificant increase. The projected number of LCFs to the population within a 50-mile radius would be $4.3×10^{-3}$ at the Livermore Site and $3.0×10^{-8}$ at Site 300.

With regard to workers, Table 5-57 presents the estimates of annual radiological doses for the Proposed Action. As shown in the table, the annual doses to individual workers would be well

[25] Actual operational emissions from the Tritium Facility and NIF are not expected to increase; however, the use of tritium reservoirs with substantially greater amounts of tritium could result in the potential for greater tritium releases from routine operations with these reservoirs. Although the potential for higher discharges is greater (within limits identified above), the facilities would continue to operate engineered systems that have proven to be highly effective at capturing tritium emissions.

below the DOE limit of 5,000 millirem (10 CFR Part 835). At LLNL, administrative control levels are multi-tiered, meaning they can vary between 500 millirem/year and up to 5,000 millirem/year with appropriate management approval (LLNL 2019w).

Table 5-57. Annual Radiological Impacts to Workers from Operations under the Proposed Action at the Livermore Site and Site 300

Receptor/Dose/Risk	No-Action Alternative (includes workers at both the Livermore Site and Site 300)	Proposed Action (includes workers at both the Livermore Site and Site 300)
Radiological Workers		
Number of radiological workers who receive a measurable dose[a]	575	615
Average annual dose to radiological worker (millirem)	180	173.5[c]
Average annual radiological worker risk (LCFs)[b]	1.1×10^{-4}	1.1×10^{-4}
Collective annual dose to radiological workers (person-rem)	103.5	106.7
Total Annual Radiological Worker Risk (LCFs)[b]	**0.06**	**0.06**

LCF = latent cancer fatality.

a. Radiological worker is defined as a general employee whose job assignment involves operation of radiation producing devices or working with radioactive materials, or who is likely to be routinely occupationally exposed above 100 millirem per year.

b. Based on a LCF risk estimator of 0.0006 LCF per rem or person-rem.

c. The increase in worker dose under the under the Proposed Action is due to the Next Generation LEP R&D Component Fabrication Building, the Domestic Uranium Enrichment Program, and sample preparation work in Building 235. For operations associated with the Next Generation LEP R&D Component Fabrication Building and the Domestic Uranium Enrichment Program NNSA has estimated that approximately 25 additional workers could receive an average annual dose of approximately 70 millirem per year. For Building 235 operations, NNSA has estimated that approximately 15 workers would receive a measurable dose of approximately 100 mrem/year.

Note: Annual doses to individual workers would be well below the DOE limit of 5,000 millirem (10 CFR Part 835). At LLNL, administrative control levels are multi-tiered, meaning they can vary between 500 millirem/year and up to 5,000 millirem/year with appropriate management approval (LLNL 2019w).

Source: LLNL 2021a, LLNL 2021w.

The increase in worker dose under the under the Proposed Action is due to the Next Generation LEP R&D Component Fabrication Building, the Domestic Uranium Enrichment Program, and sample preparation work in Building 235. For operations associated with the Next Generation LEP R&D Component Fabrication Building and the Domestic Uranium Enrichment Program NNSA has estimated that approximately 25 additional workers could receive an average annual dose of approximately 70 millirem per year. For Building 235 operations, NNSA has estimated that approximately 15 workers would receive a measurable dose of approximately 100 mrem/year. This is an addition to the No-Action Alternative doses (described above).

Overall, operations at LLNL would result in an average individual worker dose of approximately 173.5 millirem annually. The total annual collective dose to all LLNL radiological workers would be 107.7 person-rem under the Proposed Action. Statistically, a total annual dose of 106.7 person-rem would result in 0.06 LCFs annually to the LLNL radiological workforce.

Nonradiological Hazards and Occupational Health Impacts. Construction, DD&D, and operational activities would have the potential to adversely impact workers, but, as explained in this section, offsite health effects are not expected. Potential human health impacts to workers were evaluated using BLS occupational injury/illness/fatality rates. Injury/illness/fatality rates at DOE/NNSA sites are historically lower than BLS values due to the increased focus on safety fostered by ongoing health and safety processes and requirements at LLNL (i.e., adherence to EMS, ISMS, EMS, OHSMS, and WP&C requirements). Consequently, the potential risk of occupational injuries/illnesses and fatalities to workers engaged in construction, DD&D, and operations at LLNL would be bounded by injury/illness and fatality rates for general industrial construction and general manufacturing operations.

Table 5-58 lists the potential estimates of injuries/illnesses and fatalities estimated in an average year for the Proposed Action. As shown in the table, in an average year, approximately 92.5 days of lost work from illness/injury and 0.18 fatality would be expected from LLNL operations under the Proposed Action. For illness/injury, this would represent an increase of 19.3 percent compared to the No-Action Alternative. For fatalities, the increase would be 20.0 percent above the No-Action Alternative. These increases are largely associated with increases in the construction/DD&D workforce.

Table 5-58. Occupational Injury/Illness and Fatality Estimates at LLNL for Construction, DD&D, and Operations under the Proposed Action

Injury, Illness, and Fatality Categories	No-Action Alternative			Proposed Action			Percent Change versus No-Action Alternative[f]
	Construction and DD&D[c]	Operations[c]	Total	Construction and DD&D[d]	Operations[e]	Total	
Lost days due to injury/illness[a]	3.2	74.3	77.5	10.7	81.8	92.5	19.3%
Number of fatalities[b]	0.01	0.14	0.15	0.03	0.15	0.18	20.0%

a. Based on 152.6 injuries in California per 10,000 workers for construction/DD&D and 81.4 injuries in California per 10,000 workers for manufacturing (operations).
b. Based on 6.5 fatalities in California per 100,000 workers for construction/DD&D and 1.5 fatalities in California per 100,000 workers for manufacturing (operations).
c. No-Action Alternative workforce would have 210 construction workers and 9,130 operational workers annually.
d. Based on 700 construction workers annually.
e. Based on 10,050 operational workers annually.
f. Percent change is presented for the "Total."
Source: BLS 2021.

Nonionizing Radiation and Radiation Generating Devices (RGD). Under the Proposed Action, the following new facilities would include operations involving x-rays machines, lasers and electron beam devices, or accelerators:

- Livermore Nuclear Science Center: would utilize a high-intensity pulsed beam mono-energetic neutron source;
- New High Bay: RGDs would be used for radiography and testing operations;
- Dynamic Radiography Development Facility: would utilize an accelerator and/or NIF-like laser-based application technologies;
- Advanced 3D Hydrotest Facility: would include radiographic facilities using the N-pulse (20 pulses per 10 nanoseconds) solid-state driven 8-10 MeV linear accelerator;
- Accelerator Bay and Support Bunker Expansion: would include radiographic facilities using a linear accelerator.

- Accelerator and Pulsed Power Laboratory: would utilize RGDs that involve electron accelerators;
- Domestic Uranium Enrichment Program: would utilize laser-based technologies;
- Replacement Animal Care Facility: CT imager, x-ray machine;
- SMRDC: would include operations involving RGDs and x-rays;
- NDE Stockpile Test and Evaluation Capability Expansion: would use low-energy RGD equipment similar to B327 operations; and
- HED Capability Support Facility Replacement: would have HED equipment.

Potential health impacts associated with nonionizing radiation would be similar to the discussion under the No-Action Alternative. Potential health impacts associated with ionizing radiation are included in the Radiological Impacts section.

Chemical Health Impacts. As was true for the No-Action Alternative, workers would be protected from overexposure to hazardous chemicals by adherence to regulatory occupational standards that limit concentrations of potentially hazardous chemicals and implementation of EMS, ISMS, OHSMS, and WP&C to identify hazards and minimize potential impacts. All buildings and systems would require regulatory planning, document preparation, and characterization and deactivation before any DD&D activities would be allowed to commence. Facilities would be characterized to identify waste types (e.g., radiological and hazardous waste), construction material types (e.g., steel, roofing, concrete), presence of equipment, levels of contamination, expected waste volumes, and other information that would be used to support safe demolition and clarify requirements for developing facility-specific plans.

Active systems (e.g., electric, water, telecommunications) would be identified and deactivated, as appropriate. Adaptive reuse of such infrastructure would be considered, and recyclable materials would be sorted and managed separately, to the extent practicable. Because of the age of some facilities that would undergo DD&D, regulated ACM may be present. Proper pre-demolition surveys would be conducted to identify any ACM present and all potential ACM in the facilities would be handled and disposed of according to applicable federal, state, and local regulations.

Overall site usage of chemicals would increase under the Proposed Action as activity levels increase at existing facilities and as new facilities are constructed and begin operation. As discussed in Section 5.13.2, the square footage associated with new facilities with expanded or new laboratory or research functions could increase by approximately 5.3 percent for the Proposed Action compared to No-Action Alternative operations at the Livermore Site. At Site 300, the square footage associated with new facilities with expanded or new laboratory or research functions could increase by approximately 56 percent for the Proposed Action compared to No-Action Alternative operations. However, no notable chemical-related health impacts are associated with normal (accident-free) operations at LLNL. Initial screens for the hazard analyses did not result in the identification of any controls necessary to protect the public or workers from direct chemical exposures during normal operations. Facility design features that minimize worker exposures during facility operations act as defense-in-depth controls. In addition to these controls, worker protection is augmented by ISMS, EMS, OHSMS, a Worker Safety and Health Program, WP&C, chemical hygiene, industrial hygiene personnel monitoring, and emergency preparedness. Potential impacts from chemical accidents are presented in Section 5.16.

A review of new facility includes the Experimental Synthesis/Chemistry Replacement Capability, Packaging and Transportation Safety and Operational Support Facility, LVOC Advanced Biotechnology Research and Response Facility, ES&H Analytical Laboratories Replacement, and Forensic Science Center present chemical hazards to workers and the public. Another facility, the Micro/Nano Technology Laboratory Facility would present chemical and other nano materials hazards. Workers would follow appropriate safety procedures documented in work control documents. Any potential release of materials to the public would be controlled by use of chemical fume hoods with appropriate filtrations. Accident releases would be bounded by the analysis in Accident section.

Biological Materials Health Impacts. The potential human health impacts associated with working with biological materials (agents) would be the same as presented in Section 5.14.1. The Proposed Action includes a replacement facility for the aging A/BSL-3 facility, which would utilize similar biological agents up to RG3 and would employ more current enhanced safety design and operational features than the current BSL-3 facility to continue to prevent and minimize releases and exposures to biological agents. The facility would include modernized safety equipment, and additional storage and lab space that houses sufficient containment devices for specialized scientific equipment to minimize equipment decontamination and movement out of the laboratory and efficient workflow. The current space doesn't allow for all of the scientific equipment needed to be located into the BSL-3, which means a lot of movement of equipment in and out of the facility. Additionally, operations would continue to be conducted in accordance with all applicable CDC and NIH standards. Lastly, under NIH regulations, operations at the A/BSL-3 laboratory would be conducted in accordance with research approval and guidance from the LLNL Institutional Biosafety Committee.

A review of new facilities includes the LVOC Biotechnology Research and Response Facility and the Forensics Science Center. These facilities would handle small quantities of biological materials and would not result in releases to the environment. The Forensic Science Center would handle small quantities of CBRNE materials, and all work would be done in fume hoods and biosafety cabinets. Workers would follow appropriate safety procedures documented in work control documents.

5.14.3 Summary of Human Health Impacts for the Alternatives

Table 5-59 summarizes the potential human health impacts for the No-Action Alternative and the Proposed Action.

Table 5-59. Potential Human Health Impacts for the Alternatives

Resource/Metric	Baseline (Existing Environment)		No-Action Alternative		Proposed Action	
	Livermore Site	Site 300	Livermore Site	Site 300	Livermore Site	Site 300
MEI Risk (LCF)	2.4×10^{-6}	1.0×10^{-10}	2.4×10^{-6}	1.0×10^{-10}	2.5×10^{-6}	1.0×10^{-10}
Population Risk (LCF)	1.6×10^{-4}	2.0×10^{-8}	3.6×10^{-4}	3.0×10^{-8}	4.3×10^{-3}	3.0×10^{-8}
Collective annual dose to radiological workers (person-rem)	8.45		103.5		106.7	
Total Annual Radiological Worker Risk (LCFs)	0.005		0.06		0.06	
Lost days due to injury/illness per year	65.0		77.5		92.5	
Number of occupational fatalities per year	0.13		0.15		0.18	

5.15 ENVIRONMENTAL REMEDIATION

5.15.1 No-Action Alternative

Under the No-Action Alternative, the ongoing activities described in Chapter 2 and Chapter 4 would continue at LLNL. In addition, the new facility construction, modernization/upgrade/utility projects, operational changes, and DD&D activities described in Section 3.3 would occur. With regard to remediation activities, NNSA complies with provisions specified in FFAs (DOE 1988; DOE 1992c) DOE entered into with USEPA, the California EPA Department of Health Services (now DTSC), and the San Francisco Bay and Central Valley Regional Water Quality Control Board. Any future remediation actions would be conducted in accordance with the FFAs, and NNSA is not proposing any specific future remediation activities in this SWEIS. However, new actions are anticipated based on current and future remedial investigations/feasibility studies (RI/FS) and the potential for encountering unknown contamination during construction and other activities.

The Livermore Site and Site 300 are both CERCLA Superfund Sites with known historical environmental impacts. Both sites have existing environmental requirements under applicable environmental laws. Although DOE/LLNL has conducted extensive characterization of historical environmental impacts, there is potential for encountering previously unknown impacts during site development efforts. DOE/LLNL has an existing process for conducting environmental investigations prior to the initiation of construction projects to identify these potential liabilities. If environmental impacts are identified during site development activities, DOE/LLNL will follow existing agreements with the regulatory agencies, including the FFAs, to take appropriate actions to minimize human health and ecological risks. The actual design and construction of any proposed new structures will be reviewed to ensure that impacts to existing CERCLA environmental restoration program monitoring and remediation operations, including groundwater treatment facilities and infrastructure and current and potential future cleanup activities and meeting of milestones are not negatively impacted.

Planned remediation of groundwater and soil contamination at both the Livermore Site and Site 300 would also continue, as described in Section 4.15. LLNL's cleanup remedies at both the Livermore Site and Site 300 are designed and implemented to achieve the goals of reducing risks and hazards to human health and the environment and satisfying regulatory remediation action objectives, meeting cleanup standards for chemicals and radionuclides in water and soil, and preventing contaminant migration in groundwater to the extent technically and economically feasible (LLNL 2019f, 2020r). Since remediation efforts began at the Livermore Site in 1989, more than 6.3 billion gallons of groundwater and approximately 34 million cubic yards of soil vapor have been treated, removing about 7,400 pounds of VOCs (LLNL 2020r).

At Site 300, approximately 460 million gallons of groundwater and 46 million cubic yards of soil vapor have been treated, resulting in removal of approximately 1,400 pounds of VOCs, 3.7 pounds of perchlorate, 44,000 pounds of nitrate, 5.9 pounds of RDX, 21 pounds of silicone oils, and 0.019 pounds of uranium since groundwater remediation began in 1990. At both sites, groundwater concentration data indicate declines in contaminant concentrations in 2018 and progress toward off-site and on-site plume and source area cleanup. Tritium in groundwater continues to decay on-site, reducing tritium activities in groundwater (LLNL 2020r).

Under the No-Action Alternative, NNSA would continue to utilize ISMS, EMS, OHSMS, a Worker Safety and Health Program, and WP&C to ensure operations are conducted in a manner that protects the health and safety of workers and the public, preserves the quality of the environment, and prevents property damage. NNSA would also continue to comply with applicable ES&H laws, regulations, and requirements, and the FFAs applicable to LLNL. NNSA expects that remediation efforts and natural attenuation would continue to reduce the contamination concentrations in both soils and groundwater at the Livermore Site and Site 300. Remediation efforts would continue to employ cleanup workers and generate hazardous and nonhazardous wastes that would be managed by the LLNL waste management system. NNSA does not expect any activities associated with the No-Action Alternative to complicate or delay any of the monitoring or cleanup activities at the Livermore Site or Site 300.

5.15.2 Proposed Action

Under the Proposed Action, the ongoing activities described in Chapter 2 and Chapter 4 would continue at LLNL, and the activities associated with the No-Action Alternative would occur. In addition, the new facility construction, modernization/upgrade/utility projects, operational changes, and DD&D activities described in Section 3.3 would occur. As discussed in Section 5.15.1, with regard to remediation activities, NNSA complies with provisions specified in the FFAs. Any future remediation actions would be conducted in accordance with the FFAs, and NNSA is not proposing any specific future remediation activities in this SWEIS. Because the remediation efforts associated with the Proposed Action would be the same as under the No-Action Alternative, the discussion in Sections 5.15.1 applies equally to the Proposed Action and is not repeated.

5.16 ACCIDENT ANALYSIS AND INTENTIONAL DESTRUCTIVE ACTS

5.16.1 Introduction

NEPA requires that an agency evaluate reasonably foreseeable adverse effects on the human environment in an EIS. This LLNL SWEIS informs the decisionmaker and the public about the chances that reasonably foreseeable accidents could occur, as well as the potential adverse consequences. An accident is considered bounding if no reasonably foreseeable accident can be found with greater consequences. An accident is reasonably foreseeable if the analysis of occurrence is supported by credible scientific evidence, is not based on pure conjecture, and is within the rule of reason (40 CFR 1502.21[d]; DOE Order 458.1; DOE-STD-1020-2016).

As described in Chapter 2, many research activities at LLNL require the use of radioactive materials, hazardous chemicals, explosives and biological hazards, all of which have the potential, under certain circumstances, to be involved in an accident. These materials are received at the sites, transferred on site, and often shipped off site. Activities using these materials onsite involve specialized facilities with appropriate safety equipment and procedures to reduce the possibility or the severity of accidents. Many of these specialized facilities are described in Section 2.2.

An accident is a sequence of one or more unplanned events with potential outcomes that endanger the health and safety of workers and the public. An accident can involve a combined release of energy and hazardous materials (radiological or chemical) that might cause prompt or latent health effects. The sequence usually begins with an initiating event, such as human error, equipment failure, or earthquake, followed by a succession of other events that could be dependent or independent of the initial event, which dictate the accident's progression and the extent of materials released. Initiating events are presented in Appendix C, Section C.3 of this LLNL SWEIS.

If an accident were to occur involving the release of radioactive, chemical, or biological materials, workers, members of the public, and the environment would be at risk. Workers in the facility where the accident occurs would be particularly vulnerable to the effects of the accident because of their location. The offsite public and non-involved workers would also be at risk of exposure to the extent that meteorological conditions exist for the atmospheric dispersion of released hazardous materials. Using approved computer models, NNSA predicted the dispersion of released hazardous materials and their effects. However, prediction of latent potential health effects becomes increasingly difficult to quantify for facility workers as the distance between the accident location and the worker decreases. This is because the individual worker exposure cannot be precisely defined with respect to the presence of shielding and other protective features. The facility worker also may be injured or killed by physical effects of the accident itself.

This section presents the potential impacts on non-involved workers and the public due to potential accidents associated with operation of LLNL. Additional details supporting the information presented here, as well as the methodologies used to perform the analyses, are provided in Appendix C, Section C.3. Sections 5.16.2–5.16.6 present the accident analyses that are applicable to continued operations at LLNL under either the No-Action Alternative or the Proposed Action. Section 5.16.7 presents site-wide accident events (e.g., seismic events or wildfires) that could impact multiple facilities and are applicable to either the No-Action Alternative or the Proposed Action. Section 5.16.8 presents the accident analyses that are specifically applicable to new projects under the No-Action Alternative. Section 5.16.9 presents the accident analyses that are specifically applicable to new projects under the Proposed Action. Section 5.16.10 presents the results of the intentional destructive acts (IDA) analysis. Because the potential impacts of IDAs are compared against the accident analyses, it is appropriate to include the IDA analysis in this section of the SWEIS.

5.16.2 Radiological Accident Analysis Applicable to the No-Action Alternative and the Proposed Action

5.16.2.1 *Methodology*

Selection Process. Radiological accident analyses have been performed at LLNL since it was first established in 1952. The selection of accidents for inclusion in this SWEIS was built upon these existing accident analyses. That is, all of the major onsite facilities that handle radiological, chemical, biological, or explosive materials have an existing documented safety analysis (DSA) or safety basis document (SBD) and/or an emergency planning hazard assessment (EPHA). Each of these documents, as well as other documents as described in Appendix C.3, was reviewed to select the accidents to be included in this SWEIS. Most of the DSAs and SBDs identified a complete spectrum of accidents (e.g., the Plutonium Facility DSA (LLNL 2017j) identified over 250 potential hazard events), but only analyzed those with the most severe consequences (e.g., the Plutonium Facility DSA analyzed 11 design-basis events [DBEs], plus two beyond-DBEs). The accidents selected for inclusion in this SWEIS were selected from the analyzed DBEs for each of the major LLNL facilities. Specifically, the DSAs, SBDs, and/or EPHAs provided the initiating events, the accident frequencies, the material-at-risk (MAR), and the source term for each of the accidents analyzed for this SWEIS.

Consequence Analysis. NNSA estimated radiological consequences to three receptors: (1) the MEI at the LLNL boundary, (2) the offsite population within 50 miles of LLNL, and (3) a non-involved worker located 100 meters from the accident. Because not all of the DSAs, SBDs, and EPHAs utilized the same methodology for determining accident consequences; NNSA has re-calculated the consequences for all analyzed accidents using the methodology described in Appendix C, Section C.3.1.

The offsite population dose is based on a population of approximately 7.8 million persons residing within 50 miles of LLNL (LLNL 2019f).[26] Section C.3 describes the basis for using this offsite population. The MEI was assumed to be located along the site boundary. The shortest distance to the boundary from each release location in all 16 directions was identified for the MEI analysis. Similarly, the non-involved onsite worker location was taken as 100 meters from the release in any direction. The calculated radiation doses were converted to LCFs using the factor of 6×10^{-4} LCF per rem for both members of the general public and workers (Lawrence 2002).

[26] See Section C.3.1.3 for a discussion of how impacts would change to account for future population projections.

5.16.2.2 *Results*

Four categories of accidents have been identified based upon the types of radionuclides they release: plutonium, tritium, TRU, and mixed fission products. This SWEIS analyzes the following bounding accidents for these four categories of radionuclides:

> **Plutonium**: (1) Hydrogen Explosion with Room Fire at the Plutonium Facility (B332); and (2) NIF Complex (B582) Transfer Vehicle Fire.
>
> **Tritium**: (1) Aircraft Crash at the Tritium Facility (B331); (2) NIF (B581) Tritium Processing System Fire; (3) Waste Storage Facilities (A625) Fire; and (4) Tritium Facility (B331) Aircraft Crash.
>
> **TRU Material**: (1) TRUPACT-II Crane Drop and Fire in the A625 Yard; (2) Yard TRU Waste Event at the Plutonium Facility (B332); (3) Waste Storage Facilities (B625) Aircraft Crash; (4) B696R Aircraft Crash.
>
> **Mixed fission products**: (1) B332 Plutonium Criticality; and (2) B332 Uranium Criticality.

Tables 5-60 and 5-61 show the accident frequency, calculated dose and fatality risk to the MEI, 50-mile radius population, and non-involved worker under both average and conservative meteorological conditions, respectively. For almost all accidents, the actions under the Proposed Action would not result in a change to any of the No-Action Alternative radiological accident source terms. As a result, for almost all accidents, the consequences presented in these tables are applicable to both the No-Action Alternative and the Proposed Action. The only exceptions to this are the NIF Complex (B582) Transfer Vehicle Fire, the NIF (B581) Tritium Processing System Fire, and the B235 General Facility Fire. As shown in Tables 5-60 and 5-61, there are differences in those accidents between the No-Action Alternative and the Proposed Action. Consistent with DOE NEPA accident analysis recommendations (DOE 2002), the consequences presented in Table 5-60 and Table 5-61 represent the range or "spectrum" of reasonably foreseeable accidents, including low probability/high consequence accidents and high probability/low consequence accidents. Per DOE 2002, because "risk" is a combination of the accident's probability (or frequency) and consequence, the accidents with the highest doses in Table 5-60 and 5-61 do not dominate LLNL's radiological accident risk, as described below.

Table 5-60. Radiological Accident Frequency and Consequences under the No-Action Alternative and the Proposed Action—Conservative Meteorology

Accident Scenario[g]		Frequency (per year)	Maximally Exposed Individual[a, e]		Offsite Population[b]		Non-involved Worker[c, e]	
			Dose (rem)	Latent Cancer Fatalities[f]	Dose (Person-rem)	Latent Cancer Fatalities[f]	Dose (rem)	Fatalities[d]
B332 – Hydrogen explosion with subsequent Fire		≤1×10^{-4} to 1×10^{-6}	5.4×10^{-4}	3.0×10^{-7}	0.12	7.2×10^{-5}	0.021	1.3×10^{-5}
B332 – Yard Fire		≤1×10^{-4} to 1×10^{-6}	1.5	9.1×10^{-4}	340	0.2	64	0.039
B625 – Aircraft Crash		6.3×10^{-7}	4.9	0.0029	4,300	2.6	18	0.011
B696R – Aircraft Crash		6.4×10^{-7}	1.4	8.3×10^{-4}	970	0.58	2.7	0.0016
B582 NIF – Transfer Vehicle Fire	No-Action Alternative	There is not a comparable No-Action Alternative accident.						
	Proposed Action	2×10^{-5}	0.015	9.2×10^{-6}	0.98	5.9×10^{-4}	0.18	1.1×10^{-4}
B331 – Aircraft Crash – Increment		≤1×10^{-4} to 1×10^{-6}	0.97	5.8×10^{-4}	220	0.13	38	0.023
B331 – Aircraft Crash – Total		8.7×10^{-7}	1.1	6.8×10^{-4}	250	0.15	45	0.027
B581 – Tritium Processing System Fire	No-Action Alternative	1×10^{-6}	0.09	5.4×10^{-5}	5.8	0.0035	1	6.2×10^{-4}
	Proposed Action		0.18	1.1×10^{-4}	12	0.0069	2.1	0.0012
B693 – Waste Storage Facility Fire		≤1×10^{-4} to 1×10^{-6}	17	0.01	160	0.096	26	0.015
A625 Yard –TRUPACT-II Crane Drop and Fire		≤1×10^{-4} to 1×10^{-6}	16	0.0096	400	0.24	76	0.045
B332 – Plutonium Criticality		≤1×10^{-4} to 1×10^{-6}	0.1	6.0×10^{-5}	22	0.013	3.1	0.0019
B332 – Uranium Criticality		≤1×10^{-4} to 1×10^{-6}	0.035	2.1×10^{-5}	7.8	0.0047	6.2	0.0037
B235 – General Facility Fire	No-Action Alternative	There is not a comparable No-Action Alternative accident.						
	Proposed Action	≤1×10^{-4} to 1×10^{-6}	0.0017	1.0×10^{-4}	0.34	2.0×10^{-4}	0.062	3.7×10^{-5}

a. See Appendix C (Section C.3) for distances from each facility to its MEI.
b. Based on a population of approximately 7.8 million persons residing within 50 miles of LLNL (LLNL 2019f).
c. At a distance of 100 meters from the facility.
d. If the dose is ≥1,000 rem, these are prompt fatalities, otherwise they are LCFs.
e. The MEI and the non-involved worker scenarios each assume that one person was exposed. If more than one person was exposed in either of these scenarios, then that scenario's dose would be per person and the fatalities would be multiplied by the number of persons exposed.
f. Based on an LCF risk estimate of 0.0006 LCF per rem or person-rem.
g. Where only one scenario is presented, it represents both No-Action Alternative and Proposed Action.

Table 5-61. Radiological Accident Frequency and Consequences under the No-Action Alternative and the Proposed Action—Average Meteorology

Accident Scenario[f]	Frequency (per year)	Maximally Exposed Individual[a, d]		Offsite Population[b]		Non-involved Worker[c, d]	
		Dose (rem)	Latent Cancer Fatalities[e]	Dose (Person-rem)	Latent Cancer Fatalities[e]	Dose (rem)	Latent Cancer Fatalities
B332 – Hydrogen explosion with subsequent Fire	$\leq 1\times10^{-4}$ to 1×10^{-6}	5.1×10^{-5}	3.0×10^{-8}	0.0031	1.9×10-6	0.0027	1.6×10^{-6}
B332 – Yard Fire	$\leq 1\times10^{-4}$ to 1×10^{-6}	0.15	9.1×10^{-5}	9.4	0.0057	8	0.0048
B625 – Aircraft Crash	6.3×10^{-7}	1.8	0.0011	510	0.30	6.4	0.0038
B696R – Aircraft Crash	6.4×10^{-7}	0.52	3.1×10^{-4}	110	0.068	0.93	5.6×10^{-4}
B582 NIF – Transfer Vehicle Fire – No-Action Alternative	There is not a comparable No-Action Alternative accident.						
B582 NIF – Transfer Vehicle Fire – Proposed Action	2×10^{-5}	0.0017	1.0×10^{-6}	0.027	1.6×10^{-5}	0.022	1.3×10^{-5}
B331 – Aircraft Crash – Increment	$\leq 1\times10^{-4}$ to 1×10^{-6}	0.094	5.6×10^{-5}	5.8	0.0035	5	0.003
B331 – Aircraft Crash – Total	8.7×10^{-7}	0.11	6.6×10^{-5}	6.8	0.0041	5.8	0.0035
B581 – Tritium Processing System Fire – No-Action Alternative	1×10^{-6}	0.01	6.0×10^{-6}	0.16	9.6×10^{-5}	0.14	8.2×10^{-5}
B581 – Tritium Processing System Fire – Proposed Action		0.024	1.2×10^{-5}	0.32	1.9×10^{-4}	0.27	1.6×10^{-4}
B693 – Waste Storage Facility Fire	$\leq 1\times10^{-4}$ to 1×10^{-6}	0.82	4.9×10^{-4}	1.7	0.001	0.26	1.5×10^{-4}
A625 Yard –TRUPACT-II Crane Drop and Fire	$\leq 1\times10^{-4}$ to 1×10^{-6}	0.85	5.1×10^{-4}	5	0.003	3.9	0.0023
B332 – Plutonium Criticality	$\leq 1\times10^{-4}$ to 1×10^{-6}	0.01	6.0×10^{-6}	0.62	3.7×10^{-4}	0.39	2.3×10^{-4}
B332 – Uranium Criticality	$\leq 1\times10^{-4}$ to 1×10^{-6}	0.0035	2.1×10^{-6}	0.22	1.3×10^{-4}	0.78	4.7×10^{-4}
B235 – General Facility Fire – No-Action Alternative	There is not a comparable No-Action Alternative accident.						
B235 – General Facility Fire – Proposed Action	$\leq 1\times10^{-4}$ to 1×10^{-6}	1.7×10^{-4}	1.0×10^{-7}	0.0092	5.5×10^{-6}	0.0078	4.7×10^{-6}

a. See Appendix C (Section C.3) for distances from each facility to its MEI.
b. Based on a population of approximately 7.8 million persons residing within 50 miles of LLNL (LLNL 2019b).
c. At a distance of 100 meters from the facility.
d. The MEI and the non-involved worker scenarios each assume that one person was exposed. If more than one person was exposed in either of these scenarios, then that scenario's dose would be per person and the fatalities would be multiplied by the number of persons exposed.
e. Based on an LCF risk estimate of 0.0006 LCF per rem or person-rem.
f. Where only one scenario is presented, it represents both No-Action Alternative and Proposed Action.

The LCFs identified in Table 5-60 and Table 5-61 are "conditional" risks, based on the assumption that the accident has occurred with the assumed meteorological conditions. Table 5-62 shows the total fatality risk[27] for each analyzed accident, and the meteorological conditions (as described in Section C.3.1.4). As shown in Table 5-60, the total risk from an accident is small-- even with conservative meteorology, the maximum offsite population risk is estimated to be 1.0×10^{-6} fatalities per year, or about one fatality for every 1 million years of operation. To put this risk into perspective, in 2019, the total annual death rate from all causes in California was 682.9 deaths per

[27] Risk is determined by multiplying the consequence and frequency of an accident.

100,000 people (CDC 2021). Within the 50-mile radius of LLNL, about 53,000 deaths occurred in 2019.

Table 5-62 shows that the high consequence/low probability accidents have the largest total risk. The B625 Aircraft Crash accident contributes about 58 percent to the total offsite population risk, while the B693 Waste Storage Facility (A625) Yard Fire and A625 Yard TRUPACT-II Crane Drop and Fire accidents contribute about 43 percent and 42 percent to the MEI total risk, respectively. Because each facility has different individuals as both their MEI and non-involved worker, simply adding the risks from all accident (as was done in Table 5-62) conservatively overestimates the total risk to these individuals.

Table 5-62. Radiological Accident Fatality Annual Risk under the No-Action Alternative and the Proposed Action

<table>
<tr><th colspan="2" rowspan="2">Accident Scenario[a]</th><th colspan="3">Conservative Meteorology (Stability Class F and 1 m/sec.)</th><th colspan="3">Average Meteorology (Stability Class D and 3 m/sec.)</th></tr>
<tr><th>MEI</th><th>Offsite Population</th><th>Non-involved Worker</th><th>MEI</th><th>Offsite Population</th><th>Non-involved Worker</th></tr>
<tr><td colspan="2">B332 – Hydrogen explosion with subsequent Fire</td><td>1.6×10^{-13}</td><td>3.6×10^{-11}</td><td>6.4×10^{-12}</td><td>1.5×10^{-14}</td><td>9.4×10^{-13}</td><td>8.0×10^{-13}</td></tr>
<tr><td colspan="2">B332 – Yard Fire</td><td>4.6×10^{-10}</td><td>1.0×10^{-7}</td><td>1.9×10^{-8}</td><td>4.6×10^{-11}</td><td>2.8×10^{-9}</td><td>2.4×10^{-9}</td></tr>
<tr><td colspan="2">B625 – Aircraft Crash</td><td>9.2×10^{-11}</td><td>8.2×10^{-8}</td><td>3.5×10^{-10}</td><td>3.5×10^{-11}</td><td>9.6×10^{-9}</td><td>1.2×10^{-10}</td></tr>
<tr><td colspan="2">B696R – Aircraft Crash</td><td>2.7×10^{-11}</td><td>1.9×10^{-8}</td><td>5.2×10^{-11}</td><td>1.0×10^{-11}</td><td>2.2×10^{-9}</td><td>1.8×10^{-11}</td></tr>
<tr><td rowspan="2">B582 NIF – Transfer Vehicle Fire</td><td>No-Action Alternative</td><td colspan="6">There is not a comparable No-Action Alternative accident.</td></tr>
<tr><td>Proposed Action</td><td>9.2×10^{-12}</td><td>5.9×10^{-10}</td><td>1.1×10^{-10}</td><td>1.0×10^{-12}</td><td>1.6×10^{-11}</td><td>1.3×10^{-11}</td></tr>
<tr><td colspan="2">B331 – Aircraft Crash – Increment</td><td>2.9×10^{-10}</td><td>6.5×10^{-8}</td><td>1.1×10^{-8}</td><td>2.8×10^{-11}</td><td>1.7×10^{-9}</td><td>1.5×10^{-9}</td></tr>
<tr><td colspan="2">B331 – Aircraft Crash – Total</td><td>2.9×10^{-11}</td><td>6.5×10^{-9}</td><td>1.2×10^{-9}</td><td>2.8×10^{-12}</td><td>1.8×10^{-10}</td><td>1.5×10^{-10}</td></tr>
<tr><td rowspan="2">B581 – Tritium Processing System Fire</td><td>No-Action Alternative</td><td>2.7×10^{-12}</td><td>1.7×10^{-10}</td><td>3.1×10^{-11}</td><td>3.0×10^{-13}</td><td>4.8×10^{-12}</td><td>4.1×10^{-12}</td></tr>
<tr><td>Proposed Action</td><td>5.4×10^{-12}</td><td>3.5×10^{-10}</td><td>6.2×10^{-11}</td><td>6.0×10^{-13}</td><td>9.6×10^{-12}</td><td>8.2×10^{-12}</td></tr>
<tr><td colspan="2">B693 – Waste Storage Facility Fire</td><td>5.2×10^{-9}</td><td>4.8×10^{-8}</td><td>7.7×10^{-9}</td><td>2.5×10^{-10}</td><td>5.1×10^{-10}</td><td>7.7×10^{-11}</td></tr>
<tr><td colspan="2">A625 Yard – TRUPACT-II Crane Drop and Fire</td><td>5.0×10^{-9}</td><td>1.2×10^{-7}</td><td>2.3×10^{-8}</td><td>2.6×10^{-10}</td><td>1.5×10^{-9}</td><td>1.2×10^{-9}</td></tr>
<tr><td colspan="2">B332 – Plutonium Criticality</td><td>3.0×10^{-11}</td><td>6.7×10^{-9}</td><td>9.3×10^{-10}</td><td>3.0×10^{-12}</td><td>1.9×10^{-10}</td><td>1.2×10^{-10}</td></tr>
<tr><td colspan="2">B332 – Uranium Criticality</td><td>1.1×10^{-11}</td><td>2.4×10^{-9}</td><td>1.9×10^{-9}</td><td>1.1×10^{-12}</td><td>6.5×10^{-11}</td><td>2.3×10^{-10}</td></tr>
<tr><td rowspan="2">B235 – General Facility Fire</td><td>No-Action Alternative</td><td colspan="6">There is not a comparable No-Action Alternative accident.</td></tr>
<tr><td>Proposed Action</td><td>1.0×10^{-12}</td><td>2.0×10^{-10}</td><td>3.7×10^{-11}</td><td>1.0×10^{-13}</td><td>5.5×10^{-12}</td><td>4.7×10^{-12}</td></tr>
</table>

a. Where only one scenario is presented, it represents both No-Action Alternative and Proposed Action.

5.16.3 Chemical Accident Analysis Applicable to the No-Action Alternative and the Proposed Action

5.16.3.1 *Methodology*

Selection Process. Similar to the radiological accident selection process, this SWEIS independently reviewed the DSAs, SBDs, EPHAs, and Risk Management Plan Update (LLNL 2016c) and determined five categories of chemicals warranted further examination. The following lists the chemicals and their locations on site:

1. Beryllium/beryllium oxide is stored and used at a number of facilities on the LLNL site, including Engineering High Bay (B131HB), the Radiography Facility (B239), and the Hardened Engineering Test Building (B334).
2. Lithium hydride is stored and used at a number of facilities on the LLNL site, including Engineering High Bay (B131HB), Development and Assembly Engineering vault (B231V), OS232FAMaterials Management ground vault (B233GV), Radiography Facility (B239), Tritium Facility (B331), Hardened Engineering Test Building (B334), Materials Fabrication Shop Wing C (B321C), and Site 300.
3. Chlorine/hydrogen chloride is used at the Plutonium Facility (B332).
4. Nitric, hydrofluoric, and hydrochloric acids are used at the Metal Finishing Facility (B322).
5. Uranium in Buildings 239, 332, 334, B131HB, 231V, OS232FA, 233GV
6. Chlorine trifluoride in B151.

Additional discussion of the chemical accident scenarios (e.g., MAR, frequency) is in Section C.3.3 of Appendix C.

Protective Action Criteria. The adverse effects of exposure vary greatly among chemicals. They range from physical discomfort and skin irritation to respiratory tract tissue damage, and, at the extreme, death. For this reason, allowable exposure levels differ from substance to substance. None of the chemicals of concern in the bounding accidents are known carcinogens. For the evaluation of chemicals, this SWEIS utilizes protective action criteria (PAC) to quantify the significance of an accident on both non-involved workers and the public, as recommended by DOE Order 151.1D and DOE-STD-3009-2014. The three levels of PACs are:

PAC-1 – mild, transient health effects
PAC-2 – irreversible or other serious health effects that could impair the ability to take protective action
PAC-3 – life-threatening health effects

For chemical hazards, PAC values are based on the following hierarchy of exposure limit values:

- If available, use the USEPA's 60-minute Acute Exposure Guideline Level values
- If Acute Exposure Guideline Level values are not available, use the American Industrial Hygiene Association's Emergency Response Planning Guideline values

- If neither Acute Exposure Guideline Level values nor Emergency Response Planning Guideline values are available, use the DOE's Temporary Emergency Exposure Limit values

The numerical PAC values used in this SWEIS were obtained from DOE (2021) and are provided in Table 5-63.

Table 5-63. Toxic Chemical Protective Action Criteria

Chemical	Formula	PAC (mg/m^3)		
		PAC-1	PAC-2	PAC-3
Beryllium	Be	0.0023	0.025	0.11
Beryllium Oxide	BeO	0.0063	0.069	0.28
Lithium Hydride	LiH	0.025	0.1	0.5
Lithium Hydroxide	LiOH	0.091	1	42
Uranium Dioxide[a]	UO_2	0.068	10	30
Chlorine Trifluoride	ClF_3	0.45	7.6	79
Chemical	**Formula**	**PAC (ppm)**		
		PAC-1	**PAC-2**	**PAC-3**
Chlorine	Cl_2	0.50	2.0	20
Hydrogen Chloride/ Hydrochloric Acid	HCl	1.8	22	100
Nitric Acid	HNO_3	0.16	24	92
Hydrofluoric Acid	HF	1.0	24	44

a. The PAC values for uranium dioxide are provided because uranium forms uranium dioxide in a fire.
Source: DOE 2021a.

Consequence Analysis. Chemical release consequences (i.e., concentrations) to the MEI and non-involved worker were determined for both average (i.e., 50th percentile) and conservative (i.e., 95th percentile) meteorological conditions.

5.16.3.2 *Results*

Table 5-64 and Table 5-65 present the calculated consequences (i.e., concentration) for chemical release accident scenarios under average and conservative meteorological conditions, respectively. The chemical concentrations are also compared to the PACs.

Table 5-64 shows that under average meteorological conditions the MEI chemical concentrations are each below their respective PAC-1 levels, except for chlorine and hydrogen chloride (HCl), which are below their respective PAC-2 levels. For the non-involved worker under average meteorological conditions, Table 5-4 shows that one of the hydrogen chloride release accidents is above its PAC-2 level, and the chlorine and the other hydrogen chloride accident are above their PAC-3 levels.

