Title
Lawrence Berkeley Laboratory 1994 Site Environmental Report

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Lawrence Berkeley Laboratory

1993 Site Environmental Report

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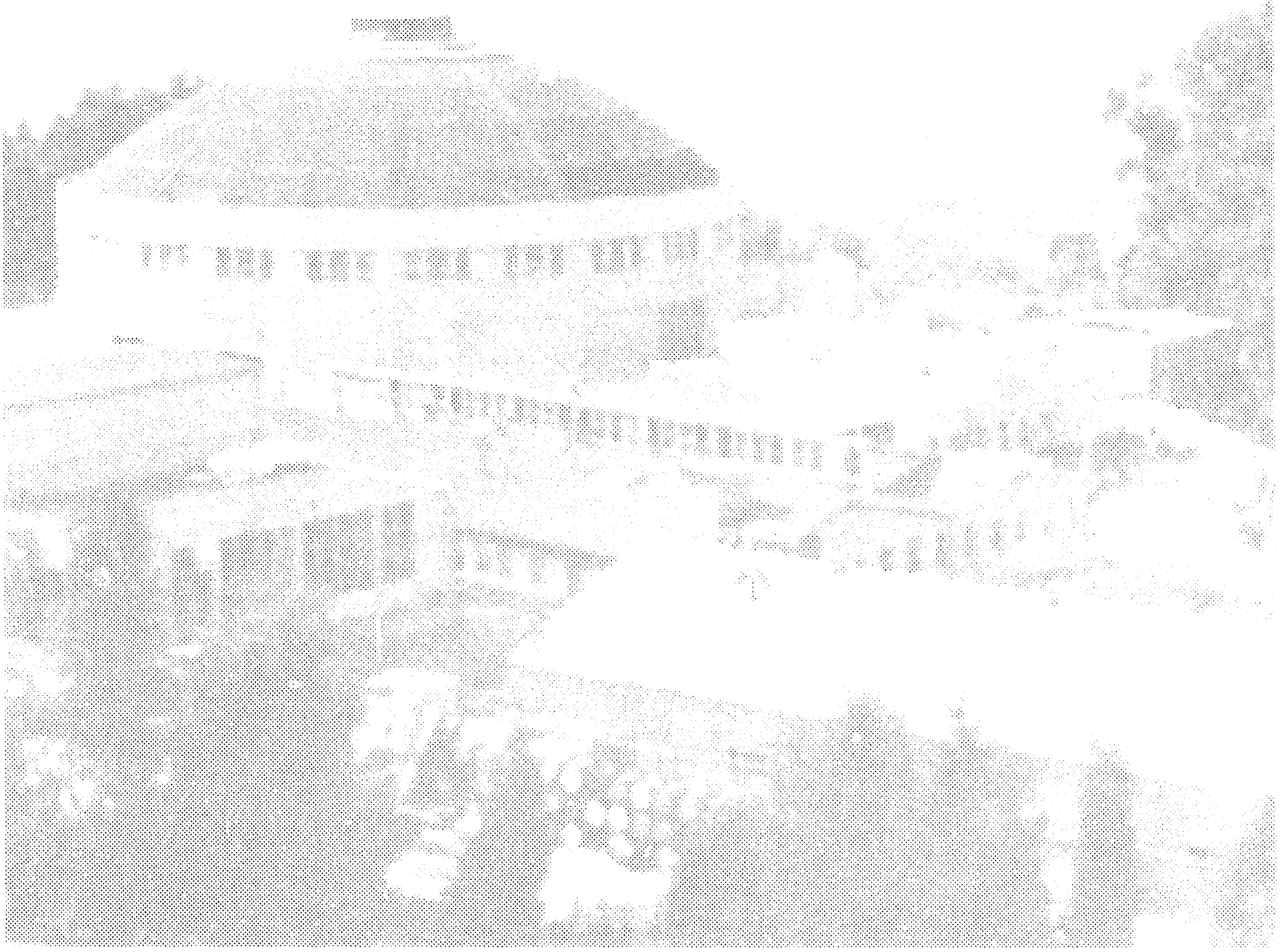


1 – Executive Summary

This annual Site Environmental Report summarizes Lawrence Berkeley Laboratory's (LBL's) environmental activities in calendar year (CY) 1993. The purpose of this report is to characterize site environmental management performance, confirm compliance status with environmental standards and requirements, and highlight significant programs and efforts. Its format and content are consistent with the requirements of the U.S. Department of Energy (DOE) Order 5400.1, *General Environmental Protection Program.*

The Environment Department of LBL's Environment, Health, and Safety Division is responsible for overseeing environmental compliance activities at the Laboratory. The Environment Department is structured into three groups: Environmental Protection, Environmental Restoration, and Waste Management. Programs within each group focus on issues related to environmental compliance, environmental permitting, audits and inspections, corrective actions, monitoring, spills and accidental releases, and program planning.

Environmental monitoring and surveillance activities at LBL are conducted on a routine and continuous basis throughout the year. These activities include

- measuring environmental penetrating radiation,
- performing environmental radiological dose assessments, and
- conducting sampling and analysis of air effluent, ambient air, sewage effluent, surface water, ground water, and soil. Environmental samples are analyzed for both radioactive and nonradioactive substances.

Environmental Compliance Programs

Several of LBL's environmental programs deserve recognition for their efforts in 1993. In response to the attention placed on phasing out ozone-depleting substances (ODSs) by the Clean Air Act Amendments of 1990 and other mandated requirements, LBL established an aggressive program for eliminating or reducing ODS usage in solvent cleaning, packaging materials, refrigeration and air conditioning, and fire suppression operations. LBL's program is consistent with recently prepared DOE guidance and requires the cooperative involvement of many organizational entities at the Laboratory.

LBL's water quality compliance program established an *Accidental Spill Prevention and Containment Plan* (ASPCP) in areas with the potential for accidentally releasing hazardous materials to the sanitary sewers. Thirty-four sites received the ASPCP, including all photoprocessing areas, two metal finishing areas, and the Motor Pool. Also, LBL's hazardous materials management program updated its *Spill Prevention, Control, and Countermeasures* (SPCC) Plan. The plan provides standards for storage and usage of petroleum products that will prevent accidental releases to the environment. LBL placed emergency spill kits at 13 appropriate sites, and trained responsible personnel on both the SPCC Plan and use of the emergency kits. In accordance with State law under the Business Plan, LBL provided the City of Berkeley with a complete update of its onsite chemical inventory information in July.

LBL continued to develop programs in the area of waste minimization and pollution prevention in 1993. The Laboratory's sitewide program focuses on issues that serve the entire Laboratory, such as employee awareness, solid waste recycling, and conscientious procurement practices. Waste reduction efforts at the LBL Hazardous Waste Handling Facility continued, and several new efforts were initiated, including the development of a Chemical Exchange Program, amendments to the Laboratory's garbage refuse contract to require higher levels of recycling, and examination of LBL's plating shops and operations that generate waste oil for waste minimization opportunities.

The Laboratory's groundwater monitoring program included quarterly analyses of water samples from more than 50 monitoring and slope stability wells for a variety of potential contaminants, including organic compounds, metals, and tritium. Twenty new wells were completed in 1993, bringing the total to 74. Water samples from approximately half of the new wells showed low levels of contamination with volatile organic compounds. This new information served to better define the distribution of contaminated groundwater on the site, a necessary prerequisite to meaningful evaluation of alternatives to remove contaminants from the groundwater.

Effective October 1, 1992, DOE and the University of California entered into a new contract agreement for the five-year period ending in 1997. The contract includes objective performance-based goals that measure the success of LBL programs designed to achieve compliance with applicable laws, regulations, ordinances, and DOE Orders relating to environmental protection. LBL devoted considerable effort in 1993 in developing meaningful environmental, as well as health and safety related performance measures.

Environmental Permitting

LBL has numerous environmental operating permits issued by regulatory agencies for its air emissions, hazardous waste handling and treatment operations, stormwater and wastewater discharges, and underground storage tanks. Section 3 describes each of these permitted activities in greater detail, and includes summary tables where appropriate.

The Bay Area Air Quality Management District (BAAQMD) issues operating permits for stationary sources of air pollutant emissions. LBL finished 1993 with a facility-wide total of 40 operating permits, including 16 new operating permits and 12 formerly permitted sources redesignated to registered-exempt. Eight sources were removed from operation in 1993. LBL's operating permits cover a wide range of equipment and operations, such as epoxy mixing, gasoline dispensing, painting, sandblasting, semiconductor research, solvent cleaning, and vacuum coating, as well as abatement equipment to control emissions from material machining operations and sulfur hexafluoride discharges.

LBL's Hazardous Waste Handling Facility (HWHF) operates under a Resource Conservation and Recovery Act (RCRA) permit issued by the California Environmental Protection Agency's (Cal/EPA) Department of Toxic Substances Control (DTSC) for the U.S. Environmental Protection Agency (US/EPA). Revised Part A and B permit applications for both the existing and proposed replacement HWHF were submitted to DTSC in August 1992 and approved by DTSC in May 1993.

The RCRA permits require that LBL investigate and address potential problems associated with past waste management practices at the site. Investigations of potential environmental contamination of soil, surface water, and groundwater are now conducted at LBL under the Facility Investigation Phase of the RCRA Corrective Action Process. This process began in the fall of 1993.

Hazardous waste treatment and storage units not requiring a RCRA permit fall under the State's new Tiered Permitting program, also administered by DTSC. LBL has five fixed treatment units (FTUs), that are within this program. LBL applied for permits for these units in early April, prior to the regulatory deadline, and received formal authorization to operate the FTUs from Cal/EPA's DTSC in August. The Tiered Permitting program allowed operation of each FTU between the regulatory deadline and the formal authorization date.

Water discharges are categorized as either stormwater or wastewater. LBL's stormwater runoff is authorized under a general State permit issued by the State Water Resources Control Board (SWRCB) for the entire site, and enforced by the Regional Water Quality Control Board (RWQCB) and the City of Berkeley (COB). Under the permit, LBL implemented a *Storm Water Pollution Prevention Plan* and a *Storm Water Monitoring Plan*. Together these documents represent LBL's plan and procedures for identifying, monitoring, and preventing contamination in its stormwater discharges.

Discharge limits for wastewater effluent at LBL are permitted by the East Bay Municipal Utility District (EBMUD). LBL requires three separate EBMUD wastewater permits: one general site-wide permit and two source-specific permits for treatment units at metal finishing operations in Building 25 and Building 77. As a result of LBL's compliance record of no violations in 1993, EBMUD decreased the site's monitoring and reporting requirements slightly compared to previous years.

Permits for LBL's underground storage tanks (USTs) are issued by COB. LBL ended 1993 with thirteen permitted USTs containing diesel, gasoline, or transformer oil. All tanks meet the State's requirements for leak monitoring. Eight of the USTs are double-walled tanks. Five have single steel walls and will be upgraded to meet the December 1998 regulatory standards.

Two single-walled tanks were removed in March. Sampling of the surrounding areas revealed no soil contamination from leaks from either tank. LBL intends to remove three additional USTs in 1994, one double-walled and two single-walled tanks. In December, COB conditionally approved LBL's plans for removal of two of these tanks in 1994.

Audits and Inspections

Several dozen audits and inspections of LBL's environmental programs were conducted during 1993 by regulatory agencies, as well as various divisions or affiliations of DOE. Agencies included BAAQMD, various organizations within Cal/EPA, COB, EBMUD, and US/EPA. Table 3-1 contains a complete list of environmental audits and inspections.

COB began conducting inspections of LBL's hazardous materials and hazardous waste programs in December 1992. The inspections continued with seven additional visits occurring in January and February. No violations were issued.

There were no Notices of Violation (NOVs) issued by EBMUD in 1993. However, LBL completed corrective action in early 1993 on an NOV that occurred in December 1992. The NOV resulted from operations at the Building 77 Plating Shop Waste Treatment Unit where the daily maximum discharge limits into the sanitary sewer system were exceeded.

Westinghouse Hanford Company completed a two-day audit of LBL's waste management program in March. The purpose was to determine conformity with the latest revision of the *Hanford Site Solid Waste Acceptance Criteria*. The audit included only the low-level waste (LLW) and low-level radioactive mixed waste (RMW) programs. The Hanford group reported no findings.

US/EPA performed an audit of LBL's radionuclide NESHAPs (National Emission Standard for Hazardous Air Pollutants) program in April. The audit was a follow-up to a finding by US/EPA in 1991 (see *Significant Corrective Actions,* below). US/EPA noted two areas of concern during the audit, but recommended no US/EPA action since both concerns were judged to be minor. In response, LBL modified its dose assessment methodology by deleting the occupancy factor previously used. LBL also created a new procedure to address quality assurance in recordkeeping.

Also in April, US/EPA conducted an unannounced inspection of LBL in their review of EBMUD's regulation of the site. All issues of concern raised by US/EPA were satisfactorily resolved, and no violations were issued.

The DOE Oakland Operations Office (OAK) conducted a week-long appraisal of LBL's environmental programs in April. The appraisal avoided duplicating areas addressed under other recent audits. LBL presented a Corrective Action Plan for seven findings and seven observations to DOE in August. None of the findings were considered imminent hazards.

BAAQMD conducted five inspections of nonradioactive air emission sources during June and July. During one inspection, BAAQMD issued an NOV for use of an unauthorized nozzle at a paint spray booth. LBL immediately removed the noncompliant nozzle from operation.

LBL reached a settlement with Cal/EPA's DTSC in September for Reports of Violations (ROVs) issued between November 1990 and March 1993 for alleged hazardous waste violations. The settlement required that LBL reimburse DTSC for inspection and enforcement costs, offer technical guidance and other assistance to University of California campuses, and pay a monetary fine. In November, DTSC performed another inspection and no violations were found. The director of DTSC stated that "the Lab's hazardous waste practices have improved to the point where we think they can be a role model for other university facilities."

In November, DTSC conducted an inspection of LBL's five fixed treatment units subject to the State's Tiered Permitting program. DTSC concluded that all five treatment units were in compliance and operating within the correct permitting tier. LBL was among very few California facilities that were found fully compliant in this type of audit in 1993.

The Agreement in Principle (AIP) program between DOE and the State of California affecting LBL and five other DOE facilities in California was continued in 1993. The State Department of Health Services (DHS) continued to familiarize itself with LBL's environmental monitoring and laboratory analysis programs through meetings and reviews of past environmental monitoring data. LBL hosted AIP progress meetings in January and July. DHS also installed thermoluminescent dosimeters (TLDs) at seven sites at or near LBL in January. The TLDs were located adjacent to LBL monitoring instrumentation and were changed quarterly.

Significant Corrective Actions

US/EPA and DOE signed a Federal Facilities Compliance Agreement (FFCA) in August 1993 that established a schedule for bringing LBL's program into full compliance with the NESHAPs for radionuclides by February 1995. The FFCA emerged from a Finding of Violation issued by US/EPA in April 1991. The FFCA schedule includes a $1.8 million corrective action project that will upgrade LBL's stack emissions monitoring program to NESHAPs standards. LBL has met all milestone deadlines identified in the FFCA. LBL submitted quarterly progress reports to US/EPA Region IX on the corrective action project for both the third and fourth quarters of 1993, as required by the FFCA.

In addition to the radiological environmental NESHAPs stack monitoring upgrades project, LBL is investing an additional $1.7 million on corrective action projects identified during the 1991 DOE Tiger Team visit. These projects will upgrade the site's meteorological monitoring network, abate air emissions from sources of hazardous air pollutants, and improve the sitewide radiological ambient air monitoring network. Completion of the non-NESHAPs projects is expected in 1994. Section 4, *Environmental Program Information*, addresses these and other corrective action projects in greater detail.

Progress continued on LBL's Corrective Action Plan generated by the findings of the 1991 DOE Tiger Team appraisal. DOE held a week-long audit on the progress of the corrective action program during February. DOE concluded that LBL has made satisfactory to excellent progress in the areas of review: management, safety and health, environmental, radiation protection, and emergency preparedness.

Spills and Accidental Releases

Four small spills or releases occurred at LBL during 1993. In February, approximately 30 liters (eight gallons) of diesel fuel spilled from secondary containment after an overfill at a 4,000-liter (1,000-gallon) underground storage tank. LBL cleaned up the overfill within eight hours of detection. No diesel fuel was released to the storm drain or the sanitary sewer during the incident. LBL notified the City of Berkeley in writing shortly after the incident, and sent a follow-up status letter one month later in March.

In March, a dropped battery spilled approximately 2 liters (one-half gallon) of acid onto the bed of a truck. About one-quarter liter (one cup) of the diluted acid entered the storm drain after the vendor inappropriately hosed off the acid from the truck. The spill was not of a reportable size; however, appropriate regulatory agencies were notified as a courtesy.

In July, a faulty weld in secondary containment of a double-walled aboveground tank contributed to a release of approximately 160 liters (40 gallons) of fuel oil to a parking lot surface. Fuel siphoned from the primary tank into the secondary containment because the filling hose was not equipped with a backflow preventer. The defective secondary containment allowed the fuel to escape. Most of the fuel was contained on site; however, a small amount appeared to reach a storm drain before cleanup teams arrived. The storm drain and the North Fork of Strawberry

Creek were sampled, but no diesel fuel oil was detected in either sample.

In August, tritium began to leak through the silica gel bed used by the National Tritium Labeling Facility (NTLF) to adsorb tritium from the exhaust air stream. Approximately 44 curies of tritium were released in this event. This release was determined to be not reportable since it was well within permitted emission limits set by US/EPA. However, LBL conducted a thorough investigation and several corrective action measures were implemented to prevent recurrence of this situation, including implementing more formal procedures for exchanging the silica gel beds and lowering the real-time monitor alarm level to 25 curies of tritium released per day.

Environmental Planning

DOE established the Environment, Safety and Health (ES&H) Management Plan, to identify the magnitude of effort, prioritize deficiencies, and determine funding needed to bring DOE into full compliance with all environment, safety, and health laws and regulations. Environmental planning documents request the level of resources necessary to maintain or improve compliance within program areas. The current funding period requested by the Activity Data Sheets (ADSs) is Fiscal Year (FY) 96 through FY 2000. In 1993 and early 1994, LBL prepared 21 environmental protection ADSs.

Radiological Monitoring

External penetrating radiation is associated mainly with operation of LBL's accelerators and irradiators. Five real-time radiation monitoring stations around LBL's perimeter record direct gamma and neutron radiation. Results from these monitoring stations are summarized in Table 5-1. During 1993, the offsite maximally exposed individual received about 2.96 millirem (mrem) of direct radiation from LBL accelerator operations. This dose is well below the 100 mrem yearly limit set forth in DOE Order 5400.5.

DOE Order 5400.5 also directs DOE facilities to comply with requirements of 40 CFR 61 Subpart H, the "National Emission Standard for Hazardous Airborne Pollutants Other Than Radon From DOE Facilities" (NESHAPs). NESHAPs requires that DOE facilities limit doses to offsite individuals to less than 10 mrem per year from all exposure pathways resulting from airborne releases of radionuclides. The maximum effective dose equivalent delivered to a member of the community is defined as the maximum perimeter effective dose equivalent (EDE) at an area where non-LBL personnel work or reside.

During 1993, about 104 curies (Ci) of tritium in the form of tritiated water vapor and elemental tritium were released to the atmosphere; of that, 44 Ci were due to one unplanned release from the National Tritium Labeling Facility. This amount of tritium represents about 92% of LBL's total airborne radionuclide emission. The effective dose equivalent attributable to LBL's airborne radionuclide releases was 0.13 mrem to a hypothetical maximally exposed individual, who is located offsite about 110 meters northwest of LBL's Building 75. This dose represents about 1.3% of the NESHAPs limit. Tritium accounts for about 95% of the individual dose at LBL.

An additional assessment of LBL radiological impact is the "population dose." Throughout this report, the phrase "population dose" means collective effective dose equivalent (CEDE) and "dose" or "dose equivalent" means effective dose equivalent. CEDE is defined as the sum of the "doses" delivered to all individuals within an 80-km (50-mile) radius of the Laboratory. The collective effective dose equivalent for LBL's operations in 1993 was estimated to be 1.3 person-rem, with tritium accounting for about 90% of the collective dose at LBL.

Dose equivalents attributable to LBL radiological operations in 1993 were a small fraction of the relevant radiation protection guidelines (RPG) of 100 mrem/year and of the total natural radiation background of approximately 300 mrem/year. The total dose due to direct penetrating radiation from accelerator operations and airborne radionuclide releases compared to typical radiation doses received by the general public are summarized in Figure 1-1.

In addition to monitoring airborne effluent at building stacks, LBL also monitors atmospheric ambient air at onsite and offsite locations. Environmental air samples are analyzed for tritium, carbon-14, gamma emitters, gross alpha, and gross beta radioactivities.

Levels of radioactivity in environmental air and water for the period 1983–1992 are presented in Section 5 of this report for comparison with the 1993 data. This analysis shows that concentrations in air and water in the vicinity of LBL are statistically within the historical background levels.

Tritium levels averaging 31,100 pCi/l, which exceed the current US/EPA 40 CFR 141 Community Drinking Water Standard of 20,000 pCi/l, were found in one of LBL's many slope stability wells, and an average of 12,000 pCi/l was found in rainwater samples taken at an onsite location 70 m from the National Tritium Labeling Facility exhaust stack. Since no practical way yet exists to remove tritium from water, no remediation effort is planned. However, the National Tritium Labeling Facility has instituted a program that has markedly reduced airborne tritium releases.

The Environmental Monitoring Plan details the soil and sediment sampling that will be performed on an annual basis at LBL. This plan was based on a history of site activities and was developed prior to the completion of the Storm Water Monitoring Plan in October 1992. Sediment samples were taken from the stormwater sampling locations and at all locations where the creeks are sampled for radionuclides. The samples were analyzed for gross alpha and beta and tritium. The levels of radioactivity were well within the regulatory levels of concern.

Nonradiological Monitoring

EBMUD issues permits for LBL wastewater discharges to the public sanitary sewer. Fifteen samples were taken during 1993 and analyzed for metals and toxic organics. All wastewater discharge levels were below the limits established in the three permits issued by EBMUD for the LBL site.

Stormwater discharges are regulated under a general permit issued by SWRCB. The permit program is in its infancy, and stormwater discharges are regulated in a manner different from that for wastewater. Currently there are no specific discharge limits cited in the general permit, although there may be in the future. References in the permit to the RWQCB Water Quality Control Plan (Basin Plan) for the San Francisco Bay Basin are intended to indicate guidelines. Constituent limits presented in the Basin Plan are water quality targets, not measures of compliance for stormwater discharges.

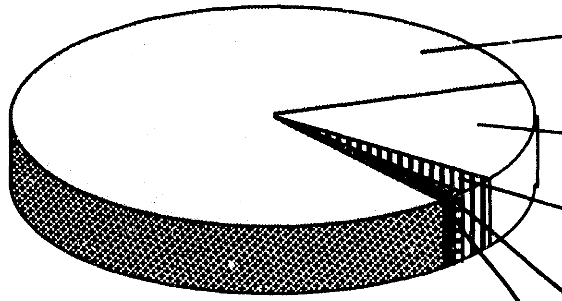


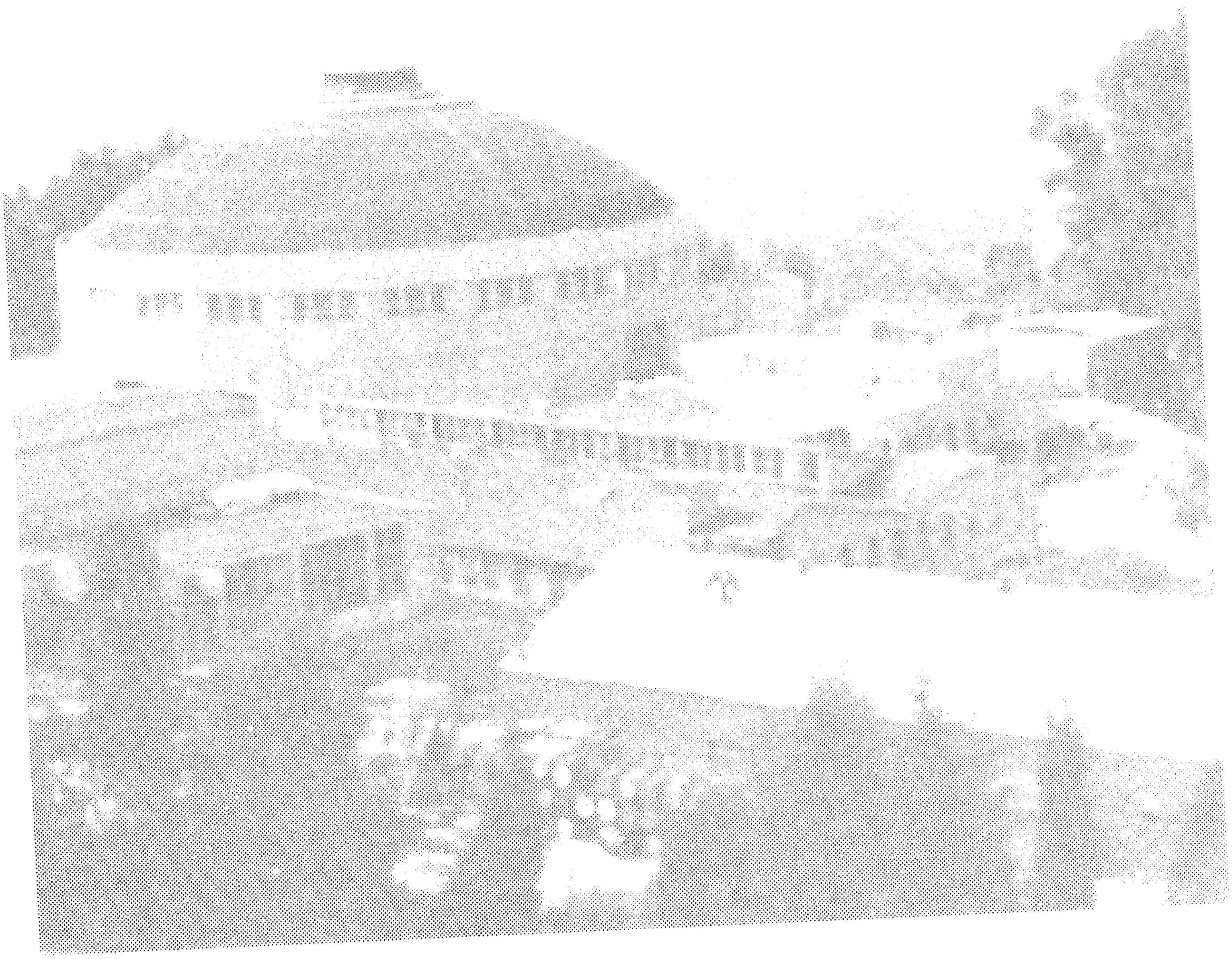
Figure 1-1. Typical Radiation Doses Received by the General Public and the Maximum Contribution From LBL

Stormwater samples are analyzed for an extensive suite of possible contaminants, depending upon the location of the sample. In 1993, 127 samples were taken from 10 influent and effluent locations and analyzed for metals and toxic organics. All of the analyses were within the baseline established by the sampling program to date.

None of the toxic organic analyses exceeded the limitations for Human Health 30-day average; in any case, this water is not used for domestic or agricultural purposes. In accordance with permit requirements, this information is reported as part of the Annual Report due July 1.

Sediment samples were also analyzed for metals and a suite of toxic organics, including polychlorinated biphenyls (PCBs), diesel, kerosene, and oil. Two locations showed very low levels of PCBs, and one site exhibited low-level contamination with chlorinated hydrocarbons. These areas will be further investigated in 1994.

Section 2. Introduction



History

LBL began as an accelerator laboratory in 1931, when Earnest O. Lawrence established the Radiation Laboratory with the construction of the 27-Inch Cyclotron on the University of California at Berkeley (UCB) Campus. In 1939, the need for higher-energy accelerators resulted in the construction of the 184-Inch Cyclotron on a hill overlooking the campus and the City of Berkeley. During a period of rapid growth, between 1940 and 1946, the original hillside Laboratory site became crowded with temporary wooden buildings hastily erected in response to national defense needs. However, further development during the 1950s was more carefully planned, with the construction of permanent concrete and steel-frame structures east and west of the earlier construction.

Under the auspices of the Atomic Energy Commission, LBL's largest accelerator, the Bevatron, became operational in 1954 as the nation's leading high-energy physics facility. The Heavy Ion Linear Accelerator (HILAC) was completed in 1958, and the 88-Inch Cyclotron began operation in 1964. The HILAC and Bevatron were closed in 1993, and plans for decommissioning the facility are under way.

Mission

Since its establishment in 1931 as a single-purpose accelerator-based University research facility, LBL has evolved into a multiprogram national laboratory with a mission to:

- Perform leading multidisciplinary research in the energy sciences, general sciences, and biosciences in a manner that ensures employee and public safety and the protection of the environment. The energy sciences include materials research, chemistry, earth sciences, and energy and environmental research. The general sciences include nuclear and high-energy physics and accelerator research. The biosciences include the life sciences and structural biology research.
- Develop and operate unique national experimental facilities for use by qualified investigators from throughout the world, including the Advanced Light Source, the 88-Inch Cyclotron, the National Center for Electron Microscopy, and the National Tritium Labeling Facility.
- Educate and train future generations of scientists and engineers. Over 440 graduate students pursue research at LBL, with about 100 students receiving advanced degrees each year. Precollege programs are conducted for science educators and students.
- Foster productive relationships with industry. The Center for Advanced Materials, the Center for X-Ray Optics, and the California Institute for Energy Efficiency are examples of collaborations with industry. Technology transfer programs promote the application of research results.

The Site

San Francisco Bay Area

LBL is located eight kilometers (5 miles) east of San Francisco Bay on the slopes of the Coast Range within 479 hectares (1,183 acres) of contiguous University of California (UC) land.

Most of the Laboratory's main-site buildings are owned by DOE and were constructed on University land under a long-term lease to the Federal government. The Laboratory's 54-hectare (134-acre) site is in Alameda County (population 1,280,000), with the eastern portion of the site in Oakland (population 370,000) and the western portion in Berkeley (population 103,000), largely a university and residential community. Research is also conducted in buildings on the UCB campus (student population 31,500), and at the Richmond Field Station, a University facility within the City of Richmond (population 70,000), about five kilo.neters (3 miles) north of Berkeley (Figures 2-1 and 2-2).

The San Francisco Bay Area is a cosmopolitan region comprising nine counties with a total land area of 1.9 million hectares (4.6 million acres) and a population of 6.0 million. Although metropolitan areas are highly developed, only 12% of the total land has been developed as residential, commercial, or industrial areas. The highly diversified, technology- and service-oriented labor force of the region totals 3.3 million people. Aerospace, computers, electronics, scientific instruments, and communications equipment comprise more than 50% of all manufacturing jcbs.

Alameda County, with an area of 189,950 hectares (469,400 acres), has major educational, research, industrial, and agricultural resources, including six colleges and universities, large private and public research laboratories, heavy and light industry, and extensive nursery and viticulture acreage. Important industries include electronics, automobile assembly,

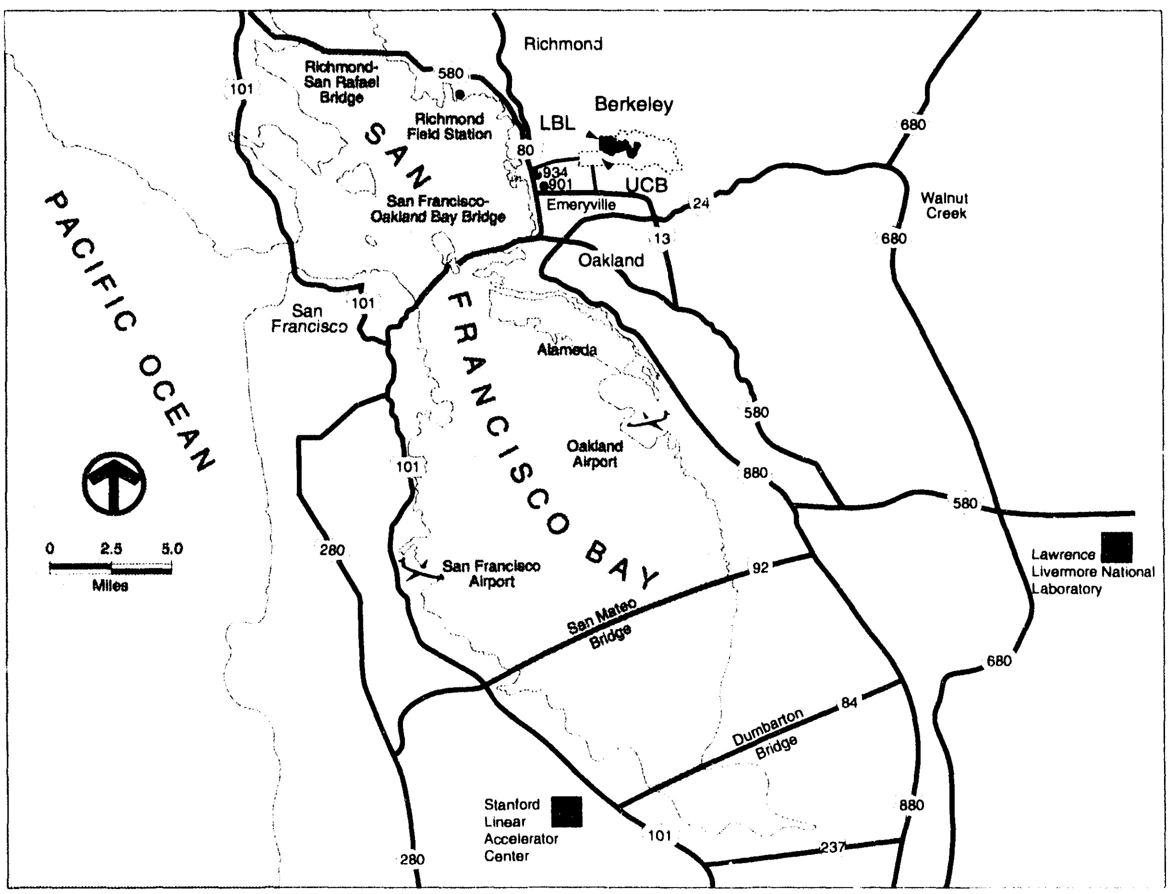


Figure 2-1. San Francisco Bay Area Map

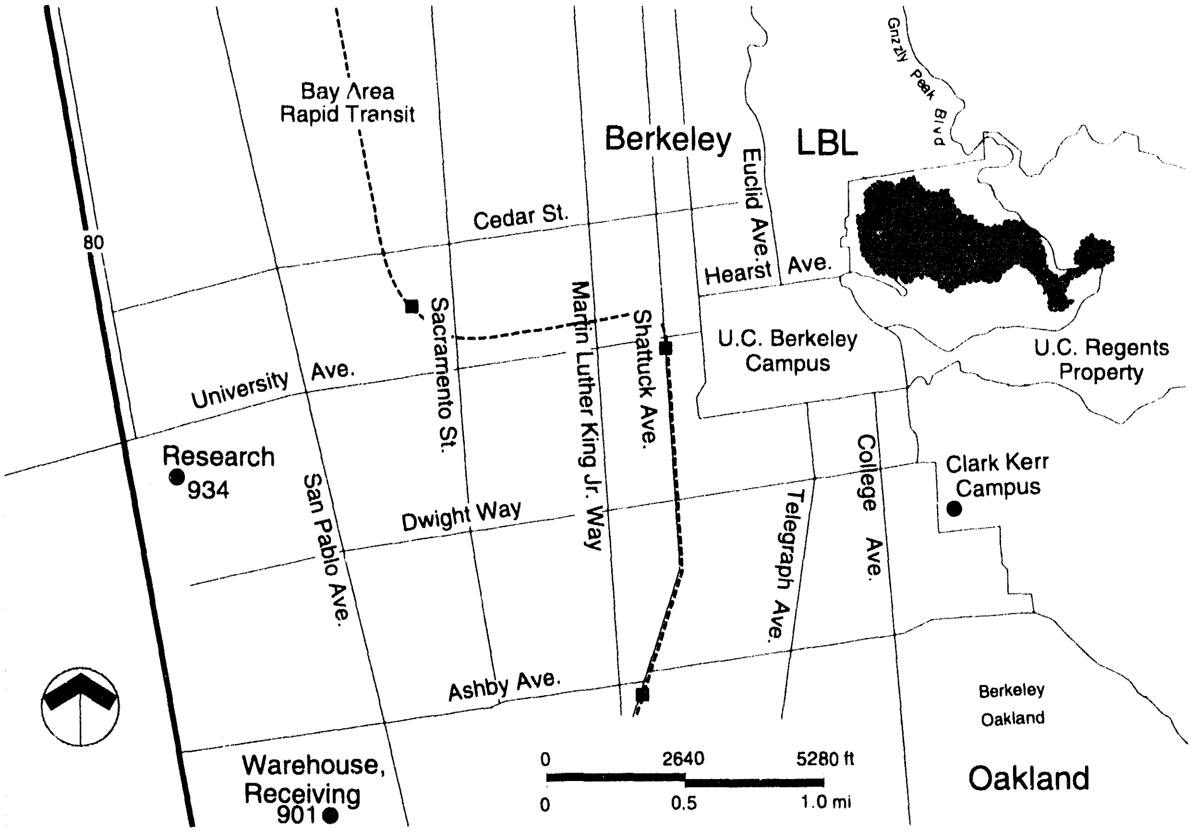


Figure 2-2. Vicinity Map

biotechnology, and food processing. The civilian labor force is approximately 600,000. The annual population growth rate during the mid-1980s was 7%. Most of the growth is projected for the southern area of the county. The Alameda County Planning Department prepares General Plans that are primarily directed toward the unincorporated areas of the County.

The County General Plan for the Central Metropolitan, Eden, and Washington Units was prepared in 1991 and includes the communities and land surrounding LBL. These plans include elements relating to land use, noise, scenic routes, and housing.

City of Berkeley

Berkeley is a residential, university, and industrial city encompassing 2,720 hectares (6,720 acres). The City is best known for the University of California Berkeley Campus. Industries include major biotechnology, electronics, chemical, and pharmaceutical companies; small foundries and fabrication companies; and other high-technology companies and service industries. The population of Berkeley has not changed significantly during recent years.

The Laboratory

The Laboratory (Figures 2-3 and 2-4) is sited on the ridges and draws of Blackberry Canyon, which forms the central part of the site, and Strawberry Canyon, which generally forms the southern boundary. The area to the south, which is University land, is maintained largely in a natural state and includes recreational facilities and the University Botanical Garden. Above and to the east of the Laboratory are the University's Lawrence Hall of Science and the Mathematical Sciences Research Institute. LBL is bordered on the north by predominantly single-family homes and on the west by multi-unit dwellings, student residence halls, and private homes.

The eastern section of the main Laboratory site is located on the northeast portion of the City of Oakland. Although the area to the west is largely urban, the Laboratory site has a backdrop of botanical gardens and regional parks that preserve the rural character of the foothills.

The Laboratory is served by a network of State, county, city, University, and LBL roadways and public, University, and Laboratory transit services. The Laboratory is within commuting distance to the Lawrence Livermore National Laboratory, Sandia National Laboratory, and the Stanford Linear Accelerator Center (Figure 2-1).

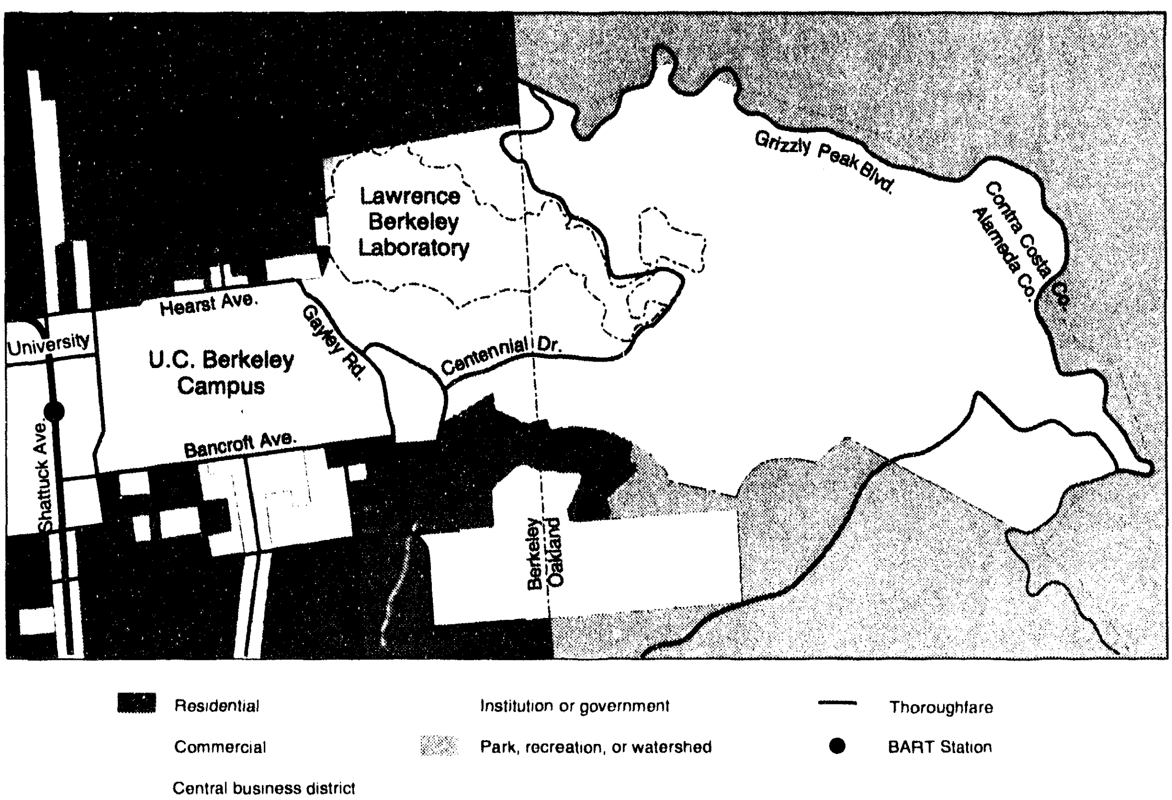


Figure 2-3. Adjacent Land Use Map

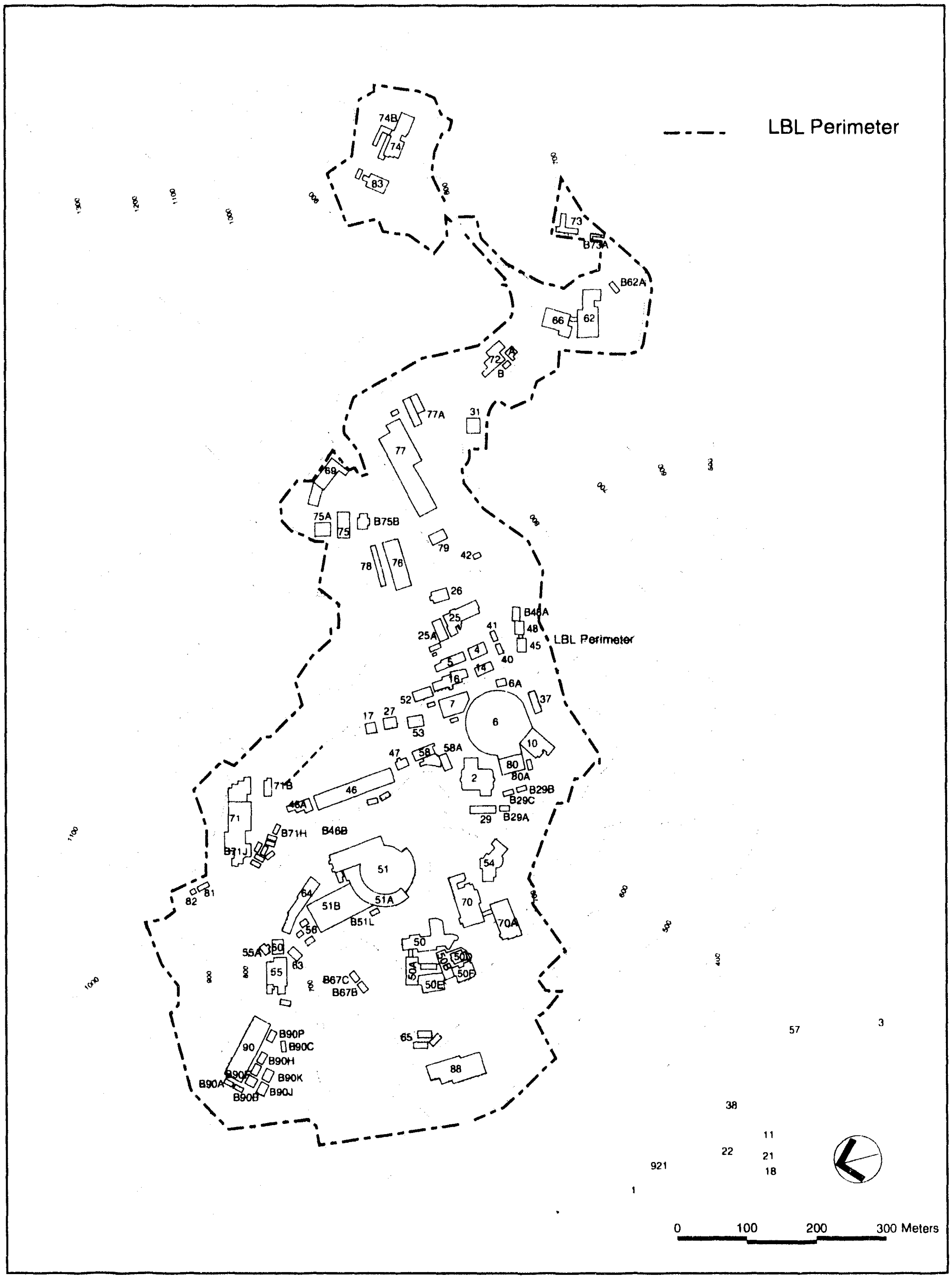


Figure 2-4. Lawrence Berkeley Laboratory Buildings

1	Donner Laboratory
2	Advanced Materials Laboratory (AML) & Center for X-ray Optics (CXRO)
3	Chemical Biodynamics Laboratory
4	Magnetic Fusion Energy (MFE)
5	Magnetic Fusion Energy (MFE)
6	Advanced Light Source (ALS)
7	Central Stores & Electronics Shops
10	Cell & Molecular Biology Research & Photography
14	Accelerator & Fusion Research & Earth Sciences
16	Magnetic Fusion Energy Laboratory
17	EH&S/Applied Sciences Lab
25	Mechanical Technology
25A	Electronics Shops
26	Medical Services
27	High Voltage Test Facility & Cable Shop
29	Electronics Engineering, Research Medicine/Radiation Biophysics Offices
31	Chicken Creek Maintenance Bldg.
36	Grizzly Substation Switchgear Bldg.
37	Utilities Service
40	Electronics Development Lab
41	Magnetic Measurements Lab
42	Salvage
43	Compressor Bldg.
44	Indoor Air Pollution Studies
45	Fire Apparatus
46	RTSS, ALS, Accelerator Development
46A	Real Time Systems Section (RTSS)
47	Advanced Accelerator Study
48	Fire Station
50	Physics, Accelerator & Fusion Research & Nuclear Science
50A	Director's Office, Environment & Laboratory Development, Administration Division, Patents
50B	Physics, Computer Center, IRD & ICSD
50C	PID, Physics
50D	MCSD & Nuclear Science
50E	Earth Sciences
50F	Computing Services, IRD
51	Bevalac/Bevatron
51A	Bevatron Experimental Area
51B	External Particle Beam (EPB) Hall
52	Magnetic Fusion Energy Laboratory
53	SuperHILAC Development
54	Cafeteria
55	Research Medicine/Radiation Biophysics
55A	Nuclear Magnetic Resonance (NMR)
56	Cryogenic Facility
58	Accelerator Research & Development
58A	Accelerator Research & Development Addition
60	High Bay Laboratory
61	Standby Propane Plant
62	Materials & Chemical Sciences
63	Accelerator & Fusion Research
64	Accelerator & Fusion Research
65	Data Processing Services
66	Surface Science & Catalysis Lab
68	Upper Pump House
69	Business Services, Materiel Management, Mail Room & Purchasing
70	Nuclear Science, Applied Science & Earth Sciences
70A	Nuclear Science, Materials & Chemical Sciences & Earth Sciences
71	Heavy Ion Linear Accelerator (HILAC)
71A	HILAC Rectifier
71B	HILAC Annex
72	National Center for Electron Microscopy (NCEM)
72A	High Voltage Electron Microscope (HVEM)
72B	Atomic Resolution Microscope (ARM)
72C	ARM Support Laboratory
73	Atmospheric Aerosol Research
74	Research Medicine/Radiation Biophysics, Cell & Molecular Biology Laboratory
74B	Research Medicine/Radiation Biophysics, Cell & Molecular Biology Laboratory Annex
75	Radioisotope Service & National Tritium Labeling Facility (NTLF)
75A	Compactor, Processing & Storage Facility
76	Construction & Maintenance & Craft Shops
77	Mechanical Shops
77A	Ultra High Vacuum Assembly Facility (UHV)
78	Craft Stores
79	Metal Stores
80	Electronics Engineering
80A	Office Building
81	Liquid Gas Storage
82	Lower Pump House
83	Lab Cell Biology
88	88-Inch Cyclotron
90	Applied Science, Employment, Engineering, Occupational Health, Personnel, Protective Services

SMALL BUILDINGS AND TRAILERS

B-13A	Environmental Monitoring West of 88
B-13B	Environmental Monitoring West of 90
B-13C	Environmental Monitoring South of UC Recreation Area
B-13D	Environmental Monitoring North of 71
B-13E	Sewer Monitoring Station, Hearst Avenue
B-13F	Sewer Monitoring Station, Strawberry Canyon
B-13G	Waste Monitoring Station, West of 70

Figure 2-4 (p. 2). Key to LBL Buildings shown on previous page

Laboratory Operations

To support the national infrastructure for fundamental science and engineering research, LBL provides a range of unique research facilities and centers to investigators from industry, universities, and government. In Fiscal Year (FY) 1992, LBL had over 200 facility users and signed 43 user agreements for a total of $3,300,000. The major national facilities available to qualified users include:

- The Advanced Light Source, which provides photon beams of unprecedented brightness and coherence and with picosecond time structure. The Injector was commissioned in FY 1992, and the storage ring was commissioned in FY 1993. The facility began operation in the fall of 1993.
- The 88-inch Cyclotron, which provides light ions, polarized protons and deuterons, and intense and high-charge-state beams of heavy ions (up to krypton) at energies up to about 35 MeV per nucleon. The cyclotron facility has experimental areas for conducting nuclear science experiments, as well as research in other areas such as biomedicine, atomic physics, and radiation damage in semiconductors.
- The National Center for Electron Microscopy, which consists of the High Voltage Electron Microscope, operating at up to 1.5 MeV (the highest energy in the U.S.); the Atomic Resolution Microscope, offering 1.5-Å resolution; and analytical microscopes and support facilities. An upgrade of the facility is planned.
- The National Tritium Labeling Facility, which provides advanced instrumentation to investigators needing high specific activities of tritiated compounds as tracers in chemical and biomedical research.

In addition to these national facilities, other research facilities involved in collaborative research include the Center for Computational Seismology, the Sky Simulator, the Mobile Window Thermal Test Facility, and the Low Background Counting Facility.

The Laboratory has established programmatic research centers with specific objectives of fostering collaborative research with industrial and educational institutions. These include, for example, the Center for Advanced Materials, the Human Genome Center, the Center for X-Ray Optics, the Center for Computational Seismology, the Center for Building Sciences, and the Center for Isotope Geochemistry.

In addition, radiochemical and radiobiological studies performed in many laboratories at LBL typically use extremely small (millicurie) quantities of a large number of radionuclides.

Future Programs

Human Genome Laboratory

The Human Genome Laboratory will be a 3,800 gross square meter (gsm) [41,000 gross square foot (gsf)], three-story building located near the Biomedical Laboratory (Building 74) and the Cell Culture Laboratory (Building 83).

This state-of-the-art molecular genetics research facility will contain open laboratory areas furnished with modular wet benches and desks. Support facilities, including cold rooms, darkrooms, cell tissue rooms, autoclaves, and laboratories for robotics, instrumentation, and computation, will be adjacent to the laboratory area. Design work on the Human Genome Laboratory will begin in 1994.

Chemical Dynamics Research Laboratory (CDRL)

Located in a new three-story, 4330-gsm (46,600-gsf) building adjacent to the ALS, the CDRL will be a state-of-the-art national facility for chemical-dynamics research using laser and synchrotron radiation. The laboratory includes an infrared free-electron laser (IRFEL), ALS beamlines optimized for chemical sciences research, advanced lasers and molecular-beam apparatus, universal-particle mass detectors, computer-based modeling systems, and auxiliary instrumentation. The building includes a high-bay heavy laboratory, eight support laboratories, and 40 offices. Construction is currently scheduled to begin in 1995, with completion in 1999.

Building Technology Initiative

A new light laboratory and office building, the Energy and Environment Facility, will support Energy and Environment Division programs in building energy conservation, solar heat technologies, electrochemical energy storage, and thermal energy storage.

Environmental Monitoring and Industrial Hygiene (EMIH) Building

The EMIH Building will have three stories with a total of 3000 gsm (32,000 gsf) and 2100 net square meters (nsm) (22,300 nsf) of laboratory and office space. It will be located near Building 75 (the National Tritium Labeling Facility), with access from Centennial Drive and Cyclotron Road. The building will provide offices and laboratory space for Environmental Protection, Occupational Safety, Radiation Assessment, EH&S Training, and EH&S Division Administration. Construction is expected to begin in 1997.

Hazardous Waste Handling Facility

A new Hazardous Waste Handling Facility (HWHF) is scheduled to replace the existing HWHF. The new HWHF will be located at the east end of the site and will be built to meet the latest waste management requirements.

Land Use

LBL's hillside location, with elevations ranging from 200 to 330 meters (650 to 1000 feet) above sea level, affords dramatic views of neighboring San Francisco Bay. The LBL site is drained by the west and south branches of Blackberry Creek and by Strawberry Creek, and is underlain by folded and faulted sedimentary and volcanic rock that has weathered to form soils several meters thick.

The hillside topography and vistas are both an amenity and a constraint and add an important dimension to site planning at LBL. Grading and filling are necessary to provide most building sites, and a slope-stabilization program that includes shallow dewatering wells, vegetation cover, and soils management is critical to site management. The Hayward fault (a part of the active San Andreas fault system), which developed as the Berkeley Hills were uplifted, is at the western edge of the main LBL site. Buildings and building additions will not be sited across the fault. Originally the site was coastal shrubland, but during the last 100 years the area was extensively grazed by cattle and, except near creeks, became primarily grassland. Since the 1950s the halt of grazing and subsequent land management have resulted in the growth of trees, especially eucalyptus, oak, and evergreens. Control of this vegetation is an important element of the Hillside Fire Management Plan. Deer, various small mammals and reptiles, and birds populate the Laboratory site and the adjacent hills. No threatened or endangered species have been identified in or adjacent to the LBL site.

Adjacent land use consists of residential, institutional, and recreation areas (Figure 2-3). Development within the Laboratory site is governed by guidelines which state that operations must be compatible with the surrounding community. Visually the Laboratory is associated by the public with the UCB campus, and the Laboratory works with municipal, county, and university planning staffs to maintain and improve relationships and to coordinate development plans.

Facilities

LBL research and support activities are conducted in structures totaling 180,000 gsm (1.97 Mgsf), including 153,000 gsm (1.65 Mgsf) on the main site, 16,000 gsm (0.17 Mgsf) on the UC Berkeley Campus, and 14,000 gsm (0.15 Mgsf) leased off site. In 1993, the average age of the main-site buildings was 34 years. The inventory of building space, including current construction, is

- Adequate: 50,600 gsm (544,500 gsf)
- Substandard, can be made adequate: 82,500 gsm (887,800 gsf)
- Substandard, cannot be made adequate: 20,100 gsm (216,700 gsf).

Figure 2-5 shows the 1993 LBL space distribution.

Water Supply

The Laboratory's water is supplied continuously from two sources. The primary water supply is the East Bay Municipal Utility District's (EBMUD's) Shasta Reservoir. The Laboratory's high-pressure fire and domestic system is supplied from this reservoir. A secondary source is EBMUD's Berkeley View tank, with a capacity of approximately 11,350 m^3 (3.0 million gallons), connected to LBL by EBMUD piping.

The LBL water distribution system contains several backup safety distribution loops and is valved to provide control in case of emergency. The system normally operates by gravity flow, requiring no pumps or energy consumption for operation within the Laboratory. The Laboratory has two 750-m^3 (200,000-gallon) fire-protection storage tanks. One is located near Building 75 in the Shops and Support Facilities Area, and the other is near Building 71 in the Bevalac Accelerator Complex. Automatically starting diesel-powered pumps will maintain a reliable flow for the fire-protection system during emergencies.

Two auto shutoff valves are installed to keep the pumps from emptying the tanks if there is a major break.

The LBL system that distributes the EBMUD water within the site consists of an extensive piping layout providing domestic water and fire-protection water to all LBL installations. The LBL system also supplies makeup water for cooling towers, irrigation water, and water for other miscellaneous uses. The system includes fire hydrants and Fire Department

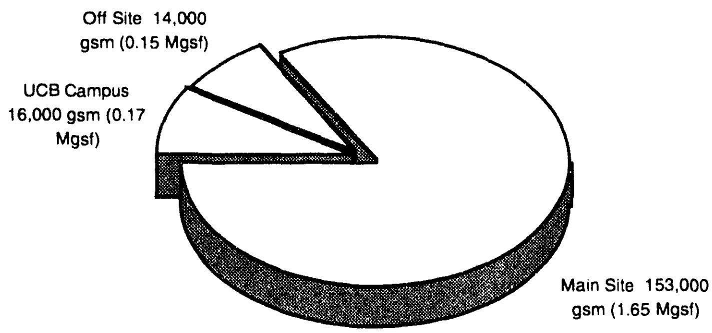


Figure 2-5. LBL 1993 Space Distribution
Total: 83,000 gsm (1.97 Mgsf)

connections and sprinkler services to almost all buildings.

Because of the differences in elevation at the LBL site, there are two main pressure zones, both of which operate at the nominal pressure of about 70 psi. Most of the existing pipe is either cement-lined and coated steel pipe with welded joints or cast iron and/or ductile iron pressure pipe with mechanical joints.

Much of the pipe has been designed and installed to resist forces caused by earth movement due to slides and/or earthquakes. All of the newer lines have been located to avoid potential unstable earth areas.

The water system at LBL has a high degree of reliability for both domestic use and emergency purposes. This reliability exists by virtue of the two separate connections to EBMUD sources, the two 200,000-gallon storage tanks, and the high quality of both the LBL and EBMUD systems. The system has sufficient capacity to meet the flow-rate and duration requirements for fire protection; in the case where EBMUD service is not available, the capacity is currently limited to 400,000 gallons. There is no present restriction on the volume of water available from EBMUD, except the capacity of the existing pipes.

Sanitary Sewer Systems

The western portion of LBL's sanitary sewer system (Table 2-1 and Figure 2-6) connects to the City of Berkeley sewer main at Hearst Avenue. On the south side of the Laboratory, a second connection is made to the City of Berkeley system at Centennial Drive.

The sanitary sewer system at LBL consists of pipe, manholes, and two monitoring stations. Pipe in the system is cast iron or ductile iron. The system is entirely gravity flow and discharges through either a monitoring station at Hearst Avenue or one located adjacent to Centennial Drive in Strawberry Canyon. The Hearst Avenue monitoring system services most of the buildings on the hill, and discharges approximately 33% of the water used at LBL, except for those buildings that lie within the South Strawberry Canyon watershed.

Effluent from the Hearst Avenue monitoring station flows to a manhole located at the intersection of Cyclotron

Table 2-1. Site Mechanical Utilities—Sanitary Sewer System

Functional Area	Existing: Length, m (ft)	Existing: Utilization (%)	Existing: Life (yr)	Additions Planned
88-Inch Cyclotron Research Area	268 (880)	50	25+	No
Central Research and Administration Area	1,450 (4,580)	50	15–25+	Yes
Bevalac Accelerator Complex	1,132 (3,715)	50	15–25+	No
Light Source Research and Engineering Area	911 (2,990)	50	15–25+	Yes
Shops and Support Facilities Area	1,320 (4,330)	50	15–25+	No
Material and Chemistry Research Area	335 (1,100)	50	15–25+	No
Life Sciences Research Area	241 (790)	50	15–25+	Yes

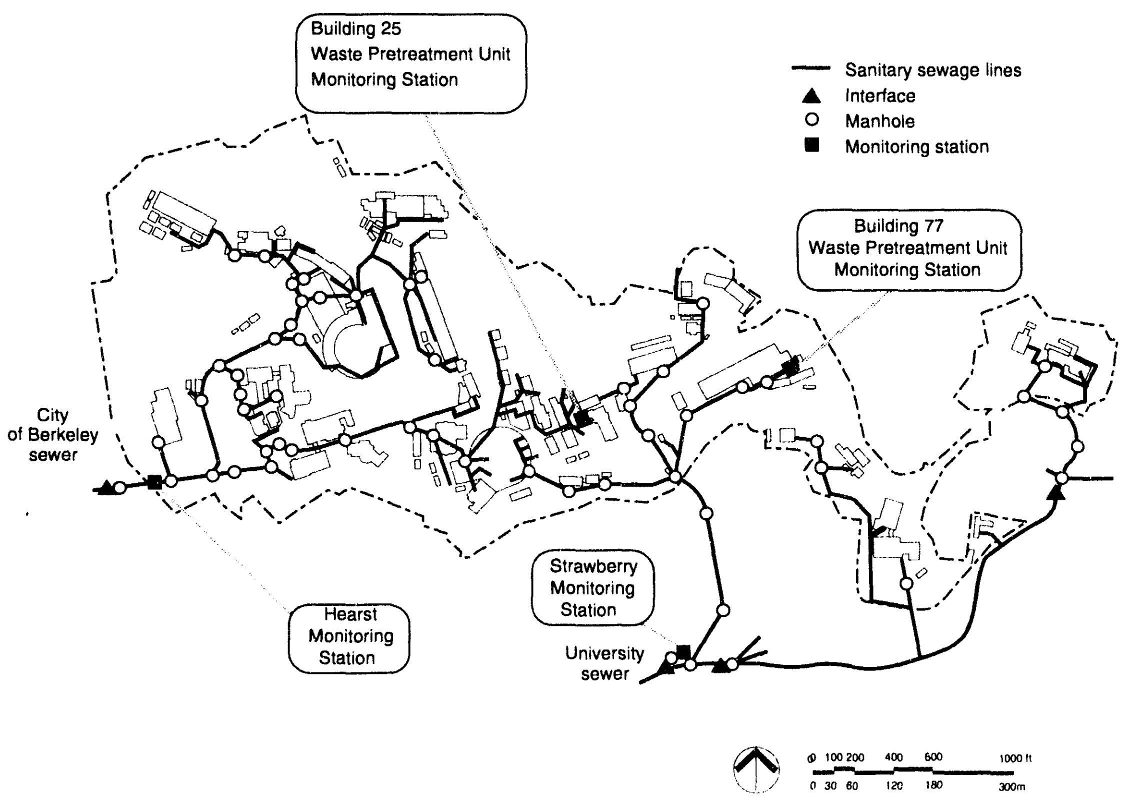


Figure 2-6. Sanitary Sewer System

Road and Highland, where it enters the City of Berkeley pipe system and is transported to the EBMUD North Interceptor sewer. The EBMUD North Interceptor carries the effluent to the District's wastewater treatment plant south of the Bay Bridge toll plaza. Here, the wastewater undergoes primary and secondary treatment before it discharges to the San Francisco Bay.

