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Annual Site Environmental Report of the Lawrence Berkeley Laboratory-1992



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# Lawrence Berkeley Laboratory
UNIVERSITY OF CALIFORNIA

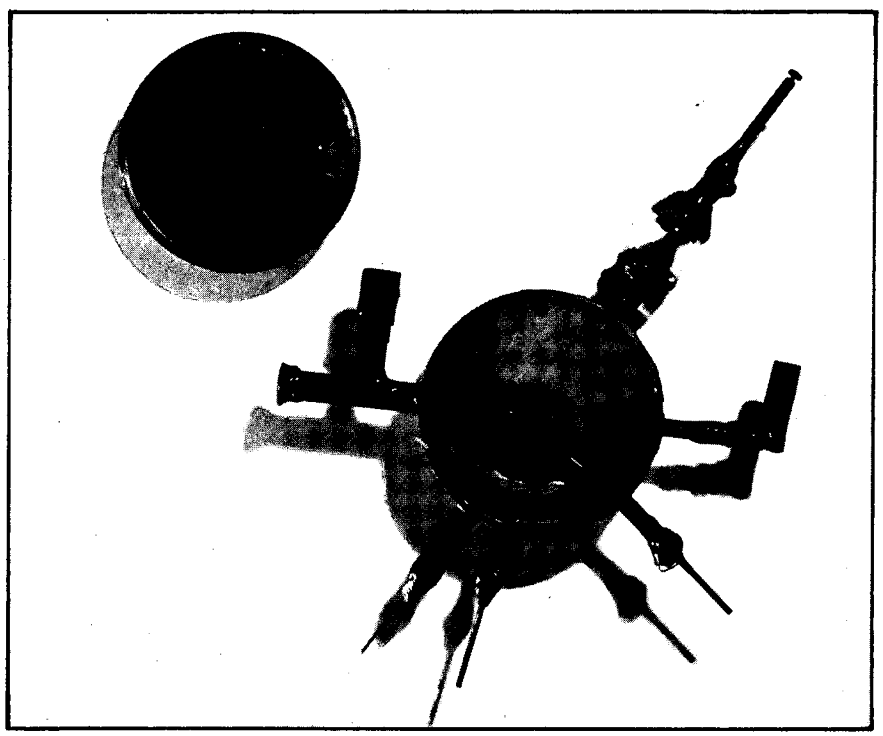
# ENVIRONMENT, HEALTH AND SAFETY DIVISION

**Annual Site Environmental Report of the Lawrence Berkeley Laboratory**

**1992**

D.A. Balgobin, I. Javandel, R.O. Pauer,
G.E. Schleimer, and P.A. Thorson

May 1993





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LBL-27170 (1993)

# Annual Site Environmental Report of the Lawrence Berkeley Laboratory

## Calendar Year 1992

Prepared by the Staff of the
Environmental Protection Group
Environment, Health and Safety Division
Lawrence Berkeley Laboratory
University of California
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# Contents

## List of Tables and Figures

### Tables

## Figures

# Executive Summary

This Annual Site Environmental Report summarizes LBL environmental activities in calendar year (CY) 1992. The purpose of this Report is to present summary environmental information in order to characterize site environmental management performance, confirm compliance 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."

## Compliance Summary

The emission of radioactive materials into the atmosphere is regulated under the National Emissions Standards for Hazardous Air Pollutants (NESHAPs) provisions of the Clean Air Act. The United States Environmental Protection Agency (US/EPA) and DOE have negotiated a draft Federal Facilities Compliance Agreement (FFCA) in response to a 1991 violation received by DOE and LBL for noncompliance with these regulations. The proposed schedule in the draft FFCA would bring the Laboratory into compliance by February 1995. This schedule is based on a $1.5-million corrective-action undertaking for three projects that will upgrade the environmental-monitoring equipment to NESHAPs standards. Approval of the draft FFCA is expected in the second quarter of 1993.

Nonradioactive air emissions are regulated by the Bay Area Air Quality Management District (BAAQMD). Two Notices of Violation were issued in 1992 for administrative deficiencies. Both deficiencies were promptly resolved.

Expanded permitting requirements called for by the Clean Air Act Amendments of 1990 currently do not consider LBL a major source, and consequently the Laboratory is exempt from the more stringent control requirements that will be placed on certain sources of hazardous air pollutants in the coming years. Locally, BAAQMD is adhering to the US/EPA policy as it begins modification of its permitting program to comply with the amended Clean Air Act.

The East Bay Municipal Utility District (EBMUD) issued six Notices of Violation during 1992 for excursions of sanitary sewer system discharge limits from LBL. Mitigation measures were adopted in response to three of the six events to prevent recurrence of these situations. All six excursions were investigated to the satisfaction of EMBUD. In spite of these excursions, LBL remains categorized as in compliance with EBMUD discharge limits. There were no monitored excursions during the first quarter of 1993.

In March 1992, LBL submitted a Notice of Intent for coverage under a statewide National Pollutant Discharge Elimination System (NPDES) general permit from the State Water Resources Control Board for storm water discharges from industrial activities. The NPDES permitting requirements include both a pollution prevention plan and a monitoring plan, which LBL completed and implemented by October 1992.

Two underground storage tanks were removed from LBL during March 1993, and soil samples were taken. The sample analytical results will be evaluated, and this information will be included in a closure report that LBL will prepare and submit to the City of Berkeley in June 1993. In February 1993, a small diesel fuel overspill occurred in secondary containment at a permitted underground storage tank. No diesel fuel was released to the storm drain or the sanitary sewer during the incident. The City of Berkeley was notified of this incident.

Since 1989, LBL has been in the process of applying for a new Resource Conservation and Recovery Act (RCRA) Part A and B permit for its Hazardous Waste Handling Facility (HWHF) operations. A revised Part A and B permit application addressing both the existing and proposed HWHF was submitted to the Department of Toxic Substances Control (DTSC; part of the State of California's Environmental Protection Agency, or Cal/EPA) in August 1992. DTSC concluded that the application was administratively complete. There were no comments submitted by either the public or other regulatory agencies during the comment period that followed the DTSC review. Final approval of the permit application is expected from DTSC during the second quarter of 1993 after completion of the California Environmental Quality Act (CEQA) review.

Five treatment units located outside of the HWHF at LBL are subject to the State's new tiered permit program. A Facility Specific Notification and Unit Specific Notifications covering these units were submitted to Cal/EPA in April 1993.

Negotiations between DTSC, the State's Office of Attorney General, DOE, and LBL for a DTSC Report of Violations for hazardous waste activities in 1991 and 1992 are expected to culminate in a final settlement in the second quarter of 1993.

A series of audits beginning in July 1992 by the Westinghouse Hanford Company has led to formal certification of the Laboratory's low-level waste and low-level radioactive mixed waste program. Authorization to ship this waste was critical in LBL's efforts to eliminate the backlog of radioactive waste that had accumulated over the last two years. Shipments of waste to Hanford began in August 1992.

In August 1992, US/EPA, acting under the powers of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), sent LBL and various other parties a Notice of Potential Liability and Request for Information on the North American Environmental Inc. site in Clearfield, Utah. LBL removed all of its hazardous wastes from the site prior to its being officially designated a Superfund site. US/EPA acknowledged in a December 1992 draft Administrative Order on Consent that Potentially Responsible Parties such as LBL who had removed their wastes prior to September 1, 1992, and had declined to participate in further removal actions, were not subject to this draft Order. US/EPA advised, however, that such parties should not necessarily consider themselves relieved of liability at the Clearfield site.

In November 1992, LBL also responded to a Request for Information from DTSC for information regarding the Bay Area Drum Site, a former drum recycling and reconditioning facility located in San Francisco, pursuant to state hazardous waste laws. LBL has not yet received a response from the State regarding LBL's possible status as a Potentially Responsible Party at this site.

LBL's Environmental Restoration Program is now guided by the RCRA Corrective Action Process. Past actions had taken place under both RCRA and CERCLA.

LBL submitted its Business Plan to the City of Berkeley in January 1992. The Business Plan incorporates the requirements of the State's Hazardous Materials Release Response Plan and Inventory Law, which includes Sections 311 and 312 of the federal Superfund Amendments and Reauthorization Act (SARA Title III). The chemical inventories required by the law must be updated annually. The training, safety, and contingency plan portions of the Business Plan must be updated every two years.

In March 1992, LBL prepared a report for the State's Hazardous Waste Source Reduction and Management Review (SB14) program. This report reflected LBL's strong commitment to waste minimization. The goal of LBL's program is to substantially reduce waste generation and increase recycling. The plan focuses on larger waste streams at LBL. The hazardous waste management and source reduction review components of the plan must be updated every two and four years, respectively.

In compliance with CEQA, LBL prepared a Supplemental Environmental Impact Report (SEIR) in April 1992 for the renewal of the contract between DOE and the University of California (UC) for operation and management of the Laboratory. The SEIR addressed potential environmental impacts associated with UC's operations of the Laboratory over the five-year period 1992 through 1997. The new operating contract approved by DOE and UC requires, for the first time, the use of a performance-based management system. These performance-based measures include requirements that the Laboratory have programs in place designed to achieve compliance with applicable laws, regulations, ordinances, and DOE Orders relating to environmental protection. Furthermore, the Laboratory is required to report the results of a self-assessment on the performance measures to UC annually. Additionally, UC is required to have an annual audit, conducted by an external organization, performed of the Laboratory's environmental programs.

DOE and the State of California first entered into an Agreement in Principle (AIP) in August 1990. The AIP provides 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. In September 1992, a workplan for the period January 1, 1993, through July 31, 1994, was approved by DOE and the State's Department of Health Services. The workplan covers activities expected by the State agencies in the areas of program planning, reporting and data management, training, and community relations.

Progress on the Laboratory's Corrective Action Plan for resolving the findings of the Tiger Team's site visit in early 1991 continued. Over 70% of the tasks established in the Corrective Action Plan have been completed, of which nearly 40% have been verified by DOE. A Tiger Team Follow-up Review audit on the progress of LBL's corrective action program recently occurred. 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.

## Environmental Surveillance Program

In order to assess the level to which LBL research activities impact the population surrounding the Laboratory, LBL conducts a program of environmental surveillance and air and water sampling. DOE Order 5400.5 (1990) limits the total effective dose equivalent to any member of the public from all of a facility's sources to less than 100 mrem/yr above natural background. The Order also provides tables that contain derived concentration guides (DCGs) for airborne and waterborne radionuclides. A DCG is that concentration of a single radionuclide in air or water that, if routinely consumed or continuously inhaled, will individually produce an effective dose equivalent of 100 mrem in one year to the exposed individual. Exposures to a hypothetical maximally exposed member of the public are determined, as well as the sum of all exposures to the population within 80 km (50 mi) of LBL (see Table 1). In 1992, dose equivalents attributable to LBL radiological operations were a small fraction of the relevant radiation protection guidelines (RPG) of 100 mrem/yr and of the total natural radiation background of approximately 300 mrem per year (see Figure 1). As is clear from Figure 1, taking a single transcontinental jet flight would expose an individual to more than twice the maximum radiation exposure the same individual could get as a result of all LBL operations conducted during 1992.

Note that in Table 1, the background radiation for the accelerators is 100 mrem, while the background value for airborne radionuclides is 200 mrem. These are the values for background radiation attributable to penetrating radiation (neutron and gamma), and radionuclides that could be inhaled, respectively. Both of these values are lower than the total natural background radiation of 300 mrem.

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 exposure attributable to LBL airborne radionuclide releases was 0.06 mrem to an offsite worker 110 meters west of the LBL Building 88, 0.06% of the NESHAPs limit.

**Table 1.** Summary of LBL radiological impact.

| | Maximum Individual (Accelerators) | Maximum Individual (Airborne Nuclides) | Maximum All Sources | Collective Dose to Persons < 80 km from LBL All Sources |
|---|---|---|---|---|
| Dose | ≤ 2.3 mrem | ≤ 0.06 mrem | ≤ 2.3 mrem | ≤ 3.4 person-rem |
| Location | Residence NE of B13D | Residence W of B13A | Residence NE of B13D | ≤ 80 km from Laboratory |
| DOE Radiation Protection Standard[b] | 100 mrem | 10 mrem | 100 mrem | — |
| % of STD | 3 | 0.06 | 2% | — |
| Background | 100 mrem | 200 mrem | 300 mrem | $1.5 \times 10^6$ person-rem |
| LBL impact as a % of background | 3 | ≤ 0.04 | ≤ 0.8 | ≤ 0.0007 |

[a]LHS = Lawrence Hall of Science
[b]Source: DOE Order 5400.5.

**LBL's Impact**
**as a Percentage of Background**

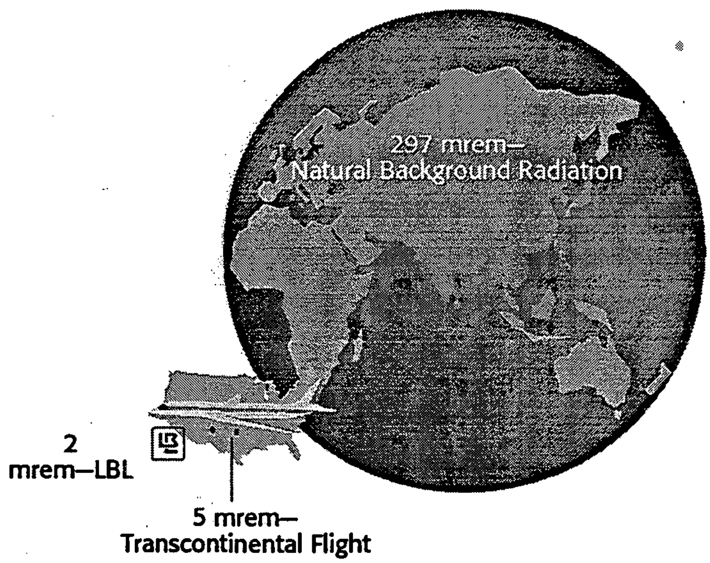



**Figure 1**

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. The 1992 maximum annual EDE value was delivered to a resident northeast of the Olympus Gate Environmental Monitoring Station B-13D. The EDE northeast of Building B13D was estimated to be ≤ 2.3 mrem for the year.

An additional assessment of LBL radiological impact is the "population dose". [The reader should note that, throughout this report, the phrase "population dose" should be taken to mean collective effective dose equivalent (CEDE) and "dose" or "dose equivalent" to mean effective dose equivalent.] CEDE is defined as the sum of the "doses" delivered to all individuals within an 80-km (50-mi) radius of the Laboratory. The total population dose equivalent attributable to LBL operations during 1992 was ≤ 3.4 person-rem, an average of about 0.0007% of the RPG of 100 mrem maximum effective dose equivalent to individual members of the surrounding population.

The majority of the CEDE is assignable to two sources. Approximately one third of the impact of LBL radiological operations during 1992 is from the airborne release of 87 Ci of tritium as tritiated water (HTO), from the National Tritium Labeling Facility Stacks. The other two thirds of the 1992 CEDE is attributable to direct radiation from accelerator operation and releases of accelerator-produced air-activation radionuclides. An estimated 0.2 Curie of $^{18}F$, small amounts of $^{14}C$, $^{35}S$, $^{123}I$, $^{125}I$, $^{95}Zr$, and unidentified alpha emitters were released from various other LBL laboratory stacks. The CEDE attributable to the foregoing releases is much less than 0.1 person-rem. Table 2 lists the radionuclide discharges to the atmosphere from LBL during 1992.

**Table 2.** Total quantities of radionuclides discharged into the atmosphere, 1992.

| Nuclide | Half Life | Quantity Discharged (Ci/yr) | Quantity Discharged (Bq/yr) |
|---|---|---|---|
| $^{3}H$ as HTO | 12.3 yr | 87 | $3.2 \times 10^{12}$ |
| $^{18}F$[a] | 1.83 h | 0.2 | $7 \times 10^{9}$ |
| $^{14}C$ as $^{14}CO_2$ | 5730 yr | $2 \times 10^{-3}$ | $7 \times 10^{7}$ |
| $^{123}I$[b] | 13.2 h | $1 \times 10^{-4}$ | $4 \times 10^{6}$ |
| $^{125}I$ | 60.1 d | $2 \times 10^{-4}$ | $7 \times 10^{6}$ |
| $^{35}S$ | 87.2 d | $2 \times 10^{-4}$ | $7 \times 10^{6}$ |
| Unidentified alpha emitters[c] | — | $<1 \times 10^{-6}$ | $<4 \times 10^{4}$ |
| $^{95}Zr$ | 87.2 d | $2 \times 10^{-6}$ | $7 \times 10^{4}$ |
| Estimated Total Accelerator Air Activation Radionuclides Discharged Into The Atmosphere, 1992 | | | |
| $^{11}C$ | 20.5 min | 7 | $2.6 \times 10^{11}$ |
| $^{13}N$ | 10 min | 8 | $3 \times 10^{11}$ |
| $^{15}O$ | 2.1min | 2 | $7 \times 10^{10}$ |
| $^{41}Ar$ | 1.8 hr | 0.1 | $3.7 \times 10^{9}$ |

[a]A release fraction of 2% is assumed.
[b]Releases inferred from measured $^{125}I$ releases . LBL will monitor for short-lived nuclides in 1994.
[c]Conservatively assumed to be 232Th.

To put the Laboratory's impact into perspective, we refer to the National Commission on Radiation Protection and Measurements (NCRP) for an approximate value for absorbed dose from external and internal natural sources to residents of the U.S. (e.g., cosmic rays, radiation from continental rocks, naturally occurring radioactive potassium-40 in our muscles and bones, and exposure from radon and its daughters). The NCRP's estimate of the effective dose equivalent from the foregoing is 300 mrem/yr (NCRP, 1987), which implies an annual population dose from natural sources of ~1,500,000 person-rem to the 5.1 million people within 80 km (50 mi) of LBL. However, in this report, when comparing LBL's penetrating radiation impact (from accelerator operations) to natural sources, only the penetrating whole-body component of natural background (about 33% of the foregoing total, or 100 mrem) is used. LBL measures radioactivity in onsite and offsite creeks, rainwater, sewer and storm water discharges, and horizontal wells (hydraugers). Additionally, the laboratory measures nonradioactive contaminants in hydraugers and wells. The discharges from a group of onsite hydraugers was found to contain levels of chlorinated hydrocarbons that exceed the US/EPA drinking water limits. These hydraugers are used to stabilize the slope, east of Building 51, by draining the groundwater. The discharges from these hydraugers have been combined and processed through a treatment system. The treated effluent is used as makeup water for the Building 51 cooling towers. A major LBL subsurface characterization study concluded in FY 1991 and 1992. (See the Environmental Activities and Groundwater sections of this report.)

Tritium levels averaging 22,000 pCi/l, which exceed the US/EPA 40 CFR 141 Community Drinking Water Standard of 20,000 pCi/l, were found in the outflow of one of LBLs many hydraugers (designated 7712H in this report; most of LBLs hydraugers do not contain tritium), and an average of 12,000 pCi/l was found in rainwater samples taken at an onsite location 70 m from the tritium stack. The hydrauger flow rate is low (average 0.2 l/min), and the effluent eventually flows into Strawberry Creek. Neither the hydrauger water nor that of Strawberry Creek is potable or used for agriculture or recreation. Since no practical way exists to remove existing tritium from water, no remediation effort is planned. However, the National Tritium Labeling Facility instituted a program to markedly reduce airborne tritium releases (the origin of the environmental tritium). The releases from the facility during 1992 were comparable to those of 1991 and reflect a sharp downward trend (see Figure 4-9 of this report).

Aside from LBL sewage, no tritium has been detected in samples taken from offsite water.

Gross data for radioactivity in environmental air and water for the period 1983–1992 are presented in this report for comparison with the 1992 data. These gross data show that, except for a period following the Chernobyl fire (1986), gross radioactivity concentrations in air and water in the vicinity of LBL show only small fluctuations from historical background levels.

# Section 1
# Introduction

## 1.1 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 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 the 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, 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 was completed in 1964. The HILAC and Bevatron were closed in FY 1993, and plans for decommissioning the facility are under way.

## 1.2 The Site

### *1.2.1 San Francisco Bay Area*

LBL is located five kilometers east of San Francisco Bay on the slopes of the Coast Range within 479 hectares (1183 acres) of contiguous UC land. Most of the Laboratory's main-site buildings are owned by DOE and were constructed on University land under long-term lease to the Federal government. The Laboratory's 54-hectare (134-acre) site is in Alameda County, with the eastern portion of the site in Oakland and the Western portion in Berkeley, largely a university and residential community with a population of 103,000. 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, about five kilometers north of Berkeley (Figures 1-1 and 1-2).

The San Francisco Bay Area is a cosmopolitan region comprising nine counties in the 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 a residential area, commercial, industrial, or highways. The highly diversified, technology- and service-oriented labor force of the region totals 3.3 million people. The industrial base is not oriented toward cyclically sensitive heavy industry but toward high technology. Aerospace, computers, electronics, scientific instruments, and communications equipment comprise more than 50% of all manufacturing jobs.

Alameda County, with a population of 1,280,000 and 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

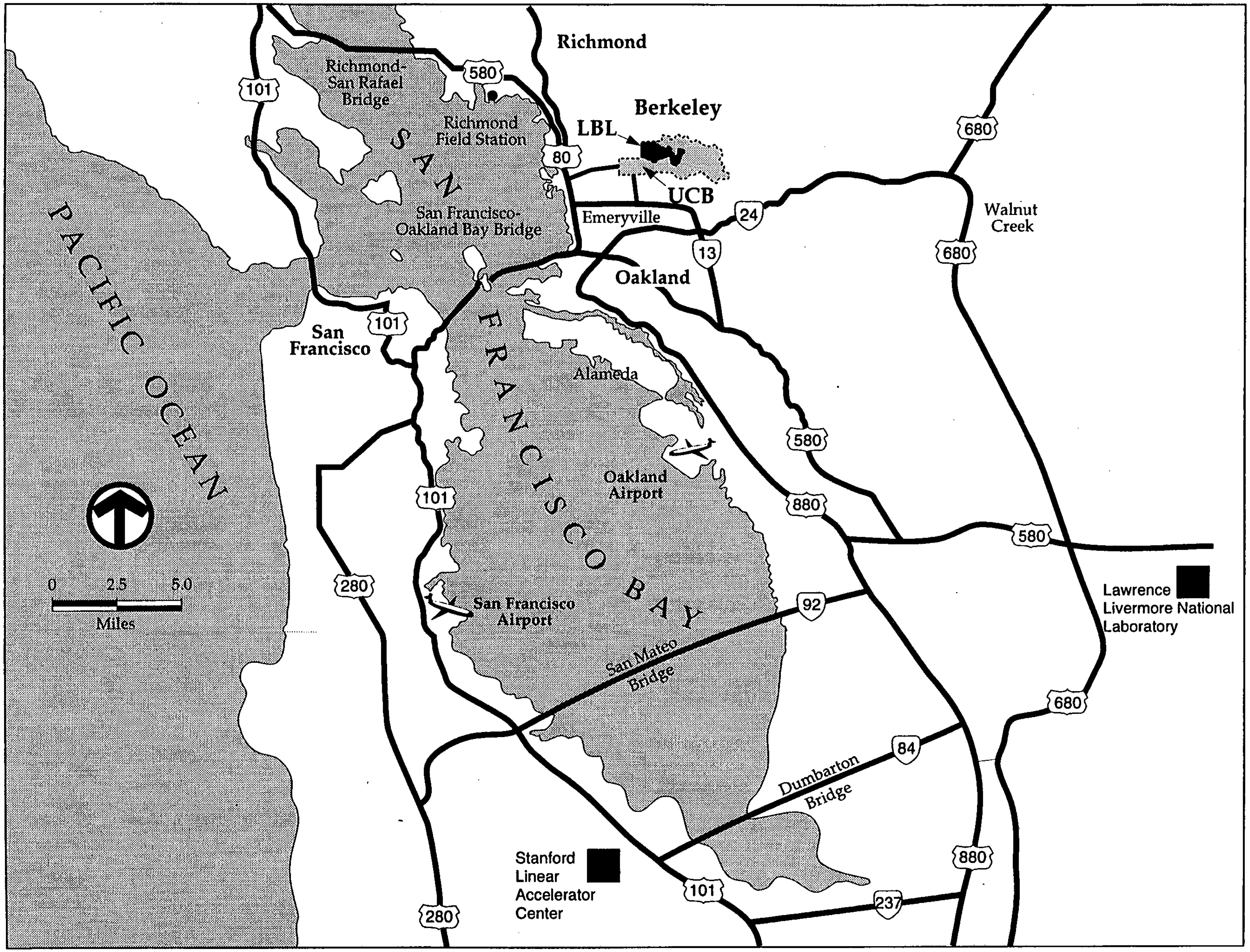



**Figure 1-1.** San Francisco Bay Area Map.

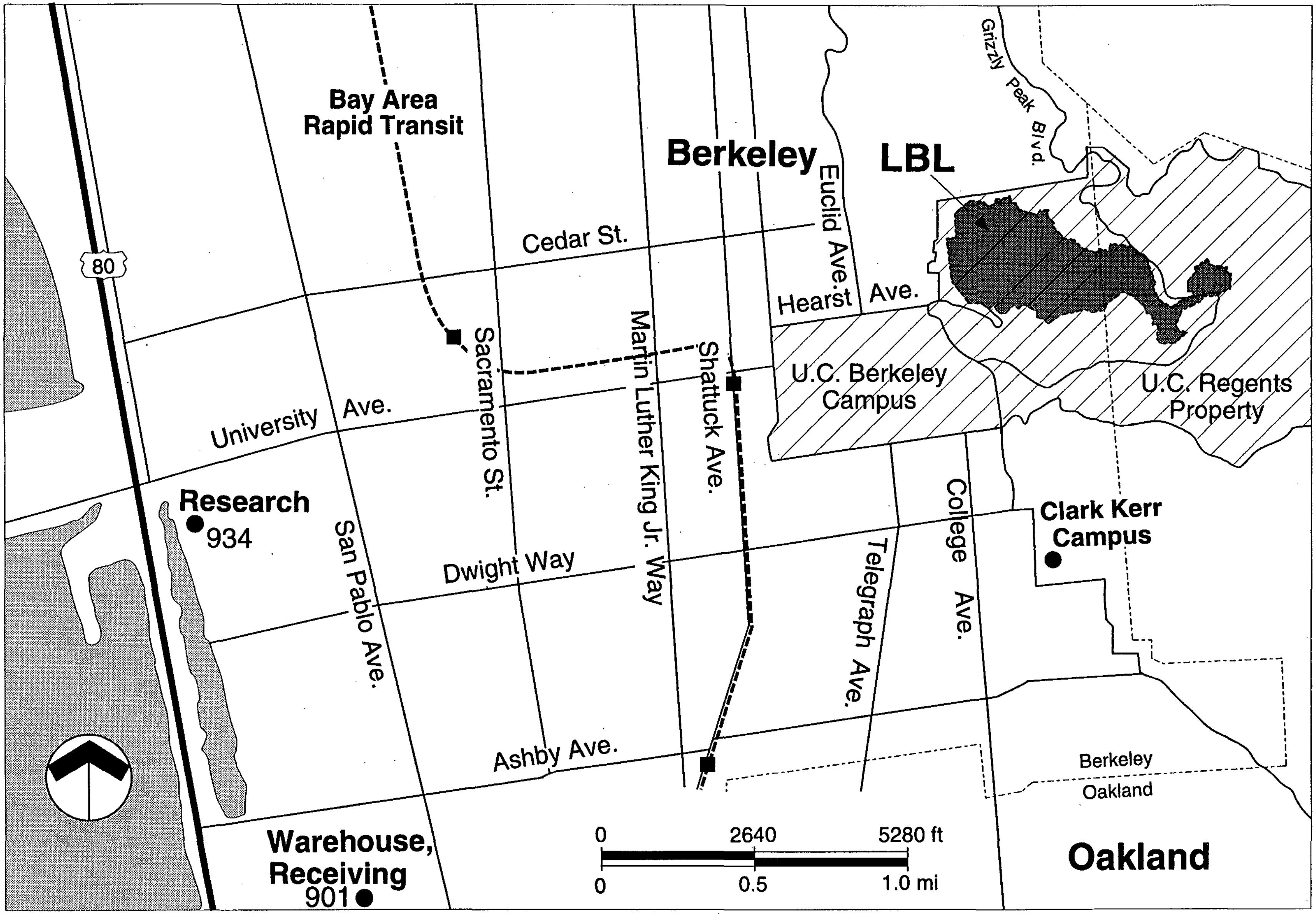



**Figure 1-2.** Vicinity Map.

electronics, automobile assembly, biotechnology, and food processing. Alameda Naval Air Station is home base for several aircraft carriers of the Pacific Fleet. 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 land use, noise, scenic routes, and housing.

### *1.2.2 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. 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 during recent years.

### *1.2.3 The Laboratory*

The Laboratory 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 (Figures 1-3 and 1-4). 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 located 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 multiunit dwellings, student residence halls, and private homes.

The eastern section of the main Laboratory site is located along the northeast boundary of Oakland. Although the area 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. The DOE Operations Office at San Francisco (DOE/SF) is located in Oakland. In addition DOE/SF maintains offices and staff at its Site Office at LBL.

## 1.3 Laboratory Operations

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 science research that is appropriate for an energy research laboratory. The Laboratory also supports nationwide university-based research by providing national facilities, including the National Center for Electron Microscopy, three large accelerators (the Bevatron, the SuperHILAC, and the 88-Inch Cyclotron), the Human Genome Center, several small accelerators, a number of radiochemical laboratories, several large gamma irradiators, and the National Tritium Labeling Facility.

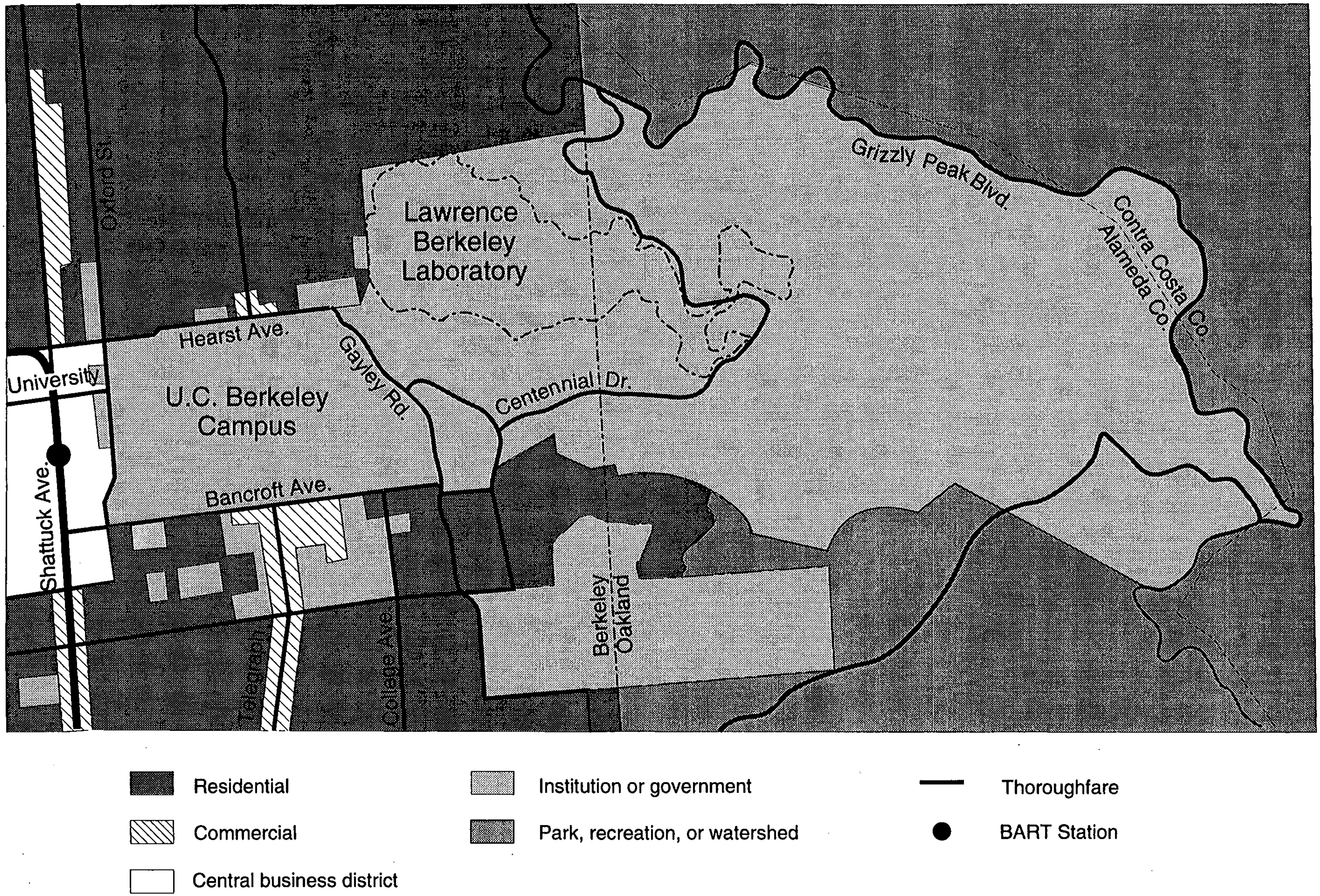



**Figure 1-3.** Adjacent Land Use Map.

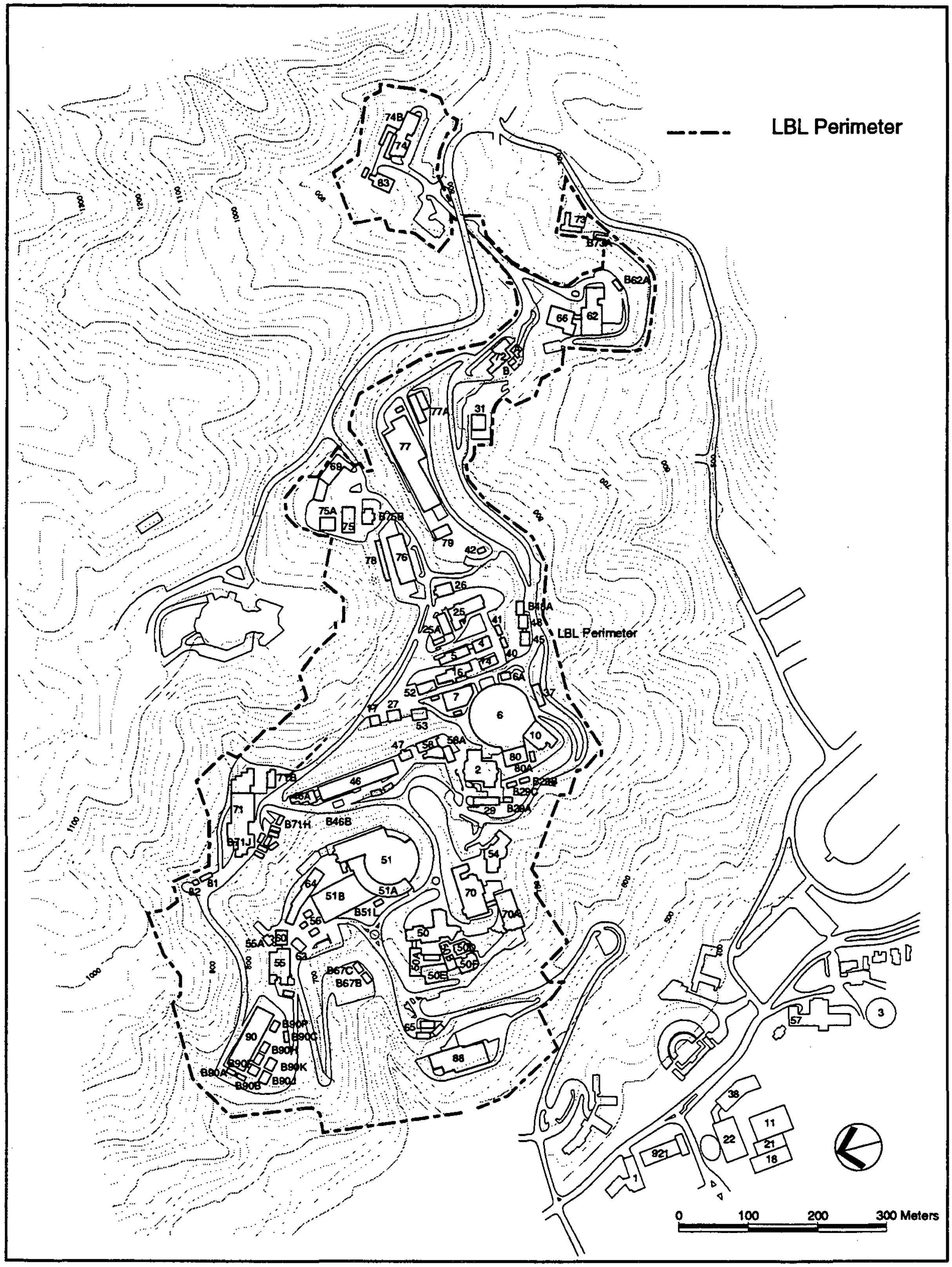



**Figure 1-4.** Lawrence Berkeley Laboratory Buildings.

## HILL-SITE 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 |
| 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 (NTF) |
| 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 1-4 (p. 2).** Key to LBL Buildings shown on previous page

The Bevatron (Building 51) is the most massive of LBL's accelerators. Originally designed as a 6-GeV proton synchrotron, it is presently capable of accelerating ions up to $^{40}Ca$ from 20 MeV/nucleon to 2.1 GeV/nucleon, and ions up to uranium to 1 GeV/nucleon. For certain beams the SuperHILAC is used as an injector. (This combination is called the Bevalac.) The SuperHILAC (Building 71), a heavy-ion accelerator, produces ion beams up to 8.5 MeV/nucleon. Both the Bevatron and the SuperHILAC were fully operational during 1992. Aside from shutdown periods, these two accelerators provided beams around the clock. In 1993, DOE ceased funding the operation of the Bevatron and SuperHILAC. Both accelerators were shut down in February 1993.

The 88-Inch Variable Energy Sector-Focused Cyclotron (Building 88) routinely produces intense beams of protons to about 60 MeV, alpha particles to 140 MeV, and heavy ions to mass 40 to energies of 350 MeV. The 88-Inch Cyclotron provides beams ~120 hr/wk.

The National Tritium Labeling Facility, located in Building 75, was designed to handle kilocurie quantities of tritium, 3H, a radioactive isotope of hydrogen used as a labeling agent for a variety of molecules subsequently employed in chemical, pharmaceutical, and biomedical research. The facility is funded by the National Institutes of Health.

Radiochemical and radiobiological studies performed in many laboratories at LBL typically use millicurie quantities of a great variety of radionuclides.

## 1.4 Future Programs

### *1.4.1 Human Genome Laboratory*

The Human Genome Laboratory will be a 3800 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. If Congress approves funding this fall, design work on the Human Genome Laboratory will begin in early 1995.

### *1.4.2 Advanced Light Source (ALS) Structural Biology Support Facilities*

The Structural Biology Support Facilities will occupy a total of 1030 gsm (11,100 gsf) on the second floor of ALS (Building 6) and the second floor in Building 80, which adjoins Building 6. This location provides the Support Facilities with direct access to the ALS experimental facilities for optimum integration of associated research and development activities. The ALS Structural Biology Support Facilities will support life sciences research activities at the ALS, including x-ray microimaging and microholography, x-ray spectroscopy, and x-ray crystallography.

### *1.4.3 ALS Beamlines Initiative*

This project will provide a second complement of experimental facilities for the ALS, including insertion devices, beamlines, and 1880 gsm (20,200 gsf) of finished light laboratory and office space for ALS users. Located on the second floor of the ALS building, these new facilities will support research in materials and surface science, chemical dynamics, and structural biology.

### *1.4.4 Induction LINAC Systems Experiment*

The Induction LINAC Systems Experiment (ILSE) will be housed in Building 51B, a part of the Building 51 Bevatron Complex. Building 51B is an open high-bay industrial space used as an Experimental Hall. The Conventional Facilities portion of this project will include a weather-tight building within Building 51B to house the ILSE Accelerator and its associated equipment. The project includes planning, designing, and construction to accommodate ILSE.

### *1.4.5 Chemical Dynamics Research Laboratory (CDRL)*

Located in a new three-story, 4330-gsm (46,600-gsf) building directly 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.

### *1.4.6 IsoSpin Laboratory*

This facility will be able to produce intense nuclear beams of nearly any element for studies of nuclear structure, nuclear reaction dynamics, astrophysics, high-spin physics, nuclei far from stability, material and surface science, and atomic-interaction and hyperfine-interaction physics. The IsoSpin Laboratory will have two coupled accelerators. One will deliver a high-current, light-ion beam to a target; the other will accelerate the resulting radioactive species that emanate from the target, achieving excellent beam qualities. Among several options under study for the coupled accelerators, one of the most attractive uses a 70–100 MeV LINAC injector and rapid-cycling synchrotron to accelerate the primary beam into one or more target stations, and a heavy-ion LINAC to accelerate the resulting radioactive species.

### *1.4.7 National Biomedical Tracer Facility*

The National Biomedical Tracer Facility (NBTF) will include a proton accelerator, isotope-processing laboratories, radiochemical laboratories, and infrastructure. The facility will support DOE's Health and Environmental Research program of isotope-based research and of development of tracer isotope resources for biomedical research. The NBTF will draw on LBL's existing expertise in isotope preparation and handling; radiochemical systems; accelerator design, engineering, and operation; and EH&S operations. In addition, the facility will be able to use many existing resources, including utilities, shielding, and some accelerator components.

### *1.4.8 Molecular Design Institute*

A new laboratory building designed to optimize interactions among physicists, chemists, materials scientists, and biologists, the Molecular Design Institute will provide laboratory resources for the design and synthesis of novel, complex molecules for physics, electronics, materials science, and environmental science. State-of-the-art techniques and research equipment will be used and developed to investigate the physical and chemical properties of artificial structures at the atomic and microscopic level. Investigators will interact closely with core groups of synthetic bio-organic and inorganic chemists to develop new techniques for controlled synthesis of new molecular structures.

### *1.4.9 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.

### *1.4.10 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 Division Administration. Facilities will include 1360 gsm (14,650 gsf) of office space, 1390 gsm (15,000 gsf) of laboratory space, 116 gsm (1,250 gsf) of new training facilities, and 102 gsm (1,100 gsf) of acid neutralization space.

### *1.4.11 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 just east of Building 83 and will be built to meet the latest waste management requirements. This facility is due to be operational by the end of the second quarter of 1995.

## 1.5 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 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. There are no threatened or endangered species that have been identified in or adjacent to the LBL Site.

Adjacent land use consists of residential, institutional, and recreation areas (Figure 1-3). Development within the Laboratory site is governed by guidelines that were developed with the understanding 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.

## 1.6 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 FY 1992 the average age of the main-site buildings is 33 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 1-5 shows the 1992 LBL space distribution.

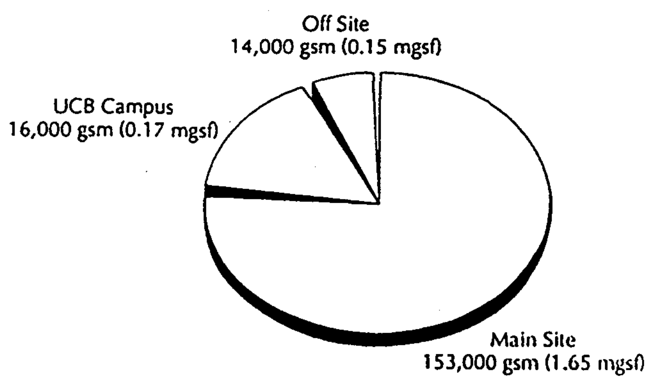



**Figure 1-5.** LBL 1992 space distribution
Total: 180,000 gsm (197 Mgsf)

## 1.7 Water Supply

The East Bay Municipal Utility District (EBMUD) supplies water to LBL primarily from large-capacity reservoirs (260 million $m^3$) (68 trillion gallons or 210 thousand acre feet) in the Sierra Nevada foothills. Water is transported via 150 km (90 miles) of aqueducts to five local reservoirs. The system supplies 20 communities, comprising 1.1 million people (348,000 water meters) in an 821-$km^2$ (317 square-mile) service area. Average use is 830 million $m^3$ (219 billion gallons) per day during high-use years. During a recent drought, customer conservation incentives reduced consumption to 685 million $m^3$ (181 billion gallons) per day. Additional local storage capacity is planned with the construction of three new reservoirs. LBL uses approximately 550 $m^3$ (144,000 gallons) of water per day.

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 connections and sprinkler services to almost all buildings.

The LBL system is looped in many areas and is equipped with block valves that can be used to isolate portions of the pipe for repair or replacement while still maintaining full service to most facilities.

Because of the differences in elevation at the LBL site, there are two main pressure zones that operate at the nominal pressure of about 70 psi. The system is entirely a gravity system, except for the emergency fire-protection system described later. 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 LBL emergency fire-protection system consists of two 200,000-gallon water-storage tanks, one of which is located near Building 75 and the other near Building 71. At each 200,000-gallon tank site there is a diesel-driven fire pump with automatic controls that can pressurize the LBL system if EBMUD service is interrupted. In normal operation, water is slowly circulated from the LBL system through the 200,000-gallon tanks so they are always filled with potable water and the full 400,000 gallons are always available if required. The emergency fire-water system was installed in about 1979. An additional 300,000-gallon water-storage tank is also being proposed by LBL.

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 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.

## 1.8 Sanitary Sewer Systems

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

**Table 1-1.** 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 | 1450 (4580) | 50 | 15–25+ | Yes |
| Bevalac Accelerator Complex | 1132 (3715) | 50 | 15–25+ | No |
| Light Source Research and Engineering Area | 911 (2990) | 50 | 15–25+ | Yes |
| Shops and Support Facilities Area | 1320 (4330) | 50 | 15–25+ | No |
| Materials and Chemistry Research Area | 335 (1100) | 50 | 15–25+ | No |
| Life Sciences Research Area | 241 (790) | 50 | 15–25+ | Yes |

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 in 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 60% of the water used at LBL, except those that lie within the South Strawberry Canyon watershed.

Effluent from the Hearst Avenue monitoring station flows to a manhole located above the intersection of Cyclotron Road and Highland, where it enters the City of Berkeley pipe system, which transports it 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 UC 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 six inches in diameter. However, most of the lines are on a steep gradient and have operated satisfactorily. The monitoring stations measure the volume and the pH of the effluent on a continuous basis. Proportional samples of the sewage are also taken at regular intervals and analyzed for heavy-metal content and radioactivity. After the effluent leaves the monitoring stations, it enters the City of Berkeley system, as described above. Part of the effluent flowing through the LBL monitoring stations originates from University of California Berkeley campus facilities, mainly the UC Berkeley Lawrence Hall of Science and the UC Berkeley Space Science Laboratory.

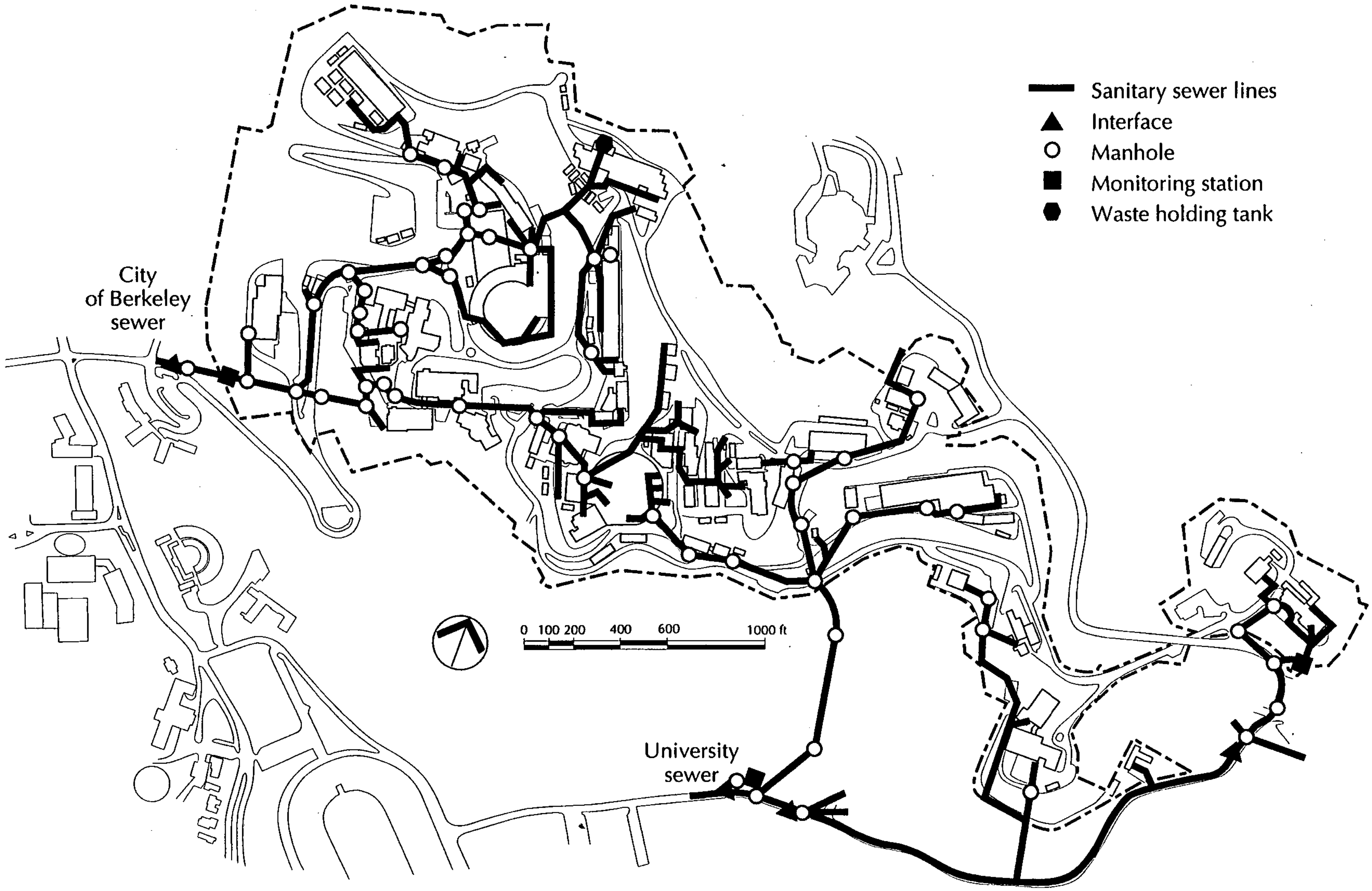



**Figure 1-6.** Sanitary sewer system.

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

The measured wastewater volume for calendar year 1992 at LBL was 234 million liters (62 million gallons). This was approximately 70 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 storm water 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.

## 1.9 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 Blackberry Creek watershed on the north side of LBL and the Strawberry Creek watershed on the south side (Figure 1-7). 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 874 acres. There are two main creeks in the watershed, namely the North Fork and the South Fork of Strawberry Creek.

Storm water runoff generated from LBL and from the upper parts of the Blackberry Creek watershed discharges into a 1.5-m (60-inch) concrete culvert at the head of LeConte Avenue in 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. Subsequent to that time extensive improvements have been made by LBL and UC Berkeley. Current drainage facilities have been able to accommodate all runoff since the improvements have been made. These improvements included additional pipe and culvert capacity, a retention basin, trash racks, and hardening of stream channels.

## 1.10 Laboratory Population

In 1992, the Laboratory's employee population consisted of 3,510 full- and part-time employees. These employees included 838 staff scientists, 234 faculty scientists, 1,034 technical staff, 121 postdoctoral fellows, 453 graduate students, and approximately 177 undergraduates. LBL maintains a register of official guests, updated monthly, which contained 1,550 registered guests in 1993. About 600 of these guests were on site at any one time, so that total Laboratory population was 4,110 (Figure 1-8). Of this total, 3,486 are located at the main site, 500 are located in UC Berkeley Campus buildings, and 130 are located in offsite leased buildings.

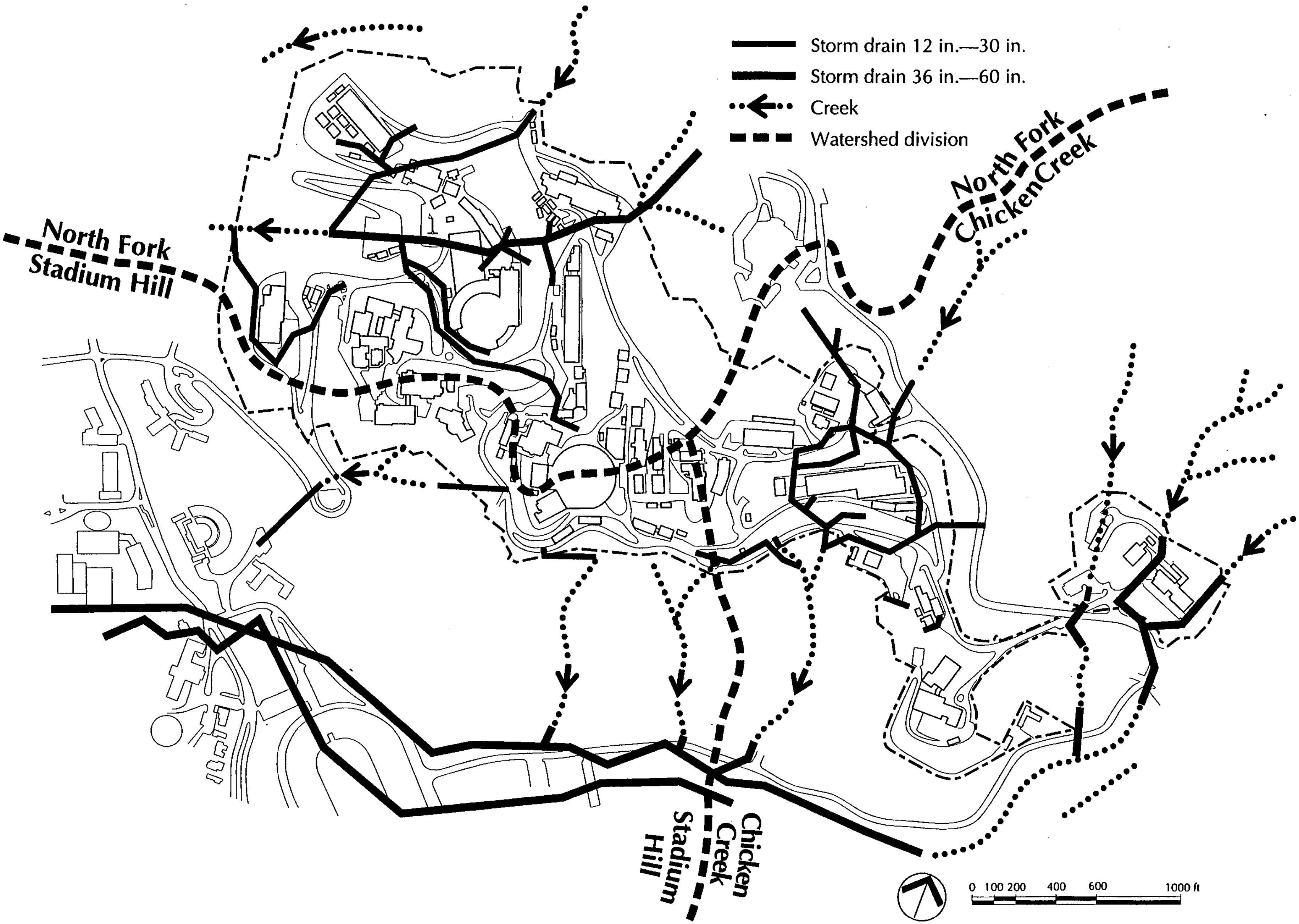



**Figure 1-7.** Hydrology and storm drainage.

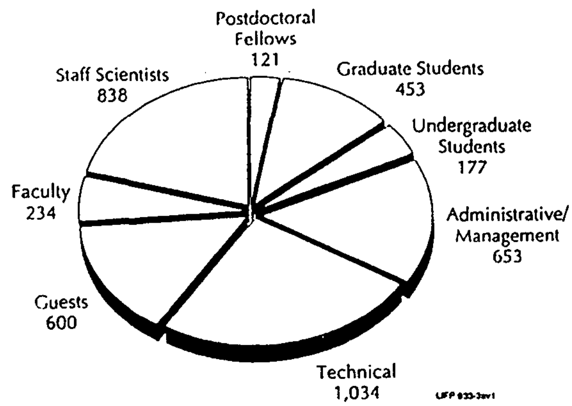



**Figure 1-8.** LBL peak population, FY 1992 (total: 4110)

## 1.11 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 1-2). 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 affects 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 10 mph, blowing from the east in the morning and from the west in the afternoon (Table 1-3). In late spring and summer ocean fog often flows across San Francisco Bay to envelop the LBL site during morning and evening hours.

