# Executive Summary

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## Introduction

Lawrence Livermore National Laboratory (LLNL), a U.S. Department of Energy (DOE) facility operated by the University of California, serves as a national resource of scientific, technical, and engineering capabilities. The Laboratory's mission focuses on nuclear weapons and national security, and over the years has been broadened to include areas such as strategic defense, energy, the environment, biomedicine, technology transfer, the economy, and education. The Laboratory carries out this multifaceted mission in compliance with local, state, and federal environmental regulatory requirements. It does so with the support of the Environmental Protection Department, which is responsible for environmental monitoring and analysis, hazardous waste management, environmental restoration, and ensuring compliance with environmental laws and regulations.

LLNL comprises two sites: the Livermore site and Site 300. The Livermore site occupies an area of 3.28 square kilometers on the eastern edge of Livermore, California. Site 300, LLNL's Experimental Testing Site, is located 24 kilometers to the east in the Altamont Hills, and occupies an area of 30.3 square kilometers. Environmental monitoring activities are conducted at both sites as well as in surrounding areas.

This summary provides an overview of LLNL's environmental activities in 1995, including radiological and nonradiological surveillance, effluent and compliance monitoring, remediation, assessment of radiological releases and doses, and determination of the impact of LLNL operations on the environment and public health.

## Environmental Monitoring Results

During 1995, the Environmental Protection Department sampled air, sewage effluent, ground water, surface water, soil, vegetation and foodstuffs, and measured environmental radiation. Over 18,700 environmental samples were taken and analyses were conducted for more than 248,000 analytes. These numbers represent increases of 10% and 5%, respectively, over the previous year.

LLNL's sampling networks undergo constant evaluation; changes are made, as necessary, to ensure adequate, cost effective monitoring of all media potentially affected by LLNL operations. Once samples are collected, they are analyzed for radioactive and nonradioactive substances using standard methods such as analytical procedures approved by the U.S. Environmental Protection Agency

(EPA), special systems such as the continuous monitoring system for Livermore site sewage, or special analytical techniques designed to measure very low levels of radionuclides. Environmental radiation is also measured directly using dosimeters.

The amount of radioactivity released from LLNL during 1995 was slightly less than in 1994 and was below the range of earlier years. The most significant radiological effluent for the Livermore site continues to be tritium, the radioactive isotope of hydrogen. The source of nearly all tritium emissions is Building 331, the Tritium Facility. Reduced operations in the Tritium Facility have led to continually declining emissions in recent years. Tritium values measured in surface water, rain water, and runoff were low in 1995, comparable to levels the previous year and consistent with a generally decreasing historical trend. Measured values for tritium in air and vegetation in 1995 were slightly less than those in 1994. At Site 300, the dominant radioactive effluent is depleted uranium, which contains isotopes with atomic weights 238, 235, and 234 in the weight percentages 99.8, 0.2, and 0.0005, respectively. The primary sources of these emissions were experiments on the firing tables adjacent to Buildings 801 and 851, resulting in estimated releases of the three isotopes that were about 72% of those in 1994 but within the range of variation seen from year to year due to changes in the level of operations at the firing tables.

Air surveillance monitoring was performed for various airborne radionuclides (including particles and tritiated water vapor) and beryllium at locations on the Livermore site, Site 300, throughout the Livermore Valley, and in Tracy. Concentrations of all monitored radionuclides and beryllium at all of these locations were well below levels that would endanger the environment or public health, according to current regulatory standards. As examples: the concentration of plutonium on air filter samples collected in the Livermore Valley showed a median value of only 0.01% of the federal Derived Concentration Guide (DCG), and on the Livermore site the highest median value for plutonium was 0.02% of the DCG ; median concentrations of tritiated water vapor at Livermore Valley sampling locations showed a highest median value of 0.0006% of the DCG, while the highest median on the Livermore site was 0.05% of the DCG; the highest median concentration of beryllium on the Livermore site perimeter was 0.06% of the limit established by the Bay Area Air Quality Management District.