Table 5-65 shows that under conservative meteorological conditions, the MEI chemical concentrations are each below their respective PAC-2 levels, except for the chlorine accident, which is below its PAC-3 level. The chlorine accident concentrations falls below its PAC-2 level at a distance of 1,040 meters from the release point, or 240 meters beyond the site boundary. For the non-involved worker under conservative meteorological conditions, Table 5-65 shows that a number of the chemical release accidents are above their PAC-2 levels, and the chlorine and the two hydrogen chloride accidents are above their PAC-3 levels.

The analysis found that the concentrations the B332 chlorine and B322 (hydrochloric acid) and B332 hydrogen chloride release accidents can exceed the PAC-2 and even the PAC-3 levels for the non-involved worker. at 100 meters within the Livermore Site. This fact has been documented in the DSAs for buildings that are located near these two buildings (e.g., the Tritium Facility [B331]). To mitigate the impacts, workers at these nearby facilities are instructed to stay in place or move inside the facility and shelter in place. Appendix C.3 provides additional discussion of these acid release accidents.

Table 5-64. Potential Chemical Accident Consequences -- Average Meteorology

Chemical	Facility	Non-Involved Worker		MEI	
		Concentration	PAC[c]	Concentration	PAC[c]
Beryllium (BeO)	B131HB	0.013 (mg/m^3)	<PAC-2	0.0015 (mg/m^3)	<PAC-1
	B239	0.0014 (mg/m^3)	<PAC-1	3.8×10^{-5} (mg/m^3)	<PAC-1
	B334	0.00019 (mg/m^3)	<PAC-1	6.0×10^{-6} (mg/m^3)	<PAC-1
Lithium Hydride (LiOH)	B131HB	0.29 (mg/m^3)	<PAC-2	0.016 (mg/m^3)	<PAC-1
	B321C	0.098 (mg/m^3)	<PAC-2	0.0029 (mg/m^3)	<PAC-1
	B231V	0.39 (mg/m^3)	<PAC-2	0.0087 (mg/m^3)	<PAC-1
	OS232FA	0.39 (mg/m^3)	<PAC-2	0.0087 (mg/m^3)	<PAC-1
	B233GV	0.39 (mg/m^3)	<PAC-2	0.0087 (mg/m^3)	<PAC-1
	B239	0.029 (mg/m^3)	<PAC-1	0.0005 (mg/m^3)	<PAC-1
	B331	0.026 (mg/m^3)	<PAC-1	0.0005 (mg/m^3)	<PAC-1
	B334	0.12 (mg/m^3)	<PAC-2	0.0017 (mg/m^3)	<PAC-1
	Site 300	0.29 (mg/m^3)	<PAC-1	0.0602 (mg/m^3)	<PAC-1
Chlorine	B332	59.9 (ppm)	>PAC-3	1.05 (ppm)	<PAC-2
Hydrogen Chloride	B332	624 (ppm)	>PAC-3	2.7 (ppm)	<PAC-2
Hydrochloric Acid	B322	78.5 (ppm)	<PAC-3	1.07 (ppm)	<PAC-1
Hydrofluoric Acid	B322	2.18 (ppm)	<PAC-2	0.032 (ppm)	<PAC-1
Nitric Acid[a]	B322	5.49 (ppm)	<PAC-2	0.0882 (ppm)	<PAC-1
Chlorine Trifluoride	B151	2 (mg/m^3)	<PAC-2	0.14 (mg/m^3)	<PAC-1
Uranium[b]	B131HB	2.5 (mg/m^3)	<PAC-2	1.4 (mg/m^3)	<PAC-1

a. Appendix C presents multiple B322 accidents for each type of acid. This table only presents the accident with the highest MEI concentration.
b. Appendix C presents multiple accidents for each facility and type of uranium (DU, EU, HEU). This table only present the accident with the highest MEI concentration and due to the proximity to fence line, the results from B131HB bound those for B231V, OS232SA, B2332GV, B239, B332, B334.
c. The PAC values for the chemicals shown in this table are provided in Table 5-63.

Table 5-65. Potential Chemical Accident Consequences -- Conservative Meteorology

Chemical	Facility	Non-Involved Worker		MEI	
		Concentration	PAC[a]	Concentration	PAC[a]
Beryllium (BeO)	B131HB	0.18 (mg/m^3)	<PAC-3	0.021 (mg/m^3)	<PAC-2
	B239	0.0026 (mg/m^3)	<PAC-1	8.3×10^{-5} (mg/m^3)	<PAC-1
	B334	0.02 (mg/m^3)	<PAC-2	0.00053 (mg/m^3)	<PAC-1
Lithium Hydride (LiOH)	B131HB	2.2 (mg/m^3)	<PAC-3	0.13 (mg/m^3)	<PAC-2
	B321C	0.75 (mg/m^3)	<PAC-2	0.026 (mg/m^3)	<PAC-1
	B231V	3 (mg/m^3)	<PAC-3	0.08 (mg/m^3)	<PAC-1
	OS232F A	3 (mg/m^3)	<PAC-3	0.08 (mg/m^3)	<PAC-1
	B233GV	3 (mg/m^3)	<PAC-3	0.08 (mg/m^3)	<PAC-1
	B239	0.22 (mg/m^3)	<PAC-2	0.0053 (mg/m^3)	<PAC-1
	B331	0.2 (mg/m^3)	<PAC-2	0.005 (mg/m^3)	<PAC-1
	B334	0.88 (mg/m^3)	<PAC-2	0.016 (mg/m^3)	<PAC-1
	Site 300	0.42 (mg/m^3)	<PAC-2	0.11 (mg/m^3)	<PAC-2
Chlorine	B332	145 (ppm)	>PAC-3	3.22[b] (ppm)	<PAC-3
Hydrogen Chloride	B332	1510 (ppm)	>PAC-3	8.31 (ppm)	<PAC-2
Hydrochloric Acid	B322	419 (ppm)	>PAC-3	6.63 (ppm)	<PAC-2
Hydrofluoric Acid	B322	10.9 (ppm)	<PAC-2	0.205 (ppm)	<PAC-1
Nitric Acid	B322	15.8 (ppm)	<PAC-2	0.413 (ppm)	<PAC-2
Chlorine Trifluoride	B151	4 (mg/m^3)	<PAC-2	0.44 (mg/m^3)	<PAC-1
Uranium[c]	B131HB	2.3 (mg/m^3)	<PAC-2	1.4 (mg/m^3)	<PAC-2

a. The PAC values for the chemicals shown in this table are provided in Table 5-63.
b. The chlorine accident concentrations falls below its PAC-2 level at a distance of 1,040 meters from the release point, or 240 meters beyond the site boundary.
c. Appendix C presents multiple accidents for each facility and type of uranium (DU, EU, HEU). This table only present the accident with the highest MEI concentration and due to the proximity to fence line, the results from B131HB bound those for B231V, OS232SA, B2332GV, B239, B332, B334.

5.16.4 High Explosive Accident Analysis Applicable to the No-Action Alternative and the Proposed Action

5.16.4.1 *Selection Process*

Based on an independent review of previous LLNL analyses, this SWEIS evaluated HE accident scenarios occurring at the Building 191 HEAF and at Site 300. Appendix C, Section C.3.4, provides additional discussion of the high explosive accident analysis.

5.16.4.2 *Results*

Consistent with previous LLNL analyses, since the HEAF has administrative controls in place that place limits on the amounts of explosives, hazardous chemicals, and radiological material that may be present in the HEAF, an accident analysis was not performed for this SWEIS; the protection of the non-involved worker and public is ensured by the structural design of the HEAF and the administrative controls. These analyses have determined that a non-involved worker located 100 meters from the explosion would not be affected by the blast.

For Site 300 the SBD determined that the only consequence to the non-involved worker and the MEI would be if the explosion resulted in the dispersal of radiological or hazardous chemical material. To address those concerns the SBD evaluated two potential HE accidents:

- accidental detonation of explosives commingled with chemicals
- accidental detonation of explosives commingled with radiological materials

Consistent with previous LLNL analyses, it was determined for this SWEIS that there was an administrative control in place that reduced the likelihood of an accidental detonation of explosives commingled with hazardous chemicals from unlikely to extremely unlikely or less, effectively precluding the event from occurring, and no further analysis was performed.

The results of the analysis of the accidental detonation of explosives commingled with radiological materials are presented in Table 5-66 for both average and conservative meteorological conditions. Because the smallest explosive mass will result in the highest concentrations for a given mass of radiological material, the analysis assumed an explosive mass of 0.022 pound (10 grams) equivalent TNT, and the MAR was assumed to be at the facility limit for each radionuclide.

Table 5-66. Site 300 Detonation with Radiological Materials Impacts

Radionuclide	Dose (rem)					
	100 m	200 m	300 m	400 m	600 m	1100 m
Average Meteorology						
Tritium (H-3)	0.42	0.13	0.063	0.038	0.019	7.0×10^{-3}
Th-232	4.3×10^{-3}	1.3×10^{-3}	6.5×10^{-4}	3.9×10^{-4}	1.9×10^{-4}	7.1×10^{-5}
U-234	5.4×10^{-3}	1.7×10^{-3}	8.2×10^{-4}	5.0×10^{-4}	2.5×10^{-4}	8.9×10^{-5}
U-235	3.7×10^{-4}	1.1×10^{-4}	5.5×10^{-5}	3.3×10^{-5}	1.7×10^{-5}	6.0×10^{-6}
U-238	0.027	8.2×10^{-3}	4.0×10^{-3}	2.4×10^{-3}	1.2×10^{-3}	4.4×10^{-4}
Conservative Meteorology						
Tritium (H-3)	9.8	4.1	2.2	1.4	0.73	0.27
Th-232	0.090	0.036	0.019	0.012	5.8×10^{-3}	1.9×10^{-3}
U-234	0.12	0.046	0.025	0.015	7.4×10^{-3}	2.5×10^{-3}
U-235	7.8×10^{-3}	3.1×10^{-3}	1.7×10^{-3}	1.0×10^{-3}	5.0×10^{-4}	1.7×10^{-4}
U-238	0.57	0.23	0.12	0.075	0.036	0.012

Note: The distance from the HEAF to the nearest site boundary (MEI) is 250 meters; the distance from each Site 300 Complex/Facility ranges from 200 to 1,100 meters.

5.16.5 Biological Accident Analysis Applicable to the No-Action Alternative and the Proposed Action

Microbiology laboratories are unique work environments that may pose special risks to personnel working within that environment. For purposes of this section, NNSA has selected a representative facility accident that the U.S. Army previously analyzed in its *Final Programmatic Environmental Impact Statement Biological Defense Research Defense Program* (Army 1989). NNSA believes that this accident scenario is comparable to and bounds any potential scenarios associated with the BSL-3 Facility, Building 368 at LLNL. Appendix C, Section C.3.5, provides further details on this accident scenario.

The organism selected for this scenario is *Coxiella burnetii*, the *rickettsial* agent causing Q fever, a disease of varying degrees of incapacitation. *Coxiella burnetii* grows to high concentrations in chick embryos. It is a hardy organism that withstands laboratory manipulation with little or no loss in viability. It is highly stable in aerosol and undergoes a biological decay rate of about one percent per minute over a wide range of humidity. *Coxiella burnetii* is extremely infectious in a small particle aerosol.

This accident scenario involves an immunized laboratory worker processing *Coxiella burnetii*. In this scenario, the laboratory worker fails to use rubber O-rings to seal the centrifuge tubes, and all six bottles leak, allowing some of the slurry into the rotor, with some of the slurry also escaping into the centrifuge compartment that houses the rotor. The leakage of six bottles is highly improbable.

As shown in Appendix C, Section C.3, approximately 5×10^4 HID_{50} (i.e., the dose causing infection 50 percent of the time for humans) could escape from the building exhaust stack. This is a conservative assumption, as the facility would likely have HEPA filters on the exhaust system. The quantity of human infectious doses, by simple Gaussian plume dispersion models, would dissipate to less than 1 HID_{50} per liter of air at less than 2 meters from the stack, less than 0.1 HID_{50} per liter of air at 16 meters, and less than 0.01 HID_{50} per liter of air at 38 meters. Thus, this level of escape of *Coxiella burnetii* from the containment laboratory, even under the worst-case meteorological conditions, does not represent a credible risk to the non-involved worker or offsite population.

The centrifuge operator would be at the greatest risk of becoming ill with Q fever. In opening the centrifuge, the infectious aerosol would be released initially and momentarily into a confined area. The researchers at the LLNL A/BSL-3 wear PAPR hoods with HEPA filters, so an exposure is unlikely.

5.16.6 Onsite Transportation of Materials Accident Analysis Applicable to the No-Action Alternative and the Proposed Action

Onsite transfers at LLNL are defined as the movement of materials by RHWM Program and Materials Management Vaults and Transportation Group (MM) transfer vehicles on the LLNL Main Site. LLNL radioactive waste transfer operations begin when the vehicle leaves the boundary of RHWM's originating facility and end when the transfer vehicle enters the boundary of RHWM's receiving facility. Onsite transportation at Site 300 is limited to activities related to materials within the geographically contiguous property of Site 300. Appendix C, Section C.3.6, provides further details on the onsite transportation of materials accident analysis.

5.16.6.1 *Selection Process*

As shown in Table 5-67, an evaluation of the hazards associated with the onsite transportation of materials (LLNL 2017c, LLNL 2017k) found that the only hazard needing analysis is the transport of HC-3 radiological material on the Livermore Site.

Table 5-67. Onsite Transportation Hazards Evaluation Results

Type of Hazard	Onsite Transportation Hazard Classification	
	LLNL	Site 300
Chemical	Light Science and Industry (LSI)	LSI
Biological	Low	No regulated biohazardous materials are authorized for research activities at Site 300
Explosives	Low	Moderate
Industrial	LSI	LSI
<HC-3 Radiological	Low	Low
≥HC-3 Radiological	See analysis below	No ≥HC-3 quantity radioactive materials are handled or transported at Site 300

Source: LLNL 2017c, LLNL 2017k. HC=Hazard Category

In addition to radioactive material, the RHWM transfers may contain quantities of toxicological materials within the package. These toxicological materials could include lead, acetone, toluene, trichloroethylene, Freon, carbon tetra chloride, hydroquinone, solvents, asbestos, and beryllium. An analysis of the consequences of beryllium release during the bounding RHWM accident would bound all toxicological material consequences.

5.16.6.2 *Results*

As shown in Table 5-68, the calculated radiological consequences from the onsite transport of RHWM and MM are small. For example, the non-involved worker's exposure following a MM unique sealed-source impact accident has the largest exposure, but the worker's total LCF risk is only about 1 in 5.5 billion (i.e., 1.5×10^{-8}) per year. The total LCF for the MEI is also small (i.e., 3.7×10^{-10} per year).

Table 5-68. Onsite Transportation Bounding Accident Radiological Consequences (Stability Class F and 1 m/sec.)

Frequency (per year)	Maximally Exposed Individual				Non-involved Worker		
	Distance (m)	Dose (rem)	Latent Cancer Fatality Risk		Dose (rem)	Latent Cancer Fatality Risk	
			Conditional	Total (yr^{-1})		Conditional	Total (yr^{-1})
RHWM: Impact Followed by Fire							
6.22×10^{-7}	90	1.15	6.9×10^{-4}	4.3×10^{-10}	1.15	6.9×10^{-4}	4.3×10^{-10}
	170	1.31	7.9×10^{-4}	4.9×10^{-10}	3.76	2.3×10^{-3}	1.4×10^{-9}
MM: Unique Sealed-Source Impact							
5.5×10^{-7}	800	1.13	6.8×10^{-4}	3.7×10^{-10}	45.4	0.027	1.5×10^{-8}

The impact followed by fire accident results in the largest beryllium source term. As shown in Table 5-69, the calculated toxic chemical consequences from the onsite transport of RHWM would be small (i.e., less than the PAC-1 value for the MEI and less than the PAC-2 value for the non-involved worker).

Table 5-69. RHWM Onsite Transportation Bounding Accident Toxic Chemical (Beryllium) Consequences (Stability Class F and 1 m/sec.)

Frequency	MEI Distance (m)	Be Concentration (mg/m^3)	
		MEI	Non-involved Worker
RHWM: Impact Followed by Fire			
6.22×10^{-7}	90	3.5×10^{-3}	3.5×10^{-3}
	170	2.5×10^{-3}	7.0×10^{-3}

Note: The beryllium oxide PAC-1, PAC-2, and PAC-3 values are 0.0063, 0.069, and 0.28 mg/m^3, respectively.

5.16.7 Site-Wide Events/Accident Analysis Applicable to the No-Action Alternative and the Proposed Action

This section addresses the potential releases and consequences of a situation involving multiple source terms (both radiological and chemical) stemming from a single event affecting LLNL, such as an earthquake or a wildfire.

Seismic Events. Although the Livermore Site has numerous facilities that could be impacted during a seismic event, they are dispersed over the site's entire 821 acres. Therefore, unless the facilities are located near each other, the release from one facility is not likely to significantly increase impacts on the non-involved worker or MEI at another facility. The Superblock however contains multiple buildings in close proximity to each other, with each building housing hazardous and/or radiological materials. A single seismic event could cause releases from multiple buildings that potentially could impact the non-involved workers or MEI.

Superblock: Buildings 239, 331, 332, & 334. The four main buildings within the Superblock are: Building 239 Radiography Facility, Building 331 Tritium Facility, Building 332 Plutonium Facility, and Building 334 Hardened Engineering Test Building. The four Superblock Buildings have each been designed to withstand an evaluation basis earthquake (EBE), i.e., an earthquake with a peak ground acceleration of 0.57 g. At the Livermore site a 0.57 g earthquake has a return period of 1,000 years or a frequency of 0.001 per year.

The DSAs for each of these buildings contain a summary of the hazards that may result from seismic events. The Building 332 DSA (LLNL 2017d) contains a detailed analysis of the EBE. The results of that analysis are included in Table 5-70. The Building 331 DSA (LLNL 2018f) indicates that larger quantities of tritium in the Tritium Science Station and the Tritium Processing Station are typically stored on beds that are not susceptible to release under EBE conditions. However, the DSA also indicated that a large release could occur from Building 331 if the EBE initiated a fire in one of the increments. For this SWEIS it was conservatively assumed that Building 331 tritium releases following an EBE initiated fire would be the same as those presented in Table 5-70. The Building 331 DSA estimated the frequency of an EBE initiated fire to be from $<1\times10^{-4}$ to 1×10^{-6} per year. Table 5-70 presents the consequences of an EBE initiated fire at Building 331. Although the Building 239 and Building 334 DSAs (LLNL 2017f, 2017g) do not contain detailed EBE analyses, the DSAs do conclude that the consequences following a EBE to the non-involved worker and the public would be negligible due to no or minor radiological releases. The Building 239 and Building 334 DSAs define negligible consequences as <0.1 rem, but the consequences could be as low as zero if no radiological release occurs due to the EBE. This information has also been included in Table 5-70.

As Table 5-70 shows, the consequences from all four Superblock Buildings of an EBE occurring at the Livermore site are dominated by the consequences from Building 331.

Table 5-70. Superblock Evaluation Basis Earthquake Consequences and Risks

Superblock Building	Frequency (per year)	Consequence			Fatality Risks		
		MEI (rem)	Offsite Population (person-rem)	Non-involved Worker (rem)	MEI (LCF)	Offsite Population (LCF)	Non-involved Worker (LCF)
Building 239	0.001	Negligible*	Negligible	Negligible	Negligible	Negligible	Negligible
Building 331	$<1\times10^{-4}$ to 1×10^{-6}	0.97	220	38	5.8×10^{-4}	0.13	0.023
Building 332	0.001	2.6×10^{-5}	0.0059	0.0011	1.6×10^{-8}	3.5×10^{-6}	6.4×10^{-7}
Building 334	0.001	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible

* The B239 and B334 DSAs (LLNL 2017f and LLNL 2017g) define negligible consequences as <0.1 rem, but the consequences could be as low as zero if no radiological release occurs due to the EBE.

Source: LLNL 2017d, 2017f, 2017g; LLNL 2018f.

Based on this quantitative evaluation of the Superblock analyses, the risk to both the MEI and non-involved worker due to multiple events during a single earthquake is low considering both radiological and chemical releases.

Wildfires. Wildland fires are a concern at LLNL. Historically, wildland fires have not been a threat at the Livermore Site. However, wildland fires are a significant concern at Site 300. Precautions are taken to reduce the potential for a wildland fire spreading at Site 300 by reducing/controlling the growth of vegetation within a buffer area inside the perimeter fence, and by conducting an annual prescribed burn. The prescribed burn confines a potential fire to the property boundaries of Site 300, eliminates the fuel in high fire probability areas (HE test areas), and generally breaks the fuel path, thereby limiting the size of potential fires in other areas. LLNL has successfully conducted prescribed burns at Site 300 for over 45 years. (LLNL 2016d, p 24)

Additionally, the Alameda County Fire Department, under contract to LLNL, maintains fire department stations at the Livermore Site (Station 20) and Site 300 (Station 21). Should a wildfire approach either site, the Alameda County Fire Department would immediately act to extinguish it. Additional discussion of the precautions taken to reduce the potential risk due to wildfires at both the Livermore Site and Site 300 is provided in Appendix C, Section C.3.6.2. Based on these precautions, the risk to both the MEI and non-involved worker due to wildfires is low.

5.16.8 Accident Analysis Specific to New Projects under the No-Action Alternative

The accidents presented and analyzed previously in this section are based on the existing Livermore Site and Site 300 buildings and facilities. Under the No-Action Alternative, LLNL would use existing capabilities to continue to support major DOE/NNSA capabilities/programs described in Chapter 2 of this LLNL SWEIS and would proceed with projects that have been approved or are in the process of being approved for implementation, as shown on Tables 3-1, 3-2, and 3-3. Each of these new facilities, modernization/upgrade/utility projects, and DD&D projects is described in Section 3.2 of this LLNL SWEIS. Each of these projects was reviewed to determine whether the consequences from a radiological, chemical, biological, or HE accident resulting from the project could potentially result in greater consequences than the previous analysis of existing buildings and facilities. Many of the No-Action Alternative projects involve infrastructure improvement and similar projects, which by their nature would not result in any potential for a radiological, chemical, biological, or HE accident. However, there are several No-Action Alternative projects for which that conclusion is not intuitively obvious:

- Seismic Risk Reduction – This project involves the following facilities: 235, 321A, 411 271, 381B, and 431. None of these facilities affects the above accident analyses, and none contains sufficient quantities of radiological, chemical, biological, or HE to exceed the quantities assumed in the above accident analyses.
- Building 850 Revitalization Project – A review of this project found that, due to the assumed quantity of HE, the analysis presented in Section 5.16.4 bounds the consequences.

Therefore, it is concluded that the No-Action Alternative projects do not impact the accidents that have been previously analyzed and also do not pose any additional radiological, chemical, biological, or HE accident threat.

5.16.9 Accident Analysis Specific to New Projects under the Proposed Action

Under the Proposed Action, LLNL would continue to support national security and the other laboratory mission requirements described in Chapter 2 and Chapter 4 of this LLNL SWEIS and supports the need to replace many badly aged facilities with consolidated new construction. These new facilities, modernization/upgrade/utility projects, DD&D projects, and operational changes associated with the Proposed Action are identified in Tables 3-4, 3-5, and 3-6 and described in Section 3.3 of this LLNL SWEIS. Each of these projects was reviewed to determine whether the consequences from a radiological, chemical, biological, or HE accident resulting from the project could potentially result in greater consequences than the previous analysis of existing buildings and facilities. Many of the Proposed Alternative projects involve infrastructure improvement and similar projects, which by their nature would not result the any potential for a radiological, chemical, biological, or HE accident. However, there are several Proposed Alternative projects for which that conclusion is not intuitively obvious, those projects have been discussed below in further detail.

- High Explosives Infrastructure Revitalization Projects—This series of projects includes DRDF, HEX, HE Manufacturing Incubator, HE Safety Facility, HEAF Modular Aging Facility, and the HEAF Dynamic Studies Facility. Section 3.3.1.2 provides a complete list and description of these projects designed to enhance LLNL's HE capabilities. A review of these projects found that, due to the assumed quantity of HE, the analysis presented in Section 5.16.4 bounds the consequences from these Proposed Action projects.

- Packaging and Transportation Safety Operational Support Facility—Section 5.16.2 addresses a TRUPACT-II crane drop and fire in the A625 yard. Since the proposed location of the Packaging and Transportation Safety Operational Support Facility is farther from the site boundary than the A625 yard, a similar accident at the new facility would result in lower offsite consequences.

- Decrease Administrative Limit for plutonium-239 equivalent radioisotopes—Section 5.16.2 includes a plutonium release accident. The MAR used in this accident was based on the current plutonium-239 equivalent limits for the various Building 332 areas. While the Proposed Alternative operational change would reduce the plutonium-239 equivalent LLNL Administrative Limit for the entire Superblock, the limits for the various Building 332 areas would either be reduced or remain unchanged. Therefore, the consequences presented in Section 5.16.2 are bounding for this Proposed Action.

- A/BSL-3 Facility and Animal Care Facility Replacement—Section 5.16.5 addresses an analysis of accidents occurring at LLNL BSL-3 facilities. Because the Proposed Action would replace the current A/BSL-3 facility with a new, modernized facility with upgraded safety systems and storage capability, the consequences presented in Section 5.16.5 are considered to be conservative for this project.

- Domestic Uranium Enrichment Program—As described in Section 3.3.1.5, NNSA is proposing to develop pilot-scale laser-based uranium enrichment technology at LLNL. The facility would be a radiological facility that would remain below HC-3 thresholds. DOE-STD-1027 describes accidents at HC-3 facilities as having "only local significant consequences," and states that for below HC-3 facilities the accident consequences would be less than for an HC-3 facility. Thus, consistent with the approach described in Section C.3.1.2, accidents due to the proposed Domestic Uranium Enrichment Program have not been addressed in detail in this SWEIS.

- Revised National Ignition Facility Radioactive Materials Administrative Limits—Under the Proposed Action, NIF would increase tritium inventory from 8,000 Ci to 16,000 Ci; and increase plutonium administrative limits to below 38.2 grams. Future NIF experiments are expected to require the occasional transfer between NIF and other onsite LLNL locations of radioactive materials representing large fractions of HC-3 threshold limits. Consequence analyses have been conservatively performed based on the upper limits of plutonium and tritium defined for a Low Hazard Facility (HC-3 lower threshold values defined in DOE-STD-1027-2018). The consequences of a B581 Tritium Processing System Fire accident from this proposed increase are provided in Tables 5-60, 5-61, and 5-62.

- Revised Building 235 Plutonium Inventory Limits—Building 235 (B235), the Materials Science Division Offices and Labs, is considering an increase to its plutonium mixture inventory limits consistent with less-than-HC-3 designation per DOE-STD-1027-2018 (DOE 2018).

Therefore, it is concluded that the Proposed Action projects do not impact the accidents that have been previously analyzed and also do not pose any additional significant radiological, chemical, biological, or HE accident threat.

5.16.10 Intentional Destructive Acts

The Department of Energy's (DOE's) *Recommendations for Analyzing Accidents under the National Environmental Policy Act* (NEPA) (DOE 2002) requires that EIS's include a range of accident scenarios analyzed for intentional destructive acts (IDAs). Although these IDAs (i.e., malevolent acts of sabotage or terrorism) are not accidents, their physical acts – whether caused by a fire, explosion, missile, or other impact force – may be compared to the effects of postulated accidents. These consequences, involving radioactive and hazardous materials with environmental and/or health risks, caused by an act of sabotage or terrorism, can then be compared to the accident analyses documented in this SWEIS.

NNSA has prepared a Security Risk Assessment (SRA) to support this LLNL SWEIS that analyzes the potential impacts of intentional destructive acts (e.g., sabotage, terrorism). The SRA contains Official Use Only information related to security concerns and is not publicly releasable. A publicly-releasable summary of the SRA is shown in Appendix C. The IDA analysis applies to both the No-Action Alternative and the Proposed Action projects.

As noted in C.4.3, a comparison of the IDA analysis against the SWEIS accident analysis shows that many events have similar environmental impacts. The IDA impacts and the SWEIS accident impacts have similar consequences for radioactive materials dispersal, criticality events, chemicals, and biological events. The radioactive materials direct exposure events in the IDA analysis are comparable to the prompt dose from a criticality event in the SWEIS accident analysis. Additionally, sabotage for key chemical facilities, as well as National Critical Facilities, are comparable to SWEIS accident analyses. In summary, the accident analyses done in the SWEIS represents the bounding accidents relative to environmental concerns for the IDA analysis.

5.16.11 Emergency Management

DOE/NNSA requires all sites to implement a comprehensive emergency management system that considers and incorporates in its planning responses to a broad spectrum of hazards and possible consequences. The extent of emergency planning and preparedness for a particular LLNL building or facility corresponds to the type and amount of hazards and the potential effects on workers, the public, the environment and/or national security (LLNL 2021g).

LLNL has prepared an *Emergency Management Plan* (LLNL 2021g) that documents the comprehensive emergency management program, including response to operational emergencies, at LLNL. The *Emergency Management Plan* was prepared and structured in accordance with the DOE programmatic guidance for a standard format and content of DOE/NNSA emergency plans. The *Emergency Management Plan* addresses the contractor-applicable requirements of DOE Order 151.1D and provides an overview of the roles, responsibilities, and lines of authority for the Emergency Response Organization. The *Emergency Management Plan* also describes the interfaces and coordination with offsite agencies that provide community awareness and protection through notifications, protective action recommendations, and mutual aid. The concepts outlined in the *Emergency Management Plan* provide for the protection of workers, responders, the public, the environment, and national assets (LLNL 2021g). Appendix C, Section C.5, provides additional details regarding LLNL Emergency Management.

5.16.12 Summary of Accident Impacts

Table 5-71 summarizes the potential accident impacts for the alternatives.

Table 5-71. Potential Accident Impacts for the Alternatives

Accidents Applicable to the No-Action Alternative and the Proposed Action	Potential Impact
Livermore Site Facility Radiological Accidents—Bounding MEI Impact	
Conservative Meteorology: B693 – Waste Storage Facility Fire	Frequency: $\leq 1\times10^{-4}$ to 1×10^{-6} **MEI Dose: 17 rem; MEI LCF: 0.01** Population Dose: 160 person-rem; Population LCF: 0.096
Average Meteorology: A625 Yard TRUPACT-II Crane Drop and Fire	Frequency: $\leq 1\times10^{-4}$ to 1×10^{-6} **MEI Dose: 0.85 rem; MEI LCF: 5.1×10^{-4}** Population Dose: 5 person-rem; Population LCF: 0.003
Livermore Site Facility Radiological Accidents—Bounding Population Impact	
Conservative Meteorology: B625 Aircraft Crash	Frequency: 6.3×10^{-7} MEI Dose: 4.5 rem; MEI LCF: 0.0027 **Population Dose: 5,200 person-rem; Population LCF: 3.1**
Average Meteorology: B625 Aircraft Crash	Frequency: 6.3×10^{-7} MEI Dose: 0.041 rem; MEI LCF: 2.5×10^{-5} **Population Dose: 610 person-rem; Population LCF: 0.37**
Site 300 Radiological Accidents	Site 300 facilities are below HC-3 and have no offsite impacts.
Other Accidents	
Livermore Site Site-wide Earthquake	Frequency: $\leq 1\times10^{-4}$ to 1×10^{-6} MEI Dose: 0.97 rem; MEI LCF: 5.8×10^{-4} **Population Dose: 220 person-rem; Population LCF: 0.013**
Chemical Accidents	<u>Average Meteorology for the Livermore Site</u>: MEI chemical concentrations are each below their respective PAC-1 levels, except for accidents with chlorine and hydrogen chloride/hydrochloric acid, all of which are below their PAC-2 level. For Site 300, the MEI chemical concentrations are each below their respective PAC-1 levels. <u>Conservative Meteorology for the Livermore Site</u>: MEI chemical concentrations are each below their respective PAC-2 levels, except for the chlorine accident, which is below its PAC-3 level at the fenceline. For the chlorine accident scenario at 240 meters distance beyond the site boundary, concentrations are below PAC-2. For Site 300, the bounding chemical accident is a lithium hydride fire scenario, with a distance of 35 meters beyond the site boundary where concentrations are below PAC-2.
Livermore Site and Site 300 High Explosives Accidents	No offsite impacts.
Biological Accidents	No credible risk to the offsite population from escape of the bounding biological agent, even under the worst-case meteorological conditions at the Livermore Site.
Intentional Destructive Acts	
Theft, Sabotage, Others	All of the IDA consequences would be similar to, and consistent with, the accident consequences.

5.17 POTENTIAL IMPACTS OF ALTERNATIVES AT THE ARROYO MOCHO PUMP STATION

5.17.1 No-Action Alternative

No new facility construction or DD&D would occur at the Arroyo Mocho Water Pump Station under the No-Action Alternative; however, planned Pump Station modernizations would occur. In 2022, LLNL would replace deficient pumps and a deficient electrical motor control center to ensure continued reliability of its water supply. Sustained operations at Arroyo Mocho or along the pipeline would have no observable effects compared to existing operations. The potential resource impacts are presented in Table 5-72.

Table 5-72. No-Action Alternative Impacts at Arroyo Mocho Pump Station

Resource	Potential Impacts
Land Use	No land disturbance and no impact on land use at the Pump Station or along the pipeline.
Visual and Aesthetics	Construction would have short-term visual effects from laydown areas, additional vehicles, workers, and equipment. There would be no permanent impact on the visual character of Arroyo Mocho.
Geology and Soils	Construction activities would occur within previously disturbed areas and geology and soils would be unaffected.
Water Resources	Installation of new pumps would improve the water distribution system. Installation of pumps would be scheduled such that water service to the Livermore Site would not be disrupted. The pump replacements would have no impact to Site 300 because it primarily uses onsite groundwater wells for water supply.
Air Quality	Emissions from Arroyo Mocho were combined with Livermore Site emissions, as they are in the same non-attainment region. Emissions associated with the Arroyo Mocho Pump Station are *de minimis* (*see* Section 5.6.1).
Biological Resources	Pump replacement would occur within the existing building and would not affect vegetation, fish and wildlife, protected and sensitive species, or wetlands.
Cultural Resources	Pump replacement would occur within the existing building and would have no potential to impact cultural or paleontological resources.
Socioeconomics and Environmental Justice	Construction workforce estimates for the Livermore Site include pump replacement at the Arroyo Mocho Pump Station (*see* Section 5.10.1). There would be no environmental justice impacts from Arroyo Mocho activities.
Transportation	Transportation impacts for pump replacement would be unnoticeable.
Infrastructure	Pump replacements would not affect infrastructure.
Waste Management	No notable wastes from construction activities. No wastes are generated from operations.
Human Health	Human health impacts from construction at the Arroyo Mocho Pump Station are included in the Livermore Site analysis (*see* Section 5.13.1).
Accidents	There are no notable accident scenarios at the Arroyo Mocho Pump Station that could cause notable impacts.

5.17.2 Proposed Action

Under the Proposed Action, the Arroyo Mocho Pump Station and pipelines would be refurbished and upgraded as follows: (1) installation of a second telemetry control system; (2) replacement of the pump control systems and associated electrical switchgear; and (3) refurbishment of the seven-mile-long pipeline. Sustained operations at Arroyo Mocho or along the pipeline would have no observable effects compared to existing operations. The potential resource impacts are presented in Table 5-73.

Table 5-73. Proposed Action Impacts at Arroyo Mocho Pump Station

Resource	Potential Impacts
Land Use	Construction activities would occur within areas that were previously disturbed when the pipeline was constructed; there would be no impact on land use at the Pump Station or along the pipeline.
Visual and Aesthetics	Construction would have short-term visual effects from laydown areas, additional vehicles, workers, and equipment. There would be no permanent impact on the visual character of Arroyo Mocho.
Geology and Soils	Construction activities would occur within areas that were previously disturbed when the pipeline was constructed. Geology and soils would be unaffected.
Water Resources	These projects would improve the reliability and life of the supply system for the Livermore Site and SNL/CA. The upgrades would be scheduled such that water service to the Livermore Site would not be disrupted. There is no FEMA 100-year floodplain at the Arroyo Mocho Pump Station. The proposed refurbishment of pipeline at Arroyo Mocho Pump Station to SNL/CA would involve enhanced maintenance and any additional permits or assessments would be obtained if needed.
Air Quality	Emissions from Arroyo Mocho were combined with Livermore Site emissions, as they are in the same non-attainment region. Emissions associated with the Arroyo Mocho Pump Station are *de minimis* (*see* Section 5.6.2).
Biological Resources	The Proposed Action includes the refurbishment of the Arroyo Mocho water supply pipeline line. The pipeline refurbishment project spans areas of natural habitat, developed areas, agricultural land, and some potential wetlands. The proposed pipeline refurbishments project includes some areas that may be waters of the state or waters of the US. Prior to the start of the pipeline refurbishment project wetland delineations will be conducted at the location of potential wetlands within the project footprint. Appropriate permits would be obtained from the Army Corps of Engineers and the state Regional Water Quality Control Board if jurisdictional waters or wetlands may be impacted by this project. The pipeline refurbishment project includes areas that are habitat for several state and federal listed species including the Alameda whipsnake, the California red-legged frog, the foothill yellow-legged frog, and the California tiger salamander. Conservation measures would be developed in consultation with the USFWS and the CDFW to minimize impacts to these species as required by the ESA and CESA.
Cultural Resources	Construction activities would occur within previously disturbed areas and would have no potential to impact cultural or paleontological resources.
Socioeconomics and Environmental Justice	Construction workforce estimates for the Livermore Site include activities at the Arroyo Mocho Pump Station (*see* Section 5.10.2). There would be no environmental justice impacts from Arroyo Mocho activities.
Transportation	Transportation impacts for construction activities would be unnoticeable.
Infrastructure	Proposed actions would not affect infrastructure.
Waste Management	No notable wastes from construction activities. No wastes are generated from operations.
Human Health	Human health impacts from construction at the Arroyo Mocho Pump Station are included in the Livermore Site analysis (*see* Section 5.13.2).
Accidents	There are no notable accident scenarios at the Arroyo Mocho Pump Station that could cause notable impacts.

5.18 NEW HYBRID WORK ENVIRONMENT

As discussed in Sections 3.2.4 and 3.3.4, the new hybrid work environment is a DOE/NNSA initiative at the Administrator-level involving all NNSA laboratories, including LLNL. The new hybrid work environment would represent a different approach to conducting operations at LLNL, but would not change the fundamental NNSA mission requirements or overall facility operations.

Under this initiative, approximately 20 to 30 percent of the LLNL workforce could telework a maximum of 2.5 days per week without detriment to NNSA mission requirements.

This section provides an analysis of the potential environmental impacts associated with a new hybrid work environment at LLNL.

Although consolidation of personnel could help accelerate DD&D and construction activities, the number of facilities and offices would not change; potential decreases in office space would be countered by COVID-19 distancing requirements that may be required/accommodated for in the future. There would be no net change in safety, health, and waste generation because facility and laboratory personnel would continue to operate facilities and conduct the same types and amounts of experiments and tests. As a result, for both the No-Action Alternative and the Proposed Action, there would be no change in the following resources: land use, visual and aesthetic resources, geology and soils, water resources, biological resources, cultural resources, socioeconomics and Environmental Justice, human health, and accidents.

Impacts to the following resources could change because of the new hybrid work environment:

Air Quality. Reduced worker commuting and reduced travel would decrease air emissions. However, some of this decrease would likely be offset by workers using their home heating and air conditioning systems. NNSA estimates that onsite traffic could be reduced by up to 10 percent on any given day, which could reduce emissions by a maximum of approximately one percent.[28] Because LLNL operations do not violate any air quality standard or contribute substantially to an existing or projected air quality violation, a reduction of one percent in emissions would be inconsequential. Effects on air quality from construction would be the same with or without the implementation of this option. The reduced employee commuting and business travel is expected to have a positive impact on reduction of Scope 3 GHGs.

Transportation. Reduced worker commuting would result in positive impacts on the level-of-service (LOS) of area roads. Compared to the current baseline, which assumes 7,909 workers would use area roads daily to commute to LLNL, average daily traffic as a result of LLNL workers would decrease by 150 vehicles for both the No-Action Alternative and the Proposed Action. Reduced onsite worker population would also reduce onsite vehicle circulation and parking.

Infrastructure. Reduced onsite worker population would reduce domestic water use by a maximum of approximately 7.4 million gallons annually. Because steady-state water usage is expected to be approximately 475-535 million gallons annually, the reduction would amount to approximately 1.4-1.6 percent of the LLNL usage.

[28] This small percentage reflects the fact that the majority of operational air emissions are associated with facility operations and the heating and cooling of facilities.

5.19 DESIGN FEATURES, BEST MANAGEMENT PRACTICES, AND MITIGATION MEASURES

5.19.1 Introduction

As specified in the CEQ's NEPA regulations (40 CFR 1508.20), mitigation includes:

- Avoiding the impact altogether by not taking a certain action or parts of an action;
- Minimizing impacts by limiting the degree or magnitude of the action and its implementation;
- Rectifying the impact by repairing, rehabilitating, or restoring the affected environment;
- Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and
- Compensating for the impact by replacing or providing substitute resources or environments.

The No-Action Alternative and the Proposed Action have the potential to affect one or more resource areas. If mitigation measures above and beyond those required by regulations are needed to reduce impacts, NNSA is required to describe mitigation commitments in the ROD and prepare a mitigation action plan (10 CFR 1021.331). The mitigation action plan would explain how, before implementing the Proposed Action, certain measures would be planned and implemented to mitigate adverse environmental impacts. Because no potential adverse impacts were identified that would require additional mitigation measures beyond those required by regulation or achieved through design features or BMPs, NNSA does not expect to prepare a mitigation action plan.

For any new projects, a combination of design features and BMPs would be implemented to avoid or reduce potential environmental impacts that could result from implementing the Proposed Action. Facility designs could include features such as HEPA filtration and seismically qualified confinement structures that could minimize potential impacts to worker and public safety. BMPs are policies, practices, and measures that reduce the environmental impacts of proposed activities, functions, or processes.