Effluent from the Strawberry Canyon monitoring station flows through a campus sewer that ties to the City of Berkeley system at a manhole near the intersection of Rimway Road and Canyon Road, just south and east of the UCB Memorial Stadium. The City system then delivers the sewage to the EBMUD North Interceptor.

Several of the main sewer lines have been in service since before 1950, and some are as small as 15 cm (six inches) in diameter. However, most of the lines are on a steep gradient and have operated satisfactorily.

The monitoring stations continuously measure the volume and periodically measure the pH of the wastewater effluent on a continuous basis. Proportional samples of the sewage are also taken at regular intervals and analyzed for heavy-metal content and radioactivity. Part of the effluent flowing through the LBL monitoring stations originates from UCB campus facilities, mainly the UCB Lawrence Hall of Science and the UCB Space Science Laboratory.

In 1991, LBL initiated a program to check for breaks in its sewer lines and repair them. This program will reduce stormwater infiltration and potential releases of sewage to the soil.

The measured wastewater volume for LBL was approximately 500,000 liters per day (125,000 gallons per day). This was approximately 50 percent of water purchased from EBMUD during this period.

A regional sewage project recently has been undertaken in the East Bay. The purpose of the project is to decrease the amount of stormwater infiltration into the sanitary sewers and to provide additional transport capacity in sewer lines so that raw sewage will no longer overflow manholes or be discharged into the Bay during the rainy season.

Storm Drainage System

Because of its hillside location and moderate annual rainfall, surface runoff is a prevalent feature at LBL. Consequently, an inclusive storm drain system, designed and installed in the 1960s, discharges into the North Fork watershed on the north side of LBL and the Strawberry Creek watershed on the south side (Figure 2-7). This system provides for runoff intensities expected in a 25-year maximum-intensity storm. This watershed also includes other University of California property, public streets of both the cities of Oakland and Berkeley, and private property.

The total Strawberry Creek watershed above Gayley Road contains about 354 hectares (874 acres). There are two main creeks in the watershed, namely the South Fork and the North Fork of Strawberry Creek.

Stormwater runoff from LBL and from the upper parts of the North Fork watershed discharges into a 1.5-m (60-inch) concrete culvert at the head of LeConte Avenue in

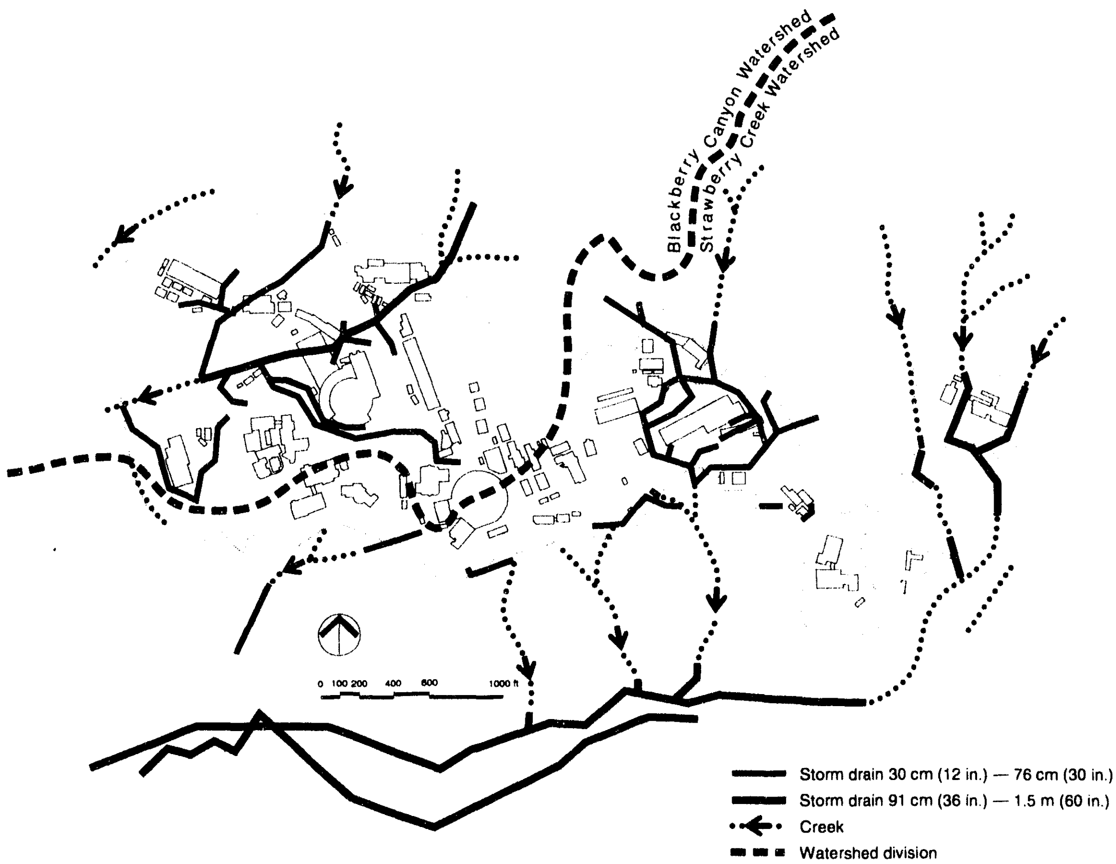


Figure 2-7. Hydrology and Storm Drainage

Berkeley. The drainage facilities in this watershed have proven to be adequate during the heavy rains of the past few years.

Grounds and buildings in the Strawberry Creek watershed area were heavily damaged during storms in October 1962. Subsequently, extensive improvements have been made by LBL and UCB. These improvements included additional pipe and culvert capacity, a retention basin, trash racks, and hardening of stream channels. Current drainage facilities have been able to accommodate all runoff since the improvements have been made.

Laboratory Population

In 1993, the Laboratory's employee population consisted of 3,535 full- and part-time employees, equating to 2,600 full-time employees (see Figure 2-8). LBL maintains a register of official guests, updated monthly, which contained 1,533 registered guests at the end of 1993. About 600 of these guests were on site at any one time, so that total Laboratory population was close to 4,200. Of this total, 3,480 are located at the main site, 500 are located in UCB Campus buildings, and 130 are located in offsite leased buildings. The 20-year plan would allow additional growth up to a total Laboratory average daily population of 4,750, including 640 on the UCB campus.

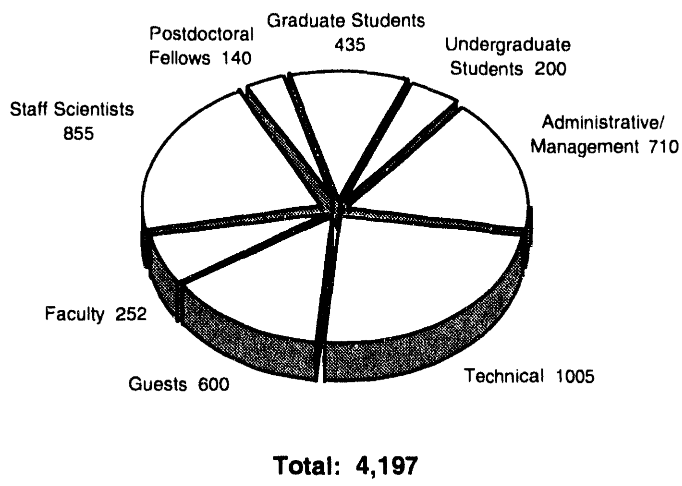


Figure 2-8. LBL population, 1993

Meteorology

LBL has a Mediterranean climate with cool, dry summers and relatively warm, wet winters. The proximity of the Pacific Ocean and the maritime air that flows through the Golden Gate moderate local weather, keeping seasonal temperature variations small. The mean summer and winter temperatures are 62°F and 51°F, respectively (Table 2-2). Generally comfortable outdoor conditions prevail throughout the year, although occasional hard freezes can occur in mid-winter.

Relative humidity ranges from 85-90% in the early morning, when ocean fog often blankets the site, to 65-75% in the afternoon. Annual insolation ranges from 65 to 75% of that theoretically available, and the average daytime cloudiness is about the same in summer and winter. Heating degree-days number about 2,600 and cooling degree-days about 150. Winds are generally cool and light, less than 16 km/hr (10 mph), blowing from the east in the morning and from the west in the afternoon (Table 2-3). About 95% of the average annual rainfall of 64 centimeters (25 inches) at the Laboratory occurs from October through April, the winter rainy season. Rainfall intensities are seldom greater than 1/2 centimeter (one-quarter inch) per hour (Table 2-4), and thunderstorms, hail, and snow are rare. Drought periods of several years duration are not uncommon, and abnormally wet winters also occur. Overall, however, LBL's climate provides generally favorable conditions for comfort control, energy efficiency, and outdoor activities.

Geology

LBL occupies west- and south-facing slopes immediately east of the main UCB campus. Elevations range from approximately 200 meters (650 feet) to 330 meters (1000 feet) above sea level. The LBL site is underlain by sedimentary and

Table 2-2. LBL Temperature Normals (˚F) by Month

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Max	56.1	59.5	61.1	63.3	66.4	69.2	69.5	69.6	71.7	69.6	62.9	57.0	64.7
Min	43.2	45.8	46.0	47.6	50.3	53.0	53.9	54.7	55.6	52.9	48.3	43.9	49.6
Mean	49.7	52.7	53.6	55.5	58.4	61.1	61.7	62.2	63.7	61.3	55.6	50.4	57.2

Table 2-3. LBL Wind Data

	Velocity, kph (mph)				
Direction	1–5 (1–3)	6–16 (4–10)	17–34 (11–21)	35–44 (22–27)	%
N	0.59	0.97	0.05		1.61
NNE	0.61	0.61	.01		1.23
NE	0.89	1.10	0.20		2.19
ENE	1.10	1.52	.59	0.03	3.24
E	1.97	1.68	0.45	0.03	4.13
ESE	2.46	1.87	0.17		4.50
SE	3.31	3.53	0.39	0.01	7.24
SSE	3.59	4.76	1.13	0.01	9.49
S	3.12	4.44	0.70	0.01	8.27
SSW	3.36	3.86	0.18		7.40
SW	3.24	3.30	0.03		6.57
WSW	3.17	4.28	0.09		7.54
W	4.02	6.45	0.14		10.61
WNW	3.65	4.86	0.26		8.77
NW	3.33	3.19	0.13		6.65
NNW	1.64	2.24	0.08		3.96
Calm					6.60
Total					**100.00**

Table 2-4. Rainfall Intensity and Probability

Period (yr)	Intensity, cm/hr (in/hr)	24-Hour Duration, cm (in)
25	0.51 (0.20)	10.92 (4.30)
50	0.56 (0.22)	13.41 (5.28)
100	0.64 (0.25)	15.24 (6.00)

volcanic rocks. Paleotopography, interbedding, faulting, and folding of these rocks have created a complex geological structure. In general, the bedrock is relatively weak and weathers deeply.

Three major geologic formations have been identified at the LBL site. The western and southern parts of LBL are underlaid by moderately to well-consolidated upper Cretaceous marine sediments. These rocks consist of shales, siltstones, sandstones, and conglomerates. The upper Miocene or lower Pliocene Orinda Formation overlies the Cretaceous rocks and underlies most of the Laboratory property. It consists of poorly consolidated claystones, siltstones, sandstones, and conglomerates of relatively low strength and hardness. These rocks are blanketed by clay soils having high shrink-swell characteristics. The volcanic Moraga Formation underlies most of the higher elevations of the Laboratory as well as much of the "Old Town" area around the Advanced Light Source. The Moraga Formation overlies the Orinda Formation. However, in some areas the volcanic rocks of the lower Moraga are interbedded with sedimentary rocks similar to the Orinda. The Moraga Formation consists of basalt and andesite flows and pyroclastic tuffs.

Several other formations underlie the easternmost portion of the LBL site. These include siltstones of the Sobrante Formation and siltstones and cherts of the Claremont Formation. These rocks are separated from the three main formations underlying the LBL site by the Wildcat Fault complex.

Due to the hilly terrain at the LBL site, extensive grading and filling has been necessary to provide suitable building sites. Consequently, cuts up to tens of meters deep have been made in some of the ridges and high ground, and fills up to tens of meters thick are present in some of the original ravines and depressions.

Landslide deposits have been encountered in numerous locations within the LBL site. Many of these slides are related to the contact between the Orinda and the Moraga Formations and/or to cutting and filling of the original topography. A soft clay bed up to 0.3 meter (one foot) thick typically exists at the Orinda/Moraga contact. Slide planes develop readily in this material. During the past 20 years the Laboratory has carried out a program of slope stabilization to reduce the risk of property damage due to soil movement.

The Laboratory is situated between the active Hayward fault on the west and the apparently inactive Wildcat fault on the east. Shorter, apparently inactive, subsidiary faults transect the Laboratory.

Hydrology

The hydrogeology at LBL is complex. Year-round springs, annual surface seeps, and variable water levels in observation wells indicate discontinuous and localized aquifers. These conditions are due to a number of factors. The different rock units underlying LBL have contrasting permeabilities. Volcanic rocks are typically fractured, while the sedimentary rocks consist of interbedded impervious claystones and siltstones and include moderate-permeability sandstones. Orinda Formation sandstones are discontinuous, and probably exist primarily as channel fillings in the claystones and siltstones. The relation between the high-permeability volcanic rocks and the low-permeability sedimentary rocks is complex due to paleotopography, interbedding, faulting, and folding.

Groundwater is a concern for LBL because of its potential effect on slope stability. The fractured bedrock underlying the Laboratory allows percolation that augments groundwater. Faults that cut through bedrock tend to drain groundwater, whereas clay layers impede or direct flow. LBL's complex geology includes both elements. Across the site, water-table depths vary from less than 3 meters (10 feet) to more than 27 meters (90 feet).

During the winter rainy season, groundwater levels and hydrostatic pressures increase, intensifying slide dangers. The Laboratory has installed an extensive system of monitoring wells and storm drainage lines (Figure 2-7) to maintain slope stability. To control possible groundwater contamination, the Laboratory's Environment, Health and Safety (EH&S) Division has initiated a program that characterizes and remediates groundwater contaminants (see Section 7, *Groundwater Protection*).

Biological Resources

Vegetation

Most of the major vegetation remaining within the LBL site is located around the periphery, away from the centrally developed portion. Since cattle-grazing operations ceased in the 1950s, Baccharis brushland has re-established on open slopes, and introduced trees have formed large stands. Without management intervention or occasional wildfires, open areas of the site will continue the transition to an oak-bay woodland.

Vegetation on the Laboratory site can be broadly categorized into four types: native woodland, eucalyptus plantations, a hillside habitat of grasses and brush, and mixed introduced species (which include ornamental plantings near buildings). Only the remnant stands of Oak-Bay Woodland consist of species native to the site. The most common and widespread vegetation types on the Laboratory site are the hillside habitat and the eucalyptus plantations. The open grassy slopes of the hillside habitat occur primarily in the eastern portion of the Laboratory, while the western portion of the site is more heavily forested (Figure 2-9).

Native Woodland

A mix of coast live oak (*Quercus agrifolia*) and California bay (*Umbellularia*

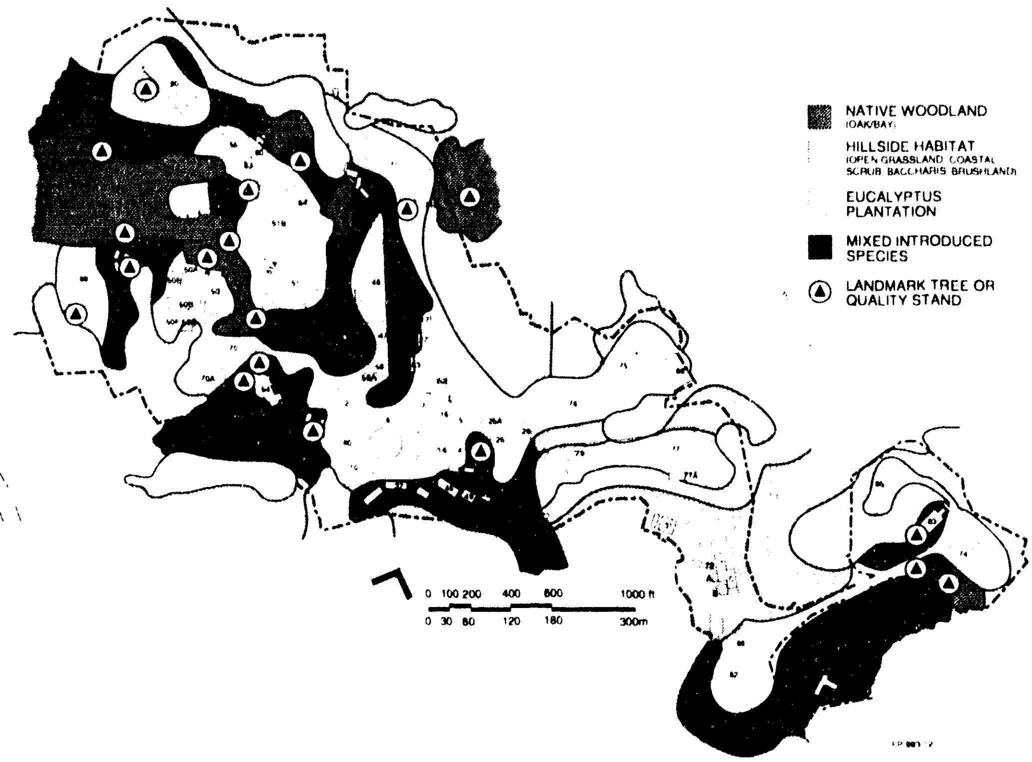


Figure 2-9. Vegetation Types

californica) occurs naturally in ravines and drainages that retain some moisture during the long dry season. The understory can be quite open under the spreading canopies or dense with tangled underbrush. The trees grow relatively slowly, reaching a height of up to 15 meters (50 feet) in about 25 years.

Eucalyptus Plantations

The Berkeley Hills have been widely planted with introduced eucalyptus, primarily *Eucalyptus globulus*, the Blue Gum eucalyptus. The Laboratory has extensive stands of this tree both on the site and surrounding its borders. Several other eucalyptus species also occur on the Laboratory singularly or in small clusters. The Blue Gum eucalyptus grows vigorously and tall, easily reaching a height of 24 to 30 meters (80 to 100 feet). Fruit drop, leaf debris, and large pieces of exfoliated bark from the trees present maintenance and fire management concerns, although eucalyptus stands usually have an open understory.

Hillside Habitat

Several types of grassy, brushy vegetation share the open slopes on and around LBL. Coyote brush (*Baccharis pilularis*) occurs in sporadic clumps until it spreads sufficiently to form a dense shrub mass about 2 meters (6 feet) tall. Coastal scrub areas on south- and west-facing slopes host sparse, low shrubs up to 1 meter (3 feet) tall dominated by California sagebrush (*Artemisia californica*). Introduced annual grasses have naturalized in open areas and on most disturbed sites. The major grass species present are soft chess (*Bromus* *mollis*), wild oats (*Avena* spp.), and wild barley (*Hordeum* spp.) Low broad-leaved plants commonly associated with annual grassland include rabbit-foot clover (*Trifolium arvense*), cut-leaved geranium (*Geranium dissectum*), and English plantain (*Plantago lanceolata*). Recent hydroseeding operations to control surficial erosion have used native grass seeds (*Stipa pulchra* and *Stipa sernua*) for their deep rooting and drought-resistant characteristics.

Mixed Introduced Species

Introduced species include trees native to the State, but not naturally occurring on the site, such as Monterey pine (*Pinus radiata*), knobcone pine (*Pinus attenuata*), Canary Island pine (*Pinus canariensis*), and coast redwood (*Sequoia sempervirens*). The conifers are fast-growing trees with a generally sparse understory.

A variety of other introduced ornamental species of trees, shrubs, and perennials has been planted around existing facilities. Many are not Mediterranean-type species and so have not evolved to withstand a long annual dry season. These introduced species require regular supplemental irrigation to maintain health and appearance.

Landscape Buffers

To facilitate appropriate siting of buildings and to protect important open space areas, the Laboratory has established nine landscape buffer zones across the site (Table 2-5 and Figure 2-10). The Laboratory manages these landscape buffers for a variety of functions:

- site amenity for employees and visitors
- scale and context for Laboratory development
- separation of adjacent uses, internal and external
- visual and sound screening, internal and external
- microclimate modification
- erosion control
- wildlife corridors and habitat.

A special importance of the landscape buffers is their capacity to blend the developed LBL areas with the surrounding hillside context. Except on the western edge, perimeter landscape buffers merge with adjacent open space beyond the LBL fence line.

Erosion Control

The steepness of the Laboratory site makes protection from wind and water erosion a serious concern. Vegetation provides the best control of surficial erosion by reducing the impact of rain on soil, while plant roots stabilize and hold topsoil.

In 1992, LBL developed a hydroseed project to revegetate bare soil areas on the Laboratory site. The seeding operation depends on winter rains sufficient to produce germination without washing the seed away. Variable weather can require repeated applications for success.

LBL also uses other means to control surficial erosion, including retaining walls, slope terracing, and paving of footpaths.

Fire Management

Within the LBL fence line most of the Laboratory's north perimeter is managed as a fuel or fire break (Figure 2-10). Fire

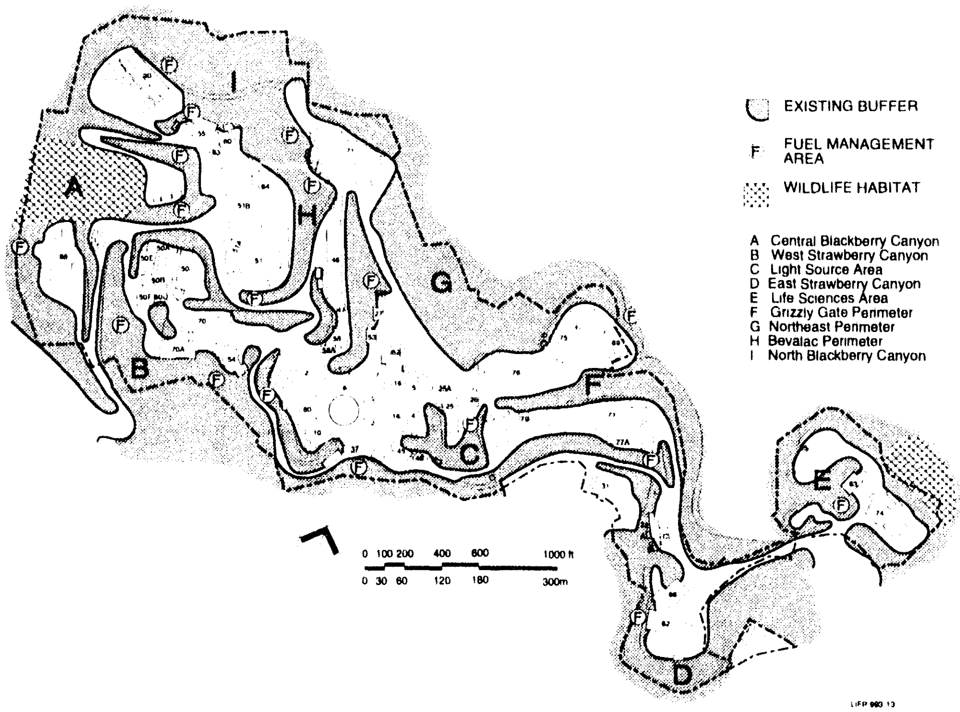


Figure 2-10. Landscape Management

protection along the south and east perimeters is complicated by limited buffer space within the fence line and proximity to less-managed University lands.

Since the fire of October 1991, which devastated the adjacent Berkeley/Oakland Hills south of the Laboratory, LBL has updated and intensified its fire management efforts. The primary objective of the renewed effort remains to reduce and control fire hazards in the outdoor areas of the Laboratory. The basic strategy involves reducing fuel loads and fire "laddering" capabilities.

A management and reforestation plan is currently being developed in order to assure long-term continuity in LBL's landscape value. Both inappropriate species and declining trees will require replacement, and the Laboratory will benefit from increased tree cover in several areas.

Wildlife

In general, the Laboratory site supports habitats and associated wildlife that are typical of disturbed portions of the Berkeley-Oakland hills. Approximately 79 species of birds, 20 mammal species, and 19 reptile and amphibian species, none rare or endangered, occur on or near the site.

The most significant wildlife habitats at LBL (Figure 2-10) occur in Blackberry Canyon and to a lesser degree at the northeasterly edge of Functional Planning Area 7, also known as the East Canyon. The lower portion of Blackberry Canyon supports a relatively intact oak-bay woodland, but it is completely surrounded by development, so the habitat is small and limited. The East Canyon area is rated as important because of the high interspersion of habitats and the proximity of adjacent undeveloped lands.

Table 2-5. Landscape Buffer Zones

	Planning and Protection Criteria				
	Views or Exposure	Building Density	Hydrology and Stability	Vegetation	Special Considerations
A. Central Blackberry Canyon			•	•	Forested area with creek
B. West Strawberry Canyon	•			•	Bay view; eucalyptus, dawn redwoods, and cork oaks
C. Light Source Area	•	•		•	Sequoia redwoods, building density
D. East Strawberry Canyon	•	•		•	Dawn redwoods, other evergreens
E. Life Sciences Area	•			•	Forested area; evergreen and eucalyptus
F. Grizzly Gate Perimeter	•		•		Slope stability
G. Northeast Perimeter	•		•		Stability, drainage, and exposure
H. Bevalac Perimeter	•	•	•	•	Slope stability; evergreen trees
I. Blackberry Canyon	•			•	Exposure, eucalyptus trees

The Baccharis brushland at LBL provides cover, food, and breeding sites for a variety of common birds and mammals of the region, the dominant mammals of which are brush rabbits and mule deer. The Laboratory's tree stands offer nesting sites for many bird species; during the flowering season, the eucalyptus provide food for nectar-eating birds. In general, the sparse tree understory offers poor wildlife habitat.

Seismicity

LBL is located in a seismically active region (Figure 2-11). The seismically active Hayward Fault, a branch of the San Andreas Fault System, trends northwest-southeast along the base of the hills at the Laboratory's western edge. It has the potential to produce an earthquake of approximately Richter magnitude 7.5. Traces of the Wildcat Fault, also part of the San Andreas System, traverse the Laboratory site, but analysis indicates no evidence that the fault is active in this area.

The San Andreas Fault zone, which has potential for a magnitude 8.3 earthquake, lies about 32 km (20 miles) west of LBL, off shore beyond the Golden Gate. The Calaveras Fault, another branch of the San Andreas, lies about 24 km (15 miles) east of LBL. For an earthquake of any given magnitude, the Hayward Fault would produce the most intense ground shaking at LBL because of its proximity.

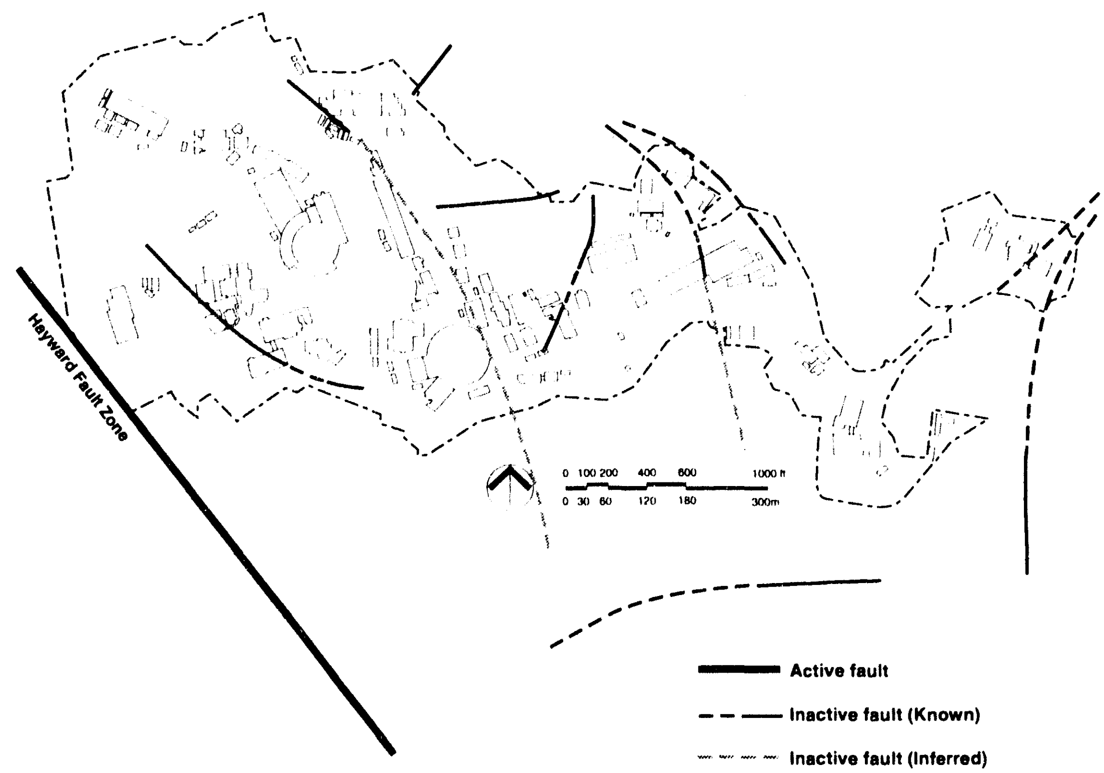


Figure 2-11. Mapped Faults

To reduce the potential for damage from seismic activity, the Laboratory has carried out a comprehensive earthquake safety program since 1971. All new facilities have been designed and constructed to resist the maximum credible earthquake estimated for the site. All existing LBL buildings have been reviewed, and 34 have been strengthened to meet current risk criteria. Building 90 is undergoing seismic strengthening in 1993 and 1994.

Historical and Archaeological Resources

A surface examination of all undeveloped land and proposed building locations within LBL was completed in preparation of the 1987 Long Range Development Plan Environmental Impact Report.

A check of the data on file with the Archaeological Resource Service indicated that no new archaeological sites have been reported since their last review of this literature, performed in 1982.

Three archaeological sites have been identified that are associated with the Strawberry Creek drainage, the main natural drainage channel through the campus. No prehistoric cultural resources are reported to lie within LBL, as delineated by the chain link fence that borders the Laboratory area.

On July 14, 1986, a surface reconnaissance was conducted of the proposed building locations at LBL and any other open ground accessible within the fenced LBL area. All reasonably accessible parts of the LBL area were examined. Special attention was given to areas of relatively flat land, or rock outcrops. The steep hillsides were not examined intensively, although transects through accessible areas were made.

No indications of historic or prehistoric archaeological resources were encountered in any location within the project area. As previously indicated, the Laboratory is located on a steep hillside with limited amounts of flat land. Those relatively flat areas that do exist are generally covered by buildings or parking areas. Cut and fill operations have been numerous. It appears that all of the LBL areas that might have been suitable for prehistoric occupation and use have been utilized by LBL already. Building 6 (now the Advanced Light Source and formerly the 184-inch Cyclotron) occupies the most likely area to have contained evidence of prehistoric human occupation or use. Thus far, no evidence of any such use has been uncovered.

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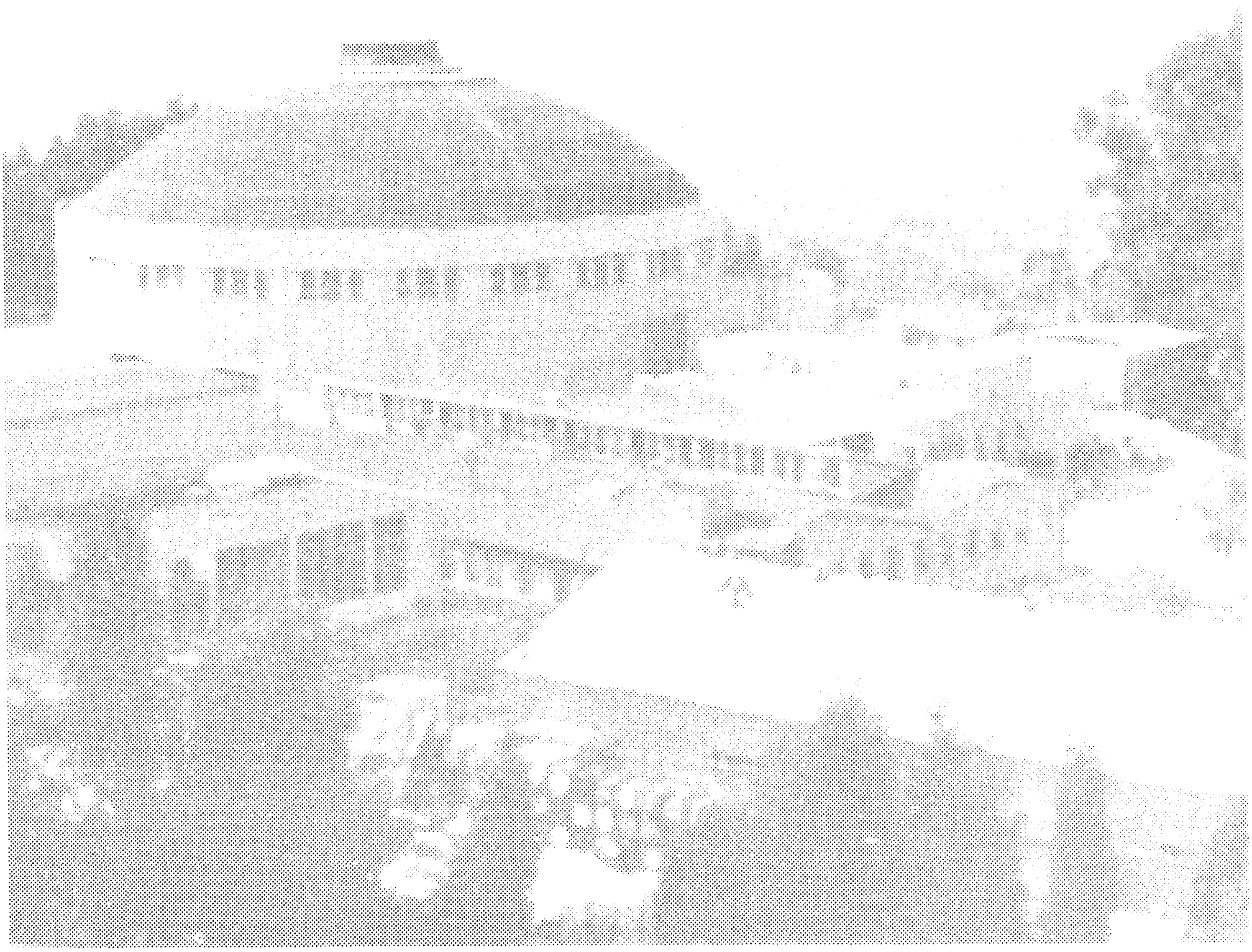
Section 3. Compliance Summary



This section of the report summarizes LBL's compliance status with major statutes and Executive Orders during 1993. Information regarding the status of compliance activities and corrective actions is discussed, along with information concerning notices of violation issued to the site. Also included is a brief discussion of the environmental permits at LBL and noteworthy practices in the site's environmental programs.

Clean Air Act (CAA)

US/EPA issued an Administrative Order and Finding of Violation, dated April 19, 1991, for noncompliance with the requirements of 40 CFR 61, Subpart H, *National Emissions Standard for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities.* This regulation is a subpart of the National Emission Standards for Hazardous Air Pollutants (NESHAPs). On August 30, 1993, US/EPA and DOE signed a Federal Facilities Compliance Agreement (FFCA) that outlines a schedule for bringing LBL's program into full NESHAPs compliance by February 1995. The FFCA includes a $1.8 million corrective action project that will upgrade the stack-emissions monitoring program to NESHAPs standards. LBL began effort on this corrective action project in 1991, well before the FFCA was drafted or signed. The compliance schedule contained in the FFCA identifies 12 milestone activities upon which US/EPA, DOE, and LBL have agreed. Since the approval of the FFCA, all compliance milestones have been met and LBL is on schedule to meet the pending milestones. Two of these milestones were completed in 1993. They included preparing a records management procedure for NESHAPs compliance and completing the engineering work on the stack-monitoring equipment.

On April 19, 1993, US/EPA performed a radionuclide NESHAPs audit of the facility. The audit was a follow-up to the finding in 1991, and was held in conjunction with a DOE Environmental Functional Appraisal. Two noteworthy items emerged from the audit; however, US/EPA did not recommend any action as a result of the audit. First, US/EPA noted that LBL's modeling dose assessment methodology included an additional factor not allowed under the modeling guidance and that insufficient documentation existed to verify dose assessments. This factor reduced the exposure duration at the point of highest impact (Lawrence Hall of Science) to account for the noncontinuous occupancy of the site. LBL deleted the occupancy factor from its dose assessment methodology. The second item led to inclusion of a recordkeeping procedure into the FFCA compliance schedule with an October 1, 1993 deadline. Prior to this date, LBL created a new procedure to address a quality assurance requirement for recordkeeping.

The FFCA compliance schedule also specified that engineering for the radiological stack monitoring upgrades would be completed by December 1, 1993. Contracts for installing new monitoring equipment, which were based on the final engineering of the three individual stack monitoring projects, were awarded at various times during 1993. LBL submitted quarterly progress reports on the FFCA to US/EPA Region IX for both the third and fourth quarters of 1993, as required by the FFCA.

The Bay Area Air Quality Management District (BAAQMD) conducted five separate inspections of permitted and registered-exempt stationary air emission sources during 1993. A startup inspection occurred on February 19 for a newly registered unheated-solvent-based cleaning source. The remaining four site visits were part of BAAQMD's annual inspection program. Dates for these inspections were June 3, June 8, June 22, and July 13. (See Table 3-1 for a list of all regulatory agency inspections and DOE audits held in 1993.) An inspection close-out meeting between BAAQMD and LBL took place on July 20. A total of 110 sources (25 permitted and 85 registered-exempt sources) were reviewed during the five inspections. The inspections resulted in one Notice of Violation (NOV #23526) during the June 8 inspection for use of a prohibited spray gun nozzle at a paint spray booth. LBL took corrective action by installing a new compliant spray gun nozzle on the day of the citation, and paid a $275 settlement penalty. The BAAQMD inspector who cited the deficiency confirmed acceptability of the replacement spray gun nozzle during the next inspection.

BAAQMD adopted a rule in late 1992 to reduce oxides of nitrogen and carbon monoxide emissions from boilers larger than certain rated capacities. The rule was modified in September 1993 to add tune-up procedures as one of the compliance options for low-fuel-usage-boilers. LBL has six boilers affected by this rule, and all are considered to be low-fuel-usage types. The effective date for implementing these procedures is January 1, 1996. LBL must notify BAAQMD by January 1, 1995 of how it intends to comply with the rule. LBL expects to follow the tune-up procedure, since meeting the emission limit options would require significant modifications to each of the boilers.

BAAQMD also administers the asbestos regulations of 40 CFR 61 Subpart M, "National Emissions Standard for Asbestos." Inspections occur whenever renovation or demolition projects involve regulated asbestos-containing materials. There were no asbestos-related inspections conducted or violations issued in 1993.

The Clean Air Act Amendments of 1990 created a wide-ranging and extremely stringent set of statutory requirements for air quality compliance at major source facilities. Based on the current definition and LBL's assessment of its known air emissions, LBL is not considered a major source under either Title III (Hazardous Air Pollutants) or Title V (Operating Permits). Major sources are defined as having the potential to emit more than 10 tons per year of a single hazardous air pollutant or more than 25 tons per year of all hazardous air pollutants or more than 100 tons per year of any regulated air pollutant. The latest facility-wide inventory of annual air emissions indicates the following:

Regulated Air Pollutants

- slightly more than 1800 kilograms (2 tons) of carbon monoxide
- about 8175 kilograms (9 tons) of nitrogen oxides
- nearly 2275 kilograms (2.5 tons) of all organic compounds
- over 910 kilograms (1 ton) of particulate matter
- approximately 3000 kilograms (3.3 tons) of Class I ozone-depleting substances

Hazardous Air Pollutants (HAPs)

- about 1450 kilograms (1.6 tons) of 1,1,1-trichloroethane

Table 3-1. Environmental Inspections of LBL During 1993

Inspection Title	Visiting Organization	Start Date	Duration (days)
Hazardous Materials and Hazardous Waste Inspection	City of Berkeley	1/5/93	1
Hazardous Materials and Hazardous Waste Inspection	City of Berkeley	1/7/93	1
Hazardous Materials and Hazardous Waste Inspection	City cf Berkeley	1/14/93	1
Hazardous Materials and Hazardous Waste Inspection	City of Berkeley	1/26/93	1
Agreement in Principle Progress Meeting	DHS	1/27/93	1
Hazardous Materials and Hazardous Waste Inspection	City of Berkeley	1/28/93	1
Hazardous Materials and Hazardous Waste Inspection	City of Berkeley	2/2/93	1
Hazardous Materials and Hazardous Waste Inspection	City of Berkeley	2/4/93	1
BAAQMD Initial Inspection	BAAQMD	2/19/93	1
Waste Management	DTSC	3/11/93	2
Hanford LLW/RMW Conformity Inspection	Westinghouse Hanford Company	3/17/93	2
Environmental Functional Appraisal	DOE	4/19/93	5
Radionuclide NESHAPs Audit	US/EPA	4/19/93	1
EBMUD Oversight Audit	US/EPA, EBMUD	4/19/93	1
BAAQMD Annual Inspection	BAAQMD	6/2/93	1
DOE Environmental Restoration Program Review	DOE	6/7/93	3
BAAQMD Annual Inspection	BAAQMD	6/8/93	1
SRC Triennial Audit of EH&S Division	Safety Review Committee	6/15/93	1
BAAQMD Annual Inspection	BAAQMD	6/22/93	1
Operations Assessment Training - Waste Management	DOE	7/12/93	10
Agreement in Principle Progress Meeting	DHS	7/12/93	1
BAAQMD Annual Inspection	BAAQMD	7/13/93	1
BAAQMD Annual Inspection Close-out	BAAQMD	7/20/93	1
Fixed Treatment Units	DTSC	11/2/93	2
Hazardous Waste Handling Facility	DTSC	11/24/93	2

- around 8625 kilograms (9.5 tons) of all HAPs

By regulation, there are 189 hazardous air pollutants and 5 categories of regulated air pollutants. Locally, BAAQMD drafted a new regulation on September 30, 1993, that would modify its permitting program to adopt the federal operating permit requirements listed in the amended Clean Air Act.

Title VI of the Clean Air Act Amendments of 1990 addresses the phase-out of ozone-depleting substances (ODSs). LBL has established an aggressive program for eliminating or reducing its ODS usage in solvent cleaning, packaging materials, refrigeration and air conditioning, and fire suppression operations in response to Title VI and other mandated requirements (see Executive Order 12843 later in this section). The program is both near- and long-term oriented and is tailored to comply with US/EPA's Significant New Alternatives Policy program for ODSs. Acceptable alternative substances presently exist for certain operations, while other operations do not have either acceptable alternatives or committed funding needed for required capital investments. Those operations with funding constraints are now included in future-year budgetary requests. Also under new ODS requirements, LBL certified with US/EPA on August 5, 1993, that the two refrigerant recovery and recycling systems used at LBL on refrigeration and air conditioning systems meet criteria specified in regulations promulgated earlier in the year.

Clean Water Act (CWA)

LBL's sanitary sewer discharge activities in 1993 did not result in any Notice of Violations from the East Bay Municipal Utility District (EBMUD). However, LBL did complete corrective actions on an NOV that resulted from operations in December 1992 at the Building 77 Plating Shop Waste Treatment Unit. This violation was discovered and reported to EBMUD within the framework of the self-monitoring program for an excursion of the daily maximum discharge limits for nickel and zinc into the City of Berkeley sanitary sewer system. EBMUD issued the NOV to LBL on January 4, 1993. LBL performed required notifications and investigations, and undertook corrective action to prevent recurrence of the violation. Measures within this program included a new plan for long-term operation and maintenance of the system, including building a roof over the treatment unit, installing upgraded metering devices, and preparing and implementing administrative controls in the form of calibration and maintenance procedures. These measures are consistent with a suggestion made by EBMUD. EBMUD assessed an administrative fee against LBL related to the follow-up inspections and monitoring totaling $801. Throughout all of 1993, LBL remained in compliance with EBMUD discharge limits. LBL has also met all other terms and conditions of its permits, for example instituting an Accidental Spill Prevention and Containment Plan (ASPCP) in those areas where there is a potential for spills of hazardous materials to the sanitary sewers. Thirty-four such sites were identified at LBL and received the ASPCP: 31 photographic areas, Building 77, Building 25, and the Motor Pool at Building 76.

In April, at the same time that LBL's Environmental Protection staff was participating in the DOE Functional Environmental Appraisal, a team of US/EPA and EBMUD inspectors conducted an unannounced inspection of the site. The purpose of the inspection was for US/EPA to review EBMUD's regulation of LBL in regard to the Clean Water Act. In August, US/EPA issued a report on this inspection containing 14 items called findings and conclusions pertaining to federal categorical pretreatment standards applicable to LBL as well as questions on processes and compliance limits. LBL subsequently met with the agencies involved and resolved all issues to their satisfaction, and no violations were issued.

According to the Regional Water Quality Control Board (RWQCB) in a January 5, 1994 letter, LBL currently complies with requirements of the State General Permit for Storm Water Activities Associated with Industrial Discharges. Within its stormwater program, LBL updated its *Storm Water Monitoring Program* (SWMP) in March 1993 to include monitoring experience gained during the first rainy season. LBL had first implemented its SWMP on October 1, 1992, in response to a commitment to DOE and to coincide with the rainy season. This implementation date was well before the regulatory deadline of January 1, 1993. In accordance with its stormwater permit, LBL submitted its first Annual Report pertaining to its stormwater activities on July 1, 1993, to the RWQCB and the City of Berkeley. LBL's *Storm Water Pollution Prevention Plan* (SWPPP) identified non-stormwater discharges at the facility that could not be eliminated prior to implementing the SWPPP. LBL submitted a letter to the RWQCB on June 4, 1993, detailing the Laboratory's intent to eliminate these discharges by March 30, 1995, and the Laboratory is presently implementing the plan.

Construction is currently in progress on corrective actions to eliminate any connections of industrial and sanitary wastewater to the storm sewer. As a result of surveys undertaken in 1992 in accordance with its SWPPP, LBL found 38 such connections, and has now embarked on a program to fund, design, and construct piping modifications. During 1993, corrective actions at four buildings were completed. It is expected that repairs will be completed at six more buildings by the end of fiscal year 1994, as will design efforts for the remaining connections. Consistent with the General Stormwater Permit, all such connections will be eliminated by March 30, 1995.

Requirements for the State Water Resources Control Board's (SWRCB) General Construction Activity Stormwater Permit currently state that such a permit is necessary if five or more acres of a site are under construction. Since LBL has not had five or more acres under construction at any one time, no application for the General Construction Activity Permit has been made. However, LBL does institute best management practices at all its construction sites and seeks to avoid impact to the storm drain system by soil erosion or construction materials to the extent possible. Examples of LBL's practices include covering excavation piles with weighted plastic, protecting storm drains from dirt or other materials by covering them or blocking them, general good housekeeping on a site, and storing hazardous materials in containers and away from storm drains

LBL updated and recertified its *Spill Prevention, Control, and Countermeasures* (SPCC) Plan in October of 1993 to reflect changes in locations and capacities of relevant areas, previous spills, and facility improvements and procedures to be implemented, and to achieve consistency with other site plans. The plan provides standards for storage and usage of petroleum products in a manner that will prevent accidental releases to the environment. Spill kits have been placed at 13 appropriate sites around LBL, and personnel training has been conducted on procedures connected with the SPCC Plan.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

In 1991, LBL submitted a preliminary assessment/site inspection (PA/SI) package to US/EPA for review. The objectives of US/EPA review were twofold: (1) to determine if the facility had met Superfund Amendments and Reauthorization Act (SARA) requirements as defined in Section 120; and (2) to determine if site conditions at LBL posed a significant threat to human health and the environment such that the site warranted placement on the National Priorities List. US/EPA determined in September 1991 that LBL had provided enough information on the site for US/EPA to certify its PA/SI review. LBL did not rank high enough under the Hazard Ranking System to warrant inclusion on the National Priorities List, and US/EPA recommended that there be no further remedial action planned under CERCLA. As a result, site restoration activities became subject to the Corrective Action Program of the Resource Conservation and Recovery Act (RCRA) and are discussed in Section 7 of this report.

In August 1992, US/EPA sent various parties, including LBL, a Notice of Potential Liability and Request for Information on the North American Environmental, Inc. (NAE) site in Clearfield, Utah, pursuant to Sections 106 and 104(e) of CERCLA. LBL was provided information indicating that 13 drums of polychlorinated biphenyl (PCB) waste originating at LBL had been transported to the Utah site in violation of an agreement between NAE and an LBL subcontractor, which had required disposal of these wastes in compliance with Federal law. LBL removed all of its reported waste from the site prior to its official designation as a Superfund site on September 1, 1992. The wastes were removed in accordance with a March 1992 US/EPA protocol and were transported by a licensed hauler to Aptus/Westinghouse Environmental Services in Coffeyville, Kansas, on September 23, 1992.

LBL submitted a response to US/EPA's Notice of Potential Liability on October 21, 1992. LBL stated that it would be inappropriate to participate in further removal actions at the NAE site, because no reported LBL wastes remained at the site and there was no evidence to indicate that reported LBL wastes had caused a release while at the site. LBL submitted its response to US/EPA's Request for Information on November 9, 1992.

On December 2, 1992, US/EPA issued a draft Administrative Order on Consent. In a cover letter, US/EPA noted that the draft Order had not been sent to Potentially Responsible Parties (PRPs), such as LBL, that had removed their wastes prior to September 1, 1992, and had declined to participate in further removal actions. US/EPA advised, however, that such parties should not necessarily consider themselves relieved of liability at the Clearfield site. LBL was informed that, as of March 1994, the NAE warehouse owner, Freeport Center, and the Defense Logistics Agency were in the process of conducting an inventory prior to beginning the actual removal of the remaining wastes at the NAE site.

In November 1992, LBL also responded to a request for information from Cal/EPA's Department of Toxic Substances Control (DTSC) on the Bay Area Drum (BAD) Site, a former drum recycling and reconditioning facility located in San Francisco, pursuant to Health and Safety Code Sections 25185.6, 25358.1, and 25358.3. By the end of 1993, LBL had received no further inquiry or direction from DTSC regarding LBL's status as a possible PRP at the site. In 1992, LBL also received an invitation to join a PRP group organized to evaluate and address environmental matters at the BAD site and negotiate a favorable resolution with DTSC. Because all available evidence indicated that the wastes attributed to LBL were attributable to other specifically identifiable parties, LBL declined to join the PRP group in June 1993.

Emergency Planning and Community Right-To-Know Act (EPCRA)

The implementation of LBL's hazardous and toxic materials reporting requirements is overseen by the local administering agency, the City of Berkeley (COB). A Business Plan containing documentation of compliance with these requirements was submitted to COB in January, 1992. This Business Plan included detailed chemical inventory report information and an emergency response plan. Site evacuation and reporting is also required in the event of an actual or threatened release, as well as evidence of adequate employee training for handling such a release. Subsequent to the full Business Plan submission in 1992, LBL provided COB with a complete update of chemical inventory information in July 1993 to comply with the requirements for annual updates of the inventory. The other portions of the Business Plan must be updated every two years, or more frequently as significant changes occur. COB recently modified its reporting deadline from January 1 to July 1; therefore, the next comprehensive Business Plan update is due on July 1, 1994.

Endangered Species Act (ESA)

A biological resources survey of approximately 0.6 hectare (1.5 acres) of land along a portion of Chicken Creek south of Building 31 was undertaken in April 1993 for a proposed parking lot. No threatened, endangered, or candidate species were identified on the proposed project site. Two small wetlands (measuring 3 m by 3 m and 3 m by 15 m) were identified by the survey. These wetlands were formed by water from subdrains that drain the adjacent hillslope and are represented by standing water and rushes. These wetlands were determined to be outside the area of project impact and off LBL facility property.

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)

LBL used registered pesticides in 1993. "Restricted use" pesticides were applied by licensed contractors. LBL personnel apply "general use" pesticides only.

Hazardous Waste Source Reduction and Management Review (SB 14)

This State requirement resulted in LBL preparing and approving a two-part report in 1992: (1) *Source Reduction Evaluation Review Plan and Plan Summary*, and (2) *Hazardous Waste Management Report Summary*. The report required certification on two levels: technical and financial. The goal of the LBL program is for substantially reduced waste generation, increased recycling, and promoting pollution prevention. This plan established a timetable for performing process waste assessments (PWAs) on those waste streams that are at least 5% of the total waste stream from LBL. Those waste streams include:

- aqueous wastewater treatment effluent
- spent empty drums ≥ 30 gallons
- waste liquids with pH ≤ 2
- waste machining and grinding coolant/water
- waste mercury (extremely hazardous)
- waste oil (nonautomotive)

The aqueous wastewater treatment effluent was included in LBL's plan because it represented the largest waste stream on-site. A wastewater renovation project in 1991 routed only necessary water to LBL's treatment towers. No further assessment of this waste stream is required under SB14 guidance. LBL completed two PWAs in 1993: one for waste oil (non-automotive) and the other for a portion of the waste liquids with pH ≤ 2 from the Building 25 Printed Circuit Board process.

The *Hazardous Waste Management Report Summary* is primarily meant to assess changes in waste management activities. Updates to both parts of the report are scheduled for September 1995. LBL activities in waste minimization are ongoing.

Medical Waste Tracking Act of 1988

LBL's medical research programs generated approximately 15,020 kg (33,110 lb) of medical waste in 1993. Medical waste is defined to include biohazardous waste (*e.g.*, blood and blood contaminated materials), "sharps" waste (*e.g.*, needles), and other waste produced in research relevant to the diagnosis, treatment, or immunization of human beings or animals, or in the production of biological products used in medicine.

There were no inspections of LBL's medical waste program by the California Department of Health Services (DHS) in 1993. Under the State's program, LBL is considered a large-quantity generator since it generates more than 91 kilograms (200 pounds) of medical waste each month. LBL prepared a *Medical Waste Management Plan* in July 1993 in accordance with the requirements for facilities classified as large-quantity generators. This plan included sections on training; emergency action; medical waste hauling, treatment, and disposal; hazardous medical waste; radioactive medical waste; document control and recordkeeping; and program certification. Also included in the plan are LBL's *Medical and Biohazardous Waste Generator's Guide* and *Medical and Biohazardous Waste Generator's Training Plan*. DHS issued a Certificate of Registration (#00555R3) for Medical Waste Large Quantity Generator on November 22, 1993. The certificate must be renewed annually.

LBL generates medical waste in about 120 different locations distributed over 15 buildings, including four offsite buildings. LBL has contracted with a certified medical waste hauler who visits the Laboratory pickup sites weekly. The pickup schedule varies from location to location. Nearly all generator locations have medical waste pickups either weekly or monthly. The remaining few are serviced on an "as needed" basis.

National Environmental Policy Act (NEPA)

In 1993, LBL prepared 128 formal documents in accordance with DOE policies and procedures for NEPA compliance. These included 125 categorical exclusions and 3 environmental assessments (EAs). The EAs include the following:

1. The Human Genome Laboratory EA was submitted to DOE in December 1993.
2. The EA for disposition of copper coil windings from the 184-inch Cyclotron was submitted by DOE to the State of California for review in February 1993. The State had no comments. In October, the EA was sent by ER-8 to EH for issuance of a Finding of No Significant Impact (FONSI). As of the end of the year, the FONSI had not been issued.
3. The EA for the Biomedical Isotope Facility was completed in June. A FONSI for the project was issued by DOE on July 30, 1993.

Under the California Environmental Quality Act (CEQA), LBL completed initial studies for the following activities:

1. The Biomedical Isotope Facility. During the public comment period, comments were received from the Berkeley Community Environmental Advisory Committee (CEAC). A letter responding to comments was submitted to the CEAC, and a Negative Declaration was issued on April 21, 1993.
2. The continued Operation of and Alterations and Upgrades to the Existing Hazardous Waste Handling Facility at LBL. A Negative Declaration was issued on February 26, 1993.
3. Modification of Permitted Hazardous Waste Handling Facility (HWHF) Operations at LBL and Transportation of Hazardous and Mixed Wastes from an Offsite LBL-leased Building to LBL's HWHF was prepared in October 1993. During the public comment period, comments were received from the Committee to Minimize Toxic Wastes. LBL is revising the Initial Study to reflect changes in the project. The revised Initial Study will include responses to comments and will be recirculated for public review in 1994.

Other 1993 activities under CEQA included preparation of the Environmental Impact Report (EIR) for the proposed Human Genome Laboratory. In addition, LBL documented and received University of California Office of the President (UCOP) concurrence that seven proposed projects were categorically exempt from CEQA.

LBL also prepared draft *Guidelines for Compliance with the National Environmental Policy Act and California Environmental Quality Act*, which outline the compliance process and provide Laboratory-wide procedures for complying with these regulations. These guidelines were reviewed by DOE and UCOP. The final document was published in February 1993. In concert with preparing the guidelines, LBL prepared a draft NEPA and CEQA training program plan, and began developing training materials for courses that would be provided to Laboratory Division personnel as one of the required EH&S training programs. Following publication of the guidelines, 1.5 days of training on its implementation was provided to LBL division personnel. LBL also developed a Laboratory-wide system for tracking the status of documents prepared in compliance with NEPA and CEQA.

National Historical Preservation Act (NHPA)

LBL evaluated the potential historic architectural significance of Building 7 because of considerations to demolish this structure. The evaluation indicated that the building is not eligible for listing on the National Register of Historic Places. Concurrence with this determination was received from the State Historic Preservation Officer on March 19, 1993.

In 1993, LBL procured consultant services to conduct a historic architectural evaluation of the Bevatron and SuperHILAC. The Bevatron was the largest, highest-energy accelerator in the world when it began operation in 1954. During the 1950s and 1960s, four Nobel Prizes were awarded for particle physics research conducted in whole or in part at the Bevatron. The consultant's report is due in 1994.

Pollution Prevention Act of 1990 (PPA)

The Pollution Prevention Act of 1990 declares that source reduction is a national policy and directs US/EPA to study and encourage source reduction policies. LBL does not meet the *de minimis* levels identified in the Act and is not subject to the Act's reporting requirements. However, LBL does have a substantial waste minimization and pollution prevention program in place at the facility.

Resource Conservation and Recovery Act (RCRA)

On March 21, 1991, Cal/EPA's DTSC issued a Report of Violation (ROV) for alleged hazardous waste violations found during a 1990 inspection. DTSC, the Office of the Attorney General, LBL, and DOE began negotiations on the 1991 ROV in February 1992. DTSC issued a second ROV on April 9, 1992, for additional alleged hazardous waste violations found during an inspection in February and March 1992. The findings for both ROVs were combined into one settlement agreement effective September 30, 1993. The agreement required LBL to pay $19,616 to DTSC in reimbursement for its inspection and enforcement costs, and to offer technical guidance and other assistance to University of California campuses.

DTSC conducted an inspection at LBL on March 11 and 12, 1993. Following the inspection, DTSC issued an ROV and Enforcement Order specifying its findings, which included, among others, a violation for storage of incompatible materials in separate, sealed drums on a pallet that was awaiting offsite shipment, and a violation for a December 1992 fire in the waste facility caused by improper waste packaging of lithium. Settlement on DTSC's findings was reached on September 28, 1993, which required LBL to pay $18,000 in penalties and administrative costs.

DTSC conducted another inspection of the HWHF on November 24, 1993. No violations of hazardous waste laws were found. The director of DTSC announced that LBL's "hazardous waste practices have improved to the point where we think they can be a role model for other university facilities."

LBL prepared the Biennial Hazardous Waste Report for 1993 in March 1994. The report was submitted to US/EPA with a copy to Cal/EPA's DTSC. It contains specific generator and transport information for all activity at the Hazardous Waste Handling Facility for 1993. LBL also prepared the Annual Waste Reduction Report for the previous calendar year in March 1993. This report was submitted to DOE. It contains a detailed analysis of waste minimization efforts made by waste generators.

The Environmental Restoration program, including the final RCRA Facility Investigation (RFI) Workplan, is now conducted pursuant to the RCRA Corrective Action requirements set forth in the 1993 permit for LBL's Hazardous Waste Handling Facility. The discussion on CERCLA earlier in this section describes how the Environmental Restoration program at LBL evolved into its present state. The objective of the Environmental Restoration program is to identify areas where soil and/or groundwater are contaminated, determine sources and the extent of contamination, and develop and implement plans to remediate contaminated media. In November 1992, LBL submitted an RFI Workplan to DTSC. In this Workplan, LBL outlined two general activities: (1) areas requiring further site restoration effort to define the extent of contamination and identify sources, and (2) areas where no further restoration effort is needed. DTSC provided written comments on the Workplan on September 14, 1993. These comments requested additional work in some areas, and justification from LBL for excluding other areas from further field activity. LBL sent DTSC a response to these concerns on December 13 and amended the RFI Workplan in March 1994 to reflect this clarification. DTSC agreed with LBL on most concerns. Since environmental restoration activities are conducted in a phased manner, remaining concerns will be handled through addenda to the Workplan. The Environmental Restoration program provides DTSC with quarterly progress reports on the program.