Discharges of radioactive and hazardous materials to the combined sanitary and industrial sewer at the Livermore site are controlled by limiting the use of those materials, implementing engineering controls, and routing discharged material to retention tanks for later characterization and treatment. Flow-proportional samples of discharged wastewater are regularly collected and analyzed to assure

that LLNL's sewage effluent meets the requirements of the permit granted by the City of Livermore. In addition, effluent is monitored continuously for pH, selected metals, and radioactivity. Should concentrations be detected above warning levels, LLNL's sewer diversion system is automatically activated. The diversion system captures all but the first few minutes of wastewater flow that causes an alarm, thereby protecting the Livermore Water Reclamation Plant (LWRP) and minimizing any required cleanup. In 1995, the Livermore site discharged approximately one million liters per day of wastewater to the City of Livermore sewer system, an amount that constitutes 4.9% of the total flow to the system. During the year, no releases exceeded discharge limits for the release of radioactive materials to the sanitary sewer system, and concentrations of metals in LLNL's sewer effluent were well below discharge limits. There was one discharge above alarm limits in 1995—an alkaline discharge of 3 minutes duration. About 400 liters of effluent was diverted and later returned to the sanitary sewer without incident.

A special study of plutonium in Big Trees Park in the City of Livermore began in 1994. During a 1993 EPA investigation of plutonium in soils in the southeast quadrant of the Livermore site, EPA personnel collected a soil sample at Big Trees Park about two kilometers to the west to serve as a background sample. This soil sample showed plutonium at a higher concentration than expected from global fallout for this region. The park was resampled by EPA, LLNL, and the California Department of Health Services (DHS) in 1995. The results confirmed the finding of plutonium, but all levels are below the EPA's preliminary remediation goal for residential exposure to plutonium. The EPA and DHS concur that there is no regulatory concern or significant impact on human health or the environment.

Water sampling and analysis are a large part of the LLNL surveillance and compliance monitoring effort for the Livermore site, Site 300, and their surrounding regions. The waters monitored include reservoirs and ponds, streams, rainfall, tap water, storm water runoff, drinking-water supply wells, and ground water monitoring wells. LLNL has two projects under the jurisdiction of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA): the Livermore Site Ground Water Project and the Site 300 Environmental Restoration Program.

Depending on location, the water samples may be analyzed for gross alpha and gross beta radiation, tritium, uranium, and nonradioactive pollutants, including solvents, metals, high explosives, and pesticides and other properties such as total suspended solids, conductivity, and pH. Median activities for gross alpha and gross beta radiation in surface water samples for the Livermore site and Livermore Valley in 1995 were less than 10% of the drinking water maximum contaminant level (MCL). Storm water gross alpha and gross beta were well

below MCLs, with the exception of samples collected December 11 at two influent sampling locations. The sources of these sampling locations are upstream and off the Livermore site; no link to airborne emissions from LLNL has been found. The origin of the elevated readings has not been determined; this investigation is continuing into 1996. Livermore site rainfall has exhibited elevated tritium activities in the past, but during 1995 as in 1994, measurements were far below the MCL established by the EPA for drinking water; the highest activity measured was 10% of the MCL. Tritium values for surface and drinking water samples were less than 0.3% of the drinking water standard.

At Site 300, LLNL routinely monitors 57 ground water wells and, in addition, conducts compliance monitoring associated with known areas of ground water contamination. Ground water samples are routinely measured for tritium, uranium, and other radioisotopes, gross radioactivity, toxic metals, a wide range of organic chemicals, and other general contaminant indicators. Special consideration is given to monitoring those dissolved elements and organic compounds that are known to be toxic in trace amounts.