**Table 1-2.** 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 1-3.** LBL Wind Data

| Direction | Speed, kph (mph) 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** |

About 95% of the average annual rainfall of 25 inches at the Laboratory occurs from October through April, the winter rainy season. Rainfall intensities are seldom greater than one-quarter inch per hour (Table 1-4), 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.

**Table 1-4.** 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) |

## 1.12 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 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. Consequently, the soil profile developed from these rocks is typically a few feet thick.

Three major formations have been identified at the LBL site. The western and southern part of LBL are underlain 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 very eastern 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.

## 1.13 Hydrogeology

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. The volcanic flow rocks typically contain open fractures, while the sedimentary rocks consist of interbedded impervious claystones and siltstones and low- to moderate-permeability sandstones. In the Orinda Formation the 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 it, whereas clay layers impede or direct flow. LBL's complex geology include both elements. Across the site, water-table depths vary from 3 meters (10 feet) to more than 27 meters (90 feet) (Table 1-5).

During the winter rainy season, groundwater levels and hydrostatic pressure increase, intensifying slide dangers. The Laboratory has installed an extensive system of monitoring wells and drainage lines (Figure 1-7) to maintain slope stability.

Because of LBL's hillside location, surface runoff is a prevalent feature of the site in the winter rainy season. The Laboratory straddles three divisions of the Strawberry Creek watershed well above any flood-plain zone. Various tributaries of the watershed's two main creeks provide natural drainage across the LBL site. Within the central portion of LBL, natural drainages have been engineered to accommodate development and a system of storm drains directs creek flows and collects runoff. To control possible groundwater contamination, the Laboratory's Environment, Health and Safety Division (EH&S) has initiated a program that characterizes and remediates groundwater contaminants.

**Table 1-5.** Water Table Depths

| Functional Area | Depth (ft)[a] |
|---|---|
| 88-Inch Cyclotron Research Area | >40 |
| Central Research and Administration Area | 16–30 |
| Bevalac Accelerator Complex | 18–50 |
| Light Source Research and Engineering Area | >20 |
| Shops and Support Facilities Area | 65–100 |
| Material and Chemistry Research Area | 10–15 |
| Life Sciences Research Area | 10–30 |

[a]Depths represented as > X indicate that existing borings have encountered no free water to that depth.

Existing LBL storm drains can accommodate peak water runoff based on a 25-year storm and the intensity-duration data for seasonal rainfall (Table 1-4). Over the last 30 years the drainage system has been improved with large conduits, special inlet and exit structures, energy dissipaters, trash racks, and hardened channels. Successful system operation depends on regular removal of accumulated debris. If the system does become clogged, an emergency bypass system in the Upper Strawberry watershed can be activated.

Two creeks and their tributaries provide natural drainage for the LBL site. Groundwater drains into the North Fork of Strawberry Creek in the north portion of the site, and to Strawberry Creek in the south portion of the site. Both creeks flow through the UCB campus and then into the City of Berkeley storm drainage system. Both creeks eventually drain to the San Francisco Bay.

## 1.14 Biological Resources

### *1.14.1 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 established large stands. Without recurrent wildfires or other management intervention, 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 (Figure 1-9): 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 forested.

*Native Woodland*

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


**Figure 1-9.** Vegetation types.

*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 two meters tall (six feet). Coastal scrub areas on south- and west-facing slopes host sparse, low shrubs (up to 1 meter or three 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 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 handle a long annual dry season. These introduced species require regular supplemental irrigation to maintain health and appearance.

### *1.14.2 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 1-10) 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.

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.


**Figure 1-10.** Landscape management.

### *1.14.3 Landscape Management*

*Landscape Buffers*

To facilitate appropriate siting of buildings and protect important open space areas, the Laboratory has established nine landscape buffer zones across the site (Table 1-6 and Figure 1-10). 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 campus 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 has 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. Fire protection along the south and east perimeters is complicated by limited buffer space within the fence line and concomitant proximity to less-managed University lands. Since the fire of October 1991, which devastated the adjacent Berkeley/Oakland Hills, 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. The Laboratory's Fire Inspector and Consulting Landscape Architect coordinated the effort to reduce fire hazard while maintaining landscape value. Initial priority measures (Figure 1-10), including revegetation with native species, were completed in the fall of 1992, and the next steps are under way.

**Table 1-6** 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 |

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 need replacement,and the Laboratory would benefit from increased tree cover in several areas.

## 1.15 Seismicity

LBL is located in a seismically active region (Figure 1-11). 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.

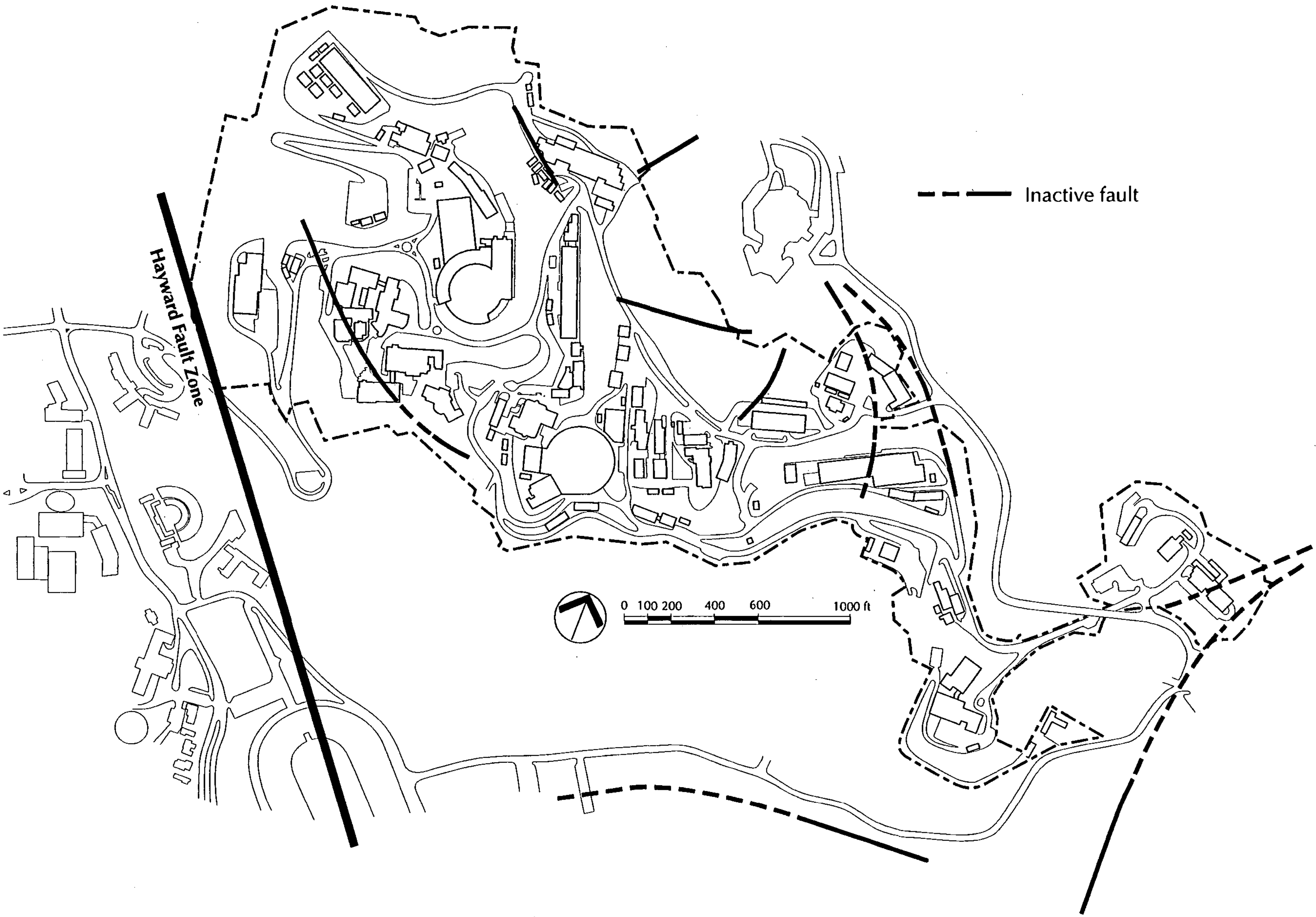



**Figure 1-11.** Earthquake faults.

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.

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 slated to undergo seismic strengthening in FY 1993.

### 1.16 Historical and Archaeological Resources

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

A check of the data on file with 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. The LBL area lies in the headwaters of Strawberry Creek, in the offshoot called Blackberry Canyon. No prehistoric cultural resources are reported to lie within the Lawrence Berkeley Laboratory, as delineated by the chain link fence which 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 relatively 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) itself occupies what is probably 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.

# Section 2
# Compliance Summary

## 2.1 1992 Calendar Year

### *2.1.1 Compliance Status*

*Clean Air Act (CAA)*

US/EPA issued an Administrative Order and Finding of Violation, dated April 19, 1991, for noncompliance with all the requirements of 40 CFR 61 Subpart H, "National Emissions Standard for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities" (part of NESHAPs). US/EPA and the DOE have negotiated a draft Federal Facilities Compliance Agreement (FFCA) that will outline a schedule for bringing the Laboratory's program into full NESHAPs compliance by February 1995. The FFCA includes a $1.5 million corrective action project which will upgrade the environmental monitoring equipment to NESHAPs standards. A meeting between DOE/SF, LBL, and the US/EPA Region IX, technical, legal, and compliance staff members was held on February 13, 1992, to discuss monitoring and scheduling issues. (See Section 2.2.1, *Compliance Status*, for the current status.)

The Bay Area Air Quality Management District (BAAQMD) conducted a total of nine inspections of stationary air emission sources during 1992. These annual inspections occurred between April 7 and July 24. The inspections resulted in the issuance of one Notice of Violation (NOV) for incomplete recordkeeping at a paint spray booth. A procedure for recording the required information was prepared and implemented. This revised procedure was approved by the BAAQMD inspector who cited the deficiency.

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. One violation was issued in 1992 for an administrative error. LBL submitted the required advance notification to BAAQMD. However, LBL failed to inform BAAQMD of a delay in the project.

*Clean Water Act (CWA)*

The East Bay Municipal Utility District (EBMUD) issued six Notices of Violation during 1992 for excursions of discharge limits into the City of Berkeley sanitary sewer systems. Three of these excursions resulted from activities in Building 77; two of the excursions were linked to the treatment unit and the other resulted from Building 77 operations. The remaining three excursions were discovered by downstream sewer monitoring; investigations could not identify the causal source(s). LBL investigated all six violations. All of the investigations are considered adequately reviewed and therefore closed by EBMUD. Mitigation measures were adopted in response to three of the events to prevent recurrence of these situations. EBMUD has assessed penalties for each violation. These penalties have taken the form of fees related to the follow-up inspections and monitoring. LBL remains in compliance with EBMUD discharge limits. However, the increased number of NOVs has initiated discussions by

EBMUD on LBL's potential for being recategorized to Significant Noncompliance. LBL has worked closely with EBMUD to avoid such a designation, which would lead to considerably increased administrative and enforcement actions.

In August 1992, the Laboratory revised its *Spill Prevention, Control, and Countermeasure Plan* (SPCC) in compliance with US/EPA "Oil Pollution Prevention" 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. The DOE/SF Operations Office approved the SPCC Plan in October 1992.

In September 1992, LBL prepared a *Storm Water Pollution Prevention Plan* (SWPPP) and a *Storm Water Monitoring Program* (SWMP) in accordance with the National Pollutant Discharge Elimination System (NPDES) requirements for storm water discharges associated with industrial activities. Together they represent LBL's plan and procedures for identifying illicit discharges, as well as monitoring and reducing the potential for pollutants in its storm water discharges.

*Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by Superfund Amendments and Reauthorization Act (SARA) and California Carpenter–Presley–Tanner Hazardous Substances Account Act (HSAA, also known as the State Superfund Act)*

In 1991, LBL submitted a preliminary assessment/site inspection (PA/SI) package to US/EPA for review. The objective of US/EPA review was twofold: (1) to determine if the facility had met SARA requirements as defined in Section 120; and (2) to determine if site conditions at LBL pose a significant threat to human health and the environment such that it warrants placement on the National Priorities List. Completion of US/EPA review in late 1991 determined that LBL had submitted enough information to meet the PA/SI requirements. LBL did not rank high enough under the Hazard Ranking System to warrant inclusion on the National Priorities List, and US/EPA's recommendation was that there be no further remedial action planned under CERCLA. Therefore, 1992 site restoration activities are discussed under the section on the Resource Conservation and Recovery Act.

In August 1992, US/EPA sent various parties, including LBL, a Notice of Potential Liability and Request for Information pursuant to Sections 106 and 104(e) of CERCLA for the North American Environmental Inc. (NAE) site in Clearfield, Utah. LBL was provided information indicating that thirteen drums of PCB waste originating at LBL had been transported to the Utah site in violation of an agreement between NAE and LBL's subcontractor, which had required disposal of these wastes in compliance with the Federal law. LBL removed all of its waste from the site prior to its being officially designated a Superfund site on September 1, 1992. The wastes were removed in accordance with a March 1992 US/EPA protocol and 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 the position that it would be inappropriate for LBL to participate in further removal actions at the NAE site, because no reported LBL wastes were any longer 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 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.

In November 1992, LBL also responded to a Request for Information from Cal/EPA's Department of Toxic Substances Control (DTSC) for information regarding the Bay Area Drum 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. LBL has not yet received a response from the State regarding LBL's possible status as a Potentially Responsible Party at the site.

*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)*

Sections 311 and 312 of SARA Title III are incorporated into the requirements of the Hazardous Materials Release Response Plan and Inventory Law. Section 311 requires that Material Safety Data Sheets (MSDS) be prepared 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. Locally, LBL's reporting requirements are overseen by the City of Berkeley. These requirements are administered through a submittal entitled "The Business Plan." The Business Plan requires detailed inventories as well as an emergency response plan and procedure to be carried out in the event of an actual or threatened release. The inventories must be updated annually. The training, safety, and contingency plan portions of the Business Plan must be updated every two years, unless significant changes occur. LBL last submitted the Business Plan to the City in January 1992. (See Section 2.2.1, *Compliance Status*, for the current status.)

In September 1992, a DOE Secretarial Memorandum directed DOE's voluntary participation in a Toxic Release Inventory (TRI) reporting and US/EPA "33/50" Pollution Prevention Program pursuant to Section 313 of the Emergency Planning and Community Right-to-Know Act (SARA Title III). Participation is slated to begin with submittal of Calendar Year 1993 information. (See Section 2.2.1, *Compliance Status*, for the current status.)

*Endangered Species Act (ESA)*

A complete assessment of endangered and threatened plant and wildlife species known or suspected to occur within the vicinity of LBL took place in 1991. This review, which was verified by the U.S. Fish and Wildlife Service, found no endangered or threatened organisms within the LBL site. In 1992, there was no new or planned building construction that would have required a reevaluation of these earlier findings.

However, LBL did conduct an ecological resource literature review and initiated interactions with the U.S. Fish and Wildlife Service for its proposal to conduct a two-year site restoration study to develop improved methods for removing contaminated groundwater from fractured aquifers at an existing well field located in Madera County, California, under an agreement with US/EPA. It was determined that the proposed activity did not have the potential to disturb protected species habitat or have the potential to result in incidental harm to threatened or endangered species.

*Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)*

LBL used registered pesticides in 1992. "Restricted use" pesticides were applied by licensed contractors. LBL personnel apply "general use" pesticides only.

*Hazardous Waste Source Reduction and Management Review (SB 14)*

In complying with this State requirement, LBL prepared a report that included two components: (1) *Source Reduction Evaluation Review Plan and Plan Summary*, and (2) *Hazardous Waste Management Report Summary*. This report was approved by LBL on March 26, 1992. It required certification on three levels; technical, financial, and operational. It clearly 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 *Source Reduction Evaluation Review Plan and Plan Summary* must be kept on site and updated every four years. The next update is scheduled for 1994. This plan established a timetable for performing Process Waste Assessments on those waste streams that are 5% or greater of the total waste stream from the Laboratory. Those waste streams include:

- spent empty drums greater than or equal to 30 gallons
- waste liquids with pH equal to or less than 2
- waste machining and grinding coolant/water
- waste mercury (extremely hazardous)
- waste oil (non-automotive)

The *Hazardous Waste Management Report Summary* is primarily meant to assess changes in activities. The first opportunity to assess any changes will be in 1994.

*Medical Waste Tracking Act of 1988 and California Medical Waste Management Act of 1990*

LBL's medical waste program generated approximately 12,300 kg (27,100 lb) of waste in 1992. There have not been any inspections of the Laboratory's medical waste program by the California Department of Health Services (DHS) since the program's inception in 1991.

*National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA)*

In 1992, LBL prepared 71 formal documents in accordance with DOE policies and procedures for NEPA compliance. These included 68 categorical exclusions and three Action Description Memorandums. The Action Description Memorandums were used by DOE to determine that

Environmental Assessments (EAs) were required for the proposed Human Genome Laboratory, and for disposition of copper coil windings from the 184-inch Cyclotron. LBL began preparation of these EAs and continued preparation of the EA for the Biomedical Isotope Facility. In October, DOE issued a Finding of No Significant Impact for Construction and Operation of a replacement Hazardous Waste Handling Facility at LBL.

In compliance with CEQA, the *Draft Supplemental Environmental Impact Report for the Proposed Renewal of the Operating Contract Between the United States Department of Energy and the Regents of the University of California for Operation and Management of the Lawrence Berkeley Laboratory* was approved by the UC Regents in November 1992. The Supplemental Environmental Impact Report addresses potential environmental impacts associated with the UC's operations of the Laboratory over the five-year period 1992 through 1997. The Laboratory also began preparation of an Initial Study for the Biomedical Isotope Facility and began data gathering and analysis for an Environmental Impact Report (EIR) for the proposed Human Genome Laboratory. In addition, LBL documented and received University of California Office of the President concurrence that 20 proposed projects were categorically exempt from CEQA.

*National Historical Preservation Act (NHPA)*

LBL is considering demolishing Building 7 because it presents a potential fire and safety hazard at LBL. This building was constructed in 1942 and was first used as a mechanical and electronics shop for the 184-inch cyclotron. In compliance with the NHPA, the Laboratory evaluated the building's potential historic architectural significance (Dobkin and Corbett, 1992). The evaluation indicated that the building is not eligible for listing on the National Register of Historic Places. Concurrence by the State Historic Preservation Office has been requested by DOE.

*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 has fallen out of the reporting requirements of this Act because it does not meet the *de minimis* levels identified in the Act. However, the hazardous waste manifest forms used by LBL include a generator's statement certifying that a waste minimization program is in place at the facility.

*Resource Conservation and Recovery Act (RCRA) and California Hazardous Waste Control Law (HWCL)*

On March 21, 1991, Cal/EPA's DTSC issued a Report of Violation (ROV) for hazardous waste violations found during a 1990 inspection. On January 7, 1992, the Office of the Attorney General for the State of California Department of Justice notified LBL that it was considering initiating legal action for these violations under the provisions of California hazardous waste control laws. DTSC, the Office of the Attorney General, LBL, and DOE began negotiations on the 1991 ROV in February 1992. On March 24, 1992, LBL submitted an information package to Cal/EPA that included up-to-date information on LBL's compliance activities. Meanwhile, DTSC issued a second ROV on April 9, 1992, for additional hazardous waste violations found during an inspection in February and March 1992. LBL submitted information in response to this ROV on May 13, 1992. The findings for both ROVs were combined into one settlement agreement. Negotiations toward a settlement on both the 1990 and 1992 violations continued for the remainder of the year. (See Section 2.2.1, *Compliance Status*, for the current status.)

LBL prepared the Biennial Hazardous Waste Report for the period 1990 through 1991 in March 1992. The report was submitted to US/EPA with a copy to the California DTSC. It contains specific generator and transport information for all activity at the Hazardous Waste Handling Facility for this two-year period. LBL also prepared the Annual Waste Reduction Report for the previous calendar year in March 1992. This report was submitted to DOE. It contains a detailed analysis of waste minimization efforts made by waste generators.

As part of the RCRA Part A and B permitting process, DTSC conducted a RCRA Facility Assessment (RFA) for LBL in 1991. The purpose of the RFA was to identify releases of hazardous waste and hazardous constituents to the environment from solid waste management units and areas of concern that may require corrective action. Thirty-five solid waste management units and eight areas of concern were identified at LBL in a report received in April 1992. Based on the findings of the RFA, it was concluded that corrective action will be necessary to clean up past and present contamination at the site.

In November 1992, LBL submitted a RCRA Facility Investigation (RFI) Workplan to DTSC. The Environmental Restoration Program is now being conducted under the RCRA Corrective Action Process. 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. The RFI Workplan outlines required field activities to define the extent of contamination and identify sources.

*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. Over 100 backflow devices have been installed during this phase alone. (See Section 2.2.1, *Compliance Status*, for the current status.)

*Toxic Substances Control Act (TSCA)*

There were no inspections or compliance issues in 1992. However, LBL prepared an annual PCB report as required by TSCA. This report inventories and documents PCB-related activities for the calendar year. The report is not submitted to US/EPA, but it must be made available to the agency if requested.

*Executive Order 11988, "Floodplain Management"*

The 1991 DOE Tiger Team Assessment of the Laboratory found that LBL had not performed floodplain assessments for DOE-owned or -leased facilities, or for facilities on the University of California at Berkeley campus where DOE activities take place. In response, the Facilities Department prepared a *Design Management Procedures Manual for Floodplain Assessment at LBL* in 1992. In addition, floodplain assessments were completed for every relevant onsite and offsite facility during 1992. The floodplain assessment consisted of a description of the facility (e.g., year constructed, construction type, relationship to floodplain) and a map depicting the facility and floodplain. None of the LBL facilities are located in the designated floodplain areas. 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.

*Executive Order 11990, "Protection of Wetlands"*

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

*Executive Order 12780, "The Federal Agency Recycling and the Council on Federal Recycling and Procurement Policy"*

LBL has established an affirmative recycling procurement group which meets every other month to address the key issues involved in this Executive Order. These issues include:

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

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

A total of 46 Occurrence Reports (ORs) were submitted by LBL to DOE during 1992. Of this total, about 23 ORs were for environmentally related incidents such as fires, small gas releases, sanitary sewer discharge excursions, and small fuel spills. The remaining ORs were for various incidents such as burglaries and operation procedure breaches.

*DOE Order 5400.1, "General Environmental Protection Program"*

Chapter IV of this Order provides the requirements and basic guidance for operating an effluent monitoring and environmental surveillance program. In accordance with these requirements, LBL completed an Environmental Monitoring Plan in November 1992 which was subsequently approved by DOE/SF.

### *2.1.2 Summary of Permits*

*Air Emissions*

BAAQMD issues operating permits for stationary sources of air pollutant emissions. LBL had obtained a facility-wide total of 36 such operating permits. These permits cover a broad spectrum 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. Eighty-one other sources are registered with BAAQMD and listed as exempt from permits. Of LBL's 36 operating permits, 13 were issued for either new or modified sources in 1992. In addition to the 13, one Authority-to-Construct approval was granted in 1992 for the renovation of the Instrument Support Laboratory in Building 70A. The Permit-to-Operate is expected once the construction is completed. (See Section 2.2.2, *Summary of Permits*, for the current status.) 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.

BAAQMD also manages the State's Air Toxics "Hot Spots" Information and Assessment Act (AB 2588). This Act requires 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, making 1992 the first year it was subjected to the update requirements. (See Section 2.2.2, *Summary of Permits*, for most recent change in AB 2588 reporting.)

*Hazardous Waste*

The Hazardous Waste Handling Facility (HWHF) operates under a RCRA permit issued by DTSC for US/EPA. Since 1989, LBL has been in the process of applying for a new RCRA permit. A revised Part A and B permit application addressing both the existing and proposed HWHF was submitted to DTSC on August 17, 1992. DTSC completed its internal review of this most recent application by deciding on October 29, 1992, that the application was administratively complete. This decision opened up a 45-day public review and comment period. The comment period ended on December 16, 1992, without the submission of comments by either the public or other regulatory bodies. (see Section 2.2.2, *Summary of Permits*, for the current status.)

The State's permit program for hazardous waste treatment and storage units, not requiring a RCRA permit, is in the initial implementation phase with a five-tiered permitting structure under AB 1772. The five tiers, listed in increasing order of regulatory complexity, include:

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

There are five treatment units located at LBL that fall within the scope of the tiered permitting program. They are:

- acid wastewater (Building 2)
- acid wastewater (Building 70A)
- oil/water wastewater (Building 76)
- plating wastewater (Building 25)
- plating wastewater (Building 77)

Efforts in 1992 concentrated on understanding the impact of the new rule, gathering relevant technical and administrative information needed on the permit application for each treatment unit, and completing needed engineering upgrades that are required by this new program. (See Section 2.2.2, *Summary of Permits*, for the current status.)

*Storm Water Discharge*

In March 1992, LBL submitted a Notice of Intent to the State Water Resources Control Board for coverage under the statewide general industrial permit for storm water discharges associated with industrial activities in compliance with NPDES requirements. The State acknowledged LBL's registration as a general permittee in October 1992 by assigning a permit identification number (2-01S002421) to the Laboratory. In September 1992, LBL prepared a *Storm Water Pollution Prevention Plan* and a *Storm Water Monitoring Program* in accordance with the NPDES permitting requirements. Together these documents represent LBL's plan and procedures for identifying, monitoring, and reducing pollutants in its storm water discharges. The regulatory implementation date of the SWPPP was October 1, 1992. The implementation date for the SWMP was January 1, 1993. However, LBL had the SWMP implemented by October 1, 1992 under a previous commitment to DOE.

*Underground Storage Tank*

Fifteen operating permits, issued by the City of Berkeley, have been obtained for tanks containing diesel, gasoline, photoprocessing solution, oil-spill control, transformer oil, and waste oil materials. Closure plans for two single-walled tanks (ID# 12, oil-spill control; ID# 14, photoprocessing solution) were submitted to the City of Berkeley in November 1992.

*Wastewater Discharge*

EBMUD has issued one site-wide wastewater discharge permit (Account No. 066-00791) and two specific permits for discharge from treatment units at metal finishing operations (plating) in Building 25 (Account No. 502-38911) and Building 77 (Account No. 502-38921). These permits are renewed annually in July.

## 2.2 Current Issues and Actions

### *2.2.1 Compliance Status*

*Clean Air Act (CAA)*

The draft FFCA between DOE and US/EPA is expected to be approved in the second quarter of 1993. Corrective action projects in the NESHAPs program have proceeded while negotiations continue on the final version of the FFCA. Two of the three NESHAPs compliance projects will need schedule modifications due to bids coming in over cost estimates. These schedule changes caused a modification to the draft FFCA compliance schedule. The modified schedule has been approved by US/EPA.

On July 16, 1992, US/EPA published an initial list of major and area source categories of hazardous air pollutants as required under Title III of the Clean Air Act Amendments of 1990. Title III requires that US/EPA establish a separate source category covering research or laboratory facilities to ensure equitable treatment of those facilities. However, US/EPA felt it did not have sufficient information to include these facilities as a source category at this time. As such, research or laboratory facilities will not be regulated under Title III of the CAA, as amended. Likewise, US/EPA has discretionary authority to establish lesser threshold quantities to define a major source of radionuclide emissions. US/EPA concluded that it was not prepared at this time to establish an alternate emissions threshold. For LBL, these two US/EPA actions mean that the Laboratory is currently not considered a major source for Title V permitting requirements and therefore not considered under any Title III source category for maximum achievable control technology requirements that will be forthcoming. Locally, BAAQMD is adhering to US/EPA policy as it begins modification of its permitting program to comply with the amended Clean Air Act.

Title VI of the Clean Air Act Amendments of 1990 addresses the phase-out of ozone-depleting substances (ODS). LBL has established a program for eliminating or reducing its ODS usage in solvent cleaning, refrigeration/comfort cooling, and fire suppression operations. The program is both near- and long-term oriented, as acceptable alternative substances are presently available for certain operations, while other operations do not have either acceptable alternatives or committed funding needed for the capital equipment purchases. Those operations with funding constraints are now included in future-year budgetary requests.

*Clean Water Act (CWA)*

After the increase in EBMUD Notices of Violation in 1992, there were no monitored excursions during the first quarter of 1993. In addition, LBL modified its Storm Water Monitoring Plan in March 1993. This plan had originally been implemented on October 1, 1992, along with the SWPPP, as part of the permitting requirements of the Laboratory's storm water discharge permit application. The regulatory assigned deadline for initial implementation of the SWMP had been January 1, 1993, but LBL had earlier made an October commitment to DOE.

*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)*

LBL is currently assessing its participation in the voluntary TRI reporting program agreed upon between DOE and US/EPA. LBL's participation is slated to begin with calendar year 1993 information. In April 1993, DOE notified Cal/EPA that it would respond at a later date to Cal/EPA's request for accelerating this submission date forward one year to include Calendar Year 1992.

LBL must provide the sitewide chemical inventory portion of the Business Plan to the City of Berkeley annually. LBL recently received concurrence from the City of Berkeley to change the reporting due date to July 1. This change gives LBL more time to prepare the inventories and, equally important, aligns LBL's submittal date with all other businesses in Berkeley.

The City of Berkeley has also notified the Laboratory that it must prepare and implement a Risk Management and Prevention Program (RMPP) prior to December 7, 1993. The RMPP is a requirement of the La Follette Bill (AB 3777) for a facility handling acutely hazardous materials above certain thresholds. LBL has triggered these thresholds for sitewide amounts of five substances; anhydrous ammonia, hydrofluoric acid, nitric acid, phophorus pentoxide, and sulfuric acid.

*Medical Waste Tracking Act of 1988 and California Medical Waste Management Act of 1990*

LBL prepared a draft *Medical Waste Management Plan* in March 1993 in accordance with the requirements for facilities classified as large-quantity generators [i.e., more than 90 kg (200 lb) per month of medical waste].

*National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA)*

In the first quarter of 1993, LBL prepared 14 formal documents in accordance with DOE policies and procedures for NEPA compliance. These included 11 categorical exclusions and three preliminary draft Environmental Assessments. The EAs are being prepared for the Human Genome Laboratory, the Biomedical Isotope Facility, and disposition of copper coil windings from the 184-inch Cyclotron.

In compliance with CEQA, the Laboratory continued preparation of an Initial Study for the Biomedical Isotope Facility and continued data gathering and analysis for an EIR for the proposed Human Genome Laboratory. LBL prepared an Initial Study for ongoing operations of and alterations and upgrades to the existing HWHF. Public notice of a proposed Negative Declaration was issued on March 1. The comment period extended through March 30. A notice of decision on the negative declaration is expected to be issued in April, after which DTSC is expected to issue the RCRA permit for continuing operation of LBL's existing HWHF and construction and operation of a replacement HWHF. In addition, LBL documented and received University of California Office of the President concurrence that three proposed projects were categorically exempt from CEQA.

*Resource Conservation and Recovery Act (RCRA) and California Hazardous Waste Control Law (HWCL)*

Cal/EPA's Department of Toxic Substances Control conducted an audit of the HWHF operations on March 11 and 12, 1993. Two potential Class I violations were cited: one for storage of incompatible materials in separate, sealed drums on a pallet that was awaiting offsite shipment; the second for a fire in the waste facility caused by improper waste packaging of lithium. Both findings resulted from work actions taken by LBL's waste contractor.

Negotiations on a settlement for the 1991 and 1992 DTSC Report of Violations continued, with a final settlement expected in the second quarter of 1993.

*Safe Drinking Water Act (SDWA)*

The second phase of the two-phase project for retrofitting the LBL drinking water system with backflow prevention devices is expected to be complete in May 1993.

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

Three Occurrence Reports have been filed by LBL in the first quarter of 1993. Two of these reports were for small fires, and the third was for an operations procedure failure.

### *2.2.2 Summary of Permits*

*Air Permits*

A Permit-to-Operate is expected from BAAQMD once construction of the Instrument Support Laboratory is completed in the second quarter of 1993. One new operating permit has been granted by BAAQMD thus far in 1993. Sixteen additional applications for individual operating permits are presently under review by BAAQMD.

During late 1992, BAAQMD modified its reporting requirements under the Air Toxics "Hot Spots" Information and Assessment Act (AB 2588). While the Act requires updates on toxic air contaminant inventories every two years, BAAQMD now requests inventory review every year during the annual permit renewal process. LBL's 1993 renewal will be the first submittal subject to these latest reporting changes.

*Hazardous Waste Permits*

A third RCRA Part A and B application for a permit to operate the HWHF has been reviewed by DTSC. Final signature of the new Part A and B permit is expected from DTSC in April 1993, after completion of the CEQA review for the project.

Five treatment units located at LBL are subject to the State's tiered permitting program for treatment and storage of hazardous waste. A Facility Specific Notification and Unit Specific Notifications covering these units was submitted to Cal/EPA on the April 1, 1993, regulatory deadline. Notification for three of the treatment units was submitted under the conditional authorization tier. Notification for the two treatment units serving plating operations was submitted under the permit by rule tier.

*Storm Water Discharge Permits*

In March 1993, LBL received information indicating that the State Water Resources Control Board is taking a position contrary to UC's position on the filing of a Notice of Intent (NOI) to obtain coverage under a General Construction Activity storm water NPDES permit. Based on this information, LBL is assessing the possible need to file an NOI for coverage under a General Construction Activity storm water NPDES permit for the LBL site as a whole.

*Underground Storage Tanks*

The two tanks for which closure plans were submitted to, and accepted by, the City of Berkeley in 1992 were removed from the site in March 1993. Soil samples were taken at both removal locations, as specified in the closure plans. A closure report will be submitted to the City of Berkeley in June 1993. The report will include an evaluation of the sample results. Also in March 1993, LBL submitted a closure plan for removal of a double-walled waste oil tank (ID# 69-1).

On February 6, 1993, an overfill of approximately eight gallons of diesel fuel occurred in secondary containment at a 1,000-gallon underground storage tank (ID# 2-2). The overfill was investigated and cleaned up within eight hours of detection. 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, with a follow-up status letter sent by LBL on March 12, 1993.

### 2.2.3 *Other Ongoing Environmental Activities*

As expected, several of LBL's current environmental activities arise from the Laboratory's affiliation with DOE. Progress on the Laboratory's Corrective Action Plan for resolving the findings of the Tiger Team's site visit in early 1991 continued. The total number of tasks at LBL generated from the Tiger Team assessment stands at 385, as several duplicate tasks were combined in 1992 to streamline reporting. Laboratory-wide, 1443 milestones were established to complete these tasks. The total number of tasks and milestones closed as of March 1993 were 271 and 1141, respectively. The number of tasks and milestones completed in 1992 were 156 and 575, respectively. Thus far, 29 tasks and 57 milestones have been completed in 1993. Of the 271 completed tasks, DOE had verified closure of 105 tasks as of April 1, 1993.

As a follow-up to the initial Tiger Team visit, 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/SF were performed concurrently with the follow-up visit: (1) the annual multi-disciplinary 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, and radiation protection and emergency preparedness.

Earlier, the DOE/SF Operations Office conducted a Functional Appraisal of LBL's environmental programs during the week of February 24–28, 1992. The purpose of this appraisal was to review the status of operations in the functional areas of environmental monitoring, air quality, and waste management relative to the 1988 Environmental Survey Team and the 1991 Tiger Team audits. The Functional Appraisal identified 13 findings and 12 observations; however, no imminent hazards were found. A Corrective Action Plan was accepted by DOE/SF in June. LBL developed 24 tasks with 56 milestones to address the Functional Appraisal's findings. DOE has validated 19 of the 25 findings and observations as complete. The 1993 functional appraisal is scheduled for April.

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 August 31, 1990. The State's designated lead agency for the purposes of the AIP is the Department of Health Services. The section of DHS delegated with overseeing the program is the Environmental Management Branch, although the State Water Resources Control Board, the San Francisco Bay Regional Water Quality Control Board, and the Office of Emergency Services will provide appropriate assistance. The AIP provides 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. Several introductory meetings (March 11, 1992, and August 6, 1992) were held to familiarize DHS with LBL's environmental monitoring and laboratory analysis programs. In September 1992, a workplan for the period January 1, 1993, through July 31, 1994, was approved by DOE and DHS. The work plan covers activities expected by the State agencies in the areas of program planning, reporting and data management, training, and community relations. In October 1992, the annual statewide AIP meeting between DHS and all six California-participating facilities was held in Monterey. Also in October, LBL provided DHS with radiological environmental monitoring data for the preceding five-year period. In December 1992, the first AIP quarterly update meeting focusing on LBL activities took place at LBL.

On July 21, 1992, the Westinghouse Hanford Company began a two-day audit of LBL's waste management program for the purpose of determining conformity with the requirements of WHC-EP-0063-3, *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. LBL received conditional permission to ship LLW and RMW, contingent upon completion of waste certification plans. A follow-up audit by the Hanford group on September 16 and 17, 1992, led to formal acceptance of the LLW and RMW from LBL's waste management program. Authorization to ship LLW and RMW was critical in LBL's efforts to eliminate the backlog of radioactive waste that had accumulated over nearly the last two years. Shipments of waste to Hanford began in August 1992. Four shipments have occurred since LBL received the conditional permission. The Hanford group returned on March 17 and 18, 1993, to observe the Waste Management Group's actual procedures for both waste types. The review included visiting waste sites, observing waste pickups, and reviewing procedures. The Hanford group did not report any findings during this audit.

The Waste Management Group has also made significant progress in other areas of its program. Specifically, the addition of more staff at both the professional and operational levels of the program, the realignment of field responsibilities, further training of technicians, and increasing the storage capacity and security of the HWHF has lead to the elimination of the chemical waste backlog that burdened waste operations during the past several years. The group has implemented numerous procedures that affect such activities as waste characterization, generator storage, and waste analysis tracking. In February 1993, DOE/SF authorized the restart of the Laboratory's waste compactor, which had been shut down since US/EPA's NESHAPs violation citing in 1991. Also of note, a new chemical waste contractor began handling and transporting hazardous waste off site during 1992.

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. The focus of the inspections was on the storage and use of hazardous materials as well as the procedures followed by hazardous waste generators for satellite and waste accumulation areas. The overall assessment made by the City was that improvements in generator training were needed to overcome various shortcomings in labeling of waste containers. Conversely, the City inspector noted several positive traits of the program at the generator level, namely waste reduction efforts, material storage practices, labeling and housekeeping, daily and weekly inspection checklists, and training records.

Also reflecting the heightened involvement by the City of Berkeley, the City Council requested further information from LBL during this period of inspections. On February 19, 1993, LBL presented an in-depth summary of its environmental programs at an open public meeting. The comprehensive presentation was designed to foster an open relationship with the City and community. The City Council was very impressed and appreciative of LBL's efforts.

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. First submittals were for the funding period FY94 through FY98 and limited to safety and health programs. The planning process expanded in 1992 to include environmental programs. In January 1993, LBL completed preparation of a series of Activity Data Sheets (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. Core activities are those necessary to maintain current levels of risk and compliance. Compliance activities are new and ongoing activities to raise the current core program to full compliance. These ADSs covered the period from FY95 through FY99. The funding request associated with these core and compliance ADSs totaled $8.8 million and $5.0 million, respectively. The complete list of environmental ADSs includes:

- <u>Core and Compliance</u>
  - air
  - management
  - toxics
  - waste generation

- waste minimization
- water

- Compliance Only
  - aboveground storage tank
  - illicit connections
  - underground storage tank
  - wastewater recycling

Additionally, LBL prepared eight ADSs during 1992 and thus far in 1993 for Environmental Restoration and Waste Management (ERWM) five-year planning activities in waste management and environmental restoration. 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 quite similar; the ADSs cover the same planning period and include breakdowns by cost, resources, and trackable milestones, plus a narrative justification for the funding request. The total package for these eight waste management and environmental restoration ADSs amounted to $64.6 million and $64.3 million, respectively. The ERWM ADSs prepared include:

- Waste Management
  - facility operations and maintenance
  - Hazardous Waste Handling Facility (new)
  - LBL waste storage
  - waste minimization management
- Environmental Restoration
  - closure of Hazardous Waste Handling Facility (existing)
  - program management
  - San Francisco facilities transition; Bevalac (ER)
  - soil and groundwater; environmental assessment and remediation

In February 1992, LBL requested a reprogramming of its ERWM corrective action project entitled *Air Toxics Facility Assessment and Rehabilitation.* This reprogramming divided the overall project into six subprojects, totaling nearly $3.2 million in corrective action work:

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

Currently, these projects are in various stages of design and construction. The majority of projects have scheduled completion dates at the end of FY93. However, the two NESHAPs projects will likely take until February 1995 to complete.

LBL also expended a large effort to either write or significantly modify a number of plans and procedures for environmental programs in 1992 and early 1993. These include:

- *Air Quality Program Manual*
- *Asbestos Management Plan*
- *Environmental ALARA Program*
- *Environmental Monitoring Plan*
- *Environmental Protection Group Procedures*
- *Environmental Protection Implementation Plan*
- *Groundwater Protection Management Plan*
- *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*
- *Procedures, Hazardous Waste Handling Facility*
- *RCRA Facility Investigation Workplan*
- *Spill Prevention, Control, and Countermeasure Plan*
- *Storm Water Monitoring Program*
- *Storm Water Pollution Prevention Plan*
- *Underground Storage Tank Management Plan*
- *Underground Storage Tank Monitoring Procedures*
- *Underground Storage Tank Response Plan.*

Some of these plans and procedures have a training element associated with them. For Laboratory-wide programs, training is administered by the EH&S Training Group. There are over 110 courses available through this group. Nearly 30 of these courses are directly related to environmental compliance issues. These 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.

Additionally, the Laboratory 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 the University of California Office of the President. The final document was published in February 1993. In concert with preparation of the guidelines, the Laboratory prepared a draft NEPA and CEQA training program plan, and began to develop training materials for courses that would be provided to Laboratory Division personnel and would be one of the Laboratory's required EH&S training programs. Following publication of the guidelines, 1.5 days of training on its implementation was provided to LBL Division personnel. The Laboratory also developed a Laboratory-wide tracking system for tracking the status of documents prepared in compliance with NEPA and CEQA.

Development of the LBL Self-Assessment Program was completed in 1992. The program provides a formal process for assuring quality and regulatory compliance in all facets of Laboratory operations. It generates targeted performance data in the areas of environment, safety, and health compliance through evaluations conducted at all levels of the Laboratory organization. The data are analyzed against LBL-established performance objectives and criteria to identify strengths, areas for improvement, and corrective actions.

Implementation of the LBL Self-Assessment Program is now under way. Divisions have developed implementation plans. Appraisal teams have attended self-assessment training, are conducting self-appraisals, and are tracking identified deficiencies to completion. Oversight is provided by the Office of Assessment and Assurance. In February 1993, the program was nominated for DOE Best Management Practice Recognition.

Effective October 1, 1992, DOE and the University of California (UC) 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 the Laboratory have programs in place that are designed to achieve compliance with applicable laws, regulations, ordinances, and DOE Orders relating to environmental protection. Furthermore, the Laboratory is required to report the results of a self-assessment on the performance measures to UC annually. Additionally, UC is required to have an annual audit of the Laboratory's environmental programs conducted by an external organization. The UC oversight will be independent of DOE.

In reference to new large-scale programs, the Advanced Light Source (ALS) came on-line in April 1993. In preparation of this startup, an ALS Operational Readiness Review began in April 1992. The purpose of the review is to fulfill a final and independent review of facility, equipment, and safety systems, operating, support, and supervisory personnel, and management systems and procedures. Twenty-one operational readiness areas were formally identified for the readiness review.

Also, the new HWHF is going through the preconstruction design phases. At the same time, an assessment of the environmental operating permits for the HWHF has begun. Construction of the HWHF is currently scheduled to begin in the fall of 1993.

Lastly, an event of tremendous historical significance in the global high-energy physics research community occurred on February 20, 1993, when the Bevatron (Building 51) completed its last experimental run. The Bevatron is the most massive of LBL's accelerators and had been operational since 1954. Age, technology, and funding were key issues in this determination. Support operations from the SuperHILAC (Building 71), a heavy-ion accelerator, had earlier shut down on December 23, 1992. The SuperHILAC had been operational since 1956. Numerous high-energy physics discoveries are credited to the Bevatron and SuperHILAC complex, or “Bevalac,” as it has become known as over the years. In addition to the historical loss, this will be a major loss of revenue for LBL.

Future plans for the Bevalac were submitted to DOE in April 1993. The current ER-funded Stand Down and Secure program will last through FY94. At that point, the Bevalac facilities will be transferred to DOE’s Environmental Management–60 (EM-60) for a three-year transition period, during which time the site will be adequately characterized, excess property will be removed, future-use plans will be formalized, and structural modifications will be made to the facilities. After the transition phase, Decommissioning and Decontamination (D&D) under EM-40 will take place. It is anticipated that the transition phase will greatly reduce the time and cost of D&D, since most of the materials in the Bevalac complex will have been removed for use at other DOE sites prior to the start of D&D.

The Bevalac closure will result in several beneficial impacts on environmental compliance activities. The most significant of these include eliminating water discharges into the sewer system from the cooling towers, atmospheric releases of chlorofluorocarbons from the accelerator's coolant systems, and public radiological doses from both penetrating radiation and airborne radionuclides.

# Section 3

# Environmental Program Information

## 3.1 Environmental Program Overview

This section of the report provides an overview of LBL's environmental surveillance practices and the rationale for those activities. The overviews that follow will identify the managing group, describe the governing environmental actions, and provide a summary of LBL's program. Detailed information on environmental monitoring activities associated with these programs will follow in subsequent sections.

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 (UC) reiterates these compliance objectives.

The Environment Department of LBL's Environmental, Health, and Safety Division is responsible for overseeing environmental regulatory compliance. The Environment Department is further structured into three groups; Environmental Protection, Environmental Restoration, and Waste Management. The two notable exceptions to environmental oversight include the Office of Assessment and Assurance, which manages the Laboratory's self-assessment program, and Planning and Development, which administers the environmental assessment program.

### *3.1.1 DOE Orders*

The requirement for the preparation of this annual report, its format, and the DOE environmental protection guidelines is found in DOE Order 5400.1, *General Environmental Protection Program*. Radiation protection guidelines are found in DOE Order 5400.5, *Radiation Protection of the Public and the Environment.*

### *3.1.2 Environmental Protection*

*Air Quality*

The Regulatory Affairs Unit of the Environmental Protection Group oversees compliance activities of air quality regulations. Air quality can be further categorized into nonradiological and radiological compliance.

*Nonradiological.* The Clean Air Act (CAA) is a broad Federal statute first passed in 1955 and amended several times, most recently in 1990. The CAA specifies ambient air quality standards; sets emission limits for specific air pollutants from mobile and new or modified stationary sources; and controls emissions for a number of hazardous air pollutants. The 1990 Amendments comprehensively revised the Federal air quality law to address many issues, including:

- classifying air quality in urban areas
- consolidating permit requirements for major sources

- developing maximum achievable control technology for 189 toxic 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 regulations implementing the amendments has just begun and will extend into the next century to fully complete. In one of its first actions, US/EPA published its initial list of major and area source categories of hazardous air pollutants in July 1992. This list did not include a source category covering research or laboratory facilities as required by the amendments. This requirement is included in the amendments to ensure equitable treatment of those facilities. US/EPA felt that it did not have sufficient information at the time to make this source category determination.

US/EPA also has discretionary authority to establish lesser emission threshold quantities of any substance for the purpose of defining a major source. In the case of radionuclide emissions, US/EPA concluded that it was not prepared to establish an alternate emissions threshold. For LBL, these two decisions mean that the Laboratory is currently not considered a major source for the new permitting requirements of the CAA amendments and therefore not presently subjected to the stringent control technology requirements that will be forthcoming for the listed source categories. US/EPA can update both the source category and threshold listings at any time.

The Clean Air Act Amendments of 1990 address the phase-out of ozone-depleting substances. LBL has established a program for eliminating its usage of affected ozone-depleting substances in solvent cleaning, refrigeration/comfort cooling, and fire-suppression operations. The program is both near- and long-term oriented, as acceptable alternative substances are presently available for certain operations, while other operations do not have either acceptable ozone-depleting substances alternatives or current year funding needed for the capital equipment purchases.

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 local and regional districts. There are two types of districts in California: Air Quality Management Districts (multi-county urban areas) and Air Pollution Control Districts (other areas). District programs must be as stringent as that of US/EPA. The mechanism ensuring this requirement is the development of a plan entitled a State Implementation Plan (SIP) prepared by each district. The SIP contains the enforceable rules and regulations needed by an individual district to attain compliance with air quality standards and emissions limitations. LBL is located within the Bay Area Air Quality Management District (BAAQMD), an agency with jurisdiction over a nine-county region that surrounds the San Francisco Bay.

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. This Act significantly expanded the scope and accelerated the pace of air pollution control efforts in the state.

Locally, it has led to development of the 1991 Clean Air Plan by BAAQMD. This plan is designed to comply with the following legal requirements arising from the Act:

- 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
- reduce population exposure to ambient pollutants
- regional public education program
- transportation control measures to achieve no net increase in vehicular emissions

BAAQMD implements both the Federal Clean Air Act and California Clean Air Act by establishing a set of enforceable Rules and Regulations for operations or equipment that may cause air pollution. These regulations are enforced through an air quality source permit system and periodic inspection program. If a violation of the District's regulations is found, a notice of violation is issued.

The permit system requires review of operation design for new or modified sources, plus an inspection of the source to proper operational compliance. Sources require two types of permits: an Authority-to-Construct, followed by a Permit-to-Operate. The Authority-to-Construct is issued prior to construction of a new or modified source. During the source startup period after construction is complete, District personnel inspect the source to verify that the equipment performs in compliance with the District's requirements. If compliance is verified, the District 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. There are 36 permitted sources at LBL as well as 81 registered exempt sources.

BAAQMD conducted nine inspections of stationary air emission sources during 1992. One Notice of Violation for incomplete recordkeeping at a paint spray booth was issued after inspecting over 110 registered sources. A procedure for recording the required information was prepared and implemented. This revised procedure was approved by BAAQMD inspector who cited the deficiency.

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. One violation was issued in 1992 for an administrative error. LBL submitted the required advance notification to BAAQMD. However, LBL failed to inform BAAQMD of a delay in the project.

*Radiological.* US/EPA issued an Administrative Order and Finding of Violation, dated April 19, 1991, for noncompliance with all the requirements of 40 CFR 61 Subpart H, "National Emissions Standard for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities." US/EPA and DOE have negotiated a draft Federal Facilities Compliance

Agreement (FFCA) that will outline a schedule for bringing the Laboratory into full compliance with this NESHAPs regulation by February 1995. The draft FFCA is expected to be approved in the second quarter of 1993. Corrective action projects in the NESHAPs program have proceeded while negotiations continue on the final version of the FFCA. The compliance schedule changed as the result of a recent unanticipated delay in awarding the procurement and installation contract for two of the three corrective action projects.

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 1992.

*Special Air Toxics Provisions.* The California Air Toxics "Hot Spots" Information and Assessment Act (AB 2588) was passed in 1987. The requirements of AB 2588 are implemented locally through BAAQMD. The initial intent of AB 2588 was to gather, and make public, information from facilities on more than 330 chemical substances that may pose a chronic or acute threat to public health when emitted into the ambient air. It is based on the assumption that certain facilities emit enough toxic air contaminants to create localized "hot spots" where concentrations exceed typical ambient levels and may exceed health and safety thresholds. These "hot spots" are identified through a risk assessment of emissions.

AB 2588 was modified in 1992 by the Calderon Toxic Hot Spots Bill (AB 1731). The new legislation requires the State to modify the risk assessment guidelines giving facilities the opportunity to provide information not required by the guidelines but which may provide a better reflection on the actual risk posed by a facility. The legislation also requires that facilities identified as significant risk contributors conduct a risk reduction audit and develop a plan that will reduce risk below the significance level within five years.

Two reports were submitted to BAAQMD at the beginning of this program in 1989:

- *Air Toxics Emission Inventory Plan (AB 2588)*, which identifies the substances that must be reported and provides a plan to estimate source emissions
- *Air Toxics Emissions Estimates* report, presenting calculations that were specified in the emission inventory plan

Updated information was submitted to the District in 1991. Thereafter, the program requires biennial toxic air contaminant inventory updates. Recently, BAAQMD has incorporated the update requirements into its annual permit renewal program and therefore requests the information more frequently.

The estimates provided by LBL during the initial and updated submittals represent emissions from the following sources: boilers, cooling towers, epoxy mixing and epoxy curing, exterior painting, lead pot hood, metal part cleaners, nondestructive testing hood, oil tank hood, paint spray booths, printing press, sandblasting, semiconductor laboratories, soldering, solvent wipe cleaning, steam evaporator, storage tanks, tritium labeling, vacuum coating hood, vapor degreasers, and welding. Annual average emissions and hourly maximum emissions were estimated for the sources analyzed.

Table 3-1 summarizes the emission estimates from these sources. These estimates were determined in 1989 and updated in both 1992 and 1993 for compliance with AB 2588.

**Table 3-1.** Air Toxics Emission Estimates

| Substance | Annual Average Emissions, kg/yr (lb/yr) | | Degree of Accuracy, kg/yr[a] (lb/yr) | |
|---|---|---|---|---|
| Acetone | 796 | (1755) | 45 | (100) |
| Benzene | <1 | (<2) | 4.5 | (10) |
| Carbon tetrachloride | 3 | (7) | 4.5 | (10) |
| Chloroform | 1 | (2) | 4.5 | (10) |
| Chromium, hexavalent | <0.01 | (<0.02) | 0.045 | (1) |
| 1,4-dioxane | 2 | (4) | 45 | (100) |
| Epichlorohydrinpolyglycol | 23 | (51) | 45 | (100) |
| Ethylene glycol butyl ether | 3 | (7) | 45 | (100) |
| Formaldehyde | 12 | (26) | 45 | (100) |
| Gasoline vapors | 605 | (1334) | 45 | (100) |
| Hydrochloric acid | 31 | (68) | 45 | (100) |
| Hydrogen fluoride | 4 | (9) | 4.5 | (10) |
| Isophorone diisocyanate | <1 | (<2) | 45 | (100) |
| Isopropyl alcohol | 160 | (352) | 45 | (100) |
| Lead | 1 | (2) | 4.5 | (10) |
| Lead chromate | 1 | (2) | 0.045 | (1) |
| Methyl alcohol | 404 | (891) | 45 | (100) |
| Methylene chloride | 1 | (2) | 45 | (100) |
| Methyl ethyl ketone | 43 | (95) | 45 | (100) |
| Naphthalene | 2 | (4) | 45 | (100) |
| Nickel | <0.01 | (<0.02) | 0.45 | (1) |
| Nitric acid | 6 | (13) | 45 | (100) |
| Phenol | 1 | (2) | 45 | (100) |
| Phosphoric acid | 4 | (9) | 45 | (100) |
| Propylene glycol methyl ether | 15 | (33) | 45 | (100) |
| Sodium hydroxide | 52 | (115) | 45 | (100) |
| Toluene | 68 | (150) | 45 | (100) |
| 1,1,1-trichloroethane | 1901 | (4191) | 45 | (100) |
| Trichloroethylene | 39 | (86) | 45 | (100) |
| Trichlorotrifluoroethane[b] | 4469 | (9853) | 45 | (100) |
| Tritium (as HTO) | $6 \times 10^{-5}$ | $(1.3 \times 10^{-4})$ | | |
| Xylene | 43 | (95) | 45 | (100) |
| Zinc compounds | 1 | (2) | 45 | (100) |

[a]Degree of accuracy represents the regulatory level of concern or *de minimis* level under the AB 2588 Air Toxics "Hot Spots" program.

[b]Emission of trichlorotrifluoroethane was from a coolant system attached to the linear accelerator in the Bevalac research complex. The coolant system was eliminated and the substance removed as part of the Bevalac closure.

*Environmental Monitoring*

The Environmental Monitoring Unit of the Environmental Protection Group manages environmental monitoring programs.

To ensure that LBL research activities are carried out in compliance with DOE Orders, as well as the legal and regulatory requirements imposed by Federal, state, and local agencies, the Laboratory supports a program of monitoring of the workplace, effluents, and environment. DOE Orders contain requirements and guidance for environmental monitoring programs.

LBL's environmental monitoring program consists of two major activities: (1) measurement and monitoring of effluents from DOE 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 3-2.

An Environmental Monitoring Plan was prepared by LBL in November 1992 and approved by DOE. The plan identifies the monitoring needs for the facility and details the existing and planned monitoring activities that satisfy these needs. It focuses considerable attention to the importance of quality assurance in all aspects of environmental monitoring. LBL's monitoring plan is comprehensive, covering:

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

In addition to monitoring programs already in place, a large Environmental Restoration and Waste Management corrective action project entitled *Air Toxics Facility Assessment and Rehabilitation* is currently in various stages of design and construction. The total project includes nearly $3.2 million in corrective action work. This entire project was rescoped in February 1992 into six subprojects that upgrade:

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

The majority of projects have scheduled completion dates at the end of FY93. However, the three NESHAPs projects will likely take until February 1995 to complete.