On July 29, 1993, DTSC provided LBL with a breakdown of the jurisdictional and oversight responsibilities that various agencies play in the RFI corrective action program at LBL. These agencies included the State Water Resources Control Board, the Regional Water Quality Control Board, the Environmental Management Branch of the California Department of Health Services, the City of Berkeley, and the California Department of Toxic Substances Control. The intent of this breakdown was to avoid duplication, delays, and unnecessary hardships on both LBL and the various agencies.

On November 3, 1993, Cal/EPA's DTSC conducted an inspection of LBL's five fixed treatment units subject to the State's Tiered Permitting program. DTSC concluded that all five treatment units were in compliance and operating within the correct permitting tier. LBL is one of only a few California facilities to have passed this inspection in 1993.

Safe Drinking Water Act (SDWA)

Drinking water is supplied to LBL by the East Bay Municipal Utility District. There are no drinking water wells on site.

LBL has a program of upgrading its drinking water distribution system by replacing cross-connections having a potential for contamination between domestic water and wastewater with backflow prevention devices that meet plumbing code requirements. The second phase of this project began in 1989 and was completed in May 1993. Over 100 backflow devices were installed during this phase.

In 1993, LBL identified its "blue water" problem in Building 66. Copper originating from the drinking fountains themselves was discovered as the source of the contamination. Three questionable fountains were replaced in early 1994.

Toxic Substances Control Act (TSCA)

There were no US/EPA or State of California TSCA inspections in 1993. Under TSCA, regulated PCBs are defined as substances with a concentration greater than 500 parts per million (ppm) of PCBs. Other lesser categories of PCB concentrations are PCB-containing and PCB-contaminated. LBL has identified and inventoried all true PCB transformers on the site.

LBL identified three additional transformers containing PCBs in 1993. On June 30, a power-supply rack transformer holding less than 19 liters (5 gallons) of oil with a PCB concentration of 3,200 ppm was found in Building 71. The transformer was disposed of through the HWHF. On September 30, two large utility transformers containing approximately 1,135 liters (300 gallons) of oil each were reported in Building 16A. The concentrations of PCBs were 610 ppm and 520 ppm, respectively. LBL drained each transformer and disposed of the PCB-contaminated oil as waste.

The number of PCB items and volume of PCBs at LBL has decreased since the US/EPA program began. All utility transformers, which total around 100, are below 50 ppm PCB concentration. The primary sources of PCBs at LBL are now large low- and high-voltage capacitors. Approximately 250 of these capacitors are still in use, containing an estimated 420 kilograms (930 pounds) of PCBs. 1992 records indicate 580 capacitors in use at LBL, retaining an estimated 1,450 kilograms (3,200 pounds) of PCBs.

LBL is currently developing a written plan for the management of PCBs on the site. Approval of the document and implementation of its provisions are scheduled for 1994. As required by TSCA, LBL prepared an Annual PCB Activity Document, which inventoried and documented PCB-related activities at the site for the previous calendar year (1992). LBL is not required to submit the report to US/EPA, but it will be made available to the agency if requested.

Executive Order 11988, "Floodplain Management"

There were no new facilities added or assessments performed in 1993. LBL's Facilities Department completed all the necessary floodplain assessments in 1992 for DOE-owned or leased facilities, or for facilities on the University of California at Berkeley campus where DOE activities take place. Those floodplain areas nearest LBL include the coastal zone near the San Francisco Bay and a narrow band at the edge of Strawberry Creek, which flows through the LBL boundary. An assessment for the Building 901 replacement facility will be performed in 1994 after approval of the lease by the Regents of the University of California.

Executive Order 11990, "Protection of Wetlands"

Since there are no wetlands affecting LBL facilities, wetlands investigations are not required at LBL's main site and current offsite locations. All offsite projects are reviewed for protection of wetlands.

Executive Order 12843, "Procurement Requirements and Policies for Federal Agencies for Ozone-Depleting Substances"

President Clinton's signing of E.O. 12843 on April 21, 1993, gave Federal agencies six months to submit a report to the Office of Management and Budget (OMB) on each agency's plan to reduce and eventually phase out both the procurement and use of substances that cause stratospheric ozone depletion. DOE submitted its report to OMB in November 1993. The DOE report identified efforts in four main usage areas: refrigeration and air conditioning, fire protection, solvent cleaning, and miscellaneous uses. Concurrently, DOE distributed a document entitled *Refrigerant Management Plan for Department of Energy Facilities* to all DOE sites to provide guidance on the implementation of this executive order in the largest area affected by this order, refrigeration and air conditioning. The refrigerant management program that LBL began in the first quarter of 1993 takes a proactive approach to phasing out ODS procurement and use at the Laboratory. LBL's program achieves the objectives specified in the DOE guidance document.

Executive Order 12873, "Federal Acquisition, Recycling, and Waste Prevention"

This executive order, signed on October 20, 1993, supersedes Executive Order 12780, *The Federal Agency Recycling and the Council on Federal Recycling and Procurement Policy*. LBL has established an affirmative procurement group, which meets every other month to address the key issues involved in this executive order. These issues include the integration of recycled materials in the following products:

- building insulation materials
- cement and concrete containing fly ash
- lubricating oils containing refined oil
- paper and paper products
- retread tires

In addition to regular purchases of products of recycled components, the new executive order mandates that all Federal agencies buy printing and writing paper consisting of at least 20% post-consumer material by December 31, 1994, and at least 30% post-consumer material by December 31, 1998. No increase in Federal spending on paper products will be allowed under the Order. Instead, agencies must compensate for price increases by reducing paper use and waste.

DOE Order 5000.3B, "Occurrence Reporting and Processing of Operations Information"

All three environmentally related Occurrence Reports (ORs) were classified as Off Normal. These included: (1) an acid spill of about two liters (one-half gallon), of which around one-quarter liter (one cup) entered the storm drain; (2) a spill of an estimated 150 liters (40 gallons) of fuel oil onto a parking lot surface, of which an undetermined but insignificant amount reached the storm drain before cleanup teams arrived (sampling confirmed that there was no offsite release); and (3) a release of an estimated 44 curies of tritiated water vapor from the National Tritium Labeling Facility. Initial estimates of the tritiated water vapor placed the value at 60 curies based on the normal average flow rate through the system. However, a more accurate stack-flow calibration lowered by the flow rate about 25%, reducing the release of tritium by the same percentage down to 44 curies. This tritiated water-vapor release accounted for about 42% of LBL's total environmental dose impact in 1993, or about 0.05 millirem per year, well below the EPA standard of 10 millirem per year.

DOE Order 5400.1, "General Environmental Protection Program"

The LBL Parameter Review Plan (PRP) was completed and approved in 1993. This plan forms the foundation of the Environmental Monitoring Plan. The PRP develops all pathways and action levels for all sampling media and analytes. Proposed rules to codify many of the DOE Orders were published in the March 1993 Federal Register. Codification of the proposed rules into 10 CFR 834 is expected in 1994 or 1995, and will have some impact on environmental protection activities at LBL.

Summary of Permits

Air Emissions

BAAQMD issues operating permits for stationary sources of air pollutant emissions. Additionally, sources that are exempt from permit requirements but for which operating information has been provided to BAAQMD in a permit application are classified as registered-exempt. At the end of 1993, LBL had a facility-wide total of 40 operating permits and 85 registered-exempt sources. This is a change from 1992 when the totals were 36 operating permits and 81 registered-exempt sources. Activities in 1993 included obtaining operating permits for 16 new sources and registered-exempt status for four additional sources. These four additional sources include abatement devices, which presently must be registered with BAAQMD. The new sources include building-wide solvent wipe cleaning (14), semiconductor research (2), lead pot with abatement (1), machine tools with abatement (2), and sandblast with abatement (1). Also, 12 formerly permitted sources were redesignated as registered-exempt as a result of the 1992 BAAQMD annual inspections and eight sources were removed from operation.

LBL's operating permits cover a wide range of equipment and operations, such as epoxy mixing, gasoline dispensing, painting, sandblasting, semiconductor research, solvent cleaning, and vacuum coating, as well as abatement equipment controlling emissions from machining, wood-dust collection, and sulfur hexafluoride discharges. See Table 3-2 for a complete listing of permitted sources.

Operating permits are renewed annually by BAAQMD. The process begins in March with a request for updated information by BAAQMD on certain registered sources and ends around July 1 when the new permits are issued. LBL's registered-exempt sources fall under source categories of chemical processing, furnaces, combustion, liquid storage, material

Table 3-2. BAAQMD Permitted Air Emission Sources at End of 1993

BAAQMD Source Category	BAAQMD Source #	Description	Building	Permit Condition	Abatement Device	Abatement Type
Furnaces,	104	Paint drying oven	77			
Ovens, and Kilns	145	Crystal Growth Furnace	2	X	X	Mist Eliminator
	148	Epoxy Curing Oven	53			
	149	Epoxy Curing Oven	53			
	150	Epoxy Curing Oven	53			
Gasoline Dispensing	76	Gasoline Pumps	76		X	vapor recovery
Material Working and Handling	64	Sawdust collector	74		X	Cyclone, Simple
	73	Machine shop tools	76		X	Cyclone, Dynamic
	116	Machine shop tools	79		X	Cyclone, Simple
Miscellaneous	84	Solder/grinding hood	77			
	124	Sulfur hexafluoride chamber	58A		X	Refrigeration
	159	Vacuum coating chambers	25	X	X	Baghouse, Simple
Semiconductor Manufacturing	168	Instrument Support Laboratory	70A	X		
	186	Semiconductor Fabrication Area	70A	X		
Surface Coating	74	Paint spray booth	76	X	X	Liquid Separator
and Printing	96	Paint spray booth	77		X	Dry Filter
	147	Epoxy Mixing Hood	53	X		
Surface	38	Ultrasonic cleaner	53	X		
Preparation and	92	Vapor/spray degreaser	77	X	X	Refrigeration
Cleaning	97	Sandblast booth	77		X	Baghouse, Shaking
	118	Printing press ink removal	934			
	119	Aluminum parts washer	77			
	130	Solvent cleaning, 60 gal/yr. net	77			
	140	Vapor degreaser	52	X		
	141	Ultrasonic degreaser	76	X		
	166	Sandblast booth	71B	X	X	Baghouse, Simple
	172	Wipe Cleaning	52	X		
	173	Wipe Cleaning	58	X		
	174	Wipe Cleaning	62	X		
	175	Wipe Cleaning	77	X		
	176	Wipe Cleaning	80	X		
	177	Wipe Cleaning	88	X		
	178	Wipe Cleaning	16	X		
	179	Wipe Cleaning	25	X		
	180	Wipe Cleaning	46	X		
	181	Wipe Cleaning	53	X		
	182	Wipe Cleaning	2	X		
	183	Wipe Cleaning	66	X		
	184	Wipe Cleaning	70A	X		
	185	Wipe Cleaning	1	X		

working and handling, semiconductor manufacturing, surface coating and printing, surface preparation and cleaning, and miscellaneous.

BAAQMD also manages the State's Air Toxics "Hot Spots" Information and Assessment Act (AB 2588). This Act originally required that affected facilities submit a Toxic Air Contaminant Inventory and update it every two years. BAAQMD has opted to request this information as part of the annual permit renewal process. LBL's original inventory was submitted in 1990 and updated in 1992. In 1993, BAAQMD modified the reporting requirements under AB 2588 to request an air toxics inventory review every year during the permit renewal process. LBL's 1993 permit renewal was subject to these more stringent requirements.

Hazardous Waste

LBL's Hazardous Waste Handling Facility (HWHF) operates under the provisions of the Resource Conservation and Recovery Act (RCRA) and the State Hazardous Waste Control Law. This includes a RCRA permit issued by Cal/EPA's DTSC for US/EPA, pursuant to California Health and Safety Code Section 25200. A revised Part A and B permit application addressing both the existing and proposed replacement HWHF was submitted to DTSC on August 17, 1992. Final approval of the new Part A and B permit was obtained from DTSC in May 1993. The permit includes a requirement for LBL to investigate and address problems associated with past waste management practices at the site.

The objective of the Environmental Restoration program is to identify areas where soil and/or groundwater are contaminated, determine sources and the extent of contamination, and develop and implement plans to remediate contaminated media. Investigations of potential environmental contamination of soil, surface water, and groundwater are currently being conducted at LBL under the RCRA Facility Investigation Phase of the RCRA Corrective Action Process. This process began in the fall of 1993.

The State's Tiered Permitting program for hazardous waste treatment and storage units not requiring a RCRA permit was implemented in 1993. The five tiers, listed in increasing order of regulatory complexity, are:

1) conditional exemption
2) conditional authorization
3) permit-by-rule
4) standardized permit
5) full permit

There are five hazardous waste treatment units, called fixed treatment units (FTUs), located at LBL that fall within the scope of Tiered Permitting (Table 3-3). LBL submitted a Facility Specific Notification and five Unit Specific Notifications to Cal/EPA and the City of Berkeley on the April 1, 1993, regulatory deadline for the five FTUs. LBL received formal authorization to operate from Cal/EPA's DTSC on August 2, 1993. Under the Tiered Permitting program, DTSC allowed continued operation of each FTU between the regulatory deadline and the formal authorization date.

Table 3-3. LBL's Fixed Treatment Units Subject to Tiered Permitting During 1993

Building	FTU	Description	Permit Tier
77	001	Aqueous waste containing metals and inorganic acid	Permit-by-Rule
25	002	Aqueous waste containing metals and inorganic acid	Permit-by-Rule
76	003	Oil mixed with water	Conditional Authorization
70A/70F	004	Inorganic acid	Conditional Authorization
2	005	Inorganic acid	Conditional Authorization

Stormwater Discharge

LBL's stormwater releases require a permit under the State-wide General Permit for Stormwater Discharges Associated With Industrial Activity (No. 2-01S002421). The State-wide permit is issued by the State Water Resources Control Board (SWRCB) and administered and enforced by the Regional Water Quality Control Board (RWQCB) as a National Pollutant Discharge Elimination System (NPDES) permit for discharges of stormwater under the Clean Water Act. The State is authorized to administer and implement the NPDES program within California. Under the permit, LBL has implemented a *Stormwater Pollution Prevention Plan* and a *Stormwater Monitoring Program.* Together, these documents represent LBL's plan and procedures for identifying, monitoring, and reducing pollutants in its stormwater discharges. The General Permit was promulgated by the state in 1991 and will be in effect for five years, after which it is subject to renewal or revision by the SWRCB.

Underground Storage Tanks

At the beginning of 1993, there were 15 active permitted underground storage tanks (USTs) on the LBL site (see Table 3-4), all of which were permitted by the City of Berkeley. The operating permits are for tanks containing diesel fuel, gasoline, or transformer oil. Eight of the operating tanks are double-walled and meet all required construction, monitoring, and industry standards. Five of the operating tanks have single steel walls and require upgrades to meet the December 1998 regulatory standards. Closure plans for two of the single-walled tanks (permit registration ID# 12, oil-spill control, and ID #14, photoprocessing solution) were submitted to the City of Berkeley in November 1992. The two tanks were removed in March 1993. Sampling and analysis of soils from the areas surrounding each tank revealed no soil contamination that could be ascribed to leaks.

On February 6, 1993, an overfill of approximately eight gallons of diesel fuel occurred in secondary containment at UST ID# 2-2. No diesel fuel was released to the storm drain or the sanitary sewer, and the spill was cleaned up within eight hours of the incident. The City of Berkeley was initially notified of this spill in writing on February 11, 1993, with a follow-up status letter sent by LBL on March 12, 1993.

Table 3-4. Underground Storage Tank Operating Permits from City of Berkeley for 1993

Registration Tank ID #	LBL Building	Stored Material	Capacity gallons (liters)	Construction	Year Installed
Fiberglass tanks, double-walled					
2-1	2	Diesel	4,000 (15,200)	Fiberglass	1988
2-2	2	Diesel	1,000 (3,800)	Fiberglass	1988
Double-walled steel with fiberglass plastic corrosion protection					
55-1	55	Diesel	1,000 (3,800)	Glasteel	1986
66-1	66	Diesel	4,000 (15,200)	Glasteel	1987
66-2	66	Diesel	2,000 (7,600)	Glasteel	1987
69-1[a]	69	Waste oil	2,000 (7,600)	Glasteel	1987
76-1	76	Unleaded gasoline	10,000 (38,000)	Glasteel	1990
76-2	76	Diesel	10,000 (38,000)	Glasteel	1990
Single-walled tanks					
4[a]	51	Diesel	550 (2,100)	Steel	1968
6	70	Diesel	600 (2,300)	Steel	1953
7	70A	Diesel	1,000 (3,800)	Fiberglass	1975
8	74	Diesel	12,000 (46,000)	Fiberglass	1979
11	58	Transformer oil	2,000 (7,600)	Steel	1978
12[b]	58A	Spill control	2,000 (7,600)	Steel	1978
14[b]	50	Photo solution	550 (2,100)	Steel	1970s

[a] Closure plan submitted to the City of Berkeley in November 1993, removal expected in 1994.

[b] Removed from site in March 1993.

Aboveground Storage Tanks

LBL updated and recertified its *Spill Prevention, Control, and Countermeasures* (SPCC) Plan in October 1993 to reflect changes in locations and capacities of areas of aboveground petroleum product storage, previous spills, facility improvements, and new procedures, and to achieve consistency with other site plans. The SPCC Plan provides standards for storage and usage of petroleum products in a manner that will prevent accidental discharges into or upon navigable waters or adjoining shorelines. SPCC kits have been placed at 13 appropriate sites around LBL, and personnel training has been conducted on procedures connected with the SPCC Plan. In addition, a corrective action program was begun in 1993 that aims to provide secondary containment to all areas on the site where large amounts [greater than 173 liters (45 gallons)] of petroleum products are stored, principally in electrical transformers and aboveground storage tanks that fuel the Laboratory's emergency electrical generator system (see *Aboveground Storage Tank Modifications* in Section 4).

Wastewater Discharge

In September 1993, EBMUD issued LBL three wastewater discharge permits: one site-wide (Acct. No. 066-00791) and one each for discharge from treatment units at metal finishing operations in Building 25 (Acct. No. 502-38911) and Building 77 (Acct. No. 502-38921). The permits incorporate standard terms and conditions, as well as individual discharge limits, provisions, and reporting requirements. Because of LBL's excellent compliance record in 1993, EBMUD decreased LBL's monitoring and reporting requirements slightly compared to last year's permits. The three permits are renewed annually.

Other Noteworthy Environmental Activities

Tiger Team Activities

Progress on LBL's Corrective Action Plan for resolving the findings of the DOE Tiger Team's site visit in early 1991 continued. The total number of tasks generated from the Tiger Team assessment stands at 380, as several more duplicate tasks were identified and combined in 1993. Laboratory-wide, 1443 milestones were established to complete the Corrective Action Plan. The total number of tasks and milestones closed by the end of 1993 were 327 and 1297, respectively, with 81 tasks and 206 milestones completed in 1993. Specific to environmental issues, 83 tasks and 380 milestones were established in LBL's corrective action program. The total number of environment-specific tasks and milestones closed by the end of 1993 were 77 and 364, respectively, with 15 tasks and 38 milestones of this type completed in 1993.

The DOE Office of Energy Research conducted a Tiger Team Follow-up Review audit on the progress of LBL's corrective action program during the week of February 22–26, 1993. In an effort to make the review and appraisal process more efficient, two additional reviews administered by DOE were performed concurrently with the follow-up visit: (1) the annual multidisciplinary environmental review, and (2) the triennial safety review. The entire review team included 18 specialists from DOE Headquarters and various Operations Offices. The scope of the review focused on corrective actions taken to resolve Tiger

Team findings and/or those pivotal to root-cause elimination. Evaluations were based on interviews, document reviews, and observation of work practices. The team concluded that LBL has made satisfactory to excellent progress in the areas of review: management, safety and health, environmental, radiation protection, and emergency preparedness.

DOE Functional Appraisal

The Oakland Operations Office conducted a Functional Appraisal of LBL's environmental programs during the week of April 19, 1993. The primary objective of this appraisal was to review the status of policies, procedures, and management systems that have been developed or improved since the 1988 Environmental Survey Team and the 1991 Tiger Team audits. The Functional Appraisal did not review areas covered by the 1992 Functional Appraisal, nor did it duplicate efforts addressed under recent State and Hanford audits. The Functional Appraisal identified seven compliance findings and seven best-management-practice observations; however, no imminent hazards were found. A corrective action plan was submitted to DOE in August, with an addendum submitted in November. LBL developed 14 tasks with 48 milestones to address the Functional Appraisal's findings and observations.

Agreement in Principle

In addition to audits and appraisals of LBL by DOE, an Agreement in Principle (AIP) was entered into between DOE and the State of California (State) on September 6, 1990. The State's designated lead agency for the AIP Program is the Department of Health Services (DHS). The Environmental Management Branch of DHS oversees the program, although the SWRCB, the San Francisco Bay RWQCB, and the Office of Emergency Services provide appropriate assistance. The agreement reflects the understanding and commitment between DOE and the State regarding DOE's provision of additional technical and financial support to the State for its activities in environmental oversight, monitoring access, facility emergency preparedness, and initiatives to ensure compliance with applicable Federal, State, and local laws at LBL and five other DOE facilities in California. Effort on the AIP Program gained momentum in 1992 and carried over into 1993 as DHS familiarized itself with LBL's environmental monitoring and laboratory analysis programs through meetings and sharing environmental monitoring data. In 1993, AIP progress meetings were held at LBL on January 27 and July 12. There was no annual statewide AIP meeting between DHS and the six California-participating facilities in 1993.

As part of the AIP, the SWRCB provided comments on LBL's *Stormwater Monitoring Plan* in a letter dated December 3, 1993. The Board noted that the plan was well written and that only a few issues needed clarification or were deficient. Deficiencies were limited to maps that were excluded from the plan. Clarification was needed on estimating stormwater flows and on using US/EPA's methods for parameters of concern.

The AIP program also allowed DHS to install thermoluminescent dosimeters (TLDs) at six LBL perimeter monitoring stations and one at the DHS monitoring station on Berkeley Way. These TLDs were located adjacent to the LBL monitoring instrumentation and performed the function of providing a general comparison of radiological measurements around the facility. The TLDs were installed on January 11, 1993, with dosimeter exchanges taking place on April 5, July 6, and October 1. TLD data from DHS's monitoring network have not been provided to LBL as of this date.

Waste Management Audits

LBL's waste management program underwent a two-day audit by the Westinghouse Hanford Company on March 17 and 18, 1993, foı the purpose of determining conformity with the requirements of the latest revision of the *Hanford Site Solid Waste Acceptance Criteria*. The scope of the audit addressed only the low-level waste (LLW) and low-level radioactive mixed waste (RMW) programs. The review included visiting waste sites, observing waste pickups, and reviewing procedures. The Hanford group did not report any findings during this audit.

The City of Berkeley began conducting inspections of LBL's hazardous materials and hazardous waste programs on December 15, 1992. After breaking for the holidays, the inspections resumed with a total of seven additional visits occurring between January 5 and February 4, 1993. No violations were issued as a result of the inspections. However, the City made recommendations on thoroughness of training, storage, and labeling of containers for hazardous materials and hazardous wastes at a few of the inspected areas.

Environmental Planning

In November 1991, the Secretary of Energy directed the development of the first Safety and Health Five-Year Plan. The objective of the plan was to identify the magnitude of effort, prioritize the deficiencies, and determine the funding needed to bring DOE into full compliance with all safety and health laws and regulations. Under this plan, core activities are those necessary to maintain current levels of risk and compliance. Compliance activities are ongoing activities for lower-priority programs. First submittals were for the funding period FY 1994 through FY 1998 and were limited to safety and health programs. The scope of the planning process expanded in 1992 to include environmental programs and the Plan was renamed the ES&H Five-Year Plan. Environmental planning Activity Data Sheets (ADSs) are categorized below as Environmental Protection, Environmental Restoration, and Waste Management.

Environmental Protection

In January 1993, LBL prepared a series of ADSs for six core and ten compliance activities in the environmental functional areas of air quality, water quality, solid waste generation and control, toxic substances control, and management of environmental activities. The ADSs prepared in 1993 covered the period from FY 1995 through FY 1999 and the requested level of support for the core and compliance activities totaled $8.8 million and $5.0 million, respectively.

Later in 1993, the ES&H Five-Year Plan was renamed the ES&H Management Plan and was broadened to provide complete coverage of all A-106 Environmental Project and Pollution Prevention activities. Environmental core ADSs are as follows:

- Protection of Water Quality
- Protection of Air Quality
- Solid/Hazardous Waste Generation and Control

- Environmental Management, Oversight, and Reporting
- Control of Toxic Substances
- Waste Minimization and Pollution Prevention

Environmental compliance ADSs include requests for supplemental staff to work on areas of lower-risk compliance, as well as funding for construction and renovation needed to minimize the impacts of LBL operations on environmental quality. A notable emphasis in the 1994 submission is Waste Minimization and Pollution Prevention programs and projects, reflecting the recent focus on these areas by the Environmental Protection Agency (EPA), the Department of Energy, and many other agencies and interested parties. The complete list of compliance ADSs prepared for the ES&H Management Plan in 1994 are as follows:

- Building 25 Photofabrication Fixed Treatment Unit Upgrade
- Environmental Data Management
- Spill Prevention, Countermeasures, and Control
- Hearst Sewer Monitoring Equipment Installation
- Stormwater/Sanitary Sewer Connections Repair
- Waste Minimization and Pollution Prevention Implementation
- NESHAPs Air Toxics Monitoring Program
- Building 71 Storm Sewer Monitoring System
- Environmental Monitoring Plan Implementation
- Underground Storage Tank Removals
- Elimination of Stormwater Point Sources
- Ozone-Depleting Substances Elimination Program
- Spent Abrasives Residue Reduction
- Deionizing Resin Reuse
- Building 77 Coolant Recycling System
- Air Monitoring Equipment Maintenance Program

Environmental Restoration

LBL has prepared four ADSs since the beginning of 1992 for ERWM Five-Year Planning activities in its environmental restoration program. Unlike the environmental ADS development discussed above, ERWM programs have required this planning process since 1991. The structure of the ADSs in either program is similar: the ADSs cover the same planning period and include breakdowns by cost, resources, and trackable milestones, as well as a narrative justification for the funding request. The total package for the four environmental restoration ADSs completed in early 1994 amounted to $42.0 million and include:

- Closure of the existing Hazardous Waste Handling Facility (HWHF)
- Environmental Restoration Program Management
- San Francisco Facilities Transition — Bevalac
- Soil and Groundwater Environmental Assessment and Remediation

With the exception of Environmental Restoration Program Management, these activities share two common tasks: an initial assessment or characterization of the situation, followed by surveillance and/or remediation efforts. The HWHF closure and Soil and Groundwater Assessment programs include an additional close-out report. The Bevalac Decontamination and Decommissioning program will be closely coordinated with other activities planned for the Bevalac complex.

Waste Management

Three ADSs were prepared by LBL for ERWM Five-Year Planning activities in waste management in 1993 and early 1994, covering the period FY 1996 through FY 2000, and include the following waste management activities:

- Facility Operations and Maintenance
- New Hazardous Waste Handling Facility
- EM Waste Minimization and Pollution Prevention

The Facility Operations and Waste Minimization ADSs are similar to the programmatic ADSs prepared for environmental programs in that they describe the elements required to maintain or improve compliance programs. This waste minimization ADS is principally directed at end-of-stream activities within the HWHF, but includes the nucleus of a site-wide program as well. The new HWHF ADS requests funding for construction of the new HWHF.

LBL's Environment Department also spent considerable effort either writing or significantly revising a number of plans and procedures for environmental programs in 1993, including the following:

- *Accidental Spill Prevention and Containment Plan*
- *Air Quality Program Manual*
- *Asbestos Management Plan*
- *Environmental ALARA Program*
- *Environmental Monitoring Plan*
- *Environmental Protection Group Procedures*
- *Environmental Protection Function Notebook*
- *Environmental Protection Implementation Plan*
- *Guidelines for Generators of Hazardous Waste at LBL and Guidelines for Generators of Radioactive and Mixed Waste at LBL*
- *Hazardous Materials Bulk Storage Plan*
- *Laboratory Analysis Unit Quality Control Manual*
- *Medical and Biohazardous Waste Generator's Guide*
- *Medical and Biohazardous Waste Generator's Training Plan*
- *Medical Waste Management Plan*
- *Parameter Review Plan*
- *Procedures, Hazardous Waste Handling Facility*
- *RCRA Facility Investigation Workplan*
- *Spill Prevention, Control, and Countermeasure Plan*
- *Stormwater Monitoring Program*
- *Underground Storage Tank Management Plan*
- *Underground Storage Tank Monitoring Procedures*
- *Underground Storage Tank Response Plan*
- *Wastewater Discharge Investigation Compliance Plan*

ERWM Corrective Action Projects

Design and construction efforts continued on LBL's ERWM corrective action project entitled *Air Toxics Facility Assessment and Rehabilitation*. This nearly $3.2 million project is divided into five subprojects:

- airborne emissions source abatement
- meteorological monitoring upgrade
- radiological NESHAPs stack monitoring upgrades (two separate projects)
- sitewide radiological ambient air monitoring

All of these projects showed substantial progress in 1993. The airborne emissions source abatement and meteorological monitoring upgrade projects are expected to be completed in the first half of 1994. The two NESHAPs projects will close out the Air Toxics corrective action projects in February 1995. Each of these projects is discussed in detail in Section 4, *Environmental Program Information.*

Training

LBL expended a large effort to either write or significantly modify a number of plans and procedures for environmental programs in 1993. See the *Environmental Planning* discussion above for complete information on the extent of this activity. Training elements were included in several of these plans and procedures.

There are approximately 40 EH&S courses available through the EH&S Division Training Unit, many of which focus on environmental compliance. The largest of these courses are the *Hazardous Waste Generators'* and *Radioactive/Mixed Waste Generators'* training. Over 1,000 Laboratory employees have been trained in one or both of these classes since their inception; the number of current LBL staff trained in these areas is 771. The first annual retraining of over 500 waste generators occurred in 1993. Other classes of significant size include the Chemical Hygiene and Safety and the Medical/Biohazardous Waste training classes. Training courses are offered to employees over a wide range of frequencies, from every other week to once a year. On-demand training is also available. Significant progress has been made in making Laboratory-wide training documentation available in a central, easily accessed database.

Self-Assessment

The LBL Self-Assessment Program provides a formal process for assuring quality and regulatory compliance in all facets of Laboratory operations. It satisfies the requirements of DOE Order 5700.6C, *Quality Assurance*, for worker, management, and independent assessments. The Office of Assessment and Assurance prepared the *FY 93 LBL Self-Assessment Report*, which describes LBL's self-assessment activities and summarizes the results of the Divisions' self-appraisals in the areas of environmental protection and occupational safety and health. It also describes opportunities for improving environmental protection and occupational safety and health at LBL, discusses root causes, and presents corrective action strategies. This report fulfills the requirement in the *Mitigation Monitoring Plan for the Proposed Renewal of the Contract Between DOE and the Regents of the University of California for Operation and Management of the Lawrence Berkeley Laboratory* (September

1992) for LBL to implement Mitigation Measure IV-K-1 (Hazardous Materials).

In February 1993, the LBL Self-Assessment Program was nominated for DOE Best Management Practice recognition. In July 1993, LBL sponsored a two-day workshop entitled *The Nuts and Bolts of Implementation*, for DOE Office of Energy Research (ER) laboratories to share their experiences with implementing self-assessment in a research and development environment. This workshop was attended by over 50 individuals representing 14 ER laboratories and DOE. Proceedings for the workshop were prepared and distributed by OAA (Document Number CONF-9307131).

UC/DOE Contract

Effective October 1, 1992, DOE and the University of California entered into a new contract agreement for the five-year period ending in 1997. The contract requires the use of a performance-based management system that uses objective performance measures. These performance-based measures include requirements that LBL have programs in place that are designed to achieve compliance with applicable laws, regulations, ordinances, and DOE Orders relating to environmental protection. Furthermore, LBL is required to report the results of a self-assessment on the performance measures to UC annually. Additionally, the performance measures are to be revised annually (in cooperation with DOE) to continually improve performance related to environmental programs.

LBL Programs

The future of LBL will be significantly shaped by several new or upgraded programs.

- The Advanced Light Source (ALS) came on-line in April 1993. The ALS Operational Readiness Review was completed, a final report was generated, and DOE gave the ALS formal approval to operate on August 23, 1993. The ALS has two insertion devices and two bend magnets which became operational in 1993. The first scientific results were obtained with the high brightness ultraviolet/soft x-ray light.
- The new HWHF is in the final pre-construction design phase. Preliminary site work began on May 19, 1993, and has been completed. Construction of the HWHF is currently scheduled to begin in September 1994. An assessment of the necessary environmental operating permits for the HWHF also began in 1993.
- The Human Genome Laboratory and Biomedical Isotope Facility projects are two additional programs that are approaching the construction phase (see *NEPA/CEQA* earlier in this section for more information).

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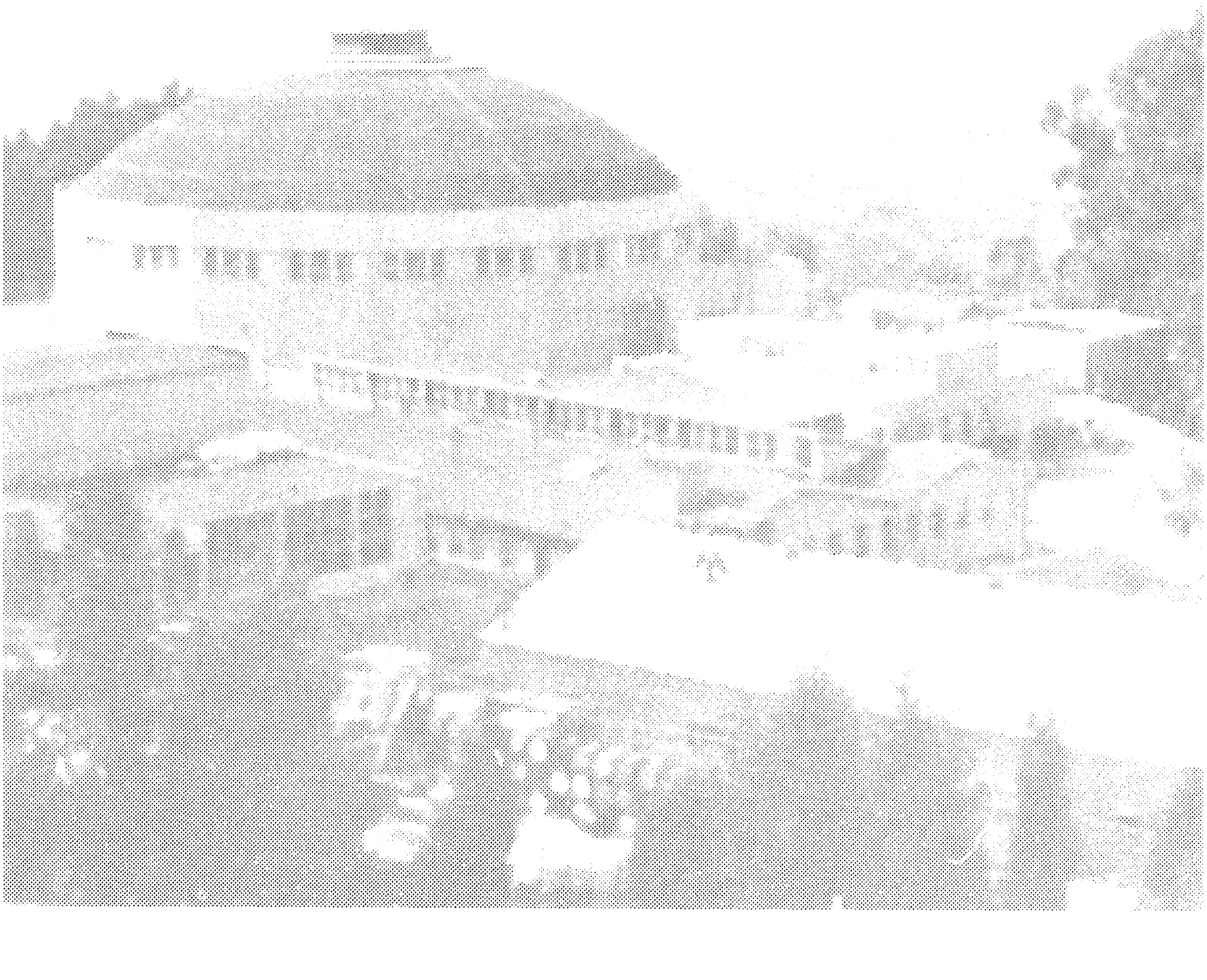
Section 4. Environmental Program Information



Environmental Program Overview

This section of the report describes LBL's major environmental programs, nearly all of which are regulated at either the State, regional, or local level in California. This downward delegation can happen only if the administering agency's program is as stringent as the Federal, and in some cases, the State program. Many of the regulatory programs in California far exceed the Federal requirements.

The Environment Department of the Environment, Health, and Safety Division is responsible for overseeing environmental regulatory compliance at LBL. The Environment Department is structured into three functional areas: the Environmental Protection, Environmental Restoration, and Waste Management Groups. Figure 4-1 displays the Department's organization by Group. The summaries that follow identify the managing Group and provide a brief description of the primary environmental responsibilities of that Group. Detailed information on specific environmental-program corrective action projects is presented later in this section. Descriptions of environmental monitoring activities associated with these programs follow in subsequent sections.

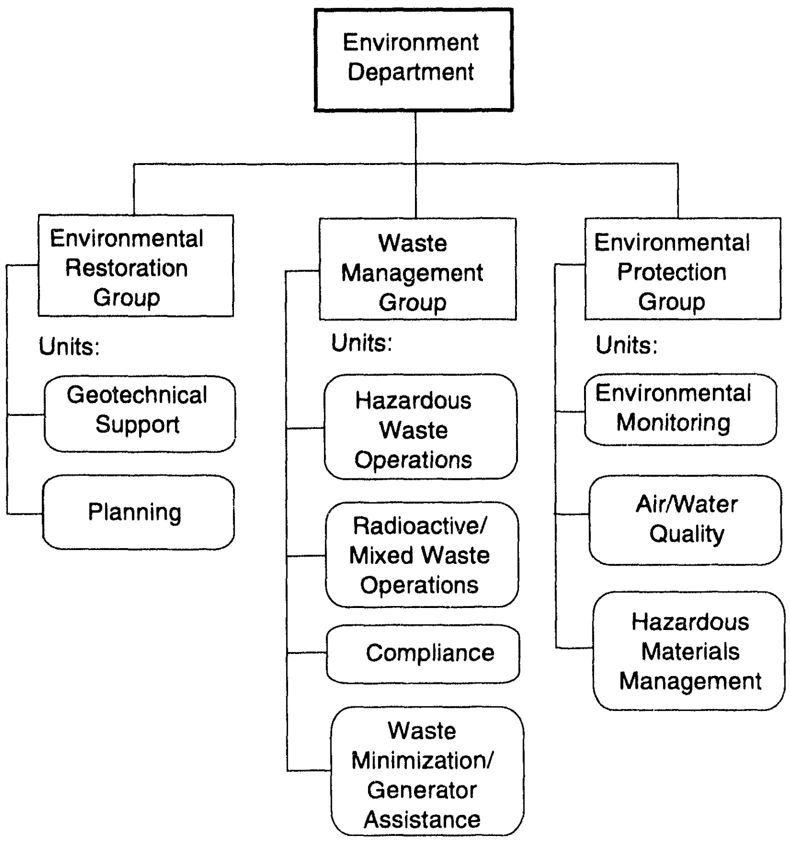


Figure 4-1. Environment Department Organization

DOE Orders require that DOE facilities and DOE contractor-managed facilities like LBL comply with applicable Federal, State, and local environmental laws, regulations, ordinances, and DOE Orders. The recently extended operating contract between DOE and the University of California reiterates these compliance objectives.

Environmental Protection Group

The Environmental Protection Group consists of three units: Air/Water Quality, Hazardous Materials Management, and Environmental Monitoring. The Air/Water Quality Unit oversees compliance with air and water quality regulations, including permitting and standards of operation, routine and accidental release reporting, and coordinating regulatory inspections. The Hazardous Materials Management Unit directs compliance activities related to underground storage tanks, aboveground storage tanks, and hazardous waste treatment units, including permitting and reporting, and other sitewide activities such as waste minimization, pollution prevention, and waste generator support. The Environmental Monitoring Unit conducts the environmental monitoring programs, including sampling of air emissions, stormwater and wastewater discharges, and soils; performing release investigations; supporting the other two units; and managing contract laboratory analytical services. Each unit also prepares necessary operating procedures, reports, and plans.

The regulations that frame the oversight responsibilities of the Environmental Protection Group are considerably more diverse that those of the other two groups. Environmental protection encompasses a series of media and corresponding regulations and monitoring requirements: air, water, and soil. The discussion below provides background on the key responsibilities of this group.

Air Quality

Sources of air emissions are categorized as stationary or mobile sources. Activities at LBL that generate air emissions from stationary sources are categorized as either nonradiological or radiological.

Nonradiological

Regulations affecting nonradiological air emissions are governed locally by the Bay Area Air Quality Management District, an agency with jurisdiction over a nine-county region that surrounds the San Francisco Bay. BAAQMD further defines air emissions as either regulated air pollutants (RAPs) or hazardous air pollutants (HAPs). In general, regulated air pollutants (four groups) are those with standards issued prior to the amendments of 1990 in the Federal Clean Air Act, whereas hazardous air pollutants (189 pollutants) are a new group identified in amendments for which standards will be established. BAAQMD implements both the Federal Clean Air Act (CAA) and California Clean Air Act (CCAA) through a set of enforceable Rules and Regulations for operations or equipment that may cause air pollution, including nonradiological NESHAPs sources such as asbestos.

The mechanism for ensuring that the BAAQMD program is as stringent as that of US/EPA is through the development of a Site Implementation Plan (SIP) prepared by BAAQMD. The SIP contains the enforceable rules and regulations needed to attain compliance with air quality standards and emissions limitations.

The Federal CAA is a broad statute first passed in 1955 and amended several times, most recently in 1990. The recent amendments comprehensively and significantly revised the Federal law, and expanded its scope, to address many issues, including

- classifying air quality in urban areas
- consolidating permit requirements for major sources
- developing maximum achievable control technology for 189 hazardous air pollutants
- phasing out stratospheric ozone-depleting substances
- reducing emissions of substances contributing to acid rain
- strengthening civil and criminal enforcement powers for US/EPA
- tightening vehicular emission standards for mobile sources.

Promulgation of the numerous regulations from the amended CAA will extend int· the next century. US/EPA has identified the major and area source categories of hazardous air pollutants that will be affected by the initial regulatory modifications. This list did not include a source category covering research or laboratory facilities as required by the amendments. The amendments specifically included this requirement to ensure equitable treatment of those facilities. Insufficient information existed on research or laboratory facilities for US/EPA to include them in the list at this time.

A key component of the new requirements will be the development of a Federally enforceable Title V operating permit program for "major" sources of air emissions. These operating permit programs will be developed at the State or regional level. BAAQMD submitted its plan to US/EPA for implementing Title V before the regulatory deadline of November 15, 1993. BAAQMD also approved its Title V permitting rule for major sources in November. In the Bay Area a major source is defined as a source that emits more than 100 tons per year of RAPs, or either emits or has the potential to emit at least 10 tons per year of a single HAP or at least 25 tons per year of all HAPs. US/EPA has discretionary authority to establish lesser emission threshold levels of any pollutant for the purpose of defining a major source. US/EPA has concluded that it is not prepared to establish an alternate emissions threshold for any pollutant, including radionuclides, which are considered a HAP under the amendments.

These two US/EPA decisions mean that LBL is currently not considered a major source under the CAA amendments, and therefore is not required to obtain a Title V operating permit and is not subject to the stringent control technology requirements that will be placed on the listed source categories. Again, US/EPA can update both the source category and threshold quantity listings at any time.

The CAA amendments place important emphasis on the phase-out of stratospheric ozone-depleting substances (ODSs). The more harmful ODSs are called Class I. This class will no longer be produced after 1995, severely limiting availability. The production phase-out dates for Class II ODSs presently range from 2010 to 2030. Regulations already in place apply to servicing of motor vehicle air conditioners, labeling of products using ODSs, banning nonessential products containing ODSs, and recovering and recycling ODSs during servicing of appliances. LBL has a very active program for eliminating usage of Class I ODSs in the main usage areas: solvent cleaning, refrigeration and air conditioning systems, and fire-suppression operations. All conversion or replacement activities follow the requirements stated in US/EPA's Significant New Alternatives Policy (SNAP) program, which was first proposed in May 1993, with promulgation expected in 1994. Since the phase-out date for Class I ODSs is very aggressive, development of acceptable alternatives is extremely dynamic at the present time. In some cases, acceptable alternative substances are not yet available.

In California, the State's Air Resources Board (CARB) is the responsible agency for implementation of the Clean Air Act and its amendments. CARB also has direct oversight of air pollution control programs administered by agencies such as BAAQMD.

The California air quality legislative program has been in place since 1955. It was significantly modified recently with passage of the California Clean Air Act of 1988. The CCAA significantly expanded the scope and accelerated the pace of air pollution control efforts in the state. Locally, the CCAA led to development of the 1991 Clean Air Plan by BAAQMD. This plan is designed to comply with the following legal requirements in the CCAA:

- best available retrofit controls on existing stationary sources
- cost-effective control measures
- district-wide reduction in emissions of 5% per year for each nonattainment pollutant or its precursors
- emissions tracking systems
- indirect source and area source control programs
- permitting program that achieves no net increase in stationary source emissions
- reduction of population exposure to ambient pollutants
- regional public education program
- transportation control measures to achieve no net increase in vehicular emissions.

BAAQMD regulations implementing Federal and State air quality requirements are enforced through an air quality source permit system and periodic inspection program.

The BAAQMD rule and regulation program is oriented primarily toward controlling organic compound emissions. Many of these substances eventually lead to the formation of ground level ozone, a RAP for which BAAQMD has historically exceeded both the Federal and State air quality standards. BAAQMD has over 50 rules pertaining to organic compounds alone. Rule changes for these compounds in 1993 that affect LBL activities occurred in the areas of adhesives, aerosol paints, storage of organic liquids, and surface coating of metal or plastic parts. Other rule changes impacting LBL took place in BAAQMD's permit review and fee schedule rules. BAAQMD rule changes expected in 1994 include glass and lead melting operations, and several modifications to permitting requirements, including source exemptions and hazardous air pollutants. It is also worth noting that BAAQMD approved a trip reduction rule at the end of 1992 that requires LBL to prepare an Employer Trip Reduction Program no later than May 31, 1995. LBL will conduct a survey of its employees' commuting patterns in 1994. The results of the survey will dictate LBL's compliance requirements under this new rule.

The BAAQMD permit system requires prior review of operation design for new or modified sources. Permit review is a two-step process. First, BAAQMD will issue an Authority-to-Construct if the review is favorable. During the source startup period after construction is complete, BAAQMD may inspect the source to verify operational compliance. Upon this verification, BAAQMD issues a Permit-to-Operate, which may contain specific operating conditions for the source. All permitted sources are renewed and reinspected by the District annually.

LBL's diverse research and support operations result in a wide range of equipment and operations affected by BAAQMD regulations. Presently, regulated air emission sources at LBL include chemical processing, combustion, epoxy mixing, furnaces, gasoline dispensing, liquid storage, material working and handling, painting, sandblasting, semiconductor research, surface coating and printing, surface preparation and solvent cleaning, and vacuum coating. LBL has emission control equipment on a number of these sources. At the end of 1993, LBL had a facility-wide total of 40 operating permits and 85 registered-exempt sources. BAAQMD conducted five inspections in 1993 to review each of these sources. There was one violation issued during these inspections for a minor infraction at one of the spray paint booths. See Section 3, *Compliance Summary*, for more information on the status of the air quality program.

In addition to implementing the acts mentioned above, BAAQMD is also responsible for implementing annual legislative changes made at the State level, such as the California Air Toxics Hot Spots Information and Assessment Act (AB 2588) of 1987. BAAQMD has folded this reporting program on air toxics usage into a facility's annual renewal of its operating permits. Table 4-1 summarizes the most current air toxic emission estimates from the LBL site.

Radiological

Regulations on radiological air emissions are one of the few programs not delegated from US/EPA to the State. Sources of radiological air emissions are subject to the regulations administered by US/EPA under 40 CFR 61 Subpart H, National Emissions Standard for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities, one of the NESHAPs regulations. NESHAPs regulations originate from the Federal CAA. US/EPA has developed seven NESHAPs regulations. LBL's radiological compliance program identifies sources of dispersible radionuclide emissions, initially and periodically assesses the environmental dose assessment attributed to each source, and analyzes both the emission control and monitoring requirements. NESHAPs also requires that facilities releasing radionuclides into the air report these releases to the appropriate regional office of US/EPA in a specific format. See Appendix A for a copy of LBL's report for Calendar Year 1993.

In 1991, US/EPA found LBL's radiological NESHAPs program out of compliance with regulatory requirements. A Federal Facilities Compliance Agreement was signed by DOE and US/EPA in August 1993 to correct LBL's stack monitoring program. The upgrade project necessary to

Table 4-1. Facility-wide Air Toxics Emission Estimates from 1993

Substance	Annual Average Emissions (kg/yr)	Regulatory Level of Concern (kg/yr)[a]
Acetone	525.3	45
Benzene	1.2	4.5
Chromium	14.1	45
1,4-Dioxane	52.8	45
Epichlorohydrinpolyglycol	22.7	45
Ethylene glycol butyl ether	3.0	45
Formaldehyde	11.7	45
Chlorofluorocarbons	1306.3	1540[b]
Gasoline vapors	399.1	45
Hydrochloric acid	911.7	45
Hydrogen fluoride	<0.05	4.5
Isophorone diisocyanate	0.2	45
Isopropyl alcohol	294.1	45
Lead	23.3	4.5
Lead chromate	97.3	0.045
Lead compounds (inorganic)	95.6	4.5
Methyl alcohol	330.4	45
Methylene chloride	1.3	45
Naphthalene	2.4	45
Methyl ethyl ketone	42.6	45
Nitric acid	473.1	45
Phosphoric acid	4.3	45
Propylene glycol methyl ether	15.1	45
Sodium hydroxide	45.4	45
Sulfuric acid	4274.6	45
Toluene	22.9	45
1,1,1-trichloroethane	1714.6	45
Xylene	0.4	45
Zinc chloride	0.5	45
Zinc chromate	0.2	45

[a] Regulatory level of concern is the emission threshold quantity of a substance above which reporting is required under the AB2588 Air Toxics Hot spots program (August 10, 1992).

[b] Threshold level identified in BAAQMD Risk Management policy (May 9, 1991).

bring LBL into full compliance with NESHAPs regulations by the February 1995 deadline specified in the agreement will affect nearly 70 stacks around the entire LBL facility. Both Section 3, *Compliance Summary*, and the *Corrective Action Projects* portion later in this section contain more information on this US/EPA finding and LBL's corrective action efforts under the FFCA.

Water Quality

The main programs at LBL regulated by water quality regulations are wastewater and stormwater. Wastewater discharges occur from continuous activities at LBL, whereas discharges to the stormwater system are intermittent. Water quality regulations influencing LBL's operations arise mainly from the Water Quality Act (WQA) of 1987, which substantially modified the Clean Water Act (CWA) of 1977. The CWA itself was a major amendment to the Federal Water Pollution Control Act of 1972. A Bill is presently under consideration by the U.S. Congress that would amend and reauthorize the WQA. The Bill (Senate Bill 1114) was introduced to the Senate on June 15, 1993. It is too early in the reauthorization process to assess what the amendments will contain and how they will impact the Laboratory.

Wastewater Discharges

The CWA supports the maintenance and restoration of water quality in all waters throughout the country. The CWA establishes categories of regulated waters (including surface waters and wetlands), applicable water quality standards and objectives, and permit programs regulating the discharge of facility wastewater from both point and nonpoint sources. To implement the act, US/EPA issued pretreatment standards for industrial discharges as well as general standards controlling toxic pollutants.

In California, Cal/EPA administers the Federal permit and enforcement programs for both direct and indirect discharges through the State Water Resources Control Board. LBL is an indirect discharger, since wastewater is discharged to a Publicly-Owned Treatment Works (POTW) facility, which in turn discharges the treated effluent into surface waters. Local POTWs adopt pretreatment standards to ensure that the sewage facility can adequately treat the wastewater it receives.

At LBL, the local POTW that enforces the pretreatment standards is the East Bay Municipal Utility District (EBMUD). EBMUD's authority and procedures are based on local Ordinance No. 311 (Wastewater Control Ordinance), which establishes the regulations for the interception, treatment, and disposal of wastewater. The primary tool for enforcing the requirements of the EBMUD pretreatment program is a permitting process. A listing of each wastewater discharge point is included in each permit. The permit sets specific limits on pollutants known to be present and defines a number of conditions that must be met, including self-monitoring, sampling, analysis, reporting, and recordkeeping requirements. LBL's operations affected by the EBMUD ordinance and thus requiring wastewater discharge permits include general effluent from the LBL site, and two specific metal-finishing operations:

- Plating Shop, Building 77
- Photofabrication Shop, Building 25.

Both operations must comply with the Metal Finishing Category Standard (40 CFR 433). Wastewater pretreatment units have been installed at each metal-finishing operation to meet the standard's discharge requirements. To ensure compliance with the pretreatment standard, the effluent from the treatment unit is tested periodically. The test methods and schedules are established by the wastewater discharge permit for each operation.

In addition, a third wastewater discharge permit has been issued for the entire LBL site. Discharge requirements of this permit must be met at the site boundary. Wastewater effluent leaves the site through two sanitary sewer outfalls: one outfall (Hearst) on the western edge of LBL, and the other (Strawberry) on the south side. It is important to note that combined wastewaters from University of California and LBL facilities flow through the Strawberry outfall. LBL wastewater discharge permit compliance is determined from samples taken from this outfall. In the past, wastewater violations have been recorded that have jeopardized LBL's compliance standing with EBMUD. It is exceedingly difficult to verify that these violations were not entirely or even partially attributable to LBL activities. A request has been submitted through the ES&H Management Plan process to fund a project that would segregate LBL's wastewaters from those of the University.

LBL's perfect compliance record in 1993 allowed EBMUD to decrease the Laboratory's monitoring and reporting requirements. EBMUD, along with US/EPA, conducted one site inspection of the LBL wastewater discharge program in 1993. See Section 3, *Compliance Summary*, for the current status on all EBMUD permits.

Stormwater Discharges

Reauthorization of the CWA in 1987 (WQA) directed US/EPA to develop a permit system for stormwater runoff that might discharge toxic pollutants. The permit system is designed to apply to facilities (or portions of facilities) where stormwater could intermingle with hazardous materials. Locally, this program is implemented by Cal/EPA's State Water Resources Control Board through the San Francisco Bay Regional Water Quality Control Board.

LBL's stormwater discharges are allowable since the facility is covered by the statewide general industrial permit. This statewide permit complies with National Pollutant Discharge Elimination System requirements. LBL has been covered by this general permit since 1992, when the program was first implemented. LBL's *Storm Water Pollution Prevention Plan* and *Storm Water Monitoring Program* represent the Laboratory's plan and procedures for identifying improper connections between the sanitary and storm drain systems, as well as monitoring and reducing the potential for pollutants in stormwater discharges. LBL also submits a monitoring and observations report to the Regional Water Quality Resources Control Board by July 1 of each year. Presently, improper connections to the storm drain system are being actively resolved by LBL. The *Corrective Action Projects* discussion later in this section contains more information on the Storm Drain Corrective Action Project.

Hazardous Materials

More compliance programs are regulated by specific hazardous materials laws than by either air or water quality programs. Notable programs include underground and aboveground storage tanks, hazardous waste treatment units, and toxic substances. Also in this category are waste minimization and pollution prevention programs, which are addressed separately later in this section.

Toxic Substances

The Toxic Substances Control Act (TSCA) establishes the legal framework for the manufacture, distribution, use, and disposal of regulated substances. TSCA created a means of systematically identifying and evaluating environmental and health effects of existing chemicals and all new substances that enter the marketplace. The principal TSCA-regulated substances in general use at LBL are asbestos and polychlorinated biphenyl (PCB) oils, the latter commonly found in electrical equipment such as capacitors and transformers. TSCA provides detailed requirements for the management of PCB-containing equipment when PCB levels exceed 50 parts per million.

Since 1987, LBL has been reducing the inventory of its PCB-containing equipment. Non-PCB capacitors have replaced PCB units whenever possible. All utility transformers have been tested and placed on a PCB reduction program, as necessary. Approximately 100 transformers remain on site. PCB concentrations in these transformers are all below 50 parts per million.

TSCA underwent modification in 1986 when Congress legislated the Asbestos Hazard Emergency Response Act (AHERA). AHERA was originally written to address asbestos-containing materials in schools. More recently, US/EPA passed regulations that require all asbestos inspection, design, supervision, and work done in public or commercial facilities to be performed by AHERA-accredited persons.

LBL has an Asbestos Management Program that merges the applicable requirements of AHERA with other appropriate asbestos regulations issued by US/EPA, BAAQMD, DTSC, and the Occupational Safety and Health Administration. LBL's policy recommends immediate removal or repair of all asbestos-containing materials that pose a significant health hazard due to location or condition, but asbestos in good condition will be managed in place. LBL personnel who perform asbestos-related work have received training through an AHERA-certified course.

Hazardous Waste Treatment Units

Hazardous materials in the wastewater effluent are treated at five onsite locations. These fixed treatment units are regulated under the State's Tiered Permitting program, first implemented in 1993. Cal/EPA's DTSC developed this program in an attempt to streamline the permitting process for hazardous waste treatment and storage facilities and to ease the burden associated with obtaining facility permits. There are five tiers to the program, listed in increasing order of regulatory complexity:

- conditional exemption
- conditional authorization
- permit-by-rule
- standardized permit
- full permit

LBL received formal permit authorization from DTSC in August for all five units. The State conducted one inspection of LBL's treatment units in 1993 and found no violations. The current status of these fixed treatment units is found in Section 2, *Compliance Summary*.

Aboveground Storage Tanks

LBL's aboveground storage tanks must comply with US/EPA oil pollution prevention regulations derived from the Clean Water Act. In August 1992, the Laboratory revised its *Spill Prevention, Control, and Countermeasure* (SPCC) Plan in compliance with these regulations. This plan provides standards for storage and usage of oil in a manner that will prevent the discharge of oil into or upon navigable waters or adjoining shorelines. DOE approved the SPCC Plan in October 1992. In addition, SPCCs must be approved by a professional engineer. In LBL's case, the engineering certification came from the Facilities Department. SPCCs need not be submitted to US/EPA unless a spill of more than 1,000 gallons occurs or two spills of harmful quantities, as defined in 40 CFR 110, occur in any continuous 12-month period.

LBL revised the SPCC Plan in 1993 to include the following:

- The *Oil Removal Contingency Plan* (Appendix F) has been updated to be consistent with the LBL Fire Services Group's procedures entitled *Hazardous Materials Response Procedures* (Procedure No. 6-I) and *EH&S Emergency Organization and HAZMAT Procedures*.
- The spill history section has been updated to include more detailed information on spills that have occurred at the site. Spills that were mentioned in Site Restoration reports entitled *RCRA Facility Assessment* and *RCRA Facility Investigation Work Plan* have now been included in the SPCC Plan spill-history section.
- The 1993 SPCC Plan contains a list of facility improvements and procedures to be implemented to more adequately address and control potential spills at LBL. Secondary containment for electrical transformers, emergency generators, and drum storage areas have been added.
- The tables that show capacities and locations of aboveground storage tanks, underground storage tanks, and drum storage areas have been updated to reflect the results of a facility-wide assessment performed by EH&S Division staff in the Spring of 1993.

A training program plan and a lesson plan were prepared in 1993 to provide training to users of petroleum storage and hazardous materials storage areas. In addition, spill kits were distributed to all underground storage tank sites in 1993 to reduce the likelihood of environmental impacts in the event of accidental spills.

The *Corrective Action Projects* section below describes efforts underway to upgrade the aboveground storage tank program.

Underground Storage Tanks

Underground storage tanks have been regulated by California State law since 1983. The State UST laws predate the Federal UST program, although both are similar in scope. Regulations implementing the State UST laws are developed by the State Water Resources Control Board. The City of Berkeley administers the UST program's permit, inspection, and enforcement requirements through the implementation of a local ordinance that also integrates Federal and State requirements. UST laws cover storage of hazardous substances in tanks, including ancillary piping systems that are substantially beneath the ground. Hazardous substances are broadly defined by State law to include flammable and combustible liquid fuels, listed hazardous wastes, hazardous materials, and the Director's List of Hazardous Substances, which includes most common chemicals and fuels.

The key elements of the Laboratory's UST program include

- registration and permits
- construction standards
- monitoring and leak detection
- integrity testing
- release recording and reporting
- closure, both temporary and permanent
- cleanup of contaminated sites
- financial requirements

LBL presently has 13 USTs onsite which contain petroleum products. These are all permitted by the City of Berkeley. Their locations are shown in Figure 4-2. The *Corrective Action Projects* section below describes modification activities in the UST program that occurred in 1993, and upcoming modifications in 1994.

Waste Minimization and Pollution Prevention

The California legislature passed the Hazardous Waste Source Reduction and Management Review (SB14) law in 1989. The regulations derived from SB14 apply to generators of more than 12,000 kilograms of hazardous waste or 12 kilograms of extremely hazardous waste in a calendar year. The goals of the law are to reduce hazardous waste at its source, reduce environmental releases of chemical contaminants, and document hazardous waste management. In complying with this State requirement, LBL prepared a report that included two components: *Source Reduction Evaluation Review Plan and Plan Summary*, and *Hazardous Waste Management Report Summary*. This report, which was approved by LBL on March 26, 1992, required certification on two levels: technical and financial. It presents the strong commitment to waste minimization made at all levels of LBL. The LBL program strives to substantially reduce waste generation and increase recycling.