Tritium activities in ground water samples from several downgradient wells in the Pit 1 and Pit 7 areas at Site 300 were above the MCL for drinking water in 1995 as noted in previous reports. In the high explosives process area, ground water samples exceeded California drinking water MCLs for arsenic, selenium, nitrate, and trichloroethene. No wells in these areas supply water for agriculture or for human or animal consumption. Off-site water supply wells showed some level of contaminants of concern, but far below drinking water MCLs. All tritium and other radioactivity measurements in off-site surveillance wells showed very low values, equivalent to background. Thus the impact of LLNL operations on ground water beyond Site 300 boundaries is minimal.

Area vegetation and foodstuffs are monitored for their tritium content. The tritium concentrations taken near the Livermore site were greater than those taken from more distant locations. The tritium concentrations were slightly less than those reported in 1994. As in the past, the tritium concentrations in Livermore Valley wines analyzed in 1995 are slightly above those for wines tested from Europe and other locations in California, but were the lowest since this monitoring program began. Even the highest detected value, 6.0 Bq/L (160 pCi/L), represents only 0.8% of the amount California allows in drinking water. This amount is slightly less than the highest value for 1994, 8.0 Bq/L (216 pCi/L).

## Radiological Impact Assessment

Radiological dose-assessment modeling, using EPA-mandated computer models, actual LLNL meteorology, population distributions appropriate to the two sites, and 1995 radionuclide inventory and monitoring data, was conducted this past year for each key facility and each new emission point at the Livermore site and Site 300.

The calculated total potential dose for a hypothetical person having the greatest possible exposure at the Livermore site in 1995 was 0.19 μSv (0.019 mrem) from point-source (stack) emissions, and 0.22 μSv (0.022 mrem) from diffuse-source (area) emissions. Summing these contributions yields a total dose of 0.41 μSv (0.041 mrem) for the Livermore site. This total potential dose for 1995 continues the gradual decline in levels seen over the last six years; it is only 17% of the 1990 level.

The calculated total potential dose to a hypothetical person having the greatest possible exposure at Site 300 during 1995 was 0.23 μSv (0.023 mrem). Explosive tests at the Building 801 and Building 851 firing tables accounted for all of the point source dose of 0.20 μSv (0.020 mrem), while a source representing resuspension of LLNL-contributed uranium in surface soils throughout the site was responsible for nearly all of the diffuse sources total of 0.03 μSv (0.003 mrem). This total dose is only about 28% of the previous year's value. Total annual dose levels from Site 300 operations fluctuate from year to year, primarily in response to the total quantity of depleted uranium used in explosives experiments at the Site 300 firing tables.

The doses to the maximally exposed public individual from Livermore site and Site 300 emissions amount to less than 0.5% of the EPA National Emission Standards for Hazardous Air Pollutants (NESHAPs) standard. These doses are a small fraction (about 1/8000) of the doses received by these populations from natural background radiation, not including medical and other anthropogenic sources. Thus, the potential radiological doses from LLNL operations in 1995 were well within regulatory standards and were very small compared to doses from natural background radiation sources.

## Environmental Compliance Activities

LLNL works to ensure that its operations have limited environmental impacts and comply with environmental laws and federal, state, and local regulatory guidelines. Many activities related to water, air, waste, waste reduction, community “right to know,” and other environmental issues were addressed in 1995.

Both the Livermore site and Site 300 are Superfund sites under CERCLA and are undergoing remedial activities. The primary treatment technology used at the Livermore site to remediate contaminated ground water is pump-and-treat

technology. In 1995, treatment facilities TFA, TFB, TFC, TFD, and TFF at the Livermore site processed hundreds of millions of liters of ground water, removing tens of kilograms of volatile organic compounds (VOCs) plus smaller quantities of dissolved fuel hydrocarbons (FHCs). These efforts at control and remediation have stopped the off-site westward migration of VOC plumes and reduced plume size. Significant progress also occurred at Site 300, where remedial activities are in an earlier stage. All requirements of the Federal Facility Agreements negotiated with DOE and EPA for both sites were met.