The principal radionuclides released from LBL stacks are gases or vapors, specifically tritium ($^{3}H$) as HTO (water vapor), radioiodine ($^{125}I$) in various gaseous forms, $^{14}C$ as $CO_2$, and $^{35}S$ as $SO_2$. Stack effluent sampling and ambient air is sampled for HTO, radioiodines, $^{14}CO_2$, and gross alpha and beta.

**Table 3-2.** Environmental Monitoring Program Elements

| Monitoring Activity | Frequency | Effluent | Reference |
|---|---|---|---|
| **Effluent Monitoring** | | | |
| Sampling effluent air in all areas where significant quantities of radionuclides are handled. Samplers are changed weekly. | Weekly | Air | DOE/EH-0173T |
| Sampling of the two LBL sewer outfalls. Outfall flow pH are continuously measured at each site. Composite samples are analyzed for tritium, radioiodines, and gross alpha and beta emitters. | Weekly | Waste-water | DOE/EH-0173T; CCR Title 17, §§ 30287 and 30288 |
| **Environmental Surveillance** | | | |
| Monitoring of penetrating radiation at four perimeter stations and in each major accelerator complex (to quantify the impact of LBL accelerator operations). Data from the perimeter and accelerator stations are telemetered to a central location and collected by a computerized data acquisition system. | Continuous: gamma and neutron flux; Weekly: particulates, tritium, and radioiodines | Air | DOE 5400.5 |
| 24-hour composites 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. Nonradiological assays are mandated by LBL's sitewide wastewater discharge permit. | 24-hour composites once every 2 or 3 months (stated on permit) | Waste-water | 40 CFR 433 |
| Continuous sampling of environmental air at ten points onsite and at five offsite and perimeter locations. Fourteen of the sites sample for particulate matter, eight for tritiated water (HTO), four for radioiodine, and one for $^{14}CO_2$. Samplers are changed weekly. | Weekly | Air | DOE 5400.1; DOE/EH-0173T |
| Rainfall and dry-deposition routinely sampled at nine onsite and four perimeter locations. Two additional sites are sampled whenever there is a significant rainfall. The rainwater is analyzed for tritium and gross alpha and beta activity. | Monthly | Air | DOE/EH-0173T |
| Sampling of groundwater by collecting "grab" samples at six LBL hydraugers and at five of the 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, plus additional "grab" samples from creeks and streams. Samples analyzed for gross alpha, beta, tritium, metals, organics, oil/grease, gasoline, and diesel. | First storm, plus at least one other | Water | 40 CFR 122 |

Significant (or even measurable) releases of particulate radioactivity from LBL are rare, since all areas where significant quantities of particulate radionuclides are handled have high-efficiency particulate air (HEPA) filters installed in their exhaust streams. Nonetheless, LBL samples effluent air and ambient air for particulate radioactivity to validate the efficacy of the HEPA systems, observe atmospheric trends, and detect offsite releases of particulate radionuclides (e.g., from atmospheric nuclear weapons tests or nuclear power plant accidents).

*Solid Waste Generation and Control*

The Regulatory Affairs Unit of the Environmental Protection Group and the Operations Unit of the Waste Management Group oversee compliance activities for solid waste generation and control.

DOE Order 6430.1A, *General Design Criteria* is principally guiding LBL's program for bulk storage of hazardous materials. LBL has adopted a best management practice for this program that is tailored after the requirements for Spill Prevention, Control, and Countermeasure (SPCC) plan development. The Hazardous Materials Bulk Storage (HMBS) Plan addresses bulk quantities of hazardous materials not covered by LBL's SPCC. It refers to hazardous materials stored in tanks and drums having capacities of at least 55 gallons. The HMBS does not address materials classified as oils, nor does it consider hazardous materials stored in the Hazardous Waste Handling Facility (HWHF).

The HMBS plan will be amended within six months of any change in facility design, construction, operation, or maintenance which affects bulk storage of hazardous materials. Furthermore, the HMBS Plan will be reviewed and evaluated every three years.

*Toxic Substances Control*

The Regulatory Affairs Unit of the Environmental Protection Group guides compliance activities for regulations on toxic substances control. Asbestos is an exception in the sense that EH&S' Industrial Hygiene Group directs the compliance program, however carrying out the program requires a tremendous cross blending of groups from several LBL Divisions and Departments, including Environmental Protection and Waste Management.

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 PCB oils, commonly found in electrical equipment such as capacitors and transformers. TSCA provides detailed requirements for the management of this PCB-containing equipment when the PCB levels exceed 50 parts per million.

In 1987, LBL initiated a program to reduce the inventory of PCB-containing equipment. PCB capacitors have been identified and replaced with non-PCB units whenever possible. All utility transformers have been tested and placed on a PCB reduction program, if necessary. Approximately 120 transformers remain onsite. PCB concentrations in these transformers are all below 50 parts per million. There were no inspections or compliance issues in 1992. However, LBL prepared an annual PCB report as required by TSCA. This report inventories and documents PCB-related activities for the calendar year. The report is not submitted to US/EPA, but it must be made available to the agency if requested.

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 must be done by AHERA accredited persons.

LBL is preparing 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. The program's policy is to immediately remove or repair all asbestos-containing materials that pose a significant health hazard due to location or condition. Asbestos in good condition will be managed in place. LBL personnel who perform asbestos-related work have received training through an AHERA certified course.

In other toxic substances related activities, the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) provides for the registration, transportation, use, and disposal of pesticides. At LBL, all applications of regulated pesticides are performed by licensed contractors who provide the pesticides used and remove unused portions. LBL personnel apply only unregulated herbicides.

*Water Quality*

The Regulatory Affairs Unit of the Environmental Protection Group directs compliance efforts for all water quality regulations, except drinking water responsibilities, which are shared with EH&S's Industrial Hygiene Group. Water quality includes drinking water, storm water discharges, wastewater discharges, and wastewater treatment.

*Wastewater Discharges*. The Clean Water Act (CWA) was established in 1977 as a major amendment to the Federal Water Pollution Control Act of 1972. The CWA was substantially modified by the Water Quality Act of 1987. The Act provides a set of statutes intended to support 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 to waters from both point and nonpoint sources. To implement the Act, US/EPA issued pretreatment standards for industrial dischargers as well as general standards controlling toxic pollutants.

In California, Cal/EPA, including the State Water Resources Board and the various Regional Water Quality Control Boards, administers the Federal permit and enforcement programs for both direct and indirect discharges. LBL is an indirect discharger since its wastewater is discharged to a Public-Owned Treatment Works (POTW) facility, which in turn discharges the treated effluent into surface waters. In conformance with both the Federal and State water quality regulating programs, local POTWs must 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 upon local Ordinance No. 311 (Wastewater Control Ordinance), which established 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, which 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 record keeping requirements.

There are two operations at LBL that are regulated by the EBMUD pretreatment program that have wastewater discharge permits:

- Plating Shop, Building 77
- Printed Circuit Board Shop, Building 25

Both operations must comply with the Metal Finishing Category Standard (40 CFR 433). In order to meet the standard's discharge requirements, wastewater pretreatment units have been installed at each shop. To ensure compliance with the pretreatment standard, the effluent from the treatment unit is tested periodically. The test methods and schedule 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. This permit has established discharge requirements that must be met at the site boundary.

EBMUD issued six Notices of Violation during 1992 for excursions of discharge limits into the City of Berkeley sanitary sewer systems. The NOVs occurred between March 4 and December 9. Five of the six excursions were monitored and reported by LBL. The sixth excursion was recorded by EBMUD. Three of the excursions were attributable to activities in Building 77; two were linked to the treatment unit and the other from degreasing operations within the building. The remaining three excursions were discovered by downstream sewer monitoring, however the subsequent investigations could not identify the culpable source(s). LBL investigated all six violations. All of the investigations are considered adequately reviewed and therefore closed by EBMUD. Mitigation measures were adopted in response to three of the events to prevent recurrence of these situations. EBMUD has assessed penalties for each violation. These penalties have taken the form of fees related to the follow-up inspections and monitoring.

LBL received no NOVs from EBMUD for Technical Review Criteria (TRC). TRC violations are more severe and may reflect more persistent operational problems. LBL remains in compliance with EBMUD discharge limits. However, the increased number of NOVs has initiated discussions by EBMUD on LBL's potential for being recategorized to Significant Noncompliance. LBL has worked closely with EBMUD to avoid such a designation, which would lead to considerably increased administrative and enforcement actions, including publication of a notice in the largest daily newspaper in the municipality in which EBMUD is located. It is worth noting that no monitored excursions occurred during the first quarter of 1993.

*Wastewater Treatment.* In an effort to streamline the permitting process for hazardous waste treatment and storage facilities and to ease the regulatory burden associated with obtaining facility permits, DTSC has developed a new procedure enabling some facilities to obtain permits more easily. These new regulations are part of a tiered permitting structure. The five tiers of the program, listed in increasing order of regulatory complexity, include:

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

There are five treatment units located at LBL that fall within the scope of this new program:

- acid wastewater (Building 2)
- acid wastewater (Building 70A)
- oil/water wastewater (Building 76)
- plating wastewater (Building 25)
- plating wastewater (Building 77)

Individual permit applications that contained the relevant technical and administrative information on these units were submitted to Cal/EPA by April 1, 1993. Until review and approval is granted, the wastewater treatment unit at the Building 77 Plating Shop will continue operating under a variance granted in 1984.

*Storm Water Discharges.* Reauthorization of the CWA in 1987 sanctioned US/EPA to develop a permit system for storm water runoff that may discharge toxic pollutants. The permit system is designed to apply to facilities (or portions of facilities) where storm water could intermingle with hazardous materials. In California, this program is being implemented by Cal/EPA's State Water Resources Control Board through the Regional Water Quality Control Boards.

In March 1992, LBL submitted a Notice of Intent (NOI) to the State Water Resources Control Board (SWRCB) for coverage under the statewide general industrial permit for storm water discharges associated with industrial activities in compliance with National Pollutant Discharge Elimination System (NPDES) requirements. In September 1992, LBL prepared a *Storm Water Pollution Prevention Plan* (SWPPP) and a *Storm Water Monitoring Program* (SWMP) in accordance with the NPDES permitting requirements. Together they represent LBL's plan and procedures for identifying illicit discharges, as well as monitoring, and reducing the potential for pollutants in its storm water discharges. The regulatory implementation date of the SWPPP was October 1, 1992, while the implementation date for the SWMP was January 1, 1993. However, LBL committed to DOE that both documents would be implemented by October 1, 1992. In addition to implementing these programs, LBL must submit a monitoring and observations report to the State Water Resources Control Board by July 1 of each year.

A separate general permit for construction activities that result in disturbances to five acres or more of land is required by the State. Guidance on the definition of disturbance has only been recently released. LBL is currently assessing the possible need to file an NOI for coverage under a General Construction Activity storm water NPDES permit for the LBL site as a whole on the basis of this guidance.

*Tanks – Aboveground Storage.* The CWA also has regulations affecting aboveground storage tanks. LBL submitted a bienniel storage statement to US/21

EPA on June 29, 1992, as required by the Aboveground Petroleum Storage Act. In August 1992, the Laboratory revised its *Spill Prevention, Control, and Countermeasure Plan* (SPCC) in compliance with US/EPA "Oil Pollution Prevention" 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. The DOE/SF Operations Office 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. The state is expected to further expand the development of SPCC plans in response to recent passage of the Aboveground Petroleum Storage Act.

*Tanks – Underground Storage.* The State began its underground storage tank (UST) regulatory program in 1983. The State UST laws predate the Federal UST program, and include regulations that are similar in scope to the Federal program. Regulations implementing the State UST laws are developed by the SWRCB, and local county or fire departments administer the program's permit, inspection, and enforcement requirements. County fire and health departments generally administer the UST program by local ordinance that is compatible with state board regulations. The scope of the law covers storage of hazardous substances in tanks, including ancillary piping systems that are substantially beneath the ground. Hazardous substances is broadly defined by the law to include flammable and combustible liquid fuels, listed hazardous waste, hazardous material, and the Director's List of Hazardous Substances (Labor Code §6382), which includes most common chemicals and fuels.

The Federal program for regulating USTs is found under the Resource Conservation and Recovery Act regulations, 40 CFR Parts 280-281. The City of Berkeley is the local agency which consolidates the Federal, State, and local UST requirements into an integrated program. The key elements of the regulatory program LBL must comply with 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

The LBL facility has 15 permitted USTs, which contain diesel, gasoline, oil-spill control, photoprocessing solution, transformer oil, and waste oil. Eight USTs are new double-walled tanks, and seven USTs are existing single-walled tanks. All of these tanks are routinely monitored for leaks.

Closure plans for two of the single-walled tanks (oil-spill control, photoprocessing solution) were submitted to the City of Berkeley in November 1992. In March 1993, LBL submitted a closure plan for removal of a double-walled waste oil tank. The two single-walled tanks were removed in March 1993, reducing the number of active USTs on site to 13. Permits for these two tanks remain valid until the closure reports are submitted to the City of Berkeley. (These reports are expected to be submitted in June 1993.) The closure reports will also evaluate the results of soil sampling that ocurred during the tank removal. The need for these samples was specified in the closure plan approved earlier by the City of Berkeley.

One minor spill occurred recently at one of the tanks. On February 6, 1993, an overfill of approximately eight gallons of diesel fuel occurred during a filling operation at a 1,000-gallon underground storage tank. The overfill was investigated and cleaned up within eight hours of detection. 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, with a follow-up status letter sent by LBL on March 12, 1993.

*Drinking Water*

The Safe Drinking Water Act (SDWA) established a program to ensure that public drinking water supplies are free of potentially harmful chemicals. It established maximum contaminant levels to protect human health and provide aesthetically acceptable water.

The sole source of water supplied to LBL is EBMUD; there are no drinking water wells onsite. EBMUD obtains its water from western-slope Sierra Nevada surface waters more than 150 kilometers east of LBL. Water from this source is piped to a nearby reservoir, where it is stored, treated, filtered, and tested before distribution.

The LBL system that distributes EBMUD water within the site consists of an extensive piping layout providing domestic and fire-protection water to all LBL installations. The system also supplies makeup water for cooling towers, irrigation water, and water for other miscellaneous uses, including industrial, deionized, and distilled water systems. The domestic water is routinely sampled for coliform bacteria.

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. Over 100 backflow devices have been installed during this phase alone. Retrofitting of the LBL drinking water system with backflow prevention devices is expected to be complete in May 1993. A regular maintenance program for the backflow prevention devices is also in effect.

The National Primary Drinking Water Regulations limit radiological exposure to the public from community drinking-water systems to 4 millirem (mrem) per year. Although no local surface or well water is used as a community drinking water supply, this report uses the standards listed in 40 CFR 141 as a basis of comparison for the radiological contamination of local waters. The regulation lists limits for several radionuclides. Limits were generated based on the consumption by an individual, for 12 months, of water contaminated by a single substance that would produce an exposure of 4 mrem to that person The standard for tritium is 20,000 picocuries per liter (pCi/l). The unidentified alpha emitter limit is 5 pCi/l. The unidentified beta emitter limit is 8 pCi/l.

### *3.1.3 Environmental Restoration*

The Environmental Restoration Group of the Environment Department oversees site restoration compliance activities. The Environmental Restoration Group is comprised of Planning and Geotechnical Support Units

*Onsite Activity*

The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980 as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986 provides the regulatory framework and funding needed to properly cleanup closed and abandoned hazardous waste sites. Under the provisions of CERCLA, facilities are required to 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 (NPL) and are forced into environmental cleanup. California has statutory authority similar to CERCLA. It is entitled the California Carpenter-Presley-Tanner Hazardous Substances Account Act or the State Superfund Act.

In 1992, a formal review of the LBL site restoration potential through a preliminary assessment and site inspection by US/EPA concluded no further remedial action is planned under CERCLA, but rather that any future remedial actions be performed under the Resource Conservation and Recovery Act (RCRA) Corrective Action Program. This RCRA Facility Assessment (RFA) identified seventy-three solid waste management units and sixty-three areas of concern. As part of the RFA, LBL conducted a detailed sampling evaluation that included surveying soil gases and installing twenty-eight monitoring wells. Over nine hundred soil analyses and nearly three hundred groundwater analyses were conducted.

In November 1992, LBL submitted a RCRA Facility Investigation (RFI) Workplan to DTSC. The Environmental Restoration Program is now being conducted under the RCRA Corrective Action Process. 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. The RFI Workplan outlines required field activities to define the extent of contamination and identify sources.

*Offsite Activity*

Since LBL contracts to have its hazardous waste off site, the Laboratory subjects itself to becoming a Potentially Responsible Party should the eventual waste site become contaminated and require cleanup efforts. Recently there have been two such incidences involving LBL.

The more complex of the two incidences occurred in August 1992, when US/EPA sent various parties, including LBL, a Notice of Potential Liability and Request for Information pursuant to Sections 106 and 104(e) of CERCLA for the North American Environmental Inc. (NAE) site in Clearfield, Utah. LBL was provided information indicating that 13 drums of PCB waste originating at LBL had been transported to the Utah site in violation of an agreement between NAE and LBL's subcontractor, which had required disposal of these wastes in compliance with the Federal law. LBL removed all of its waste from the site prior to its being officially designated a Superfund site on September 1, 1992. The wastes were removed in accordance with a March 1992 US/EPA protocol and 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 the position that it would be inappropriate for LBL to participate in further removal actions at the NAE site, because no reported LBL wastes were any longer 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 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.

The second incident occurred in November 1992, when LBL responded to a Request for Information from Cal/EPA's Department of Toxic Substances Control (DTSC) for information regarding the Bay Area Drum 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. LBL has not yet received a response from the State regarding LBL's possible status as a Potentially Responsible Party at the site.

### *3.1.4 Waste Management*

*Hazardous Waste*

The Compliance Unit of the Waste Management Group oversees hazardous waste compliance issues such as permitting and certification. The Planning Unit coordinates hazardous waste tracking and data management. The Operations Unit manages the Hazardous Waste Handling Facility (HWHF).

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 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. The 1986 SARA amendments added stipulations that require financial responsibility to owners for the cleanup of leaks from underground storage tanks.

RCRA established a "cradle-to-grave" system for regulating hazardous wastes, and prescribes facility standards, waste handling protocols, land-disposal restrictions, record keeping, 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 record keeping, 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.

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 the HWCL govern the disposal of hazardous wastes, including the disposal of mixed radioactive and hazardous chemical wastes.

Local health departments have entered into a Memorandum of Understanding with Cal/EPA, via DTSC, to administer the RCRA/HWCL requirements 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.

LBL prepared the Biennial Hazardous Waste Report for the period 1990 through 1991 in March 1992. The report was submitted to US/EPA with a copy to the California DTSC. It contains specific generator and transport information for all activity at the Hazardous Waste Handling Facility for this two-year period. LBL also prepared the Annual Waste Reduction Report for the previous calendar year in March 1992. This report was submitted to DOE. It contains a detailed analysis of waste minimization efforts made by waste generators.

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. This facility was initially permitted in 1983, with an expiration date established for 1988. In 1987, a new RCRA Part A and B permit application was submitted because of extensive modifications needed to the original permit. However, due to an extremely large workload, DHS was unable to process this revision, and the initial permit was extended pending resolution of the new application. In 1989, the 1987 application was revised in order to update the application in general, and to add a proposed new Hazardous Waste Handling Facility. A series of Notices of Deficiency (NOD) were issued by DTSC upon reviewing the new permit application. The last NOD, based on an application submitted on March 29, 1991, was received on February 18, 1992. In its review, DTSC quite clearly stated that failure to provide adequate responses to the deficiencies in the next application may result in the issuance of a Notice of Decision to Deny the permit.

LBL submitted a revised Part A and B permit application addressing both the existing and proposed HWHF to DTSC on August 17, 1992. DTSC completed its internal review with a decision on October 29, 1992, that the application was administratively complete. This decision opened up a 45-day public review and comment period. The comment period ended on December 16, 1992, without the submission of comments by either the public or other regulatory agencies. Final signature of the new Part A and B permit is expected from DTSC in the second quarter of 1993. The new Hazardous Waste Handling Facility is going through the pre-construction design phases. At the same time, an assessment of the environmental operating permits for the HWHF has begun. Construction of the HWHF is currently scheduled to begin in the fall of 1993.

On July 21, 1992, the Westinghouse Hanford Company began a two-day audit of LBL's waste management program for the purpose of determining conformity with the requirements of WHC-EP-0063-3, *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. LBL received conditional permission to ship LLW and RMW, contingent upon completion of waste certification plans. A follow-up audit by the Hanford group on September 16 and 17, 1992, led to formal acceptance of the LLW and RMW from LBL's waste management program. Authorization to ship LLW and RMW was critical in LBL's efforts to eliminate the backlog of radioactive waste that had accumulated over nearly the last two years. Shipments of waste to Hanford began in August 1992. A total of four shipments have occurred since LBL received the conditional permission. The Hanford group returned on March 17 and 18, 1993, to observe the Waste Management Group's actual procedures for both waste types. The review included visiting waste sites, observing waste pickups, and reviewing procedures. The Hanford group did not report any findings during this audit.

The Waste Management Group has also made significant progress in other areas of its program. Specifically, the addition of more staff both at the professional and operational levels of the program, the realignment of field responsibilities, further training of technicians, and increasing the storage capacity and security of the HWHF has lead to the elimination of the chemical waste backlog that burdened waste operations during the past several years. The group has implemented numerous procedures that affect such activities as waste characterization, generator storage, and waste analyses tracking. In February 1993, DOE/SF authorized a conditional restart of the Laboratory's waste compactor, which had been shut down since US/EPA's NESHAPs violation citing in 1991. Also of note, a new chemical waste contractor began handling and transporting hazardous waste off-site during 1992.

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. The focus of the inspections was on the storage and use of hazardous materials as well as the procedures followed by hazardous waste generators for satellite and waste accumulation areas. The overall assessment made by the City was that improvements in generator training were needed to overcome various shortcomings in labeling of waste containers. Conversely, the City inspector noted several positive traits of the program at the generator level, namely waste reduction efforts, material storage practices, labeling and housekeeping, daily and weekly inspection checklists, and training records.

*Medical Waste*

The Compliance Unit of the Waste Management Group coordinates medical and infectious waste compliance activities.

The Federal Medical Waste Tracking Act of 1988 and California Medical Waste Management (CMWMA) Act of 1990 provide the regulatory framework for medical waste generating facilities such as LBL. The State program is considerably more stringent than that of the Federal. 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.

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 is currently completing a *Medical Waste Management Plan* in accordance with the regulatory implementation of the CMWMA. A draft plan was completed in March 1993 and is expected to be approved in the second quarter of 1993. The LBL *Medical Waste Management Plan* will address all the regulatory requirements. It 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 in the plan are LBL's *Medical and Biohazardous Waste Generator's Guide* and *Medical and Biohazardous Waste Generator's Training Plan.*

LBL generates medical waste in about 120 different locations distributed over 15 buildings, including 4 buildings which are located off the main LBL facility grounds. LBL has contracted with a certified medical waste hauler who visits the Laboratory pickup sites weekly. However the pickup schedule varies from generator location to generator location. Nearly all generator locations have medical waste pickups either weekly or monthly. The remaining few are on an "as needed" basis. During 1992, LBL generated approximately 12,300 kilograms (27,100 pounds) of medical waste.

*Waste Minimization and Pollution Prevention*

The Compliance Unit of the Waste Management Group coordinates waste minimization and pollution prevention activities.

The California legislature passed the Hazardous Waste Source Reduction and Management Review (SB 14) law in 1989. The regulations derived from SB 14 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: (1) *Source Reduction Evaluation Review Plan and Plan Summary*, and (2) *Hazardous Waste Management Report Summary*. This report was approved by LBL on March 26, 1992. It required certification on three levels; technical, financial, and operational. It clearly 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 *Source Reduction Evaluation Review Plan and Plan Summary* must be kept on site and updated every four years. The next update is scheduled for 1994. This plan established a timetable for performing Process Waste Assessments on those waste streams that are 5% or greater of the total waste stream from the Laboratory. Those waste streams include:

- spent empty drums greater than or equal to 30 gallons
- waste liquids with pH equal to or less than 2
- waste machining and grinding coolant/water
- waste mercury (extremely hazardous)
- waste oil (nonautomotive)

The *Hazardous Waste Management Report Summary* is primarily meant to assess changes in activities. The first opportunity to assess any changes will be in 1994.

LBL activities in the area of waste minimization are ongoing. LBL has developed, and adopted a *Waste Minimization and Pollution Prevention Awareness Plan*, which serves as a template for future activities in the area of waste minimization. This plan is updated annually. In addition, LBL had actively pursued several waste minimization techniques, including inventory control, material and process substitution, waste segregation, and toxicity reduction. LBL also prepared and submitted to EBMUD a *Waste Minimization Opportunities Assessment Report* for the metal-finishing activities in Buildings 25 and 77.

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. Similarly, under the Hazardous Waste Control Law, Cal/EPA requires that facilities that treat, store, or dispose of hazardous wastes 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. In addition, 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, the hazardous waste manifest forms used by LBL include a generator's statement certifying that a waste minimization program is in place at the facility.

## 3.2 Environmental Permits

In order to carry on its research, LBL designs and builds much of its apparatus. These activities require substantial technical support, including the operation of fabrication, assembly, testing, and waste-handling facilities. The Laboratory operates these facilities under a series of environmental permits issued by State and local agencies. These permits are listed below, by type and issuing agency, with expiration dates.

### *3.2.1 Environmental Protection*

*Air Emissions*

BAAQMD issues operating permits to LBL (BAAQMD Plant #723) that must be renewed annually. Thirty-six operating permits have been issued for equipment associated with pollutant abatement, furnaces and ovens, liquid storage and loading, material working, semiconductor laboratory, surface cleaning, surface coating, and surface preparation operations. The current set of permits will expire on July 1, 1993. A list of sources that have operating permits is found in Table 3-3.

Eighty-two sources are listed by BAAQMD as exempt from permits.

*Storm Water Discharges*

LBL has submitted a Notice of Intent (Order #91-13-DWQ) to the State Water Resources Control Board for coverage under the statewide general industrial permit for storm water discharges associated with industrial activities in compliance with NPDES requirements. The State acknowledged LBL's registration as a general permittee in October 1992 by assigning a permit identification number (2-01S002421) to the Laboratory. The permitting process also required the development of a *Storm Water Pollution Prevention Plan* and a *Storm Water Monitoring Program*, both of which were implemented by the regulatory deadlines of October 1, 1992 and January 1, 1993, respectively. In fact, LBL implemented the monitoring program also by October 1, 1992. The general industrial permit program requires an annual fee, but no formal permit renewal.

The State requires a separate NPDES general permit for storm water runoff from construction sites of 5 acres or greater. LBL is presently assessing whether such a permit is required for the site.

*Underground Storage Tanks*

The City of Berkeley issues operating permits for underground storage tanks. Permits are for a five-year period. The current set of permits will require renewal on July 1, 1997. There are currently 15 permitted tanks at LBL, summarized in Table 3-4. Two of the permitted tanks were removed recently. Their permits will expire once the formal closure reports to the City of Berkeley are submitted. This is expected in June 1993.

*Wastewater Discharges*

EBMUD issues wastewater discharge permits annually. The current set will expire on July 8, 1993. LBL has three wastewater discharge permits, as follows:

- LBL Sitewide (Account No. 066-00791)
- Plating Shop, Building 25 (Account No. 50238911)
- Plating Shop, Building 77 (Account No. 50238921)

**Table 3-3.** Air Emission Source Operating Permits from BAAQMD

| Category | Description | BAAQMD Source ID | LBL Building |
|---|---|---|---|
| Abatement Device | Sawdust collector | S-64 | 74 |
| | Machine shop tools | S-73 | 76 |
| | Machine shop tools | S-116 | 79 |
| | Sulfur hexafluoride chamber | S-124 | 58A |
| | Baghouse[a] | S-156, -57, -58 | 77 |
| | Baghouse | S-169 | 46 |
| Furnaces and Ovens | Paint spray booth drying oven | S-104 | 77 |
| | Epoxy curing oven | S-148 | 53 |
| | Epoxy curing oven | S-149 | 53 |
| | Epoxy curing oven | S-150 | 53 |
| Liquid Storage and Loading | Gasoline dispensing facility | S-76 | 76 |
| Material Working | Machine shop tools | S-39 | 53 |
| | Machine shop tools | S-46 | 58 |
| | Machine shop tools | S-55 | 70A |
| | Machine shop tools | S-68 | 76 |
| | Machine shop tools | S-84 | 77 |
| | Machine shop tools | S-85 | 77 |
| | Machine shop tools | S-105 | 79 |
| | Machine shop tools | S-114 | 88 |
| | Machine shop tools | S-115 | 88 |
| Semiconductor Laboratory | Crystal growth furnace | S-145 | 2 |
| Surface Cleaning | Vapor solvent cleaner | S-22 | 25A |
| | Vapor solvent cleaner | S-38 | 53 |
| | Vapor solvent cleaner | S-92 | 77 |
| | Vapor solvent cleaner | S-140 | 52 |
| | Vapor solvent cleaner | S-141 | 76 |
| | Cold solvent cleaner | S-72 | 76 |
| | Cold solvent cleaner | S-119 | 77 |
| | Cold solvent cleaner | S-130 | 77 |
| | Ink remover | S-118 | 934 |
| Surface Coating | Paint spray booth | S-74 | 76 |
| | Paint spray booth | S-96 | 77 |
| | Epoxy mixing hood | S-147 | 53 |
| | Vacuum coating | S-159 | 25 |
| Surface Preparation | Abrasive blast | S-97 | 77 |
| | Abrasive blast | S-166 | 71B |
| | Abrasive blast | S-167 | 71B |

[a]Considered a permitted abatement device, but an exempt operating source.

Note: Operating permits exist for 36 emission sources. Another 82 emission sources are registered exempt.

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

| Registration Tank ID # | LBL Building | Stored Material | Capacity (gallons) | Construction | Year Installed |
|---|---|---|---|---|---|
| **Fiberglass Tanks, Double-Walled** | | | | | |
| 2-1 | 2 | Diesel | 4,000 | Fiberglass | 1988 |
| 2-2 | 2 | Diesel | 1,000 | Fiberglass | 1988 |
| **Double-Walled Steel with Fiberglass Plastic Corrosion Protection** | | | | | |
| 55-1 | 55 | Diesel | 1,000 | Glasteel | 1986 |
| 66-1 | 66 | Diesel | 4,000 | Glasteel | 1987 |
| 66-2 | 66 | Diesel | 2,000 | Glasteel | 1987 |
| 69-1[a] | 69 | Waste Oil | 2,000 | Glasteel | 1987 |
| 76-1 | 76 | Unleaded Gasoline | 10,000 | Glasteel | 1990 |
| 76-2 | 76 | Diesel | 10,000 | Glasteel | 1990 |
| **Single-Walled Tanks** | | | | | |
| 4 | 51 | Diesel | 550 | Steel | 1968 |
| 6 | 70 | Diesel | 600 | Steel | 1953 |
| 7 | 70A | Diesel | 1,000 | Fiberglass | 1975 |
| 8 | 74 | Diesel | 12,000 | Fiberglass | 1979 |
| 11 | 58 | Transformer oil | 2,000 | Steel | 1978 |
| 12[b] | 58A | Spill control | 2,000 | Steel | 1978 |
| 14[b] | 50 | Photo solution | 550 | Steel | 1970's |

[a]Closure plan submitted to the City of Berkeley in March 1993
[b]Removed from site in March 1993

*Wastewater Treatment*

DTSC administers the newly developed tiered-permitting program for hazardous waste treatment and storage units not requiring Federal RCRA permits. LBL submitted permit applications to DTSC at the end of March 1993 for five treatment units at LBL:

- acid wastewater (Building 2)
- acid wastewater (Building 70A)
- oil/water wastewater (Building 76)
- plating wastewater (Building 25)
- plating wastewater (Building 77)

These wastewater treatment permit renewals will subsequently occur annually.

### *3.2.2 Waste Management*

A RCRA Part A and B permit application is under review by Cal/EPA's DTSC for both the existing and proposed Hazardous Waste Handling Facility (US/EPA CA Identification Number 4890008986). The current permit has been extended until resolution of the new RCRA application. Final signature of the new RCRA permit is expected from DTSC in April 1993. Once approved, this permit will extend through 1998. At that time, LBL will renew the permit for only the remaining HWHF.

Currently, LBL has a permit (#2-15668) from DTSC that authorizes the offsite transport of extremely hazardous waste. This permit is unaffected by the new RCRA permit application.

## 3.3 Environmental Assessments

Assessments of the environmental impacts from proposed projects are conducted by the Planning and Analysis Department of the LBL's Planning and Development Division. Federal and state regulations both 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 documentation for identifying and assessing the individual and cumulative impacts from a project range from a Categorical Exclusion (CX) at the minimal end to an Environmental Impact Statement (EIS) at the high end, with an Environmental Assessment (EA) in between. To comply with NEPA, LBL follows the procedures outlined in the Council on Environmental Quality (CEQ) regulations, and the policies and procedures established by DOE for NEPA compliance.

As with many other Federal environmental programs, California has its own legislative requirements for assessing potential environmental impacts from proposed projects besides those required by NEPA. 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. To comply with CEQA, LBL follows the State CEQA Guidelines, as issued by the California Resources Agency. LBL also follows the procedures for CEQA implementation established by the UC Regents.

During 1992 and the first quarter of 1993, the Laboratory began or continued preparation of four EAs under NEPA, and two Initial Studies and an EIR under CEQA. Brief descriptions of the proposed project activities addressed in these six documents and the document status are provided below. In addition, the *Draft Supplemental Environmental Impact Report for the*

*Proposed Renewal of the Contract Between the United States Department of Energy and the Regents of the University of California for Operations and Management of the Lawrence Berkeley Laboratory* was approved by the UC Regents in November 1992. The SEIR addressed potential environmental impacts associated with UC's operations of the Laboratory over the five-year period 1992 through 1997.

LBL began preparation of a preliminary draft EA and preliminary administrative draft EIR for the Human Genome Laboratory in November, 1992. The Human Genome Laboratory is a proposed 3800 square meter (41,100 square feet) laboratory and office building to support research to provide an understanding of the structure and function of the human genome (the genetic basis of susceptibility to disease-causing agents) for use in defining risk and providing health protection.

Preparation of the EA for modification of existing LBL Building 56 to operate as a Biomedical Isotope Facility continued throughout 1992. Operations would consist of producing radionuclides and preparing radio-pharmaceuticals to be used in existing Building 55 where biomedical imaging research using these compounds has been ongoing. A draft EA was submitted to DOE in November, 1992. A draft Initial Study checklist was submitted to University of California Office of the President for review in February 1993.

LBL also began assembling a draft EA in 1992 for the disposition of copper coil windings from the 184-Inch Cyclotron. This project would transfer 140 metric tons of copper that is currently in storage to a scrap metal dealer for recycling. The document was submitted to DOE for review in January, 1993. The proposal was considered to be not a project under CEQA.

A draft EA for the new HWHF project (*Construction and Operation of a Replacement Hazardous Waste Handling Facility at LBL*) was submitted to both DOE and DTSC for review in June, 1992. A Finding of No Significant Impact was issued by DOE on October 20, 1992.

An Initial Study for the *Continued Operation Of and Alterations and Upgrades to the Existing Hazardous Waste Handling Facility* was prepared and a Notice of Completion and draft Negative Declaration submitted to the State for public review on March 1, 1993. The 30-day public comment period ended March 30. It is anticipated that a Notice of Determination and Negative Declaration will be issued in early April. Under NEPA, the project was determined to be categorically excluded from preparation of either an EA or EIS.

Besides these larger NEPA and CEQA projects, Laboratory-proposed actions, such as Work for Others, general Plant Engineering projects, and Field Task Proposals, received NEPA and CEQA evaluations. LBL prepared 79 Categorical Exclusions under NEPA and 20 Categorical Exemptions under CEQA since the beginning of 1992.

Additionally, the Laboratory 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 the University of California Office of the President. The final document was published in February 1993. In concert with preparation of the guidelines, the Laboratory prepared a draft NEPA and CEQA training program plan, and began to develop training materials for courses that would be provided to Laboratory Division personnel and would be one of the Laboratory's required EH&S training programs. Following publication of the guidelines, 1.5 days of training on its implementation was provided to LBL Division personnel. The Laboratory also developed a Laboratory-wide tracking system for tracking the status of documents prepared in compliance with NEPA and CEQA.

LBL's Planning and Analysis Department also assists with other environmentally-related assessments of pending projects affecting the Laboratory. For example, LBL conducted an historic/architectural survey and evaluation of Building 7 in compliance with Section 106 of the National Historic Preservation Act. This survey was conducted because of LBL's proposed plans to demolish the building as part of the Safety and Support Services Facility project.

Building 7 was constructed in 1942 as a mechanical and electronics shop for the 184-inch cyclotron, and was used as a shop and storehouse for a variety of Laboratory facilities during the period of expansion at LBL since World War II. The historic association of Building 7 with the 184-inch cyclotron, its association with E.O. Lawrence, and its attributes as a support building for a research and development laboratory were considered as a basis for potential eligibility to the National Register of Historic Places. However, because the building's function is no longer associated with the cyclotron, the interior of the building has been altered to accommodate the new functions of the building, and the exterior has been substantially altered by the removal of one corner of the structure, the State Historic Preservation Officer concurred with DOE's finding of no affect for the project.

LBL also conducted an ecological resource literature review and initiated interactions with the U.S. Fish and Wildlife Service (FWS) for its proposal to conduct a two-year study to develop improved methods for removing contaminated groundwater from fractured aquifers at an existing well field located in Madera County, California under an agreement with US/EPA. Studies included tracer tests and small-scale mock pump and treat tests. FWS provided a species list that indicated that the Valley Elderberry Longhorn Beetle is a listed endangered and threatened species that could occur in the area of the project. With further analysis of information provided by the FWS, it was found that the project area does not contain the beetle's habitat and is not within the boundaries of the designated critical habitat. It was determined that the proposed activity did not have the potential to disturb protected species habitat or have the potential to result in incidental take of threatened or endangered species.

## 3.4 Environmental Activities

### *3.4.1 Programmatic Audits and Appraisals*

Many of LBL's current environmental activities arise from the Laboratory's affiliation with DOE. Progress on the Laboratory's Corrective Action Plan for resolving the findings of the Tiger Team's site visit in early 1991 continued. The total number of tasks generated from the Tiger Team assessment stands at 385, as several duplicate tasks were combined in 1992 to streamline reporting. Laboratory-wide, 1443 milestones were established to complete these tasks. The total number of tasks and milestones closed as of March 1993 were 271 and 1141, respectively. The number of tasks and milestones completed in 1992 were 156 and 575, respectively. Thus far, 29 tasks and 57 milestones have been completed in 1993. Of the 271 completed tasks, DOE had verified closure of 105 tasks as of April 1, 1993.

As a follow-up to the initial Tiger Team visit, the DOE Office of Energy Research conducted a Tiger Team Follow-up Review audit on 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/SF were performed concurrently with the follow-up visit: (1) the annual multi-disciplinary 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 and radiation protection, and emergency preparedness.

Earlier, the DOE/SF Operations Office conducted a Functional Appraisal of LBL's environmental programs during the week of February 24–28, 1992. The purpose of this appraisal was to review the status of operations in the functional areas of environmental monitoring, air quality, and waste management relative to the 1988 Environmental Survey Team and the 1991 Tiger Team audits. The Functional Appraisal identified 13 findings and 12 observations; however, no imminent hazards were found. A Corrective Action Plan was accepted by DOE/SF in June. LBL developed 24 tasks with 56 milestones to address the Functional Appraisal's findings. To date, DOE/SF has verified that 19 of the 25 findings and observations have been completed. The DOE/SF Operations Office has scheduled the 1993 Functional Appraisal for the end of April.

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 August 31, 1990. The State's designated lead agency for the purposes of the AIP is the Department of Health Services (DHS). The section of DHS delegated with overseeing the program is the Environmental Management Branch, although the State Water Resources Control Board, the San Francisco Bay Regional Water Quality Control Board, and the Office of Emergency Services will provide appropriate assistance. The AIP provides 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. Several introductory meetings (March 11, 1992, and August 6, 1992) were held to familiarize DHS with LBL's environmental monitoring and laboratory analysis programs. In September 1992, a workplan for the period January 1, 1993, through July 31, 1994, was approved by DOE and DHS. The work plan covers activities expected by the State agencies in the areas of program planning, reporting and data management, training, and community relations. In October 1992, the annual statewide AIP meeting between DHS and all six California-participating facilities was held in Monterey. Also in October, LBL provided DHS with radiological environmental monitoring data for the preceding five-year period. In December 1992, the first AIP quarterly update meeting focusing on LBL activities took place at LBL.

### *3.4.2 Hazardous Materials/Community Right-to-Know*

The Planning and Special Projects Group of EH&S oversees compliance activities for both the Federal Emergency Planning and Community Right-To-Know Act (EPCRA or SARA Title III) and the California Hazardous Materials Release Response Plans and Inventory Law (The Business Plan).

Title III of the 1986 Superfund Amendments and Reauthorization Act (SARA) to CERCLA created a system for addressing the effects of chemical releases on communities. SARA Title III is essentially made up of three programs: (1) development of emergency response plans, (2) access rights granted to the general public and local emergency response personnel to information on chemicals stored and used at a facility, and (3) annual reporting of toxic chemicals routinely released into the environment. According to SARA, facilities that handle more than the threshold planning quantities of any extremely hazardous substance are required to submit three distinct planning and inventory reports to the State and local agency. California also adopted a community right-to-know law called the Hazardous Materials Release Response Plan and Inventory Law (the Business Plan). The state law has been modified three times since first passage in 1985. The last modification in 1989 (AB 2189) reduced inconsistencies with the Federal EPCRA requirements. AB 2189 also defined public facilities, including state and local government as well as schools and universities, as "businesses," thus subject to these hazardous materials requirements for the first time.

The state program requires the submission of a "Business Plan" that provides the information and emergency procedures necessary to prevent or mitigate damage to human health and the environment from the release of hazardous material at a facility. Each business that handles a hazardous material must adopt a business plan that includes both an inventory of every hazardous material it handles and emergency response plans and procedures it will follow in the event of a release or threatened release of a hazardous material. In California, the following threshold amounts for defining whether a facility handles hazardous materials have been established:

- 55 gallons for liquids
- 500 pounds for solids
- 200 cubic feet for compressed gases

Business plans must be submitted to local administering agencies for review. This act also requires a business to report a release or threatened release immediately to the local emergency responders, local administering agency, and the State Office of Emergency Services. In California, the reporting requirements of SARA Sections 311 and 312 were incorporated into the requirements of the Business Plan. LBL is exempt from the third report, which is required by SARA Section 313, since it applies only to facilities in SIC codes 20 to 39. LBL is classified as a "Noncommercial Research Organization," giving it a SIC code of 8733.

Locally, LBL's reporting requirements under the Hazardous Materials Release Response Plan and Inventory Law are overseen by the City of Berkeley. The City of Berkeley has established more stringent inventory thresholds than those codified by the State. The chemical inventories must be updated annually. The training, safety, and contingency plan portions of the Business Plan must be updated every two years, unless significant changes occur. LBL last submitted the Business Plan to the City in January 1992. LBL recently received concurrence from the City of Berkeley to change the annual calendar year reporting due date to July 1, beginning in 1993. This change gives LBL more time to prepare the inventories and, equally important, aligns LBL's submittal date with all other businesses in Berkeley.

The City of Berkeley has also notified the Laboratory that it must prepare and implement a Risk Management and Prevention Program (RMPP) prior to December 7, 1993. The RMPP is a requirement of the La Follette Bill (AB 3777) for a facility handling acutely hazardous materials above certain thresholds. An RMPP must contain the following information:

- accidents involving acutely hazardous materials that have occurred at the facility in the past three years
- controls in place that minimize the risk of an accident involving acutely hazardous materials
- equipment used to handle acutely hazardous materials
- schedule for implementing additional risk reduction measures

LBL has triggered these thresholds for sitewide amounts of five substances; anhydrous ammonia, hydrofluoric acid, nitric acid, phophorus pentoxide, and sulfuric acid.

In September 1992, a DOE Secretarial Memorandum directed DOE's voluntary participation in a Toxic Release Inventory (TRI) reporting and US/EPA "33/50" Pollution Prevention Program pursuant to Section 313 of the Emergency Planning and Community Right-to-Know Act (SARA Title III). LBL is currently assessing its participation in the voluntary TRI reporting program agreed upon between DOE and US/EPA. Participation is slated to begin with submittal of Calendar Year 1993 information. In April 1993, DOE notified Cal/EPA that it would respond at a later date to Cal/EPA's request for accelerating this submission date forward to include Calendar Year 1992.

### *3.4.3 Environmental Planning*

*Environmental Protection*

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. First submittals were for the funding period FY94 through FY98 and limited to safety and health programs. The scope of the planning process expanded in 1992 to include environmental programs. In January 1993, LBL completed preparation of a series of Activity Data Sheets (ADS) 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. Core activities are those necessary to maintain current levels of risk and compliance. Compliance activities are new and ongoing activities to raise the current core program to full compliance. These ADSs covered the period from FY95 through FY99. The funding request associated with these core and compliance ADSs totaled \$8.8 million and \$5.0 million, respectively. The complete list of environmental ADSs include:

- <u>Core and Compliance</u>
  - air
  - management
  - toxics
  - waste generation
  - waste minimization
  - water
- <u>Compliance Only</u>
  - aboveground storage tank
  - illicit connections
  - underground storage tank
  - wastewater recycling

*Environmental Restoration*

Additionally, LBL 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 quite similar; the ADSs cover the same planning period and include breakdowns by cost, resources, and trackable milestones, plus a narrative justification for the funding request. The total package for these four environmental restoration ADSs amounted to $64.3 million. The ERWM environmental restoration ADSs include:

- closure Hazardous Waste Handling Facility (existing)
- program management
- San Francisco facilities transition; Bevalac (ER)
- soil and groundwater; environmental assessment and remediation

These environmental restoration activities, except for program management, 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 include an additional close-out report. The Bevalac environmental restoration program will be coordinated with other activities planned for the Bevalac complex.

*Waste Management*

Four ADSs were prepared by LBL for ERWM five-year planning activities in waste management in 1992 and early 1993. Preparation followed the layout described for environmental restoration ADSs. The ADSs covered the period FY95 through FY99. The funding request for these four waste management activities totaled $64.3 million. The ERWM waste management ADSs include:

- facility operations and maintenance
- general plant projects
- Hazardous Waste Handling Facility (new)
- waste minimization

The facility operations and waste minimization ADSs are similar to the programmatic ADSs prepared for environmental programs in that they describe the elements needed to maintain or improve compliance programs. This waste minimization ADS is only for activities within the HWHF, whose DOE landlord is ERWM. The earlier waste minimization ADS addresses activities across the remainder of the LBL facility, whose DOE landlord is ER. The General Plant Projects and HWHF ADSs request funding for specific upcoming projects, such as installation of HEPA filters and Berkeley manifolds, procurement of deionization regeneration equipment, and construction of the new HWHF. It should be noted that the funding request of $5.8 million for the HWHF is not included in the $64.3 million above because the request is for FY94 funds.

LBL's Environment Department also expended a large effort to either write or significantly modify a number of plans and procedures for environmental programs in 1992 and early 1993. These include:

- *Air Quality Program Manual*
- *Asbestos Management Plan*
- *Environmental ALARA Program*
- *Environmental Monitoring Plan*
- *Environmental Protection Group Procedures*
- *Environmental Protection Implementation Plan*
- *Groundwater Protection Management Plan*
- *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*
- *Procedures, Hazardous Waste Handling Facility*
- *RCRA Facility Investigation Workplan*
- *Spill Prevention, Control, and Countermeasure Plan*
- *Storm Water Monitoring Program*
- *Storm Water Pollution Prevention Plan*
- *Underground Storage Tank Management Plan*
- *Underground Storage Tank Monitoring Procedures*
- *Underground Storage Tank Response Plan.*

### *3.4.4 Environmental Occurrence Reporting*

DOE has established a system for reporting events or conditions at DOE-owned or operated facilities that require appropriate corrective action, including notification of DOE. DOE Order 5000.3A, "Occurrence Reporting and Processing of Operations Information" outlines the requirements of the reporting program. The structure of the program begins with identification and categorization of the event or condition. The categories for Reportable Occurrences include Emergencies, Unusual Occurrences, and Off-Normal Occurrences. Once categorized, Reportable Occurrences require both oral and written notification to DOE. Notification is followed by the formal Occurrence Report and Follow-up process that details the event, including the root cause(s) and the corrective actions taken to prevent recurrence.

A total of 46 Occurrence Reports (ORs) were submitted by LBL to DOE during 1992. Of this total, about 23 ORs were for environmentally related incidents such as fires, small gas releases, sanitary sewer discharge excursions, and small fuel spills. The remaining ORs were for various incidents such as burglaries and operation procedure breaches.

Three Occurrence Reports have been filed by LBL in the first quarter of 1993. Two of these reports were for small fires, and the third was for an operations procedure failure.

### *3.4.5 Environmental Training*

Many of the plans and procedures developed for LBL's environmental programs have a training element imbedded in them. Training requirements vary widely from program to program. Examples of the variety of training requirements include teaching environmental monitoring personnel proper sample handling procedures and instructing hazardous waste generators on satellite and waste accumulation area guidelines. A significant amount of effort is spent training individuals on specific compliance or operational requirements. The EH&S Training Group is currently developing method of accounting for this on-the-job training.

For Laboratory-wide programs, training is administered by the EH&S Training Group. There are over 110 courses available through this group. Nearly 30 of these courses have an environmental compliance theme. The largest of these courses are the *Hazardous Waste Generators'* and *Radioactive/Mixed Waste Generators'* training. Over 1000 Laboratory employees have been trained in one or both of these 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.

### *3.4.6 Self-Assessment*

LBL's Office of Assessment and Assurance completed development of the LBL Self-Assessment Program in 1992. The program provides a formal process for assuring quality and regulatory compliance in all facets of Laboratory operations. It generates targeted performance data in the areas of environment, safety, and health compliance through evaluations conducted at all levels of the Laboratory organization. The data are tracked and analyzed against LBL-established performance objectives and criteria to identify strengths, areas for improvement, and corrective actions for trends.

Implementation of the LBL Self-Assessment Program is now underway. Divisions have developed implementation plans. Appraisal teams have attended self-assessment training, are conducting self-appraisals, and are tracking identified deficiencies to completion. Oversight is provided by the Office of Assessment and Assurance. In February 1993, the program was nominated for DOE Best Management Practice Recognition.

The EH&S Division performs functional appraisals. These are independent inspections which will verify the appraised Division's line management of EH&S compliance activities.

### *3.4.7 Other Environmental Activities*

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 the Laboratory have programs in place designed to achieve compliance with applicable laws, regulations, ordinances, and DOE Orders relating to environmental protection. Furthermore, the Laboratory is required to report the results of a self-assessment on the performance measures to UC annually. Additionally, UC is required to have an annual audit of the Laboratory's environmental programs conducted by an external organization. This UC oversight will be independent of DOE oversight activities at LBL.

In reference to new large-scale programs coming on line, the Advanced Light Source (ALS) became operational in April 1993. In preparation of this startup, an ALS Operational Readiness Review began in April 1992. The purpose of the review is to fulfill a final and independent review of facility, equipment, and safety systems, operating, support, and supervisory personnel, and management systems and procedures. Twenty-one operational readiness areas were formally identified for the readiness review.

Lastly, an event of tremendous historical significance in the global high-energy physics research community occurred on February 20, 1993, when the Bevatron (Building 51) completed its last experimental run. The Bevatron is the most massive of LBL's accelerators and had been operational since 1954. Age, technology, and funding were key issues in this determination. Support operations from the SuperHILAC (Building 71), a heavy-ion accelerator, had earlier shut down on December 23, 1992. The SuperHILAC had been operational since 1956. Numerous high-energy physics discoveries are credited to the Bevatron and SuperHILAC complex, or “Bevalac,” as it has become known as over the years. In addition to the historical loss, this will be a major loss of revenue for LBL.

Future plans for the Bevalac were submitted to DOE in April 1993. The current ER-funded Stand Down and Secure program will last through FY94. At that point, the Bevalac facilities will be transferred to DOE’s Environmental Management–60 (EM-60) for a three-year transition period, during which time the site will be adequately characterized, excess property will be removed, future-use plans will be formalized, and structural modifications will be made to the facilities. After the transition phase, Decommissioning and Decontamination (D&D) under EM-40 will take place. It is anticipated that the transition phase will greatly reduce the time and cost of D&D, since most of the materials in the Bevalac complex will have been removed for use at other DOE sites prior to the start of D&D.

The Bevalac closure will result in several beneficial impacts on environmental compliance activities. The most significant of these include eliminating water discharges into the sewer system from the cooling towers, atmospheric releases of chlorofluorocarbons from the accelerator's coolant systems, and public radiological doses from both penetrating radiation and airborne radionuclides.

# Section 4
# Environmental Radiological Program Information

## 4.1 Penetrating Radiation

LBL has monitored the neutron and proton emissions from its accelerators for more than 20 years. During that time impacts from a wide variety of experiments at the 88-Inch Cyclotron, the Heavy Ion Linear Accelerator (HILAC), and the Bevatron have been measured. Historically the measurements have been taken with real-time neutron and photon detection. The real-time measurement systems were not operable during 1992. Offsite doses attributable to accelerator operations are estimates based on accelerator run histories and their concomitant offsite doses. The real-time systems were put back in service in early 1993.

The 88-Inch Cyclotron averaged 116 hours per week for 43 weeks during 1992. On 17% of the shifts, light ions were accelerated from low to maximum beam current. Over the last several years, more than 90% of the offsite neutron dose produced by the 88-Inch Cyclotron was produced by beams of 40–110 MeV $^3He$ ions that were directed into Experimental Cave 2.

In analyzing accelerator histories, the following is observed:

The relationship between offsite exposures and 88-Inch Cyclotron light-ion beam current was found to be reasonably well approximated by the expression

$$H_o = 10^{-4} \Sigma Ae_i t_i \quad , \qquad (1)$$

where $H_o$ is the fence-post dose in mrem, $Ae_i$ is the average beam current in μA-hours at the extraction radius for the $i^{th}$ $^3He$ beam runs in the 88-Inch Cyclotron's Cave 2, and $t_i$ is the beam run duration in hours. The nearest offsite dwelling is immediately adjacent to the perimeter fence approximately 80 meters west of the Cyclotron.

During 1992 integrated beam current was roughly equal to 1300 μA-hours, and thus the fence-post exposure is estimated to have been $10^{-4}$ mrem/μAhr × 1300 μAhr = 0.13 mrem.

During 1992 the Bevalac ran a reduced schedule of 116 hours per week, compared to the historic 160 hours per week. We estimate the Bevatron's exposure to the maximally exposed individual by multiplying the average exposure to the maximum individual over the last ten years of 3.1 mrem/year by 116/160 to get 2.3 mrem.

Table 4-1 lists the estimated doses for 1992.

Historically, DOE facilities have reported "fence-post doses," which are measured or computed values reflecting the exposures to hypothetical individuals 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 report will provide both maximum fence-post dose estimates and estimates of exposures to workplaces or dwellings of LBL's nearest neighbors.

**Table 4-1.** Fencepost Annual Effective Dose Equivalent Estimates at the LBL Boundary due to Accelerator Operations, 1992.

| | 1992 total above background | | |
|---|---|---|---|
| Monitoring station | gamma (mrem) | neutrons (mrem) | Total (mrem) |
| Station 13 A (Bldg. 88) | 0 | 0.13 | 0.13 |
| Station 13 B (Bldg. 90) | 0 | 0 | 0 |
| Station 13 C (Panoramic) | 0 | 0 | 0 |
| Station 13 D (Olympus Gate) | 0 | 2.3 | 2.3 |
| Standard for comparison | — | — | 100[a] |
| (Dose to individuals at maximum point of exposure) | | | |

(Bounding estimates based on run histories)

[a]Source: DOE Order 5400.5.

LBL is storing two shielded irradiators, a $^{137}Cs$ unit and a $^{60}Co$ unit, in the Building 75 waste yard behind a large earth berm, to minimize potential for worker exposures. The field attributable to the irradiators measured at the perimeter fence nearest to the devices was < 2 μR/hr, which predicts an annual fence-post dose of < 18 mrem/year ( 2 μrem/year × $10^{-3}$ mrem/μrem × 8.760 x $10^3$ hours/year). The perimeter fence at this location is on UC land, however, and there are no residences or offsite workplaces in the immediate vicinity. The nearest offsite workplace (40-hour/week occupancy), the Lawrence Hall of Science, is approximately 270 m from the fence. The nearest home is approximately 500 m away, and both sites are shielded by a hillside. If the shielding by the hillside is ignored, the predicted doses from the stored sources would be ~0.005 mrem/yr at the Lawrence Hall of Science or ~0.007 mrem/yr at the nearest home. The units are clearly marked, barricaded, and cordoned off at the ~0.2 mrem/hr isodose line.