Table 5-74 provides examples of design features and potential BMPs that could be utilized for new projects at LLNL. The first column of Table 5-74 lists a series of potential design features and BMPs, and the remaining columns identify those environmental resource areas that could benefit from the potential design features and BMPs. Sections 5.19.1–5.19.12 discuss these features and BMPs as applicable to the environmental resources evaluated in this SWEIS. In general, activities associated with the Proposed Action would follow standard practices, such as BMPs for minimizing impacts on environmental resources as required by regulation, permit, or guidelines. For the Proposed Action, NNSA would implement stewardship practices that are protective of the air, water, land, and other natural and cultural resources affected by NNSA operations in accordance with an environmental management system established pursuant to DOE Order 436.1, "Departmental Sustainability."

Table 5-74. Design Features and Potential BMPs

Design Feature or BMP	Land Use & Visual	Geology and Soils	Water Resources	Air Quality & Noise	Ecological Resources	Cultural Resources	Infrastructure	Socioeconomics	Environmental Justice	Waste Management	Human Health	Transportation
Potential Design Features or BMPs During Construction												
• Erosion and sediment control plans		✓	✓		✓							
• Sequencing or scheduling of work		✓		✓	✓		✓	✓				✓
• Spill prevention control and countermeasures		✓	✓		✓						✓	
• Use of low-sulfur, more-refined fuels				✓	✓						✓	✓
• Dust suppression measures	✓	✓		✓	✓						✓	
• HEPA filters, ventilation systems				✓	✓						✓	
• Silencers/mufflers, hearing protection programs				✓							✓	
• Preconstruction characterization/surveys of site		✓	✓		✓	✓					✓	
• Personal protective equipment				✓							✓	
Potential Design Features or BMPs During Operations												
• Water conservation practices			✓				✓					
• Spill prevention control and countermeasures		✓	✓		✓						✓	
• Personal protective equipment				✓							✓	
• Confinement and shielding systems				✓							✓	
• Ventilation and filter systems			✓	✓	✓						✓	
• Emergency preparedness and response plans									✓		✓	✓
• Radiological Protection and ALARA Program											✓	✓
• High-efficiency electric equipment/off-peak use							✓					
• Pollution prevention and waste minimization							✓			✓	✓	✓
• Public outreach and training									✓		✓	
• Scheduling, carpooling							✓	✓				✓

ALARA = as low as reasonably achievable; BMP = best management practice; HEPA = high-efficiency particulate air

5.19.2 Land Use and Visual Resources

Several measures could be considered for minimizing impacts on land use and visual resources, including the following:

- Follow the objectives of the LLNL Site Development Plan and permitting requirements.
- Where possible, limit land disturbed to previously disturbed areas or areas already designated for industrial use.
- Use existing infrastructure and rights-of-way to the extent practicable.
- Designate an environmental inspector for construction activities to ensure protection of vegetation and adherence to ground disturbance limits.
- Minimize damage to drainage features and other improvements such as ditches, culverts, levees, tiles, and terraces; however, if these features or improvements are inadvertently damaged, they would be repaired and/or restored.
- Site access roads and temporary work areas to avoid and/or minimize impacts to existing operations and structures.
- Restore and landscape open areas upon completion of construction-related activities.
- Implement measures (such as rock construction entrances) to minimize the transfer of mud onto primary roads.

The generation of dust during construction and operations activities could be reduced by limiting speed and/or travel routes utilized by equipment. Water, dust palliative, or gravel may be applied to access roads or exposed surfaces to reduce dust.

5.19.3 Geology and Soils

Facility construction or modification would disturb soil. At all areas on the Livermore Site or Site 300 where construction or facility modifications would occur, adherence to BMPs for soil erosion and sediment control during land-disturbing activities would minimize soil erosion and loss. In general, limiting the amount of time soils are exposed, limiting the area disturbed during any phase of a construction project, and applying protective coverings to denuded areas during construction (e.g., mulching and/or geotextiles) until such time as disturbed areas could be revegetated or otherwise covered by facilities would reduce the potential for soil loss. Soil loss would be further reduced by the use of appropriate sedimentation and erosion control measures as weather conditions dictate. Stockpiles of soil removed during construction would be covered with a geotextile or temporary vegetative covering and enclosed by a silt fence to prevent loss by erosion.

Contaminated soils and possibly other media could be encountered during excavation and other site activities. Prior to commencing any new ground disturbance, NNSA would survey potentially affected areas to determine the extent and nature of any contaminated media and required remediation in accordance with the procedures established under LLNL's soils or wastes program. Any contaminated soils and media would be managed in accordance with existing waste management practices. Depending on the nature and extent of any newly discovered soil (and associated media) contamination, remediation and cleanup could be conducted under existing CERCLA environmental restoration agreements, including the Livermore Site and Site 300 FFAs.

5.19.4 Water Resources

There would be no direct discharge of effluents to surface waters or groundwater during construction or operations; therefore, the Proposed Action would not result in appreciable direct impacts on water quality. Potential impacts from stormwater discharges during construction and operations would be minimized by compliance with existing LLNL NPDES permits. These permits and related regulations have required LLNL to prepare and implement plans to control or eliminate discharge of pollutants, including hazardous and toxic substances, sediment, and contaminated stormwater. These plans include a best management plan, an SPCC plan, and an SWPPP. These plans, particularly the SPCC plan, also protect surface waters from spills of hazardous materials in instances where hazardous materials are being handled.

During construction, these plans would address the presence of heavy equipment and staged fuel storage containers, as applicable, and would require actions, such as putting temporary storage containers within secondary containment and identifying the types and locations of equipment available to respond to (i.e., contain and cleanup) spills or leaks of potential pollutants. These efforts to protect surface water from spills and leaks also act to protect groundwater from pollutants infiltrating from the surface.

No mitigation would be required to reduce potential impacts from water use, but existing site-wide efforts to identify and implement water conservation opportunities would be pursued in the new operations.

5.19.5 Air Quality and Noise

Construction or modification of facilities under the Proposed Action would result in some emissions of criteria and hazardous air pollutants, of which particulate matter would be a primary concern. Construction equipment criteria pollutant emissions would be minimized by using specific fuels (e.g., low-sulfur diesel fuel, alternative ethanol-containing fuel) and by maintaining equipment to ensure that emissions control systems and other components are functioning at peak efficiency. Soils exposed in excavations and slope cuts during new facility construction would be subject to wind or rain erosion if left exposed. In addition, fugitive dust emissions would result from land disturbed by heavy equipment and motor vehicles. Construction emissions would be minimized using water to control dust emissions from exposed areas, revegetation of exposed areas, watering of roadways, and minimizing construction activities under dry or windy conditions.

Facility operations would result in air emissions of various criteria and non-criteria air pollutants, including radionuclides, and organic and inorganic constituents. These emissions would be controlled using best available control technologies to ensure that emissions are compliant with applicable standards. Impacts would be minimized by use of biosafety cabinets, glovebox confinement and air filtration systems (e.g., HEPA filters) to remove particulates (e.g., radioactive, microorganism) before discharging process exhaust air to the atmosphere.

Construction and operations workers could be exposed to noise levels higher than acceptable limits, particularly for confined areas, as specified in OSHA noise regulations. DOE/NNSA has implemented hearing protection programs that meet or exceed OSHA standards to minimize noise impacts on workers. These include the use of standard silencing packages on construction equipment, sequencing and scheduling work shifts, administrative controls, engineering controls, and personal hearing protection. There would be some temporary, additional noise during construction due to additional worker traffic. Operations would not increase noise levels over existing activities, although there could be some additional noise due to additional worker traffic to support additional activities.

5.19.6 Biological Resources

Biological impacts during construction activities would be minimized by using previously disturbed land where possible. With the exception of the New North Entry and the new Fire Station (alternate location), both of which would be constructed in the north buffer zone at the Livermore Site, the proposed sites for construction of new facilities at the Livermore Site are in previously disturbed or developed areas. Under the Proposed Action at Site 300, the proposed construction of new facilities and implementation of modernization/upgrade/utility projects would result in development on approximately 0.5 percent of the total acreage at Site 300. The Proposed Action includes construction of new facilities in upland habitat for the California red-legged frog and California tiger salamander. Because all of Site 300 is within critical habitat designation for the California red-legged frog, surveys would be required for all new facilities prior to construction. These projects would be completed in consultation with the USFWS as required by Section 7 of the federal *Endangered Species Act*. Implementation of soil erosion and sediment control and SWPPPs would prevent runoff and dust from impacting offsite areas. Following construction, the cleared and graded areas not covered with facilities, parking lots, or roads would be landscaped except for areas required to remain clear for security or fire prevention purposes.

During operations, SWPPPs and wastewater treatment would minimize potential impacts to offsite resources from stormwater runoff and effluent discharges. The Radiological Protection and ALARA Program designed to protect human health would also minimize or eliminate potential radiological impacts to ecological resources.

5.19.7 Cultural and Paleontological Resources

BMPs would be used during construction to control drainage and erosion patterns, thereby limiting the potential for erosion impacts to cultural and paleontological resources. In the unlikely event of a discovery of cultural or paleontological resources, such discovery would be evaluated, as necessary, in accordance with LLNL procedures.

5.19.8 Socioeconomics and Environmental Justice

Impacts related to population changes, availability of housing, and community services during the life of the project are expected to be small. Payroll and materials expenditures would have a positive impact on the local economies. During construction, NNSA could consider sequencing or scheduling work to more evenly distribute the number of personnel. This measure could reduce potential impacts on population, housing, and community services.

No mitigation measures specific to environmental justice would be necessary because the Proposed Action would not result in disproportionately high and adverse impacts on minority or low-income populations. However, measures that would minimize impacts to human health, as well as emergency preparedness and response plans and public outreach and training, would help ensure adverse impacts related to environmental justice would not occur

5.19.9 Transportation

Measures that could be used to minimize transportation impacts include transporting materials and wastes during periods of light traffic volume, providing vehicle escorts, avoiding high-population areas, avoiding high-accident areas, and training drivers and emergency response personnel. The Department of Homeland Security is responsible for coordinating the response to accidents involving radioactive materials and waste, with DOE maintaining many of the resources that would be used if such an event were to occur. In addition, to reduce the possibility of an accident, DOE issued DOE Manual 460.2-1A, which establishes a set of standard transportation practices for the DOE, including the NNSA, to use in planning and executing offsite shipments of radioactive materials and wastes. BMPs related to minimizing commuter traffic fatalities include encouraging carpooling and promoting safe driving practices among the workforce.

5.19.10 Infrastructure

In general, construction activities associated with the Proposed Action would occur in areas with existing utility infrastructure. The consumption of energy, fuel, and water resources would be within the capabilities of the existing infrastructure. Impacts on the regional electrical grid would be minimized by incorporating high-efficiency motors, pumps, lights, and other energy-saving equipment into the design of new facilities, and by scheduling some operations during off-peak times. Impacts on water use would be minimized by using water-conserving processes and equipment. Impacts on fuel use would be reduced by using fuel-efficient processes, equipment, and vehicles (e.g., hybrids or electric vehicles). Pursuant to DOE Order 436.1, DOE has established goals for energy efficiency and water conservation improvements at DOE sites, including reductions in energy and potable water consumption, use of advanced electric metering systems, use of sustainable building materials and practices, and use of innovative renewable and clean energy sources (LLNL 2019j). Incorporation of the Guiding Principles for Federal Sustainable Buildings would further reduce impacts on site infrastructure.

5.19.11 Waste Management

NNSA would manage wastes generated during the Proposed Action in a manner consistent with existing practices. That is, each waste type would be managed through facilities and processes that have the appropriate operational permits and are in compliance with applicable waste management regulations.

Section 5.13 of this SWEIS identifies the amounts of TRU waste and LLW that would be generated during operations. These projected volumes are higher than the amounts currently generated at LLNL. Impacts from the increased waste are expected to be minimal. NNSA would implement waste minimization efforts that could potentially make waste management simpler and even conserve resources. Waste minimization would be pursued during operations as part of the goals and objectives of the LLNL Environmental Management System and Site Sustainability Plan (*see* Section 4.12.5).

5.19.12 Human Health

Construction activities would generally occur in nonradiological areas and doses to workers would be essentially zero. Although contaminated soils are not expected, NNSA would prevent potential exposure from excavation activities by assessing or sampling the soil for radioactive contamination before excavation begins. If contaminated soil is discovered, appropriate techniques would be applied to remediate the conditions and ensure worker safety.

Safety features would be incorporated into the design of new facilities to minimize impacts to workers and the public. These include, but are not limited to, confinement (e.g., gloveboxes), shielding, ventilation, and air filtration systems. BMPs to ensure radiation protection would include formal analysis by workers, supervisors, and radiation protection personnel of methods to reduce exposure of workers to the lowest practicable level. For all activities involving radiation work, NNSA would employ ALARA measures, such as minimizing time spent in high-radiation areas, maximizing distances from sources of radiation, using shielding, and/or reducing the radiation source. The radiological limit for an individual worker is 5,000 millirem per year (10 CFR Part 835). However, DOE's goal is to maintain radiological exposure as low as reasonably achievable. At LLNL, administrative control levels are multi-tiered, meaning they can vary between 500 millirem/year and up to 5,000 millirem/year with appropriate management approval (LLNL 2019w).

LLNL adheres to programs used to ensure minimization of human health and safety impacts to the maximum extent practicable. The Radiological Protection and ALARA Program ensures that radiological exposures and doses to all personnel are maintained to ALARA levels and by providing job-specific instructions in job hazard analyses to the facility workers regarding the use of personal protective equipment. The Emergency Preparedness Program minimizes accident consequences by ensuring that appropriate organizations (e.g., fire department, operations, medical, and security) are available to respond to emergency situations and take appropriate actions to recover from anticipated events while reducing the spread of contamination and protecting facility personnel and the public.

Occupational safety risks to workers would be minimized by adherence to federal and state laws; OSHA regulations; DOE requirements, including regulations and orders; and plans and procedures for performing work. DOE regulations addressing worker health and safety include 10 CFR Part 851, "Worker Safety and Health Program," and 10 CFR Part 850, "Chronic Beryllium Disease Prevention Program." Workers are protected from specific hazards by training, monitoring, use of personal protective equipment, and administrative controls (i.e., job hazard analyses).

5.19.13 Facility Accidents

Appendix C, Section C.3, discusses mitigation measures related to accidents.

5.20 DECONTAMINATION, DECOMMISSIONING AND DEMOLITION

Eventually, the facilities associated with the No-Action Alternative and the Proposed Action would be subject to DD&D at their end-of-life. For any new facility, the primary DD&D goal would be to reduce or remove substances that pose a substantial hazard to human health or the environment, retire the facility from service, and ultimately eliminate all or a portion of the building or structure. The facility decontamination would be conducted in accordance with all applicable regulations and requirements and in a manner that would minimize potential impacts to the health and safety of workers, the general public, and the environment.

Prior to the initiation of DD&D activities, the facility operator would prepare a detailed DD&D plan for NNSA approval. The DD&D plan would contain a detailed description of the facility-specific DD&D activities to be performed and would be sufficient to allow an independent reviewer to assess the appropriateness of the decommissioning activities; the potential impacts on the health and safety of workers, the public, and the environment; and the adequacy of the actions to protect health and safety and the environment. All buildings and systems would require regulatory planning, document preparation, and characterization and deactivation before any DD&D activities would be allowed to commence. Facilities would be characterized to identify waste types (e.g., radiological and chemical waste), construction material types (e.g., steel, roofing, concrete), presence of equipment, levels of contamination, expected waste volumes, and other information that would be used to support safe demolition and clarify requirements for developing facility-specific plans. Active systems (e.g., electric, water, telecommunications) would be identified and deactivated, as appropriate. Adaptive reuse of such infrastructure would be considered, and recyclable materials would be sorted and managed separately, to the extent practicable.

Because the Proposed Action in this SWEIS involves radiological materials, there is a potential for residual contamination, in the following areas:

- Surface contamination in and on building structures, such as equipment (e.g., gloveboxes), walls, ceilings, roof, floors, sinks, laboratory hoods, and air ventilation ducts;
- Solid and liquid contaminated waste from normal operations and off-normal and accident events; and
- Land contamination from normal and off-normal operations and accident events.

The extent and amount of DD&D associated with the Proposed Action cannot be estimated without a detailed assessment of the facilities, which would not be conducted until facilities reach their end-of-life. However, this SWEIS acknowledges that the Proposed Action could eventually involve the DD&D of approximately 3.3 million square feet of buildings and structures, which would account for the amount of new construction identified in Table 3-4. Any LLW would be disposed of at NNSS or other appropriate permitted disposal facility, while nonradioactive waste would likely be disposed of at landfills in the LLNL area.

Although DD&D activities would generate nonradiological air emissions, there is a potential for radiological air emissions to occur. The intermittent nature of DD&D emission sources would result in dispersed concentrations of air pollutants adjacent to DD&D activities. The transport distance of DD&D emissions from the Livermore Site to offsite areas would result in farther dispersion. Ambient air concentrations at LLNL are in compliance with the applicable standards or guidelines, as discussed in Section 4.6. As a result, air pollutant concentrations generated from DD&D activities are expected to remain below the applicable NAAQS.

Potential impacts to ecological resources during DD&D operations could occur from changes in land use and human disturbance and noise. However, given the minimal ecological resources at the Livermore Site, impacts would not be notable. Infrastructure demands associated with DD&D are expected to be less than construction demands, and the LLNL infrastructure is expected to have adequate supply to meet demand.

DD&D activities could also cause health and safety impacts to workers (occupational and radiological), as well as potential health impacts to the public through the release of radiological materials. DD&D planning would implement ALARA objectives and follow radiological protection guidelines to ensure that radiation doses to employees are kept below administrative guidelines and that airborne releases, which could impact the public, are kept to *de minimis* levels. Lessons learned from DD&D at other DOE sites would be applied to minimize impacts to workers and the public. Experience with other DD&D operations has shown that while occupational impacts to workers are expected, BMPs can reduce impacts. For example, at the Rocky Flats Plant in Colorado, occupational impacts during DD&D were considerably less than impacts in the construction industry as a whole. At the Rocky Flats Plant, the 12-month total recordable cases rolling average was 0.9 per 100 full-time workers. By comparison, the total recordable cases rolling average in the construction industry for calendar year 2004 was 6.4 per 100 full-time workers (GAO 2006).

While DD&D activities would also produce socioeconomic impacts, it would be speculative to quantify the number of jobs that would be created; however, DD&D activities at other DOE sites, such as the East Tennessee Technology Park in Oak Ridge and the Rocky Flats Plant, have created a significant number of temporary jobs relative to the number of operational jobs that were lost when a facility ceased operations.

It is expected that most surface contamination would be easily removed and reduced to acceptable levels. Any wastes from such decontamination would likely be categorized as LLW, in accordance with the *Low-Level Radioactive Waste Policy Amendments Act of 1985* (42 U.S.C. § 2021b), since the wastes would not be HLW, SNF, or byproduct material as defined by the *Atomic Energy Act of 1954* (NNSA 2008). These wastes (e.g., clothing, gloves, equipment, rags, paper, filters, and plastic) would likely be disposed of at NNSS and Energy*Solutions*. There would also likely be TRU wastes, which would be sent to WIPP for disposal.

5.21 UNAVOIDABLE ADVERSE IMPACTS

This SWEIS has identified potential adverse impacts that could occur under the No-Action Alternative and the Proposed Action and measures that could be taken to minimize or avoid these impacts. The residual adverse impacts of actions remaining after design features and BMPs are credited, if any, are considered to be unavoidable. In accordance with NEPA requirements (40 CFR 1502.16), this section discusses any potential unavoidable adverse impacts that could occur if the Proposed Action were implemented.

Construction activities associated with the Proposed Action would disturb approximately 85.5 acres of land at the Livermore Site and approximately 36 acres of land at Site 300.[29] This land requirement represents approximately 10.4 percent of the land at the Livermore Site and approximately 0.5 percent of the land at Site 300. Although construction activities would change the existing land use, the facilities/projects associated with the Proposed Action would be compatible and consistent with the land use plans at LLNL and would be compatible with the current local land use designations.

The majority of the Livermore Site consists of highly developed and previously disturbed industrial area; therefore, there would be no notable loss of habitat or impacts to biological, cultural, or archaeological resources. The only exception to this would be the construction of the

[29] Majority of land that would be disturbed has been previously disturbed.

New North Entry and the new Fire Station (alternate location), both of which would be constructed in the north buffer zone. Because of its large size, and implementation of appropriate BMP's and mitigation, including complete surveys that have identified extant cultural resources for protection, there would be no notable loss of habitat or impacts to biological, cultural, or archaeological resources at Site 300 from disturbance of 0.5 percent of the site. Construction impacts would be minor, and appropriate soil and erosion mitigation measures would minimize any adverse impacts. No federal- or state-threatened or endangered species and other species of special interest are expected to be impacted by the Proposed Action. Paleontological resources could be impacted by construction projects; however, appropriate BMPs are in place to minimize any impact, ensuring that no projects would cause any significant impacts. but the types of fossils found at the Livermore Site and Site 300 are not unique and such impacts would not be considered significant.

For both construction and operations, the use of water, fuel, and electricity is considered unavoidable. During construction and operations, water use would be approximately 380 million gallons per year, which is approximately 36 percent of the existing capacity of the Livermore Site domestic water system. At Site 300, water use would be approximately 20 million gallons per year, which is approximately 20 percent of the existing capacity of the Site 300 domestic water system. As reported in Section 4.12.2, fuel capacity would generally not be limited, as delivery frequency would be increased to meet demand. The maximum amount of electrical consumption would be adequately supported by the existing infrastructure at both the Livermore Site and Site 300.

Although there would be overall positive socioeconomic impacts associated with construction and operational workforces, an increase in vehicle traffic could affect the roads and transportation network surrounding LLNL's sites. Even though the employment increases would represent less than one percent of the total employment in the socioeconomic ROI, the resulting impacts on traffic and congestion resulting from socioeconomic growth, although minor, would be off-set by increase direct and indirect economic growth.

During normal operations, a minimal amount of radioactive material and activation products could be released to the environment. However, any radiation dose received by a member of the public from emissions would be small and well below regulatory limits. At the Livermore Site, the collective dose to the 50-mile population is estimated to be 7.1 person-rem per year, which translates into an LCF risk of 4.3×10^{-3}. At Site 300, the collective dose to the 50-mile population is estimated to be 5.0×10^{-5} person-rem per year, which translates into an LCF risk of 3.0×10^{-8}. During normal operations, workers would be exposed to an increased risk of cancer as a result of occupational exposure to radiation. The collective dose to radiological workers is estimated to be a maximum of 106.7 person-rem per year, which translates into an LCF risk of 0.06.

Operations would generate a variety of wastes (including radioactive, hazardous, mixed, and sanitary) as an unavoidable result of normal operations. Although LLNL uses pollution prevention and waste avoidance measures, generation of chemical and radioactive wastes would be unavoidable. LLNL would continue to further reduce hazards and potential exposures through the continued success of pollution prevention and waste avoidance measures.

There would be approximately 888 annual shipments of radiological materials and wastes (2023 to 2035), which could impact the public along transportation routes. Under the Proposed Action, modeling of all 888 potential offsite shipments would yield a bounding collective (i.e., cumulative) incident-free dose to transport crews of 69.2 person-rem per year, with an associated increased risk of 0.042 LCF; a bounding collective incident-free dose to the general public of 24.7 person-rem, with an associated increased risk of 0.015 LCF; and a bounding cumulative increased risk of 2.9 $\times 10^{-6}$ LCF to the general public from accidents that result in a container breach/release. As a point of comparison, the bounding cumulative increased risk of 0.038 additional traffic fatalities (due to traffic accidents) would result from all shipments conducted under the Proposed Action; this would be a factor of roughly 10,000 higher than the bounding incremental increase of 2.9 $\times 10^{-6}$ LCF estimated to the public from the potential radiological impacts associated with such shipment accidents.

5.22 Relationship Between Short-Term Uses and Enhancement of Long-Term Productivity

Sections 5.2–5.16 of this SWEIS discuss potential impacts that could occur under the No-Action Alternative and the Proposed Action, and Chapter 6 identifies cumulative impacts that could occur from the Proposed Action and ongoing and reasonably foreseeable future actions. NNSA reviewed these potential impacts and determined that land use, biological resources, water resources, air quality, and waste management warranted discussion regarding short-term uses of the environment and the maintenance and enhancement of long-term productivity. In accordance with NEPA requirements (40 CFR 1502.16), this section discusses the relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity.

Land Use and Biological Resources. Construction activities associated with the Proposed Action would disturb approximately 85.5 acres of land at the Livermore Site and approximately 36 acres of land at Site 300. Once construction is complete, operations would not adversely affect the long-term productivity of the land because operations would be compatible with historic operations at LLNL. With the exception of the New North Entry and the new Fire Station (alternate location), both of which could be constructed in the north buffer zone, construction would occur in previously disturbed areas at the Livermore Site. Losses of terrestrial habitat to accommodate the Proposed Action are not expected due to the industrialized nature of the Livermore Site, and short-term disturbances of previously disturbed land is not expected to cause long-term reductions in the biological productivity of the area as a whole. At Site 300, because of its large size, and implementation of appropriate BMP’s and mitigation, there would be no notable loss of habitat or impacts to biological resources from disturbance of 0.5 percent of the site. This represents an increase of 10.3 percent over the existing 350 acres of disturbed areas. After the operational life of any new facilities, NNSA would perform DD&D of the facilities (*see* Section 5.18) in accordance with applicable regulatory requirements and then close in place or restore the areas occupied by the facilities to brownfield sites that would be available for other industrial use. Appropriate reviews under CERLCA and/or NEPA would be conducted before initiation of DD&D actions.

Water Resources. LLNL’s primary water supplier is the San Francisco Public Utilities Commission (SFPUC) Hetch Hetchy Regional Water System. The secondary water source for the Livermore Site is Zone 7, which is used several months each year when SFPUC is conducting maintenance. Municipal water would be used to meet process and sanitary wastewater needs over the short term (during construction and operations). LLNL’s effluent contains both domestic waste and process wastewater and is discharged in accordance with Wastewater Discharge Permit (Permit #1250) requirements administered by the City of Livermore Water Resources Division and the City of Livermore Municipal Code. Most of the process wastewater generated at the Livermore Site is collected in retention tanks and discharged to LLNL's collection system following characterization and approval from LLNL's Wastewater Discharge Authorization Record approval process (LLNL 2019f). The use of water is not likely to affect the long-term productivity of water resources.

Air Resources. Air emissions associated with construction and operation of the Proposed Action would add small amounts of radiological and nonradiological constituents to the LLNL regional air environment. During the short term, these emissions are not expected to affect LLNL compliance with radiation exposure or air quality standards. LLNL continues to work towards the goal of reducing GHG emissions by 50 percent by the year 2025 (LLNL 2019j). The Proposed Action Alternative would increase LLNL GHG emissions by approximately 5,239 metric tons per year (3.4 percent increase) over the No-Action Alternative estimates. In California, state-wide GHGs are estimated to be approximately 363.5 million metric tons per year (EIA 2016). GHG emissions associated with the Proposed Action at LLNL would account for less than 0.03 percent of those emissions. No significant residual environmental effects on long-term environmental productivity are expected.

Wastes. The management and disposal of solid wastes would require energy and space at treatment, storage, or disposal facilities in regional landfills. Most LLW would be disposed of at the NNSS. Land used for LLW and solid waste disposal would require a long-term commitment of terrestrial resources. The short-term use of these facilities to support LLNL activities is not expected to change their planned closure dates, and therefore, should not result in an incremental change in the potential long-term productivity of these sites. Similarly, disposal of TRU waste at WIPP would require the continued long-term commitment of that site to support national defense missions.

5.23 IRREVERSIBLE AND IRRETRIEVABLE RESOURCE COMMITMENTS

A commitment of resources is irreversible when its primary or secondary impacts limit the future options for a resource. For example, as a landfill receives waste, the primary impact is a limit on waste capacity. The secondary impact is a limit on future land use options. An irretrievable commitment refers to the use or consumption of a resource that is neither renewable nor recoverable for use by future generations. NNSA reviewed the impacts in Chapters 5 and 6 of this SWEIS and determined that land, energy, material, and water have the potential to be committed irreversibly or irretrievably under the No-Action Alternative and the Proposed Action. In accordance with NEPA requirements (40 CFR 1502.16), this section discusses any potential irreversible or irretrievable commitments of resources under the Proposed Action.

Land. The land requirements in support of the Proposed Action would be minimal in relation to the existing land at the Livermore Site and Site 300 and would represent an irreversible commitment of the land. Construction activities associated with the Proposed Action would disturb approximately 85.5 acres of land at the Livermore Site and approximately 36 acres of land at Site 300. The areas identified for the Proposed Action were previously committed to DOE/NNSA mission support. Once any new facilities are operational, the land would not be available for other uses. Once the new facilities reach their end-of-life, it is possible that the land would not be restored to its original condition or even to minimum cleanup standards. This land could be permanently unusable because the substrata would not be available for other potential intrusive uses such as mining, utility infrastructure, or foundations for other buildings. However, the surface area appearance and biological habitat lost during construction and operation of the facilities/projects associated with the Proposed Action could, to a large extent, be restored to pre-disturbed conditions.

Energy. The irretrievable commitment of resources during construction and operation of the Proposed Action projects/facilities would include the consumption of fossil fuels used to generate heat and electricity. Energy would also be expended in the form of diesel fuel, gasoline, and oil for construction equipment and transportation vehicles. The amounts of irretrievable energy required to construct and operate the Proposed Action projects/facilities are estimated in Section 5.12 of this SWEIS. In general, the irretrievable energy amounts would represent a fraction of the Livermore Site and Site 300 capacity and current uses.

Materials. The irreversible and irretrievable commitment of material resources during the life of the Proposed Action projects/facilities includes construction materials that cannot be recovered or recycled, materials that are rendered radioactive and cannot be decontaminated, and materials consumed or reduced to unrecoverable forms of waste. Materials used during construction would include wood, concrete, sand, gravel, plastics, steel, aluminum, and other metals. At this time, no unique construction material requirements have been identified— whether type or quantity. The construction resources, except for those that can be recovered and recycled with present technology, would be irretrievably lost. However, none of these identified construction resources is in short supply and all are readily available in the vicinity of LLNL. The materials to be manufactured into new equipment that could not be recycled at the end of the project's useful life are considered irretrievable. While irretrievable, consumption of operating supplies, miscellaneous chemicals, and gases would not constitute a permanent drain on local sources or involve any material in critically short supply in the United States as a whole. Plans to recover and recycle as much of useful materials as practical would depend upon need. Each item would be considered individually at the time a recovery decision is required.

Water. Water is a scarce resource in many parts of the United States, and especially in California, where long-term drought conditions are common. During construction and operations, water use would be a maximum of approximately 482 million gallons per year, which is approximately 51 percent of the current capacity of the Livermore Site domestic water system. At Site 300, water use would be approximately 21 million gallons per year, which is approximately 20 percent of the current capacity of the Site 300 domestic water system. There would be minimal impacts on surface water and groundwater resources. Nonhazardous facility wastewater, stormwater runoff, and other industrial waste streams would be managed and disposed of in compliance with the NPDES permit limits and requirements. There would be no direct release of contaminated effluents to groundwater or surface waters. To the extent water is recoverable, it has been designed into the facility planning process.

5.24 STATUTORY REQUIREMENTS AND ENVIRONMENTAL STANDARDS

Activities at LLNL must be performed in a manner that ensures the protection of public health, safety, and the environment through compliance with all applicable federal, state, and local laws, regulations, and other requirements. This section identifies the statutory requirements and environmental standards that are applicable to the No-Action Alternative and the Proposed Action activities addressed in this SWEIS. These requirements and standards originate from several sources. Federal and state statutes define broad environmental and safety programs and provide authorization to agencies to carry out the mandated programs. More specific requirements are established through regulations at both the federal and state level. Federal agencies, such as DOE/NNSA, receive additional direction in complying with executive policy through Executive Orders. In addition, DOE/NNSA has established regulations and management directives (DOE Orders) that are applicable to DOE/NNSA activities, facilities, and contractors. Regulations often include requirements for permits and consultations, which provide an in-depth, facility-specific review of the activities proposed. Laws, regulations, Executive Orders, and DOE Orders are discussed in Section 5.24.1. Other regulatory activities and environmental permits are discussed in Sections 5.24.2 and 5.24.3, respectively.

5.24.1 Laws, Regulations, Executive Orders, and DOE Orders

Multiple federal agencies regulate specific aspects of activities that would be conducted at the Livermore Site and Site 300. The USEPA regulates air emissions, hazardous waste management, water quality, and emergency management. In many cases, the USEPA delegated all or part of its environmental protection authorities to states, including California, but retains oversight authority. For example, air emissions are regulated by the Bay Area Air Quality Management District (BAAQMD) for Alameda County and the Livermore Site, and the San Joaquin Valley Air Pollution Control District (SJVAPCD) for San Joaquin County and Site 300.

DOE/NNSA imposes its own standards on many aspects of activities that would be conducted at the Livermore Site and Site 300 through regulations, orders, and contract requirements related to facility design and operations, radioactive waste management, and health and safety, including radiation protection. U.S. Department of Transportation (USDOT) regulates commercial transportation of hazardous and radioactive materials.

Table 5-75 provides a listing, of environmental laws, regulations, and other requirements, including but not limited to those mentioned below, that are potentially applicable to the Proposed Action.

Table 5-75. Major Federal and State Environmental Laws and Regulations with Permit Approval, Consultation, and Notification Requirements

Law or Regulation	Citation	Responsible Agency	DOE/NNSA Responsibilities
General			
Atomic Energy Act of 1954, as amended	42 U.S.C. §2011 et seq.	DOE	NNSA shall follow its own standards and procedures to ensure the safe operation of its facilities. The Act assigns responsibility to DOE for providing nuclear weapons to support U.S. national security strategy.
NEPA	42 U.S.C. §4321 et seq.	CEQ	Establishes requirements for environmental impact statements. Statutory requirements for preparation of EISs apply to all major federal actions significantly affecting the environment. NNSA shall comply with NEPA implementing procedures in accordance with 10 CFR Part 1021. NNSA's NEPA compliance program is established in Policy NAP-451.1.
Regulations for Implementing the Procedural Provisions of NEPA	40 CFR Parts 1500–1508	CEQ	These regulations seek to integrate the NEPA process into the early planning phase of a project to insure appropriate consideration of NEPA policies and to eliminate delays, emphasize cooperative consultation among agencies before the environmental document is prepared, identify at an early stage the significant environmental issues deserving of study, provide a mechanism for putting appropriate time limits on the environmental documentation process, and provide for public participation in the NEPA process.
NEPA Implementing Procedures	10 CFR Part 1021	DOE	DOE established its NEPA implementing procedures to meet the requirements of Section 102(2)(c) of NEPA, CEQ implementing regulations, and EO 11514, Protection and Enhancement of Environmental Quality (35 FR 4247). DOE's implementing procedures formalize DOE's policy to follow the letter and spirit of NEPA, comply fully with the CEQ regulations, and apply the NEPA review process early in the planning stages for DOE proposals. The Site-wide Environmental Impact Statement is being prepared under 10 CFR §§1021.330, programmatic (including site-wide) NEPA documents, requiring preparation of site-wide environmental documentation for certain of its large, multiple-facility sites.
EO 11514: Protection and Enhancement of Environmental Quality	3 CFR Parts 1966–1970 Comp., p. 902	CEQ	Requires federal agencies to demonstrate leadership in achieving the environmental quality goals of NEPA; provides for DOE consultation with appropriate Federal, state, and local agencies in carrying out their activities as they affect the environment.
EO 12898: Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations	N/A	USEPA	Requires each federal agency to identify and address any disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low-income populations.

Law or Regulation	Citation	Responsible Agency	DOE/NNSA Responsibilities
EO 13045: Protection of Children from Environmental Health Risks and Safety Risks	N/A	USEPA	Requires each federal agency to identify and assess any environmental health risks and safety risks that may disproportionately affect children and ensure that its policies, programs, activities, and standards address these disproportionate risks.
EO 14057: Executive Order on Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability	N/A	Office of the President	Announces policy to achieve a carbon pollution-free electricity sector by 2035 and net-zero emissions economy-wide by no later than 2050.
California Environmental Quality Act	California Public Resources Code, §21000 et seq.	Governor's Office of Planning and Research	CEQA sets goals to identify significant environmental effects of public agency actions and to avoid or mitigate those environmental effects. CEQA applies to projects proposed to be undertaken or requiring approval by State and local government agencies.
Ecology			
Fish and Wildlife Coordination Act	16 U.S.C. §661 et seq.	USFWS	Requires consultation on the possible effects on wildlife if there is construction, modification, or control of bodies of water in excess of 10 acres in surface area.
Bald and Golden Eagle Protection Act	16 U.S.C. §668 et seq.	USFWS	Consultations should be conducted to determine if any protected birds are found to inhabit the area. If so, DOE must obtain a permit prior to moving any nests due to mission requirements.
Migratory Bird Treaty Act	16 U.S.C. §703 et seq.	USFWS	Requires consultation to determine if there are any impacts on migratory bird populations due to mission requirements. If so, DOE will develop mitigation measures to avoid adverse effects.
Endangered Species Act of 1973	16 U.S.C. §1531 et seq.	USFWS/National Marine Fisheries Service	Requires consultation to identify endangered or threatened species and their habitats, assess DOE impacts thereon, obtain necessary biological opinions, and, if necessary, develop mitigation measures to reduce or eliminate adverse effects of construction or operation.
California Endangered Species Act	Fish and Game Code §2050 et seq.	California Department of Fish and Game (CDFG)	The *California Endangered Species Act* generally parallels the main provisions of the federal *Endangered Species Act*. Under the *California Endangered Species Act* , the term "endangered species" is defined as a species of plant, fish, or wildlife that is "in serious danger of becoming extinct throughout all, or a significant portion of its range" and is limited to species or subspecies native to California. The Act prohibits the "taking" of listed species except as otherwise provided in state law. Unlike its federal counterpart, the Act applies the take prohibitions to species petitioned for listing (state candidates).

Law or Regulation	Citation	Responsible Agency	DOE/NNSA Responsibilities
Natural Community Conservation Planning Act	Fish and Game Code §2800 et seq.	CDFG	The NCCP program of the CDFG is an effort by the State of California and numerous private and public partners to take a broad-based ecosystem approach to planning for the protection and perpetuation of biological diversity. The goal of NCCP programs is to identify and provide for the regional or area-wide protection of plants, animals, and their habitats, while allowing compatible and appropriate economic activity. The NCCP program applies statewide, although there is currently no NCCP region that includes LLNL. The closest NCCP to LLNL facilities is the East Contra Costa County NCCP, which is approximately 5.5 miles north of the Livermore Site.
EO 13112: Invasive Species, as amended by EO 13751	N/A	Department of Interior, National Invasive Species Council	EO 13112 establishes the National Invasive Species Council. It requires federal agencies to act to prevent the introduction of invasive species and provide for their control; to implement restoration with native species; and to minimize actions that could spread invasive species. EO 13751 amended EO 13112 and included an updated definition of invasive species, which is "a non-native organism whose introduction causes or is likely to cause economic or environmental harm, or harm to human, animal, or plant health."
EO 13186: Responsibilities of Federal Agencies to Protect Migratory Birds	N/A	USFWS	Requires federal agencies to avoid or minimize the adverse impact of their actions on migratory birds and to assure that environmental analyses under NEPA evaluate the effects of proposed f ederal actions on such species. A Memorandum of Understanding between DOE and USFWS implements the Order targeting the conservation and management of migratory birds and their habitats.
Protection of Birds' Nests	Fish and Game Code §3503 and 3503.5	CDFG	These sections make it unlawful to "take, possess, or needlessly destroy" the nest or eggs of any bird (§3503) or any bird-of-prey (§3503.5)
Air Quality			
Clean Air Act of 1970, as amended	42 U.S.C. § 7401 et seq. 40 CFR Part 61, Subpart H	USEPA	Protects and enhances the nation's air quality. Requires federal agencies to comply with air quality regulations. The California Air Resources Board (CARB) is the State agency charged with coordinating efforts to attain and maintain ambient air quality standards. CARB delegates the responsibility of regulating the State's stationary emission sources to regional air agencies. CARB is responsible for interactions with EPA, for ensuring the local air districts maintain compliance with regulatory requirements, and for regulating vehicular sources. 40 CFR Part 61, Subpart H provides the dose standard for DOE radionuclide air emissions.
National Ambient Air Quality Standards	40 CFR Part 50	USEPA	The *Clean Air Act* requires EPA to set NAAQS for pollutants considered harmful to public health and the environment. The *Clean Air Act* establishes two types of NAAQS. Primary standards set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings
National Emission Standards for	40 CFR Part 61	USEPA	Emissions of hazardous air pollutants, including radionuclides and asbestos that could be released during operation, demolition, or renovation of DOE facilities, are regulated under the NESHAPs program.