A risk-based bioremediation approach for remediating underground contamination from leaking fuel tanks was proposed in 1995 by an LLNL-led team of researchers from LLNL and four University of California campuses. The team found that naturally occurring microbes in the soil and ground water usually can break down most of the fuel hydrocarbons before they reach sources of drinking water. On the basis of this study, the California State Water Resources Control Board is revising its water cleanup policy for fuel leaks, ranking cleanup sites by risk to drinking water sources, selecting cleanup techniques based on risk, and halting pump-and-treat cleanup activities in low-risk cases. As a result, large dollar savings could accrue to the State and to tank owners, and thousands of acres of land could be returned to beneficial use sooner.

Efforts at solid-waste minimization at LLNL in 1995 resulted in reductions of 12.5% and 27.8%, respectively, in the amount of aggregate waste and hazardous waste generated, compared to 1994. The total quantity of potential waste that was diverted from landfills and recycled off site increased 32% over the previous year as a result of recycling programs focused on paper, batteries, ferrous material, tires, and other materials. The Laboratory also made strides in the areas of source reduction and pollution prevention. To cite two examples, in 1995 use of chlorofluorocarbons (CFCs) as degreasing agents, dielectric media, and refrigerants was significantly reduced, and operation of LLNL's Chemical Exchange Warehouse (CHEW), which receives, temporarily stores, tracks, and makes available for reuse excess usable chemicals, won a national award from DOE.

LLNL continues to perform all activities necessary to comply with clean air and clean water requirements. In 1995, the Bay Area Air Quality Management District (BAAQMD) issued or renewed 178 permits to operate for the Livermore site, and two boilers were replaced and two retrofitted to comply with new BAAQMD regulations (Regulation 9, Rule 7). The San Joaquin Valley Unified Air Pollution Control District issued or renewed 41 permits to operate for Site 300. LLNL has permits for underground and above ground storage tanks and for discharge of treated ground water, industrial and sanitary sewage, and storm water. Site 300 has additional permits for inactive landfills, cooling tower

discharges, operation of the sewer lagoon, septic tanks, and leach fields. The Laboratory complies with all requirements for self-monitoring and inspections associated with these permits.

Notification of environmental occurrences at the Laboratory is required under a number of environmental laws, regulations, and DOE orders. LLNL responded to 14 incidents that required federal and/or state agency notification during 1995. None of these caused adverse impact to human health or the environment.

LLNL has one federally listed endangered plant species, *Amsinckia grandiflora* (large-flowered fiddleneck), which is found at Site 300. In 1995, two natural populations and one experimental population of this plant all appeared to be robust. Regarding special-status wildlife species, LLNL's Miniature Optical Lair Explorer (MOLE, a miniature tracked vehicle with a tiny camera that allows subterranean tunnels and animal dens to be explored) was used successfully in 1995 to study burrowing owl and badger dens.

## Conclusion

LLNL is committed to protecting the environment and ensuring that its operations are conducted in accordance with applicable federal, state, and local laws and regulations.

The current techniques used at the Laboratory for environmental monitoring are very sensitive, allowing detection at extremely low levels of constituents. The combination of surveillance and effluent monitoring, source characterization, and computer modeling show that radiological doses to the public caused by LLNL operations are less than 0.5% of regulatory standards and are about 8000 times smaller than the doses received from background radiation. The analytical results and evaluations generally show a decrease in contaminant levels, reflecting both decreased operations and the commitment of the Laboratory to control pollutants.

In 1995, notable achievements were made in environmental compliance activities related to water, air, waste, and waste reduction. Ground water remediation activities have stopped the westward migration of plumes at the Livermore site; waste minimization efforts have significantly reduced the amount of waste generated in LLNL operations; recycling efforts have diminished the quantity of waste sent to landfills; efforts at waste reduction and pollution prevention have capitalized on a variety of opportunities to reduce or eliminate, recover, or recycle potential pollutants, with a prime example being the reduced use of CFCs and other hazardous organic solvents in Laboratory operations.

In summary, the results of the 1995 environmental programs demonstrate that the environmental impacts of LLNL operations remain minimal and pose no threat to the public or the environment.