LBL has several multicurie gamma irradiators used in 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.) Surveys taken when the irradiator was upgraded and reloaded found no area where the stray radiation field exceeded 1 mrem/hr at 1 m from the outside walls or ceiling when the source was in the exposed position. The Building 74 irradiator is ~80 m from the LBL perimeter fence, 150 m from the nearest "commercial" occupancy (a UCB Botanical Garden building), and more than 700 m from the nearest house. The projected annual dose equivalents to members of the public would be < 1.4 mrem/yr at the perimeter fence, < 0.1 mrem/yr at the Botanical Garden building (40-hr/wk occupancy), and <0.02 mrem/yr at the nearest house (168-hr/wk occupancy).

## 4.2 Airborne Radionuclides

LBL uses a wide variety of radionuclides in its research programs, including $^{3}H$, $^{14}C$, $^{32,33}P$, $^{35}S$, $^{22}Na$, $^{45}Ca$, $^{51}Cr$, $^{57,60}Co$, $^{68}Ge/Ga$, $^{54}Mn$, $^{55,59}Fe$, $^{82,85,90}Sr$, $^{86}Rb$, $^{95}Nb/Zr$, $^{99}Mo$, $^{99M}Tc$, $^{111}In$, $^{123,125}I$, $^{123}Te$, $^{172,175}Hf$, $^{207}Bi$, $^{226}Ra$, $^{227}Ac/Th$, $^{228,232}Th$, $^{231,233}Pa$, $^{235,238}U$, DEP-U, $^{237}Np$, $^{238,239}Pu$, $^{241,243}Am$, $^{244,246,248}Cm$, $^{249}Bk$, $^{249,252}Cf$, and $^{254}Es$. Of the foregoing, the most commonly and widely used nuclides are $^{3}H$, $^{14}C$, $^{32}P$, $^{35}S$, and $^{123,125}I$. The principal form in which nuclides are released from LBL stacks is as vapors or gases. Particulate materials are filtered from effluent streams, and measurable particulate releases are rare. Nuclides in the foregoing list that were released to the atmosphere from LBL stacks during 1992 are $^{3}H$ as HTO (water vapor), $^{14}C$ as $^{14}CO_2$, $^{35}S$ as $^{35}SO_2$, 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—but the $^{226}Ra$ and $^{227}Ac$ used in LBL research activities are either in sealed sources used for calibration (i.e., $^{226}Ra$ in gram quantities), in natural uranium ores, or in electroplated targets or foils in quantities too small to produce any consequential environmental impact. (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.)

Consequential to their operation, LBL accelerators produce air-activation radionuclides, specifically $^{11}C$, $^{13}N$, $^{15}O$, and $^{41}Ar$, inside their massive vault shields. A number of other activation products are also produced, including $^{10}C$, $^{16}N$, $^{14}O$, and $^{38,39}Cl$ (produced from $^{40}Ar$, which is approximately 1% of the atmosphere), but these nuclides represent less than 5% of the total discharged activation products, are shorter-lived than the four major species listed, and therefore do not significantly contribute to the offsite dose equivalent.

The vaults are vented to the atmosphere. The air-activation product release estimates, listed in Table 2 in the Executive Summary, were calculated using a set of equations developed in Patterson and Thomas (1973). The model relates air-activation production to Accelerator-beam energy, intensity, and duration. LBL will install air-activation product monitors on all accelerators by 1995.

The "unidentified alpha-emitter releases" figure in Table 2 is an estimate of the quantity of material that could have been released undetected (below the detection limit) from LBL stacks. These estimated releases are represented by $^{232}Th$. The calculated human exposure from such releases would be less than 0.02 mrem/yr to a maximally exposed offsite individual.

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 $200 \times 10^{-12}$ μCi/ml.

Silica-gel HTO samples are changed weekly at eight stations identified in Figure 4-1. Three of the facilities are on site:

- ENV 69A (northeast corner of Building 69)

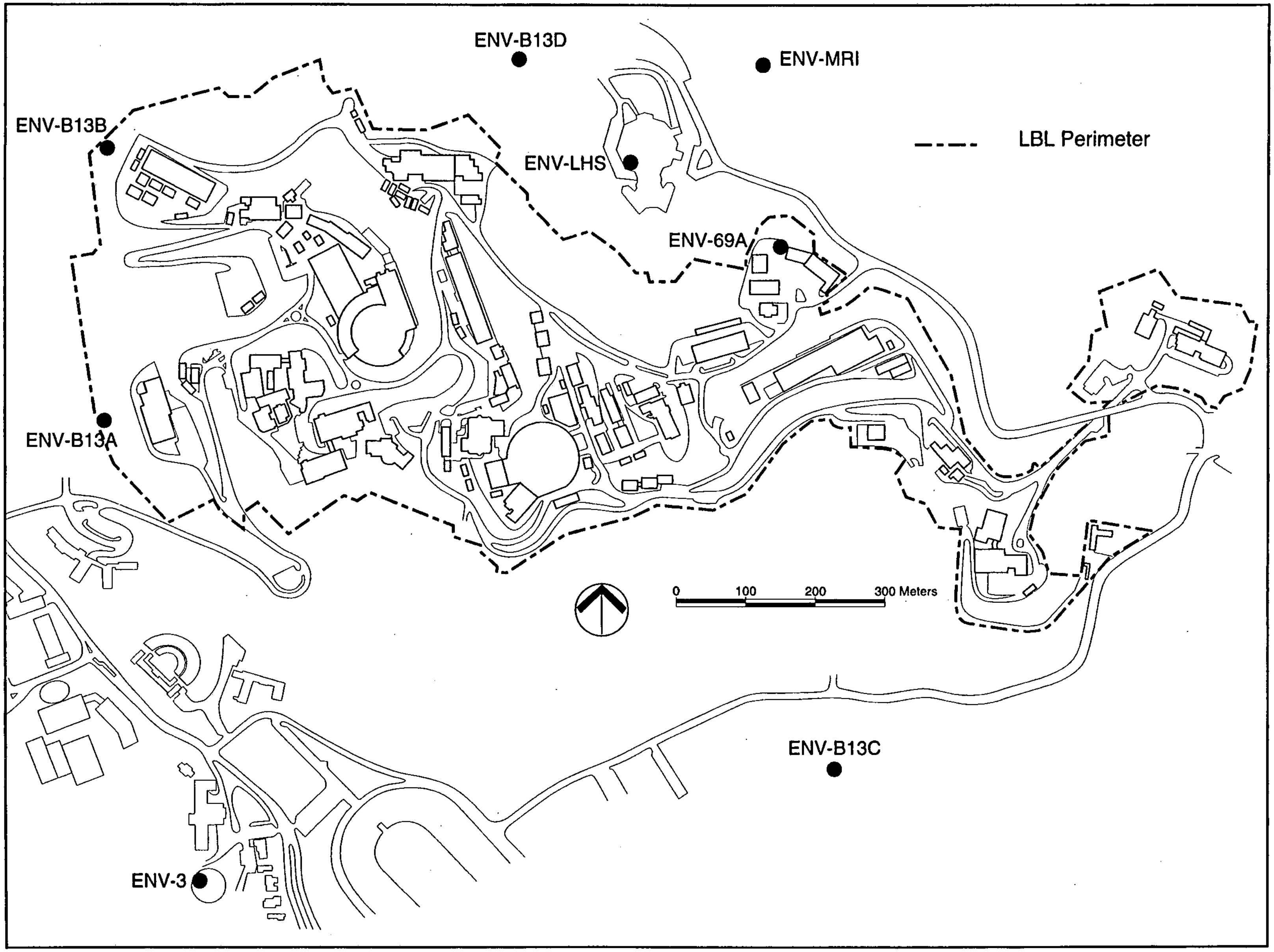



**Figure 4-1.** Map of airborne environmental tritium sampling sites

- ENV B13A (west of Building 88)
- ENV B13B (northwest of Building 90).

Five of the facilities 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 UC Mathematical Science Research Institute)
- ENV B13C (across Strawberry Canyon, south of LBL)
- ENV B13D (northwest of the Lawrence Hall of Science)

The stack from the National Tritium Labeling Facility is also monitored for tritium as described above.

Filter papers containing 55% activated carbon are used to sample effluent air 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 $2 \times 10^{-11}$ µCi/ml.

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 0.2 M 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 $200 \times 10^{-12}$ µCi/ml.

Gross atmospheric particulate beta and alpha activities are measured by air sampling at the 14 points shown in Figure 4-2.

The gross beta and alpha sampling media are 10 cm × 23 cm (4 × 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 removed weekly. 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 $3 \times 10^{-15}$ µCi/ml. The detection limit for beta emitters is $120 \times 10^{-15}$ µCi/ml. To ensure accuracy of all counting results, each group of samples counted includes at least one radiation standard sample and a number of background samples.

LBL's Low-Background-Counting Facility (LBCF), located in Bldg. 72, aggregated the 14 weekly environmental particulate air samples into sets and analyzed the sets for airborne particulate gamma-emitting nuclides. The sets were allowed to decay for at least two weeks and were then analyzed with a large high-purity germanium detector. Each set represented particulates collected from ~14,500 $m^3$ of air, and was counted for a minimum of 1,000

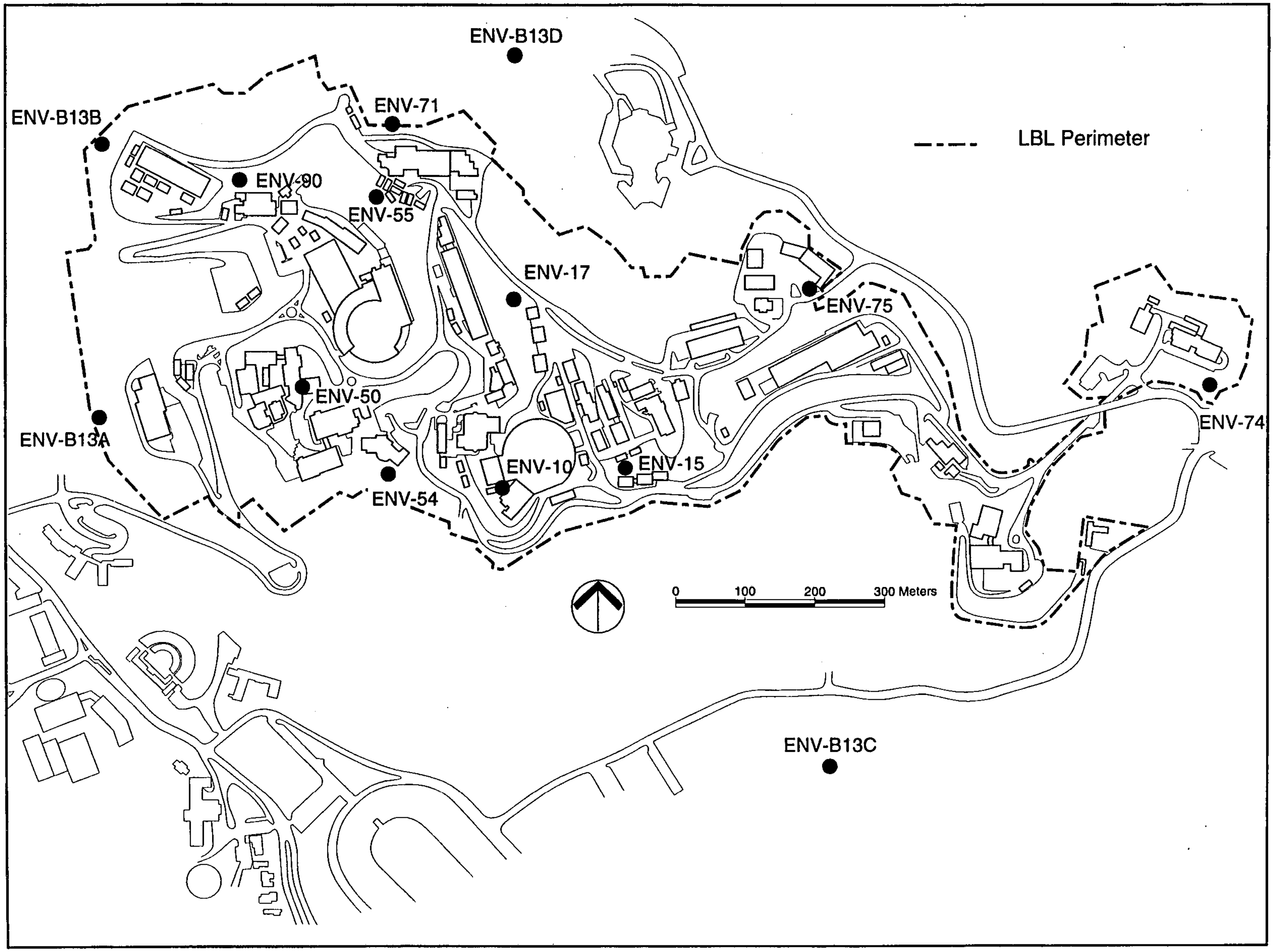



**Figure 4-2.** Map of airborne radioactive particulate sampling sites

minutes. The only gamma emitters found in the samples were $^{7}Be$ and $^{210}Pb$. The $^{7}Be$ is produced by cosmic-ray interactions with atmospheric nitrogen (and can also be produced by accelerators). The detection limit for $^{7}Be$ is $2 \times 10^{-16}$ µCi/ml for a 1,000-minute count. 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. The detection limit for $^{210}Pb$ is $5 \times 10^{-16}$ µCi/ml for a 1,000-minute count. ($^{210}Pb$ 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 eminate from most rocks and soils. (Most rocks and soils contain uranium and thorium, the primordial parents of radon and thoron.) Table 4-2 summarizes the gamma-emitting radionuclides found on environmental air samples. The numbers are for the aggregated sets of weekly samples from all 14 onsite and offsite atmospheric air stations, for a total of approximately 710 samples.

Inasmuch as the DOE Orders (e.g., DOE Order 5400.5) make no provision for unidentified radionuclides, throughout this report unidentified radionuclides will be conservatively labeled $^{232}Th$ if they are alpha-emitting material or $^{90}Sr$ if they are beta-emitting material. The assertion of conservatism is made because, although $^{90}Sr$ and $^{232}Th$ are used at LBL, they are only in a few LBL laboratories and, for isotopes used at LBL, represent the most restrictive beta and alpha emitters, respectively, listed in DOE Order 5400.5. $^{90}Sr$ is used as a calibration source in radioanalytical environmental laboratories. $^{232}Th$ is used for research 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, 18-day $^{227}Th$ and 14-day $^{223}Ra$, and it would thus be detected as an alpha emitter.

The total quantities of radionuclides discharged into the atmosphere are summarized in Table 2 in the Executive Summary. Aside from the 87 curies of tritium released in 1992, which is comparable to that of 1991 and 53% of the 1990 value, the figures are similar to those of last year, and the releases resulted in a small collective effective dose equivalent (see Table 1 in the Executive Summary and Section 4.4).

Although small quantities of radionuclides (Table 2) were discharged into the atmosphere during 1992, the data from the general environmental air sampling program were within the range of historical background values. In addition to the air activation products, releases of the two additional nuclides in Table 2 ($^{123}I$ and $^{18}F$)were estimates.

**Table 4-2**. Summary of Gamma Emitters Found in Environmental Air Samples, 1992.

| | | $^{7}Be$ | $^{210}Pb$ |
|---|---|---|---|
| Concentration | Minimum | 5 ± 1 | 0.17 ± 0.04 |
| ($10^{-14}$ µCi/ml) | Maximum | 20 ± 6 | 4.3 ± 1 |
| | Average | 12 ± 3 | 1.1 ± 0.3 |
| Standard | | $5 \times 10^{6}$ | 90 |
| Average as % of Standard | | 0.0002 | 1.2 |

The release fraction for $^{123}I$ was assumed to be comparable to that of $^{125}I$. The estimate of $^{18}F$ releases (2% of inventory) was based on a set of measurements made at a facility that produces the same radiopharmaceuticals as does LBL (Keck et al., 1991).

The environmental air sampling program for $^{14}C$ and $^{3}H$ found detectable concentrations of these nuclides (Tables 4-3 and 4-4). Essentially 100% of the tritium released from LBL was discharged from the Building 75 stacks. Table 4-5 summarizes the gross particulate radioactivity measured in LBL air samples during 1992. The Table 4-5 data for 1992 may be compared with data from Table 4-6, which lists LBL perimeter air-sample-data maxima and averages for the period 1983–1992.

One may note that a number of the average values listed in several of the tables in this report (notably Tables 4-4, 4-5, 4-7, 4-9, and 4-11) are less than the minimum values listed for individual samples. This occurs whenever the actual average value of a substance measured is less than the detection limit for that substance in an individual sample, and the average represents the arithmetic sum of all measurements divided by the number of measurements taken (as in this report). The uncertainties listed with tabular quantities represent 95% confidence limits of the assay values (or sum of assay values).

**Table 4-3.** Summary of Airborne Environmental HTO and $^{14}CO_2$ Sampling, 1992.

| | No. of Samples | Concentration ($10^{-9}$ μCi/ml) Avg. | Min. | Max. | Average as % of Standard |
|---|---|---|---|---|---|
| Samples for Tritium as HTO | | | | | |
| ENV 69A | 44 | 0.6 ± 0.2 | ≤ 0.2 | 7.1 ± 2 | 0.6 |
| ENV 3 | 44 | 0.08 ± 0.04 | ≤ 0.2 | 1.1 ± 0.4 | 0.08 |
| Perimeter | | | | | |
| MRI | 44 | ≤ 0.03 | ≤ 0.2 | 0.2 ± 0.2 | ≤ 0.03 |
| LHS | 44 | ≤ 0.03 | ≤ 0.2 | 0.2 ± 0.2 | ≤ 0.03 |
| B-13A (Bldg 88)[a] | 44 | ≤ 0.03 | ≤ 0.2 | ≤ 0.2 | ≤ 0.03 |
| B-13B (Bldg 90) | 44 | ≤ 0.03 | ≤ 0.2 | 1 ± 0.3 | ≤ 0.03 |
| B-13C (Panoramic) | 44 | ≤ 0.03 | ≤ 0.2 | ≤ 0.2 | ≤ 0.03 |
| B-13D (Olympus) | 44 | 0.3 ± 0.3 | ≤ 0.2 | 0.3 ± 0.2 | ≤ 0.3 |
| Standard for comparison[a] | — | 100 | — | | — |
| Samples for Carbon-14 (as $^{14}CO_2$) | | | | | |
| Onsite | | | | | |
| ENV 3 | 49 | ≤ 0.03 | ≤ 0.2 | 0.2 ± 0.2 | ≤ 0.006 |
| Standard for comparison[a] | — | 500 | — | — | — |

[a]Source: DOE Order 5400.5.

**Table 4-4.** Summary of Perimeter Airborne Environmental HTO and $^{14}CO_2$ Sampling, 1983–1992.

| | | Concentration ($10^{-9}$ µCi/ml) | | | | |
|---|---|---|---|---|---|---|
| | HTO | | | $^{14}CO_2$ | | |
| Year | No. of Samples | Avg. | Max. | No. of Samples | Avg. | Max. |
| 1983 | 101 | 0.4 ± 0.1 | 3 ± 1 | 49 | < 0.01 | 0.3 ± 0.2 |
| 1984 | 97 | 0.5 | 7 ± 3 | 51 | 0.6 | 30 ± 10 |
| 1985 | 102 | ≤ 0.3 | 5 ± 1 | 50 | ≤ 0.1 | 1.1 |
| 1986 | 100 | 0.5 ± 0.1 | 12 ± 3 | 51 | 0.07 ± 0.02 | 0.4 ± 0.1 |
| 1987 | 97 | < 0.5 | 5 ± 1 | 51 | < 0.05 | 0.4 ± 0.1 |
| 1988 | 144 | 0.2 ± 0.1 | 3 ± 1 | 51 | < 0.05 | 0.2 ± 0.1 |
| 1989 | 142 | 0.2 ± 0.07 | 3 ± 1 | 50 | <0.06 | <0.3 |
| 1990 | 204 | ≤ 0.1 | 3 ± 1 | 49 | ≤ 0.03 | 0.4 ± 0.1 |
| 1991 | 268 | ≤ 0.1 | 5 ± 1 | 49 | ≤ 0.03 | ≤ 0.2 |
| 1992 | 264 | ≤ 0.03 | 7 ± 1 | 49 | ≤ 0.03 | 0.2 ± 0.2 |
| Standard for comparison[a] | | 100 | | 500 | | |

[a]Source: DOE Order 5400.5.

**Table 4-5.** Summary of Gross Particulate Radioactivity in Air Samples, 1992.

| | | Concentration ($10^{-15}$ µCi/ml) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Alpha | | | Beta | | | Average as % of standard | |
| | No. of samples | Avg. | Min | Max[a] | Avg. | Min. | Max[a] | Alpha | Beta |
| Onsite average of 10 locations | 496 | 0.6 ± 0.1 | ≤ 2 | 6 ± 2 | ≤ 13 | ≤ 80 | 170 ± 90 | 9 | ≤ 0.2 |
| Perimeter stations | | | | | | | | | |
| B 13 A | 40 | 0.6 ± 0.6 | ≤ 3 | 6 ± 2 | ≤ 20 | ≤ 120 | ≤ 120 | 9 | ≤ 0.2 |
| B 13 B | 50 | ≤ 0.5 | ≤ 3 | 6 ± 2 | 19 ± 17 | ≤ 120 | 140 ± 130 | ≤ 7 | 0.2 |
| B 13 C | 49 | ≤ 0.5 | ≤ 3 | 5 ± 2 | ≤ 18 | ≤ 120 | 130 ± 130 | ≤ 7 | ≤ 0.2 |
| B 13 D | 48 | ≤ 0.5 | ≤ 3 | 6 ± 2 | ≤ 18 | ≤ 120 | 150 ± 140 | ≤ 7 | ≤ 0.2 |
| Standard for comparison[b] | | 7 | | | 9,000 | | | | |

[a]Highest single weekly sample.

[b]Source: DOE Order 5400.5; alpha conservatively assumed to be $^{232}Th$; beta assumed to be $^{90}Sr$.

**Table 4-6.** Annual Gross Particulate Radioactivity Found in LBL Perimeter Air Samples, 1983–1992.

| | | Concentration ($10^{-15}$ μCi/ml) | | | |
|---|---|---|---|---|---|
| | | Alpha | | Beta | |
| Year | No. of Samples | Avg. | Max. | Avg. | Max. |
| 1983 | 201 | 0.49 ± 0.1 | 2 | < 6 | 110 ± 80 |
| 1984 | 187 | 0.46 ± 0.1 | 3 ± 2 | < 6 | 120 ± 100 |
| 1985 | 198 | 0.54 ± 0.2 | 4 ± 3 | 12 ± 6 | 120 ± 80 |
| 1986 | 195 | 0.5 ± 0.2 | 9 ± 3 | 40 ± 10 | 700 ± 100[a] |
| 1987 | 191 | ≤ 0.5 | 5 ± 3 | ≤ 16 | 200 ± 160 |
| 1988 | 197 | ≤ 0.5 | 5 ± 3 | ≤ 16 | 130 ± 120 |
| 1989 | 191 | 0.45 ± 0.35 | 5 ± 3 | <16 | 170 ± 130 |
| 1990 | 204 | ≤ 1.3 | 5 ± 3 | ≤ 16 | 140 ± 120 |
| 1991 | 188 | ≤ 0.5 | 5 ± 2 | ≤ 16 | 180 ± 130 |
| 1992 | 187 | ≤ 0.5 | 6 ± 2 | ≤ 18 | 150 ± 140 |
| Standard for comparison[b] | | 7 | | 9000 | |

[a]Chernobyl fire, April 26, 1986.

[b]Source: DOE Order 5400.5; alpha conservatively assumed to be $^{232}Th$; beta conservatively assumed to be $^{90}Sr$.

## 4.3 Waterborne Radionuclides

Rainwater (see Figure 4-3); creek water (see Figure 1-6); groundwater, which flows from the horizontal wells (hydraugers), whose bores are represented by the heavy dashed lines in Figure 4-4; and sewage from LBL's two sewer outfalls are analyzed for tritium, gross beta, and alpha emitters (see Figure 4-4; the Strawberry Sanitary Sewer is the southern site; Hearst is the western sewer). Additionally, sewer effluent is analyzed for gross halogen (radioiodine) content. (Hydrauger sampling procedures and results are discussed in Section 6, Groundwater Protection.)

The four perimeter environmental monitoring stations have 46-cm-diameter (18-in.) cylindrical rainfall collectors on their roofs. During rainy months (generally October through May), rainwater is collected monthly and analyzed for tritium and for gross alpha and beta activities. During the dry California summer, each collector is rinsed monthly with a quart of tap water, and the rinse is analyzed for "dry deposition." The nine onsite locations shown in Figure 4-3 also contain 46-cm-diameter (18-in.) combination rain/dry deposition collectors, which are sampled on a monthly basis in the same manner as the four perimeter environmental monitoring stations.

Rain that falls into the collectors on the north side of Building 75 and on the roof of Building 4 are analyzed wherever there is a significant rainfall 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 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 Tritium Facility (Tables 4-7 and 4-8). The deposition values, adjusted for rainfall, are compared with the Safe Drinking Water Act standards found in drinking-water standards. 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.

Sewer outfalls are sampled continuously (Figure 4-4), sample-to-flow ratios are designed to be between 10 and 20 parts per million, and composite samples are taken weekly. The five creek-sampling points (indicated in Figure 1-6) are sampled weekly. A 1-qt grab sample is taken from each site and analyzed for tritium and gross alpha and beta emitters.

Since radioiodine would be driven out of the water samples when they are acidified, aliquots of the sewer effluent samples are preserved for radioiodine analysis. 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 precipitated radioiodine is placed in the planchette and is counted.

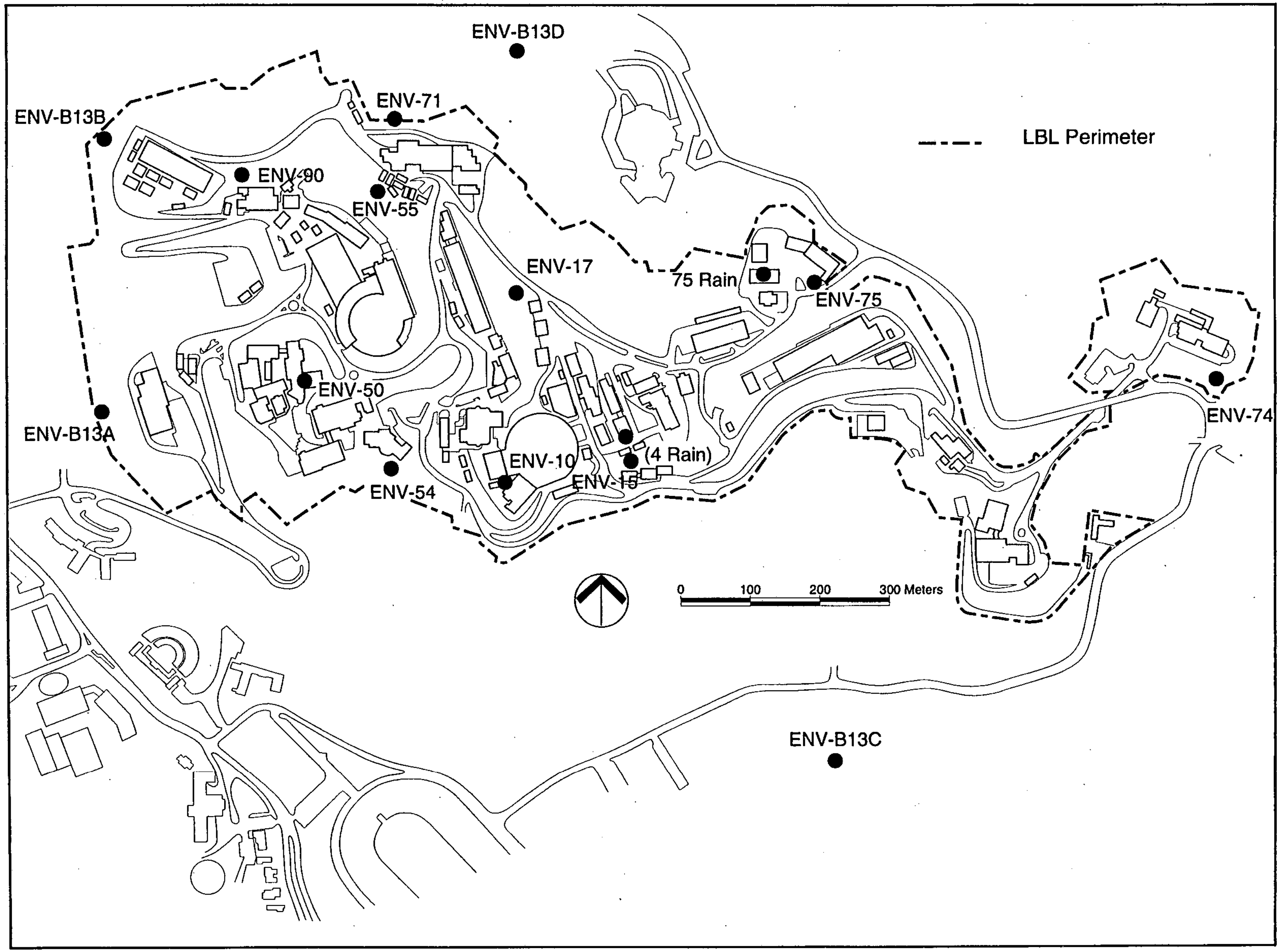



**Figure 4-3.** Map of rain and dry deposition collectors

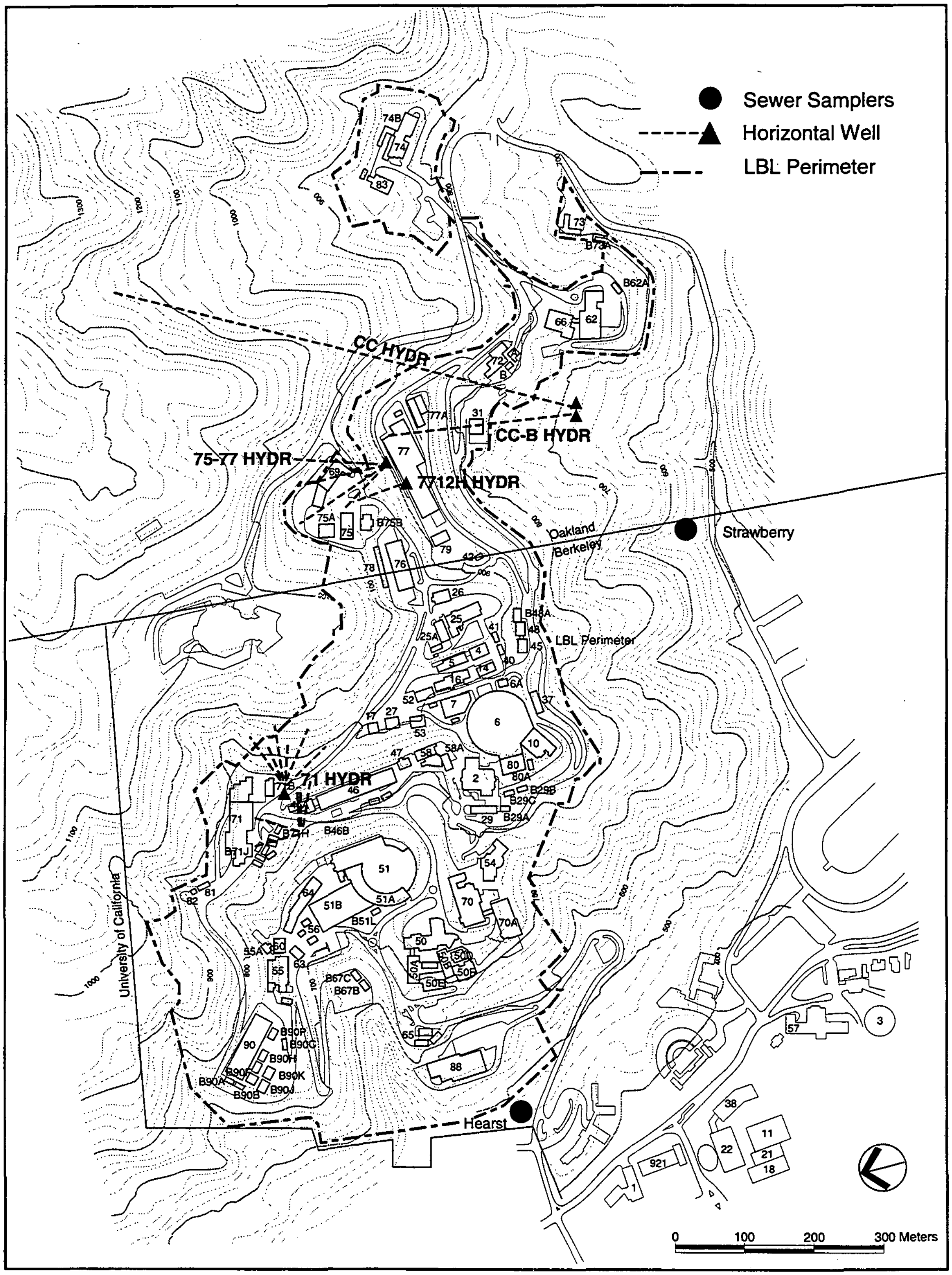



**Figure 4-4.** Map of LBL hydrauger and sewer sampling sites.

**Table 4-7.** LBL Perimeter Station Deposition Trends 1983–1992.

| | | | Concentration ($10^{-3}$ μCi/m²) | | | | (μCi/m²) | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Alpha | | Beta | | HTO | | |
| Year | No. of Samples | Rainfall (cm) | Avg. | Max. | Avg. | Max. | No. of Samples | Avg. | Max. |
| 1983 | 48 | 119.4 | 0.02 | 0.07 | 1.6 | 3.5 | 36 | < 0.2 | 0.4 |
| 1984 | 48 | 45.5 | 0.05 | 0.08 | < 1 | 3 | 36 | < 0.2 | 0.2 |
| 1985 | 48 | 44.5 | 0.02 | 0.4 | 0.7 | 2 | 27 | < 0.2 | 0.2 |
| 1986 | 48 | 81.4 | 0.03 | 0.04 | 0.8 ± 0.2 | 2 | 29 | 0.1 | 0.3 |
| 1987 | 48 | 53.4 | ≤ 0.04 | 0.06 | 0.8 ± 0.5 | 2 | 24 | 0.1 | 0.2 |
| 1988 | 48 | 45.5 | 0.03 | 0.06 | 0.6 | 1.4 | 35 | 0.6 | 0.9 |
| 1989 | 48 | 47.8 | 0.04 | 0.04 | 0.8 | 1.7 | 28 | 0.2 | 0.6 |
| 1990 | 48 | 47.4 | 0.02 | 0.04 | 0.6 | 1.3 | 36 | ≤ 0.01 | < 0.05 |
| 1991 | 48 | 46.0 | 0.06 | 0.1 | 0.8 | 1.6 | 24 | ≤ 0.01 | ≤ 0.2 |
| 1992 | 44 | 60.5 | 0.1 | 0.2 | 0.3 | 1 | 20 | ≤ 0.7 | ≤ 1 |

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 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 cm²), assuming an alpha energy of 5.2 MeV and a beta energy of 1 MeV.

Table 4-9 summarizes the 1992 data from the surface- and tap-water sampling programs. The results are similar to those obtained in past years, and all lie within historical normal range of background activity. Table 4-10 summarizes the surface- and drinking-water samples for 1983–1992.

Table 4-11 summarizes the sewage sampling data for 1992. The average and maximum values listed for sewer beta concentrations reflect the weekly activity found in the more radioactive of the acid or radioiodine planchettes. Table 4-12 summarizes the sewage data for the years 1983–1992.

**Table 4-8.** Summary of Atmospheric Deposition, 1992.

| | Total deposition ($10^{-3}$ µCi/m²) | | | | | | Tritium in rainfall as HTO (µCi/m²) | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Alpha | | Beta | | | | | |
| | No. of samples | Avg. | Max.[a] | Avg. | Min. | Max.[a] | No. of samples | Avg. | Max.[a,b] |
| Onsite (12 locations) | 147 | 0.1 | 0.2 | 0.8 | 0.3 | 3 | 103 | 1 ± 0.4 | 12 ± 3 |
| Perimeter (4 locations) | 44 | 0.1 | 0.2 | 0.5 | 0.3 | 1 | 20 | 0.7 | 1.3 |
| Perimeter averages as a % of standards | | 3 | | 10 | | | | 6 | |
| Drinking-water standard × 605[c] | | 3.02 | | 4.84 | | | | 12.1 | |

[a]Highest total for any one site.

[b]The location of this deposition collector is on the north side of Bldg. 75 (see Fig. 4-3). The average HTO concentration in samples taken from the Bldg. 75 collector was 50% of the EPA HTO drinking-water standard of 20,000 pCi/l.

[c]The standards used for comparison are derived from 40 CFR 141 for alpha and beta ($^{90}Sr$) values. The deposition represents that quantity of activity found in 605 liters of water (the average quantity of rainfall/m² during 1992). Thus, the values used are 605 times the 40 CFR 141 values. [No standards for comparison have been established, so drinking-water standards (radionuclide concentration/l) are used.]

**Table 4-9.** Summary of Surface- and Drinking-Water Samples, 1992.

| | | Concentration ($10^{-9}$ μCi/ml) | | | | | | Concentration ($10^3$ pCi/l) | | | Average as % of standard | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Alpha | | | Beta | | | Tritium as HTO | | | | | |
| | No. of samples | Avg. | Min. | Max. | Avg. | Min. | Max. | Avg. | Min. | Max | Alpha | Beta | Tritium |
| Onsite streams | | | | | | | | | | | | | |
| Blackberry | 40 | ≤ 0.8 | ≤ 2 | 9 ± 6 | 1.9 ± 0.1 | ≤ 0.7 | 4 ± 1 | 0.3 ± 0.06 | ≤ 0.7 | 4 ± 1 | ≤ 16 | 24 | 2 |
| Lower Strawberry | 40 | 0.4 ± 0.3 | ≤ 1 | 4 ± 3 | 1.5 ± 0.1 | 0.5 ± 0.4 | 5 ± 0.9 | ≤ 0.1 | ≤ 0.7 | 5 ± 3 | 8 | 19 | ≤ 0.5 |
| Upper Strawberry | 40 | ≤ 1 | ≤ 3 | 7 ± 6 | 2.1 ± 0.2 | ≤ 0.6 | 16 ± 3 | ≤ 0.1 | ≤ 0.7 | 4 ± 3 | ≤ 20 | 26 | ≤ 0.5 |
| Average | | ≤ 0.7 | | | 1.8 ± 0.1 | | | 0.2 | | | ≤ 14 | 22 | 1 |
| Offsite streams | | | | | | | | | | | | | |
| Claremont | 38 | ≤ 0.7 | ≤ 3 | ≤ 8 | 2.3 ±0.1 | ≤ 0.4 | 8 ± 1 | ≤ 0.1 | ≤ 0.7 | 3 ± 2 | ≤ 14 | 29 | ≤ 0.5 |
| Wildcat | 40 | 0.7 ± 0.7 | ≤ 1 | ≤ 7 | 1.4 ± 0.1 | ≤ 0.5 | 4 ± 0.8 | ≤ 0.1 | ≤ 0.7 | 3 ± 2 | 14 | 15 | ≤ 0.5 |
| Tap water | 40 | ≤ 0.1 | ≤ 0.3 | 0.8 ± 0.8 | 0.7 ± 0.1 | ≤ 0.4 | 1.3 ± 0.6 | 0.1 ± 0.06 | ≤ 0.7 | 1.8 ± 1 | 2 | 9 | 0.5 |
| Standard for comparison[a] | | 5 | | | 8 | | | 20 | | | | | |

[a]Source: 40 CFR 141.

**Table 4-10.** Summary of Surface- and Drinking-Water Samples, 1983–1992.

| | Concentration ($10^{-9}$ µCi/ml) | | | | | | | | Concentration ($10^3$ pCi/l) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Three onsite streams | | | | Two offsite streams | | | | Drinking water | | | |
| | Alpha | | Beta | | Alpha | | Beta | | Alpha | | Beta | |
| Year | Avg. | Max. | Avg. | Max. | Avg. | Max. | Avg. | Max. | Avg. | Max. | Avg. | Max. |
| 1983 | < 0.1 | 4 ± 2 | 1.5 ± 0.1 | 4 ± 1 | < 0.3 | < 2 | 1.2 ± 0.1 | 4 ± 2 | < 0.04 | 1.2 ± 0.5 | 0.9 ± 0.1 | 2.3 ± 0.7 |
| 1984 | < 0.13 | < 2 | 1.6 ± 0.3 | 3 ± 1 | 0.6 ± 0.3 | 3 ± 2 | 1 | 8 ± 1 | 0.03 | 0.3 | 0.9 ± 0.1 | 7 ± 1 |
| 1985 | < 0.2 | < 2 | 2 ± 0.5 | 25 ± 2 | ≤ 0.3 | ≤ 3 | 1 ± 0.1 | 5 ± 1 | 0.06 ± 0.05 | ≤ 2 | 0.9 ± 0.1 | 2 ± 1 |
| 1986 | < 0.2 | 8 ± 5 | 2.3 ± 0.1 | 27 ± 2 | 0.4 ± 0.3 | 4 ± 3 | 1.6 ± 0.1 | 10 ± 2 | 0.06 ± 0.04 | < 0.4 | 1.1 ± 0.1 | 6 ± 2 |
| 1987 | ≤ 0.2 | 7 ± 4 | 1.7 ± 0.1 | 13 ± 2 | 0.4 ± 0.2 | ≤ 3 | 1.5 ± 0.2 | 5 ± 1 | < 0.03 | < 0.4 | 0.7 ± 0.1 | 1.5 ± 0.7 |
| 1988 | ≤ 0.2 | 6 ± 4 | 2.9 ± 0.2 | 110 ± 20 | ≤ 0.2 | 3 ± 2 | 1.0 ± 0.1 | 9 ± 2 | ≤ 0.04 | ≤ 0.5 | 0.7 ± 0.1 | 1.7 ± 0.8 |
| 1989 | ≤ 0.3 | 15 ± 8 | 2.2 ± 0.2 | 22 ± 2 | ≤ 0.4 | 6 ± 4 | 1.5 ± 0.1 | 5 ± 1 | ≤ 0.07 | < 3 | 0.9 ± 0.1 | 2.1 ± 0.8 |
| 1990 | ≤ 0.2 | < 2 | 2.1 ± 0.1 | 5.1 ± 1 | ≤ 0.2 | ≤ 3.5 | 1.7 ± 0.1 | 6 ± 1 | ≤ 0.04 | ≤ 0.5 | 0.8 ± 0.1 | 1.4 ± 0.6 |
| 1991 | ≤ 0.4 | 7 ± 1 | 2.1 ± 0.1 | 6 ± 1 | ≤ 0.7 | 21 ± 8 | 1.9 ± 0.1 | 9 ± 2 | ≤ 0.06 | 1.2 ± 0.7 | 0.9 ± 0.1 | 2 ± 0.7 |
| 1992 | ≤ 0.7 | 9 ± 6 | 1.8 ± 0.1 | 16 ± 3 | 0.7 ± 0.7 | ≤ 8 | 1.8 ± 0.1 | 8 ± 1 | ≤ 0.1 | 0.8 ± 0.8 | 0.7 ± 0.1 | 1.3 ± 0.6 |

**Table 4-11a.** Summary of Sewage Sampling Data, 1992.

| | Total quantities discharged | | | |
|---|---|---|---|---|
| | Total volume ($10^6$ liters) | Alpha (mCi) | Beta emitters | Quantity mCi |
| Hearst Sewer | 120 | ≤ 0.05 | Gross | 1.4 ± 0.4 |
| | | | Tritium | ≤ 12 |
| Strawberry Sewer | 93 | ≤ 0.04 | Gross | 1.7 ± 0.5 |
| | | | Tritium | 110 ± 40 |
| Standard for comparison[e] | | — | | 1000 |

[a]California Code of Regulations (CCR) Title 17, Section 30287.

**Table 4-11b.** Summary of Sewage Sampling Data, 1992 (continued).

| | | Concentration ($10^{-9}$ μCi/ml)[a] | | | | | | | Concentration ($10^3$ pCi/l) | | | Average as % of standard | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Alpha[b] | | | Beta[c] | | | | Tritium | | | Alpha | Beta | Tritium |
| | No. of samples | Avg. | Min. | Max. | Avg. | Min. | Max. | No. of samples | Avg. | Min. | Max. | % | % | % |
| Hearst | 74 | ≤ 0.4 | ≤ 1.4 | ≤ 2.6 | 12 ± 3 | 4 ± 2 | 21 ± 4 | | ≤ 0.1 | ≤ 0.7 | 5 ± 3 | ≤ 0.1 | 0.01 | $10^{-4}$ |
| Strawberry | 74 | ≤ 0.4 | ≤ 1.4 | ≤ 2.4 | 18 ± 4 | ≤ 3 | 55 ± 6 | | 1.2 ± 0.4 | ≤ 0.7 | 13 ± 2 | ≤ 0.1 | 0.02 | $1.2 \times 10^{-3}$ |
| Overall | 148 | ≤ 0.3 | | | 14 ± 3 | | | | 0.6 | | | ≤ 0.08 | 0.02 | $4 \times 10^{-4}$ |
| Standard for comparison[d] | | 400 | | | $9 \times 10^4$ | | | | $10^5$ | | | | | |

[a]The alpha and beta values are based on 37 samples.

[b]Conservatively assumed to be $^{232}Th$.

[c]Conservatively assumed to be $^{90}Sr$.

[d]CCR Title 17, Section 30355, Appendix A, Table I, Col. 2.

**Table 4-12.** Sanitary-Sewer Discharge Trends, 1983–1992.

| | Concentration ($10^{-9}$ µCi/ml) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Hearst | | | | | | Strawberry | | | | | |
| | | | Gross alpha | | Gross beta | | | | Gross alpha | | Gross beta | |
| Year | No. of samples | Total flow ($10^6$ l) | Avg. | Max. | Avg. | Max. | No. of samples | Total flow ($10^6$ l) | Avg. | Max. | Avg. | Max. |
| 1983 | 49 | 190 | 0.05 | < 5 | 9 | 80 ± 7 | 38 | 140 | < 0.4 | < 20 | 60 | 640 ± 401 |
| 1984 | 51 | 170 | 0.02 | < 5 | 80 | 1100 ± 50 | 39 | 74 | 0.02 | < 2 | 70 | 250 ± 10 |
| 1985 | 50 | 160 | < 0.2 | < 3 | 15 | 90 ± 10 | 49 | 120 | < 0.2 | < 2 | 140 | 1600 ± 30 |
| 1986 | 47 | 200 | < 0.1 | 1 ± 0.3 | 10 ± 1 | 50 ± 10 | 47 | 110 | < 0.1 | 1.1 ± 0.3 | 400 ± 10 | 4200 ± 700 |
| 1987 | 44 | 140 | ≤ 0.1 | ≤ 1.4 | 11 ± 2 | 80 ± 20 | 48 | 120 | ≤ 0.1 | 1.2 ± 1.1 | 180 ± 40 | 2200 ± 500 |
| 1988 | 41 | 160 | ≤ 0.1 | ≤ 1.1 | 9 ± 3 | 25 ± 5 | 46 | 120 | ≤ 0.1 | ≤ 4 | 43 ± 20 | 1100 ± 300 |
| 1989 | 40 | 80 | ≤ 0.2 | 3 ± 2 | 13 ± 4 | 28 ± 10 | 43 | 160 | ≤ 0.2 | ≤ 2 | 26 ± 10 | 190 ± 60 |
| 1990 | 48 | 160 | ≤ 0.2 | ≤ 1.5 | 32 ± 6 | 500 ± 100 | 49 | 100 | ≤ 0.2 | ≤ 1.5 | 20 ± 4 | 120 ± 50 |
| 1991 | 45 | 140 | ≤ 0.2 | 7 ± 3 | 17 ± 4 | 60 ± 20 | 44 | 80 | ≤ 0.3 | 5 ± 2 | 12 ± 3 | 30 ± 10 |
| 1992 | 37 | 120 | ≤ 0.4 | ≤ 2.6 | 12 ± 3 | 21 ± 4 | 37 | 93 | ≤ 0.4 | ≤ 2.4 | 18 ± 4 | 55 ± 6 |

## 4.4 Public Doses Resulting from LBL Operations

### *4.4.1 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). The model used population figures from the 1970 U.S. census.

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 1980 census produced no significant difference in its impact/insult value. (The 1990 census data were not used.)

The LBL model developed by Thomas (1976) computes population dose equivalent from the maximum measured value of perimeter (fence-post) neutron dose. During 1992 the maximum fence-post dose, estimated at the Olympus Gate Monitoring Station, was ≤ 2.3 mrem for the year (Table 4-1). The model's expression relating population dose equivalent M (in person-rem) to maximum measured fence-post dose $H_o$ (in rem—a rem is 1000 mrem) is

$$M < 10^3 \times H_o (1.0 - 0.56f) , \tag{2}$$

where f = the fraction of the fence-post dose contributed by the 88-Inch Cyclotron and/or the SuperHILAC. For 1992, f = 0. [In Eq. (2), as the telemetry information was not available, we must conservatively assign all of the dose to the Bevatron.]

Thus the expression becomes

$$M < 10^3 H_o \quad . \tag{3}$$

Since $H_o$ was ≤ 2.3 mrem (or ≤ 0.0023 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 1992 was ≤ 2.3 person-rem.

### *4.4.2 Airborne Radionuclides*

The dose to the maximally exposed individual and the CEDE resulting from airborne releases of radionuclides are (Table 1 in the Executive Summary) 0.06 mrem and 1 person-rem, respectively. The US/EPA 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, COMPLY, a microcomputer radionuclide dispersion and dose assessment code supplied by US/EPA, was used to compute the effective dose equivalent to a maximally exposed offsite person. The code requires

- radionuclide release data
- stack height and flow data
- distance to the nearest offsite individual.

For nuclides other than air activation products from accelerators, the following data were used:

- The released quantities of tritium, $^{14}C$, $^{18}F$, $^{123}I$, $^{125}I$, $^{95}Zr$, $^{35}S$, and "$^{232}Th$" are listed in Table 2 in the Executive Summary.
- The stack and nearest-neighbor data are listed in Attachment II of Appendix A of this report.

For accelerator-produced air-activation-products impacts, the following data were used.

Air Activation Nuclides
Annual Estimated Releases (Ci/yr)

| | Nuclides | | | | |
|---|---|---|---|---|---|
| Accelerator | $^{11}C$ | $^{13}N$ | $^{15}O$ | $^{41}Ar$ | Distance to Receptor (m) |
| Bevatron | 6 | 7 | 2 | 0.07 | 420 |
| HILAC | $8 \times 10^{-5}$ | $1 \times 10^{-4}$ | $5 \times 10^{-5}$ | $5 \times 10^{-6}$ | 120 |
| 88" Cyclotron | 0.6 | 0.9 | 0.5 | 0.03 | 110 |

The respective modeled maximum individual exposures for 1992 were:

- Bevatron: 0.04 mrem
- HILAC: $3 \times 10^{-6}$ mrem
- 88" Cyclotron: 0.02 mrem

Since COMPLY cannot compute population dose equivalent, CAP88PC (an additional US/EPA-approved computer program) was used.

CAP88PC computes contributions to the doses from inhalation, ingestion, and exposures from surface contamination and immersion. The code requires

- radionuclide release data,
- site-specific meteorological data
- agricultural parameters,
- site-specific food and water source parameters,
- distribution of the population within 80 km (50 mi) of LBL.

The data were obtained from the following sources:

- The released quantities of $^{3}H$, $^{11}C$, $^{13}N$, $^{14}C$, $^{15}O$, $^{18}F$, $^{41}Ar$, $^{95}Zr$, $^{123}I$, $^{125}I$, and $^{35}S$ listed in Table 2 in the Executive Summary are used.
- 1960–1964 Oakland Airport five-year average data were used. Although it is most desirable to use onsite meteorology data for the "release year" (1992), the US/EPA

Region 9 regional meteorologist indicated that the use of the Oakland Airport five-year average data is, acceptable (Vimont, 1988). (LBL expects to begin collecting onsite data by the end of 1993.)

- Default parameters provided with the CAP88PC code were used.
- Food and water source parameters were compiled by Victor J. Montoya of the EH&S's Environmental Monitoring Unit from data provided by the water boards and agricultural commissioners of the 11 San Francisco Bay Area counties. The average values for foodstuffs and water not collected or grown within 80 km (50 mi) of LBL were found to be as follows: 35% of the drinking water is imported; 95% of the produce and leafy vegetables are imported; 25% of the milk is imported; and 90% of the meat is imported. (Imported food and water are assumed to be uncontaminated.)
- The population distribution about LBL used was that labeled UFCBERKL.POP in the Version 1.0 release of CAP88PC. UFCBERKL.POP contains the population within 80 km of LBL from the 1980 census data, distributed into 16 sectors at 13 distances from latitude 37°52'35" N, longitude 122°15'10" W (the location of the 88-inch Cyclotron stack).

Table 4-13 summarizes the total CEDE due to LBL operations.

**Table 4-13.** Population Effective Dose Equivalent Resulting from LBL Operations, 1992.[a]

| Contributing factor | | Population effective dose equivalent (person-rem) |
|---|---|---|
| Penetrating radiation from accelerator operations | | ≤ 2.3 |
| Accelerator air activation products | | 0.12 |
| Radionuclide release | | |
| $^{3}H$ | 0.9 | |
| $^{14}C$ | 0.0003 | |
| $^{18}F$ | 0.004 | |
| $^{123}I$ | 0.000004 | |
| $^{125}I$ | 0.001 | |
| $^{35}S$ | 0.00001 | |
| $^{95}Zr$ | 0.000008 | |
| Unidentified alpha emitters[b] | 0.014 | |
| Subtotal | 1 | |
| Total LBL-produced effective population dose equivalent | | 3.4 |

[a]The population dose attributable to natural background sources for the population within 80 km (50 mi) of LBL was approximately $6.0 \times 10^6$ persons × 0.3 rem/person/yr = $1.8 \times 10^6$ man-rem.
[b] $^{232}Th$ was used as a conservative substitute.

## 4.5 Trends—LBL Environmental Impact

### *4.5.1 Accelerator-Produced Penetrating Radiation*

Figures 4-5 through 4-8 show the annual accelerator-produced dose equivalent reported by the four perimeter environmental monitoring stations from the year they were established to date. (The 1991 and 1992 values are estimates.) 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 and had increased the dose equivalent at the Building 88 EMS somewhat. In recent years the trend has been gradually downward. The 1992 maximum estimated perimeter dose equivalent of ≤ 2.3 mrem (Figure 4-5) remains a fraction of the radiation protection guideline (DOE, 1988, 1990) of 100 mrem/yr, reflecting improvements in accelerator beam optics, local shielding, and cave selection.

On December 23, 1992, the SuperHILAC ran its last beam. The Bevatron shut down in February 1993. The shutdown of the Bevelac (the combination of the superHILAC and the Bevatron) will mean a reduction of the maximum offsite exposure of at least a factor of three from the most recent estimated 2 mrem.

Since early 1991, the 88-Inch Cyclotron has administratively controlled its use of light-ion runs, minimizing 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 ≤ 10 μA.

### *4.5.2 Airborne and Waterborne Radionuclides*

Figure 4-9 shows the annual releases of tritium (as HTO) from the Building 75 Tritium Facility from 1974 through 1992. The 87 Ci released during routine operations in 1992 is approximately equal to the 1991 releases and 53% of the 1990 releases and is responsible for approximately 30% of the LBL-produced population dose equivalent from all sources for 1992. The releases occur during molecular tagging and tritium waste processing.

The NTLF staff presented a five-stage proposal to be phased in over a 14-month period beginning in April of 1990. The design basis of the proposal was to reduce tritium discharges by at least 75% and tritium waste shipments by an equivalent, or greater, percentage. The proposal was approved by Laboratory management, and the overall reduction in tritium releases from 1989 to 1992 was > 80% (570 to 87 curies). Thus, the improvement exceeded design expectations.

Releases of accelerator-produced air-activation nuclides are estimated. Real-time emission monitors will be installed in 1995. It is expected that the actual releases of activation products and their concomitant exposures will be well less than calculated values.

Except for high readings from occasional known offsite releases (e.g., atmospheric nuclear weapons tests and the Chernobyl fire), the atmospheric sampling program has yielded data over the past few years that are within the range of historical normal background. Figures 4-10 through 4-12 illustrate atmospheric air and deposition trends.