The Pollution Prevention Act (PPA) of 1990 declares that source reduction is a national policy and directs US/EPA to study and encourage source reduction activities. Similarly, under the Hazardous Waste Control Law, Cal/EPA requires facilities that treat, store, or dispose of hazardous wastes to certify that generators sending hazardous wastes to their facilities have established a program to reduce the quantity and/or toxicity of hazardous wastes being generated.

Larger generators in California are required to evaluate source-reduction opportunities, develop and implement a source-reduction plan, prepare a plan summary, and prepare hazardous waste management performance reports. LBL has fallen out of the reporting requirements because it does not meet the *de minimis* levels identified in the PPA. However, LBL continues to have a diligent waste minimization and pollution prevention program in place in response to both regulatory and DOE emphasis.

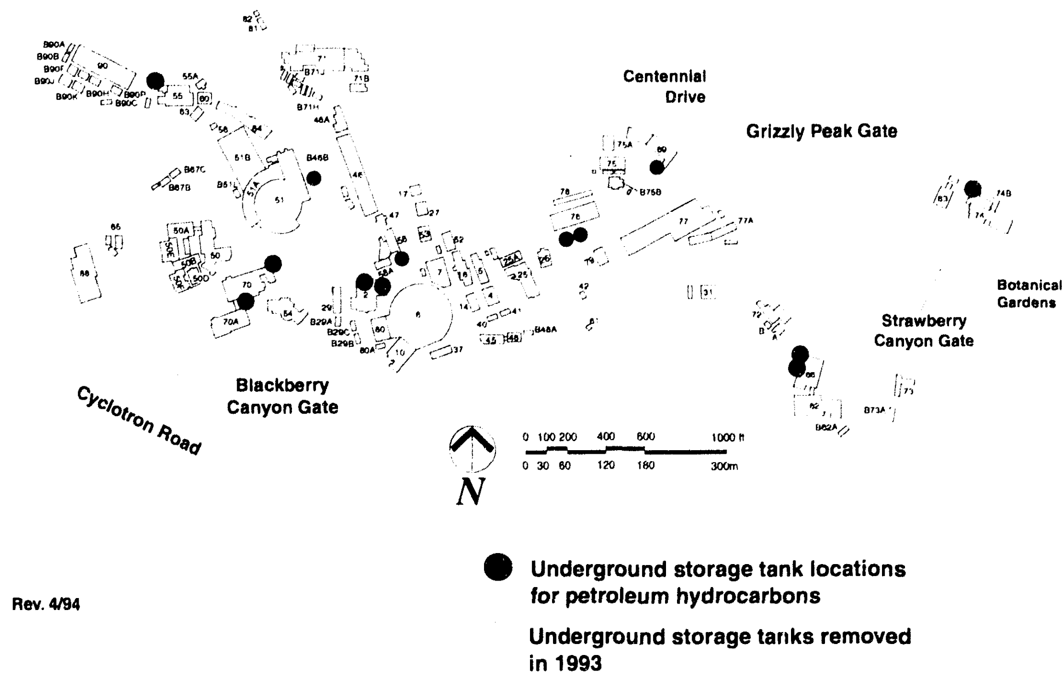


Figure 4-2. Underground Storage Tanks

In 1993, the Laboratory's waste minimization and pollution prevention activities focused on continued development of a sitewide waste minimization and pollution prevention program, and on reducing wastes at the LBL Hazardous Waste Handling Facility. The major areas of focus in 1993 were employee awareness, solid waste recycling, and process waste assessments. A waste minimization specialist position was added late in 1993, to provide waste generators at the Laboratory with support and advice on waste-related issues at the waste source. This addition will represent a significant expansion in the waste minimization and pollution prevention capabilities and activities at the Laboratory, and will allow a new focus on source reduction through consultations with generators and opportunity assessments at the points of origin, rather than at the end of the stream.

One notable sign of progress in employee awareness and pollution prevention was the in-house development of a Laboratory-wide Chemical Exchange Database (CED), which was brought on line in August 1993, and is accessible on LBL's computer network. The CED was developed to promote the use of surplus chemicals that might have been shipped for disposal as hazardous waste in previous years. Extensive promotion of this new feature has been carried out through channels such as the LBL newspaper (*Currents*), division safety meetings, and hands-on demonstrations at the LBL Cafeteria.

In 1993, the Laboratory's garbage refuse contract was revised to require an increase in solid waste recycling. The new requirement states that all subcontractors must recycle at least 25% of the waste they collect. LBL assists in this effort by segregating wood scraps, organic compost, and cardboard. This program is required by the California Integrated Waste

Management Act of 1989 (AB 939) and is relevant only to recyclables in 20-yard bins of regular wastes.

Several process waste assessments (PWAs) were completed in this reporting year. The first was performed at the Building 25 Plating Shop wastewater treatment operations. The activities included source identification and sampling, bench-scale wastewater treatability studies with subsequent minor process wastewater adjustments, treatment alternatives evaluations, and integration of waste minimization practices with total quality control as applied to the printed-circuit-board manufacturing process. Two reports, *Building 25 Printed Circuit Board Manufacturing Wastewater Treatment Alternatives Evaluation Report* (Phase I) and *FTU002 Wastewater Treatability and Waste Minimization Study* (Phase II), were issued. The following conclusions arose from the investigation:

(1) Treating wastewater with $FeSO_4$ (iron sulfate) can effectively reduce copper concentrations to less than 1.0 mg/liter.

(2) Segregating electroless copper and AA accelerator (product name) rinses from other rinses minimizes waste.

(3) A closed-loop rinse system with reverse osmosis would allow for recycling of spent baths and rinsewater from electroless copper, AA accelerator, and micro-etch units.

(4) The treatment process can be optimized and integrated with an ion exchange or a reverse osmosis system as a polishing step or backup unit, which would make this a zero-discharge unit.

Nine batches of wastewater were successfully treated at the Building 25 Photofabrication Shop wastewater treatment unit (FTU002), using iron sulfate and the recommended pollution prevention and waste minimization strategies to meet the discharge limits.

A second PWA, completed in December 1993, focused on non-automotive waste oil to fulfill a requirement of the State waste minimization regulations. These waste oils include vacuum pump, transformer, lubricating, hydraulic, refrigeration, and coolant oils. The PWA focused on operational improvements to achieve source reduction and made it clear that many of the maintenance activities at LBL generate waste oils, most of which can be recycled or reused. The process evaluation of non-automotive waste oils identified several feasible and practicable source-reduction measures. Included among these is the need for a stronger focus on maintenance of vacuum pumps and of hydraulic machinery, which would extend the useful lifetime of the oils. The PWA also recognized more than 20 waste minimization practices that were already in place or were being implemented to reduce the quantity of waste oils at the Laboratory. A sampling of these practices includes installation of in-line filters to prolong the useful lifetime of the oils, storing oil waste in compatible containers, establishing a central distribution center to dispense chemicals, and turning off pumps when not in use. This latter practice would also reduce the energy requirements of operations that do not require continuous pumping.

Environmental Monitoring

LBL's environmental monitoring program of radiological and nonradiological activities consists of two major activities: (1) measurement and monitoring of effluents from Laboratory operations, and (2) surveillance (*i.e.*, the measurement, monitoring, and calculation) of the effects of those operations on the environment and public health. Current elements of the environmental monitoring program are presented in Table 4-2.

The *Environmental Monitoring Plan* and *Parameter Review Plan* are the foundation documents for the program. Together, these plans identify the monitoring needs for the facility and detail the existing and planned monitoring activities designed to satisfy these needs and determine the environmental impact of Laboratory operations. The monitoring plan focuses considerable attention on the importance of quality assurance in all aspects of environmental monitoring. More discussion on quality assurance is found in Section 8 of this Report.

LBL's monitoring plan is comprehensive, covering

- air (radiological and nonradiological)
- groundwater
- penetrating radiation
- meteorology
- soil/sediment
- surface water
- vegetation

LBL's environmental monitoring program collects over 6000 radiological and non-radiological samples each year. Depending upon the type of analysis, this yields roughly 16,000 data points. In 1993, data management procedures were finalized and implemented. Implementation will address sampling and analytical accuracy and precision. These procedures will also serve to highlight areas of environmental monitoring that need improvement.

Environmental Restoration

The Environmental Restoration Group of the Environment Department oversees site-restoration compliance activities. The Environmental Restoration Group consists of two units: Planning and Geotechnical Support. The Planning Unit manages such issues as regulatory compliance, workplan preparations, project management, data management, community relations, and contractor coordination for group activities. The Geotechnical Support Unit is responsible for monitoring, sampling, and analysis operations for both soil and groundwater media, including well construction, structural mapping, and the preparation of geologic cross sections.

Nearly all of LBL's environmental restoration activities occur onsite. LBL's site-restoration activities for cleaning up hazardous waste sites are no longer carried out under CERCLA, which provides the regulatory framework and funding to clean up closed and abandoned hazardous waste sites. Under the provisions of CERCLA, facilities must collect information on sites that are potentially contaminated by hazardous materials. This information is submitted to US/EPA, and the sites are ranked according to their potential for impairing human health or damaging the environment. The sites with the highest potential are placed on the National Priorities List and are forced into environmental cleanup. Based on the information provided by LBL in 1992, US/EPA concluded that any future remedial actions at the Laboratory will be performed under the RCRA Corrective Action Program. This program is administered in California by Cal/EPA's DTSC.

Table 4-2. Environmental Monitoring Program Elements

Monitoring Activity	Frequency	Media	Reference
Monitoring of penetrating radiation at five perimeter stations and in each major accelerator complex. Data are telemetered from the stations to a central location and collected by a computerized data acquisition system.	Continuous: gamma and neutron flux	Air	DOE 5400.5
Sampling stack emissions in all areas where significant quantities of radionuclides are handled.	Weekly	Air	DOE/EH-0173T; 40 CFR 61, subpart H
Continuous sampling of ambient air at ten points onsite and at five offsite and perimeter locations. Fourteen sites are sampled for particulate matter, eight for tritiated water (HTO), four for radioiodine, and one for $^{14}CO_2$.	Weekly	Air	DOE 5400.1; DOE/EH-0173T
Rainfall and dry deposition are sampled at nine onsite and four perimeter locations. Two additional sites are sampled whenever there is a significant rainfall. Rainwater is analyzed for tritium and gross alpha and beta activity.	Monthly	Air	DOE/EH-0173T
Sediments are sampled annually at creek sampling locations.	Yearly	Sediments	DOE 5400.1, DOE 5400.5
Sampling of the two LBL sewer outfalls. Outfall flow and pH are continuously measured at each site. Composite samples are analyzed for tritium, radioiodines, and gross alpha and beta emitters.	Weekly	Wastewater	DOE/EH-0173T; CCR Title 17, 30287 and 30288
24-hour composite samples from the two sewer outfalls and LBL's two plating shops are analyzed for a series of regulated metals. Grab samples are analyzed for chlorinated hydrocarbons, oil and grease, cyanide, phenols, total suspended solids, and filterable chemical oxygen demand.	Once every 2 or 3 months (stated on wastewater discharge permit)	Wastewater	40 CFR 433
Sampling of groundwater by collecting grab samples at six LBL hydraugers and at five creeks that drain the LBL watershed. The samples are analyzed for tritium and gross alpha and beta emitters.	Monthly: hydraugers; Weekly: creeks	Water	DOE/EH-0173T
30-minute composite sample at the start of a storm event, plus additional "grab" samples from creeks and streams. Samples analyzed for gross alpha, beta, tritium, metals, organics, oil/grease, gasoline, and diesel.	First storm event, plus at least one other	Water	40 CFR 122

A RCRA Facility Assessment (RFA) in 1992 identified 73 solid waste management units and 63 areas of concern. As part of the RFA, LBL conducted a detailed sampling evaluation that included soil gas surveys and installation of 28 monitoring wells. Over 900 soil analyses and nearly 300 groundwater analyses were conducted. In November 1992, LBL submitted a RCRA Facility Investigation (RFI) Workplan to DTSC. The RFI Workplan outlines required field activities to define the extent of contamination and identify sources.

In the fall of 1993, LBL began conducting the RFI phase of the RCRA Corrective Action process. Investigations of areas of potential environmental contamination, including soil, surface water, and groundwater contamination, and the determination of source(s) of contamination are currently being conducted. See Section 7, *Groundwater Protection*, for more details on environmental-restoration monitoring activities in 1993.

Since LBL contracts to have its hazardous waste removed from the site, the Laboratory subjects itself to becoming a Potentially Responsible Party should the eventual waste site become contaminated and require cleanup efforts. Two such incidents have occurred in the past two years. The first incident involved the North American Environmental, Inc. (NAE) site in Clearfield, Utah, where 13 drums of PCB waste originating at LBL that had been transported in violation of an agreement between NAE and LBL's subcontractor. The second incident involved the Bay Area Drum Site, a former drum recycling and reconditioning facility located in San Francisco. LBL responded to a Request for Information from Cal/EPA's DTSC. The *Compliance Summary* in Section 3 contains a complete report on the status of these two incidents.

Waste Management

The Waste Management Group manages hazardous, medical, and radiological waste activities at LBL. This group is divided into four Units: Compliance, Generator Assistance and Waste Minimization, Hazardous Waste Operations, and Radioactive Waste Operations. The Compliance Unit oversees hazardous waste compliance issues such as permitting, certification, document and contract management, budget tracking, training coordination, quality assurance and quality control plans, data management, and medical and infectious waste. The Generator Assistance and Waste Minimization Unit provides assistance on waste disposal issues, including waste minimization and pollution prevention, waste reduction, and process evaluations. The two operations units coordinate hazardous and radiological waste issues such as onsite transfers and offsite shipments, waste contractor supervision, and internal inspections. The two units also manage operation of the Hazardous Waste Handling Facility.

Hazardous Waste

The hazardous waste laws and regulations that LBL must comply with are among the most stringent and complicated in the nation. The Federal Resource Conservation and Recovery Act (RCRA) of 1976 is a complex body of regulations intended to ensure that hazardous wastes are disposed of in an environmentally safe manner and that facilities treat, store, and dispose of hazardous waste in a way that protects human health and the environment. Delegation of the RCRA program, including all generator requirements, from US/EPA to Cal/EPA was completed in July 1992. Cal/EPA was already administering the more stringent State Hazardous Waste Control Law (HWCL). Both RCRA and HWCL govern the disposal of hazardous wastes, including the disposal of mixed radioactive and hazardous chemical wastes.

RCRA's cradle-to-grave system for regulating hazardous wastes prescribes facility standards, waste handling protocols, land-disposal restrictions, recordkeeping, and training requirements. These requirements apply to generators and transporters of hazardous wastes, and to hazardous waste treatment, storage, and disposal facilities. Generators who store hazardous waste onsite for 90 days or less must register with US/EPA, obtain an identification number, and comply with hazardous waste recordkeeping, labeling, training, and other handling requirements. Generators who store waste for longer than 90 days, or who treat or dispose of hazardous wastes on site, are subject to far more extensive requirements, and must obtain a discretionary permit from US/EPA and Cal/EPA's DTSC.

Local health departments have entered into a Memorandum of Understanding with Cal/EPA, via DTSC, to administer the requirements of RCRA and HWCL for hazardous waste generators. LBL's hazardous waste generator activities are inspected by the City of Berkeley Toxics Program, and the onsite treatment and storage facility is subject to the ongoing jurisdiction of DTSC and US/EPA.

Due to the nature of the research activities conducted at LBL, a large number of waste chemicals classified as hazardous under RCRA are generated; however, most are generated in relatively small quantities. In order to manage hazardous waste before offsite shipment or onsite treatment, LBL operates a RCRA permitted storage facility. LBL's Hazardous Waste Handling Facility was initially permitted in 1983, with an expiration date established for 1988. Reapplication efforts for a new RCRA Part A and B permit began in 1987. A series of review delays and application modifications, including the addition of the proposed new HWHF, prolonged the approval process. DTSC gave final approval of the new RCRA permit for the HWHF in May 1993.

DTSC also conducted two separate inspections in 1993. One inspection resulted in a Report of Violation that later reached settlement with DTSC. The other, in November, resulted in no findings of violation. The City of Berkeley conducted seven inspections of LBL's hazardous materials and hazardous waste programs in early 1993. The City made recommendations, but did not issue any citations. More information on Waste Management activities is found in Section 3, *Compliance Summary,* including the status of the new HWHF.

Medical Waste

The Federal Medical Waste Tracking Act of 1988 and California Medical Waste Management Act (CMWMA) of 1990 provide the regulatory framework for medical-waste generating facilities such as LBL. The State program is considerably more stringent than the Federal program. Medical waste is defined to include biohazardous waste (*e.g.*, blood and blood-contaminated materials), "sharps" waste (*e.g.*, needles), and other waste produced in research relevant to the diagnosis, treatment, or immunization of human beings or animals, or in the production of biologicals, which are biological products used in medicine.

LBL is considered a large-quantity generator by the State, since it generates more than 91 kilograms (200 pounds) of medical waste each month. LBL's program is registered with the State and must be renewed annually.

LBL completed a *Medical Waste Management Plan* in 1993 in accordance with the regulatory requirements. The Plan includes sections on training; emergency action; medical waste hauling, treatment, and disposal; hazardous medical waste; radioactive medical waste; document control and recordkeeping; and program certification. Also included are LBL's *Medical and Biohazardous Waste Generator's Guide* and *Medical and Biohazardous Waste Generator's Training Plan*. Medical waste is generated in about 120 different locations distributed over 15 buildings, including four offsite buildings. A certified medical waste hauler visits LBL weekly. However, the pickup schedule varies from generator to generator: weekly, monthly, or "as needed" for infrequent generators. During 1993, LBL generated approximately 15,020 kilograms (33,110 pounds) of medical waste. There were no inspections of LBL's medical waste program by DHS in 1993.

Emergency Planning and Community Right-To-Know Act (EPCRA or SARA Title III) and California Hazardous Materials Release Response Plans and Inventory Law (The Business Plan)

Section 304 (emergency notification) and Sections 311 and 312 of the Superfund Amendments and Reauthorization Act (SARA) Title III are incorporated into requirements of the California Hazardous Materials Release Response Plan and Inventory Law (AB 2185; California Health & Safety Code 25500 *et seq.*). SARA Title III Section 304 requires emergency notifications in the event of certain hazardous-material releases. Section 311 requires that material safety data sheets (MSDSs) be prepared for all hazardous substances on the site, pursuant to the Occupational Health and Safety Act of 1970. Section 312 requires that facilities subject to MSDS requirements prepare an annual emergency and hazardous chemical inventory form. Section 302 of SARA Title III is covered by the State requirements derived from AB 3777 (California Health & Safety Code 25531 *et seq.*). Section 302 requires notification from facilities handling greater than threshold amounts of extremely hazardous materials. Finally, Section 313 of SARA Title III requires facilities that use more than specified amounts of certain toxic chemicals to report annual emissions.

In September 1992, former DOE Secretary Watkins issued a Memorandum directing DOE's participation in Toxic Release Inventory (TRI) reporting and US/EPA "33/50" Pollution Prevention Program pursuant to Section 313 of SARA Title III. Subsequently, on August 6, 1993, President Clinton signed Executive Order 12856, requiring that federal facilities submit TRI information to US/EPA no later than July 1, 1995 (covering calendar year 1994), regardless of whether a facility's activities fall within applicable SIC codes. DOE participation in the TRI and "33/50" programs is slated to begin with submittal of calendar year 1993 information by July 1, 1994, in accordance with Secretary Watkins' 1992 Secretarial Memorandum. DOE will submit a 1993 TRI report to

US/EPA for the LBL facility if threshold quantities of TRI chemicals are exceeded. DOE will provide Cal/EPA with a copy of the TRI report in response to Cal/EPA's March 1993 request for TRI information pursuant to legislation enacted in 1992.

LBL is currently implementing a container-tracking system based on a bar-code scheme to collect chemical inventory information. This new system will be the basis for the July 1, 1994, Business Plan submittal. Information from existing chemical-tracking records is being collected to assess LBL status with respect to SARA Section 313 requirements. LBL is also currently collecting information on TRI chemical use during calendar year 1993 to establish a baseline for both TRI reporting and pollution prevention requirements (50% TRI emissions reduction program). It is anticipated that the Laboratory will not exceed the 10,000 pounds (4,536 kg) per year chemical usage threshold for any hazardous or toxic chemical during 1993.

The City of Berkeley notified LBL in December 1992 that it must prepare and implement a Risk Management and Prevention Program (RMPP), as required by the La Follette Bill (AB 3777) for facilities handling acutely hazardous materials above certain thresholds. At the time the request was made, LBL triggered the thresholds requiring the preparation of this plan for the following substances: nitric acid, sulfuric acid, sodium cyanide, and potassium cyanide. The City of Berkeley and LBL are presently establishing a new mutually agreeable date because the Building 77 Plating Shop, which is responsible for triggering the RMPP requirements, will undergo major facility upgrades beginning in the second quarter of 1994 that will eliminate or significantly reduce most of these substances. It is expected that a RMPP may be required only for sulfuric acid once this shop is fully converted to an ultrahigh-vacuum cleaning facility in February 1995.

Environmental Assessments

Assessments of the environmental impacts from proposed projects are performed at LBL. Both Federal and State regulations require such analyses prior to approval of project development.

The National Environmental Policy Act (NEPA) serves as a mechanism for Federal government decision-makers to review the potential environmental consequences from projects proposed by other Federal agencies, and to take actions that protect, restore, and enhance the environment. NEPA also created the President's Council on Environmental Quality (CEQ) to advise the president and to prepare an annual environmental quality status report for Congress. After 23 years of existence, this council was replaced by a White House Office on Environmental Policy in 1993. The three categories of documentation for identifying and assessing the individual and cumulative impacts from a project are Categorical Exclusion, Environmental Assessment (EA), and Environmental Impact Statement, depending on the potential impact of the project. LBL follows the procedures for NEPA outlined in the CEQ regulations, as well as the policies and procedures established by DOE. In 1993, LBL prepared 128 NEPA documents: 125 categorical exclusions and three EAs. The EAs were prepared for the following

- new Human Genome Laboratory
- disposition of copper coil windings from the 184-inch Cyclotron
- new Biomedical Isotope Facility

In addition, the California Environmental Quality Act (CEQA) applies to projects that are sponsored or funded by a government agency, require government approval or permits, and are determined to have a significant effect on the environment. The State has set guidelines for defining CEQA applicability. Since multiple agencies may be involved in reviewing a CEQA submittal, defining the lead agency and creating a uniform, consistent process are important elements of the CEQA review. Projects determined to pose no significant effect on the environment receive a Categorical Exemption or Negative Declaration. For all other projects, an Environmental Impact Report (EIR) is required. The EIR process opens the proposed project to public review and comment. LBL follows both the State CEQA guidelines, as issued by the California Resources Agency, and the procedures for CEQA implementation established by the University of California Regents. In 1993, seven proposed projects were Categorically Exempt from CEQA and three projects required Initial Studies that led to Negative Declarations for two of the three (determination not final on the third). Initial studies were completed for the following:

- new Biomedical Isotope Facility
- Continued Operation of and Alterations and Upgrades to the Existing Hazardous Waste Handling Facility at LBL
- Modification of Permitted Hazardous Waste Handling Facility (HWHF) Operations at LBL and Transportation of Hazardous and Mixed Wastes from an Off-site LBL-leased Building to LBL's HWHF

LBL continued preparing the EIR for the new Human Genome Laboratory throughout 1993.

Corrective Action Projects

A key element of LBL's environmental management program involves upgrading or improving site activities to fully comply with environmental regulations. This activity has increased significantly in the past few years in response to the Tiger Team investigation of 1991, changing regulations, and life cycle replacement of aging infrastructure. The more significant corrective action projects currently in progress are associated with the Tiger Team investigation of the LBL site. Since 1991, a large Environmental Restoration and Waste Management (ERWM) corrective action project entitled *Air Toxics Facility Assessment and Rehabilitation* has gone through various stages of design and construction. The project includes nearly $3.2 million in corrective action work, and contains the following subprojects:

- radiological NESHAPs stack monitoring upgrades
- sitewide radiological ambient air monitoring
- meteorological monitoring upgrade
- airborne emissions source abatement

The majority of projects have scheduled completion dates at the end of FY 1993. However, the three NESHAPs projects will likely be completed in February 1995.

Other significant corrective action projects discussed in this section include:

- sanitary sewer monitoring
- storm drain connection repairs

- aboveground storage tank modifications
- underground storage tank modifications

NESHAPs Stack Monitoring

US/EPA issued a Finding of Violation and Order against DOE in April 1991 because LBL was not conducting its radionuclide sampling program in compliance with applicable NESHAPs stack monitoring requirements. A Federal Facilities Compliance Agreement between DOE and US/EPA will bring LBL's NESHAPs stack monitoring program into full compliance by February 1, 1995. Project funds have been approved that will address shortcomings in the current sampling and monitoring programs. The total estimate of the project is $1.8 million.

In 1993, plans, specifications, and designs were completed by LBL's design team, and construction contracts were awarded. The overall project is divided into three levels. The first level upgrades stacks so emission measurements can be taken with either a portable or continuous sampling device. These represent the lower end of the regulated radionuclide emission sources. At the end of 1993, this upgrade affected 43 stacks that require periodic monitoring (portable sampler) and 28 stacks that require a fixed, non-isokinetic, continuous sampler.

The second and third levels of the compliance project upgrade the stacks that have the greatest potential to emit radionuclides at LBL. Both levels include real-time monitoring capability. The second level focuses on installing real-time, isokinetic monitoring of radionuclide emissions from Buildings 75 and 75A. This upgrade will include the emissions from the National Tritium Labeling Facility and the existing Hazardous Waste Handling Facility. The third level of the project involves to real-time non-isokinetic monitoring of air-activation emissions from accelerator activities in Buildings 56 and 88. Building 56 will be the location of LBL's new Biomedical Isotope Facility. Building 88 is the location of the 88-Inch Cyclotron. While there have been some minor changes to the design and scope at all three levels of the project, the Laboratory is on schedule to complete the upgrades by January 1995.

NESHAPs-regulated radionuclides may be released to the atmosphere as a result of research being conducted at LBL. These research activities are dynamic. Research projects often have a fixed duration, and new projects may occur at new locations and emit a different set of radionuclides. These changes affect both the sampling strategy and sampling devices. To track compliance and continually assess stack monitoring requirements, LBL reviews all activities that may release radionuclides through the LBL Radiological Work Permit (RWP) program. This program tracks the use and inventory of all radionuclides on site. An assessment based on the nature of the work being proposed and the state of the radionuclide provides part of the basis for determining the dose to the nearest offsite member of the public in the event of a release. Following DOE EH-1073T and US/EPA regulations, this assessment is performed with the assumption that no portion of the release is collected by emission controls. Using the US/EPA-approved models COMPLY and CAP88-PC, dose estimates are used in conjunction with a compliance strategy approved by US/EPA to determine the degree of sampling/monitoring or administrative controls necessary to achieve compliance. The compliance strategy is summarized in Table 4-3. The sampling/monitoring strategy adopted by LBL in order to come into compliance with NESHAPs is summarized in Table 4-4.

Compliance with NESHAPs will be an ongoing program to accommodate changing LBL research activities in meeting the Laboratory mission.

Sitewide Radiation Monitoring and Sampling

A Tiger Team Finding in 1991 cited deficiencies in a number of monitoring areas, including an insufficient distribution of monitoring stations and an unsatisfactory ambient air monitoring network. The Finding referenced DOE Order 5400.1, Chapter III, which sets forth the requirements for environmental monitoring. Broadly speaking, environmental monitoring consists of effluent monitoring and environmental surveillance.

The Sitewide Radiation Monitoring and Sampling Project adds nine new high-volume air samplers strategically located to measure the highest expected concentrations of particulate releases from the Laboratory. Two new gamma and neutron monitoring stations are positioned to detect direct radiation and backscatter from the 88-Inch Accelerator and the Advanced Light Source. Figure 4-3 shows the locations of the existing ambient air samplers and the proposed locations for the new high-volume air samplers. The current network of ambient air samplers and

Table 4-3. Summary of LBL NESHAPs Compliance Strategy

Category	Annual Effective Dose Equivalent (AEDE) (millirem/year)	Sampling/Monitoring Strategy	Number of Sources (1993)
Non-compliant	AEDE $\geq$ 10.0	Reduce or relocate source term and reevaluate prior to authorization	0
I	10.0 > AEDE $\geq$ 0.1	US/EPA Application to Construct or Modify required, along with continuous isokinetic sampling. Analytical differences associated with half-life of radionuclide. Half-life greater than 100 hours: weekly analysis. Half-life less than 100 hours: hourly telemetry to central location.	4
II	0.1 > AEDE $\geq$ 0.05	Continuous isokinetic sampling with weekly analysis.	0
III	0.05 > AEDE $\geq$ 0.01	Continuous isokinetic sampling with monthly analysis.	1
IV	0.01 > AEDE $\geq$ 0.001	Sampled annually during project activity (continuous two-week sampling run). Isokinetic sample probe design, with sample mass flow set for average stack velocity.	6
V	0.001 > AEDE	No monitoring required. Inventory controlled by administrative methods (Radiation Work Permit) and annual reconfirmation.	57

Table 4-4. NESHAPs Point Source Compliance Sampling/Monitoring Summary

Sampling/Monitoring Method	Sampling Location
Real time monitoring of HT and HTO	B75 NTLF exhaust
Continuous isokinetic sampling of HT and HTO	B75 NTLF exhaust
Real time monitoring of ^{11}C, ^{13}N, ^{15}O	B88 accelerator exhaust
Real time monitoring of ^{1}C, ^{13}N, ^{15}O	B56 Biomedical Isotope Facility accelerator exhaust
Real time monitoring of particulates and iodine	B75 mixed and radioactive waste handling area
Continuous isokinetic sampling of particulates and iodine	B75A waste compactor
Continuous isokinetic sampling of particulates and iodine	B75 mixed and radioactive waste handling area
Continuous sampling of particulates, iodines, tritium, and sulfur	17 stacks located on 13 onsite and offsite building.
Periodic sampling of particulates, iodines, tritium, and sulfur	44 stacks located on 13 onsite and offsite buildings
Periodic monitoring of ^{18}F	3 stacks located on B74B

monitoring stations will remain in operation until their value with respect to the new stations is determined. The scheduled completion date for this project is October 1994.

Sanitary Sewer Monitoring Upgrade

All LBL wastewater effluents are discharged though one of two sanitary sewer outfalls. The effluent is monitored from vaults, which are located near the LBL boundary of each outfall. The Hearst vault is located in Blackberry Canyon east of Hearst Avenue, and the Strawberry vault is located on Centennial Avenue, south of the site. The Hearst vault was a confined space and access was costly and difficult. Frequent acce was necessary to maintain and repair the pH probe and flow monitors. Flow measurement involved measuring the level of water in a stilling well adjacent to the outfall flume. The well communicates with the flume via a narrow pilot tube. Frequently, this tube would become blocked with debris. The water level in the stilling well would not reflect the level in the outfall flume, and incorrect flows would be recorded. The wastewater discharge permit is administered by EBMUD and requires that accurate flow measurement be performed. In order to stay in compliance with the wastewater discharge permit, modifications to the outfall would have to address operation of the stilling well.

A project to upgrade the Hearst and Strawberry sanitary sewer monitoring stations was completed in December 1993. The corrections included the construction of a new Hearst vault and flume and the installation of sampling pumps. The design objective was realized in providing a reliable means of measuring the wastewater flow and providing a nonconfined-space access to the flume vault. The Strawberry flume was modified to make the flow readings more reliable and to correct a faulty stilling section for the pH probe.

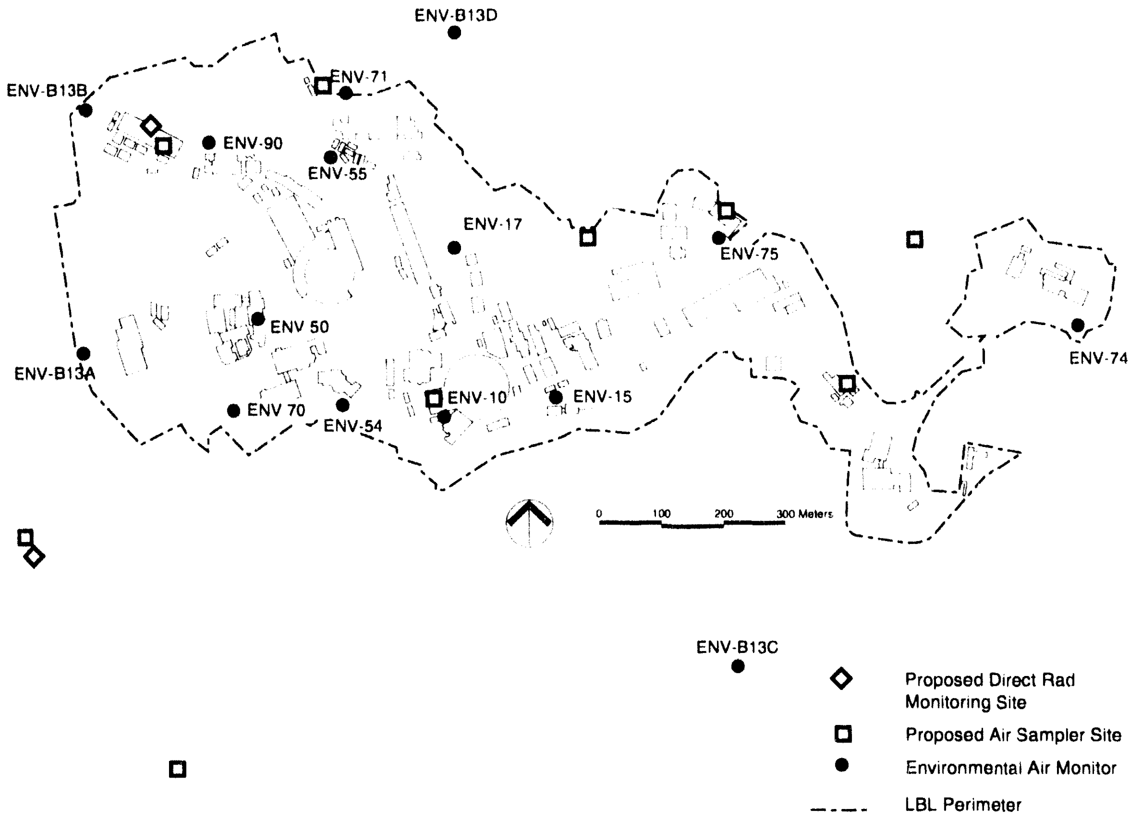


Figure 4-3. Site Map Indicating the Location of Existing and Proposed Ambient Air Samplers and Gamma and Neutron Monitors

Meteorological Monitoring Stations

Onsite meteorological data of wind speed, wind direction, and temperature have been collected at LBL since at least the 1970s. These data are used to estimate the impact of LBL's radiological emissions on the environment for NESHAPs compliance as required by DOE Orders. Other uses include estimating the impact of air toxic emissions for obtaining environmental operating permits from regulatory agencies, or preparing health risk assessments of new projects as a planning tool. Additionally, meteorological data can be vital for emergency response activities such as spills, gas releases, or fires.

Both a 1988 DOE Functional Appraisal of environmental programs and the 1991 DOE Tiger Team found the LBL meteorological monitoring program to be inadequate. LBL agreed to update its monitoring program in its Tiger Team corrective action plan. Funding was obtained in 1991 for this ERWM upgrade subproject. This specific project was divided into two stages: (1) prepare a monitoring plan based on LBL's existing monitoring site, physical setting, and regulatory requirements; and (2) implement the plan through design and installation of the recommended equipment.

The monitoring plan evolved into one that focused on using remote-sensing instrumentation to gather the needed airflow information after it became apparent that using traditionally instrumented tower systems was not feasible at LBL. The number and height of towers needed to accurately characterize and collect meteorological data created insurmountable architectural and aesthetic obstacles. The only reasonable technical alternative for collecting near-ground-level wind speed, wind direction, and atmospheric turbulence data is with remote-sensing instrumentation called SODAR (SOnic Detection And Ranging). SODAR technology works on the principle that a signal of known frequency is sent upwards in known directions. The unit then listens for a return signal. Three-dimensional wind fields are derived based on the detected frequency from the different directions. For example, if no change in the signal frequency is detected, then the SODAR concludes that calm wind conditions prevail.

SODAR technology has certain advantages over conventional tower monitoring systems: portability, cost, and considerably increased data-collection capability. This last feature is represented by the SODAR system's ability to collect wind information at many levels while a tower collects data usually at only one level. This enhanced resolution gives a much more realistic perspective of the wind profile near the ground, which changes considerably both in direction and speed in complex settings such as LBL. Around the time LBL began upgrading its monitoring plan, vendors introduced mini-SODAR systems that concentrated on gathering wind data in the lower several hundred meters above the ground with a finer vertical resolution (*i.e.*, smaller distance between data points). Previous models were larger and more powerful and attempted to collect data up to a kilometer or more above the ground. Since nearly all of LBL's emissions to the atmosphere are at or near ambient temperature (*i.e.*, little thermal buoyancy), understanding differences in airflow patterns in the zone just above building rooftops is important.

In the second half of 1992, LBL coordinated several onsite tests of mini-SODAR systems to verify that the technology did not conflict with local conditions, such as rooftop air handling units. A monitoring plan was finalized in late 1992 based on the results of these tests. The plan recommended up to three mini-SODAR monitoring locations around LBL, with a 20 meter tower located at one of the mini-SODAR sites for quality assurance purposes (see Figure 4-4 for specific locations). LBL's design team of Facilities Engineering experts in architecture and electrical, mechanical, and structural engineering, as well as technical experts in Environmental Protection, established and formalized the requirements of the monitoring plan during the first half of 1993. In the summer of 1993, LBL awarded contracts to individual vendors for the mini-SODAR and the monitoring-tower components of the monitoring network. The remainder of 1993 was spent coordinating onsite preparation activities and interfacing with the chosen vendors. Actual installation of the mini-SODAR systems and the meteorological tower began in January 1994. Two of the three mini-SODAR stations and the tower were declared operational in February 1994. The third mini-SODAR station encountered delays as the result of a last minute conflict identified with the chosen location. This conflict temporarily set back the startup date of this site, as redesign and site-preparation support services were required. This location is now ready for startup. Data from this monitoring network are routinely

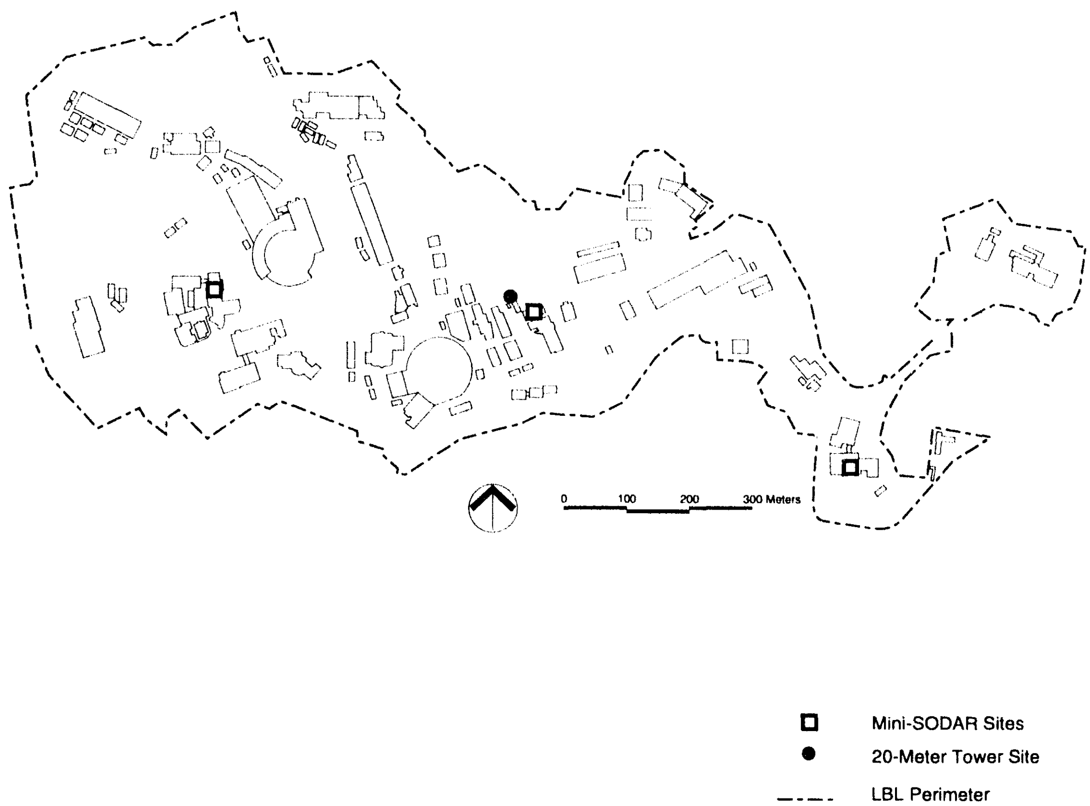


Figure 4-4. Meteorological Monitoring Locations

collected and reviewed in near real-time. A minimum of one year of quality-assured data must be collected before LBL is ready to use these data for NESHAPs dose assessments or other applications.

Airborne Emissions Source Abatement Systems

Certain activities at LBL emit, or have the potential to emit, hazardous air pollutants directly to the environment. The Airborne Emissions Source Abatement Systems project evolved from the rescoped ERWM corrective action project in early 1992. Its objective was to reduce or eliminate emissions of hazardous air pollutants. The project was further divided into several subprojects:

- lead pot ventilation and filtration
- glass shop ventilation and filtration
- centrifugal chiller replacement
- walk-in refrigeration replacement
- ice machine replacement.

The lead pot melting and pouring operation, located at Building 77, has not operated since the Tiger Team audit in 1991 because of an inadequate exhaust ventilation system. Lead pouring for fabricating specially designed beamline shielding is a critical support capability for LBL's research programs. The upgrade performed in 1993 dramatically improved the workplace ventilation at the lead pot while adding HEPA-type filtration efficiency of harmful lead emissions to the exhaust system. Design and construction of the improvement project was completed in October 1993. The new operation was approved and permitted by BAAQMD in November.

The glass shop is another support facility located in Building 77. This shop produces specialty glassware used in laboratory research. The raw materials used in making these products have changed over time as the need for stronger containers has evolved. Presently, quartz is one of the products used in the process. The heating process creates a hazardous byproduct called amorphous silica. Design of the improved exhaust ventilation system, with emission controls, began in 1993 and was completed in early 1994. Completion of construction is expected in 1994. The new glass shop design is presently under permit review by BAAQMD.

The remaining three subprojects were included because of the extensive attention focused on eliminating the use of ozone-depleting substances (ODSs), since these materials will be phased out of production globally by December 31, 1995. The three subprojects were identified as high-priority tasks under LBL's Refrigerant Management Plan (see Section 3, *Compliance Summary*). Preliminary design efforts were completed in 1993, and final design is scheduled for early 1994. Installation is expected to be complete in the first half of 1994. The designs all specify replacement systems that are consistent with US/EPA's Significant New Alternatives Policy (SNAP) Program. Additionally, all refrigerants in systems affected by this replacement will be properly recovered and recycled from the existing systems as part of the project.

The first ODS phase-out project will convert one of the two large centrifugal chillers that provide air conditioning to the Building 2 complex. These two centrifugal chillers were installed only a few years ago during the construction of this building and are considered young in terms of a life-cycle analysis. Retrofitting is the best option for such systems. They each contain hundreds of kilograms of Freon-11, which will be recovered during the conversion process and properly inventoried as backup material for the three remaining large centrifugal chillers at LBL (one in Building 2 and two in Building 50B). LBL's project will convert one system from Freon-11 to hydrochlorofluorocarbon-123 (HCFC-123) and make any required upgrades to ventilation and monitoring systems within the room housing the centrifugal chillers. The second centrifugal chiller will be retrofitted at a future date, after successful conversion of the first system.

The two remaining ODS phase-out projects involve lesser design efforts and smaller amounts of refrigerant than the Building 2 centrifugal chiller. One project will convert two walk-in refrigeration units in Building 1 (Donner Lab) from Freon-12 to HCFC-22. The other project will replace seven ice machines containing Freon-12 with systems containing HCFC-22. These ice machines are found in various buildings across the LBL site.

Storm Drain Connection Repairs

The Clean Water Act requires that discharges of stormwaters associated with industrial activities be regulated by National Pollutant Discharge Elimination System permits. LBL has been covered under the statewide General Permit since 1992. The permit requires the Laboratory to develop, implement, and maintain a Storm Water Pollution Prevention Plan (SWPPP). It also requires that non-stormwater discharges into storm drain systems be eliminated prior to implementing the SWPPP (October 1, 1992), or that an extension be requested. LBL notified the State that the improper connections could not be eliminated by that date and requested an extension until March 30, 1995. This date was the maximum extension allowable under the regulation.

In 1992, LBL performed a sitewide survey that identified 38 improper connections: 31 within buildings and seven at exterior locations. To date, six buildings have been corrected through either engineering and construction or removal. Engineering efforts have been completed on all remaining connections. Construction on correcting an additional five buildings will proceed in 1994. Additional funding has been requested for both 1994 and 1995 to complete the remaining connections before the regulatory deadline.

Aboveground Storage Tank Modifications

The Clean Water Act outlines the regulatory requirements for aboveground storage tanks. In May 1993, a sitewide audit was conducted to assess the current conditions of approximately 70 petroleum storage areas on the LBL site, including transformers, engine generators, and petroleum drum storage areas. This audit showed that 33 petroleum storage areas will require the installation or repair of secondary containment to contain potential leaks. The full list of items was prioritized, with highest priority items scheduled to be completed in 1994 and funding requested for the remaining items in 1995. The preliminary design of the three highest priority items was initiated in 1993.

Underground Storage Tank Modifications

Underground storage tanks (USTs) at LBL are regulated by a City of Berkeley ordinance that integrates Federal and State UST requirements.

LBL removed two single-walled tanks from the Laboratory site in March 1993 (shown as gray dots on Figure 4-2), reducing the number of active USTs on site from 15 to 13. Sampling of the surrounding areas revealed no soil contamination from leaks from either tank. However, five 55-gallon (209-liter) drums of soil, contaminated by exterior tank corrosion, were removed from the Building 50 site. The soil was physically discolored with a yellowish tint. Laboratory analysis revealed that the primary contaminants in the soil were chromium and nickel. These are not the types of materials expected from a leak in a tank that solely served a photoprocessing operation during its lifespan. Subsequent sampling surrounding the removed soil confirmed removal of all of the contaminated soil.

LBL ceased operation of two additional tanks in 1993: a double-walled waste oil tank and a single-walled diesel oil tank. Closure plans were submitted to the City of Berkeley in November 1993. In December 1993, the City of Berkeley approved LBL's plans for removal of these two tanks, scheduled for 1994.

On February 6, 1993, an overfill of approximately 31 liters (eight gallons) of diesel fuel occurred in secondary containment at a 1,000-gallon (3,800-liter) underground storage tank (ID# 2-2). The overfill was investigated, and cleanup was initiated. No diesel fuel was released to the storm drain or the sanitary sewer during the incident. The City of Berkeley was initially notified of this incident in writing on February 11, 1993, with a follow-up status letter sent by LBL on March 12, 1993. Subsequent evaluation and preconstruction activities encountered a small amount of old oil in a nearby area, apparently unrelated to the underground storage tank. LBL's

Environmental Restoration Program will perform follow-up activities relating to this discovery.

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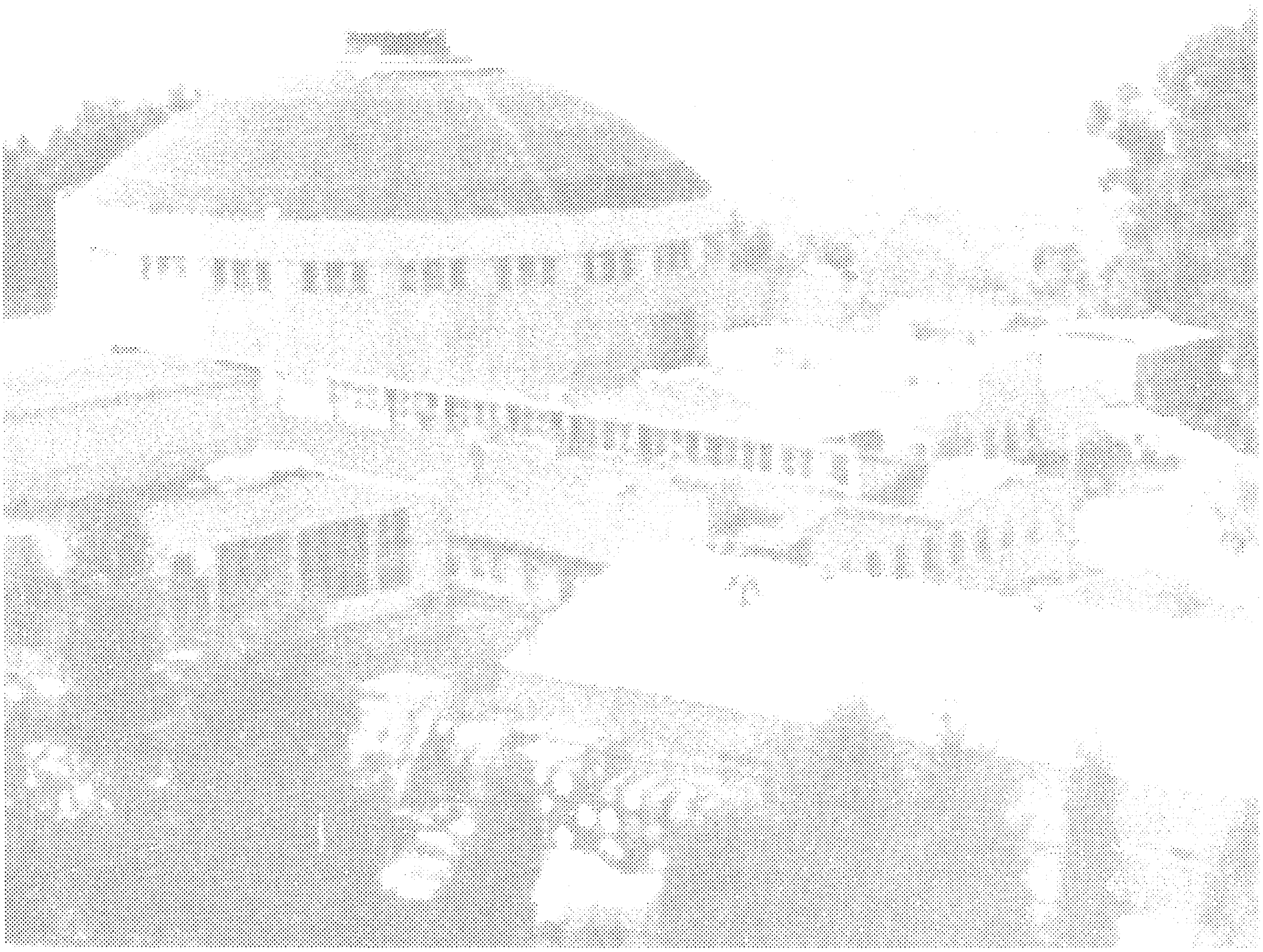
Section 5. Environmental Radiological Program Information



External Penetrating Radiation

Radiation-producing machines (accelerators, x-ray machines, and irradiators) and various radionuclides are used at LBL for high energy particle studies and biomedical research. At LBL, external penetrating radiation is mainly associated with accelerator/irradiator operations.

Accelerator-Produced Penetrating Radiation

To determine the environmental radiological impact of LBL accelerator operations, LBL maintains five permanent real-time environmental monitoring stations (EMSs) at various locations around LBL's perimeter. These EMSs continuously record direct gamma and neutron radiation. Each station contains sensitive neutron and gamma pulse counters. The neutron detector is mainly a 500-cm^3 cylindrical boron trifluoride (BF_3) gas-proportional counter housed in a 6-cm (2.5-inch) thick cylindrical paraffin moderator. The gamma detector is an energy-compensated Geiger-Muller (GM) chamber. The output pulses from these detectors are individually prescaled and telemetered to a computer in Building 75. A typical dose equivalent value for an EMS neutron detector is about 0.13 millirem (mrem) per pulse, while that of a gamma-register pulse is about 1.3 mrem per pulse.

During the past several years, the LBL accelerators have run heavy ions during a significant fraction of their operating schedules. Successful work in beam development had served to increase beam currents in recent years, which slightly increased the dose equivalent at the Building 88 EMS. Recently the trend has been gradually downward, resulting from improvements in accelerator beam optics, local shielding, and cave selection. Other large-scale accelerator activity at LBL has recently decreased. On December 23, 1992, the SuperHILAC accelerated its last particle. The Bevatron ceased operation in February 1993. The shutdown of the Bevalac (the combination of the SuperHILAC and the Bevatron) resulted in an overall reduction of the maximum offsite exposure and population dose.

Since early 1991, the 88-Inch Cyclotron has administratively controlled its use of light-ion runs, reducing the potential for an offsite dose exceeding 0.5 mrem. The former injection source that provided beam currents up to 100 μA is no longer used. The new source will only allow beam currents of less than 10 μA. During 1993, light ion runs (^{1}H and ^{3}He) in the 88-Inch Cyclotron averaged about 10 percent (528 hours) of all running time for the year. The gamma and neutron doses attributable to these accelerator operations during 1993 are listed in Table 5-1, as estimated from measurements at five EMSs.

Irradiator-Produced Penetrating Radiation

Historically, DOE facilities have reported "fence-post doses," which are measured or computed values reflecting the exposures to a hypothetical individual living 100% of the time at the perimeter of the facility. In keeping with the DOE trend toward presenting realistic assessments of exposures to actual individuals, this section will provide both maximum fence-post dose estimates and estimates of exposures to workplaces or dwellings of LBL's nearest neighbors. LBL is currently storing two shielded gamma irradiators in the Building 75 waste yard

Table 5-1. 1993 Annual Penetrating Radiation Dose due to Accelerators (Measured by EMSs at the LBL Perimeters)

Monitoring Station	Net Gamma Dose (mrem*/yr)	Net Neutron Dose (mrem*/yr)	Total Dose (mrem*/yr)
Station 13 A (Bldg. 88)	1.01	1.95	2.96
Station 13 B (Bldg. 90)	0.94	0.37	1.31
Station 13 C (Panoramic)	1.04	0.08	1.12
Station 13 D (Olympus Gate)	0.47	0.27	0.74
Station 13 H (ALS)	0.07	0.4	0.47

(*) 1 mrem = 0.01 mSv

behind a large earth berm to minimize the potential worker exposure. One unit contains about 543 curies (Ci) of ^{137}Cs, and the other unit contains 270 Ci of ^{60}Co. The gamma radiation field attributable to these irradiators measured at the perimeter fence nearest to the devices was less than 2 µrem/hr, which results in an annual fence-post dose of less than 18 mrem/year. However, the perimeter fence at this location is on UCB land, and there are no residences or offsite workplaces in the immediate vicinity. The nearest offsite workplace (40-hour/week occupancy) is the Lawrence Hall of Science, which is approximately 270 meters from the fence. The nearest residence is approximately 500 meters away. Both of these offsite locations are shielded by a hillside. Even if the hillside shielding is ignored, the predicted doses from these irradiators would be about 0.005 mrem/yr and 0.007 mrem/yr at the Lawrence Hall of Science and at the nearest home, respectively. These retired irradiators are clearly marked, barricaded, and cordoned off. The dose rate at the nearest accessible distance to these units is approximately 0.2 mrem/hr.

Several multicurie gamma irradiators are being used at LBL to carry out radiobiological and radiochemical research. The largest of these units is a ^{60}Co unit housed in an interlocked, massive reinforced-concrete-covered labyrinth built as part of Building 74. This unit is also the irradiator closest to the LBL perimeter. Routine surveys taken when the source was in the exposed position confirmed that no area exceeded 1 mrem/hr at 1 meter from the outside walls or ceiling. The Building 74 irradiator is about 80 meters from the LBL perimeter fence, 150 meters from the nearest "commercial" occupancy (a UCB Botanical Garden building), and more than 700 meters from the nearest residence. The projected annual dose equivalents to members of the public are about 1.4 mrem/yr at the perimeter fence, 0.1 mrem/yr at the Botanical Garden building, and less than 0.02 mrem/yr at the nearest residence. A summary of the 1993 penetrating radiation doses due to gamma irradiators is given in Table 5-2.

Air

LBL employs a wide variety of radionuclides in its radiochemical and biomedical research programs. In addition, radioactive materials are inevitably produced by the operations of the charged-particle accelerators such as the 88-Inch Cyclotron. Table 5-3 characterizes most of the dominant airborne radionuclides used and/or monitored at LBL during 1993.

Table 5-2. Estimated 1993 Annual Penetrating Radiation Dose due to Gamma Irradiators

	Estimated Gamma Dose (mrem*/yr.)		
Irradiator Location	Fence-Post	Nearest Residence	Nearest Workplace
Building 75	<18	<0.007	<0.005
Building 74	<1.4	<0.02	<0.1

(*) 1 mrem = 0.01 mSv

The most commonly and widely used radionuclides in LBL research programs are ^{3}H, ^{14}C, ^{18}F, ^{32}P, ^{35}S, and ^{125}I.

The principal form in which radionuclides are released from LBL stacks is as vapors or gases. Particulate materials are normally filtered from effluent streams such that measurable radioactivities of particulate releases are rarely observed. Radionuclides in the above list that were released to the atmosphere from LBL stacks during 1993 are ^{3}H as HTO water vapor, ^{14}C as CO_2, ^{35}S as SO_2, and ^{125}I in various gaseous forms.

Both ^{226}Ra and ^{227}Ac produce gaseous radioactive daughters, specifically two isotopes of radon, ^{222}Rn and ^{219}Rn, respectively. ^{226}Ra and ^{227}Ac are being used in LBL research activities. However they are either in sealed canisters (calibration sources), in natural uranium ores, or in electroplated targets or foils in quantities too small to produce any consequential environmental impact. In addition, both ^{226}Ra and ^{227}Ac are daughters of natural uranium isotopes (^{238}U and ^{235}U, respectively) which are found, along with their daughters, in most continental rocks and soils in concentrations of a few parts per million.

DOE Order 5400.5 makes no provision for unidentified radionuclides. Throughout this report, unidentified radionuclides will be labeled ^{232}Th if they are alpha-emitting material or ^{90}Sr if they are beta-emitting material. This is a conservative approach because these assigned radionuclides represent the most restrictive alpha and beta emitters listed in DOE Order 5400.5. ^{90}Sr is normally used as a calibration source in radioanalytical environmental laboratories. ^{232}Th is occasionally used in only five of LBL's more than 80 laboratories. Although ^{227}Ac, which is 4500 times more restrictive a beta emitter than ^{90}Sr, is also used at LBL, its most likely state is in equilibrium with its alpha-emitting daughters (^{227}Th and ^{223}Ra) and it would thus be detected as an alpha emitter.

Radioactive gases produced by the accelerator operations are mainly short-lived radionuclides such as ^{11}C, ^{13}N, ^{15}O, and ^{41}Ar. These induced radioactive gases are normally produced in areas where the beam strikes beam line components. A number of other activation products, including ^{10}C, ^{16}N, ^{14}O, and ^{38}Cl and ^{39}Cl (produced from ^{40}Ar, which is approximately 1% of the atmosphere) are also produced. However, these radionuclides represent less than 5% of the total discharged activation products and are shorter-lived than the four major species listed. Therefore, they do not significantly contribute to the offsite dose equivalent.

At present, discharge points with the most significant potential for routine or accidental release are continuously or periodically

Table 5-3. Airborne Radionuclides Used and/or Monitored at LBL During 1993

Nuclide Name (Atomic Number)	Radio-Nuclide Symbol	Principal Radiation Types	Principal Energy (MeV)	Half-Life
Americium (95)	^{241}Am	α	5.40	432 years
		γ	0.06	
Argon (18)	^{41}Ar	β	1.2	1.83 hours
		γ	1.3	
Carbon (6)	^{11}C	β^+/γ	0.511	20.5 minutes
Carbon (6)	^{14}C	β	0.156	5730 years
Curium (96)	^{248}Cm	α	5.08	3.39×10^5 years
Cobalt (27)	^{60}Co	β	0.318	5.27 years
		γ	1.33	
Fluorine (9)	^{18}F	β^+/γ	0.511	109.7 minutes
Hydrogen /Tritium (1)	^{3}H	β	0.0186	12.28 years
Iodine (53)	^{125}I	γ	0.027	60.14 days
Nitrogen (7)	^{13}N	β^+/γ	0.511	9.97 minutes
Nickel (28)	^{63}Ni	β	0.066	100.1 years
Oxygen (8)	^{15}O	β^+/γ	0.511	122 seconds
Phosphorus (15)	^{32}P	β	1.71	14.3 days
Rubidium (37)	^{86}Rb	β	1.77	18.66 days
		γ	1.08	
Sulfur (16)	^{35}S	β	0.167	87.44 days
Strontium (38)	^{90}Sr	β	0.546	28.6 years
Thorium (90)	^{232}Th	α	4.01	1.4×10^{10} years
		β	0.04	
Uranium (92)	^{238}U	α	4.2	4.47×10^9 years
		β	0.029	
Zinc (30)	^{65}Zn	γ	1.12	244 days
Zirconium (40)	^{95}Zr	β	0.4	64 days
		γ	0.757	

sampled. The exception to this procedure is the air-activation-product discharges from accelerators, which currently are not monitored. LBL will install air-activation-product monitors on all accelerators by February 1995. The 1993 discharges from LBL accelerators were estimated using a model developed by H.W. Patterson and R.H. Thomas, and described in their book *Accelerator Health Physics*, Academic Press, New York, NY, 1973, pp. 519-531. The total airborne effluent released during 1993 is presented in Table 5-4.

