3. Environmental Program Information

Heather Ottaway

Lawrence Livermore National Laboratory (LLNL) is committed to enhancing its environmental stewardship and reducing any impacts its operations may have on the environment. This chapter describes LLNL's Environmental Management System (EMS) and Pollution Prevention/Sustainability Program (P2S).

3.1 Environmental Management System

LLNL continues to enhance its EMS through systematic process improvements and increased focus on establishing specific environmental objectives and performance measures contained in Environment, Safety & Health (ES&H) Action Plans. Progress toward goals is regularly measured and provided to senior management and other interested parties through a variety of means, including periodic senior management reports and the yearly update of this report. The Laboratory's EMS has successfully maintained its International Organization for Standardization (ISO) 14001 registration since 2009 and is audited annually by a third-party internationally recognized ISO registrar for continued conformance and certification. In Fiscal Year (FY) 2021, the Laboratory was successfully recertified for another three years to the ISO 14001:2018 standard.

3.1.1 ES&H Action Plans

ES&H Action Plans are established each year to detail the objectives and track progress toward meeting environmental goals focused on addressing identified risks and opportunities associated with significant environmental aspects. Each institutional ES&H Action Plan is championed by a senior manager who is responsible for developing objectives, assigning a process owner to successfully lead the project to meet objectives, providing adequate resources such as team members and data, holding the team accountable to goals and objectives, and presenting interim reviews to the senior management team. All ES&H Action Plans are reviewed and approved by the Laboratory Deputy Director. Organizations also have the option to implement action plans targeted to their specific risks and opportunities. Senior managers championed ten ES&H Action Plans during FY2022. **Table 3-1** lists the two ES&H Action Plans that address environmental aspects along with progress made in FY2022 toward meeting the objectives (three other ES&H Action Plans address health & safety issues). The environmental Action Plans in place also help to ensure that related U.S. Department of Energy (DOE) sustainability goals are addressed. LLNL's status toward meeting the DOE sustainability goals, along with planned actions (including ES&H Action Plans) to ensure continued progress toward attaining these goals, can be found in the *LLNL FY2023 Site Sustainability Plan* in **Appendix C.**

Table 3-1. ES&H Action Plan Summary

Action Plan	Related DOE SSP Goal Category	Objectives	FY2022 Progress
AP-10 Hazardous Waste Compliance	Waste Management	Perform post-CUPA (Certified Unified Program Agency) walkthrough six months after the CUPA inspection to ensure continued compliance in waste generator areas.	Completed post-CUPA inspections to establish a baseline for continued improvement in hazardous waste generator compliance.
AP-11 Greenhouse Gas Compliance Emissions Reduction	Greenhouse gas emissions, energy use, adaptation, and resilience	**Greenhouse Gas (GHG) Cap and Trade Compliance:** develop and implement a strategy to comply with California Cap-and-Trade and to minimize the costs of this market-based regulatory regime. **Gas Insulated Equipment (GIE) Sulfur Hexafluoride (SF6) Emissions Management:** develop and implement a GIE SF6 emissions management and reduction plan to reduce GIE SF6 use and minimize the institutional risk associated with GIE SF6 emissions. **Refrigerant Management Compliance:** develop and implement an improved Refrigerant Management Program allowing the Laboratory to comply with current and future federal and state regulations.	Determined baseline conditions and developed strategy to delay entry into California Cap-and-Trade and minimize costs of market-based regulatory regime. Implemented Gas-Insulated Equipment (GIE) SF6 Task Force to identify and propose efforts to reduce GIE SF6 use and minimize the institutional risk associated with GIE SF6 emissions. Developed and implemented improved Refrigerant Management Program, allowing the Laboratory to efficiently comply with current and future federal and state regulations.

3.1.2 EMS Audits and Reviews

The Laboratory successfully completed one external third-party independent surveillance audit of its ISO 14001 EMS program (May 2022) with recommendations from the auditor to continue LLNL's ISO 14001:2015 registration through 2024. This independent audit was conducted by NSF International Strategic Registrations and validated the Laboratory's solid commitment to environmental stewardship.

3.1.2.1 Internal Assessments and Reviews

In February – March 2022, an internal audit (Joint Functional Area Line Management Assessment [JFLMA]) was performed to assess if LLNL continued to meet the requirements of the standard. This audit used a management assessment model to ensure objectivity and impartiality were maintained during the process.