With historically noted exceptions, the surface-water sampling program has yielded results within the range of historical normal background. Because no substantial changes in the quantities of radionuclides used are anticipated, no changes are expected in these observations. Figure 4-13 shows surface and drinking water trends. Figures 4-14 and 4-15 illustrate annual average radionuclide concentrations in the LBL sewer outfalls. The apparent upward trend in alpha outfall concentration does not reflect increasing alpha activity in sewer discharges. The trend shows an increase in the lower limit of detection for alpha emtters in sewer water. The 1992 averages are less than or equal to 0.1% of the State of California's limit for discharges to the sewers.

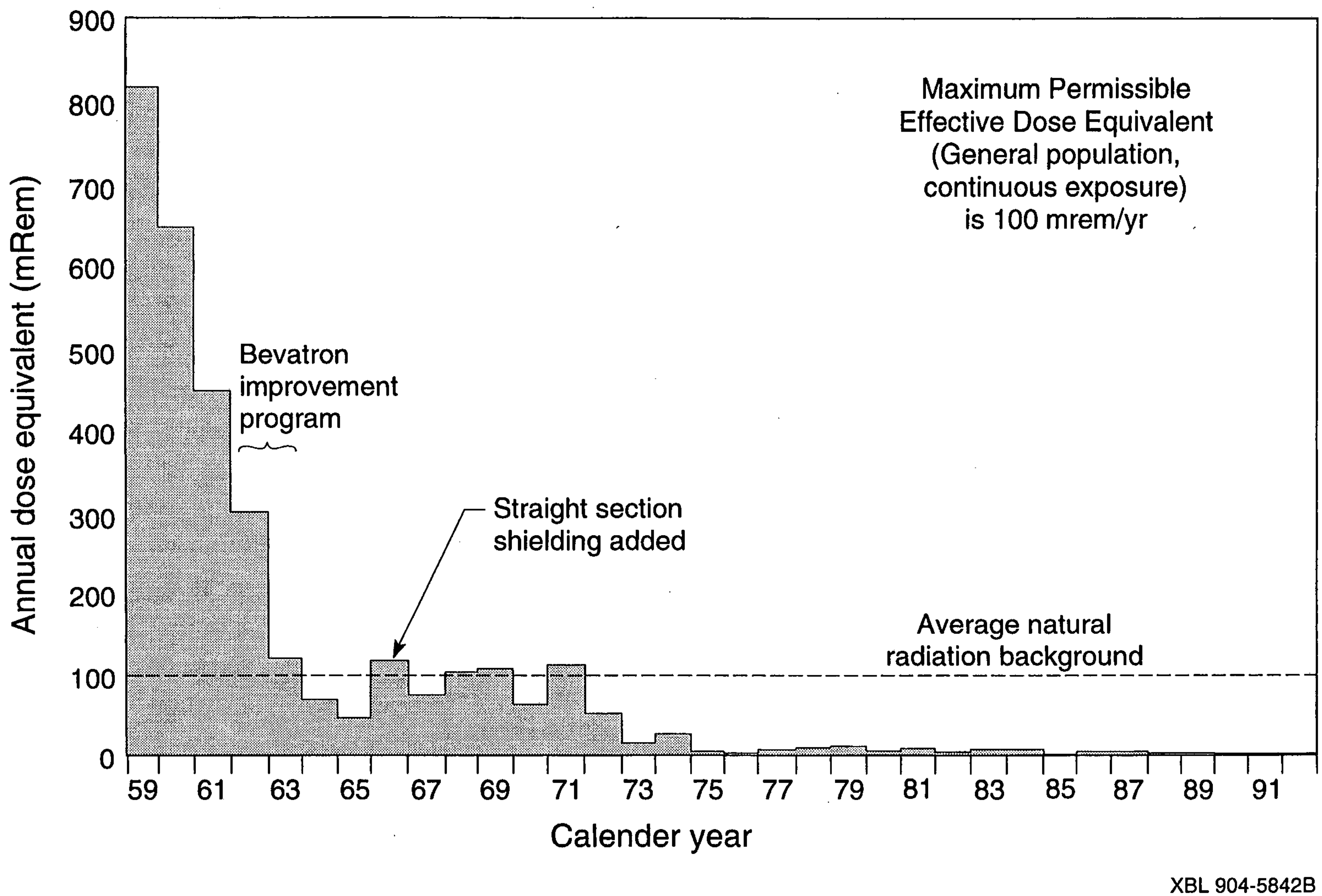



**Figure 4-5.** Annual accelerator-produced dose equivalent at the Olympus Gate Environmental Monitoring Station, 1959–1992.

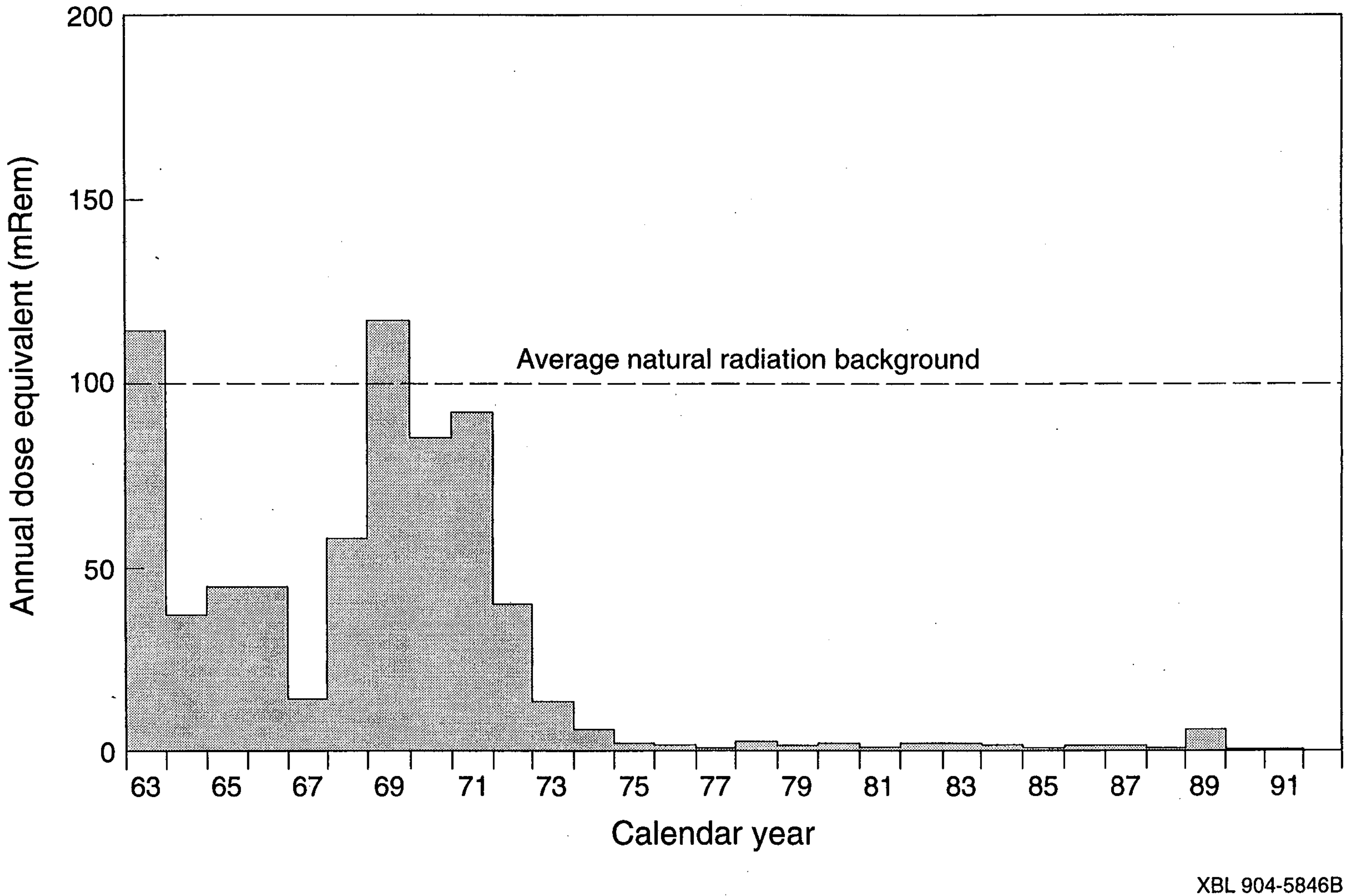
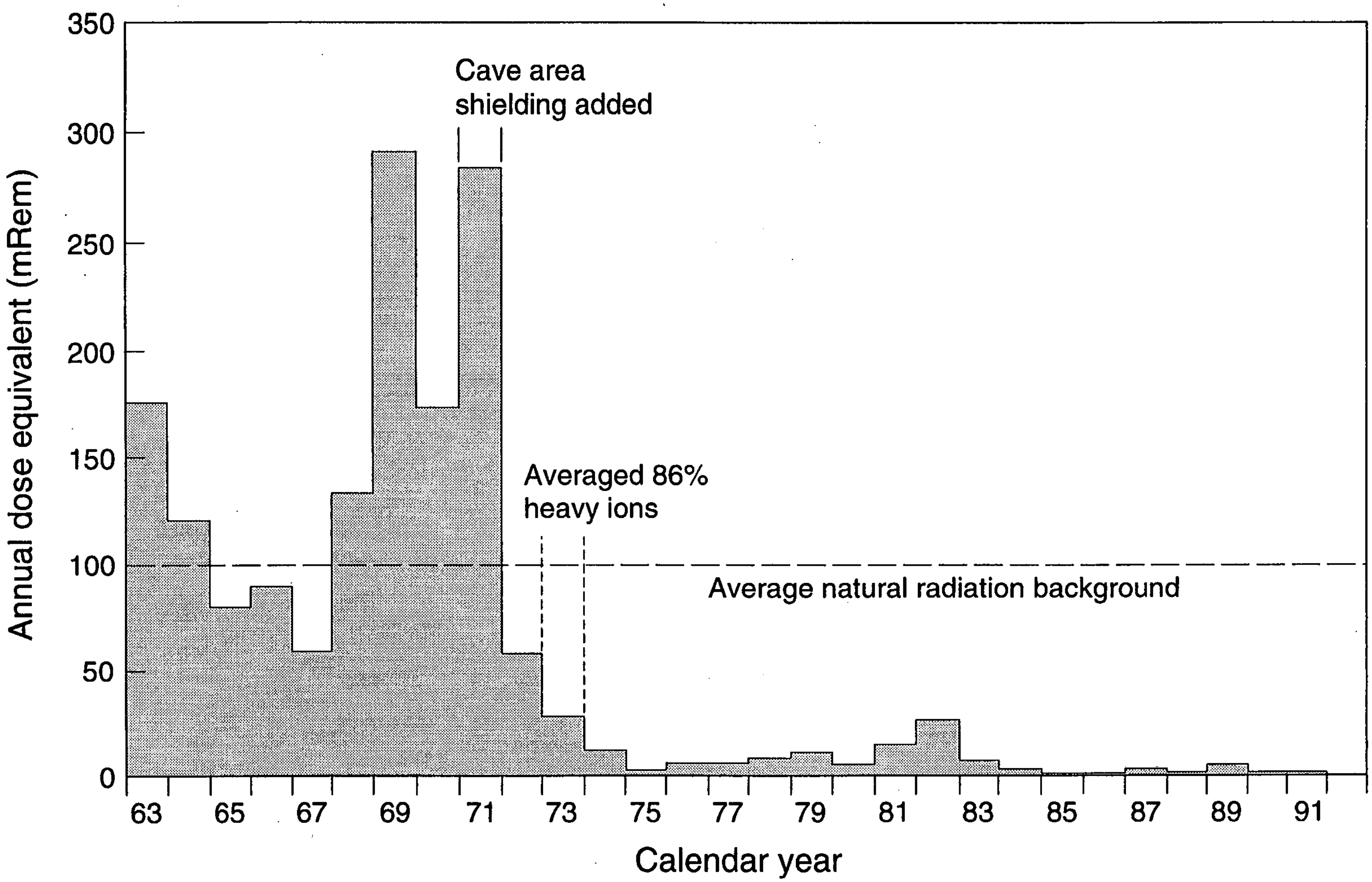



**Figure 4-6.** Annual accelerator-produced dose equivalent at Building 90 Environmental Monitoring Station, 1962–1992.




XBL 904-5845B

**Figure 4-7.** Annual accelerator-produced dose equivalent at the 88-Inch Cyclotron Environmental Monitoring, 1963–1992.

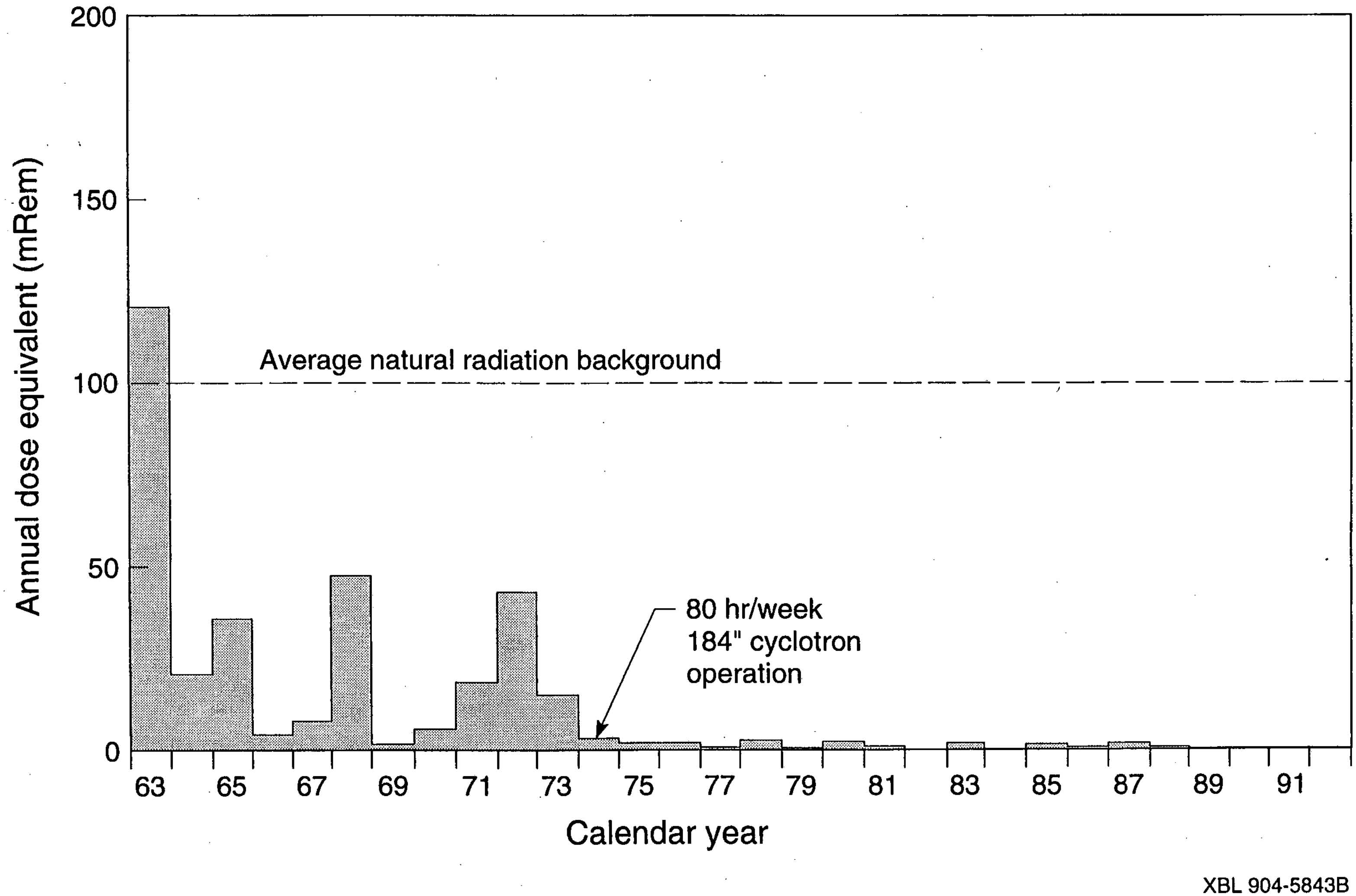



**Figure 4-8.** Annual accelerator-produced dose equivalent at the Panoramic Way Environmental Monitoring Station, 1963–1992.

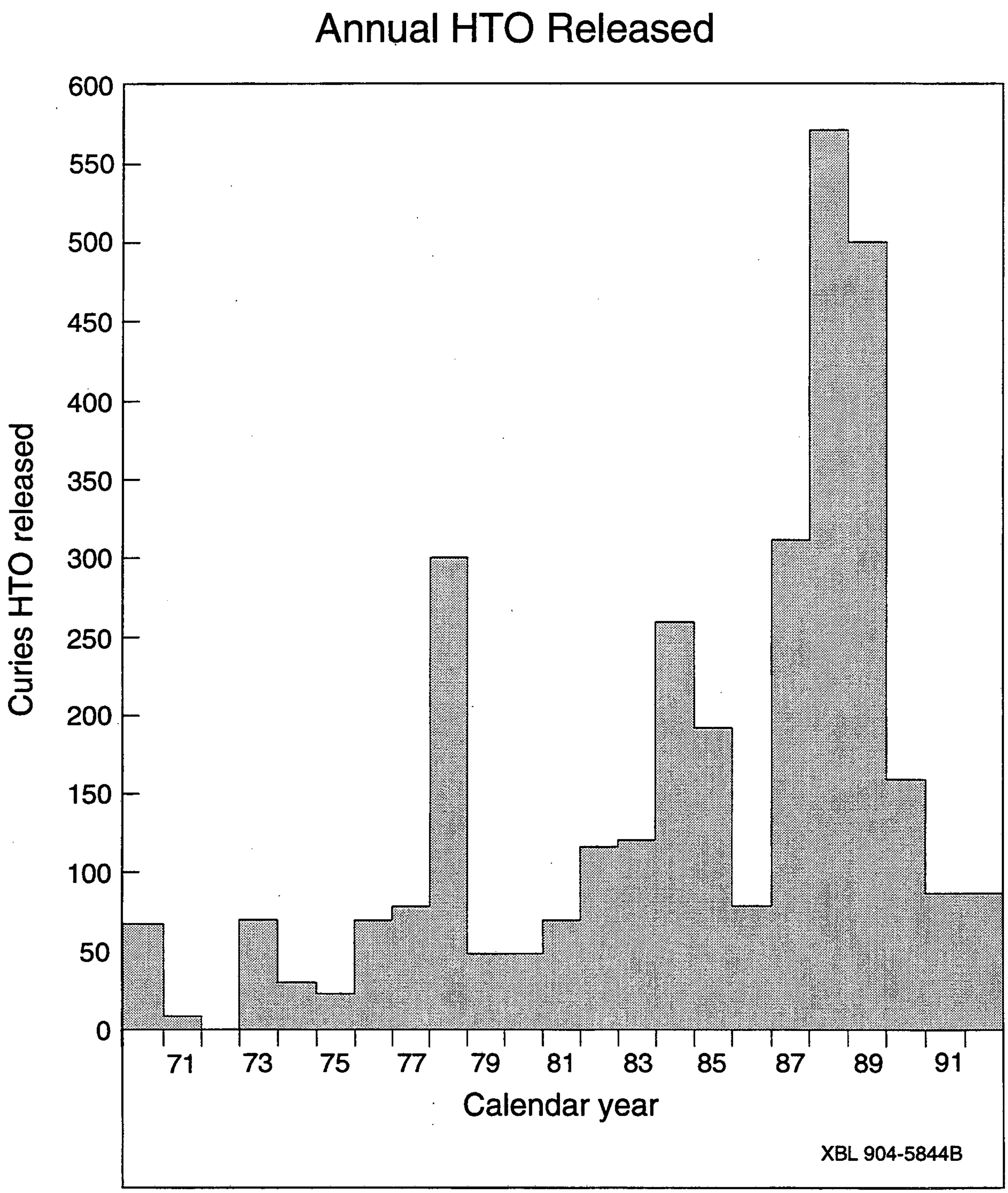



**Figure 4-9.** Annual releases of tritium (HTO) from the Building 75 National Tritium Labeling Facility, 1970–1992.

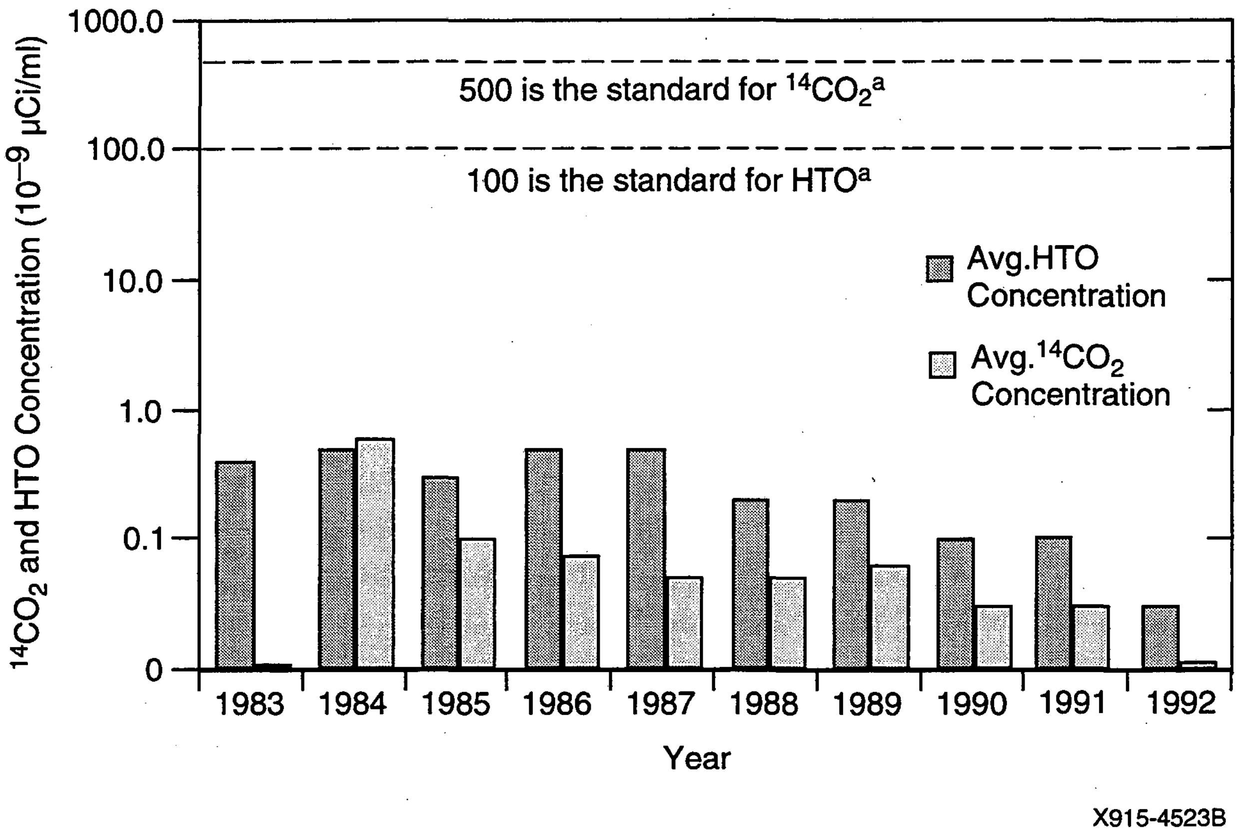



**Figure 4-10.** Perimeter airborne environmental HTO and $^{14}CO_2$ trends (Table 4-4 data plotted). Note that the scale for $^{14}CO_2$ concentration is 10 times the scale for HTO concentration.

[a]Source: DOE Order 5400.5

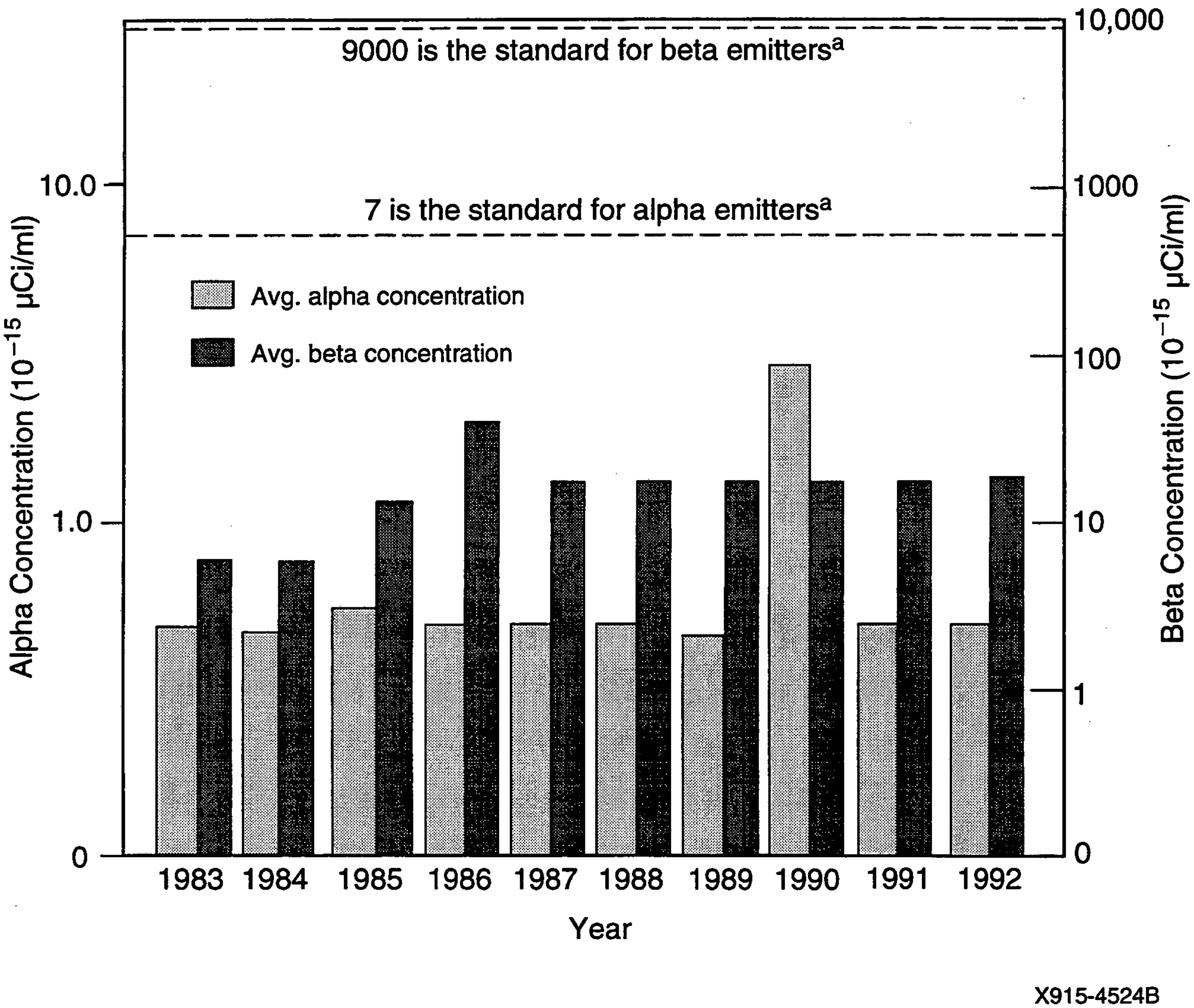



**Figure 4-11.** Annual average gross alpha and beta particulate radioactivity found in LBL perimeter air samples, 1983-1992 (Table 4-6 data plotted). Note that the scale for beta emitters is 100 times the scale for alpha emitters.

[a]Source: DOE Order 5400.5

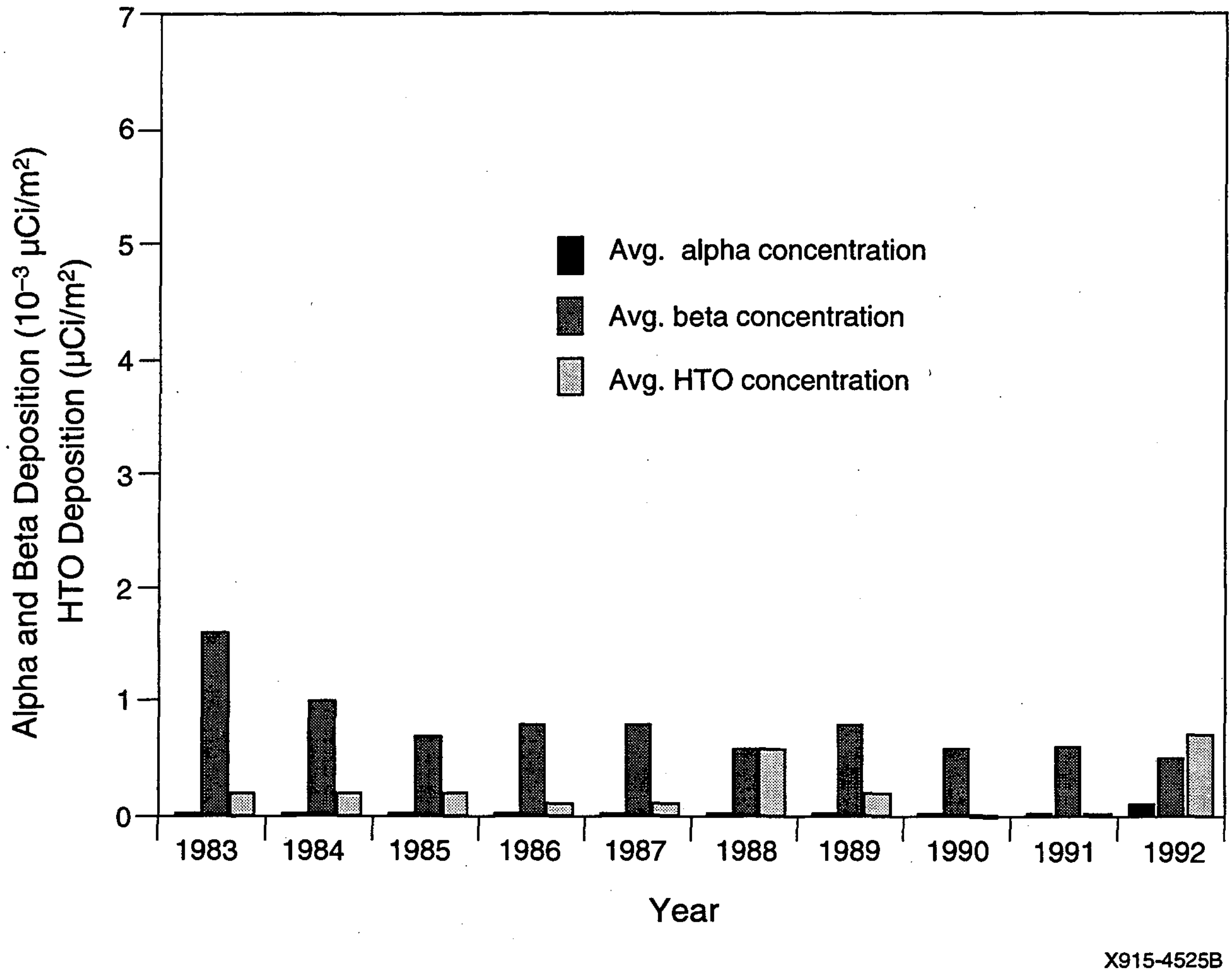



**Figure 4-12.** Annual alpha and beta emitters and HTO in LBL perimeter deposition samples, 1983–1992 (Table 4-7 data plotted).

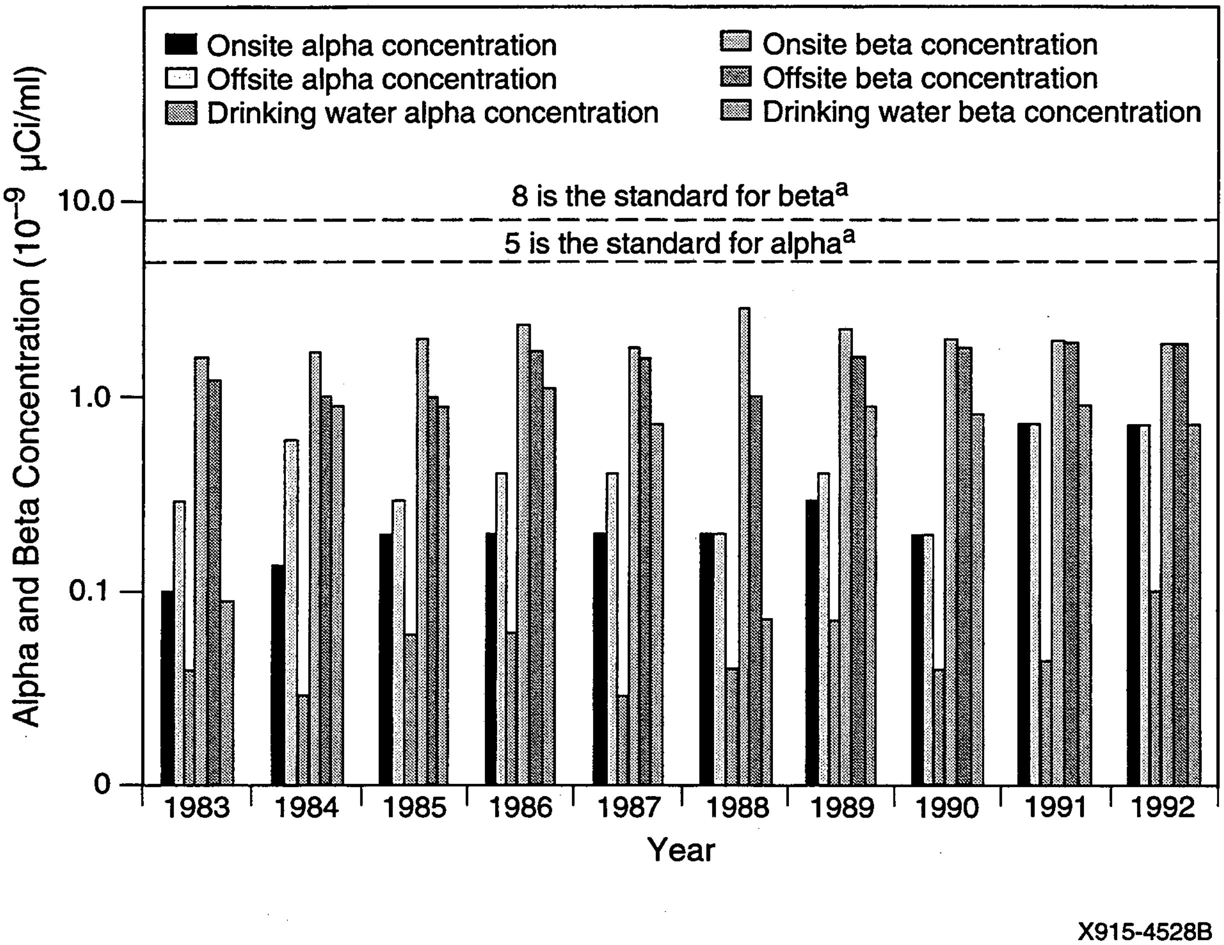



**Figure 4-13.** Annual average concentrations of alpha and beta emitters in surface and drinking water, 1983–1992 (Table 4-10 data plotted).

[a]Source: DOE Order 5400.5

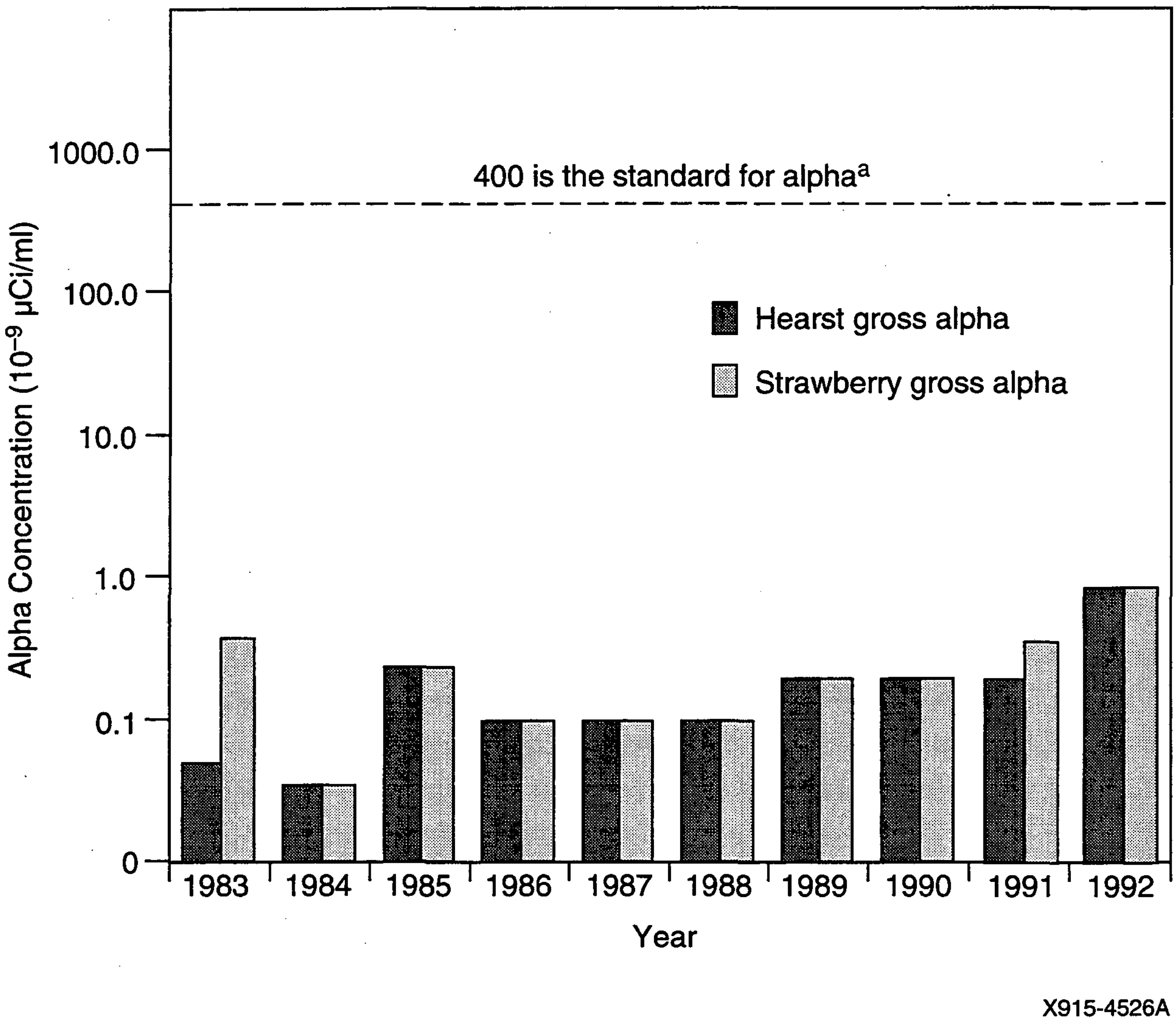



**Figure 4-14.** Annual average alpha-emitter concentrations in LBL sewer effluents, 1983–1992 (Table 4-12 alpha data plotted). The values plotted since 1985 reflect the lower limit of detection (LLD) for alpha emitters in sewers. The 1992 LLD of 0.1% is the sewage standard. (The 1984 LLDs shown are unrealistically low.)

[a]Source: CCR Title 17, Section 30355, Appendix A, Table I, Col. 2.

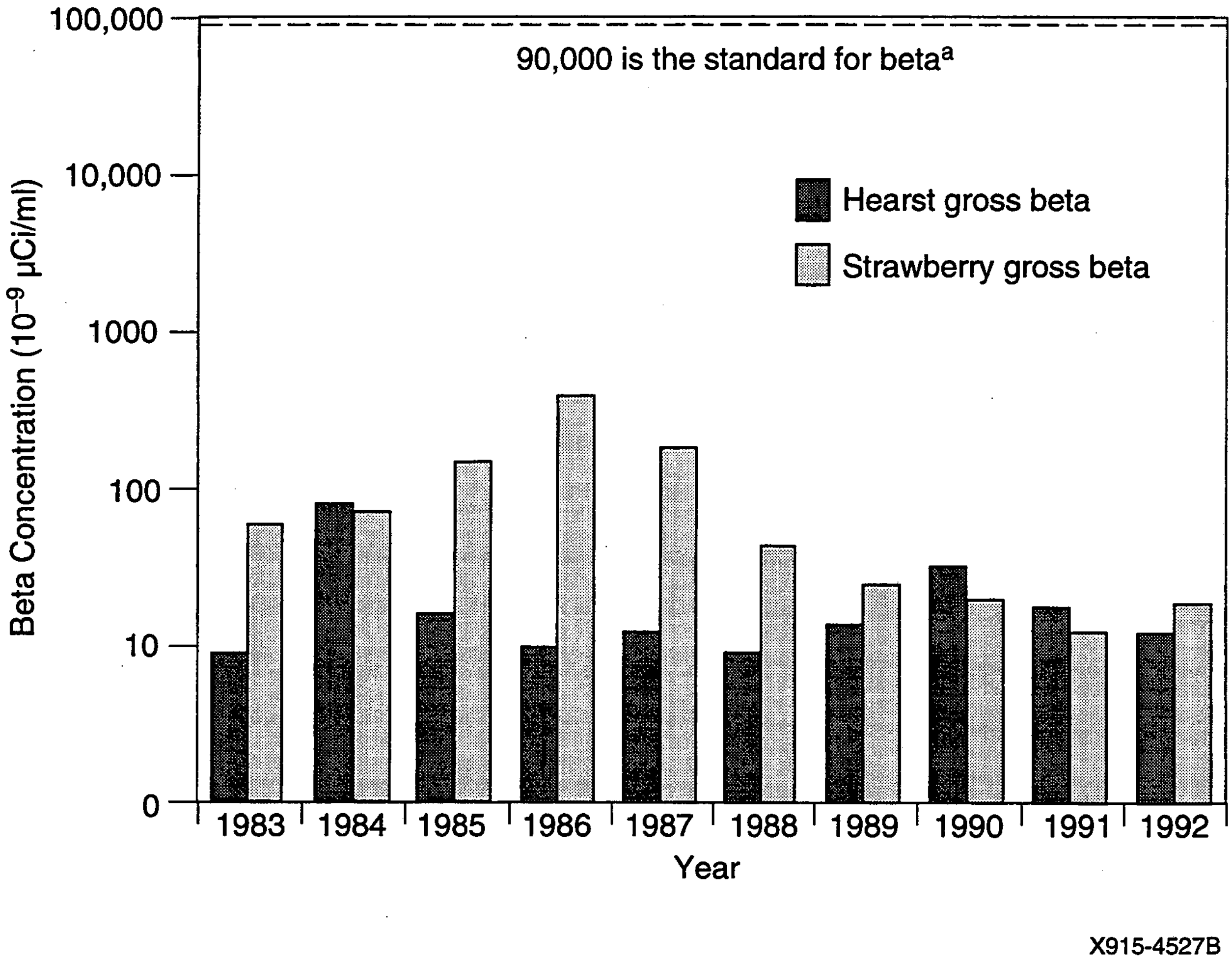



**Figure 4-15.** Annual average beta-emitter concentrations in LBL sewer effluents, 1983–1992 (Table 4-12 beta data plotted).

[a]Source: CCR Title 17, Section 30355, Appendix A, Table I, Col. 2.

# Section 5
# Environmental Nonradiological Program Information

## 5.1 General Industrial Storm Water Permit

The Storm Water Monitoring Program (SWMP) is one component of the requirements of the NPDES General Permit for Storm Water Discharges Associated with Industrial Activities. This program does not have to be submitted to any agency, but it must be available for inspection upon request. The program written for LBL was completed by October 1, 1992, and is maintained by the Environmental Protection Group. The program details storm water monitoring activities that should be performed at the site during the normal wet season. The normal wet season is defined in the permit as running from October 1 to April 1.

The 1992–93 wet season marked the end of a six-year drought in California. This wet season saw its first storm on the morning of October 1, 1992. From then until April 1, 1993, over 29 inches of rainfall were recorded at the site, the most rainfall recorded at the site since 1986.

Preparation of the monitoring plan included identifying likely influent and effluent streams and creeks. Many streams flow intermittently and only in significant wet seasons. As this was the first significant wet season in seven years, streams that were not originally identified in the plan were added at a later date.

Automatic samplers were installed on three of the most significant creeks: the North Fork of Strawberry Creek, Chicken Creek, and the Strawberry Creek Inlet. All the other creeks were grab-sampled. The automatic samplers are programmed to composite the first 30 minutes of storm water runoff. Grab samples are taken within the first 30 minutes or as close to that time window as possible. One inlet stream located adjacent to Building 71, designated as StW, was not sampled, as the sampling location was inaccessible. A sampling-station installation is planned for 1993 to capture 1993–1994 wet-season samples.

The sampling strategy is summarized in Table 5-1. The sampling locations are shown in Figure 5-1. Each location is given a name and code for data-management purposes. Visual-observation forms are completed for each storm event.

A summary of sampling analyses is presented in Table 5-2. Samples are analyzed for different analytes in different locations depending on the potential pollutant chemical characteristics of the stream water. The list of analytes for each stream was developed based on current and historical hazardous materials and waste-handling management practices. Table 5-3 summarizes the analytical methods used by State-certified laboratories.

All of the analyses for oil and grease, TPH/BTEX (gasoline), TPH Extractables (diesel, kerosene), PCBs, cyanide, and volatile organics were nondetectable. These results have not been tabulated. All streams were sampled twice during two separate storm events for the 96-hour acute toxicity test. All samples passed with 100% survival of the indicator species. Table 5-4 summarizes analytical results for the three major streams serving the site. As the State Water Resources Control Board (SWRCB) Basin Plan is still in draft form, there are no current applicable limits for the general permit. Tables 5-5, 5-6, and 5-7 list the results from metals analyses conducted for each of the three main streams. The SWRCB draft basin plan limits are included for comparative purposes only.

Figure 5-1 maps the site with the two principal drainage basins: the Strawberry Creek watershed and the Blackberry Canyon watershed. The principal inlet and outlet site-monitoring points for the Strawberry Creek watershed are StW3 and StW4, respectively. The other monitoring points (StW5, StW6, StW8, StW9, and StW10) are located on intermittant streams (based on casual observations and estimates of relative stream flow during the 1992/1993 wet season). Table 5-8 provides a comparison of metals analyses for two storms for sampling points StW3 and StW4. The analytical results for the two sampling points are compared, as the comparison will yield some information on the impact to storm water as it flows across the site. It is assumed, based on the storm-drainage map (Figure 5-1), that much of what flows onto the site at StW3 will flow off the site at StW4. However, the stream at sampling point StW4 collects storm water from a wide area below Buildings 25 and 31. The additional storm water from these areas may serve to either dilute or add metals to the storm water.

It is clear from Table 5-8 that, in general, for both storms the concentrations of most metals increased as the storm water flowed acros the site from StW3 to StW4. The only metals that decreased were zinc (in the 10/29/92 storm) and thallium (in the 12/2/92 storm). The overall stream loading (sum of all metal concentrations for a given storm) decreased from the 10/29/92 storm to the 12/2/92 storm. This would be expected: as the wet season proceeds, each ensuing storm will flush out and dilute any soluble metal salts in the soil. However, the relative change in the loading remained approximately the same: 210% for the 10/29/92 storm and 282% for the 12/2/92 storm. This relative change in the stream loading is a measure of how well the storm water accumulates metal salts as it flows across the site.

Clearly the results of the first wet season's storm water monitoring activities raise many questions. Among them are:

- Is the increase in metals concentrations attributable to LBL operations (current or historical), or is the increase a natural artifact attributable to the soil chemistry?
- Are similar increases in metals concentration observed in other streams that cross the site?
- What, if any, is the significance of any decrease in metals concentration?

As the program is in its infancy, and the amount and significance of the data is limited, more sampling will be conducted during the next wet season (October 1, 1993 to April 1, 1994). The next sampling program will be structured to address these questions.

**Table 5-1.** Summary of Sampling Strategy for Storm Water Monitoring.

| Monitoring Locations | Task | | | | |
|---|---|---|---|---|---|
| | | Sampling | | | |
| | | First Storm[b] | | Other Storms[b] | |
| | Visual Observation[a] | Grab[c] | Composite | Grab[c] | Composite |
| 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) | • | | | • | |
| Pinapple Creek Outlet (StW10) | • | | | • | |

[a]One storm per month
[b]Significant storm water discharge must be proceded by 72 hours of dry weather.
[c]Grab samples must be taken during the first 30 minutes of the discharge. Except for the first storm, such grab sampling will not be performed during the same storm event at all locations.

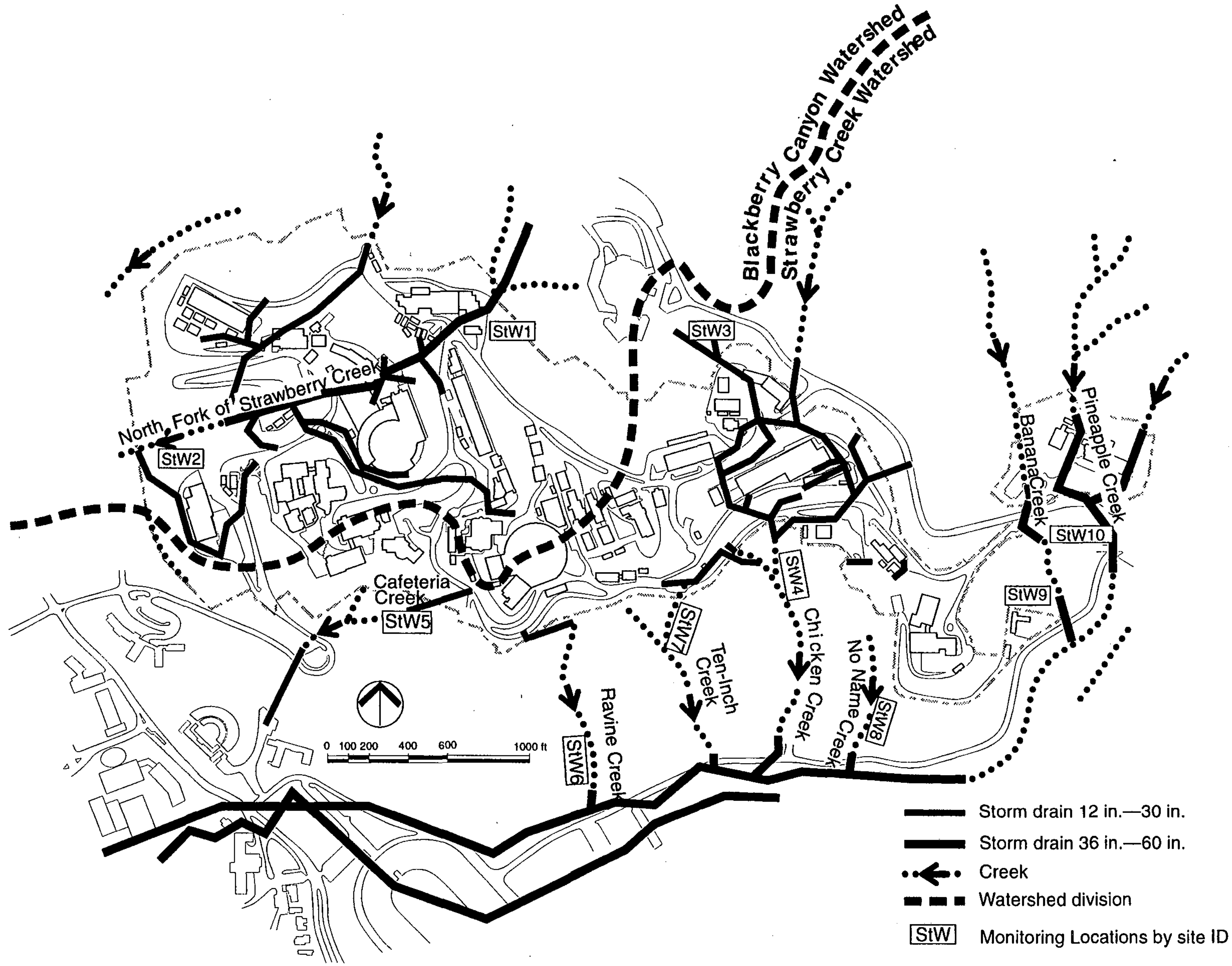



**Figure 5-1.** Site Storm Drainage and Monitoring Locations

**Table 5-2.** Analyses to be Performed for Monitoring Locations at LBL.

| Monitoring Locations | Parameters of Concern[a] | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Metals | VOCs | PCBs | CN | TPH/ BTEX | TPH/ Extractable | Gross Alpha and Beta | Tritium | Whole Effluent Toxicity |
| StW 2 | • | • | • | | • | | | | |
| StW 3[b] | • | • | • | • | • | • | • | • | |
| StW 4 | • | • | • | • | • | • | • | • | |
| StW 5 | | | • | | • | • | | | • |
| StW 6 | • | • | | | | • | | | • |
| StW 7[c] | | | | | | | | | • |
| StW 8 | | • | | | | • | | | • |
| StW 9[c] | | | | | | | | | • |
| StW 10 | | | | | | • | | | • |

[a]All samples are tested for pH, total suspended solids (TSS), specific conductance, and either total organic carbon (TOC) or oil and grease.

[b]For the first storm event, all analyses will be run for the two influent locations. For subsequent storm events, analyses will be modified as appropriate, according to previous results and any contaminants expected to be present.

[c]No contaminants are expected to be present at these outfalls. Analyses for the standard parameters as in footnote [a] above will be performed.