Law or Regulation	Citation	Responsible Agency	DOE/NNSA Responsibilities
Hazardous Air Pollutants			
Air Pollution Control Rules and Regulations	N/A	BAAQMD, jurisdiction includes Alameda County. SJVUAPCD jurisdiction includes San Joaquin County. Oversight agencies include both CalEPA CARB and U.S. EPA	Establishes requirements for the control of air pollutants from stationary (nonmobile) sources, including permit requirements and prohibitory rules associated with activities or equipment with the potential to emit air pollutants. Includes requirements for the control of criteria, toxic, and hazardous air pollutants, which are at least as stringent as applicable federal and state requirements. Source-specific requirements are incorporated into enforceable permit conditions. Establishes air district authority and responsibility to routinely inspect and enforce applicable regulations.
California Executive Order S-3-05	NA	CalEPA	This State Executive Order establishes GHG emission reduction targets, creates the Climate Action Team, and directs the Secretary of CalEPA to coordinate efforts to meet the targets with the heads of other State agencies. The Executive Order also requires the Secretary to report to the governor and legislature biannually on progress toward meeting the GHG targets, GHG impacts to California, and mitigation and adaptation plans. GHG emission reduction targets established for California consist of a reduction to 2000 levels by 2010; to 1990 levels by 2020; and to 80 percent below 1990 levels by 2050
Water			
Clean Water Act	33 U.S.C. §1251 et seq.	USEPA	Requires EPA- or state-issued permits and compliance with provisions of permits regarding discharge of effluents to surface waters.
Safe Drinking Water Act (SDWA) of 1944, as amended	42 U.S.C. §300f	USEPA	The *Safe Drinking Water Act* sets national standards for contaminant levels in public drinking water systems, regulates the use of underground injection wells, and prescribes standards for groundwater aquifers that are a sole source of drinking water. The Act applies to federal facilities that own or operate a public water system. A public water system is defined as a system for the provision of piped water for human consumption that has at least 15 service connections or regularly serves at least 25 individuals. LLNL provides drinking water to its employees. LLNL is required to monitor drinking water quality for organic and inorganic compounds, radionuclides, metals, turbidity, and total coliform bacteria.
Porter-Cologne Water Quality Control Act	California Water Code, Division 7, §13000 et seq.	State Water Resources Control Board	The *Porter-Cologne Act* gives jurisdiction of water rights to the State Water Resources Control Board. Nine Regional Water Quality Control Boards manage water quality within their regions. The regional boards determine beneficial uses of water for bodies of water in their areas, establish

Law or Regulation	Citation	Responsible Agency	DOE/NNSA Responsibilities
			and enforce water quality standards for both surface and groundwater, and take actions to maintain standards by controlling pollution sources.
NPDES Stormwater Permit	33 U.S.C. §1342	State Water Resources Control Board/Central Valley Regional Water Quality Control Board/San Francisco Bay Regional Water Quality Control Board	The NPDES Stormwater Program requires operators of construction sites, industrial facilities, and municipal separate storm sewer systems to obtain authorization to discharge stormwater under an appropriate NPDES permit for construction, industrial, or municipal operations. Federal facilities have been defined by regulation to be a municipal separate storm sewer system. The NPDES program at the Livermore Site is enforced by the State Water Resources Control Board; at Site 300, it is enforced by the Central Valley Regional Water Quality Control Board.
Dredged or Fill Material (Section 404 of *the Clean Water Act*)/*Rivers and Harbors Appropriations Act* of 1899	33 U.S.C. §1344/ 33 U.S.C. §401 et seq.	U.S. Army Corps of Engineers	Requires permits to authorize the discharge of dredged or fill material into navigable waters or wetlands and to authorize certain structures or work in or affecting navigable waters.
Compliance with Floodplain/ Wetlands Environmental Review Requirements	10 CFR Part 1022	DOE	Requires DOE to comply with all applicable floodplain/wetlands environmental review requirements.
Noise			
Noise Control Act of 1972	42 U.S.C. §4901 et seq. as amended by the *Quiet Communities Act* of 1978	USEPA	Protects the health and safety of the public from excessive noise levels. Requires federal agencies to comply with Federal, State, and local noise abatement requirements.
East (Alameda) County Area Plan (Alameda County 1994)	Alameda County General Code, Title 6 Health and Safety,	Alameda County	Sets limits on the allowable amount of noise (maximum decibels) that can be heard from one property to another to protect certain noise-sensitive land uses.

Law or Regulation	Citation	Responsible Agency	DOE/NNSA Responsibilities
	Chapter 6.60 Noise		
City of Livermore Municipal Code	Chapter 9.36: Noise	City of Livermore	Provides acceptable noise levels for certain land uses, based on state guidelines.
San Joaquin County Code	Development Title, Subsection 9-1025-9 Noise	San Joaquin County	Stipulates maximum allowable noise exposure levels associated with proposed activities.
Self-Imposed Limit on Impulse Noise	N/A	LLNL	Self-imposed maximum allowable sound pressure level of 126 decibels, not to be exceeded in nearby populated areas. At Site 300, for open air detonations LLNL uses "blast forecasting" to determine the maximum explosive weight that can be detonated without an irritant effect on the nearby populated areas.
Cultural and Paleontological			
National Historic Preservation Act of 1966	54 U.S.C. §300101 et seq.	Advisory Council on Historic Preservation	Protects historic properties. Section 106 of this Act requires consultation with the State Historic Preservation Officer and other consulting parties prior to any federal funding, permit, or action that could affect cultural resources. Additional provisions of the Act provide direction to federal agencies on the protection and management of cultural resources located on federally managed lands.
National Register of Historic Places	54 U.S.C. §302101 et seq. 36 CFR Part 60	National Park Service	Sets forth the procedural requirements for listing properties in the National Register of Historic Places.
Native American Graves Protection and Repatriation Act of 1990	25 U.S.C. §3001 et seq. 43 CFR Part 10	National Park Service	Protects American Indian burial remains, funerary objects, sacred objects, and objects of cultural patrimony found on federal or Tribal land.
Archaeological Resources Protection Act of 1979	16 U.S.C. §§470aa–mm 32 CFR Part 229	Federal agencies	Makes it a federal offense to excavate, remove, damage, alter, or otherwise deface archaeological resources on federal lands without authorization. ARPA permits allowing for professional archaeological excavations can be granted by the land-managing agency.
Antiquities Act of 1906	16 U.S.C. §§431–433	Federal agencies	Establishes a penalty for the unlawful appropriation, excavation, or injury to any "historic or prehistoric ruin or monument, or any object of antiquity" that is situated on federal lands or federally controlled lands. Paleontological resources that have significant research potential are protected under this law.

Law or Regulation	Citation	Responsible Agency	DOE/NNSA Responsibilities
Worker Health and Safety			
Occupational Safety and Health Act of 1970	29 U.S.C. §651 et seq.	Occupational Safety and Health Administration	Ensures worker and workplace safety, including a workplace free from recognized hazards, such as exposure to toxic chemicals, excessive noise levels, and mechanical dangers.
Occupational Safety and Health Standards	29 CFR Part 1910 29 CFR Part 1926	Occupational Safety and Health Administration	Protect workers from hazards encountered in the workplace (Part 1910) and at the construction site (Part 1926).
Worker Safety and Health Program	10 CFR Part 851	DOE	Defines controls and monitoring of hazardous materials to ensure that workers are not being exposed to health hazards, such as toxic chemicals, excessive noise, and ergonomic stressors.
Chemical Accident Prevention Provisions	40 CFR Part 68	USEPA	Provides the list of regulated substances and thresholds, and the requirements for owners or operators of stationary sources concerning the prevention of accidental releases.
Occupational Radiation Protection	10 CFR Part 835	DOE	Defines radiation protection standards, limits, and program requirements for protecting workers from ionizing radiation resulting from DOE activities.
Traffic and Transportation			
Hazardous Materials Transportation Act	49 U.S.C. §5101 et seq.	USDOT	Provides the USDOT with authority to protect against the risks associated with transportation of hazardous materials, including radioactive materials, in commerce.
Hazardous Materials Regulations	49 CFR Parts 171–185, 385, 397	USDOT	Establish USDOT requirements for classification, packaging, hazard communication, incident reporting, handling, and transportation of hazardous materials; hazardous materials safety permits; and driving and parking rules.
Materials and Waste Management			
TSCA	15 U.S.C. §2601 et seq.	USEPA	DOE shall comply with inventory reporting requirements and chemical control provisions of TSCA to protect the public from the risks of exposure to chemicals; TSCA imposes strict limitations on use and disposal of polychlorinated biphenyl-contaminated equipment.
Emergency Planning and Community Right-To-Know Act of 1986	42 U.S.C. §11001 et seq.	USEPA	Requires the development of emergency response plans and reporting requirements for chemical spills and other emergency releases, and imposes right-to-know reporting requirements covering storage and use of chemicals that are reported in toxic chemical release forms.
Pollution Prevention Act of 1990	42 U.S.C. §13001 et seq	USEPA	Establishes a national policy that pollution should be reduced at the source and requires a toxic chemical source reduction and recycling report for an owner or operator of a facility required to file an annual toxic chemical release form under section 313 of the SARA.
Federal Facility Compliance Act of 1992	42 U.S.C. §6961	Department of Toxic Substances Control	Eliminates *Resource Conservation and Recovery Act* waiver of sovereign immunity for federal facilities and requires DOE to develop plans and enter into agreements with states as to specific management actions for specific mixed waste streams.

Law or Regulation	Citation	Responsible Agency	DOE/NNSA Responsibilities
RCRA/Hazardous and Solid Waste Amendments of 1984	42 U.S.C. §6901 et seq./Public Law (PL) 98-616	USEPA	Requires proper management and, in some cases, permits for current operations involving hazardous waste and remediation of contamination from past activities (not addressed by the *Comprehensive Environmental Response, Compensation, and Liability Act*); changes to site hazardous waste operations could require amendments to *Resource Conservation and Recovery Act* hazardous waste permits involving public hearings.
Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level, and Transuranic Radioactive Wastes	40 CFR Part 191	DOE	Indicates the standard for radiation doses received by members of the public as a result of the management (except for transportation) and storage of used nuclear fuel, high-level radioactive wastes, and TRU waste.
Low-Level Radioactive Waste Policy Act of 1980	42 U.S.C. §2021 et seq.	DOE	Specifies that the Federal Government is responsible for the disposal of certain low-level radioactive waste, including low-level radioactive waste owned or generated by DOE.
Licensing Requirements for Land Disposal of Radioactive Waste	10 CFR Part 61	NRC	These regulations establish the procedures, criteria, terms, and conditions upon which NRC issues licenses for land disposal of LLW containing byproduct, source, and special nuclear material. These regulations do not apply to high-level radioactive waste or DOE-managed LLW, but do apply to LLW managed in commercial facilities, regardless of the generator. The regulations also apply to LLW such as mixed low-level radioactive waste that is also regulated under other statutory authorities.
California Hazardous Waste Control Law	Health and Safety Code, Division 20, Chapter 6.5	Department of Toxic Substances Control	California Hazardous Waste Law that provides hazardous waste management requirements. Additionally, this law provides DTSC with the statutory authority to write additional requirements into Title 22 regulations.
Environmental Health Standards for the Management of Hazardous Waste	California Code of Regulations; Title 22, Division 4.5	Department of Toxic Substances Control	California, in order to be authorized to regulate hazardous waste in lieu of EPA, has enacted regulations under Title 22, beginning with Section 66250, that are similar in nature to RCRA regulations. These regulations may be more stringent than EPA's regulations, but may not be less stringent.
California Medical Waste Act	California Health and Safety Code	Department of Public Health	Governs medical waste management at the facility where waste is generated, at transfer stations, and at treatment facilities. The Act also governs the tracking of medical waste beyond what is required in federal shipping documents and regulates aspects of the transport of regulated medical waste.

Law or Regulation	Citation	Responsible Agency	DOE/NNSA Responsibilities
	Sections 117600 - 118360		
Site Contamination and Remediation			
CERCLA/ SARA	42 U.S.C. §9601 et seq./ PL 99- 499	USEPA	Requires cleanup and notification if there is a release or threatened release of a hazardous substance; requires DOE to pursue interagency agreements with EPA and state to control the cleanup of each DOE site on the National Priorities List.
Community Environmental Response Facilitation Act	PL 102-426	USEPA	Amends *Comprehensive Environmental Response, Compensation, and Liability Act* (40 CFR Part 300) to establish a process for identifying, prior to the termination of federal activities, property that does not contain contamination. Requires prompt identification of parcels that will not require remediation to facilitate the transfer of such property for economic redevelopment purposes.
California Hazardous Waste Control Law and other California hazardous waste regulations	Health and Safety Code, Division 20, Chapter 6.5 California Code of Regulations, Title 22	DTSC	Sets requirements for managing hazardous waste in California.

CARB = California Air Resources Board; BAAQMD = Bay Area Air Quality Management District; CalEPA California Environmental Protection Agency; CDFG = California Department of Fish and Game; CEQ = Council on Environmental Quality; CEQA = California Environmental Quality Act; CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act*; CFR = *Code of Federal Regulations*; DOE = U.S. Department of Energy; DOT = U.S. Department of Transportation; EIS = environmental impact statement; EO = Executive Order; EPA = Environmental Protection Agency; FR = *Federal Register*; GHG = greenhouse gases; LLW = low-level radiative waste; NA = not available; N/A = not applicable; NAAQS = National ambient Air Quality Standards; NCCP = Natural Community Conservation Planning; NEPA = *National Environmental Policy Act*; NESHAP = national emission standards for hazardous air pollutants; NNSA = National Nuclear Security Administration; NPDES = National Pollutant Discharge Elimination System; NRC = Nuclear Regulatory Commission; RCRA = *Resource Conservation and Recovery Act*; SJVUAPCD = San Joaquin Valley Unified Air Pollution Control District; PCB = polychlorinated biphenyl; SARA = *Superfund Amendment and Reauthorization Act*; TSCA = *Toxic Substances Control Act*; U.S.C. = United States Code; USFWS = U.S. Fish and Wildlife Service

5.24.2 Regulatory Activities

Activities associated with the Proposed Action would be conducted in accordance with a variety of applicable laws and regulations. Below is a brief discussion of the major laws and regulations that would apply to the Proposed Action facilities/projects.

With respect to design requirements, the major DOE design criteria are found in DOE Order 6430.1A (1989), "General Design Criteria," and its successive Orders 420.1C, Change 3 (2019), "Facility Safety," and 430.1C, "Real Property Asset Management," which delineate applicable regulatory and industrial codes and standards for both conventional facilities designed to industrial standards and "special facilities," defined as nonreactor nuclear facilities and explosive facilities. Nuclear facilities would also comply with all the requirements of 10 CFR Part 830, "Nuclear Safety Management." 10 CFR Part 830 provides both quality assurance and safety requirements for the design and operations of the facilities, as documented in the required facility safety analysis. Prior to operation, the facilities would undergo cold and hot startup testing and an operational readiness review in accordance with the requirements of DOE Order 425.1D, Change 2 (2019), "Verification of Readiness to Start Up or Restart Nuclear Facilities." Prior to startup, NNSA would prepare a safety evaluation report to evaluate the proposed safety basis and controls for the new facilities and would obtain approval of the NNSA Administrator or designee prior to startup.

Nuclear facilities would need to comply with 10 CFR Part 820, "Procedural Rules for DOE Nuclear Facilities," and other applicable regulations and standards related to worker and public health and safety and environmental protection, including radiation protection standards (10 CFR Part 835, "Occupational Radiation Protection," and 10 CFR Part 851, "Worker Safety and Health Program"). Occupational Safety and Health Administration regulations governing industrial safety aspects of chemical risks to workers would apply. Also, radiological exposure levels to members of the public would apply, as regulated under DOE O 458.1, "Radiation Protection of the Public and the Environment" (DOE Order 458.1 2013), 40 CFR Part 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities," for radionuclide emissions to air. The protection of the environment from chemical risks is regulated by EPA and the California Department of Toxic Substances Control (DTSC).

Federal or state regulations implementing the *Clean Water Act* and the *Clean Air Act* would also be applicable. In addition, DOE requirements affecting site interfaces and infrastructure would also be applicable. These regulations are implemented through permits, mainly through DTSC. Prior to any new facility operations, an evaluation would be required to determine whether emissions and activities require modification of existing permits and the acquisition of additional air and water permits. TRU waste would be generated routinely but would be regularly shipped off site to WIPP for disposal. Before any TRU waste could be sent to WIPP for disposal, NNSA would prepare or modify waste certification plans, quality assurance plans, and TRU waste authorized methods for payload control, as applicable. Methods of compliance with each requirement and associated criteria to be implemented at LLNL shall be described or specifically referenced and shall include procedural and administrative controls consistent with the Carlsbad Field Office *Quality Assurance Program Document* (DOE 2017). NNSA would be required to submit these program documents to the Carlsbad Field Office for review and approval prior to their implementation (DOE 2017). NNSA would then certify that each container of TRU waste intended for transport to WIPP meets the most current waste acceptance criteria (DOE 2016a).

Operations at LLNL would produce solid LLW. Offsite disposal of LLW at NNSS (or a commercial facility such as Energy*Solutions*) would be contingent on waste meeting the disposal facility's waste acceptance criteria and adherence to the associated performance assessment. The performance assessment sets limits based on the type and amount of radionuclides and still meet the worker and public health and safety performance standards and other applicable regulatory criteria for the disposal facility.

5.24.3 Permits

LLNL's various missions require a variety of permits. Many of the Proposed Action activities would be conducted within existing structures in developed areas of the Livermore Site and Site 300, would use existing infrastructure, and would operate under existing permits. The need for new permits or modifications to existing permits would depend on new construction, demolition of existing structures, and operation scenarios. Prior to project implementation, required environmental permits would be obtained in accordance with Federal, State, and local requirements. Table 5-76 is a summary of active permits in 2019 at the Livermore Site and Site 300. The external agencies that issue the permits may also perform inspections required by the permits. Table 5-77 lists environmental inspections and findings from both LLNL sites in 2019.

Table 5-76. Active Permits at the Livermore Site and Site 300

Livermore Site	Site 300
Hazardous Waste	
• EPA ID No. CA2890012584. Hazardous Waste Facility Permit Number 99-NC-006 and RCRA Part A/B permit application—to operate hazardous waste management facilities. Agency–DTSC. • Registered Hazardous Waste Hauler authorized to transport regulated wastes on public roadway. Permit number 1351. Agency– DTSC. • Facility I.D. # 10697. Hazardous Waste Generator Program, On-site treatment of hazardous waste (tiered permitting) program: Conditionally Exempt Specified Wastestream, CE231-1, Hazardous Materials Business Program, Above Ground Petroleum Tank Program, and • CA Accidental Release Program. Agency – LPFD CUPA.	• EPA ID No. CA2890090002. Hazardous Waste Facility • Permit and RCRA Part A/B permit application to operate CSA (Building 883), EWTF and EWSF. Agency–DTSC. • EPA ID No. CA2890090002. Hazardous Waste Facility Post-Closure Permit and RCRA Site 300 Building 829 PostClosure Operation Plan. Agency–DTSC. • Facility I.D. # FA0003934 RCRA Hazardous Waste Generator category: waste generation in an amount equal to or more than 50 tons, but less than 250 tons. Agency–SJCEHD CUPA.
Medical Waste	
ACDEH issued a Large Quantity Medical Waste Generator permit (PT0200461/PT0305526) that covers medical waste generation and treatment activities for BSL 2 facilities at B132 North and South, B150 Complex, B360 Complex, and the BSL 3 facility.	• Registered with SJCEHD as a Small Quantity Medical Waste Generator.
Air	
• BAAQMD and CARB issued 123 permits for operation of various types of equipment.	• SJVAPCD issued 37 permits for operation of various types of equipment.

Livermore Site	Site 300
• BAAQMD issued 2 new permits for emergency standby diesel engines. • BAAQMD conducted compliance inspections of 76 air sources and 2 asbestos compliance inspections. • BAAQMD issued a revision to the SMOP in 2015, which was initially issued in 2002 to ensure the NOx and HAPs emissions from the site do not exceed federal Clean Air Act Title V emission limits. • BAAQMD issued 3 Asbestos Removal and Demolition Permits. • CARB renewed 1 permit and issued 1 new permit for the operation of portable diesel engines.	• SJVAPCD approved a Prescribed Burn Plan for the burning of 1,575 acres of grassland. • SJVAPCD conducted 1 compliance inspection and 1 start-up inspection. • SJVAPCD issued 1 Asbestos Renovation Permit. • SJVAPCD issued 3 Permits to Operate (PTOs) for B-827 new ovens as a result of modifying the sources, 1 PTO for an ERD treatment facility, and 1 Authority to Construct (ATC) permit for an emergency diesel generator. • BAAQMD approved a Prescribed Burn Plan for the burning of 139.1 acres of grassland. • CARB issued 1 PERP permit for the operation of a leaf collector.
Underground Storage Tanks	
• One operating permit (1016-09202018) issued by LPFD covering operation of 9 USTs from September 20, 2018– September 19, 2023.	• One operating permit covering 3 underground petroleum storage tanks assigned individual permit numbers • (PT0006785 [879TFUD01], PT0006530 [882TFUD01], and PT0007967 [879TFUG01]).
Sanitary Sewer	
• Discharge Permit 1250(b) for discharges of wastewater to the sanitary sewer. • Permit 1510G for discharges to the sanitary sewer of groundwater from CERCLA restoration activities.	• WDR R5-2008-0148 for operation of sewage evaporation pond.
Water	
• WDR No. 88-075 for discharges of treated groundwater from Treatment Facility A to recharge basin. (c) • NPDES General Permit 2014-0057-DWQ (Waste Discharge Identification Number [WDID] 2 01I025682) for discharge of storm water associated with industrial activities. • NPDES General Permit 2009-0009-DWQ for discharges of storm water associated with construction activities affecting 0.4 hectares (1 acre) or more. • FFA for groundwater investigation/remediation. • Domestic Water Supply Permit No. 02-04-20P-0110701	• WDR No. 93-100 for post-closure monitoring requirements for two Class I landfills. • WDR R5-2008-0148 for operation of sewage evaporation pond and discharges to percolation pits and septic systems. • NPDES General Permit 2014-0057-DWQ (WDID • 5S39I021179) for discharge of storm water associated with industrial activities. • NPDES General Permit 2009-0009-DWQ for discharges of storm water associated with construction activities affecting 0.4 hectares (1 acre) or more. • Regional Limited Threat General Order R5-2016-0076-025 and NPDES Permit No. CAG995002 for large volume discharges from the drinking water system. Domestic Water Supply Permit Amendment No. 01-10-16PA-003. • FFA for groundwater investigation/remediation. • Approximately 32 registered Class V injection wells.

Note: See the SWEIS Acronyms list for acronym definitions.

a. Numbers of permits are based on actual permitted units or activities maintained and/or renewed by LLNL during 2019.

b. Permit 1250 includes some wastewater generated at Site 300 and discharged at the Livermore Site.

c. Recharge basin referenced in WDR Order No. 88-075 is located south of East Avenue within Sandia National Laboratories/California. boundaries. The discharge no longer occurs; however, the agency has not rescinded the permit.

Source: LLNL 2020b.

Table 5-77. Inspections of Livermore Site and Site 300 by External Agencies in 2019

Description	Agency	Date	Finding
Air			
Air pollutant emission sources (Livermore Site)	BAAQMD	1/10/19 4/10/19 5/09/19 7/11/19 9/12/19 9/24/19 10/23/19 10/31/19	No violations BAAQMD issued one violation for failure to start asbestos demolition activities on the date indicated on the notification. No violations No violations No violations No violations No violations No violations
Synthetic Minor Operating Permit (SMOP) (Livermore Site)	BAAQMD	8/29/19	No violations
Air pollutant emission sources (Site 300)	SJVAPCD	4/08/19 6/13/19	No violations No violations
Hazardous Materials Business Plan			
CUPA Inspection (Livermore Site)	LPFD	9/23/19–9/26/19	No violations
CUPA Inspection (Site 300)	SJCEHD		No Hazardous Materials Business Plan inspection during 2019.
Sanitary sewer			
Annual Inspection of the Sewer Monitoring Complex (Livermore Site)	WRD	10/08/19	No violations
Categorical sampling and inspection, Buildings 153 and 321C (Livermore Site)	WRD	4/09/19 10/09/19	No violations No violations
Annual compliance sampling at the Sewer Monitoring Complex (Livermore Site)	WRD	10/09/19	No violations

Description	Agency	Date	Finding
Café grease interceptor inspections, Buildings 125and 471 (Livermore Site)	WRD	10/08/19	No violations
Quarterly BOD/total suspended solids (TSS) sampling at Outfall (Livermore Site)	WRD	2/21/19 4/18/19 7/02/19 11/14/19	No violations No violations No violations No violations
Storage tanks			
Spill bucket and Overfill Repair Inspection at B112 (Livermore Site)	LPFD	3/26/19	No violations
Overfill Prevention Equipment Inspection (Site 300)	SJCEHD	4/18/19 4/25/19 6/10/19	No violations
Annual Spill Bucket/Monitoring Equipment Inspection (Site 300)	SJCEHD	7/30/19 8/13/19	SJCEHD issued one violation on 07/30 and two violations in follow up visit 08/13. One violation for improper operation of the monitoring and shut off system located in the sump/under dispenser containment. One violation for water found in the secondary containment not removed, analyzed and disposed of properly. One violation for the LLNL Designated Operator not inspecting all items included on the monthly inspection checklists.
Annual Spill Bucket/ Monitoring Equipment Inspection (Five emergency generators at the Livermore Site)	LPFD	7/15/19	No violations
Annual Spill Bucket/ Monitoring Equipment Inspection (B611 at the Livermore Site)	LPFD	8/13/19	No violations
493TFBD01, 197TFBD01,	LPFD	9/13/19	No violations

Description	Agency	Date	Finding
519TFBD02, 451TFAD01 & 695TFBD01Tank Closures (Livermore Site)			
Repair of E85 STP Sump (Livermore Site)	LPFD	10/30/19	No violations
Waste			
CUPA Inspection (Livermore Site)	LPFD	9/23/19–9/26/19	No violations
Hazardous waste facilities Compliance Evaluation Inspection (CEI) (Livermore Site)	DTSC	4/23/19–4/25/19 5/03/19	DTSC issued two violations. One violation was received for failure to ensure container containment area surface was free of cracks. A second violation was received for failure to note the cracked surface and rainwater accumulation in the inspection log.
Hazardous waste facilities Compliance Evaluation Inspection (CEI) (Site 300)	DTSC	1/23/19–1/24/19	DTSC issued two violations. One violation was for failure to remove treatment ash residue from the Open Burn Cage, and a second violation for failure to update the Contingency Plan emergency coordinator list.
Medical Waste facilities inspection	ACDEH	10/29/19	No violations
Water			
Permitted operations (Site 300 Drinking Water)	SWRCB	5/08/19 9/16/19	No violations No violations
Waste Discharge Requirements for sewage pond, percolation pits, and septic systems	CVRWQCB	3/16/19 10/29/19	No violations
Closed Landfill Pit 1	CVRWQCB	3/06/19 10/29/19	No violations
BSL and Animal Programs			
Compliance Inspection	U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, Division of Select Agents and Toxins	4/2-3/2019	No violations

Description	Agency	Date	Finding
Compliance Inspection	US Department of Agriculture Animal and Plant Health Inspection Service	11/29/2019, 11/7/2019, 12/18/2019	No violations

Source: LLNL 2020b.

CHAPTER 6

Cumulative Impacts

6.0 CUMULATIVE IMPACTS

6.1 INTRODUCTION

This chapter discusses the potential cumulative impacts resulting from the Proposed Action and the No-Action Alternative. CEQ NEPA regulations at 40 CFR Part 1508.7 define cumulative impacts as "…the incremental impact of [an] action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time." Thus, the cumulative impacts of an action can be viewed as the total effects on a resource (e.g., land, air, water, soil), ecosystem, or human community of that action and all other activities affecting that resource no matter what entity (federal, non-federal, or private) is taking the actions (USEPA 1999). It is possible that a potential impact that may be small by itself could result in a moderate or large cumulative impact when considered in combination with the impacts of other actions on a particular affected resource. For example, if a resource is regionally declining or imperiled, even a small, individual impact could be substantial if it contributes to or accelerates the overall resource decline.

Cumulative impacts can also result from spatial (geographic) and/or temporal (time) crowding of environmental perturbations (i.e., concurrent human activities and the resulting impacts on the environment are additive if there is insufficient time for the environment to recover). The geographic area over which past, present, and reasonably foreseeable future actions could contribute to cumulative impacts is dependent on the type of resource considered.

6.2 METHODOLOGY AND ASSUMPTIONS

The following approach was used to estimate cumulative impacts for this LLNL SWEIS:

- In general, potential cumulative impacts are determined by considering the baseline affected environment, the SWEIS alternatives (No-Action Alternative and Proposed Action), and other regional current and reasonably foreseeable future actions. The existing environment, which is described in Chapter 4 of this SWEIS, includes the impacts of ongoing LLNL operations through 2019 and serves as the baseline for the cumulative impacts analysis.

- Regional current and reasonably foreseeable future actions include projects and activities that could result in impacts to resources, ecosystems, or human communities within the defined region of influence (ROI) as defined in Chapter 4. These actions are described in Section 6.3.

- Cumulative impacts are assessed by combining the effects of the SWEIS alternatives (No-Action Alternative and Proposed Action) with the impacts of other present, and reasonably foreseeable future actions in the ROI. Many of these actions occur at different times and locations and the potential impacts may not be truly additive. For example, actions affecting air quality occur at different times and locations across the ROI; therefore, it is unlikely that the impacts would be completely additive. In order to envelope any uncertainties in the projected activities and their effects, the analysis combines the effects, irrespective of the time and location of the impact. This approach produces a conservative estimation of cumulative impacts for the activities considered.

- This cumulative impact analysis is conducted for all resources identified with impacts analyses in Chapter 5. Some cumulative impacts analysis will be quantitative, while others will include a qualitative discussion.

6.3 Current and Reasonably Foreseeable Future Actions

In addition to the No-Action Alternative and the Proposed Action evaluated in this SWEIS, other regional actions that may contribute to cumulative impacts include offsite projects conducted by federal, state, and local governments or the private sector that are within the ROIs of this SWEIS. Information on current and reasonably foreseeable future regional actions was obtained by reviewing publicly available information for the region, site-specific actions, and local NEPA/CEQA documents. The current and reasonably foreseeable future actions discussed below represent the major projects that may contribute to cumulative impacts.

6.3.1 Other Regional Actions near LLNL

Livermore Solar Community Farm. A Draft Environment Impact Report (EIR) was published in March 2020 for the proposed Alameda County Livermore Solar Community Farm (Alameda 2020a). The proposed project would develop a 58.7-acre solar photovoltaic facility with the capacity of 6 MW alternating current (AC) on a 71.64-acre parcel located at 4871 North Livermore Avenue in Alameda County, California. This parcel is about 43 miles east of San Francisco and immediately north of the city of Livermore.

Aramis Solar Project/North Livermore Road. A Draft EIR was published in September 2020 for the proposed Alameda County Aramis Solar Energy Generation and Storage (Alameda 2020b). IP Aramis, LLC, a subsidiary of Intersect Power, LLC, has submitted an application for a Conditional Use Permit for construction of a solar energy production (up to 100 MW) facility, with related battery storage, using photovoltaic panels over a mostly contiguous 533-acre portion of the 747-acre site. This site is located approximately 75 feet from the proposed Livermore Solar Community Farm in Alameda County, California. An estimated 153-acre portion of the whole site would be subdivided as a non-development area. Other areas are sloped or unsuited for development, such as the flood plain for Cayetano Creek. Single-axis tracker racks, approximately 8-feet high, would be used. A project substation and battery area would border an existing PG&E substation. The panels would allow sheep grazing and honey-bee foraging. Panels will be set back 50 feet from North Livermore Road and Manning Road.

Valley Link Rail Project. A Final EIR was published on April 30, 2021 (ICF 2021) by the Tri-Valley–San Joaquin Valley Regional Rail Authority. The Final EIR evaluates the potential environmental impact of the proposed Valley Link Rail Project, which spans Alameda and San Joaquin counties. The project would provide rail service from the existing Dublin/Pleasanton BART station to the approved ACE North Lathrop Station. The alignment would be located within the I-580 median through Dublin, Pleasanton, and Livermore, follow the Alameda County Transportation Corridor (formerly the Southern Pacific line) over the Altamont Hills, and then follow along existing rail lines through Tracy to Lathrop and Stockton.

6.3.2 General Area-Wide Regional Growth

The area surrounding LLNL continues to grow. From 2010 to 2019, the total population in the ROI increased at an average annual rate of 0.9 percent, which was higher than the state-wide growth rate (USCB 2019a). As discussed in Section 6.4.2.10, regional growth is expected to continue, which would spur additional regional development (infrastructure, housing, and commercial). Examples of current development activities include the following:

- The **Dublin Boulevard–North Canyons Parkway Extension Project**, a collaborative project among the city of Dublin, the city of Livermore, Alameda County, Alameda County Transportation Commission, and the California Department of Transportation. The project includes the extension of Dublin Boulevard eastward from Dublin to the western boundary of the city of Livermore. The Final Environmental Impact Report (EIR) was published in August 2019 (Dublin 2019);

- The **Isabel Neighborhood Specific Plan**, which would allow development of 4,095 new multi-family housing units and approximately 2.1 million square feet of net new office, business park, and commercial development (including a neighborhood commercial center). This plan would guide future development of the area surrounding the Valley Link rail station. The Final Supplemental Environmental Impact Report was published on September 30, 2020 (Livermore 2020d);

- The **Exeter (FedEx) Warehouse on Greenville Road Project**, which includes the construction of a freight distribution facility on a vacant parcel located at 225 North Greenville Road that would include 48,592± square feet of warehouse and 5,858± square feet of office space. The Initial Study/Mitigated Negative Declaration was published in January 2019 (Livermore 2019b). This facility has now been completed.

- The **Greenville Plaza Project**, which consists of the development of a 4,425-square-foot convenience store and adjoining 2,800-square-foot fast-food drive-through restaurant in a single 7,225-square foot building; a 4,600-square-foot retail building that may include a quick-serve single-lane drive-through option; a 12-pump gas station; an enclosed automatic carwash; 60 parking spaces; landscaping and lighting; and associated improvements. This commercial development would be located between Northfront Road and I-580 near Greenville Road. The draft Initial Study/Mitigated Negative Declaration has been prepared and published June 19, 2020 (Livermore 2020e); and

- The **North Livermore Avenue Chick-fil-A Project**, which is in Alameda County adjacent to the city of Livermore with a street address of 1754 Livermore Avenue. The draft Initial Study/Mitigated Negative Declaration was prepared and published in June 2020 (Livermore 2020f). This project is expected to be completed in 2022.

Other similar actions near Site 300 currently planned or being completed include:

- The **Avenues Specific Plan**, which creates a residential village and a comprehensive land use plan for the development of approximately 95 acres. The plan area is located within the southwestern portion of the city of Tracy, south of I-205 and north of I-580. The Final

Initial Study/Mitigated Negative Declaration Environmental Checklist was published in August 2018 (Tracy 2018);

- The **International Park of Commerce (IPC)–Interchange and Parkway Improvements,** which will improve freight and employee access to the IPC, an office, retail, and industrial park comprising approximately 1,800 acres of fully-entitled Master-planned park and generally located on the west side of Tracy bounded by I-205, the former Mountain House Parkway, Schulte Road, and just east of Hansen Road. This project directly accesses two routes on the National Highway Freight Network, I-205 and I-508, and is 50 miles from the Port of Oakland. Numerous facilities have already been built and occupied. The Park was included in the Cordes Ranch Specific Plan Final EIR issued in 2013. The city of Tracy and the California Department of Transportation (Caltrans) are working cooperatively to examine and analyze feasible alternatives for two interchange projects within the city of Tracy's limits. Proposed improvements are needed due to increased traffic demands from existing commercial development and planned future growth in San Joaquin County. The proposed I-205 & I-580/International Parkway Interchange Projects will reduce congestion resulting from ongoing and planned development of the Cordes Ranch Specific Plan and improve local traffic circulation (Tracy 2021b).

- The **Tracy Hills Project Area**, which encompasses approximately 2,731 acres within the southern portion of Tracy surrounding the existing interchange at Corral Hollow Road and the proposed Lammers Road interchange on I-580. The Tracy Hills Final Environmental Impact Report Notice of Determination was published in April 2016 (Tracy 2016); and

- The **Westside Specific Plan**, which is envisioned to accommodate a broad variety of commercial, institutional, and residential (both age-restricted [senior] and non-age-restricted) land uses. The plan area is located on the western side of the city of Tracy and would serve as a gateway entrance from eastbound I-205, with direct access from Eleventh Street and Lammers Road. A Notice of Preparation of an Environmental Impact Report was published on October 29, 2019 (Tracy 2019b).

The analyses in Sections 6.4.2 through 6.4.15 address the projects described above, as well as other reasonably foreseeable other projects, within the context of general area-wide regional growth.

6.3.3 DOE and non-DOE Actions Related to Radiological Waste Disposal and Radiological Transportation

For the analysis related to radioactive waste disposal, this SWEIS presents the cumulative impacts of the No-Action Alternative and the Proposed Action and other DOE actions that would generate the same waste types. For example, the analysis of cumulative TRU wastes (Section 6.4.6.3) includes consideration of TRU wastes from LLNL as well as all other DOE sites/projects that generate TRU wastes. For radiological transportation, the cumulative analysis includes consideration of present, and reasonably foreseeable future shipments of radiological material for both DOE projects and non-DOE projects.

6.4 CUMULATIVE IMPACTS BY RESOURCE AREA

6.4.1 Introduction

Chapter 5 of this SWEIS presents the potential environmental impacts associated with the No-Action Alternative and the Proposed Action. This section combines the Chapter 5 impact information with the potential impacts from current and reasonably foreseeable future regional actions. The potential cumulative impacts (Sections 6.4.2 through 6.4.15) are presented in the same order as the resource analyses in Chapter 5.

6.4.2 Land Use Cumulative Impacts

Key metrics in this analysis include: (1) amount of land disturbance; and (2) a qualitative analysis of consistency with current land use plans, classifications, and policies.

No-Action Alternative and Proposed Action. As discussed in Section 5.2.1, the No-Action Alternative would permanently disturb 6.4 acres at the Livermore Site (0.8 percent of the Livermore Site area) and 0.1 acre at Site 300 (0.001 percent of the Site 300 area). Land disturbances would occur within site boundaries and would not impact offsite land uses. At both sites, the No-Action Alternative activities would be consistent with current land use plans, classifications, and policies. As discussed in Section 5.2.2, the Proposed Action would permanently disturb 52.5 acres at the Livermore Site (6.4 percent of the Livermore Site area) and 34.6 acres at Site 300 (0.5 percent of the Site 300 area). Land disturbances would occur within site boundaries, and would not impact offsite land uses. At both sites, the Proposed Action activities would be consistent with current land use plans, classifications, and policies. There are no NNSA plans in either the No-Action Alternative or the Proposed Action to acquire land beyond the site boundaries of the Livermore Site and Site 300.

Much of the area within Livermore's city limits has been urbanized. Population and job growth in the Livermore Valley has resulted in pressure to develop housing and commercial establishments on lands historically used for agriculture. However, agricultural resources remain, and the southern portion of the city is surrounded by an Urban Growth Boundary which is intended to protect existing agricultural uses and natural resources outside the city from future urban development (Livermore 2014).

With regard to offsite impacts from non-NNSA activities, it is reasonable to assume that regional development activities would result in increased land disturbances (particularly for residential, office, and industrial uses) as the population increases. By 2035, the regional population is expected to increase by approximately 14.6 percent over the 2019 baseline (*see* Tables 6-3 and 6-4 in Section 6.4.10). Consequently, it is reasonable to assume that residential, office, and industrial uses would increase by approximately 14.6 percent by 2035. As discussed in Section 4.2.1.3, local governments in the region have established city or county general plans and zoning requirements to guide future developments and any future land development would need to comply with those city or county general plans and zoning requirements. As such, future offsite development would likely utilize undeveloped parcels, while parks, recreation, open space, and agricultural uses would be protected, to the extent practicable.

With regard to Site 300 specifically, the majority of land immediately surrounding Site 300 is native grassland that is either undeveloped or utilized for agricultural purposes, primarily for grazing cattle and sheep (*see* Figure 4-10). The closest housing development to Site 300 is Tracy Hills, which is currently being developed by Integral Communities. As shown in Figure 4-10, the Tracy Hills development could be as close as approximately 1.15 miles from Site 300. Over the next 12 years, approximately 4,700 housing units will be developed at Tracy Hills, at a density of 2.6 dwelling units per acre (Tracy 2019b). The denser development will occur east of I-580, while the land west of I-580 is reserved for estates (approximately 0.5 to 2.0 dwelling units per acre), and low-density housing (2.1 to 5.8 dwelling units per acre). Figure 4-11 shows the specific plan for Tracy Hills and its development densities.

Because land use impacts associated with the No-Action Alternative and the Proposed Action would occur within the boundaries of government-owned land, and are consistent with land use plans, classifications, and policies, NNSA's actions would not contribute to offsite cumulative land use impacts.

6.4.3 Visual and Aesthetics Cumulative Impacts

The key metric in this analysis is visual compatibility.

No-Action Alternative and Proposed Action. As discussed in Sections 5.3.1 and 5.3.2, the No-Action Alternative and the Proposed Action would be consistent with current landscapes, would not obscure views, would not detract from the existing scenic perspectives, and would not cause glare. The most notable visual change would result from the construction of the New North Entry and Fire Station in the north buffer zone under the Proposed Action.

Offsite, general area-wide regional growth would continue to occur, which would have the potential to change the landscapes and scenic perspectives around the Livermore Site and Site 300. However, any potential offsite impacts from non-NNSA activities would be mitigated by appropriate parties to maintain compliance with city or county general plans and zoning requirements. While NNSA's actions under the No-Action Alternative and the Proposed Action would contribute to visual cumulative impacts, the impacts would remain similar to the 2019 baseline as the character of both onsite and non-NNSA offsite development would remain similar.

6.4.4 Geology and Soils Cumulative Impacts

Key metrics in this analysis are: (1) amount of soil disturbance; and (2) potential for causing erosion, soil loss, landslides, or impacts to prime farmland.

No-Action Alternative and Proposed Action. As discussed in Section 5.2.1, the No-Action Alternative would permanently disturb 6.4 acres at the Livermore Site (0.8 percent of the Livermore Site area) and 0.1 acre at Site 300 (0.001 percent of the Site 300 area). As discussed in Section 5.2.2, the Proposed Action would permanently disturb 52.5 acres at the Livermore Site (6.4 percent of the Livermore Site area) and 34.6 acres at Site 300 (0.5 percent of the Site 300 area). At both sites, no soils are classified as prime farmland. Erosion controls and Best Management Practices (BMPs) would be used to minimize soil erosion during construction and operations, and significant impacts would not be expected. Soil disturbances would occur within site boundaries and would not impact offsite soils.