Table 5-4. Total Air Effluent Radioactivities Released during 1993

Nuclide	Total Air Effluent [Ci*/yr]	% Total Effluent
^{3}H	1.0×10^{2}	92.24%
^{13}N**	2.9×10^{0}	2.57%
^{18}F**	2.3×10^{0}	2.04%
^{11}C**	1.8×10^{0}	1.55%
^{15}O**	1.7×10^{0}	1.50%
^{41}Ar**	1.0×10^{-1}	0.09%
^{35}S	3.3×10^{-4}	0.00%
^{125}I	3.5×10^{-5}	0.00%
^{14}C	3.1×10^{-5}	0.00%
^{86}Rb	1.2×10^{-5}	0.00%
^{90}Sr	9.3×10^{-6}	0.00%
^{32}P	8.7×10^{-6}	0.00%
^{95}Zr	3.7×10^{-6}	0.00%
^{63}Ni	2.6×10^{-6}	0.00%
^{65}Zn	1.7×10^{-6}	0.00%
^{248}Cm	2.4×10^{-7}	0.00%
^{238}U	5.1×10^{-8}	0.00%
^{241}Am	3.6×10^{-8}	0.00%
^{232}Th	2.2×10^{-8}	0.00%
^{60}Co	3.4×10^{-14}	0.00%
TOTAL:	**1.1×10^{2}**	**100.00%**

(*) 1 Ci = 3.7×10^{10} Bq

(**) Estimated/calculated values

Tritium Monitoring

Atmospheric tritium, as HTO, is measured at eight locations by passing atmospheric air through a column containing silica gel. Adsorbed water is "exchanged" into distilled water, and an aliquot (5 ml) is placed in a vial and counted in a liquid scintillation counter. The detection limit for HTO in air is 200 x 10[illegible] µCi/ml.

Silica gel HTO samples are changed weekly at the eight stations identified in Figure 5-1. Three of the stations are on site:

- ENV 69A (northeast corner of Building 69)
- ENV B13A (west of Building 88)
- ENV B13B (northwest of Building 90).

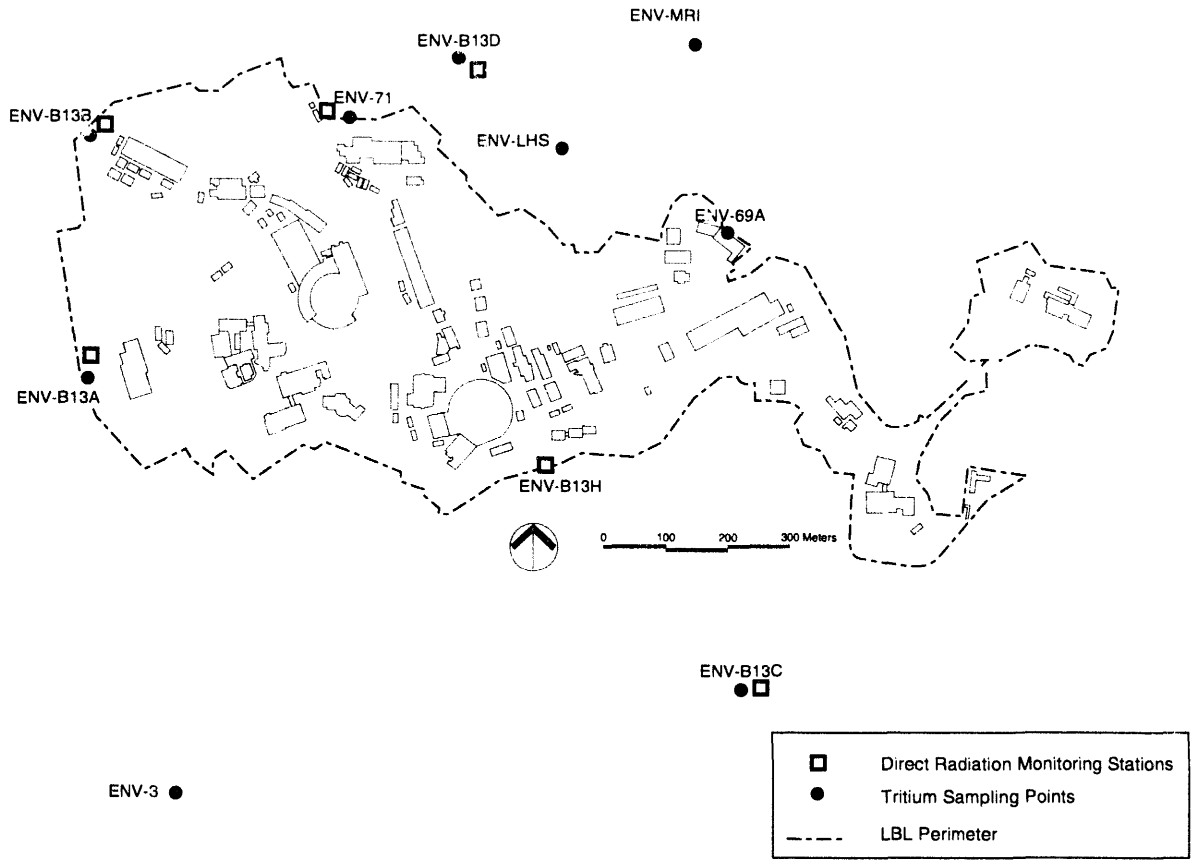


Figure 5-1. Map of Environmental Direct Radiation Monitoring Stations and Airborne Environmental Tritium Sampling Sites

Five of the stations are off site:

- ENV 3 (on the roof of Building 3)
- ENV LHS (in the public area of the Lawrence Hall of Science)
- ENV MRI (in the public area of the UCB Mathematical Science Research Institute)
- ENV B13C (across Strawberry Canyon, south of LBL)
- ENV B13D (northwest of the Lawrence Hall of Science)

Atmospheric tritium concentrations measured by these stations for 1993 are presented in Table 5-5. All values are within the permitted standard.

Nearly all of the tritium released from LBL was discharged from the Building 75 (National Tritium Labeling Facility and Hazardous Waste Handling Facility) stacks. These stacks are monitored for tritium as described above. During 1993, approximately 104 Ci of tritium emission were measured from these stacks. Of this, 60 Ci were associated with LBL normal operations and 44 Ci were from an unplanned release that occurred in August. A summary of the annual releases of tritium (as HTO) from the Building 75 activities for the period 1983 through 1993 is presented in Table 5-6 and Figure 5-2.

Table 5-5. Summary of ^3H Concentration for Airborne Environmental HTO Samples

		Concentration [1.0 x 10^{-9} pCi*/l]		
Sample Location	Number of Samples	Average	Maximum	Average as % of Standard**
ENV 69A	45	1.00	4.8	1.00%
ENV 3	46	0.06	0.5	0.06%
MRI	42	0.16	0.9	0.16%
LHS	35	≤0.03	0.1	≤0.03%
B-13A (Bldg. 88)	42	≤0.03	0.2	≤0.03%
B-13B (Bldg. 90)	42	≤0.03	1.0	≤0.03%
B-13C (Panoramic)	42	≤0.03	0.2	≤0.03%
B-13D (Olympus)	42	≤0.03	0.30	≤0.03%
Average/Total:	**336**	**0.18**	**4.8**	**0.18%**

(*) 1 μCi = 3.7 x 10^4 Bq

(**) DOE 5400.5 standard = 100 x 10^{-9} μCi/ml

Table 5-6. LBL Annual HTO (Tritium) Releases (from 1983 through 1993)

YEAR	Annual Release [Ci*/yr]
1983	120
1984	260
1985	185
1986	75
1987	310
1988	575
1989	500
1990	160
1991	80
1992	80
1993	104
Average:	**223**

(*) 1 Ci = 3.7x 10^{10} Bq

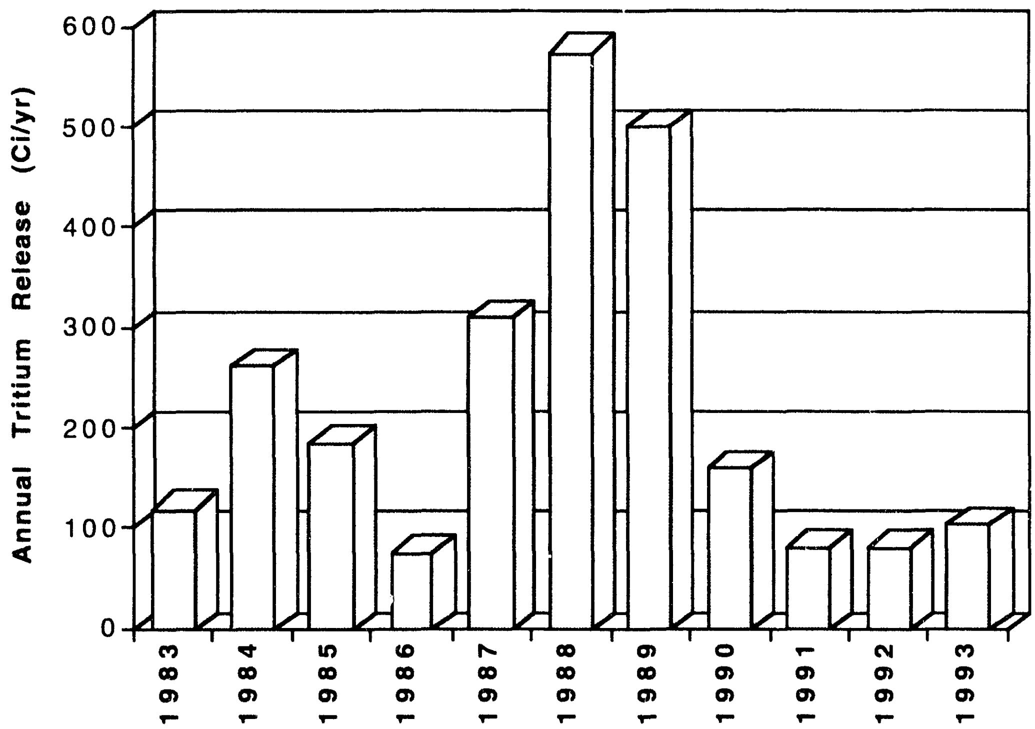


Figure 5-2. Summary of Annual Tritium Releases, 1983 through 1993

Radioiodine Monitoring

Filter papers containing 55% activated carbon are used to sample air effluent for radioiodine. Radioiodines in air, specifically ^{125}I, are assayed by analyzing the activated-carbon filters with a thin-window Geiger-Muller detector. The detection limit for ^{125}I in stack effluents is 2×10^{-11} μCi/ml.

Carbon-14 Monitoring

Atmospheric $^{14}CO_2$ is measured by air sampling with NaOH. Samplers are changed weekly. Air is bubbled through a jar containing 30 ml of 0.2M NaOH and thymol blue as a pH indicator. An aliquot (5 ml) of the NaOH is added to a liquid scintillation "cocktail" and counted in a liquid scintillation counter. The detection limit for $^{14}CO_2$ is 200×10^{-12} pCi/ml. The average concentration of atmospheric ^{14}C for 1993 is given in Table 5-7.

Gross Alpha/Beta Monitoring

Gross atmospheric particulate beta and alpha activities are measured by air sampling at the 14 points shown in Figure 4-3. The gross alpha and beta sampling media are 10 cm x 23 cm (4 in. x 9 in.) fiberglass-polyester filters through which air is pumped at 113 l/min (4 ft^3/min) at the onsite locations, and 75 l/min (2.7 ft^3/min) at the perimeter stations.

Samples are collected weekly for radioanalyses. Before they are counted, they are set aside for five days to allow short-lived radon and thoron daughters (naturally occurring airborne radionuclides) to decay. The filters are loaded into an automatic counter that determines gross alpha activity by means of a large-area 0.25-mil Mylar-window gas-proportional counter. Gross beta activity is counted with Geiger-Muller detectors with 30 mg/cm^2 windows. The detection limit for alpha emitters is 3×10^{-15} µCi/ml. The detection limit for beta emitters is 120×10^{-15} µCi/ml. To ensure accuracy of all counting results, each group of samples counted includes at least one NIST-traceable reference standard and a number of background samples. Gross alpha and gross beta concentrations for these particulate air samples are presented in Tables 5-8 and 5-9, respectively.

Gamma-Emitters Monitoring

At LBL's Low-Background Counting Facility (LBCF), located in Building 72, the 14 weekly environmental particulate air samples are aggregated into sets and analyzed for airborne particulate gamma-emitting radionuclides. These grouped sets are allowed to decay for at least two weeks and were then analyzed with a large hyper-pure germanium detector. Each set represents particulates collected from approximately 14,500 m^3 of air, and is counted for a minimum of 1,000 minutes.

The only gamma emitters found in the 1993 samples were ^{7}Be and ^{210}Pb. The ^{7}Be is produced by cosmic-ray interactions with atmospheric nitrogen but can also be produced by accelerators. The detection limit for ^{7}Be is 2×10^{-16} µCi/ml for a counting time of 1,000 minutes. The ^{210}Pb found on the particulate air samplers represents the only measurable radon or thoron daughter that remains on air samples after five days of decay. (^{210}Pb has a half-life of 22.3 years.) As mentioned previously, radon and thoron (^{222}Rn and ^{220}Rn, respectively) are naturally occurring radioactive gases that emanate from most rocks and soils. (Most rocks and soils contain uranium and thorium, the primordial parents of radon and thoron.) Table 5-10 summarizes the gamma-emitting radionuclides found on environmental air samples. The data are for the aggregated sets of weekly samples from all 14 onsite and offsite atmospheric air stations, for a total of approximately 710 samples.

Table 5-7. Summary of ^{14}C Concentrations for Airborne Environmental Samples

Sample Location	Number of Samples	Concentration [1.0 x 10^{-9} µCi*/ml]		
		Average	Maximum	Average as % of Standard**
ENV3	12	≤0.2	0.35	≤0.04%

(*) 1 µCi = 3.7 x 10^4 Bq

(**) DOE Order 5400.5 standard = 500 x 10^{-9} µCi/ml

Table 5-8. Summary of Gross Alpha Concentrations for Particulate Air Samples

Sample Location	Number of Samples	Concentration [1.0 x 10^{-15} µCi/ml] Average	Maximum	Average as % of Standard**
B-13A (Bldg. 88)	42	≤0.5	4.0	≤7.1%
B-13B (Bldg. 90)	42	≤0.6	4.0	≤8.6%
B-13C (Panoramic)	42	≤0.5	4.0	≤7.1%
B-13D (Olympus)	42	≤0.8	5.0	≤11%
Average/Total:	**168**	**≤0.6**	**5.0**	**≤8.6%**

(*) 1 µCi = 3.7×10^{4} Bq
(**) DOE Order 5400.5 (^{232}Th) = 7.0×10^{-15} µCi/ml

Table 5-9. Summary of Gross Beta Concentrations for Particulate Air Samples

Sample Location	Number of Samples	Concentration [1.0 x 10^{-15} µCi*/ml] Average	Maximum	Average as % of Standard**
B-13A (Bldg. 88)	42	7.0	160	0.08%
B-13B (Bldg. 90)	42	≤ 1.0	150	≤0.01%
B-13C (Panoramic)	42	9.0	120	0.10%
B-13D (Olympus)	42	4.0	110	0.04%
Average/Total:	**168**	**5.3**	**160**	**0.06%**

(*) 1 µCi = 3.7×10^{4} Bq
(**) DOE Order 5400.5 (^{90}Sr) standard = $9,000 \times 10^{-15}$ µCi/ml

Table 5-10. Summary of Gamma Emitter Concentrations for Particulate Air Samples

	Concentration [1.0 x 10^{-14} µCi/ml]			
Radionuclides	Average	Maximum	Standard**	Average as % of Standard**
^{7}Be	14	40.00	5.00 x 10^{6}	0.00%
^{210}Pb	0.9	3.00	9.00 x 10^{1}	1.00%

(*) 1 µCi = 3.7x10^{4} Bq
(**) DOE Order 5400.5

Water

Rainwater

The four perimeter environmental monitoring stations have cylindrical rainfall collectors, 46 cm (18 in.) in diameter, on their roofs. During the rainy season, generally October through May, rainwater is collected monthly and analyzed for tritium and for gross alpha and beta activities. During other periods, each collector is rinsed monthly with 1 liter (1 quart) of tap water, and the rinse is analyzed for "dry deposition." The nine onsite locations shown in Figure 5-3 also contain 46-cm-diameter (18-in.-diameter) combination rain/dry-deposition collectors, which are sampled on a monthly basis in the same manner as the four perimeter environmental monitoring stations. Whenever there is significant rainfall, rainwater in the collectors on the north side of Building 75 and on the roof of Building 4 are analyzed for tritium and gross alpha and beta activities. Tritium analysis of water samples is accomplished by liquid scintillation counting. Water samples are prepared for gross alpha and beta analysis by acidification (HNO_3) and evaporation into 5-cm-diameter (2-in.-diameter) stainless steel planchettes.

Organic residues not wet-ashed by the nitric acid treatment are oxidized by flaming the planchettes.

All measurements of gross alpha and beta activity from atmospheric deposition at outlying perimeter and onsite stations lie within the range of historical normal background measurements; however, tritium exceeding the US/EPA drinking water standards was detected in rainfall collected within the Laboratory boundary near the stack from the Building 75 National Tritium Labeling Facility (see Table 5-11). Historically, tritium in rainwater at LBL has exceeded the drinking water standard, although 1992 was an exception to this trend. As mentioned earlier, local drinking water is supplied by EBMUD from sources located more than 150 km east of LBL. EBMUD does not use local well water or surface water as a drinking-water source.

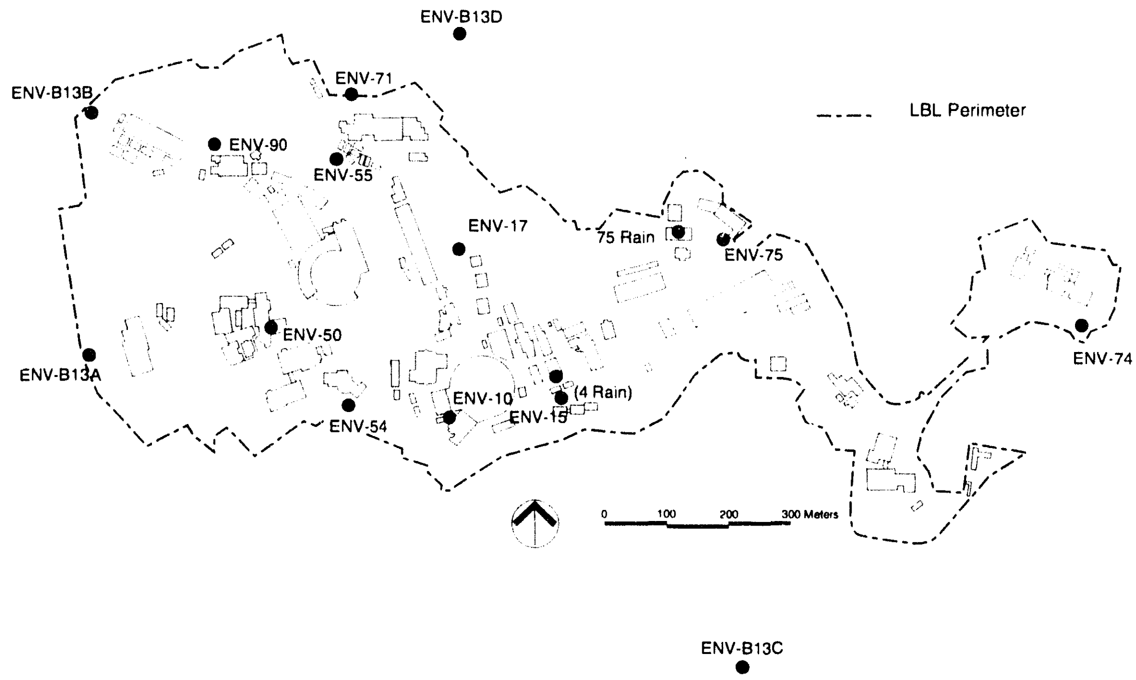


Figure 5-3. Map of Rain and Dry Deposition Collectors

Surface (Creek) Water

Weekly samples are obtained from the five creek sampling points indicated in Figure 6-1. A 1-liter (1-quart) grab sample is taken from each site and analyzed for tritium and gross alpha and beta emitters. Gross alpha, gross beta, and tritium concentrations for these water samples are given in Tables 5-12, 5-13, and 5-14, respectively.

Groundwater

Groundwater flows from the sub-horizontal slope stability wells (hydraugers), whose bores are represented by the heavy dashed lines in Figure 5-4. Sampling and analysis of this medium is fully discussed in Section 7, Groundwater Protection.

Wastewater (Sanitary Sewer)

LBL sewer outfalls are sampled continuously. Sample-to-flow ratios are designed to be between 10 and 20 parts per million, and composite samples are taken weekly.

Water samples for gross alpha/beta and tritium analyses are preserved with nitric acid (HNO_3). No preservation is made to the sewage water samples for radioiodine analysis, since radioiodine would be driven out of the water samples when they are acidified. The iodine contained in the samples is precipitated with silver using stable KI as a carrier. The iodine aliquots are filtered, and the filtrate is processed in the same manner as the acid (HNO_3) samples described earlier. After the filtrate planchette has been flamed, the filter containing any

Table 5-11. Summary of ^3H Concentrations for Rainwater Samples

Sample Location	Number of Samples	Concentration [1.0 x 10^3 pCi*/l]		
		Average	Maximum	Average as % of Standard**
Building 4	10	≤0.7	0.1	≤3.5%
Building 75	16	11.8	34.8	59%
Average/Total:	**26**	**7.5**	**34.8**	**38%**

(*) 1 pCi = 3.7×10^{-2} Bq
(**) 40 CFR 141 standard = 20 x 10^3 pCi

Table 5-12. Summary of Gross Alpha Concentrations for Surface Water Samples

Sample Location	Number of Samples	Concentration [1.0 x 10^{-9} μCi*/ml]		
		Average	Maximum	Average as % of Standard**
Blackberry	46	0.2	3.2	4.0%
Lower Strawberry	44	0.2	2.3	4.0%
Upper Strawberry	48	0.0	3.2	0.8%
Claremont	49	0.6	4.2	12.2%
Wildcat	46	0.0	2.1	0.0%
Average/Total:	**233**	**0.2**	**4.2**	**4.3%**

(*) 1 μCi = 3.7×10^4 Bq
(**) DOE Order 5400.5 standard = 5.0 x 10^{-9} μCi/ml

precipitated radioiodine is placed in the planchette and is counted. The prepared planchettes are weighed (the tare weight of each planchette is first determined) and counted in a thin-window, low-background gas-proportional counter for both gross alpha and gross beta activities. Since the samples are thick, self-absorption is computed based on areal sample density, which is the sample weight divided by the area of the planchette (20.26 cm^2), assuming an alpha energy of 5.2 MeV and a beta energy of 1 MeV. Radioanalyses of sewer wastewater for 1993 are summarized in Tables 5-15, 5-16, and 5-17.

Table 5-13. Summary of Gross Beta Concentrations for Surface Water Samples

Sample Location	Number of Samples	Concentration [1.0 x 10^3 pCi*/l] Average	Maximum	Average as % of Standard**
Blackberry	41	0.5	1.4	6.0%
Lower Strawberry	45	0.7	2.3	9.3%
Upper Strawberry	44	0.6	1.6	7.5%
Claremont	42	0.5	1.2	6.0%
Wildcat	49	0.5	1.4	6.3%
Average/Total:	**221**	**0.6**	**2.3**	**7.0%**

(*) 1 pCi = 3.7×10^{-2} Bq
(**) 40 CFR 141 standard = 20 x 10^3 pCi/l

Table 5-14. Summary of ^{3}H Alpha Concentrations for Surface Water Samples

Sample Location	Number of Samples	Concentration [1.0 x 10^3 pCi*/l] Average	Maximum	Average as % of Standard**
Blackberry	44	≤0.7	1.6	≤3.5%
Lower Strawberry	44	≤0.7	1.01	≤3.5%
Upper Strawberry	45	≤0.7	0.9	≤3.5%
Claremont	43	≤0.7	0.7	≤3.5%
Wildcat	41	≤0.7	1.1	≤3.5%
Average/Total:	**217**	**≤0.7**	**1.6**	**≤3.5%**

(*) 1 pCi = 3.7×10^{-2} Bq
(**) 40 CFR 141 standard = 20 x 10^3 pCi/l

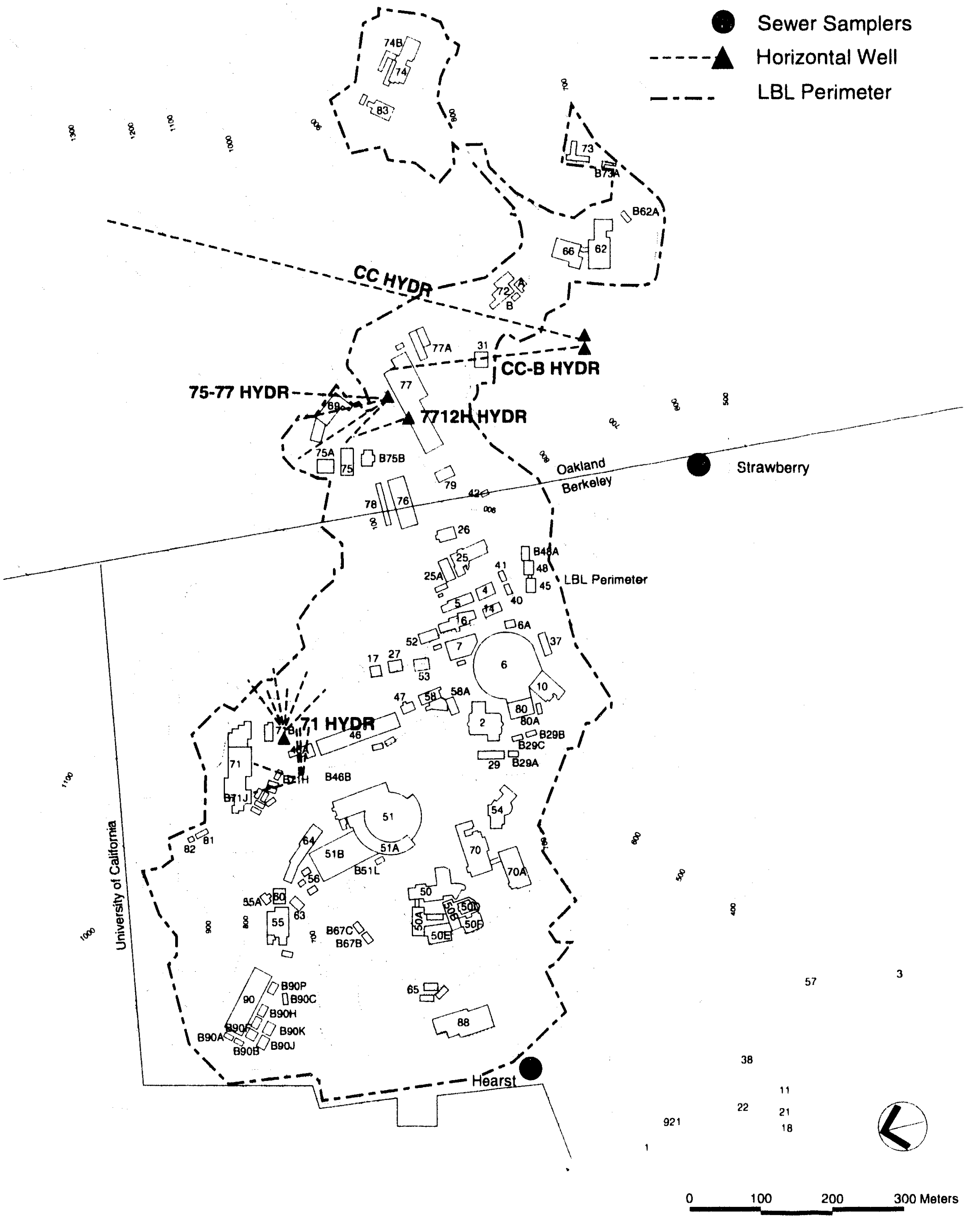


Figure 5-4. Map of LBL Hydrauger and Sewer Sampling Sites

Table 5-15. Summary of Gross Alpha Concentrations for Sewage Water Samples

Sample Location	Number of Samples	Concentration [1.0 x 10^{-9} µCi*/ml] Average	Maximum	Average as % of Standard**
Heart Station	49	0.0	2.5	0.0%
Strawberry Station	45	0.0	2.8	0.0%
Average/Total:	**94**	**0.0**	**2.8**	**0.0%**

(*) 1 µCi = 3.7×10^4 Bq
(**) CCR Title 17 (^{232}Th) standard = 400 x 10^{-9} µCi/l

Table 5-16. Summary of Gross Beta Concentrations for Sewage Water Samples

Sample Location	Number of Samples	Concentration [1.0 x 10^{-9} µCi*/ml] Average	Maximum	Average as % of Standard**
Heart Station	44	4.7	12.6	0.01%
Strawberry Station	42	5.2	16.7	0.01%
Average/Total:	**86**	**4.9**	**16.7**	**0.01%**

(*) 1 µCi = 3.7×10^4 Bq
(**) CCR Title 17 (^{90}Sr) standard = 90,000 x 10^{-9} µCi/ml

Table 5-17. Summary of ^3H Concentrations for Sewage Water Samples

Sample Location	Number of Samples	Concentration [1.0 x 10^3 pCi*/l] Average	Maximum	Average as % of Standard**
Heart Station	42	≤0.7	1.0	0.0%
Strawberry Station	38	1.7	9.2	0.0%
Average/Total:	**80**	**1.2**	**9.2**	**0.0%**

(*) 1 pCi = 3.7×10^{-2} Bq
(**) CCR Title 17 standard = 100,000 x 10^3 pCi/l

Sediment/Soil and Vegetation

Sediment/Soil

The Environmental Monitoring Plan details the soil and sediment sampling that will be performed on an annual basis. This plan was based on a history of site activities and was developed prior to the completion of the *Storm Water Monitoring Plan* in October 1992.

During 1993, sediment samples were taken from the stormwater sampling locations and at all locations where the creeks are sampled for radionuclides. The samples were analyzed for gross alpha and beta and tritium (Table 5-18). With respect to radionuclides, no reason for concern was seen in any of the locations. The sampling locations described in the table are shown in Figure 6-1.

Vegetation

Currently, there is no routine vegetation monitoring at LBL. Proposals for sampling locations, frequencies, and analyses for the future vegetation monitoring program at LBL are documented in the LBL *Environmental Monitoring Plan.*

Unplanned Releases

During 1993, there was one unplanned tritium release to the atmosphere from LBL. A tritiation reaction involving 150 Ci of tritium gas was conducted at the NTLF (Building 75) on Thursday August 12, 1993. Approximately 111 Ci of this reaction material was trapped on a uranium bed, and the remainder was treated in the NTLF recovery system (*i.e.*, burned to HTO and condensed in an ethanol-cooled trap over the night of August 12, 1993). The condensed

Table 5-18. Soils and Sediments Radioanalysis Results

Sampling Location	Gross Alpha [pCi*/g]	Gross Beta [pCi*/g]	Tritium [pCi*/g]
NFS-1	< 25	27	< 0.2
NFS-2	< 25	28	< 0.2
BCI-1	< 25	22	0.4
BCI-2	< 25	35	< 0.2
BCO-2	< 25	32	< 0.2
STW4-1	< 25	33	0.7
STW4-2	< 25	36	0.3
STW5-1	< 25	36	< 0.2
STW5-2	< 25	38	< 0.2
STW6-1	< 25	50	< 0.2
STW6-2	< 25	43	< 0.2
STW7-1	< 25	33	< 0.2

(*) 1 pCi = 3.7×10^{-2} Bq

HTO was drained and counted on August 13, 1993 (about 15 Ci), and disposed as radioactive waste. The recovery system was then evacuated through a bed of silica gel, to prepare the apparatus for its next use. Normal practice is to replace the silica gel bed soon after pumping out the system, thus disposing of any HTO trapped during the evacuation. This procedure was not performed.

It is believed that the HTO trapped on the silica gel slowly migrated through the bed until it began releasing to the Building 75 stack early on August 15, 1993. Continuous monitoring data collected from this stack revealed that approximately 44 Ci of HTO was released to the environment during the week of release. The dose impact from this unplanned release is estimated to have been (based on CAP88-PC computer modeling) about 0.051 mrem (5.1×10^{-4} mSv) EDE to a maximally exposed individual (MEI) 110 meters northwest of Building 75. This level is well within the permitted emission limit of 10 mrem for the year. The reported EDE for 1993 due to airborne radionuclides includes this unplanned release contribution.

Radiological Dose Assessment

Accelerator-Produced Radiation

The development of LBL's model used to assess the population dose equivalent attributable to penetrating radiation is detailed in Thomas (1976). Population figures from the 1970 US census are used in this calculation. Although the population within 80 km (50 mi) of LBL increased by about 30% during the 1970s and 1980s from 4.6 to 6.0 million, the populations of Berkeley and Oakland, the two cities immediately adjacent to LBL, declined. Recomputing the population dose model with population statistics from the 1990 census produced no significant difference.

In the LBL model developed by Thomas (1976), population dose equivalent is computed from the maximum measured value of perimeter (fence-post) neutron dose. During 1993 the maximum fence-post dose, estimated at EMS 13A (near Building 88), was 1.95 mrem for the year (Table 5-1). The model's expression relating population dose equivalent M (in person-rem) to maximum measured fence-post dose H_0 (in rem—a rem is 1000 mrem) is

$$M < 10^3 \times H_0.$$

Since H_0 was 2.0 mrem (or 2.0×10^{-3} rem), the collective effective dose equivalent (CEDE) to the 6.0 million people within 80 km (50 miles) of LBL attributable to penetrating radiation from LBL accelerator operation during 1993 was 2 person-rem.

Airborne Radionuclides

The dose to the maximally exposed individual and the CEDE resulting from airborne releases of radionuclides for 1993 are 0.13 mrem (1.3×10^{-3} mSv) and 1.3 person-rem (1.3×10^{-2} person-Sv), respectively. The NESHAPs regulations in 40 CFR 61 Subpart H require that facilities releasing airborne radionuclides compute the impact of such releases using an approved code. In this report, CAP88-PC, a microcomputer radionuclide dispersion and dose assessment code supplied and approved by US/EPA, was used to compute the effective dose equivalent to a maximally exposed offsite person. This dose was calculated for the point of maximum off-site exposure, and represents the cumulative exposure from all significant exposure pathways (inhalation, ingestion, air immersion, and surface exposure). The methods and parameters used to calculate the dose are very conservative. A major portion of the food consumed by the hypothetical individual was assumed to have been grown locally. The individual was assumed to reside at this location continuously throughout the year. In addition, all of the tritium released was assumed to be the most hazardous form, tritium oxide (HTO). Consequently, this dose is not a dose actually received by anyone, but an upper-bound estimate.

Fifteen CAP88-PC "individual" runs were executed to model 15 single/grouped release points as described in Section II of Appendix A. As mentioned previously, the NTLF was identified as the major release point at LBL; therefore, the maximally exposed individual (MEI) associated with this facility was also specified (with appropriate distances and directions) in each of these fifteen "individual" CAP88-PC runs. The reported EDE to a MEI at LBL includes contributions from all of these fifteen CAP88-PC models (see Table 5-19).

Collective population dose is calculated as the average radiation dose to an individual in a specified area, multiplied by the number of individuals in that area. One "population"

Table 5-19. Summaries of Dose Assessment from All LBL Release Points

Building Number	Building Name	Relative to the MEI of Building 75			
		75 MEI Distance [m]	75 MEI Dir.	75 MEI Dose [mrem*/yr]	% Total EDE
75	National Tritium Labeling Facility	110	NW	1.20×10^{-1}	95.12%
74, 74B & 83	Buildings 74/74B/83 Research Med.	730	WNW	2.00×10^{-3}	1.59%
88	88-Inch Cyclotron	670	ENE	1.40×10^{-3}	1.11%
51	Bevatron (ceased operation 02/93)	390	ENE	8.60×10^{-4}	0.68%
75A (D)	Waste Storage Area (Diffuse)	150	NW	7.40×10^{-4}	0.59%
934	Molecular & Cell Biol. (off-site)	4900	ENE	5.40×10^{-4}	0.43%
55	Research Med & Rad Biol.	490	E	4.60×10^{-4}	0.36%
75-127 & 75A	Hazardous Waste Handling Facility	150	NW	1.10×10^{-4}	0.09%
1	Donner Laboratory at UCB	980	ENE	2.10×10^{-5}	0.02%
6	Advanced Light Source (ALS)	370	NNE	1.80×10^{-5}	0.01%
2	Advanced Material Lab.	370	NE	1.30×10^{-13}	0.00%
3	Calvin Lab at UCB	1070	NE	2.70×10^{-7}	0.00%
26	Medical Services & Counting Lab.	240	N	9.60×10^{-8}	0.00%
62	Materials & Chem. Science	650	NW	8.30×10^{-8}	0.00%
70 & 70A	Nuclear / Applied Science	510	NE	5.90×10^{-6}	0.00%
TOTAL				**1.26×10^{-1}**	**100.00%**

(*) 1 mrem = 1.0×10^{-2} mSv

CAP88-PC run was used to carry out this population dose assessment. This CAP88-PC model is based on the input parameters from the Building 75 computer run, with the source terms replaced by all the radionuclides listed in Table 5-4.

A summary of this collective dose assessment attributed to each radionuclides is given in Table 5-20.

Radiological impact from accelerator operations and airborne radionuclides is minimal compared to applicable standards and nominal background radiation. As presented in Table 5-21 and Figure 5-5, the maximum effective dose equivalent due to 1993 LBL operation is about 3 mrem per year. This value is about 1% of the nominal background and less than 3% of the DOE-permitted annual limits.

Table 5-20. Summary of Collective (Population within 80 km of LBL) EDE Assessment

Nuclide	Collective EDE [Person-rem* /yr]	% Total Collective EDE
^{3}H	1.2×10^{0}	90.10%
^{18}F	5.9×10^{-2}	4.46%
^{13}N	2.2×10^{-2}	1.64%
^{11}C	2.1×10^{-2}	1.58%
^{248}Cm	2.1×10^{-2}	1.57%
^{15}O	3.7×10^{-3}	0.28%
^{41}Ar	2.9×10^{-3}	0.22%
^{241}Am	8.4×10^{-4}	0.06%
^{232}Th	3.4×10^{-4}	0.03%
^{238}U	2.6×10^{-4}	0.02%
^{90}Sr	2.3×10^{-4}	0.02%
^{125}I	1.3×10^{-4}	0.01%
^{65}Zn	2.4×10^{-5}	0.00%
^{35}S	2.3×10^{-5}	0.00%
^{95}Zr	1.7×10^{-5}	0.00%
^{86}Rb	8.4×10^{-6}	0.00%
^{14}C	6.1×10^{-6}	0.00%
^{32}P	3.8×10^{-6}	0.00%
^{63}Ni	3.4×10^{-7}	0.00%
^{60}Co	1.1×10^{-11}	0.00%
TOTAL	$\mathbf{1.3 \times 10^{0}}$	**100.00%**

(*) 1 Person-rem = 1.0×10^{-2} Person-Sv

Table 5-21. Summary of LBL Radiological Impact

	Maximum Individual (Accelerators)	Maximum Individual (Airborne Nuclides)	Maximum All Sources	Collective Dose within 80 km of LBL (All Sources) [person-rem /yr]
Annual EDE [mrem/yr]	2.96	0.13	2.96	3.3
MEI LOCATION	Residence (110m W of Bldg. 88)	Workplace (110 m NW of Bldg. 75)	Residence (110 m W of Bldg. 88)	Within 80 km of LBL
DOE / EPA Standards [mrem/yr]	100	10	100	na
LBL impact as % of DOE/EPA Standard	2.96%	1.30%	2.96%	na
Annual Background [mrem/yr]	100	200	300	1.50×10^6
LBL impact as % of background	2.96%	0.07%	0.99%	0.00%

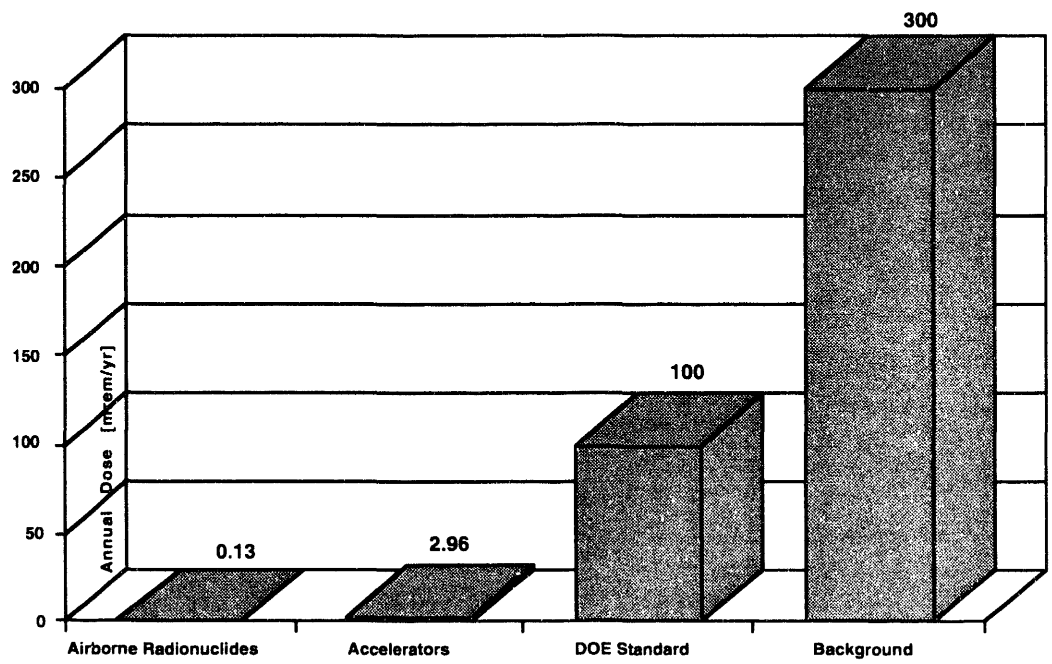
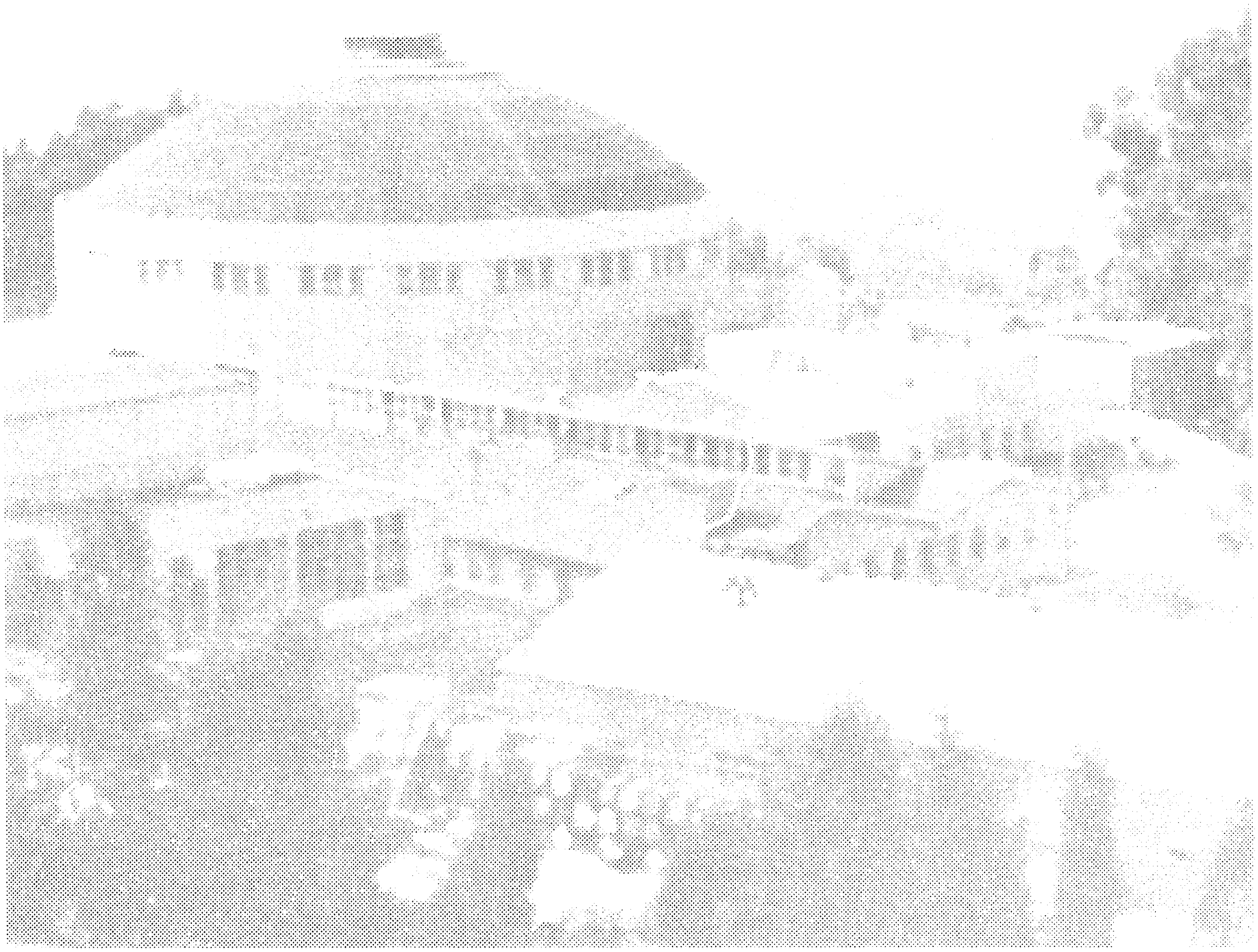


Figure 5-5. LBL Radiological Impact for 1993

Section 6. Environmental Nonradiological Program Information



General Industrial Stormwater Permit

Applicability to LBL

The Clean Water Act, enacted by Congress in 1972 as an amendment to the Federal Water Pollution Control Act, gave the United States Environmental Protection Agency (US/EPA) authority to regulate the discharge of any pollutant from a point source to navigable waters by means of a permit system called the National Pollutant Discharge Elimination System (NPDES). The State of California has an authorized NPDES program, which is administered by the State Water Resources Control Board (SWRCB).

The SWRCB administers its NPDES program through the General Industrial Storm Water Permit, general permit number CAS000001. Under this permit, industries identified by their Standard Industrial Code (SIC) number must file a Notice of Intent (NOI) and satisfy a number of other requirements including development of a *Storm Water Monitoring Plan* (SWMP) and *Storm Water Pollution Prevention Plan* (SWPPP). These are the guiding documents for the facility's compliance with stormwater permitting regulations.

Although LBL's general classification is 8733, Noncommercial Research Organization, two of the SIC codes under which LBL is classified, 7539 (Automotive Repair Shops) and 3499 (fabricated metal products), require at least portions of the facility to acquire a stormwater permit. SIC code 7539 applies to the automotive repair facility in Building 76, and 3499 refers to the plating shop facility in Building 77. Additionally, because it contains a hazardous waste treatment, storage, and disposal facility, LBL is specifically subject to permitting under the stormwater rules. Accordingly, LBL submitted an NOI in March of 1992, and has embarked on a program to identify and eliminate all nonstormwater discharges, including connections to stormwater systems. The SWPPP and SWMP were in place by October 1, 1992.

Offsite locations where LBL activities are conducted (including parts of 21 buildings on the UCB campus and three offsite leased buildings) have not been included in this program, because (1) they are not physically contiguous to the property addressed in this program, and (2) they do not contain any industrial activity or have any hazardous materials exposed to stormwater.

Discussion of results

The *Storm Water Monitoring Plan* details the rationale for sampling, sampling locations, and the suite of analyses performed. The basis for sampling is summarized in Table 6-1. The site operations were reviewed with respect to the potential contaminants that could be released to surface runoff. The sampling points were chosen based on their representativeness of the site and runoff. The sampling points, labeled StW 1 through StW 10, are indicated in Figure 6-1. This sampling strategy must be flexible, because not all the creeks flow during a given storm. Decisions are made in the field to modify the strategy if a particular creek is not flowing.

Table 6-1. Sampling Design

Monitoring Location	TASK					
	Test for Non-Storm-water Discharge (2x/Season)	Visual Observation[1]	SAMPLING			
			First Storm Event[2]		Other Storm Events[2]	
			Grab[3]	Composite	Grab[3]	Composite
North Fork of Strawberry Creek Inlet (StW1)	•	•	•	•	•	•
North Fork of Strawberry Creek Outlet (StW2)	•	•	•	•	•	•
Strawberry Canyon Inlet (StW3)	•	•	•	•	•	•
Chicken Creek Outlet (StW4)	•	•	•	•	•	•
Cafeteria Creek Outlet (StW5)	•	•			•	
Ravine Creek Outlet (StW6)	•	•			•	
Ten-Inch Creek Outlet (StW7)	•	•			•	
No Name Creek Outlet (StW8)	•	•			•	
Banana Creek Outlet (StW9)	•	•			•	
Pineapple Creek Outlet (StW10)	•	•			•	

1 One storm per month.
2 Significant storm water discharge must be preceded by 72 hours of dry weather.
3 Grab samples must be taken during the first 30 minutes of the discharge. Except for the first storm event, such grab sampling will not be performed during the same storm event at all locations.

On October 1, 1992, LBL implemented its stormwater monitoring program. From October 1 to December 31, 1992, a number of storms were sampled. All creeks must be sampled and analyzed for

- pH, total suspended solids (TSS), specific conductance, and total organic carbon (TOC). Oil and grease may be subsitituted for TOC.
- Toxic chemicals and other pollutants that are likely to be present in stormwater discharge in significant quantities.

Table 6-2 summarizes the analytical results for stormwater samples taken in 1993.

In the 1992 *Annual Site Environmental Report* it was reported that there appeared to be metals uptake in the stormwater as it

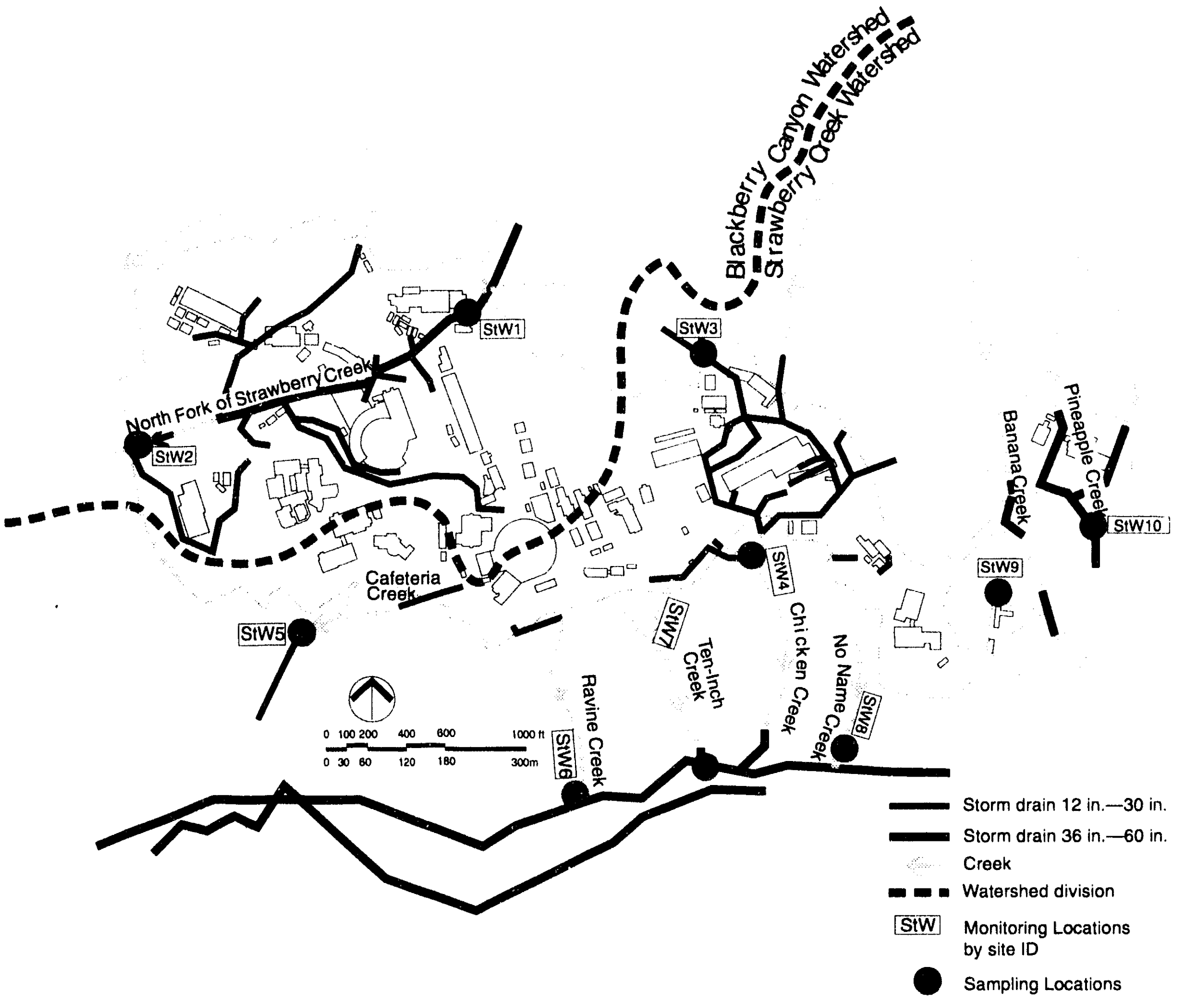


Figure 6-1. Site Storm Drainage and Monitoring Locations

flowed from Building 69 (the influent) to Building 31 (the effluent). Analyses for samples taken from these points during the same storm indicated a general increase in metals. These areas were not resampled during the balance of the 1992–1993 stormwater season as resources were committed to sampling in different locations to satisfy the requirements of the SWMP. These areas were resampled at the commencement of the 1993–1994 wet season in October 1993. A list of the metals analyses for these and other stormwater sampling points is presented in Table 6-3. In the 1993–1994 stormwater samples, there was no comparable increase in metals for samples taken at Buildings 31 and 69.

The General Permit references the Water Quality Control Plan (Basin Plan) for the San Francisco Bay Region. Table IV-1A, of the Basin Plan contains Shallow Water Effluent Limitations for some constituents that are used as a guideline to assess surface water runoff quality. Table 6-3 compares the analytical values with the effluent limitations in the row titled

Table 6-2. Stormwater Sampling Summary

ID	Statistic	Toxic Organics (µg/l)	Cyanide (mg/l)	PCB's (µg/l)	pH	TOC (mg/l)	TPH-Diesel (µg/l)	TPH-Gasoline (µg/l)	Aquatic toxicity (% survival)	Conductivity (µmho)	Oil and Grease (mg/l)	TSS (mg/l)
StW2	Max.	0	0	0	8.01	111	1500	0	100	580	14	2220
	Min.	0	0	0	6.9	42	0.06	0	95	250	12	0
	Avg.				7.35	55	500	0	na	384	6.5	494
	Std. Dev.	na	na	0	0.43	51	866	0	na	126	7.5	966
	Sample Size	3	1	6	6	3	4	4	2	5	4	5
StW3	Max.	0	0	0	8	38	750	0	100	900	8	162
	Min.	0	0	0	6.8	5.2	0	0	95	83	2	2.3
	Avg.	0	0	0	7.4	na	na	na	97	444	na	55
	Std. Dev.	na	na	na	0.52	na	na	na	3	384	na	73
	Sample Size	3	2	2	4	2	2	2	3	4	2	4
StW4	Max.	0	0	0	8.2	42	810	0	95	240	8	793
	Min.	0	0	0	6.7	10	0	0	95	240	2	34.8
	Avg.	0	0	0	7.3	na	270	0	na	na	na	na
	Std. Dev.	na	na	na	0.81	na	467	na	na	na	na	na
	Sample Size	3	2	2	3	2	3	3	1	2	2	2
StW5	Max.								100			
	Min.								100			
	Avg.								100			
	Std. Dev.								0			
	Sample Size								3			
StW6	Max.								100			
	Min.								100			
	Avg.											
	Std. Dev.								na			
	Sample Size								2			
StW7	Max.								100			
	Min.								100			
	Avg.								na			
	Std. Dev.								na			
	Sample Size								2			
StW8	Max.								100			
	Min.								100			
	Avg.								100			
	Std. Dev.								0			
	Sample Size								3			
StW9	Max.								100			
	Min.								100			
	Avg.								100			
	Std. Dev.								0			
	Sample Size								3			

Table 6-3. Stormwater Sampling Summary (Metals Analyses)

		Metals (mg/l)							
ID	Statistic	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper
STW 2	Max.	nd	0.017	0.664	nd	0.013	0.242	0.163	0.432
	Min.	nd	0.002	0.07	nd	0.006	0.01	0.01	0.03
	Avg.	nd	0.009	0.314	nd	0.0095	0.11	0.064	0.1636
	Std. Dev.	na	0.00	0.31	na	0.00	0.11	0.09	0.16
	Sample Size	6	6	6	6	6	6	6	6
	Basin Plan limit (µg/l)	none	5	none	none	10	50	none	1000
	Percent of Basin Plan limit	na	340	na	na	130.00	484	na	43.20
STW 3	Max.	nd	0.005	nd	nd	nd	0.018	0.017	0.053
	Min.	nd	0.002	nd	nd	nd	0.018	0.017	0.01
	Avg.	na	0.003	na	na	na	0.018	0.017	0.0377
	Std. Dev.	na	0.00	na	na	na	na	na	0.02
	Sample Size	5	5	5	5	5	5	5	5
	Basin Plan limit (µg/l)	none	5	none	none	10	50	none	1000
	Percent of Basin Plan limit	na	100	na	na	na	36	na	5.30
STW 4	Max.	0	0.012	0.275	0	0.006	0.077	0.017	0.183
	Min.	0	0.003	0.1	0	0	0	0	0.02
	Avg.	0	0.0067	0.179	0	0.002	0.044	0.01	0.0897
	Std. Dev.	0.00	0.00	0.09	0.00	0.00	0.04	0.00	0.08
	Sample Size	3	3	3	3	3	3	3	3
	Basin Plan limit (µg/l)	none	5	none	none	10	50	none	1000
	Percent of Basin Plan limit	na	240	na	na	60.00	154	na	18.30
STW 10		ND	0.006	ND	ND	ND	0.173	ND	0.084
	Basin Plan limit (µg/l)	none	5	none	none	10	50	none	1000
	Percent of Basin Plan limit	na	120	na	na	na	346	na	8.40

Table 6-3. Stormwater Sampling Summary (metals analyses), continued

		Metals mg/l								
ID	Statistic	Lead	Mercury	Molybdenum	Nickel	Selium	Silver	Titanium	Vanadium	Zinc
STW 2	Max.	0.375	0.0024	0.02	0.185	0.002	0.026	nd	0.173	3.33
	Min.	0.011	0.0003	0.01	0.056	0.002	0.026	nd	0.006	0.017
	Avg.	0.1004	0.00105	0.0124	0.1205	0.002	0.026	na	0.079	0.9067
	Std. Dev.	0.15	0.00	0.00	0.09	na	na	na	0.09	1.27
	Sample Size	6	6	6	6	6	6	6	6	6
	Basin Plan limit (µg/l)	50	0.01	none	600	10	50	none	none	5000
	Percent of Basin Plan limit	750.00	24000.00	na	30.83	20.00	52.00	na	na	66.60
STW 3	Max.	0.114	0.0002	0.01	nd	0.002	nd	nd	nd	0.392
	Min.	0.012	0.0002	0.01	nd	0.002	nd	nd	nd	0.07
	Avg.	0.0457 5	0.0002	0.01	na	0.002	na	na	na	0.1624
	Std. Dev.	0.05	na	na	na	0.00	na	na	na	0.13
	Sample Size	5	5	5	5	5	5	5	5	5
	Basin Plan limit (µg/l)	50	0.01	none	600	10	50	none	none	5000
	Percent of Basin Plan limit	228.00	2000.00	na	na	20.00	na	na	na	7.84
STW 4	Max.	0.049	0.0012	nd	0.075	0.0022	nd	nd	0.068	1.07
	Min.	nd	nd	nd	nd	nd	nd	nd	nd	0.037
	Avg.	0.032	0.00053	na	0.042	0.0007	na	na	0.0393	0.49
	Std. Dev.	0.03	0.00	na	0.04	0.00	na	na	0.04	0.53
	Sample Size	3	3	3	3	3	3	3	3	3
	Basin Plan limit (µg/l)	50	0.01	none	600	10	50	none	none	5000
	Percent of Basin Plan limit	98.00	12000.00	na	12.50	22.00	na	na	na	21.40
STW 10		0.033	0.0011	0.029	ND	0.002	ND	ND	ND	0.466
	Basin Plan limit (µg/l)	50	0.01	none	600	10	50	none	none	5000
	Percent of Basin Plan limit	66.00	11000.00	na	na	20.00	na	na	na	9.32

"Percent of Basin Plan Limit" (PBL). Fourteen analyses exceed the Basin Plan limit (PBL > 100%).

Sediment Sampling

Section 4.2.3 of the *Environmental Monitoring Plan* (EMP) details the soil and sediment sampling that will be performed on an annual basis. The plan design was based on a history of site activities and was developed prior to the completion of the SWMP in 1992. Sediment sampling is performed wherever stormwater samples or creek samples (for radionuclides) are taken. The locations for stormwater samples differ from the sample locations identified in the EMP, but do satisfy the EMP requirements and the DOE guidelines. The samples were analyzed for metals and a suite of toxic organics, including PCBs, diesel, kerosene and oil, gross alpha and beta, and tritium. Table 6-4 summarizes the analytical results for all sampling locations.

Two locations assayed very low levels of PCBs. Chicken Creek and the North Fork of Strawberry Creek indicated a maximum of 0.3 mg/kg (soil) Arochlor 1254. One site assayed 4.3 mg/Kg (soil) trichlorofluoromethane. These areas will be investigated further in 1994. The remainder of the sites sampled assayed nondetectable for PCBs.