**Table 5-3.** Analytical Methods Used by State-Certified Laboratories.

| Parameter | EPA Method |
|---|---|
| TSS | 160.2 |
| Specific conductance | 120.1 |
| pH | 150.1 |
| Oil and grease | 413.1 |
| TOC | 415.1 |
| Metals (Ag, As, Ba, Be, Cd, Co, Cr, Cu, Hg, Mo, Ni, Pb, Sb, Se, Tl, V, Zn) | 6010 or 7000 series or Appendix D to 40 CFR 136 |
| Volatile organics by GC/MS | 624 or 8240 |
| PCBs | 608 or 8080 (mod.) |
| Cyanide | 335.2 |
| TPH gasoline/BTEX | 8015/5030 or 8020 |
| TpH extractable (diesel, kerosene, motor oil) | 8015/3510 |
| Gross alpha and beta | 900 |
| Tritium | Liquid scintillation counting |

**Table 5-4.** Summary of Results for 1992 Wet Season (Oct. 1, 1992–Dec. 31, 1992)

| Monitoring Location | Analyte: TSS (ppm) | Conductivity (µmho/cm) | pH | Gross Alpha (pCi/L) | Gross Beta (pCi/L) | Tritium (pCi/L) |
|---|---|---|---|---|---|---|
| North Fork Strawberry Outlet (StW2) | 97 | 530 | 7.1 | <1 | <1 | <700 |
| Strawberry Canyon Inlet (StW3) | 120 | 320 | 6.1 | <1 | <1 | <700 |
| Chicken Creek Outlet (StW4) | 350 | 840 | 8.0 | <1 | <1 | <700 |

**Table 5-5.** Results of Metals Analysis for the Strawberry Canyon Inlet

| Metals | SWRCB draft limits (µg/l) | Results (µg/l): 10/29/92 Sample | 12/2/92 Sample |
|---|---|---|---|
| Antimony (Sb) | No limit | 0.0 | 0.0 |
| Arsenic (As) | 5.00 | 0.0 | 0.0 |
| Barium (Ba) | No limit | 64.0 | 21.0 |
| Beryllium (Be) | No limit | 0.0 | 0.0 |
| Cadmium (Cd) | 10.00 | 0.0 | 0.0 |
| Chromium (Cr) | 50.00 | 0.0 | 0.0 |
| Copper (Cu) | 1,000.00 | 100.0 | 21.0 |
| Lead (Pb) | 50.00 | 110.0 | 25.0 |
| Mercury (Hg) | 0.01 | 0.0 | 0.0 |
| Molybdenum (Mo) | No limit | 0.0 | 0.0 |
| Nickel (Ni) | 600.00 | 0.0 | 0.0 |
| Selenium (Se) | 10.00 | 20.0 | 0.0 |
| Silver (Ag) | 50.00 | 0.0 | 0.0 |
| Thallium (Tl) | No limit | 0.0 | 21.0 |
| Vanadium (V) | No limit | 0.0 | 0.0 |
| Zinc (Zn) | 5,000.00 | 410.0 | 99.0 |

**Table 5-6.** Results of Metals Analysis for the North Fork of Strawberry Creek.

| Metals | SWRCB draft limits (µg/l) | Results (µg/l) 10/1/92 Sample | 10/29/92 Sample | 12/2/92 Sample |
|---|---|---|---|---|
| Antimony (Sb) | No limit | 0.0 | 0.0 | 0 |
| Arsenic (As) | 5.00 | 17.0 | 0.0 | 0 |
| Barium (Ba) | No limit | 69.0 | 66.0 | 91 |
| Beryllium (Be) | No limit | 0.0 | 0.0 | 0 |
| Cadmium (Cd) | 10.00 | 0.0 | 0.0 | 0 |
| Chromium (Cr) | 50.00 | 11.0 | 0.0 | 17 |
| Copper (Cu) | 1,000.00 | 130.0 | 360.0 | 65 |
| Lead (Pb) | 50.00 | 11.0 | 0.0 | 54 |
| Mercury (Hg) | 0.01 | 2.0 | 0.0 | 0 |
| Molybdenum (Mo) | No limit | 32.0 | 6.0 | 0 |
| Nickel (Ni) | 600.00 | 0.0 | 0.0 | 0 |
| Selenium (Se) | 10.00 | 20.0 | 30.0 | 24 |
| Silver (Ag) | 50.00 | 0.0 | 0.0 | 0 |
| Thallium (Tl) | No limit | 130.0 | 0.0 | 0 |
| Vanadium (V) | No limit | 20.0 | 0.0 | 12 |
| Zinc (Zn) | 5,000.00 | 150.0 | 200.0 | 52 |

**Table 5-7.** Results of Metals Analysis for Chicken Creek.

| Metal | SWRCB draft limits (µg/l) | Results (µg/l) 10/1/92 Sample | 10/29/92 Sample | 12/2/92 Sample |
|---|---|---|---|---|
| Antimony (Sb) | No limit | 0.0 | 0.0 | 20.0 |
| Arsenic (As) | 5.00 | 20.0 | 0.0 | 5.0 |
| Barium (Ba) | No limit | 61.0 | 760.0 | 71.0 |
| Beryllium (Be) | No limit | 0.0 | 0.0 | 1.0 |
| Cadmium (Cd) | 10.00 | 6.0 | 0.0 | 1.0 |
| Chromium (Cr) | 50.00 | 20.0 | 40.0 | 18.0 |
| Copper (Cu) | 1,000.00 | 230.0 | 250.0 | 39.0 |
| Lead (Pb) | 50.00 | 74.0 | 130.0 | 57.0 |
| Mercury (Hg) | 0.01 | 0.0 | 0.0 | 1.0 |
| Molybdenum (Mo) | No limit | 34.0 | 0.0 | 5.0 |
| Nickel (Ni) | 600.00 | 0.0 | 0.0 | 20.0 |
| Selenium (Se) | 10.00 | 60.0 | 90.0 | 12.0 |
| Silver (Ag) | 50.00 | 8.0 | 0.0 | 5.0 |
| Thallium (Tl) | No limit | 30.0 | 70.0 | 10.0 |
| Vanadium (V) | No limit | 10.0 | 30.0 | 12.0 |
| Zinc (Zn) | 5,000.00 | 410.0 | 110.0 | 250.0 |

**Table 5-8.** Comparison of Metals Analyses for Two Storms for Sampling Points StW3 and StW4.

| Metal | 10/29/92 Storm | | | 12/2/92 Storm | | |
|---|---|---|---|---|---|---|
| | Concentration (µg/l) | | Percent change in metals concentration | Concentration (µg/l) | | Percent change in metals concentration |
| | StW3 (inlet) | StW4 (outlet) | | StW3 (inlet) | StW4 (outlet) | |
| Antimony | 0.0 | 0.0 | 0 | 0.0 | 20.0 | 20[a] |
| Arsenic | 0.0 | 0.0 | 0 | 0.0 | 5.0 | 5[a] |
| Barium | 64.0 | 760.0 | 1187 | 21.0 | 71.0 | 338 |
| Beryllium | 0.0 | 0.0 | 0 | 0.0 | 1.0 | 1.0[a] |
| Cadmium | 0.0 | 0.0 | 0 | 0.0 | 1.0 | 1.0[a] |
| Chromium | 0.0 | 40.0 | 40[a] | 0.0 | 18.0 | 18.0[a] |
| Copper | 100.0 | 250.0 | 250 | 21.0 | 39.0 | 186 |
| Lead | 110.0 | 130.0 | 118 | 25.0 | 57.0 | 228 |
| Mercury | 0.0 | 0.0 | 0 | 0.0 | 1.0 | 1.0[a] |
| Molybdenum | 0.0 | 0.0 | 0 | 0.0 | 5.0 | 5.0[a] |
| Nickel | 0.0 | 0.0 | 0 | 0.0 | 20.0 | 20.0[a] |
| Selenium | 20.0 | 90.0 | 450 | 0.0 | 12.0 | 12.0[a] |
| Silver | 0.0 | 0.0 | 0 | 0.0 | 5.0 | 5.0[a] |
| Thallium | 0.0 | 70.0 | 70[a] | 21.0 | 10.0 | –52 |
| Vanadium | 0.0 | 30.0 | 30[a] | 0.0 | 12.0 | 12.0[a] |
| Zinc | 410.0 | 110.0 | –73 | 99.0 | 250.0 | 253 |
| Stream Loading | 704 | 1480 | 210 | 187 | 527 | 282 |

[a]This is a net increase, as the influent concentration was 0.0 µg/l.

## 5.2 Sanitary Sewer Discharge Permit Self-Monitoring

### *5.2.1 General*

The site sanitary-sewer discharge permits were renewed on July 9, 1992. The following three permits were issued:

| LBL Location Identifier | EBMUD Identifier | Permit Number |
|---|---|---|
| Building 25 Plating Shop | Lab. No. 25 | 50238911 |
| Building 77 Plating Shop | Lab. No. 77 | 50238921 |
| Hearst Monitoring Station | Side Sewer #1 | 066-00791 |
| Strawberry Monitoring Station | Side Sewer #2 | 066-00791 |

Self-monitoring activities were conducted for all permit locations. The self-monitoring activities for the Building 25 Plating Shop ceased after March 1992 as the treatment unit was shut down for repairs and process modifications. It remains out of commission as of the writing of this report.

In 1992 EBMUD served LBL with six Notices of Violation (NOV). These NOVs are summarized in Table 5-9. A NOV is served whenever either LBL, through its self-monitoring program, or EBMUD, through it site-sampling program, measures a regulated parameter at levels exceeding the permit limit for that parameter. Three NOVs were for exceedances at Side Sewer 2 on the Strawberry outfall. Two NOVs were for exceedances at the Building 77 Plating Shop. One NOV was for an exceedance at Side Sewer 1 on the Hearst outfall. Figures 5-2, 5-3, and 5-4 provide a five-year historical summary of the sanitary-sewer analyses.

### *5.2.2 Building 25 Plating Shop*

As required by the EBMUD permit, one self-monitoring sample was taken at this site in February 1992. The results are summarized in Table 5-10. At the end of February 1992, the unit was shut down for repairs and process modifications. It remains out of commission.

### *5.2.3 Building 77 Plating Shop*

As required by EBMUD permit 50238921, six self-monitoring samples were taken of the Building 77 Wastewater Treatment effluent. On October 16, 1992, a sample taken for cyanide was analyzed as 4 ppm. The discharge limit is 1.2 ppm. Subsequent investigations indicated that the treatment unit was functioning well and the Plating Shop operations were normal. The analysis did indicate a colorimetric interference, which would result in a "high" reading. To minimize the potential for future analytical laboratory errors, samples will be split and sent to separate laboratories.

On December 9, 1992, one sample was analyzed as high in lead, nickel, copper, cadmium, and zinc, with values exceeding the daily maximum and monthly average limits. In response to this excursion, the sampling frequency was increased from bimonthly to biweekly, thus providing more timely feedback to the operator. It appears that the high zinc level was due to rainfall from an adjacent roof. A roof has been installed over the open treatment tanks to protect them from incident rain. Other process modifications have been completed that should address the adequate treatment of all the heavy metals discharged by the Plating Shop. The analytical results are summarized in Table 5-11.

**Table 5-9.** Overview of EBMUD Violations in 1992

| Letter Date | Violation Date | Sampler | Location | Parameter | Cause | Follow-up |
|---|---|---|---|---|---|---|
| April 13, 1992 (memo of excursion)<br>May 21, 1992 (NOV)<br>May 21, 1992 (report of investigation) | March 4, 1992 | LBL | Strawberry Sewer | TCA | Degreaser in Bldg. 77; degreased parts stored on an exterior covered pad served by a sanitary sewer drain. | 1. Trained degreaser operators.<br>2. Ensured proper draining of degreased parts.<br>3. Monitored manholes in this area weekly for the next month. |
| July 17, 1992 (NOV)<br>August 5, 1992 (report of investigation) | April 23/24, 1992 | EBMUD | Hearst Sewer | TICH (TCA) | One-time event whose notification by EMBUD to LBL was 4 months after the event. All investigations indicated that the Lab was operating normally during the period in which the excursion was detected. All subsequent analyses have been within limits. | 1. Reviewed pre-and post- event analytical results.<br>2. Reviewed current chemical inventory to find users.<br>3. Planned interview of users.<br>4. Follow-up report March 19, 1993. |
| August 31, 1992 (notice of excursion)<br>Sept. 24, 1992 (NOV)<br>Oct. 1, 1992 (rept. of investigation) | Aug. 26, 1992 | LBL | Strawberry Sewer | pH | The pH probe location was inappropriate. The pH being measured was not representative of the whole waste stream. All subsequent analyses have been within limits. | 1. Asked UC if any of its facilities were using unusually large amounts of acid.<br>2. Surveyed LBL facilities using acid.<br>3. Provided requested information to EBMUD on duration of and flow during the event.<br>4. Relocated pH probe to sample whole waste stream. |
| Sept. 29, 1992 (report of excursion)<br>Feb 23, 1993 (NOV)<br>March 8, 1993 (report of investigation) | Aug. 25/26, 1992 | LBL | Strawberry Sewer | VTCH (TCA, DCA) | Subsequent investigation by Site Restoration discovered a leaking pit containing TCA and DCA. This pit is believed to be the source. All subsequent analyses have been within limits. | 1. Surveyed chemical inventory of the site to pinpoint use of relevant chemicals.<br>2. Asked UC facilities if TCA was in use.<br>3. Initiated Wastewater Discharge Investigation.<br>4. Remediated pit. |
| Oct. 16, 1992 (report of excursion)<br>Dec. 30, 1992 (NOV)<br>no action required by NOV | Sept. 17, 1992 | LBL | B77 | CN | Possible waste-treatment system malfunction. Possible incorrect lab analysis. All subsequent analyses have been within limits. | 1. Examined sampling procedures and protocol.<br>2. Marked, calibrated, and certified sampling equipment.<br>3. Applied administrative controls to analytical laboratory and operating unit. |
| Dec. 23, 1992 (notice of excursion)<br>Jan. 4, 1993 (NOV)<br>Jan. 8, 1993 (response to NOV) | Dec. 9, 1992 | LBL | B77 | Pb, Ni, Cu, Cd } monthly<br>Ni, Zn } daily | Possible waste-treatment system malfunction. Possible contamination by rain water from adjacent roof. All subsequent analyses have been within limits. | 1. Relocated chemical addition lines and reduced flow rate.<br>2. Took further samples.<br>3. Met with manufacturer's representative.<br>4. Provided requested further sample results to EBMUD.<br>5. Replaced meters and probes on treatment unit.<br>6. Increased administrative controls and long-term maintenance plan.<br>7. Installed a roof over the unit. |

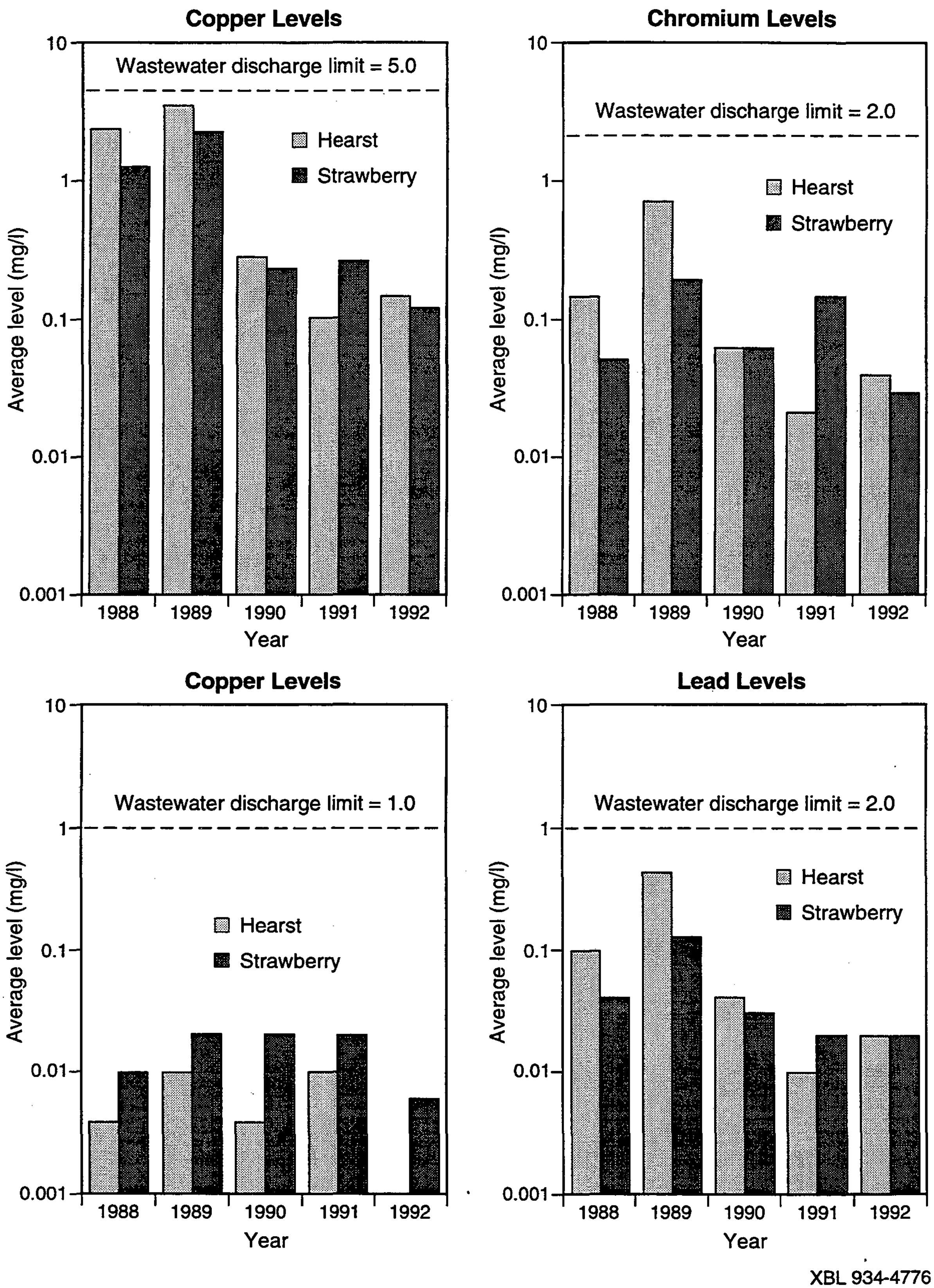



**Figure 5-2.** Hearst and Strawberry Monitoring Stations: Effluent Trends for Copper, Chromium, Cadmium, and Lead.

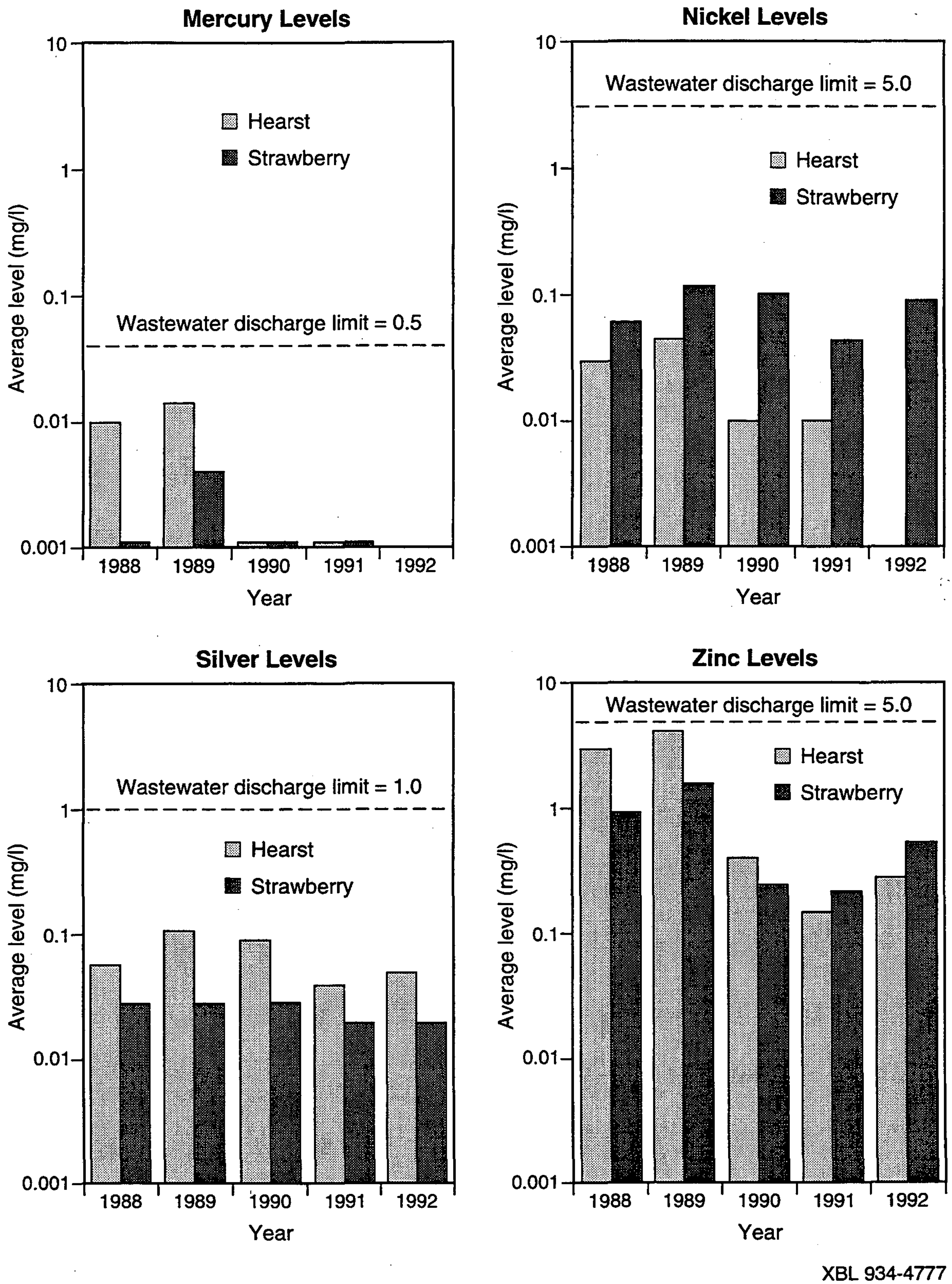



**Figure 5-3.** Hearst and Strawberry Monitoring Stations: Effluent Trends for Mercury, Nickel, Silver, and Zinc.

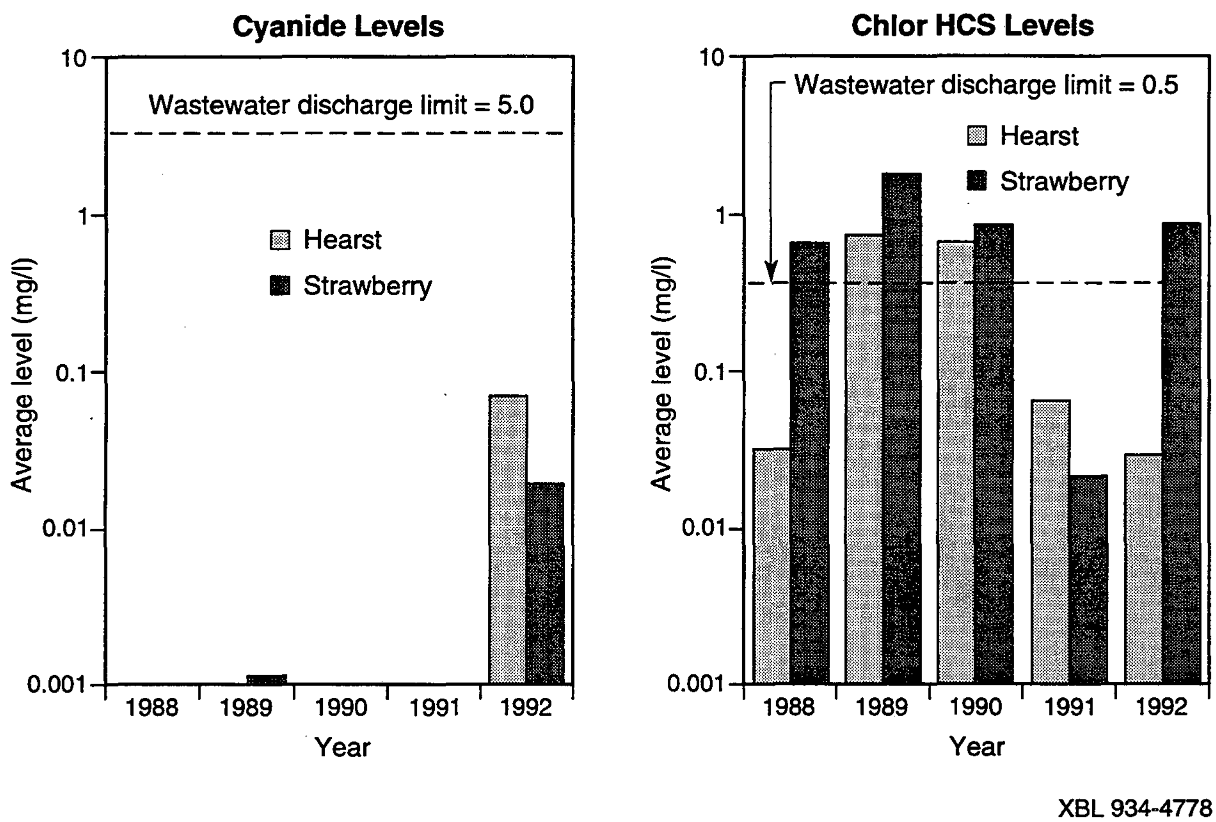



**Figure 5-4.** Hearst and Strawberry Stations: Effluent Trends for Cyanide and Chlorinated Hydrocarbons

**Table 5-10**. Building 25 Self-Monitoring Results.

| | Cadmium | Chrom. | Copper | Lead | Nickel | Silver | Zinc | Cyanide | Chlor HCS | pH | TSS | COD F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of Samples | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Minimum Level (mg/L) | 0.000 | 0.00 | 0.54 | 0 | 0.15 | — | 0.13 | — | — | — | — | — |
| Maximum Level (mg/L) | 0.000 | 0.00 | 0.54 | 0 | 0.15 | — | 0.13 | — | — | — | — | — |
| Average Level (mg/L) | 0.000 | 0.00 | 0.54 | 0.00 | 0.15 | — | 0.13 | — | — | — | — | — |
| Avg. Percent of Limit | 0.0 | 0.0 | 16.0 | 0.0 | 3.8 | — | 5.0 | — | — | — | — | — |
| 2 × Standard Deviation | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — | 0.0 | — | — | — | — | — |
| Number > Limit | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Limit (mg/L) | 0.69 | 2.00 | 3.38 | 0.69 | 3.98 | 0.43 | 2.61 | 1.20 | 0.5 | 5.5 | — | — |

**Table 5-11**. Building 77 Self-Monitoring Results.

| | Cadmium | Chrom. | Copper | Lead | Nickel | Silver | Zinc | Cyanide | Chlor HCS | pH | TSS | COD F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of Samples | 6 | 6 | 6 | 6 | 6 | 4 | 6 | 6 | 2 | 5 | 1 | 0 |
| Min. Level (mg/L) | 0.003 | 0.18 | 0 | 0 | 0.02 | 0 | 0.04 | 0 | 0.11 | 9.3 | 10 | — |
| Max. Level (mg/L) | 0.880 | 1.40 | 2.2 | 0.58 | 4.9 | 0.23 | 6.2 | 4 | 0.13 | 11.5 | 10 | — |
| Avg. Level (mg/L) | 0.233 | 0.67 | 0.79 | 0.20 | 1.63 | 0.06 | 2.02 | 0.67 | 0.12 | 10.3 | 10.0 | — |
| Avg. Percent of Limit | 9.2 | 9.1 | 6.3 | 7.8 | 1.11 | 2.7 | 21.1 | 15.3 | 2.2 | 0.0 | — | — |
| 2 × Standard Deviation | 0.6 | 1.0 | 1.8 | 0.6 | 4.4 | 0.2 | 5.4 | 3.0 | 0.0 | 1.4 | — | — |
| Number > Limit | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 1 | 0 | 0 | 0 | 0 |
| Limit (mg/L) | 0.69 | 2.00 | 3.38 | 0.69 | 3.98 | 0.43 | 2.61 | 1.20 | 0.5 | 5.5 | — | — |

### 5.2.4 *Side Sewer 1 (Hearst Monitoring Station)*

As required by EBMUD Permit 066-00791, eight self-monitoring samples were taken from Side Sewer 1 (the Hearst Monitoring Station). On July 17, 1992, LBL reviewed an NOV for Total Identifiable Chlorinated Hydrocarbons (TICH) from EBMUD. A sample taken by EBMUD triggered the NOV. The EBMUD sample analyzed trichloroethane (TCA) at 0.5 ppm. The discharge limit for TICH is 0.5 ppm. As the NOV was served three months after the sample was taken, the investigation focused upon the site chemical inventory, and the location and use of TCA at all site locations that discharge to the Hearst monitoring station. No direct cause was determined.

Table 5-12 summarizes the 1992 self-monitoring analyses for the Hearst Sewer.

### 5.2.5 *Side Sewer 2 (Strawberry Monitoring Station)*

As required by EBMUD Permit 066-00791, eight self-monitoring samples were taken from Side Sewer 2 (the Strawberry Monitoring Station). On March 4, 1992, a self-monitoring sample was analyzed for TICH at 0.6 ppm. The limit for TICH is 0.5 ppm. The solvent was 1,1,1-TCA, used as a degreaser in Building 77. The investigation determined that degreased parts were removed from the degreaser and stored over a sanitary drain before all the 1,1,1-TCA was allowed to drain back into the degreaser tank. The solvent subsequently dripped into the sanitary drain. Building 77 management retrained their operators in degreaser operations.

On August 26, 1992, Environmental Monitoring Unit personnel noted that the pH recorder indicated a pH of 3.6. This value remained unchanged after the probe was calibrated. There are no known LBL site operations that discharge into the Strawberry monitoring station that would cause the pH to fall below 5.5, the permit limit. As UC Berkeley facilities also drain into the Strawberry monitoring station, they were queried regarding their operations. No low-pH waste was being discharged by any of the UC facilities. An improved investigation program is slated for development and implementation in 1993.

On August 25, 1992, a self-monitoring sample was analyzed at 0.6 ppm TICH. The discharge limit is 0.5 ppm. Equal parts of TCA and dichloroethane (DCA) were detected in the sample. These constituents are usually found in contaminated groundwater as decomposition products of 1,1,1-TCE. While TCE is used at LBL as a degreaser, neither TCA nor DCA are used at the site.

Table 5-13 summarizes the 1992 self-monitoring analyses for the Strawberry sewer.

**Table 5-12.** Hearst Sewer Self-Monitoring Results.

| | Cadmium | Chrom. | Copper | Lead | Nickel | Silver | Zinc | Cyanide | Chlor HCS | pH | TSS | COD F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of Samples | 8 | 8 | 8 | 8 | 8 | 3 | 8 | 7 | 7 | 6 | 8 | 8 |
| Min. Level (mg/L) | 0.000 | 0.00 | 0.054 | 0 | 0 | 0.019 | 0 | 0 | 0.00 | 7.6 | 160 | 120 |
| Max. Level (mg/L) | 0.011 | 0.16 | 0.29 | 0.13 | 0.02 | 0.11 | 0.44 | 0.44 | 0.10 | 8.7 | 670 | 400 |
| Avg. Level (mg/L) | 0.001 | 0.04 | 0.13 | 0.02 | 0.00 | 0.05 | 0.28 | 0.07 | 0.03 | 8.2 | 308.8 | 256.3 |
| Avg Percent of Limit | 0.0 | 0.3 | 0.5 | 0.2 | 0.0 | 0.4 | 1.0 | 0.2 | 0.9 | 0.0 | — | — |
| 2 × Standard Deviation | 0.0 | 0.2 | 0.2 | 0.0 | 0.0 | 0.0 | 0.2 | 0.4 | 0.0 | 0.8 | — | — |
| Number > Limit | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Limit (mg/L) | 1.00 | 2.00 | 5.00 | 2.00 | 5.00 | 1.00 | 5.00 | 5.00 | 0.5 | 5.5 | — | — |

**Table 5-13**. Strawberry Sewer Self-Monitoring Results.

| | Cadmium | Chrom. | Copper | Lead | Nickel | Silver | Zinc | Cyanide | Chlor HCS | pH | TSS | COD F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of Samples | 8 | 8 | 8 | 8 | 8 | 3 | 8 | 7 | 7 | 6 | 8 | 8 |
| Min. Level (mg/L) | 0.000 | 0.00 | 0.05 | 0 | 0 | 0.005 | 0.16 | 0 | 0.01 | 3.7 | 84 | 52 |
| Max. Level (mg/L) | 0.020 | 0.06 | 0.18 | 0.05 | 0.44 | 0.026 | 1.5 | 0.088 | 3.54 | 8.6 | 1700 | 1000 |
| Average Level (mg/L) | 0.006 | 0.03 | 0.11 | 0.02 | 0.09 | 0.02 | 0.52 | 0.02 | 0.88 | 6.8 | 596.8 | 340.1 |
| Avg. Percent of Limit | 0.1 | 0.2 | 0.4 | 0.2 | 0.3 | 0.1 | 1.9 | 0.1 | 21.5 | 0.0 | — | — |
| 2 × Standard Deviation | 0.0 | 0.0 | 0.2 | 0.0 | 0.2 | 0.0 | 0.8 | 0.0 | 2.4 | 3.2 | — | — |
| Number > Limit | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Limit (mg/L) | 1.00 | 2.00 | 5.00 | 2.00 | 5.00 | 1.00 | 5.00 | 5.00 | 0.5 | 5.5 | 0 | 0 |

# Section 6
# Groundwater Protection

## 6.1 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 several 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 (51-1-3 and 51-1-4) east of Building 51 (see Figure 6-1) 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.

During Fiscal Year 1990, LBL carried out a preliminary investigation that concentrated on three areas. The areas chosen for study were regions 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 Blackberry Creek, the Old Town area, and the Corporation Yard. The contaminants detected consisted primarily of chlorinated solvents [perchloroethyene (PCE), trichloroethylene, (TCE), and cis-1,2-dichlorethylene (DCE)] in 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 (Figure 6-2) 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 initially tested for volatile organic compounds (VOCs) according to EPA Method 8240 and CAM 17 metals according to the California Code of Regulations (CCR) Title 26. A water sample from one of these monitoring wells located downgradient of the plating shop (Building 77) was also tested for hexavalent chromium. Only one of the nine peripheral wells (MWP-7) contained measurable levels of contamination (24 µg/L TCE). Monitoring well MWP-7 is located close to the southeast corner of Building 37, about 130 feet north of the LBL property line.

A granular activated carbon (GAC) treatment system, consisting of a series of filters followed by two GAC drums, has been installed to treat discharges from all contaminated hydraugers that are located northeast of Building 51. Water samples from a port between two GAC drums are collected every month and tested for VOCs. The first drum is replaced as soon as breakthrough of VOCs is detected. Treated water from the GAC system has been routed to the cooling tower located at Building 51.

In 1991, LBL 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

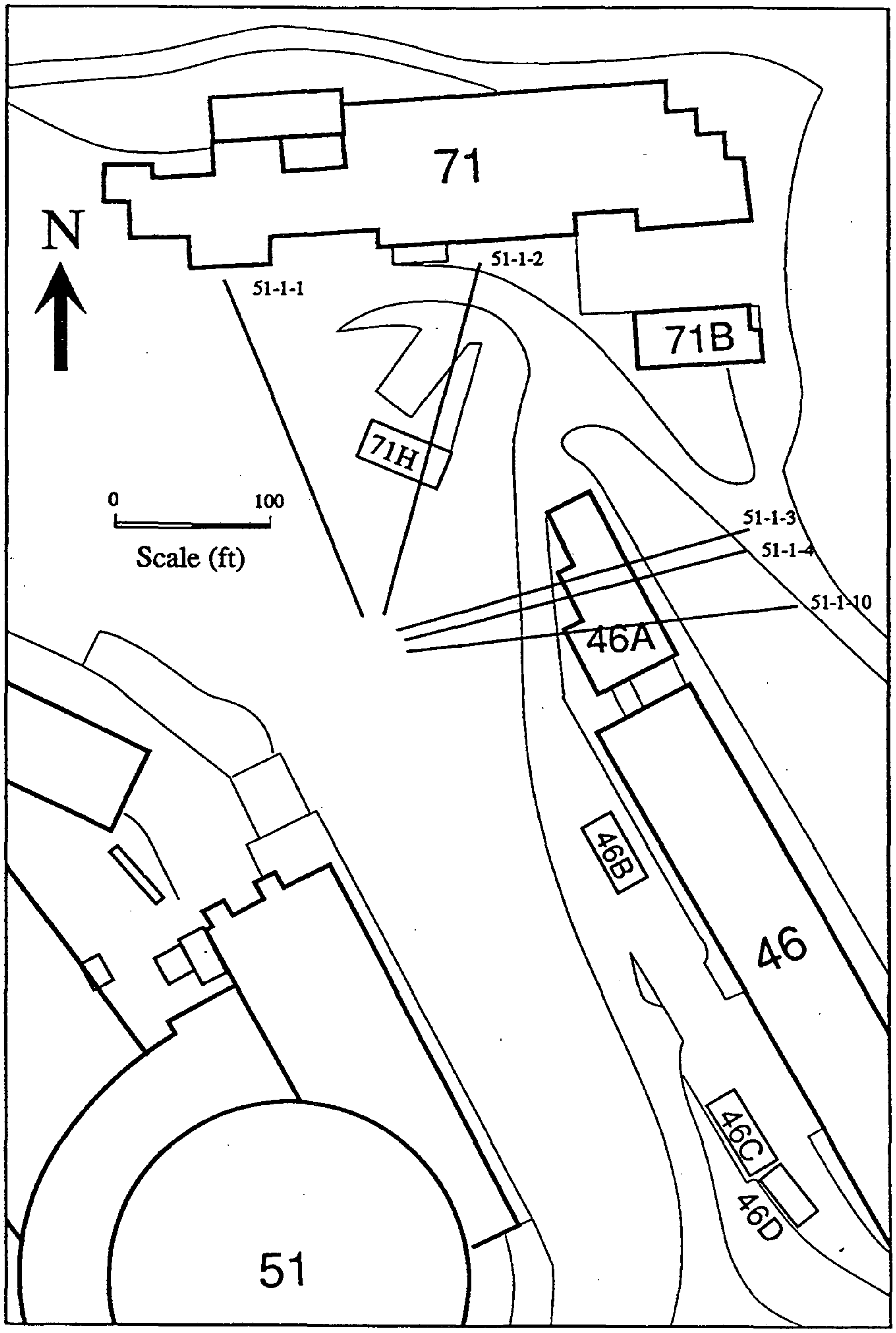
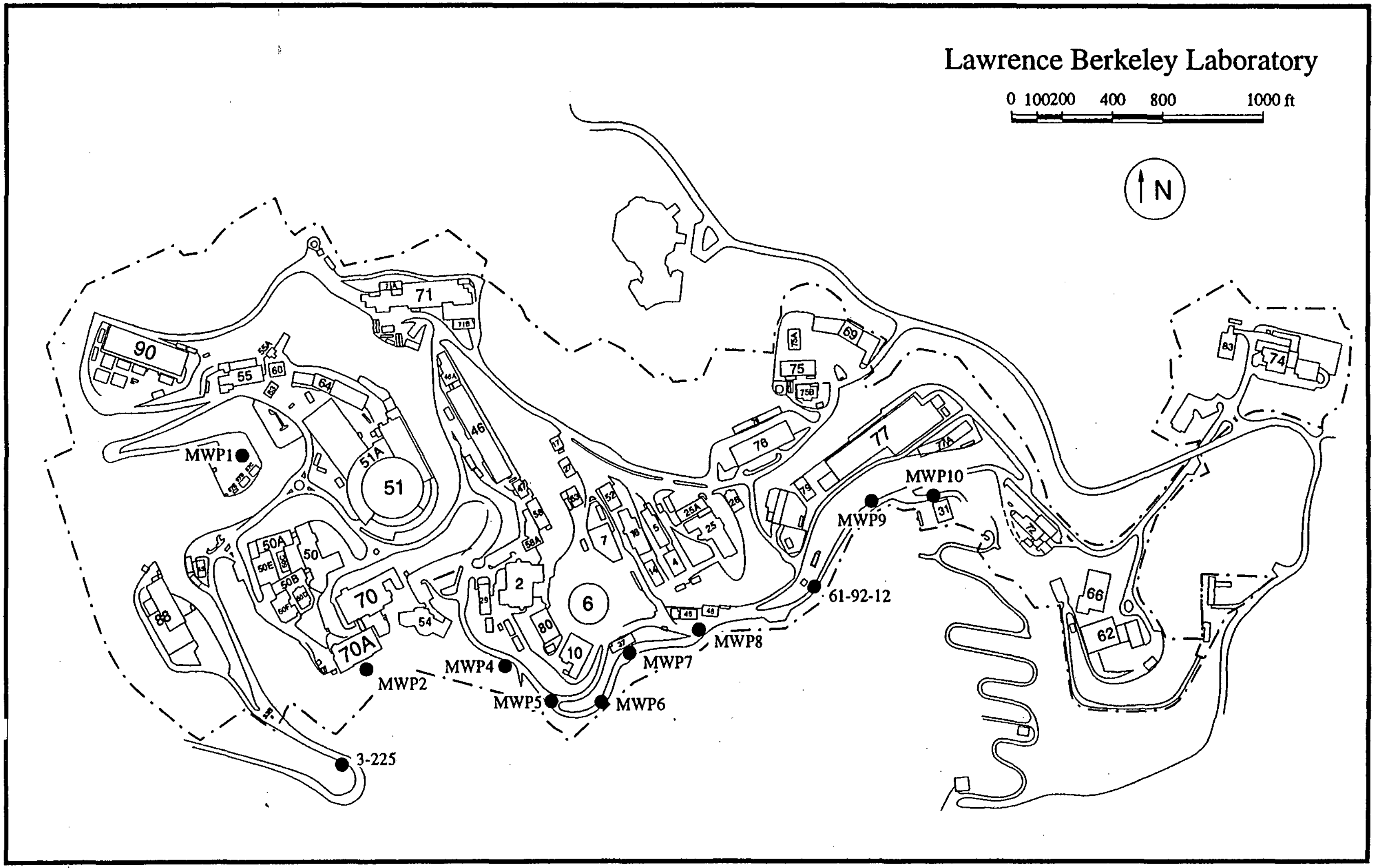



**Figure 6-1. Approximate position of some of the Hydraugers east of Building 51.**




ESD-9105-0102A

**Figure 6-2. Approximate locations of peripheral monitoring wells.**

Facility (NTLF). Three other wells were constructed in the Old Town area, two in the vicinity of Building 53 and one north of Building 5. The reason for their construction was to find the extent of contamination in the Old Town area. All three wells in the Old Town area showed contamination with chlorinated hydrocarbons.

## 6.2 Groundwater Studies During 1992

Twenty-six new monitoring wells were installed in 1992 to investigate areas of known or potential groundwater contamination. Twenty-five of these newly installed wells were added to the quarterly monitoring program during 1992, to complement the twenty-eight previously existing monitoring wells currently in the quarterly groundwater monitoring program. Groundwater samples from new and existing monitoring wells are generally obtained quarterly and analyzed for volatile organic compounds (VOCs) by EPA Method 8260. Samples from the monitoring wells are also analyzed annually for CCR CAM 17 Metals. All the wells in the Corporation Yard are tested twice a year for tritium. Selected wells from other areas at LBL were also tested for tritium. Flowing hydraugers have also been sampled annually for selected contaminants, including VOCs, CCR CAM 17 Metals, and tritium.

To date, five plumes of contaminated groundwater have been identified at LBL. Contaminants in three of the plumes principally consist of halogenated hydrocarbons. The contaminant in the fourth plume is mainly tritium, and the contamination in the fifth plume consists primarily of fuel hydrocarbons (Figure 6-3).

### *6.2.1 Building 71 VOC Plume*

The maximum concentration of total halogenated hydrocarbons measured in the plume south of Building 71 in 1992 was approximately 112 µg/L, as shown in Figure 6-4. Contaminants present in the plume consist mainly of PCE, TCE, cis-1,2-DCE, 1,1-dichloroethane (DCA), 1,1-DCE, trans-1,2-DCE, and vinyl chloride. Freon-113 has also been detected at low concentrations. Figure 6-5 shows the location of monitoring wells in the vicinity of the Building 71 plume. Well 46A-92-15 was installed in 1992 to determine the northeast extent of the plume. 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. This water is treated using an activated carbon system (as described above), and treated water is then discharged to the Building 51 cooling tower. Figure 6-6 is a piezometric map in the vicinity of Blackberry Canyon Creek as measured in the Spring of 1992. Figure 6-7 shows the variation of contaminants in MW90-3, near the center of the plume during 1992. With the exception of a decrease in the concentration of PCE during the year, contaminant concentrations showed no significant trends. Water samples from all flowing hydraugers in the vicinity of the plume have been tested annually for VOCs. Figures 6-8 and 6-9 show the variation of selected contaminants over time for hydraugers 51-01-01 and 51-01-03, respectively. A general decrease in contaminant concentrations over time can be observed in the effluent from hydrauger 51-01-03.

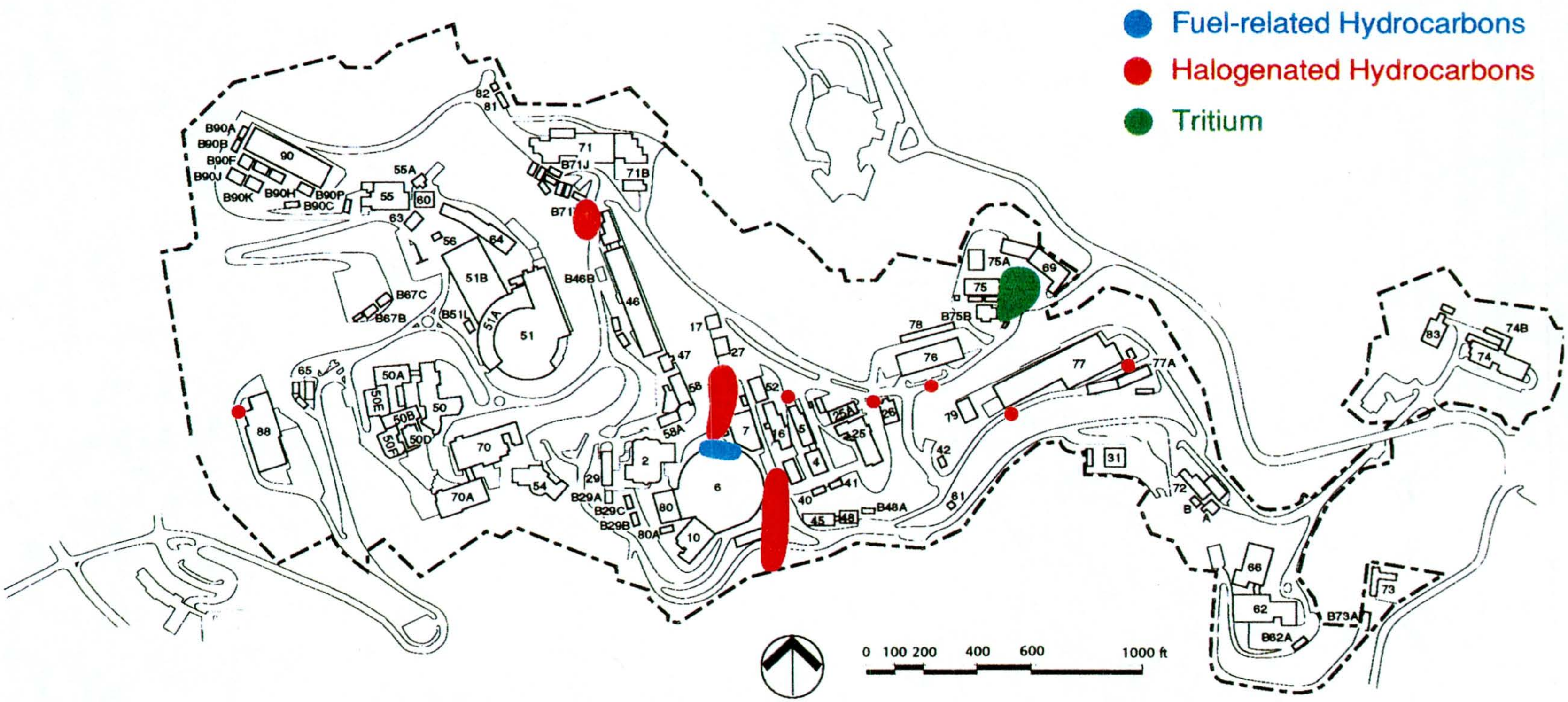



**Figure 6-3. Areas where groundwater contamination has been observed (October 1992).**

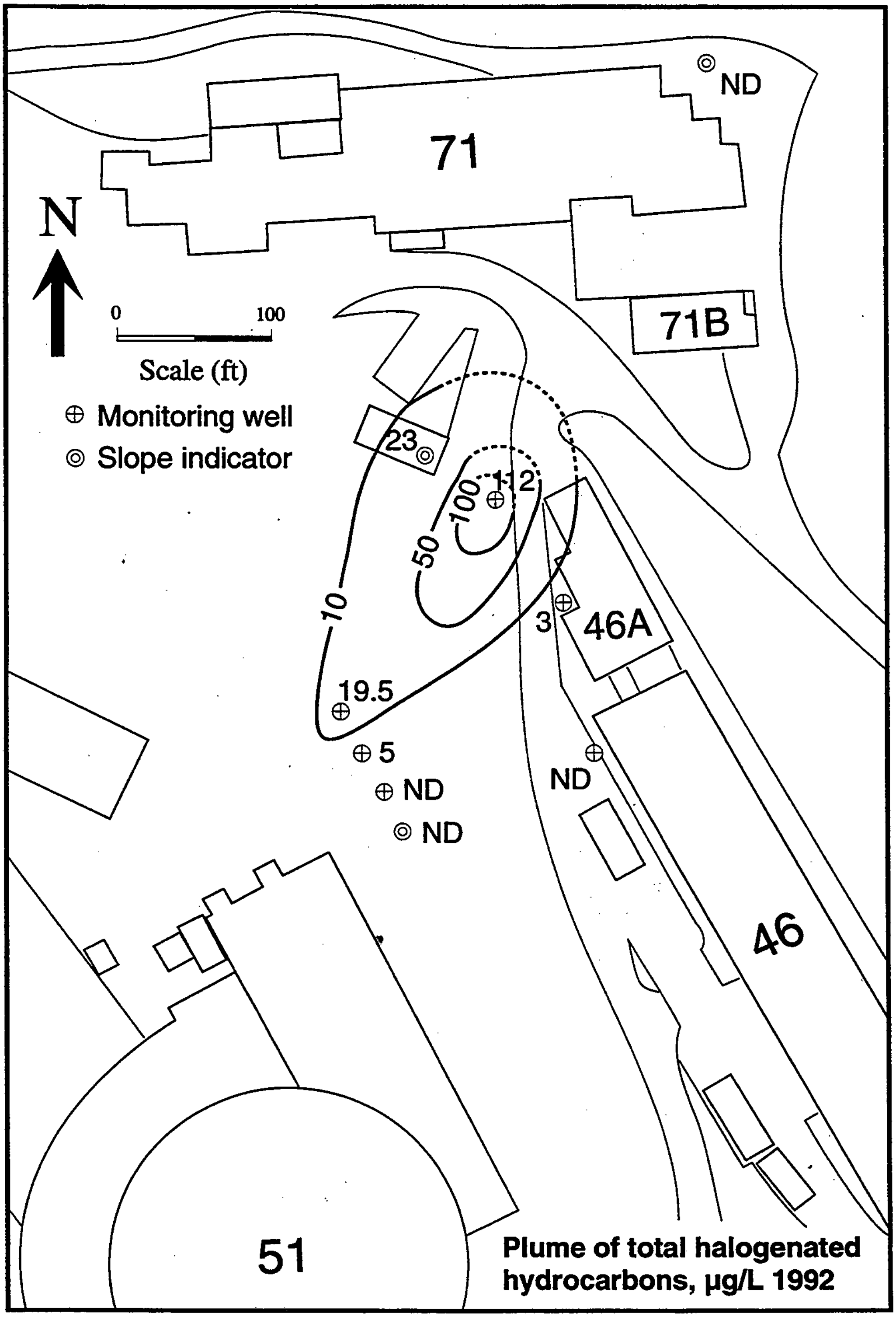



Figure 6-4. Isoconcentration contours of total VOCs in µg/L for groundwater plume south of Building 71.

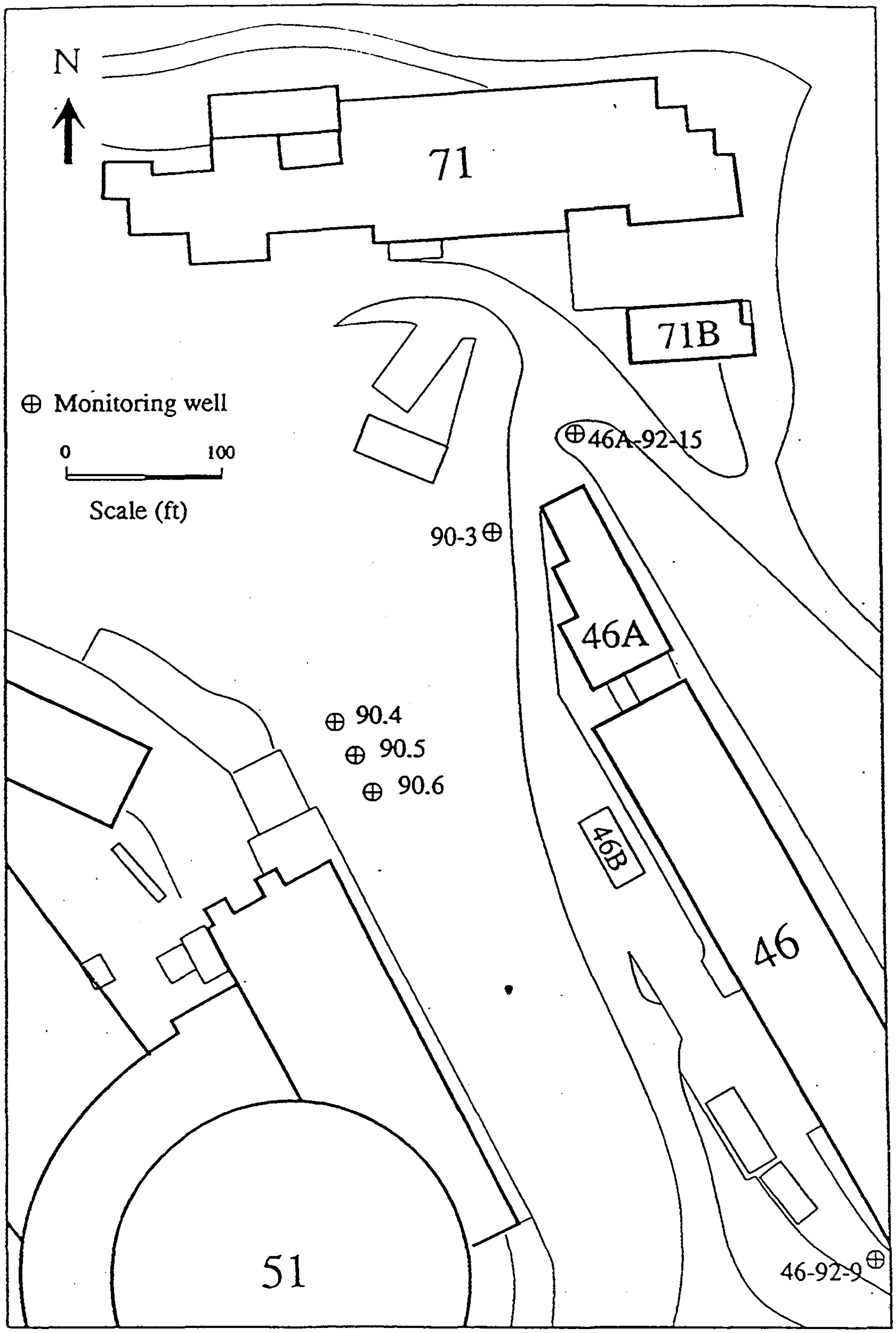



Figure 6-5. Location of monitoring wells in the vicinity of the Building 71 plume (October 1992).

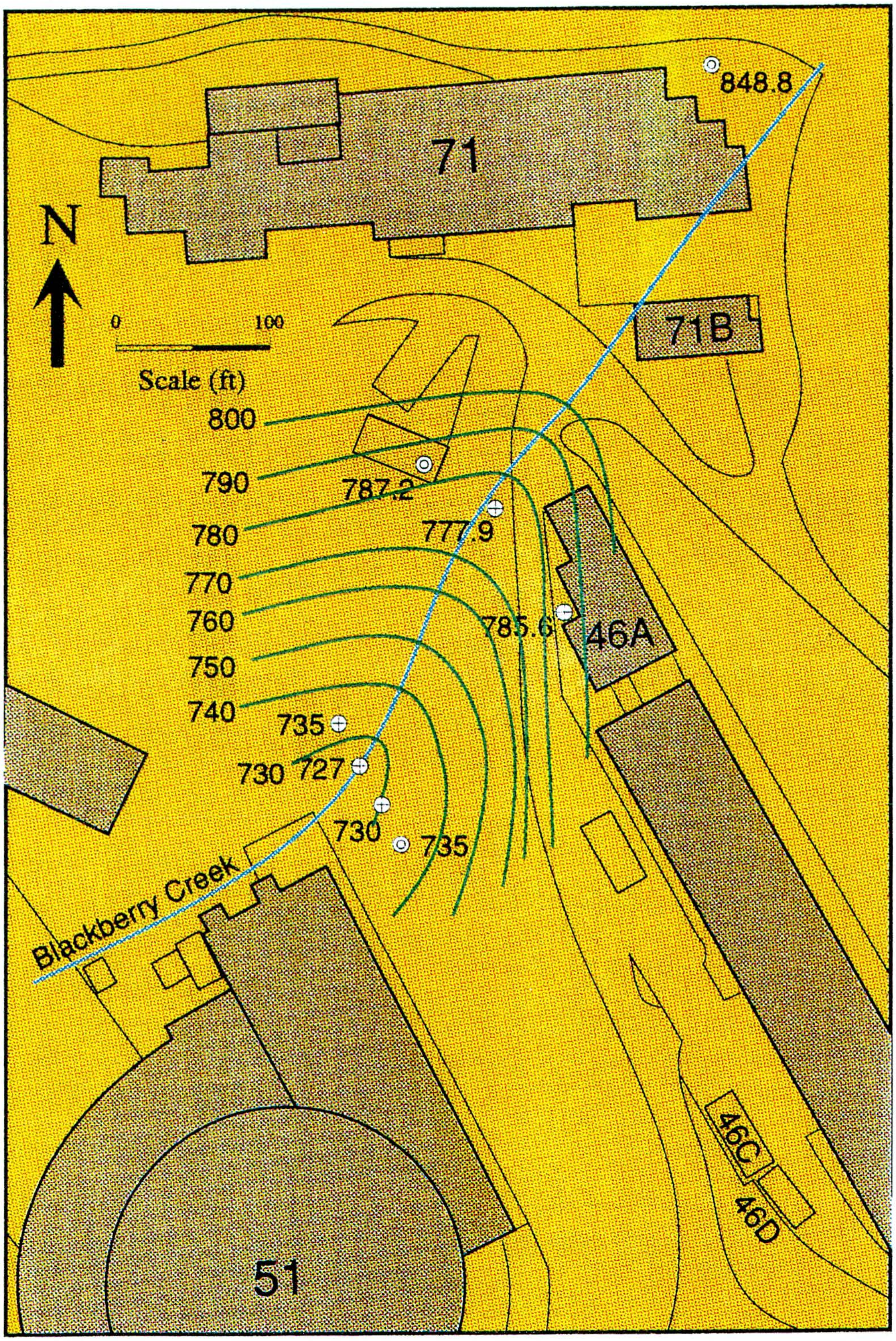



Figure 6-6. Piezometric map in the vicinity of Blackberry Creek, Spring 1992.