With regard to offsite impacts from non-NNSA activities, as discussed in Section 6.4.2, soils in undeveloped parcels could be disturbed by regional development activities (particularly for residential, office, and industrial uses) as the population increases. Because one of the city of Livermore's stated goals is to "preserve valuable agricultural soils in the Planning Area" (Livermore 2014), it is reasonable to assume that offsite soil disturbances would not impact agricultural soils. Because impacts to geology and soils would occur within the boundaries of government-owned land, NNSA's actions would not contribute to offsite cumulative impacts to geology and soils.

6.4.5 Water Resource Cumulative Impacts

Key metrics in this analysis include: (1) increases in impervious areas and stormwater effects; (2) analysis of effluents and the potential for surface/groundwater contamination; and (3) potential floodplain impacts.

No-Action Alternative. As discussed in Section 5.4.1, the No-Action Alternative would create 6.4 acres of additional impervious surfaces at the Livermore Site (0.8 percent of the Livermore Site area) and 0.1 acre at Site 300 (0.0001 percent of the Site 300 area). By complying with NPDES and Wastewater Discharge Permit limits and requirements, and the use of BMPs, potential impacts to surface water and groundwater quality would be minimized. Groundwater monitoring would continue to ensure that remediation of contamination already present continues to be effective. Over time, groundwater quality should continue to improve because extracted groundwater would be collected and treated at the treatment facilities. There are no projects that would affect floodplains. Irrespective of any offsite development activities, because no offsite impacts to water resources would occur under the No-Action Alternative, NNSA's actions would not contribute to offsite cumulative impacts to water resources.

With regard to offsite surface waters, major sources of pollution in and around Livermore include runoff from urban and agricultural areas. These sources contribute petroleum hydrocarbons, metals, fertilizers, insecticides, and other chemicals to the water system. The Regional Water Quality Control Board (RWQCB) periodically reviews available data on surface water bodies and evaluates whether beneficial uses for the water body may be impaired. If a water body is designated as "impaired" for a particular pollutant, then the water body is listed under Section 303(d) of the *Clean Water Act*.

With regard to groundwater, in general, the city of Livermore's groundwater meets primary drinking water standards, however, there are concerns over other parameters such as total dissolved solids and hardness. Salts are initially introduced into the Main Basin with imported water supplies and via runoff from saline/alkali soils. Additional in-valley sources of salt include the use of recycled water and water softener regeneration. Although the water may leave the Main Basin by evaporation, evapotranspiration, or through surface and groundwater outflow, much of the salts stay behind, potentially leading to a build-up of salt in the soil and groundwater. Excessive salt loading can result in a degraded water supply, particularly if concentrations exceed the Secondary Drinking Water Standard of 500 milligrams per liter (mg/L). Zone 7 estimates that if the salt loading continues unchecked, the usability of the groundwater in the Main Basin could be substantially affected. Preserving and enhancing existing groundwater quality will hinge on the success of the Salt Management Plan, which has been prepared by Zone 7 to implement strategies that fully offset salt loading in the Main Basin (Livermore 2014).

The city of Livermore has stated goals to "conserve Livermore's waterways, tributaries and associated riparian habitats," and "continue efforts to ensure that development does not harm the quality or quantity of Livermore's surface or groundwater" (Livermore 2014). Actions consistent with the goals would mitigate the water impacts from non-NNSA sources.

Proposed Action. As discussed in Section 5.4.2, the Proposed Action would create 52.5 acres of additional impervious surfaces at the Livermore Site (6.4 percent of the Livermore Site area) and 34.6 acres of additional impervious surfaces at Site 300 (0.5 percent of the Site 300 area). As was the case for the No-Action Alternative, regulatory compliance and BMPs would minimize potential impacts to surface water and groundwater quality. Groundwater monitoring would continue to ensure that remediation of contamination already present continues to be effective. Over time, groundwater quality should continue to improve because extracted groundwater would be collected and treated at the treatment facilities.

The New North Entry would cross approximately 0.9 acres (approximately 2 percent) of the 500-year floodplain in the north buffer zone and approximately 0.1 acres of the 100-year floodplain along Arroyo Las Positas. In addition, the new Fire Station (alternate location) could be located in the north buffer zone and could disturb approximately 0.7 acres in the 500-year floodplain. As discussed in Appendix E, there would be negligible effects on the floodplain storage capacity, stormwater quality, and aquatic resources for the California red-legged frog and California tiger salamander. Because no offsite impacts to water resources would occur, NNSA's actions would not contribute to offsite cumulative impacts to water resources. The discussion of offsite surface water and groundwater quality and the city of Livermore's stated goals under the No-Action Alternative would also be applicable to the Proposed Action.

6.4.6 Air Quality and Greenhouse Gases (GHG)

Key metrics presented in this analysis are: (1) quantities of air emissions from LLNL activities and regional activities; (2) quantities of GHG emissions from LLNL activities and state-wide emissions; and (3) quantities of radiological emissions.

No-Action Alternative. Table 6-1 shows the maximum quantity[1] of air emissions from LLNL along with emissions in the region. As shown in that table, LLNL contributions to regional emissions are less than 0.01 percent for all pollutants.

Table 6-1. Cumulative Annual Emissions for the No-Action Alternative

Pollutant	No-Action Alternative[a] (tons/year)	Regional Emissions[b] (tons/year)	Cumulative Emissions (tons/year)	Percentage of Cumulative Emissions from LLNL No-Action Alternative
CO	17.3	484,355	484,372	0.004%
NO_x	15.0	115,340	115,355	0.01%
Fine particulate matter (PM_{10}/$PM_{2.5}$)	1.8	54,750	54,752	0.004%

[1] Maximum quantity includes emissions from both the Livermore Site and Site 300.

Pollutant	No-Action Alternative[a] (tons/year)	Regional Emissions[b] (tons/year)	Cumulative Emissions (tons/year)	Percentage of Cumulative Emissions from LLNL No-Action Alternative
Sox	0.7	7,665	7,666	0.01%
VOC	6.3	99,645	99,651	0.006%

a. From Table 5-10. Includes emissions from both the Livermore Site and Site 300.
b. From BAAQMD 2014, which is the most current emission data from BAAQMD.

In order to reduce future air emissions, the BAAQMD has developed a control strategy based on four key priorities:

- Reduce emissions of criteria air pollutants and toxic air contaminants from key sources;
- Reduce emissions of "super-GHGs" such as methane, black carbon and fluorinated gases;
- Decrease demand for fossil fuels (gasoline, diesel and natural gas) by (1) increasing the efficiency of industrial processes and energy and transportation systems, and (2) reducing demand for vehicle travel, and high-carbon goods and services; and
- Decarbonize energy system by (1) making electricity supply carbon-free, and (2) electrifying the transportation and building sectors (BAAQMD 2017).

The control strategy is aimed at reducing emissions of the air pollutants that pose the greatest health risk to area residents. Although monitoring data shows that the region meets national and state standards for $PM_{2.5}$, the region is still formally designated as non-attainment for several $PM_{2.5}$ standards. In regard to the national standards, the region continues to meet fine Particulate Matter standards, while continuing to make progress toward attaining state and national ozone standards. The proposed control measures are estimated to reduce emissions of VOCs by approximately 11 tons per day, NOx by 9.3 tons per day, and $PM_{2.5}$ by 3.1 tons per day (BAAQMD 2017).

With regard to GHG, LLNL's GHG emissions associated with the No-Action Alternative would be approximately 152,569 metric tons per year (*see* Table 5-11). In California, state-wide GHGs are estimated to be approximately 363.5 million metric tons per year (EIA 2016). GHG emissions associated with the No-Action Alternative at LLNL would account for less than 0.03 percent of those emissions. Regional GHG emissions total about 85 million metric tons per year. The control measures discussed above are estimated to reduce GHG emissions by approximately 4.4 million metric tons per year (BAAQMD 2017). Within the city of Livermore, the city's greenhouse gas inventory determined that 63 percent of Livermore's carbon emissions come from automobiles. Hence, the city is in the process of updating its bicycle master plan. Livermore already plans to double its bike paths from 46 miles to nearly 90 miles and walking trails from 22 miles to 108 miles (Livermore 2009).

With regard to radiological emissions, accelerator operations at the Lawrence Berkeley National Laboratory (LBNL) in Berkeley, California and the Stanford Linear Accelerator (SLAC) in Menlo Park, California also release airborne radionuclides which could contribute to cumulative impacts (*see* Section 6.4.14).

Proposed Action. Table 6-2 shows the maximum quantity[2] of air emissions from LLNL along with emissions in the region. As shown in that table, LLNL contributions to regional emissions are less than 0.02 percent for all pollutants.

Table 6-2. Cumulative Annual Emissions for the Proposed Action

Pollutant	Proposed Action[a] (tons/year)	Regional Emissions[b] (tons/year)	Cumulative Emissions (tons/year)	Percentage of Cumulative Emissions from LLNL Proposed Action
CO	21.0	484,355	484,376	0.004%
NO_x	18.2	115,340	115,358	0.02%
Fine particulate matter (PM_{10}/$PM_{2.5}$)	2.2	54,750	54,752	0.005%
Sox	0.9	7,665	7,666	0.01%
VOC	7.6	99,645	99,653	0.006%

a. From Table 5-14. Includes emissions from both the Livermore Site and Site 300.
b. From BAAQMD 2014, which is the most current emission data from BAAQMD.

The discussion in the No-Action Alternative regarding the BAAQMD's control strategy to reduce emissions also applies to the cumulative impacts for the Proposed Action.

With regard to GHG, LLNL's GHG emissions associated with the Proposed Action would be approximately 157,808 metric tons per year (*see* Table 5-15). In California, state-wide GHGs are estimated to be approximately 363.5 million metric tons per year (EIA 2016). GHG emissions associated with the Proposed Action at LLNL would account for less than 0.03 percent of those emissions. Regional GHG emissions total about 85 million metric tons. The control measures discussed above are estimated to reduce GHG emissions by approximately 4.4 million metric tons per year (BAAQMD 2017). Within the city of Livermore, the city's greenhouse gas inventory determined that 63 percent of Livermore's carbon emissions come from automobiles. Hence, the city is in the process of updating its bicycle master plan. Livermore already plans to increase its bike paths from 46 miles to nearly 90 miles, and walking trails from 22 miles to 108 miles (Livermore 2009).

With regard to radiological emissions, accelerator operations at LBNL and SLAC also release airborne radionuclides which could contribute to cumulative impacts (*see* Section 6.4.14).

6.4.7 Noise

Key metrics presented in this analysis include: (1) identification of new projects within approximately 400-800 feet of site boundaries, which may cause offsite cumulative noise impacts; and (2) cumulative traffic noise analysis.

No-Action Alternative and Proposed Action. As shown in Table 5-19, including the Emergency Operations Center (EOC), there would be approximately five projects constructed within a distance of approximately 800 feet of the Livermore Site boundary under the No-Action Alternative. At Site 300, the Range Facility Replacement would be located within 500 feet of the southern site boundary. However, because there are no residences or other noise receptors within

[2] Maximum quantity includes emissions from both the Livermore Site and Site 300.

several miles of this facility, there would be no additional offsite noise impacts at Site 300. For the Proposed Action, as shown in Table 5-20, there would be approximately 15 projects constructed within a distance of approximately 800 feet of the Livermore Site boundary. Six of the new projects would be constructed within approximately 500 feet of a site boundary. At Site 300, four facilities would be located within 500 feet of the southern site boundary.

Any construction or DD&D conducted within approximately 800 feet of the Livermore Site boundary could create construction noise impacts to offsite areas. Implementation of BMPs would reduce noise effects and NNSA would not expect any offsite noise levels to exceed thresholds outlined in any applicable federal, state, or local noise regulations. Any offsite construction projects within approximately 800 feet of the Livermore Site or Site 300 boundary would contribute to cumulative noise impacts; however, the noise levels from these activities would remain similar to the construction/DD&D activities for the 2019 baseline. Once operational, the new facilities would not introduce any machinery or equipment that would differ from the existing heating, ventilation and air conditioning (HVAC) systems, cooling towers, motors, pumps, fans, generators, air compressors, and loudspeakers currently on the Livermore Site and Site 300. Nonetheless, the potential for noise impacts would increase with every new facility that is located within 800 feet of a site boundary. Given the proximity of residential areas to the Livermore Site, particularly to the west, extra precautions would be taken to incorporate noise controls into the final design of the facilities to ensure compliance with local noise regulations. Reductions by design (i.e., silencers, enclosures, and other engineering controls) may be required to ensure the noise from new facilities does not lead to a violation of the local noise regulations.

With regard to cumulative noise from traffic, as discussed in Section 5.7.1, a doubling in traffic volume would be required to increase the noise level by 3 dBA, which is the threshold whereby changes in noise levels would be perceptible to individuals with average hearing. As discussed in Section 6.11 (below), the cumulative increase in traffic on area roads would have an imperceptible effect on traffic noise in the vicinity of LLNL. Consequently, no increase in cumulative noise impacts from traffic would be expected. The city has a goal to reduce the level of noise generated by mechanical and other noise-generating equipment by means of public education, regulation, and/or political action (Livermore 2014). Such actions would mitigate or minimize the noise impacts from non-NNSA sources.

6.4.8 Biological Resources

Key metrics presented in this analysis include: (1) identify disturbances to land/vegetation and discuss impact on habitats, fish and wildlife, and special status species; (2) identify and discuss wetland impacts; and (3) quantify tritium levels and potential impacts on vegetation and commodities.

No-Action Alternative. As discussed in Section 5.8.1, the No-Action Alternative would have minimal impacts on vegetation and wildlife because construction and operational activities would be in associated developed areas, conservation measures would be implemented, and the disturbed area would be less than 0.8 percent of the total acreage at either site. No critical habitat is designated by the USFWS at the Livermore Site. At Site 300, the entire site is within critical habitat designated for the California red-legged frog. Critical habitat for the Alameda whipsnake covers 2,492 acres of Site 300. Additionally, 160 acres within Site 300 are designated as critical habitat for the survival and recovery of large-flowered fiddleneck. Land disturbances would occur within previously developed areas and would not harm, harass, kill, or injure special status species. No projects would impact wetlands.

The tritium emissions limits would not change under the No-Action Alternative. These total approximately 300 Ci for the Tritium Facility, NIF, B298, and other miscellaneous diffuse sources (Table 3-8). Note that limits only apply to the Tritium Facility and NIF and were established in the 2011 Supplement Analysis. The actual emissions in the 2019 baseline year were 129.2 Curies. However, the analysis in Section 5.8.1 assumes that if the tritium emissions were to increase to its current limits of approximately 300 Curies, the maximum estimated ingestion dose from LLNL operations would be 0.020 millirem/year. This maximum dose is about 1/15,000 of the average annual background dose in the United States from all-natural sources. For Livermore Valley wines, the highest concentration of tritium (156.4 pCi/L) would be just 0.78 percent the USEPA standard for maximal permissible level of tritium in drinking water (20,000 pCi/L). Drinking one liter per day of the Livermore Valley wine with the highest concentration would result in a dose of 0.001 millirem/year (based on LLNL 2020r). There are no other sources of tritium emissions in the region that would cumulatively add to these values.

On a local level, the city of Livermore has a stated goal to "conserve the value and function of Livermore's open space as a biological resource" (Livermore 2014). More specifically, the city of Livermore has stated that it will:

- give priority to land acquisition efforts that would result in the creation and expansion of linkages between existing protected natural resource areas;
- support efforts to preserve and maintain Corral Hollow, important as the most northerly range of desert plants and animals, as open space;
- minimize impacts to sensitive natural habitats including alkali sinks, riparian vegetation, wetlands and woodland forest; and
- require project proponents to identify and map sensitive biological and wetland resources on each development parcel and identify the measures necessary to avoid and/or minimize impacts on sensitive biological and wetland resources prior to approving the development (Livermore 2014).

On a state-level, the California Department of Fish and Wildlife has developed the California State Wildlife Action Plan (2015 SWAP) which includes conservation actions that respond to current and future challenges with objectives and goals that are specific, measurable, and time bound (CDFW 2015). The 2015 SWAP focuses on conservation of the wildlife resources of the nation's most biologically diverse state using an approach that is in harmony with a growing human population and the need for resilience in the face of a changing climate (CDFW 2015).

CDFW's vision for conserving the state's wildlife is to sustain the floral and faunal biodiversity of California over the next decade, and to establish a solid conservation framework for the decades that follow. Through the 2015 SWAP, CDFW seeks to:

- maintain and enhance the integrity of ecosystems by conserving key natural processes and functions, habitat qualities, and sustainable native species population levels, so that

California's ecosystems are resilient to shifting environmental conditions resulting from climate change and other causes;

- promote partnerships with federal, state, and local agencies; tribal governments; and non-governmental organizations with aligned conservation goals to leverage efficient use of funding and other public resources;
- inspire greater understanding and recognition of critical needs for conserving wildlife and their habitats by lawmakers, land use planners, private landowners, and others who have influence in developing and implementing conservation actions;
- allocate sufficient water and manage water resources to maintain healthy ecosystems and fish and wildlife populations when considering state and regional water supply needs;
- provide resources and coordinate efforts with partners to eradicate or control invasive species and prevent new introductions;
- sustain the quality of California's natural resources and biodiversity in harmony with predicted economic growth and human population increases;
- integrate wildlife conservation with working landscapes and environments, recognizing both the economic and ecological values of agriculture, rangeland, forestry, and fisheries;
- support conservation programs that benefit native species, habitats, and ecosystems through broad-based public funding from federal, state, special district, and local government sources; and
- enhance conservation capacity by clearly articulating conservation purposes, applying adaptive management principles, and effectively using staff and financial resources.

The 2015 SWAP identifies species of greatest conservation need in the Bay Delta and Central Coast Province that are the focus of the CDFW conservation strategies. There are no invertebrate species in the list of focal species for the province, and fish species do not include species associated with the project areas. Amphibians identified as focal species in the California Wildlife Action Plan that are associated with the project area include the California tiger salamander, foothill yellow-legged frog, and California red-legged frog. Reptile focal species associated with the project area include San Joaquin coachwhip and Alameda whipsnake. Avian focal species associated with the project area include bald and golden eagles, Swainson's hawk, northern harrier, white-tailed kite, long-eared owl, loggerhead shrike, least Bell's vireo, bank swallow, Swainson's thrush, yellow warbler, and tricolored blackbird. Mammal focal species associated with the project area include pallid bat and western red bat. The State's action plan identifies stressors on conservation targets as habitat loss and degradation from population growth and development; non-native and invasive species; row crops, vineyards, and orchards; wildfire and fire suppression; and climate change (CDFW 2015).

Because only minimal offsite impacts (i.e., a dose of 0.001 millirem/year from wine consumption) are expected under the No-Action Alternative, NNSA's actions would not be expected to contribute to offsite cumulative impacts.

Proposed Action. As discussed in Section 5.8.2, the Proposed Action would have minimal impacts on vegetation and wildlife because construction and operational activities would be in associated developed areas, conservation measures would be implemented, and the disturbed area would be small (6.4 percent of the total acreage at the Livermore Site and 0.5 percent at Site 300). Most land disturbances would occur within previously developed areas and would not be expected to harm, harass, kill, or injure special status species.

The New North Entry is the only Proposed Action project that would potentially affect wetlands or waters at the Livermore Site. The proposed bridge across the Arroyo Las Positas would span the Arroyo and would not impact the associated intermittent stream-wetlands. The proposed project would avoid the destruction or modification of wetlands and new construction in wetlands. DOE would implement best management practices for constructing the roadway and use a bridge across the Arroyo Las Positas to avoid potential impacts to wetlands. The additional landscaping around Lake Haussmann would not affect DOE wetlands or intermittent stream waters adjacent to the lake. Because no offsite wetlands impacts are expected under the Proposed Action, NNSA's actions would not be expected to contribute to offsite cumulative impacts.

Under the Proposed Action, tritium emission limits are proposed to increase at the Livermore Site. Although actual tritium emissions may not change, NNSA has analyzed the potential impacts if tritium emissions limits increased from approximately 300 Curies (No-Action Alternative maximum level) to limits of approximately 3,610 Curies. As discussed in Section 5.8.2, if tritium emissions increased to approximately 3,600 Curies per year, the maximum estimated ingestion dose from LLNL operations would be 0.24 millirem/year. This maximum dose is about 1/1,250 of the average annual background dose in the United States from all-natural sources. For Livermore Valley wines, the highest concentration of tritium (1,876 pCi/L) would be just 9.4 percent of the USEPA standard for maximal permissible level of tritium in drinking water (20,000 pCi/L). Drinking one liter per day of the Livermore Valley wine with the highest concentration would result in a dose of 0.012 millirem/year (based on LLNL 2020r). There are no other sources of tritium emissions in the region that would cumulatively add to these values.

The local and state-wide goals described for the No-Action Alternative would also be applicable to the Proposed Action.

6.4.9 Cultural Resources

The key metric presented in this analysis is a qualitative analysis of the potential to impact cultural and paleontological resources.

No-Action Alternative and Proposed Action. The Livermore Site and Site 300 have undergone comprehensive reviews in 2007 and 2012 to identify significant historic buildings, structures, and objects, and those that were determined eligible for the National Register have already been mitigated and are no longer eligible. There are currently no significant architectural properties at the Livermore Site or Site 300 and no impacts to these resources would be expected.

Scattered fossil remains have been discovered at both the Livermore Site and Site 300, and any proposed ground-disturbing activities would have the potential to disturb cultural resources. However, the probability of impacting cultural resources would be low because implementation of current management practices would avoid and protect any sensitive areas. Nonetheless, unrecorded subsurface resources could still be inadvertently discovered during new construction or other ground-disturbing activities undertaken on undisturbed land. Standard LLNL practice would require work to be halted if any previously unknown resources were discovered during ground-disturbing activities, and that a qualified paleontologist be provided an opportunity to assess the finds. None of the NNSA actions would cause impacts to offsite cultural resources.

Offsite areas have the potential to contain cultural resources, and non-NNSA actions would have the potential to impact those resources. Any such impacts would be independent of NNSA activities at LLNL. The potential for an offsite area to contain cultural resources is strongly site-specific; consequently, without site-specific information as to where non-NNSA actions would occur, no specific judgments can be made about potential cumulative impacts. Compliance with federal and state laws and regulations pertaining to cultural resources would mitigate any impacts.

6.4.10 Socioeconomics and Environmental Justice

Key metrics presented in this analysis include: (1) employment and population changes; and (2) impacts to housing, community services, and schools.

6.4.10.1 *Socioeconomics*

No-Action Alternative. As shown in Table 6-3, approximately 14,490 direct and indirect workers were employed as a result of LLNL operations in 2019. This accounted for 0.73 percent of the regional (ROI) labor force of 1.98 million workers. By end of 2022, direct and indirect labor from LLNL operations associated with the No-Action Alternative would increase to 17,018, which would be 0.83 percent of the projected regional 2022 workforce of 2.04 million. In 2022, the population in the ROI is expected to increase from 4,084,802 to 4,261,288 persons, which would be an increase of 176,486 persons. Of this increase, the No-Action Alternative would add approximately 7,584 persons to the ROI by 2022, which would represent approximately 4.3 percent of the population increase.

Due to the low potential for impacts on the population, the No-Action Alternative would not have cumulative effects on fire protection, police protection services, or medical services. Similarly, there would be minimal impacts on housing or availability, as those issues would be largely driven by non-NNSA population increases. For example, as discussed in Section 5.10.1.1, there were 78,413 vacant housing units in the ROI in 2020 (DOF 2020b). Because a large influx of workers/families into the ROI is not expected as a result of LLNL activities, the No-Action Alternative would not result in notable changes in vacant housing units. At most, the additional jobs associated with the No-Action Alternative would reduce the vacant housing units by 2,528, or approximately 3.2 percent. In contrast, the population increase of 176,486 persons associated with regional growth would require approximately 58,800 housing units (based on an average of 3 persons per household).

With regard to schools, the number of school-aged children in the ROI in 2018-2019 was 667,493. Assuming an average of 0.4 school-age children per household (NAHB 2017), the maximum number of school-age children associated with the additional direct and indirect workforce potentially migrating into the ROI would be 1,011 children (2,528 multiplied by 0.4 average school-age children per household). The increase in school enrollment would represent 0.2 percent of the projected 2021-2022 school enrollment of 656,132 for the ROI (DOF 2021a). This minimal increase in school enrollment would be offset by estimates from the California Department of

Finance (DOF) that the number of school-aged children in the ROI in 2022 will drop by 11,361 relative to the 2019 baseline (DOF 2021a).

Proposed Action. As shown in Table 6-4, approximately 17,018 direct and indirect workers would be employed as a result of LLNL operations in 2022. This would account for 0.83 percent of the projected 2022 regional (ROI) labor force of 2.04 million workers. By 2035, direct and indirect labor from LLNL operations associated with the Proposed Action would increase to 19,288, which would be 0.86 percent of the projected regional 2035 workforce of 2.24 million. In 2035, the population in the ROI is expected to increase from 4,261,288 to 4,752,927 persons, which would be an increase of 491,639 persons. Of this increase, the Proposed Action would add approximately 6,810 persons to the ROI by 2035, which would represent approximately 1.4 percent of the population increase.

Due to the low potential for impacts on the population, the Proposed Action would not have cumulative effects on fire protection, police protection services, or medical services. Similarly, there would be minimal impacts on housing or availability, as those issues would be largely driven by non-NNSA population increases. For example, as discussed in Section 5.10.1.2, there were 78,413 vacant housing units in the ROI in 2020 (DOF 2020b). Because a large influx of workers/families into the ROI is not expected as a result of LLNL activities, the Proposed Action would not result in notable changes in vacant housing units. At most, the additional jobs associated with the Proposed Action would reduce the vacant housing units by an additional 2,270 over the No-Action Alternative, or approximately 2.9 percent. In contrast, the population increase of 491,639 persons associated with regional growth would require approximately 163,900 housing units (based on an average of 3 persons per household). This would require additional housing units to be constructed within the ROI.

With regard to schools, assuming an average of 0.4 school-age children per household (NAHB 2017), the maximum number of school-age children associated with the additional direct and indirect workforce of 2,270 potentially migrating into the ROI would be 908 (2,270 multiplied by 0.4 average school-age children per household) children above the No-Action Alternative baseline. The increase in school enrollment would represent 0.1 percent of the projected 2034–2035 school enrollment of 643,318 for the ROI (DOF 2021a). This minimal increase in school enrollment would be offset by projections that the number of school-aged children in the ROI will drop from 656,132 in 2022 to 643,318 by 2035 (projected from DOF 2021a).

Table 6-3. Cumulative Socioeconomic Impacts from LLNL Activities for the No-Action Alternative

Resource/Metric	Baseline (Existing) Environment) 2019	Change to Baseline as a Result of the No-Action Alternative			No-Action Alternative (by end of 2022)	Percentage Increase Over Baseline (%)
		Construction and DD&D (Peak year)	Operations (by the end of 2022)	Total		
Jobs						
Total Direct and Indirect employment from LLNL activities	14,490	291	2,237	2,528	17,018	17.4
Total ROI labor force (persons)	1,976,800	-	-	-	2,039,210[a]	3.1[b]
Earnings/Value Added						
Earnings from direct jobs at LLNL (millions of dollars)	$1,334M[c]	$18.6M[d]	$206.0M[c]	$224.6M	$1,558.6M	16.8
Earnings from indirect jobs from LLNL in ROI (millions of dollars)[e]	$1,110M	$7.2M	$171.4M	$178.6M	$1,288.6M	16.1
Value added from LLNL (millions of dollars)	$2,436M[f]	$31.6M[g]	$376.1M[f]	$407.7M	$2,843.7M	16.7
Population						
Total ROI population	4,084,802	873[h]	6,711[h]	7,584	4,261,288[i]	4.3[j]

a. Calculated using the average labor force growth rate of historic labor force in the ROI (EDD 2020a).
b. ROI labor force increase of 3.1 percent would largely occur independent of LLNL activities. The direct and indirect employment increase from LLNL activities would only contribute a 0.12 percent increase.
c. Earnings were estimated using a final-demand earnings multiplier of 0.4374 applied to the change in jobs / change in final demand multiplier of 2.5926 (BEA 2021).
d. Earnings were estimated using a final-demand earnings multiplier of 0.4467 applied to the change in jobs / change in final demand multiplier of 5.0364 (BEA 2021).
e. Derived from earnings from directs jobs / direct jobs.
f. Value added was estimated using a final-demand value added multiplier of 0.7986 applied to the change in jobs / change in final demand multiplier of 2.5926 (BEA 2021).
g. Value added was estimated using a final-demand value added multiplier of 0.7584 applied to the change in jobs / change in final demand multiplier of 5.0364 (BEA 2021).
h. Based on an average of 3 persons per household for the ROI (USCB 2021) and the conservative assumption that new direct LLNL workers and indirect workers would move with their families.
i. Population projection for year 2022 for counties in the ROI from California's Department of Finance, Table P-1: State Population Projections (2010-2060) (DOF 2020a).
j. ROI population increase of 4.3 percent would largely occur independent of LLNL activities. The population increase from LLNL activities would contribute a 0.2 percent increase.
Sources: DOF 2020a, EDD 2020a, LLNL 2019i; USCB 2021, BEA 2021.

Table 6-4. Cumulative Socioeconomic Impacts from LLNL Activities for the Proposed Action

Resource/Metric	No-Action Alternative (by end of 2022)	Change to No-Action Alternative as a Result of the Proposed Action			Proposed Action (by end of 2035)	Percentage Increase Over No-Action Alternative (%)
		Construction and DD&D (peak year)	Operations (by end of 2035)	Total		
Jobs						
Total Direct and Indirect Employment	17,018	970	1,300	2,270	19,288	13.4
Total ROI labor force (persons)	2,039,210	-	-	-	2,238,799[a]	9.8[b]
Earnings/Value Added						
Earnings from direct jobs at LLNL (millions of dollars)	$1,558.6M[c]	$62.1M[d]	$119.8M[c]	$181.9M	$1,740.5M	11.6
Earnings from indirect jobs from LLNL in ROI (millions of dollars)[e]	$1,288.6M	$24.8M	$99.5M	$124.3M	$1,412.9M	9.6
Value added from LLNL (millions of dollars)	$2,843.7M[f]	$104.4M[g]	$218.7M[f]	$324.1M	$3,167.8M	11.4
Population						
Total ROI population	4,261,288	2,910[h]	3,900[j]	6,810	4,752,927[i]	11.5[j]

a. Calculated using the average labor force growth rate of historic labor force in the ROI (EDD 2020a).
b. ROI labor force increase of 9.8 percent would largely occur independent of LLNL activities. The direct and indirect employment increase from LLNL activities would only contribute a 0.11 percent increase.
c. Earnings were estimated using a final-demand earnings multiplier of 0.4374 applied to the change in jobs / change in final demand multiplier of 2.5926 (BEA 2021).
d. Earnings were estimated using a final-demand earnings multiplier of 0.4467 applied to the change in jobs / change in final demand multiplier of 5.0364 (BEA 2021).
e. Derived from earnings from directs jobs / direct jobs.
f. Value added was estimated using a final-demand value added multiplier of 0.7986 applied to the change in jobs / change in final demand multiplier of 2.5926 (BEA 2021).
g. Value added was estimated using a final-demand value added multiplier of 0.7584 applied to the change in jobs / change in final demand multiplier of 5.0364 (BEA 2021).
h. Based on an average of 3 persons per household for the ROI (USCB 2021) and the conservative assumption that new direct LLNL workers and indirect workers would move with their families.
i. Population projection for year 2035 for counites in the ROI from California's Department of Finance, Table P-1: State Population Projections (2010-2060) (DOF 2020a).
j. ROI population increase of 11.5 percent would largely occur independent of LLNL activities. The population increase from LLNL activities would contribute a 0.1 percent increase.
Sources: DOF 2020a, EDD 2020a, LLNL 2019i; USCB 2021, BEA 2021.

6.4.10.2 *Environmental Justice*

The analysis in this section identifies and addresses any disproportionately high and adverse human health or environmental effects on minority or low-income populations, based on other resource impacts.

No-Action Alternative and Proposed Action. As documented in Section 5.10.2, based on the analysis of impacts for the resource areas in this SWEIS, no disproportionately high and adverse impacts are expected under the No-Action Alternative or the Proposed Action. To the extent that any impacts could be adverse, NNSA expects the impacts to affect all populations in the area equally. As shown in Section 5.14, at both the Livermore Site and Site 300, the annual radiation dose to the offsite MEI would be much less than the limit of 10 millirem per year for airborne releases of radioactivity. The risk of an LCF to the MEI from operations at the Livermore Site would be a maximum of 2.5×10^{-6} per year, and the projected number of LCFs to the population within a 50-mile radius of the Livermore Site would be 4.3×10^{-3} per year. At Site 300, the risk of an LCF to the MEI from operations would be 1.0×10^{-10} per year, and the projected number of LCFs to the population within a 50-mile radius of Site 300 would be 3.0×10^{-8} per year. Consequently, the impacts from NNSA's actions are small and would not be expected to contribute to offsite cumulative environmental justice impacts from other non-NNSA actions.

For radiological and hazardous materials transportation between LLNL and other sites, the potential impacts would be small (less than 23.8 person-rem annually, which equates to an LCF risk of 0.014 [*see* Table 5-31]). NNSA expects the impacts to be equal to all populations along routes. With specific regard to transportation of TRU waste to WIPP, previous DOE analyses have concluded that there would be no disproportionately high and adverse safety risks to low-income or minority populations along the routes (*see* NNSA 2020b and DOE 2016d).

6.4.11 Transportation

Key metrics presented in this analysis include: (1) traffic changes on area roads; and (2) impacts to the public and transport crews from shipments of radiological and hazardous materials.

6.4.11.1 *Local Transportation*

No-Action Alternative. Cumulative traffic impacts were determined by comparing current traffic levels with projected traffic increases associated with the No-Action Alternative and general area-wide regional growth. In 2022, the population in the ROI is expected to increase from 4,084,802 to 4,261,288 persons, which would be an increase of 4.3 percent. As shown in Table 6-5, local traffic would increase by an average of approximately 6.7 percent (note: as Table 6-5 shows, traffic on specific roads in the vicinity of the Livermore Site would increase by 5.9 – 7.7 percent). Traffic congestion is a non-linear function, meaning that a small increase in peak traffic volume can cause a proportionally larger delay. For example, a 5 percent increase in traffic volumes on a congested road (for example, from 1,900 to 2,000 vehicles per hour) may cause a 10-30 percent decrease in average vehicle speeds (e.g., decreasing traffic speeds from 45 to 35 miles per hour). As a result, even relatively small changes in traffic volume or capacity on congested roads can provide relatively large increases in traffic delay. Consequently, increasing traffic by an average of 6.7 percent would exacerbate traffic levels on area roads, particularly during peak commuting hours.

However, the traffic increases would not be expected to degrade the level of service (LOS) on area roads, all of which operate at between LOS C and LOS D at intersections. In general, traffic would need to increase by at least 20 percent to cause a LOS change (Traffic 2021).[3]

Table 6-5. Cumulative Impacts to Area Roads for the No-Action Alternative

Road	2019 Baseline Average Daily Traffic (ADT) Volume (vehicles/day)[a]	Potential Increase in ADT Volume Due to No-Action Alternative[a] (vehicles/day)	Potential Increase in ADT Volume Due to General Area-Wide Growth[b] (vehicles/day)	2022 No-Action Alternative Cumulative ADT Volume (vehicles/day)	Potential Cumulative Percentage Increase in ADT Volume
East Avenue	17,842	286	767	18,895	5.9%
Patterson Pass Road	6,740	143	290	7,173	6.4%
Greenville Road	13,944	472	600	15,016	7.7%
Vasco Road	20,108	530	865	21,503	6.9%
Total	**58,634**	**1,431**	**2,522**	**62,587**	**6.7%**

a. Values from Table 5-28.
b. Based on 4.3 percent growth in traffic on each road.
Source: Livermore 2016.

Proposed Action. Cumulative traffic impacts were determined by comparing 2022 traffic levels with projected traffic increases associated with the Proposed Action and general area-wide regional growth. In 2035, the population in the ROI is expected to increase from the 2022 level of 4,261,288 to 4,752,927 persons, which would be an increase of 11.5 percent. As shown in Table 6-6, local traffic would increase by an average of approximately 13.7 percent (note: as Table 6-6 shows, traffic on specific roads in the vicinity of the Livermore Site would increase by 13.0 – 14.6 percent). Increasing traffic by an average of 13.7 percent would exacerbate traffic levels on area roads, particularly during peak commuting hours. However, as explained above, the traffic increases would not be expected to degrade the LOS on area roads, all of which operate at between LOS C and LOS D at intersections.

[3] The distinctions between LOS ratings are subjective, and many factors can affect how a given traffic change will affect the LOS on a given road, including road design, number of lanes, number of intersections, speed limit, and signalization. Consequently, the ability to make definitive conclusions about an LOS change on a given road is limited.

Table 6-6. Cumulative Impacts to Area Roads for the Proposed Action

Road	2022 No-Action Alternative Cumulative ADT Volume (vehicles/day)[a]	Potential Increase in ADT Volume Due to Proposed Action[b] (vehicles/day)	Potential Increase in ADT Volume Due to General Area-Wide Growth[c] (vehicles/day)	2035 Cumulative ADT Volume (vehicles/day)	Potential Cumulative Percentage Increase in ADT Volume
East Avenue	18,895	282	2,173	21,350	13.0%
Patterson Pass Road	7,173	141	825	8,139	13.5%
Greenville Road	15,016	465	1,727	17,208	14.6%
Vasco Road	21,503	522	2,473	24,498	13.9%
Total	**62,587**	**1,410**	**7,198**	**71,195**	**13.7%**

a. Values from Table 6-5.
b. Values from Table 5-29.
c. Based on 11.5 percent growth in traffic on each road.
Source: Livermore 2016.

6.4.11.2 *Radiological Transportation*

As stated in Sections 5.11.3.1 and 5.11.3.2 of this SWEIS, the No-Action Alternative and the Proposed Action would involve offsite and onsite shipment of radiological materials and wastes during operations. Radiological materials and wastes to be transported include:

- LLW and MLLW shipments to NNSS, Energy*Solutions* in Utah, Perma-Fix Environmental Services in Tennessee;[4]
- TRU waste shipments to WIPP;
- Security Category III SNM to and from LANL and NNSS;
- Tritium gas from the Savannah River Site (SRS) to the Livermore Site; and
- Sealed americium-241 sources to and from SRS.

The assessment of cumulative impacts includes other nationwide facilities and their present, and reasonably foreseeable future actions involving radioactive material transport; and focuses on radiological impacts from offsite transportation throughout the nation that would result in potential radiation exposure to the general population. This is in addition to those impacts evaluated for the alternatives for LLNL in this SWEIS. Cumulative radiological impacts from transportation are measured using the collective dose to the general population and workers because dose can be directly related to LCFs using a dose conversion factor.

Table 6-7 compares the potential impacts on transport workers and the general population from future transportation activities considered in this SWEIS with the cumulative impacts estimates from past, present, and reasonably foreseeable future DOE actions; past, present, and reasonably foreseeable future non-DOE actions; and general radioactive material transport.

[4] LLW and MLLW could also be sent to Perma-Fix in Richland, Washington and Waste Control Specialists in Andrews County, Texas. NNSA bounded the potential impacts for LLW and MLLW by modelling shipments to Perma-Fix Environmental Services in Oak Ridge, Tennessee, which is the longest and most populated route.

Table 6-7. Cumulative Radiological Transportation Impacts

Action		Crew Dose (person-rem)	Risk of Latent Cancer Fatality	Population Dose (person-rem)	Risk of Latent Cancer Fatality
Past, Present, and Reasonably Foreseeable Future DOE Actions as identified in the Surplus Plutonium Disposition (SPD) SEIS (NNSA 2015)					
Historical (Spent Nuclear Fuel [SNF] to SRS) – (1953 to 1993)		49	0.03	25	0.02
Past, present, and reasonably foreseeable DOE actions[a]		30,900	18.5	36,700	22.5
Additional Reasonably Foreseeable Future DOE Actions since Publication of the SPD SEIS (NNSA 2015)					
Permanent disposal or interim storage of SNF[b]		5,600–5,900	3.4–3.5	1,100–1,200	0.66–0.72
Greater-than-Class C waste EIS[c]		180	0.1	68	0.04
WIPP Supplement Analysis[d]		492	0.3	383	0.23
Production of tritium in a commercial light-water reactor[e]		25–60	0.02–0.04	2.7–12	0.0–0.01
SPD SEIS proposed action[f]		230–650	0.4	150–580	0.3
SRS Pit Production EIS[g]		580.5–901	0.4–0.48	334–455	0.17–0.23
Versatile Test Reactor (VTR) EIS preferred alternative[h]		624–1,920	0.38–1.2	699–1,780	0.42–1.1
Total DOE Actions		**38,680–41,052**	**23–24.6**	**39,500–41,200**	**24-25**
Past, Present, and Reasonably Foreseeable Future Non-DOE Actions					
Enrichment facility in Lea County[i]		1,500	0.90	450	0.27
Eagle Rock enrichment facility[j]		3,350	2.01	60,000	36
GE Global laser enrichment[k]		242	0.15	419	0.25
American Centrifuge plant[l]		285	0.17	390	0.23
General radioactive material transport (1943 to 2073)[a]		384,000	230	338,000	203
Total Non-DOE Actions		**389,000**	**233**	**399,000**	**239**
Subtotal		**427,680–430,000**	**256–258**	**438,500–440,200**	**263–264**
LLNL SWEIS	No-Action Alternative[m] (over 15 years)	924	0.56	324	0.19
	Proposed Action[m] (over 15 years)	1,038	0.62	370	0.22
Total Impacts (up to 2073)		**428,603–431,038**	**257.2–258.6**	**438,811–440,570**	**263.2–264.3**

a. Does not include the doses from shipping Greater-than-Class C waste.
b. Source: DOE 2008, Table 8-14; assumed the Yucca Mountain, Nevada, surrogate for repository or interim storage.
c. Source: DOE 2016b, Table 4.3.9-1, pp. 4-68 and 4-69; DOE 2018, p. 3-20
d. Source: DOE 2009, Table 2.
e. Source: DOE 2016c, Table F-12; calculated from LCFs.
f. Source: NNSA 2015.
g. Source: NNSA 2020a, Table 5-7.
h. Source: DOE 2020f. INL VTR Alternative (preferred alternative).
i. Source: NRC 2005. The values presented are for 30 years of operation.
j. Source: NRC 2011, Table 4-12.
k Source: NRC 2012, Table 4-14.
l. Source: NRC 2006.
m. Impact indicators are from Chapter 5, Tables 5-30 and 5-31 of this SWEIS.