In accordance with LLNL's EMS, the Laboratory's environmental compliance is regularly evaluated through reviews of internal assessments including Management Self Assessments

(MSAs), Management Observations and Inspections (MOIs), regulatory inspections, internal and external monitoring and compliance reports, and facility walk-throughs and work-control assessments. As a result of these reviews, LLNL identified specific practices and recommendations for corrective and preventive measures, demonstrating the Laboratory's commitment to environmental compliance.

3.2 Pollution Prevention/Sustainability Program

LLNL's P2S Program operates within the framework of the Integrated Safety Management System (ISMS) and EMS and in accordance with applicable laws, regulations, and DOE orders as required by contract. It encompasses stewardship and maintenance, waste stream analysis, reporting waste generation and P2S accomplishments, and fostering P2S awareness through presentations, articles, and events. The P2S Program supports institutional and directorate P2S activities via environmental teams and includes implementation and facilitation of source reduction and/or reclamation, recycling, and reuse programs for hazardous and nonhazardous waste; facilitation of sustainable acquisition; contribution to the Site Sustainability Plan; and preparation of P2S opportunity assessments.

The P2S Program at LLNL strives to systematically reduce all types of waste generated and eliminate or minimize pollutant releases to all environmental media from all aspects of the operations at the Livermore Site and Site 300. These efforts help protect public health and the environment by reducing or eliminating waste, improving resource usage, and reducing inventories and releases of hazardous chemicals. These efforts also benefit LLNL by reducing compliance costs and minimizing the potential for civil and criminal liabilities under environmental laws. In accordance with United States Environmental Protection Agency (EPA) guidelines and DOE policy, the P2S Program uses a hierarchical approach to waste reduction (i.e., source elimination or reduction, material substitution, reuse and recycling, and, lastly, treatment and disposal) which is applied to all types of waste. Radioactive and hazardous waste generation is tracked using Radioactive and Hazardous Waste Management's (RHWM's) HazTrack database (a system used to track all waste managed by RHWM). By reviewing the information in this database, program managers and P2S Program staff can monitor and analyze waste streams managed by RHWM to determine cost-effective improvements to LLNL operations. The P2S Program primarily focuses on opportunities to reduce routine waste from ongoing operations and non-routine waste from construction and demolition activities. Data on non-routine hazardous, transuranic, and radioactive waste can be found in the *2022 Annual Yearbook for the LLNL SW/SPEIS* (Bibby, Price 2023).

3.2.1 Routine Hazardous, Transuranic, and Radioactive Waste

Routine waste listed in **Tables 3-2** and **3-3** includes waste from ongoing operations produced by any type of production, analysis, and research and development taking place at LLNL.

Table 3-2. Routine Hazardous Waste at LLNL, FY2018–2022 (Metric Tons [MT])

Waste Category	FY2018	FY2019	FY2020	FY2021	FY2022
Routine hazardous waste generated	167	155	111	253	118

Table 3-3. Routine Transuranic and Radioactive Waste at LLNL, FY2018–2022 (m^3)

Waste Category	FY2018	FY2019	FY2020	FY2021	FY2022[(a)]
Routine LLW generated	526	369	297	736	106
Routine mixed LLW generated	38	40	28	67	7.8
Routine TRU/mixed TRU waste generated	17	22	5	1	1

Note: See the **Acronyms and Glossary** section for acronym definitions

(a) Values for FY2022 are estimated from data originally recorded in pounds.

3.2.2 Diverted Waste

LLNL maintains an active waste-diversion program, encouraging recycling and reuse of both routine and non-routine waste, which prevents waste from going to the landfill. Site sustainability goals require separate accounting for construction/demolition and municipal solid wastes as reflected in **Tables 3-4** and **3-5.**

3.2.2.1 Municipal Solid Waste

Together, the Livermore Site and Site 300 generated 3,184 MT of routine nonhazardous solid waste in FY2022. This volume includes diverted waste (e.g., material diverted through recycling and reuse programs) and landfill waste.

Combined, both sites diverted a total 2,312 MT of routine nonhazardous waste in FY2022, which represents a diversion rate of 73%. The portion of routine nonhazardous waste sent to landfill was 871 MT, see **Table 3-4.** In 2022, LLNL recycled over 4,000 computers, monitors, and laptops, which were resold or managed as universal waste. LLNL recycled 24 MT of large and small batteries, which were also managed as universal waste. Cell phones and tablets that are no longer needed by LLNL are sold to a vendor who refurbishes the items for reuse.