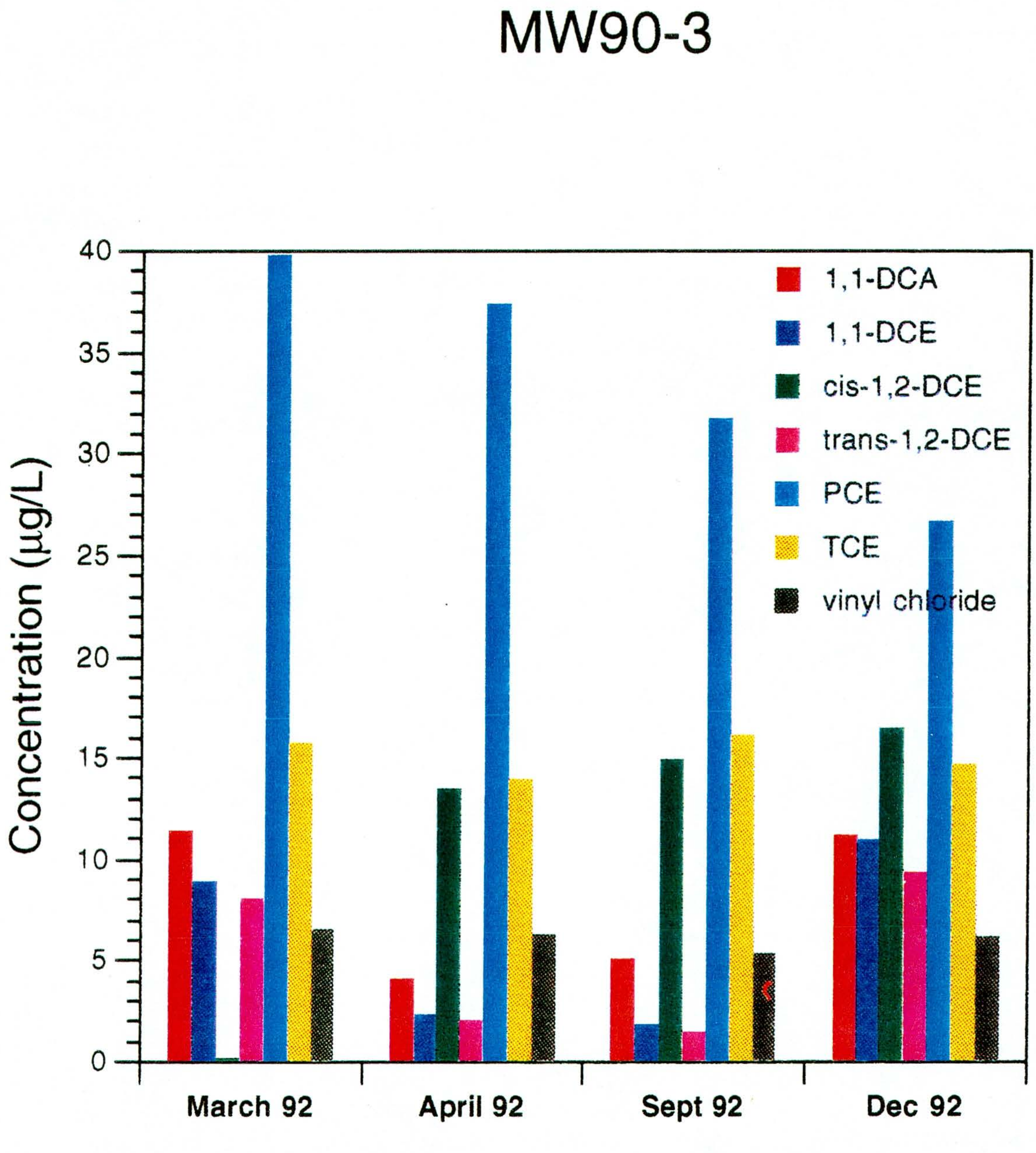



Figure 6-7. Time variation of contaminants in well MW90-3.

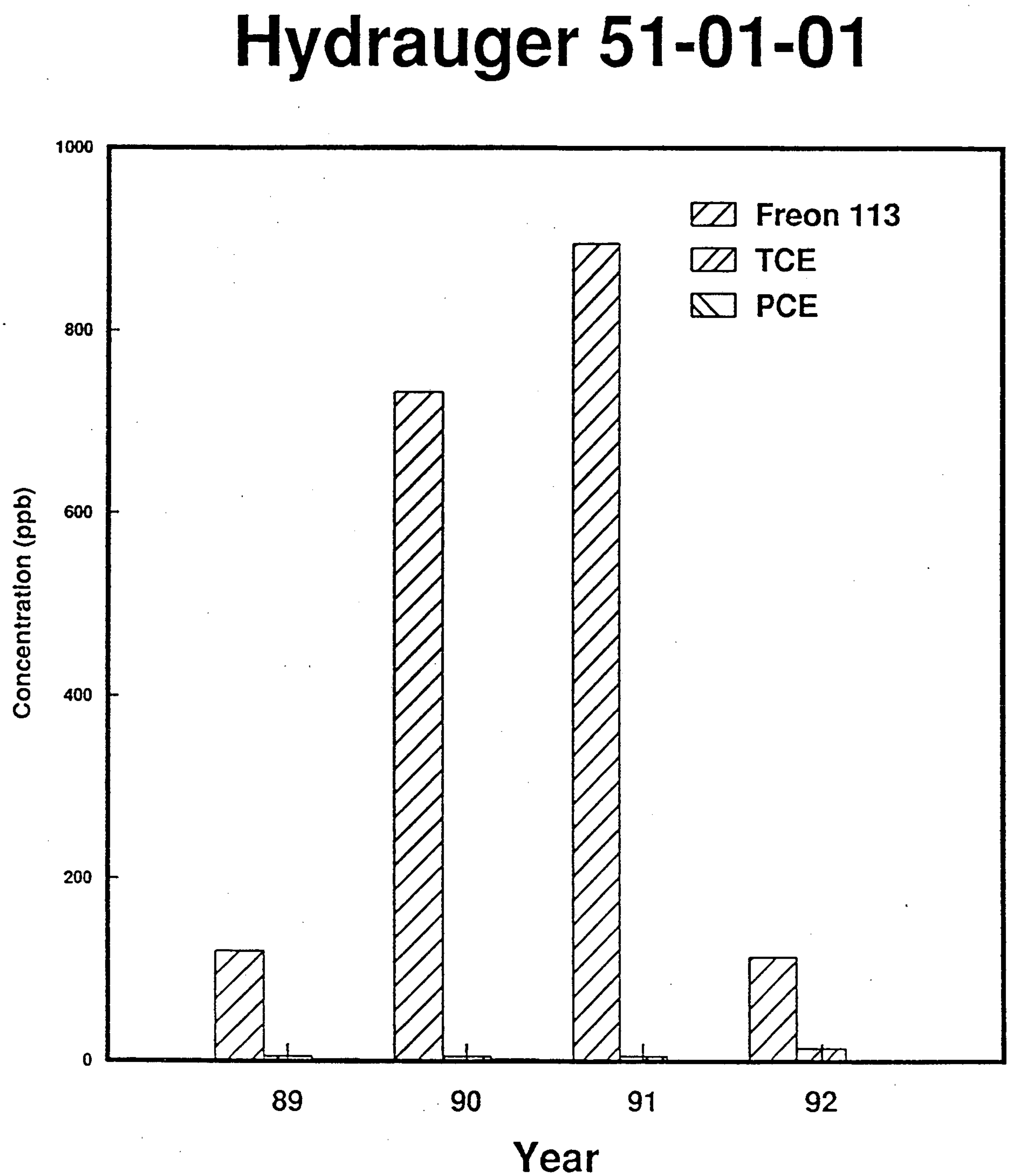



Figure 6-8. Time variation of contaminants in Hydrauger 51-01-01.

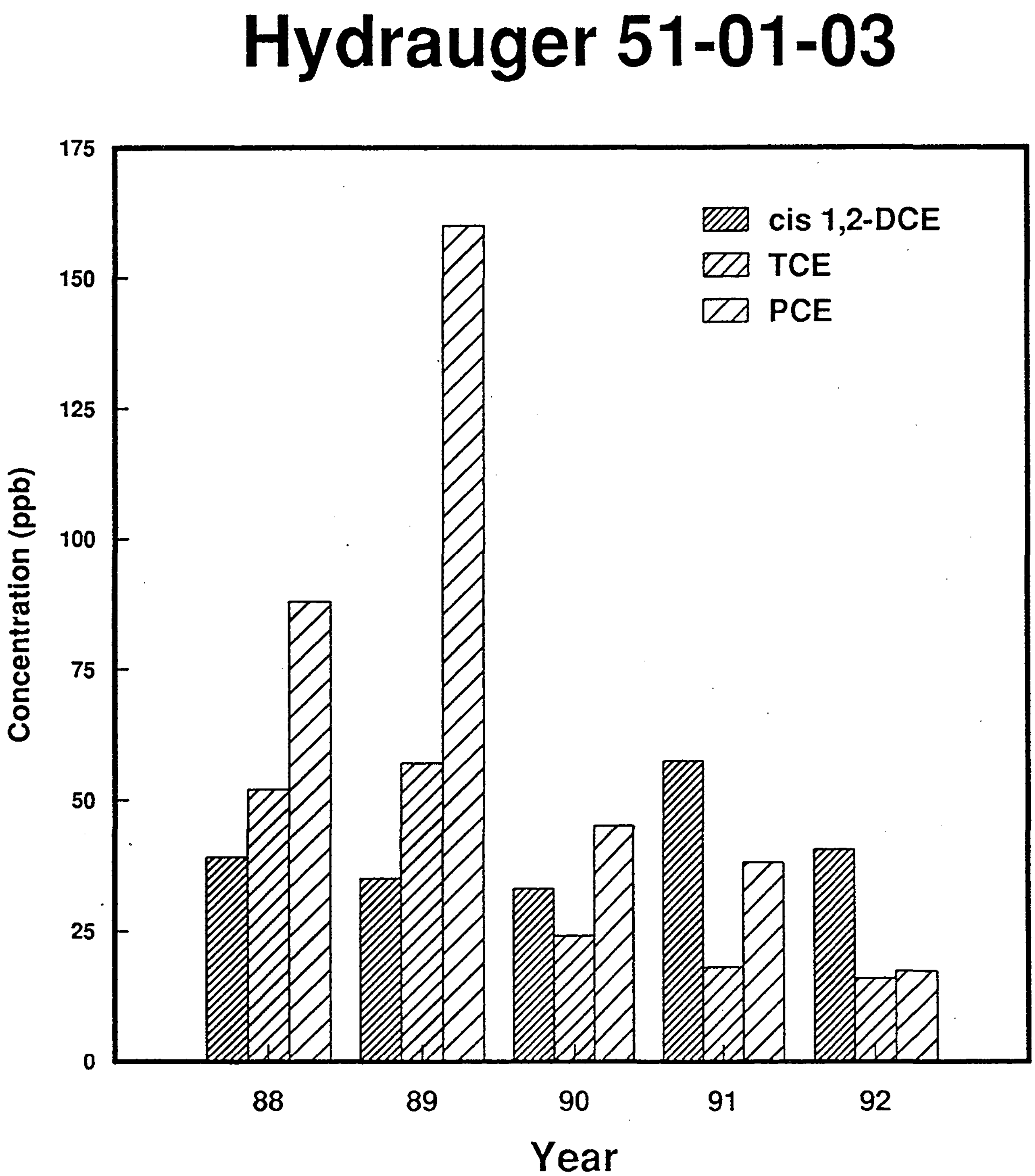



Figure 6-9. Time variation of contaminants in Hydrauger 51-01-03.

### 6.2.2 *Old Town VOC Plume*

The maximum concentration of total halogenated hydrocarbons detected north of Building 7 (Old Town Plume) in 1992 was approximately 1600 μg/L, as shown in Figure 6-10. This value is the maximum VOC contaminant concentration measured to date in groundwater 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. MW7-92-19 was installed near the center of the plume in 1992. Figure 6-11 shows the contaminant concentrations in MW7-92-19 from September to December 1992. Contaminant concentrations detected in two other wells (MW91-7 and downgradient well MW91-8) during 1992 are shown in Figures 6-12 and 6-13, respectively. No significant trends in contaminant concentrations for 1992 can be observed on the figures. A multi-level groundwater monitoring well was installed south of Building 53 to a total depth of approximately 200 feet in order to evaluate the vertical extent of groundwater contamination of the Old Town Plume. No contamination was detected in any of the four levels screened in Orinda Formation. A highly contaminated abandoned sump adjacent to Building 7 was located and cleaned in 1992. The sump is now believed to have been the primary source of the contaminants that constitute the Old Town plume

### 6.2.3 *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 detected VOCs include PCE, chloroform, Freon 113, 1,1-DCE, 1,1-DCA, cis-1,2-DCE, and 1,2-DCA. TCE was detected at concentrations of approximately 15 to 30 μg/L in 1992, as measured in MWP-7 near the center of the plume. Figure 6-14 shows the contaminant concentrations in MWP-7 from February to November 1992. No significant trend in contaminant concentrations was observed. Offsite monitoring well CD-92-28 was installed downgradient of the plume on University of California at Berkeley (UCB) property. No contamination has been detected in this well to date.

### 6.2.4 *Building 75 Tritium Plume*

A plume of tritium-contaminated groundwater extends southeast of the National Tritium Labeling Facility, Building 75. Figure 6-15 shows the concentration of tritium measured in slope stability wells and monitoring wells in the Corporation Yard area in July and August 1992. Tritium was detected in four of the monitoring wells shown on the figure at concentrations ranging from approximately 500 to 10,000 pCi/L. All values were below the drinking water maximum contaminant level (MCL) of 20,000 pCi/L. Figure 6-16 shows the location of other wells that were sampled for tritium in April 1992. No tritium was detected in any of the wells shown in Figure 6-16, which indicates that tritium contamination of the groundwater is restricted to the Corporation Yard area. Tritium was also detected in discharges from seven hydraugers in 1992. Further information regarding tritium monitoring of hydraugers is provided below in the Ongoing Radiological Hydrauger Monitoring section of this report.

### *6.2.5 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 discovered south of Building 7 during construction of the Advanced Light Source (ALS). A sample collected from monitoring well 7-92-16 in September 1992 contained 800 µg/L of gasoline-range total petroleum hydrocarbons (TPH-G) and 750 µg/L of diesel-range total petroleum hydrocarbons (TPH-D). In addition to the Building 7 plume, gasoline contamination was also detected in groundwater samples collected in 1992 from monitoring well 83-92-14 (140 µg/L), located between Buildings 83 and 74, and from monitoring well 76-1 (99 µg/L), located south of Building 76 motor pool and garage.

## 6.3 Underground Tank Monitoring

In the past, LBL installed four monitoring wells downgradient from the previously decommissioned or removed underground storage tanks. Figure 6-17 shows the location of these four wells. Quarterly water samples are collected from these wells and tested for VOCs (EPA method 8240/8260). Figure 6-18 shows time variation of contaminants in well MW76-1, which is located downgradient from the previously removed underground storage tanks at the motor pool. Concentration variations of contaminants in well MW7-1, located downgradient from the previously decommissioned waste-oil storage tank under B52-B, are shown on Figure 6-19. Analyses of water samples collected from two other monitoring wells, namely 62-B1A, and 62-B2, located at the site and downgradient from a previously removed underground storage tank, did not show any detectable contaminants.

## 6.4 Well Inventory

A comprehensive well inventory of all known cased and uncased borings at LBL was completed in 1992. The study indicates that during the past 50 years, a total of 642 known monitoring wells, slope stability wells, observation wells, slope indicators, and uncased boring have been drilled on site. At least 114 of the borings have been cased either as monitoring wells, slope stability wells, observation wells or slope indicators. Of the cased borings 92 have been located, and 22 have been destroyed or were not found. Twenty-four of the cased borings are groundwater monitoring wells. The remaining 90 were installed to investigate slope stability problems. LBL began identifying slope-stability wells and slope indicators for abandonment. LBL will continue to work to take appropriate actions to protect the groundwater.

## 6.5 Ongoing Radiological Monitoring

As part of the ongoing environmental monitoring program, ten hydraugers were sampled and analyzed on a semiannual basis in 1992 for tritium. Tritium levels showed the presence of tritium above the drinking water MCL of 20,000 pCi/L in effluent from one hydrauger. A maximum concentration of 32,000 pCi/L of tritium was detected in hydrauger 77-01-02. Table 6-1 summarizes the 1992 analytical data for the Building 77 hydraugers. Figure 6-20 locates the hydraugers shown in Table 6-1. Table 6-2 summarizes the 1992 analytical data for those hydraugers sampled monthly by the Environmental Protection Group.

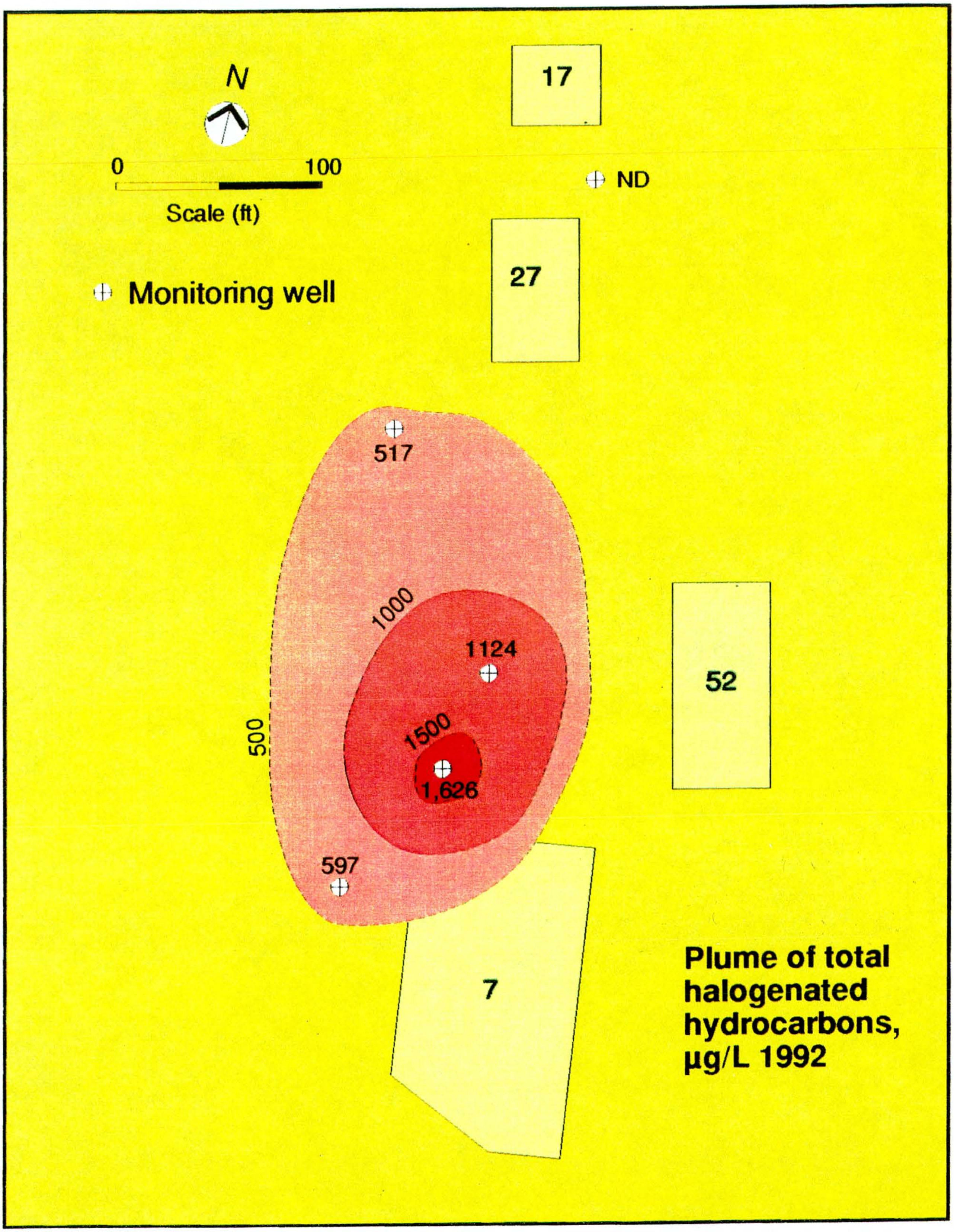



Figure 6-10. Plume of groundwater contamination in the Old Town (1992).

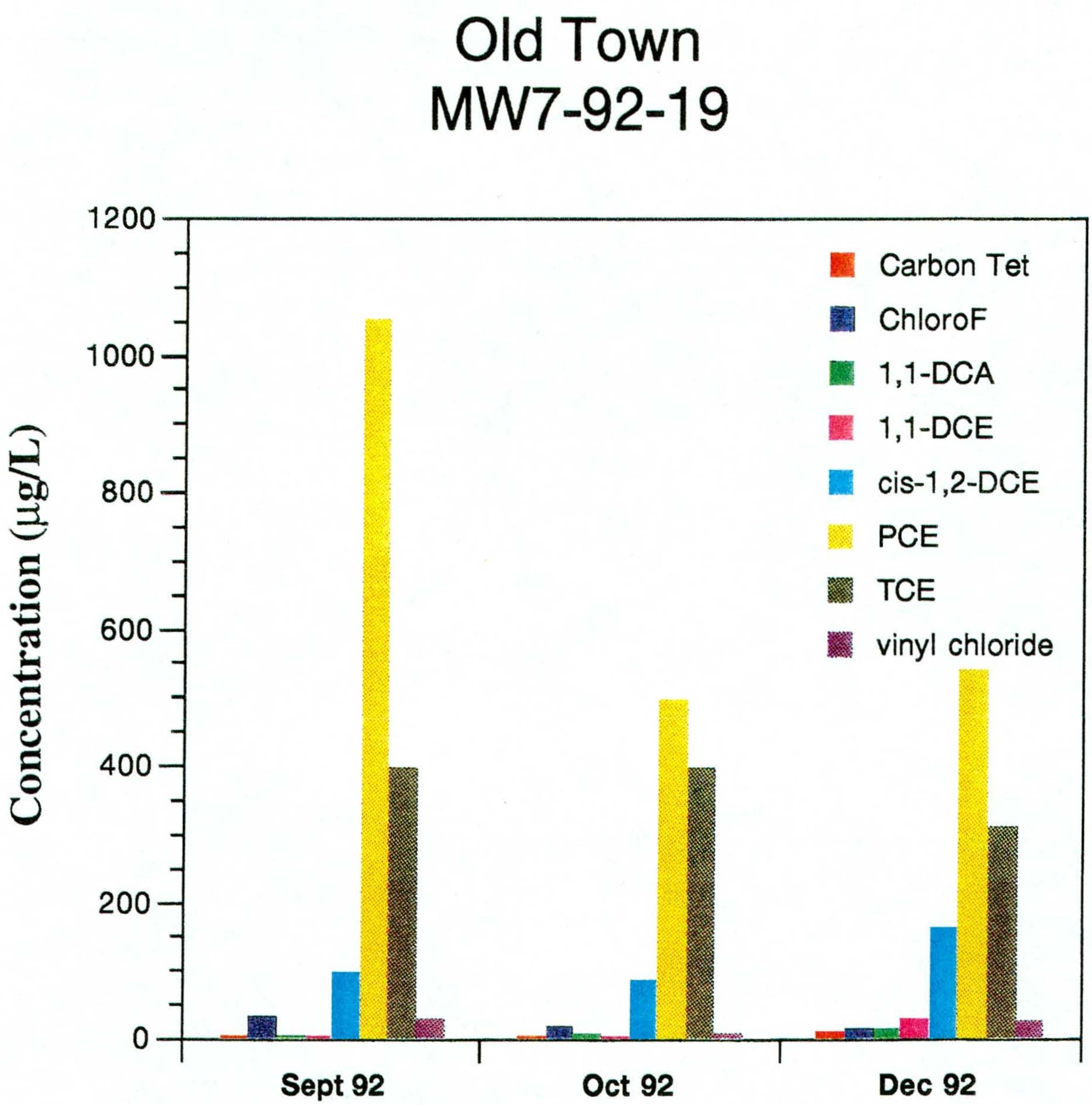



Figure 6-11. Time variation of contaminants in well MW7-92-19.

# 91.7

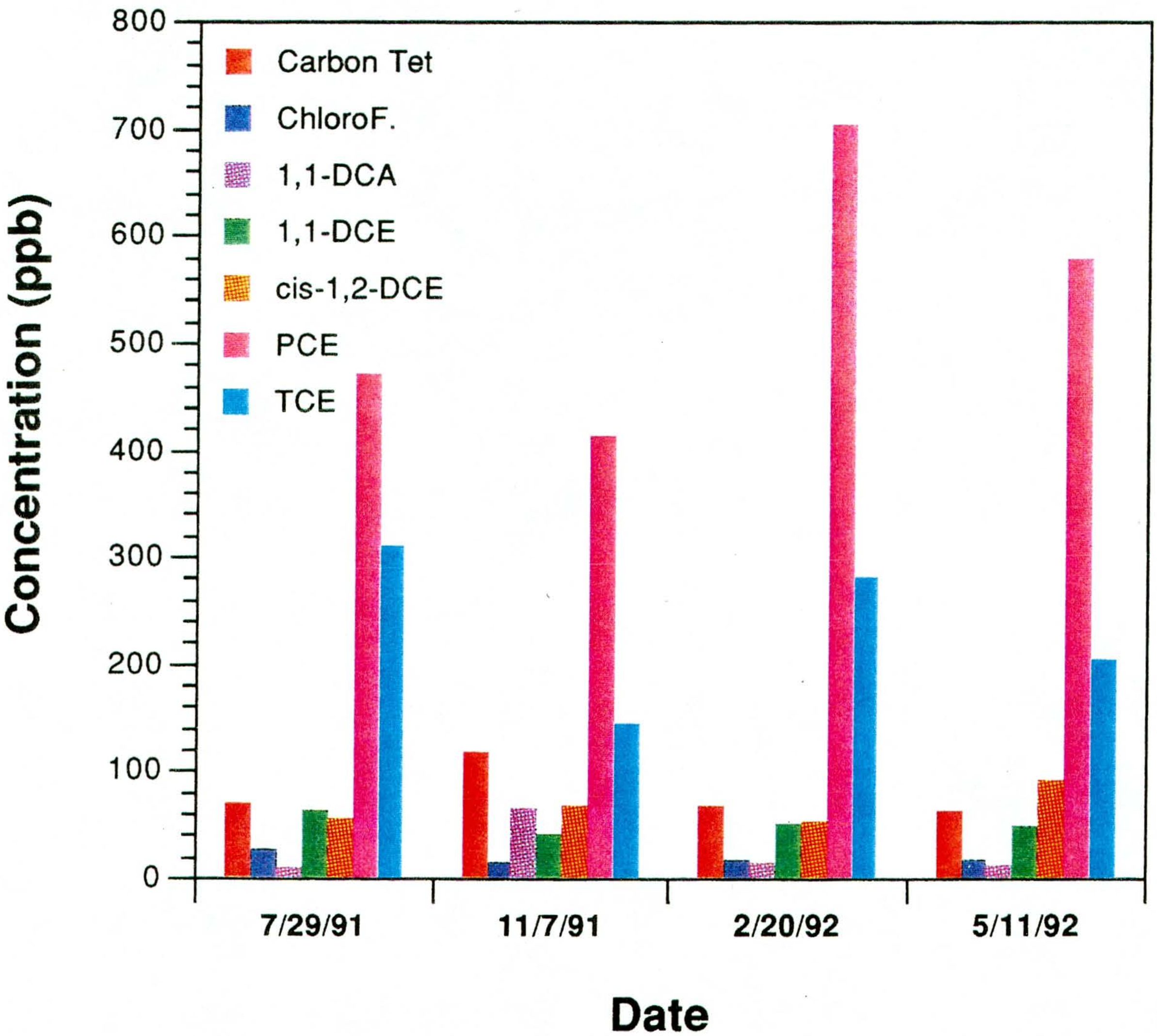



Figure 6-12. Time variation of contaminants in well MW91-7.

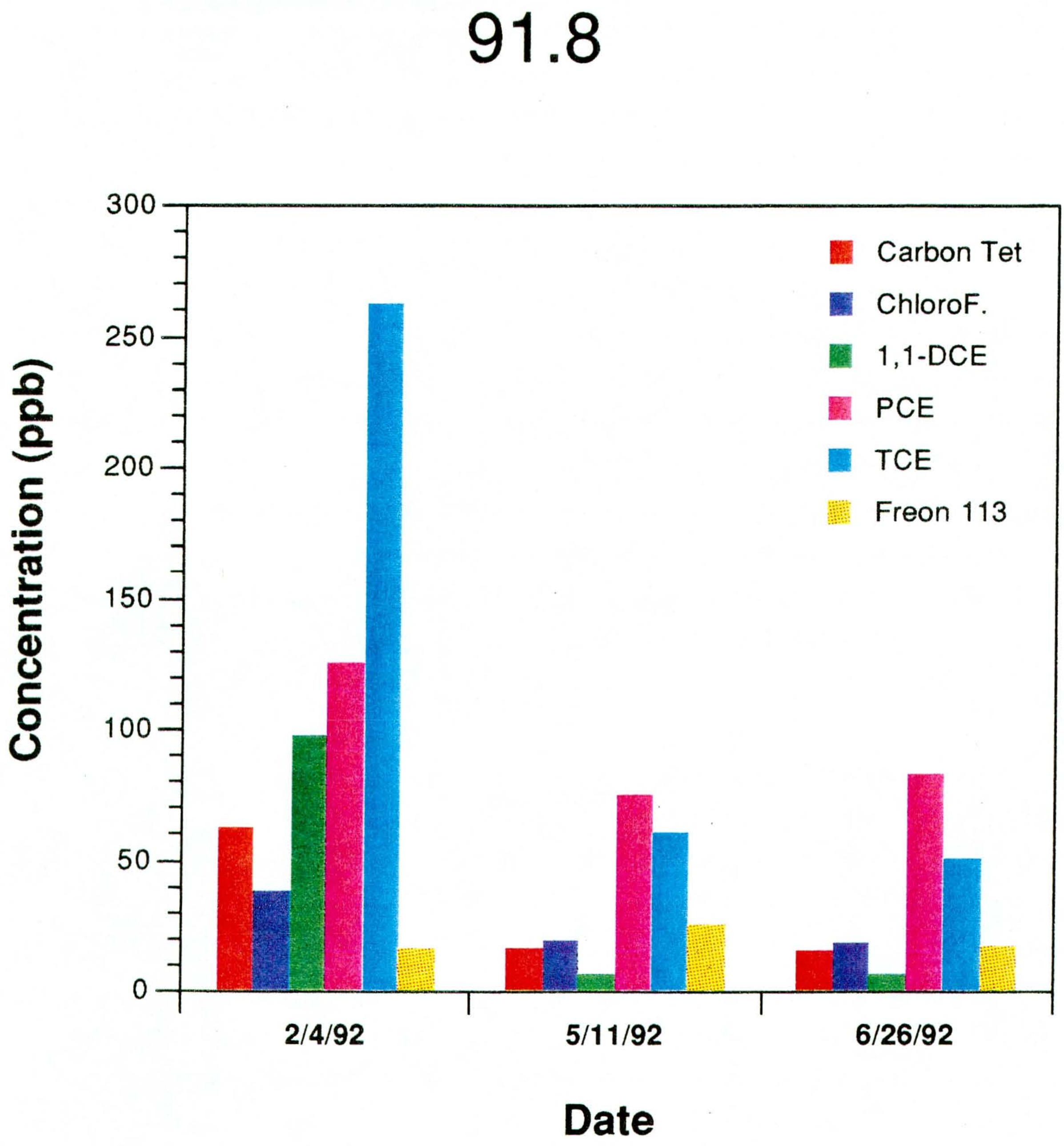



Figure 6-13. Time variation of contaminants in well MW91-8.

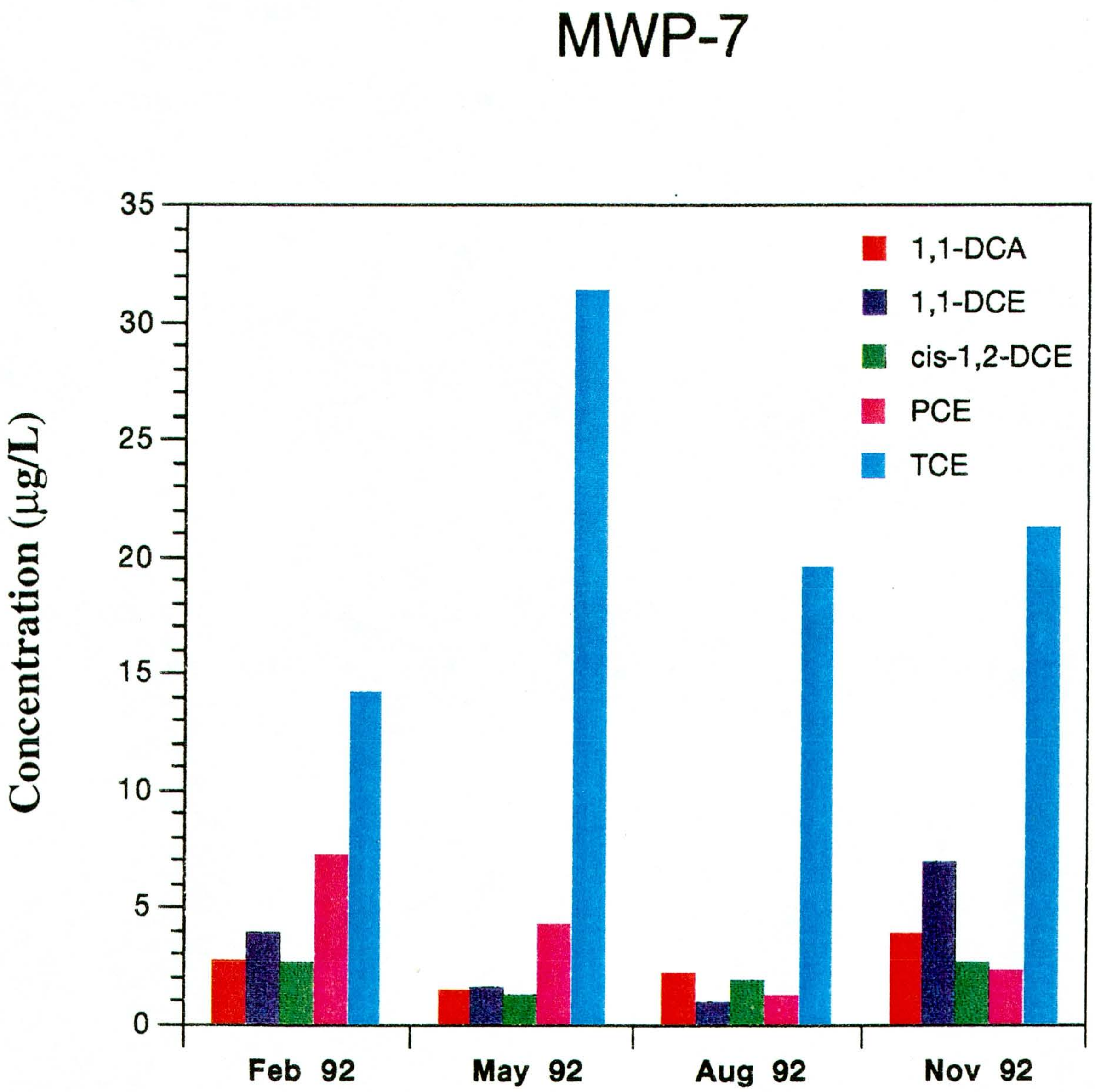
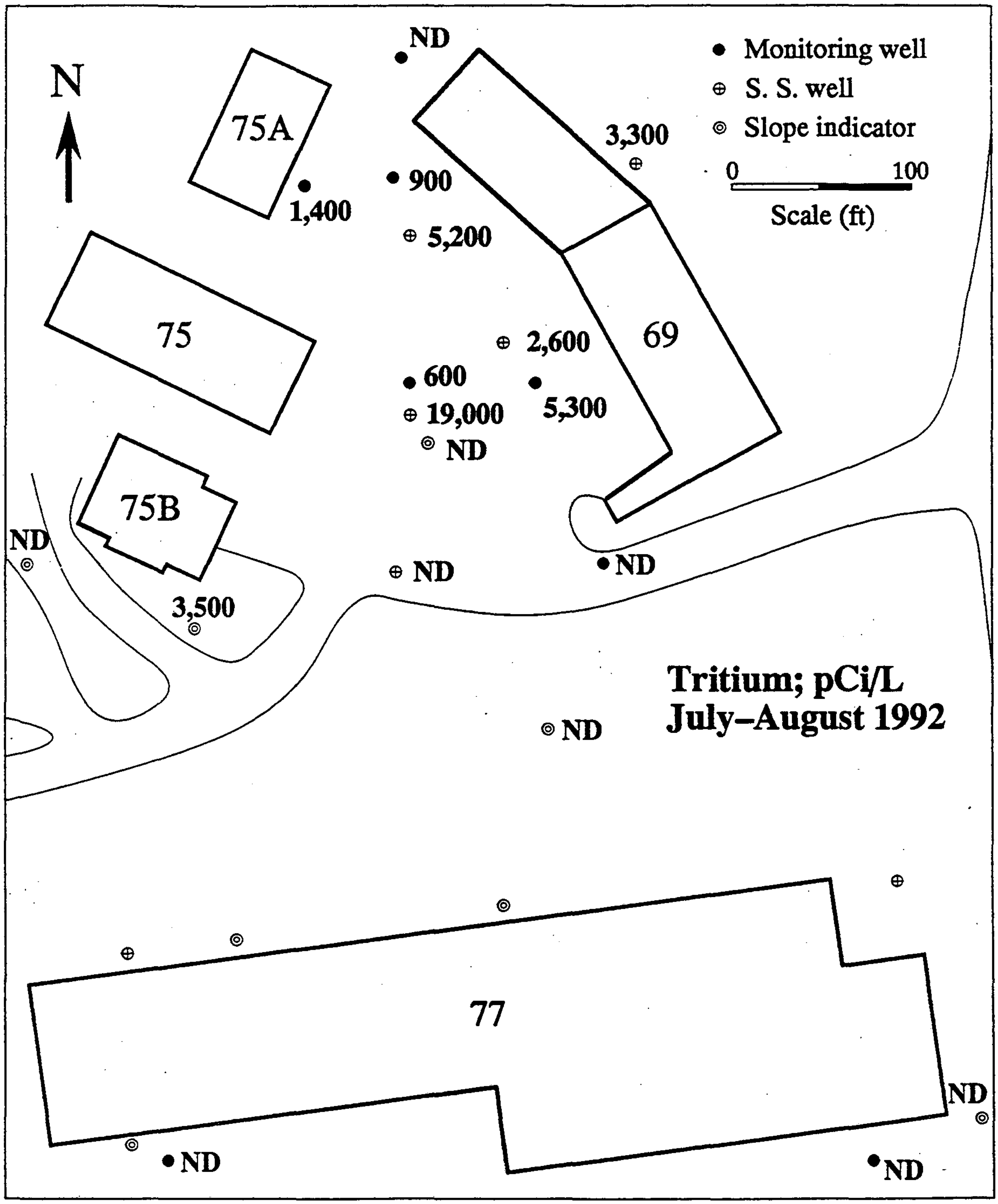
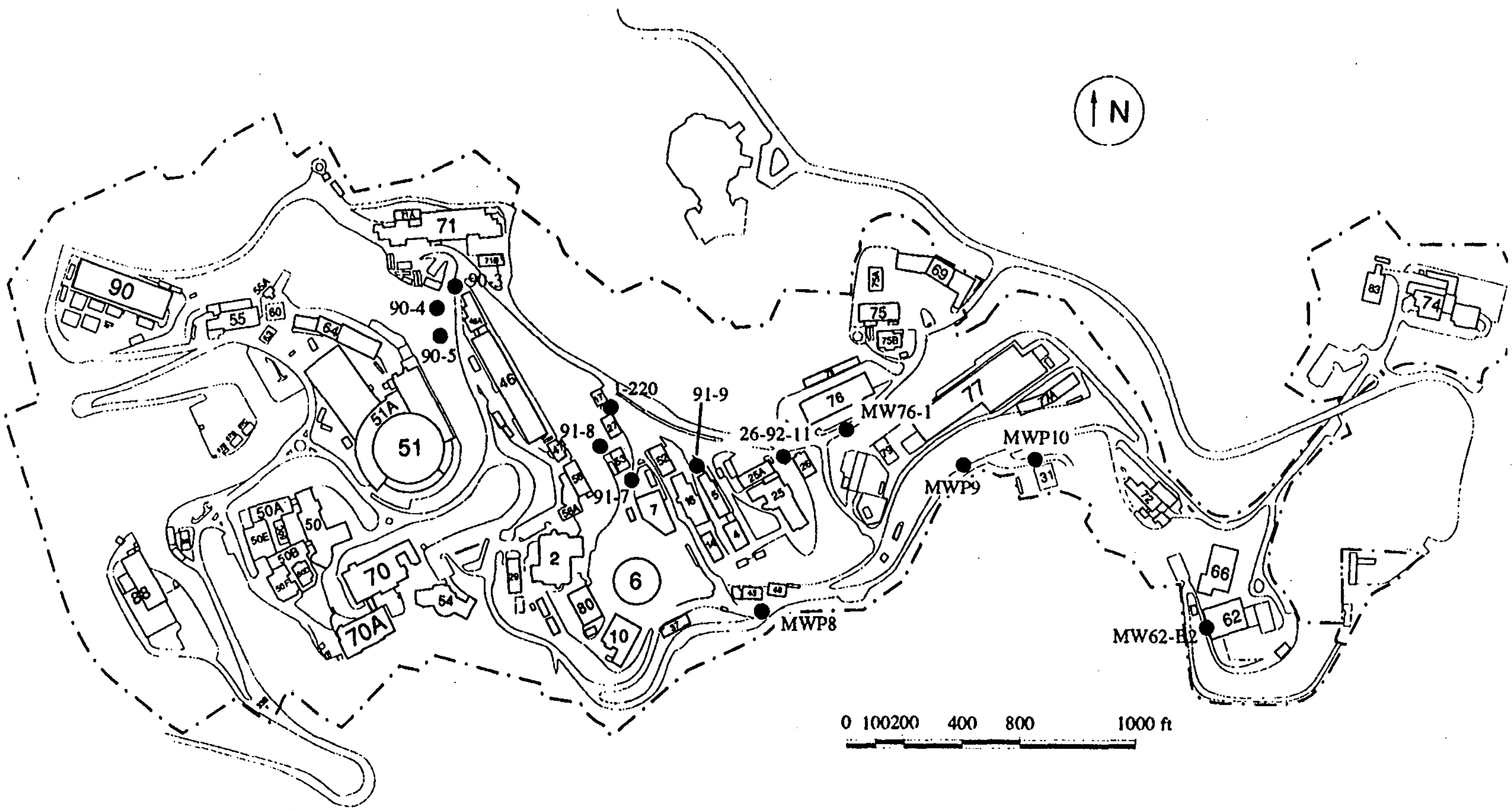



Figure 6-14. Time variation of contaminants in well MWP-7.




ESD-9108-0145

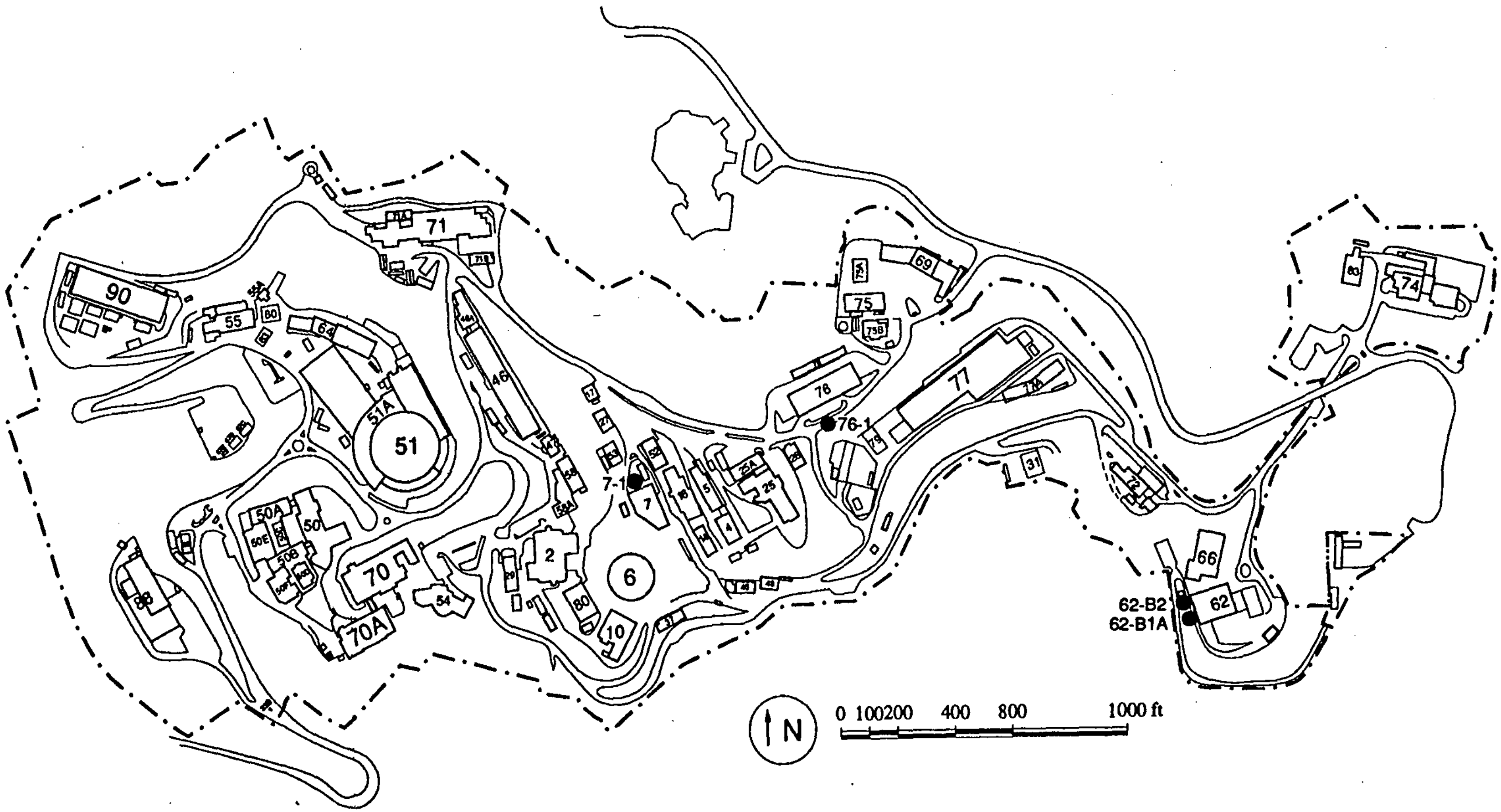
Figure 6-15. Tritium concentration measured in water samples from wells in the Corporation Yard.




Locations of wells sampled for tritium in April 1992.
No tritium was detected in any of these wells.

ESD-9107-0126b

**Figure 6-16. Location of wells sampled for tritium in April 1992.**




ESD-9107-0127A

Figure 6-17. Location of monitoring wells downgradient from present and decommissioned underground storage tanks.

**Table 6-1.** 1992 Hydrauger Quarterly Sampling Summary for Tritium.

| | Concentrations in pCi/L | | | |
|---|---|---|---|---|
| Location | Quarter 1 | Quarter 2 | Quarter 3 | Quarter 4 |
| 77-01-02 | NS | 15,300 ± 300 | 22,000 ± 2000 | 32,700 ± 2000 |
| 77-02-05 | NS | 5000 ± 1000 | NS | 6900 ± 500 |
| 77-02-07 | NS | <700 | NS | <200 |
| 77-02-11 | NS | <700 | NS | NS |
| 77-03-01 | NS | <700 | NS | <200 |
| 77-04-04 | NS | <700 | NS | 650 ± 100 |
| 77-04-06 | NS | <700 | NS | 740 ± 100 |
| 77-04-07 | NS | <700 | NS | 830 ± 100 |
| 77-04-08 | NS | <700 | NS | 900 ± 200 |
| 77-05-01 | NS | <700 | NS | 700 ± 100 |

NS: Not sampled

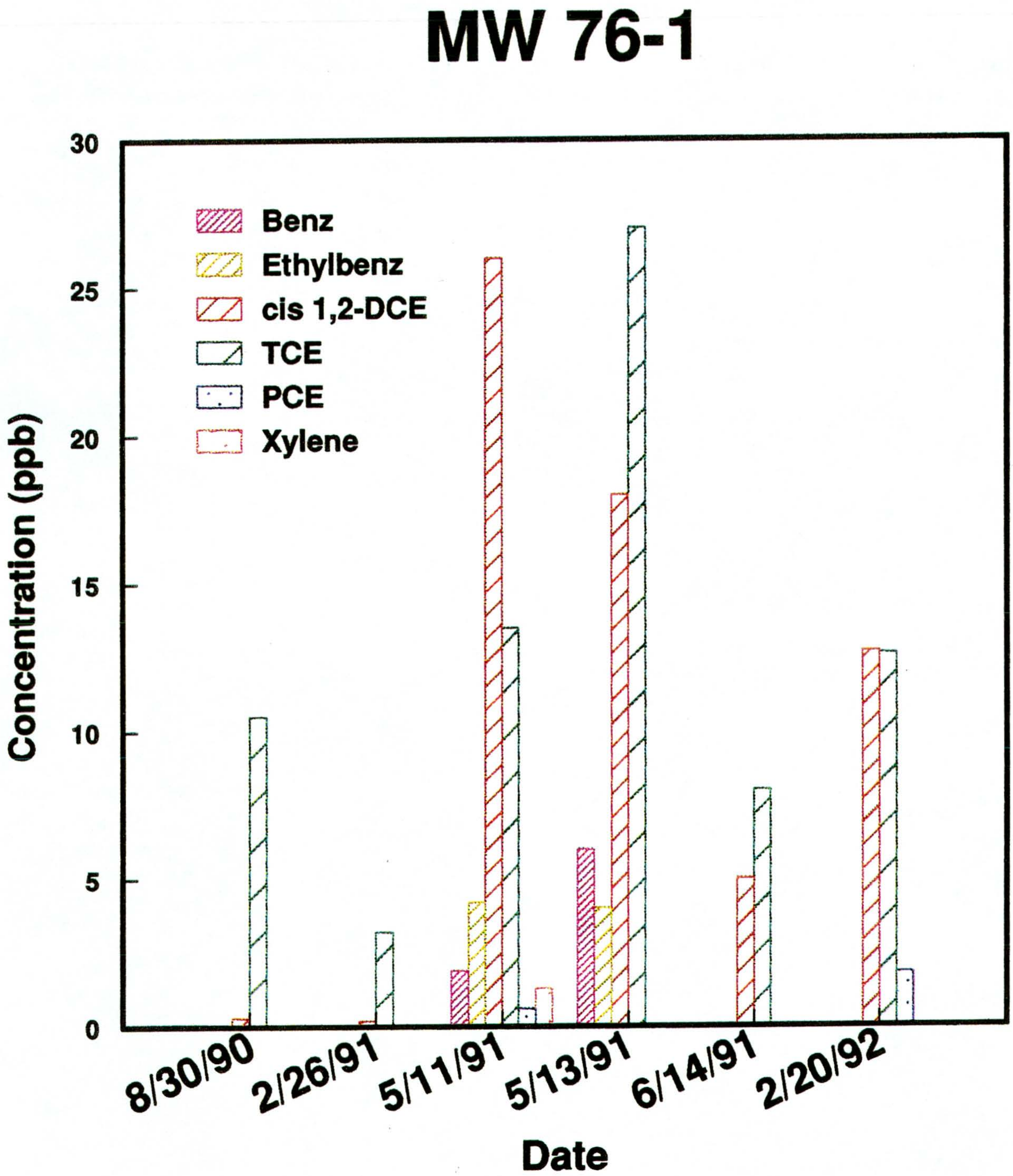



Figure 6-18. Time variation of contaminants in well MW76-1.