6.4.12 Infrastructure

Key metrics presented in the infrastructure analysis are: (1) quantities of water, electricity, sanitary sewer (wastewater), and fuel (petroleum and natural gas); and (2) current infrastructure to meet these demands.

6.4.12.1 *Water Consumption*

No-Action Alternative. Livermore Site's primary water supplier is the San Francisco Public Utilities Commission (SFPUC) Hetch Hetchy Regional Water System. The secondary water source for the Livermore Site is Zone 7. The Site 300 domestic water system has three sources. Starting in March 2020, the primary water source is purchased surface water from the SFPUC Hetch Hetchy Aqueduct System (HHAS) through the Thomas Shaft pumping station. Additionally, Site 300 has two deep wells: well 20 (the primary water supply well) and well 18 (the backup water supply well). In Addition, Small Firearms Training Facility gets its water (up to 500 gallons per day) from a well located on adjacent Carnegie State Vehicle Recreation Area (SVRA) property. The water system's capacity is estimated to be 648,000 gallons per day, with expansion capability of 1.2 million gallons per day (NNSA 2011).

As stated in Section 5.12.1, under the No-Action Alternative, annual water consumption is estimated to be approximately 386 million gallons per year at the Livermore Site and approximately 14.5 million gallons per year at Site 300. The existing capacity of the Livermore Site and Site 300 domestic water system is approximately 1,524 million gallons per year. As shown in Table 6-8, this represents about 26.2 percent of the existing site capacity. The Livermore Site and Site 300 domestic water system has adequate capacity to meet future water demand. However, any increase in water use at LLNL would add to overall water demands and water supply issues in the region.

With regard to regional water use, the Hetch Hetchy Reservoir provides water to 2.7 million residents and businesses in the San Francisco Bay Area. The reservoir can store as much as 117 billion gallons for the Hetch Hetchy Regional Water System, which serves San Francisco, Santa Clara, Alameda and San Mateo counties. Most of SFPUC's wholesale customers rely on the Hetch Hetchy Regional Water System for more than 60 percent of their water needs (Water Ed. 2021). The estimated 390 million gallons per year associated with Livermore Site water consumption under the Proposed Action represents approximately 0.3 percent of the Hetch Hetchy capacity.

The Zone 7 Water Agency supplies treated drinking water to retailers serving more than 260,000 people in Pleasanton, Livermore, Dublin, and, through special agreement with the Dublin San Ramon Services District, to the Dougherty Valley area. The Zone 7 Water Agency also supplies untreated water for irrigation of 3,500 acres, primarily to South Livermore Valley vineyards. The 2020 Urban Water Management Plan (UWMP) for Zone 7 explains how the agency plans to develop and deliver municipal and industrial water supplies to Zone 7's water service area and details how the agency will maintain a reliable water supply. The 2020 UWMP estimates a high-level projected water use on Zone 7 through 2045 of approximately 55,300 acre-feet per year, which equates to approximately 18,020 million gallons per year. The estimated 482 million gallons per year associated with Livermore Site water consumption under the Proposed Action represents approximately 2.6 percent of Zone 7's total water demand (Zone 7 Water Agency 2020b).

An issue that could impact future water supplies is the ongoing California drought. In a normal year in California, most rain and snow occurs during November through April, which fills the reservoirs and aquifers used to supply homes, businesses, and farms. Because of the warm temperatures in April and early May in California, 2021 was a critically dry year. As a result, snow melted and runoff evaporated at a faster rate in the Sacramento, Feather, and American River watersheds. The State of California continues to track drought conditions and is committed to tackling the drought emergency while addressing long-standing water challenges (California 2021).

In the summer of 2019, Zone 7 management formally asked NNSA/LLNL to reduce Zone 7 water use as much as possible (NNSA 2021b). Potential future reductions in Zone 7 water use could impact LLNL, particularly during the periods when the SFPUC supply system is down for maintenance that could be as much as 2 to 3 months per year.

Table 6-8. Water Consumption for the Alternatives at both LLNL sites

Metric	Existing Capacity (million gallons/year)	No-Action Alternative (million gallons/year)	Proposed Action (million gallons/year)	No-Action Alternative Percentage of Existing Capacity	Proposed Action Percentage of Existing Capacity
Water Use	1,524[a]	400[a]	503[a]	26.2%	33.0%

a. From Table 5-34.

Proposed Action. Under the Proposed Action, water consumption would increase to approximately 503 million gallons per year due to LLNL operations. As shown in Table 6-8, this represents about 26.2 percent of the existing sites' capacity. Potable water usage does not change under the Proposed Action, despite an increase in site activity, because of the planned use of reclaimed water from the City of Livermore's Livermore Water Reclamation Plant (LWRP).

As discussed in Section 5.12.2, under the Proposed Action, LLNL would improve its water resource sustainability practices by extending the supply of reclaimed water from the City of Livermore's LWRP for use in cooling towers at the Livermore Site. The reclaimed water pipeline project would enable LLNL to use approximately 200 million gallons per year of treated wastewater for cooling tower cooling water instead of using fresh Hetch Hetchy water. This project would reduce Hetch Hetchy potable water usage at LLNL by approximately 200 million gallons per year, as compared to not using reclaimed water.

6.4.12.2 *Sanitary Sewer*

No-Action Alternative. As discussed in Section 5.12.1, under the No-Action Alternative, wastewater generation would increase by an additional 43,600 gallons per day at the Livermore Site and an additional 1,750 gallons per day at Site 300. In 2019, the Livermore Site discharged approximately 328,000 gallons of wastewater per day to the LWRP system. The cumulative amount of wastewater for the No-Action Alternative at the Livermore Site would be approximately 371,600 gallons per day. As shown in Table 6-9, this represents about 14.9 percent of the existing site capacity. For Site 300, the increase would be about 77 percent of the existing capacity predominated by construction usage.

The City of Livermore Water Resources Division is responsible for managing and maintaining Livermore's wastewater (sewer) system. The city of Livermore relies on a network of more than 300 miles of sewer mains and four lift stations to transport wastewater from individual properties to the LWRP for treatment. The LWRP treats 2.2 billion gallons of wastewater each year (6.0 million gallons per day). Approximately 73 percent of this treated wastewater is discharged into the San Francisco Bay, while the rest is used locally as recycled water (Livermore 2021c). The 371,600 gallons per day of wastewater for the No-Action Alternative at the Livermore Site would represent 6.2 percent of the volume of wastewater treated at the LWRP. By 2022, the regional population is expected to increase by approximately 3.1 percent compared to the 2019 baseline (*see* Table 6-3 in Section 6.4.10). That increase could be expected to increase the amount of wastewater treated in the LWRP by approximately 186,000 gallons per day. Such an increase would be more than four times larger than the increase associated with the LLNL No-Action Alternative.

Site 300 sanitary sewage generated outside the GSA is disposed of through septic tanks and leach fields or cesspools at individual building locations. Sanitary sewage generated within the GSA is piped into an asphalt-membrane-lined oxidation pond east of the GSA at an average rate of 4,000 gallons per day. There is sufficient capacity at Site 300 to handle the increase in sanitary wastewater. No offsite sewage treatment would be required.

Table 6-9. Sanitary Sewer Impacts for the Alternatives at Both LLNL Sites

Resource/Metric	Existing Capacity (gallons/day)	No-Action Alternative (gallons/day)	Proposed Action (gallons/day)	No-Action Alternative Percentage of Existing Capacity	Proposed Action Percentage of Existing Capacity
Wastewater	2,500,000[a]	371,594[a]	421,689[a]	14.9%	16.9%

a. From Table 5-34.

Proposed Action. Under the Proposed Action, the overall increase in wastewater discharges at the Livermore Site would be 50,095 gallons per day, which would be an increase of 13.5 percent compared to the No-Action Alternative. As shown in Table 6-9, this represents about 16.9 percent of the existing site capacity. The 421,695 gallons per day of wastewater for the No-Action Alternative at the Livermore Site would represent 7.0 percent of the volume of wastewater treated at the LWRP. By 2035, the regional population is expected to increase by approximately 11.5 percent compared to the No-Action Alternative (*see* Table 6-4 in Section 6.4.10). That increase could be expected to increase the amount of wastewater treated in the LWRP by approximately 700,000 gallons per day. This regional increase would be more than fourteen times larger than the increase associated with the LLNL Proposed Action.

At Site 300, an additional 4,815 gallons of wastewater per day (including 4,125 gallons per day due to construction/DD&D) would require disposal under the Proposed Action. This would be an increase of 83.8 percent over the No-Action Alternative. A total of 10,561 gallons per day of wastewater would need to be disposed. Because the available capacity for wastewater disposal at the Site 300 treatment system is approximately 7,500 gallons per day, it may be necessary to transport excess wastewater offsite during construction and DD&D activities.

6.4.12.3 *Electricity Consumption*

Introduction. As discussed in Section 2.2.9.1, electricity for LLNL is dual sourced by the Pacific Gas and Electric (PG&E) Company and WAPA, with automatic transfer. PG&E is one of the largest combined natural gas and electric energy companies in the United States. The service area stretches from Eureka in the north to Bakersfield in the south, and from the Pacific Ocean in the west to the Sierra Nevada in the east. PG&E has approximately 5.5 million electric customer accounts and has 106,681 circuit miles of electric distribution lines and 18,466 circuit miles of interconnected transmission lines. PG&E is part of a nationwide effort to modernize the energy grid, i.e., Smart Grid. This is expected to increase the efficiency and reliability of energy and help PG&E reach the goal of reducing its carbon footprint. PG&E has a supply capacity of approximately 65,000 MW, with a current demand of roughly 29,400 MW at peak (California ISO 2021). The Western Area Power Administration (WAPA) is responsible for marketing and delivering wholesale federal hydropower to customers in 15 central and western states, including California.

LLNL is part of the DOE Northern California Electric Power Consortium. The Consortium also includes Lawrence Berkeley National Laboratory, SLAC National Laboratory, and Sandia National Laboratories-CA. The Consortium has three sources of electric energy supply: a federal hydropower allocation, wholesale market purchases, and on-site generation. Hydropower is received via an allocation of the U.S. Bureau of Reclamation, Central Valley Project (CVP). CVP includes 20 dams, 11 hydroelectric power plants, 18 substations, and 884 miles of 69-kV to 500-kV transmission lines. This variable source of energy supply provides approximately 20 percent of the LLNL annual energy requirements in a normal hydropower year. In a drought year, this supply can decrease by 50 percent or more (NNSA 2022).

Wholesale market purchases are made using WAPA as DOE's procurement agent, where WAPA is the counterparty purchaser to the power purchase agreements (PPAs) with the entities selling electricity in the wholesale market. PPAs provide approximately 78 percent of LLNL's energy requirements in a normal hydropower year, and more in a low hydropower year and less in a high hydropower year. Solar photovoltaic (PV) energy is received from the Whitethorn Solar Project located at the Livermore Site and provides less than 2 percent of LLNL's energy requirements. As LLNL's energy use grows, hydropower is projected to supply less of the energy requirement and PPAs will supply more of the energy requirement. It was a strong year for hydropower in 2019 with both CVP and PPAs and providers of hydropower in the Pacific Northwest providing a large percentage of the energy requirement. As the West experiences more frequent and longer periods of drought, hydropower is projected to supply far less of the energy requirement. Table 6-10 shows the power mix for the DOE Northern California Electric Power Consortium, PG&E, the State of California, and the National Average (NNSA 2022).

Table 6-10. Power Mix for Electric Power Supply

Energy Resources	DOE Northern California Electric Power Consortium Power Mix	PG&E Electric Power Mix	CA Power Mix	National Average Power Mix
Coal	0%	0%	2.7%	19.3%
Large Hydroelectric	80.4%	10.1%	12.2%	*included in renewable
Natural Gas	16.9%	16.4%	37.1%	40.3%
Nuclear	1.9%	42.8%	9.3%	19.7%
Oil	0%	0%	0%	0.4%
Eligible Renewable	0.8%	30.6%	33.1%	19.8%

Source: NNSA 2022.

No-Action Alternative. Under the No-Action Alternative, electricity demand at the Livermore Site would be expected to increase to a peak of 475 million kilowatt hours per year in 2028. This would represent an 18 percent increase over the average 2015-2019 baseline demand. At Site 300, electricity demand would be expected to increase to 12.6 million kilowatt hours per year in 2028. This would represent a 3.3 percent increase over the average 2015-2019 baseline demand.

In February 2018, the California Energy Commission issued its Final Report on California Energy Demand 2018–2030 Revised Forecast (CEC 2018). This report describes the California Energy Commission's revised 12-year forecasts for electricity consumption, retail sales, and peak demand for each of five major electricity planning areas and for the state as a whole. The report forecasts that state-wide electricity demand by 2030 will hit 339,863 gigawatt-hours under the high-demand scenario, 328,215 gigawatt-hours under the mid-range scenario, and 317,491 gigawatt-hours under the low-growth scenario. As shown in Table 6-11, the LLNL electric power consumption of 487.6 million kilowatt-hours per year would represent less than one percent of any of the state-wide demand scenarios.

The Clean Energy and Pollution Reduction Act (Senate Bill 350) established clean energy, clean air, and GHG reduction goals, including reducing GHG to 40 percent below 1990 levels by 2030 and to 80 percent below 1990 levels by 2050. This objective will increase the use of Renewables Portfolio Standard eligible resources, including solar, wind, biomass, geothermal and others. Two solar initiatives, the Livermore Solar Community Farm and the Aramis Solar Project/North Livermore Road, would provide additional electrical capacity for the ROI and would have a positive impact on electrical capacity and GHG reduction goals for the ROI in the future.

Table 6-11. Cumulative Electricity Consumption Impacts for the Alternatives

Resource/Metric	No-Action Alternative (million kilowatt-hours/year)	Proposed Action (million kilowatt-hours/year)	State-Wide Electricity Demand by 2030 (million gigawatt - hours/year)	No-Action Alternative Percentage of State-Wide Demand	Proposed Action Percentage of State-Wide Demand
Electricity Consumption at the Livermore Site and Site 300	487.6[a]	559.7[a]	317,491 to 339,863	<0.01%	<0.01%

a. From Table 5-34.

Proposed Action. Under the Proposed Action, the electric power consumption at LLNL is expected to increase from 487.6 million kilowatt-hours under the No-Action Alternative to approximately 559.7 million kilowatt-hours per year under the Proposed Action. As shown in Table 6-11, the LLNL electric power consumption of 559.7 million kilowatt-hours per year would represent less than one percent of any of the state-wide demand scenarios.

6.4.12.4 *Fuel Consumption*

No-Action Alternative. Under the No-Action Alternative natural gas consumption rates are expected to increase by 3.1 percent to approximately 12,750 therms per day as projects become operational. This demand would represent approximately 52 percent of the capacity of the natural gas system (24,500 therms per day).

LLNL has a goal to reduce petroleum usage by approximately two percent year-over-year. By end of 2023, petroleum usage is expected to be 96,000 gallons per year and LLNL would strive to continue reducing usage by two percent year-over-year going forward. By 2035, the usage would be 75,300 gallons per year under the No-Action Alternative.

Proposed Action. Compared to the No-Action Alternative natural gas consumption of 12,750 therms per day, the Proposed Action would increase natural gas consumption by 5.9 percent to approximately 13,500 therms per day. This increase would remain below the existing available capacity (24,500 therms per day).

PG&E supplies natural gas to the Livermore Site via the meter station at the south end of Southgate Drive. Site 300 does not use natural gas. The PG&E natural gas system spans central and northern California. The service area stretches from Eureka in the North to Bakersfield in the South and from the Pacific Ocean in the west to the Sierra Nevada in the east. PG&E provides 970 billion cubic feet of natural gas per year. This amount equates to roughly 2.6 billion cubic feet per day (2.7 trillion therms per day) (PG&E 2021). The fuel consumed by LLNL is a small fraction in comparison to the overall supply system provided by PG&E.

For the Proposed Action, NNSA has assumed that the goal to reduce petroleum usage by 2 percent annually would continue, even with increased operations associated with the Proposed Action. Consequently, by 2035, petroleum usage at LLNL is expected to decline to 85,000 gallons per year.

6.4.13 Waste Management

The cumulative impact analysis considers the generation and disposal of radioactive waste, specifically LLW, MLLW, and TRU waste, from the No-Action Alternative and Proposed Action and compares them to estimates of waste generation and disposal from other DOE sites and commercial sites. The assessment also addresses the cumulative impacts of hazardous waste and solid nonhazardous waste generation and evaluates the potential cumulative impacts on commercial disposal facilities for those waste types.

6.4.13.1 *Low-Level Radioactive Waste*

As discussed in Section 5.13.1.1, approximately 85 percent of routine LLNL LLW and 10 percent of nonroutine LLW is shipped to the NNSS for disposal. During the five-year timeframe from 2015 through 2019, the NNSS disposed of an average of 997,000 cubic feet (NNSS 2015, 2016, 2017, 2018, 2019), or 28,200 cubic meters, of LLW per year in its land-based disposal cells.

Approximately 15 percent of LLNL's routine LLW and 90 percent of nonroutine LLW is sent to the Energy*Solutions* facility in Clive, Utah, a commercial facility licensed as a Class A LLW disposal facility by the Utah Department of Environmental Quality (UDEQ). UDEQ has this authority under agreement with the U.S. Nuclear Regulation Commission (NRC) (UDEQ 2020). During the five-year period from 2015 through 2019, the Energy*Solutions* facility received an average of 3,420,000 cubic feet (96,800 cubic meters) of LLW per year. There was a marked increase in the volume of LLW received in the last three years of that span, resulting in a three-year average of 4,750,000 cubic feet (134,000 cubic meters) per year (NRC 2020).

No-Action Alternative. Based on the 10-year average (2010-2019), LLNL's current LLW generation rate accounts for about 1.9 percent of the LLW sent to NNSS. Under the No-Action Alternative, the LLW contribution from LLNL could increase to 1123 – 1523 cubic meters per year and would account for approximately 4.0-5.4 percent of the average volume of LLW disposed of at NNSS (*see* Table 6-12). This increase would be well within the normal fluctuation reported in NNSA's annual waste disposal records. From 2015 through 2019, the difference between the NNSS' highest and lowest LLW disposal years was more than 11,000 cubic meters.

During the five-year span from 2015 through 2019, Energy*Solutions* received an average of 3,420,000 cubic feet (96,800 cubic meters) of LLW per year. There was a marked increase in the volume of LLW received in the last three years of that span, resulting in a three-year average of 4,750,000 cubic feet (134,000 cubic meters) per year (NRC 2020). In either case, the 3,727–7,327 cubic meters per year of LLNL LLW estimated under the No-Action Alternative would account for approximately 2.8-5.4 percent of the annual waste managed by Energy*Solutions.* Accordingly, additional LLW associated with the No-Action Alternative would not be expected to affect operations of the offsite commercial facility.[5]

Proposed Action. As shown in Table 6-12, under the Proposed Action, 1,550 cubic meters per year LLNL's LLW contribution could increase from 4.0-5.4 percent (No-Action Alternative) to 5.5 percent of the total LLW received by NNSS. This increase would likely not be noticeable to

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[5] LLW could also be sent to Perma-Fix in Richland, Washington and Waste Control Specialists in Andrews County, Texas.

NNSS waste management operations, and would be within normal fluctuations reported in NNSA's annual waste disposal records.

Disposal of approximately 6,450 cubic meters per year of LLNL LLW would be approximately 4.8 percent of the waste managed by Energy*Solutions*. Accordingly, additional LLW associated with the Proposed Action would not be expected to affect operations of the offsite commercial facility.

6.4.13.2 *Mixed Low-Level Radioactive Waste*

As stated in Chapter 5, Section 5.13.1.1, LLNL manages its MLLW by sending it to NNSS for disposal or to a commercial facility that can provide treatment and/or disposal. Use of commercial facilities is limited to those able to show adequate capacity and compliance with applicable permitting and regulatory requirements. The commercial facilities recently used by LLNL for MLLW include the Energy*Solutions* facility in Utah and a Perma-Fix facility (specifically, Diversified Scientific Services Inc., or DSSI) in Tennessee.[6] Both of these facilities (i.e., Energy*Solutions* and Perma-Fix) have permits with their applicable states allowing them to receive MLLW for treatment, disposal, or both. Perma-Fix describes its Tennessee facility as a treatment facility using a combustion process and dealing primarily with liquid waste, so the LLNL waste types (largely from DD&D-type activities) amenable to this facility would be expected to be limited.

In the five-year period from 2015 through 2019, NNSS received an average of 103,000 cubic feet of MLLW per year (NNSS 2015, 2016, 2017, 2018, 2019). In the biennial reporting required under RCRA for hazardous waste facilities, Energy*Solutions* and Perma-Fix reported receiving 2,060 tons (USEPA 2018b) and 212 tons (USEPA 2018c), respectively, of hazardous waste in 2017. Both commercial facilities describe their expertise as management of radiological waste materials, including MLLW, so it is assumed that all of the reported RCRA waste received was actually MLLW.

No-Action Alternative. The 813 cubic meters (28,700 cubic feet) of MLLW generated annually under the No-Action Alternative (*see* Table 5-38) would represent only about nine percent of the total volume sent to NNSS, Energy*Solutions*, and Perma-Fix DSSI. This increase would be within the annual waste fluctuations at those facilities. However, if all or most of the No-Action Alternative MLLW were sent to either NNSS or Perma-Fix, the facilities' normal operations might have to be altered at times to accommodate the increased waste quantities. Other commercial treatment and/or disposal facilities such as Perma-Fix in Richland Washington and Waste Control Specialists in Andrews County, Texas, are also available and would be considered, as appropriate.

Proposed Action. The 3,258 cubic meters (115,100 cubic feet) of MLLW generated annually from the Proposed Action would represent about 37 percent of the total MLLW currently sent to NNSS, Energy*Solutions*, and Perma-Fix DSSI. In general, the increased waste volumes fall within year-to-year fluctuations at these receiving facilities; however, the volumes may also represent levels, particularly at the upper end, that would require additional operating capacity. If a large portion of the Proposed Action MLLW were to be directed toward one of the receiving facilities,

[6] MLLW could also be sent to Perma-Fix in Richland, Washington and Waste Control Specialists in Andrews County, Texas.

that facility may be unable to accommodate the load without adversely impacting other services, or simply be unable to take all of LLNL MLLW. LLNL may have to evaluate other facilities capable of receiving MLLW to ensure adequate offsite capacity for the Proposed Action MLLW. There are commercial facilities other than those described here that have appropriate capacity and permits to accept MLLW. DOE recognizes the need to ensure the availability of commercial waste management capacity and, on August 31, 2020, issued a *Request for Proposal for Nationwide Low-Level and Mixed Low-Level Waste Treatment Services* (DOE 2020c). The Basic Ordering Agreement or Agreements established through this effort would be available to LLNL and could provide needed alternatives should the amount or characteristics of MLLW generated under the Proposed Action be unsuitable for the offsite facilities currently being used.

Table 6-12. Cumulative Low Level Waste Disposal Impacts for the Alternatives

LLW Disposal Location	Baseline/Existing Environment (10-year Average: 2010 to 2019)[a,b] (m^3/yr)	Percent of Total LLW Disposed per year	No-Action Alternative[a,b] (m^3/yr)	Percent of Total LLW Disposed per year	Proposed Action[a,c] (m^3/yr)	Percent of Total LLW Disposed per year
NNSS	536	1.9	1,123 – 1,523	4.0 – 5.4	1,550	5.5
Energy*Solutions*[a]	486	<1	3,727 – 7,327	2.8 – 5.4	6,450	4.8
Total	1,022	N/A	4,850 - 8,850	N/A	8,000	N/A

a. Relatively small amounts of LLW (one to five shipments per year) may also be sent to other offsite facilities such as Perma-Fix Environmental Services in Oak Ridge, Tennessee; Perma-Fix in Richland Washington; and Waste Control Specialists in Andrews County, Texas. These, or other offsite facilities, would only be utilized if they had appropriate permits/licenses and the capacity and capability to treat, store, and/or dispose of the specific LLW.
b. From data in Table 5-35.
c. From data in Table 5-42.
N/A = not applicable.

6.4.13.3 *Transuranic Waste*

The WIPP facility is the only permanent disposal option for transuranic (TRU) waste generated by atomic energy defense activities as required by the WIPP Land Withdrawal Act (LWA; Public Law 102-579). The LWA specifies a TRU waste disposal volume capacity of 6.2 million cubic feet (175,564 cubic meters). The *Annual TRU Waste Inventory Report* (ATWIR) (DOE 2020e) serves as a current estimate of the TRU waste inventory for potential disposal at WIPP and documents the TRU waste that may be considered in future Compliance Recertification Applications submitted to the Environmental Protection Agency. The ATWIR estimates are also used for technical analyses, strategic planning and NEPA analyses. The TRU Waste Inventory Profile Reports (Appendices A and B of the ATWIR) reflect the information reported by the TRU waste generator/storage sites. The TRU waste inventory estimates in the ATWIR have inherent uncertainties and therefore the inventory estimates change annually. The TRU waste inventory estimates typically change due to factors, such as: updates or revisions to site treatment plans, waste minimization activities, packaging adjustments, technical and planning changes, etc.

As of the data collection cutoff date for the 2019 ATWIR, approximately 67,400 cubic meters of TRU waste were disposed at WIPP (DOE 2019). The maximum amount of TRU waste estimated to potentially be generated over the life of the Proposed Action at LLNL is 2,621 cubic meters[7] (note: this estimate includes: 52.8 cubic meters of routine TRU waste and 60 cubic meters of non-routine TRU waste that would be generated annually under the No-Action Alternative between 2020-2022; and 52.8 cubic meters of routine TRU waste and up to 122.8 cubic meters of non-routine TRU waste that would be generated annually under the Proposed Action between 2023-2035). The 2,621 cubic meters of TRU waste would represent 1.5 percent of the LWA TRU waste disposal volume capacity of 175,564 cubic meters. It would also represent 2.4 percent of the available WIPP capacity, based on the 2019 ATWIR.

The maximum TRU waste volume estimates in this document represent TRU waste volume estimates and not the volume of the overpack disposal container(s). In addition, other proposed actions since publication of the current ATWIR[8] could change the TRU waste inventory for potential disposal at WIPP. These actions will be incorporated, as appropriate, into future ATWIR TRU waste inventory estimates.

TRU waste volume estimates such as those provided in NEPA documents cannot be used to determine compliance with the WIPP LWA total TRU waste disposal volume capacity limit. The TRU waste estimates in the ATWIR change annually. Determining compliance to the WIPP LWA disposal capacity limit is determined by proven and audited procedures and process implemented for the WIPP facility by the Carlsbad Field Office (CBFO). CBFO monitors and tracks the actual defense related TRU waste volume emplaced at the WIPP facility to ensure compliance with the WIPP LWA and will take action as appropriate in a timely and appropriate manner to ensure needs of the DOE complex are met.

[7] In contrast, the No-Action Alternative would generate a maximum of 1,692 cubic meters of TRU waste over 2020-2035.
[8] The latest ATWIR can be found at: https://wipp.energy.gov/Library/TRUwaste/DOE-TRU-19-3425_R0_FINAL.pdf.

6.4.13.4 *Hazardous Waste*

No-Action Alternative. As described in Section 4.13.2.1, LLNL utilizes a variety of commercial facilities in order to accommodate the varied and often unique nature of the hazardous waste generated from its operations. The quantities of hazardous waste associated with the No-Action Alternative are not large on a national, or even state level. Based on USEPA's biennial reports for hazardous waste, there were 35 million tons of hazardous waste generated nationally in 2017, with 322,000 tons generated in California the same year (USEPA 2018a). The 2,210 metric tons (or 2,440 tons) per year projected for LLNL represents a small portion (less than one percent) of these waste quantities.

Proposed Action. The total volume of hazardous waste projected for the Proposed Action is the same as projected for the No-Action Alternative. Expected impacts would be the same as described for the No-Action Alternative; that is, existing LLNL waste management units would have adequate capacity to handle the increased volume of hazardous waste and offsite commercial hazardous waste treatment/disposal facilities would continue to be used as the means of final disposition.

6.4.13.5 *Other, Nonhazardous Solid Waste*

No-Action Alternative and Proposed Action. Routine and nonroutine segments are considered as being municipal solid waste and construction and demolition (C&D) waste, respectively. Under the No-Action Alternative and Proposed Action, nonhazardous solid waste could be generated within LLNL at the annual rate shown in Table 6-13.

Table 6-13. Cumulative Nonhazardous Solid Waste Impacts for the Alternatives

Nonhazardous Solid Waste Category	No-Action Alternative[a] (MT/yr)	Proposed Action[a] (MT/yr)
Routine (Municipal Solid Waste)	3,050	3,400
Nonroutine (Construction and Demolition Waste)	900 - 5,500	5,500
Total	3,950 - 8,550	8,900

MT/yr = metric tons per year (1 metric ton = 1,000 kilograms). Metric tons multiplied by 1.1023 equals tons.
a. From Table 3-8.

Nonhazardous solid waste generated from within the Livermore Site is taken to either the Altamont Landfill or the Vasco Road Landfill. Nonhazardous solid waste generated at Site 300 generally goes through the Tracy Material Recovery and Transfer Station, but unrecovered waste may go to one of the same landfills. The maximum permitted throughput for the Altamont Landfill is 11,150 tons per day (CalRecycle 2020a). The maximum permitted throughput for the Vasco Road Landfill is 2,518 tons per day (CalRecycle 2020b). The Tracy Facility is permitted for material recovery/processing, composting, and waste transfer and its permitted maximum throughput is 1,800 tons per day (CalRecycle 2020c).

If it is assumed that the total nonhazardous solid waste associated with the Proposed Action is sent to an offsite landfill over five days per week, 50 weeks per year (i.e., 250 days per year), the average of 8,900 metric tons per year would equate to 36.6 metric tons (or 40.3 tons) per day. This daily amount of waste represents 0.36 percent of the Altamont Landfill's permit limit of 11,150 tons per day and 1.6 percent of the Vasco Road Landfill's permit limit of 2,518 tons per day. Also, as described in Section 4.13.5, LLNL diverts a significant portion of its nonhazardous solid waste from landfill through various recycling or reuse efforts. During the past 10 years, more than 70 percent of both the municipal solid waste segment and the C&D segment have been diverted from landfill disposal. Accordingly, the actual amounts of waste that would go to either the Altamont or Vasco Road landfills should be lower than evaluated above. A small portion of the LLNL nonhazardous solid waste generated at Site 300 could be processed at the Tracy Material Recovery and Transfer Station. That waste quantity would be small in comparison to its operating limit of that facility (1,800 tons per day).

Alameda County adopted its Countywide Integrated Waste Management Plan (CoIWMP) in 2020. This plan serves as a roadmap to approaching Alameda County's solid waste management and recycling issues. This document contains two elements of the CoIWMP and describes both the current and desired state of waste and materials management in the County. Similar to a city's general plan, it is intended to be far-reaching with long-term relevance. In addition to addressing core infrastructure needs – collection, transport, processing facilities, and landfills – this document provides the context and rationale for a comprehensive approach to the current and future waste management issues facing Alameda County. In response to these issues, as well as fulfilling the requirement to provide a minimum 15 years of landfill capacity, the Alameda County Waste Management Authority has adopted the goals, objectives, and policies included therein to guide decision-making and programs (Alameda WMA 2020).

6.4.14 Human Health

The key metric presented in this analysis is radiological doses and potential latent cancer fatalities (LCF) to the public.

No-Action Alternative. Although construction and DD&D activities would have the potential to adversely impact workers, they would not cause offsite health effects. Similarly, there would be no offsite health effects from normal operations involving nonradiological materials. Consequently, the analysis in this section focuses on potential cumulative radiological impacts offsite.

Members of the public would be subject to radiological exposures from: (1) LLNL operations; (2) other radiological facility operations within 50 miles of LLNL; and (3) background radiation (*see* Table 4-42). Facilities at LBNL and SLAC can cause radiological doses to the public from both penetrating radiation and airborne radionuclides. Each of these facilities are approximately 30 miles from LLNL.

At LBNL, in 2020, the estimated dose to the MEI was approximately 0.57 millirem per year and the estimated dose to the 50-mile population was approximately 0.071 person-rem per year (LBNL 2021). At SLAC, in 2018, the estimated dose to the MEI was approximately 0.04 millirem per year and the estimated dose to the 50-mile population was approximately 0.02 person-rem per year (SLAC 2019).

As shown in Table 6-14, the doses from operations at LLNL, LBNL, and SLAC are minimal compared to the doses from background radiation. Statistically, the projected number of annual LCFs to the population within a 50-mile radius of LLNL would be 3,137, all of which would be attributed to doses from background radiation.

Table 6-14. Cumulative Radiological Impacts to Public for the No-Action Alternative

Receptor/Dose/Risk	Background Radiation	LLNL No-Action Alternative	LBNL and SLAC[d]	Cumulative
Population Within 50 Miles[a]				
Collective dose (person-rem)	5,227,825[c]	0.60	0.091	5,227,825
LCF[b]	3,137	3.6×10^{-4}	5.5×10^{-5}	3,137

a Based on projection of 8,364,520 people living within 50 miles of LLNL in the year 2030.
b. Based on an LCF risk estimate of 0.0006 LCF per person-rem.
c. Based on background radiation dose of 625 millirem/year to the average person (*see* Table 4-42).
d. Conservatively assumes that all doses from LBNL and SLAC impact the same 50-mile population that surrounds LLNL.
Note: Data from Table 4-42 and Table 5-52.

Proposed Action. As was true for the No-Action Alternative, members of the public would be subject to radiological exposures from: (1) LLNL operations; (2) LBNL and SLAC operations; and (3) background radiation. As shown in Table 6-15, the doses from LLNL operations are minimal compared to the doses from background radiation. Statistically, the projected number of annual LCFs to the population within a 50-mile radius of LLNL would be the same as the No-Action Alternative (3,137), all of which would be attributed to doses from background radiation.

Table 6-15. Cumulative Radiological Impacts to Public for the Proposed Action

Receptor/Dose/Risk	Background Radiation	LLNL Proposed Action	LBNL and SLAC[d]	Cumulative
Population Within 50 Miles[a]				
Collective dose (person-rem)	5,227,825[c]	7.1	0.091	5,227,825
LCF[b]	3,137	4.3×10^{-3}	5.5×10^{-5}	3,137

a Based on projection of 8,364,520 people living within 50 miles of LLNL in the year 2030.
b. Based on an LCF risk estimate of 0.0006 LCF per person-rem.
c. Based on background radiation dose of 625 millirem/year to the average person (*see* Table 4-42).
d. Conservatively assumes that all doses from LBNL and SLAC impact the same 50-mile population that surrounds LLNL.
Note: Data from Table 4-42 and Table 5-55.

6.4.15 Environmental Remediation

No-Action Alternative and Proposed Action. With regard to remediation activities, NNSA complies with provisions specified in FFAs entered into by USEPA, DOE, the California EPA Department of Health Services (now DTSC), and the San Francisco Bay and Central Valley Regional Water Quality Control Boards. Any future remediation actions would be conducted in accordance with the FFAs, and NNSA is not proposing any specific future remediation activities in this SWEIS.

Remediation of groundwater and soil contamination at both the Livermore Site and Site 300 would also continue, as described in Section 4.15. LLNL's cleanup remedies at both the Livermore Site and Site 300 are designed and implemented to achieve the goals of reducing risks and hazards to human health and the environment and satisfying remediation action objectives, meeting cleanup standards for chemicals and radionuclides in water and soil, and preventing contaminant migration in groundwater to the extent technically and economically feasible (LLNL 2019f, 2020r). Any non-NNSA initiatives/actions regarding offsite contamination remediation would be expected to add to the improvements that would result from NNSA remediation actions.

6.4.16 Accidents

No-Action Alternative and Proposed Action. An earthquake or wildfire are the most likely single event accidents that could cause cumulative consequences from LLNL and non-NNSA activities. As discussed in Section 5.16.7, the risk due to wildfires is considered to be lower than an earthquake; therefore, this analysis focuses on the cumulative impacts of an earthquake. Although a single seismic event could cause releases from multiple buildings on LLNL that could cause offsite impacts, based on the quantitative evaluation in Section 5.16.7, the offsite risk from NNSA operations on the Livermore Site is low considering both radiological and chemical releases (*see* Table 5-68). With regard to non-NNSA offsite impacts from earthquakes, a major earthquake in the Livermore Valley could cause deaths, injuries, property damage, and economic losses. Such impacts would be independent of impacts from NNSA operations at LLNL.

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CHAPTER 7

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7.0 REFERENCES

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CHAPTER 8

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CHAPTER 9

Glossary

9.0 Glossary

Accelerator: An apparatus for imparting high velocities to charged particles.

Acoustic: Containing, producing, carrying, arising from, actuated by, related to, or associated with sound.

Activation products: Radionuclides formed by bombardment and adsorption in material with neutrons, protons, or other nuclear particles. For example, cobalt-60 is an activation product resulting from neutron activation of cobalt-59.

Action level: Defined by regulatory agencies, the level of pollutants which, if exceeded, requires regulatory action.

Acute: With respect to dose or toxicity, one that occurs in a short time.

Acute exposure: The absorption of a relatively large quantity of radiation or intake of radioactive or toxic material over a short period of time.

Activity: The number of nuclear transformations occurring in a given quantity of material per unit time.

Administrative limit: A limit imposed by procedure on the quantity of a radionuclide permitted in a building or part of a building.

Aerosol: A gaseous suspension of very small particles of liquid or solid.

Air Pollutant: Generally, an airborne substance that could, in high enough concentrations, harm living things or cause damage to materials. From a regulatory perspective, an air pollutant is a substance for which emissions or atmospheric concentrations are regulated or for which maximum guideline levels have been established due to potential harmful effects on human health and welfare.

Air Quality Control Region (AQCR): An interstate or intrastate area designated by the U.S. Environmental Protection Agency for the attainment and maintenance of National Ambient Air Quality Standards.

Air stripper: A groundwater treatment system in which volatile organic compounds are removed from soil by aeration.

Airborne Release Fraction (ARF): The coefficient used to estimate the amount of radioactive material that can be suspended in air and made available for airborne transport under a specific set of induced physical stresses. ARF is used, along with other factors, to determine the source term for an accident or event.

Alameda County Flood Control and Water Conservation District: Also known as Zone 7, the water management agency for the Livermore-Amador Valley with responsibility for water treatment and distribution, and responsible for management of agricultural and surface water and the groundwater basin.

Alluvial fan: Cone-shaped deposits of alluvium made by a stream. Fans generally form where streams emerge from mountains onto the lowland.

Alluvium: Sediment deposited by flowing water.

Alpha particle: A positively charged particle emitted from the nucleus of an atom, having mass and charge equal to those of a helium nucleus (two protons and two neutrons).

Ambient air: The surrounding atmosphere, usually the outside air, as it exists around people, plants, and structures; not considered in monitoring purposes when immediately adjacent to emission sources.

Ambient noise: The residual (background) sound in the absence of specific identifiable noise sources.

Ambient sound level (LDN): The 24-hour equivalent continuous sound level with a night-time penalty added, i.e., the time-averaged A-weighted sound level, in decibels, from midnight to midnight, obtained after the addition of 10 dB to sound levels from midnight to 7:00 a.m. and from 10:00 p.m. to midnight.

***American Indian Religious Freedom Act* of 1978:** This Act establishes national policy to protect and preserve for Native Americans their inherent right of freedom to believe, express, and exercise their traditional religions, including the rights of access to religious sites, use and possession of sacred objects, and the freedom to worship through traditional ceremonies and rites.

Anticline: A fold in rocks in which the strata dip outward from both sides of the axis, where the oldest strata are in the core of the fold.

AP-42: An EPA compilation of air pollution emission factors and other technical data pertaining to air quality. *See* “emission factors.”

Aquifer: A saturated layer of rock or soil below the ground surface that can supply usable quantities of groundwater to wells and springs, and be a source of water for domestic, agricultural, and industrial uses.

Aquitard: Low-permeability geologic formation that bounds an aquifer.

Archival research: Examination of records at the regional offices of the State Historic Preservation Office for evidence of recorded historic and/or prehistoric sites; the use of other archival sources (libraries, private collections, museums) to gather information on historic and prehistoric sites that have not been formally recorded or that have not been completely documented.

Aromatic hydrocarbons: Volatile organic compounds characterized by unsaturated ring structures; in this SWEIS, benzene, toluene, ethylbenzene, and xylenes.

Arithmetic mean: The average of a set of terms, computed by dividing their sum by the number of terms. *See* "geometric mean."

Arroyo: A gully or channel cut by an intermittent stream.

Arsenic (As): A trivalent and pentavalent solid poisonous element of atomic number 33. Arsenic is commonly metallic steel-gray, crystalline, and brittle.

As low as reasonably achievable (ALARA): An approach to radiation protection to manage and control worker and public exposures (both individual and collective) and releases of radioactive material to the environment to as far below applicable limits as social, technical, economic, practical, and public policy considerations permit. ALARA is not a dose limit, but a process for minimizing doses to as far below limits as possible.

Atmospheric dispersion: The spreading downwind of airborne material due to wind speed and atmospheric turbulence; the greater the spread, the greater the dilution and the smaller the airborne material concentrations.

Attainment area: An area considered to have air quality as good as or better than the national ambient air quality standards as defined in the *Clean Air Act*. An area may be an attainment area for one pollutant and a nonattainment area for others (*see* "nonattainment area").

Atom: The smallest particle of an element capable of entering into a chemical reaction.