The comingled recycling and composting program initiated in May 2011 continued during 2022, diverting an estimated 125 MT of comingled recycling and 130 MT of compostable material from the landfill. Recycling opportunities for plastics continues to be limited, but LLNL searches for alternatives to disposable plastic items and works with vendors to take back plastic items such as containers and drums that can be reused or recycled.

Table 3-4. Routine Municipal Waste in FY2022, Livermore Site and Site 300 Combined

Destination	Waste Description	Amount in FY2022 (MT)
Diverted	Baled paper	69
	Corrugated cardboard	77
	Cooking grease (including grease traps)	8.4
	Mixed metals	1355.5
	Scrap lead (Pb)	2.3
	Plastic	0
	Office paper	22
	Toner cartridges	5.7
	Greenwaste (chips, compost, mulch, clean wood)	516.5
	Comingled recycling	125.5
	Compost (food scraps, paper towels, food containers)	130
	TOTAL diverted	**2,311.9**
Landfill	Compacted (landfill)	871
	TOTAL landfill	**871**
	TOTAL routine nonhazardous waste	**3,183**

3.2.2.2 Construction and Demolition (C&D) Waste

C&D wastes include excavated soils, wastes, and metals from construction, decontamination, and demolition activities. The Livermore Site and Site 300 generated a total of 1,405 MT of waste related to construction and demolition activities in FY2022. The two sites combined diverted 1,020 MT of non-routine nonhazardous solid waste through reuse or recycling, which represents a diversion rate of 73% in FY2022. LLNS continues to make improvements to better streamline reporting of C&D recycling efforts between LLNS' sustainability team, construction team, and construction subcontractors. Diverted C&D waste includes soil and concrete reused either on-site for other projects or as cover at Class II landfills. See **Table 3-5.**

Table 3-5. Construction and Demolition Waste in FY2022, Livermore Site and Site 300 Combined

Destination	Waste Description	Amount in FY2022 (MT)
Diverted	Class II cover soil (reused on-site or as landfill cover)	469
	Class II concrete (reused at the landfill for roads, pads, etc. or as cover)	466.5
	Scrap metals (recycled)	84.5
	TOTAL diverted	**1,020**
Landfill	Construction and demolition (non-compacted landfill)	385
	TOTAL landfill	**385**
	TOTAL non-routine non-hazardous waste	**1,405**

3.2.3 Sustainable Acquisition

LLNL has a comprehensive Sustainable Acquisition program that includes preferential purchasing of recycled content and bio-based products. In 2022, the Sustainable Acquisition program continued to include a preference for Electronic Product Environmental Assessment Tool (EPEAT) registered computers and monitors, imaging equipment, and televisions. Over 95% of all desktop electronics, imaging equipment, television, server, and cell phone purchases in FY2022 were EPEAT Bronze, EPEAT Silver, or EPEAT Gold, indicating that the products meet or exceed the Institute of Electrical and Electronics Engineers (IEEE) environmental performance standards for electronic products (1680.1-2018; 1680.2-2012; 1680.3-2012).

Additional sustainable acquisition highlights can be found in the *LLNL FY2023 Site Sustainability Plan* in **Appendix C.**

3.2.4 Pollution Prevention/Sustainability Activities

3.2.4.1 Sustainability Accomplishments

LLNL's P2S Program assists the site in meeting Site Sustainability Plan goals related to municipal waste reduction, acquisition, and electronic stewardship by conducting and responding to opportunity assessments; these include direct calls from program areas as well as Green Hotline inquiries. During FY2022 the P2S Program assisted with several sustainability projects that include participating in workgroups to determine a recycling pathway for excess refrigerants, refining construction and demolition waste tracking, installing additional electric vehicle charging infrastructure, and expanding the recycling and composting program to additional buildings.

3.2.4.2 High-Performance Sustainable Buildings and Energy Conservation

One new facility, the Emergency Operations Center, was completed in FY2022 and met LEED Gold certification. This provides an additional 20,550 square feet to the assessed and/or certified total.

A new office building design standard – Standardized Acquisition and Recapitalization (STAR) – was developed by the National Nuclear Security Administration (NNSA) to reduce the complexities typically associated with building at a DOE site and to streamline the design and construction of a STAR office building. The STAR design standard incorporates the 2020 Guiding Principles for Sustainable Federal Buildings. Five STAR facilities are planned for completion in FY2023 and two facilities are planning to obtain LEED Silver certification.