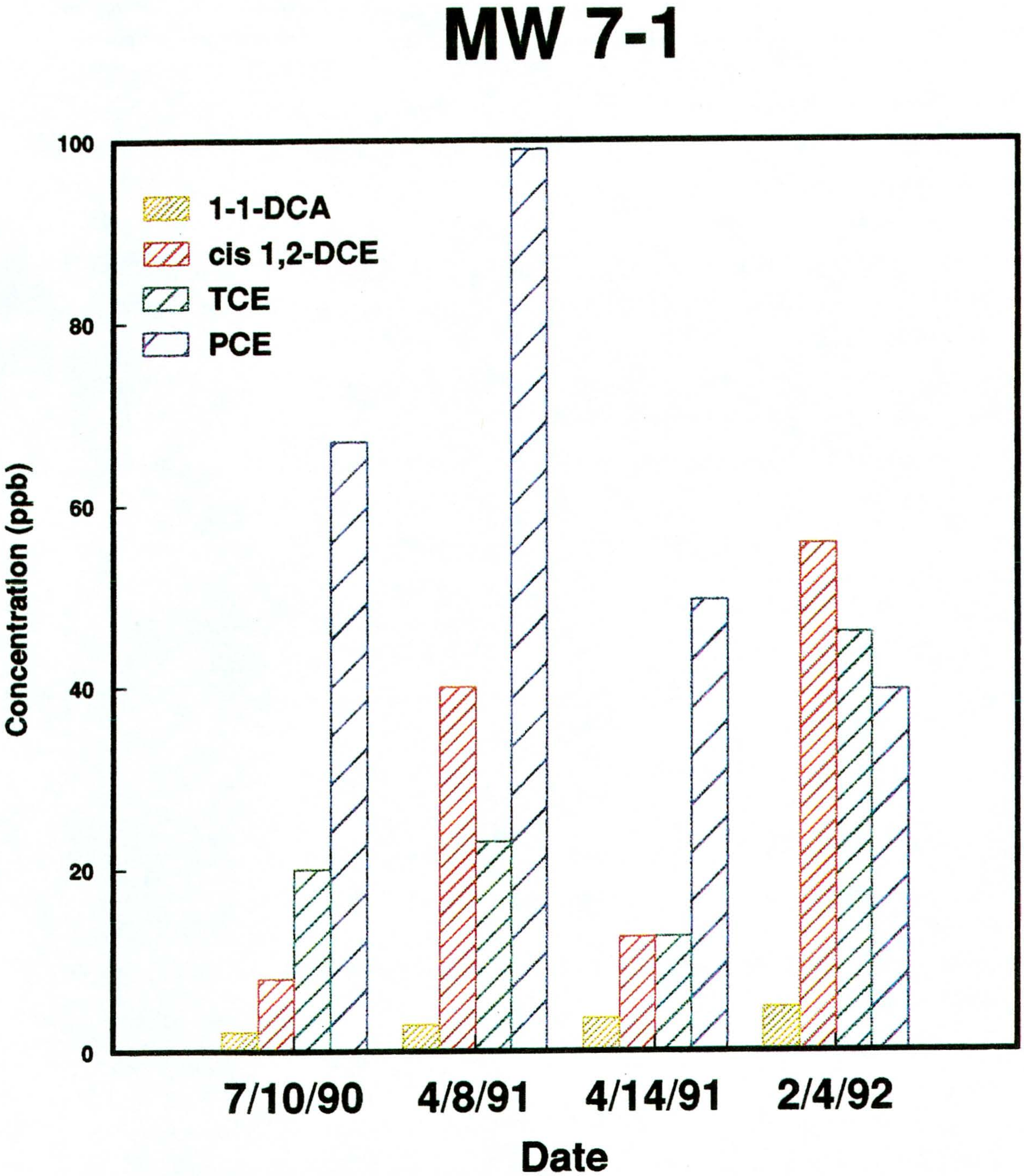
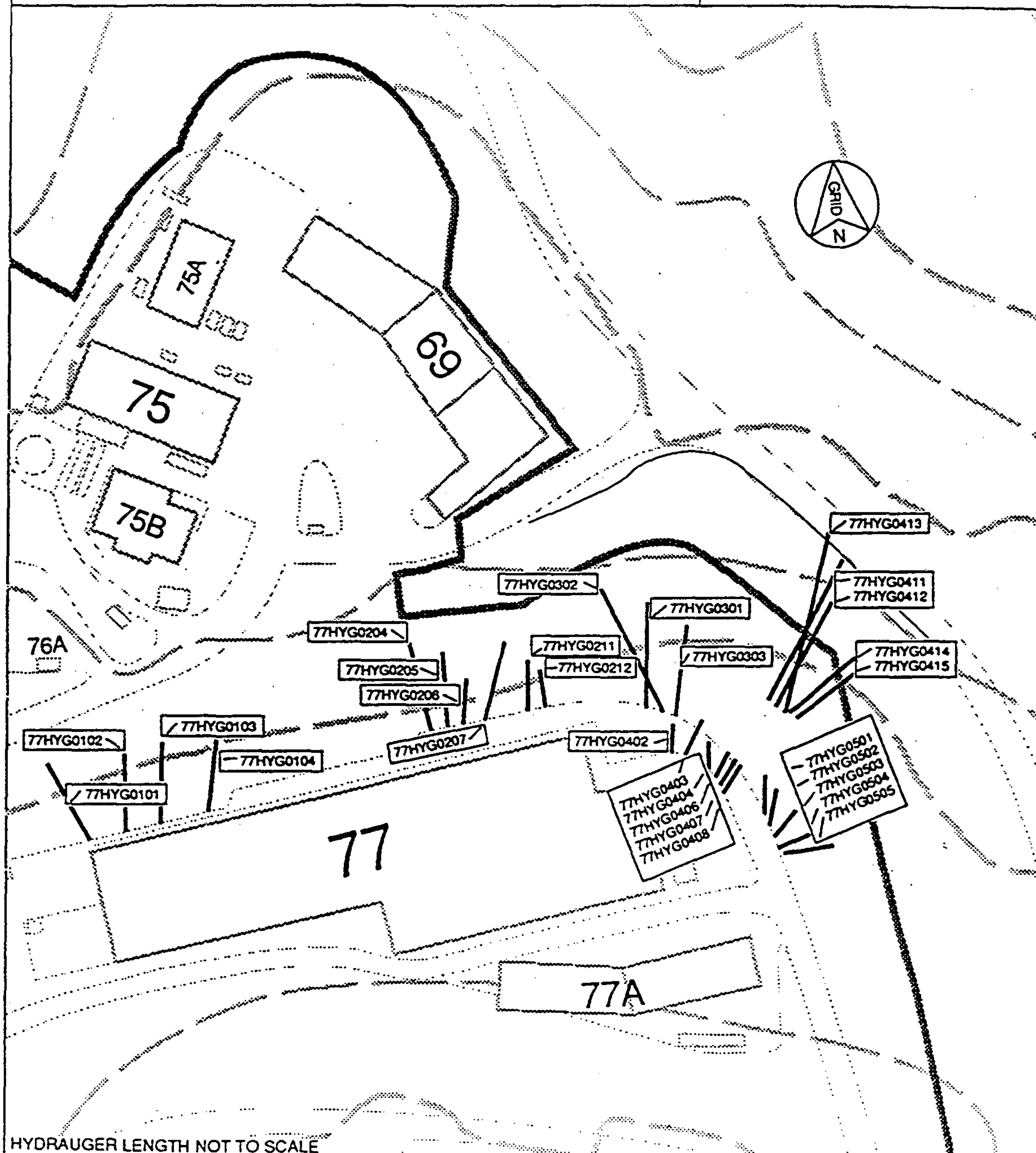



Figure 6-19. Time variation of contaminants in well MW7-1.

| HYDRAUGER SYSTEM - LBL | SHEET 6 OF 7 |
|---|---|




4/26/90 **Figure 6-20** DETAIL OF HYDRAUGERS NEAR BLDG 77

**Table 6-2.** Summary of Groundwater Samples taken by Environmental Protection Group, 1992.

| | | Concentration ($10^{-9}$ µCi/ml) | | | | | | Concentration ($10^{3}$ pCi/l) | | | Average as % of drinking-water standard | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Alpha | | | Beta | | | Tritium as HTO[a] | | | Alpha | Beta | Tritium |
| Hydrauger Designation | No. of Samples | Avg. | Min. | Max. | Avg. | Min. | Max. | Avg. | Min. | Max. | % | % | % |
| CC Hydr. | 10 | ≤ 2 | ≤ 2 | ≤ 6 | 0.5 ± 0.2 | ≤ 0.4 | 1.7 ± 0.6 | ≤ 0.2 | ≤ 0.7 | 4 ± 2 | ≤ 40 | ≤ 5 | ≤ 1 |
| CC-B Hydr. | 10 | ≤ 3 | ≤ 5 | ≤ 7 | 1.8 ± 0.3 | ≤ 0.4 | 1.5 ± 0.8 | ≤ 0.2 | ≤ 0.7 | 3 ± 2 | ≤ 60 | ≤ 5 | ≤ 1 |
| 71 Hydr. | 10 | ≤ 0.1 | ≤ 2 | ≤ 4 | 0.6 ± 0.2 | 0.6 ± 0.5 | 1.1 ± 0.5 | ≤ 0.2 | ≤ 0.7 | 2 ± 1 | ≤ 20 | 8 | ≤ 1 |
| 75–77 Hydr. | 10 | ≤ 3 | ≤ 3 | ≤ 10 | 1.8 ± 0.3 | 0.7 ± 0.5 | 5 ± 1 | 2 ± 0.6 | ≤ 0.7 | 5 ± 1 | ≤ 60 | 9 | 10 |
| 77 12H Hydr. | 5 | ≤ 3 | ≤ 4 | ≤ 12 | 2.3 ± 0.5 | 5 ± 1 | 5 ± 2 | 22 ± 3 | 15 ± 3 | 42 ± 7 | ≤ 60 | ≤ 12 | 110[d] |
| Drinking-water standard[b] | | 5 | | | 8 | | | 20 | | | | | |

[a]12 tritium samples were taken at each location.
[b]40 CFR 141, beta assumed to be $^{90}$Sr.

[c]During 1990 the Department of Energy officially adopted the Environmental Protection Agency's (EPA) values for community drinking-water standards. The EPA Standard for tritium in drinking water is $20 \times 10^{-6}$ µCi/ml. Thus, the average tritum concentration in hydrauger 77 12H exceeded the EPA limit. The hydrauger does not deliver water to or from any community drinking water supply.

# Section 7
# Quality Assurance

Quality Assurance at LBL is conducted through the implementation of PUB-3111, Operating and Assurance Program (OAP), dated February 3, 1993. 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 EPA guidance on quality assurance (ANSI/ASQC E-4) was used in its creation.

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

The Function Notebook for environmental Protection includes provisions for documentation of items such as design of sampling events, data acquisition and analysis, data identification/use in reports, control of samples, control of measuring and test equipment, inspection and testing, procurement of vendor services or products, and computer software control. Other nonwork-process related but important items are included, such as organizational functions and responsibilities, personnel training and qualification, document control, records management, and assessment.

The Radioanalytical Laboratory continued its participation in the USFPA Intercomparison Studies Program. During 1992 the Laboratory received 10 samples and analyzed them for seven analytes. All the Lab analyses passed. A summary of the analytical report is presented in Table 7-1.

The Radioanalytical laboratory also analyzed DOE's Environmental Measurements Laboratory (EML) QAP XXXVII and QAP XXXVI air, water, and soil samples for a number of gamma-emitting radionuclides (Sanderson and Scarpita, 1992; Sanderson and Klusek, 1993). The results are presented in Table 7-2.

The Radioanalytical Laboratory processes approximately 10% blind spiked samples with all its analyses. Its counting equipment is calibrated on a regular schedule.

All nonradiological analyses are performed by State-Certified analytical laboratories. Sample containers and preservatives are provided by those laboratories. Sample collection, preservation, and chain-of-custody activities were performed according to procedures developed in 1992 for LBL.

The Site Restoration analytical laboratory received State certification for performing EPA 6101 and EPA 8260 analyses. This laboratory participates in the EPA WP performance program. Several sample unknowns were sent to the laboratory in 1992. All samples passed.

The Environmental Monitoring Plan was completed and accepted by DOE. This plan lays an important foundation stone for current and future field operations. All penetrating-radiation monitors were calibrated with National Institutes of Standards and Technology (NIST)–traceable radioactive standards.

**Table 7-1.** Summary of Performance in EPA Intercomparison Study Samples, 1992.

| Date Received | Analysis | Media | LBL Results (pCi/L) | | | Mean | EPA Value (pCi/L) | Passed |
|---|---|---|---|---|---|---|---|---|
| 1/17/92 | $^{89}Si$ | Water | 49 | 50 | 51 | 50 | 51 ± 5 | Yes |
| | $^{90}Sr$ | Water | 20 | 20 | 19 | 19.67 | 2 ± 5 | Yes |
| 2/21/92 | $^{3}H$ | Water | 7201 | 6900 | 6900 | 7000 | 7904 ± 790 | Yes |
| 4/31/92 | Gross α | Water | 28 | 27 | 25 | 26.67 | 30 ± 8 | Yes |
| | Gross β | Water | 36 | 35 | 33 | 34.67 | 30 ± 5 | Yes |
| 5/15/92 | Gross α | Water | 15 | 16 | 12 | 14 | 15 ± 5 | Yes |
| | Gross β | Water | Not submitted | | | | | |
| 6/19/92 | $^{3}H$ | Water | 1780 | 1810 | 1846 | 1812 | 2125 ± 347 | Yes |
| 8/28/92 | Gross α | Filter | 28 | 28 | 33 | 29 | 30 ± 8 | Yes |
| | Gross β | Filter | 72 | 74 | 68 | 71 | 69 ± 10 | Yes |
| | $^{90}Sr$ | Filter | 25 | 25 | 25 | 25 | 25 ± 5 | Yes |
| | $^{137}Cs$ | Filter | 21 | 21 | 21 | 21 | 18 ± 5 | Yes |
| 9/11/92 | $^{89}Si$ | Water | 26 | 27 | 28 | 27 | 20 ± 5 | Yes |
| | $^{90}Sr$ | Water | 14 | 15 | 13 | 14 | 15 ± 5 | Yes |
| 10/20/92 | Gross α | Water | 39 | 41 | 40 | 40 | 41 ± 17[a] | Yes |
| | Gross β | Water | 44 | 45 | 47 | 45 | 53 ± 10 | Yes |
| | $^{60}Co$ | Water | 17 | 17 | 17 | 17 | 15 ± 5 | Yes |
| | $^{89}Si$ | Water | 9 | 9 | 8 | 9 | 8 ± 5 | Yes |
| | $^{90}Sr$ | Water | 9 | 9 | 8 | 9 | 10 ± 5 | Yes |
| | $^{134}Cs$ | Water | 5 | 6 | 5 | 5 | 5 ± 5 | Yes |
| | $^{137}Cs$ | Water | 10 | 9 | 11 | 10 | 8 ± 5 | Yes |
| 10/23/92 | $^{3}H$ | Water | 4890 | 5090 | 4980 | 4986 | 5962 596<br>6996 4928[a] | Yes |

[a]Control limits (wider than expected for "EPA value" for gross alpha).

**Table 7-2.** LBL QAP Sample Results, 1992.

| QAP Sample # | Date | Medium | Nuclide | Reported LBL Results (± percent) | EML Value | Ratio LBL/EML |
|---|---|---|---|---|---|---|
| XXXVI | 3/1/92 | Air | $^{7}Be$ | 31 ± 3 | 28.6 | 1.08 |
| | | Air | $^{54}Mn$ | 6 ± 1 | 5.9 | 1.01 |
| | | Air | $^{57}Co$ | 7 ± 1 | 7.9 | 0.88 |
| | | Air | $^{60}Co$ | 6 ± 1 | 5.8 | 1.03 |
| | | Air | $^{90}Sr$ | 0.8 ± 0.2 | 0.207 | 3.86 |
| | | Air | $^{134}Cs$ | 4 ± 1 | 4.44 | 0.90 |
| | | Air | $^{137}Cs$ | 6 ± 1 | 5.76 | 1.04 |
| | | Air | $^{144}Ce$ | 66 ± 6 | 63.9 | 1.03 |
| | | Water | $^{3}H$ | 238 ± 50 | 227 | 1.05 |
| | | Water | $^{54}Mn$ | 46 ± 10 | 56.6 | 0.81 |
| | | Water | $^{60}Co$ | 79 ± 15 | 94.0 | 0.84 |
| | | Water | $^{90}Sr$ | 2 ± 1 | 2.13 | 0.94 |
| | | Water | $^{134}Cs$ | 57 ± 4 | 71.8 | 0.79 |
| | | Water | $^{137}Cs$ | 71 ± 15 | 84.6 | 0.84 |
| | | Water | $^{144}Ce$ | 130 ± 26 | 189 | 0.69 |
| | | Water | $^{238}U$ | 0.46 ± 0.07 | 0.423 | 1.09 |
| | | Soil | $^{137}Cs$ | 1.8 ± 0.2 | 5.2 | 0.34 |
| | | Soil | $^{40}K$ | 303 ± 24 | 719 | 0.42 |
| XXXVII | 9/1/92 | Air | $^{7}Be$ | 324 ± 22 | 308 | 1.05 |
| | | Air | $^{57}Co$ | 5.4 ± 0.2 | 6.4 | 0.84 |
| | | Air | $^{60}Co$ | 3.5 ± 0.5 | 3.1 | 1.13 |
| | | Air | $^{90}Sr$ | 0.16 ± 0.04 | 0.137 | 1.14 |
| | | Air | $^{134}Cs$ | 3.6 ± 0.4 | 3.7 | 0.97 |
| | | Air | $^{137}Cs$ | 6.2 ± 0.5 | 5.8 | 1.07 |
| | | Air | $^{144}Ce$ | 34 ± 1 | 43 | 0.79 |
| | | Water | $^{54}Mn$ | 35 ± 2 | 33 | 1.06 |
| | | Water | $^{60}Co$ | 29 ± 3 | 27 | 1.07 |
| | | Water | $^{90}Sr$ | 1.9 ± 0.2 | 2.2 | 0.86 |
| | | Water | $^{134}Cs$ | 49 ± 4 | 44 | 1.11 |
| | | Water | $^{137}Cs$ | 34 ± 3 | 29 | 1.17 |
| | | Water | $^{144}Ce$ | 54 ± 3 | 51 | 1.06 |
| | | Soil | $^{90}Sr$ | 12 ± 2 | 9.57 | 1.25 |
| | | Soil | $^{137}Cs$ | 100 ± 8 | 285 | 0.35 |

# Section 8
# References


Dakin, H.S. and Stephens, L.D., *Environmental Radiation Telemetry System*, Lawrence Radiation Laboratory Report UCRL-16482 (1967).

Dobkin, M.M., and Corbett, M., *Final Historic Architectural Evaluation of Building #7, Lawrence Berkeley Laboratory*, University of California, Berkeley, 1992.

Javandel, I., *Preliminary Environmental Investigations at the Lawrence Berkeley Laboratory*, Lawrence Berkeley Laboratory Report LBL-29898, 1990.

Keck, J.A. et al., *Assessment of $^{18}F$ Gaseous Releases During the Production of $^{18}F$-Fluorodeoxyglucose*, Health Phys. **60**, 657 (1991).

National Council on Radiation Protection and Measurements, *Exposure of the Populations in the United States and Canada from Natural Background Radiation*, 1987.

SAIC, Communication of M. Rugierri to R. Pauer, *LBL Accelerator Airborne Effluent Release Estimates*, June 28, 1991.

Patterson, H.W., and Thomas, R.H., "Accelerator Health Physics," Academic Press, New York, NY, 1973.

Sanderson, C.G., and Scarpita, S.C., *Semi-Annual Report, Department of Energy, Office of Environmental Restoration and Waste Management, Quality Assessment Program*, Environmental Measurements Laboratory EML-546, July 1, 1992.

Sanderson, C.G., and Klusek, C.S., *Semi-Annual Report, Department of Energy, Office of Environmental Restoration and Waste Management, Quality Assessment Program*, Environmental Measurements Laboratory EML-551, January 4, 1993.

Thomas, R.H. (ed.), The Environmental Surveillance Program of the Lawrence Berkeley Laboratory, Lawrence Berkeley Laboratory Report LBL-4678 (1976).

U.S. Department of Commerce, Bureau of the Census, *Characteristics of the Population: Number of Inhabitants—California 1980*, PC 80 1 AC (March 1982).

U.S. Department of Energy, *General Environmental Protection Program,* DOE 5400.1, Attachment II (1988 and 1990).

U.S. Department of Energy, *Requirements for Radiation Protection*, DOE 5400.5, Chapter III, "Concentration Guides for the Protection of the Public."

University of California Systemwide News, UC Headcount Environments (October 31, 1983).

Vimont, John, private communication (March 1988).

# Appendix A
# U.S. Department of Energy
# Radionuclide Air Emission Annual Report
# (Subpart H, 40 CFR 61.94)
# Calendar Year 1992

**U.S. Department of Energy**
**Radionuclide Air Emission Annual Report**
**(Subpart H, 40 CFR 61.94)**
**Calendar Year 1992**

Site Name: Lawrence Berkeley Laboratory

Operations Office Information

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

Site Information

| | | | |
|---|---|---|---|
| Operator: | Lawrence Berkeley Laboratory | | |
| Address: | 1 Cyclotron Road | | |
| | Berkeley, CA 94720 | | |
| Contractor Contact: | Gary Schleimer | Phone: | (510) 486-7623 |
| 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 research that is appropriate for an energy research laboratory. 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)

LBL facilities also include:

- The 88-inch Cyclotron (Building 88)
- The Bevatron (Building 51)[1]
- The HILAC (Building 71)[2]
- 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

Figure 1 illustrates the LBL site, Table 1 identifies the buildings and Figure 2, a map of the San Francisco Bay area, identifies the location of LBL Building 934. A fourth accelerator, the "Advanced Light Source" (Building 6) began limited operations in 1992 and is expected to be fully operational in 1993.

Radiochemical and radiobiological studies performed in many laboratories at LBL typically use millicurie quantities of a great variety of radionuclides. (One millicurie is equal to $3.7 \times 10^7$ Bq)

[1] the Bevatron ceased operations in February 1993
[2] The HILAC ceased operations on December 23, 1992


Figure 1. Lawrence Berkeley Laboratory buildings.

| Bldg. No. | Description |
|---|---|
| | **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 (NTF) |
| 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 |

6/8/93

Table 1. Key to LBL Buildings Shown in Figure 1

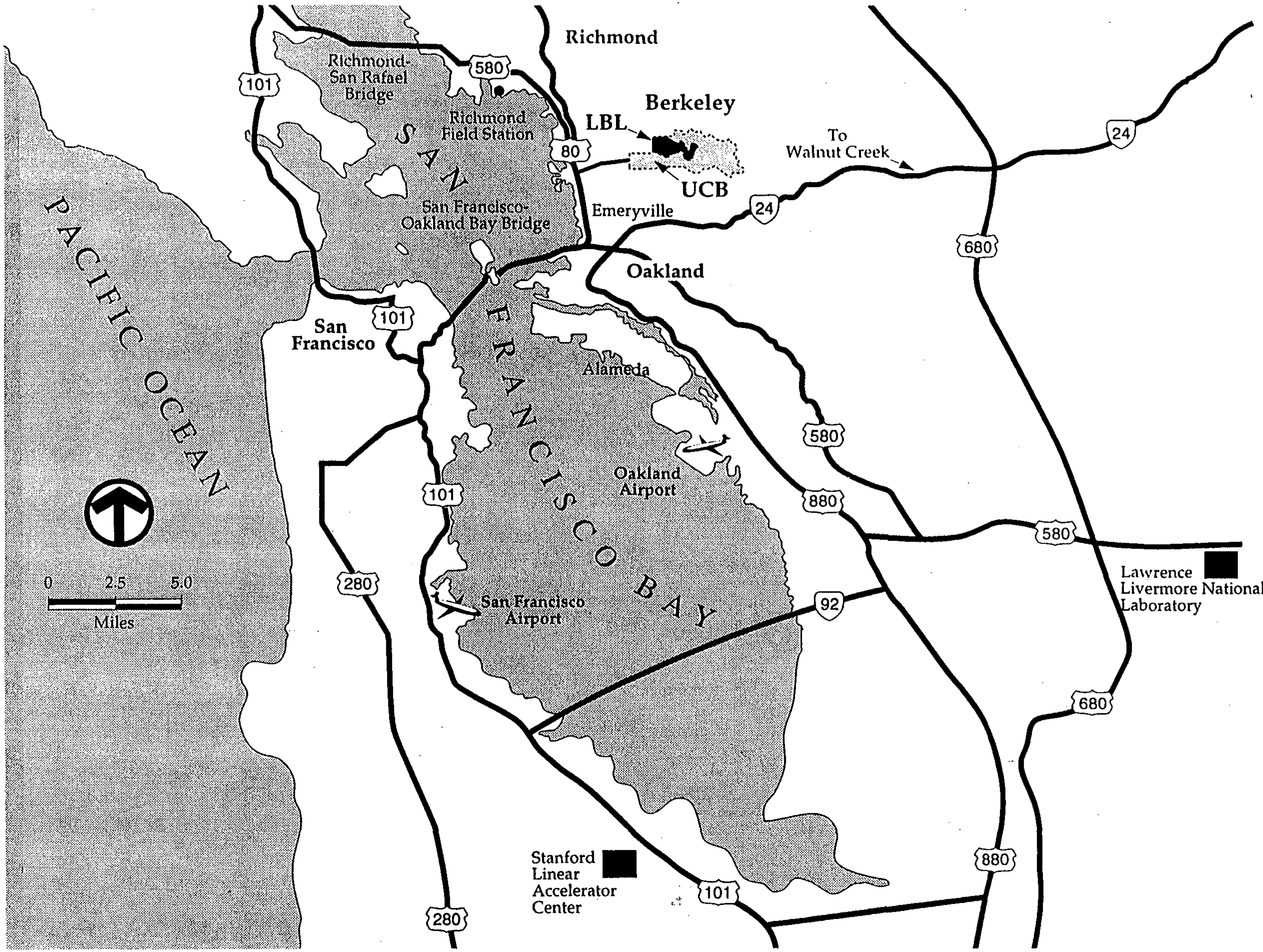



Figure 2. San Francisco Bay Area Map

*The Site*

LBL is situated upon a hillside above the main campus of UC. The 130-acre site is located on the west-facing slope of the Berkeley Hills, at elevations ranging from 150 to 330 meters above sea level within the Cities of Berkeley and Oakland. It is located three miles east of San Francisco Bay and about fifteen miles east of the City of San Francisco (Fig. 2).

LBL is located in an urban environment on land owned by UC. The LBL site is bordered on the north by predominantly single-family homes and on the west by 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 located on 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 and the Melvin Calvin Laboratory. 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. (See Figure 2 for the location of LBL Building 934.)

The Laboratory's population is approximately 4,000, including about 600 visiting scientists and engineers. About 3,200 are located on site, 500 are located in campus buildings, and about 100 are in off-site leased space.

*The Climate*

The climate of the LBL site is greatly influenced by its nearness 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. About 95% of the rainfall occurs from October through April, and intensities are seldom greater

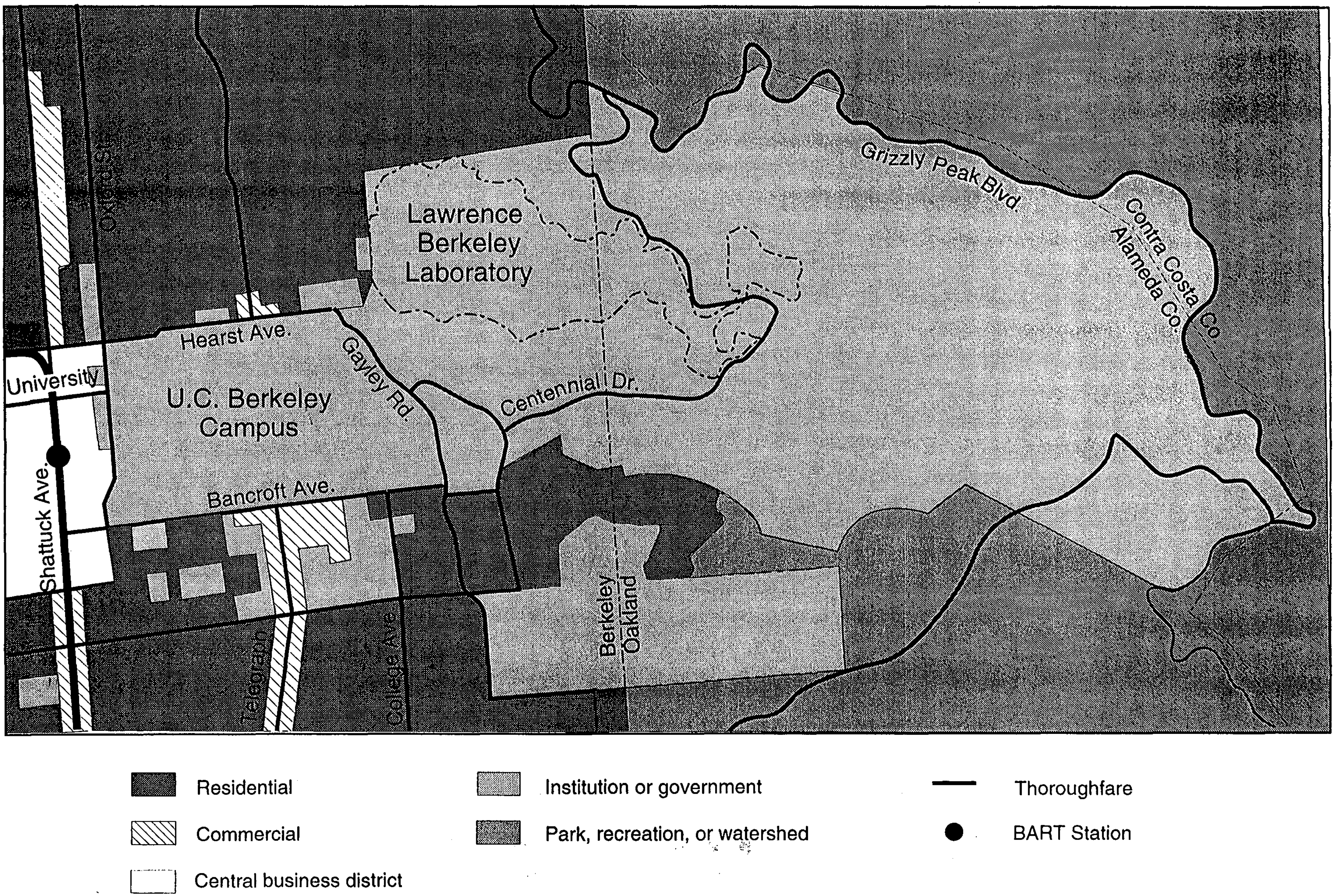



Figure 3. Land Use Map

than 1.3 cm/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.

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. 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). LBL is in compliance with the exposure standard of 10 mrem to a maximally exposed offsite individual. The laboratory is not in compliance with the monitoring requirements of the regulation and is negotiating a Federal Facilities Compliance Agreement (FFCA) with Region IX of the EPA. During 1991 LBL identified all actual and potential sources of dispersible radionuclides, evaluated all release point discharges, and proposed monitoring methods for each stack or vent. During 1992 LBL separated the monitoring upgrades into 3 projects, obtained funding, completed preliminary designs for the proposed monitoring systems and prepared bid documents for Project 1 (Project 1 included stacks subject to periodic confirmatory monitoring).

Source Description:

LBL employs a wide variety of radionuclides in its research program, including: $^{3}H$, $^{14}C$, $^{18}F$,$^{32,33}P$, $^{35}S$, $^{22}Na$, $^{45}Ca$, $^{51}Cr$, $^{55,59}Fe$, $^{57,60}Co$, $^{68}Ge/Ga$, $^{54}Mn$, $^{82,85,90}Sr$, $^{86}Rb$, $^{95}Nb/Zr$, $^{99}Mo$, $^{99M}Tc$, $^{111}In$, $^{125}I$, $^{207}Bi$, $^{226}Ra$, $^{227}Ac/Th$, $^{231,233}Pa$, $^{235,238}U$, DEP-U, $^{237}Np$, $^{238,239,242}Pu$, $^{241,243}Am$, $^{244,246,248}Cm$, $^{249}Bk$, $^{249,252}Cf$, and $^{254}Es$.

Of the foregoing, the most commonly and widely used nuclides are: $^{3}H$, $^{14}C$, $^{32}P$, $^{35}S$, and $^{125}I$.

LBL carries on operations which have the potential to emit radionuclides into the atmosphere in 18 laboratory buildings. All of LBL's sources which were operational during 1992 are "small sources;" i.e., the effective dose equivalent (EDE) from each source is < 0.1 mrem (< $10^{-6}$ Sv), and no collection of sources imposed an EDE of greater than 0.1 mrem ($10^{-6}$ Sv) to an offsite individual in 1992 (see Attachment II for a tabular listing of LBL stacks). LBL has identified 6 release points subject to the continuous monitoring requirement of Section 61.93, but only 1 of the sources was operating during 1992 and the source impact was 0.02 mrem (Building 75 Tritium Stack).

- At present, discharge points with the most significant potential for routine or accidental release are continuously sampled. The categorical exception to the foregoing are the air activation product discharges from accelerators, which are not monitored. The 1992 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 iEDE mpacts of < 0.005 mrem (< 5 x $10^{-8}$ Sv) are, in general, <u>not</u> sampled continuously. The program LBL proposed to Region IX formalizes the foregoing process and includes a graded strategy for performing the "periodic confirmatory monitoring" called for in Section 61.93 (b)(4)(i) of the NESHAP Act.

Activities with low potential impact (EDE < 0.01 mrem (< $10^{-7}$ Sv) 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.

In addition to being small sources, 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:

1. The sum of the EDEs attributable to all stacks in the group must be < 0.1 mrem (< $10^{-6}$ Sv).
2. Sources must be in close proximity (same or nearby building), and/or similar operations with similar nuclides are carried out in the facilities.
3. Sources grouped in the description section may not be grouped in the dose assessment section if the critical receptors are not the same (see Attachment II).

**Building 75** houses LBL's National Tritium Labeling Facility (NTLF), in which a wide variety of molecules are labeled with tritium and purified for further use in chemical, biochemical, and radiopharmaceutical 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) or tritiated water (HTO). Only HTO releases are quantified. HT releases are not because HT impacts are 1/25,000 of those of comparable releases of HTO. More than 90% of the 87 Ci (3.2 x $10^{12}$ Bq) of HTO released during 1992 operations was released from the stack located up the northern hillside from Bldg. 75. The aforementioned stack is the closest discharge point to offsite individuals. The other discharge point from the NTLF, located on the roof of Building 75, is further from offsite individuals and released less than 10% of the 1992 discharges. The EDE to a maximally exposed individual from the two stacks was 0.02 mrem (2 x $10^{-7}$ Sv).

The LBL radiological waste handling facility, is located in Buildings 75 and 75A. Bags of radioactive waste stored in a ventilated cabinet in Building 75A outgassed 60 µCi (2.2 x $10^{6}$ Bq) of $^{125}$I. The EDE from the waste cabinet bag discharges was 8 x $10^{-5}$ mrem (8 x $10^{-10}$ Sv). Building 75A is a diffuse source of HTO, as HTO waste is processed and stored in the building.

**Building 88** contains 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 air activation radionuclides produced in the cyclotron vault during the fraction of the beam year when intense light ions are accelerated (approximately 17% of the time during 1992). There is presently no active stack monitor on this source. Releases were estimated as described previously in this report. The 1992 releases were estimated at 17% of the theoretical maximum. As there is no practical mechanism to do so, there are no controls on the release of air activation products. The quantity of activation products is controlled by the fraction of the beam year spent running light ions, and limits on circulating beam current. For 1992, the EDE from the 88 inch cyclotron discharges was modeled at 0.02 mrem (2 x $10^{-7}$ Sv).

**Buildings 71 and 51**, "the Bevalac." These two buildings house a large linear accelerator (71) and a heavy ion synchrotron (51). The machines are used to accelerate ions from helium to uranium in order to carry on nuclear studies and radiotherapy. Releases from these machines are air activation products produced by beam loss. Air activation product releases for 1992 from the Bevatron were estimated at 66% of the theoretical maximum as the machine only ran for 2/3 of the time. Venting is diffuse (from building ventilators along the buildings' roof lines). The EDE to an offsite individual from Bevalac airborne releases is estimated at 0.04 mrem (4 x $10^{-7}$ Sv) for 1992. The EDE from Building 71 airborne releases is estimated at 3 x $10^{-6}$ mrem (3 x $10^{-11}$ Sv). There are no emission controls on these sources.

**Building 6** contains the "Advanced Light Source" (ALS). The ALS is a new LBL accelerator which, when fully operational, will provide intense "light" beams for surface science studies. The ALS is a "small source" which is modeled to produce an offsite EDE of $4 \times 10^{-4}$ mrem, from air activation products produced primarily by the accelerator's injector operations. The accelerator was not fully operational in 1992 so the EDE was $< 4 \times 10^{-4}$ mrem ($< 4 \times 10^{-9}$ Sv).

**Buildings 70 and 70A** are nuclear science and chemical science facilities . Programs carried out in the 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 work is carried out by five research groups in 14 of the many laboratories in 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 too small to require sampling. The modeled EDE from the two facilities is less than $10^{-5}$ mrem ($10^{-10}$ Sv). There is also a pit storage room where radionuclides are stored in a fireproof pit in closed containers. Aside from the release of 1 mCi of $^{14}C$ as $CO_2$ from the pit storage room, releases from the facility were below the detection limit which is $< 1 \times 10^{-6}$ Ci ($< 3.7 \times 10^{4}$ Bq) of alpha activity from all 19 stacks. The EDE from such releases would be $< 0.004$ mrem ($< 4 \times 10^{-8}$ Sv).

**Buildings 1 and 3, "Donner Laboratory" and "Calvin Laboratory."** Cell and molecular biology studies are performed in both facilities. The buildings are located on the University of California campus. The predominant nuclides used are $^{3}H$, $^{32}P$, $^{35}S$, and $^{14}C$ as labeled amino acids and DNA precursors. $^{14}CO_2$ is also used in Building 3 as an "incubant." Building 1 has non-LBL employees who work in the building, but Building 3 is wholly occupied by LBL personnel. Work is done on benchtops and in hoods in both buildings. Releases are from building vents and hoods (11 stacks in Building 1 and five in Building 3). Five Stacks in Building 1 and four in Building 3 are sampled. The respective EDEs from Buildings 1 and 3 are 0.0009 mrem ($9 \times 10^{-9}$ Sv) and 0.003 mrem ($3 \times 10^{-8}$ Sv) for 1992.

**Building 2** One semiconductor research group uses germanium which contains nCi quantities (a nanocurie is 37 Bq) of activation impurities. The modeled releases of radioactivity predict an EDE of $< 2 \times 10^{-11}$ mrem ($< 2 \times 10^{-16}$ Sv).

**Buildings 74, 74B, and 83** 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 for administration to patients in Building 55. (Releases of $^{18}F$ occur during the synthesis of the compound, not when it is administered.) Building 83 vents are through HEPA-filtered biological cabinets. In laboratories where >10 mCi/yr. of $^{125}I$ is used, the material is worked up 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. The EDE from this group of stacks was 0.0008 mrem ($8 \times 10^{-9}$ Sv) for 1992.

**Buildings 26 and 62.** There is a single user of radionuclides in both Buildings 26 and 62. The LBL bioassay laboratory is in Building 26. Trace quantities of a variety of nuclides are used in sample spiking and standards preparation. A thorium aerosol study with mg quantities of 0.1μ 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. The EDE from Building 62 for 1992 was $5 \times 10^{-6}$ mrem ($5 \times 10^{-11}$ Sv). The EDE modeled from release estimate for Building 26 is $2 \times 10^{-6}$ mrem ($2 \times 10^{-11}$ Sv).

**Building 55, Research Medicine.** The primary radiological activities carried out in Building 55 are positron emission tomography (PET) and metabolic studies. The studies are carried out on human patients. The radiological activities take place in 2 laboratories and a PET camera room. As > 200 mCi (>$7.4 \times 10^9$ Bq) of radioiodine is worked up in the facility annually, operations with radioiodine are done in a HEPA and TEDA-doped carbon-filtered enclosure. Two radiation hoods and the radioiodine box stacks are sampled continuously. The EDE from this facility's releases was 0.0004 mrem ($4 \times 10^{-9}$ Sv) for 1992.

**Building 934** is located off site roughly 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 $^{3}H$, $^{14}C$, $^{32}P$, and $^{35}S$. Metabolism of $^{35}S$ amino acids produces $^{35}SO_2$, which is released to the atmosphere. Our studies indicate that < 0.1% of the activity incubated is available for release. No stacks are sampled at this location. The offsite EDE modeled from 934 release estimates is 1 x $10^{-4}$ mrem (1 x $10^{-9}$ Sv).

## Section II. Air Emissions Data

| Point Source | # of Stacks | Type Control | Efficiency (%) | Distance to Nearest Receptor |
|---|---|---|---|---|
| *88 Vault | 1 | None (1) | 0 | 110 m (residence) |
| *71 Vault | 1 | None (1) | 0 | 120 m (residence) |
| *51 Vault | 1 | None (1) | 0 | 410 m (residence) |
| *Building 2 | 1 | None | 0 | 370 m (school) |
| *Building 6 | 1 | None | 0 | 360 m (school) |
| Building 62 | 1 | HEPA | >99 | 240 m (workplace) |
| Building 75A Storage Box | 1 | T-DAC(3)<br>HEPA | >75<br>>99 | 150 m (school) |

| Grouped Source | # Stacks | Type Control | Efficiency (%) | Distance to Receptor |
|---|---|---|---|---|
| Building 75 National Tritium Labeling Facility | 2 | Silica gel(2) | >99 | 110 m (school) |
| Buildings 74, 74B& 83 Stacks | 14 | T-DAC(3)<br>NONE(4) | >75<br>0 | 200 m (residence) |
| Building 55 Stacks | 5 | HEPA<br>T-DAC(3) | >99<br>>75 | 170 m (residence) |
| Building 3 Stacks | 3 | NONE(4) | 0 | 60 m (workplace) |
| Buildings 70 & 70A(5) Stacks | 20 | HEPA (Manifolds)<br>NONE (Hood) | >99<br>0 | 330 m (residence) |
| *Building 934 Stacks | 9 | NONE(4) | 0 | 38 m (workplace) |
| Building 1 Stacks | 11 | NONE(4) | 0 | 10 m (same bldg.) |
| *Buildings 26 | 2 | HEPA | >99 | 240 m (workplace) |

*Not monitored, emissions estimated.

Quantities of nuclides released from LBL stacks contributing > 10% of the EDE from a release point

| Radionuclide | Annual Quantity (Ci) | (Bq) |
|---|---|---|
| H-3 | 87 | $3.2x10^{12}$ |
| C-14 | $1 \times 10^{-3}$ | $3.7x10^{7}$ |
| F-18 | 0.2 | $7.4x10^{9}$ |
| S-35 | $3 \times 10^{-4}$ | $1x10^{7}$ |
| I-125 | $2 \times 10^{-4}$ | $7.4x10^{6}$ |
| Unidentified Alpha Emitters | $<1 \times 10^{-6}$ | $<3.7x10^{4}$ |
| C-11 | 7 (E) | $2.6x10^{11}$ |
| N-13 | 8 (E) | $3x10^{11}$ |
| O-15 | 3 (E) | $1x10^{11}$ |

(E) Estimated

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1 The Radionuclides released from the accelerators are air activation products which are impractical to control. (The maximum offsite EDE from LBL accelerators in 1992 was 0.06 mrem ($5x10^{-7}$ Sv).)

2 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.

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

4 The uncontrolled releases are from LBL fume hoods which are unfiltered.

5 The stacks included in this group source vent a number of laboratories whose research employs µCi and mCi (between $3.7 \times 10^{4}$ and $3.7 \times 10^{7}$ Bq) quantities of a number of actinides. The estimated release is the sum of the product of the lower detection limit times the annual flow for each stack over the 19 stacks. $^{232}Th$ was used as a conservative dose-equivalent representative of the actinides used.

Non-Point Source

**Bldg. 75A waste processing area**

| Non-Point Source Radionuclide | Annual Quantity Released (Ci) | (Bq) |
|---|---|---|
| HTO | 0.06 | $2 \times 10^9$ |

## Section III. Dose Assessments

Description of Dose Model

COMPLY (V1.5d) was used to compute maximum offsite effective dose equivalent for all stacks and stack groups. COMPLY was chosen because it allows the user to describe the nearest neighbor in 16 sectors from release points. AIRDOS-PC and CAP88PC do not.

Summary of Input Parameters
(See Attachment II for a list by stack group.)

All nearest receptors were assumed to grow all vegetables and produce at home if a residence or at the nearest residence to the receptor if a workplace or school.

The nearest farm where milk and meat is produced is >2000 meters from any "maximum offsite receptor." The meteorology used with COMPLY was reformatted data from the AIRDOS PC OAK 0319.wnd file, as onsite meteorology was not available. LBL completed a preliminary study of meteorological monitoring, siting, equipment, and quality assurance requirements during 1991. Equipment will be in place, and collecting data, on or before December of 1993

Compliance Assessment

Effective Dose Equivalent: 0.06 mrem (6 x $10^{-7}$ Sv) to an offsite individual in a residence 110 meters west of LBL Building 88. This exposure represents the sum of impacts from Building 88, Building 51, and Building 70 and 70A modeled to that location.

## Section IV. Additional Information

Additions or Modifications

The Advanced Light Source (ALS) came on line in 1992. The ALS is a small source requiring neither permitting nor monitoring. 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 88" 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 ($3 \times 10^9$ Bq) and 0.006 Ci ($2 \times 10^8$ Bq) respectively. The offsite dose to the maximally exposed individual would be $4 \times 10^{-4}$ mrem ($4 \times 10^{-9}$ Sv) when the ALS has been fully operational for a year (1994).

Unplanned Releases

There were no unplanned airborne releases to the atmosphere from LBL during 1992.

Diffuse Emissions

Fugitive emissions from stored tritium waste are estimate at < 0.06 Ci ($2.2 \times 10^9$ Bq). The maximum effective dose equivalent (EDE) to a member of the public from such releases would be $< 2 \times 10^{-6}$ mrem ($<2\times10^{-11}$ Sv). 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 EDE estimate from the releases was determined by comparison with the National Tritium Labeling Facility (NTLF) stack releases and the concomitant offsite EDE.

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 V. Supplemental Information

*Provide an estimate of collective effective dose equivalent (person-rem/yr.) for 1992 releases.*

The estimated collective effective dose equivalent (CEDE) to persons living within 80 km of LBL is 1 man-rem ($10^{-2}$ person-Sv) attributable to 1992 LBL airborne releases.

*Provide information on the status of compliance with Subparts Q and T of 40 CFR Part 61 if applicable.*

*Although exempt form 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, $^{226}$Ra, $^{232}$U, or $^{232}$Th, 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 6 points subject to the continuous monitoring requirements of 40 CFR subpart H, Section 61.93(b). During 1992 only 1 of the 6 points produced discharges and was continuously monitored (sampled). The single point monitored was the NTLF main stack whose EDE was modeled at 0.02 mrem (2 x $10^{-7}$ Sv). The monitoring and analytical methods conform to Section 61.93(b) requirements; the monitoring methods of the other 5 points do not conform to the standard. 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 1991. The cost to upgrade all monitoring systems to satisfy 40 CFR 61 subpart H requirements is approximately \$1.2 x $10^6$ (funding approved).

LBL presented Region IX a proposal for a graded approach to periodic confirmed monitoring. The proposal separates stacks into four categories graded by EDE. As a minimum LBL will carry out the following:

1. For sources whose EDE is <0.001 mrem ($10^{-8}$ Sv), LBL will verify that established annual use limits are not exceeded.
2. For stacks with 0.001 EDE < 0.01 (>$10^{-8}$ Sv but <$10^{-7}$ Sv), LBL will sample during a typical two week work cycle annually.
3. For stacks with 0.01 ≤ EDE < 0.05 (≤$10^{-8}$ Sv but <5 x $10^{-7}$ Sv), LBL will sample continuously and change and analyze samples monthly.*
4. For stacks 0.05 ≤ EDE < 0.1 (≤5 x $10^{-7}$ Sv but <$10^{-6}$ Sv) LBL will sample continuously and change and analyze samples weekly.

* For species with T 1/2 < 100 hours, a continuous emission monitor will be employed.

At LBL the only parent species nuclides routinely used or produced during 1992 whose T 1/2 were < 100 hours were accelerator-produced air activation products, $^{18}F$, $^{123}I$ and $^{99m}Tc$. (Any future programs employing short-lived nuclides will be evaluated on a case-by-case basis.)

Under its Tiger Team action plan, LBL is upgrading all monitoring and analytical QA. The program will meet or exceed all provisions contained in Appendix B method 114.

*Estimate release levels (Curies) from unmonitored sources and describe the methods used in the assessment. Determine the EDE to the public form each source.*

The total release to the atmosphere from unmonitored sources from LBL is estimated at 17 Ci (6.3 x $10^{11}$ Bq) of produced air activation products and 0.2 Ci (7.4 x $10^9$ Bq) of nuclides released from laboratory stacks (T1/2 ≤ 1.8 hr). The air activation product release values are based on air activation modeling (See the descriptions of Bldgs. 51, 71, and 88 discharges in the sources and emissions data section of this report). The laboratory stack releases from small unmonitored sources are computed from quantities used multiplied by typical release fractions (based on LBL measurements and NRC literature values). The $^{18}F$ releases (assumed to be 2% of the fluorine used) are based on an article by Keck et. al. "Assessment of $^{18}F$ gaseous releases during the production of $^{18}$Fluorodeoxyglucose", Health Physics **60**, 657-660 (1991). $^{123}I$ releases are assumed to mimic the measured releases of $^{125}I$

LBL DRAFT 1992 NESHAPS REPORT - ATTACHMENT II 05-May-93

LBL NESHAPS REPORT "COMPLY" INPUT PARAMETER AND MODELED DOSE INFORMATION - 1992

| Source (LBL Facility or Bldg) | Number of Stacks grouped | Control (s) | Efficiency (%) | Nuclides | Release (Ci) | Receptor | Distances - (M) To Receptor | To Produce | To Meat and Milk | Stack Height (M) | Bldg. Height (M) | Bldg. Width (M) | Bldg. Length (M) | Effective Dose Equivalent (EDE) (mrem) | (Sv) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 75 NTLF | 2 | Silica Gel | >99(1) | H-3 (HTO) | 87 | School | 110 | 500 | 2000 | 10 | 0 | 1 | 1 | 2 X 10-2 | 2 x 10-7 |
| 88 VAULT | 1 | NONE | 0 | C-11 | 0.6(E) | Residence | 110 | NA | NA | 12 | 10 | 85 | 40 | 2 X 10-2 (4) | 2 x 10-7 (4) |
| | | | | N-13 | 0.9 (E) | | | | | | | | | | |
| | | | | 0-15 | 0.5(E) | | | | | | | | | | |
| | | | | AR-41 | 0.02 (E) | | | | | | | | | | |
| 75A STORAGE BOX | 2 | T-DAC (2) | >75% | I-125 | 6 x 10-5 | Workplace | 150 | 500 | 2000 | 8 | 6 | 24 | 17 | 8 x 10-5 | 8 x 10-10 |
| | | HEPA | >99% | | | | | | | | | | | | |
| 75A DIFFUSE DISCHARGES | NA | NONE | NA | H-3 as HTO | 6 x 10-2 | workplace | 150 | 500 | 2000 | | | | | 2 x 10-6 | 2 x 10-11 |
| 74,74B & 83 STACKS | 5 | T-DAC(2) | >75% | I-125 | 5 x 10-5 | Residence | 200 | 200 | 2000 | 7 | 5 | 60 | 40 | 8 x 10-4 | 8 x 10-9 |
| | | NONE | | S-35 | 2 x 10-4 | | | | | | | | | | |
| | | | | F-18 | 2 x 10-1(E) | | | | | | | | | | |
| BLDG 55 STACKS | 3 | HEPA | >99% | I-125 | 1 x 10-4 | Residence | 170 | 170 | 2500 | 9 | 7 | 60 | 30 | 4 x 10-4 | 4 x 10-9 |
| | | T-DAC(2) | >75% | I-123 | 1 X 10-4(E) | | | | | | | | | | |
| BLDG 3 STACKS | 5 | NONE | | C-14 AS CO2 | 1 x 10-3 | Workplace | 60 | 270 | 2000 | 15 | 14 | 33 | (round) | 3 x 10-3 | 3 x 10-8 |
| | | | | S-35 | 6 x 10-6 | | | | | | | | | | |
| BLDG 70 & 70A STACKS | 20 | HEPA (MANIFOLDS) | >99% | "TH-232" (3) | <1 x 10-6 | Residence | 330 | 330 | 2500 | 13 | 11 | 100 | 75 | <4 x 10-3 (4) | <4 x 10-8 (4) |
| BLDG 62 | 1 | HEPA | >99% | TH-232 | ≤2 x 10-9 | Workplace | 240 | 400 | 2000 | 13 | 11 | | | 5 x 10-7 | 5 x 10-12 |
| BLDG 26 STACKS | 2 | HEPA | >99% | S-35 | 3 x 10-5 | School | 240 | 550 | 2500 | 8 | 8 | 18 | 30 | 2 x 10-5 | 2 x 10-10 |
| | | NONE | | | | | | | | | | | | | |
| 51 VAULT | BV | NONE | 0 | C-11 | 6 (E) | Residence | 360 | NA | NA | 15 | 15 | 100 | (round) | 4 x 10-2 (4) | 4 x 10-7 (4) |
| | | | | N-13 | 7 (E) | | | | | | | | | | |
| | | | | 0-15 | 2 (E) | | | | | | | | | | |
| | | | | AR-41 | 0.07 (E) | | | | | | | | | | |
| 71 VAULT | BV | NONE | 0 | AS ABOVE | <10-3 (E) | Residence | 150 | NA | NA | 10 | 10 | 130 | 30 | 3 x 10-6 | 3 x 10-11 |
| 934 | 9 | NONE | 0 | S-35 | 1 x 10-4 | Business | 38 | 400 | 5600 | 4 | 4 | 70 | 70 | 1 x 10-4 | 1 x 10-9 |
| 1 STACKS | 11 | NONE | 0 | S-35 | 9 x 10-6 | School | 10 | 400 | 3000 | 9 | 9 | 55 | 40 | 9 x 10-4 | 9 x 10-9 |
| 2 VENT | 1 | NONE | 0 | Co-60 | 3 x 10-4 (E) | School | 370 | 540 | 2500 | 20 | 18 | 16 | 53 | 2 x 10-11 | 2 x 10-16 |
| 6 (Adv. Light Source) | BV | NONE | 0 | N-13/O-15 | | School | 360 | NA | NA | 19 | 11 | 100 | 100 | <4 x 10-4 | <4 x 10-9 |

(1) Silica Gel traps are >99% efficient traps for HTO as long as they are changed before breakthrough.
NTLF Personnel routinely change traps when working in the facility.

(2) TEDA-doped activated carbon traps.

(3) The "Th-232" value is the "effective" release from all 20 stacks in the listed group assuming continuous release at the lower limit of detection.

(4) The maximum EDE is 0.06 mrem to a resident 110m west of Building 88. Buildings 51, 88, and 70/70A contribute to the exposure.

(BV) Building Vents.

(E) Estimated.

A Sievert (Sv) is equivalent to 1 x 10 5 rem

# Appendix B
# Acronyms and Other Initialisms

| | |
|---|---|
| ADS | activity data sheet |
| AHERA | Asbestos Hazard Emergency Response Act |
| AIP | Agreement in Principle |
| ALARA | as low as reasonably achieveable |
| ALS | Advanced Light Source |
| BAAQMD | Bay Area Air Quality Management District |
| CAA | Clean Air Act |
| Cal/EPA | California Environmental Protection Agency |
| CARB | California Air Resources Board |
| CCF | 100 cubic feet |
| CCR | California Code of Regulations |
| CDRL | Chemical Dynamics Research Laboratory |
| CEDE | collective effective dose equivalent |
| CEQ | Council on Environmental Quality |
| CEQA | California Environmental Quality Act |
| CERCLA | Comprehensive Environmental Response, Compensation and Liability Act |
| CFR | Code of Federal Regulations |
| CWA | Clean Water Act |
| CX | Categorical Exemption |
| CY | calendar year |
| D&D | decommissioning and decontamination |
| DCA | dichloroethane |
| DCE | dichloroethylene |
| DCG | derived concentration guide |
| DHS | California Department of Health Services |
| DOE | U.S. Department of Energy |
| DOE/SF | DOE's San Francisco Operations Office (actually located in Oakland) |
| DTSC | Department of Toxic Substances Control (part of Cal/EPA) |
| EA | Environmental Assessment |
| EBMUD | East Bay Municipal Utility District |

| | |
|---|---|
| EDE | effective dose equivalent |
| EH&S | Environment, Health and Safety Division (at LBL) |
| EIR | Environmental Impact Report |
| EIS | Environmental Impact Statement |
| EMIH | Environmental Monitoring and Industrial Health |
| EML | Environmental Measurements Laboratory |
| EMS | Environmental Monitoring Station |
| EPCRA | Emergency Planning and Community Right to Know |
| ERDA | U.S. Energy Research and Development Agency |
| ESA | Endangered Species Act |
| FFCA | Federal Facilities Compliance Agreement |
| FIFRA | Federal Insecticide, Fungicide and Rodenticide Act |
| FY | fiscal year |
| GAC | granulated activated carbon |
| gsf | gross square feet |
| gsm | gross square meters |
| HEPA | high-efficiency particulate air (filter) |
| HILAC | High-Energy Linear Accelerator |
| HMBS | Hazardous Materials Bulk Storage |
| HSAA | Hazardous Substances Account Act |
| HTO | tritiated water |
| HWCL | Hazardous Waste Control Laws (State of California) |
| HWHF | Hazardous Waste Handling Facility (at LBL) |
| ILSE | Induction LINAC Systems Experiment |
| IRFEL | infrared free-electron laser |
| LBCF | Low-Background Counting Facility |
| LBL | Lawrence Berkeley Laboratory |
| LHS | Lawrence Hall of Science |
| LINAC | linear accelerator |
| LLW | low-level (radioactive) waste |
| MCL | (drinking water) maximum contaminant level |
| Mgsf | million gross square feet |

| | |
|---|---|
| MS | monitoring station |
| MSDS | material safety data sheet |
| MSRI | UC Mathematical Sciences Research Institute |
| NAE | North American Environmental, Inc. |
| NBTF | National Biomedical Tracer Facility |
| MW | monitoring well |
| NCRP | National Commission on Radiation Protection and Measurements |
| NEPA | National Environmental Protection 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 |
| NOV | Notice of Violation |
| NPDES | National Pollutant Discharge Elimination System |
| NPL | National Priorities List |
| nsf | net square feet |
| nsm | net square meters |
| NTLF | National Tritium Labeling Facility |
| OAP | Operating and Assurance Program (at LBL) |
| OR | Occurrence Report |
| PA/SI | preliminary assessment/site inspection |
| PBR | Permit-by-Rule |
| PCB | polychlorinated biphenyls |
| PCE | perchloroethylene |
| POTW | Public Owned Treatment Works |
| PPA | Pollution Prevention Act |
| RCRA | Resource Conservation and Recovery Act |
| RFA | RCRA Facility Assessment |
| RFI | RCRA Facility Inspection |
| RMPP | Risk Management and Prevention Program |
| RMW | radioactive mixed waste |

| | |
|---|---|
| ROV | Report of Violation |
| RPG | radiation protection guidelines |
| RWQCB | Regional Water Quality Control Board |
| S&H | safety and health |
| SARA | Superfund Amendments and Reauthorization Act |
| SDWA | Safe Drinking Water Act |
| SEIR | Supplemental Environmental Impact Report |
| SIC | Standard Industrial Classification |
| SIP | State Implementation Plan |
| SPCC | Spill Prevention, Control, and Countermeasure Plan |
| SWMP | Storm Water Monitoring Program |
| SWPPP | Storm Water Pollution Prevention Act |
| SWRCB | State Water Resources Control Board |
| TCA | trichloroethane |
| TCE | trichloroethylene |
| TEDA | tetraethylene diamine |
| 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 |
| TSCA | Toxic Substances Control Act |
| TSS | total suspended solids |
| TTFR | Tiger Team Follow-up Review |
| UC | University of California |
| UCB | University of California at Berkeley |
| UST | underground storage tanks |
| US/EPA | U.S. Environmental Protection Agency |
| VSI | Visual Site Inspection |
| VOC | volatile organic compounds |

# Appendix C
# Distribution List

*Internal:*

| | |
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| R. Fleischman | 1 |
| C.B. Harris | 1 |
| I. Javendel | 1 |
| S.-H Kim | 1 |
| M. Kotowski | 1 |
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UC-407 distribution 46

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