Background radiation: Radiation from 1) cosmic sources; 2) naturally occurring radioactive materials, including radon (except as a decay product of source or special nuclear material); 3) global fallout as it exists in the environment (e.g., from the testing of nuclear explosive devices); 4) air travel; 5) consumer and industrial products; and 6) diagnostic x-rays and nuclear medicine.

Bay Area Air Quality Management District (BAAQMD): The local agency responsible for regulating stationary air emission sources (including the Livermore Site) in the San Francisco Bay Area.

Beamlets: Independent laser beams.

Bedrock mortar: Depression worn in the floors of rock shelters or on the flat portions of exposed bedrock where prehistoric peoples ground grass seeds and acorns into meals. The depression is created by the continual grinding motion of a stone pestle, which is alternately used to pound and grind from side to side.

Beryllium (Be): A toxic and extremely lightweight element with the atomic number 4. It is metallic and used in reactors as a neutron reflector.

Best Available Control Technology (BACT): A term used in the Federal *Clean Air Act* that means the most stringent level of air pollutant control considering economics for a specific type of source based on demonstrated technology.

Best estimate: An estimate made with the numerical inputs that are believed to be representative of the real situation, not biased conservatively.

Best Management Practices: Activities, procedures, or physical structures for reducing the amount of pollution entering the surface water and groundwater.

Bioassay: Measurement of the amount or concentration of radioactive material in the body or in biological material excreted from or removed from the body and analyzed for purposes of estimating the quantity of radioactive material in the body. This typically includes analysis of urine samples and whole-body scans or lung counts.

Bioremediation: Cleanup of contaminated groundwater by bacteria.

Biota: The plant and animal life of a region.

Block: U.S. Bureau of the Census term describing small areas bounded on all sides by visible features or political boundaries; used in tabulation of census data.

Blowdown: Water discharged from cooling towers in order to control total dissolved solids concentrations by allowing make-up water to replenish cooling apparatuses.

Bounding: An accident is bounding if no reasonably foreseeable, equally probable accident can be found with greater consequences. A bounding envelope consists of a set of individual bounding accidents that cover the range of probabilities and possible consequences. The term is also used to identify conservative assumptions that will likely overestimate actual risks or consequences.

British thermal unit (Btu): A unit of heat; the quantity of heat required to raise the temperature of one pound of water by one degree Fahrenheit. One British thermal unit equals 1,055 joules (or 252 calories).

Cadmium (Cd): A bluish white malleable ductile toxic bivalent metallic element of atomic number 48. Used especially in protective plating and in bearing metals.

California Code of Regulations (CCR): Codification of regulations promulgated by the State of California.

***California Environmental Quality Act* of 1970 (CEQA):** Statute that requires that all California state, local, and regional agencies document, consider, and disclose to the public the environmental implications of their actions.

Cancer: A group of diseases characterized by uncontrolled cellular growth. Increased incidence of cancer can be caused by exposure to radiation or to certain chemicals at sufficient concentrations and exposure durations.

Candidate species: Species being reviewed by the United States Fish and Wildlife Service for possible listing as endangered or threatened, but for which substantial biological information to support a listing is lacking and legal protection is not provided.

CAP88-PC: Computer code for modeling air emissions of radionuclides.

Carbon monoxide (CO): A colorless, odorless gas that is toxic if breathed in high concentration over a period of time.

Carcinogen: A substance that directly or indirectly causes cancer.

Chlorocarbon: A compound of carbon and chlorine, or carbon, hydrogen, and chlorine, such as carbon tetrachloride, chloroform, and tetrachloroethene.

Chlorofluorocarbon (CFC): Any of several simple gaseous compounds that contain carbon, chlorine, fluorine, and sometimes hydrogen, that are used as refrigerants, cleaning solvents, and aerosol propellants and in the manufacture of plastic foams.

Chromium (Cr): A blue-white metallic element of atomic number 24 found naturally only in molecular combination with other elements and used especially in alloys and in electroplating.

Chronic Beryllium Disease: Acute or chronic lung disease caused by inhalation of beryllium particulate. Skin irritation may result from direct contact with soluble beryllium compounds and healing is impaired in beryllium-contaminated wounds.

Chronic exposure: The absorption of radiation or intake of radioactive and/or chemical materials over a long period of time.

Class I area: Pristine areas in the United States whose air quality requires special protection from pollution from new sources.

Class II area: Areas in the United States with acceptable air quality levels where moderate increases in air pollutant concentrations from new sources are allowed.

Class III area: Areas in the United States with acceptable air quality levels where larger increases in air pollutant concentrations from new sources are allowed than in Class II areas.

Class I substance: One of several groups of chemicals with an ozone depletion potential of 0.2 or higher. Class I ozone-depleting substances have the highest ozone depleting potential and include chlorofluorocarbon, halons, carbon tetrachloride, methyl chloroform, hydrobromofluorocarbon, and methyl bromide.

Clean Air Act**:** Federal Act that mandates the promulgation and enforcement of air pollution control standards for stationary sources and motor vehicles.

***Clean Air Act* Amendments of 1990:** Expands the EPA’s enforcement powers and adds restrictions on air toxins, ozone-depleting chemicals, stationary and mobile emissions sources, and emissions implicated in acid rain and global warming.

***Clean Water Act* of 1972, 1987:** Federal Act regulating the discharge of pollutants from a point source into navigable waters of the United States in compliance with a National Pollution Discharge Elimination System permit as well as regulating discharges to or dredging of wetlands.

Climatology: The science that deals with climates and investigates their phenomena and causes.

Code of Federal Regulations (CFR): A codification of all regulations promulgated by Federal government agencies.

Collective dose equivalent and collective committed effective dose equivalent: The sums of the dose equivalents or effective dose equivalents to all individuals in an exposed population within 80 km (50 miles) of the radiation source. These are evaluated by multiplying the dose received by an individual at each location by the number of individuals receiving that dose, and summing over all such products for locations within 80 km of the source. They are expressed in units of person-rem or person-sievert. The collective EDE is also referred to as the "population dose."

Colluvium: A general term applied to any loose, heterogeneous, and incoherent mass of soil material and/or rock fragments deposited by rainwash, sheetwash, or slow continuous downslope creep, usually collecting at the base of gentle slopes or hillsides. Deposition by a combination of gravity and water.

Committed effective dose equivalent (CEDE): The calculated effective dose to an individual after exposure to radiation summed over the life of the individual. CEDE assumes a 70-year lifetime for the general population and a 50-year lifetime for the worker population.

Community Noise Level: A time-weighted 24-hour average noise level based on the A-weighted decibel scale. The community noise level scales includes an additional 5-dB adjustment to sounds occurring in the evening (7:00 p.m. to 10:00 p.m.) and a 10-dB adjustment to sounds occurring in the late evening and early morning hours (10:00 p.m. to 7:00 a.m.).

***Comprehensive Environmental Response, Compensation and Liability Act of 1980* (CERCLA):** Administered by EPA, this program, also known as Superfund, requires private parties to notify EPA after the release of hazardous substances or conditions that threaten to release hazardous substances, and undertake short-term removal and long-term remediation.

Computational modeling: Using a computer to develop a mathematical model of a complex system or process and to provide conditions for testing it.

Confined aquifer: An aquifer bounded above and below by impermeable beds, or beds of distinctly lower permeability than that of the aquifer itself.

Conformity: Conformity is defined in the Clean Air Act as the action's compliance with an implementation plan's purpose of eliminating or reducing the severity and number of violations of the National Ambient Air Quality Standards, expeditious attainment of such standards, and that such activities will not (1) cause or contribute to any new violation of any standard in any area; (2) increase the frequency or severity of any existing violation of any standard in any area; or (3) delay timely attainment of any standard, required interim emission reduction, or other milestones in any area.

Conservative: Having consequences that are greater than the most likely consequences; using assumptions that tend to overestimate consequences and err on the safe side.

Contact-handled waste—Radioactive waste or waste packages whose external dose rate is low enough to permit contact handling by humans during normal waste management activities. (*See* remote-handled waste.)

Container—In regard to radioactive waste, the metal or plastic envelope in the waste package that provides the primary containment function of the waste package, which is designed to meet the containment requirements of 10 CFR Part 60.

Containment barrier: In the context of a high-level waste repository, a barrier to release of radioactivity made by man, such as a corrosion-resistant container.

Controlled material: Material designated by DOE, LLNL, or SNL/CA for special control because they are classified, hazardous, of national interest, or of high monetary value.

Conventional weapon: A non-nuclear weapon.

Council on Environmental Quality regulations: Regulations at 10 CFR Parts 1500–1508 that direct Federal agencies in complying with the procedures of and achieving the goals of the *National Environmental Policy Act*.

Cosmic radiation: Radiation with very high energies originating outside the Earth's atmosphere; it is one source contributing to natural background radiation.

Criteria air pollutant: An air quality pollutant for which EPA has established criteria documents and for which concentration standards exist. These pollutants are sulfur dioxide (SO_2), particulates, carbon monoxide (CO), ozone (O_3), hydrocarbons, nitrogen dioxide (NO_2), and lead.

Critical habitat: "Specific area within the geographical area occupied by [an endangered or threatened] species…, essential to the conservation of the species and which may require special management considerations or protection; and specific areas outside the geographical area occupied by the species… that are essential for the conservation of the species" (*Endangered Species Act*, Section 3).

Criticality: The state of a mass of fissile and/or fissionable material when it is sustaining a nuclear fission chain reaction.

Cryogenic target positioner: The system that is composed of a telescoping arm that is used to insert and withdraw the complete target cryogenic system and target, and allows aiming, alignment, and engagement by the NIF laser.

Cultural resources (historic): Material remains, such as trash dumps and architectural features, including structures, foundations, basements, and wells; any other physical alteration of the landscape, such as ponds, roads, landscaping, and fences.

Cultural resources (prehistoric): Any material remains of items used or modified by people, such as artifacts of stone, bone, shellfish, or wood. Animal bone, fish remains, bird bone, or shellfish remains used for foods are included. Physical alteration of the landscape, such as hunting blinds, remains of structures, excavated house pits, and caches of artifacts or concentrations of stones (such as cooking stones) are also prehistoric cultural resources.

Cumulative impacts: As defined by CEQA, "…two or more individual effects which, when considered together, are considerable or which compound or increase other environmental impacts. (a) The individual effects may be changes resulting from a single project or a number of separate projects. (b) The cumulative impact from several projects is the change in the environment, which results from the incremental impact of the project when added to other closely related past, present, and reasonably foreseeable probable future project. Cumulative impacts can result from individually minor but collectively significant projects taking place over a period of time."

Curie (Ci): A unit of measurement of radioactivity defined as the amount of radioactive material in which the decay rate is 3.7×10^{10} disintegrations per second or 2.22×10^{12} disintegrations per minute; one curie is approximately equal to the decay rate of one gram of pure radium.

Damage Ratio (DR): The fraction of the material-at-risk impacted by accident-generated conditions.

Day-night average level (LDN): The average noise level in dBA over a 24-hour period with a 10 dB adjustment for events occurring during the night (10:00 p.m. to 7:00 a.m.), and ignoring an evening-hour adjustment.

Decibel (dB): A unit measure of a sound pressure ratio. The reference sound pressure is 0.0002 dynes per square centimeter, or the equivalent of 200 microbar or 20 Pascal (Pa). This is the smallest sound human can hear.

Decibel, A-weighted (dBA): A frequency correction that correlates overall sound pressure levels with the frequency response of the human ear; measured by the use of a metering characteristic and the "A" weighting specified by the American National Standard Institute S1.41971(R176).

Decontamination, Decommissioning, and Demolition (DD&D): Actions taken at the end of the useful life of a building or structure to reduce or remove substances that pose a substantial hazard to human health or the environment, retire it from service, and ultimately eliminate all or a portion of the building or structure.

Deflagration: To burn or cause to burn with great heat and intense light.

De minimis: Shortened form of "de minimis non curat lex," which means, "The law does not care for, or take notice of, very small or trifling matters," meaning a level that is so inconsequential that it cannot be cause for concern.

Depleted uranium: Uranium having a lower proportion of the fissile isotope uranium-235 than is found in naturally occurring uranium.

Derived Concentration Guide: Concentrations of radionuclides in water and air that could be continuously consumed or inhaled for one year and not exceed the DOE primary radiation standard to the public (100 mrem/y EDE).

Deterministic: With results determined by input assumptions and data, but without the probability of occurrence.

Deuterium: The hydrogen isotope that is twice the mass of ordinary hydrogen and that occurs in water; also called heavy hydrogen.

Direct employment: The number of jobs required to implement an alternative.

DOE Orders: Rules indicating the procedures and responsibilities of the various units of DOE. DOE orders give details on how overall Federal rules and regulations apply to DOE operations and indicate who shares responsibilities for administering them.

Dose: The energy imparted to matter by ionizing radiation; the unit of absorbed dose is the rad, equal to 0.01 joules per kilogram for irradiated material in any medium. Various technical terms—such as dose equivalent, effective dose equivalent, and collective dose—are used to evaluate the amount of radiation an exposed individual or population receives.

Dose equivalent—A measure of radiological dose that correlates with biological effect on a common scale for all types of ionizing radiation. Defined as a quantity equal to the absorbed dose in tissue multiplied by a quality factor (the biological effectiveness of a given type of radiation) and all other necessary modifying factors at the location of interest. The units of dose equivalent are the rem and sievert.

Dose rate—The radiation dose delivered per unit of time (e.g., rem per year).

Dosimeter: a portable detection device for measuring the total accumulated exposure to ionizing radiation.

Dosimetry: The theory and application of the principles and techniques of measuring and recording radiation doses.

Downgradient: In the direction of groundwater flow from a designated area; analogous to downstream.

Drinking water standard: The level of constituents or characteristics in a drinking water supply specified in regulations under the *Safe Drinking Water Act* as the maximum permissible.

Driver: A device for supplying the primary source of energy to an inertial fusion energy target; drivers can be lasers, ion beams, or intense gamma ray sources.

Dynamic test: A non-nuclear scientific experiment that shows how materials react to high explosive shocks.

Ecosystem: A community of organisms and their physical environment interacting as an ecological unit.

Effective dose equivalent (EDE): An estimate of the total risk of potential effects from radiation exposure, it is the summation of the products of the dose equivalent and weighting factor for each tissue. The weighting factor is the decimal fraction of the risk arising from irradiation of a selected tissue to the total risk when the whole body is irradiated uniformly to the same dose equivalent. These factors permit dose equivalents from nonuniform exposure of the body to be expressed in terms of an effective dose equivalent that is numerically equal to the dose from a uniform exposure of the whole body that entails the same risk as the internal exposure (ICRP 1990). The effective dose equivalent includes the committed effective dose equivalent from internal deposition of radionuclides and the effective dose equivalent caused by penetrating radiation from sources external to the body, and is expressed in units of rem (or sievert).

Effluent: A liquid or gas discharged to the environment.

Emission factors: An average value that relates to the quantity of an air pollutant released to the atmosphere by an activity associated with the release of the pollutant and usually expressed as the weight of pollutant divided by a unit weight, volume, distance, or duration of the activity that emits the pollutant. Emission factors are widely used for estimating air pollutant emissions and are often acceptable by regulatory authorities as an appropriate estimation of air pollution emissions to determine compliance with regulations.

Emission offsets: Emission credits used to offset the pollutants to be generated from a new air emission source. Areas that allow no net increase in air pollution emissions require that a new source offset emission increases by decreasing an equivalent amount of emissions from an existing source. In some cases emission offsets or credits can be obtained from a depository that collects emission credits from retired sources.

***Emergency Planning and Community Right-to-Know Act* of 1986 (EPCRA):** Act that requires facilities that produce, use, or store hazardous substances to report releases of reportable quantities or hazardous substances to the environment.

Emergency Response Planning Guidelines: Estimates of concentration ranges at which adverse effects can be expected if exposure to a specific chemical lasts more than 1 hour.

Endangered species: Species of plants and animals that are threatened with either extinction or serious depletion in their range and that are formally listed as such by the United States Fish and Wildlife Service and that are legally protected.

Enduring stockpile: The United States nuclear stockpile of the foreseeable future, consisting of about seven nuclear weapon systems. No new weapon systems will be added to the United States stockpile during this period. Many weapons within the enduring stockpile are older than their design lifetime.

Energetic material: Term that includes high explosives and propellants.

Enriched uranium: Uranium, found in natural uranium, with content of the fissile isotope uranium-235 being greater than 0.7 percent (by weight).

Environmental Assessment (EA): A concise public document that provides sufficient evidence and analysis for determining whether to prepare an environmental impact statement (EIS) or a finding of no significant impact for a proposed action. An EA includes brief discussions of the need for the proposed action, the features of alternatives, the environmental impacts of the proposed action and alternatives, and a listing of agencies and persons consulted.

Environmental impact report (EIR): A detailed report prepared pursuant to CEQA on the environmental impacts from any action carried out, approved, or funded by a California state, regional, or local agency.

Environmental Impact Statement (EIS): A detailed report, required by the National Environmental Policy Act, on the environmental impacts from a federally approved or funded project. An EIS must be prepared by a Federal agency when a “major” Federal action that may have “significant” environmental impacts is proposed.

Environmental justice: The fair treatment of people of all races, cultures, incomes, and educational levels with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment implies that no population of people should be forced to shoulder a disproportionate share of the negative environmental impacts of pollution or environmental hazards due to a lack of political or economic strength.

Epicenter: The point on the Earth’s surface directly over the point at which earthquake motion starts.

Emergency Response Planning Guidelines-1 (ERPG-1): The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing other than mild transient and adverse health effects or perceiving a clearly defined, objectionable odor.

Emergency Response Planning Guidelines-2 (ERPG-2): The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual’s ability to take protective action.

Emergency Response Planning Guidelines-3 (ERPG-3): The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects.

Environmental Justice: The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people, including racial, ethnic, or socioeconomic groups, should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of Federal, State, local, and Tribal programs and policies. Executive Order 12898 directs Federal agencies to make achieving environmental justice part of their missions by identifying and addressing disproportionately high and adverse effects of agency programs, policies, and activities on minority and low-income populations. (See minority population and low-income population.)

Evapotranspiration: A process by which water is transferred from the soil to the air by plants that take the water up through their roots and release it through their leaves and other aboveground tissue.

Explosives: *See* "high explosives."

Exponential notation: A means of expressing large or small numbers in powers of ten. For example, 4.3×10^6 = 4,300,000 and 4.3×10^{-5} = 0.000043. This relationship is also sometimes expressed in the form 4.3E+6 = 4,300,000, and 4.3E-5 = 0.000043.

Exposure: The condition of being made subject to the action of radiation or toxic material. Sometimes also used as a generic term to refer to the dose of radiation absorbed by an individual or population.

Exposure assessment: The determination of the magnitude, frequency, duration, and route of exposure.

Exposure pathways: The course a chemical or physical agent takes from the source to the exposed organism. An exposure pathway describes a unique mechanism by which an individual or population is exposed to chemicals or physical agents at or originating from a release site. Each exposure pathway includes a source or release from a source, an exposure point, and an exposure route. If the exposure point differs from the source, a transport/exposure medium such as air is also included.

External exposure: Radiation exposure from sources outside of the body: cloud passage, material deposited on the ground, and nearby surfaces.

Fault: A fracture in the Earth's crust accompanied by displacement of one side of the fracture with respect to the other and in a direction parallel to the fracture.

Federal facility: A facility that is owned or operated by the Federal government, subject to the same requirements as other responsible parties when placed on the Superfund National Priorities List.

Federal facility agreement (FFA): A negotiated agreement that specifies required actions at a Federal facility as agreed upon by various agencies (e.g., EPA, RWQCB, and DOE).

Federal Register: A document published daily by the Federal government containing notification of government agency actions, including notification of EPA and DOE decisions concerning permit applications and rule making.

Federally listed species: S*ee* "threatened, endangered, candidate, or rare species."

Finding of No Significant Impact: A public document issued by a Federal agency briefly presenting the reasons why an action for which the agency has prepared an environmental assessment has no potential to have a significant effect on the human environment and, thus, will not require preparation of an environmental impact statement. (See environmental assessment and environmental impact statement.)

Fiscal year: LLNL's fiscal year is from October 1 through September 30.

Fissile material/fissile isotope: An isotope that readily fission after absorbing a neutron of any energy, either slow or fast.

Fission: The splitting of a heavy atomic nucleus into two nuclei of lighter elements, accompanied by the release of energy and generally one or more neutrons. Fission can occur spontaneously or be induced by neutron bombardment.

Fissionable material: Material that will undergo nuclear fission when exposed to fast neutrons.

Flash x-ray: An x-ray apparatus that emits short pulses of x-rays useful for examining the behavior of rapidly changing mechanical systems.

Flood, 100-year: A flood event of such magnitude that occurs, on average, every 100 years (equates to a 1 percent probability of occurring in any given year).

Flood, 500-year: A flood event of such magnitude that occurs, on average, every 500 years (equates to a 0.2 percent probability of occurring in any given year).

Floodplain: The valley floor adjacent to the incised channel of a stream, which may be inundated during high water.

Fold: A bend in strata or any other planar structure.

Footprint: The layout of a facility on the ground; also refers to an area affected by release of radioactive materials.

Freon-11: Trichlorofluoromethane.

Freon-113: 1,1,2-trichloro-1,2,2-trifluoroethane; also known as CFC 113.

Frequency: Number of complete oscillation cycles per unit of time. The unit of frequency is the hertz (Hz).

Fuel-grade plutonium: Plutonium with a high enough content of other plutonium isotopes other than plutonium-239 (such as plutonium-240) that it cannot be used in weapons although it can be used in reactors.

Fugitive dust: The dust released from activities such as construction, manufacturing, or transportation.

Fugitive emissions: Uncontrolled emissions to the atmosphere from pumps, valves, flanges, seals, and other process points not vented through a stack. Also includes emissions from area sources such as ponds, lagoons, landfills, and piles of stored material.

Fusion: The energy releasing process in which atoms of very light elements such as deuterium and tritium combine to produce heavier elements.

Fusion fuel: Mixture of deuterium and tritium contained in a small capsule called the target.

Fusion reaction: When two nuclei of lighter elements are brought into close enough proximity, they can undergo thermonuclear fusion forming a single nucleus and releasing energy at the slight expense in mass of the original constituents. Typically, a deuterium and tritium nucleus are fused in such a reaction to produce a helium nucleus plus one free neutron. The released energy of 17.6 million electron volts (MeV) is carried mostly as kinetic energy by the neutron (14 MeV).

***g* notation:** Accelerations measured relative to the acceleration of gravity at the Earth's surface. Thus, 0.1 g = 3.2 ft/sec^2 or 98.3 cm/sec^2.

Gamma radiation: Short-wavelength electromagnetic radiation emitted from the atomic nucleus with typical energies ranging from 10 keV to 9 MeV. Individual gammas considered as particles are also called photons. Gamma radiation frequently accompanies alpha and beta emissions and always accompanies fission. Gamma rays are very penetrating and are best stopped or shielded against by dense materials such as lead or uranium. Gamma rays are similar to x-rays, but are usually more energetic.

Gamma ray: High-energy, short-wavelength, electromagnetic radiation emitted from the nucleus of an atom, frequently accompanying the emission of alpha or beta particles.

Gaussian plume: A plume of contaminants is said to be Gaussian when the contaminant concentrations are greatest at the centerline and decrease to either side as exp $[-(x/\sigma)^2/2]$, where x is the distance from the centerline and σ is the distance to the point where the concentration is down to 37 percent of the centerline concentration. *See* "standard deviation."

General Plan: A compendium of city or county policies regarding long-term development in the form of maps and accompanying text. The General Plan is a legal document required of each local agency by California Government Code section 65301 and adopted by the City Council or Board of Supervisors. The General Plan may also be called "City Plan," "Comprehensive Plan," or "Master Plan."

Geology: The earth science that deals with the study of the materials, processes, environments, and history of the earth, including rocks and their formation and structure.

Geometric mean: For a set of n terms, the nth root of their product. For a set of positive numbers, the geometric mean is always less than or equal to the arithmetic mean (*see* "arithmetic mean").

Glovebox: A sealed box in which workers, while remaining outside and using gloves attached to and passing through openings in the box, can safely handle and work with radioactive materials, other hazardous materials, and non-hazardous air-sensitive compounds.

Gram (g): The standard metric measure of weight approximately equal to 0.035 ounce.

Gross alpha: The concentration of all alpha-emitting radionuclides in a sample.

Gross beta: The concentration of all beta-emitting radionuclides in a sample.

Ground acceleration: The intensity of the strong phase of ground shaking in units of *g* (Earth's gravitational attraction).

Groundwater: Water below the ground surface in the saturated zone.

Habitat: Area where a plant or animal lives.

Half-life (biological): The time required for the body to eliminate one-half of an administered dosage of any substance by regular processes of elimination.

Half-life (ecological): The time required for removal of one-half of the amount of a material deposited in the local environment.

Half-life (radiological): The time required for one-half the radioactive atoms in a given amount of material to decay; for example, after one half-life, half of the atoms will have decayed; after two half-lives, three-fourths; after three half-lives, seven-eighths; and so on, exponentially.

Hazard Index (HI): The ratio between the intake of a chemical and an acceptable health-based reference level. A hazard index of less than 1 indicates a safe level of intake.

Hazardous air pollutants (HAPs): Air pollutants not covered by ambient air quality standards, but that may present a threat of adverse human health or environmental effects. Those specifically listed in 40 CFR 61.01 are asbestos, benzene, beryllium, coke oven emissions, inorganic arsenic, mercury, radionuclides, and vinyl chloride. More broadly, HAPs are any of the 189 pollutants listed in or pursuant to Section 112(b) of the Clean Air Act. Very generally, HAPs are any air pollutants that may realistically be expected to pose a threat to human health or welfare.

Hazardous chemical: Any chemical that is a physical hazard or a health hazard as defined by the Occupational Safety and Health Administration (29 CFR §1910.1201). For *Superfund Amendments and Reauthorization Act* (SARA) Title III, Section 311, the term is defined the same with certain named exceptions.

Hazardous material: A material, including a hazardous substance as defined by 49 CFR 171.8, that poses a risk to health, safety, and property when transported or handled.

Hazardous waste: Hazardous wastes exhibit any of the following characteristics: ignitability, corrosivity, reactivity, or EP-toxicity (yielding toxic constituents in a leaching test), but other wastes that do not necessarily exhibit these characteristics have been determined to be hazardous by USEPA. Although the legal definition of hazardous waste is complex, according to USEPA the term generally refers to any waste that, if managed improperly, could pose a threat to human health and the environment. The word is defined as under the *Resource Conservation and Recovery Act*, a solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may (a) cause or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or (b) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed. Source, special nuclear material, and byproduct material, as defined by the *Atomic Energy Act*, are specifically excluded from the definition of solid waste.

(*California) Hazardous Waste Control Act* (HWCA): Legislation specifying requirements for hazardous waste management in California.

Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX): A high explosive compound.

High-efficiency particulate air (HEPA) filter: An extended-media, dry type filter used to capture particulates in an air stream; HEPA collection efficiencies are at least 99.97% for 0.3 micrometer diameter particles.

High explosives: Materials that release large amounts of chemical energy when detonated.

Highly enriched uranium: Uranium enriched to 20 percent or greater in uranium-235.

High Performance Computing: The use of supercomputers and parallel processing techniques with multiple computers to perform computational tasks.

Historic resources: The sites, districts, structures, and objects considered limited and nonrenewable because of their association with historic events or persons, or social or historic movements.

Hohlraum: The metal case surrounding the target on indirect-drive inertial confinement fusion.

Holocene: A standard epoch of geological time, from 10,000 years ago until the present.

Hood: An enclosure of canopy provided with a draft to remove toxic or other noxious vapors or aerosols from the workplace.

Human genome: A set of chromosomes with the genes they contain.

Hydraulic gradient: In an aquifer, the rate of change of total head (water-level elevation) per unit distance of flow at a given point and in a given direction.

Hydric soils: Soils that are saturated, flooded, or ponded long enough (7 days or longer) during the growing season to develop anaerobic conditions in their upper layer.

Hydrology: The science dealing with the properties, distribution, and circulation of natural water systems.

Hydrodynamic test or hydrotest: A non-nuclear scientific experiment that shows how materials react to high explosives detonation. "Hydro" refers to the fluid-like flow of solids at the center of an explosion. Results are used to investigate hydrodynamic aspects of primary function during pit implosion.

Hydrophytic vegetation: Vegetation that grows in water, soil, or on a substrate that is at least periodically deficient in oxygen as a result of excessive water content.

Igneous: Refers to a rock or mineral that solidified from molten or partly molten material, i.e., from magma; also, applied to processes leading to, related to, or resulting from the formation of such rocks. Igneous rocks constitute one of the three main classes into which rocks are divided, the others being metamorphic and sedimentary.

Ignition: Self-sustained thermonuclear reaction.

Ignitron switch: A high current switch used to discharge energy storage capacitors, which are used to fire laser flashlamps.

Impact: The effect, influence, or imprint of an activity on the environment. Impacts include direct or primary effects, which are caused by the project and occur at the same time and place, and indirect or secondary effects, which are caused by the project and are later in time or farther removed in distance, but still reasonably foreseeable. Indirect or secondary effects may include growth-inducing and other effects related to induced changes in the pattern of land use, population density, or growth rate, and related effects on air and water and other natural systems, including ecosystems.

Implosion: Sudden inward compression and reduction in volume of fissionable material inside a nuclear weapon brought about by the detonation of conventional explosives.

Incident-free: Normal transport or operation.

Incident-free risk: The radiological or chemical impacts resulting from emissions during normal operations and packages aboard vehicles in normal transport. This includes the radiation or hazardous chemical exposure of specific population groups such as crew, passengers, and bystanders.

Indirect employment: Jobs generated or lost in related industries within a regional economic area as a result of a change in direct employment.

Inertial confinement fusion (ICF): An energetic driver beam (laser, x-ray, or charged particle) initiated nuclear fusion using the inertial properties of the reactants as a confinement mechanism.

Inertial fusion energy (IFE): The use of high-repetition-rate lasers or ion drivers (about 10 pulses per second) to accomplish laboratory and commercial thermonuclear fusion.

Infrastructure: Utilities and other physical support systems needed to operate a laboratory or test facility. Included are electric distribution systems, water supply systems, sewage disposal systems, roads, and so on.

Ingestion dose: An internal dose that results from the oral intake of food, water, soil, or other media contaminated with radioactive material.

Inorganic compounds: Compounds that either do not contain carbon or do not contain hydrogen along with carbon, including metals, salts, and various carbon oxides (e.g., carbon monoxide and carbon dioxide).

Input parameters: Values of variables needed to run a computer model.

In situ: Refers to the treatment of contaminated areas in place without excavation or removal, as in the in situ treatment of onsite soils through biodegradation of contaminants.

Integrated Safety Management System (ISMS): A system is a systematic approach to defining the scope of work, identifying the hazards, establishing controls, performing the work, and concluding with feedback and improvement. The system defines a process for identifying, planning and performing work that provides for early identification of hazards and associated control measures for hazards mitigation or elimination. The ISMS process also forms the basis for work authorization and provides for both internal and external assessment that provides a continuous feedback and improvement loop for identifying both shortcomings and successes for incorporation into subsequent activities.

Interim Action: An action concerning a proposal that is subject of an ongoing EIS and that DOE proposes to take before a record of decision is issued, and is permissible under 40 CFR §1506.1: Limitation on actions during the NEPA process.

Interim status: A legal classification allowing hazardous waste incinerators or other hazardous waste management facilities to operate while EPA considers their permit applications, provided that they were under construction or in operation by November 19, 1980 and can meet other interim status requirements.

Internal exposure: Radiation exposure from sources inside the body: from materials ingested, inhaled, or (in the case of tritium) absorbed through the skin.

International Commission on Radiological Protection (ICRP): An international organization that studies radiation, including its measurement and effects.

Inventory: The amount of a radioactive or hazardous material present in a building or facility.

Involved worker: Workers that would be involved in a proposed action as opposed to workers that would be on the site of a proposed action but not involved in the action.

Isoconcentration map: A map showing contours of equal concentration of contaminant.

Isotopes: Forms of an element having the same number of protons in their nuclei, but differing numbers of neutrons.

Juniper-oak cismontane woodland: An open woody plant community dominated by California juniper with a shrubby understory of coastal shrubby species.

Joule: The basic SI unit of work or energy. A joule is equal to the kinetic energy of a two-kilogram mass moving at the speed of one meter per second.

Jurassic: A standard period of geologic time, from about 181 million to 135 million years ago.

Laboratories, heavy: Laboratories characterized by high-bay construction, overhead cranes, and in some cases, shielding. Heavy laboratories are typically used for large research apparatus or large mechanical test equipment.

Laboratories, light: Laboratories characterized by small equipment and apparatus. Light laboratories are typically used for direct bench-scale research.

Land use: The purpose or activity for which a piece of land or its buildings is designed, arranged, or intended, or for which it is occupied or maintained.

Laser: A device that produces a beam of monochromic (single-color) "light" in which the waves of light are all in phase. This condition creates a beam that has relatively little scattering and has a high concentration of energy per unit area of the beam.

Latent cancer fatality: Term used to indicate the estimated number of cancer fatalities which may result from exposure to a cancer-causing element. Latent cancer fatalities are similar to naturally occurring cancers and may occur at any time after the initial exposure.

L_{dn}: *See* "ambient sound level."

Leaching test: A test conducted to determine the leach rate of a waste form. The test results may be used for judging and comparing different types of waste forms, or may serve as input data for a long-term safety assessment of a repository.

Lead (Pb): Lead is a bluish-white lustrous metal. It is very soft, highly malleable, ductile, and a relatively poor conductor of electricity. It is very resistant to corrosion but tarnishes upon exposure to air.

Leak Path Factor (LPF): The fraction of airborne materials transported from containment or confinement deposition or filtration mechanism (e.g., fraction of airborne material in a glovebox leaving the glovebox under static conditions, fraction of material passing through a HEPA filter). LPF is one of the factors used to calculate the source term for an accident or event.

Level of concern: The concentration of an extremely hazardous substance (EHS) in the air above which there may be serious irreversible health effects or death as a result of a single exposure for a relatively short period of time.

Level of service (LOS): The extent of community, healthcare and educational services provided by local jurisdictions in the vicinity of the proposed sites. LOS is measured in terms of per capita expenditures on services in each of these categories. In traffic studies, LOS means the different operating conditions that occur in a lane or roadway when accommodating various traffic volumes. A qualitative measure of the effect of traffic flow factors such as special travel time, interruptions, freedom to maneuver, driver comfort, convenience, and (indirectly) safety and operating cost. Levels of service are described by a letter rating system of A through F, with LOS A indicating stable traffic flow with little or no delays and LOS F indicating excessive delays and jammed traffic conditions.

Life Extension Program: A program that refurbishes warheads of a specific weapon type to extend the service life of a weapon. LEPs are designed to extend the life of a warhead by 20 to 30 years, while increasing safety and security.

Limited-lifetime component: A weapon component that decays with age and must be replaced periodically.

Liquefaction: A type of soil failure in which a mass of saturated soil is transformed from a solid to a liquid state.

Liter (L): The SI measure of capacity approximately equal to 1.057 quart.

Lithic scatter: Concentrations of stone once used for the manufacture of artifacts. The stone includes finished artifacts, roughly formed artifacts, the cores of the stone from which they were made, and the wastes flakes from the manufacturing process.

Livermore Water Reclamation Plant (LWRP): The city of Livermore's municipal wastewater treatment plant, which accepts discharges from the Livermore Site.

Low-income population: Defined in terms of U.S. Census Bureau annual statistical poverty levels, a population may consist of groups or individuals who live in geographic proximity to one another or who are geographically dispersed or transient (e.g., migrant workers or Native Americans), where the population experiences common conditions of environmental exposure or effect. (See environmental justice and minority population.)

Low-level waste (LLW): Waste defined by DOE O 5820.2A, which contains transuranic nuclide concentrations less than 100 nCi/g. LLW is radioactive waste that is not high-level radioactive waste, spent nuclear fuel, transuranic waste, byproduct material (as defined in section 11e.(2) of the *Atomic Energy Act* of 1954, as amended), or "naturally occurring radioactive material" as defined by DOE O 435.1, Radioactive Waste Management. Test specimens of fissionable material irradiated for research and development only, and not for the production of power or plutonium, may be classified as LLW, provided the concentration of transuranic waste is less than 100 nanocuries per gram.

Magazine: An approved structure designed for the storage of explosives, excluding operating buildings.

Maintenance pollutants: Criteria air pollutants in an Air Quality Maintenance Area that may exceed the ambient air quality standard over time.

Magnitude: A measure of the strength of an earthquake or the strain energy released by it; the logarithm of the amplitude of motion recorded on a seismograph.

Material-at-risk: A material-at-risk limit is defined as the maximum amount of the referenced material that is involved in the process and thus at risk in the event of a postulated accident. Material locked in a secure storage is not considered material-at-risk.

Maximally exposed individual (MEI): A hypothetical member of the public at a fixed location who, over an entire year, receives the maximum effective dose equivalent (summed over all pathways) from a given source of radionuclide releases to air. Generally, the MEI is different for each source at a site.

Maximum Contaminant Level (MCL): The highest level of a contaminant in drinking water that is allowed by the United States Environmental Protection Agency regulation.

Maximum credible accident: An accident that has the greatest offsite consequences from hazardous material release and that has a frequency of occurrence greater than 10^{-6} per year, when credit for mitigation is allowed. Such an accident is one of the set of reasonably foreseeable accidents.

Maximum design yield: The maximum theoretical yield expected from a NIF experiment.

Maximum yield experiment: A fusion ignition experiment that generates maximally expected fusion energy.

Metamorphic rock: Any rock derived from preexisting rocks by mineralogical, chemical, and/or structural changes, essentially in the solid state, in response to marked changes in temperature, pressure, shearing stress, and chemical environment, generally at depth in the Earth's crust.

Mercury (Hg): A metallic element mostly obtained by reduction from cinnabar, one of its ores. It is a heavy, opaque, glistening liquid (commonly called quicksilver), and is used in barometers, thermometers, etc.

Meteorology: The science dealing with the atmosphere and its phenomena, especially as it relates to weather.

Metric units: Metric system and United States customary units and their respective equivalents are shown in the table below. Except for temperature for which specific equations apply, United States customary units can be determined from metric units by multiplying the metric units by the United States customary equivalent. Similarly, metric units can be determined from United States customary equivalent units by multiplying the United States customary units by the metric equivalent.

MeV: A unit of energy equal to 1.6×10^{-6} ergs or 1.6×10^{-13} joules. Short for "million electron volts," an electron volt being the energy acquired by an electron when it is accelerated through a potential drop of one volt.

Midden: Characteristic soil containing cultural resources and other evidence of use of an area, such as the decomposed organic remains of vegetal foods, animals, and evidence of fires (e.g., ash, carbon, charcoal). Because of the organic content, midden soils tend to differ from surrounding soils in texture and color.

Millirem (mrem): One-one-thousandth of a rem (*see* "rem").

Minority population: Minority populations exist where either: (1) the minority population of the affected area exceeds 50 percent, or (2) the minority population percentage of the affected area is meaningfully greater than in the general population or other appropriate unit of geographic analysis (such as a governing body's jurisdiction, a neighborhood, census tract, or other similar unit). "Minority" refers to individuals who are members of the following population groups: American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic.

"Minority populations" include either a single minority group or the total of all minority persons in the affected area. They may consist of groups of individuals living in geographic proximity to one another or a geographically dispersed/transient set of individuals (such as migrant workers or American Indians), where the population experiences common conditions of environmental exposure or effect. (See environmental justice and low-income population.)

Miocene: A standard epoch of geologic time between the Pliocene and Oligocene, from about 28 million to 5.3 million years ago.

Mitigation: CEQA defines as: "(a) Avoiding the impact altogether by not taking a certain action or parts of an action; (b) Minimizing impacts by limiting the degree or magnitude of the action and its implementation; (c) Rectifying the impact by repairing, rehabilitating, or restoring the affected environment; (d) Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and (e) Compensating for the impact by replacing or providing substitute resources or environments" (40 CFR §1508.20, CEQA Guidelines 15370). NEPA also says regarding alternatives: "…Include appropriate mitigation measures not already included in the proposed action or alternatives" (40 CFR §1502.14[f]).

Mixed fission products: The ensemble of fission products resulting from the fission of a heavy element such as uranium. *See* "fission."

Mixed waste: Waste that contains both nonradioactive hazardous waste and radioactive waste.

Mock nuclear material: Material that is nonradioactive and nonfissile, but similar in density and other characteristics to nuclear material. Mock nuclear material is substituted for a weapon's nuclear parts in hydrodynamic experiments and flight tests.

Modification (Mod): A program that changes a weapon's operational capabilities. A Mod may enhance the margin against failure, increase safety, improve security, replace limited life components, and/or address identified defects and component obsolescence.

Model: A conceptual, mathematical, or physical system obeying certain specified conditions, whose behavior is used to understand the physical system to which it is analogous.

Modified Composite Noise Rating (CNR): Noise rating system that determines impacts from a fixed noise source using objective and subjective factors. Noise ranked A through D is generally considered to be acceptable with "A" representing essentially no impacts. Rankings above "D" are usually addressed with mitigative measures unless the source is temporary.

Modified Mercalli Scale or Intensity: An earthquake intensity scale, with 12 divisions ranging from I (not felt by people) to XII (damage nearly total). It is a unitless expression of observed effects.

Molecular sieve: A material with a rigid, uniform pore structure that completely excludes molecules larger than the structure pore openings and that can absorb certain classes of small molecules from a fluid in contact with the material.

National Ambient Air Quality Standards (NAAQS): Air quality standards established by the *Clean Air Act*, as amended. The primary National Ambient Air Quality Standards are intended to protect the public health with an adequate margin of safety, and the secondary National Ambient Air Quality Standards are intended to protect the public welfare from any known or anticipated adverse effects of a pollutant.

National Emission Standards for Hazardous Air Pollutants (NESHAP): A set of national emission standards for listed hazardous pollutants emitted from specific classes or categories of new and existing sources. These were implemented in the *Clean Air Act* Amendments of 1977.