Applying best practices continues to help reduce LLNL's energy intensity and greenhouse gas (GHG) emissions. These best practices include alerting facility managers of excessive use in their facilities, updating and adapting equipment operating schedules to meet the changing requirements of occupants, providing staff with the training and tools they need, and tracking energy use and comparing against expected performance. LLNL's Livermore Site and Site 300 each have a site-wide direct digital control (DDC) system that is used to control temperatures, pressures, and humidity in many buildings. The system is state-of-the-art and in 2022 had approximately 1,200 (compared to 941 in 2021) high-speed, connected digital processors in 63 buildings with several more installations planned.

LLNL has also implemented many on-going sustainability efforts to increase the energy efficiency of data center facilities that include installing Cold Aisle Containment (CAC) systems, increasing ambient temperature and reducing occupancy lighting in several key data center facilities, and implementing server consolidation and server virtualization (i.e., using software to divide one physical server into multiple isolated virtual environments). LLNL continues to identify and decommission data centers that are no longer needed. The $100 million Exascale Computing Facility Modernization (ECFM) project was completed in FY2022 providing additional power and cooling to operate two exascale supercomputers in Building 453 (B453). Although designed with energy saving controls and innovative cooling technology, ECFM will have a significant impact on the future energy and water use at the Livermore Site. In response, LLNL is exploring energy and water conservation opportunities, including the feasibility of wastewater reuse, alternative data center cooling technologies, and energy savings in other areas.

Additional information on energy conservation goals can be found in the *LLNL FY2023 Site Sustainability Plan* in **Appendix C.**

3.2.5 Resilient Operations

Although the P2S Program conducted awareness activities throughout the year, the COVID-19 pandemic caused many activities to be cancelled or converted to virtual platforms. P2S staff participated in several DOE-wide forums. Additionally, P2S staff presented to various groups at symposiums about LLNL's sustainable acquisition efforts, the EMS program, and action plans.

LLNL, Sandia National Laboratories (SNL/CA), and the Livermore Laboratory Employee Services Association (LLESA) (a non-profit employee services group that supports both sites) typically host a joint Bike to Work and Share Your Ride event each May. However, this event was not held in 2020 or 2021 due to COVID-19. In FY2022, LLESA transitioned from hosting an onsite Bike-to-Work Day energizer station to hosting a Biking Challenge during the same month.

The Biking Challenge promoted participation in the official Bike-to-Work Day event and encouraged visits to other Livermore energizer stations. This new format enables employees to participate in the Biking Challenge regardless of their work situation as many employees continue to incorporate telecommuting into their work schedules. LLESA will continue to promote participation in the official Bike-to-Work Day event.

The P2S Program continued to conduct training for staff on Sustainable Acquisition requirements and support the Green Hotline to help employees with questions, suggestions, or ideas regarding LLNL's pollution prevention and waste diversion endeavors, as well as other environmental issues.

New regulations (e.g., Executive Orders 14008, 14030, 14057) required LLNL to complete additional deliverables this fiscal year including a Vulnerability Assessment and Resiliency Plan (VARP) and a 5-year electric vehicle infrastructure plan.

LLNL completed a VARP in September 2022 to identify the most significant climate impacts to the Livermore Site and Site 300 and present resilient solutions to address these impacts. For both sites the climate impacts with the highest calculated risk include increased number of extreme heat days, extreme weather events (and riverine flooding at Site 300), drought (and reduced snowpack for the Livermore Site), actual loss from wildfires, and degraded air quality from wildfires. These hazards are anticipated to impact the on-site workforce, site buildings, specialized or mission-critical equipment, energy generations and distribution systems, IT and telecommunications, water and wastewater systems, transportation and fleet, and availability of critical materials. Additional information on identified resilience solutions can be found in the *LLNL FY2023 Site Sustainability Plan* in **Appendix C.**

A 5-year electric vehicle infrastructure plan was completed to evaluate various parking lots across the LLNL campus and provide solutions to consolidate and increase the overall number of electric vehicle (EV) charging stations. Expanded onsite charging infrastructure is needed to support the transition of fleet vehicles to zero-emission vehicles by 2035 as required by E.O. 14057.