Table 6-4. Summary of Sediment Metals Analyses for 1993

Metal	Average (mg/kg sediment)	Minimum	Maximum	Standard Deviation
Silver	0.68	0.00	4.90	1.13
Arsenic	2.61	0.00	9.00	2.73
Barium	120.50	62.00	250.00	51.98
Beryllium	0.12	0.00	0.30	0.11
Cadmium	0.38	0.20	0.70	0.16
Cobalt	14.37	8.50	46.00	8.27
Chromium	46.22	27.00	68.00	14.21
Copper	35.11	13.00	110.00	20.70
Mercury	0.26	0.00	1.40	0.33
Molybdenum	0.48	0.00	1.30	0.41
Nickel	43.39	28.00	84.00	14.10
Lead	58.17	13.00	230.00	52.18
Antimony	0.00	0.00	0.00	0.00
Selenium	0.17	0.00	3.00	0.71
Thallium	0.00	0.00	0.00	0.00
Vanadium	41.39	27.00	66.00	12.68
Zinc	116.72	66.00	220.00	45.26

Sanitary Sewer Discharge Permit Self-Monitoring

The site sanitary sewer discharge permits were renewed on August 6, 1993. The 1993 self-monitoring dates listed in the July 1992 and August 1993 permits are presented in Table 6-5.

A semiannual effluent-meter calibration report was submitted on November 29, 1993. Each of the flowmeters at the Hearst and Strawberry outfalls was calibrated for four different levels. The average accuracies of the meters was 99% and 98%, respectively. An annual sewage meter reading report was submitted on June 3, 1993. Sewer flows for 1993 are measured in the Hearst and Strawberry outfalls for the site. The Strawberry outfall is shared with other offsite UCB campus buildings. The flows measured in these outfalls were 6.7×10^7 l (1.7×10^7 gal) and 9.8×10^7 l (2.6×10^7 gal), respectively.

No notices of violation (NOVs) were served by the East Bay Municipal Utility District in 1993; in contrast, 6 NOVs were served in 1992. The marked decrease in NOVs is due to additional resources available for internal training of operators.

Trend histograms for various contaminants for the last 5 years are presented in Figures 6-2, 6-3, and 6-4. These figures indicate a downward trend for all principal contaminants. This is consistent with changes in LBL operations in metals finishing and the implementation of programs designed to reduce pollution discharge.

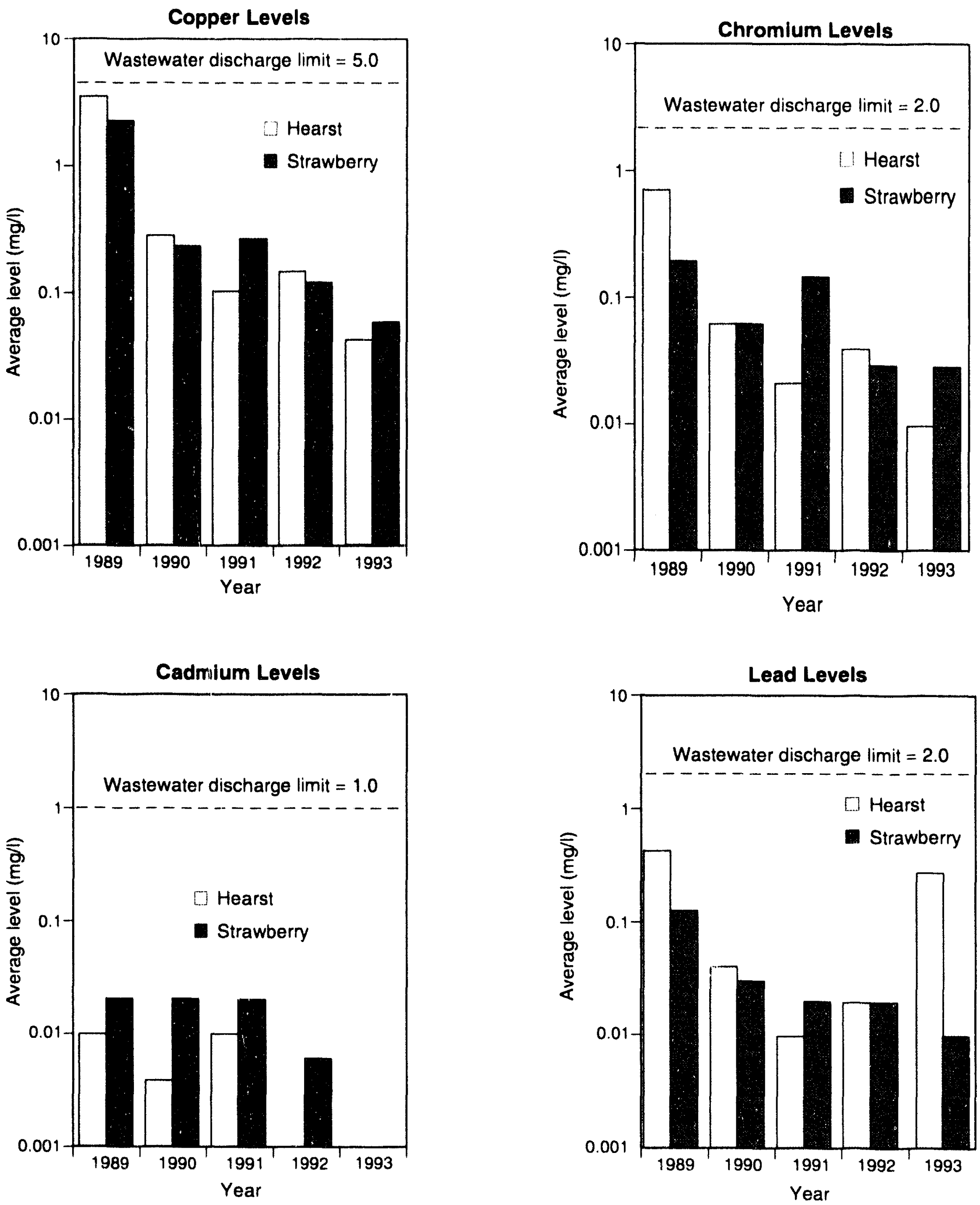
Building 25 Photofabrication Shop

This treatment unit had been shut down for a number of years while improvements were made to it. During the week of December 13, 1993, the B25 fixed treatment unit (FTU) was started up and operated in batch mode. No treated water was released until the operators were satisfied, by certified analyses, that the water quality would not exceed the waste permit requirements. No self-monitoring samples were taken from this facility in 1993.

Table 6-5. LBL Wastewater Self Monitoring Dates for 1993

Hearst and Strawberry sanitary sewer	Building 25 Metal finishing fixed treatment unit	Building 77 metal finishing fixed treatment unit
2/8/93		2/8/93
4/12/93	4/12/93*	4/12/93
5/14/93	5/14/93*	5/14/93
	8/16/93*	8/16/93
8/23/93		
9/27/93		
	11/15/93*	11/15/93
11/22/93		

* No sampling done since the Building 25 FTU was shut down until December



XBL 934-4776

Figure 6-2. Hearst and Strawberry Monitoring Stations: Effluent Trends for Copper, Chromium, Cadmium, and Lead

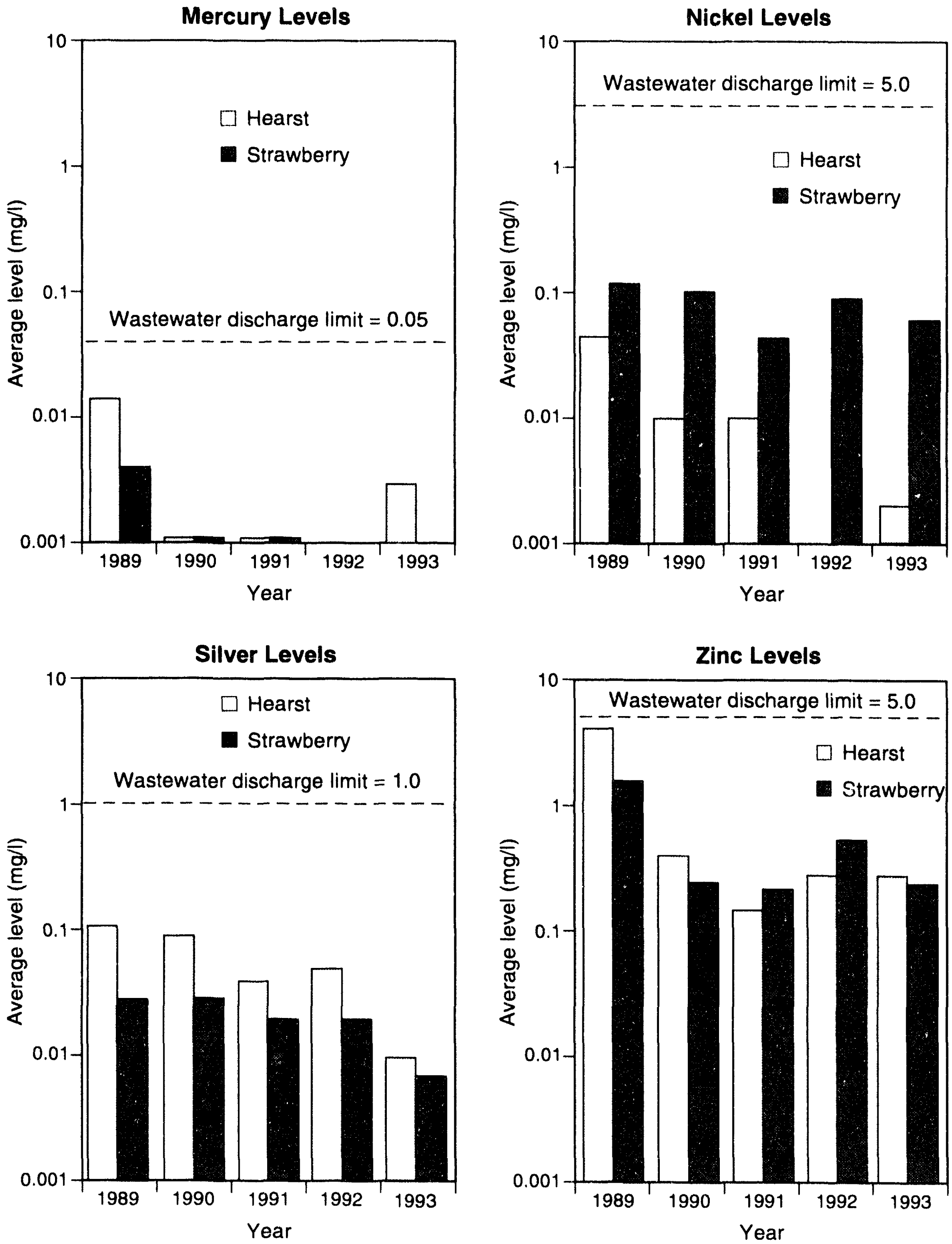


Figure 6-3. Hearst and Strawberry Monitoring Stations: Effluent Trends for Mercury, Nickel, Silver, and Zinc

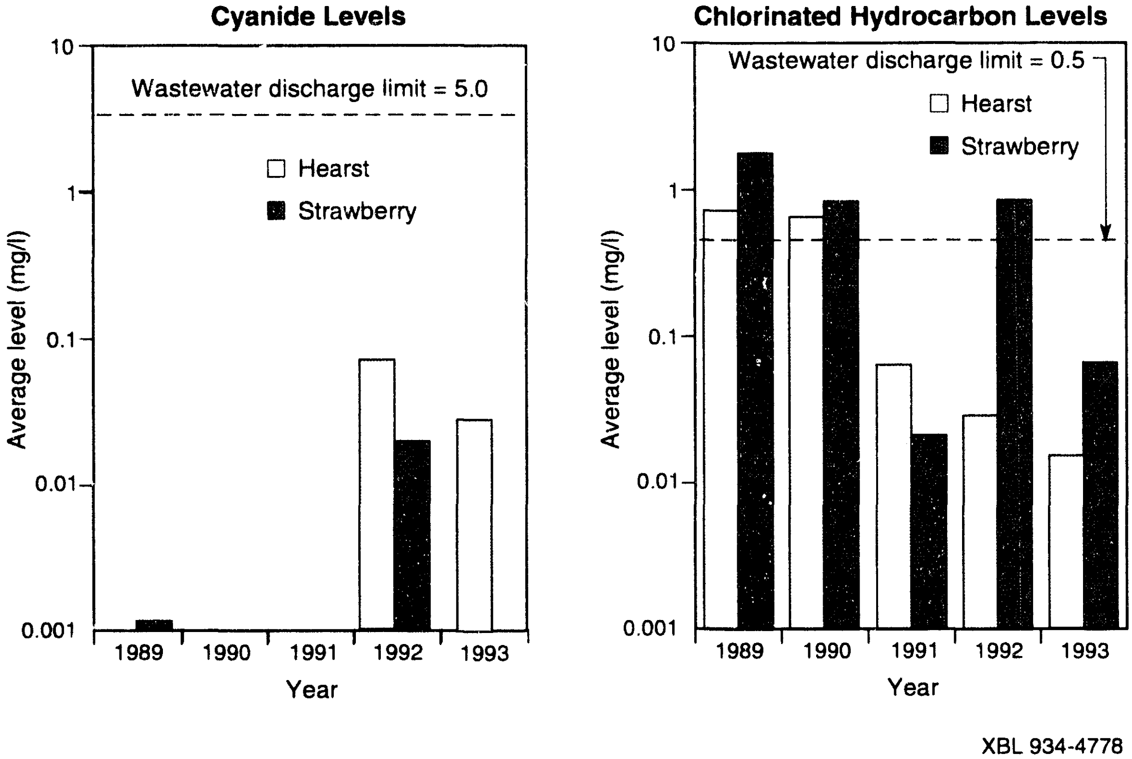


Figure 6-4. Hearst and Strawberry Monitoring Stations: Effluent Trends for Cyanide and Chlorinated Hydrocarbons

Building 77 Fixed Treatment Unit

Five self-monitoring samples were taken from the B77 FTU. None of the sample analyses exceeded any of the discharge limits set by EBMUD. Table 6-6 summarizes the analytical results for 1993.

Hearst and Strawberry Sewer Outfalls

Six self-monitoring samples were taken from the Hearst and Strawberry outfalls. None of the samples exceeded any of the discharge limits set by EBMUD. Tables 6-7 and 6-8 summarize the analytical results for 1993.

Continuous-Release Reporting

LBL is required to report any releases to the environment under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). In 1993 there were no releases of any materials listed in CERCLA Section 304.2 that exceeded the reportable quantity.

Environmental Occurrences

DOE Order 5000.3B, "Occurrence Reporting and Processing of Operations Information," requires LBL to report to DOE any unusual occurrences that have programmatic significance. In 1993 there were three environmentally related Occurrence Reports; all were classified as

Table 6-6. Building 77 Self-Monitoring Results for 1993

	Cadmium	Chromium	Copper	Lead	Nickel	Silver	Zinc	Cyanide	Chlorinated Hydro-carbons	pH
Number of Samples	5	5	5	5	5	5	5	5	5	5
Minimum Level (mg/l)	nd	nd	nd	nd	0.41	nd	nd	0.01	nd	6.60
Maximum Level (mg/l)	0.03	0.72	2.00	0.00	1.80	0.38	0.23	0.37	0.111	11.30
Average Level (mg/l)	0.02	0.40	0.79	0.00	0.93	0.11	0.10	0.13	0.0467	9.45
Standard Deviation	0.01	0.24	0.71	0.00	0.47	0.14	0.08	0.14	0.058	1.74
Number Outside Limit	0	0	0	0	0	0	0	0	0	0
Daily Limit (mg/l)	0.69	2.0	3.38	0.69	3.98	0.43	2.61	1.20	0.50	<5.5
Monthly Limit (mg/l)	0.26	1.71	2.07	0.43	2.38	0.24	1.48	0.65	na	na

Table 6-7. Hearst Sewer Self-Monitoring Results for 1993

	Cadmium	Chromium	Copper	Lead	Nickel	Silver	Zinc	Cyanide	Chlorinated Hydro-carbons	pH	COD F	TSS
Number of Samples	6	6	6	6	6	6	6	6	6	6	6	6
Minimum Level (mg/l)	nd	nd	nd	nd	nd	nd	0.13	nd	nd	7.9	70	90
Maximum Level (mg/l)	0.002	0.05	0.22	0.07	0.02	0.029	0.65	0.07	0.02	8.6	480	830
Average Level (mg/l)	0	0.01	0.07	0.03	0	0.01	0.3	0.03	0.0162	8.31	181.14	314.29
Standard Deviation	0	0.02	0.07	0.03	0.01	0.01	0.18	0.03	0.0077	0.24	130.47	227.84
Number Outside Limit	0	0	0	0	0	0	0	0	0	0	na	na
Daily Limit (mg/l)	1	2	5	2	5	1	5	5	0.50	<5.5	none	none

Table 6-8. Strawberry Sewer Self-Monitoring Results for 1993

	Cadmium	Chromium	Copper	Lead	Nickel	Silver	Zinc	Cyanide	Chlorinated Hydro-carbons	pH	COD F	TSS
Number of Samples	6	6	6	6	6	6	6	6	6	6	6	6
Minimum Level (mg/l)	nd	nd	0.02	nd	0.03	nd	0.16	nd	nd	7.3	28	100
Maximum Level (mg/l)	0.002	0.05	0.16	0.05	0.1	0.03	0.4	0.13	0.44	8.4	310	360
Average Level (mg/l)	0	0.03	0.1	0.01	0.06	0.01	0.26	0.06	0.072	7.95	129	197
Standard Deviation	0	0.01	0.05	0.02	0.02	0.01	0.08	0.05	0.16	0.39	96	85
Number Outside Limit	0	0	0	0	0	0	0	0	0	0	na	na
Daily Limit (mg/l)	1	2	5	2	5	1	5	5	0.50	<5.5	none	none

Off Normal. These were for an acid spill to the storm drain; a spill of an estimated (unconfirmed) 150 liters (40 gallons) of fuel oil to the storm drain (there was no offsite release); and a release of tritiated water vapor from the National Tritium Labeling Facility. None of the Unusual Occurrence Reports were related to environmental concerns.

Battery Acid Spill by Vendor (SAN LBL ADMIN 1993 0001)

Battery acid (sulfuric acid) was released to the environment in March 1993 when a vendor hosed off spilled battery acid onto the ground. An LBL forklift operator was lowering a battery onto the bed of a vendor's truck when the battery fell 15 cm (six inches) from its hoist. The battery spilled approximately two liters (one-half gallon) of acid into the bed of the truck. The forklift operator immediately informed his supervisor, who directed him to contact the Fire Department. The vendor was instructed not to take any actions. While the Fire Department was being summoned, the vendor hosed off the acid onto the ground with a utility hose. About one-quarter liter (one cup) of the diluted acid entered the storm drain. All accessible acid was neutralized and cleaned up. Appropriate regulatory agencies were notified as a courtesy; the spill was not of a reportable size.

The direct and contributing causes centered around violation of established procedures and inadequate supervision. Corrective actions were fashioned accordingly: the supervisor has conducted safety training of all his staff, and the vendor has been advised in writing to observe OSHA requirements when handling hazardous materials and in loading trucks.

Hazardous Material Contamination (SAN LBL OPERATIONS 1993 0006)

In July 1993 secondary containment of a double-walled fuel oil tank released approximately 150 liters (40 gallons) of fuel oil to the surface of a parking lot. The vendor had left a filling hose in the primary tank; the hose was not equipped with a fuel nozzle. Fuel siphoned out into the secondary tank and leaked from a faulty weld. The fuel oil eventually reached a storm drain.

Emergency responders used oil-absorbent blankets and spill pillows. The storm drain was sampled, and samples of the North Fork of Strawberry Creek were taken. Both set of samples analyzed as nondetectable for diesel fuel oil.

The direct and contributing causes centered around the defective fuel hose (missing fuel nozzle), inattention to detail, and inadequate administrative control. A construction safety meeting was conducted in which the following was discussed:

- Review of conditions in subcontractor laydown areas
- Advance approval of changes in safety plans
- The need for ongoing communications with subcontractors.

Tritium Release of Less Than 100 Curies (SAN LBL SBD 1993 0001)

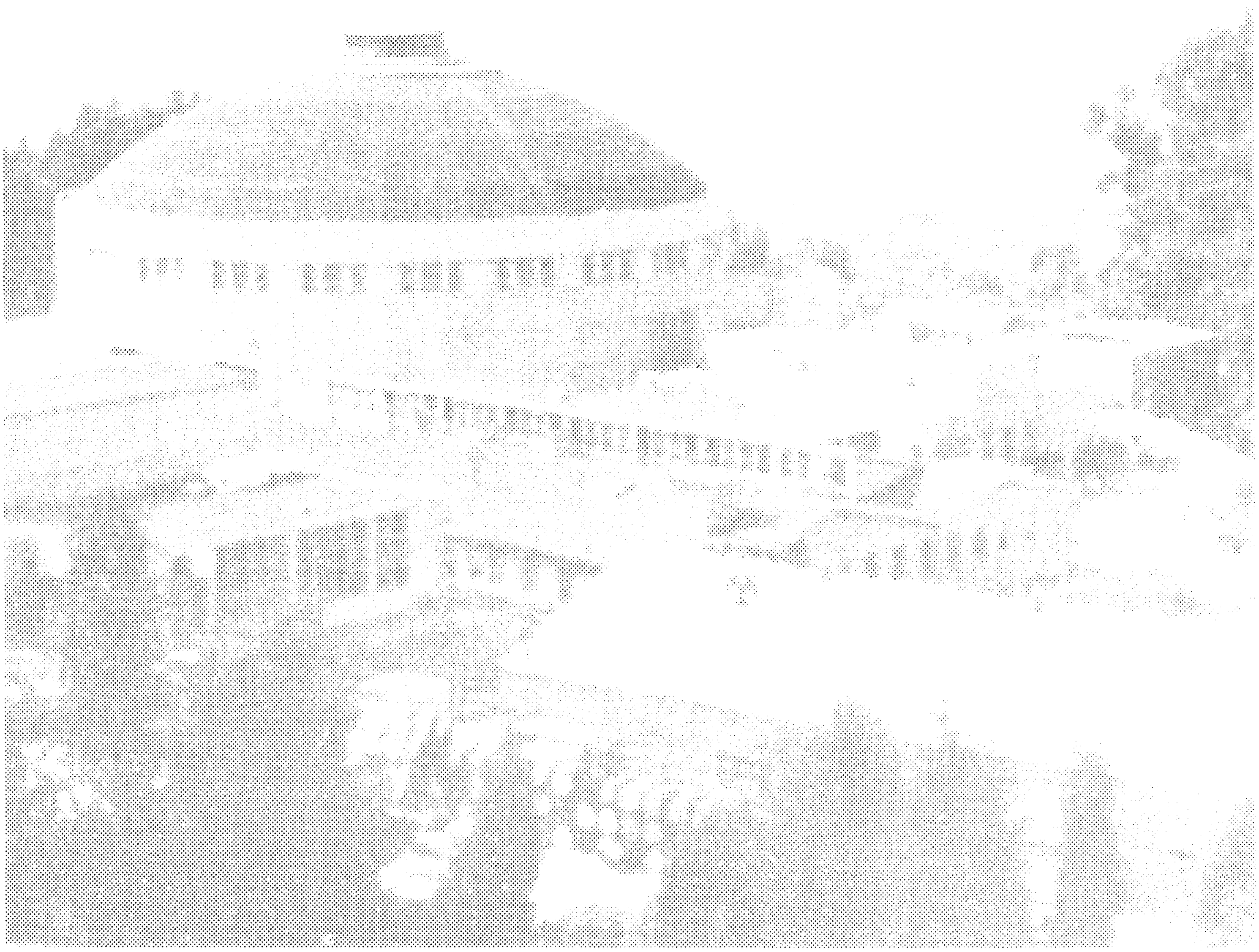
The National Tritium Labeling Facility (NTLF) is engaged in work labeling various complex organic molecules, such as research pharmaceuticals. Unreacted tritium is oxidized to HTO and passed through a bed of silica gel, where it is adsorbed, effectively removing most of it from the exhaust air stream. Administrative procedures require the facility operators to change the silica gel beds before they are exhausted. On the morning of August 15, 1993, tritium began to break through the silica gel bed. Environmental monitoring samplers in the stack picked up a representative portion of the tritium. The samplers were analyzed normally and the results made available on August 31, 1993. Approximately 44 curies of tritium were released in this event.

The direct and contributing causes for this event were attributed to inattention to detail, poor real-time monitoring equipment design, and poor policy implementation. Corrective actions included the following:

- Written procedures were implemented for exchanging the silica gel beds.
- LBL Radiation Assessment Group staff will meet with the NTLF staff on a weekly basis to review safe handling practices of tritium.
- The NTLF will review options for modifying their existing real-time monitor to alarm at 25 Ci per day release of tritium.

Under the sitewide NESHAPs upgrade, the NTLF will be equipped with a high volume tritium sampler, effectively raising the sensitivity by a factor of 10, and a real-time tritium monitor. These improvements will be fully implemented by February 1, 1995.

Section 7. Groundwater Protection



Previous Studies

In the summer of 1986, as part of the environmental baseline study for the development of the East Canyon area, LBL staff collected samples of soil, groundwater, surface water, and vegetation from within the LBL property boundary and from adjacent areas. Groundwater samples were collected from a few flowing horizontal drains (hydraugers) that had previously been installed for slope-stability purposes. Chemical analysis of water samples from two adjacent hydraugers (51-01-03 and 51-01-04) east of Building 51 (see Figure 7-1) showed low levels of chlorinated solvents. The presence of contaminants in the effluent water from these two hydraugers and the observation of contamination elsewhere on the site prompted LBL to submit a proposal to the DOE for a site-wide environmental characterization and monitoring program in 1989. Discharge from contaminated hydraugers in this area is currently collected, treated, and discharged into the sanitary sewers.

During 1990, LBL carried out a preliminary investigation that concentrated on three areas where subsurface contaminants were known to exist, or previous practices or activities made the areas suspect. The 1990 investigation detected three areas of contaminated groundwater: south of Building 71 and north of Building 51 along

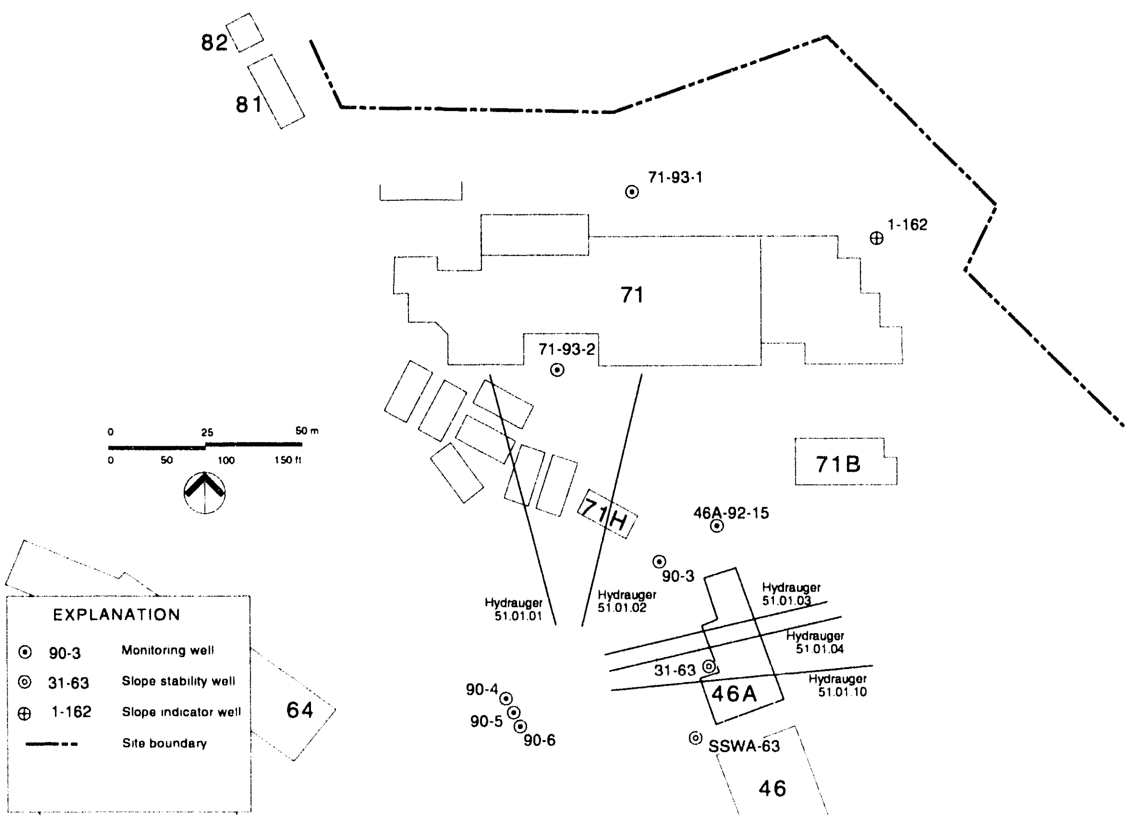


Figure 7-1. Approximate Locations of Some of the Hydraugers and Monitoring Wells in the Building 71 and 51 Areas

Blackberry Creek, the Old Town area near Building 7, and the Corporation Yard around Building 69. The contaminants detected consisted primarily of the chlorinated solvents perchloroethylene (PCE), trichloroethylene (TCE), and cis-1,2-dichlorethylene (DCE) in the first two areas and tritium in the Corporation Yard. Additional monitoring wells were installed to investigate the extent of the groundwater contamination.

During 1991, nine peripheral wells, identified with the MWP prefix in Figure 7-2, were installed at strategic locations to monitor the quality of groundwater leaving the western and southern boundaries of the LBL property. Water samples from these wells were collected and tested for volatile organic compounds (VOCs) according to US/EPA method 8240 and for California Assessment Manual (CAM) 17 metals according to the California Code of Regulations (CCR), Title 26. Only one of the nine peripheral wells (MWP-7), contained measurable levels of contamination (24 μg/l TCE). Monitoring well MWP-7 is located about 40 meters north of the LBL property line in the Old Town area.

Also in 1991, LBL also installed nine interior monitoring wells to investigate potential groundwater contamination. Two wells were installed south of Building 77 to investigate the impact of operations conducted in this building on the groundwater quality in the area. Four wells were installed in the area between Buildings 69 and 75. The purpose of these wells was to study the occurrence of tritium in groundwater in the vicinity of the National Tritium Labeling Facility (NTLF). Three additional wells were constructed in the Old Town area, two in the vicinity of Building 53 and one north of Building 5. The wells were constructed to find the extent of contamination in the Old Town area. All three wells in the Old Town area confirmed contamination with chlorinated

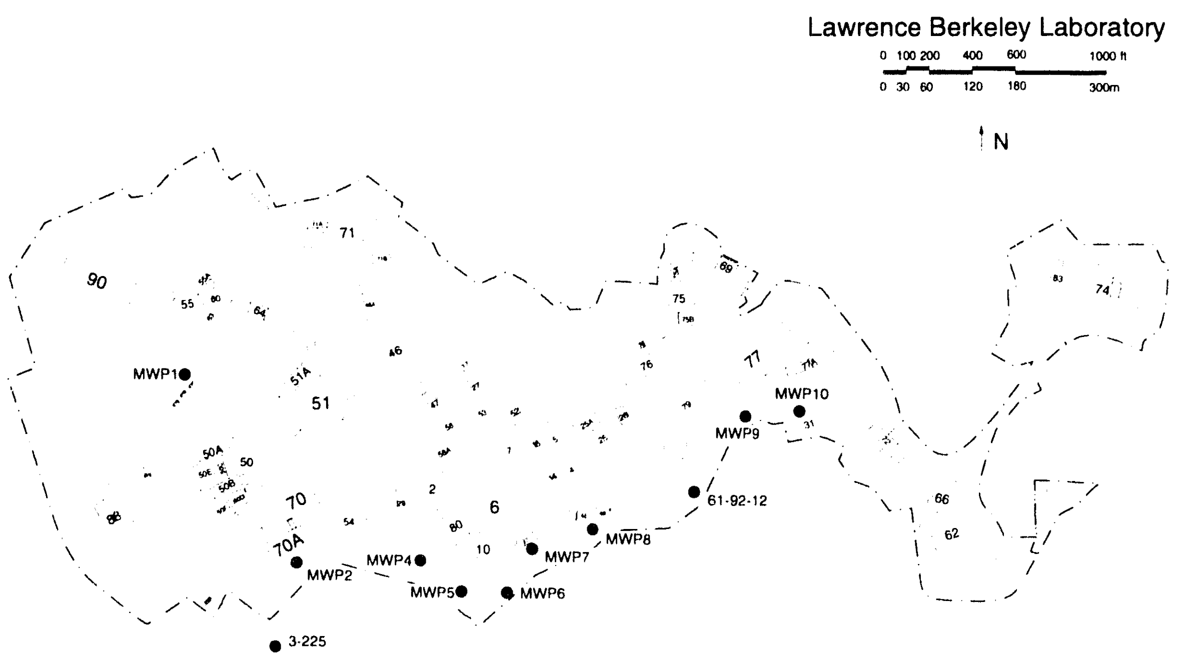


Figure 7-2. Approximate Locations of Peripheral Monitoring Wells

hydrocarbons. Twenty-six monitoring wells were installed during 1992, bringing the total number of groundwater monitoring wells to 54. In addition, a deep multilevel well array, which consists of four nested wells, was installed in the Old Town area to evaluate the vertical extent of contamination and determine vertical hydraulic gradients. A vadose-zone monitoring well was installed in the Corporation Yard to investigate the migration of contaminants through the unsaturated zone.

Groundwater Monitoring Program

The groundwater monitoring program at LBL began in 1991. This task currently consists of quarterly sampling and analysis for volatile organic compounds (VOCs) (EPA Method 8260) and annual sampling and analysis for dissolved metals (CAM 17) in all available site monitoring wells and two offsite wells. Samples from monitoring wells and some slope-stability facilities (slope-stability wells, slope indicator wells, and observation wells) in the Corporation Yard (Building 75 and 69 area) are also tested, at least annually, for tritium. During 1993, samples were collected for tritium analysis during three quarters.

Groundwater samples from other areas are selectively tested for tritium and other radionuclides where there is potential radiological contamination. Samples from wells associated with underground fuel storage tanks are analyzed for fuel contaminants approximately annually. During 1993, these wells were sampled once for total petroleum hydrocarbons in the gasoline range (TPH-G) and/or the diesel range (TPH-D). In addition, all flowing hydraugers are sampled annually by the Environmental Restoration Group and analyzed for VOCs, and selected hydrauger samples are also analyzed for tritium. Analytical results and a discussion of all groundwater sampling activities are included in Quarterly Progress Reports submitted to DTSC.

Groundwater Studies During 1993

Twenty additional monitoring wells were installed during 1993, increasing the total number to 74. VOCs were detected in approximately half of the new wells. With the exception of MWP-7 (Figure 7-2), VOCs were not detected in any of the site peripheral monitoring wells or in the two offsite wells sampled. The concentration of total halogenated hydrocarbons detected in any individual monitoring well was less than 100 µg/l in all site monitoring wells except for eight wells. Three of these eight wells had VOC concentrations in excess of 1000 µg/l. Contamination in two of the wells consists primarily of PCE and TCE and is associated with the Old Town groundwater VOC plume. Contamination in the third well, which is located immediately south of Building 71, consists primarily of chlorofluorocarbon 113 (Freon 113).

Locations where contamination was detected in groundwater in November 1993 are shown in Figure 7-3. To date, five primary plumes of contaminated groundwater have been identified. Contaminants in three of the plumes consist principally of halogenated hydrocarbons. The contaminant in the fourth plume is mainly tritium, and the contamination in the fifth plume consists primarily of fuel hydrocarbons. Short descriptions of these plumes are given below.

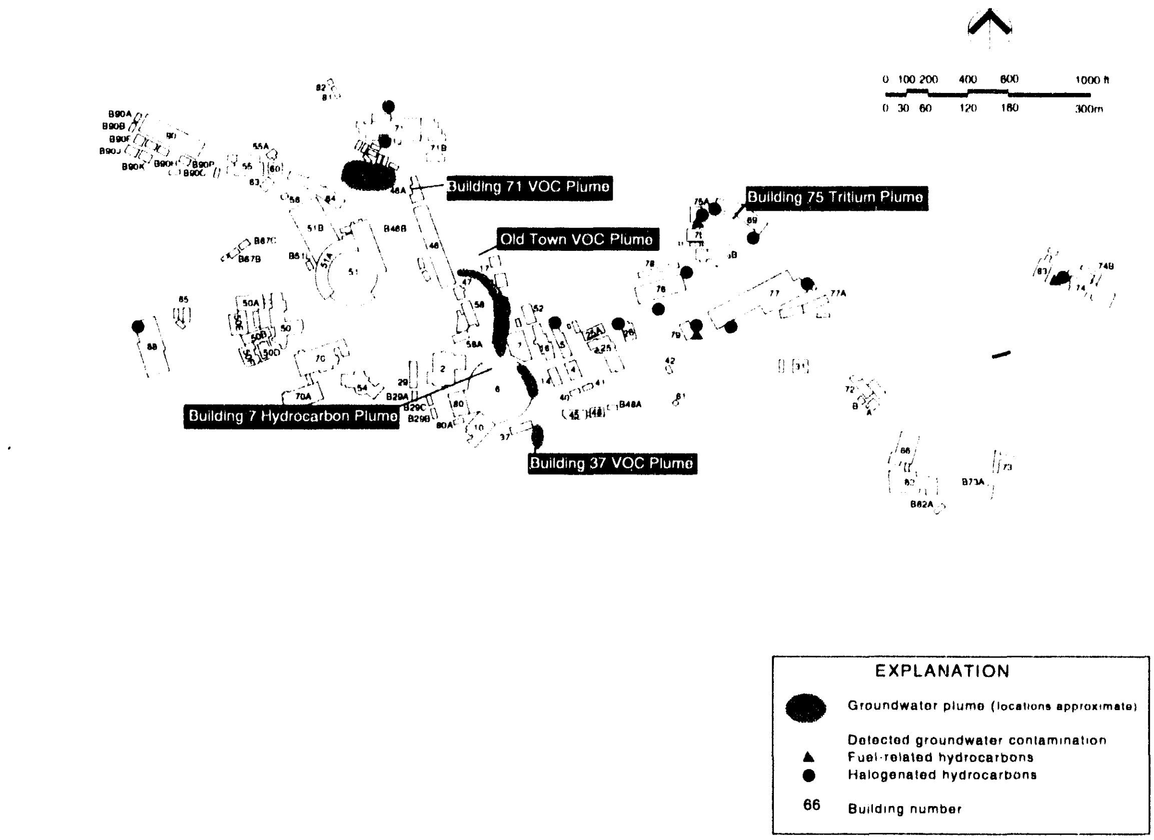


Figure 7-3. Areas Where Groundwater Contamination was Detected (November 1993)

Building 71 VOC Plume

The locations of monitoring wells in the vicinity of the Building 71 plume are shown in Figure 7-4. Monitoring wells MW71-93-1 and MW71-93-2 were installed in 1993 immediately north and south of Building 71, respectively, to help identify the source of the previously identified VOC plume. MW71-93-1 was also installed to evaluate whether contaminants might be migrating along the geologic formation contact, northward toward the site boundary. The maximum concentration of total halogenated hydrocarbons measured in this plume in 1993 was approximately 68 µg/l, as shown in Figure 7-4. Contaminants present consist mainly of PCE, TCE, cis-1,2-DCE, 1,1-dichloroethane (DCA), 1,1-DCE, trans-1,2-DCE, and vinyl chloride. In 1992, a pump was installed in well 90-5 at the downgradient edge of the plume to extract and treat the contaminated groundwater and prevent further downgradient migration of contamination.

In addition, Freon-113 was detected in water samples from MW71-93-1 (30 µg/l) and MW71-93-2 (1625 µg/l). The full extent of the Freon-113 contamination has not yet been determined. The time variation of the primary contaminants during 1993 in MW90-3 is shown in Figure 7-5. Water samples from all flowing hydraugers in the vicinity of the plume have been tested annually for VOCs. Figures 7-6 and 7-7

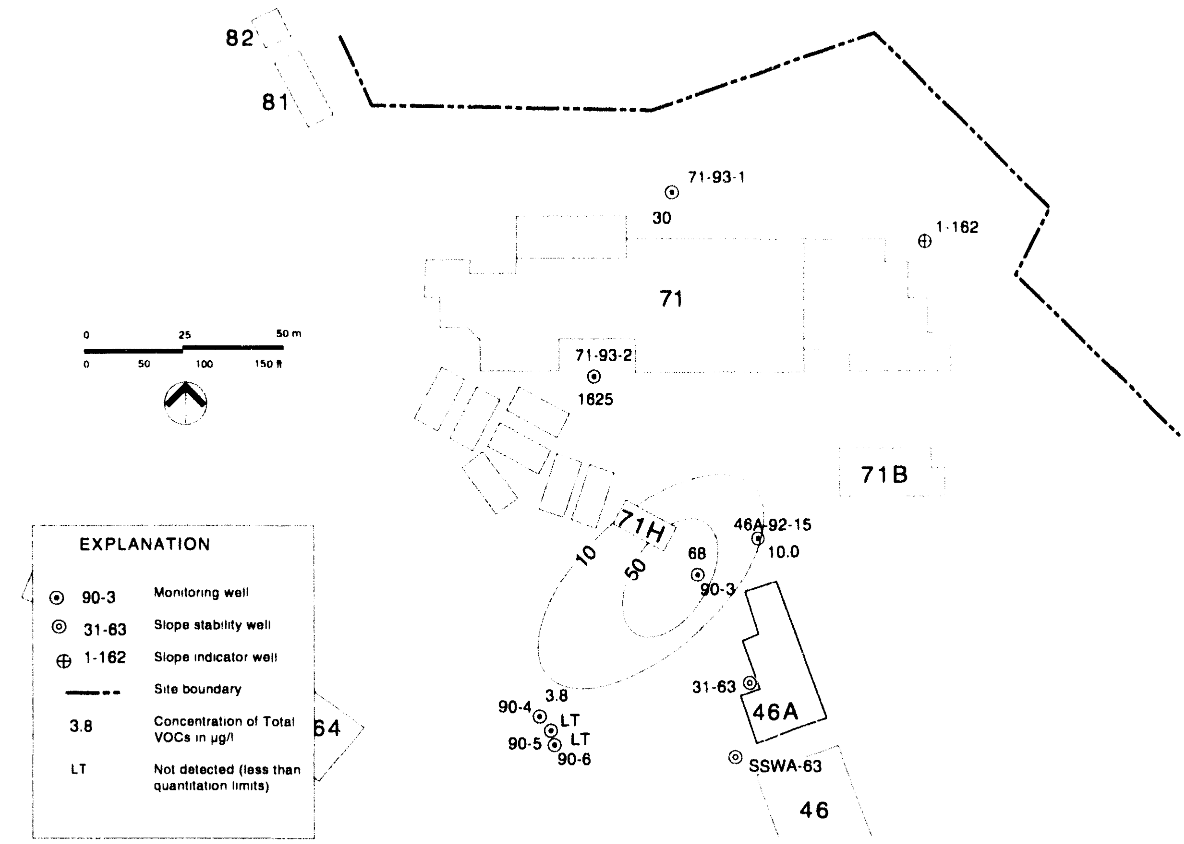


Figure 7-4. Isoconcentration Contours of Total VOCs in µg/l for Building 71 Groundwater Plume (November 1993)

show the variation of selected contaminants over time for hydraugers 51-01-01 and 51-01-03, respectively.

Old Town VOC Plume

The maximum concentration of total halogenated hydrocarbons detected in the Old Town Plume in 1993 was approximately 2063 µg/l. This value is the maximum VOC contaminant concentration measured to date in groundwater monitoring wells at LBL. Contaminants present in the plume are mainly PCE, TCE, and cis-1,2-DCE. Other VOCs detected include 1,1-DCA, 1,1-DCE, trans-1,2-DCE, carbon tetrachloride, chloroform, and vinyl chloride. An isoconcentration contour map of the plume is shown in Figure 7-8. MW7-92-19 was installed near the center of the plume in 1992. Figure 7-9 shows the seasonal variation in contaminant concentrations at MW7-92-19 during 1993.

Contaminant concentrations detected in two downgradient wells (MW91-7 and MW91-8) during 1993 are shown in Figures 7-10 and 7-11, respectively. An abandoned sump adjacent to Building 7 was located and removed in 1992. The sump is now believed to have been a major source of the contaminants that constitute the Old Town plume.

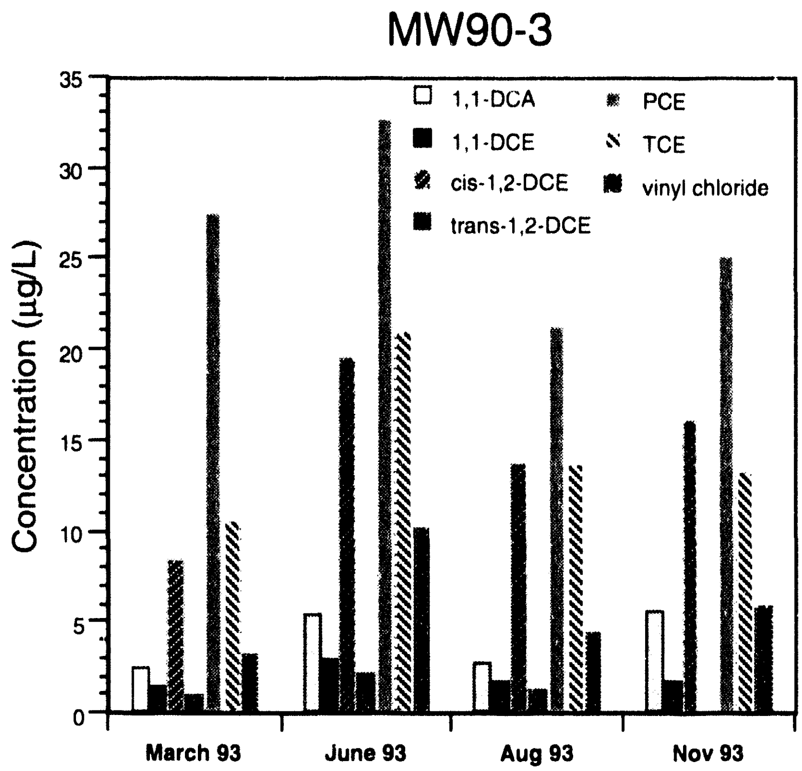


Figure 7-5. Time Variation of Contaminants in Well MW90-3

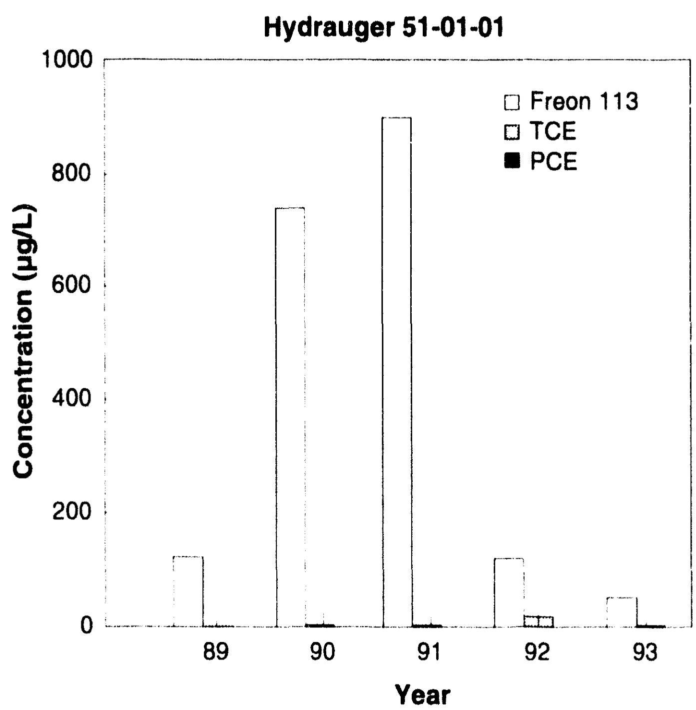


Figure 7-6. Time Variation of Contaminants in Hydrauger 51-01-01

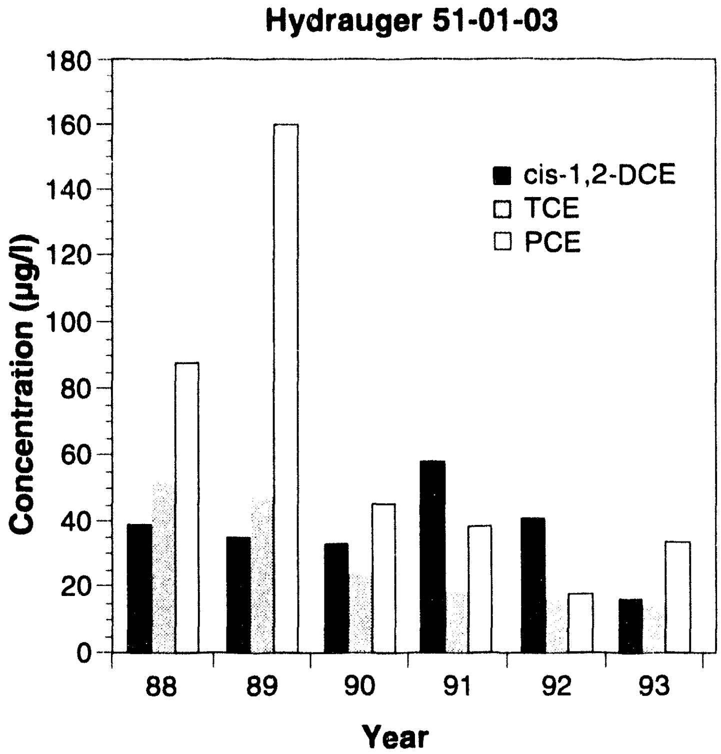


Figure 7-7. Time Variation of Contaminants in Hydrauger 51-01-03

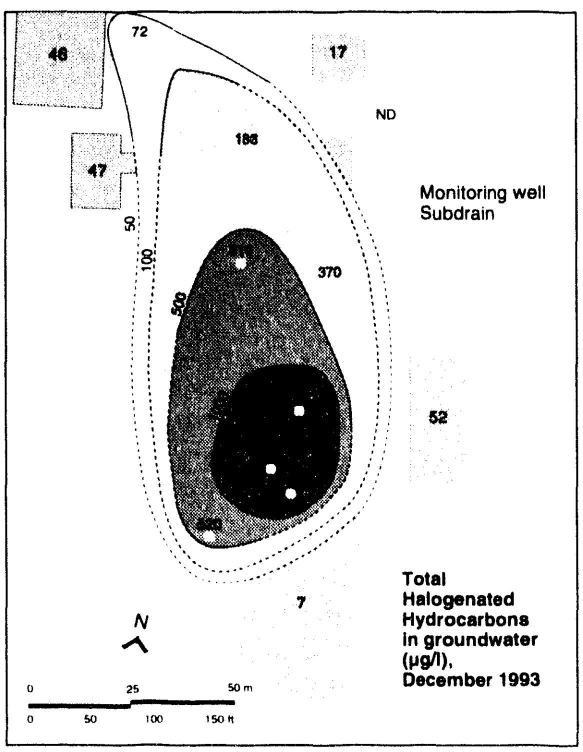


Figure 7-8. Plume of Groundwater Contamination in the Old Town (1993)

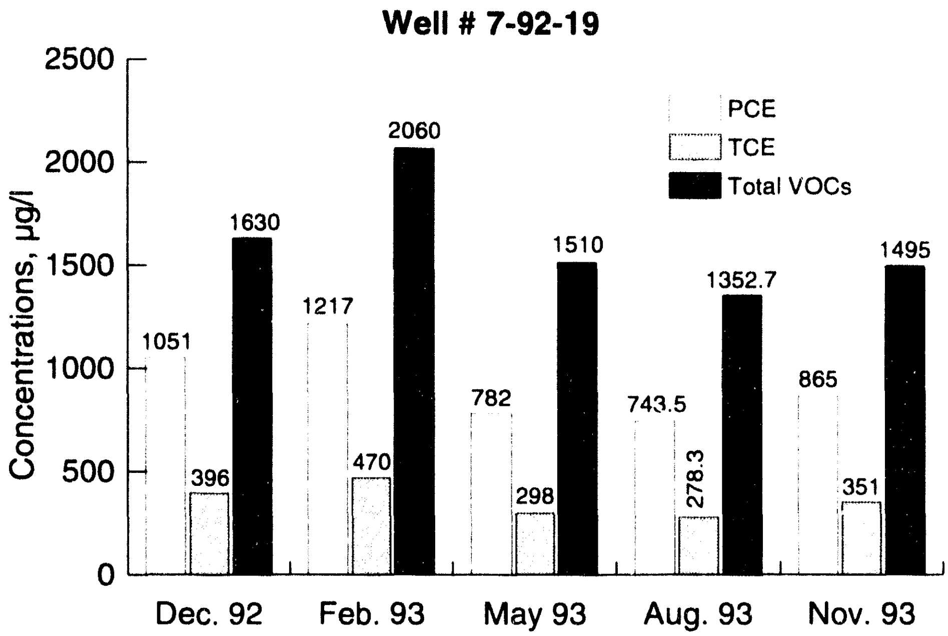


Figure 7-9. Time Variation of Contaminants in Well MW7-92-19

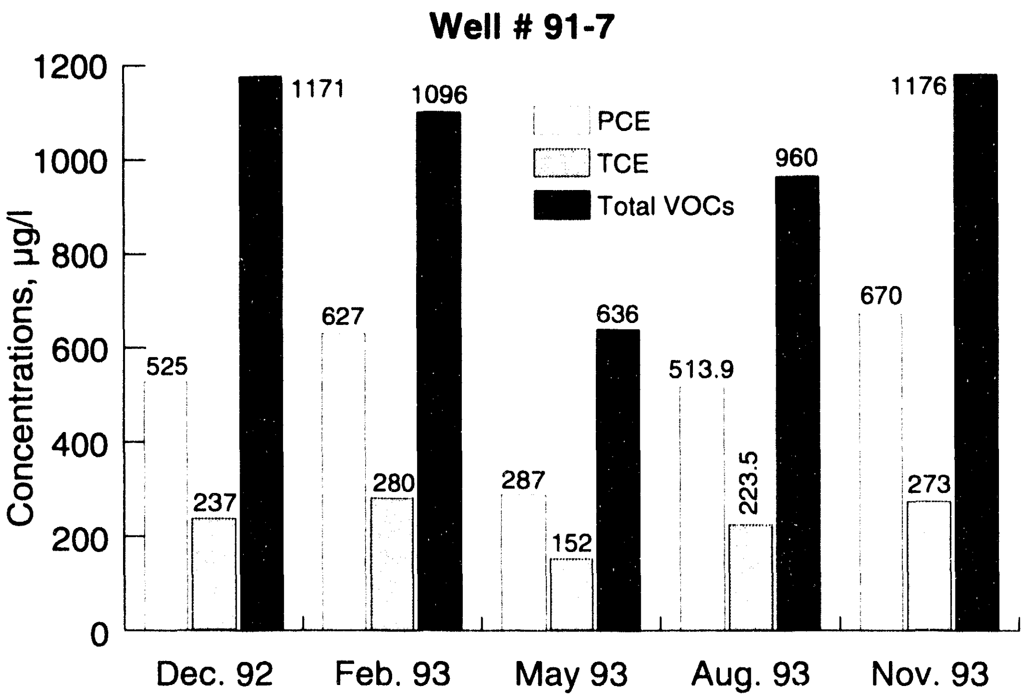


Figure 7-10. Time Variation of Contaminants in Well MW91-7

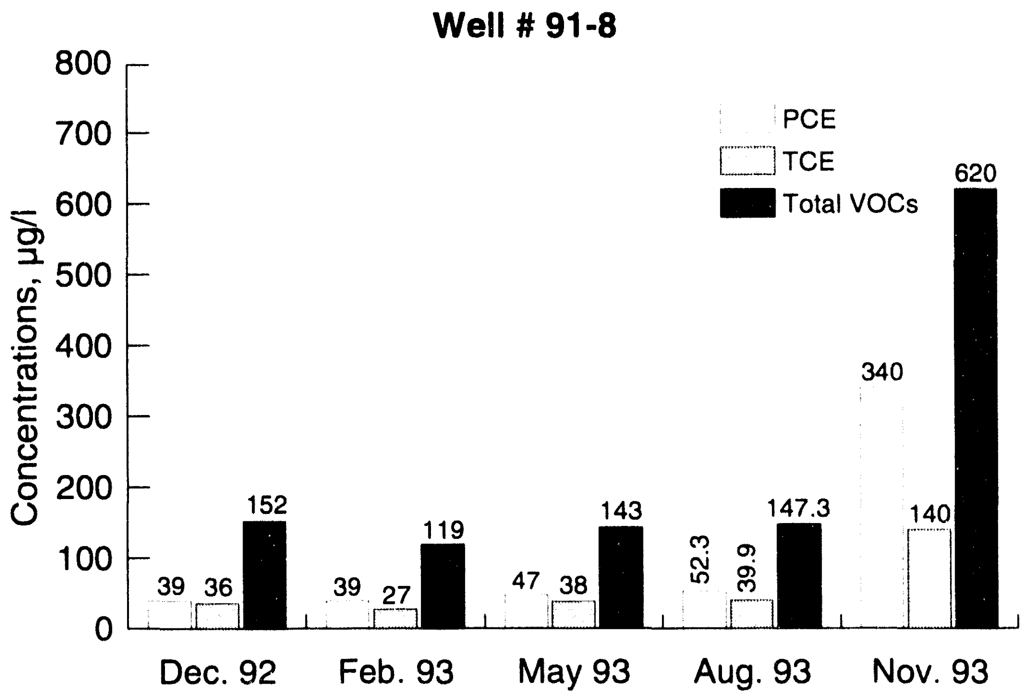


Figure 7-11. Time Variation of Contaminants in Well MW91-8

In the early 1950s, a subdrain was installed east of Building 46 to drain groundwater in this area for slope-stability purposes. Detailed geologic investigations revealed that there was a potential migration pathway from the contaminated zone under Building 53 to the area east of Building 46. Analyses of water samples collected from the Building 46 subdrain in 1993 indicated that the subdrain intercepts the leading edge of the Old Town plume. Upon this finding, a treatment system was installed that collects and treats the subdrain water. The clean water is transferred to the Building 88 cooling tower.

Building 37 VOC Plume

A third plume of halogenated hydrocarbons extends east and south of Building 6, which houses the Advanced Light Source (ALS). The primary contaminant present in the plume is TCE. Other VOCs detected in this plume included PCE, Freon-113, 1,1-DCE, 1,1-DCA, cis-1,2-DCE, and 1,1,1-DCA. TCE was detected at concentrations of approximately 11 to 20 µg/l in 1993 as measured in MWP-7 near the center of the plume. Figure 7-12 shows the time variation of the contaminant concentrations in MWP-7 during 1993. Contaminant concentrations showed no significant trends over the year. Chloroform was the only VOC detected in monitoring well MW37-93-5, which was installed in 1993 to determine the western extent of the plume. The lack of significant VOCs in this well indicates the VOC plume is relatively narrow. Offsite monitoring well CD-92-28 was installed downgradient of the plume on UCB property. No contamination has been detected in this well to date. In 1993, a pump was installed in wells MWP-7 and MW37-92-6 at the downgradient edge of the plume to extract and treat the contaminated groundwater and prevent potential downgradient migration of contamination.