***National Environmental Policy Act* (NEPA):** Federal legislation enacted in 1969 that requires all Federal agencies to document and consider environmental impacts for federally funded or approved projects and the legislation under which DOE is responsible for NEPA compliance at LLNL.

***National Historic Preservation Act* of 1966, as amended (NHPA):** This Act provides that property resources with significant national historic value be placed on the National Register of Historic Places. It does not require any permits but, pursuant to Federal code, if a proposed action might impact an historic property resource, it mandates consultation with the proper agencies.

National Ignition Facility (NIF): The laser facility to be used to achieve ignition of fusion fuel and energy gain in a laboratory. The NIF's primary mission is to perform stockpile stewardship experiments.

National Nuclear Security Administration (NNSA): A semi-autonomous agency within the United States (U.S.) Department of Energy (DOE) responsible for meeting the national security requirements established by the President and Congress to maintain and enhance the safety, reliability, and performance of the U.S. nuclear weapons stockpile.

National Pollutant Discharge Elimination System (NPDES): Federal regulation under the *Clean Water Act* that requires permits for discharges into surface waterways.

National Register of Historic Places (NRHP): A register of districts, sites, buildings, structures, and objects significant in American history, architecture, archaeology, engineering, and culture. It is in the Department of Interior and was established pursuant to the *National Historic Preservation Act* of 1966, as amended (16 U.S.C. §470 et seq.).

Natural uranium: Uranium as it occurs in nature. The natural substance is 99.28 percent uranium-238, 0.72 percent uranium-235, and 0.0055 percent uranium-234.

NEPA: *See* "*National Environmental Policy Act*."

Neutron: An uncharged elementary particle with a mass slightly greater than that of the proton, found in the nucleus of every atom heavier than hydrogen-1; a free neutron is unstable and decays with a half-life of about 13 minutes into an electron and a proton.

Nitrogen oxides (NO_x): Refers to the oxides of nitrogen, primarily NO (nitrogen oxide) and NO_2 (nitrogen dioxide). These are produced in the combustion of fossil fuels and are considered major air pollutants. When nitrogen dioxide combines with volatile organic compounds, in sunlight, ozone is produced.

***Noise Control Act* of 1972:** This Act directs all Federal agencies to carry out programs in a manner that furthers a national policy of promoting an environment free from noise that jeopardizes health or welfare.

Nonattainment area: An air quality control region (or portion thereof) in which the Environmental Protection Agency has determined that ambient air concentrations exceed national ambient air quality standards for one or more criteria pollutants.

Nonhazardous wastes: Routinely generated, nonhazardous wastes include general facility refuse such as paper, cardboard, glass, wood, plastics, scrap, metal containers, dirt, and rubble.

Non-invasive imaging: Imaging methods that do not damage the test specimen, including radiography, computed tomography, and other techniques.

Noninvolved worker: Workers in a fixed population outside the day-to-day process safety management controls of a given facility area. In this SW/SPEIS, this term includes both individual noninvolved workers (an LLNL worker not directly involved with operation of the facility, but located 100 meters from the facility), and the population of noninvolved workers (the LLNL employee population, plus the population at SNL/CA).

Non-ionizing radiation: Electromagnetic radiation of wavelengths greater than 10^{-7} m (1000Å), such as laser, thermal, or radio frequency radiation.

Nonpoint source: Any nonconfined area from which pollutants are discharged into a body of water (e.g., agricultural runoff, construction runoff, and parking lot drainage), or into air (e.g., fugitive dust from construction sites).

Nonproliferation: Preventing the spread of nuclear weapons, nuclear weapons materials, or nuclear weapons technology to rogue nations, terrorists, and countries that have not signed nonproliferation agreements.

Non-yield experiments: Experiments without tritium and deuterium with no detectable generation of neutrons.

Normal operations: All normal conditions and those abnormal conditions that frequency estimation techniques indicate occur with a frequency of more than 0.1 event per year.

Notice of Availability: A formal notice, published in the Federal Register, that announces the issuance and public availability of a draft or final environmental impact statement. The U.S. Environmental Protection Agency Notice of Availability is the official public notification of an environmental impact statement; a U.S. Department of Energy Notice of Availability is an optional notice used to provide information to the public.

Notice of Intent: Public announcement that an environmental impact statement will be prepared and considered. It describes the Proposed Action, possible alternatives, and scoping process, including whether, when, and where any scoping meetings will be held. The Notice of Intent is usually published in the Federal Register and in the local media. The scoping process includes holding at least one public meeting and requesting written comments on issues and environmental concerns that an environmental impact statement should address.

Nuclear assembly: The collective term for the primary, secondary, and radiation case in a nuclear weapon.

Nuclear component: A nuclear weapon part that contains fissionable or fusionable material.

Nuclear material: Composite term applied to (1) special nuclear material; (2) source material such as uranium, thorium, or ores containing uranium or thorium; and (3) byproduct material, which is any radioactive material that is made radioactive by exposure to the radiation incident or to the process of producing or using special nuclear material.

Nuclear reaction: A reaction in which an element’s atomic nucleus is transformed into another isotope of the same element or into another element altogether. The process always is accompanied by the release of particles or energy.

Nuclear Regulatory Commission (NRC): The Federal agency charged with oversight of nuclear power and nuclear machinery and applications not regulated by DOE or the Department of Defense.

Nuclear Security Enterprise: The physical infrastructure, technology, and workforce at the national security laboratories, the nuclear weapons production sites, and the Nevada National Security Site.

Nuclear warhead: A device that contains fissionable and fusionable material, the nuclear assembly, and the non-nuclear components.

Nuclear weapon: A warhead that contains fissionable and fusionable material, the nuclear assembly, and the non-nuclear components packaged as a deliverable weapon.

Nuclear weapons complex: The network of laboratories and fabrication plants involved in the design, production, testing, surveillance, and maintenance of United States, nuclear weapons.

Nuclide: A species of atom characterized by the constitution of its nucleus. The nuclear constitution is specified by the number of protons, number of neutrons, and energy content; or, alternatively, by the atomic number, mass number, and atomic mass. To be regarded as a distinct nuclide, the atom must be capable of existing for a measurable length of time.

Numerical simulation: The use of mathematical formulas and models of physical processes to simulate through calculations, the behavior or performance of a device or complex system.

Occupational Safety and Health Administration (OSHA): Oversees and regulates workplace health and safety, created by the *Occupational Safety and Health Act* of 1970.

Obligate plant species: Species that occur in wetlands most of the time (99 percent).

Offsite: Outside the boundaries of the Livermore Site and Site 300 properties.

Onsite: Within the boundaries of the Livermore Site or Site 300 properties.

Opacity restrictions: Visible-emission regulations that are based on the light-scattering properties of suspended matter in the ambient atmosphere and apply to near-field emissions of fixed sources.

Open space: Any area of land or body of water set aside and left essentially unimproved that is dedicated, designated, or reserved for public or private use or enjoyment, or for the use and enjoyment of owners and occupants of land adjoining or neighboring such open house.

Order of magnitude: A factor of ten. When a measurement is made with a result such as 3×10^7, the exponent of 10 (here 7) is the order of magnitude of that measurement. To say that this result is known to within an order of magnitude is to say that the true value lies (in this example) between 3×10^6 and 3×10^8.

Ozone (O_3): The triatomic form of oxygen. In the stratosphere, ozone protects the Earth from the sun's ultraviolet rays; in lower levels of the atmosphere, ozone is considered an air pollutant.

Ozone-Depleting Substance(s) (ODS): A compound that contributes to stratospheric ozone depletion. ODS include chlorofluorocarbons, hydrochlorofluorocarbon, halon, methyl bromide, carbon tetrachloride, and methyl chloroform. They are generally very stable in the troposphere and only degrade under intense ultraviolet light in the stratosphere. When they breakdown, they release chlorine or bromine atoms, which then deplete ozone.

Packaging: In the NRC regulations governing the transportation of radioactive materials (10 CFR Part 71), the term "packaging" is used to mean the shipping container together with its radioactive contents.

Paleontology: The study of fossils.

Paleontological resources: Fossils.

Part B permit: The second, narrative section submitted by generators in the RCRA permitting process that covers in detail the procedures followed at a facility to protect human health and the environment.

Particulate (airborne): Small particles that are emitted from fixed or mobile sources and dispersed in the atmosphere.

Parts per billion (ppb): A unit of measure for the concentration of a substance in its surrounding medium; for example, one billion grams of water containing one gram of salt has a salt concentration of one part per billion.

Parts per million (ppm): A unit of measure for the concentration of a substance in its surrounding medium; for example, one million grams of water containing one gram of salt has a salt concentration of one part per million.

Pasquill stability categories: Classification scheme that describes the degree of atmospheric turbulence. Categories range from extremely unstable (A) to extremely stable (F). Unstable conditions promote the rapid dispersion of atmospheric contaminants and result in lower air concentrations as compared with stable conditions.

Peak Ground Acceleration: A measure of the maximum horizontal acceleration (as a percentage of the acceleration due to the earth's gravity) experienced by a particle on the surface of the earth during the course of earthquake motion.

Perched aquifer: Aquifer that is separated from another water-bearing stratum by an impermeable layer.

Perennial stream: A watercourse that flows year-round.

Performance: Essentially equivalent to "reliability," a nuclear weapon, weapon system, or weapon component's ability to perform its required function in terms of yield, range, accuracy, and radiation spectrum under stated conditions for a specified period.

Performance standards (incinerators): Specific regulatory requirements established by EPA limiting the concentrations of designated organic compounds, particulate matter, and hydrogen chloride in incinerator emissions.

Permissible Exposure Limit (PEL): Occupational exposure limit regulations endorsed by OSHA. May be for short term or 8-hour duration exposure.

Person-rem: A unit of collective dose commitment to a given population; the sum of individual doses received by a population group.

Petroglyph: Art that was carved or inscribed into bedrock by historic or prehistoric people.

pH: The negative logarithm of the concentration of hydrogen ions in a liquid measured in gram equivalents per liter. A pH of 7 is neutral; smaller numbers indicate an acidic condition, while larger numbers indicate a basic condition.

Photochemical oxidant: A class of compounds typified by ozone that represents oxidizing compounds created in the atmosphere with sunlight as a catalyst under low wind conditions.

Piedmont: An area, plain, slope glacier, or other feature at the base of a mountain.

Piezometer: Instrument for measuring fluid pressure used to measure the elevation of the water table in a small, non-pumping well.

Pit: A nuclear weapon's central core, containing plutonium-239 and/or highly enriched uranium, that undergoes fission when compressed by high explosives. The pit and the high explosive are known as the nuclear weapon's "primary."

Plasma: A cloud of charged particles containing about equal number of positive ions and electrons and exhibiting some properties of a gas but differing from a gas in being a good conductor of electricity and being affected by magnetic fields.

Plate tectonics: A theory of global-scale dynamics involving the movement of rigid plates of the Earth's crust.

Pleistocene: A standard epoch of geological, from about 1.6 million to 10,000 years ago.

Pliocene: Geological epoch of the Tertiary period, starting about 12 million years ago.

Plume: The spatial distribution of a release of airborne or waterborne material as it disperses in the environment.

Plutonium (Pu): An artificial fissile element of atomic number 94. Defined as a heavy, radioactive, metallic element, with atomic number 94, that produces ionization radiation in the form of alpha particles. Produced in a reactor by bombarding uranium with neutrons, plutonium is used in nuclear weapons and also can be used as fuel in fission reactors. The 15 radioactive plutonium isotopes have half-lives ranging from less than a second to thousands of years.

PM_{10}: Fine particulate matter with an aerodynamic diameter equal to or less than 10 microns.

Point source: Any confined and discrete conveyance (e.g., pipe, ditch, well, or stack).

Population dose (population exposure): Summation of individual radiation doses received by all those exposed to the source or event being considered. The collective radiation dose received by a population group, usually measured in units of person-rem.

Precambrian: Dating from before the Cambrian geologic period more than 570 million years ago.

Precursor pollutants: Pollutants that must be present in the atmosphere before chemical reactions take place and form the pollutant of interest. For example, nitrogen oxides, and volatile organic compounds are precursor pollutants to the formation of ozone.

Prehistoric resources: *See* "cultural resources (prehistoric)."

Prevention of Significant Deterioration (PSD): Regulations established by the 1977 *Clean Air Act* Amendments to limit increases in criteria air pollutant concentrations above baseline.

Primary and secondary containment: Primary containment is that set of engineered safety features immediately around a radioactive or hazardous material designed to prevent its release; secondary containment is the set of backup features outside the primary containment.

Prime farmland: Under the Farmland Protection Policy Act of 1981, defined as land with the best combination of physical and chemical characteristics (i.e., soil quality, growing season, and moisture supply) for economically producing high yields of food, feed, forage, fiber, and oilseed crops, with minimum inputs of fuel, fertilizer, pesticides, and labor without intolerable soil erosion. Land classified as prime farmland includes crop land, pasture land, range land, and forest land, but not urban or built-up land or land covered with water. Prime farmlands are designated by the Natural Resources Conservation Service.

Probabilistic: With results taking into account the probability of occurrence. Probabilistic calculations sometimes combine the results of several deterministic calculations, weighting their results by their probabilities. *See* “deterministic.”

Programmatic EIS: An EIS that, when complete, will examine a nationwide issue.

Prompt radiation: Gamma or neutron radiation emitted during the fission process is said to be prompt (within microseconds) as distinguished from delayed (as much as seconds).

Protective (Preventive) Action Guide: FDA-recommended levels of radiation exposure above, which action should be taken to prevent or reduce the radioactive contamination of human food or animal feeds.

Public: Anyone outside the boundary of a DOE site at the time of an accident or during normal operations.

Quality assurance (QA): A system of activities whose purpose is to provide the assurance that standards of quality are attained with a stated level of confidence.

Quality control (QC): Procedures used to verify that prescribed standards of performance are attained.

Quality factor: The factor by which the absorbed dose (rad) is multiplied to obtain a quantity that expresses (on a common scale for all ionizing radiation) the biological damage to exposed persons, usually used because some types of radiation, such as alpha particles, are biologically more damaging than others. Quality factors for alpha, beta, and gamma radiation are in the ratio 20:1:1.

Quaternary: The geologic era encompassing the last 2–3 million years.

Rad: The unit of absorbed dose and the quantity of energy imparted by ionizing radiation to a unit mass of matter such as tissue, and equal to 0.01 joule per kilogram, or 0.01 gray.

Radiation: The emitted particles or photons from the nuclei of radioactive atoms; including alpha, beta, gamma, and neutrons. Some elements are naturally radioactive; others are induced to become radioactive by bombardment in a reactor. Naturally occurring radiation is indistinguishable from induced radiation.

Radioactive decay: The spontaneous transformation of one radionuclide into a different nuclide (which may or may not be radioactive), or de-excitation to a lower energy state of the nucleus by emission of nuclear radiation, primarily alpha or beta particles, or gamma rays (photons).

Radioactive material: Any material having a specific activity greater than 0.002 microcuries per gram, as defined by 49 CFR §173.403 (y).

Radioactive waste: Material that contains radionuclides regulated under the *Atomic Energy Act* of 1954, as amended, and is of negligible economic value given the cost of recovery.

Radioactivity: The spontaneous emission of nuclear radiation, generally alpha or beta particles, or gamma rays, from the nucleus of an unstable isotope.

Radiological risk: The product of the accident consequence (dose) and the probability of the accident occurring; calculated by considering a wide range of accidents, from high-probability low-consequence events to low-probability high-consequence events.

Radionuclide: An unstable nuclide. *See* "nuclide and radioactivity." Standard practice for naming a radionuclide is to use the name or atomic symbol of an element followed by its atomic weight (e.g., cobalt-60, a radionuclide of cobalt).

RADTRAN: An NRC-approved code for estimating the radiological impacts of transportation of radioactive materials.

Rare species: Populations and/or individuals occurring in very low numbers relative to other similar taxa in the state, although common or regularly occurring throughout much of their range. They may be found in a restricted geographic region or occur sparsely over a wider area. Although rare, populations are apparently stable.

RCRA Part B permit: A permit issued by EPA under the *Resources Conservation and Recovery Act* (RCRA) that have allowed LLNL to operate landfills at Site 300 for the disposal of debris from high explosives wastes.

Reasonably foreseeable: An accident or action whose impacts "may have large or catastrophic consequences, even if their probability of occurrence is low, provided that the analysis of the impacts is supported by credible scientific evidence, is not based on pure conjecture, and is within the rule of reason" (40 CFR §1502.22[b][4]).

Record of Decision (ROD): A concise public document that records a Federal agency's decision(s) concerning a proposed action for which the agency has prepared an environmental impact statement. The ROD is prepared in accordance with the requirements of the Council on Environmental Quality National Environmental Policy Act regulations (40 CFR 1505.2). A ROD identifies the alternatives considered in reaching the decision, the environmentally preferable alternative(s), factors balanced by the agency in making the decision, whether all practicable means to avoid or minimize environmental harm have been adopted, and if not, why they were not.

Refraction: The change in direction of propagation of a sound upon passage into a medium with different sound speed.

Region of influence (ROI): A geographic area within which LLNL activities may affect a particular resource.

Regional Water Quality Control Board (RWQCB): The California regional agency responsible for water quality standards and the enforcement of state water quality laws within its jurisdiction.

California is divided into a number of RWQCBs; the Livermore Site is regulated by the San Francisco Bay Region, and Site 300 is regulated by the Central Valley Region.

Release fraction: The fraction of the material-at-risk that is released in an accident.

Rem: A unit of radiation dose equivalent and effective dose equivalent describing the effectiveness of a type of radiation to produce biological effects; coined from the phrase "roentgen equivalent man." The product of the absorbed dose (rad) and a quality factor (Q).

***Resource Conservation and Recovery Act* of 1976 (RCRA):** A program of Federal laws and regulations that govern the management of hazardous wastes, and applicable to all entities that manage hazardous wastes.

Respirable Fraction (RF): The fraction of airborne radionuclides as particles that can be transported through air and inhaled into the human respiratory system. This term is commonly assumed to include particles 10-µm (micron) Aerodynamic Equivalent Diameter and less.

Resuspension: The process by which material deposited on the ground is again made airborne, such as by wind or vehicle disturbance.

Resuspended inhalation: Exposure route in which radioactive materials enter the body through inhalation of air contaminated with radioactive particulates that were previously deposited on the ground following an accidental release.

Retention tanks: Tanks in which liquid wastes and other effluents are held pending determination of what, if any, treatment they require before disposal.

Richter magnitude: The Richter scale magnitudes are based on a logarithmic scale (base 10), which means that for each whole number increase on the Richter scale, the amplitude of the ground motion recorded by a seismograph goes up 10 times. Using this scale, a magnitude 5 earthquake would result in 10 times the level of ground shaking as a magnitude 4 earthquake.

Riparian: Located along the banks of streams, rivers, lakes, and other bodies of water.

Risk: The probability of a detrimental effect from exposure to a hazard. Risk is often expressed quantitatively as the probability of an adverse event occurring multiplied by the consequence of that event (i.e., the product of these two factors). However, separate presentation of probability and consequence is often more informative.

Risk assessment: The use of established methods to measure the risks posed by an activity or exposure by evaluating the relationship between exposure to radioactive substances and the subsequent occurrence of health effects and the likelihood for that exposure to occur.

Risk estimator: A number used to convert the measured or calculated effective dose equivalent to estimates of latent fatal cancers that can be attributed to the exposure.

Risk factor: Numerical estimate of the severity of harm associated with exposure to a particular risk agent.

Risk Group (RG): NIH classification of agents known to infect humans as selected animal agents that may pose theoretical risks if inoculated into humans. There are four groups for the classification of biohazardous agents, RG1, RG2, RG3, and RG4, as described below.

Basis for the Classification of Biohazardous Agents	
RG1	Agents are not associated with disease in healthy adult humans
RG2	Agents are associated with human disease which is rarely serious and for which prevent therapeutic interventions are *often* available
RG3	Agents are associated with serious or lethal human disease for which preventative or therapeutic interventions *may* be available.
RG4	Agents are likely to cause serious or lethal human disease for which preventive or therapeutic interventions are *not usually* available.

Rock shelter: An opening in exposed rock of sufficient size to allow people to be sheltered from the weather. Used by both historic and prehistoric people, rock shelters contain midden deposits, grinding holes, evidence of fires, artifacts, and sometimes artwork carved or inscribed onto the walls of the shelters.

Roentgen: A unit of exposure to ionizing x-rays or gamma radiation equal to or producing 1 electrostatic unit per cubic centimeter of air. It is approximately equal to 1 rad.

***Safe Drinking Water Act*, as amended:** This Act protects the quality of public water supplies, water supply and distribution systems, and all sources of drinking water.

San Francisco Bay Regional Water Quality Control Board (SFBRWCB): The local agency responsible for regulating stationary air emission sources (including the Livermore Site) in the San Francisco Bay Area.

San Joaquin Valley Air Pollution Control District (SJVAPCD): The local agency responsible for regulating stationary air emission sources (including Site 300) in the San Joaquin Valley.

Sanitary waste: Most simply, waste generated by routine operations that is not regulated as hazardous or radioactive by state or Federal agencies.

Saturated zone: A subsurface zone below which all rock pore-space is filled with water; also called the phreatic zone.

Scenario: A particular chain of hypothetical circumstances that could, in principle, release radioactivity or hazardous chemicals from storage and handling site, or during a transportation accident.

Scenic corridor: A long, axial vista formed by regularly placed buildings or landscaping.

Scoping: An early and open process, including public notice and involvement, for determining the scope of issues to be addressed in an environmental impact statement and for identifying the significant issues related to a Proposed Action. The scoping period begins after publication in the Federal Register of a Notice of Intent to prepare an environmental impact statement. The public scoping process is that portion of the process where the public is invited to participate. The U.S. Department of Energy's scoping procedures are found in 10 CFR 1021.311.

Sealed source: A manufactured source of radioactive material that is contained in such a way that the material is not easily dispersed or altered chemically under normal use. Sealed sources are generally used to provide a known intensity of a specific type of radiation (e.g., a small gamma-ray source used to calibrate radiation survey instruments).

Section 106 process: A process under the *National Historic Preservation Act* for identifying, evaluating, and nominating historic properties for inclusion in the National Register.

Security: An integrated system of activities, systems, programs, facilities, and policies for the protection of Restricted Data and other classified information or matter, nuclear materials, nuclear weapons and nuclear weapons components, and/or U.S. Department of Energy or contractor facilities, property, and equipment.

Sedimentary rock: A rock resulting from the consolidation of loose sediment that has accumulated in layers.

Seeps: A spot where water or petroleum oozes from the Earth, often forming the source of a small trickling stream.

Sedimentary rock: A rock resulting from the consolidation of loose sediment that has accumulated in layers, consisting of mechanically formed fragments of older rock transported from its source and deposited in water or from air or ice.

Seismic zone: An area defined by the Uniform Building Code (1991), designating the amount of damage to be expected as the result of earthquakes. The United States is divided into six zones: (1) Zone 0 - no damage; (2) Zone 1 - minor damage; corresponds to intensities V and VI of the modified Mercalli intensity scale; (3) Zone 2A - moderate damage; corresponds to intensity VII of the modified Mercalli intensity scale (eastern United States); (4) Zone 2B - slightly more damage than 2A (western United States); (5) Zone 3 - major damage; corresponds to intensity VII and higher of the modified Mercalli intensity scale; (6) Zone 4 - areas within Zone 3 determined by proximity to certain major fault systems.

Seismicity: The tendency for the occurrence of earthquakes.

Select Agents: A select agent is defined as an agent, virus, bacteria, fungi, rickettsiae, or toxin listed in Appendix A of *Federal Register* 29327 (42 CFR Part 72) titled, *Additional Requirements for Facilities Transferring or Receiving Select Agents*. Select Agents also includes (a) genetically modified micro-organisms or (b) genetic elements that contain nucleic acid sequences associated with pathogenicity from organisms listed in Appendix A, (c) genetically modified micro-organisms listed in Appendix A, and (d) genetically modified micro-organisms or genetic elements that contain nucleic acid sequences coding for any of the toxins in Appendix A, or their toxic subunits.

Sensitivity: The capability of methodology or instrumentation to discriminate between samples having differing concentrations or containing varying amounts of analyte.

Severity: Function of the magnitudes of the mechanical forces (impact) and thermal forces (fire) to which a package may be subjected during an accident; any sequence of events that results in an accident in which a transport package is subjected to forces within a certain range of values is assigned to the accident severity category associated with that range.

Sewerage: The system of sewers.

Shear: Force or motion tangential to the section on which it acts.

Shielding: Any material or obstruction (bulkheads, walls, or other constructions) that absorbs radiation in order to protect personnel or equipment.

Site: In this SW/SPEIS, the term "site" refers to a DOE-controlled Federal site, such as Lawrence Livermore National Laboratory.

Site-Wide Maximally Exposed Individual (site-wide MEI): A hypothetical person who receives, at the location of a given publicly accessible facility (such as a church, school, business, or residence), the greatest LLNL-induced effective dose equivalent (summed over all pathways) from all sources of radionuclide releases to air at a site. Doses at this receptor location caused by each emission source are summed, and yield a larger value than for the location of any other similar public facility. This individual is assumed to continuously reside at this location 24 hours per day, 365 days per year.

Slip: To move or displace; a movement dislocation adjacent blocks of crust separated by a fault.

Sludge: Precipitated solid matter produced by water and sewage treatment processes. In the context of this EIS/EIR, also the moist precipitate resulting from the dewatering of hazardous waste.

Socioeconomics (analyses): Analyses of those parts of the human environment in a particular location that are related to existing and potential future economic and social conditions. The welfare of human beings as related to the production, distribution, and consumption of goods and services.

Solid waste: Any nonhazardous garbage, refuse, or sludge that is primarily solid; but may also include, semisolid, or contained gaseous material resulting from residential, industrial, commercial, agricultural, or mining operations, and community activities.

Solid Waste Management Unit (SWMU): Any discernible unit at which solid wastes have been placed at any time regardless of whether the unit was intended for solid or hazardous waste management.

Sound level: The quantity in decibels measured by a sound level meter satisfying requirements of the American National Standard Specifications for Sound Level Meters SI.4-1971. Sound level is the frequency-weighted sound pressure level obtained with the standardized dynamic characteristic "fast" or "slow" and weighting A or C.

Sound pressure level (SPL): The level of the A-weighted sound pressure referenced to 20 level micropascal (for air).

Source: Any physical entity that may cause radiation or chemical exposure, for example by emitting ionizing radiation or releasing radioactive or hazardous material.

Source term: In a calculation of contaminant dispersion, the amount of that contaminant assumed available to be dispersed. Source term is calculated as the product of material-at-risk (MAR), damage ratio (DR), respirable fraction (RF), airborne release fraction (ARF), and leak path factor (LPF).

Special nuclear material (SNM): Plutonium, uranium enriched in the isotope uranium-233 or in the isotope uranium-235, and any other material that, pursuant to the provisions of section 51 of the *Atomic Energy Act* of 1954, as amended, has been determined to be special nuclear material, but does not include source material, or any other material enriched by any of the foregoing.

Species of concern: Plants and animals whose conservation status may be of concern to the United States Fish and Wildlife Service, but do not have official or legal protection status.

Specific activity: The amount of radioactivity per unit volume or mass.

Specific conductance: Measure of the ability of a material to conduct electricity; also called conductivity.

Stability class: *See* "Pasquill stability categories."

Standard deviation: A measure of dispersion used in statistical theory for the average variation of a random quantity. The root-mean-square deviation from an average value.

State Historic Preservation Office: State office charged with the identification and protection of prehistoric and historic resources in accordance with the National Historic Preservation Act.

Stockpile management: The specific tasks and functions including production, routine surveillance and servicing, assembly and dismantlement, and disposal of weapons-related parts and materials.

Stockpile stewardship: The science and technology aspects of ensuring the safety, security, and reliability of the stockpile, including research and development to provide technologies required for stockpile management.

Stockpile Stewardship and Management Program: A single, highly integrated technical program for maintaining the safety and reliability of the United States nuclear stockpile in an era without nuclear testing and without new weapons development and production.

Stockpile surveillance: Routine and periodic examination, evaluation and testing of stockpile weapons and weapon components to ensure that they conform to performance specifications, and to identify and evaluate the effect of unexpected or age-related changes.

Stormwater Pollution Prevention Plan: A plan required by an NPDES permit for controlling stormwater pollution resulting from construction or industrial activities.

Strata: Plural of stratum, which is a single sedimentary, bed or layer.

Strike (of a stratum or fault): The direction of the line of intersection of a horizontal plan with an uptilted geologic stratum or fault plane.

Strike-slip fault: A fault in which the net slip is horizontal, parallel to the strike of the fault.

Subcritical experiment: A dynamic scientific experiment involving special nuclear material in which none of the materials reaches criticality or involves self-sustaining chain reaction.

Sulfur oxides (SO_x): A general term used to describe the oxides of sulfur; pungent, colorless gases formed primarily by the combustion of fossil fuels. Sulfur oxides, which are considered major air pollutants, may damage the respiratory tract as well as vegetation.

Superfund: The common name used for the *Comprehensive Environmental Response, Compensation and Liability Act of* 1980 (CERCLA). California has also established a “State Superfund” under provisions of the *California Hazardous Waste Control Act*.

***Superfund Amendments and Reauthorization Act* (SARA):** Act enacted in 1986, which amended and reauthorized CERCLA for five years at a total funding level of $8.5 billion. SARA more stringently defines hazardous waste cleanup standards and emphasizes remedies that permanently and significantly reduce the mobility, toxicity, or volume of wastes. Title III of SARA, the *Emergency Planning and Community Right-to-Know Act*, mandates establishment of community emergency planning programs, emergency notification, reporting of chemicals, and emission inventories.

Supplemental environmental impact statement: A document prepared as a supplement to an environmental impact statement, required when a change in a Proposed Action is substantial and relevant to environmental concerns or when new circumstances or information relevant to environmental concerns are significant.

Surface faulting: As opposed to a thrust fault, a fault that does intersect the surface of the Earth; the displacement of ground along the surface trace of a fault.

Surface impoundment: A facility or part of a facility that is a natural topographic depression, man-made excavation, or diked area formed primarily of earthen materials, although it may be lined with man-made materials. The impoundment is designed to hold an accumulation of liquid wastes, or wastes containing free liquids, and is not an injection well. Examples of surface impoundments are holding, storage, settling and aeration pits, ponds, and lagoons.

Surrogate material: A material, such as tungsten, used to simulate the characteristics of actual weapons materials so tests can be conducted more cost-effectively.

Système International d'Unités (SI): An international system of physical units which include meter (length), kilogram (mass), kelvin (temperature), becquerel (radioactivity), gray (radioactive dose), and sievert (dose equivalent).

Targets: Refers to a microstructure containing a tiny fuel capsule at which the lasers are directed.

Tectonic: Pertaining to the processes causing, and the rock structures resulting from, deformation of the Earth's crusts.

Temporary Emergency Exposure Limits: The Temporary Emergency Exposure Limits were developed by the DOE Subcommittee on Consequences Assessment and Protective Actions (SCAPA) for chemicals where ERPG values are not available and serve as a temporary guidance until ERPGs can be developed.

Terawatt (TW): The equivalent of one trillion watts (1012).

Terraces: Relatively horizontal or gently inclined surfaces or deposit sometimes long and narrow, which are bounded by a steeper ascending slope on one side and by a steeper descending slope on the opposite side.

Terrestrial: Pertaining to plants or animals living on land rather than in water.

Tertiary: The period of geologic time between the Cretaceous and the Pleistocene, comprising the Pliocene, Miocene, Oligocene, Eocene, and Paleocene, from about the 65 million to 1.6 million years ago.

Test readiness: Maintaining the essential technologies, staff; skills and infrastructure to resume nuclear testing, if mandated by the president.

Thermoluminescent dosimeter (TLD): A device used to measure external beta or gamma radiation levels, and which contains a material that, after exposure to beta or gamma radiation, emits light when processed and heated.

Thermonuclear: The process by which very high temperatures are used to bring about the fusion of light nuclei, such as deuterium and tritium, with an accompanying release of energy.

Threatened species: A species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range that is legally protected.

Threshold limit Values/Time-Weighted Average (TLV®/TWA): Guidelines or recommendations that refer to airborne concentrations of potentially hazardous substances. A time-weighted average TLV® is an average for a normal 8-hour workday or 40-hour workweek, to which it is believed all workers may be repeatedly exposed, day after day, without adverse effect.

Thrust fault: A fault dipping less than 45 degrees, in which the block above appears to have moved upward relative to the block below.

Time-weighted average (TWA): Time-weighted average representing 8 or 10 hours of work per day during a 40-hour work week.

Total dissolved solids (TDS): The portion of solid material in a waste stream that is dissolved and passed through a filter.

Total suspended solids (TSS): The total mass of particulate matter per unit volume suspended in water and wastewater discharged that is large enough to be collected by a 0.45-micron filter.

Toxicity assessment: Identification of the types of adverse health effects associated with exposures and the relationship between the magnitude of the exposure and of the adverse effects.

***Toxic Substances Control Act* of 1976 (TSCA):** Act authorizing the Environmental Protection Agency to secure information on all new and existing chemical substances and to control any of these substances determined to cause an unreasonable risk to public health or the environment. This law requires that the health and environmental effects of all new chemicals be reviewed by the Environmental Protection Agency before they are manufactured for commercial purposes.

Trace: A line on one plane representing the intersection of another plane with the first one (e.g., a fault trace).

Transect: A sample area (as of vegetation), usually in the form of a long continuous strip.

Transportainer: A portable container usually constructed of metal that is typically used as temporary storage space.

Transuranic waste (TRU): Material contaminated with alpha-emitting transuranium nuclides, which have an atomic number greater than that of uranium (i.e., 92); including neptunium, plutonium, americium, and curium; with half-lives longer than 20 years, except for: (1) high-level radioactive waste; (2) waste that the Secretary of Energy has determined, with the concurrence of the Administrator of the Environmental Protection Agency, does not need the degree of isolation required by the 40 CFR Part 191 disposal regulations; or (3) waste that the Nuclear Regulatory Commission has approved for disposal on a case-by-case basis in accordance with 10 CFR Part 61, and are present in concentrations greater than 100 nCi/g of waste.

Trend (of a fault): If the fault intersects the surface, the general direction of that intersection.

Tritiated water: Water in which one of the hydrogen atoms has been replaced by a tritium atom; sometimes shown as HTO.

Tritium: The radioactive isotope of hydrogen, containing one proton and two neutrons in its nucleus, which decays at a half-life of 12.3 years by emitting a low-energy beta particle. Common symbols for this isotope are H-3 and T.

Transuranic Package Transporter-II (TRUPACT-II): The package designed to transport contact-handled transuranic waste to the WIPP site.

Tuff: A rock formed of compacted volcanic fragments, generally smaller than 4 mm in diameter.

Type A packaging: "A packaging designed to retain the integrity of containment and shielding…under normal conditions of transport as demonstrated by" a water spray test, a free-drop test, a compression test, and a penetration test (49 CFR §§173.403, 173.465).

Type B packaging: A DOE, DOT, and NRC certified container that must be used for the transport of transuranic waste containing more than 20 curies of plutonium per package. Type B packaging must be able to withstand both normal and accident conditions without releasing its radioactive contents. These containers are tested under severe, hypothetical-accident conditions that demonstrates resistance to impact, puncture, fire, and submersion in water (49 CFR Part 173).

Unsaturated zone: That portion of the subsurface in which the pores are only partially filled with water and the direction of water flow is vertical; is also referred to as the vadose zone.

Uranium: *See* "natural uranium." A naturally occurring, heavy metallic element. Designated atomic number 92, uranium has many radioactive isotopes. Enriched uranium is most commonly used as a fuel for nuclear fission, while uranium-238 is the most abundant isotope in nature.

United States Department of Energy (DOE): The Federal agency responsible for conducting energy research and regulating nuclear materials used for weapons production.

United States Environmental Protection Agency (EPA): The Federal agency responsible for enforcing Federal environmental laws. Although some of this responsibility may be delegated to state and local regulatory agencies, EPA retains oversight authority to ensure protection of human health and the environment.

Vacuum-induced stripping or venting: A groundwater treatment system in which a vacuum in the subsurface soil draws off volatile organic contaminants for treatment and/or disposal.

Vadose zone: The partially saturated or unsaturated region above the water table that does not yield water to wells.

Valley fever (coccidioidomycosis): A fungal disease of the lungs endemic to the southwest United States characterized in severe cases by high fever and extreme fatigue.

Vernal pool: A wetland created from standing water, typically in the spring, hence its name.

Viewpoint: A location from which a site is visible.

Viewshed: The geographic area from which a site is visible; a collection of viewpoints.

Visual Resource Management: A process devised by the Bureau of Land Management to assess the aesthetic quality of a landscape, and consistent with the results of that analysis, to design proposed activities so as to minimize their visual impact on that landscape. The process consists of a rating of visual quality followed by a measurement of the degree of contrast between proposed development activities and the existing landscape. Four classifications are employed to describe different degrees of modification to landscape elements: Class I, areas where the natural landscape is preserved, including national wilderness areas and the wild sections of national wild and scenic rivers; Class II, areas with very limited land development activity, resulting in visual contrasts that are seen but do not attract attention; Class III, areas in which development may attract attention, but the natural landscape still dominates; and Class IV, areas in which development activities may dominate the view and may be the major focus in the landscape.

Volatile organic compound (VOC): Liquid or solid organic compounds that have a high vapor pressure at normal pressures and temperatures and thus tend to spontaneously pass into the vapor state.

Volcanic rock: A generally finely crystalline or glassy igneous rock resulting from volcanic action at or near the Earth's surface either ejected explosively or extruded as lava (e.g., basalt). The term also included near-surface intrusions that form a part of the volcanic structure.

W80-4 LEP: An LEP for the W80 warhead aboard a cruise missile, delivered by the Air Force B-52 bomber and future launch platforms.

W87-1: An intercontinental ballistic missile warhead designed to replace the W78 and support the Air Force's Ground-Based Strategic Deterrent missile system planned to replace the Minuteman III.

Waste accumulation area (WAA): An officially designated area that meets current environmental standards and guidelines for temporary (less than 90 days) storage of hazardous waste before pickup by the Hazardous Waste Management Division for offsite disposal.

Waste Generator: Any individual or group of individuals that generate radioactive, mixed, or hazardous wastes at LLNL or SNL/CA. Waste generator responsibilities are discussed in Section B.3.1.1.

Waste Isolation Pilot Plant (WIPP): A facility in southeastern New Mexico which was developed as the disposal site for transuranic and transuranic mixed waste. Operations began on March 26, 1999.

Waste management: The planning, coordination, and direction of those functions related to generation, handling, treatment, storage, transport, and disposal of waste, as well as associated surveillance and maintenance activities.

Waste management facilities: One or more of the waste management units for Livermore Site, Site 300, and SNL/CA, respectively.

Waste minimization: Actions that economically avoid or reduce the generation of waste by source reduction, reducing the toxicity of hazardous waste, improving energy usage, or recycling. These actions will be consistent with the general goal of minimizing current and future threats to human health, safety, and the environment.

Wastewater treatment plant: A collection of treatment processes and facilities designed and built to reduce the amount of suspended solids, bacteria, oxygen-demanding materials, and chemical constituents in wastewater.

Water table: The water-level surface below the ground at which the unsaturated zone ends and the saturated zone begins, and the level to which a well that is screened in the unconfined aquifer would fill with water.

Weapons effects: Deals with outputs of nuclear weapons and the associated effects on materials, components, systems, and the environment.

Weapons of mass destruction: Umbrella term that includes nuclear, chemical, and biological weapons.

Weapons-grade: Any fissionable material in which the abundance of fissile isotopes is high enough that the material is suitable for use in thermonuclear weapons.

Wetland: An area that has water at or near the surface of the ground during the growing season (wetland hydrology). It supports or is capable of supporting plants that are adapted to wet habitats (hydrophytic vegetation) and has soils that have developed under wet conditions (hydric soils).

Wetland hydrology: Permanent or periodic inundation for at least 7 days during the growing season.

Whole-body radiation: Radiation to the whole body, as opposed to individual organs or parts of the body.

Wind rose: A diagram that shows the frequency and intensity of wind from different directions at a specific location.

X-rays: Penetrating electromagnetic radiations with wavelengths shorter than those of visible light, usually produced by irradiating a metallic target with large numbers of high-energy electrons. In nuclear reactions, it is customary to refer to photons originating outside the nucleus as x-rays and those originating in the nucleus as gamma rays, even though they are the same.

Yield: The energy released from a thermonuclear reaction.

Yield experiments: A measure of fusion energy/neutron production in experiments that use a mixture of deuterium and tritium isotopes as fuel.

Zinc (Zn): A bluish white crystalline metallic element of atomic number 30. Zinc has low to intermediate hardness and is ductile when pure but in the commercial form is brittle at ordinary temperatures and becomes ductile on slight heating. It occurs abundantly in minerals, is an essential micronutrient for both plants and animals, and is used especially as a protective coating for iron and steel.

Zone 7: The common name for the Alameda County Flood Control and Water Conservation District.

Zoning: The division of city or county by legislative regulations into areas, or zones, that specify allowable uses for real property and size restrictions for buildings within these areas; a program that implements the policies of the General Plan.

Zoning District: A designated section of a city or county wherein prescribed land use requirements and building and development standards are uniform.

CHAPTER 10

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10.0 LIST OF PREPARERS

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Milton Gorden	B.S., Nuclear Engineering Over 29 years of experience	Radiological Transportation
Stephen Marschke	B.S., Nuclear Engineering Over 46 years of experience	Accidents
Gil Waldman	M.S., Engineering Management B.S., Nuclear Engineering Over 29 years of experience	Radiological Transportation

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Name	Education/Expertise	Responsibility
Diana Hirrlinger	M.B.A. Organizational Behavior and Marketing B.S., Conservation of Natural Resources Over 35 years of experience	Cumulative Impacts
Mary Alice Spivey	B.S., Environmental Science Over 35 years of experience	Cumulative Impacts