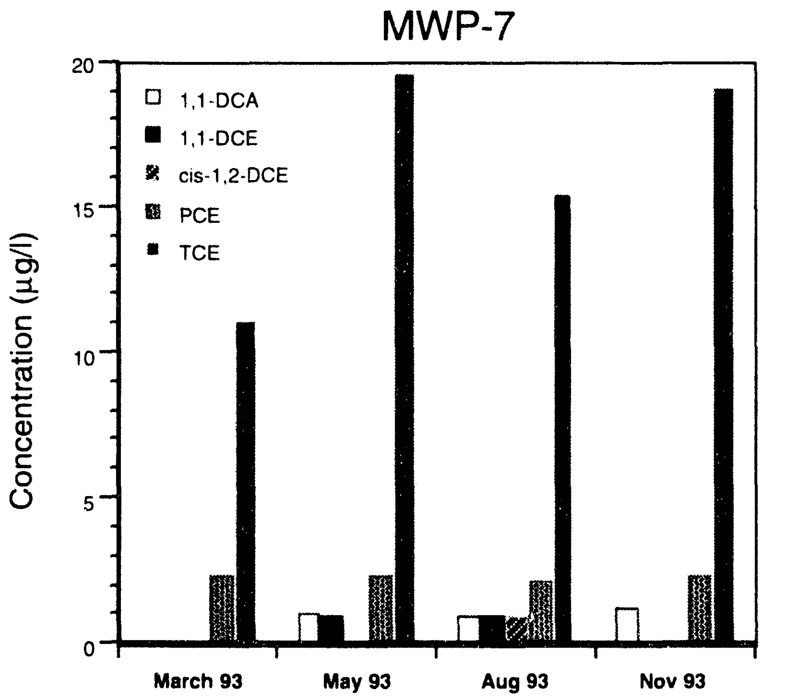


Figure 7-12. Time Variation of Contaminants in Well MWP-7

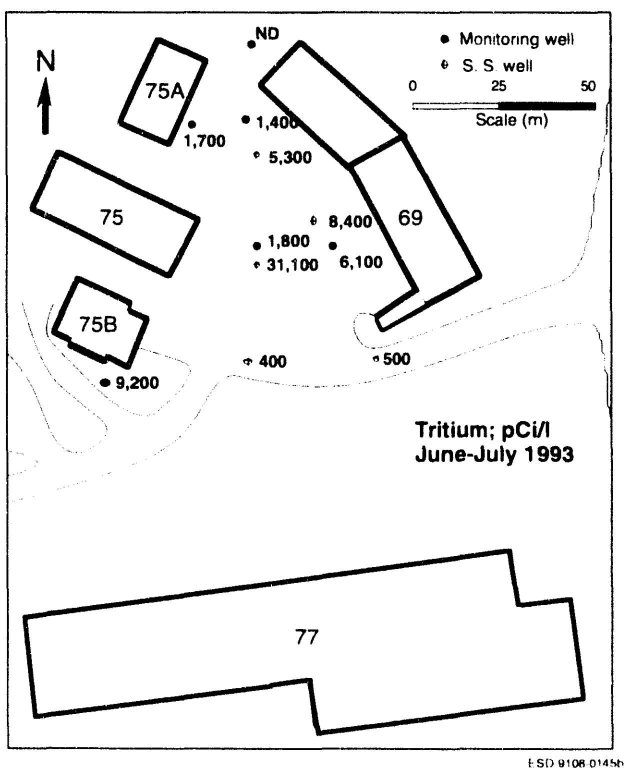


Figure 7-13. Tritium Concentration Measured in Water Samples from Wells in the Corporation Yard (1993)

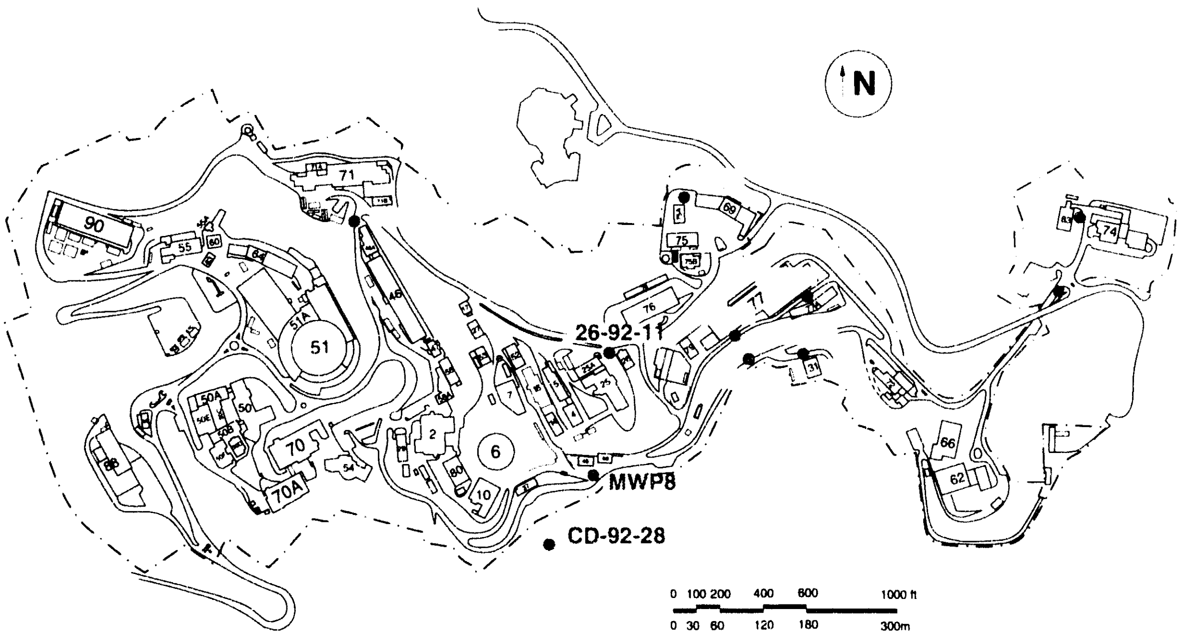


Figure 7-14. Location of Wells Sampled for Tritium in July 1993

Building 75 Tritium Plume

A plume of tritium-contaminated groundwater extends southeast of the National Tritium Labeling Facility, Building 75 (Corporation Yard area). The concentration of tritium measured in slope stability and groundwater monitoring wells in the Corporation Yard area in June and July 1993 is shown in Figure 7-13. With one exception, tritium concentrations in monitoring wells have been below the drinking water maximum contamination level (MCL) of 20,000 pCi/l, ranging up to approximately 10,000 pCi/l. A tritium concentration of 31,100 pCi/l has been observed in one of the slope stability wells in this area. Figure 7-14 shows the location of other wells that were sampled for tritium in June and July 1993. No tritium was detected in any of the wells shown on Figure 7-14, which indicates that tritium contamination of the groundwater is restricted to the Corporation Yard area.

Building 7 and Other Petroleum Hydrocarbon Plumes

A plume of hydrocarbon-contaminated groundwater was detected in 1992 at the location of a former underground fuel tank that was discovered south of Building 7 during construction of the ALS. Monitoring well MW7-92-16 is located at the former tank site, and MW6-93-4 was installed downgradient of the tank site in 1993. A sample collected from MW7-92-16 in May 1993 contained 520 µg/l of TPH-G and 170 µg/l of TPH-D. A sample collected from MW6-93-4 in November 1993 contained 460 µg/l of TPH-kerosene.

Underground Tank Monitoring

LBL has installed seven monitoring wells downgradient from one present and three previously decommissioned or removed underground storage tanks, including the tank at Building 7 discussed above.

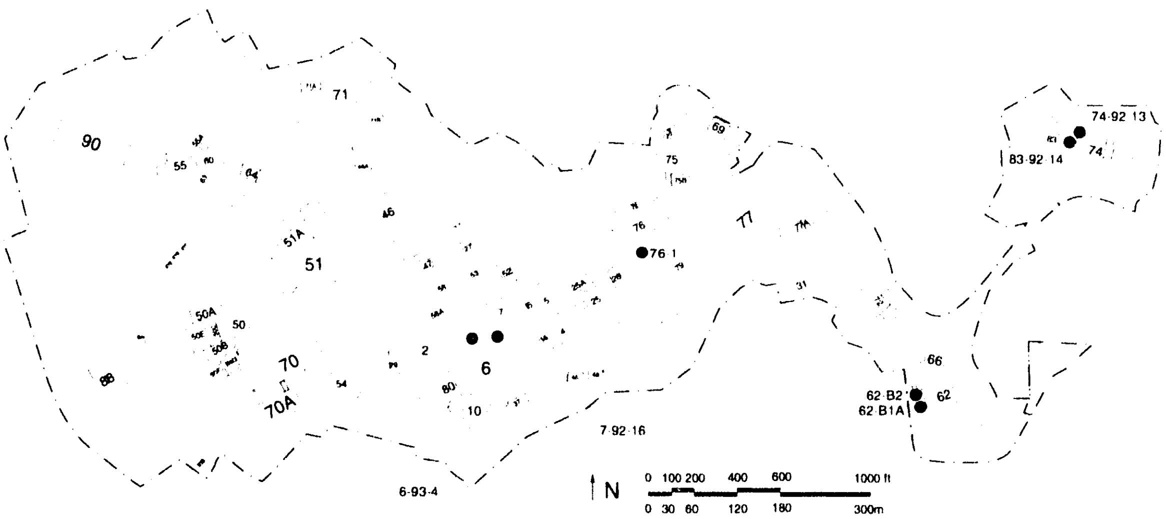


Figure 7-15. Locations of Monitoring Wells Downgradient from Present and Decommissioned Underground Storage Wells

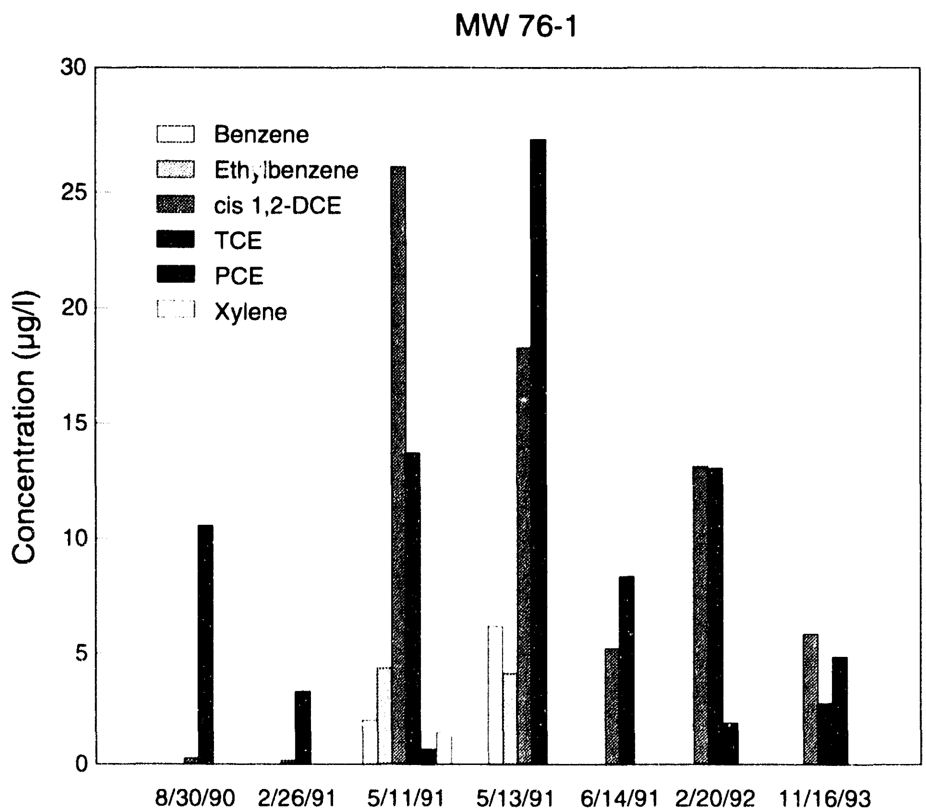


Figure 7-16. Time Variation of Contaminants in Well MW76-1

Table 7-1. 1993 Hydrauger Sampling Summary for Tritium

	Concentrations in pCi/l			
	CC Hydrauger	CC-B Hydrauger	75-77 Hydrauger	77-01-02H Hydrauger
Number of Samples	11	11	11	6
Minimum Value	<700*	<700	1,300	17,000
Maximum Value	1,340	<700	5,100	22,000
Mean	<700*	<700	3,400	19,000
Standard Deviation	933	769	1,300	1,800

* Detection limit ≅ 700 pCi/l

Figure 7-15 shows the locations of these seven tanks. Quarterly water samples are collected from the wells and tested for VOCs (EPA method 8260). Samples are also collected at least annually and analyzed for TPH-D and TPH-G. No contaminants were detected in 1993 in monitoring wells MW62-B1A and MW62-B2, located at the site and downgradient from the Building 62 former underground diesel storage tank. Total aromatic hydrocarbons detected in MW83-92-14 ranged between 1.0 and 10.0 μg/l. TPH-G (69 μg/l) and TPH-D (430 μg/l) were also detected in MW83-92-14 in May 1993. Figure 7-16 shows the time variation of contaminants in well MW76-1, which is located downgradient from the underground storage tanks at the Building 76 motor pool.

Ongoing Radiological Monitoring

As part of the ongoing environmental monitoring program, one hydrauger (77-01-02) was sampled and analyzed for tritium in March 1993. Tritium was detected in effluent from the hydrauger at a concentration of 20,300 pCi/l, slightly above the drinking water maximum contaminant level (MCL) of 20,000 pCi/l. As a result of recent construction, this hydrauger was obstructed. Table 7-1 summarizes the 1993 analytical data for those hydraugers sampled monthly by the Environmental Protection Group.

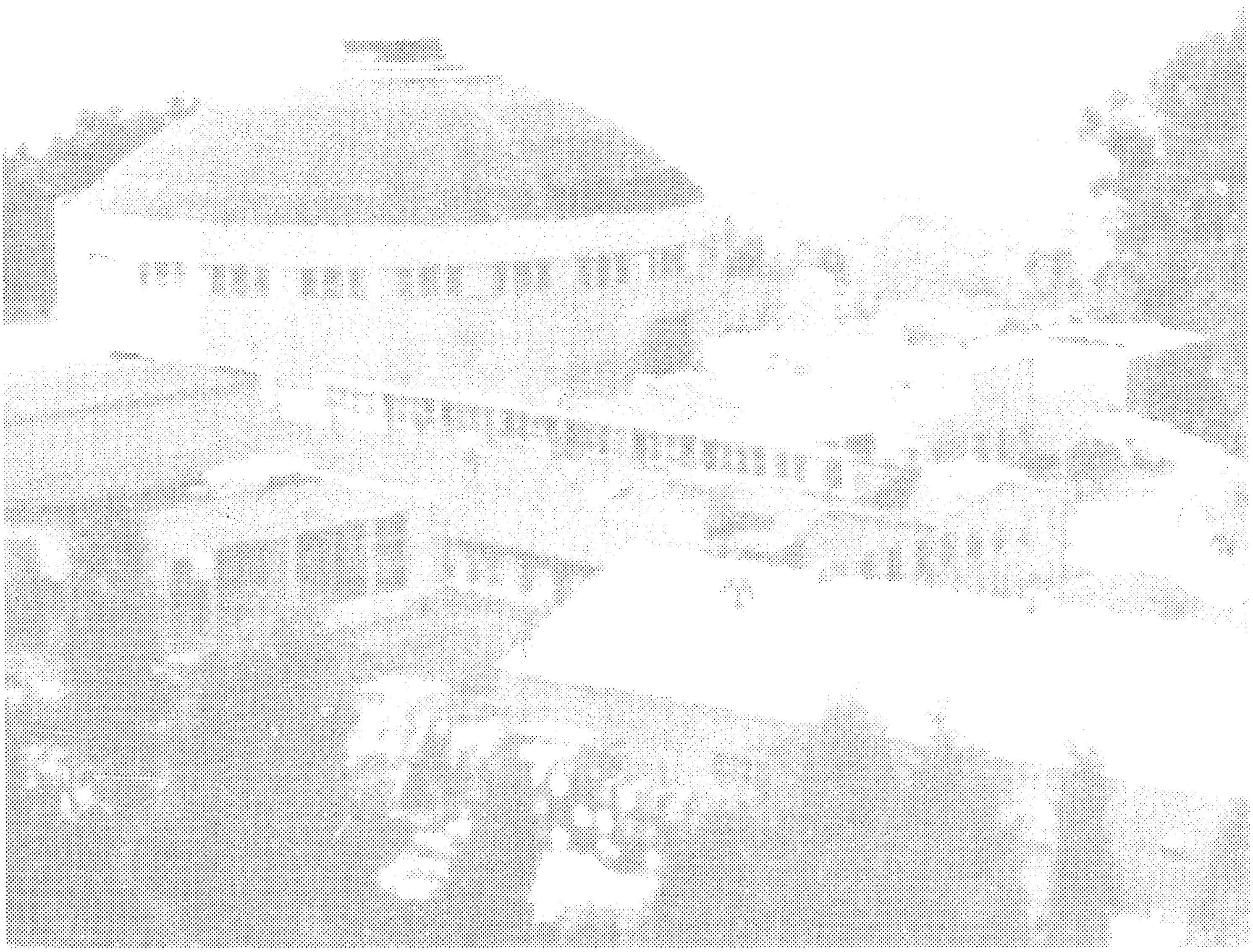
Interim Corrective Measures

Granular activated carbon treatment (GAC) systems have been installed in order to prevent further migration of known groundwater contamination plumes, or prevent groundwater contamination from impacting surface waters. The systems consist of two in-line GAC drums that reduce contaminant concentrations to nondetectable levels. The treated water is either reused in LBL cooling towers or discharged to the sanitary sewer. Where the treated water is discharged to the sanitary sewer, East Bay Municipal Utility District approval has been obtained.

The following GAC systems have been installed:

- A groundwater extraction and treatment system was installed east of Building 37 in 1993. Groundwater is pumped and treated from monitoring wells MWP-7 and MW37-92-6. Effluent from hydrauger 37-01-01 is also treated by the system. The treated water is used as makeup water for the Building 37 cooling tower.
- A groundwater extraction and treatment system was installed east of Building 46 in 1993, to collect and treat the groundwater from the Building 46 subdrain. The treated water flows through a pipe under Building 46 to a 44-cubic-meter aboveground storage tank. The water then travels by gravity flow to the Building 88 cooling tower, where it is used as makeup water for the cooling tower.
- Water from hydraugers with detectable concentrations of VOCs east of Building 51 (51-01-01, 51-01-02, 51-01-03, 51-01-03A, and 51-01-04) is treated and the treated water is then discharged to the sanitary sewer.

Section 8. Quality Assurance



General

For environmental programs quality assurance (QA) consists of all activities conducted to ensure that data acquired provide a valid representation of actual conditions. QA at LBL is implemented through PUB-3111, the LBL *Operating and Assurance Program* (OAP). This document incorporates the guidance of DOE Order 5700.6C, *Quality Assurance*, DOE Order 5480.19, *Conduct of Operations*, and DOE Order 4330.4A, *Maintenance Management Program*. Additionally, draft US/EPA guidance on QA (ANSI/ASQC E-4) was used in its creation as well as US/EPA QA requirements identified in 40 CFR Part 61, Subpart H, and Appendix B Method 114.

The OAP includes provisions for the creation of notebooks at all levels within LBL. Function notebooks provide guidance in the performance of support services such as environmental program activities. Facility notebooks are created to provide guidance in the operations of facilities to preclude operational incidents or environmental releases. Project notebooks provide guidance to researchers regarding their activities.

The function notebooks for Environmental Programs (Environmental Protection, Waste Management, Environmental Restoration, Analytical Services, *et al.*) includes provisions for documentation of items such as

- The organizational structure, functional responsibilities, levels of authority, and lines of communications for all activities related to the emissions measurement program.
- Administrative controls prescribed to ensure prompt response in the event that emission levels increase due to unplanned operations.
- Identification of sampling sites and number of sampling points, including the rationale for site selections.
- A description of sampling probes and representativeness of the samples.
- A description of any continuous monitoring system used to measure emissions, including the sensitivity of the system, calibration procedures, and frequency of calibration.
- A description of the sample collection systems for each radionuclide measured, including frequency of analysis, calibration procedures, and frequency of calibration.
- A description of the laboratory analysis procedures used for each radionuclide measured, including frequency of analysis, calibration procedures, and frequency of calibration. Additionally, the in-house laboratory (Analytical Services) function notebook includes chain-of-custody and calibration procedures.
- A description of vendor control practices, which provides the basis for selection of vendors and includes verification activities related to the vendor calibration practices.
- A description of the sample flow-rate measurement systems or procedures, including calibration procedures and frequency of calibration.
- A description of the effluent-flow-rate measurement procedures, including frequency of measurements, calibration procedures, and frequency of calibration.
- Documented objectives of the QA program, which state the required precision, accuracy, and completeness of the emission measurement data, including a description of the

procedures used to assess these parameters. Accuracy is the degree of agreement of a measurement with a true or known value. Precision is a measure of the agreement among individual measurements of the same parameters under similar conditions. Completeness is a measure of the amount of valid data obtained compared to the amount expected under normal conditions.

- A quality control program established to evaluate and track the quality of the emissions measurement data against preset criteria. The program includes, where applicable, a system of replicates, spiked samples, split samples, blanks, and control charts. The number and frequency of such quality control checks are identified.
- A sample-tracking system established to provide for positive identification of samples and data through all phases of the sample collection, analysis, and reporting system.
- Sample handling and preservation programs to maintain the integrity of samples during collection, storage, and analysis.
- The performance of periodic internal and external audits to monitor compliance with the QA program. These audits are performed in accordance with written procedures and conducted by personnel who do not have responsibility for performing any of the operations being audited.
- The establishment of a corrective action program, including criteria for when corrective action is needed, what corrective actions will be taken, and who is responsible for taking the corrective action.
- Periodic reports prepared for management that describe the performance of the emissions measurements program. These reports include assessment of the quality of the data, results of audits, and descriptions of corrective actions.

An internal assessment of the Environmental Monitoring Program was conducted in 1993, with a focus on the line organization's achievement of quality. Assessment personnel monitored work performance, identified abnormal performance and precursors of potential problems, identified potential problems, and verified satisfactory resolution of problems. Criteria used in the assessment included applicable portions of DOE Order 5400.1 and 40 CFR 61.

In 1993, the LBL Office of Assessment and Assurance, which provides the independent oversight function for LBL, developed a checklist of audit criteria for performing independent audits of environmental QA programs; developed a schedule of independent audits; and initiated a QA audit of a subcontractor analytical laboratory (completed in 1994).

Analytical Services Group

Radiochemical analysis of environmental samples is performed by the LBL Analytical Services Group (ASG), part of EH&S's Health Department.

The ASG continued its participation in the US/EPA Intercomparison Studies program. During 1993, the lab received 22 assorted samples. Table 8-1 summarizes these analytical results. One sample, gross beta in an air filter, was above the control limit. The ASG is obtaining State DHS laboratory accreditation.

Table 8.1 Summary of EPA Interlab Comparison Studies for Various Radionuclides

Analyte/ Radionuclide	EPA Value (pCi/l)	EPA Precision (pCi/l)	LBL Avg. Value (pCi/l)	LBL Analytical Std. Dev.	Deviation
Gross Alpha	40	10	33.67	2.89	1.1
Radium-228	12.5	3.1	13.37	1.29	0.48
Gross Beta	58	10	53	2	-0.87
Strontium-89	15	5	12	0	-1.04
Strontium-90	10	5	18.33	.58	2.89
Performance Evaluation-B					
Gross Beta	177	27	183	3.46	0.38
Strontium-89	41	5	40.67	2.08	-0.12
Strontium-90	29	5	29.67	2.08	0.23
Cobalt-60	39	5	39.33	3.06	0.12
Cesium-134	27	5	22	1	-1.73
Cesium-134	32	5	33.67	2.52	0.58
Gross Alpha	95	24	112	4.36	1.23
Radium-228	19	4.8	19.53	.78	0.19
Strontium In Water					
Strontium-89	15	5	13	1	-0.69
Strontium-90	10	5	9.67	1.15	-0.12
Tritium In Water					
Tritium	7,395	740	7,492	433.78	0.22
Tritium	9,844	984	10,158	118.51	0.55
Gross Alpha-Beta In Water					
Gross Alpha	20	5	19.33	2.52	-0.23
Air Filter					
Alpha	19	19	2	0	
Beta	47	5	55.67	.58	3
Strontium-90	19	5	11.67	.58	-2.54

Environmental Protection Group

Quality assurance for the Environmental Protection Group (EPG) is outlined in the Environmental Protection Function Notebook, and the *Quality Assurance Project Plan* (QAPP). It provides for self and independent assessments of environmental quality assurance programs, including the Environmental Monitoring Unit (EMU). The rationale for all routine sampling and monitoring activities is described in the *Environmental Monitoring Plan*. The *Parameter Review Plan*, completed in 1993, describes the pathways, monitoring and sampling criteria, and action limits for all sample media and analytes.

All EMU personnel are trained in the performance and execution of their duties. Since there are few specific formal environmental monitoring and sampling training courses, EMU personnel are trained in areas and skills closely aligned with their specific duties. Training records are maintained for EMU personnel, who periodically review their records to ensure that their training is current.

Accuracy and precision requirements cited in the *Parameter Review Plan* form the basis of the EMU data quality objectives (DQOs). Three data management procedures were completed in 1993: *Data Quality Objectives*, *Data Validation And Verification*, and *Data Analysis*. These procedures will be implemented in 1994. They form the basis for quality improvement within the EMU. Analytical data are assessed by applying the data validation and verification procedures with respect to the DQOs. If the precision and accuracy criteria set forth in the DQOs are met, then no further change in sampling/analytical procedure is required. If the DQOs are not met, then the sampling and analytical procedures will be reviewed to identify any required corrective actions.

Environmental Restoration Group

The Environmental Restoration Group (ERG) prepared a Function Notebook in 1993, which is designed to comply with LBL's institutional QA requirements.

QA requirements and quality control (QC) procedures are further specified in the QAPP, dated August 1991, and in ERG *Standard Operating Procedures* (SOPs). The QAPP and the SOPs are applicable to all field and laboratory activities conducted in support of the ERG. QA requirements include definition and implementation of controls on accuracy, precision, completeness, comparability, and representativeness of sample data; and controls on data reduction and reporting.

The overall QA objective is to collect and analyze environmental samples in a manner that ensures that all technical data generated during site investigations withstand scientific scrutiny and are useful in planning environmental restoration activities at the LBL site. The SOPs and the QAPP underwent major revision in 1993 and will be finalized in 1994. The revised QAPP describes the ERG organization and responsibilities, including an assigned Quality Assurance Manager (QAM). The QAM conducts general oversight of the ERG QA program and is responsible for conducting and documenting annual assessment audits to ensure that requirements of the QAPP are fulfilled. The QAM also documents compliance with pertinent DOE and LBL QA policies.

Sample collection, preservation, and custody activities are performed according to procedures specified in the QAPP and SOPs. All required sample analyses are completed by laboratories certified by the State of California Department of Health Services Environmental Laboratory Accreditation Program. Internal QC checks for field operations include the collection of equipment (rinse) blanks, trip blanks, and sample duplicates or replicates. Table 8-2 lists the number of QC samples that were collected during quarterly groundwater sampling in 1993. No contaminants were detected in either the equipment blanks or trip blanks.

Table 8-2. 1993 ERG Quality Control Samples

Analysis	Number of Samples	Duplicate Samples	Equipment Blanks	Trip Blanks
Volatile Organic Compounds	247	15	21	28
Title 22 Metals	74	9	0	0
Total Petroleum Hydrocarbons	13	0	1	1
Radionuclides/Tritium	23	8	2	1

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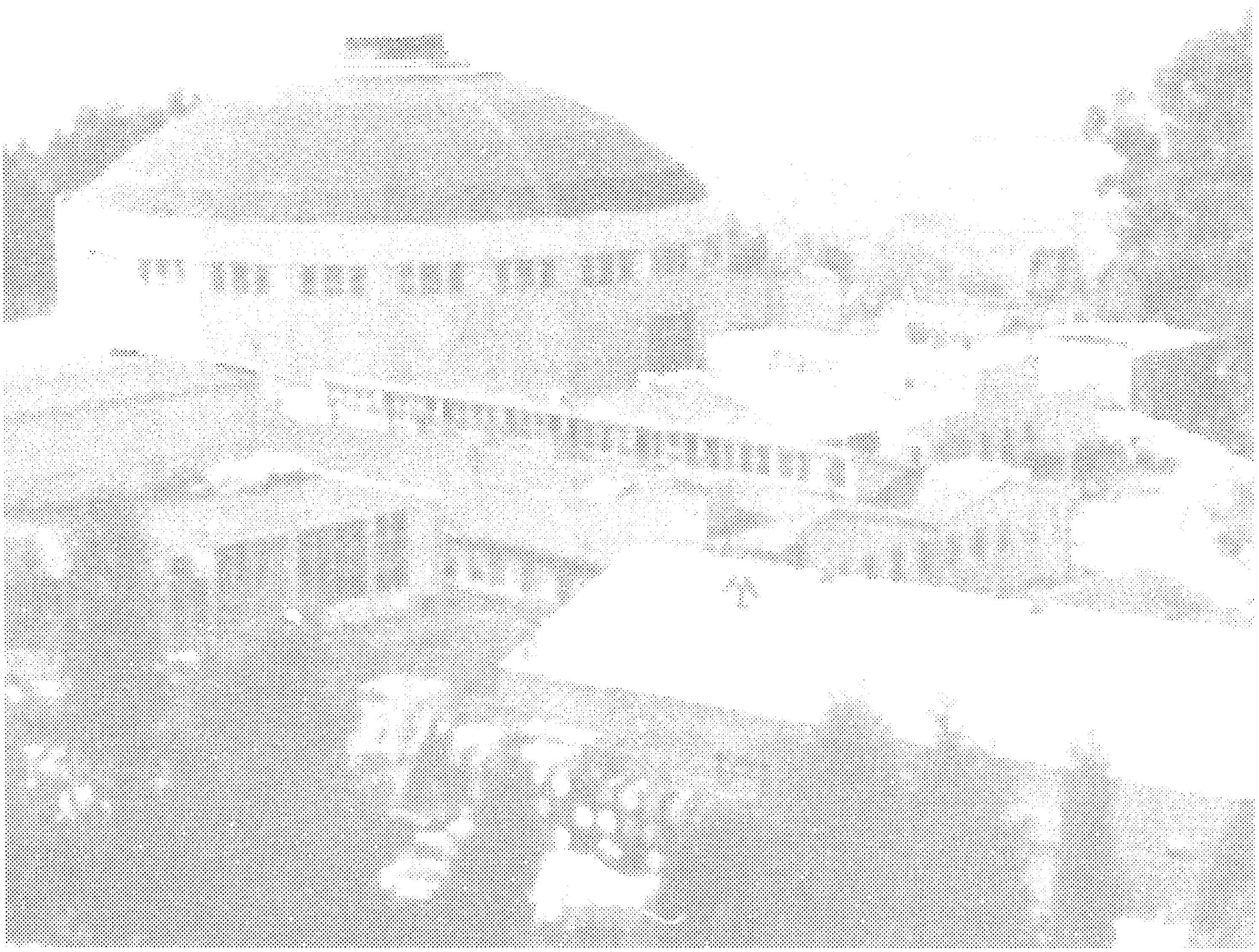
Glossary



Acronyms and Terms

A	Ampere
accuracy	The closeness of the result of a measurement to the true value of the quantity measured.
ADS	Activity Data Sheet
AEDE	Annual effective dose equivalent
AHERA	Asbestos Hazard Emergency Response Act
AIP	Agreement in Principle
ASPCP	Accidental Spill Prevention and Containment Plan
air particulates	Airborne particles. These may include dust, dirt, and pollutants that occur as particles, and any pollutants that may be associated with or carried on the dust or dirt.
ALARA	As Low as Reasonably Achievable
aliquot	A portion of a sample taken for analysis
alpha particle	A charged particle (identical to the helium nucleus) comprising two protons and two neutrons that are emitted during decay of certain radioactive atoms. Alpha particles are stopped by several centimeters of air or a sheet of paper.
ALS	Advanced Light Source (at LBL)
ambient air	The surrounding atmosphere, usually the outside air, as it exists around people, plants, and structures. It does not include the air adjacent to emission sources.
AML	Advanced Materials Laboratory (at LBL)
ANSI	American National Standards Institute
aquifer	A saturated layer of rock or soil below the ground surface that can supply usable quantities of groundwater to wells and springs. Aquifers can be a source of water for domestic, agricultural, and industrial uses.
arroyo	An intermittent or seasonal stream
ASG	Analytical Services Group (at LBL)

Glossary

ASPCP	Accidental Spill Prevention and Containment Plan
BAAQMD	Bay Area Air Quality Management District. Agency responsible for regulating stationary sources of regulated or hazardous air pollutants in the San Francisco Bay Area.
background radiation	Ionizing radiation from sources other than the laboratories. This background may include cosmic radiation; external radiation from naturally occurring radioactivity in the earth (terrestrial radiation), air, and water; internal radiation from naturally occurring radioactive elements in the human body; and radiation from medical diagnostic procedures.
BACT	Best Available Control Technology
BAD	Bay Area Drum, Inc.
becquerel (Bq)	Unit of radioactive decay equal to one disintegration per second (SI unit).
beta particle	A charged particle (identical to the electron) that is emitted during decay of certain radioactive atoms. Most beta particles are stopped by <0.6 cm of aluminum.
CAA	Clean Air Act (Federal)
Cal/EPA	California Environmental Protection Agency
CAM	California Assessment Manual
CARB	California Air Resources Board
categorical process	An industrial process governed by Federal regulations of wastewater discharges
CCAA	California Clean Air Act
CCF	100 cubic feet
CCR	California Code of Regulations
CDRL	Chemical Dynamics Research Laboratory (at LBL)
CEAC	(Berkeley) Community Environmental Advisory Committee
CED	Chemical Exchange Database (at LBL)

CEDE	collective effective dose equivalent
CEQ	Council on Environmental Quality (Federal)
CEQA	California Environmental Quality Act
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
Ci	Curie. Unit of radioactive decay equal to 2.22 x 10^{12} disintegrations per minute (conventional units).
cm	centimeter
CMWMA	California Medical Waste Management Act
COB	City of Berkeley
collective effective dose equivalent	Population dose. The sum of effective dose equivalents of all individuals in an exposed population within a certain radius; expressed in units of person-rem (or person-sievert).
contaminant	Any hazardous or radioactive material present in an environmental medium, such as water or vegetation.
controlled area	Any laboratory area to which access is controlled to protect individuals from exposure to radiation and radioactive materials.
cosmic radiation	High-energy particulate and electromagnetic radiation that originates outside the earth's atmosphere. Cosmic radiation is part of natural background radiation.
CWA	Clean Water Act
CX	Categorical Exemption
CXRO	Center for X-ray Optics (at LBL)
CY	calendar year
D&D	decommissioning and decontamination
DCA	dichloroethane
DCE	dichloroethylene

DCG	derived concentration guide
DHS	California Department of Health Services
discharge	A release into an area not controlled by LBL.
DOE	U.S. Department of Energy
DOELAP	DOE Laboratory Accreditation Program
dose	A term denoting the quantity of radiation energy absorbed.
dose, absorbed	The energy imparted to matter by ionizing radiation per unit mass of irradiated material. (The unit of absorbed dose is the rad.)
dose, effective	The hypothetical whole-body dose that would give the same risk of cancer mortality and/or serious genetic disorder as a given exposure and that may be limited to just a few organs. The effective dose equivalent is equal to the sum of individual organ doses, each weighted by degree of risk that the organ dose carries. For example, a 100-mrem dose to the lung, which has a weighting factor of 0.12, gives an effective dose that is equivalent to 12 mrem (100 x 0.12).
dose, equivalent	A term used in radiation protection that expresses all types of radiation (alpha, beta, and so on) on a common scale for calculating the effective absorbed dose. It is the product of the absorbed dose in rads and certain modifying factors. (The unit of dose equivalent is the rem.)
dose, maximum boundary	The greatest dose commitment, considering all potential routes of exposure from a facility's operation, to a hypothetical individual who is located at the facility boundary where the highest dose rate occurs. It assumes that the hypothetical individual is present 100% of the time (full occupancy) and it does not take into account shielding (for example, by buildings).
dose, maximum individual	The greatest dose commitment, considering all potential routes of exposure from a facility's operation, to a hypothetical individual who is in an uncontrolled area where the highest dose rate occurs. It assumes that the hypothetical individual is present 100% of the time (full occupancy), and it does not take into account shielding (for example, by buildings).
dose, population	The sum of the radiation doses to individuals of a population. It is expressed in units of person-rem. For

	example, if 1000 people each received a radiation dose of 1 rem, their population dose would be 1000 person-rem.
dosimeter	A portable detection device for measuring the total accumulated exposure to ionizing radiation. See also *thermoluminescent dosimeter.*
downgradient	In the direction of groundwater flow from a designated area of interest; analogous to downstream.
DQO	data quality objective
DTSC	Department of Toxic Substances Control (part of Cal/EPA). State agency that regulates hazardous waste management and remedial actions.
EA	Environmental Assessment
EBMUD	East Bay Municipal Utility District. The local municipal wastewater treatment facility, which accepts and regulates sanitary sewer discharges from LBL.
EDE	effective dose equivalent
effective dose	Abbreviated EDE; the summation of the products of the dose.
effluent	A liquid or gaseous waste discharged to the environment
EH&S	Environment, Health and Safety Division (at LBL)
EIR	Environmental Impact Report (State of California)
EIS	Environmental Impact Statement (US/EPA)
EM	DOE Office of Environmental Management
EMIH	Environmental Monitoring and Industrial Health
emission	A gaseous or liquid stream containing one or more contaminants.
EML	Environmental Measurements Laboratory
EMP	Environmental Monitoring Plan
EMS	Environmental Monitoring Station
EMU	Environmental Monitoring Unit (at LBL)

Glossary

environmental remediation	The process of restoring a contaminated area to a noncontaminated or safe condition.
EPCRA	Emergency Planning and Community Right to Know Act
EPG	Environmental Protection Group
equivalent specific weighting factor	Equivalent received by specified tissues of the body. This sum is a risk-equivalent value and can be used to estimate the health risk of the exposed individual. The tissue-specific weighting factor represents the fraction of the total health risk resulting from uniform whole-body irradiation that would be contributed by that particular tissue. The EDE includes the committed EDE from internal deposition of radionuclides and the EDE due to penetrating radiation from sources external to the body; it is expressed in units of rem (or sievert).
ER	DOE Office of Energy Research
ERDA	U.S. Energy Research and Development Agency
ERG	Environmental Restoration Group (at LBL)
ERWM	Environmental Restoration and Waste Management (at LBL)
ES&H	Environment, Safety and Health (term used by DOE)
ESA	Endangered Species Act
exposure	A measure of the ionization produced in air by x or gamma radiation. (The unit of exposure is the roentgen.)
external radiation	Radiation originating from a source outside the body.
extractable pollutants	Pollutants that can be removed from a contaminated sample by passing water through the sample.
FFCA	Federal Facilities Compliance Agreement
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FONSI	Finding of No Significant Impact
FS	feasibility study
FTU	fixed treatment unit
FY	fiscal year

GAC	granulated activated carbon
gamma radiation	Short-wavelength electromagnetic radiation of nuclear origin that has no mass or charge. Because of its short wavelength (high energy), gamma radiation can cause ionization. Other electromagnetic radiation (such as microwaves, visible light, and radio waves) have longer wavelengths (lower energy) and cannot cause ionization.
groundwater	A subsurface body of water in the zone of saturation (where soils or rocks have become saturated with water).
gsf	gross square feet
gsm	gross square meters
half-life, radioactive	The time required for the activity of a radioactive substance to decrease to half its value by inherent radioactive decay. After two half-lives, one-fourth of the original activity remains (1/2 x 1/2); after three half-lives, one-eighth remains (1/2 x 1/2 x 1/2); and so on.
HAP	hazardous air pollutant
hazardous waste	Waste exhibiting any of the following characteristics: ignitability, corrosivity, reactivity, or EP-toxicity (yielding toxic constituents in a leaching test). Because of its concentration, quantity, physical, or chemical characteristics, it may: (1) cause or significantly contribute to an increase in mortality rates or cases of serious irreversible illness; or (2) pose a substantial present or potential threat to human health or the environment when improperly treated, stored, transported, disposed of, or handled.
HEPA	high-efficiency particulate air (filter)
HILAC	High-Energy Linear Accelerator (at LBL)
HMBS	hazardous materials bulk storage
HSAA	Hazardous Substances Account Act
HT or T_2	tritium gas
HTO or T_2O	tritiated water
HWCL	Hazardous Waste Control Law (State of California)
HWHF	Hazardous Waste Handling Facility (at LBL)

Glossary

ICRP	International Commission on Radiological Protection
ILSE	Induction LINAC Systems Experiment
internal radiation	Radiation from a source within the body as a result of deposition of radionuclides in body tissues by processes such as ingestion, inhalation, or implantation. Potassium (^{40}K), a naturally occurring radionuclide, is a major source of internal radiation in living organisms.
IRFEL	infrared free-electron laser
l	liter
LBCF	Low-Background Counting Facility (at LBL)
LBL	Lawrence Berkeley Laboratory
LHS	Lawrence Hall of Science
LINAC	linear accelerator
LLW	low-level (radioactive) waste
lysimeter	A device for sampling soil moisture in the unsaturated zone. See *vadose zone.*
m	meter
MCL	maximum contaminant level (drinking water)
MDA	minimum detectable activity
MEI	maximally-exposed individual
MeV	million electron volt
MFE	magnetic fusion energy
Mgsf	million gross square feet
mrem	millirem (10^{-3} rem). See rem.
MS	monitoring station
MSDS	material safety data sheet
MSRI	UC Mathematical Sciences Research Institute

MW	monitoring well
NAAQS	National Ambient Air Quality Standards
NAE	North American Environmental, Inc.
NBTF	National Biomedical Tracer Facility
NCEM	National Center for Electron Microscopy (at LBL)
NCRP	National Commission on Radiation Protection and Measurements
NEPA	National Environmental Policy Act
NESHAPs	National Emission Standard for Hazardous Airborne Pollutants (other than Radon from DOE facilities)
NHPA	National Historic Preservation Act
NIST	National Institute of Standards and Technology
NOD	Notice of Deficiency
NOI	Notice of Intent
nonattainment area	An area that does not meet the National Ambient Air Quality Standards.
NOV	Notice of Violation (issued by BAAQMD)
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NRC	Nuclear Regulatory Commission
nsf	net square feet
nsm	net square meters
NTLF	National Tritium Labeling Facility
nuclide	A species of atom characterized by what constitutes the nucleus, which 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 able to exist for a measurable length of time.

OAA	Office of Assessment and Assurance (at LBL)
OAK	DOE's Oakland Operations Office
OAP	Operating and Assurance Program (at LBL)
ODS	ozone-depleting substance
OMB	Office of Management and Budget (Federal government)
OR	Occurrence Report
organic compound	A chemical whose primary constituents are carbon and hydrogen.
organochloride	An organic compound in which one or more of the hydrogen atoms have been replaced with a chlorine atom.
PA/SI	preliminary assessment/site inspection
Part B permit	The second, narrative section submitted by generators in the RCRA permitting process. It details the procedures followed at a facility to protect human health and the environment.
PBL	Percent of Basin Plan limit
PBR	Permit-by-Rule
PCB	polychlorinated biphenyl
PCE	perchloroethylene
pCi	picocurie
person-rem	The unit of population dose, which expresses the sum of radiation exposures received by a population. For example, two persons, each with a 0.5-rem exposure, receive 1 person-rem, and 500 people, each with an exposure of 0.002 rem, also receive 1 person-rem.
pH	A measure of hydrogen ion concentration in an aqueous solution. Acidic solutions have a pH less than 7, basic solutions have a pH greater than 7, and neutral solutions have a pH of 7.
piezometer	Generally, a small-diameter, nonpumping well used to measure the elevation of the water table or potentiometric surface (an imaginary surface that represents the static

	head of groundwater and is defined by the level to which water will rise).
pollutant	Any hazardous or radioactive material present in an environmental medium, such as water or vegetation.
POTW	Public Owned Treatment Works
PPA	Pollution Prevention Act
pretreatment	Any process used to reduce a pollutant load before wastewater enters the sewer system. National wastewater pretreatment regulations (40 CFR 403) adopted by EPA in compliance with the 1977 amendments to the Clean Water Act, which required that EPA establish pretreatment standards for existing and new industrial sources.
priority pollutants	A set of organic and inorganic chemicals identified by EPA as indicators of environmental contamination.
PRP	potentially responsible party and Parameter Review Plan
PWA	Process Waste Assessment
QA	quality assurance
QAM	quality assurance manager
QAPP	Quality Assurance Project Plan
QC	quality control
purgeable pollutants	Pollutants that can be removed from a sample by passing nitrogen gas through the sample.
rad	A unit of absorbed dose from ionizing radiation (0.877 rad/roentgen).
radiation	Energy emitted from the nucleus of an atom in the form of waves or particles.
radiation protection	Limits on radiation exposure regarded as necessary for protection standard of public health. These standards are derived based on acceptable levels of risk to individuals.
radioactivity	The property or characteristic of a nucleus of an atom to spontaneously disintegrate accompanied by the emission of energy in the form of radiation.

radiological	Arising from radiation or radioactive materials.
radionuclide	An unstable nuclide. See *nuclide* and *radioactivity.*
RAP	regulated air pollutants
RCRA	Resource Conservation and Recovery Act (Federal)
recharge zone	An area of the ground in which surface water migrates to the groundwater.
rem	A term that stands for roentgen equivalent man; a unit of ionizing radiation, equal to the amount of radiation needed to produce the same biological effect to humans as 1 rad of high-voltage x-rays. It is the product of the absorbed dose (rad), quality factor (Q), distribution factor, and other necessary modifying factors. It describes the effectiveness of various types of radiation in producing biological effects.
remediation	See *environmental remediation.*
RFA	RCRA Facility Assessment
RFI	RCRA Facility Inspection
RI	remedial investigation
RMPP	Risk Management and Prevention Program
RMW	radioactive mixed waste
roentgen (R)	A unit of radiation exposure that expresses exposure in terms of the amount of ionization produced by x or gamma rays in a volume of air. One roentgen (R) is 2.58 x 10^{-4} coulombs per kilogram of air.
ROV	Report of Violation (issued by Cal/EPA)
RPG	radiation protection guidelines
RTSS	Real Time Systems Section
RWP	Radiological Work Permit
RWQCB	Regional Water Quality Control Board
S&H	safety and health
SARA	Superfund Amendments and Reauthorization Act

scintillation cocktail	A solution of organic compounds that emits light upon interacting with radiation. For the purposes of this report, it is used primarily for the analysis of tritium.
SDWA	Safe Drinking Water Act
SEIR	Supplemental Environmental Impact Report
SI	Systéme Internationale, the internationally accepted system of scientific measurement and units
SIC	Standard Industrial Classification
sievert (Sv)	A unit of radiation dose equivalent. The Sv is the SI unit equivalent to the rem. It is the product of the absorbed dose (gray), quality factor (Q), distribution factor, and other necessary modifying factors. It describes the effectiveness of various types of radiation to produce biological effects; 1 Sv = Gy x Q x N = 100 rem.
SIP	Site Implementation Plan
SNAP	Significant New Alternatives Policy (US/EPA)
SODAR	sonic detection and ranging
source	Any operation or equipment that produces and/or emits pollutants (*e.g.*, pipe, ditch, well, or stack).
SPCC	Spill Prevention, Control, and Countermeasures Plan
SWMP	Storm Water Monitoring Program
SWPPP	Storm Water Pollution Prevention Plan
SWRCB	State Water Resources Control Board. Agency responsible for promulgating the California General Permit for Storm Water Discharge associated with industrial activities.
TCA	trichloroethane
TCE	trichloroethylene
TEDA	tetraethylene diamine
terrestrial	Pertaining to or deriving from the earth.

terrestrial radiation	Radiation emitted by naturally occurring radionuclides, such as ^{40}K; the natural decay chains ^{235}U, ^{233}U, or ^{232}Th; or cosmic-ray-induced radionuclides in the soil.
thermoluminescent dosimeter (TLD)	A type of dosimeter. After being exposed to radiation, the material in the dosimeter (lithium fluoride) luminesces upon being heated. The amount of light the material emits is proportional to the amount of radiation (dose) to which it was exposed. See also *dosimeter*.
TICH	total identifiable chlorinated hydrocarbons
TOC	total organic carbon
TPH-D	total petroleum hydrocarbons, diesel-range
TPH-G	total petroleum hydrocarbons, gasoline-range
TRC	technical review criteria
TRI	Toxic Release Inventory
tritium	A radionuclide of hydrogen with a half-life of 12.3 years. The very low energy of its radioactivity decay makes it one of the least hazardous radionuclides.
TSCA	Toxic Substances Control Act
TSS	total suspended solids
TTFR	Tiger Team Follow-up Review
TTO	total toxic organics
UC	University of California
UCB	University of California at Berkeley
UCOP	University of California Office of the President
uncontrolled area	An area beyond the boundaries of a controlled area; see *controlled area*.
upgradient	Opposite of the direction of groundwater flow from a designated area of interest; analogous to upstream.
uranium	A metallic element that is highly toxic and radioactive.

uranium, depleted	Uranium consisting primarily of ^{238}U and having less than 0.72 wt% ^{235}U. Except in rare cases occurring in nature, depleted uranium is man-made.
uranium, total	The amount of uranium in a sample, assuming that the uranium has the isotopic content of uranium in nature (99.27 wt% ^{238}U, 0.72 wt% ^{235}U, and 0.0057 wt% ^{234}U).
US/EPA	U.S. Environmental Protection Agency
UST	underground storage tank
vadose zone	The partially saturated or unsaturated region of the ground above the water table that does not yield water to wells.
VOC	volatile organic compound
WMPPAP	Waste Minimization And Pollution Prevention Awareness Plan
VSI	visual site inspection
wind rose	A diagram that shows the frequency and intensity of wind from different directions at a particular place.
WQA	Federal Water Quality Act of 1987
Zone 7	The common name for the Alameda County Flood Control and Water Conservation District. Zone 7 is the water management agency for the Livermore-Amador Valley with responsibility for water treatment and distribution. Zone 7 is also responsible for management of agricultural and surface water and the groundwater basin.

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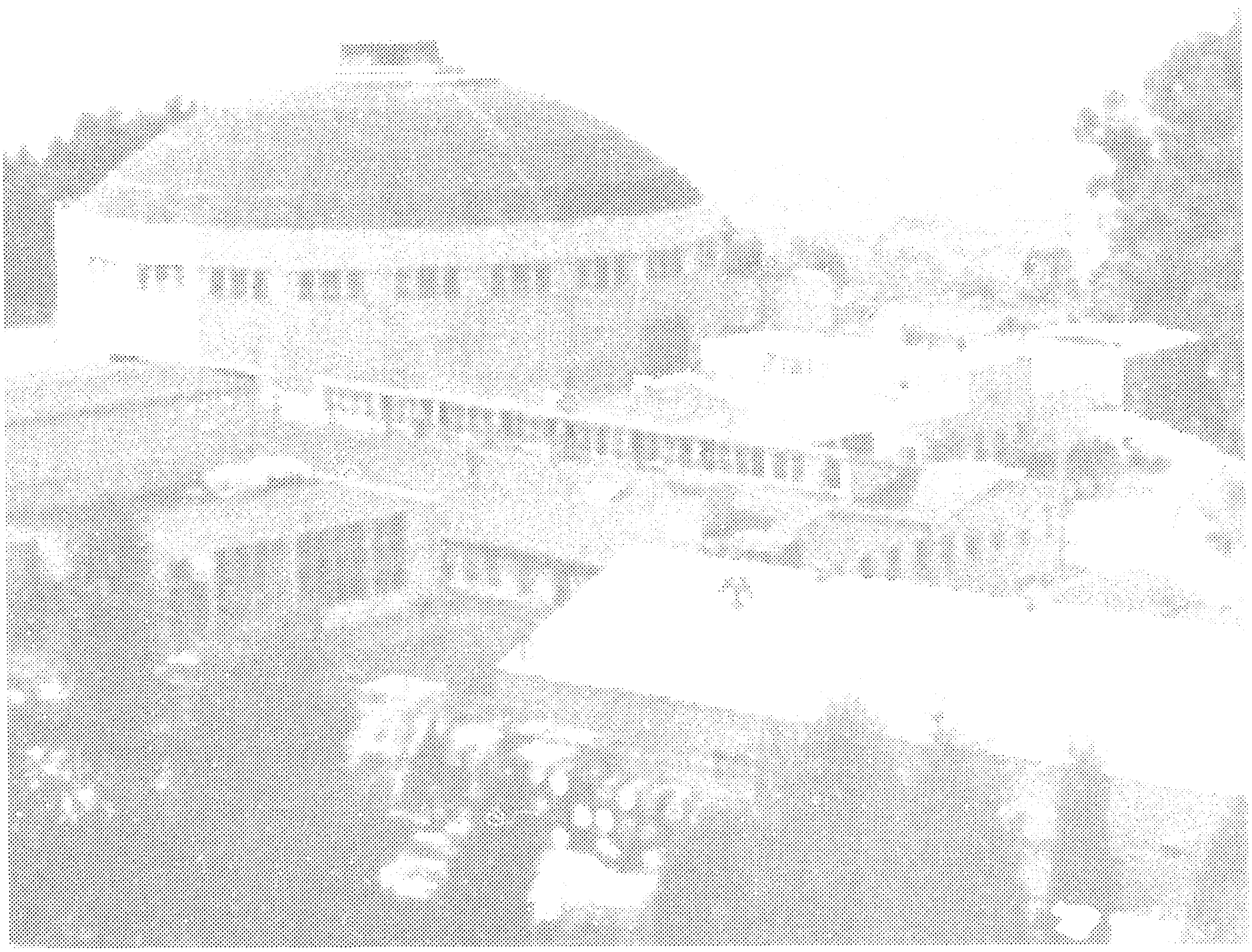
Appendix A - NESHAPs



U.S. Department of Energy
Radionuclide Air Emission Annual Report
(Subpart H of 40 CFR 61)
Calendar Year 1993

Site Name:	**Lawrence Berkeley Laboratory (LBL)**		

<u>Operation Office Information</u>

Office:	Oakland Operations Office		
Address:	1301 Clay St. Room 700 N Oakland, CA 94612		
Contact:	Steven Lasell	Phone:	(510) 637-1602

<u>Site Information</u>

Operator:	Lawrence Berkeley Laboratory		
Address:	1 Cyclotron Road Berkeley, CA 94720		
Contractor Contact:	Patrick Thorson	Phone:	(510) 486-5852
DOE Site Contact:	Carl Schwab, 50B-3238	Phone:	(510) 486-4298

Section I. Facility Information

Site Description:

Laboratory Operations

The Lawrence Berkeley Laboratory (LBL) is a multiprogram national laboratory managed by the University of California (UC) for the U.S. Department of Energy (DOE). LBL's major role is to conduct basic and applied researches in biology, physics, chemistry, materials, and energy. LBL, birthplace of the cyclotron, was founded by the late Nobel Laureate Ernest Orlando Lawrence in 1931.

LBL also supports nationwide university-based research by providing national facilities, including:

- The National Center for Electron Microscopy (Building 72).
- The National Tritium Labeling Facility (Building 75).

Other LBL facilities that are relevant to the radioactive air emission program governed by Subpart H of the National Emission Standard for Hazardous Airborne Pollutants (NESHAPs) include:

- The 88-inch Cyclotron (Building 88).
- The Advanced Light Source (Building 6).
- A number of radiochemical and radiobiological laboratories located in Buildings 1, 2, 3, 26, 55, 62, 70, 70A, 74, 74B, 83, 88, and 934.
- A Hazardous Waste Handling Facility Located in Buildings 75 and 75A.
- The Bevatron (Building 51)[1]

Figure 1 illustrates the LBL general site configuration and locations of potential NESHAPs source terms. Table 1 identifies the buildings illustrated in Figure 1. Figure 2 identifies other LBL off-site locations (Buildings 1, 3, and 934) that potentially involve radioactive air emissions.

Radiochemical and radiobiological studies performed in many on-site/off-site laboratories at LBL typically use millicurie quantities of a great variety of radionuclides. (One millicurie is equal to 3.7×10^7 Becquerel (Bq).)

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[1]The Bevatron ceased operations in February 1993

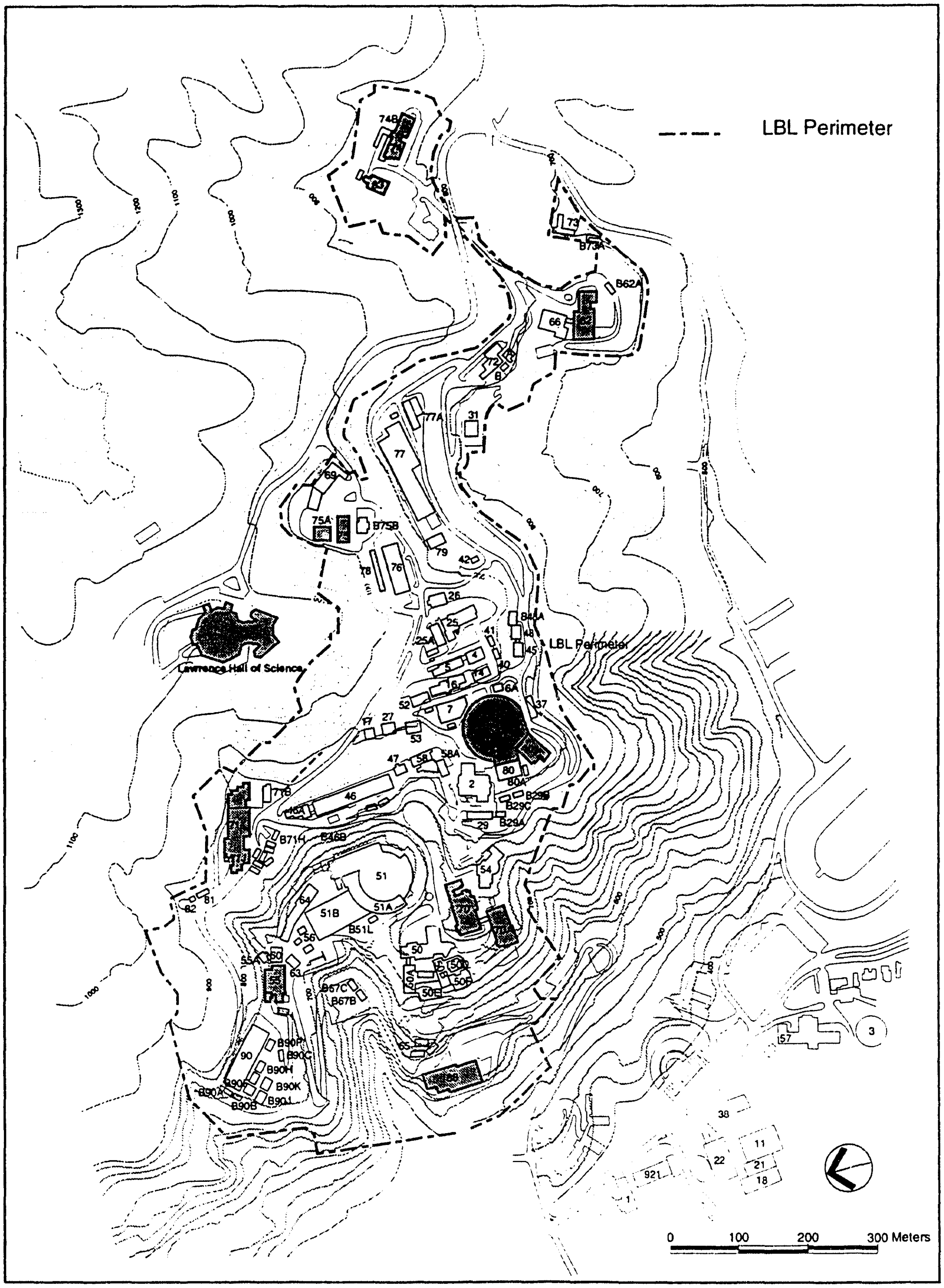


Figure 1. LBL On-Site Buildings

HILL-SITE BUILDINGS

2	Advanced Materials Laboratory (AML) & Center for X-ray Optics (CXRO)
4	Magnetic Fusion Energy (MFE)
5	Magnetic Fusion Energy (MFE)
6	Advanced Light Source (ALS)
7	Central Stores & Electronics Shops
10	Cell & Molecular Biology Research & Photography
14	Accelerator & Fusion Research & Earth Sciences
16	Magnetic Fusion Energy Laboratory
17	EH&S/Applied Sciences Lab
25	Mechanical Technology
25A	Electronics Shops
26	Medical Services
27	High Voltage Test Facility & Cable Shop
29	Electronics Engineering, Research Medicine/Radiation, Biophysics Offices
31	Chicken Creek Maintenance Bldg.
36	Grizzly Substation Switchgear Bldg.
37	Utilities Service
40	Electronics Development Lab
41	Magnetic Measurements Lab
42	Salvage
43	Compressor Bldg.
44	Indoor Air Pollution Studies
45	Fire Apparatus
46	RTSS, ALS, Accelerator Development
46A	Real Time Systems Section (RTSS)
47	Advanced Accelerator Study
48	Fire Station
50	Physics, Accelerator & Fusion Research & Nuclear Science
50A	Director's Office, Environment & Laboratory Development, Administration Division, Patents
50B	Physics, Computer Center, IRD & ICSD
50C	PID, Physics
50D	MCSD & Nuclear Science
50E	Earth Sciences
50F	Computing Services, IRD
51	Bevalac/Bevatron
51A	Bevatron Experimental Area
51B	External Particle Beam (EPB) Hall
52	Magnetic Fusion Energy Laboratory
53	SuperHILAC Development
54	Cafeteria
55	Research Medicine/Radiation Biophysics
55A	Nuclear Magnetic Resonance (NMR)
56	Cryogenic Facility
58	Accelerator Research & Development
58A	Accelerator Research & Development Addition
60	High Bay Laboratory
61	Standby Propane Plant
62	Materials & Chemical Sciences
63	Accelerator & Fusion Research
64	Accelerator & Fusion Research
65	Data Processing Services
66	Surface Science & Catalysis Lab
68	Upper Pump House
69	Business Services, Materiel Management, Mail Room & Purchasing
70	Nuclear Science, Applied Science & Earth Sciences
70A	Nuclear Science, Materials & Chemical Sciences & Earth Sciences
71	Heavy Ion Linear Accelerator (HILAC)
71A	HILAC Rectifier
71B	HILAC Annex
72	National Center for Electron Microscopy (NCEM)
72A	High Voltage Electron Microscope (HVEM)
72B	Atomic Resolution Microscope (ARM)
72C	ARM Support Laboratory
73	Atmospheric Aerosol Research
74	Research Medicine/Radiation Biophysics, Cell & Molecular Biology Laboratory
74B	Research Medicine/Radiation Biophysics, Cell & Molecular Biology Laboratory Annex
75	Radioisotope Service & National Tritium Facility (NTLF)
75A	Compactor, Processing & Storage Facility
76	Construction & Maintenance & Craft Shops
77	Mechanical Shops
77A	Ultra High Vacuum Assembly Facility (UHV)
78	Craft Stores
79	Metal Stores
80	Electronics Engineering
80A	Office Building
81	Liquid Gas Storage
82	Lower Pump House
83	Lab Cell Biology
88	88-Inch Cyclotron
90	Applied Science, Employment, Engineering, Occupational Health, Personnel, Protective Services

SMALL BUILDINGS AND TRAILERS

B-13A	Environmental Monitoring West of 88
B-13B	Environmental Monitoring West of 90
B-13C	Environmental Monitoring South of UC Recreation Area
B-13D	Environmental Monitoring North of 71
B-13E	Sewer Monitoring Station, Hearst Avenue
B-13F	Sewer Monitoring Station, Strawberry Canyon
B-13G	Waste Monitoring Station, West of 70

Table 1. Key to LBL Buildings Shown in Figure 1

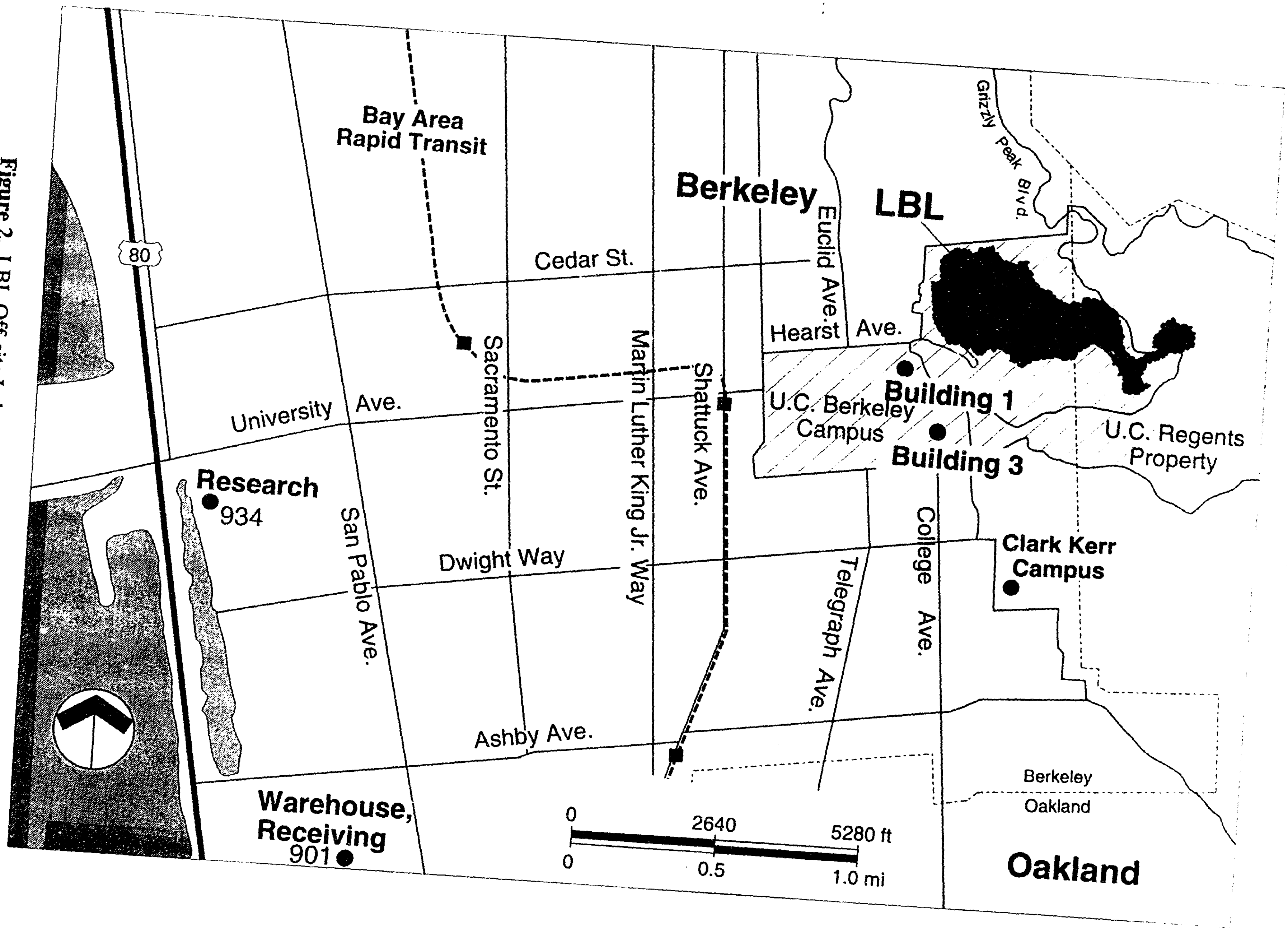


Figure 2. LBL Off-site Laboratories & Vicinity Map

The Site

LBL is situated upon a hillside above the main campus of UC. The 54-hectare (134-acre) site is located on the west-facing slope of the Berkeley Hills, at elevations ranging from 150 to 300 meters (500 to 1,000 feet) above sea level within the Cities of Berkeley and Oakland. It is located about five kilometers (three miles) east of San Francisco Bay and about 25 kilometers (fifteen miles) east of the City of San Francisco (Figure 3).

LBL is located in an urban environment on land owned by UC. On all sides of the Laboratory is a buffer zone of UC land. In addition, the Laboratory maintains a landscape buffer zone between its facilities and the site boundary. Beyond the northern side of the buffer zone there are predominantly single-family homes and beyond the west side are multiunit dwellings, student residence halls, and commercial districts. The area to the east and south, which is part of the University lands, is maintained in a largely natural state and includes recreational facilities and the University Botanical Garden. The population within an 80-km (50-mi) radius of the Laboratory is approximately 5.1 million (1980 census).

The Laboratory's activities are conducted on and off the main LBL site and off site. LBL activities take place in structures totaling 180,000 gross square meters (gsm), or 1.97M gross square feet (gsf). The buildings are on the LBL hillside site, plus additional facilities located on the University campus, notably the Donner Laboratory of Biology and Medicine (Building 1) and the Melvin Calvin Laboratory (Building 3). The on-site space consists of 125,000 gsm in about 60 buildings: 121,000 gsm in DOE buildings and trailers, and 4,000 gsm in University-owned buildings. Off-site space utilized by LBL consists of 25,000 gsm in various University buildings on the UC at Berkeley (UCB) campus and 14,000 gsm in leased facilities in Emeryville and Berkeley.

In 1993 the Laboratory's total population was approximately 4,200, including about 600 visiting scientists and engineers. Of this total, about 3,500 are located at the main site, 500 are located in UC Berkeley campus buildings, and about 100 are in off-site leased buildings.

The Climate

The climate of the LBL site is greatly influenced by its close proximity to the Pacific Ocean and its exposure to the maritime air that flows in from San Francisco Bay. Seasonal temperature variations are small, with a mean temperature difference between the summer 17°C (63°F) and winter 9°C (48°F) of only 8.5°C (15°F). Relative humidity ranges from 85%-90% in the early morning to 65%-75% in the afternoon. The average annual rainfall is 64 cm (25 inches). About 95% of the rainfall occurs from October through April, and intensities are seldom greater than 1.3 cm/hr (0.5 in/hr). Thunderstorms, hail and snow are extremely rare. Winds are usually light, but summer sea breezes range up to 9-13m/s (20-30 mph). Winter storm winds from the south or southwest have somewhat lesser velocities.

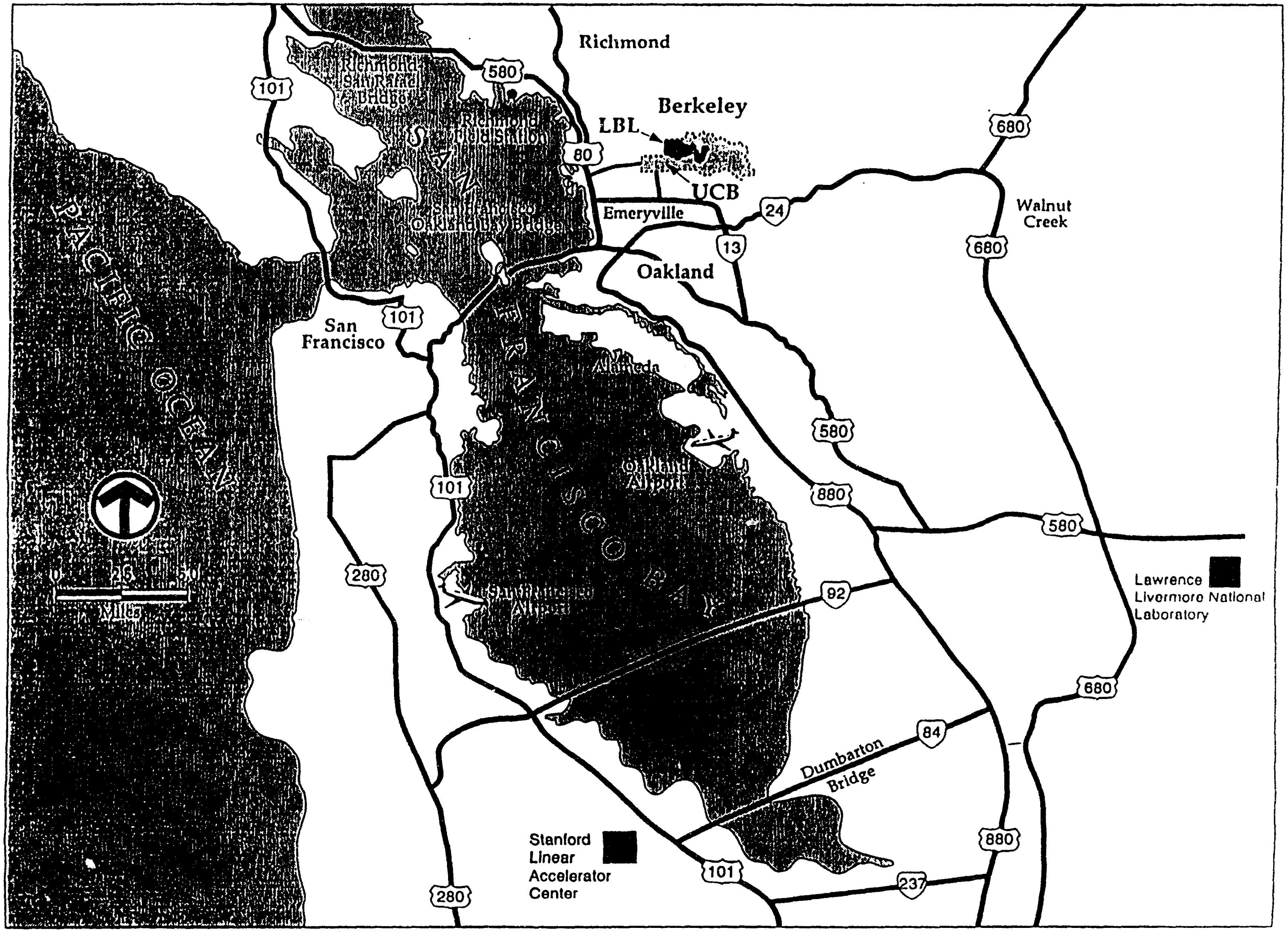


Figure 3. San Francisco Bay Area Map

Compliance Status of Lawrence Berkeley Laboratory :

On April 23, 1991, LBL received a Finding of Violation (FOV) from Region IX of the United States Environmental Protection Agency (EPA). The FOV was for the failure to evaluate *all* radionuclide release points and determine the monitoring requirements at LBL in accordance with Section 61.93 of the National Emission Standard for Hazardous Air Pollutants: Radionuclides (NESHAP). Even though LBL is fully in compliance with the exposure standard of 10 mrem to a maximally exposed offsite individual (MEI), the laboratory is not in compliance with the monitoring requirements of the regulation. During CY91 LBL identified all actual and potential sources of dispersible radionuclides, evaluated all release point discharges, and proposed monitoring strategies for each stack or vent (see Table 3) During CY92 LBL obtained funding and initiated 3 monitoring upgrade projects, completed preliminary designs for the proposed monitoring systems, and prepared bid documents for Project 1 (Project 1 included stacks subject to periodic confirmatory monitoring). Proposals were received and vendors hired for the remaining projects 2 and 3 by November 1993. A Federal Facilities Compliance Agreement (FFCA) with Region IX EPA was finalized and executed in August 1993. As stated in this FFCA (and mutually agreed upon by EPA and DOE), LBL is committed to be in full compliance with NESHAPs monitoring requirements by February 1995. To date, LBL has met all milestones that are listed in the FFCA compliance schedule.

Source Description:

LBL employs a wide variety of radionuclides in its radiochemical and biomedical research programs. In addition, radioactive materials are inevitably produced by the operations of the charged particle accelerators such as the 88-Inch Cyclotron and the Bevatron. Table 2 characterizes most of the dominant radionuclides used/monitored at LBL during CY93.

Table 2. Radionuclides Used/Monitored at LBL During CY93

Nuclide Name (Atomic Number)	Radio - Nuclide Symbol	Principal Radiation Types[a]	Principal Energy (MeV)	Half-Life
Americium (95)	Am-241	α γ	5.4 0.059	432 years
Argon (18)	Ar-41	β γ	1.2 1.3	1.83 hours
Carbon (6)	C-11	β^+/γ	0.511	20.5 minutes
Carbon (6)	C-14	β	0.156	5730 years
Curium (96)	Cm-248	α	5.08	3.39E+5 years

Table 2. Radionuclides Used/Monitored at LBL During CY93 (Cont.)

Cobalt (27)	Co-60	β γ	0.318 1.33	5.27 years
Fluorine (9)	F-18	β^+/γ	0.511	109.7 minutes
Hydrogen /Tritium (1)	H-3	β	0.0186	12.28 years
Iodine (53)	I-125	γ	0.027	60.14 days
Nitrogen (7)	N-13	β^+/γ	0.511	9.97 minutes
Nickel (28)	Ni-63	β	0.066	100.1 years
Oxygen (8)	O-15	β^+/γ	0.511	122 seconds
Phosphorus (15)	P-32	β	1.71	14.3 days
Rubidium (37)	Rb-86	β γ	1.77 1.08	18.66 days
Sulfur (16)	S-35	β	0.167	87.44 days
Strontium (38)	Sr-90	β	0.546	28.6 years
Thorium (90)	Th-232	α β	4.01 0.04	1.4E+10 years
Uranium (92)	U-238	α β	4.2 0.029	4.47E+9 years
Zinc (30)	Zn-65	γ	1.12	244 days
Zirconium (40)	Zr-95	β γ	0.4 0.757	64 days

(*) α = Alpha Particles β =Beta Particles γ =Gamma Rays

Of the foregoing, the most commonly and widely used radionuclides in the research program are: H-3, C-14, F-18, P-32, S-35, and I-125. Radioactive gases produced by the accelerator operations are mainly short-lived radionuclides such as C-11, N-13, O-15, and Ar-41. These induced radioactive gases are normally produced in areas where the beam strikes beam line components.

LBL carries on operations which have the potential to emit radionuclides into the atmosphere in 18 laboratory buildings. Based on past/historical emission experience, LBL has identified 4 release points that are potentially subject to the continuous monitoring requirement of Section 61.93 of NESHAPs standard. However, only 1 of these release points (the National Tritium Labeling Facility (NTLF) stack in Building 75) was continuously monitored during CY93. Except for the Building 75 Tritium Stack, all other LBL's sources which were operational during CY93 are "small sources;" i.e., the Effective Dose Equivalent (EDE) from each source is much less than 0.1 mrem/yr (1.0E-3 mSv/yr), the NESHAPs threshold limit for continuous monitoring.

At present, discharge points with the most significant potential for routine or accidental release are continuously/periodically sampled. The exception to the foregoing are the air activation product discharges from accelerators, which currently are not monitored. The CY93 discharges from LBL accelerators were estimated using a model developed in Patterson, H.W., and Thomas, R.H., *Accelerator Health Physics*, Academic Press, New York, NY, 1973, pp. 519-531. Very small sources, that is, sources with potential for routine annual offsite EDE impacts of less than 1.0E-2 mrem (1.0E-4 mSv) are, in general, <u>not</u> sampled continuously. As a part of the FFCA, LBL formalized the foregoing process and proposed a graded strategy for performing the "periodic confirmatory monitoring" called for in Section 61.93 (b)(4)(i) of the Title 40 of Code of Federal Regulations (40CFR61). Monitoring requirements are based on dose modeling with no emission controls in place. Table 3 summarizes the NESHAPs compliance strategy for monitoring requirements at LBL.

Table 3. Summary of NESHAPs Compliance Strategy

EDE Criteria [mrem/year]	**Category**	**Descriptions**	**Number of Sources (1993)**
EDE $\geq$ 10.0	Non-compliant	Reduce or relocate source term and re-evaluate prior to authorization.	0
10.0 > EDE $\geq 1.0 \times 10^{-1}$	I	• <u>Continuous</u> sampling required • Telemetry for nuclides with half-lives < 100 hours • EPA Application to Construct or Modify required.	4
1.0×10^{-1} > EDE $\geq 5.0 \times 10^{-2}$	II	Continuous sampling with <u>weekly</u> analysis.	0
5×10^{-2} > EDE $\geq 1.0 \times 10^{-2}$	III	Continuous sampling with <u>monthly</u> analysis.	1
1.0×10^{-2} > EDE $\geq 1.0 \times 10^{-3}$	IV	Sampled <u>annually</u> during project activity.	6
EDE < 1.0×10^{-3}	V	Inventory controlled by Radiation Work Permit and periodic evaluation. <u>No monitoring</u> required	57

Research activities with low potential impact (EDE < 0.01 mrem (< 10^{-4} mSv) in a year) are carried out in unfiltered fume hoods. Activities with higher potential impact are performed in systems with appropriate exhaust filters or absorbers in place.

Many of LBL release points qualify as "grouped sources" as described in the DOE guidance for the preparation of this document. The following criteria were used:

- The sum of the EDEs attributable to all stacks in the group must be < 0.1 mrem (< 10^{-3} mSv).
- Sources must be in close proximity (same or nearby building), and/or similar operations with similar nuclides are carried out in the facilities.
- Sources grouped in the description section may not be grouped in the dose assessment section if the critical receptors are not the same.

As identified in Figure 2, Buildings 1, 3, and 934 are located off-site (outside of LBL's perimeter) and should technically be labeled as three separate "facilities" since they are not on one "contiguous site". However, Building 1 and Building 3 are located on UC land and are within walking distances from the main LBL site. Building 934 is about five kilometers from the main site. Annual radioactive air emissions from these off-site buildings are very small compared to other on-site emission sources. In fact, the EDE of each local MEI due to local airbone releases associated with these off-site buildings is several orders of magnitude lower than the contribution due to the tritium release from the main LBL site. Thus, it would be inappropriate/misleading to model and report these much lower EDEs separately. Therefore, for reporting and dose modeling purposes, all of these off-site buildings will be considered as being on one contiguous LBL site.

For each release point, the EPA-approved atmospheric dispersion dose calculation computer code, CAP88-PC, was used to estimate the Effective Dose Equivalent (EDE) to an off-site maximally exposed individual (MEI). A total of fifteen (15) CAP88-PC computer model assessments were separately performed to simulate six (6) point sources, eight (8) grouped sources, and one (1) non-point (diffuse) source for dose assessment during CY93. These release points are discussed below:

1). Building 1 (Donner Laboratory): Cell and molecular biology studies are performed in this facility. The building is located on the University of California campus. The predominant nuclides used are H-3, C-14, P-32, S-35, and I-125 as labeled amino acids and DNA precursors. Many non-LBL employees also share this building for various other researches. Work is mostly done on bench tops and in hoods. Releases are from building vents and hoods (11 stacks). Five Stacks in Building 1 are sampled periodically. A summary of the CAP88-PC source term input parameters and EDE results for this release point is presented in Table 4.

Table 4. Building 1 Release Point Characteristics

Release Height (meter)	Local MEI Distance (meter)	Local MEI Dir.	Local MEI Description	Radio Nuclide	Annual Release (Ci*/yr)	CAP88 MEI EDE (mrem** /yr)	%Total EDE
9	10	ESE	School	U-238	5.10E-08	6.79E-05	70.45%
				P-32	1.00E-06	1.74E-07	0.18%
				I-125	2.70E-06	2.83E-05	29.36%
					TOTAL:	**9.64E-05**	**100.00%**

(*) 1 Ci = 3.7E10 Becquerel (**) 1 mrem = 1.0E-2 mSv

2). **Building 2 (Advanced Material Laboratory & Center for X-ray Optics):** One semiconductor research group uses germanium which contains nanocurie (nCi) quantities (a nanocurie is 37 Bq) of activation impurities. A summary of the CAP88-PC source term input parameters and EDE results for this release point is presented in Table 5.

Table 5. Building 2 Release Point Characteristics

Release Height (meter)	Local MEI Distance (meter)	Local MEI Dir.	Local MEI Description	Radio Nuclide	Annual Release (Ci*/yr)	CAP88 MEI EDE (mrem** /yr)	%Total EDE
20	370	NE	School	Co-60	3.40E-14	7.78E-13	100.00%
(*) 1 Ci = 3.7E10 Becquerel			(**) 1 mrem = 1.0E-2 mSv		TOTAL:	**7.78E-13**	**100.00%**

3). **Building 3 (Calvin Laboratory):** Cell and molecular biology studies are performed in this laboratory. As similar to the Building 1, this buildings is also located on the University of California campus. The predominant nuclides used are H-3, P-32, S-35, and ^{14}C as labeled amino acids and DNA precursors. $^{14}CO_2$ is also used in this laboratory as an "incubant." Building 3 is wholly occupied by LBL personnel. Work is done on bench tops and in hoods. Releases are from building vents and hoods (5 stacks). Four (4) stacks in Building 3 are sampled periodically. A summary of the CAP88-PC source term input parameters and EDE results for this release point is presented in Table 6.

Table 6. Building 3 Release Point Characteristics

Release Height (meter)	Local MEI Distance (meter)	Local MEI Dir.	Local MEI Description	Radio Nuclide	Annual Release (Ci*/yr)	CAP88 MEI EDE (mrem** /yr)	%Total EDE
15	60	S	Res. & Business	P-32	7.60E-06	4.84E-07	100.00%
(*) 1 Ci = 3.7E10 Becquerel			(**) 1 mrem = 1.0E-2 mSv		TOTAL:	**4.84E-07**	**100.00%**

4). **Building 6 (Advanced light Source):** The Advanced Light Source (ALS) began operating line in August 1993. The Advanced Light Source is an electron accelerator/storage ring which was designed to produce intense beams of soft X-rays. The ALS injector produces stray neutrons during its operation which activate the air in the injector vault. As the ALS is a low power accelerator (compared to LBL's other accelerators), its inventory of air activation products is substantially lower than the Bevatron or the 88-inch Cyclotron. The maximum potential annual releases of N-13 and O-15 (the important air activation products of the ALS) are computed to be 0.084 Ci (3 x 10^9 Bq) and 0.006 Ci (2 x 10^8 Bq) respectively. Thus, the ALS is a very small source and continuous monitoring is not required. A summary of the CAP88-PC source term input parameters and EDE results for this release point is presented in Table 7.

Table 7. Building 6 Release Point Characteristics

Release Height (meter)	Local MEI Distance (meter)	Local MEI Dir.	Local MEI Description	Radio Nuclide	Annual Release (Ci*/yr)	CAP88 MEI EDE (mrem** /yr)	%Total EDE
19	360	NE	School	N-13	8.40E-02	1.10E-04	94.82%
				O-15	5.90E-03	6.01E-06	5.18%
(*) 1 Ci = 3.7E10 Becquerel			(**) 1 mrem = 1.0E-2 mSv		**TOTAL:**	**1.16E-04**	**100.00%**

5). Building 26 (Medical Services & Bioassay/Radioanalytical Laboratory): The LBL bioassay/radioanalytical laboratory is the only radionuclide user in this building. Trace quantities of a variety of radionuclides are used in sample spiking and standards preparation. A summary of the CAP88-PC source term input parameters and EDE results for this release point is presented in Table 8.

Table 8. Building 26 Release Point Characteristics

Release Height (meter)	Local MEI Distance (meter)	Local MEI Dir.	Local MEI Description	Radio Nuclide	Annual Release (Ci*/yr)	CAP88 MEI EDE (mrem** /yr)	%Total EDE
8	240	N	School	S-35	3.00E-05	1.21E-06	100.00%
(*) 1 Ci = 3.7E10 Becquerel			(**) 1 mrem = 1.0E-2 mSv		**TOTAL:**	**1.21E-06**	**100.00%**

6). Buildings 51 (The Bevatron): Building 51 housed a heavy ion synchrotron accelerator. This machine was used to accelerate ions from helium to uranium in order to carry on nuclear studies and radiotherapy. Releases from this accelerator were mainly short-lived air activation products produced by beam loss. Air activation product releases from the Bevatron were estimated at 16% (2 months/12 months) of the theoretical maximum as the machine only ran for 2 months during CY93. The machine ceased its operations at the end of February 1993. There are no engineering emission controls on this release point. A summary of the CAP88-PC source term input parameters and EDE results for this release point is presented in Table 9.

Table 9. Building 51 Release Point Characteristics

Release Height (meter)	Local MEI Distance (meter)	Local MEI Dir.	Local MEI Description	Radio Nuclide	Annual Release (Ci*/yr)	CAP88 MEI EDE (mrem** /yr)	%Total EDE
15	360	N	Residence	N-13	7.30E-01	1.65E-03	45.86%
				O-15	5.80E-01	1.07E-03	29.74%
				C-11	3.50E-01	8.34E-04	23.18%
				Ar-41	1.50E-02	4.41E-05	1.23%
					TOTAL:	**3.60E-03**	**100.00%**

(*) 1 Ci = 3.7E10 Becquerel (**) 1 mrem = 1.0E-2 mSv

7). Building 55 (Research Medicine & Radiation Biophysics): The primary radiological activities carried out in Building 55 are positron emission tomography (PET) and metabolic studies using F-18. The radiological activities take place in 2 laboratories and a PET camera room. As less than 200 mCi (7.4 x 10^9 Bq) of radioiodine may be used in the facility annually, operations with radioiodine are done in a HEPA and Tetraethylene Diamine (TEDA)-doped carbon-filtered enclosures. Two radioisotope hoods and the radioiodine box stacks are sampled continuously. A summary of the CAP88-PC source term input parameters and EDE results for this release point is presented in Table 10.

Table 10. Building 55 Release Point Characteristics

Release Height (meter)	Local MEI Distance (meter)	Local MEI Dir.	Local MEI Description	Radio Nuclide	Annual Release (Ci*/yr)	CAP88 MEI EDE (mrem** /yr)	%Total EDE
9	170	N	Residence	Rb-86	1.20E-05	2.77E-06	0.10%
				I-125	4.20E-06	4.92E-05	1.74%
				F-18	3.00E-01	2.78E-03	98.16%
					TOTAL:	**2.83E-03**	**100.00%**

(*) 1 Ci = 3.7E10 Becquerel (**) 1 mrem = 1.0E-2 mSv

8). Buildings 62 (Material & Chemical Science): Building 62 has only one radionuclide user. A thorium aerosol study with milligram quantities of 0.1μCi thorium spheres is performed in one lab in Building 62. Operations in Building 62 are carried out in enclosures whose exhaust streams are HEPA filtered. The 62 stack is sampled periodically. A summary of the CAP88-PC source term input parameters and EDE results for this release point is presented in Table 11.

Table 11. Building 62 Release Point Characteristics

Release Height (meter)	Local MEI Distance (meter)	Local MEI Dir.	Local MEI Description	Radio Nuclide	Annual Release (Ci*/yr)	CAP88 MEI EDE (mrem** /yr)	%Total EDE
13	240	E	Workplace	Th-232	3.40E-10	6.03E-07	100.00%
(*) 1 Ci = 3.7E10 Becquerel			(**) 1 mrem = 1.0E-2 mSv		TOTAL:	**6.03E-07**	**100.00%**

9). Buildings 70 & 70A (Nuclear, Material, Chemical, and Earth Sciences): Programs carried out in these facilities include super heavy nuclear studies, waste migration studies (tracer amounts), and nuclear chemical studies. There are also two biological science groups in 70A. The radioactive works are carried out by five research groups in 14 of the many small laboratories within the two buildings. Emissions are released through 21 stacks, 19 of which are sampled continuously. Discharges from the two stacks from the biology group's Laboratories are controlled by inventory of the Radiation Work Permit (RWP) and periodic evaluation. In addition, there is also a pit storage room where radionuclides are stored in a fireproof pit in closed containers. A summary of the CAP88-PC source term input parameters and EDE results for these release points is presented in Table 12.

Table 12. Buildings 70&70A Release Point Characteristics

Release Height (meter)	Local MEI Distance (meter)	Local MEI Dir.	Local MEI Description	Radio Nuclide	Annual Release (Ci*/yr)	CAP88 MEI EDE (mrem** /yr)	%Total EDE
13	330	W	Dormitory	Th-232	1.50E-08	2.78E-05	83.38%
				Zr-95	3.70E-06	1.91E-06	5.73%
				I-125	6.30E-07	3.63E-06	10.89%
(*) 1 Ci = 3.7E10 Becquerel			(**) 1 mrem = 1.0E-2 mSv		TOTAL:	**3.33E-05**	**100.00%**

10). Buildings 74/74B (Research Medicine) & 83 (Cell Biology): These buildings include a wide variety of cell biology, virology, research medicine, and human genome projects. Releases from 74 and 74B come from hoods and stacks that vent individual workplaces. The Research Medicine Group prepares ^{18}Fluorodeoxyglucose (F-18) for administration to patients in Building 55. Building 83 vents are through HEPA-filtered biological cabinets. In laboratories where more than 10 mCi/yr of ^{125}I are used, the material is contained in Tetraethylene Diamine (TEDA)-doped activated-carbon-filtered enclosures. Eleven stacks in Building 74, three stacks in Building 74B, and one stack from Building 83 (a total of 14) are sampled. A summary of the CAP88-PC source term input parameters and EDE results for these release points is presented in Table 13.

Table 13. Buildings 74/74B&83 Release Point Characteristics

Release Height (meter)	Local MEI Distance (meter)	Local MEI Dir.	Local MEI Description	Radio Nuclide	Annual Release (Ci*/yr)	CAP88 MEI EDE (mrem** /yr)	%Total EDE
7	120	S	School	Ni-63	2.60E-06	1.82E-07	0.00%
				I-125	9.80E-07	1.64E-05	0.05%
				Am-241	3.60E-08	3.45E-04	1.15%
				Sr-90	8.30E-06	1.30E-04	0.43%
				S-35	1.60E-06	7.81E-08	0.00%
				F-18	2.00E+00	2.94E-02	98.36%
					TOTAL:	**2.99E-02**	**100.00%**

(*) 1 Ci = 3.7E10 Becquerel (**) 1 mrem = 1.0E-2 mSv

11). Building 75 (National Tritium Labeling Facility): The National Tritium Labeling Facility (NTLF) is mainly used for activities in which a wide variety of molecules are labeled with tritium and purified for further use in chemical, biochemical, and radio pharmaceutical studies. There are two stack release points for these activities, both of which are continuously sampled. The radionuclide releases are in the form of gaseous tritium (HT, T_2) or tritiated water (HTO, T_2O). Currently, only tritiated water releases are quantified. Gaseous tritium releases from the NTLF are not quantified because their impacts are 1/25,000 of those of comparable releases of tritiated water. However, LBL will soon be quantifying both forms of tritium release on a continuous basis when the installation of the new real-time tritium monitoring stations is being completed in February 1995. Normally, about 97% of tritium release comes from the stack (tritium trunk) located in the northern hillside from Building 75. This stack is the closest discharge point to the maximally exposed offsite individuals (MEI). The other discharge point from the NTLF, located on the roof of Building 75, is further from offsite individuals and released less than 3% of the yearly discharges. For CAP88-PC modeling, all tritium releases from the NTLF are conservatively assumed to originate at from the first stack (tritium trunk). This release point is the only "major source" at LBL that results in more than 1% of the NESHAPs EDE dose standard. For reporting purposes, the MEI of this release point is also identified as the MEI for the whole LBL site during CY93. A summary of the CAP88-PC source term input parameters and EDE results for this release point is presented in Table 14.

Table 14. Building 75 Release Point Characteristics

Release Height (meter)	Local MEI Distance (meter)	Local MEI Dir.	Local MEI Description	Radio Nuclide	Annual Release (Ci*/yr)	CAP88 MEI EDE (mrem** /yr)	%Total EDE
10	110	NW	School	H-3	1.04E+02	2.36E-01	100.00%
					TOTAL:	**2.36E-01**	**100.00%**

(*) 1 Ci = 3.7E10 Becquerel (**) 1 mrem = 1.0E-2 mSv

12). Building 75A (Hazardous Waste Handing Facility / Point Source): The LBL hazardous waste handling facility is located in Buildings 75A and part of Building 75. Bags of radioactive waste stored in a ventilated cabinet in Building 75A outgassed about 60 μCi (2.2 x 10^6 Bq) of ^{125}I. Summaries of the CAP88-PC's source term input parameters and EDE results for this point source Building 75A are presented in Table 15.

Table 15. Building 75A Release Point Characteristics (Point Source)

Release Height (meter)	Local MEI Distance (meter)	Local MEI Dir.	Local MEI Description	Radio Nuclide	Annual Release (Ci*/yr)	CAP88 MEI EDE (mrem** /yr)	%Total EDE
8	150	NW	School	H-3	1.70E-02	5.90E-05	29.59%
				Th-232	5.90E-09	3.01E-05	15.10%
				Sr-90	1.00E-06	1.35E-05	6.77%
				I-125	6.50E-06	9.38E-05	47.05%
				C-14	3.10E-05	2.97E-06	1.49%
					TOTAL:	**1.99E-04**	**100.00%**

(*) 1 Ci = 3.7E10 Becquerel (**) 1 mrem = 1.0E-2 mSv

13). Building 75A (Hazardous Waste Handing Facility / Diffuse Source): In addition, Building 75A is also considered as a diffuse source of HTO, as HTO waste is processed and stored in the building. Summaries of the CAP88-PC's source term input parameters and EDE results for this diffuse source of Building 75A are presented in Table 16.

Table 16. Building 75A Release Point Characteristics (Diffuse Source)

Release Height (meter)	Local MEI Distance (meter)	Local MEI Dir.	Local MEI Description	Radio Nuclide	Annual Release (Ci*/yr)	CAP88 MEI EDE (mrem** /yr)	%Total EDE
1	150	NW	School	H-3	6.00E-02	2.58E-03	100.00%
(*) 1 Ci = 3.7E10 Becquerel			(**) 1 mrem = 1.0E-2 mSv		**TOTAL:**	**2.58E-03**	**100.00%**

14). Building 88 (88-inch Cyclotron): This building houses an 88-inch diameter sector-focused cyclotron used in a wide variety of research applications. Beams of ions from H+ through uranium are accelerated onto targets used for nuclear studies. The primary airborne impact to an offsite individual from this facility is attributable to short-lived air activation radionuclides (mostly positron emitters) produced in the cyclotron vault during the fraction of the beam year when intense light ions are accelerated (approximately 10% of the time during CY93). There is presently no active stack monitor for these activation products. Releases were estimated as described previously in this report. However, LBL is currently upgrading these facilities with positron monitoring devices to fully quantify/characterize for these air activation radionuclides. The CY93 releases were estimated at 10% of the theoretical maximum. The quantity of activation products is controlled by the fraction of the beam year spent running light ions, and limits on circulating beam current. Small amounts of actinide radionuclides and other radioactive targets are monitored at experimental cave, fume hood, and glove box discharges. A summary of the CAP88-PC source term input parameters and EDE results for this release point is presented in Table 17.

Table 17. Building 88 Release Point Characteristics

Release Height (meter)	Local MEI Distance (meter)	Local MEI Dir.	Local MEI Description	Radio Nuclide	Annual Release (Ci*/yr)	CAP88 MEI EDE (mrem** /yr)	%Total EDE
12	110	W	Residence	N-13	2.10E+00	7.74E-03	44.70%
				O-15	1.10E+00	3.45E-03	19.92%
				C-11	1.40E+00	5.44E-03	31.42%
				Ar-41	8.90E-02	4.19E-04	2.42%
				Cm-248	2.20E-08	2.62E-04	1.51%
				Zn-65	1.70E-06	4.49E-06	0.03%
(*) 1 Ci = 3.7E10 Becquerel			(**) 1 mrem = 1.0E-2 mSv		**TOTAL:**	**1.73E-02**	**100.00%**

15). **Building 934 (Molecular and Cell Biology):** This building is located off-site, roughly 5 air kilometers (3 air miles) from LBL. The radiological activities include cell and molecular biology research. Also, forensic DNA investigations are carried out by a group from the California Department of Justice. The research employs RNA and DNA precursors and amino acids labeled with H-3, C-14, P-32, S-35, and I-125. Metabolism of S-35 amino acids produces $^{35}SO_2$, which is released to the atmosphere. Previous studies indicated that less than 0.1% of the activity incubated is available for release. Currently, no stacks are sampled at this location. A summary of the CAP88-PC source term input parameters and EDE results for this release point is presented in Table 18.

Table 18. Building 934 Release Point Characteristics

Release Height (meter)	Local MEI Distance (meter)	Local MEI Dir.	Local MEI Description	Radio Nuclide	Annual Release (Ci*/yr)	CAP88 MEI EDE (mrem** /yr)	%Total EDE
4	38	N	Business	S-35 I-125	3.00E-04 2.00E-05	3.84E-05 1.01E-03	3.66% 96.34%
					TOTAL:	**1.05E-03**	**100.00%**

(*) 1 Ci = 3.7E10 Becquerel (**) 1 mrem = 1.0E-2 mSv

Section II. Air Emissions Data

Point Source	# of Stacks	Type Control	Efficiency [%]	Distance to Nearest Receptor
Building 2	1	None	0	370 m (School)
Building 6	1	None	0	360 m(School)
Building 51 Vault	1	None(1)	0	360 m (Residence)
Building 62	1	HEPA	> 99	240 m (Workplace)
Building 75A	1	T-DAC HEPA(2)	> 75	150 m (School)
Building 88 Vault	1	None(1)	0	110 m (Residence)

Grouped Source	# of Stacks	Type Control	Efficiency [%]	Distance to Nearest Receptor
Building 1 Stacks	11	None(3)	0	10 m (School in the same Building)
Building 3 Stacks	3	None(3)	0	60 m (Workplace)
*Buildings 26	2	HEPA	>99	240 m (School)
Building 55 Stacks	5	HEPA T-DAC(2)	>99 >75	170 m (Residence)
Buildings 70 & 70A(4) Stacks	20	HEPA (Manifolds) None (Hood)	>99 0	200 m (Dormitory)
Buildings 74, 74B & 83 Stacks	14	T-DAC(2) None	>75 0	120 m (School)
Building 75 (NTLF)	2	Silica Gel(5)	>99	110 m (School)
*Building 934 Stacks	9	None(3)	0	38 m (Business)

* Not monitored, emissions estimated.

Non-Point Source	Radionuclide	Annual Quantity
Building 75A (Waste processing Area)	HTO	0.06 Ci (2.0×10^9 Bq)

Notes:

(1) The Radionuclides released from the accelerators are air activation products which are impractical to control.

(2) Tetraethylene Diamine (TEDA) -doped activated carbon traps.

(3) The uncontrolled releases are from LBL fume hoods which are unfiltered.

(4) The stacks included in this group source vent a number of laboratories whose research employs μCi and mCi (between 3.7×10^4 and 3.7×10^7 Bq) quantities of a number of actinides. The most conservative dose-equivalent representative of the actinides was used.

(5) Silica gel traps are >99% efficient traps for HTO as long as they are changed before breakthrough. NTLF personnel regularly change traps when working in the facility.

Quantities of nuclides released from LBL stacks contributing more than 10% of the EDEs from a release point during CY93 are given in Table 19 and Figure 4. These data will be used to calculate the collective population dose for CY93.

Table 19. Total Air Effluent Potentially released During CY93

Nuclide	Total Air Effluent (Ci*/yr)	% Total Effluent
H-3	1.0E+02	92.24%
N-13**	2.9E+00	2.57%
F-18**	2.3E+00	2.04%
C-11**	1.8E+00	1.55%
O-15**	1.7E+00	1.50%
Ar-41**	1.0E-01	0.09%
S-35	3.3E-04	0.00%
I-125	3.5E-05	0.00%
C-14	3.1E-05	0.00%
Rb-86	1.2E-05	0.00%
Sr-90	9.3E-06	0.00%
P-32	8.7E-06	0.00%
Zr-95	3.7E-06	0.00%
Ni-63	2.6E-06	0.00%
Zn-65	1.7E-06	0.00%
Cm-248	2.4E-07	0.00%
U-238	5.1E-08	0.00%
Am-241	3.6E-08	0.00%
Th-232	2.2E-08	0.00%
Co-60	3.4E-14	0.00%
TOTAL :	**1.1E+02**	**100.00%**

(*) 1Ci = 3.7E10 Bq
(**) Estimated / Computed values

Section III. Dose Assessments

Description of Dose Model

To meet DOE guidance, the EPA atmospheric dispersion/radiation dose calculation computer code, CAP88-PC version 1.0, was used to calculate the Effective Dose Equivalent (EDE) dose to an individual within each population segment at various distances and from various release points. A total of fifteen (15) CAP88-PC "individual" runs were executed to model 15 single/grouped release points as described in Section II. As mentioned previously, the NTLF (Building 75) was identified as the major release point at LBL; therefore, the Maximally Exposed Individual (MEI) associated with this facility was also specified (with appropriate distances and directions) in each of these fifteen "individual" CAP88-PC runs. The reported EDE to a MEI at LBL includes contributions from all of these fifteen CAP88-PC models (see Table 20). The EDE contribution from each building to the total EDE at LBL is compared in Figure 4.

Collective population dose is calculated as the average radiation dose to an individual in a specified area, multiplied by the number of individuals in that area. One "population" CAP88-PC run was used to carry out this population dose assessment. This CAP88-PC model is based on the input parameters from the Building 75 computer run, with the source terms replaced by all the radionuclides listed in Table 19. A summary of this collective dose assessment attributed to each radionuclides is given in Table 21 and Figure 5.

Summary of Input Parameters

The CY93 radioactivity air emissions were either measured or conservatively derived are shown in Table 19 in Section II.

As on-site meteorology was not available, the meteorological data used with CAP88-PC was taken from the OAK0319.WND file that came with the CAP88-PC distribution diskette. The use of these data had been formally approved by EPA region IX. LBL is taking steps to collect and use on-site meteorological data for performing dose assessments. LBL completed a preliminary study of meteorological monitoring, siting, equipment, and quality assurance requirements during CY91. Meteorological monitoring equipment was installed at the LBL site in 1993 and has been collecting data since January 1994. These data must be quality assured against specific criteria before deemed acceptable for use with CAP88-PC modeling.

Table 20. Summaries of Dose Assessment from All LBL Release Points

		Relative to the Specified Building					Relative to the MEI of Building 75			
Building Number	Building Name	Release Height (meter)	Local MEI Distance (meter)	Local MEI Dir.	Local MEI Description	Local MEI Dose (mrem*/yr)	BLD-75 MEI Distance (meter)	BLD-75 MEI Dir.	BLD-75 MEI Dose (mrem*/yr)	% Total EDE
BLD-1	Donner Laboratory @UCB	9	10	ESE	School	1.9E-05	980	ENE	2.10E-05	0.02%
BLD-2	Advanced Material Lab.	20	370	NE	School	1.3E-13	370	NE	1.30E-13	0.00%
BLD-3	Calvin Lab @UCB	15	60	S	Res. & Business	2.9E-07	1070	NE	2.70E-07	0.00%
BLD-6	Advanced Light Source (ALS)	19	360	NE	School	2.6E-05	370	NNE	1.80E-05	0.01%
BLD-26	Medical Services & Counting Lab.	8	240	N	School	9.6E-07	240	N	9.60E-07	0.00%
BLD-51	Bevatron (ceased operation 02/93)	15	360	N	Residence	5.7E-04	390	ENE	8.60E-04	0.68%
BLD-55	Research Med & Rad Bio	9	170	N	Residence	6.3E-04	490	E	4.60E-04	0.36%
BLD-62	Materials & Chem. Science	13	240	E	Workplace	3.7E-07	650	NW	8.30E-08	0.00%
BLD-70 & 70A	Nuclear / Applied Science	13	330	W	Dormitory	7.5E-06	510	NE	5.90E-06	0.00%
BLD-74, 74B & 83	Buildings 74/74B/83 Research Med.	7	120	S	School	7.9E-03	730	WNW	2.00E-03	1.59%
BLD-75	National Tritium Labeling Facility	10	110	NW	School	1.2E-01	110	NW	1.20E-01	95.12%
BLD-75-127 & 75A	Hazardous Waste Handling Facility	8	150	NW	School	1.1E-04	150	NW	1.10E-04	0.09%
BLD-75A (D)	Waste Storage Area (Diffuse)	1	150	NW	School	9.0E-04	150	NW	7.40E-04	0.59%
BLD-88	88-Inch Cyclotron	12	110	W	Residence	2.3E-03	670	ENE	1.40E-03	1.11%
BLD-934	Molecular & Cell Bio. (off-site)	4	38	N	Business	7.0E-04	4900	ENE	5.40E-04	0.43%
								TOTAL:	**1.26E-01**	**100.00%**

(*) 1 mrem = 1.0E-2 mSv

Table 21. Summary of Collective (Population within 80 km of LBL) EDE Assessment

Nuclide	Collective EDE (Person-rem* /yr)	% Total Collective EDE
H-3	1.2E+00	90.10%
F-18	5.9E-02	4.46%
N-13	2.2E-02	1.64%
C-11	2.1E-02	1.58%
Cm-248	2.1E-02	1.57%
O-15	3.7E-03	0.28%
Ar-41	2.9E-03	0.22%
Am-241	8.4E-04	0.06%
Th-232	3.4E-04	0.03%
U-238	2.6E-04	0.02%
Sr-90	2.3E-04	0.02%
I-125	1.3E-04	0.01%
Zn-65	2.4E-05	0.00%
S-35	2.3E-05	0.00%
Zr-95	1.7E-05	0.00%
Rb-86	8.4E-06	0.00%
C-14	6.1E-06	0.00%
P-32	3.8E-06	0.00%
Ni-63	3.4E-07	0.00%
Co-60	1.1E-11	0.00%
TOTAL :	**1.3E+00**	**100.00%**

(*) 1 Person-rem = 1.0E-2 Person-Sv

Compliance Assessment

This compliance assessment uses the computer code CAP88-PC Version 1.0 to calculate the Effective Dose Equivalent to an offsite Maximally Exposed Individual. This exposure represents the sum of impacts from all fifteen release points modeled to that location (the MEI of Building 75). Summaries of the dose assessment from each release point are presented in Table 20.

Effective Dose Equivalent: 1.3E-1 mrem/year (1.3E-3 mSv/year)

Location of Maximally Exposed Individual: School at 110 meters Northwest of Building 75

Figure 4. Percent Distribution of the Total EDE by Buildings.

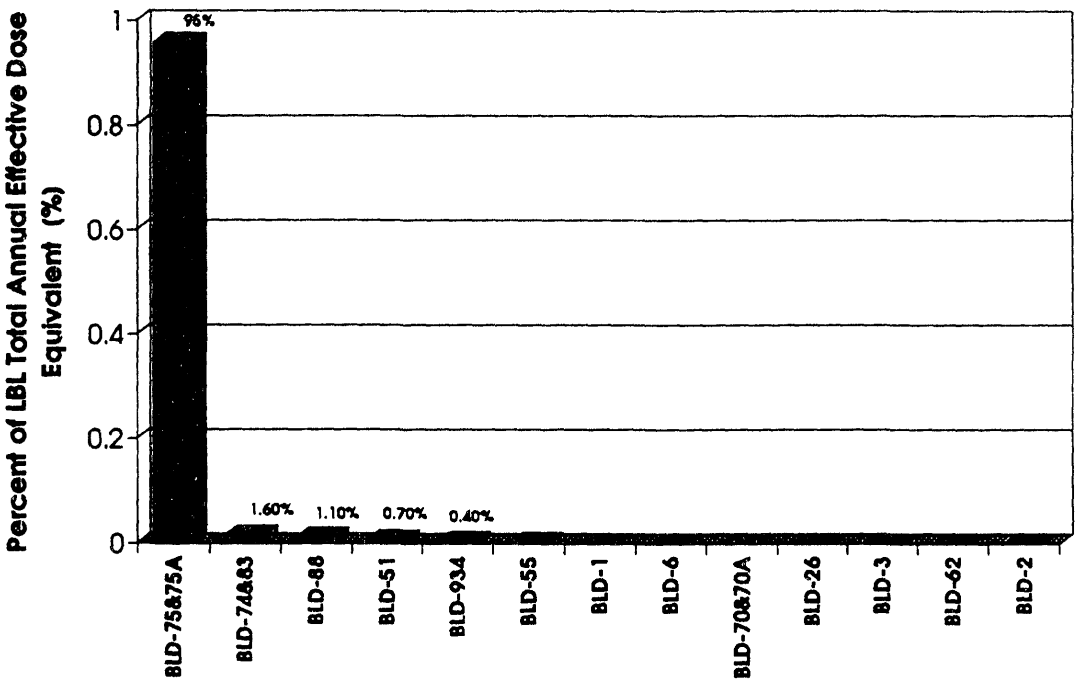
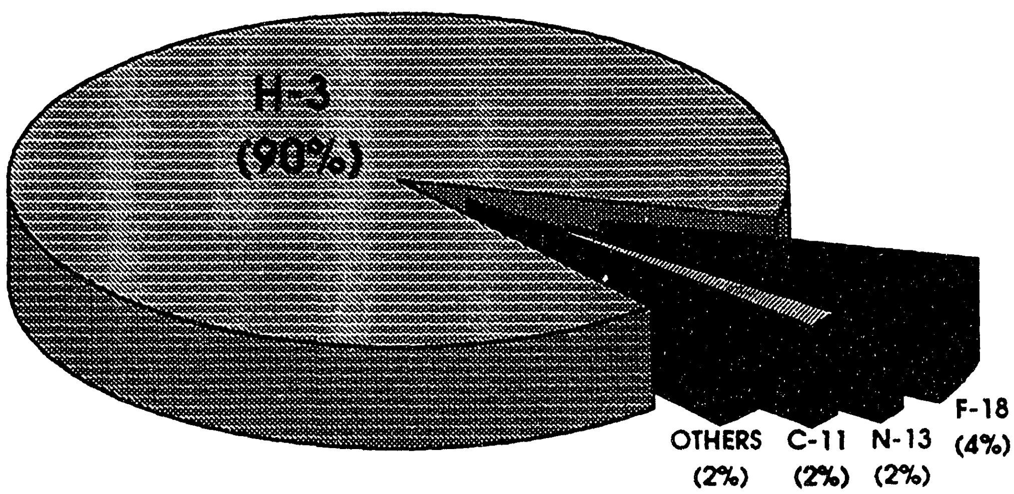


Figure 5. Percent Distribution of the Total Collective EDE by Radionuclides.



Certification

I certify under penalty of law that I have personally examined and am familiar with the information
submitted herein and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment. (See, 18 U. S. C. 1001).

Signature:________________________________Date:___________

David C. McGraw
Division Director, Environment, Health and Safety

Signature:________________________________Date:___________

Scott L. Samuelson
Director, DOE Berkeley Site Office

Section IV. Additional Information

Additions or Modifications

Building 56 (Biomedical Isotope Facility-BIF)
The BIF Title II design phase was in-progress during CY93. The facility will be located between Buildings 63 and 51. The BIF will provide dedicated equipment and workplaces for radio pharmaceutical preparation. The BIF will possess a customized commercial accelerator for radionuclide production and a separate radio pharmaceutical preparation area with glove box enclosures. Radio pharmaceuticals will be transferred from Building 56 to Building 55 for positron emission tomography (PET) scan imaging and research uses.

Dose assessments for Building 56 were conducted during NEPA review and Negative Declaration. Dose due to Building 56 emissions is anticipated to be less than 0.1 mrem/year. Radionuclide emissions will include F-18, N-13, O-15, C-11 from accelerator targets and subsequent radio pharmaceutical preparation. Smaller quantities of accelerator air activation products N-13, O-15, C-11, and Ar-41 will also be produced. Although the BIF is not a "major source," LBL has provided for continuous positron monitoring in the NESHAP Project 3 monitoring upgrade.

Unplanned Releases

There was one unplanned tritium release to the atmosphere from LBL during CY93. A tritiation reaction involving 150 Ci of tritium gas was conducted at the NTLF (Building 75) on Thursday 08/12/93. Approximately 111 Ci of this reaction material was trapped on a uranium bed, and the remainder was treated in the NTLF recovery system (e.g. burned to HTO and condensed in an ethanol cooled trap over the night of 08/12/93). The condensed HTO was drained and counted on 08/13/93 (of about 15 Ci), and disposed as radioactive waste. The recovery system was then evacuated through a bed of silica gel, to prepare the apparatus for its next use. Normal practice is to replace the silica gel bed soon after pumping out the system, thus disposing of any HTO trapped during the evacuation. This was not done on this occasion due to personnel oversight.

It is believed after investigation that the HTO trapped on the silica gel slowly migrated through the bed until it started to be released to the Building 75 stack early on 08/15/93. Continuous monitoring data collected from this stack revealed that approximately 44 Ci of HTO was released to the environment during the week of release. The dose impact from this unplanned release is estimated to be (based on CAP88-PC model) about 8.5E-2 mrem (8.5E-4 mSv) EDE to a maximally exposed individual (MEI) 110 meters Northwest of Building 75. The reported EDE for CY93 in the Compliance Assessment of Section III includes this unplanned release contribution.

Diffuse Emissions

Fugitive emissions from stored tritium waste are estimated at less than 0.06 Ci (2.2×10^9 Bq) during CY93. The fugitive release estimate is the product of the annual average workplace HTO concentration where the tritium waste is packaged and stored, times the number of air changes in the storage building per year. The estimated EDE to an offsite MEI from this diffuse emission was found to be about 1.2E-3 mrem/yr. (1.2E-5 mSv/yr.). This estimate is based on the "area" source CAP88-PC model which is highly conservative for the diffuse source (see the "BLD-75AD" CAP88-PC run).

Section V. Supplemental Information

- *Provide an estimate of collective effective dose equivalent (person-rem/yr.) for CY93 releases.*

  The estimated collective effective dose equivalent (CEDE) to persons living within 80 km of LBL is 1.3 person-rem/year (1.3E-2 person-Sv) attributable to CY93 LBL airborne releases (see Table 21).

- *Provide information on the status of compliance with Subparts Q and T of 40 CFR Part 61 if applicable. Although exempt from Subpart H, provide information on Rn-220 emission from sources containing U-232 and Th-232 where emissions potentially can exceed 0.1 mrem/yr. (10^{-6} Sv/a) to the public or 10% of the non-radon dose to the public. Provide information on non-disposal/non-storage sources of Rn-222 emissions where emissions potentially can exceed 0.1 mrem/yr. (10^{-6} Sv/a) to the public or 10% of the non-radon dose to the public.*

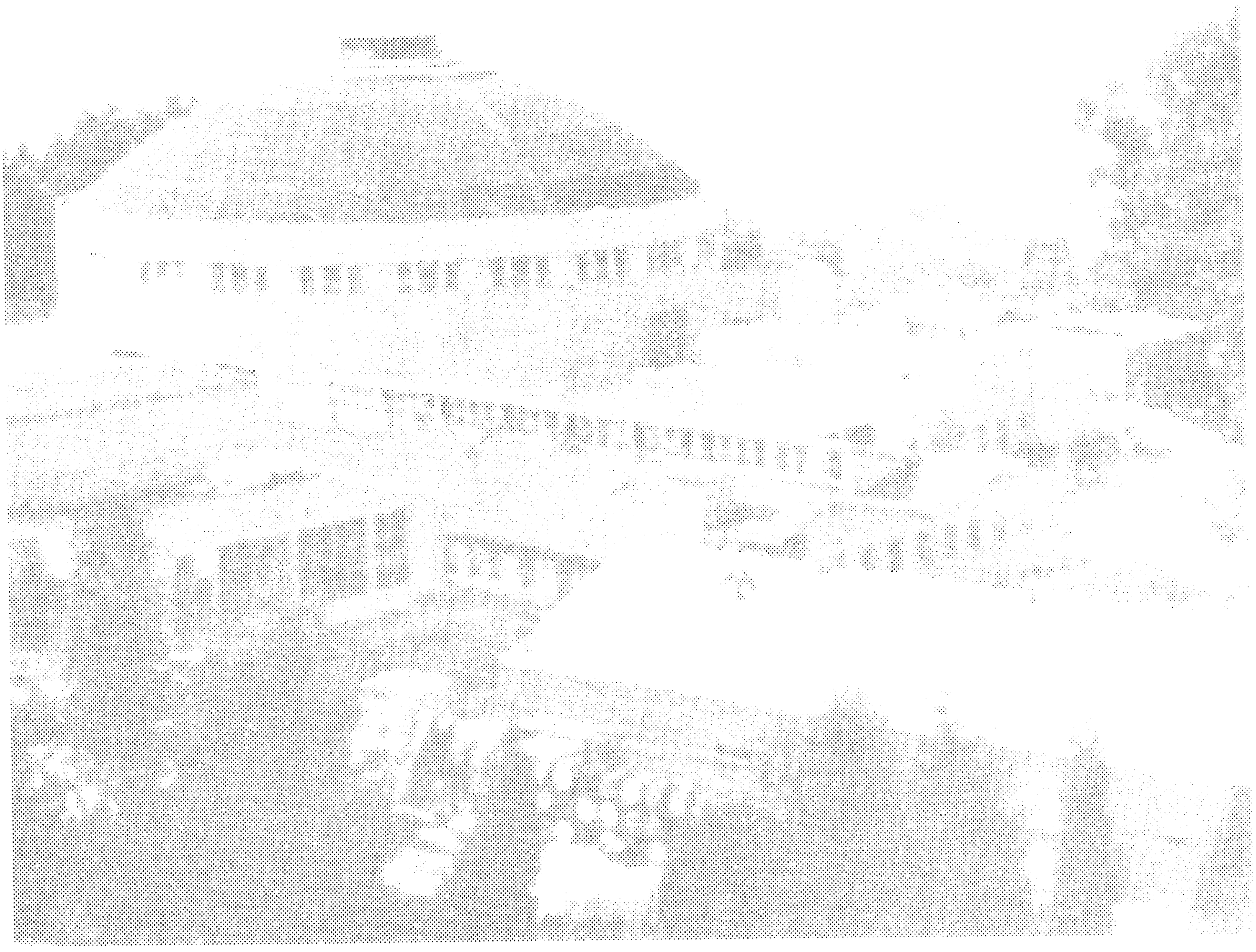
  Subparts Q and T of 40 CFR 61 are not applicable to LBL, as the Laboratory does not process, manage or possess significant enough quantities of uranium mill tailings, Ra-226, U-232, or Th-232, to produce an impact of 0.1 mrem/yr. (10^{-7} Sv/a) to a member of the public.

- *For the purpose of assessing facility compliance with the NESHAPs effluent monitoring requirements of Subpart H under Section 61.93(b), give the number of emission points subject to the continuous monitoring requirements, the number of these emission points that do not comply with the Section 61.93(b) requirements, and if possible, the cost for upgrades. Describe site periodic confirmatory measurement plans. Indicate the status of the QA program described by Appendix B, Method 114.*

  LBL has identified 4 points subject to the continuous monitoring requirements of 40 CFR subpart H, Section 61.93(b). During CY93 only 1 of the 4 points produced discharges exceeding 0.1 mrem/yr (1.0E-3 mSv/yr) and was continuously monitored (sampled). The single point monitored was the NTLF main stack whose EDE was modeled at 0.2 mrem/yr (2×10^{-3} mSv). LBL is currently upgrading the monitoring and analytical methods to fully conform to Section 61.93(b) monitoring requirements. LBL has identified: a) all emission points and evaluated releases, b) categorized stacks by EDE, and c) suggested suitable monitoring methodology for each point. The information developed in a - c above was sent to EPA region IX during CY91 and finalized in CY93. The cost to upgrade all monitoring systems to satisfy 40 CFR 61 subpart H requirements is approximately $1.5 M (funding approved).

Under its Tiger Team action plan, LBL is upgrading all monitoring and analytical QA procedures. The program will meet or exceed all provisions contained in Appendix B method 114. The current LBL Environmental Monitoring Plan and Envircnmental Protection Group Procedures contain QA elements consistent with method 114, and will be supplemented by a specific NESHAP QA plan in CY94.

Appendix B - Distribution List



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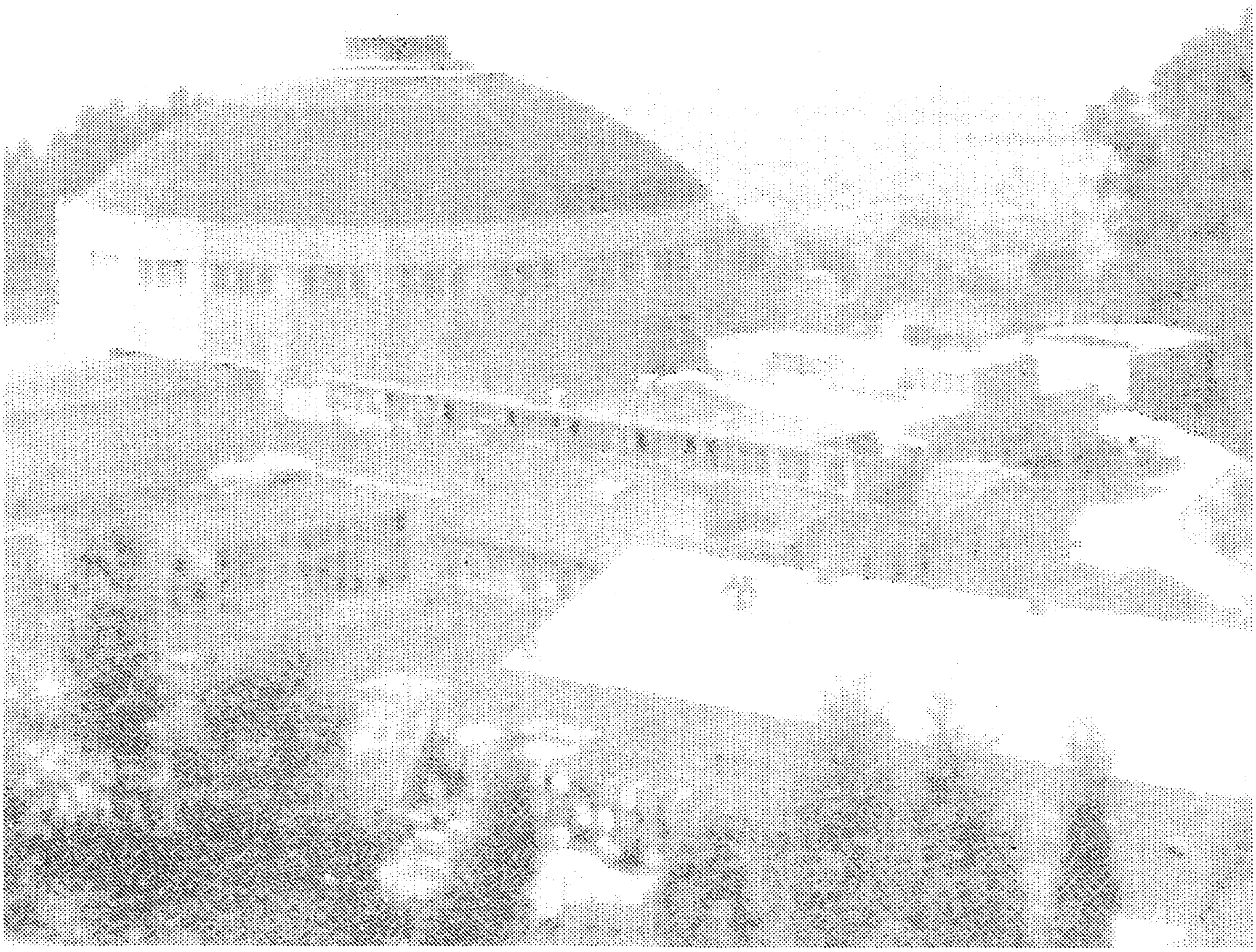

Acknowledgments

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Patrick Thorson	Air and Water Quality Protection
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